Certification Training for Operators of Animal Waste Management Systems: Type A

This publication has been prepared in cooperation with the North Carolina Department of Environmental Quality in compliance with a legislative mandate of the North Carolina General Assembly and in cooperation with the Department of Crop and Soil Sciences at NC State University, NC State Extension, the Natural Resources Conservation Service, the North Carolina Department of Agriculture and Consumer Services, and the North Carolina Farm Bureau Federation.

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go.ncsu.edu/animal-spill-press-release

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Attached

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Attached

North Carolina Guidance for Composting of Mass Animal Mortality (October 2016)
Attached

Common Abbreviations

ac = acre(s)

ac-in. = acre-inch

BMP = best management practices

CAWMP = Certified Animal Waste Management Plan

cc = cubic centimeters

CEC = cation exchange capacity

Cu = copper

ft = feet or foot

sq ft = square feet or sq ft

cu ft = cubic feet or cu ft

gal = gallon(s)

gpm = gallons per minute

G.S. = General Statutes

hr = hour(s)

in. = inch(es)

in./hr = inches per hour

lb = pound(s)

lb/1,000 gal = pounds per thousand gallons

lb/ac = pounds per acre

meq = milliequivalents

min = minute(s)

mph = miles per hour

N = nitrogen

NPDES = National Pollutant Discharge Elimination System

OIC = Operator in Charge

P = phosphorus

PAN = plant-available nitrogen

PLAT = Phosphorus Loss Assessment Tool

psi = pounds per square inch

WUP = Waste Utilization Plan

Zn = zinc

Agency Abbreviations

DAQ = Division of Air Quality

DEQ = Department of Environmental Quality

DSWC = Division of Soil and Water Conservation

DWR = Division of Water Resources

EPA = Environmental Protection Agency

NCDA&CS = North Carolina Department of Agriculture and Consumer Services

NCSU = North Carolina State University

USDA-NRCS = U.S. Department of Agriculture- Natural Resources Conservation Service

WPCSOCC = Water Pollution Control System Operators Certification Commission

USGS = United States Geological Survey

Conversion Factors

1 acre-inch = 27,154 gallons

1 acre = 43,560 square feet

lane spacing for traveling gun = 70% to 80% of wetted diameter

lane spacing for stationary gun = 50% to 65% of wetted diameter

Important formulas—Type A

1. Precipitation (application) rate for stationary equipment, inches per hour

$$\text{Precipitation rate (in/hr)} = \frac{96.3 \times \text{sprinkler flow rate (gpm)}}{\text{sprinkler spacing (ft)} \times \text{lateral spacing (ft)}}$$

2. Time of irrigation system operation for stationary systems (hours)

$$\text{Time of operation (hr)} = \frac{\text{application volume (in)}}{\text{precipitation (application) rate (in/hr)}}$$

3. Application volume (depth) for traveling gun (inches)

$$\text{Application volume (in)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{travel speed (in/min)}}$$

4. Travel speed for traveling gun; inches per minute

$$\text{Travel speed (in/min)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{application volume (in)}}$$

5. Coverage area for application (manure spreaders and honeywagons)

$$\text{Coverage area (acres)} = \frac{\text{length (ft)} \times \text{width (ft)}}{43{,}560 \text{ sq ft/acre}}$$

6. Application rate for spreader

$$\text{Application rate for spreader (gal/acre)} = \frac{\text{spreader load volume (gal)}}{\text{coverage area (acres)}}$$

7. Determination of spreader capacity

$$\text{Spreader load (tons)} = \frac{\text{weight of 5 gal manure} \times 1.5 \times \text{spreader capacity (cu ft)}}{2{,}000}$$

Formulas That Are Part of Waste Application Record Forms

A. Volume per acre (gallons per acre) for irrigation systems

$$\text{Volume per acre (gal/ac)} = \frac{\text{Number of sprinklers operating} \times \text{flow rate per sprinkler (gpm) x run time (min)}}{\text{Acres irrigated (ac)}}$$

B. Volume per acre (gallons per acre) for pump and haul systems

$$\text{Volume per acre (gal/ac)} = \frac{\text{Number of loads} \times \text{volume per load (gal)}}{\text{Acres covered (ac)}}$$

C. Volume per acre (tons per acre) for solid manure spreader systems

$$\text{Volume per acre (tons/ac)} = \frac{\text{Number of loads} \times \text{weight per load (tons)}}{\text{Acres covered (ac)}}$$

D. Pounds of plant available nitrogen (PAN) applied per acre (lb PAN/ac) for liquid wastes

$$\text{Pounds PAN/acre (lb PAN/ac)} = \frac{\text{Waste analysis PAN (lb/1000 gal)} \times \text{volume per acre applied (gal/ac)}}{\text{1,000 gal}}$$

E. Pounds of plant available nitrogen (PAN) applied per acre (lb PAN/ac) for solid wastes

$$\text{Pounds PAN/acre (lb PAN/ac)} = \text{Waste analysis PAN (lb/ton)} \times \text{weight per acre applied (tons/ac)}$$

Other Helpful Formulas

Area of a rectangle	*Area of rectangle (sq ft) = length (ft) × width (ft)*
Area of a circle	*Area of circle (sq ft) = 3.14 × (circle radius)^2*

Purpose

A proper waste management plan and waste application system are vital parts of a modern confined animal operation. If the waste from your animal operation is not properly managed, it can have many negative impacts on your overall farming operation as well as your community. The negative consequences of a poorly managed waste application system can cost in terms of dollars, loss of land values, impaired environmental quality, and loss of good standing in the community.

The North Carolina General Assembly passed legislation in 1995 and 1996 requiring certification of operators of animal waste management systems. The law requires a certified operator for animal waste management systems that serve over 250 swine, 100 confined cattle, 75 horses, 1000 sheep, or 30,000 poultry with a liquid animal waste management system. To become a certified operator, one must complete an approved training course on the operation of animal waste management systems, pass an appropriate examination, and pay the required fees. This training program is designed to provide operators of animal waste management systems the basic understanding needed to operate and maintain these systems in an efficient and environmentally sound manner. This manual is not intended to provide all of the technical details for the complete design of a waste management system or an approved animal waste management plan. There are many good reference materials that have been published on these subjects that can provide more detailed information if desired. Many of those materials will be referenced to in this manual for basic information. You are encouraged to make use of all appropriate materials in the operation of your animal waste management system.

Acknowledgments

This program is administered by the Water Pollution Control System Operators Certification Commission in conjunction with the North Carolina Department of Environmental Quality and with North Carolina Cooperative Extension.

This manual is a combination of guidance and reference materials gathered from various sources in conjunction with input and expertise from individuals with the following organizations:

- Carolina-Virginia Milk Producers Association
- Individual and Corporate Swine, Poultry, Dairy, and Egg Producers
- Natural Resources Conservation Service
- North Carolina Cooperative Extension Service
- North Carolina Dairy Producers Association
- North Carolina Department of Agriculture
- North Carolina Department of Environment and Natural Resources
- North Carolina Egg Association
- North Carolina Farm Bureau Federation
- North Carolina Pork Producers Association
- North Carolina Poultry Federation
- NC State Extension
- Water Pollution Control System Operators Certification Commission

Notes About This Manual

This manual has been written based on the current laws, rules, and technical guidance available at the time. It is possible, indeed likely, that there will be changes in the laws and technical guidance that apply to animal waste management. You should keep yourself aware of these changes. The organizations and government agencies that are involved in animal waste management will make efforts to inform the individuals who own and operate animal waste management systems of these changes as they occur. However, you are ultimately responsible to ensure that you are operating in compliance with current laws and rules. If you have questions, you should contact the appropriate resource people listed in Appendix D for questions concerning these changes.

Pursuant to G.S. 150B-21.3A, "Periodic Review and Expiration of Existing Rules," the NC Soil and Water Conservation Commission is in the readoption process for the following rules. Approved changes of these rules may impact guidance currently provided within this manual.

02 NCAC 59E Procedures and Guidelines to Implement the Nondischarge Rule for Animal Waste Management Systems
02 NCAC 59G Approval of Technical Specialist and BMPs for Water Quality Protection

How to Use This Manual

This manual is designed for individuals involved in animal production and the waste management systems that are associated with these operations. Therefore, it is assumed that the reader is at least generally familiar with the components of a waste management system and other basic farming practices.

There are two types of certification for animal waste management system operators: titled Type A and Type B. Type A is for systems that handle liquid, low fiber wastes (such as swine) and Type B is for systems that have high fiber wastes (such as cattle). A separate manual has been developed for each classification of operator. Your instructor will provide the appropriate manual for your training. Upon completion of the training and passing the appropriate examination, you will be eligible for the particular certification type for your interest. In order to be able to operate both types of systems, you must complete each class and pass each appropriate examination.

The following section is the Needs-To-Know document. It lists the abilities and skills that you, as an operator of an animal waste management system, should have in order to properly manage the waste management system on your farm.

As you proceed through each chapter, you will be alerted with an italicized note in the outside margin when you enter a section that gives you the information needed to answer a Needs-To-Know item.

At the completion of each chapter there will be review questions. These are used to emphasize important points and to generate discussion among the course participants. Your instructor may use these questions to review the material presented and to prepare you for the examination.

The focus of the training will be on the nine chapters presented. These chapters explain waste system components, waste utilization plans, proper waste application, regulations, record keeping, safety and emergency action plans, and consequences of improper management.

Following these chapters are several appendices, which provide information that is relevant and important to your operation, including forms and information sheets on how to perform certain required tasks.

Certification Process

To become certified to operate a Type A or Type B animal waste management system, you must first successfully complete the approved training program. Second, you must submit an application to the Water Pollution Control System Operators Certification Commission with the appropriate fee attached. Third, you must pass an examination administered by the Water Pollution Control System Operators Certification Commission with a score of 70 percent.

For more information on the certification process and duties of the owner and operator in charge, see Chapter 2. The examination dates and locations will be announced during the training programs.

Technical Assistance

This manual provides thorough explanations and calculations that will allow you to operate an animal waste management system under normal circumstances. However, there is a tremendous amount of technical assistance available for the planning, design, operation, and reporting that are all involved with animal waste management. This manual references those sources of technical assistance, and you are encouraged to utilize these resources.

The manual will also refer to an individual called a "technical specialist." A technical specialist has expertise in one or more components of waste management and is certified as such by the North Carolina Division of Soil and Water Conservation. A technical specialist is the only individual who may legally sign the form that completes an approved animal waste management plan. To develop a waste management plan or have one modified, you must have approval from a technical specialist. Not all individuals referenced in Appendix D are technical specialists, but they are still available to offer guidance in waste management issues.

Needs to Know

Chapter 1: Why Are We Here?—Type A

1A-1 Explain the reasons for and which farms require certified operators for animal waste management systems.

1A-1 Define surface water, groundwater, and hydrologic cycle.

1A-2 Describe what an aquifer is and how groundwater flows.

1A-3 Give examples of point source and nonpoint source pollution.

1A-4 Define the eutrophication process and problems it causes in surface waters.

1A-6 Explain why animal waste is a resource.

1A-6 List several nonproducer concerns (such as community and environmental) of livestock, egg, and milk production.

Chapter 2: Regulations Governing Animal Waste Management Systems—Type A

2A-1 Describe the rules and laws that apply to animal waste management.

2A-2 List the threshold number of animals that require an operation to have an animal waste management permit.

2A-3 Explain what a waste system permit is and describe its general conditions.

2A-3 Define "discharge" of animal waste.

2A-4 Define a 25-year, 24-hour storm.

2A-7 Describe the violations that require mandatory reporting by the owner.

2A-8 Describe the various types of regulatory action that can result from mismanagement.

2A-10 Define Operator in Charge and identify whose responsibility it is to designate an Operator in Charge for an animal operation.

2A-10 Know which commission is responsible for animal waste management system operator certification.

2A-11 Describe the necessary steps required to renew your animal waste management system operator certification.

2A-12 Describe the duties and requirements of an Operator in Charge of an animal waste management system.

2A-12 Describe what enforcement actions can be taken against an operator by the WPCSOCC.

Chapter 3: Components of a Certified Animal Waste Management Plan

3A-1 Explain the difference between a waste management plan and a general permit.

3A-2 Describe the primary goal of the waste utilization plan.

3A-3 List the components in a waste utilization plan.

3A-3 Understand how the amount of animal waste produced on a farm annually is calculated.

3A-6 Define agronomic rate.

3A-6 Describe the role of vegetation in waste management.

3A-6 List factors to consider in crop selection.

3A-7 Define realistic yield expectation (RYE).

3A-8 Describe why timing of waste applications is important.

3A-9 List ways in which best management practices protect water quality.

3A-9 Describe the importance of BMP maintenance and describe what to do if a BMP fails.

3A-12 Describe which facilities must perform a phosphorus loss assessment.

Chapter 4: Tools for the Plan—Type A

- 4A-1 Describe why the proper collection of waste samples is important.
- 4A-1 Explain how often waste samples must be taken.
- 4A-1 Describe how to take a waste sample of a lagoon, waste slurry, or dry waste and submit it for nutrient analysis.
- 4A-5 Describe information available on a Waste Analysis Report.
- 4A-6 Interpret the waste analysis report and know if lab results are reasonable.
- 4A-9 Describe how to take a soil sample and submit for analysis.
- 4A-10 Describe information available on a Soil Test Report.
- 4A-13 Describe how soil test information can help select a site and determine the sustainability of long-term waste applications.
- 4A-16 Describe the role of plant tissue and forage analysis in managing and monitoring crop and forage quality.

Chapter 5: System Components and Operation—Type A

- 5A-1 Describe the purpose and components of a Type A animal waste management system.
- 5A-1 Describe the function of an animal waste lagoon.
- 5A-2 Describe the six specific volumes for an anaerobic lagoon.
- 5A-2 Explain the need for and use of a liquid level gauging device.
- 5A-3 Explain the need for proper pipe design, and installation.
- 5A-7 Define wettable acres.
- 5A-8 Describe possible causes of lagoon failure.
- 5A-9 Explain the proper operation of an animal waste lagoon.
- 5A-10 Explain why water reuse is important.
- 5A-10 Describe the purpose of surface water diversions.
- 5A-11 Describe proper lagoon and dam maintenance.
- 5A-12 Describe the proper operation and maintenance of pumps and pipes.
- 5A-13 Explain methods to minimize crystal buildup in recycle pipes.
- 5A-14 Explain how to monitor lagoon sludge levels and develop a sludge Plan of Action.
- 5A-14 Describe the proper methods of sludge removal.
- 5A-16 Describe some methods that could be used to enhance waste treatment.

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- 6A-3 List the four factors that must be addressed before irrigating animal waste.
- 6A-7 Explain how to determine how much water to irrigate.
- 6A-7 Explain how/why irrigation amounts need to be adjusted seasonally.
- 6A-7 Define discharge rate, precipitation rate, and application volume.
- 6A-7 Explain how to obtain sprinkler discharge rates.
- 6A-8 Explain what effect changing nozzle diameter can have on discharge rate and wetted diameter.

6A-10 Explain the importance of sprinkler overlap.

6A-10 Compute the precipitation rate for a stationary sprinkler irrigation system.

6A-11 Compute the application volume for a stationary sprinkler irrigation system.

6A-11 Determine the operational time necessary to apply a desired application volume and associated nitrogen application amount.

6A-12 Determine application volume and effective coverage from manufacturer's literature for a traveling gun sprinkler.

6A-13 Compute the required travel speed for a traveling gun sprinkler to apply the desired application volume.

6A-13 Explain the effects of changing pressure on droplet size, drift, precipitation rate, and wetted sprinkler diameter.

6A-14 Describe the procedures for field calibration of waste application equipment and why it is important.

Chapter 7: Record Keeping—Type A

7A-1 Describe the importance of records maintenance.

7A-1 Describe what records need to be maintained to show compliance with environmental regulations.

7A-1 Describe proper record keeping procedures and maintenance.

7A-3 Calculate and verify application rates through the use of waste application records.

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8A-2 Describe the health effects of gases associated with livestock buildings and manure storage.

8A-4 Explain the safety precautions for manure storage.

8A-4 Describe several safety precautions that apply to vehicle operation, heavy equipment, PTOs, and hydraulic systems.

8A-6 Describe the lockout/tagout procedure of electrical safety.

8A-8 Give examples of personal protective equipment.

8A-9 Describe the correct way to lift and carry objects.

8A-10 Describe the responsibilities of the site supervisor.

8A-10 List the items that a safety program should include.

8A-10 List the topics that first aid training should include.

8A-11 Describe the responsibilities of the owner or employer.

8A-11 Describe the responsibilities of the employee.

8A-12 Define permit-required confined space entry.

8A-12 Describe the safety actions that must be taken when working in a space that does not require a confined space permit.

8A-12 Describe the components of a basic fire emergency plan.

Chapter 9: Emergencies and Catastrophes—Type A

9A-3 Describe the course of action that should be pursued should an emergency situation develop.

9A-3 Describe the main components of an emergency action plan and why each is necessary.

9A-4 List what information should be gathered when assessing the impact of a waste discharge.

9A-4 Explain who to contact and when should problems develop with the waste management system.

9A-5 Describe where the emergency action plan should be located and who should be aware of it.

9A-6 Describe the violations that require mandatory reporting by government agencies.

9A-7 Which agency is responsible for laws and regulations relating to animal mortality?

Chapter 1: Why Are We Here?—Type A

A key component of a modern animal operation is its waste management system. Land application of animal waste is currently the most viable alternative for its treatment and disposal, although many methods of treatment and disposal either have been or are under investigation.

Land application involves spraying or spreading animal waste on the land surface. Natural physical, chemical, and biological processes treat the waste as it moves into and through the soil, while crops remove nutrients and water.

When properly operated and managed, land application allows safe disposal of animal wastes and beneficial use of the nutrients and water by crops. Sound animal waste management practices reduce risks to human health and the environment, while ensuring that farmers and producers gain the maximum fertilizer value from the byproducts of their animal operations.

Explain the reasons for and which farms require certified operators for animal waste management systems.

Improperly operated and managed animal waste management systems, however, pose a serious threat to public health and natural resources. Seeking to safeguard human health and the environment, the North Carolina General Assembly passed legislation in 1996 to help prevent spills and accidental discharges due to either poor management or weather related events. Further, the North Carolina General Assembly passed legislation in 1995 and 1996 that established a permitting program for animal waste management systems and a certification program for operators of animal waste management systems. This legislation requires the presence of a certified animal waste management system operator for any animal operation in the state with a liquid waste management system that serves more than 250 swine, 100 confined cattle, 75 horses, 1,000 sheep, or 30,000 poultry.

Most likely, you have enrolled in this training program because you want or need to become a certified animal waste management system operator. This course of study is intended to provide you with the information you need to become certified. You will learn to operate and manage an animal waste management system in an efficient, environmentally sound manner, without negative impacts on water quality, soils and crops, and grazing animals or other consumers of the crops, and with minimal impacts to your neighbors.

Our Water Resources

Define surface water, groundwater, and hydrologic cycle.

Water is one of our most essential natural resources. When it occurs on the land as streams, rivers, or lakes, it is called surface water, whereas water under the surface of the land is called groundwater.

Surface water is essential for many of our most important activities, including drinking, irrigation, industry, production of electricity, transportation, and recreation. It provides habitat for plants and animals, and it recharges (replenishes) groundwater supplies.

Groundwater is equally important. Ninety percent of rural residents and 50 percent of the total population of the United States depend on groundwater for drinking water. In its natural state, groundwater is usually of excellent quality and can be used without costly treatment or purification. Wells can often be drilled near the point of use, saving the cost of transporting water over long distances. In many areas, groundwater may be the only source of drinking water available.

Surface water and groundwater are part of the **hydrologic cycle** (Figure 1-1), which is the continuous movement of water in the atmosphere, on the ground's surface, and under the ground. Water falling from the sky as precipitation either evaporates, soaks into the soil, or travels over the soil surface.

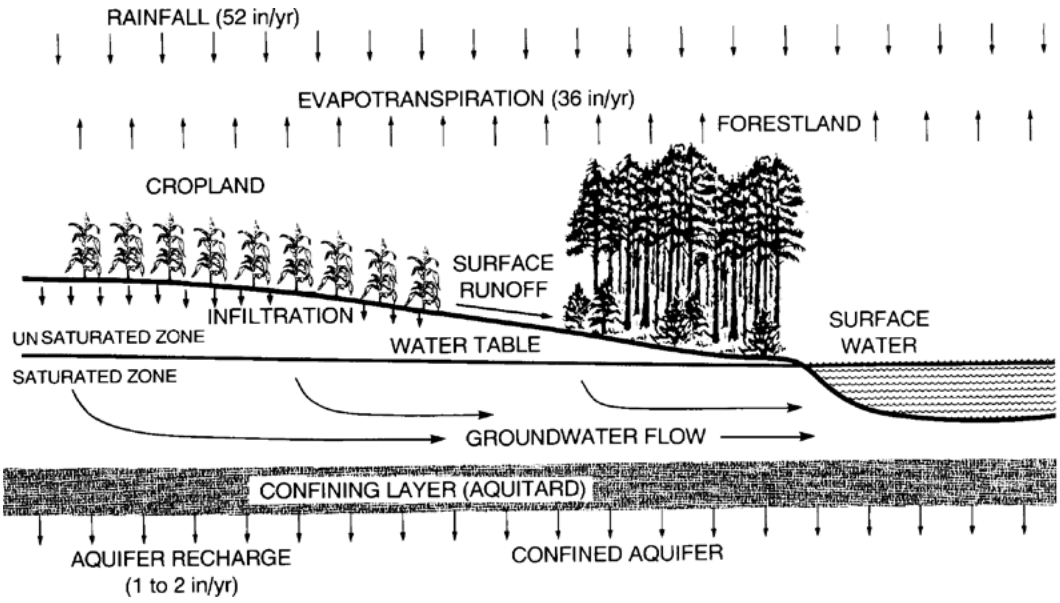

Figure 1-1. The hydrologic cycle.

When humidity is low, precipitation may evaporate before it reaches the ground. More important, water evaporates from the soil surface and from leaf surfaces. Evaporation at leaf surfaces occurs as plants draw water and nutrients from the soil into their roots, up their stems, and into their leaves. This process of water moving upward, through, and out of a plant is called **transpiration**. The combined loss of water to the atmosphere by evaporation from the soil surface and by transpiration is called **evapotranspiration**.

Describe what an aquifer is and how groundwater flows.

Precipitation soaks into the soil by a process known as **infiltration** and then **percolates** downward *into* the soil or rock surface. Some water remains close within the rooting zone, and it can be used by plants. In our humid environment, water often moves past the root zone into soil, where it moves horizontally until it emerges into streams, rivers, or lakes and becomes surface water. Some water moves even deeper into aquifers. Some aquifers are soil materials often separated from the soil above by an **aquitard** (really clayey soil) or is made of rock or **saprolite** (rock that is becoming soil). Unlike surface water that flows several feet per second, groundwater in aquifers moves very slowly, maybe only a few feet per month or even per year.

Runoff is precipitation that doesn't evaporate or soak into the soil; instead, it travels over the soil surface until it reaches surface water. Runoff often carries suspended soil particles and dissolved nutrients. This movement of soil is called soil erosion. Conditions such as slope, soil texture, cover crop condition, and soil moisture will affect whether rainfall (or applied wastewater) will soak into the soil or run off.

Effects of Animal Waste on Water Quality

The use of our water resources can produce pollution. Some of these uses produce pollution that comes from a single identifiable source, such as a pipe through which factories or treatment plants discharge treated wastewater into surface water. This is called **point source pollution**. All activities that produce point source pollution require permits.

Give examples of point source and nonpoint source pollution.

Other activities result in the release of pollutants from many diffuse or spread out locations. This type of pollution, called **nonpoint source pollution**, is more difficult to trace to its point of origin because it takes place over a broad area. Activities that produce nonpoint source pollution include highways, residential and urban development, forestry, agriculture, and animal operations (Figure 1-2). Many of these activities require permits.

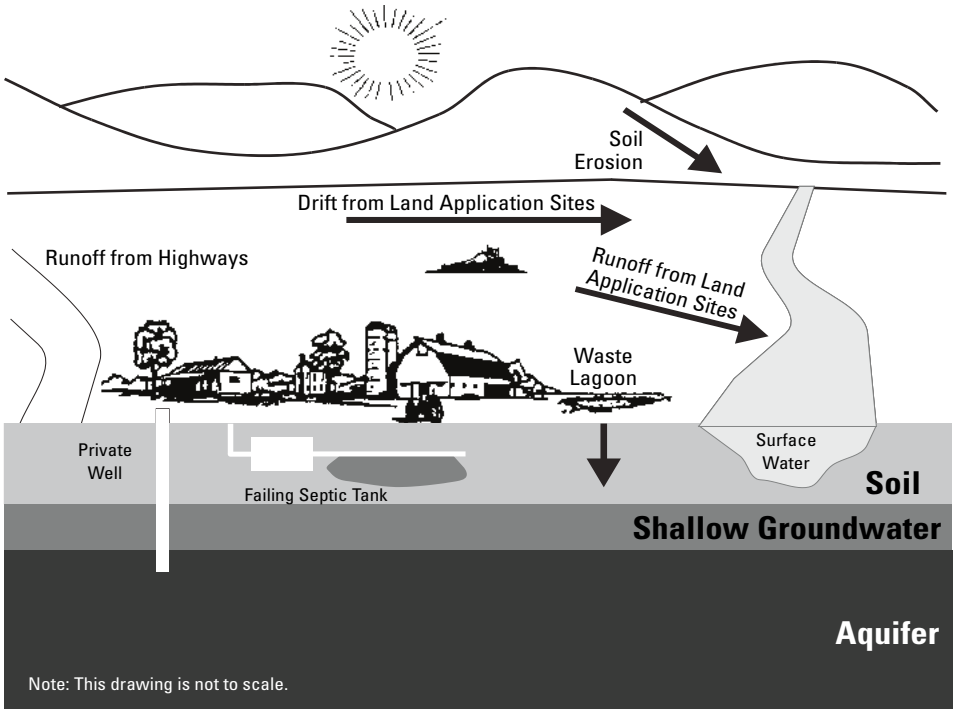

Figure 1-2. Potential sources of nonpoint source pollution.

When liquid animal waste is applied to the soil surface, it becomes part of the hydrologic cycle and acts much the same as natural precipitation. Animal waste, however, contains high concentrations of substances that can contaminate surface water and groundwater. The substances of greatest concern are nutrients—primarily nitrogen (N) and phosphorus (P)— pathogens, and organic matter.

A nutrient is any substance that promotes growth and can be taken up by plants or consumed by organisms. When land-applied, animal waste can provide crops with essential nutrients, such as N and P. In excess, however, nutrients can become contaminants that negatively impact the quality of surface water and groundwater.

Define the eutrophication process and problems it causes in surface waters.

If runoff containing excessive amounts of N and P reaches surface waters, it can speed up the process of **eutrophication**. Eutrophication is the slow, natural nutrient enrichment of streams and lakes and is responsible for the "aging" of ponds, lakes, and reservoirs. Excessive amounts of nutrients entering surface waters can accelerate eutrophication and stimulate rapid algae growth or "blooms."

When the algae die and are decomposed by organisms, the dissolved oxygen in the water is depleted. This condition can result in fish kills, offensive odors, and reduced attractiveness of the water for recreation and other public uses. Massive blooms of certain toxin-producing cyanobacteria, a type of blue-green algae, can kill livestock and pose health hazards to humans.

Groundwater quality is primarily impacted by N, in the form of nitrate. Because nitrate is not attracted to soil particles, it is very soluble and mobile in soil. If animal waste is overapplied, nitrate will leach, or flow downward beyond a crop's root zone, and eventually contaminate groundwater.

The United States Public Health Service has established a specific standard of 10 milligrams of nitrate per liter as the maximum concentration allowable in groundwater. Concentrations in excess of this standard can cause human health problems, particularly for infants.

Although nitrate-contaminated water can affect livestock, the concentrations that produce toxicity are much higher than those allowed for humans. Nitrate-contaminated water is usually a problem only when it adds to high nitrate concentrations already present in some feeds.

Pathogens are viruses, bacteria, or parasites capable of causing infection or disease in humans or other animals. In humans, pathogens can cause severe diarrhea, nausea, fever, vomiting, and even death due to bacteria such as *E. coli* from animal waste. The pathogens are most likely transported with surface runoff and erosion or by direct animal access to surface water. Streams and lakes that are used for drinking water supplies and recreational purposes provide the greatest opportunity for transporting these pathogens to humans. Pathogens in animal waste can also leach through the soil to groundwater, although this is less likely.

Like nutrients, organic matter is a valuable resource if managed properly or a contaminant if managed poorly. Animal waste contains extremely high amounts of degradable organic matter. These products can be 50 to 250 times more concentrated than raw municipal sewage.

Organic matter decomposes rapidly, and large amounts of oxygen are used during the process, which can result in similar issues as the decomposition of algae stated previously.

In short, runoff of animal waste carries contaminants to surface waters. Percolation of animal waste below the root zone of crops transports contaminants to groundwater. Therefore, runoff of animal waste is unacceptable. Deep percolation of untreated or partially treated animal waste below the root zone is also unacceptable.

Treatment and Reuse Through Land Application

Fortunately, soils and crops function as natural treatment systems. Soils are capable of physically filtering, chemically adsorbing (or retaining), and biologically converting contaminants. However, soils vary greatly in their treatment capacity.

The soil in one field often has different physical and chemical properties than the soil in another field, or on another farm. Landscape features, such as slope, also vary. The properties of the soil and the landscape features present at a specific site determine how land application of animal waste must be managed.

Soils are made up of four basic components: minerals, air, water, and organic matter. The mineral portion consists of three different sized particles: sand, silt, or clay. The relative proportion of sand, silt, and clay in a soil determines its texture. Soil texture is a very important soil property because it strongly influences water-holding capacity, nutrient retention, and contaminant treatment.

Sandy soils allow water to drain rapidly, and contaminants pass through too quickly for significant treatment to occur. In addition, these soils may not hold water and nutrients in the root zone long enough to support a healthy vegetative cover. A poor crop stand can result in an increased potential for erosion and reduced infiltration. Soils with more clay are better suited for holding the waste materials until the nutrients can be used by the crops. As a result, groundwater contamination is less likely in clay soils ; however, too much clay in the soil results in increased runoff.

Soil organic matter has a very large absorptive capacity for most nutrients. Soil organic matter contributes to improved infiltration, as well as greater water and nutrient holding capacity. Maintaining an active organic component in the topsoil, through good soil and crop management, enhances the soil's capacity to retain nutrients. As the amount of organic matter in a soil decreases, the soil's ability to hold nutrients also decreases.

Remember that crops are a critical component in the animal waste treatment process. They remove nutrients and water, reduce erosion, and maintain or increase infiltration rates. Crops vary greatly in their capacity to take up nutrients, in their tolerance of high soil moisture conditions, and in their consumptive use of water and irrigation requirements.

Your job as an operator is to match your waste application rate to both the nutrient needs of the crop and to the rate at which the soil will accept and hold the waste materials. Animal waste must be applied using rates and methods that prevent both surface runoff

of pollutants and leaching of pollutants to groundwater. Your goal is for animal waste to infiltrate into the soil and remain in the root zone long enough for contaminants to be treated by the soil and nutrients to be taken up by crops.

Animal Waste as a Valuable Resource

Explain why animal waste is a resource.

Although serious problems can result from its mismanagement, animal waste that is properly managed is a valuable resource. For centuries, it has been recognized as an excellent source of plant nutrients and as a soil amendment. When compared to commercial fertilizers, animal waste can potentially have both environmental benefits and detriments.

Because animal waste contains organic matter, it can improve soil productivity. Most nutrients from animal waste that enter the plant root zone need to be converted to plant-available forms by microorganisms. The organic matter in animal waste serves as a source of energy for the soil microorganisms that both stabilize nutrient sources and make those nutrients available to crops. Organic matter in animal waste also increases the infiltration, nutrient retention, and water-holding capacity of a soil while reducing soil erosion.

The N in animal waste can be more stable than N applied as commercial fertilizer. Commercial fertilizer N is applied as urea, nitrate, or ammonium (easily converted to nitrate) forms. Nitrate is very soluble and mobile, and it can leach downward during excess precipitation or irrigation if not absorbed by the crop. Some of the N in animal waste is stored in an organic form that is slowly released as soils warm. It is slowly converted to forms that may be better timed to crop needs, with less potential for leaching below the root zone.

Phosphorus contained in commercial fertilizers comes from mining. There are limited reserves of P remaining in the United States. Animal waste can provide an alternative to commercial P fertilizers and help conserve this limited resource. Because the amount of N and P is not balanced in animal waste, often P is overapplied and can cause environmental problems.

Environmental Stewardship

List several nonproducer concerns (such as community and environmental) of livestock, egg, and milk production.

Recognizing the value of animal waste as a resource is a fundamental principle of environmental stewardship. Managing your animal operation so that it does not negatively impact public health or natural resources is another. There are several more principles that must be considered.

Good Neighbor Policy

Animal waste management systems can create potential nuisances (including odors, water contamination, flies, and noise) in rural communities. A farmer or producer must be fully aware of these potential problems and the degree of concern they cause to neighbors. Where reasonable technologies and management strategies are available to reduce or

eliminate these nuisances, such strategies should be considered. Where such options do not exist, producers may need to consider alternatives for offsetting these nuisances.

Awareness of public perception is crucial to successful animal waste management. The appearance of your animal operation has a large impact on what people think of your facility and on their perceptions of odor or other nuisances. Because much of the population does not understand what you do in your farm operation, it is important to have good lines of communication to prevent problems from arising. Before you land-apply your waste or perform other activities, such as removing sludge from your lagoon, you should consider how your activities can impact the surrounding community.

Your animal operation may be scrutinized by neighbors and by groups like environmental organizations. These individuals and groups strive to maintain their individual standard of living and comfortable surroundings, as well as ensure that their property values and the environment are not harmed. Issues such as odor, loss of property value, and concern for drinking water quality are raised frequently by neighbors of animal operations.

Good management may help you avoid lawsuits. You cannot ignore the potential for nuisances. It is advisable to develop an individual plan, based on your local circumstances, that deals with these issues. You should consider ahead of time what course of action you may need to take if you become involved in conflicts or lawsuits concerning your operation.

Production Practices

Your production practices can also be considered a form of environmental stewardship. While it is important to properly manage your system to prevent environmental problems or conflict with neighbors, it is just as important to properly manage your waste management system for your own interests.

A good, common-sense rule is that it is far easier to prevent problems than correct them. This old saying is certainly true of animal waste management. Making amends for problems is almost always more costly than proper operation and maintenance.

Having a routine maintenance program for buildings, equipment, and grounds can reduce both environmental mishaps and safety hazards. A well-maintained and clean operation improves herd health, reduces odors, and makes management easier.

Proper application of animal waste will help you protect your farmland's productive capacity for future use. Considering animal waste as a resource, and using those nutrients properly, can save you fertilizer costs and improve your soil.

Managing your animal waste correctly will protect water supplies, which may include the ones you use on your farm for your family and the animals. Once groundwater becomes contaminated, it is nearly impossible to clean up. The only ways to get safe drinking water are to treat the water, drill a new well, or obtain water from another source. All of these options are expensive and inconvenient. Clearly, it is easier to protect our natural resources in the first place than to restore them.

Knowing the Rules

Good stewardship also includes knowledge of and compliance with current regulatory requirements established by federal, state, and local governments. These requirements are discussed next. Bear in mind that most regulations establish minimum standards for protection of public health and the environment. Good stewardship, however, often requires higher standards.

Animal Waste Operator Training Program

The training program will focus on:

1. The requirements of the laws and rules.
2. Basic knowledge of water movement and how animal waste may affect water quality.
3. How to manage and maintain waste management systems including lagoons, storage ponds, land application equipment, and crops.
4. How to take samples of animal waste for waste analysis and how to sample soils and crops for agronomic purposes.
5. Development and importance of cropping systems that efficiently use the nutrients contained in animal waste.
6. Operation of land application equipment.
7. The need to maintain adequate written records and printed copies of computer-generated records.
8. Timing of land application based on lagoon level, crop needs, weather, and soil conditions.
9. Appropriate use and maintenance of buffers.
10. Odor control.
11. Insect control.
12. Animal mortality.
13. Good neighbor practices.
14. Development of safety and emergency action plans.
15. Availability of technical and educational assistance.

Review Questions

1. What is the purpose of the law requiring a certified waste management system operator?
2. Which animal operations are required to have a certified operator?
3. Describe the hydrologic cycle.
4. Why is it important to keep waste products out of surface waters and groundwater?
5. List three reasons animal waste is seen as a valuable resource.
6. Define aquifer.

Chapter 2: Regulations Governing Animal Waste Management Systems—Type A

In the previous chapter, we examined the ways that animal waste can be both a beneficial resource and a pollutant. In this section, we will examine the laws and regulations that set basic standards for the proper operation and management of animal waste management systems.

In 1996, the North Carolina General Assembly enacted Senate Bill 1217. This state law established requirements for training and certifying operators and for permitting animal operations.

Describe the rules and laws that apply to animal waste management.

In 2003, the United States Environmental Protection Agency (EPA) required North Carolina to begin implementing provisions of the Clean Water Act of 1972. The Clean Water Act is the federal law that established the National Pollutant Discharge Elimination System (NPDES) permitting program (see General NPDES Permit Number NCA200000 in Appendix A).

The Clean Water Act defined a concentrated animal feeding operation (CAFO) as an animal feeding operation (AFO) that (a) confines animals for more than 45 days during a growing season (b) in an area that does not produce vegetation and (c) meets certain size thresholds. Animal operations that met EPA's definition of a CAFO were required to apply for an NPDES permit. Consequently, many animal operations that were originally permitted under Senate Bill 1217 were required to apply for NPDES permits under the provisions of the Clean Water Act.

In 2008, revised EPA regulations replaced the 2003 regulations. Following challenges to aspects of the 2008 rules, including the duty to apply, the federal CAFO rules were further revised in 2012. These revised regulations require large or medium CAFOs that discharge to waters of the state to be covered under an NPDES permit; otherwise, large CAFOs may choose between coverage under an NPDES permit or a State permit. Many of the operations that were required to obtain NPDES permits are now covered under State permits.

Responsibility for implementing the laws and regulations governing animal operations resides with the North Carolina Department of Environmental Quality (DEQ), specifically with the Division of Water Resources (DWR). To carry out the requirements in the state and federal laws, DWR developed state regulations that contain specific requirements for permitting and operator certification (see State General Permit Number AWG100000 in Appendix A).

The permitting and operational requirements for owners of animal waste management systems are found in state rule 15A NCAC 2T (Wastes Not Discharged to Surface Waters). The state regulations containing specific requirements for, and responsibilities of, certified

animal waste management system operators are found in state rule 15A NCAC 8F (Certification of Operators of Animal Waste Management Systems) (see Appendix B).

Animal Waste Management System Permits

A **permit** addresses the compliance needs and operational requirements of an animal waste management system. It is also a legal and binding agreement and is enforceable by law.

The owner of an animal operation is responsible for ensuring that the waste management system is properly operated and maintained and is in compliance with its permit and all related environmental regulations and laws. Ultimately, the owner is responsible for any violations, regardless of who is actually operating the system.

Of course, owners are often certified and operate their own systems. Many owners, however, employ or contract with certified operators to operate their waste management systems. Operators must understand the legal responsibilities and ramifications placed on owners by the permits. Therefore, it is equally important for owners and operators to know and fully understand the conditions of the permit.

General Permits

Most of the animal waste management system permits that DWR issues are general permits. A general permit is a standard permit that is issued to all operations of a similar type and size. The permit that is issued to any animal operation in that group is identical to permits issued to other operations in that group. Each permit is accompanied by a Certificate of Coverage that is specific to each operation and defines the owner, location, type of facility, and animal capacity for which it is permitted.

State Nondischarge General Permits

List the threshold number of animals that require an operation to have an animal waste management permit.

The passage of Senate Bill 1217 established NC General Statutes 143-215.10A-H. These statutes require State Nondischarge Permit coverage for animal operations with liquid waste management systems that serve the following number of animals:

- 250 or more swine
- 100 or more confined cattle
- 75 or more horses
- 1,000 or more sheep
- 30,000 or more confined poultry with a liquid animal waste management system

The statutes state that the intent is for as many of these operations to be covered by general permits as possible. Animal operations that fall below the threshold numbers or animal operation types not listed by NCGS 143-215.10B are considered "deemed permitted." This means that these systems are considered permitted by rule or regulation and are not actually issued a permit. There are no registration or reporting requirements, and state inspections are performed only if there is a complaint. These operations maintain their "deemed permitted" status as long as they do not discharge animal waste. Loss of

"deemed permitted" status is a situation that these facilities should make every effort to avoid.

NCGS 145-215.10C does not require permits for dry litter systems; instead, these systems are allowed to operate on a deemed permitted basis under state rule 15A NCAC 2T. However, animal operations with dry litter management systems serving 30,000 or more birds must have animal waste management plans.

NPDES Permits

As discussed earlier, AFOs that discharge to waters of the state are required to be permitted under an NPDES permit. Animal operations now have the option to be permitted under the NPDES General Permit or the State Nondischarge General Permit. The operations affected are those with 1,000 "animal units."

The following numbers represent 1000 animal units for each species:

- 2,500 swine — greater than 55 pounds
- 1,000 cattle
- 700 mature dairy cows
- 30,000 poultry with a liquid waste system

Individual Permits

General permits (both state and NPDES) are intended for compliant facilities of similar design for specific animal types. Facilities with unique waste treatment systems or for other animal types must obtain an individual permit. Noncompliant facilities (even those otherwise classified as "deemed permitted") can be required to obtain individual permits, which are types of permits issued to industries and municipalities.

Individual permits can require extensive waste and site evaluations, engineering design of system components, detailed monitoring of operations with laboratory analyses of effluent, additional buffers for waste application, and regularly scheduled compliance visits by DWR. Operations with a history of compliance problems have additional monitoring and reporting requirements.

Permit Requirements

Explain what a waste system permit is and describe its general conditions.

Although there are some differences, the State Nondischarge General Permit and the federal NPDES General Permit are similar. Some of the conditions common to both permits are discussed below. Many other similarities and differences between the permit types will be covered as we move through this training. Ultimately, it is your responsibility as a certified operator to read and fully understand your permit in its entirety.

Performance Standards

- ***Discharge of Animal Waste***

Define "discharge" of animal waste.

A **discharge** of animal waste means that animal waste leaves the waste management system. Discharges of animal waste are prohibited. **This is one of the most**

fundamental concepts you must take away from this training. A discharge can result from runoff of waste after overapplication, as we learned from our discussion of the hydrologic cycle. However, there are many other situations that can result in a discharge, including land application to saturated, frozen, or snow-covered fields; catastrophic failure of a lagoon or other storage structure; and breaks in pipes or other failures of distribution components.

Define a 25-year, 24-hour storm.

All components of the animal waste management system must be designed, constructed, operated, and maintained as a nondischarge system to prevent the discharge of pollutants to streams and ditches. The **only** exception is a discharge resulting from a storm equal to or greater in intensity than a 25-year, 24-hour storm. A 25-year, 24-hour storm means the maximum 24-hour rain amount that is likely to occur once in 25 years as defined by the National Oceanic and Atmospheric Administration Atlas 14 (NOAA 14), Volume 2, revised 2006 or most current. To be classified as a **25-year, 24-hour storm** in North Carolina, a storm must deliver 5 to 9 inches of rain (depending on the region of the state) in one 24-hour period (Figure 2-1).

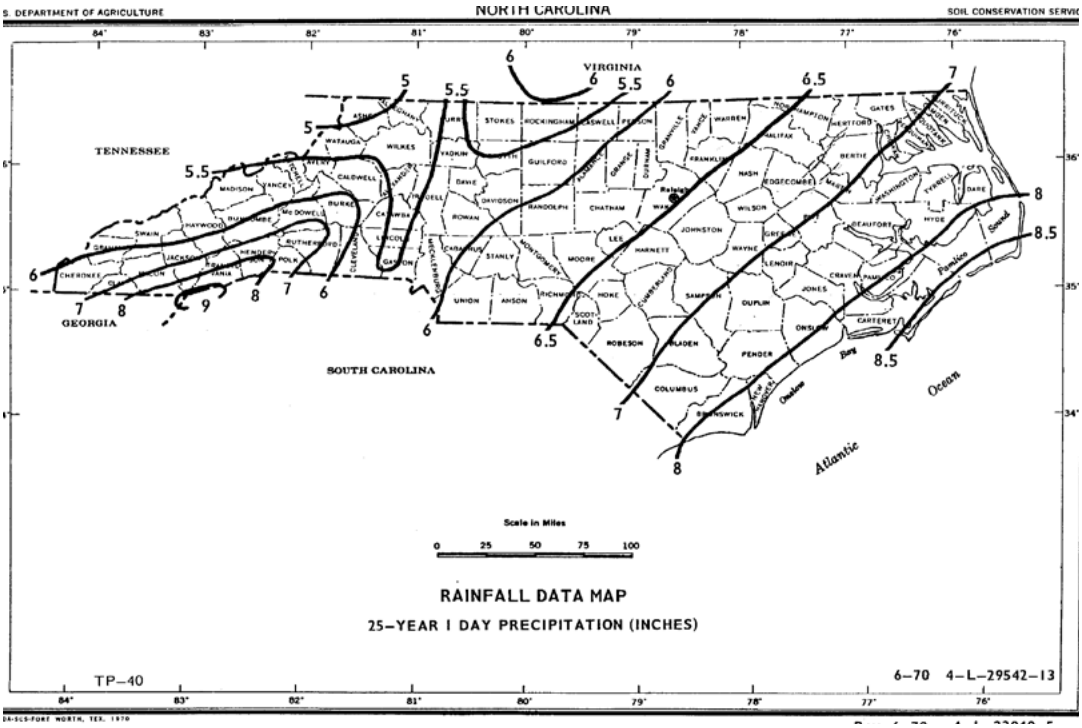

Figure 2-1. Rainfall amounts (in inches) that classify as a 25-year, 24-hour storm.

An unintentional discharge resulting from the 25-year, 24-hour storm is ***not*** a violation ***if*** the operation is in compliance with its permit. However, don't count on using rainfall as a defense for a discharge. A long rainy spell that lasts 3 to 4 days and delivers 10 inches of rain is not a 25-year, 24-hour storm.

- ***Water Quality Standards***

DWR maintains water quality standards for many pollutants, including oxygen levels, bacteria, pH, N, P, and a variety of metals and chemicals. It is against the law for anyone

to cause a water quality standard violation. For example, if waste from an animal operation lowers the dissolved oxygen level in a stream below the standard, then the owner is subject to civil/criminal penalties.

There are water quality standards for groundwater as well as surface waters. The Groundwater Quality Standards are contained in 15A NCAC 2L. Animal waste permits require compliance with the 2L regulations, which state that groundwater quality standards may not be exceeded at or beyond the Groundwater Compliance Boundary. The boundary is established at either 250 feet from the waste disposal area or 50 feet within the property boundary, whichever is closest to the waste disposal area. Exceedance of Groundwater Quality Standards at or beyond the Compliance Boundary is subject to immediate corrective action in addition to the penalty provisions applicable under the North Carolina General Statutes.

- ***Certified Animal Waste Management Plans***

An animal waste management plan that is approved or "certified" by a technical specialist is required for all permitted animal operations. Although it is actually a separate document, the Certified Animal Waste Management Plan (CAWMP) is incorporated by reference into the permit. A violation of the standards and conditions in the CAWMP is a violation of the permit.

The CAWMP contains most of the design information specific to each operation and establishes individual nutrient management requirements. It is considered the backbone of the permit because it provides the operator with a roadmap for operating a particular system. It is so important that all of Chapter 3: Components of a Certified Animal Waste Management Plan is devoted to it.

Major changes to the CAWMP require recertification and a permit modification. All major changes to the CAWMP, along with an explanation identifying the major changes, must be submitted to the DWR Central Office and an updated permit received before installing the major change. Examples of "major" are changes in animal operation type or changes to the irrigation design.

Revisions and amendments to the CAWMP, along with an explanation identifying all major changes and revisions, must be submitted to the appropriate DWR Regional Office within 30 calendar days after the major changes or revisions occur. Revisions and amendments do not require a permit modification.

All major changes, revisions, and amendments for NPDES permitted facilities must be submitted to the DWR Central Office and a public notice issued for a minimum of 30 days prior to being implemented.

Operation and Maintenance Requirements

- ***Excessive Ponding and Runoff***

Land application rates cannot result in excessive ponding (defined in the permit as "any area of the application field where visible liquid waste is ponded on the surface of the land application site more than four hours following the application of waste") or any runoff during any given application event.

- ***Certified Operator Requirements***

Owners must designate a certified animal waste management system operator to be the Operator in Charge (OIC) of the animal waste management system (see Operator in Charge Designation Form in Appendix B). The system must be operated by the OIC or a person under the OIC's supervision. During the application of waste, the site must be inspected and documented at least every 120 minutes.

- ***Soil Testing and Crop Management***

If a soil test report shows that either the copper or zinc index exceeds 3,000, land application must stop on those fields. Crops from all fields in the certified waste plan must be harvested and properly utilized. Harvestable crops cannot be allowed to become unusable due to prolonged exposure to weather.

Monitoring and Reporting Requirements

- ***System Inspections***

Inspections of all components of the waste management system must be conducted and documented at a frequency to ensure proper operation but at least monthly and after all storm events of greater than 1 inch in 24 hours.

- ***Equipment Calibration***

All waste application equipment, including irrigation systems, hose-drag systems, honey wagons, and solid spreaders, must be field tested and calibrated to verify operating performance and application amount. Field calibration to verify application amount is required once a year for NPDES permitted operations and once every other year for state permitted operations. The minimum calibration performance requirements that must be verified within specific parameters are operating pressure at the sprinkler/gun, wetted diameter, and flow rate. If these three items are within specified ranges, application uniformity is deemed acceptable.

- ***Freeboard Levels***

Lagoon freeboard levels must be recorded weekly and after rainfalls of 1 inch or greater. If lagoon freeboard violations occur in two consecutive years, owners may be required to install automated lagoon level monitors.

- ***Precipitation Events***

A rain gauge must be installed at the farm to measure all precipitation events and the precipitation type and amount must be recorded on forms supplied by or approved by DWR.

- ***Sludge Surveys***

Sludge accumulation must be measured annually in lagoons and storage ponds that are not routinely agitated and pumped out. This survey frequency may be reduced if it can be demonstrated to the satisfaction of DWR that the rate of sludge accumulation does not warrant an annual survey. The sludge survey must include a map of the lagoon with the respective measured sludge depths and a calculation of the available treatment capacity depth in the lagoon.

If the sludge accumulation is such that the structure does not satisfy the criteria set by Natural Resources Conservation Service (NCRS) NC Conservation Practice Standard no. 359, a Plan of Action (POA) for Lagoon Sludge Reduction or a certified Sludge Management Plan must be submitted to the appropriate DWR Regional Office within 90 days of the determination. The plan must describe removal and waste utilization procedures to be used. Compliance regarding sludge levels must be achieved within two years of the determination.

- ***Mandatory Reporting***

Describe the violations that require mandatory reporting by the owner.

If there is a discharge to surface waters or wetlands, the owner is responsible for ensuring that the discharge is reported and the required information is submitted to DWR.

The appropriate DWR Regional Office must be notified by the owner no more than 24 hours after the occurrence of any of the following:

- Waste discharges
- Failure to maintain required freeboard in a lagoon or storage pond
- Overapplication of waste
- Failure of any component of the animal waste system that results in a discharge or renders the system incapable of treating or storing the waste
- All waste spills from waste transporting equipment
- Deterioration or leak in lagoons or storage ponds

- ***Record Keeping***

All records required by the permit and a facility's CAWMP must be maintained by the owner in chronological and legible form. Operations with a State Nondischarge General Permit or a NPDES Nondischarge General Permit are required to maintain these records for a minimum of five years. These records include, but are not limited to, soil and waste analyses, rain gauge readings, freeboard levels, irrigation and land application event(s), past inspection reports and operational reviews, animal stocking records,

records of additional nutrient sources applied (including, but not limited to, sludges, unused feedstuff leachate, milk waste, septage, and commercial fertilizer), cropping information, waste application equipment testing and calibration, and records of transfer of separated solids to off-site location(s).

Inspections and Entry

Animal operations in the "pilot" counties (Columbus, Jones, Brunswick, and Pender) are visited once per year by the Division of Soil and Water Conservation (DSWC) instead of by DWR. DSWC immediately reports any permit violations to DWR for further investigation and enforcement actions as warranted.

Except for those located in one of four pilot counties, animal operations are visited once per year by DWR staff to check for:

- Violations of water quality standards
- Animal waste management plan compliance
- Compliance with all other permit conditions

DSWC staff also conducts operation reviews for any animal operation in the state upon request. These voluntary reviews may include review of operation records, waste storage structures, and waste application equipment.

General Conditions

Permits are issued for five years. However, DWR may reopen and modify, revoke, reissue, or terminate a permit at any time, under its authority from the Clean Water Act and state law.

Owners are required to pay an annual fee to DWR. Failure to pay the appropriate annual fee may result in revocation of the permit.

Penalties

Describe the various types of regulatory action that can result from mismanagement.

Owners must comply with all conditions of their permits. Any permit noncompliance is a violation of state and possibly federal law.

- ***Notices of Deficiency***

A Notice of Deficiency (NOD) is a letter that DWR sends to an owner when minor violations are found at a facility. An NOD is appropriate when the violations are of minor duration and gravity, resulting in little or no harm to the environment or public health.

- ***Notices of Violation***

A Notice of Violation (NOV) is a letter that DWR sends to an owner giving notice of noncompliance with the permit and with environmental law(s). The letter is designed to notify the owner of the specific violation and associated law or regulation. In addition, the NOV describes what the owner is required to do to correct the violation or what the owner must do as a result of the violation. Generally, the NOV indicates that the owner must complete the corrective actions and notify the DWR within a certain period of time.

It is very important that the owner respond to DEQ in writing if issued an NOV and that they follow through completely with corrective actions specified in the NOV.

- ***Civil Penalties***

An NOV is often the first step in an enforcement action that may result in a civil penalty. Civil penalties are fines assessed against an owner by the Director of DWR. General Statute 143-215.6A allows for the assessment of civil penalties of up to $25,000 per day per violation. Each day that a violation occurs may be considered a separate violation.

- ***Changes in Permit Status***

Major violations or continued acts of noncompliance may result in the loss of "deemed permitted" status or coverage under a general permit, requiring the operation to obtain an individual permit. A facility with a state general or individual permit may be required to obtain a NPDES permit as a result of certain violations. Permits may be terminated and coverage under any type of permit denied.

- ***Injunctions***

If an owner demonstrates consistent noncompliance with regulations or if there is an imminent danger to health or the environment, a county health director can issue an injunction, or court order, to discontinue or prevent an existing or potential violation. In the worst case scenario, this could result in the removal of animals and closure of the operation.

- ***Criminal Penalties***

Owners who willfully, knowingly, or negligently violate their permits are subject to criminal penalties, even imprisonment. State and/or Federal authorities may be involved in investigating a facility. Violations may be deemed negligent if they repeatedly occur because an owner fails to take the necessary action to correct the problem.

An example of a willful and knowing violation is the existence of a manmade "conveyance" for discharging animal waste. A conveyance is a pipe, ditch, or other structure that can be used to transport waste away from an animal operation or to discharge wastes from a holding pit or lagoon.

The *presence* of such a structure constitutes a violation, regardless of whether there is an actual discharge of waste. However, it is important to understand that man-made conveyances are different from engineered spillways considered in new designs for waste storage ponds and lagoons. Engineered spillways are not conveyances in this context.

Operator Certification Program

Senate Bill 1217 requires a certified operator for all animal operations with **liquid** waste management systems that serve the following number of animals:

- 250 or more swine;
- 100 or more confined cattle;
- 75 or more horses;
- 1,000 or more sheep; or
- 30,000 or more confined poultry.

Define Operator in Charge and identify whose responsibility it is to designate an Operator in Charge for an animal operation.

As required by North Carolina General Statute 90A-47.2, owners of animal operations with animal waste management systems must designate an OIC for each of their systems. An OIC is a person who holds a currently valid certificate to operate an animal waste management system and who has primary responsibility for the operation of the system.

The goal is to ensure that animal waste is handled properly in an environmentally sound manner, without negative impacts on state surface waters, groundwater, soils and crops, grazing animals or other consumers of the crops, and neighbors.

To help meet this goal, two training and certification programs have been developed. If you intend to operate a swine or a poultry operation with a liquid waste management system, you must obtain a Type A certificate. If you intend to operate an animal waste management system involving cattle, horses, goats, or sheep, you must obtain a Type B certificate.

Only the OIC, or someone under the OIC's direct supervision, may apply animal waste to land. The owner or other person in control of the land is responsible for making sure that the land application is performed by an OIC or a person under the direct supervision of the OIC. Fines may be imposed if waste is land-applied without a certified operator.

Water Pollution Control System Operators Certification Commission

Know which commission is responsible for animal waste management system operator certification.

The regulatory body responsible for the certification of animal waste management system operators is the Water Pollution Control System Operators Certification Commission (WPCSOCC). The WPCSOCC is also responsible for the certification of other water pollution control system operators, such as wastewater treatment plant operators, collection system operators, spray irrigation system operators, land application of residuals system operators, and subsurface system operators.

In addition to certification of operators, the WPCSOCC is responsible for the classification of water pollution control systems and the development and implementation of training programs for the certification of operators.

The WPCSOCC has 11 members. Two members represent the animal agriculture industry and are appointed by the North Carolina Commissioner of Agriculture. The remaining nine members are appointed by the Secretary of DEQ and represent other areas of the

water pollution control system industry. The WPCSOCC is assisted by the staff of DWR's Operator Certification Unit.

Classification of Animal Waste Management Systems

The WPCSOCC has established two types of animal waste management systems: Type A Animal Waste Management Systems and Type B Animal Waste Management Systems.

Type A systems primarily rely on an anaerobic lagoon and soil/plant systems for the treatment of animal waste. These systems are generally used to treat animal waste generated by animals that produce a **low-fiber waste, such as swine and poultry**. These systems generally include the following components: anaerobic lagoon; pumps, pipes and other structures that carry waste from the point of generation to the final treatment/disposal site; flushing systems; solids separation equipment; irrigation equipment; and land application site and crops.

Type B systems primarily rely on soil/plant systems for the treatment of animal waste. These systems are generally used to treat animal waste generated by animals that produce a **high-fiber waste, such as cattle, horses, goats, and sheep**. These systems generally include the following components: dry stacks; solids and slurry collection equipment; waste storage ponds for the collection of solids and runoff; pumps, pipes and other structures that carry waste from the point of generation to the final treatment/disposal site; flushing systems; solids separation equipment; irrigation equipment; and land application site and crops.

Upon classification, owners of animal waste management systems must designate an OIC by submitting a properly completed OIC Designation Form (Appendix B) to the WPCSOCC. Designation of one backup OIC is optional.

Owners of new animal operations having animal waste management systems must designate an OIC before these systems are placed into operation. Owners of existing animal operations must designate a new OIC within 30 days of a vacancy in the OIC position. Failure to designate an OIC may result in the assessment of civil penalties.

Certification of Operators

Separate training and certification programs have been developed for each type of animal waste management system. To become certified as a Type A or Type B Animal Waste Management System Operator, you must complete the appropriate training program and pass the appropriate examination.

Responsibilities of Certified Operators

To maintain your certification, you must pay an annual renewal fee and complete six hours of additional training every three years. If you fail to pay the annual renewal fee within 30 days of the due date or if you fail to complete the approved additional training within 30 days of the end of the three-year period, you must take and pass another examination to become certified again.

Describe the necessary steps required to renew your animal waste management system operator certification.

All certified operators, regardless of whether the OIC is a designated OIC of an animal waste management system, must notify the WPCSOCC within 30 days, in writing, of a change in address.

Responsibilities of an OIC or Backup OIC

As the designated OIC or back-up OIC of *any* type of animal waste management system, you must:

Describe the duties and requirements of an Operator in Charge of an animal waste management system.

- Possess a currently valid animal waste management system operators certificate of the appropriate type.
- Visit and inspect each animal waste management system at a frequency that ensures proper operation of the system.
- Inspect, or have a person under OIC supervision inspect, the land application site as required in the permit.
- Ensure that animal waste is being applied in accordance with the animal waste management plan and the permit.
- Properly manage, supervise, and document daily operation and maintenance of the system.
- Certify monitoring and reporting information as required in the permit.
- Be available for consultation, emergencies, and inspections.

In addition, the OIC or the *designated* backup OIC of a **Type A** system must:

- Inspect the waste application system as required by the permit, and inspect the land application site within 24 hours of the application of animal waste if the OIC was not present during the application of animal waste.

The OIC or the *designated* backup OIC of a **Type B** system must:

- Inspect the waste application system as required by the permit, and inspect the land application site within 48 hours of the application of animal waste if the OIC was not present during the application of animal waste.

Disciplinary Actions

Under certain circumstances, the WPCSOCC may take disciplinary actions against a certified operator. The WPCSOCC may:

- Issue the operator a letter of reprimand
- Suspend an operator's certificate
- Revoke an operator's certificate

Describe what enforcement actions can be taken against an operator by the WPCSOCC.

The WPCSOCC may take these actions if it finds that an operator:

- Has practiced fraud or deceit
- Has not exercised reasonable care, judgment, or the use of knowledge and ability in the performance of their duties
- Is incompetent or unable to perform required duties

Other Regulations

In addition to the state and federal laws and regulations discussed previously, there may be local regulations that apply to animal operations. Generally, local regulations deal with the zoning or location of animal operations as opposed to the actual operation of the facility.

However, in 1991, the N.C. General Assembly explicitly defined "bona fide farms" to include the production of livestock and poultry. These are exempted from county zoning ordinances but not from city or town ordinances.

It is beyond the scope of this manual to review pertinent local regulations and the legal issues surrounding them. The owner and operator of an animal operation should research the pertinent local regulations to make sure they are in compliance with these, if any exist. Information on such regulations should be available from the county planning and zoning office, the county manager's office, or the county health department.

Review Questions

1. What does an animal waste permit consist of?
2. What agency issues animal waste permits?
3. Define OIC and list the responsibilities of an OIC.
4. How does a certified operator renew their license?

Chapter 3: Components of a Certified Animal Waste Management Plan

Explain the difference between a waste management plan and a general permit.

Current regulations require animal waste management plans under state or NPDES permits for every animal operation involving 250 or more swine, 100 or more confined cattle, 75 or more horses, 1,000 or more sheep, and 30,000 or more confined poultry that use a liquid waste management system. The animal waste management plan describes the entire waste management system, including animal types and numbers, the amount of waste generated, manure treatment and/or storage structures, associated engineering designs, site and field maps, the fields and associated crops receiving the waste, applicable setbacks, operation and maintenance practices, and the best management practices (BMPs) and conservation practices specific to the operation.

A Certified Animal Waste Management Plan (CAWMP) contains these components:

1. **General information —** this includes the farm address, location, type of facility, name of owner, name of waste system operator, the state or NPDES general permit, certificate of coverage, and signed animal waste management plan certification form.
2. **Design and site evaluation —** this includes all details related to the siting and design of the animal operation. It includes site, soil, wetlands, and floodplain evaluations, dam hazard classification, lagoon or other waste storage/treatment structure design and construction specifications, and an operations and maintenance plan.
3. **Waste utilization plan (WUP) —** this includes all details related to the management of the waste collection, storage, handling, and land application system. It includes the volume of waste generated, all fields and receiving crops available for waste application, waste application timing, and hydraulic restrictions. It also includes any plan amendments and revisions and a list of management conditions, often referred to as the "required specifications."
   NOTE: This chapter will focus mainly on the WUP component of the waste management plan, as this contains the day-to-day issues affecting decisions and management of the waste handling system.
4. **Irrigation design —** this component includes the irrigation system layout, operating parameters, and related equipment and hardware to properly apply waste at agronomic rates on receiving crops. The design includes site maps and the system's calculations/ specifications determining the total amount of effectively irrigated or "wettable" acreage on an animal operation. If a wettable acreage determination is required, the related certification and documentation would be considered part of the waste management plan.
5. **Other CAWMP components —** these include the emergency action plan, odor control checklist, insect control checklist, mortality management checklist, sludge surveys, NPDES annual certifications, if applicable, and the necessary records, soil and waste analyses associated with these activities.

Waste Utilization Plans (WUPs)

Describe the primary goal of the waste utilization plan.

The primary goal of a WUP is to prevent accumulation of nutrients (such as N, P, potassium, calcium, magnesium, zinc, and copper) on your farm to the point where they threaten plant growth or the environment. Nutrients come to your farm as animal feeds and mineral additives. Animals transform these nutrients into body tissue, products (for example, milk or eggs), and wastes. If nutrients accumulated in waste management systems are not transported off the farm, they will build up in soils to levels that could harm soil fertility, crops, groundwater, or surface water. A land application system on the farm allows waste nutrients to be used to grow crops. The nutrients taken up by crops can then be exported from the farm to prevent nutrient buildup or recycled back to the animals as feed.

A WUP is a planning tool to help you define the number of acres and types of crops to be grown in your operation. This is based on the volume of waste produced and the nutrient requirements of the crops you would like to grow. Developing a WUP requires estimating the volume of animal waste produced annually and the amount of plant-available nutrients contained in that waste. Based on these factors, environmentally sound cropping systems are matched with your waste-handling systems to develop acceptable methods and rates of land application.

Once waste is generated on your farm, the plan must be implemented. A WUP requires proper management for successful use of the nutrients produced. A properly implemented plan will let you use the waste nutrients as a fertilizer while ensuring that water quality on and off your farm is protected. You will need to understand how to use the information in your plan, how to monitor the information, and how to calibrate the equipment to make the plan work.

The vast majority of WUPs use N as the priority nutrient. The estimated amount of N produced in your operation and the N needed to fertilize your chosen crop rotation are used to determine the number of acres needed to handle the N as a fertilizer. All plans must show a "nitrogen deficit," meaning that sufficient or excess land is available to handle all the expected N produced on the farm each year. In special situations and at larger animal operations, a periodic P assessment must be done to determine if P should be the priority nutrient for certain fields.

When discussing N, one must be familiar with the distinction between total N and plant-available N (PAN). Since not all manure N is available to crops, estimates of availability are used when developing a plan. These estimates define what percentage of total N is PAN for the purpose of nutrient management planning. This will be discussed in more detail later in this chapter.

WUP development is directed by the animal producer and is completed by a certified **technical specialist**. A technical specialist is an individual trained in waste and nutrient management and is designated by the North Carolina Soil & Water Conservation Commission to write CAWMPs and WUPs. A copy of the signed and dated plan is

maintained at the farm, and copies are filed with the local Soil and Water Conservation District (SWCD), Office and the DWR Regional Office.

List the components in a waste utilization plan.

The WUP contains the following components:

1. Waste generation rate
2. Amount of PAN produced annually
3. Farm map with soil types and acreage
4. Selection of crops to be grown
5. Determination of N utilization for these crops
6. Tables showing N utilization by crops, waste application windows, and total N budget for the cropping system
7. Irrigation application factors
8. Required specifications
9. WUP Agreement
10. Leased land or contractor agreements, if any
11. Emergency Action Plan
12. Odor, insect, and mortality management checklists
13. NRCS 590 Standard

Waste Generation Rate

Understand how the amount of animal waste produced on a farm annually is calculated.

The amount of manure produced in an animal operation can be estimated using Table 3-1. The volume of waste to be handled annually is determined by multiplying the waste generation rate by the number of animals in the operation.

At the end of this chapter is an example of a WUP. Your instructor will refer to this plan and point out important sections that you need to be familiar with.

Amount of PAN Produced Annually

The average total content of N, phosphorus (P2O5), and potassium (K2O) found in several types of animal waste is shown in Table 3-2. These statewide average values are used for planning new facilities in North Carolina. The nutrient content of your animal waste can vary widely, depending on diet, type of production facility, season, and recent rainfall.

Remember, the values in Table 3-2 are for planning purposes only. Once a farm is operating, waste applications must be based on recent waste analysis results to avoid underapplication or overapplication of nutrients. Methods of sampling and how to use waste analysis reports will be described in Chapter 4.

In addition to calculating the amount of nutrients generated by the animal manure, application method can affect the amount of total N that will become plant-available over the growing season. Therefore, availability factors found in Table 3-3 are used to estimate the amount of total PAN produced annually. In addition, you must consider all other sources of nutrients available to crops within your fields. This includes starter fertilizers or other commercial sources. Soybeans and peanuts can leave 20 to 40 pounds of residual PAN in the soil for the following crop, and clover and alfalfa can supply 60 to 100 pounds of residual PAN. The WUP will specify the required amount of carryover N to be recorded for any crop that leaves residual PAN, and that amount will be deducted from the allowable N application rate applied through manure.

Table 3-1. Average Animal Waste Generation Values for Different Production Units.

System Type (NCDA&CS Waste Code)	Animal Production System	Units	Accumulated Manure
Anaerobic Lagoon Liquid – Swine (ALS)	Farrow-to-Wean (per sow)	gal/animal/year [1]	3,203
	Farrow-to-Feeder (per sow)		3,861
	Farrow-to-Finish (per sow)		10,478
	Wean-to-Feeder (per pig)		191
	Wean-to-Finish (per pig)		776
	Feeder-to-Finish (per pig)		927
Anaerobic Lagoon Sludge – Swine (ASS)	Farrow-to-Wean (per sow)	gal/animal/year [1]	78
	Farrow-to-Feeder (per sow)		94
	Farrow-to-Finish (per sow)		382
	Wean-to-Feeder (per pig)		6.7
	Wean-to-Finish (per pig)		26.3
	Feeder-to-Finish (per pig)		33
Dairy – Slurry (LSD)	Calf	gal/animal/year [1]	1,876
	Heifer		5,535
	Milk Cow		7,749
Anaerobic Lagoon Liquid – Poultry (ALP)	Pullet (nonlaying)	gal/1,000 bird capacity/year [1]	9,110
	Pullet (laying)		22,201
	Layer		25,373
Anaerobic Lagoon Sludge – Poultry (ASP)	Pullet (nonlaying)	gal/1,000 bird capacity/year [1]	1,659
	Pullet (laying)		4,147
	Layer		4,739
Dairy – Scraped (SSD)	Calf	tons/animal/year	4.1
	Heifer		12
	Milk Cow		17
Beef – Scraped (SSB)	Stocker	tons/animal/year	1.5
	Feeder		2.2
	Brood Cow		3.0
Horse – Scraped (SSH)		tons/animal/year	9.1

[1] To convert gallons to acre-inches, divide gallons by 27,154.

Table 3-2. Estimated Nutrient Composition of Animal Manure for Developing Plans for New Operations (Total nitrogen [N], phosphorus [P] and potassium [K] from manure nutrient sources.)

System Type (NCDA&CS Waste Code)	Animal Production System	Units	N	P_2O_5	K_2O
Anaerobic Lagoon Liquid – Swine (ALS)	Boar	pounds of total nutrient per 1,000 gallons [1]	3.6	1.4	8.3
	Farrow-to-Wean		2.4	0.9	4.1
	Farrow-to-Feeder		3.6	1.4	8.3
	Farrow-to-Finish		3.6	1.4	8.3
	Wean-to-Feeder		3.6	1.4	8.3
	Wean-to-Finish		3.6	1.4	8.3
	Feeder-to-Finish		3.6	1.4	8.3
Anaerobic Lagoon Sludge – Swine (ASS)			20.4	30.6	7.5
Anaerobic Lagoon Liquid – Poultry (ALP)			3.1	1.0	13.8
Anaerobic Lagoon Sludge – Poultry (ASP)			24.4	38.1	10.3
Dairy – Slurry (LSD)			16.7	9.1	15.4
Dairy – Scraped (SSD)		pounds of total nutrient per ton	11.2	7.0	9.8
Horse – Scraped (SSH)			9.3	7.0	9.8
Beef – Scraped (SSB)			13.0	8.3	13.6

[1] To convert gallons to acre-inches, divide gallons by 27,154 (or 1,000 gallons by 27.154).

Table 3-3. First-Year Nutrient Availability Coefficients for Animal Manure for Developing Plans for New Operations (Available Nitrogen [N], Phosphorus [P] and Potassium [K] from Manure Sources)

Manure Type	Production System	NCDA&CS Waste Code	N		P		K	
			Broadcast or Irrigated	Incorporated or Injected	Broadcast or Irrigated	Incorporated or Injected	Broadcast or Irrigated	Incorporated or Injected
Anaerobic Lagoon Liquids	Swine	ALS	0.5	0.6	1.0	1.0	1.0	1.0
	Swine Farrow-to-Wean	ALF	0.5	0.6	1.0	1.0	1.0	1.0
	Poultry	ALP	0.5	0.6	1.0	1.0	1.0	1.0
	Other	ALO	0.5	0.6	1.0	1.0	1.0	1.0
Anaerobic Lagoon Sludges	Swine	ASS	0.5	0.6	1.0	1.0	1.0	1.0
	Poultry	ASP	0.5	0.6	1.0	1.0	1.0	1.0
	Other	ASO	0.5	0.6	1.0	1.0	1.0	1.0
Slurries	Beef	LSB	0.4	0.6	1.0	1.0	1.0	1.0
	Dairy	LSD	0.4	0.6	1.0	1.0	1.0	1.0
	Swine	LSS	0.4	0.6	1.0	1.0	1.0	1.0
	Other	LSO	0.4	0.6	1.0	1.0	1.0	1.0
Scraped or Stockpiled Manure	Beef	SSB	0.4	0.6	1.0	1.0	1.0	1.0
	Dairy	SSD	0.4	0.6	1.0	1.0	1.0	1.0
	Horse	SSH	0.4	0.6	1.0	1.0	1.0	1.0
	Swine	SSS	0.4	0.6	1.0	1.0	1.0	1.0
	Other	SSO	0.4	0.6	1.0	1.0	1.0	1.0

Farm Maps

Maps of the fields to be used for waste application are included in the plan. These maps depict soil types, slopes, layout of the irrigation system, blue-line streams, ditches, property lines, and field area available for manure application. Soil types are important, as the crop

yield that can be expected for a given crop is dependent on the soil type. As crop yield varies, so must your rate of manure application.

Crop Selection

To apply the waste nutrients in amounts that will not degrade water quality, you must determine the crops to be grown, their nutrient requirements, and when they are actively taking up nutrients. You will also need to understand the terms **agronomic rate, priority nutrient**, and **realistic yield expectation (RYE)**.

Define agronomic rate.

The term **agronomic rate** is often used in reference to waste utilization. Agronomic rate means that nutrients will be applied in accordance with the needs of the crop. Thus, rates and timing of application must be made to optimize the uptake of nutrients. This can be fairly straightforward for commercial fertilizers, but waste application generally requires more planning.

Plants need 17 different nutrients to complete their life cycle, 14 of which come from the soil and three (carbon, oxygen, and hydrogen) of which come from the water and air. Nutrients typically present in waste are not found in ratios that perfectly match the needs of a growing crop. Usually, only one of the many nutrients present in animal waste can be applied at a rate that meets the specific needs of that crop. If you have to choose one of the 14 essential elements to base your waste application rates on, how do you decide which one? One way is to pick the nutrient present in the highest quantity. Another option is to pick the nutrient that is most costly to purchase. From an environmental and crop production standpoint, however, it makes more sense to select the nutrient that is most likely to cause a problem either to the plant or to the environment when too much or too little is applied. This nutrient is called the **priority nutrient**. For most animal WUPs, N is the priority nutrient.

Describe the role of vegetation in waste management.

To determine the amount of waste to apply, you must know the nutrient requirements of the crops to be planted. Crops are an integral part of the waste treatment system. In a waste management system, the function of the crop is to:

- Use the applied nutrients
- Prevent soil erosion
- Take up water
- Provide food and habitat for organisms in the soil that further break down and use the waste products

List factors to consider in crop selection.

Crops for waste utilization are often selected for their ability to take up large amounts of nutrients. While this is very important, other factors should be considered. These include:

- Adaptation to the local climate, soil types, and drainage systems
- Ability to use nutrients when applications must be made
- Ease of management
- Harvest requirements
- Marketability
- Profitability

Crop Nutrient Requirements

Crops vary in their ability to use nutrients. Because the amount of nutrients required by a crop usually corresponds directly with the yield, there must be some way of estimating the yields expected on different soil types. Yields vary with weather conditions, soils, cultivars, pest pressure, level of management, and many other factors; therefore, the best way to estimate yield potential is to use existing production records. Where records are available, you can average the three highest yields in five consecutive crop years for the field. Keep in mind that if you use a multiyear rotation, such as corn-wheat-soybean, it could take 10 years to accumulate the data necessary to estimate yields on any of these crops.

Define realistic yield expectation (RYE).

The RYE is the estimated crop yield for a given field. Where records are not available, values of RYEs for agricultural soils were developed by the NRCS in conjunction with North Carolina Cooperative Extension, DWR, and other technical specialists. These values are based on inherent soil properties and long-term observations. The technical specialist uses RYE tables (**realisticyields.ces.ncsu.edu**) to develop nutrient application rates for your fields.

N Utilization

When identifying yield estimates based on soil types, the technical specialist will use the same website to also identify the realistic N rate, which is an estimate of the total PAN needed to reach the RYE and the maximum allowable PAN per acre in WUPs. Table 3-4 lists the general range of allowable PAN per unit yield (lb N/bu, lb N/ton, or lb N/cwt) for several common North Carolina crops.

Each individual field will have a PAN limit that must not be exceeded or a violation of the plan and permit will result. Once all the fields and crops have been evaluated, the total rate of PAN usage is compared to the PAN generated by the facility. A PAN deficit is required, meaning the farm is able to handle the manure nitrogen produced.

If you do not have enough land to handle the PAN produced, your options are:

- Obtain more acreage for manure application
- Change cropping types or patterns to use more N per acre
- Use a custom applicator to remove some waste from your farm
- Reduce the N in your wastewater by further treating the waste prior to application (see Chapter 5: System Components and Operation—Type A)
- Reduce number of animals proposed or already at the facility; or change type of animal production to produce less PAN (requires permit and certification change)
- Change animal feed rations to reduce total manure nutrient production

Table 3-4. Nitrogen Fertilization Guidelines.

Commodity	lb PAN/Realistic Yield Expectation
Corn (grain)	0.6 to 0.8 lb N/bu
Wheat (grain)	0.6 to 1.3 lb N/bu
Rye (grain)	1.8 to 2.4 lb N/bu
Oats (grain)	1.0 to 1.3 lb N/bu
Barley (grain)	1.4 to 1.6 lb N/bu
Soybean (grain)	3.8 to 4.0 lb N/bu
Triticale (grain)	1.4 to 1.6 lb N/bu
Sorghum (grain)	1.5 to 2.0 lb N/cwt
Corn (silage)	10 to 12 lb N/ton
Sorghum-sudangrass (hay [1])	45 to 55 lb N/dry ton
Pearl millet (hay [1])	45 to 55 lb N/dry ton
Bermudagrass (hay [1])	40 to 50 lb N/dry ton
Tall fescue (hay [1])	40 to 50 lb N/dry ton
Orchard grass (hay [1])	40 to 50 lb N/dry ton
Timothy (hay [1])	40 to 50 lb N/dry ton
Small grain (hay [1])	40 to 60 lb N/dry ton
Cotton	0.03 to 0.12 lb N/lb lint
Pine trees [2]	30 to 60 lb N/acre/year
Hardwood trees [2]	30 to 80 lb N/acre/year

[1] Reduce N rate by 25 percent when grazing.

[2] Limit dictated by NC Interagency Nutrient Management Committee/Regulatory requirements for WUPs

Application Windows

Describe why timing of waste applications is important.

Once the crops used for waste application are identified, estimates of appropriate waste application timings will be made. The WUP will contain tables that show the range of acceptable manure application dates for the crops used in the plan. These cropping windows are designed to optimize uptake of the manure nutrients while minimizing environmental impacts.

Irrigation Application Factors

Different soils have differing abilities to absorb irrigated wastewater. The technical specialist will review the soil types and assign application factors to each field. These factors are noted in inches per hour (in/hr) application rate and total inches per application event. These will be used in the irrigation system design as well as operational decisions. These topics will be covered in detail in Chapter 6: Proper Application of Waste Products—Type A.

Required Specifications (BMPs)

BMPs are the structural or operational practices that help you operate a waste management system with minimal impacts to the environment. BMPs help reduce nutrient losses from the farm. BMPs include erosion and sediment control measures to reduce movement of topsoil and nutrients into streams. Injection of wastes to reduce runoff, volatile N losses, and odors may also be a BMP.

List ways in which best management practices protect water quality.

BMPs, when properly carried out, can improve water quality. Generally, an animal operation will have a combination of several BMPs. Key BMPs for animal waste management systems include:

- Critical area planting
- Stormwater diversion
- Stream fencing
- Windbreaks
- Buffer and filter strips; riparian areas
- Grassed waterway
- Calibrated irrigation system
- Soil, waste, and plant tissue sampling
- Water control structures and controlled drainage
- Water conservation practices in the animal buildings

Describe the importance of BMPmaintenance and describe what to do if a BMP fails.

The BMPs for your operation should be designed (and the installation reviewed) by an expert trained in these systems. It is beyond the scope of this manual to explain every BMP or combination that could be implemented on your farm. However, you should keep a maintenance schedule of your BMPs and refer to it frequently. The use of BMPs will provide water quality benefits only as long as the practices are designed, installed, and maintained properly. Many studies have been performed that document water quality improvement in streams adjacent to where BMPs have been used in surrounding agricultural areas. If BMPs are not performing their functions as designed, you should contact a technical specialist for advice on appropriate remedies.

Emergency Action Plan

A plan dealing with emergency situations is required. Emergency action plans will be covered in detail in Chapter 9: Emergencies and Catastrophes—Type A.

Odor Control

On many operations, odor is likely to be the number one community issue for both producers and the general public. Because people can detect a smell that they find offensive, they assume there is an environmental problem. The good news is that odor can often be managed by reducing sources of odor. Decomposing manure is the most obvious source. Generally, decomposing manure that has undergone some type of anaerobic (without oxygen) breakdown has a more offensive odor than fresh manure. Factors that affect odor include feed source, animal metabolism, and environmental conditions in which manure is stored and spread. Decomposing feed and carcasses can also contribute to odor.

The N.C. Division of Air Quality (DAQ) regulates air quality and addresses odor complaints. This division does not routinely inspect or issue permits for air quality limits at animal operations. They will address and investigate complaints about odors and air quality. If a complaint is filed against your operation, an inspector will visit and make an assessment of the odor and nuisance potential. The findings of this visit may result in requirements for specific odor control measures to be installed. Appendix B has more information on the DAQ animal odor enforcement program (Section .1800 – Control of Odors).

A checklist of BMPs to control odor is included in Appendix B. As part of your animal waste management plan, a technical specialist will help you select practices from this list to control odors on your farm. Once the checklist is completed, it becomes your responsibility to follow those practices, so check only practices that are currently in place on the operation and update the checklist if you change your odor control practices.

Insect Control

Insect control can also be a community issue for both producers and the general public. Usually, insect problems can be found where feed has spilled or manure has accumulated. Again, the good news is that insects can be controlled using BMPs.

A checklist of BMPs to control insects is included in Appendix B. As part of your animal waste management plan, a technical specialist will help you select practices from this list to be used on your farm. Once the checklist is completed, it becomes your responsibility to follow those practices, so check only practices that are currently in place on the operation and update the checklist if you change your insect control practices.

Animal Mortality

Animal mortality is regulated by the N.C. Department of Agriculture & Consumer Services (NCDA&CS) Veterinary Division. Your WUP will address the requirements of these regulations.

The management of animal mortalities is a critical component of a farm's animal waste management system. Improper disposal of animals will produce odor and disease problems and also may contribute to the degradation of groundwater and surface water quality. Proper mortality disposal is part of an operations' daily management responsibilities.

The following are acceptable animal mortality disposal methods:

- Burial 3 feet beneath the surface of the ground within 24 hours after knowledge of the death. The burial must be at least 300 feet from any flowing stream or public body of water and 3 feet above the water table. A burial location map and plan must be included in the WUP.
- Rendering at a rendering plant licensed under G.S. 106-168.7.
- Complete incineration according to 02 NCAC 52C .0102.
- A composting system approved and permitted by NCDA&CS Veterinary Division.
- Landfill at municipal solid waste facility permitted by NC DEQ under GS 15A NCAC 13B .0200.

- In the case of dead poultry only, placing in a disposal pit of a size and design approved by the NCDA&CS.
- Any method, including composting, which in the professional opinion of the State Veterinarian would make possible the salvage of part of a dead animal's value without endangering human or animal health. Written approval of the State Veterinarian must be attached.

If there is a catastrophic natural disaster or a reportable disease event in North Carolina, the state veterinarian may issue specific mortality management guidelines for the event. Information will be communicated from the NCDA&CS Veterinary Division.

WUP Agreement and Leased Land Agreements

The WUP agreement must be signed by the animal producer and the technical specialist. This form is maintained on file by the local Soil and Water Conservation District, by DWR, and at the farm. If any land not owned by the producer is to be used in the waste management plan, agreements must be signed and maintained for the use of that land. An example agreement is in Appendix B.

WUP Changes

When a WUP must be amended to reflect changes at a farm or modifications to the plan (such as adding fields or changing crop rotations), a technical specialist must make these changes using approved forms and under approved guidance. Some minor changes can be made easily, whereas major changes may require extensive technical review and redesign of some system components. The waste system owner is required to maintain a copy of the current WUP and all of its revisions or amendments at the farm. This document must be available to the waste system operator.

Changes to WUPs must follow all laws and guidance in effect at the time of the change. For this reason, and because laws change over time, some components of the waste plan may vary depending on the time the waste plan, revision, or amendment was made. For example, it is possible for there to be several different setbacks from waste application areas to surface waters depending on the dates the fields were added to the plan.

WUP Changes: Sludge Management Plans

If the sludge survey (as required by state and NPDES permits) shows that the lagoon is in need of sludge removal, the waste plan must include a Plan of Action (POA) for Lagoon Sludge Reduction as required by DWR. The POA for Lagoon Sludge Reduction describes the method (for example, microbes or sludge removal) to be used to lower the average sludge depth to a compliant level within two years of the survey date on which the lagoon was determined to be out of compliance.

The Certified Sludge Management Plan is the farm's specific sludge removal plan. The plan must be certified by a designated technical specialist and include the volume of sludge to be removed, the cropping system and fields that will be receiving the sludge, the removal and application methods, the application windows, sludge analyses, and other related records. Consideration must also be given to the potential for heavy metal buildup (copper

and zinc) in soils due to the sludge application. A Certified Sludge Management Plan may be substituted for a Sludge Reduction POA to meet DWR's monitoring and reporting requirements.

Note: A POA for Lagoon Sludge Reduction and a Certified Sludge Management Plan are distinct. While a Certified Sludge Management Plan may be substituted for a Sludge Reduction POA, a Sludge Reduction POA cannot be substituted for a Certified Sludge Management Plan.

To prevent buildup of P and persistent metals that may render sites unsuitable for long-term waste application, it is highly recommended that sludge be applied only to fields that are not used for continual animal waste application. If the sludge is to be applied on sprayfields already listed in the CAWMP, the operation's overall PAN balance must include the additional PAN from the sludge and still remain in a PAN deficit for the animal operation.

Some waste plans were written with sludge removal guidance, but many were not. Once a certified sludge management plan has been prepared, it becomes part of the WUP to show the destination of the sludge based on agronomic rates. The operator must obtain waste analyses of the sludge to complete all sludge application records.

Waste plan modifications should be done using existing farm records. Records of crop yields, soil tests, and waste analyses are all valuable tools for the technical specialist to use to revise a waste plan. Waste plan amendments, major changes, and revisions all have specific definitions that can be found in the General Permit (Appendix A).

Phosphorus Loss Assessment Tool (PLAT)

Describe which facilities must perform a phosphorus loss assessment.

Facilities that hold an NPDES permit must perform a PLAT assessment on the fields listed in the WUP. Other facilities may also be required to perform a PLAT assessment.

This tool assesses the potential for P transport off-site by evaluating site-specific factors that address each of the four potential P loss pathways: particulate P attached to eroding soil particles, soluble P in stormwater runoff, leached soluble P moving down through the soil profile, and other P losses that could occur directly from the applied manure sources.

PLAT assessments must be performed by technical specialists designated specifically in the PLAT program. PLAT ratings are based on field conditions and information provided by the producer (current soil sampling reports, deep soil sampling reports where applicable, cropping histories, and waste application records). The PLAT assessment will result in a rating of low, medium, high, or very high. A low or medium rating means that the field may still receive manure applications based on N rates. A high rating means that manure and other nutrient sources may be applied at a rate that cannot exceed the P removal rate of the crop. This rate will be substantially lower than current manure application rates based on N. A rating of very high will allow no additional P applications, and the field must be removed from the WUP portion of the CAWMP.

The PLAT tool is a working tool in that it not only assesses a field based on its current practices, but it also looks at the "what if" possibilities to see what effect management changes might have on a PLAT rating. Conservation measures and deep tillage are mechanisms that could lower a PLAT rating and allow the continuance of an N-based manure application rate. *The producer should be aware, however, that over time if one applies manure based on the crop N needs, then soil P levels and the PLAT rating will eventually increase.*

Example WUP

Following is an example of a WUP. The topics referenced in the previous text are highlighted here to help with your understanding of the WUP. You should become very familiar with your farm's WUP, as it contains much information about operating your waste system properly and in compliance with state law.

Review Questions

1. What is the goal of a WUP?
2. Where is a waste management plan required to be maintained?
3. How can you determine how much PAN your fields are allowed to accept?
4. What is "realistic yield expectation?"
5. How are manure generation rates and PAN determined?
6. What are BMPs?
7. What agency issues permits for animal waste management?
8. Define "technical specialist."

Sample Nutrient Management Plan for Animal Waste Utilization

Nutrient Management Plan For Animal Waste Utilization
12-09-2016

This plan has been prepared for:

Sycamore Farm
Mary G Farmer
123 Sycamore Farm Lane

Anytown, NC 23456
1234567890

This plan has been developed by:

Eve H. Honeycutt
N C Cooperative Extension
Lenoir County Center
1791 Hwy 11/55
Kinston, NC 28504
252-527-2191

Developer Signature

Type of Plan: Nitrogen Only with Manure Only

Owner/Manager/Producer Agreement

I (we) understand and agree to the specifications and the operation and maintenance procedures established in this nutrient management plan which includes an animal waste utilization plan for the farm named above. I have read and understand the Required Specifications concerning animal waste management that are included with this plan.

Signature (owner) Date

Signature (manager or producer) Date

This plan meets the minimum standards and specifications of the U.S. Department of Agriculture - Natural Resources Conservation Service or the standard of practices adopted by the Soil and Water Conservation Commission.

Plan Approved By: Technical Specialist Signature 12-9-16 Date

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Nutrients applied in accordance with this plan will be supplied from the following source(s):

Commercial Fertilizer is not included in this plan.

S75	Swine Wean-Finish Lagoon Liquid waste generated 2,824,640 gals/year by a 3,640 animal Swine Wean-Finish Lagoon Liquid operation. This production facility has waste storage capacities of approximately 180 days.				
Estimated Pounds of Plant Available Nitrogen Generated per Year					
Broadcast	5091				
Incorporated	6110				
Injected	6110				
Irrigated	5091				
	Max. Avail. PAN (lbs) *	Actual PAN Applied (lbs)	PAN Surplus/ Deficit (lbs)	Actual Volume Applied (Gallons)	Volume Surplus/ Deficit (Gallons)
Year 1	5,091	6263	-1,172	3,474,560	-649,920
Year 2	5,091	5998	-907	3,327,754	-503,114

Note: In source ID, S means standard source, U means user defined source.

* Max. Available PAN is calculated on the basis of the actual application method(s) identified in the plan for this source.

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The table shown below provides a summary of the crops or rotations included in this plan for each field. Realistic Yield estimates are also provided for each crop in the plan. In addition, the Leaching Index for each field is shown, where available.

Planned Crops Summary

Tract	Field	Total Acres	Useable Acres	Leaching Index (LI)	Soil Series	Crop Sequence	RYE
1234	1	10.50	9.50	N/A	Norfolk	Small Grain Overseed	1.0 Tons
						Hybrid Bermudagrass Hay	6.5 Tons
1234	2	12.40	10.10	N/A	Goldsboro	Corn, Grain	130 bu.
						Wheat, Grain	65 bu.
						Soybeans, Manured, Double Crop	38 bu.
1234	3	5.00	4.50	N/A	Rains	Fescue Pasture	4.5 Tons
PLAN TOTALS:		27.90	24.10				

LI	*Potential Leaching*	*Technical Guidance*
< 2	Low potential to contribute to soluble nutrient leaching below the root zone.	None
>= 2 & <= 10	Moderate potential to contribute to soluble nutrient leaching below the root zone.	Nutrient Management (590) should be planned.
> 10	High potential to contribute to soluble nutrient leaching below the root zone.	Nutrient Management (590) should be planned. Other conservation practices that improve the soils available water holding capacity and improve nutrient use efficiency should be considered. Examples are Cover Crops (340) to scavenge nutrients, Sod-Based Rotations (328), Long-Term No-Till (778), and edge-of-field practices such as Filter Strips (393) and Riparian Forest Buffers (391).

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NOTE: Symbol * means user entered data.

The Waste Utilization table shown below summarizes the waste utilization plan for this operation. This plan provides an estimate of the number of acres of cropland needed to use the nutrients being produced. The plan requires consideration of the realistic yields of the crops to be grown, their nutrient requirements, and proper timing of applications to maximize nutrient uptake.

This table provides an estimate of the amount of nitrogen required by the crop being grown and an estimate of the nitrogen amount being supplied by manure or other by-products, commercial fertilizer and residual from previous crops. An estimate of the quantity of solid and liquid waste that will be applied on each field in order to supply the indicated quantity of nitrogen from each source is also included. A balance of the total manure produced and the total manure applied is included in the table to ensure that the plan adequately provides for the utilization of the manure generated by the operation.

Waste Utilization Table **Year 1**

Tract	Field	Source ID	Soil Series	Total Acres	Use. Acres	Crop	RYE	Applic. Period	Nitrogen PA Nutrient Req'd (lbs/A) N	Comm. Fert. Nutrient Applied (lbs/A) N	Res. (lbs/A) N	Applic. Method	Manure PA Nutrient Applied (lbs/A) N	Liquid ManureApplied (acre) 1000 gal/A	Solid Manure Applied (acre) Tons	Liquid Manure Applied (Field) 1000 gals	Solid Manure Applied (Field) tons
1234	1	S75	Norfolk	10.50	9.50	Small Grain Overseed	1.0 Tons	10/1-3/31	50	0	0	Irrig.	50	27.74	0.00	263.52	0.00
1234	1	S75	Norfolk	10.50	9.50	Hybrid Bermudagrass Hay	6.5 Tons	3/1-9/30	296	0	0	Irrig.	296	164.22	0.00	1,560.04	0.00
1234	2	S75	Goldsboro	12.40	10.10	Corn, Grain	130 bu.	2/15-6/30	148	0	0	Irrig.	148	82.11	0.00	829.28	0.00
1234	2	S75	Goldsboro	12.40	10.10	Wheat, Grain	65 bu.	9/1-4/30	136	0	0	Irrig.	82	45.27	0.00	457.23	0.00
1234	3	S75	Rains	5.00	4.50	Fescue Pasture	4.5 Tons	8/1-7/31	146	0	0	Irrig.	146	81.00	0.00	364.49	0.00
															Total Applied, 1000 gallons	3,474.56	
															Total Produced, 1000 gallons	2,824.64	
															Balance, 1000 gallons	-649.92	
															Total Applied, tons		0.00
															Total Produced, tons		0.00
															Balance, tons		0.00

Notes: 1. In the tract column, ~ symbol means leased, otherwise, owned. 2. Symbol * means user entered data.

Waste Utilization Table **Year 2**

Tract	Field	Source ID	Soil Series	Total Acres	Use. Acres	Crop	RYE	Applic. Period	Nitrogen PA Nutrient Req'd (lbs/A)	Comm. Fert. Nutrient Applied (lbs/A)	Res. (lbs/A)	Applic. Method	Manure PA Nutrient Applied (lbs/A)	Liquid ManureApplied (acre)	Solid Manure Applied (acre)	Liquid Manure Applied (Field)	Solid Manure Applied (Field)
									N	N	N		N	1000 gal/A	Tons	1000 gals	tons
1234	1	S75	Norfolk	10.50	9.50	Small Grain Overseed	1.0 Tons	10/1-3/31	50	0	0	Irrig.	50	27.74	0.00	263.52	0.00
1234	1	S75	Norfolk	10.50	9.50	Hybrid Bermudagrass Hay	6.5 Tons	3/1-9/30	296	0	0	Irrig.	296	164.22	0.00	1,560.04	0.00
1234	2	S75	Goldsboro	12.40	10.10	Wheat, Grain	65 bu.	9/1-4/30	136	0	0	Irrig.	54	30.18	0.00	304.82	0.00
1234	2	S75	Goldsboro	12.40	10.10	Soybeans, Manured, Double Crop	38 bu.	4/1-9/15	149	0	0	Irrig.	149	82.66	0.00	834.89	0.00
1234	3	S75	Rains	5.00	4.50	Fescue Pasture	4.5 Tons	8/1-7/31	146	0	0	Irrig.	146	81.00	0.00	364.49	0.00
																Total Applied, 1000 gallons	3,327.75
																Total Produced, 1000 gallons	2,824.64
																Balance, 1000 gallons	-503.11
																Total Applied, tons	0.00
																Total Produced, tons	0.00
																Balance, tons	0.00

Notes: 1. In the tract column, ~ symbol means leased, otherwise, owned. 2. Symbol * means user entered data.

The Irrigation Application Factors for each field in this plan are shown in the following table. Infiltration rate varies with soils. If applying waste nutrients through an irrigation system, you must apply at a rate that will not result in runoff. This table provides the maximum application rate per hour that may be applied to each field selected to receive wastewater. It also lists the maximum application amount that each field may receive in any one application event.

Irrigation Application Factors

Tract	Field	Soil Series	Application Rate (inches/hour)	Application Amount (inches)
1234	1	Norfolk	0.50	1.0
1234	2	Goldsboro	0.50	1.0
1234	3	Rains	0.40	1.0

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NOTE: Symbol * means user entered data.

The Available Waste Storage Capacity table provides an estimate of the number of days of storage capacity available at the end of each month of the plan. Available storage capacity is calculated as the design storage capacity in days minus the number of days of net storage volume accumulated. The start date is a value entered by the user and is defined as the date prior to applying nutrients to the first crop in the plan at which storage volume in the lagoon or holding pond is equal to zero.

Available storage capacity should be greater than or equal to zero and less than or equal to the design storage capacity of the facility. If the available storage capacity is greater than the design storage capacity, this indicates that the plan calls for the application of nutrients that have not yet accumulated. If available storage capacity is negative, the estimated volume of accumulated waste exceeds the design storage volume of the structure. Either of these situations indicates that the planned application interval in the waste utilization plan is inconsistent with the structure's temporary storage capacity.

Available Waste Storage Capacity

Source Name	Swine Wean-Finish Lagoon Liquid	**Design Storage Capacity (Days)**
Start Date	9/1	180
Plan Year	Month	Available Storage Capacity (Days) *
1	1	48
1	2	58
1	3	65
1	4	106
1	5	137
1	6	169
1	7	178
1	8	180
1	9	179
1	10	180
1	11	177
1	12	153
2	1	122
2	2	110
2	3	115
2	4	176
2	5	180
2	6	180
2	7	180
2	8	180
2	9	159
2	10	144
2	11	121
2	12	97

* Available Storage Capacity is calculated as of the end of each month.

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Required Specifications For Animal Waste Management

1. **Animal waste shall not reach surface waters of the state by runoff, drift, manmade conveyances, direct application, or direct discharge during operation or land application. Any discharge of waste that reaches surface water is prohibited.**

2. **There must be documentation in the design folder that the producer either owns or has an agreement for use of adequate land on which to properly apply the waste. If the producer does not own adequate land to properly dispose of the waste, he/she shall provide evidence of an agreement with a landowner, who is within a reasonable proximity, allowing him/her the use of the land for waste application. It is the responsibility of the owner of the waste production facility to secure an update of the Nutrient Management Plan when there is a change in the operation, increase in the number of animals, method of application, receiving crop type, or available land.**

3. **Animal waste shall be applied to meet, but not exceed, the nitrogen needs for realistic crop yields based upon soil type, available moisture, historical data, climatic conditions, and level of management, unless there are regulations that restrict the rate of applications for other nutrients.**

4. **Animal waste shall be applied to land eroding less than 5 tons per acre per year. Waste may be applied to land eroding at more than 5 tons per acre per year but less than 10 tons per acre per year provided grass filter strips are installed where runoff leaves the field (see USDA, NRCS Field Office Technical Guide Standard 393 - Filter Strips).**

5. **Odors can be reduced by injecting the waste or by disking after waste application. Waste should not be applied when there is danger of drift from the land application field.**

6. **When animal waste is to be applied on acres subject to flooding, waste will be soil incorporated on conventionally tilled cropland. When waste is applied to conservation tilled crops or grassland, the waste may be broadcast provided the application does not occur during a season prone to flooding (see "Weather and Climate in North Carolina" for guidance).**

7. **Liquid waste shall be applied at rates not to exceed the soil infiltration rate such that runoff does not occur offsite or to surface waters and in a method which does not cause drift from the site during application. No ponding should occur in order to control odor and flies.**

8. **Animal waste shall not be applied to saturated soils, during rainfall events, or when the soil surface is frozen.**

9. **Animal waste shall be applied on actively growing crops in such a manner that the crop is not covered with waste to a depth that would inhibit growth. The potential for salt damage from animal waste should also be considered.**

10. **Nutrients from waste shall not be applied in fall or winter for spring planted crops on soils with a high potential for leaching. Waste/nutrient loading rates on these soils should be held to a minimum and a suitable winter cover crop planted to take up released nutrients. Waste shall not be applied more than 30 days prior to planting of the crop or forages breaking dormancy.**

11. **Any new swine facility sited on or after October 1, 1995 shall comply with the following: The outer perimeter of the land area onto which waste is applied from a lagoon that is a component of a swine farm shall be at least 50 feet from any residential property boundary and canal. Animal waste, other than swine waste from facilities sited on or after October 1, 1995, shall not be applied closer that 25 feet to perennial waters.**

12. **Animal waste shall not be applied closer than 100 feet to wells.**

13. **Animal waste shall not be applied closer than 200 feet of dwellings other than those owned by the landowner.**

14. **Waste shall be applied in a manner not to reach other property and public right-of-ways.**

15. **Animal waste shall not be discharged into surface waters, drainageways, or wetlands by a discharge or by over-spraying. Animal waste may be applied to prior converted cropland provided the fields have been approved as a land application site by a "technical specialist". Animal waste shall not be applied on grassed waterways that discharge directly into water courses, and on other grassed waterways, waste shall be applied at agronomic rates in a manner that causes no runoff or drift from the site.**

16. **Domestic and industrial waste from washdown facilities, showers, toilets, sinks, etc., shall not be discharged into the animal waste management system.**

17. **A protective cover of appropriate vegetation will be established on all disturbed areas (lagoon embankments, berms, pipe runs, etc.). Areas shall be fenced, as necessary, to protect the vegetation. Vegetation such as trees, shrubs, and other woody species, etc., are limited to areas where considered appropriate. Lagoon areas should be kept mowed and accessible. Berms and structures should be inspected regularly for evidence of erosion, leakage, or discharge.**

18. **If animal production at the facility is to be suspended or terminated, the owner is responsible for obtaining and implementing a "closure plan" which will eliminate the possibility of an illegal discharge, pollution, and erosion.**

19. **Waste handling structures, piping, pumps, reels, etc., should be inspected on a regular basis to prevent breakdowns, leaks, and spills. A regular maintenance checklist should be kept on site.**

20. **Animal waste can be used in a rotation that includes vegetables and other crops for direct human consumption. However, if animal waste is used on crops for direct human consumption, it should only be applied pre-plant with no further applications of animal waste during the crop season.**

21. **Highly visible markers shall be installed to mark the top and bottom elevations of the temporary storage (pumping volume) of all waste treatment lagoons. Pumping shall be managed to maintain the liquid level between the markers. A marker will be required to mark the maximum storage volume for waste storage ponds.**

22. **Waste shall be tested within 60 days of utilization and soil shall be tested at least annually at crop sites where waste products are applied. Nitrogen shall be the rate-determining nutrient, unless other restrictions require waste to be applied based on other nutrients, resulting in a lower application rate than a nitrogen based rate. Zinc and copper levels in the soils shall be monitored and alternative crop sites shall be used when these metals approach excessive levels. pH shall be adjusted and maintained for optimum crop production. Soil and waste analysis records shall be kept for a minimum of five years. Poultry dry waste application records shall be maintained for a minimum of three years. Waste application records for all other waste shall be maintained for five (5) years.**

23. **Dead animals will be disposed of in a manner that meets North Carolina regulations.**

Chapter 4: Tools for the Plan—Type A

Now that you understand what is in a waste management plan, you need to know the tools to follow your plan. These tools include waste, soil, and plant analyses.

Waste Analysis

Describe why the proper collection of waste samples is important.

Nutrient concentrations vary in most wastes. A review of samples analyzed by the NCDA&CS Agronomic Division shows that the available nutrients in animal waste can vary greatly. Accurate, consistent sampling techniques will provide the most reliable sample results, enabling the most precise determination of application rates to meet crop nutrient requirements.

> *Note: General recommendations for sampling are provided below. You should determine if your individual waste management plan has specific sampling requirements.*

Explain how often waste samples must be taken.

N.C. General Statute 143-215.10 requires that waste sampling be performed within 60 days of a waste application. Preferably, the sample should be taken as near the application time as possible prior to the waste application. However, if it is urgent to pump down a full lagoon or storage pond, you should not wait until you can sample and obtain the results—you should sample the day of irrigation. The results can later be used to determine the nutrients applied to the fields and identify whether additional nutrients are needed to complete crop production.

Waste users who fail to test each waste source before or immediately after land application will be faced with a number of questions they simply may not be able to answer: Are they supplying plants with adequate nutrients? Are they building up excess nutrients that may ultimately move to surface waters or groundwater? Are they applying heavy metals at levels that may be toxic to plants and permanently impair soil productivity?

Because environmental damage and losses in plant yield and quality often happen before visible plant symptoms, growers should always have their waste analyzed by a competent laboratory. The NCDA&CS Agronomic Division can analyze waste samples and make agronomic recommendations regarding the use of animal waste as a fertilizer.

Waste Sampling

Describe how to take a waste sample of a lagoon, waste slurry, or dry waste and submit it for nutrient analysis.

Proper sampling is the key to reliable waste analysis. Although laboratory procedures are extremely accurate, they have little value if the sample fails to represent the waste product that was actually applied to the field.

Waste samples submitted to a laboratory should represent the average composition of the material that will be applied. Reliable samples typically consist of material collected from a number of locations. Precise sampling methods will vary according to the type of waste. All wastes should be collected in a clean, plastic bucket. Do not use galvanized containers for collection, mixing, or storage (these can introduce contaminants like zinc to your waste sample and lead to inaccurate results). Glass should never be used to submit a sample, as it

can break during shipment, becoming a safety hazard and causing loss of your sample. Your laboratory should have specific instructions on sampling, including proper containers for sample collection and submission and maximum holding or shipping times.

Liquid Wastes

Liquid waste samples submitted for analysis should meet the following requirements:

- Place sample in a sealed, clean, plastic container with about a 1pint volume.
- Leave at least 1 inch of air space in the plastic container to allow for expansion caused by the release of gas from the waste material.
- Refrigerate samples that cannot be shipped on the day they are collected; this will minimize chemical reactions and pressure buildup from gases.

Ideally, liquid wastes should be sampled after they are thoroughly mixed. Because this is sometimes impractical, samples can also be taken in accordance with the suggestions that follow.

Lagoon Liquid

Premixing the surface liquid in the lagoon is not necessary if it is the only component that is being pumped. Growers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation.

Samples can be collected using a clean, plastic container similar to the one shown in Figure 4-1. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger clean, plastic container. Waste should be collected at least 6 feet from the edge of the lagoon at a depth of about 1 foot. Shallower samples from anaerobic lagoons may be less representative than deep samples because oxygen transfer near the surface sometimes alters the chemistry of the solution. Floating debris and scum should be avoided.

Submit ¾ pint of the mixed material, leaving adequate head space in the container.

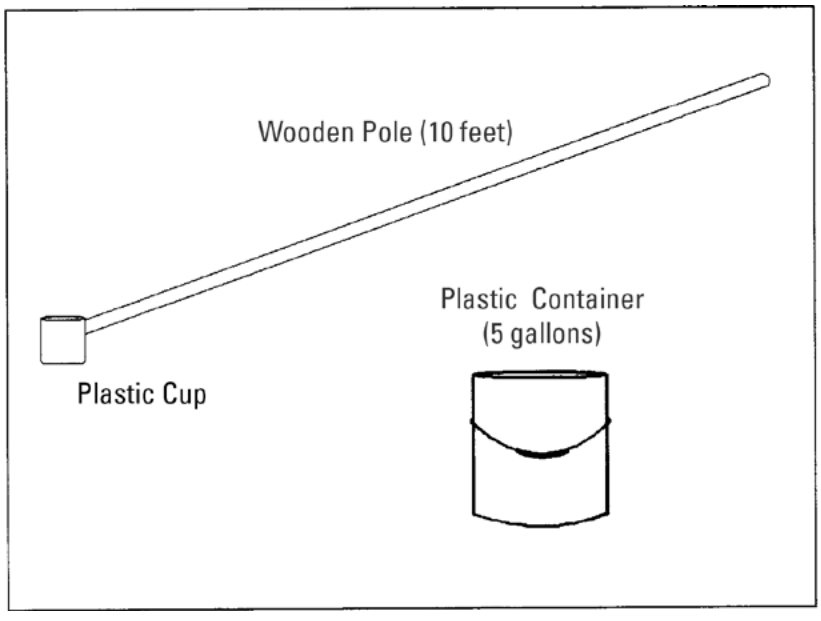


Figure 4-1. Liquid waste sampling device.

Liquid Slurry

Waste materials applied as a slurry from a pit or storage pond should be mixed prior to sampling. If you mix prior to sampling, the liquid sampling device pictured in Figure 4-1 can be used. If you wish to sample a storage structure without agitation, you must use a composite sampling device like the one shown in Figure 4-2. Waste should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of ½-inch to 3/4-inch plastic pipe can also be used: Extend the pipe into the pit, pull up the ball plug (or press your thumb over the end to form an air lock) and remove the pipe from the waste, and then release the air lock to deposit the waste in the plastic container.

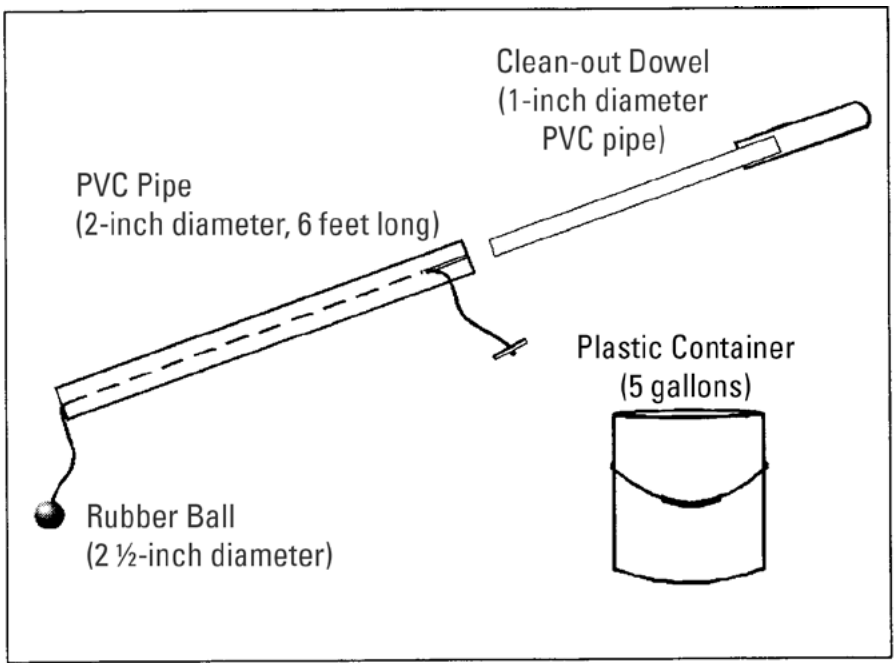


Figure 4-2. Composite sampling device.

For analysis, the laboratory requires 3/4 pint of material in a plastic container. The sample should not be rinsed into the container because that will dilute the mixture and distort nutrient evaluations. If water is typically added prior to land application, make sure to calculate and document the dilution rate for the purposes of nutrient tracking.

Solid Wastes

Solid waste samples should represent the average moisture content of the waste. Samples should be taken from approximately eight different areas in the waste, placed in a clean, plastic container, and thoroughly mixed. Sampling depth should be approximately 4 inches for poultry house litter and 18 inches for stockpiled wastes. Take samples around waterers and feeders in proportion to the space these occupy in the house. Cores should be taken from the top to the bottom of the accumulated waste (don't sample the clay liner). Place about 1 quart of the mixed sample in a plastic bag, seal it, and ship it directly to the laboratory. Solid waste analysis includes an assessment of moisture content, which makes it possible for nutrient concentrations to be converted to a wet basis after samples have

been dried for analysis. As a result, it is very important that the submitted sample be well-sealed so it retains the same moisture content as at collection. Samples stored for more than two days should be refrigerated. Figure 4-3 shows a device for sampling solid waste.

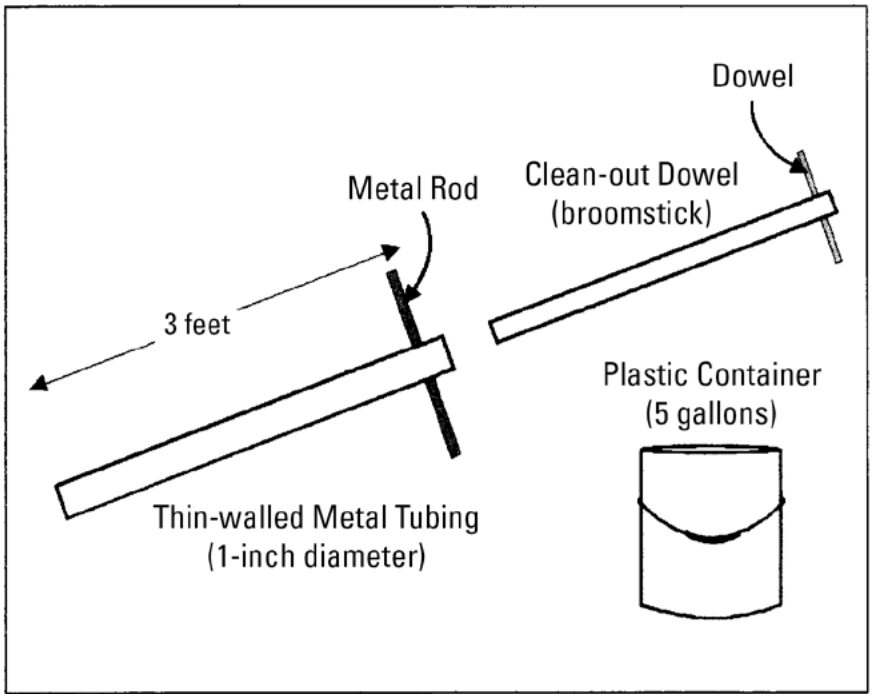


Figure 4-3. Solid waste sampling device.

Who Can Analyze My Waste Sample?

The Plant/Waste/Solution/Media Section of the NCDA&CS Agronomic Division analyzes wastes, interprets analytical results, and provides management recommendations for residents of North Carolina. Each sample must be accompanied by a completed copy of Form AD9 (Appendix C), the Waste Analysis Information Sheet, and $8 for a routine analysis. If a grower suspects that a waste may have acid neutralizing value, then a determination of liming equivalent, termed calcium carbonate equivalency (CCE), should be requested on the sample submission form for an extra $10 fee. These forms are available from your local Cooperative Extension center, the NCDA&CS Regional Agronomist, the Plant/Waste/Solution Advisory Section of the Agronomic Division, or online at **www.ncagr.gov/agronomi/uyrwaste.htm**.

Make checks payable to NCDA&CS. You can pay online for reports that are pending payment by Visa and MasterCard. You can also create an escrow account to prepay for reports by contacting the Agronomic Division at (919) 733-2655.

Directions for filling out form AD9 are printed on the bottom of the form. To get the most value from your waste analysis, please fill out form AD9 completely and accurately. For help filling out form AD9, contact your county Cooperative Extension center, NCDA&CS Regional Agronomist, or a technical specialist with the local Soil and Water Conservation District or

NRCS. Be sure that the waste samples are labeled with your name, phone number, date, waste application method, and sample identification number. This is especially important when submitting several samples at one time. Waste samples from different farms should be submitted on separate information sheets with the appropriate farm ID.

Samples and completed information sheets shipped via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
1040 Mail Service Center
Raleigh, NC 27699-1040

Samples shipped via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
4300 Reedy Creek Road
Raleigh, NC 27607

Private laboratories also offer some of these services, and their fees vary. A good analytical service should always determine the concentrations of essential plant nutrients, including N, P, K, calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (B). A list of laboratories certified for animal waste analysis is available from the N.C. Department of Environmental Quality (DEQ) website (**deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/certified-laboratory-listings**).

What Does My Waste Analysis Report Tell Me?

Describe information available on a Waste Analysis Report.

Once samples submitted to the NCDA&CS Agronomic Division have been analyzed, the sender can look up the report online using the Public Access Laboratory-information-management System (PALS) at **www.ncagr.gov/agronomi/pals**. The sample report in Figure 4-4 lists the concentration of each plant nutrient and several potentially harmful elements in the sample. Specific concentrations of nutrients and other elements are reported on a dry weight basis for solid wastes in parts per million (ppm), which is equivalent to mg/kg; results for liquid wastes are reported on a volume basis in ppm or mg/L.

The most useful information is the estimate of nutrients available for the first crop. These levels are reported on an as-is or wet weight basis in lb/ton for solids and lb/1,000 gal for liquids. Nutrient availability, primarily N, is predicted based on estimates of breakdown of the waste and nutrient loss according to application method. Of the total nutrients predicted to be released for the first crop, 40 to 60 percent likely will become available during the first month. It is, therefore, important to apply wastes near the time required by plants. The remaining nutrients gradually become available over the next three months. Nutrients not available for the first crop are slowly released to available forms over

time. For soils that do not readily leach with heavy rainfall, it is possible for nutrients to accumulate to significant quantities over time.

Interpret the waste analysis report and know if lab results are reasonable.

You should review each waste analysis report to see if the analysis is within expected ranges for your waste. It is common for waste analyses to vary somewhat between seasons, due to excess rainfall or drought, or due to changes in management practices. However, you should compare your results to the results from previous waste reports to ensure that the results appear reasonable. If your results are significantly different from what you would expect, it is advisable to resample the waste. It is possible that the original sample may have been mislabeled or improperly collected and may not be representative of the waste.

Nutrients listed in the report as "available for the first crop" should be used to determine the actual application rate to meet a specific plant nutrient requirement. For the availability prediction to be reliable, growers must have properly identified the type of waste and the application method (for example, broadcast, irrigation, injection, or soil incorporation) on the information sheet submitted to the laboratory.

Nutrient availability cannot be determined with 100 percent accuracy. Many variables, including the type of waste product and environmental factors (for example, soil type, rainfall, temperature, and general soil conditions), influence the breakdown of the waste and nutrient loss. NCDA&CS waste analysis reports provide a realistic estimation of nutrient availability based on type of waste and application method.

Animal waste management regulations require you to maintain your waste analysis reports for a minimum of five years if you have a State Nondischarge Permit or an NPDES Permit. This is to determine if there is consistency in nutrient content and justify your application rates.

Copies of the past four years of your waste analysis reports will be available at the NCDA&CS website (**www.ncagr.gov/agronomi/pals**) and can be accessed by you, your technical specialist, or your county Cooperative Extension agent. Please consult Cooperative Extension or a NCDA&CS Regional Agronomist if you need assistance in interpreting your waste analysis results.

NCDA&CS Agronomic Division Phone: (919) 733-2655 Website: www.ncagr.gov/agronomi/ FY16-W006258

Predictive

Waste Report

Client: Advisor: ,

Sampled: Received: 03/24/2016 Completed: 04/01/2016 Farm: **Links to Helpful Information**

Sample Information

Sample ID: OP60
Waste Code: ALF
Description: Swine-Farrow to Ween Lagoon
Comments:

Nutrient and Other Measurements

Nitrogen (N) (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	S (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)	Na (ppm)	C (ppm)
Total N	48.3	485	82.9	30.4	35.1	1.22	0.25	0.47	0.28	0.94	151	
Total Kjeldahl N 460												

Inorganic N	pH	DM (%)	SS (10^{-5}S/cm)	EC (mS/cm)	CCE (%)	ALE(1000 gal.)	C:N
NH4-N	7.60						
NO3-N							

Organic N	Ni (ppm)	Cd (ppm)	Pb (ppm)	Al (ppm)	Se (ppm)	Li (ppm)	As (ppm)	Cr (ppm)	Co (ppm)	Cl (ppm)	Mo (ppm)
Urea											

Estimate of Nutrients Available for First Crop (lb / 1000 gal.)

Application Method	N	P_2O_5	K_2O	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
Irrigation	1.92	0.92	4.86	0.69	0.25	0.29	0.01	T	T	T	0.01	

Other Elements (lb / 1000 gal.)

Cl	Na	Ni	Cd	Pb	Al	Se	Li
	1.26						

Agronomist's Comments:

Hunter G. Landis 3/30/2016 4:09 PM

Figure 4-4. NCDA&CS Agronomic Division Waste Analysis Report for a lagoon liquid.

North Carolina Tobacco Trust Fund Commission

Reprogramming of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.
- Steve Troxler, Commissioner of

Soil Analysis

While experienced growers can usually recognize a well-nourished crop, it is not possible to look at soil and predict if it is too acidic or if there are proper amounts of the essential nutrients present. Soils in North Carolina vary in their need for lime and other nutrients, depending on soil characteristics, previous fertilization levels, and nutrient requirements of the crop. The goal of soil testing is to find out enough about the soil to provide economically and environmentally sound nutrient and lime recommendations. Soil testing is not a perfect science, but it provides the most reasonable means for growers to assess soil pH and plant-available nutrients, determine the need for lime and fertilizers, and avoid losses and environmental damage from improper lime and fertilization practices.

Animal waste management regulations require soil sampling at least once every three years for every field that receives waste. The NCDA&CS Agronomic Division can analyze soil samples and make agronomic recommendations for lime and fertilizer applications. NCDA&CS provides soil tests for free most of the year (April 1 through late November). From late November through March 31, however, a $4 peak-season fee is charged for the processing of all soil samples. To have specific heavy metals analyzed, the fee is $25. NCDA&CS Agronomic Services Division accepts soil samples for heavy metal analysis only pertaining to regulated/permitted sites used for land application of municipal sludge, septage, or industrial waste as regulated by the DEQ. For these sites, in addition to the routine soil test levels of metals Cu and Zn, which also can be critical for waste applications, arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), nickel (Ni), and selenium (Se) are analyzed.

Sampling instructions, information sheets, and shipping boxes are free and can be obtained from county Cooperative Extension centers, Regional Agronomists of the Agronomic Division, and many businesses selling lime or fertilizer.

Samples and completed information sheets shipped via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Soil Testing Section
1040 Mail Service Center
Raleigh, NC 27699-1040

Samples and completed information sheets shipped via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Soil Testing Section
4300 Reedy Creek Road
Raleigh, NC 27607

If submitting a waste and soil sample in the same package, be sure to address the package to the Plant/Waste/Solution/Media Section rather than the Soil Testing Section so that the

package will be promptly opened and the waste sample properly refrigerated upon arrival. Also, some Cooperative Extension centers will mail samples or transport them to the lab for producers at no charge. Check with your local center for more information.

Describe how to take a soil sample and submit for analysis.

Every soil sample you submit for testing should consist of about 15 to 20 cores taken at random locations throughout one field or area. A sample should include cores from no more than about 20 acres, even if the soil appears to be uniform over a larger area. Keep in mind that each sample should represent only one general soil type or condition. If the field you are sampling contains areas that are obviously different in slope, color, drainage, and texture, and if those areas can be fertilized separately, submit a separate sample (consisting of 15 to 20 cores) for each area (Figure 4-5). The 15- to 20-core sample you have collected will most likely be more soil than the box will hold. Before filling the box, pulverize the cores and mix them thoroughly in a clean, plastic bucket. Then fill the sample box about two-thirds full with this mixture up to the red fill line shown on the box.

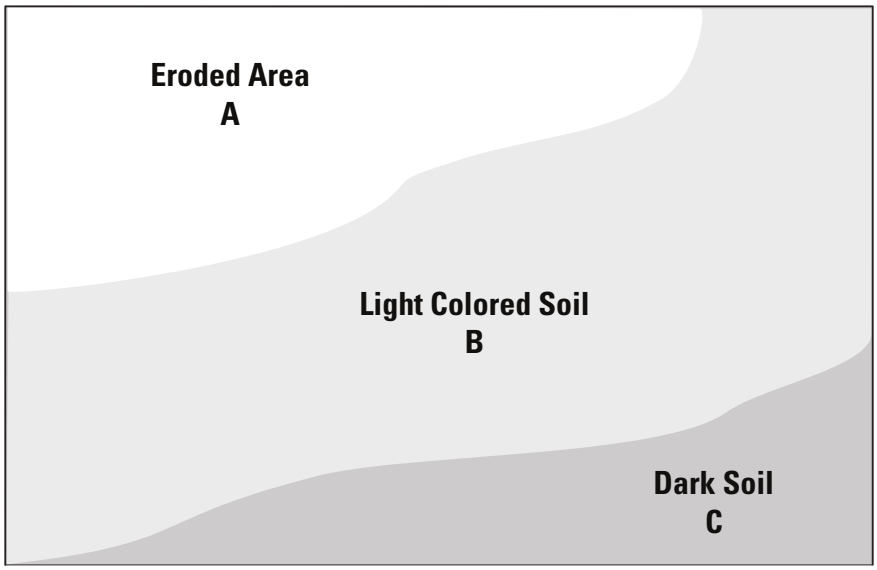


Figure 4-5. Within each field, collect a separate sample from each area that has a different type of soil.

When collecting samples, avoid small areas where the soil conditions are obviously different from those in the rest of the field—for example, wet spots, old manure and urine spots, places where wood piles have been burned, severely eroded areas, old building sites or roadbeds, fencerows, spoil banks, and burn-row areas. Because samples taken from these locations would not be typical of the soil in the rest of the field, including them could produce misleading results. Areas within a field where different crops have been grown in the past should be sampled separately, even if you now plan to grow the same crop in the whole field. Areas that have been limed and fertilized differently from the rest of the field should also be sampled separately.

Collect your samples with stainless steel or chrome-plated sampling tools and plastic buckets to avoid contaminating the samples. Avoid brass, bronze, or galvanized tools. Make

sure that the buckets and sampling tools are clean and free of lime and fertilizer residues. Even a small amount of lime or fertilizer transferred from the sampling tools to the soil can seriously contaminate the sample and produce inaccurate results.

For areas in which field crops are grown, collect samples to the same depth that the field is plowed (usually about 8 inches) because this is the zone in which lime and fertilizer have been incorporated. For fields where soil is not disturbed due to conservation tillage or where perennial crops such as fescue, alfalfa, bermudagrass, and turf are being maintained, samples taken to a depth of 4 inches will best represent the crop's lime and fertilizer needs. Where these perennial crops are to be established, however, sample to the regular plow depth.

Once the soil test levels are measured, the final fertilizer and lime suggestions must be made. Fertilizer recommendations for commercial users are given on a pound per acre basis, nutrient by nutrient. Lime recommendations are in tons per acre.

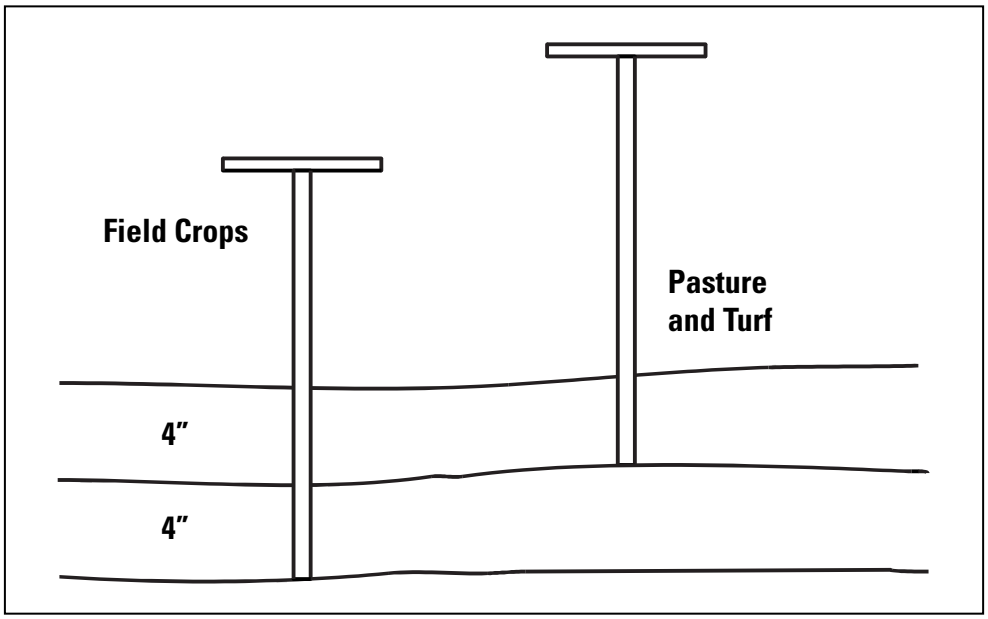


Figure 4-6. Sample to a depth of 8 inches in fields plowed for row crops and 4 inches where perennial pasture or turf crops are grown.

What Does My Soil Test Report Tell Me?

Describe information available on a Soil Test Report.

Your WUP is designed to apply N at agronomic rates. In North Carolina, N is not measured by the soil testing laboratory. However, a soil test is still an essential tool in implementing a WUP. The most immediate need for a soil test is to ensure that soil pH is within the desired range for the crops you are growing. In addition, a soil test can be used to monitor nutrient accumulation and provides information that will help you do a better job of managing the land application site. Only the most essential items found on the soil test report will be discussed here. For more information, please consult Cooperative Extension or an NCDA&CS agronomist.

NCDA&CS Agronomic Division Phone: (919) 733-2655 Website: www.ncagr.gov/agronomi/ Report No. FY15-SL035321

Client: Advisor:

Predictive

Soil Report

Mehlich-3 Extraction

Sampled: 06/03/2015 Received: 06/04/2015 Completed: 06/11/2015 Farm:

Links to Helpful Information

Sample ID: DCF01	Recommendations:	Lime	Nutrients (lb/acre)									More
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	Information
Lime History:	1 - Bermuda hay/past., E	0.8	60-80	40	60	0	0	0	0	0	0	Note: 12
	2 - Small Grain (SG)	0.0	80-100	30	60	0	0	$pH	0	0	0	Note: 3 Note: $

Test Results [units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO_3-N in mg/dm³]: Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO_3-N
0.56	1.09	5.0	66	1.7	5.6	50	38	47	15	26	16	27	20	69	69	80	0.1	2		

Sample ID: DCF02	Recommendations:	Lime	Nutrients (lb/acre)									More
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	Information
Lime History:	1 - Bermuda hay/past., E	0.8	60-80	50	80	0	20	$	0	0	0	Note: 12 Note: $
	2 - Small Grain (SG)	0.0	80-100	30	80	0	20	10	0	0	0	Note: 3

Test Results [units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO_3-N in mg/dm³]: Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO_3-N
0.51	1.13	4.5	61	1.7	5.5	47	29	43	15	25	11	24	17	34	34	161	0.0			

Sample ID: DCF03	Recommendations:	Lime	Nutrients (lb/acre)									More
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	Information
Lime History:	1 - Bermuda hay/past., E	2.3	60-80	40	30	0	20	$	0	0	0	Note: 12 Note: $
	2 - Small Grain (SG)	0.0	80-100	30	30	0	20	10	0	0	0	Note: 3

Test Results [units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO_3-N in mg/dm³]: Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO_3-N
0.60	1.02	5.1	35	3.3	4.6	48	57	20	10	25	4	19	12	31	31	118	0.0			

Figure 4-7. NCDA&CS Agronomic Division Soil Test Report for three forage fields.

North Carolina Tobacco Trust Fund Commission

Reprogramming of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.

- *Steve Trox*

Soil pH and Lime

Soil pH affects the availability of nutrients required for plant growth. An incorrect soil pH will reduce crop growth and yield, resulting in less nutrient uptake and greater potential for environmental problems. Soils in North Carolina are naturally acidic, meaning that they have a low pH. Adding high amounts of ammonia, ammonium, or urea nitrogen sources will also quickly acidify the soil. Low pH increases the availability of metals such as aluminum, Zn, Cu, and Mn, all of which can become toxic to plants at high concentrations. Depending on the amount of N applied, soils with high metal concentrations and low pH may require additions of lime to maintain the pH in a range suitable for plant growth. Dolomitic lime also supplies Ca and Mg, which are essential for crop growth.

The soil test report indicates the amount of lime required, in tons per acre, to achieve the target pH for your soil type and crop. Soils with high amounts of organic matter have a much lower target pH than soils with low organic matter contents. For this reason, soil samples received at the lab are separated into Mineral (MIN), Mineral-Organic (M-O), and Organic (ORG) classes based on their Humic Matter content (HM% on the report), weight per volume (W/V) and color. For most crops, the desired pH is 6.0 for MIN soils, 5.5 for M-O soils, and 5.0 for ORG soil classes. Current laws require you to lime fields that are in waste application systems to meet soil test recommendations. You should also maintain proof of this liming should it be requested during a site inspection.

CEC

The cation exchange capacity (CEC) gives an indication of the ability of the soil to hold nutrients. In North Carolina, CEC increases with increasing clay content or increasing organic matter content. Soils with a low CEC (1 to 5 milliequivalents per 100 cubic centimeters) have low clay and organic matter contents, and nutrients such as N, P, and K may leach from these soils during periods of excess rainfall. These soils require more frequent application of nutrients at lower rates to ensure adequate availability throughout the growing season. Micronutrients applied to soils with low CEC can become toxic to plants at lower index levels than on soils with a CEC above 5 meq/100cc.

Nutrient Index Values

The soil nutrient concentrations on an NCDA&CS soil test are reported as index values. Index values can be used as a means of predicting soil fertility levels or potential heavy metal toxicities. Essentially, the index system was developed to relate soil fertility levels to the likelihood of a crop yield increase resulting from a fertilizer application (Table 4-1). For P and K, no response to nutrient additions is generally expected for most crops when the index value is above 50. Micronutrients are required in much lower amounts, so responses are not expected when index values are above 25. When soil test index values are less than these critical levels, the soil test report will indicate the amount of nutrient to apply for optimum plant growth in the Recommendations section of the report.

Table 4-1. Relationship Between Soil Test Index and Crop Response: Expected Crop Response to Nutrient Application

Soil Test Index Range	Soil Test Index Rating	P	Mn	Zn	Cu
0 to 10	Very Low	Very High	Very High	Very High	Very High
11 to 25	Low	High	High	High	High
26 to 50	Medium	Low	None	None	None
51 to 100	High	None	None	None	None
100+	Very High	None	None	None	None

Note: Soil test index values above 100 indicate excessive amounts are present in soil.

How Can a Soil Test Be Used to Adjust and Monitor Waste Utilization Plans?

Describe how soil test information can help select a site and determine the sustainability of long-term waste applications.

Soil tests can be used to help determine the priority nutrient for nutrient management planning. The priority nutrient is the nutrient most likely to cause an adverse environmental or plant health effect. Nitrogen is most often the priority nutrient in waste management plans. As a result, most waste application rates are based on supplying crop N needs. The idea is to not apply N at rates greater than the crop can use because the nitrate form of N can move through the soil and threaten groundwater quality. Some nutrients found in animal waste may be stored in the soil just as one stores money in a bank. In most soils, P, Cu, and Zn are not subject to leaching at a soil pH normally used to grow crops, and these nutrients remain in the soil until taken up by plants. As Cu and Zn continue to accumulate, they may become toxic to plants. The level at which toxicity occurs depends on the concentration of the element in the soil, sensitivity of the crop, soil pH, and the CEC. In addition, P can become a source of nonpoint pollution if soil erodes from the site and moves into nearby surface waters.

Ranking Fields for Waste Applications

By monitoring soil test index values for various nutrients, you can take steps to avoid soil buildup to undesirable levels. In general, waste products should be applied as a priority in fields where there is evidence of the greatest need for nutrients. Because the nutrients in animal manures are not balanced with respect to crop needs, there is potential for buildup of some nutrients in the soil when manures are applied based on N rates. Examples of nutrients that have been shown to increase in the soil with repeated animal manure applications are P, Cu, and Zn. Because of this, regulations have been adopted that require monitoring of these nutrient levels.

Phosphorus—P levels in the soil can potentially lead to loss of P to surface waters. The Phosphorus Loss Assessment Tool (PLAT) has been developed to assess the potential loss of P from agricultural fields. As discussed in Chapter 2: Regulations Governing Animal Waste Management Systems—Type A, this assessment may be required for animal producers as a permit condition or on a site-specific basis. The tool assists a technical specialist in making a determination of the potential of P to impact surface waters, as well as develop management practices to reduce P loss from fields. In cases where

potential impact from excess P is high, a producer may have to reduce or eliminate manure applications to any fields in the plan that show such a rating. Assessment of P loss with PLAT requires specialized training; as such, this manual does not offer specifics on PLAT determinations. Appendix C has a fact sheet on PLAT and information on deep soil sampling.

Copper and Zinc—These micronutrients are required by plants. Typically though, when manures are applied based on N rates, these micronutrients are over-applied. Regulatory limits have been set for soil test levels of Cu and Zn.

Micronutrient	Caution level*	Critical toxic level**
Copper Index	2000	3000
Zinc Index	2000[1]	3000[1]

* Caution level means that the producer should seek alternate sites for manure application

** Critical toxic level means that no more manure application is allowed

[1] These levels are appropriate for all crops except peanuts, where the caution level is 300 and the critical toxic level is 500. Maintaining a pH of 6.0 or higher is also advised.

Producers should closely monitor the results of the soil tests for these nutrients. Should there be fields in the waste plan that exhibit these levels, or otherwise show a sharp, unexplained increase in soil test levels, advice should be sought from a technical specialist or agronomist.

Plant Analysis

Nutrient elements required for plant growth are termed "essential." Healthy plants contain predictable concentrations of these elements. Major elements (N, P, and K) are required in larger amounts. Secondary elements (Ca, Mg, and S) are required in smaller amounts. Micronutrients (Fe, Mn, Zn, Cu, B, Mo, and Cl) are required in much smaller amounts. If these elements are present in inadequate levels, then the plant suffers from a nutrient deficiency and growth and yield are reduced. In some cases, if these nutrients are present in higher concentrations than required, the plant will suffer from a nutrient toxicity. In either case, the plant is not healthy and therefore is not removing nutrients from the soil at its fullest capabilities. Plant analysis can be used to distinguish between nutrient deficiency and toxicity as compared to sufficiency.

A plant analysis has three main applications:

- To confirm a suspected nutrient deficiency or toxicity when visual symptoms are present.
- To monitor plant nutrient status in an effort to achieve optimum yield and quality while protecting the environment.
- To serve as a basis along with a soil test for fine-tuning fertilization programs.

You should consider plant analysis if you see indications that your crops are not healthy. These indications include leaf yellowing or spotting, wilting (even with sufficient moisture), and reduced growth or plant death.

You can confirm a suspected deficiency by plant analysis before applying a corrective treatment. Numerous cases can be described where incorrect diagnosis of a crop problem in the field may lead to crop failures, as well as costly and ineffective corrective treatments.

The monitoring role of a plant analysis is not used as extensively as soil testing; however, it offers the opportunity to maintain high quality production with maximum efficiency and a minimum of nutrient deficiency problems. To provide a means of noting changes in nutrient content, sample each year or on a regular basis and compare test results from one sample to the next. Study carefully the upward or downward trends along with previous manure or fertilizer inputs to identify a potential nutrient deficiency, excess, or imbalance. Corrective treatments can be applied before significant losses in yield or quality occur.

Visual observations, knowledge of the site, a soil test, and the plant analysis results provide an effective means of evaluating the nutrient status of the soil–plant environment. However, a plant analysis result may not solve every problem or uncover all unseen nutrient deficiencies or toxicities. When a nutrient deficiency is confirmed by a plant analysis or an unseen deficiency is uncovered, a corrective treatment may not always be applicable to the sampled crop. Treatments may be specified for future growing seasons, or additional plant and soil samples may be needed to fully evaluate the suspected deficiency.

A plant analysis may indicate that a nutrient deficiency or toxicity does not exist. Therefore, a factor other than nutrition, such as disease or environmental conditions, may be responsible for poor plant growth or visual symptoms. This information is invaluable in problem solving. To use the plant analysis technique effectively, take care when collecting, preparing, and sending plant tissue to the laboratory.

A recent soil test result can be helpful when interpreting a plant analysis. When visual symptoms of a suspected nutrient deficiency are present, take a soil sample at the same time from root zones of plants sampled. In this way, an evaluation of the soil in the affected area can be made along with the plant analysis result. Sampling healthy and unhealthy plants, and their respective soil, is very effective in problem solving.

Sampling instructions, information sheets, and shipping envelopes are provided at no charge and can be obtained at local Cooperative Extension centers or from regional agronomists of the Agronomic Division. The fee is $5 for most crops. The fee is $7 for certain crops that require extra services. This applies to cotton, strawberry, and vinifera grapes, which must be tested for petiole nitrates, and to alfalfa, cole crops, poinsettias, and spinach, which must be tested for molybdenum. If submitting a plant tissue and soil sample in the same package, be sure to address the package to the Plant/Waste/Solution/Media Analysis Section rather than the Soil Testing Section so that the package is promptly opened and the plant sample properly processed upon arrival.

Samples and completed information sheets shipped via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
1040 Mail Service Center
Raleigh, NC 27699-1040

Samples shipped via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
4300 Reedy Creek Road
Raleigh, NC 27607

How Can Plant Analysis Be a Predictive and Diagnostic Tool?

Describe the role of plant tissue and forage analysis in managing and monitoring crop and forage quality.

Additional nutrient applications may be needed based on nutrient deficiencies indicated in a plant analysis report. Repeated plant analyses, during the growth cycle of a plant or from one season to another, can show changes that occur with time as a result of applied fertilizer treatments. These analyses can provide a guide for corrective treatments. Supplemental treatments can be scheduled based on a series of analyses. Such analyses and the maintenance of leaf analysis result logs are invaluable. Base supplemental applications of N on a plant analysis, particularly when there is a suspected or anticipated N deficiency. If assistance is needed, contact a technical specialist prior to making additional waste applications based on the results of a plant analysis. To justify application of additional N above what is listed in the waste plan, you must work with a NCDA&CS Regional Agronomist or an agronomist certified by the N.C. Agricultural Consultants Association or Certified Crop Advisor Program.

Feed Testing

Nitrate poisoning in animals is an increasing problem in North Carolina due to the high levels of N applied to forages, which can commonly result in levels of nitrate above what is normally considered safe. Many factors affect pasture and forage quality, including species, stage of maturity, soil condition, climate, storage, and handling. Laboratory analysis is the best way to determine a forage's nutrient content and the potential for nitrate toxicity. Producers should periodically monitor the quality of their pastures to make sure animal nutrient requirements are being met and that fertilization practices are appropriate.

Forage sampling differs from plant analysis used to determine nutrient status for crops. Forage sampling is a test to help determine if there are potential problems with using a crop for animal feed. For a $10 fee, the NCDA&CS Food and Drug Protection Division will analyze forages for nutritional composition to determine safety as a food source for animals.

Forage analysis forms (see Appendix C) are available from the NCDA&CS Food and Drug Protection Division (**www.ncagr.gov/fooddrug/feed/index.htm**) or from local Cooperative Extension centers.

Samples shipped via the US Postal Service should be sent to:

NCDA&CS
Food and Drug Protection Division
Attn: Forage Testing
1070 Mail Service Center
Raleigh, NC 27699-1070

Samples shipped via FedEx or UPS should be sent to:

NCDA&CS
Food and Drug Protection Division
Attn: Forage Testing
4000 Reedy Creek Rd.
Raleigh, NC 27607

How to Sample Pastures for Feed Testing

1. Use a gallon paper bag to hold the collected tissue. Be sure there are no contaminants on your hands or on the collected tissue.
2. Walk the pasture much the same way you would for soil sampling or scouting for insects. Take a sample of grazeable vegetation by plucking or grabbing a few leaves between the thumb and index and middle finger. Snap the leaves at the same height as the animals are grazing, especially if you want to know what is being consumed at the time.
3. Complete the form and ship the sample.

Other Testing

Owners of waste application sites may also wish to sample surface water and groundwater supplies once a year to confirm that nutrient-management programs are not adversely affecting the environment. This is especially advisable for new operations, so as to establish background levels of nitrate-nitrogen and phosphorus.

Review Questions

1. How do you obtain the nutrient value of your lagoon liquid or animal waste?
2. What is meant by the term "representative sample"?
3. What types of tools should be used for waste and soil analysis?
4. Who should you contact for assistance with soil, waste, or plant tissue sampling?
5. Under what conditions should you consider NOT using a field for waste application?
6. When would you consider using plant analysis to help with your waste management program?

Chapter 5: System Components and Operation—Type A

Describe the purpose and components of a Type A animal waste management system.

Animal waste management systems are an important part of animal production operations. They are composed of structures and devices that collect, transport, recycle (flush), treat, store, and land-apply the animal waste products resulting from the production of animals. As an operator of such a system, you will become knowledgeable about system components and their proper operation and maintenance. Improper operation could lead to a spill or runoff of the wastes, both of which are violations of state law as discussed in Chapter 2: Regulations Governing Animal Waste Management Systems—Type A.

Type A animal waste management systems rely primarily on an anaerobic lagoon, in addition to soil/plant systems, for the treatment of waste. These systems are often used to treat waste generated by animals that produce a low-fiber waste, such as swine and poultry. These systems generally include the following components: anaerobic lagoon; pumps, pipes, and associated hardware that convey the waste from the point of generation to the final treatment/utilization site; flushing systems; solids separation equipment; irrigation equipment; and land-application such as on crops.

Lagoons

Describe the function of an animal waste lagoon.

Lagoons are earthen structures that treat and store animal manure. They function as digesters, where bacteria decompose organic matter. Anaerobic lagoons are used in the swine and poultry industry because of their efficiency and low cost. "Anaerobic" means that the waste is treated without aeration (or oxygen) or mixing devices. A properly sized and operated lagoon reduces organic material (which is the major source of odor), reduces the N concentration of the waste, and allows solids to settle out. Most of the P, zinc and copper will accumulate in the sludge in the bottom of the lagoon.

Lagoon Design and Construction

Proper lagoon design and construction must meet the requirements of N.C. Dam Safety Laws. A failure of a lagoon dam could affect the life, health, and property of people in varying degrees, depending on the size and location of the dam. If a dam is less than 25 feet high or if the lagoon has less than 50 acre-feet of capacity, the system is not subject to the state's dam safety regulations. The exception is when a dam is classified as "high hazard." A high hazard dam is subject to the regulations regardless of size. The failure of a high hazard dam will likely cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, primary highways, or major railroads.

Proper lagoon design and construction minimize the risk to surface water or groundwater due to overflow or seepage. An undersized lagoon increases the need for frequent pumping and more intensive management. It also increases odor potential and nutrient levels (N and P) in effluent leaving the lagoon, either as flush water or as irrigation water to a field. An undersized lagoon also increases the rate of sludge (solids) buildup in the lagoon and requires more frequent sludge removal.

Describe the six specific volumes for an anaerobic lagoon.

The capacity of an anaerobic lagoon (Figure 5-1) includes volumes designed for:

- **Sludge storage**—The design volume for organic solids that cannot be further decomposed by anaerobic bacteria and accumulates in the bottom of a lagoon.
- **Permanent liquid treatment**—The design volume for manure treatment that should always contain liquid for optimal bacterial activity.
- **Temporary liquid storage**—A design volume based on the average amount of manure, net rainfall in excess of evaporation, fresh water used to clean barns, and runoff and drainage water that enter the lagoon during a storage period when liquid cannot be irrigated onto a growing crop. Most lagoon design volumes are based on a 180-day period of manure storage.
- **Heavy rainfall factor**—A minimum volume that must be equal to or greater than the depth of a 25-year, 24-hour storm on the lagoon surface to allow for chronic rainfall periods.
- **25-year, 24-hour storm**—The maximum 24-hour precipitation event with a probable recurrence interval of once in 25 years as defined by the National Weather Service. These storm amounts vary from county to county, and generally range from 5 to 9 inches in North Carolina.
- **Structural freeboard**—The distance from the top of the lagoon dam or dike elevation to the highest waste liquid elevation (at least 1 foot) to protect structural integrity. This distance is in addition to the 25-year, 24-hour storm and the heavy rainfall factor.

The term **freeboard** describes the distance from the top of the lagoon dam or dike elevation to the wastewater level as recorded on the FRBD-1 form (discussed in Chapter 7: Record Keeping—Type A).

Note: Heavy rainfall factor is not required for lagoons designed before September 1, 1996. Although inclusion of this factor is not required, it is recommended that lagoon operators maintain storage to accommodate the heavy rainfall factor. See your original lagoon design or consult a technical specialist for more information.

The **permanent storage volume** is the total of the sludge storage volume and the permanent liquid treatment volume.

Liquid Level Gauging Device

Explain the need for and use of a liquid level gauging device.

Lagoons must have a permanent readable marker inside the lagoon to assist with liquid level management. The marker shows the absolute maximum and minimum operating levels to indicate when pumping is needed and when pumping should stop. The markers should be routinely cleaned so you can easily observe the available storage. The marker's location relative to the lagoon storage design can be seen in Figure 5-1. Lagoon level management will be discussed later in this chapter.

Liners

Lagoon liners are used to reduce the permeability (seepage) of the bottom and sidewalls of the lagoon. This prevents or restricts the potential for downward and lateral seepage of the wastes from the lagoon. The types of lagoon liners used are:

- **Clay**—Can usually be found near site; requires careful installation with proper compaction at the proper moisture content.
- **Bentonite**—Is blended with existing soil; comes from sources outside North Carolina; freight is expensive.
- **Synthetic membrane**—Typically a type of plastic; requires careful installation by experienced contractor; easy to damage.

Pipes

Explain the need for proper pipe design, and installation.

Pipes are important because they convey the waste from the animal confinement houses to the lagoon and from the lagoon to the fields for irrigation. Pipes are also used to recycle lagoon water used to flush waste from the houses.

Factors that should be considered when choosing pipes include:

- **Material**—Pipes should be made of a durable material that can withstand contact with the waste. Plastic or concrete is usually more durable than metal.
- **Size**—Pipes must be large enough to carry the volume of waste without backup in the house. Pipes conveying recycled lagoon liquid that are too small can cause problems with pumps and motors. Pipes that are too large can allow solids buildup, which may clog the pipes.
- **Slope**—Pipes that carry waste from animal confinement houses to the lagoon should be on a slope of approximately 1 percent or greater to reduce the potential for solids buildup, which may clog pipes.
- **Location**—Discharge pipes should be located where they will not cause problems, such as erosion of the lagoon liner or embankment, interference with traffic around the lagoon, or interference with diversion of surface water away from the lagoon. Pipes should not be installed in the embankment without proper engineering considerations.

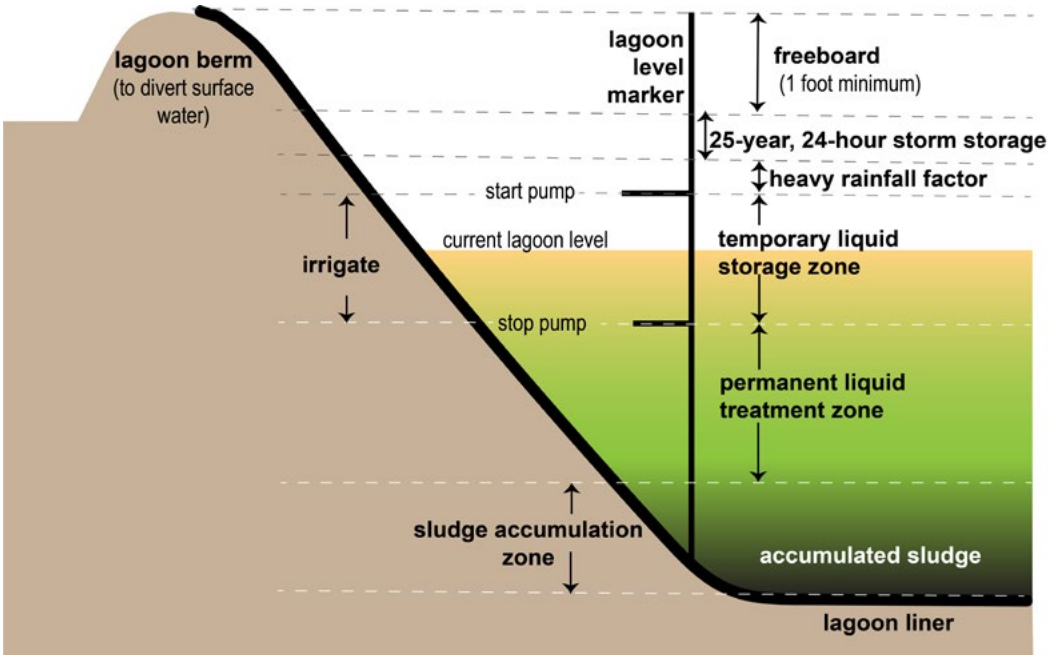


Figure 5-1. Schematic of an anaerobic waste treatment lagoon (drawing is not to scale).

Pipes through embankments must have anti-seep collars or other devices. Pipes that are above ground must be properly supported with piers, posts, or a cradle to prevent sagging. To reduce odors, pipes should discharge below the liquid surface. This also helps to minimize potential lagoon liner damage.

Flush Systems

Flushing waste into lagoons and storage ponds is a low-labor, sanitary method for manure management. It involves recycling lagoon water through a piping network and into tanks or pits, which then are manually or mechanically operated to send a set volume of water through the manure storage pits to flush the fresh manure into the lagoon.

Flush systems are very efficient but must be monitored for leaks and spills, as these systems carry wastewater away from the lagoons. Flush systems may be prone to blockage or crystal buildup, which reduces the system performance and can increase maintenance, cost of operation, and the potential for pipe breakage. Management of crystal buildup and pipes will be covered in later sections in this chapter.

Pumps

Pumps used for land application of wastewater are generally straight centrifugal pumps (for solids content less than 4 percent). A centrifugal pump consists of an impeller rotating in a casing. Open impeller-type pumps are normally used for wastewater applications. A gate valve and discharge check valve are usually installed on the discharge side of the pump. The suction line and strainer should be floated in the lagoon so that the intake is about 18 inches below the water level and able to draw the most solids-free liquid. The pump should be located as far as possible from the inlet pipe to the lagoon. If the lagoon is located in an area where a prevailing wind direction exists, the pump should be located on the upwind side of the lagoon because solids tend to migrate to the downwind side.

Pumps are rated to deliver a set number of gallons at a given operating head (pressure) for a specified efficiency. Pump manufacturers provide pump curves for each of their pumps. These curves show the relationship between head, horsepower, capacity, and efficiency. Pump curves can be used if you need to modify your operating conditions from the original irrigation design. As pump models are discontinued, it becomes more difficult to obtain this information for older pumps. Keep equipment-specific information in a safe place, such as with your other operational records.

Irrigation Systems

A properly designed irrigation system provides the operator the opportunity to apply wastewater uniformly at agronomic rates without direct runoff from the site. However, a "good design" does not guarantee proper land application. The performance of a well-designed system can be ruined by poor management; likewise, a poorly designed system can sometimes provide good performance with proper, intensive management. To keep your system in proper operating condition, you should be familiar with your system components, range of operating conditions, and maintenance procedures and schedules.

There are two primary types of wastewater irrigation systems: stationary sprinkler systems and traveling systems.

Stationary Sprinkler Systems

Stationary sprinkler systems for land application of lagoon liquid are usually permanent installations (lateral lines are PVC pipes permanently installed below ground). One of the main advantages of stationary sprinkler systems is that these systems are well suited to irregularly shaped fields. Thus, it is difficult to provide a standard layout, but there are some common features among systems. To provide proper overlap, sprinkler spacings are typically 50 to 65 percent of the sprinkler wetted diameter. Sprinkler spacing is based on nozzle flow rate and desired application rate. Sprinkler spacings are typically in the range of 80 feet by 80 feet using single-nozzle sprinklers. Other spacings can be used, and some systems are designed to use gun sprinklers (higher volume) on wider spacings. A typical layout for a permanent irrigation system is shown in Figure 5-2.

The minimum recommended nozzle size for wastewater is 1/4 inch. Typical operating pressure at the sprinkler is 50 to 60 pounds per square inch (psi). Sprinklers can operate in a full or partial circle. The system should be zoned (sprinklers operated at the same time constitute one zone) so that all sprinklers are operating on about the same amount of rotation to achieve uniform application. Gun sprinklers typically have higher application rates; therefore, adjacent guns should not be operated at the same time (referred to as "head-to-head").

Traveling Systems

Traveling systems are either cable-tow traveler, hard-hose traveler, center pivot, linear-move, or hose-drag systems.

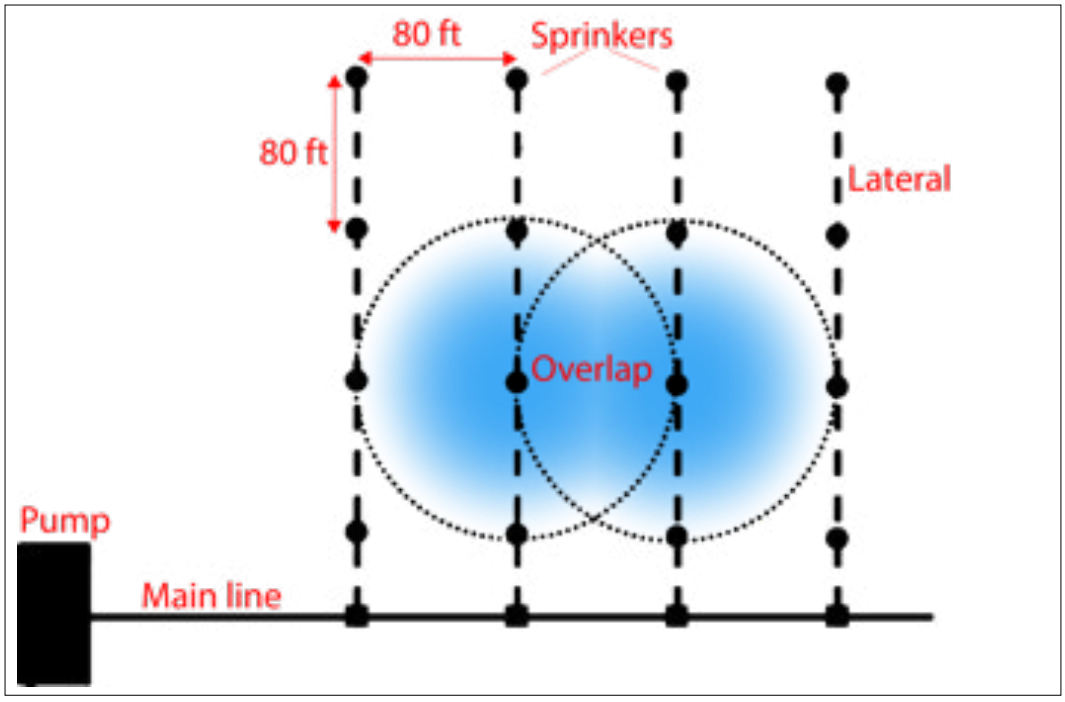


Figure 5-2. Schematic layout of a permanent irrigation system used to apply animal waste.

The cable-tow traveler consists of a single-gun sprinkler mounted on a trailer, with water being supplied through a flexible hose coated with synthetic fabric, rubber, or PVC. Pressure rating on the hose is normally 160 psi. A steel cable is used to guide the gun cart.

The hard-hose traveler consists of a hose drum, a medium-density polyethylene (PE) hose, and a gun-type sprinkler. The hose drum is mounted on a multiwheel trailer or wagon. The gun sprinkler is mounted on a wheel or sled type cart referred to as the gun cart. Usually, only one gun is mounted on the gun cart. The hose supplies animal waste to the gun sprinkler and also pulls the gun cart toward the drum. The distance between adjacent pulls is referred to as the lane spacing. To provide proper overlap, the lane spacing is typically 70 to 80 percent of the gun-wetted diameter. A typical layout for a hard-hose traveler irrigation system is shown in Figure 5-3.

The hose drum is rotated by a water turbine, water piston, water bellows, or internal combustion engine. Regardless of the drive mechanism, the system should be equipped with speed compensation so that the sprinkler cart travels at a uniform speed from the beginning of the pull until the hose is fully wound onto the hose reel. If the solids content of the wastewater exceeds 1 percent, an engine drive should be used.

Nozzle sizes recommended for gun-type sprinklers are 0.50 to 1.34 inches in diameter and require operating pressures of 50 to 80 psi at the gun for uniform distribution. System operators should be knowledgeable of the relationships between nozzle size, flow rate, wetted diameter, and travel speed before interchanging different nozzle sizes. Operators should consult with a technical specialist before changing nozzle size to one different from that specified in the certified waste management plan.

The use of center-pivot systems for wastewater irrigation is increasing. Center pivots are available in both fixed-pivot point and towable machines. Available sizes range from single tower machines that cover about 5 acres to multitower machines that can cover several hundred acres. Center pivots use either rotary sprinklers, small guns, or spray nozzles. Drop-type spray nozzles offer the advantage of applying wastewater close to the ground at low pressure, which results in little wastewater drift due to wind.

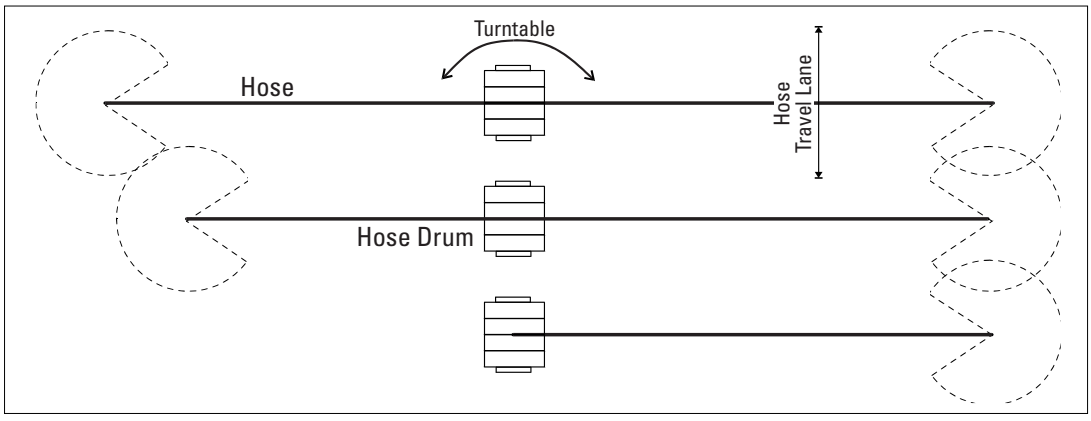


Figure 5-3. Schematic layout of a hard-hose traveler. Travel lanes are 100 to 300 feet apart, depending on sprinkler capacity and diameter coverage.

Linear-move systems are similar to center-pivot systems except that neither end of the distribution pipe is anchored and travel is in a straight line. Drives at each end move the distribution pipe across the spray field. Animal waste is supplied through a feeder hose to one end of the distribution pipe. Depending on the type of sprinkler used, operating pressure ranges from 10 to 50 psi. These system types can be used only in large fields without drainage ditches.

Hose-drag applicators are another type of traveling system (also called an umbilical, dragline, or drag-hose system). Animal waste is pumped from the lagoon through a hose that continuously supplies an application toolbar or injection unit mounted to the back of a tractor. The tractor drags the umbilical hose across the field as the toolbar or injector unit discharges the animal waste. The tractor travels through the field in an S-shaped pattern, always turning away from the hose.

Hose-drag applicators are expensive and are practical only when applying animal waste at sites with large, flat fields. However, they reduce the time required for application since they do not have to leave the field to fill up. And because there are no tanks, hose-drag applicators place less weight on the soil, reducing soil compaction.

In summary, below are several advantages and disadvantages for stationary and traveling irrigation systems:

System Type	System	Advantages	Disadvantages
Stationary Sprinkler Systems		• good for small or irregular fields • do not have to move equipment	• higher initial costs • must protect from animals and equipment • small bore sprinklers more likely to get plugged or broken • no flexibility to move to other (new) fields
Traveling Systems	Cable Tow	• system is transportable • application rate can be adjusted (speed and nozzle settings) • easily used for new fields	• does not maximize the use of area for irregularly shaped fields • impractical for small areas
	Center-Pivot and Linear-Move	• application rate can be adjusted (speed and nozzle settings) • easily used for new fields	• does not maximize the use of area for irregularly shaped fields • impractical for small areas

Wettable Acres

Define wettable acres.

Regardless of the type of irrigation system used, an assessment of either the effective irrigated acres or **wettable acres** must be performed. Wettable acres are the "usable" part of a field that actually receives the irrigated wastewater, as opposed to the total field size. Determination of effective irrigated acres and wettable acres is made by designated

technical specialists with specialized training, and often these assessments are made at the time of irrigation system installation or modification. For the operator's purpose, the main thing to note is what the usable acres for each field in the waste plan are, as this is the area that is used in record keeping and the area that determines how much waste can be applied to each field.

Pump-and-Haul Waste Application Systems

Liquid applicators and tank spreaders are an alternative to irrigation systems for transporting and applying liquid waste slurries and lagoon sludges. As compared to irrigation, tank spreaders (honey wagons) have several advantages and disadvantages:

Advantages

- More transport mobility
- Allows direct soil injection

Disadvantages

- More time and labor required
- Higher operating costs
- Requires better travel roads and ability to drive in field
- Can result in field soil compaction

Proper location and design of pumping and loading areas are necessary to protect equipment and operators and to avoid damaging the lagoon dike or embankment. Care should be taken to minimize spills during loading and transport.

Liquid tank spreaders must be accurately calibrated to apply wastes at proper rates. Calibration is the combination of settings and travel speed needed to apply wastes at a desired rate and to ensure uniform application. Calibration procedures for pump-and-haul systems are found at the end of Chapter 6: Proper Application of Waste Products—Type A.

Operation and Maintenance

Lagoons

Describe possible causes of lagoon failure.

An improperly operated and maintained lagoon can fail, resulting in the unplanned discharge of wastewater from the structure. Types of failure include seepage through the bottom or sides, overtopping, and breach of the dam. The owner has the responsibility for ensuring the structure's proper design and safety. Items that may lead to lagoon failures include:

- Lagoon liquid levels—high levels are a safety risk.
- Excess surface water flowing into the lagoon.
- Failure to inspect and maintain the dam.
- Loss of liner integrity due to wave action, inlet pipe erosion, damage during sludge removal, or rupture from lowering lagoon liquid level below groundwater table.
- Rodent and tree damage to lagoon embankments.

- Modification of the lagoon structure—an example is the placement of a pipe in the dam without proper design, construction and/or installation. (Consult an expert in lagoon design before placing any pipes in dams.)

Liquid Level Management

Explain the proper operation of an animal waste lagoon.

Proper lagoon liquid level management should be a year-round priority. This task is especially important during extended rainy and wet periods to avoid the risk of inundation or breach.

Proper liquid level management requires the operator to:

- Maintain lagoon liquid as close to the bottom of the temporary liquid storage volume as possible.
- Never pump the lagoon liquid level lower than the permanent storage except to allow for excess rainfall during hurricane season. Provided the standards in the swine permit and NRCS Guidance Document are met, lagoon levels may be lowered a maximum of 8 inches below the stop pump mark during the period of June 15 through October 31 (NC Swine Permit, October 2019 — NRCS, NC, No. 359, February 2009).
- Never lower the lagoon liquid level below the seasonal groundwater table (see your system design or contact the local office of the NRCS to determine this level).

The lagoon liquid level must never be closer than the designed structural freeboard (generally 1 foot) plus the 25year, 24hour storm storage to the top of dike elevation, unless a storm larger than the 25year, 24hour storm has occurred. The top of dike elevation should be determined from the design as it relates to the permanent benchmark. If the dike wall has not settled, it can be measured from the lowest point of the dam or embankment. For lagoons constructed after September 1, 1996, storage for the heavy rainfall factor must also be maintained.

Every effort should be made to maintain the lagoon close to the minimum liquid level as long as the weather, soil, and cropping conditions allow and in accordance with the waste management plan. Maximum storage capacity should be available in the lagoon for periods when the receiving crop is dormant (such as wintertime for bermudagrass) or when there are extended rainy spells such as the thunderstorm season in the summertime and during hurricane season.

Start irrigating at the earliest possible date in the spring based on nutrient requirements and soil moisture. Similarly, in the late summer/early fall, the lagoon should be pumped down to the stop pump elevation (minimum temporary storage liquid level) (see Figure 5-1) to allow for storage during the winter.

Waiting until the lagoon has reached its maximum storage capacity before starting to irrigate does not leave allowance for storing excess water during extended wet periods. Overflow from the lagoon for any reason except a storm equal to or greater than a 25-year, 24-hour storm is a violation of state law and subject to enforcement action.

Note: Lagoon water should not be allowed to overtop the dam. If lagoon water does overtop the dam, the moving water during overtopping will soon cause gullies to form in the dam. Once this damage starts, it can quickly cause a large discharge of wastewater and possible dam failure. Seek repair assistance from a technical specialist or professional engineer.

You should record the level of the lagoon just prior to when rain is predicted and record the level again four to six hours after a rainfall event (assuming no pumping has occurred). This will give you an idea of how much your lagoon level will rise with a certain rainfall amount (you must also record rainfall on your farm for this to work). Knowing the impact of rainfall events on your lagoon level should help in planning irrigation applications and storage. If your lagoon rises excessively, you may have an inflow problem from a failing surface water diversion or there may be seepage into the lagoon from the surrounding soil.

Other Management Guidelines

- The more frequently and regularly that wastewater is added to a lagoon, the better the lagoon will function. Flush systems that wash waste into the lagoon several times daily are optimal for treatment. Pit recharge systems, in which one or more buildings are drained and recharged each day with all buildings being recharged once per week, also work well.

Explain why water reuse is important.

- Practice water conservation (water reuse). Minimize water usage and spillage from leaking waterers, broken pipes, and washdown through proper maintenance and water conservation. This conserves fresh water and reduces the volume of wastewater that ultimately must be stored in the lagoon and land-applied.
- Minimize feed wastage and spillage by adjusting and maintaining feeders. This will reduce the amount of solids entering the lagoon. If a spill occurs, do not wash into lagoon. Remove and dispose of feed.
- Locate float-pump intakes approximately 18 inches underneath the liquid surface and as far away from the drainpipe inlets and embankments as possible.
- Prevent bedding materials (for example, wood chips, and sawdust), long-stemmed forage or vegetation, moldy feed, plastic syringes, or other foreign materials from getting into the lagoon.
- Frequently remove solids from catch basins at end of confinement houses or wherever they are installed.

Surface Water Diversions

Describe the purpose of surface water diversions.

Surface water diversion features are designed to carry all surface drainage waters (such as rainfall runoff, roof drainage, gutter outlets, and parking lot runoff) away from the lagoon and other waste treatment or storage structures. The only water that should be going in the lagoon is that which comes from flush system pipes and the rainfall that enters the lagoon directly. The only exception is if you maintain animals or waste piles outside in such a manner that runoff from the concentrated animal area or waste area may enter surface waters. You should consult with a technical specialist to see what BMPs are needed for these situations. One possible practice is to catch the contaminated runoff water in the lagoon.

Inspect the diversion system for the following:

- Adequate vegetation
- Diversion capacity
- Ridge berm height

Identified problems should be corrected promptly. Inspect diversions during or immediately following a heavy rain to see if any surface water is getting into the building flush pits, pipes, or lagoon. If technical assistance is needed to determine proper solutions, consult with appropriate experts.

Lagoon Maintenance

Describe proper lagoon and dam maintenance.

Routine inspection and maintenance of a lagoon are necessary to ensure the structure does not erode or otherwise allow waste to leak or discharge. At a minimum, the following situations should be checked at least monthly:

- Lagoon surface—look for:
  - Undesirable vegetative growth
  - Floating or lodged debris
- Inadequate biological activity, signaled by a dark color, lack of bubbling, and excessive odor. Consultation with a technical specialist is recommended if these conditions occur for prolonged periods, especially during the warm season.
- Lagoon liquid pH, which optimally should range from 7.0 to 8.0. Perform periodic checks. If the pH falls below 7.0, dose with agricultural lime at the rate of 1 pound per 1,000 cubic feet of lagoon liquid volume and thoroughly mix until the pH rises above 7.0.
- Embankment—look for:
  - Settlement, cracking, or holes on embankment and around pipes
  - Side slope stability—slumps or bulges
  - Wet or damp areas on the back slope
  - Erosion due to lack of vegetation or as a result of wave action
  - Rodent damage
  - Tree damage

  Maintain a vegetative cover on the embankment to prevent erosion. Fescue, bahiagrass, or common bermudagrass are the most common vegetative covers. The vegetation should be maintained to allow for visual inspection of the lagoon dam and fertilized each year, if needed, to maintain a vigorous stand. The amount of fertilizer applied should be based on a soils test, but if it is not practical to perform a soils test each year, the lagoon embankment and surrounding areas should be fertilized with 800 pounds per acre of 10-10-10 or equivalent.

  Brush and trees on the embankment must be controlled. This may be done by mowing, herbicide spraying, chopping, or a combination of these practices.

  Note: If the vegetation is controlled by spraying, the herbicide must not be allowed to enter the lagoon water. Such chemicals could harm the bacteria in the lagoon that

are treating the waste. Consult the North Carolina Agricultural Chemicals Manual for recommended herbicides.

Larger lagoons may be subject to liner damage due to wave action caused by strong winds. These waves can erode the lagoon sidewalls, thereby weakening the lagoon dam. Maintaining the waste liquid level near the stop pump elevation and keeping up a good stand of vegetation will reduce the potential damage caused by wave action. If wave action causes serious damage to a sidewall, inserting baffles or rip-rap in the lagoon may reduce the wave impacts.

Any of these problems could lead to erosion and weakening of the dam. If the lagoon has any of these problems, call an appropriate expert familiar with design and construction of waste lagoons. There is a list of area experts in Appendix D. A temporary fix may be needed if there is a threat of a waste discharge. However, a permanent solution should be reviewed by a professional engineer or technical specialist designated in structural design and installation. Any digging into a lagoon dam with heavy equipment is a serious undertaking with potentially serious consequences and should not be conducted unless recommended by an appropriate technical specialist.

- Conduct a sludge survey annually. Remove sludge in any of the following cases:
  - The sludge storage capacity is full, or
  - Sludge occupies 50% or more of the treatment capacity, or
  - Less than 2 1/2 feet of sludge-free supernatant are present at the intake pipe.

  See your waste plan for additional requirements. Obtain a Certified Sludge Management Plan prior to sludge removal. Sludge removal is discussed in more detail later in the chapter.

Pump and Pipe Operation and Maintenance

Describe the proper operation and maintenance of pumps and pipes.

Pumping systems should be inspected and operated frequently. Pumping system maintenance should be done when the lagoon is at its low level. This will provide a downtime period to conduct major repairs. You should consider maintaining an inventory of spare parts or pumps.

Recognize that anytime wastewater is flowing, the potential for a discharge exists. Check for proper operation of the following components:

- Recycle pumps
- Irrigation pumps
- All pipes and connections

Check for leaks, loose fittings, and overall pump operation. An unusually loud or grinding noise or a large amount of vibration may indicate that the pump needs repair or replacement. Follow manufacturers' specifications for routine pump maintenance and record all maintenance and service performed on pumps in a logbook.

Breaks in piping are a common cause of discharges of animal waste. The importance of frequent inspections of the piping system, including walking the areas where there are underground pipes, cannot be overemphasized. You should inspect piping systems at least as frequently as you evaluate the lagoon level.

- Waste inlet pipes, recycling pipes, and overflow pipes—look for:
  - Separation of joints
  - Cracks or breaks
  - Accumulation of salts or minerals
  - Overall condition of pipes

As the operator, you should know where all pipes are located at your facility. You should make a map of your facility with all pipes clearly marked. The map should show the types of pipes, size, and the type of water each pipe carries (such as flush water, drinking water for animals, and drinking water for office). A color-coded system for the pipes will help distinguish the types of pipes and their uses.

Extra repair pipes, fittings, and valves should be on hand in the event of a break. During repair of any pipe that carries waste, some temporary means must be used to ensure that all wastes and flush waters still reach the lagoon or holding pits. Commonly, a small trench is dug for such temporary situations; be careful not to damage the lagoon liner. It is crucial to know where all pipes are so that repair equipment does not cause further pipe breakage.

Crystal Buildup in Recycle Lines

Explain methods to minimize crystal buildup in recycle pipes.

Struvite (magnesium ammonium phosphate) or similar crystalline material frequently occurs in lagoon liquid recycle pipes. This material develops in pumps and at joints of restriction and turbulence in the pipeline. The material starts as a soft scum that adheres to the pipes and pumps. Once the material solidifies, additional crystal growth can be rapid and can completely block even large pipes. There is no proven method of totally preventing these crystals.

To minimize difficulties associated with struvite:

- Use only smooth-walled plastic pipe.
- Minimize joints and elbows.
- Keep pipe flow velocities low enough to minimize excessive turbulence.
- Keep pipes and pumps as free of particulates as possible.
- Minimize suction lift on the pump.
- Ground the pump housings directly to prevent any stray voltage that could contribute to crystal growth.

Some producers have installed parallel piping systems that can be used to circulate acid. Several acids, including muriatic or hydrochloric acid, have been used somewhat successfully to decrease struvite buildup. Use extreme caution when handling acid. Always wear eye protection and gloves. Place diluted acid solutions in a plastic reservoir and a pump used to circulate the acid through the piping system until it is free of struvite. After one or more uses, the acid may lose its effectiveness depending on the amount of crystal dissolved. Dispose of the acid/salt solution by pumping it into the lagoon.

Sludge Management

Explain how to monitor lagoon sludge levels and develop a sludge Plan of Action.

Anaerobic lagoons will eventually develop a layer of sludge at the bottom during normal operation. Some people have successfully used microbial or enzymatic additives to slow the buildup of sludge. They appear to work on a case-by-case basis, and no specific recommendations are offered here.

The thickness of this layer must be monitored as required by your permit (typically annually unless an extension is granted by DWR). At the specified frequency, you must survey sludge depth in all lagoons at your farm. **Design standards require that there be less than 50% of the total treatment volume as sludge and at least 2½ feet of liquid present at the intake pipe.** If these amounts are exceeded, a Plan of Action (POA) for Lagoon Sludge Reduction must be completed. A Certified Sludge Management Plan may be submitted instead of this POA. Appendix E gives an example of a sludge removal plan. NC State Extension publication AG-639, *Sludge Survey Methods for Anaerobic Lagoons* (Appendix E), explains how to do a sludge inventory.

Enough sludge must be removed to regain the minimum standard of sludge-free treatment volume. Sludge will have a drastically different nutrient content and must be sampled independently from the lagoon liquid. NC State Extension publication AG-881, Sludge Sampling in Anaerobic Treatment Swine Lagoons, explains how to collect sludge samples. Once an assessment of the sludge volume and nutrient content is made, a technical specialist must revise the waste plan to allow for land application to suitable sites at agronomic rates. Since lagoon sludge is typically high in P, copper, and zinc (all regulated nutrients), it is recommended that sludge be land-applied on fields that do not receive routine waste applications.

Sludge can be handled in a variety of ways. NC State Extension publication AG-604, *Sludge Management and Closure Procedures for Anaerobic Lagoons*, (Appendix E), lists some methods for sludge removal.

Sludge Removal

Sludge accumulation is normally a gradual process in an anaerobic lagoon, but eventually it accumulates to a point where it must be removed. The rate of lagoon sludge buildup can be reduced by:

- Proper lagoon sizing
- Mechanical solids separation of flushed waste
- Gravity-settling of flushed waste solids in an appropriately designed basin
- Minimizing feed wastage and spillage

Describe the proper methods of sludge removal.

Here are some removal techniques for removing sludge:

- Hire a custom applicator. It is your responsibility to make sure that both of you understand what the other is expected to do.
- Mix the sludge and lagoon liquid with a chopper-agitator impeller pump; pump through a large-bore sprinkler irrigation system onto nearby cropland. Check with an irrigation

specialist to be sure the equipment, including the pump, can handle the amount of solid material you plan on irrigating.

- Dewater the upper part of lagoon by irrigation onto nearby cropland or forage land; mix remaining sludge; pump into liquid sludge applicator; haul and spread onto cropland or forage land and incorporate into soil.
- Dredge sludge with a dredge barge, then haul and spread with manure spreader onto nearby cropland or forage land, and incorporate into the soil if applying to tilled land.
- Dewater using polymers and geotextile tubes/bags (or mechanical separators) to capture sludge in the tube and spread higher solids product onto cropland or forage land at a later date.
- Dewater using polymers, then compost the solids to create low-metal compost for use on cropland or forage land.

Always consult the sludge management plan, waste management plan, farm conservation plan, or local Soil and Water Conservation district office to see if the specific fields used for sludge application can be disturbed with soil incorporation equipment. Regardless of the method used, have the sludge material analyzed for waste constituents just as you would the lagoon water. The sludge will contain different nutrient and metal values from the liquid. The application of the sludge to fields will be limited by these nutrients and by any previous waste applications to that field and crop requirement.

When removing sludge, prevent damage to the liner. Close attention by the pumper or drag-line operator will ensure that the lagoon liner remains intact. If soil material or the synthetic liner material is being disturbed, stop the activity immediately and do not resume until the sludge can be removed without liner injury. If the liner is damaged, it must be repaired as soon as possible.

Sludge removed from the lagoon has a much higher P and heavy metal content than lagoon liquid. Because of this, it should be applied to land with low P and metal levels, as indicated by a soil test, and incorporated to reduce the chance of erosion. Note that if the sludge is applied to fields with very high soil-test P, it should be applied only at rates equal to the crop removal of P (see Chapter 3: Components of a Certified Animal Waste Management Plan).

As discussed in Chapter 3, it is highly recommended that sludge be applied only to fields that are not used for continual animal waste application to prevent P and persistent metal buildup that may render sites unsuitable for long-term waste application. If the sludge is to be applied on sprayfields already listed in the CAWMP, the operation's overall PAN balance must include the additional PAN from the sludge and still remain in a PAN deficit for the animal operation.

The application of sludge can increase the amount of odor at the waste application site. Extra precaution should be used to observe the wind direction and other conditions that could increase the concern of neighbors. Injection or incorporation of sludge will help reduce odors.

Lagoon Closure

Until properly closed, a lagoon must be operated and maintained according to the waste system permit and the CAWMP, even if no animals are present, there is no additional manure input, and no waste application occurs. If the owner no longer wishes to maintain the lagoon, it is the owner's responsibility to obtain and implement a lagoon closure plan to eliminate the possibility of pollutant discharge. The owner must consult with the appropriate DWR Regional Office before closing an animal operation with a waste management system, and lagoon closure must be performed under specified standards adopted by NRCS. A closure plan must include:

- An assessment of **all** of the nutrients remaining in the lagoon, including the sludge
- A proposed method of waste removal
- An amended WUP specifying the fields, crops, and rates of nutrient application at agronomic rates
- Soil samples for any new fields to be added to the waste plan
- PLAT assessment, if required (see Chapter 3: Components of a Certified Animal Waste Management Plan for more on PLAT)

Appendix D contains the current NRCS standard ("Closure of Waste Impoundments," Code 360) and related information concerning lagoon closures.

Irrigation System Operation

A thorough knowledge of the waste application system is needed to apply waste in accordance with the WUP. The operator must be familiar with such features as correct pressure settings, sprinkler spacing, travel speed, and time of operation to ensure the appropriate amount is uniformly applied. Operation of waste application systems is discussed in detail in Chapter 6: Proper Application of Waste Products—Type A.

Innovative and New Management Practices

Describe some methods that could be used to enhance waste treatment.

There are several methods of improving or enhancing the handling and treatment of animal wastes. Many of these methods involve the separation of solids and liquids within the animal waste system. The producer may benefit through decreased cost of sludge and solids removal from lagoons, decreased N concentrations in wastewaters, and the increased flexibility in the land application of waste, depending on the method used.

Solids Separation

Removal of fresh solids from manure slurries and flush water will reduce the pollutant content of manure, prolong the life of storage structures, improve the effectiveness of biological treatment, and minimize odors. Beneficial uses of the recovered solids include bedding materials, animal feed supplements, composts, soil amendments, and bioenergy sources. Solids separation can be done using mechanical or gravity devices.

Mechanical separators of animal waste include inclined screens, vibrating screens, belt presses, and screw presses. Most mechanical separators require daily cleaning and flow adjustments. Screens and moving parts will need to be replaced periodically when the solids removal capacity is decreased.

A gravity-settling basin may be less costly than a mechanical separator, while removing 50 percent or more of the solids from liquid manure. Solids can be settled and filtered by a shallow basin (2 to 3 feet deep) with concrete floors and walls and a porous dam or perforated pipe outlet. Basins should allow access by a front-end loader to remove solids every one to six months.

The use of solid/liquid separators improves the waste handling and treatment efficiencies of many livestock operations. With the removal of manure solids, the storage life of a structure will be increased and costs can be saved due to the reduced need for sludge removal. The buildup of P, copper, and zinc will also be reduced. In instances where lagoons are undersized or are not effectively treating the waste, solids removal may reduce the waste load to a level where proper anaerobic treatment can occur. The buildup of solids in transfer pipes and pumps will also be reduced.

Composting

Composting stabilizes manure into a humus-like material that increases soil organic carbon and increases fertility. Livestock producers can compost manure, separated manure solids, vegetative matter, or byproducts from other agricultural or nonagricultural sources. In some cases, composting may be a less expensive waste reduction process than alternative storage and treatment methods. The final composted product has less odor and breeds fewer flies than raw manure. The volume and weight are less than raw manure, thus requiring less cost to haul and spread the compost. Also, the heat generated by the composting process destroys pathogenic organisms and weed seeds in the manure.

Aerobic Treatment

The main advantages of aerobic (with oxygen) lagoons are that bacterial treatment tends to be more complete than with anaerobic treatment and the end products are relatively odorless. In naturally aerobic lagoons or oxidation ponds, oxygen needed for treatment must be diffused across the water surface. Mechanically aerated lagoons combine the odor control advantages of aerobic digestion with relatively small surface area requirements. Aerators are used mainly to control odors close to residential areas and N removal where land available for manure application is limited. A major limitation for mechanically aerated lagoons is the expense of continually operating electrically powered aerators. Aerobic lagoons also produce more sludge than anaerobic lagoons because more of the manure is converted to microbial biomass. Suitable land must be available to accept the sludge with its associated nutrients, although it may be possible to dewater this sludge (see above options) and move the solids off the farm for application at other farms or for other treatment, such as composting.

Two-stage Lagoons

Two-stage lagoons have certain advantages over the typical single, primary lagoon. A two-stage anaerobic lagoon system has the same total liquid volume as a single primary lagoon. The first lagoon contains the design treatment volume and the sludge storage volume, while the second lagoon provides temporary storage prior to land application. A two-stage lagoon allows a maximum liquid level to be maintained in the primary lagoon for the most

efficient stabilization of incoming wastes. The result is a more stable operation, which helps to minimize odors. More than two lagoons in series are rarely beneficial.

Pumping from a second-stage lagoon also reduces the solids pickup common to primary lagoons due to seasonal water turnovers, floating debris, and biological mixing. Because of the reduced solids, the second stage of a two-stage anaerobic lagoon system appears to have up to 25 percent less N in the lagoon liquid and up to 50 percent less P than a single primary lagoon with the same total volume. A second-stage lagoon typically functions only as storage for liquid effluent and may be pumped down completely if not used for sludge storage. There only needs to be a maximum liquid level marker in this lagoon if used only for liquid storage.

Disadvantages of two-stage lagoons include:

- Increased surface area, which collects more rainfall
- Increased construction cost

Odor Control Products

A number of commercial products advertise the ability to either reduce or control lagoon odors. These products include (1) masking agents, (2) chemicals that can temporarily bind ammonia, (3) chemicals that inhibit ammonia production, (4) chemicals that neutralize odor, (5) chemicals that stimulate bacterial growth, and (6) bacterial preparations that contain "special" strains of bacteria. However, most of these products have not been scientifically evaluated and proven to be effective. Nonetheless, numerous reports from producers attest to the partial effectiveness of some of these products. A livestock producer should be very wary of any unsupported claims by vendors of "odor control" products. Products that may show positive results in one situation may not be effective in seemingly similar situations.

Review Questions

1. Name the six design volumes for an anaerobic lagoon.
2. Describe some common types of lagoon liners.
3. Explain when and why you should pump lagoon wastewater to cropland.
4. Name several causes of lagoon failures.
5. List several ways in which you may be able to reduce the amount of solids entering an anaerobic lagoon.
6. Name some advantages and disadvantages of the following types of waste application equipment:
    a. stationary big guns;
    b. traveling systems; and
    c. pump-and-haul (honey wagon).
7. Describe how sludge is to be monitored and handled in a waste management system.

Chapter 6: Proper Application of Waste Products—Type A

Proper waste application involves knowledge of the waste application system, the soils and crops, and the required setbacks that must be adhered to. This chapter will explain the required setbacks and all other factors that must be considered when you are trying to determine when and how much to apply.

Setbacks

List the necessary setbacks for waste application.

Proper waste application involves knowledge of the waste application system, the soils and crops, and the required setbacks that must be adhered to. This chapter will explain the required setbacks and all other factors that must be considered when you are trying to determine when and how much to irrigate.

Setbacks are intended to prevent animal operations from causing surface water or groundwater contamination or creating nuisance conditions such as odor, dust, and insect problems at neighboring properties. A setback is the minimum separation in feet between application areas and physical features such as buildings, wells, property lines, or perennial streams and rivers. A "perennial stream/river" means a well-defined channel that contains water year-round during a year of normal rainfall.

There are several setbacks that must be adhered to when land-applying animal waste. The first are those that are required by law.

All operations that meet the threshold number of animals and that are required to have a permit (including swine farms sited or expanded before September 30, 1995) must meet the setback requirements in Table 6-1. The outer perimeter of the waste application area cannot be closer than the distances listed.

Table 6-1. Minimum Setback Distances for Waste Application Areas That All Permitted Animal Operations Must Meet.

Physical feature	Minimum distance from feature
Perennial water	25 feet of vegetated buffer
Dwelling not owned by the producer	200 feet
Well	100 feet

Swine operations must meet *additional* setbacks for waste application areas depending on:

- the permit;
- the date of facility siting; and/or
- the date the waste application field was placed in use.

Swine farms sited on or after October 1, 1995, and constructed or expanded before August 27, 1997, must meet the setbacks listed in Table 6-1 and Table 6-2.

Table 6-2. Additional Setback Distances for Waste Application Areas at Swine Operations Sited and Constructed or Expanded from October 1, 1995, through August 27, 1997.

Physical feature	Minimum distance from feature
Perennial stream/river other than a ditch or canal	50 feet
Residential property boundary	50 feet

Swine farms sited or expanded after August 27, 1997, must meet the setbacks listed in Table 6-1 and the setbacks in Table 6-3.

Table 6-3. Additional Setback Distances from Waste Application Areas for Swine Operations Sited and Constructed or Expanded after August 27, 1997.

Physical feature	Minimum distance from feature
Perennial stream/river other than a ditch or canal	75 feet
Residential property boundary	75 feet

Regardless of siting date, a swine farm must meet the 75-foot requirements in Table 6-3 for any new waste application field put into use after August 27, 1997, that:

a. was not within the property boundary where the waste was generated; or
b. was not within the property boundary where waste was previously applied from the operation.

Other new waste application fields within the property boundary where the waste is generated or on which waste has previously been applied are not required to meet the 75-foot setbacks in Table 6-3, but must meet the requirements in Tables 6-1 and 6-2.

Swine operations sited on or after October 1, 1995, also have setback requirements for production houses and lagoons. Houses and lagoons **cannot be located within the 100-year floodplain** and cannot be closer to the features listed in Table 6-4.

Table 6-4. Setbacks for Production Houses and Lagoons for Swine Operations Sited on or after October 31, 1995.

Physical feature	Minimum distance from feature
Perennial streams/rivers other than a ditch or canal	100 feet
Water supply wells	500 feet [a]
Property boundaries	500 feet [b]
Occupied residences	1,500 feet [b]
Schools, hospitals, churches, childcare centers, outdoor recreational facilities, national or state parks, or historic properties	2,500 feet [b]

[a] Does not apply to a well located on the same tract of land as the swine house or lagoon and that supplies water only for use on that tract of land or for the use on

adjacent tracts of land all of which are under common ownership or control.

[b] May be located closer if written permission is given by the owner of the property and recorded with the Register of Deeds.

You should also review your waste management plan or permit to see if any additional setbacks are required. Remember, the requirements in Tables 6-2, 6-3, and 6-4 are for swine operations only.

The last setback is a "good neighbor" setback. Do not land apply on days with excessive wind. Drift on these days may impact neighbors or pollute surface waters.

Describe why wind speed and direction should be considered when irrigating.

Irrigation Scheduling

Proper land application of lagoon liquid involves the use of water management strategies to best achieve a balance between:

- Optimizing the timing of nutrient application to match crop uptake.
- Maintaining adequate storage in the lagoon to handle extreme rainfall without overtopping.
- Applying lagoon liquid at a rate and amount such that no direct surface runoff or deep percolation below the root zone occurs on the application site.

A responsible system operator must understand how wastewater should be managed, have knowledge of the capacity of the system to store and apply wastewater when appropriate, and be able to make prudent management decisions concerning when and how much wastewater to land-apply. For a liquid waste management system utilizing irrigation, this decision-making process is called **irrigation scheduling** and is generally based on the flowchart in Figure 6-1.

Determining When to Irrigate

Four basic questions should be answered when deciding to irrigate:

List the four factors that must be addressed before irrigating animal waste.

1. Do I have an actively growing crop or will a crop be planted or actively growing within 30 days?
2. Is the liquid level in my lagoon above the minimum storage depth?
3. Do I have an N deficit remaining for this crop cycle?
4. Are my land application fields dry enough to be irrigated?

If the answer to all four questions above is yes, then you should schedule an irrigation event. The answer to Questions 1, 2, and 3 are straightforward and should be easy to determine. Question 3 requires knowledge of the amount of nutrients you can apply and how much has already been applied. This was discussed in Chapter 3 and is found in the WUP. **Record keeping** will be addressed further in Chapter 7. The next section discusses how to determine soil water content and how to determine irrigation rates (Question 4).

Hurricane warnings, tropical storm warnings, flood watches, and flash flood watches have special provisions related to irrigation scheduling. The farm permit will specify the provision for these weather events.

Estimating Soil-Water Content

Determining whether or not the field is "dry" enough to be irrigated is not always obvious. There are three practical ways to tell:

1. A subjective method that involves "feeling" the soil,
2. Objective methods utilizing soil-moisture measuring devices, or
3. An accounting approach (checkbook method).

One of these three methods should be used to estimate the amount of water present in the soil before irrigation begins.

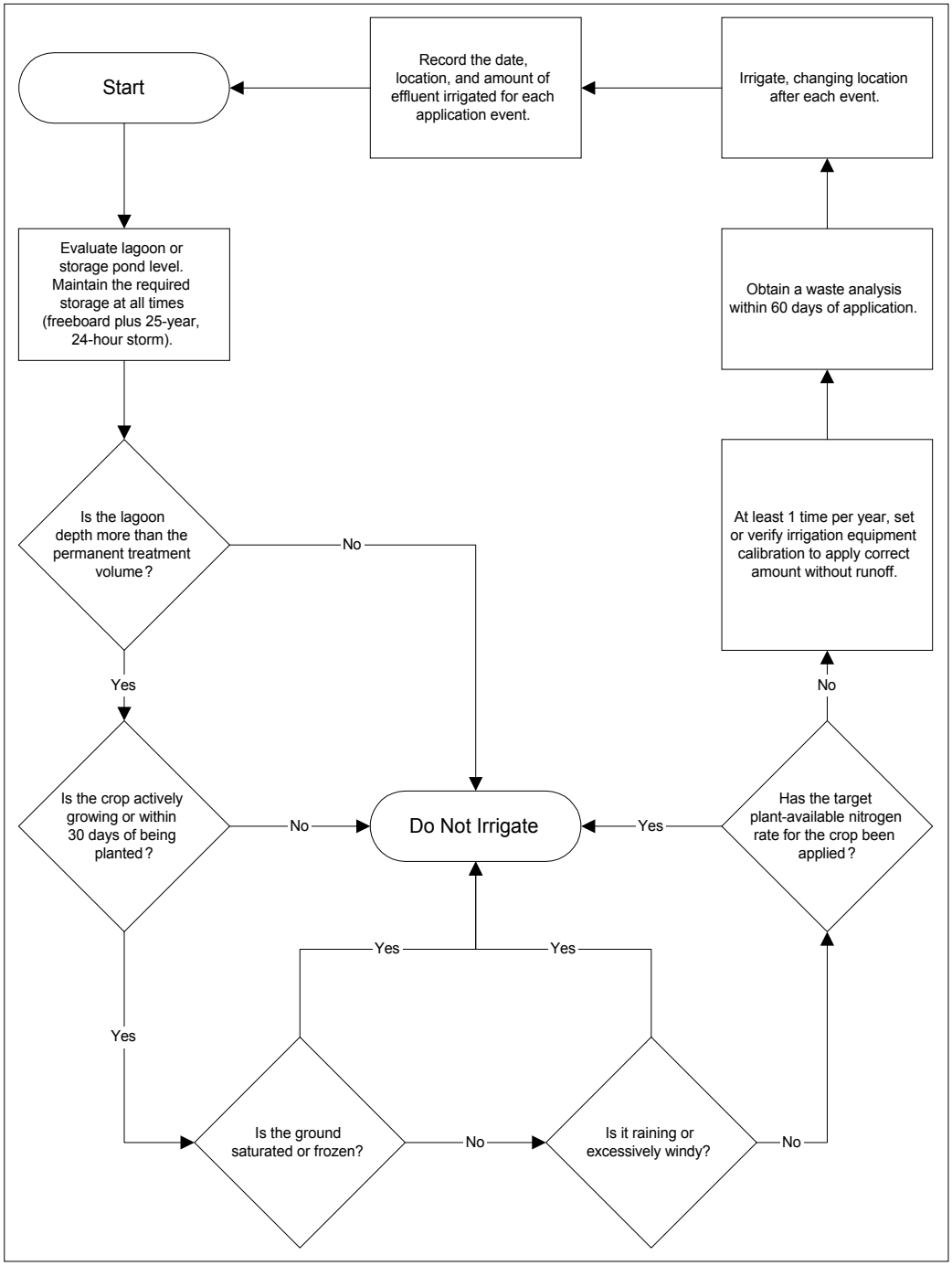


Figure 6-1. Nutrient management and irrigation scheduling decision-making flowchart.

Feel Method

The feel method involves actually feeling the soil with your hand. This method is easy to use and many growers schedule irrigation in this way. This method is subjective since the results depend on the experience of the person doing the measurement. Some guidelines for estimating soil water content by the feel method are given in Table 6-5.

Measuring Devices

Devices for measuring soil water include the gravitational method, tensiometer, electrical resistance blocks, neutron probe, Phene cell, and time domain reflectometer. These methods differ in reliability, cost, and labor intensity.

Tensiometer and electrical resistance blocks are the most cost-effective and reliable devices for on-farm measurement of soil water for irrigation in North Carolina. Tensiometers are best suited for sandy, sandy loam, and loamy soil textures, while electrical resistance blocks work best in silty or clayey soils. Manufacturers of these devices provide calibration charts and recommended ranges for traditional "fresh" water irrigation. The calibration curves and recommendations supplied by the manufacturer for these devices were developed for freshwater irrigation and general conditions and are not adequate for wastewater irrigation or specific soil conditions and fields. In addition, wastewater objectives and recommendations are different from freshwater recommendations. Therefore, for irrigating with wastewater, you will get better results if all soil water measuring devices are calibrated for the major soils you are irrigating.

Checkbook Method

The checkbook method is an accounting approach for estimating how much soil water remains in the effective root zone based on water inputs and outputs. It's much like keeping track of the daily balance on a bank account by monitoring deposits and withdrawals. Wastewater irrigation is scheduled when the soil water content in the root zone drops below a threshold level. Some of the simpler checkbook methods keep track of rainfall, evapotranspiration, and irrigation amounts. More sophisticated methods require periodic measurements of the soil water status and moisture use rates of the crop.

Checkbook methods require detailed daily record keeping, which can become time-consuming for the more complex methods. One of the advantages of the checkbook approach is that it can be programmed for a computer. Computer programs have been developed to handle the accounting and provide timely and precise scheduling recommendations. Because this method can become very complex, requiring much data input, it will not be discussed further in this manual. See NC State Extension publication AG-607, *Irrigation Scheduling to Achieve Proper Application of Wastewater* (**content.ces.ncsu.edu/irrigation-scheduling-to-achieve-proper-application-of-wastewater**), for more information.

Table 6-5. "Feel" Guidelines for Estimating the Maximum Recommended Irrigation (Per Foot of Effective Root Zone Depth) to Replace Plant-Available Water as a Function of Soil Texture

Available Water Remaining in the Soil	Sands, Loamy Sand		Sandy Loam		Clay, Clay Loam, Sandy Clay Loam		All Other Textures	
	Feel Guidelines	Max Wastewater Irrigation	Feel Guidelines	Max Wastewater Irrigation	Feel Guidelines	Max Wastewater Irrigation	Feel Guidelines	Max Wastewater Irrigation
100% (for example, field capacity)	When ball is squeezed, no free water appears on soil but wet outline of ball is left in hand.	None	When ball is squeezed, no free water appears on soil, but wet outline of ball is left in hand.	None	When ball is squeezed, no free water appears on soil, but wet outline of ball is left in hand.	None	When ball is squeezed, no free water appears on soil, but wet outline of ball is left in hand.	None
75% to 100%	Sticks together only slightly.	0.1 to 0.2 inch	Forms a ball that breaks easily.	0.2 to 0.3 inch	Forms a ball; very pliable.	0.2 to 0.4 inch	Easily ribbons between thumb and forefinger; feels slick.	0.2 to 0.4 inch
50% to 75%	Appears dry; will not form a ball.	0.2 to 0.3 inch	Forms weak ball that falls apart.	0.3 to 0.4 inch	Forms ball; slightly plastic; slightly slick.	0.3 to 0.5 inch	Forms ball; forms ribbon.	0.3 to 0.6 inch
25% to 50%	Appears dry; will not form a ball.	0.3 to 0.5 inch	Appears dry; will not form a ball.	0.3 to 0.6 inch	Somewhat crumbly but holds under pressure.	0.3 to 0.6 inch	Forms ball under pressure; somewhat pliable.	0.3 to 0.7 inch
0 to 25%	Dry and loose; single-grained; flows through fingers.	0.3 to 0.5 inch	Dry and loose; flows through fingers.	0.3 to 0.6 inch	Powdery and dry; easily breaks into powdery condition.	0.3 to 0.7 inch	Hard and cracked; may have loose crumbs on soil surface.	0.3 to 0.7 inch

Determining How Much to Irrigate

Irrigation should be scheduled and timed so that:

- No surface runoff occurs during irrigation
- The root zone is not completely saturated at the conclusion of irrigation
- The irrigated water does not leach below the root zone

Explain how to determine how much water to irrigate.

Your CAWMP should have maximum limits of how much wastewater can be applied per hour or per event. You must never exceed these amounts, but you may apply less than these amounts. Using these numbers in the plan as a maximum, the amount of wastewater that can or should be applied during any single irrigation cycle is dictated by how much water the soil can soak up. This soil condition varies from day to day and is influenced by:

- **Rainfall**—when and how much it last rained
- **Crop maturity**—water uptake rate of the crop
- **Soil type**—texture, structure, depth, and cover
- **Effective root depth**—dependent on soil characteristics and crop type and age
- **Evapotranspiration**—influenced by temperature, wind, and relative humidity

No more than 1.0 inch can be applied per 24-hour period.

Explain how/ why irrigation amounts need to be adjusted seasonally.

There are many opportunities to apply wastewater during the year at reduced rates (below the maximum allowable) that still allow the operator to manage the lagoon level. Based on the factors above, decisions can be made to apply wastewater at many times of the year to allow for lagoon level management. Some of these applications will be lighter to ensure that overapplication (for example, causing ponding or runoff) does not occur. Once you determine how much wastewater to apply, set your equipment accordingly to deliver that amount. Equipment details and settings are covered in the next section.

Regardless of the calculated rate, you, as the system operator, should monitor each waste application to verify adequate infiltration of the waste into the soil. An irrigation cycle should be stopped if ponding and runoff start to occur.

Operational Considerations

Define discharge rate, precipitation rate, and application volume.

A key component of the irrigation design is selection of the proper combination of system components such that the system precipitation rate does not exceed the infiltration rate of the soil. Several terms may be used to express the rate at which water is being applied to a field during irrigation. Terms you should be familiar with include **discharge rate**, **precipitation rate**, and **application volume**.

Discharge Rate

Explain how to obtain sprinkler discharge rates.

Discharge rate is the volume of water exiting a sprinkler per unit of time, and it is normally expressed in terms of gallons per minute (gpm). Discharge rate can also be referred to as "sprinkler flow rate." Manufacturers publish discharge rates for their sprinklers as a function of operating pressure and orifice diameter of the nozzle. You should always have a copy of the manufacturer's discharge specifications for the sprinklers on

your system. Discharge characteristics for three typical sprinklers used for wastewater irrigation are given in Table 6-6. For example, a Rain Bird Model 70 sprinkler operated at 55 psi (pounds per square inch) with a 9/32-inch diameter nozzle has a discharge rate of 17.2 gpm. Discharge characteristics for typical big guns are shown in Table 6-7a (taper bore nozzle) and Table 6-7b (ring type nozzle). For contrast, notice how much higher discharge rates are for big gun sprinklers than for rotary impact sprinklers.

Explain what effect changing nozzle diameter can have on discharge rate and wetted diameter.

Table 6-6. Discharge Characteristics for Rotary Impact Sprinklers Used with Permanent Stationary Irrigation System

Sprinkler Type	Nozzle Size (inch)	Operating Pressure (PSI)					
		50		55		60	
		Flow (GPM)	Diameter (FT)	Flow (GPM)	Diameter (FT)	Flow (GPM)	Diameter (FT)
Nelson F70APV	1/4	12.8	128	13.6	131	14.0	134
	9/32	16.0	134	16.8	137	17.6	140
Rain Bird 70 CWH	1/4	12.9	124	13.6	126	14.2	128
	9/32	16.3	131	17.2	133	18.0	135
Senniger 7025 RD-1-DFF	1/4	13.0	127	13.6	131	14.2	138
	9/32	16.3	133	17.1	137	17.8	142

Precipitation Rate and Application Volume

Precipitation rate is normally expressed as unit depth of water (inches) per unit of time (usually an hour). The precipitation rate (inches per hour) depends upon discharge rate and coverage diameter. Another important concept is **total application volume** (also expressed as application depth in inches), which is computed based on the amount of time the system operates at a given rate on a given field. For example, you might typically irrigate ½ inch (0.5 inch) per irrigation cycle.

Wastewater analyses are expressed in terms of pounds of plant-available nitrogen (lb PAN) per 1,000 gallons of wastewater. When irrigating, it is preferable to express irrigation amounts as an equivalent depth of water, for example, 1/2 inch per acre. Therefore, it is often necessary to convert between application volume expressed as gallons per acre and application volume expressed as an inch per acre. **One inch of water spread over an acre, referred to as acre-inch, is equal to 27,154 gallons.**

Example:

If you apply 0.5 inches of irrigation water, how many gallons per acre will be applied?

Solution:

27,154 gal/acre-inch × 0.5 inches = 13,577 gal/acre

Note: Most irrigation systems do not completely cover a field with wastewater during operation. For example, a 30-acre pasture may receive wastewater application on only 23 acres due to the layout of the field, setbacks that must be observed, and operational parameters of the irrigation system. A wastewater application design and the appropriate records must reflect the area that

Table 6-7a. General Flow Rates for Big Gun Sprinklers: Taper Bore Nozzle

Gun Model	Nozzle Diameter (inch)	Pressure (PSI)															
		50		60		70		80		90		100		110		120	
		GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA
100T	0.5	50	205	55	215	60	225	64	235	68	245	72	255	76	265		
150T	0.75	115	260	126	275	137	290	146	300	155	310	164	320	172	330	180	340
	1.0	205	310	225	325	245	340	260	355	275	365	290	375	305	385	320	395
200T	1.5			515	430	555	450	590	470	625	485	660	500	695	515	725	530
	2.0			912	512	980	528	1047	548	1105	568	1167	592	1220	607	1277	622

Table 6-7b. General Flow Rates for Big Gun Sprinklers: Ring Type Nozzle

Gun Model	Nozzle Diameter (inch)	Pressure (PSI)															
		50		60		70		80		90		100		110		120	
		GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA	GPM	DIA
100R	0.71	74	220	81	235	88	245	94	255	99	265	105	270	110	275		
150R	0.86	100	245	110	260	120	270	128	280	135	290	143	300	150	310	157	315
	0.97	130	265	143	280	155	290	165	300	175	310	185	320	195	330	204	335
200R	1.56	350	370	385	390	415	405	445	420	475	435	500	445	525	455	545	465
	2.0	640	435	695	455	755	475	805	490	855	505	900	520	945	535	985	545

receives wastewater; in this case the area is 23 acres as opposed to the total field size. The 23 acres in this scenario are referred to as wettable acres. Depending on when your waste plan was written or revised, or when an irrigation system upgrade occurred, you may have had a **wettable acres** *determination done on your farm. This determination must be performed by a technical specialist with training in irrigation systems.*

Explain the importance of sprinkler overlap.

To attain acceptable application uniformity, stationary sprinklers are typically arranged in a square pattern at a spacing of 50 to 65 percent of the wetted diameter. A typical layout for stationary sprinklers is shown in Figure 6-2. The orifice size, sprinkler spacing, and operating pressure are selected from manufacturer's literature to achieve the desired overlap and uniformity of coverage.

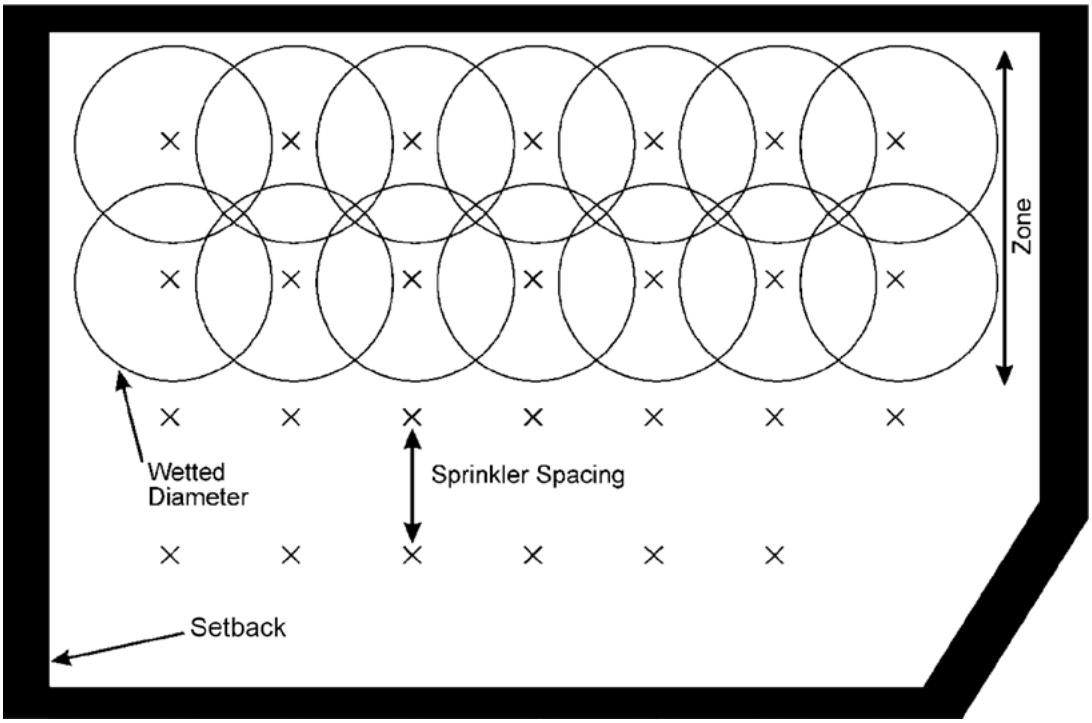


Figure 6-2. Typical layout of a stationary sprinkler system. Sprinkler spacing is typically 50 to 65 percent of wetted diameter.

Determination of Precipitation Rates for Stationary Sprinklers

Formula 1

The precipitation rate for stationary sprinklers is computed from this formula:

$$\text{Precipitation rate (in/hr)} = \frac{96.3 \times \text{sprinkler flow rate (gpm)}}{\text{sprinkler spacing (ft)} \times \text{lateral spacing (ft)}}$$

Compute the precipitation rate for a stationary sprinkler irrigation system.

Procedure for computing precipitation rate:

1. Determine the discharge rate (sprinkler flow rate) and wetted diameter from manufacturer's literature.
   Example: From Table 6-2, RainBird Model 70 with a 9/32-inch diameter nozzle operated at 55 psi:

   Sprinkler flow rate = 17.2 gpm

   Wetted Diameter = 133 feet

2. Recommended sprinkler spacing is 50 to 65 percent of wetted diameter. Using a value of 60 percent:

$$\text{Design sprinkler spacing} = 0.6 \times 133 \text{ ft} = 79.8 \text{ ft}$$

Sprinklers are normally spaced in equal multiples of 20 feet based on typical pipe length.

3. Precipitation rate is then computed as:

$$\text{Precipitation rate (in/hr)} = \frac{96.3 \times 17.2 \text{ gpm}}{80 \text{ ft} \times 80 \text{ ft}} = 0.26 \text{ in/hr}$$

Compute the application volume for a stationary sprinkler irrigation system.

The *application volume* is then computed as the precipitation rate multiplied by the operating time. In most cases, you will estimate the desired application volume based on soil conditions as described earlier. If this is the case, you then compute the time required to operate the system to achieve the desired application volume. For example, if the desired application volume is 0.6 inch, then the required operating time for the system would be:

4. Compute the time of operation:

Formula 2

$$\text{Time of operation (hr)} = \frac{\text{application volume (in)}}{\text{precipitation (application) rate (in/hr)}}$$

So:

Determine the operational time necessary to apply a desired application volume and associated nitrogen application amount.

$$\text{Time of operation (hr)} = \frac{0.6 \text{ in}}{0.26 \text{ in/hr}} = 2.3 \text{ hr}$$

$$\text{Time of operation (hr)} = 2 \text{ hr} + (0.3 \times 60 \text{ min/hr})$$

Determination of Precipitation Rates for Traveling Gun Sprinklers

The precipitation rate in inches per hour for a traveling gun sprinkler is generally not affected by travel speed because at any given position within the wetted diameter, water is usually being applied for at least an hour or longer. The precipitation rate is affected by the angle of rotation of the gun sprinkler. For example, if the gun makes only a half circle (180 degrees of rotation), the precipitation rate is twice that of a gun making a full circle (360 degrees of rotation).

Determination of Application Volume (Depth) for a Traveling Gun Sprinkler

The volume of wastewater applied by a traveling gun depends on the flow rate, lane spacing, and travel speed. The travel lane spacing should be approximately 70 to 80 percent of the sprinkler's wetted diameter, as shown in Figure 6-3. The application volume is computed by the formula:

Formula 3

$$\text{Application volume (in)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{travel speed (in/min)}}$$

Determine application volume and effective coverage from manufacturer's literature for a traveling gun sprinkler.

Example:

What is the application volume for a gun sprinkler if the operating pressure is 80 psi, the taper bore nozzle diameter is 1.0 inch, and the travel speed is 3 feet per minute?

From Table 6-3, for a gun sprinkler operated at 80 psi with a 1.0-inch nozzle, the discharge rate is 260 gpm and the wetted diameter is 355 feet.

If the lane spacing is 75 percent of the wetted diameter, the lane spacing is:

$$0.75 \times 355 \text{ ft} = 266 \text{ ft}$$

The travel speed needs to be expressed in inches per minute. A travel speed of 3 feet per minute is equal to 36 inches per minute.

$$3 \text{ ft/min} \times 12 \text{ in./ft} = 36 \text{ in./min}$$

The application volume is then computed to be:

$$\text{Application volume (in)} = \frac{19.3 \times 260 \text{ gpm}}{266 \text{ ft} \times 36 \text{ in/min}} = 0.52 \text{ in}$$

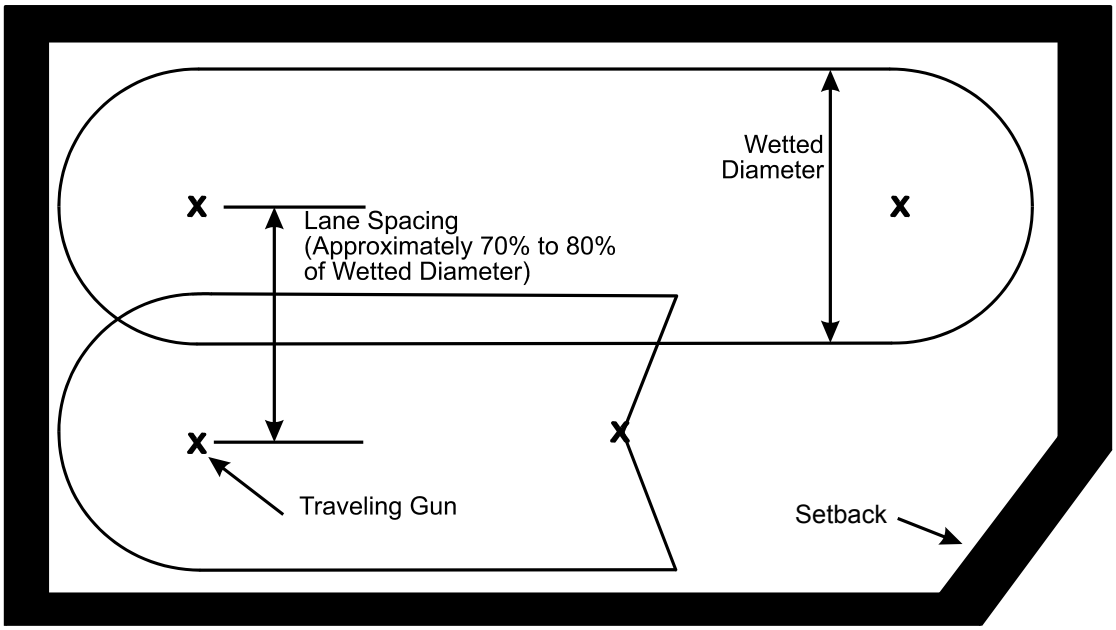


Figure 6-3. Typical layout of a traveling gun irrigation system. Lane spacing is typically 70 to 80 percent of wetted diameter.

Determination of Travel Speed for a Traveling Gun Sprinkler

In a typical operation, you select an application depth based on the soil and site conditions. Most manufacturer's charts will show how to select a travel speed to do this. It can also be computed by the following formula:

Formula 4

$$\text{Travel speed (in/min)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{application volume (in)}}$$

Example:

What travel speed is necessary to apply 0.6 inch with a gun sprinkler if the operating pressure is 80 psi and the taper bore nozzle diameter is 1.0-inch?

Compute the required travel speed for a traveling gun sprinkler to apply the desired application volume.

From Table 6-3, for a gun sprinkler operated at 80 psi with a 1.0-inch nozzle, the discharge rate is 260 gpm and the wetted diameter is 355 feet.

If the lane spacing is 75 percent of the wetted diameter, the lane spacing is:

$$0.75 \times 355 \text{ ft} = 266 \text{ ft}$$

$$\text{Travel speed (in/min)} = \frac{19.3 \times 260 \text{ gpm}}{266 \text{ ft} \times 0.6 \text{ in}} = 31.4 \text{ in/min}$$

System Changes

Before making any changes to your application equipment, including settings for travel speed or changing of nozzles, consult your waste management plan to see if there are specifications that must be adhered to. What may appear to be minor changes, such as a nozzle or ring size, can have significant effects on the discharge rate and wetted diameter of a sprinkler.

Explain the effects of changing pressure on droplet size, drift, precipitation rate, and wetted sprinkler diameter.

Operating the system differently than directed in the design will alter the application rate, diameter of coverage, and subsequently the application uniformity. For example, operating the system with excessive pressure results in smaller droplets, greater potential for drift, and accelerated wear of the sprinkler nozzle. Clogging of nozzles can result in pressure increase. Plugged intakes or crystallization of mainlines will reduce operating pressure. Operating below design pressure greatly reduces the coverage diameter and application uniformity.

Part-turn Sprinklers

Part-turn sprinklers are sometimes used to gain wettable area where a full-turn sprinkler may result in an encroachment on a required setback or field ditch. Caution must be exercised when operating part-turn sprinklers, as the discharge area is much less than that of a full-turn sprinkler. If designed properly so that the flow from a part-turn sprinkler is less than neighboring full-turn sprinklers in the same field, then a consistent application rate may be achieved. Otherwise, it could be that the operator must manually limit the run time on part-turn sprinklers by way of a valve on the individual sprinkler risers or with a field valve at the system header. This same philosophy also applies to gun angle on a traveling big gun. Many operators will set the gun angle at less than 360 degrees in order to not wet the hose reel. A smaller gun angle results in an increased precipitation rate. The operator should be aware of this situation and closely monitor the infiltration of the applied wastewater.

Managing Irrigation Systems

The operator of a waste management system must develop a consistent method of record keeping when it comes to irrigation system management. All waste applications must be recorded on approved record keeping forms (Chapter 7: Record Keeping—Type A). Because records must reflect the actual area (wetted acres) and run times for each irrigation cycle, most operators find it easier to set up each irrigation field zone or hydrant as a separate field when maintaining records. Unless a field is managed consistently throughout the year with respect to waste applications, the zone or hydrant methods seem to work the best. If an operator chooses to keep records by field, then consistency with irrigation run times and/or travel speeds must be maintained throughout the field to ensure that the waste is being applied uniformly to the entire field.

When using each individual hydrant as a field (often referred to as a "pull"), the operator should establish field markers to ensure that each pull of the gun cart is consistent and to provide proper irrigation overlap between lanes.

System Calibration

Information presented in manufacturer's charts is based on average operating conditions with relatively new equipment. Discharge rates and application rates change over time as equipment gets older and components wear. In particular, pump wear tends to reduce operating pressure and flow. With continued use, nozzle wear results in an increase in the nozzle opening, which will increase the discharge rate while decreasing the pressure and wetted diameter.

Due to possible wear, all waste application equipment, including irrigation systems, hose-drag systems, honey wagons, and solid spreaders, must be field tested and calibrated to verify operating performance and application amount. Field calibration to verify application amount is required once a year for NPDES permitted facilities and once every other year for state permitted operations.

Describe the procedures for field calibration of waste application equipment and why it is important.

Calibration of irrigation systems involves field verification of (1) operating pressure, (2) wetted diameter, (3) flow rate, and (4) application uniformity. The minimum calibration performance requirements are:

Minimum calibration performance requirements are:

1. Operating pressure at the sprinkler/gun must be verified using a properly functioning pressure gauge and observed to be operating within the range recommended by the manufacturer or specified in the irrigation design documentation for the equipment being calibrated.
2. Wetted diameter of the system being field calibrated must be measured as described in the NC State Extension Irrigated Acreage Determination Procedures for Wastewater Application Equipment publications *Hard Hose Traveler Irrigation System* (**content.ces.ncsu.edu/hard-hose-traveler-irrigation-system**) and *Stationary Sprinkler Irrigation System* (**.ces.ncsu.edu/stationary-sprinkler-irrigation-system-1**) and observed to be within 15 percent of the wetted diameter reported in the manufacturer's chart for the operating pressure observed in Item 1.

3. Flow rate must be determined to be within 10 percent of the value specified in the irrigation design documentation or as determined during the wettable/effective irrigated acre determination. Flow rate shall be determined using either:
   a. flow rate from manufacturer's chart for the measured pressure at the sprinkler/gun (Item 1) and measured sprinkler/gun orifice diameter; or
   b. flow rate measured with an approved, calibrated flow meter.
4. Application uniformity is deemed to be acceptable when Items 1 through 3 above are within the ranges specified.

Rain gauges or other containers can be used to check uniformity but not to measure flow of a system. Pans, plastic buckets, jars, or anything with a uniform opening and cross-section can be used, provided the liquid collected can be easily transferred to a scaled container for measuring.

Calibration workbooks for various types of waste application systems can be obtained from your local Cooperative Extension office.

Pump-and-Haul Waste Management Systems

Wastes that have a higher solids content that can't easily be handled through an irrigation system may require land application through a pump-and-haul system. Typically, wastes or slurries with solids concentrations above 3 to 4 percent are difficult to handle as a liquid and cause excessive wear and clogging to standard irrigation pumps and equipment. Liquid applicators and tank spreaders are an alternative to irrigation for applying these materials.

Many of the decisions on when and how much to irrigate wastewater are determined by the liquid nature of the waste and the potential for runoff. With slurry or solids application, these decisions surrounding liquid application are not as critical. Certainly, it is still your job as the system operator to ensure that the applied waste will not run off the property, but the solid nature of the wastes greatly reduces the tendency of these materials to run. Therefore, the decision process for waste application is more related to the stage of crop growth and whether the crops need nutrient applications. Another important issue is the "trafficability" of the fields or how easily your equipment can be operated to obtain uniform waste application without rutting the field or compacting the soil. Once the decision has been made to perform waste application, you must be aware of your equipment's waste application rate. This requires the calibration of the land application equipment.

A certain percentage of the nutrients in slurry and solid manures is tied up in the organic portion of the waste and is not immediately available for plant uptake. These nutrients will slowly become available to plants over the course of several years. To satisfy your waste management plan, you are required to keep track of only the nutrients that are available for the first crop. It is possible, but tedious, to develop a system to determine the "carryover" nutrients from the organic portion of the manure. It is beyond the scope of this training to do this exercise and, as mentioned, it is not required at this time. However, you may wish to consider this issue to help minimize the potential for overapplication of nutrients (especially N) that may be detrimental to your crops, soils, or groundwater.

Liquid Manure Spreaders

Manure spreaders are an alternative to irrigation for applying liquid manure. They may be the only option when manure slurry is too thick to be irrigated, as may be the case with dairy slurry or swine lagoon sludge, where solids content ranges from 3 to 12 percent. Spreader options include a liquid tanker, which is truck mounted or pulled behind a tractor, or a hose-drag type of system that is connected by piping or an irrigation reel directly to the lagoon pump. Both systems require an operator to drive the machine. Also, fields must be dry enough and firm enough to handle the heavy machinery.

Hose-drag systems have an advantage over tankers in that the wastewater or slurry is constantly being supplied to the machine, so you won't have to reload a tanker by repeated trips to the lagoon. The hose-drag system allows for higher pumping volumes when waste application conditions are suitable.

Liquid tank spreaders must be accurately calibrated to apply wastes at proper rates. Calibration is the combination of settings and travel speed needed to apply wastes at a desired rate and to ensure uniform application. To calibrate, you must know the spreader capacity, which is normally rated by the manufacturer in gallons.

Calibration method:

1. Spread at least one full load of waste, preferably in a square or rectangular pattern for ease of measuring, with normal overlaps.
2. Measure the length and width of coverage, recognizing that the outer fringe areas of the coverage will receive much lighter applications than the overlapped areas.
3. Multiply the length by the width and divide by 43,560 to determine the coverage area in acres.

Formula 5

$$\text{Coverage area (area of rectangle in sq ft)} = \text{length (ft)} \times \text{width (ft)}$$

$$\text{Coverage area (acres)} = \frac{\text{length (ft)} \times \text{width (ft)}}{43{,}560 \text{ sq ft/acre}}$$

4. Divide the gallons of wastewater in the spreader by the acres covered to determine the application rate in gallons per acre.

Formula 6

$$\text{Application rate for spreader (gal/acre)} = \frac{\text{spreader load volume (gal)}}{\text{coverage area (acres)}}$$

Repeat the procedure at different speeds and/or spreader settings until the desired application rate is achieved.

Once you have performed the calibration, note what gear settings and engine rpms correlate to a certain application rate. A simple table, similar to the following example, can be made:

Tractor Gear	Engine Speed (rpm)	PTO Speed	Application Rate (gallons/acre)
L1	1800	540	14,000
L2	1800	540	11,500
L3	1800	540	9,700
H1	1800	540	11,200
H2	1800	540	8,400
H3	1800	540	5,800

Example:

Your waste application method is a tractor-drawn tanker (honeywagon) with a 2,500-gallon capacity. You apply a load to a field and measure the application area as 22 feet wide by 480 feet long. What is the application rate in gallons per acre?

First, figure the coverage area:

$$\text{Coverage area (acres)} = \frac{480 \text{ ft} \times 22 \text{ ft}}{43{,}560 \text{ sq ft/acre}} = 0.24 \text{ acre}$$

Then figure the application rate:

$$\text{Application rate for spreader (gal/acre)} = \frac{2{,}500 \text{ gal}}{0.24 \text{ acre}} = 10{,}416.7 \text{ gal/acre}$$

Calibration for hose-drag systems is similar. You measure volume pumped with a flow meter attached to the system piping, and you apply that volume over the area (length × width) covered in the field.

Manure spreaders and hose-drag systems have an advantage over irrigation systems in that all areas in a field that meet setback restrictions can have uniform waste coverage. **Changing waste application systems requires a modification to the waste management plan.**

Review Questions

1. What setbacks and buffers must be observed during waste application?
2. A proper pumping schedule seeks to balance what three things?
3. What are the four questions you should ask yourself before deciding to irrigate wastewater?
4. Describe how to determine the application rate from a stationary sprinkler irrigation system.
5. Explain how you can measure or calibrate your actual waste application (in inches) from an irrigation system.
6. Describe some advantages and disadvantages of irrigation systems and manure spreaders for waste application.

Chapter 7: Record Keeping—Type A

Records Management

Growers who use waste materials as fertilizer or a source of lime must maintain records of the analytical results, application rates, and soil tests for each application site. This section will address the importance of records management as a vital part of an animal waste management system.

Describe the importance of records maintenance.

Record keeping is required to keep up with the management of the waste application system. The forms included here are the current state-approved forms for recording information at a permittee's animal operation. Maintaining these forms is required by state law and helps provide evidence that you are managing your waste management system properly.

Describe what records need to be maintained to show compliance with environmental regulations.

Keeping accurate records, along with the implementation of proper BMPs on your farm, is the primary way you prove to DWR, DSWC (in pilot counties), and to the general public that your animal waste management system is not causing an environmental impact. Assistance with record keeping can be obtained from a Certified Technical Specialist, N.C. Cooperative Extension, the NRCS, the local Soil and Water Conservation District, or the Agronomic Services Division of NCDA&CS.

To satisfy DWR's and DSWC's farm inspection procedures, the following items need to be available at the individual farm:

1. Waste application records
2. Map of farm fields, including waste application fields and acreage
3. CAWMP
4. Waste sample analysis (within 60 days of application)
5. Soil analysis at least once every three years for each field receiving waste applications
6. Rain gauge readings and lagoon level readings
7. Past inspection reports and operational reviews
8. Animal stocking records
9. Records of additional nutrient sources applied (for example, commercial fertilizer, sludge, or lime)
10. Waste application equipment testing and calibration
11. Removal of waste to off-site locations
12. Results of sludge surveys
13. Crop yields
14. Annual certification form (for NDPES permits)

Describe proper record keeping procedures and maintenance.

These records must be maintained in chronological and legible form for a period specified by the permit at the individual farm. Farms with State Nondischarge General Permits and NPDES Permits are required to keep records for five years.

Forms typically require the signature of the OIC for the facility. This is the individual who has been named by the farm manager or owner as the one person in charge of the waste application system.

On the forms that track nutrient loading to each field (IRR-2, SLUR-2, SOLID-2), ***all*** nutrients that are applied to the field must be recorded. This includes any commercial fertilizer that may be added as a starter or supplemental nutrient source.

It may also be beneficial for you to maintain the following additional records for verification of conditions on your farm (you should review your permit to see if you must maintain any of these or other items to be compliant with DWR guidelines):

1. Plant analysis
2. Surface water and groundwater quality records

Forms included here are:

1. **IRR-1:** The Lagoon Liquid Irrigation Field Record is used to record each irrigation event and to record the minimum two-hour inspection of application of waste.
2. **IRR-2:** The Cumulative Lagoon Liquid Irrigation Field Record is used to record the total annual waste and nutrient application to one field per crop cycle. It provides for calculating the total N application to the field and comparing it to the recommended N loading rate.
3. **IRR-1/IRR-2:** The Combination of Lagoon Liquid Irrigation Field Record and Cumulative Lagoon Liquid Irrigation Field Record.
4. **SLUR-1:** The Liquid Manure Slurry Field Record is used to record each waste application event if the producer is using a slurry or pump-and-haul system.
5. **SLUR-2:** The Cumulative Liquid Manure Slurry Field Record is used to record the total annual waste and nutrient application to one field per crop cycle with a slurry or pump-and-haul system. It provides for calculating the total N application to the field and comparing it to the recommended N loading rate.
6. **SOLID-1:** The Solid or Semisolid (dry stack) Field Record is used to record each waste application event if the producer is using a manure spreader or box spreader.
7. **SOLID-2:** The Cumulative Solid Field Record is used to record the total annual waste and nutrient application to one field per crop cycle. It provides for calculating the total N application to the field and comparing it to the recommended N loading rate.
8. **FRBD-1:** This form is used to record daily precipitation events and weekly waste structure freeboard levels.
9. **STOCK-1:** This form is used to track number of animals maintained on the farm. The average number of animals maintained may not exceed the permitted capacity specified in the facilities permit and waste management plan.
10. **CROP-1:** This form is used to track crop yields on fields that are used for waste application.
11. **TRAN-1:** This form is used to record the transfer of any waste between waste structures on the farm.
12. **DRAG-1:** This form is used to record hose-drag application records.

13. **Annual Certification Form:** This form is used for NPDES permit holders to submit to the state each year.
14. **Devices to Autmatically Stop Irrigation Events:** This form is used for State General and NPDES General permit holders to declare whether or not they wish to install automatic cutoff switches for rainfall on their irrigation equipment.

Records may be collected and maintained on a computer, smartphone, tablet, or other electronic device; however, DWR requires that paper printouts of these records be kept on file.

Calculate and verify application rates through the use of waste application records.

The record forms IRR-2, SLUR-2, and SOLID-2 require the operator to make calculations to determine the amount of N that has been applied to a given crop. The necessary formulas to complete the forms are provided in the first row of the form.

Note: For recording purposes, field size is that portion of the field that receives waste applications (often referred to as the "wetted acres" when using irrigation). Wetted acres are equal to or less than field size due to irrigation system layout and use of required buffers, or due to accessibility with spreader equipment.

Appendix F contains the following forms:

- **Change of Ownership:** Required when farm changes ownership.
- **Change of Integrator:** Required when contractor changes integrator or companies.
- **Inspection Form:** Used by DWR and DSWC staff when performing site inspections.

Note that forms other than those in this manual may be used if 1) they contain at a minimum all the information supplied by these forms in a logical, concise format, and 2) they are approved by DWR.

Review Questions

1. Explain what waste management records must be maintained at an animal operation.
2. Describe what is to be done with waste application records.
3. Describe the difference between the field records (example IRR-1) and the cumulative total records (example IRR-2).

Sample Forms

Form IRR-1

FORM IRR-1

Lagoon Liquid Irrigation Fields Record
For Recording Irrigation Events on Different Fields

Farm Owner _____

Facility Number _____ - _____

Operator _____

Tract & Field #	Date (mm/dd/yr)	Crop Type	Field Size (acres)	Irrigation Time			# Sprinklers Operating	Operator Initials	*Weather Code	**Inspections (initials)
				Start Time	End Time	Total Minutes				

* Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee's control have caused noncompliance with the CAWMP or permit, explain on reverse.

IRR-1 Form 8/3/2012

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Hydrant # _____ Field # _____ Facility Number _____ - _____

Field Size (wetted acres) = **(A)** _____

Farm Owner _____ Irrigation Operator _____

Owner's Address _____ Irrigation Operator's Address _____

Owner's Phone # _____ Operator's Phone # _____

From Waste Utilization Plan

Crop Type _____ Recommended PAN Loading (lb/acre) = **(B)** _____

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
***Nutrient Source	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre) **(B)** - (10)
											B=
					Crop Cycle Totals						

Owner's Signature _____ Operator's Signature _____

Certified Operator (Print) _____ Operator's Certification No. _____

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

IRR-2 Form 8/3/2012

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Combined Form IRR-1/2

Zone # _____ Facility Number _____ - _____

Field Size (wetted acres) = **(A)** _____ Irrigation Operator _____

Farm Owner _____ Irrigation Operator's Address _____

Owner's Address _____ Operator's Phone # _____

Owner's Phone # _____

From Waste Utilization Plan

Crop Type _____ Recommended PAN Loading (lb/acre) _____

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		
		Irrigation										
Lagoon ID	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre)	Weather Code	Inspections (Initials)
Crop Cycle Totals =													

Owner's Signature _____ Operator's Signature _____

Certified Operator (Print) _____ Operator's Certification No. _____

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM SLUR-1

Slurry and Sludge Application Field Record
For Recording Slurry Applicaton Events on Different Fields

Farm Owner
Spreader Operator

Facility Number -

Tract & Field #	Date (mm/dd/yr)	***Weather Code	Crop Type	Field Size (acres)	Application Method*	Number of Loads per Field	Volume of each Load** (gallons)

* SI = soil incorporated (disked); BR = broadcast (surface applied).
** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
*** Weather Codes: C-Clear, PC-Partly Cloudy, CI-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

3/14/03

FORM SLUR-2

Slurry and Sludge Application Field Records
One Form for Each Field per Crop Cycle

Form SLUR-2

Tract #		Field #	
Field Size(Wetted Acres)=**(A)**		Facility Number	
Farm Owner		Spreader Operator	
Owner's Address		and Address	
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type		Recommended PAN Loading (lb/acre) = **(B)**	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Volume of each Load* (gallons)	Total Volume (gallons) (2) x (3)	Volume per Acre (gallons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/1000 gal)	PAN Applied (lb/acre) (6) x (5) / 1000	Nitrogen Balance*** (lb/acre) (B) - (7) B=
		Crop Cycle Totals:						

Owners Signature _____ Spreader Operator's Signature _____

Certified Operator (print) _____ Operator Certification No. _____

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

12/20/06

FORM SOLID-1

Manure Solids Application Field Record
For Recording Manure Solids Applicaton Events on Different Fields

Farm Owner _____

Spreader Operator _____

Facility Number _____ - _____

Tract & Field #	Date (mm/dd/yr)	***Weather Code	Crop Type	Field Size (acres)	Application Method*	Number of Loads per Field	Volume of each Load** (tons)

* SI = soil incorporated (disked); BR = broadcast (surface applied).

** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

*** Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

3/14/03

FORM SOLID-2

Manure Solids Application Field Records
One Form for Each Field per Crop Cycle

Form SLD-2

Tract #		Field #	
Field Size (Acres) = **(A)**		Facility Number	-
Farm Owner		Spreader Operator	
Owner's Address		and Address	
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type		Recommended PAN Loading (lb/acre) = **(B)**	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Weight of each Load* (tons)	Total Weight (tons) (2) x (3)	Weight per Acre (tons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/ton)	PAN Applied (lb/acre) (6) x (5)	Nitrogen Balance*** (lb/acre) (B) - (7) B=
			Crop Cycle Totals:					

Owners Signature _____ Spreader Operator's Signature _____

Certified Operator (print) _____ Operator Certification No. _____

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

12/20/06

Form FRBD 1

FORM FRBD-1

Waste Structure Freeboard and Daily Precipitation Record

Farm Owner _____ Facility Number _____ - _____

Operator _____ Month/Year _____

Day	Waste Structure Freeboard (inches)[1,2]						Precipitation (inches)[3]	Initials	Comments
	#	#	#	#	#	#			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									

1. Lagoon freeboard is the difference between the lowest point of a lagoon embankment and the level of liquid.
   For lagoons with spillways, the difference between the level of liquid and the bottom of the spillway should be recorded.
2. Freeboard levels must be recorded at least weekly.
3. Rainfall must be recorded for every rain event.

Form STOCK-1

FORM STOCK-1

Average Stocking and Mortality Record

Farm Owner _____ Facility Number _____ - _____

Operator _____

*Date (mm/dd/yyyy)	(1) Previous Stocked #	(2) Placement Stocked #	(3) Stock Shipped #	(4) Mortality #	(5) **Total Stock #	(6) ***Average Stock #	(7) ****Average Mortality #

* At a minimum, records must be kept monthly.

3/14/03

** Total Stocked (5): equals (1) + (2) - (3) - (4)

*** Average Stocked (6): Add previous 12 months of Total Stocked (5) and divide by # of entries.

**** Average Mortality (7): Add previous 12 months Mortality (4) and divide by # of entries.

FORM CROP-1

CROP YIELD RECORD

Farm Owner _____

Operator _____

Facility Number _____ - _____

Date (mm/dd/yyyy)	Field/Pull ID	Crop	(1) Yield (Bales or Bushels)	Bale Size (if applicable)	(2) Field/Pull Size (wetted acres)	(3) *Yield per Acre (Bale or Bushel/Ac)

* (3) Yield/Acre = (1) Yield divided by (2) Field/Pull Size. (3)=(1)/(2)

3/14/03

FORM TRAN-1

Animal Waste Transfer Record
Record Each Transfer of Waste Between Lagoons or Third Party

Facility Number ____ - ____

Farm Owner		Irrigation Operator	
Owner's Address		Irrigation Operator's Address	
Owner's Phone #		Operator's Phone #	

Date	Time	Nutient Analysis	Transfer From (lagoon ID)	Transfer To (lagoon ID or third party)	*Volume Transferred	**Third Party Information		
						Permit #	Name	Phone #

*Volume Transferred must be recorded in gallons, tons, or cubic yards.

3/14/03

**Third Party must be provided with nutrient analysis.

Waste Transfers over 4 cubic yards must be accepted by a permitted facility or a field in the permittee's WUP.

FORM - DRAG 1

Lagoon Liquid Hose Drag Application Fields Record
For Recording Hose Drag Application Events on Different Fields

Farm Owner

Facility Number

Operator

Tract & Field #	Date (mm/dd/yr)	Crop Type	Field Size (acres)	Hose Drag Application Time			Flow Rate (gal/min)	Hydrant #'s Or Zones	Total Volume (gallons)	Volume per Acre (gal/acre)	Operator Initials	*Weather Code
				Start Time	End Time	Total Minutes						

* Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

3/14/06

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee's control have caused noncompliance with the CAWMP or permit, explain on reverse.

Annual Certification Form

ANIMAL FACILITY ANNUAL CERTIFICATION FORM

Certificate of Coverage or Permit Number _____ County _____ Year 200__

Facility Name (as shown on Certificate of Coverage or Permit)_____

Operator in Charge for this Facility _____ Certification #_____

Land application of animal waste as allowed by the above permit occurred during the past calendar year _____ YES _____ NO. If NO, skip Part I and Part II and proceed to the certification. Also, if animal waste was generated but not land applied, please attach an explanation on how the animal waste was handled.

Part I : Facility Information:

1. Total number of application Fields □ or Pulls □ (please check the appropriate box) in the Certified Animal Waste Management Plan (CAWMP): _____ Total Useable Acres approved in the CAWMP _____
2. Total number of Fields □ or Pulls □ (please check the appropriate box) on which land application occurred during the year: _____ Total Acres on which waste was applied _____
3. Total pounds of Plant Available Nitrogen (PAN) applied during the year for all application sites: _____
4. Total pounds of Plant Available Nitrogen (PAN) allowed to be land applied annually by the CAWMP and the permit: _____
5. Estimated amount of total manure, litter and process wastewater sold or given to other persons and taken off site during the year _____ tons □ or gallons □ (please check the appropriate box)
6. Annual average number of animals by type at this facility during the previous year: _____
7. Largest and smallest number of animals by type at this facility at any one time during the previous year:
   Largest _____
   Smallest_____
   (These numbers are for informational purposes only since the only permit limit on the number of animals at the facility is the annual average numbers)
8. Facility's Integrator if applicable: _____

Part II: Facility Status:

IF THE ANSWER TO ANY STATEMENT BELOW IS "**NO"**, PLEASE PROVIDE A WRITTEN DESCRIPTION AS TO WHY THE FACILITY WAS NOT COMPLIANT, THE DATES OF ANY NON COMPLIANCE, AND EXPLAIN CORRECTIVE ACTION TAKEN OR PROPOSED TO BE TAKEN TO BRING THIS FACILITY BACK INTO COMPLIANCE.

1. Only animal waste generated at this facility was applied to the permitted sites during the past calendar year. □ Yes □ No
2. The facility was operated in such a way that there was no direct runoff of waste from □ Yes □ No

the facility (including the houses, lagoons/storage ponds and the application sites) during the past calendar year.

3. There was no discharge of waste to surface water from this facility during the past calendar year. ☐ Yes ☐ No
4. There was no freeboard violation in any lagoons or storage ponds at this facility during the past calendar year. ☐ Yes ☐ No
5. There was no PAN application to any fields or crops at this facility greater than the levels specified in this facility's CAWMP during the past calendar year. ☐ Yes ☐ No
6. All land application equipment was calibrated at least once during the past calendar year. ☐ Yes ☐ No
7. Sludge accumulation in all lagoons did not exceed the volume for which the lagoon was designed or reduce the lagoon's minimum treatment volume to less than the volume for which the lagoon was designed. ☐ Yes ☐ No
8. A copy of the Annual Sludge Survey Form for this facility is attached to this Certification. ☐ Yes ☐ No
9. Annual soils analysis were performed on each field receiving animal waste during the past calendar year. ☐ Yes ☐ No
10. Soil pH was maintained as specified in the permit during the past calendar Year? ☐ Yes ☐ No
11. All required monitoring and reporting was performed in accordance with the facility's permit during the past calendar year. ☐ Yes ☐ No
12. All operations and maintenance requirements in the permit were complied with during the past calendar year or, in the case of a deviation, prior authorization was received from the Division of Water Quality. ☐ Yes ☐ No
13. Crops as specified in the CAWMP were maintained during the past calendar year on all sites receiving animal waste and the crops grown were removed in accordance with the facility's permit. ☐ Yes ☐ No
14. All buffer requirements as specified on the permit and the CAWMP for this facility were maintained during each application of animal waste during the past calendar year. ☐ Yes ☐ No

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

_____

Permittee Name and Title (type or print)

_____ _____

Signature of Permittee Date

_____ _____

Signature of Operator in Charge (if different from Permittee) Date

Devices to Automatically Stop Irrigation Events Form

DEVICES TO AUTOMATICALLY STOP IRRIGATION EVENTS

The State of North Carolina has issued NPDES General Permits for animal facilities to operate in North Carolina. These Permits meet both State and EPA requirements and provide coverage for the following types of facilities.

NCA200000 (Swine Facilities)
NCA300000 (Cattle Facilities)
NCA400000 (Poultry Facilities with a wet waste management system)

You have recently been issued a Certificate of Coverage (COC) to operate your animal facility under one of these General Permits.

Condition II. 16. of each of these Permits reads as follows:

> Within one hundred and twenty (120) days of the effective date of a COC issued under this permit, the permittee shall install, operate and maintain devices on all irrigation pumps/equipment designed to automatically stop irrigation activities during precipitation. This condition does not apply to manure spreaders or other equipment pulled by manned vehicles.
>
> The permittee will not be required to install, operate and maintain the devices if the permittee commits to provide for the presence of the OIC or the designated backup OIC at all times during the land application of waste. This commitment must be submitted in writing to the Division prior to the 120th day following the effective date of the COC on a form supplied by, or approved by, the Division.

Please check the box below that indicates your commitment to do one of the following.

☐ Within one hundred and twenty (120) days of the effective date of a COC issued under this permit, I shall install, operate and maintain devices on all irrigation pumps/equipment designed to automatically stop irrigation activities during precipitation. This condition does not apply to manure spreaders or other equipment pulled by manned vehicles.

☐ I will commit to provide for the presence of the Operator in Charge (OIC) or the designated backup OIC at all times during the land application of waste.

"I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

Facility Name_____ Facility Number _____ - _____

Permit Number_____

_____
Permittee Name and Title (type or print)

_____ _____
Signature of Permittee Date

_____ _____
Signature of Operator in Charge Date
(if different from Permittee)

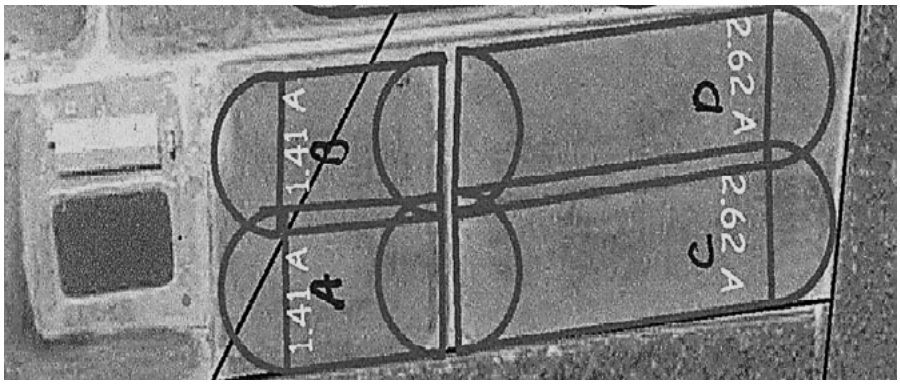
DTASIE 3-14-03

Example: Irrigation Records

Use Forms IRR-1 and IRR-2:

Joe Pigford maintains a 2,600-head weanling-to-feeder operation. His estimated volume of lagoon liquid generated annually is approximately 496,600 gallons. He conducted a waste analysis on March 10 and June 22. The March 10 analysis showed that the waste contained 1.2 pounds of plant-available nitrogen (PAN) per 1,000 gallons, and the June 22 analysis showed that the waste contained 1.7 pounds of PAN per 1,000 gallons. He irrigates two crops with wastewater using a traveling gun that applies 100 gallons per minute (GPM).

- Traveling gun pulls are considered Fields A and B, 1.41 acres each, and are established in bermuda hay.
- Traveling gun pulls are considered Fields C and D, 2.62 acres each, and are planted in corn.



His WUP shows that his anticipated yield for corn is 100 bushels per acre and he should apply 1.25 pounds of PAN per bushel yield. His yield of bermudagrass is estimated at 6 tons per acre and he should apply 50 pounds of PAN per ton of yield.

Fields A and B: PAN needed for bermuda hay:

$$\frac{6 \text{ tons hay}}{\text{acre}} \times \frac{50 \text{ lb PAN}}{\text{ton}} = 300 \text{ lb PAN/acre}$$

Fields C and D: PAN needed for corn:

$$\frac{100 \text{ bu corn}}{\text{acre}} \times \frac{1.25 \text{ lb PAN}}{\text{bushel}} = 125 \text{ lb PAN/acre}$$

Joe's Lagoon Liquid Irrigation Field Record (Form IRR-1) follows. Transfer the information for Fields B and C each on a separate Form IRR-2 and complete the calculations to determine whether Joe has met the N requirement for his corn and bermuda crops. Round off to two decimal points on the PAN applied, shown in Column 10 on Form IRR-2.

FORM IRR-1

Lagoon Liquid Irrigation Fields Record
For Recording Irrigation Events on Different Fields

Farm Owner: Joe Pigford

Facility Number: 99 - 999

Operator: Joe Pigford

Tract & Field #	Date (mm/dd/yr)	Crop Type	Field Size (acres)	Irrigation Time			# Sprinklers Operating	Operator Initials	*Weather Code	**Inspections (initials)
				Start Time	End Time	Total Minutes				
A	3/21	Bermuda	1.41	08:00 AM	12:00 PM	240	1	JP	C	JP, SJ, VW, JP
B	3/21	Bermuda	1.41	03:00 PM	07:00 PM	300	1	JP	C	JP, SJ, JP
C	3/22	Corn	2.62	08:00 AM	02:30 PM	390	1	JP	PC	JP, VW, SJ, JP
D	3/23	Corn	2.62	08:00 AM	02:30 PM	390	1	JP	Cl	JP, SJ, CW, JP
C	3/28	Corn	2.62	08:00 AM	04:00 PM	480	1	JP	C	JP, VW, CW, SJ, JP
B	3/28	Bermuda	1.41	05:00 PM	07:20 PM	140	1	JP	C	JP, JP
A	5/10	Bermuda	1.41	08:30 AM	12:45 PM	255	1	JP	PC	JP, SJ, JP
B	5/11	Bermuda	1.41	08:30 AM	12:30 PM	240	1	JP	Cl	JP, CW, SJ, JP
C	5/12	Corn	2.62	08:30 AM	03:00 PM	390	1	JP	C	JP, SJ, VW, JP
D	5/13	Corn	2.62	08:30 AM	04:00 PM	450	1	JP	PC	JP, CW, SJ, VW, JP
C	5/16	Corn	2.62	07:00 AM	01:40 PM	400	1	JP	Cl	JP, SJ, CW, JP
B	5/17	Bermuda	1.41	03:00 PM	07:20 PM	260	1	JP	C	JP, SJ, JP
C	6/1	Corn	2.62	08:00 AM	04:00 PM	480	1	JP	PC	JP, CW, SJ, VW, JP
B	6/2	Bermuda	1.41	03:00 PM	07:20 PM	260	1	JP	Cl	JP, SJ, JP
D	7/20	Corn	2.62	10:00 AM	03:30 PM	330	1	JP	C	JP, CW, SP
B	7/21	Bermuda	1.41	04:00 PM	08:20 PM	260	1	JP	PC	JP, SJ, JP

* Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee's control have caused noncompliance with the CAWMP or permit, explain on reverse.

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Hydrant #	A	Field #	A
Field Size (wetted acres) = **(A)**	1.41		
Farm Owner	Joe Pigford		
Owner's Address	123 Any Street		
	Anytown, NC		
Owner's Phone #			
Crop Type	Bermuda		

Facility Number	99 - 999
Irrigation Operator	Joe Pigford
Irrigation Operator's Address	123 Street Anytown, NC
Operator's Phone #	

From Waste Utilization Plan

Recommended PAN Loading (lb/acre) = **(B)**	300

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
***Nutrient Source	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre) **(B)** - (10)
										B= 300
Lagoon 1	3/21	08:00	12:00	240	1	100	24000	17021.28	1.2	20.43	279.57
Lagoon 1	5/10	08:30	12:45	255	1	100	25500	18085.11	1.7	30.74	248.83
					Crop Cycle Totals		49500			51.17	

Owner's Signature: Joe Pigford
Certified Operator (Print): Joe Pigford
Operator's Signature: Joe Pigford
Operator's Certification No.: 99999

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Hydrant #	B	Field #	B
Field Size (wetted acres) = **(A)**	1.41		
Farm Owner	Joe Pigford		
Owner's Address	123 Any Street		
	Anytown, NC		
Owner's Phone #			
Crop Type	Bermuda		

Facility Number	99 - 999
Irrigation Operator	Joe Pigford
Irrigation Operator's Address	123 Street Anytown, NC
Operator's Phone #	

From Waste Utilization Plan

Recommended PAN Loading (lb/acre) = **(B)**	300

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
***Nutrient Source	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre) **(B)** - (10)
										B= 300
Lagoon 1	3/21	3:00 PM	7:00 PM	240	1	100	24000	17021.28	1.2	20.43	279.57
Lagoon 1	3/28	05:00 PM	07:00 PM	140	1	100	14000	9929.08	1.2	11.91	267.66
Lagoon 1	5/11	08:30 AM	12:30 PM	240	1	100	24000	17021.28	1.7	28.94	238.72
Lagoon 1	5/17	03:00 PM	07:20 PM	260	1	100	26000	18439.72	1.7	31.35	207.38
Lagoon 1	6/2	03:00 PM	07:20 PM	260	1	100	26000	18439.72	1.7	31.35	176.03
Lagoon 1	7/21	04:00 PM	08:20 PM	260	1	100	26000	18439.72	1.7	31.35	144.68
					Crop Cycle Totals		140000			155.3191489	

Owner's Signature Joe Pigford

Certified Operator (Print) Joe Pigford

Operator's Signature Joe Pigford

Operator's Certification No. 99999

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Hydrant #	C	Field #	C
Field Size (wetted acres) = **(A)**	2.62		
Farm Owner	Joe Pigford		
Owner's Address	123 Any Street		
	Anytown, NC		
Owner's Phone #			
Crop Type	Corn		

Facility Number	99 - 999
Irrigation Operator	Joe Pigford
Irrigation Operator's Address	123 Street Anytown, NC
Operator's Phone #	

From Waste Utilization Plan

Recommended PAN Loading (lb/acre) = **(B)**	125

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
***Nutrient Source	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre) **(B)** - (10)
										B= 125
Lagoon 1	3/22	8:00 AM	2:30 PM	390	1	100	39000	14885.50	1.2	17.86	107.14
Lagoon 1	3/28	08:00 AM	04:00 PM	480	1	100	48000	18320.61	1.2	21.98	85.15
Lagoon 1	5/12	08:30 AM	03:00 PM	390	1	100	39000	14885.50	1.7	25.31	59.85
Lagoon 1	5/16	07:00 AM	01:40 PM	400	1	100	40000	15267.18	1.7	25.95	33.89
Lagoon 1	6/1	08:00 AM	04:00 PM	480	1	100	48000	18320.61	1.7	31.15	2.75
					Crop Cycle Totals		214000			122.2519084	

Owner's Signature Joe Pigford

Certified Operator (Print) Joe Pigford

Operator's Signature Joe Pigford

Operator's Certification No. 99999

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM IRR-2

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

Hydrant # D Field # D

Facility Number 99 - 999

Field Size (wetted acres) = **(A)** 2.62

Farm Owner Joe Pigford

Owner's Address 123 Any Street
Anytown, NC

Owner's Phone #

Irrigation Operator Joe Pigford

Irrigation Operator's Address 123 Street
Anytown, NC

Operator's Phone #

From Waste Utilization Plan

Crop Type Corn

Recommended PAN Loading (lb/acre) = **(B)** 125

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
***Nutrient Source	Date (mm/dd/yr)	Start Time	End Time	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate (gal/min)	Total Volume (gallons) (6) x (5) x (4)	Volume per Acre (gal/acre) (7) / **(A)**	Waste Analysis PAN* (lb/1000 gal)	PAN Applied (lb/acre) (8) x (9) / 1000	Nitrogen Balance** (lb/acre) **(B)** - (10)
										B= 125
Lagoon 1	3/23	8:00 AM	2:30 PM	390	1	100	39000	14885.50	1.2	17.86	107.14
Lagoon 1	5/13	08:30 AM	04:00 PM	450	1	100	45000	17175.57	1.7	29.20	77.94
Lagoon 1	7/20	10:00 AM	03:30 PM	330	1	100	33000	12595.42	1.7	21.41	56.53
					Crop Cycle Totals		117000			68.47	

Owner's Signature Joe Pigford

Operator's Signature Joe Pigford

Certified Operator (Print) John Pigford

Operator's Certification No. 99999

* NCDA Waste Anaylsis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

Example: Slurry Application Records

Use Forms SLUR-1 and SLUR-2:

John Milkford maintains a 120-head dairy operation and produces an estimated 919,800 gallons of waste slurry per year. He conducted a waste analysis of his slurry on March 5, which showed that the material contained 15 pounds of PAN per 1,000 gallons of slurry. He makes waste applications to four fields, which are:

Field 1: Corn — 24 acres

Field 2: Corn — 14 acres

Field 3: Bermudagrass Hay — 16 acres

Field 4: Soybeans — 18 acres

His WUP shows that his anticipated yield for soybeans is 40 bushels per acre, and he should apply 4.0 pounds of PAN per bushel of expected yield. Therefore, his PAN application rate is:

Field 4: PAN needed for soybeans:

$$\frac{40 \text{ bu soybeans}}{\text{acre}} \times \frac{4 \text{ lb PAN}}{\text{bu}} = 160 \text{ lb PAN/acre}$$

John's Liquid Manure Slurry Field Record (Form SLUR-1) follows. Transfer the information for Field 4 onto Form SLUR-2 and complete the calculations to determine whether John has met his N requirement for his soybeans in Field 4. His application equipment is a tractor-drawn tanker (honey wagon), which holds 2,500 gallons.

FORM SLUR-1

Slurry and Sludge Application Field Record
For Recording Slurry Applicaton Events on Different Fields

Farm Owner: John Milkford
Spreader Operator: John Milkford
Facility Number: 99 998

Tract & Field #	Date (mm/dd/yr)	***Weather Code	Crop Type	Field Size (acres)	Application Method*	Number of Loads per Field	Volume of each Load** (gallons)
Field 1	3/21	C	Corn	24	BR	30	2500
Field 2	3/21	C	Corn	14	BR	37	2500
Field 3	3/24	PC	Bermudagrass	16	BR	64	2500
Field 1	3/30	CI	Corn	24	BR	34	2500
Field 3	4/4	C	Bermudagrass	16	BR	48	2500
Field 4	4/8	PC	Soybeans	18	BR	54	2500

* SI = soil incorporated (disked); BR = broadcast (surface applied).
** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
*** Weather Codes: C-Clear, PC-Partly Cloudy, CI-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

FORM SLUR-2

Slurry and Sludge Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	1
Field Size(Wetted Acres)=**(A)**	24	Facility Number	99 - 998
Farm Owner	John Milkford	Spreader Operator	John Milkford
Owner's Address	123 Herd Way	and Address	
	Cowtown, NC		
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Corn	Recommended PAN Loading (lb/acre) = **(B)**	100

(1) ****Nutrient Source	(2) Date (mm/dd/yr)	(3) Number of Loads per Field	(4) Volume of each Load* (gallons)	(5) Total Volume (gallons) (2) x (3)	(6) Volume per Acre (gallons/acre) (4) / **(A)**	(7) Waste Analysis PAN** (lb/1000 gal)	(8) PAN Applied (lb/acre) (6) x (5) / 1000	Nitrogen Balance*** (lb/acre) (B) - (7) B= 100
Storage 1	3/21	30	2500	75000	3125.00	15	46.88	53.13
Storage 1	3/30	34	2500	85000	3541.67	15	53.13	0
Crop Cycle Totals:				160000			100	

Owners Signature: John Milkford

Spreader Operator's Signature: John Milkford

Certified Operator (print): John Milkford

Operator Certification No.: 99998

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM SLUR-2

Slurry and Sludge Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	2
Field Size(Wetted Acres)=**(A)**	14	Facility Number	99 - 998
Farm Owner	John Milkford	Spreader Operator	John Milkford
Owner's Address	123 Herd Way Cowtown, NC	and Address	
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Corn	Recommended PAN Loading (lb/acre) = **(B)**	100

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Volume of each Load* (gallons)	Total Volume (gallons) (2) x (3)	Volume per Acre (gallons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/1000 gal)	PAN Applied (lb/acre) (6) x (5) / 1000	Nitrogen Balance*** (lb/acre) (B) - (7) B= 100
Storage 1	3/21	37	2500	92500	6607.14	15	99.11	0.89
Crop Cycle Totals:				92500			99.11	

Owners Signature John Milkford

Spreader Operator's Signature John Milkford

Certified Operator (print) John Milkford

Operator Certification No. 99998

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM SLUR-2

Slurry and Sludge Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	3
Field Size(Wetted Acres)=**(A)**	16	Facility Number	99 - 998
Farm Owner	John Milkford	Spreader Operator	John Milkford
Owner's Address	123 Herd Way	and Address	
	Cowtown, NC		
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Bermuda	Recommended PAN Loading (lb/acre) = **(B)**	300

(1) ****Nutrient Source	Date (mm/dd/yr)	(2) Number of Loads per Field	(3) Volume of each Load* (gallons)	(4) Total Volume (gallons) (2) x (3)	(5) Volume per Acre (gallons/acre) (4) / **(A)**	(6) Waste Analysis PAN** (lb/1000 gal)	(7) PAN Applied (lb/acre) (6) x (5) / 1000	(8) Nitrogen Balance*** (lb/acre) (B) - (7) B= 300
Storage 1	3/24	64	2500	160000	10000	15	150	150
Storage 1	4/4	48	2500	120000	7500	15	112.5	37.5
		Crop Cycle Totals:		280000			262.5	

Owners Signature	John Milkford	Spreader Operator's Signature	John Milkford
Certified Operator (print)	John Milkford	Operator Certification No.	99998

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM SLUR-2

Slurry and Sludge Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	4
Field Size(Wetted Acres)=**(A)**	18	Facility Number	99 - 998
Farm Owner	John Milkford	Spreader Operator	John Milkford
Owner's Address	123 Herd Way Cowtown, NC	and Address	
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Soybeans	Recommended PAN Loading (lb/acre) = **(B)**	160

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Volume of each Load* (gallons)	Total Volume (gallons) (2) x (3)	Volume per Acre (gallons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/1000 gal)	PAN Applied (lb/acre) (6) x (5) / 1000	Nitrogen Balance*** (lb/acre) (B) - (7)
								B= 160
Storage 1	4/8	54	2500	135000	7500	15	112.5	47.5
Crop Cycle Totals:				135000			112.5	

Owners Signature John Milkford

Spreader Operator's Signature John Milkford

Certified Operator (print) John Milkford

Operator Certification No. 99998

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

Example: Solid Application Records

Use Forms SOLID-1 and SOLID-2:

Jane Manurehauler maintains an 80-head dairy operation and utilizes a dry stack waste storage system. She conducted a waste analysis of her dry stack on May 2, which showed that the material contained 6.4 pounds of PAN per ton of waste. She land-applies the manure to two fields:

Field 1: Corn — 12 acres

Field 2: Fescue Pasture — 27 acres

Her WUP shows that her anticipated yield for fescue pasture is 4 tons of hay per acre, and she should apply 50 pounds of PAN per ton of expected yield. She must reduce her application rate by 25 percent due to grazing. Therefore, her PAN application rate is:

Step 1:

$$\frac{4 \text{ tons fescue hay}}{\text{acre}} \times \frac{50 \text{ lb PAN}}{\text{ton of hay}} = 200 \text{ lb PAN/acre}$$

Step 2: Since the application rate for grazed land is 75 percent of the application rate for hay:

$$\frac{200 \text{ lb PAN}}{\text{acre}} \times 0.75 = 150 \text{ lb PAN/acre}$$

Jane's Solid or Semisolid (dry stack) Field Record (SOLID-1) follows. Transfer the information for Field 2 onto Form SOLID-2 and complete the calculations to determine whether Jane has met the N requirement for her grazed fescue pasture. She utilizes an 8-ton manure spreader and surface-applies (broadcasts) the manure.

FORM SOLID-1

Manure Solids Application Field Record
For Recording Manure Solids Applicaton Events on Different Fields

Farm Owner: Jane Manurehauler
Spreader Operator: Jane Manurehauler
Facility Number: 99 - 997

Tract & Field #	Date (mm/dd/yr)	***Weather Code	Crop Type	Field Size (acres)	Application Method*	Number of Loads per Field	Volume of each Load** (tons)
1	4/1	C	Corn	12	SI	10	8
2	4/4	PC	Fescue	27	BR	40	8
1	4/11	Cl	Corn	12	SI	13	8
2	6/13	C	Fescue	27	BR	39	8

* SI = soil incorporated (disked); BR = broadcast (surface applied).
** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
*** Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

FORM SOLID-2

Manure Solids Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	1
Field Size (Acres) = **(A)**	12	Facility Number	99 - 997
Farm Owner	Jane Manurehauler	Spreader Operator	Jane Manurehauler
Owner's Address	269 Tanker Street	and Address	269 Taker Street
	Milktown, NC		Milktown, NC
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Corn	Recommended PAN Loading (lb/acre) = **(B)**	100

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Weight of each Load* (tons)	Total Weight (tons) (2) x (3)	Weight per Acre (tons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/ton)	PAN Applied (lb/acre) (6) x (5)	Nitrogen Balance*** (lb/acre) (B) - (7)
								B= 100
Dry Stack	4/1	10	8	80	6.67	6.4	42.67	57.33
Dry Stack	4/11	13	8	104	8.67	6.4	55.47	1.87
		Crop Cycle Totals:	184				98.13	

Owners Signature Jane Milkhauler

Spreader Operator's Signature Jane Milkhauler

Certified Operator (print) Jane Milkhauler

Operator Certification No. 99997

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

FORM SOLID-2

Manure Solids Application Field Records
One Form for Each Field per Crop Cycle

Tract #		Field #	2
Field Size (Acres) = **(A)**	27	Facility Number	99 - 997
Farm Owner	Jane Manurehauler	Spreader Operator	Jane Manurehauler
Owner's Address	269 Tanker Street	and Address	269 Taker Street
	Milktown, NC		Milktown, NC
Owner's Phone #		Operator's Phone #	

From Animal Waste Management Plan

Crop Type	Fescue Pasture	Recommended PAN Loading (lb/acre) = **(B)**	150

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
****Nutrient Source	Date (mm/dd/yr)	Number of Loads per Field	Weight of each Load* (tons)	Total Weight (tons) (2) x (3)	Weight per Acre (tons/acre) (4) / **(A)**	Waste Analysis PAN** (lb/ton)	PAN Applied (lb/acre) (6) x (5)	Nitrogen Balance*** (lb/acre) (B) - (7)
								B= 150
Dry Stack	4/4	40	8	320	11.85	6.4	75.85	74.15
Dry Stack	6/13	39	8	312	11.56	6.4	73.96	0.19
Crop Cycle Totals:				632			149.81	

Owners Signature Jane Milkhauler

Spreader Operator's Signature Jane Milkhauler

Certified Operator (print) Jane Milkhauler

Operator Certification No. 99997

* Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.
***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)

Chapter 8: Safety—Type A

Accidents and injuries don't just happen, they are caused. Behind every accident is a chain of events that led up to an unsafe act, unsafe conditions, or a combination of both. Workplace safety is a shared responsibility. Communication between supervisors and employees brings awareness of risk, generates ideas, and leads to accident prevention. Safety programs, safety manuals, and safety meetings are essential to maintain lines of communication that create a safe, accident-free workplace.

In animal production facilities, risks to workplace safety and security can be biological, chemical, mechanical, or electrical in origin. Biological risks can be caused by rodents, wild animals, or visitors. Chemical risks arise from gas leaks, manure gases, and harsh detergents and cleaning products. Mechanical safety risk can be caused by ladders, tractors, belts, or moving irrigation equipment or from unsafe physical exertion. Electrical risks arise from faulty barn wiring, panels, and unsafe electric tool use.

Biosecurity

The 2007 foot-and-mouth outbreak in the United Kingdom and more recent avian flu outbreaks in several states underscore the fact that security at our facilities is vital. Global outbreak of African swine fever (ASF) is a significant example of how biological risk can severely harm the production sector. Integrators and individual farms may vary a bit in their practices. Be sure to learn and follow the rules for your site.

Agency representatives (Soil and Water Conservation District, DEQ, and Cooperative Extension) have additional practices that they must observe. These typically involve how many sites they can visit and restrictions on site visits after foreign travel or travel to an area with disease outbreak.

Dangerous Gases

Dangerous gas-related situations can be associated with five main gases that are produced in livestock and poultry buildings and manure storage structures. These gases are listed in Table 8-1 along with some of their characteristics. The density term "heavier than air" means these gases settle to the floor and are in the highest concentrations at that level. "Lighter than air" means these gases will concentrate near the ceiling. All of these gases are colorless. The Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) for each of these gases except methane, for which there are no specific exposure limits.

Describe the health effects of gases associated with livestock buildings and manure storage.

Table 8-1. Characteristics and Effects of Gases Produced in Livestock Buildings and Manure Storage Structures

Gas	Odor	Density	Health Effects	Permissible Exposure Limit (PEL)
Ammonia (NH_3)	Pungent	Lighter than air	Irritation to eyes and nose. Asphyxiating at high levels	50 ppm [1]
Carbon Dioxide (CO_2)	None	Heavier than air	Drowsiness, headache. Can be asphyxiating.	5,000 ppm [1]
Carbon Monoxide (CO)	None	Heavier than air	Headache, chest pains, potential for problems with developing fetuses. Can be asphyxiating.	50 ppm [1]
Hydrogen Sulfide (H_2S)	Rotten-egg smell	Heavier than air	TOXIC: causes headache, dizziness, nausea, unconsciousness, death.	20 ppm [2]
Methane (CH_4)	None	Lighter than air	Headache, asphyxiant, explosive in 5% to 15% mixture methane with air.	None [3]

[1] PPM averaged over an 8-hourr workday (time-weighted average: TWA).
[2] Ceiling concentration, not TWA.
[3] Recommendation is to keep oxygen concentration above 19.5%

Ammonia

Ammonia (NH_3) is released from fresh manure and urine and during anaerobic decomposition. Ammonia levels tend to be high in buildings where manure is not regularly and thoroughly removed. Examples include buildings with litter, solid floors, or scrapers where manure is spread over the floor. Heated floors can increase ammonia release. Furthermore, when pH levels are higher than 8.0, ammonia is more susceptible to being released. Ammonia is very soluble in water; therefore, liquid manure systems tend to release less ammonia. Building ventilation also affects ammonia levels in the air. Concentrations in ventilated hog buildings have been measured as high as 35 ppm (slightly irritating to the eyes and nose) and in unventilated buildings as high 176 ppm, which can produce extreme discomfort.

Carbon Dioxide

Death of animals in closed confinement buildings following a ventilation-equipment failure (such as a power failure) is due in part to excessive carbon dioxide. Carbon dioxide (CO_2) is released by unvented heaters, livestock respiration, and manure decomposition. Most of the gas in bubbles coming from stored manure or lagoons is CO_2. Vigorous agitation of stored manure can also release a large amount of CO_2 in a short time period.

Carbon Monoxide

Carbon monoxide (CO) can cause workers to develop headaches and experience chest pain. Pregnant women should be aware of the potential health hazard this gas poses to a

developing fetus. Carbon monoxide is rare in confinement buildings but can accumulate in areas with poor ventilation such as swine farrowing rooms and nursery buildings. Evidence of CO overexposure among livestock may first appear as aborted litters and stillbirth. The main sources of CO are heaters (LP-fired, radiant brooder, or space heaters).

Hydrogen Sulfide

Hydrogen sulfide (H_2S) is the most toxic gas generated from the storage of liquid manure. Exposure to 200 ppm for an hour can cause headaches and dizziness; 500 ppm for 30 minutes can cause severe headaches, nausea, excitement, or insomnia. High concentrations of 800 to 1,000 ppm can cause immediate unconsciousness and death through respiratory paralysis unless the victim is moved to fresh air and artificial respiration is immediately applied. Be aware—even the characteristic rotten-egg smell of hydrogen sulfide does not give adequate warning. The sense of smell is rapidly fatigued by the gas, and high concentrations do not give a proportionately higher odor intensity. Also note that dangerous concentrations can be released by agitation of stored liquid manure. Concentrations reaching 200 to 300 ppm have been reported in buildings a few minutes after starting to pump waste from a storage pit and can be as high as 800 ppm during vigorous agitation.

Methane

Methane (CH4) is a product of manure decomposition under strict anaerobic conditions, such as those found in an anaerobic or biogas digester. It is insoluble in water, lighter than air, and thus will accumulate in stagnant air corners in the top of enclosed pits or buildings. Methane is not toxic, but at high concentrations may cause an asphyxiating environment. Methane concentrations in confinement housing are normally well below the levels that may be explosive (Table 8-1). However, explosions and fires attributed to methane have occurred around manure storage pits.

Effect of Air Quality on Human Health

Health problems may be chronic (lasting a long time) or acute (severe but short term). Since chronic and acute problems can be mistaken for other health problems, such as the flu or allergies, the work environment is often overlooked as a cause of the symptoms, and precautions are therefore not taken.

Portable gas detectors and monitors are recommended when working in proximity to gas sources, such as an agitated manure pit/lagoon, especially if the waste management system has been altered. These detectors sound an alarm when concentration of one or more hazardous gases exceed exposure limits. Maintaining and testing these detectors are critical to ensure they provide needed protection during on-farm activities. Inversion weather conditions can result in increased risk of gas-related accidents.

Safety Precautions with Manure Storage

You should consider safety when constructing, operating, and managing animal waste management systems. The following major safety points should be considered when installing and operating manure equipment, structures, or systems:

Explain the safety precautions for manure storage.

1. Do not enter a manure storage pit or any kind of tank unless following procedures for entering a confined space.
2. When agitating a manure storage structure, always have at least one additional person available to seek help if trouble occurs.
3. Properly designed and operated ventilation systems can reduce the concentration of gases within the building, thereby improving animal performance and minimizing health problems for workers.
4. For earthen storage ponds and lagoons, erect signs: "Danger—Manure Storage." Additional precautions include having a minimum of one lifesaving station equipped with a reaching pole and a ring buoy on a line.
5. Get help before attempting to rescue livestock that have fallen into a manure storage structure.
6. Permanent ladders on the outside of aboveground tanks should have locked entry guards, or the ladder should not be reachable from the ground.
7. Never leave a ladder standing against an aboveground tank or grain bin.
8. All push-off platforms need a barrier strong enough to stop a slow-moving tractor.
9. If manure is stored outside the livestock building, use a water trap or other device to prevent gases from the storage structure from entering the building.
10. Don't smoke, weld, or use an open flame in confined, poorly ventilated areas where methane can accumulate. Electric motors, fixtures, and wiring near manure storage structures should be kept in good condition to prevent a spark from igniting the methane.

Vehicle Safety

Only employees with a current, valid N.C. driver license should drive vehicles. In the case of specialized vehicles, only trained operators should operate the vehicles. The driver of the vehicle should inspect the vehicle prior to operating it.

General Vehicle Operation

Describe several safety precautions that apply to vehicle operation, heavy equipment, PTOs, and hydraulic systems.

1. All vehicles should be operated within the legal speed limit at all times or at a lower speed where conditions warrant.
2. Vehicles should not be used to transport unauthorized personnel.
3. The driver should be familiar with the capacity and required clearances for safe use of the vehicle.
4. Objects or persons being transported should be located so that they do not obstruct the driver's view.
5. Always know the proper operating procedures for each piece of equipment used.
6. Observe all Department of Transportation (DOT) requirements for highway movement, flashers, slow moving vehicle placard, and any other applicable safety measures.

Tractor Safety

Tractors are a major source of injury at farms. A number of basic safety recommendations are important:

1. Wear a seat belt at all times.
2. Drive the tractor with care and at safe speeds when operating over rough ground, crossing ditches or slopes, and turning corners.
3. Use the handhold and step plates when getting on and off the tractor to prevent falls.
4. Do not park the tractor on a steep slope.
5. Shut off the engine and apply the parking brake before getting off the tractor.
6. Never approach tractor when it is in motion.
7. Stop engine to fill fuel tank.
8. Do not operate equipment with power take-off (PTO) guard missing.
9. Do not drive straight up and down inclines.
10. Lower all lifts to the ground when parked.
11. No passengers allowed.
12. Ensure you can see what is in front of you.
13. Shut off engine immediately if you suspect a problem with the tractor.
14. When using a front-end loader, travel at a safe speed and always keep load as close to ground as possible.
15. When hooking equipment, do not straddle hitch/draw bar when guiding driver back.
16. Never get off tractor with PTO running.
17. Never mow unclean or unleveled ground.
18. Tractors must be equipped with a rollover protection system (ROPS).
19. Hitch only to the drawbar and hitch points recommended by the manufacturer.
20. Never operate a tractor or other farm vehicle that you are not familiar with. Have an experienced person show you how to operate the vehicle and all its controls.

Equipment

All employees shall be instructed in the proper use and maintenance of any farm equipment, machinery, or mobile equipment that they may be required or expected to use in the performance of their duties.

Yard Maintenance Equipment

All yard maintenance equipment (for example, mowers and trimmers) should be maintained in good operating condition. Keep blades sharp and equipment greased. Watch for equipment wear, which could result in possible injury to operator and other personnel. Never leave a running mower unattended. Always wear safety goggles, hearing protection, and proper footwear when operating this equipment.

Power Take-Off (PTO) and Machine Guarding

1. Refer to the safety section of owner's manual.
2. Stay clear of rear of vehicle during operation.
3. Do not wear loose-fitting clothing, scarves, or jewelry that could get caught in the PTO.
4. Tie back long hair.

Machine guarding is used to keep people and machines separated. Any time a machine has moving parts, such as augers, spinning shafts, or rotating blades, those parts need to be shielded to keep hands, feet, clothing, or anything else that could result in bodily injury from becoming trapped in them.

The best method is to have a guard that encloses or covers the moving part so that entanglement is impossible. Guards of this type include covers such as those on "V" belts or the PTO guard on a tractor or PTO shafts on mower decks. These guards should be checked periodically for tightness or missing bolts. If the guard is damaged, it should be replaced before operating the equipment again.

Hydraulic Systems

Hydraulic systems are common in farm settings. The hydraulic system consists of pistons, control valves, and transfer lines that contain a hydraulic fluid that changes pressure during operation. This system enables the use of heavy implements such as plows and discs by transferring pressure from hydraulic fluid to farm implements. Pressure in the transfer lines can exceed 2,000 pounds per square inch (psi), more than 130x the atmospheric pressure. Therefore, the following recommendations are critical to avoid any hydraulic system related risk:

1. Do not open pressurized lines. Hydraulic fluid can cause severe burns, eye injury, or skin irritation.
2. Search for leaks in the line using a piece of cardboard or wood, not your hands.
3. If anyone is injured by hydraulic fluid, administer first aid, then contact a physician.
4. Stay clear of leaky hydraulic lines.
5. Have system repaired by a knowledgeable technician.

Electrical Safety

All employees must lockout/tagout (LOTO) any piece of equipment they are working on where the unexpected energization, startup, or release of stored energy could occur. In case of electrocution, turn off power to the electrical source or use an insulated implement, such as a piece of wood, to separate the victim from the source. Do not attempt to pull a victim away from the electrical source with your bare hands.

Describe the lockout/tagout procedure of electrical safety.

The LOTO procedure is used to prevent injury from machines and tools with moving parts. It requires that all moving parts have the energy source that powers the tool or equipment at "zero energy state." What this means is that the energy source that powers or makes the

tool or machine operate must be disconnected or de-energized. With electrical equipment, either unplug the machine, shut off the switch, or trip the breaker in the electrical panel. Disconnect air-driven tools at the air source. Hydraulic operating equipment must have the valves or lines "blocked." In other words, any energy source to operate or run a piece of equipment or tool must be effectively shut off or disconnected. The term LOTO comes from the practice of placing locks on the lever or handle that controls the energy to industrial tools and equipment once the handle is in the "off" position. LOTO is the preferred method of ensuring that power cannot be accidentally turned back on while the item is being repaired or serviced. In cases where the energy source cannot be locked in the off position, a tag must be placed by the switch or control where the power is turned off to let anyone know that the power is turned off for the purpose of maintenance or service. The tag is used only when the energy source can't be locked out and usually has words such as: "DO NOT TURN ON" or "DO NOT OPERATE." Tags or locks used for de-energizing equipment or tools may be removed only by the person that applied them.

Another point to remember is that some pieces of equipment may be operated or driven by more than one energy source. For example, an auger motor, which is electrically operated, also has a mechanical spring inside the housing that must be de-energized by clamping it before removing the motor cover. To be safe, only employees who have the knowledge and training required to perform the maintenance or service should be assigned the task of working on a piece of equipment or using a tool. If in doubt, **ask your manager or supervisor for assistance.**

LOTO Procedure:

1. Turn breaker to the "off" position.
2. Place lockout device over breaker and screw down tightly to switch.
3. Place lock on hole closest to the breaker switch. Place all keys in pocket of person performing maintenance work.
4. Tag lockout device with name and date.
5. Second person needing to lockout on same breaker must place lock in second hole and tag also. Remember to place keys in pocket of person performing maintenance.
6. Both persons performing maintenance on system must wait until both are finished to energize system.

Irrigation Systems

Irrigation systems consist of intake lines, pumps, and a distribution system that can be a traveling gun, central pivot, or a solid-set system. Accidents related to irrigation systems can be traced back to faulty equipment, incorrect installation or repair, or unsafe use. Unsafe operation of irrigation systems in animal production facilities can lead to various hazards such as drowning, falling, electrical shock, or entanglement. To avoid such hazards, operators need to be familiar with manufacturer guidelines for equipment use and maintenance, wear personal protective equipment (hard hat, gloves, orange vests, earplugs, and safety glasses), avoid wearing loose clothing, and coordinate activities in advance to avoid risks and ensure that co-workers are prepared to assist as needed.

Lagoon Safety

Working safely on or around lagoons and waste storage ponds is the responsibility of each employee. No one who cannot swim should be permitted near a lagoon. All persons who are on a lagoon in a boat should use personal flotation devices (PFDs) or lifejackets of the proper type. In addition, a person should be on the bank to call for assistance if there is trouble in the boat. All lagoons should have a throw buoy available at a key place where employees are typically working around the lagoon, such as irrigation pumps, recycle pumps, and level markers.

Where vehicle traffic has potential to come near lagoons, warning signs should be posted. Physical barriers should also be erected to keep farm vehicles and tractors from going into the lagoon. Lagoons and storage ponds are also sources of manure odors. Although rarely are the fumes as concentrated as in the confinement houses, they can occasionally be strong and unpleasant. Individuals with asthma or other breathing difficulty should avoid working close to a lagoon. Lagoon banks must be maintained, so follow precautions mentioned above for tractors and mowers on sloping sites. When walking around a lagoon, be alert for venomous snakes, fire ants, and holes from burrowing animals.

Heat Injury Prevention

Several things can be done to reduce the risk of injury to employees working in hot conditions. Below are some helpful hints for working during hot days.

1. Try to reschedule tasks so that the most difficult and physically demanding ones can be completed in the early morning or late afternoon hours when temperatures are lower.
2. Keep fluids available for all employees and make sure that the employees understand the need for drinking frequently. If you wait until you feel thirsty before drinking, you have probably waited too long. In hot conditions, dehydration begins before the body feels thirsty. Drinking at regular intervals is the best way to prevent dehydration.
3. Take more frequent breaks, especially during the hottest parts of the day.
4. Learn the symptoms of different heat injuries and keep a close watch on your fellow employees for signs of any of these.

Personal Protective Equipment (PPE)

Give examples of personal protective equipment.

Employees should use the appropriate personal protective equipment (PPE), or protective devices, provided for their work. Before starting work, these items should be inspected by the employee to ensure that they are in safe operating condition. These items include, but are not limited to:

1. Hard hats. Should be worn when appropriate.
2. Hearing protection. Should be used, as needed, to reduce noise levels when working around generators and heavy equipment or when mowing and weed-eating.

3. Face shield or eye protection. Should be worn when operating shop tools, mowers and weed-eaters, and when working around chemicals.
4. Rain suits. May be needed when performing duties with chemicals.
5. Safety belts/seat belts. Should be worn at all times in vehicles.
6. Approved welding goggles or helmets and gloves. Should be worn while welding, cutting, or both. Fasten clothing around the neck, wrists, and ankles.
7. Appropriate footwear. May include steel-toed boots where needed.

Lifting and Carrying

Describe the correct way to lift and carry objects.

Everyone should observe the following guidelines to avoid possible injury when lifting and carrying objects:

1. Set your feet far enough apart to provide good balance and stability (approximately the width of your shoulders).
2. Get as close to the load as practical, bending your legs at the knees, and bending at the hips to keep your back as straight as possible.
3. Straighten your legs to lift the object and at the same time bring your back to a vertical position.
4. When lifting an object with another person, be sure that both people lift at the same time and let the load down together.
5. Do not carry loads above people. Do not hoist, lower, or move any person with a crane by allowing them to stand on the hook or by any nonapproved method.
6. Do not stand under a suspended load or boom unless the nature of the work requires it.

Personal Hygiene

Wastewater contains pathogens (disease-causing organisms). Hence, good personal hygiene is very important!

1. Keep your hands away from your nose, mouth, eyes, and ears to avoid ingestion of wastewater.
2. Nonpermeable gloves should be worn when handling any equipment covered with wastewater or residuals.
3. Special care (e.g., protective, waterproof dressing) should be taken to keep any area of broken skin covered to avoid possible infection. If a worker suffers an injury which results in an open wound or laceration, they should be given a tetanus booster.
4. Wash hands thoroughly with soap before smoking, eating, drinking, or after work.
5. Work clothing should be changed and washed daily.
6. If contact with wastewater does occur, wash the area thoroughly with water and soap. Sponge any cuts with an antiseptic solution and cover with a clean, dry gauze dressing and waterproof adhesive.

Immunization

Each facility may want to consult a physician or the local health department to determine the need for immunizations for the employees working at the site. Adult tetanus and diphtheria should be given routinely every 10 years, or at shorter intervals when injury occurs.

Responsibilities of the Site Supervisor

Describe the responsibilities of the site supervisor.

The following should be the responsibility of the *site supervisor*:

1. Establish and supervise an accident prevention program and a training program that is designed to improve the skills and competency in the field of occupational safety and health for all employees.
2. Conduct preliminary investigations to determine the cause of any accident that results in injury. The results of this investigation should be documented for reference.
3. Establish and maintain a system for keeping records of occupational injuries and illnesses.
4. Provide new employees with a safety orientation on the special hazards and precautions of any new job.
5. Conduct job briefings with employees before starting any job to acquaint them with unfamiliar procedures.
6. Issue necessary safety equipment and manuals.
7. Conduct periodic group safety meetings and audits with all employees.
8. Conduct monthly safety audits on the farm.

List the items that a safety program should include.

The safety program should include:

1. Procedures for reporting injuries, unsafe conditions, or unsafe practices
2. Use and care of PPE
3. Proper actions to be taken in the event of emergencies
4. Identification of hazardous gases, chemicals, or materials
5. Instructions on safe behavior around hazardous gases, chemicals, or materials, and emergency procedures to follow after unsafe exposure.

CPR & First Aid Training

List the topics that first aid training should include.

There should be a person available at all times with first aid training in:

- Bleeding control and bandaging
- Artificial respiration, including mouth-to-mouth resuscitation
- Cardiopulmonary resuscitation (CPR)
- Poisons
- Shock, unconsciousness, stroke
- Burns
- Sunstroke, heat exhaustion, hyperthermia
- Frostbite, hypothermia

- Strains, sprains, hernia
- Fractures, dislocations
- Bites, stings
- Transportation of the injured
- Specific health hazards likely to be encountered by co-workers

Adequate, readily available first aid kits and supplies should be available on site. Emergency telephone numbers must be posted by telephones.

Suitable facilities for quick drenching or flushing of the eyes and body should be provided in areas where the eyes or body of any person may be exposed to injurious chemicals and materials.

Responsibilities of the Employer (Safe Place Standards)

Describe the responsibilities of the owner or employer.

The following are the responsibility of the *employer*:

1. The employer should furnish to each employee a workplace free from recognized hazards that may cause serious injury or death.
2. The employer should furnish and use safety devices, PPE, and practices that are reasonably adequate to render the employee workplace safe. The employer should do everything reasonably necessary to protect the life and safety of employees.
3. No employer should require an employee to be in any workplace that is not safe.

Responsibilities of the Employee

Describe the responsibilities of the employee.

The following are the responsibility of the *employee*:

1. Each employee should stay informed of the safety requirements described in the appropriate sections of this manual and any other safety manual provided by the employer and apply it to their work.
2. Each employee should perform duties in a way that is personally safe and safe for other employees.
3. An employee should request instruction from the site supervisor if there is a question about the safe performance of an assigned task.
4. Each employee should wear clothing that is suitable for the job performed.
5. Each employee must report to the site supervisor any unsafe condition, acts, or hazards.
6. Each employee should wear appropriate PPE.
7. If an employee has a specific allergy or medical condition that requires medication, it is wise to let someone know the location of the medicine in case of emergency. Examples would be an EpiPen or glucose injector.

Working in a Confined Space

Define permit-required confined space entry.

A confined space is defined as a space that has limited means of entry and exit, has an adequate size and configuration for employee entry, and is not designed for continuous worker occupancy. Pits, lift stations, and feed tanks can qualify as confined spaces. The tanks designed for storage, transport, and application of wastes are classified as confined spaces and fall under the jurisdiction of the North Carolina Department of Labor, which is the agency that enforces the Occupational Safety and Health Act (OSHA). Under OSHA regulations, certain confined spaces require a permit for entry. A permit-required confined space is defined as a confined space that has one or more of the following characteristics:

1. It contains or has the potential to contain a hazardous atmosphere;
2. It contains a material that has the potential for engulfing an occupant;
3. It is configured such that it could trap or asphyxiate an occupant; and/or
4. It contains any other recognized serious safety or health hazard.

If a facility has permit-required confined spaces, to be in compliance with OSHA regulations, a written confined space entry program must be developed and implemented. Enclosed facilities that are used to handle wastewater or wastewater solids, such as tanks and tanker trucks, would fall under the permit-required confined space regulations. Do not enter a permit-required confined space without proper training, equipment, and support personnel. (*The confined space regulations can be found in the Code of Federal Regulations 29 CFR 1910.147.*)

Describe the safety actions that must be taken when working in a space that does not require a confined space permit.

When working in a space that does not require a confined space permit, the following safety actions must be taken:

1. Always assign a standby person to remain on the outside of the confined space. It is the standby person's responsibility to be in constant contact (visually, verbally, or both) with the workers inside the confined space as long as anyone is in the space.
2. Wear ear protection, as needed. Noise within a confined space can be amplified because of the design and acoustic properties of the space.
3. Use an air-supplying respirator, such as a self-contained breathing apparatus (SCBA) or a supplied-air respirator with an auxiliary escape-only SCBA in confined spaces where there is insufficient oxygen.

Fire Prevention and Protection

Describe the components of a basic fire emergency plan.

It is important to be fire conscious. Employees should be knowledgeable of the fire conditions at the site and operate accordingly. Poor site maintenance, worn or defective electrical systems, and welding and cutting may contribute to dangerous situations. The following precautions should be observed:

1. Do not smoke near equipment or fuel trailers. No open flame should be allowed near wastewater storage tanks. Combustible gases can accumulate and when vented to the surrounding area, may become explosive.

2. Do not tamper with or remove firefighting equipment from designated locations for purposes other than firefighting or rescue operations. Access to fire equipment should not be hindered. If fire extinguishers are used, they should be promptly recharged. Inspect fire extinguishers monthly to be sure they are in good operating condition.

A basic fire emergency plan should be developed. It includes:

1. Having all employees knowing that the first step is to call 911.
2. Know locations of all fire extinguishers.
3. Know exit points from all buildings and always keep them unblocked.
4. Have an assembly point for all employees.

Fire extinguishers should be inspected annually. If discharged, they must be refilled and inspected or discarded. At least one portable fire extinguisher must be located not less than 10 feet, nor more than 25 feet, from any flammable material. All employees must be trained in the location and operation of portable fire extinguishers.

Review Questions

1. List some gases that may cause concern at an animal operation and some methods to minimize risk and exposure to these gases.
2. Name some system components at an animal operation where safety checks are necessary.
3. What is a confined space?
4. What are the major safety roles of the site owner, manager, and employee?
5. List PPE that is needed to ensure a safe farm working environment.

Chapter 9: Emergencies and Catastrophes—Type A

When emergencies and catastrophes involving the waste management system occur, owners and operators must be prepared to respond. A well-coordinated, timely response can minimize adverse impacts on public health and the environment. A poor response can lead to personal injuries, economic losses, negative public reaction, increased scrutiny by regulatory agencies, and an increased likelihood of enforcement or penalty.

This chapter covers protocols and procedures for handling emergencies and catastrophes involving the waste management system. These events fall into two general categories: (1) events related to spills or discharges of animal waste, and (2) events related to massive or catastrophic animal mortality disposal.

Animal Waste Related Emergencies

Animal waste related emergencies are often the result of human error and equipment failure, such as overapplication of waste; application to saturated, frozen, or snow-covered fields; breaks in pipes or other failures of distribution equipment; and failure of lagoons or other storage structures. Natural catastrophes such as heavy rainfall, flooding, and hurricanes can also cause or contribute to these emergencies.

The primary goal of this training is to prepare you to operate an animal waste management system as a nondischarge system. As emphasized throughout this training, discharges of animal waste are prohibited. DWR will not condone any discharge of waste from an animal operation to surface waters as part of the CAWMP or the land application of waste at levels above that specified by or in violation of the CAWMP. However, owners and operators must be prepared to handle animal waste related emergencies, whether imminent or in progress.

Imminent Emergencies: Lagoons with High Freeboard

Natural catastrophes such as hurricanes, heavy rainfall, and flooding can cause lagoon levels to exceed acceptable levels that maintain structural stability. Structural stability is lost when the lagoon level exceeds the 25-year, 24-hour storm storage level of the lagoon (Figure 9-1). Remember from Chapter 2 that a 25-year, 24-hour storm is a storm that delivers from 5 to 9 inches of rain (depending on the region of the state) in one 24-hour period.

In this situation, a discharge or spill has not yet occurred. If ignored, however, this emergency could likely result in a spill or leak within a short time.

Plan of Action (POA) for High Freeboard—30-Day Draw Down

When a lagoon level is within the acceptable zone of structural stability but does not have adequate volume to retain a 25-year, 24-hour rainfall event, the producer is required to submit (within 48 hours) a POA for High Freeboard—30-Day Draw Down to lower and

maintain the lagoon level at a point below that needed for both structural stability and to contain a 25-year, 24-hour rainfall event.

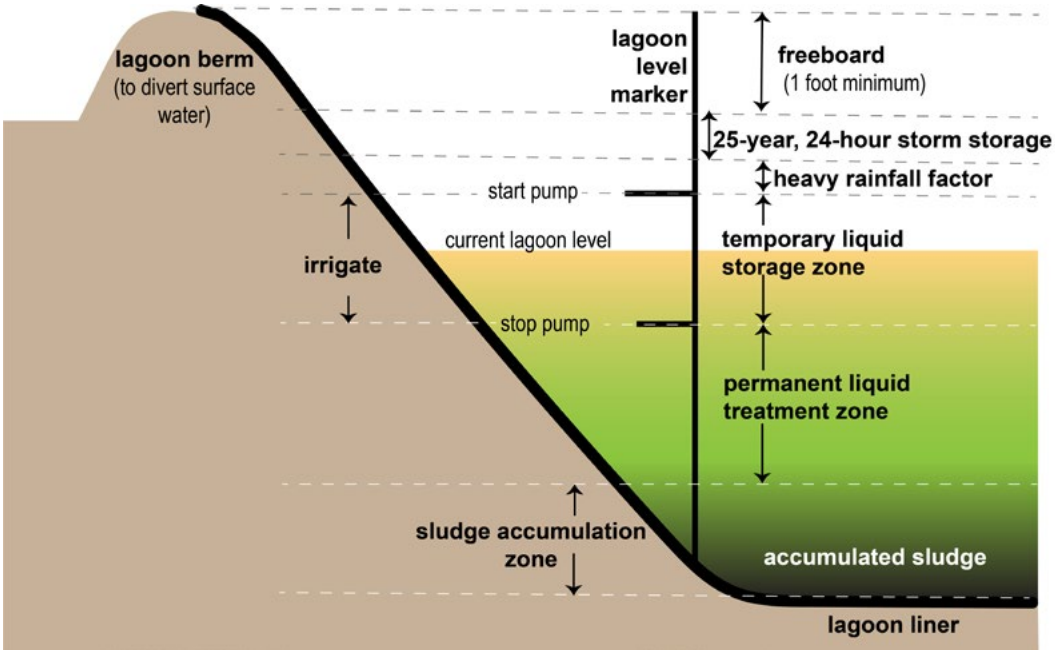


Figure 9-1. Schematic of an anaerobic waste treatment lagoon.

Plan of Action for High Freeboard—5-Day Draw Down

When a lagoon level exceeds the safe zone of structural stability, the producer is required to submit a POA (within 24 hours) for High Freeboard—5-Day Draw Down to lower and maintain the lagoon level to a point below that needed for both structural stability and the 25-year, 24-hour rainfall event. The owner must also submit a POA for High Freeboard—30-Day Draw Down at the same time.

Options To Consider for POAs (30-day and 5-day)

The producer should consider pump-and-haul to another facility that can adequately manage the waste in accordance with its CAWMP as part of the plan.

If the owner's plan cannot adequately demonstrate the ability to reduce the lagoon level below that required for structural stability within 5 calendar days without the removal of animals from the facilities, then immediate removal of animals must be a component of this plan.

The number of animals removed must be at a level at which the owner can adequately demonstrate the ability to manage the lagoon level needed for both structural stability and the 25-year, 24-hour storm event.

Forms Required

When completing a POA for High Freeboard, an owner must use the following forms developed and made available by DWR:

- POA for High Freeboard at Animal Facilities Cover Page (POA Cover Page); and
- POA for High Freeboard at Animal Facilities—5-Day Draw Down Period (POA 5 day); and/or

- POA for High Freeboard at Animal Facilities—30-Day Draw Down Period (POA 30 days).

Copies of these forms are provided in Appendix G.

Owners may need to consult a certified technical specialist for assistance when completing these forms (See Appendix G), which require the following information:

- Lagoon design information
- Current lagoon liquid level according to lagoon marker
- Current herd population
- Current waste analysis report
- CAWMP Irrigation records

The POA must be submitted to the appropriate DWR regional office within the time frames stipulated above. If an owner does not provide a plan demonstrating the ability to manage the lagoon level in the time periods outlined above, DWR will issue a Notice of Violation and proceed with enforcement action (fines).

Emergencies in Progress: Spills and Discharges

Describe the course of action that should be pursued should an emergency situation develop.

If animal waste from your operation is leaking, overflowing, or running off the site, a spill or discharge of animal waste is in progress and you *must* take immediate action. You must NOT wait until waste reaches surface waters or leaves your property to consider that you have a problem. You must make every effort to ensure that runoff does not happen by immediately implementing the waste management system's emergency action plan.

As we learned in Chapter 3, an emergency action plan is a required component of the CAWMP. Using the resource lists in Appendix D, you must develop an emergency action plan specific to your waste management system.

Describe the main components of an emergency action plan and why each is necessary.

Emergency action plans must follow this format (see an example in Appendix G):

- Stop the release of waste.
- Assess the extent of the spill and note any obvious damages.
- Contact the appropriate agencies.
- Implement procedures to rectify the damage and repair the waste management system.

Emergency Action Plans

1. Stop the release of waste. Depending on the situation, this may or may not be possible. Suggested responses to several possible problems are listed below:
    a. Lagoon overflow — possible solutions are:
        1. Add soil to berm to increase elevation of dam.
        2. Pump wastes to fields at an acceptable rate.
        3. Stop all flows to the lagoon immediately.
        4. Call a pumping contractor.
        5. Make sure no surface water is entering storage structure.

b. Runoff from waste application field — actions include:
    1. Immediately stop waste application.
    2. Create a temporary diversion to contain the waste.
    3. Incorporate waste to reduce runoff.
    4. Evaluate and eliminate the reason(s) for the runoff.
    5. Evaluate the application rates for the fields where runoff occurred.
c. Leakage from the waste pipes and sprinklers — actions include:
    1. Stop recycle (flushing system) pump.
    2. Stop irrigation pump.
    3. Close valves to eliminate further damage.
    4. Repair all leaks prior to restarting pumps.
d. Leakage from base or sidewall of lagoon or earthen storage structure (often this is seepage rather than flowing leaks) — actions include:
    1. Dig a small sump or ditch away from the embankment to catch all seepage, put in a submersible pump, and pump back to lagoon.
    2. If burrowing animals are creating holes, trap or remove the animals and fill holes, compacting with clay type soil.
    3. Have a professional evaluate the condition of the sidewalls and lagoon bottom as soon as possible.

List what information should be gathered when assessing the impact of a waste discharge.

2. Assess the extent of the spill and note any obvious damages.
    a. Did the waste reach any surface waters? If so, how much?
    b. Approximately how much was released and for what duration?
    c. Was any damage noted, such as employee injury, fish kills, or property damage?
    d. Did the spill leave the property?
    e. Does the spill have the potential to reach surface waters?
    f. Could a future rain event cause the spill to reach surface waters?
    g. Are potable water wells in danger (either on or off the property)?

Explain who to contact and when should problems develop with the waste management system.

3. Contact appropriate agencies.
    a. During normal business hours, call your DWR regional office; after hours, call this emergency number: **1-800-858-0368**. You should provide this information:
        1. Your name, facility, and telephone number
        2. Details of the incident from item #2 above
        3. Exact location of the facility
        4. Location or direction of movement of the spill
        5. Weather and wind conditions
        6. Corrective measures taken
        7. Seriousness of the situation
    b. If spill leaves property or enters surface waters, call local Emergency Management Service (EMS).
    c. Instruct EMS to contact the county Environmental Health Section of the Division of Public Health.

   d. Contact your local Cooperative Extension center, local Soil and Water Conservation District office, and local NRCS office for advice and technical assistance.
   e. If you cannot reach anyone previously specified, call 911 or the local sheriff's department and explain your problem. Ask them to contact the agencies listed above.
4. Implement procedures as advised by DWR and technical assistance agencies to rectify the damage, including assessment and repair of the waste management system, to prevent another release.

The emergency action plan must also include provisions for emergency land application or transfer of waste from all waste storage structures in the system. This may include emergency pumping or spreading (to prevent overtopping of a storage structure) during periods when the soil or crop conditions are not conducive to normal spreading or application.

You must contact DWR for guidance and authorization to land-apply waste. You must also secure the services of a technical specialist to update your waste plan to reflect changes such as land application timing, rate, and location. You should consider which fields are best able to handle the waste. If you must choose another location for application, consider the limitations that may be involved with the transfer of waste to that site and evaluate the application considerations at that location.

Describe where the emergency action plan should be located and who should be aware of it.

The emergency action plan must be available and understood by all employees at the facility, as accidents, leaks, and breaks can happen at any time. The main points of the plan (order of action) along with the relevant phone numbers must be posted in prominent locations at the site. A copy must also be available in remote locations or vehicles if the land application sites are not close to the facility office.

It is the responsibility of the owner or manager of the operation to ensure that all employees understand the circumstances that constitute an imminent danger to the environment or health and safety of workers and neighbors. Employees must be knowledgeable about how to respond to such emergencies and notify the appropriate agencies of conditions at the facility.

Notice of Discharge of Animal Waste

Owners of animal facilities, as well as municipal and industrial facilities, are required by law to notify the news media in the event of discharges and spills.

1. In the event of a discharge of 1,000 gallons or more of animal waste that reaches surface waters or wetlands, the owner or operator must:
   a. Issue a press release to all print and electronic media that provides general coverage in the county where the discharge occurred, describing the details of the discharge.
   b. Issue the press release within 48 hours of determining that the discharge reached the surface waters.

c. The press release must include the name of the facility, location of the discharge, estimated volume of wastewater entering state waters, time and date discharge occurred, duration of the discharge, and identification of the receiving water body.
d. Retain a copy of the press release and a list of the news media to which it was distributed for at least one year after the discharge.
e. Provide a copy of the press release and the list of the news media to which it was distributed to any person upon request.
f. The permittee shall provide a copy of the press release to the DWR.

2. In the event of a discharge of 15,000 gallons or more of animal waste that reaches surface waters of the state, the owner or operator must:
    a. Publish a notice of the discharge within 10 days of the discharge in a newspaper having general circulation in the county in which the discharge occurred and the county immediately downstream from the point of discharge.
    b. At minimum, the notice should include the name of the facility, location of the discharge, estimated volume of waste entering state waters, time and date discharge occurred, duration of the discharge, identification of the water body that was discharged into, including creek and river basin if applicable, actions taken to prevent further discharge, and a facility contact person and phone number.
    c. Publish the notice, which must be captioned "NOTICE OF DISCHARGE OF ANIMAL WASTE," within 10 days of the discharge.
    d. File a copy of the notice and proof of the publication with the DWR within 30 days of the discharge.
    e. Issue a press release as described above.
3. If a discharge of 1,000,000 gallons or more of animal waste reaches surface waters or wetlands, the appropriate DWR Regional Office must be contacted to determine in what additional counties, if any, a public notice must be published. A copy of all public notices and proof of publication must be sent to the DWR within 30 days after the notice is published.

Examples of a press releases and a notice of discharge are included in Appendix G.

Describe the violations that require mandatory reporting by government agencies.

Mandatory Reporting by Government Employees

Senate Bill 1217 states that certain violations are immediately reportable to DWR. The reporting requirement applies to any employee of a state agency or a unit of local government and is not limited to technical specialists who perform operations reviews. The bill requires any state or local government employee who is "lawfully on the premises and engaged in activities relating to the animal operation" to immediately report the following violations:

1. Any direct discharge of animal waste into waters of the state.
2. Any deterioration or leak in a lagoon system that poses an immediate threat to the environment.

3. Failure to maintain adequate storage capacity in a lagoon that poses an immediate threat to public health or the environment.
4. Overspraying animal waste either in excess of the limits set out in the animal waste management plan or where runoff enters waters of the state.
5. Any discharge that bypasses a treatment or collection system.

Reports of the violations are to be made to the owner or operator of the animal operation and the DWR regional office. Employees of federal agencies are encouraged, but not required, to make immediate reports of violations.

Animal Mortality Related Emergencies

As discussed in Chapter 3, proper animal mortality disposal is a part of an animal operation's routine management responsibilities and is a requirement of the CAWMP. Disease outbreaks and natural disasters like flooding, hurricanes, and tornadoes, however, can result in extensive animal loss in a very short period of time. Routine methods of dead animal disposal are usually not sufficient for handling large amounts of dead animals.

Proper disposal of dead animals during an emergency or catastrophic event will prevent potential environmental and public health problems. Proper disposal is imperative to prevent the spread of associated harmful pathogens and protect groundwater and surface water from contamination.

Which agency is responsible for laws and regulations relating to animal mortality?

The NCDA&CS Veterinary Division is the lead state agency that oversees dead domestic animal disposal under NC General Statute GS 106-403 – Disposition of Dead Domesticated Animals. The State Health Director and, by extension, the local health director in each county, are charged with preventing health risks and disease and promoting a safe, healthy environment. To the extent that dead animals become a threat to human health, the state and local health directors have broad authority to investigate and act on matters to protect the public.

Emergency Plans for Catastrophic Animal Mortality

All animal operations require specific plans for dead animal disposal in the event of catastrophic mortality. Catastrophic animal mortality in North Carolina is most likely to be caused by foreign animal diseases (FADs) such as avian influenza, foot-and-mouth disease, and African swine fever; natural disasters, such as hurricanes, floods, and severe storms; and equipment failures or power outages.

Disposal is to be performed in a manner that protects human health, animal health, and the environment and must be approved by the State Veterinarian.

Disease-Related Catastrophic Animal Mortality

A different set of emergency plans will be needed for animal mortality disposal associated with an FAD-related emergency, which is managed by the State Veterinarian and the United States Department of Agriculture Animal Plant Health Inspection Service (USDA-APHIS). The FAD **response process**, as indicated in the USDA FAD Preparedness and

Response Plan (**www.aphis.usda.gov/aphis/ourfocus/animalhealth/emergency-management/carcass-management/carcass-mgmt-tools-resources/carcass-tools-resources**), includes:

1. Detection and quarantine
2. Appraisal and compensation
3. Depopulation
4. Carcass management
5. Pathogen elimination
6. Testing
7. Restocking
8. Maintaining biosecurity

Specific environmental recommendations for response biosecurity, decontamination, burial, composting, incineration, and transport can be found in the DEQ documents *NCDENR Highly Pathogenic Avian Influenza Recommendations* (August 2015) and *NCDEQ Swine Foreign Animal Disease Recommendations* (May 2020).

Assistance with planning and training for animal mortality emergencies is available from the NCDA&CS Emergency Programs and Veterinary Divisions, N.C. Cooperative Extension, USDA APHIS, and USDA NRCS. These agencies can also provide technical assistance in the event of an emergency or catastrophic event involving animals.

Disaster-Related Catastrophic Animal Mortality

These guidelines are intended to address dead animal disposal during a declared emergency, which the governor can declare with or without a federal declaration. They are not intended to take the place of dead animal disposal that occurs under the normal permitted operation of a farm. Additional recommendations for managing disaster-related catastrophic animal mortality may be found in the NCDA&CS documents *Update on Management of Catastrophic Mortalities (November 2016)* and *NCDA&CS Mass Animal Mortality Management Plan for Catastrophic Natural Disasters (October 2016)*. These documents can be found in Appendix G.

Some counties have active County Animal Response Teams (CARTs). These teams are made up of volunteers trained to assist with animals during emergencies and disasters. Contact the county's Emergency Management or Animal Services to find out if they have an active CART and what their staff's level of training and expertise is.

Disposal Management Options

The options that follow (in boldface type) may all be used to address large emergency events, but those with three stars are the primary options when flooding is an issue. Thus, rendering would be a first option if access to carcasses allows, but landfills and composting are also acceptable methods of disposal. Burial would be more challenging but could work, depending on severity of flooding. With a large-scale event, all options could be used to some degree.

- **Rendering***:** Rendering uses a heating and drying process to turn carcasses into value-added products. Rendering is a low-cost, preferred **off-site** option with some limitations due to timing challenges (being able to remove carcasses quickly and cool them if necessary, and access to carcasses during flooding events).

  Resources needed:

  1. Rendering facilities that are fully operational;
  2. Transportation (typically available through the renderer);
  3. Timely access to carcasses (flooding conditions can often prevent timely access to animal carcasses, with carcasses too decomposed for rendering); and
  4. Carcasses must be intact and free of contamination and debris.

- **Landfills***:** Landfills have been successfully used in the past as an **off-site** option. Limiting factors in using landfills include: acceptance of carcasses by the landfill, amount of landfill material available to cover the carcasses, and the number of carcasses to be disposed of. Landfills willing to accept carcasses should be identified prior to an event.

  Resources needed:

  1. Leak-proof transport for carcasses (liners or retrofitted dump trucks can be used if vehicle is not leak-proof);
  2. Access to animals (time is not a factor, as with rendering);
  3. Equipment to load carcasses into transport vehicles; and
  4. Tipping fees.

- **Composting***:** Composting is the best **on-site** carcass disposal option because the process is highly biosecure, inactivates most pathogens, accommodates variable materials (for example, carcasses, feed, litter and eggs) and produces a useful byproduct that can be applied as a soil amendment. Dry carbon materials are mixed with the carcasses and litter if needed to create the proper moisture ratio for the composting process. A shared composting site, under the right conditions (proximity, number of animals, availability of materials and equipment, whether the cause is disease outbreak or flooding), could be used to meet the needs created by a multiple county event. Composting of poultry can be accomplished in 28 days or less. Composting of larger animals may take up to six months. Compost piles may be turned periodically to facilitate the process. Land application of composted material must be at recommended agronomic rates on agricultural land.

  Resources needed:

  1. Site allowing access for heavy equipment to form the compost pile and move carcasses;
  2. Dry carbon source—dried sawdust or shavings are the preferred material for compensating for wet litter and carcasses;

3. Other coarse or fine carbon materials are needed for proper compost windrow construction;
4. Composting subject matter expert to oversee compost windrow construction. NCDA&CS has a list of qualified personnel; and
5. If a shared composting site is utilized, a plan must be in place for how to use the finished product (for example, application to agricultural land).

- **Burial*:** On-site burial in an unlined pit or trench is an inexpensive method of disposal that minimizes transportation of carcasses and materials off the farm. However, there are concerns over the impacts to groundwater and the environment. Burial is a limited disposal option due to flooded conditions and often minimal depth to the seasonal high water table. Farmers are encouraged to obtain pre-approval for mass burial sites at their farms (contact your local Soil and Water Conservation District office to request assistance) or they must receive approval from the State Veterinarian's office prior to using. Refer to the previously referenced DEQ publications for specific information related to burial.

  Resources needed:

  1. Burial sites for catastrophic mortality (evaluated on a site-to-site basis);
  2. Heavy equipment for carcass movement and burial; and
  3. Personnel and small equipment to prepare carcasses for burial.

- **Aboveground burial*:** Is a hybrid between deep burial and composting. On-site aboveground burial (partial burial with mounding of the cover soil) is a limited disposal option due to flooded conditions and poses several challenges (availability of a suitable site, adequate personnel, equipment, and materials) that must be addressed on a case-by-case basis and receive approval from the State Veterinarian's office.

  Resources needed:

  1. Burial sites for catastrophic mortality (evaluated on a site-to-site basis);
  2. Heavy equipment for carcass movement and burial;
  3. Personnel and small equipment to prepare carcasses for burial; and
  4. Sufficient soil and other equipment.

- **Alkaline Hydrolysis**:** The alkaline hydrolysis process involves placing carcasses in a vat or chamber filled with a basic solution (for example, sodium hydroxide or potassium hydroxide), then heated and pressurized over time. The finished product can be used as a fertilizer. The alkaline hydrolysis process is not appropriate for litter, manure, and other noncarcass material. This option is uncommon and is considered a supplemental option. This option is limited by the cost, throughput capacity, and sufficient availability of hydrolysis units.

  Resources needed:

  1. Fee for service with contractors;
  2. Capacity for heavy equipment use; and

3. A means of proper disposal of resulting effluent, typically land application.

- **Incineration*:** Incineration may be considered, especially when constraints on other disposal options become prohibitive and/or when the location is particularly suitable. Incineration has many disadvantages, such as impacts to air quality, that limit this option in North Carolina. Under the right conditions, this option may be used.

  Resources needed:

  1. Incinerators rented from contractors and large amounts of fuel;
  2. Environmental incineration permits;
  3. Transportation to incineration sites;
  4. Heavy equipment to load fuel and carcasses; and
  5. 24-hour staffing.

Review Questions

1. What format should your emergency action plan follow?
2. What should be done when facilities have waste in their lagoon(s) that is above the level required for structural stability?
3. What should be done when facilities have waste in their lagoon(s) that is below the level required to be maintained for structural stability but not adequate to also retain the 25-year, 24-hour rainfall event specifications?
4. What items need to be available to complete the POA for High Freeboard forms?
5. What is required of animal, municipal, and industrial facilities in the event of discharges and spills?