Comprehensive Nutrient Management Plan Training Notebook

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Agenda for Agent Training on CNMP's

October 20, Tifton
November 6, Athens
November 13, Wayne County
November 14, Fort Valley of Macon
November 15, Carrollton

Agenda

10:00	Introduction, Regulations, CNMPs vs. Nutrient budgets, and Environmental Stewardship Dr. Mark Risse
10:30	Maps for CNMPs, Julia Gaskin
10:50	Soil and Manure Sampling and Analysis, Dr. Paul Vendrell, Dr. David Kissel, Dr. Parshall Bush
11:10	Calculating the Nutrient Supply on Your Farm, Dr. John Worley, Dr. Larry Newton
11:40	Nutrient Budgeting of Manure, Dr. Glen Harris, Frank Henning
12:00	Lunch
1:00	Phosphorus Issues, Dr. David Radcliffe, Dr. Miguel Cabrera
1:20	Manure Storage and Treatment, Dr. John Worley and Bill Merka,
1:50	Land Application, BMP's and Calibration, Mark Risse
2:10	Emergency Response Plans, Mark Risse
2:30	Mortality Management, Bill Merka
2:50	Overview of Example dairy, swine, and poultry plans
3:30	Testing and Adjorn

We would also like to acknowledge support from the College of Agriculture and Environmental Sciences, all members of the Comprehensive Nutrient Management Task Forces, the Georgia Department of Natural Resources Pollution Prevention Assistance Division and funding provided by the U.S. Environmental Protection Agency as part of the National Livestock and Poultry Environmental Stewardship Curriculum Project.

WHY WE ARE HERE.
An introduction to the regulations and CNMP development

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Intended Outcomes

The participants will

- Understand environmental issues associated with animal manure.
- Recognize the importance of balancing nutrient inputs and managed outputs for a livestock operation.
- Identify potential indicators of a "whole farm" nutrient imbalance within the producer's own operation.
- Be aware of fundamental strategies for addressing a whole farm nutrient imbalance.
- Understand the state of regulations and CNMP's in Georgia

Introduction

For most of the U.S. livestock industry, nutrients in manure represent the single largest threat to water quality. Thus, choices made relative to the management of nutrients within a livestock operation are absolutely critical to protecting water quality.

If managed correctly, manure is an excellent plant nutrient source and soil "builder" resulting in many important environmental benefits. Soils regularly receiving manure require less commercial fertilizer (conserving energy and limited phosphorus reserves), are higher in organic matter contributing to greater soil productivity, and may experience less runoff and erosion and better conservation of moisture. However, an increased risk to water quality will result from excess application of nutrients to a cropping system. The management level of the producer will often determine if the manure that is generated on his farm is a waste or a resource.

Most county agents should be well aware of the impacts that manure can have on water quality. Nitrogen, phosphorus, pathogens, and organic matter are the four primary contaminants that impact water quality. Nutrients, such as nitrogen and phosphorus, are essential for plant growth and make manure a good fertilizer. When nutrients reach rivers and lakes, they present environmental risks and can cause algal blooms, fish kills, and eutrophication. Nitrogen moves with water more easily than phosphorus and excess nitrates from nitrogen can cause health problems in animals and people. Pathogens are disease causing organisms. Manure can contain many pathogens including E. coli, C. parvum, and giardia. These organisms can present serious human health hazards but they usually can not survive long periods of time in lagoons or on land surfaces. Animal housing and manure storage should therefore be located away from surface water and wells to prevent transfer. Organic matter provides benefits in the soil but in water, the decomposition of organic matter creates Biological Oxygen Demand or BOD. This removes oxygen from the water and can often result in fish kills or other aquatic problems. Organic matter will usually on present problems when large amounts enter a water body and therefore is more of a direct discharge or point source problem.

Due to time constraints, principles of environmental stewardship for animal feeding operations will not be discussed in detail, but I have included a chapter from the National Animal and Poultry waste curriculum on environmental stewardship that agents may find helpful in local programming. This national curriculum includes powerpoint presentations and an additional 20 chapters on several other aspects of Animal Feeding Operations. It will soon be available to all county agents via the internet. Contact Mark Risse from more information on this material.

Nutrient Concentration and Distribution

If one reviews all the environmental issues associated with Animal Feeding Operations, the fact that nutrients are being concentrated on livestock or poultry operations leads to many of the problems. Most nutrient-related issues associated with livestock production are a result of poor nutrient

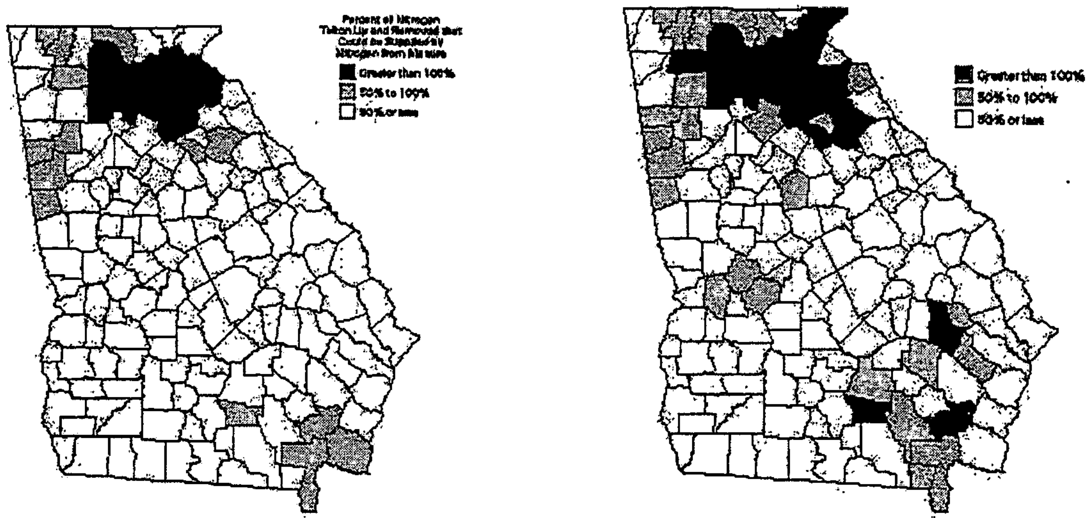

Figure 1. Nutrient Imbalances in Georgia. The figure on the left shows nitrogen while the one on the right depicts phosphorus. In each figure, the nutrient needs for the total amount of cropland, pastures, and hayfields in a county were calculated. The nutrients generated in the form of animal waste were also calculated for each county. The lighter counties can supply less than 50% of the nutrient needs with animal waste, the gray shades supply between 50% and 100%, and the dark counties produce more nutrients than they can use in their county.

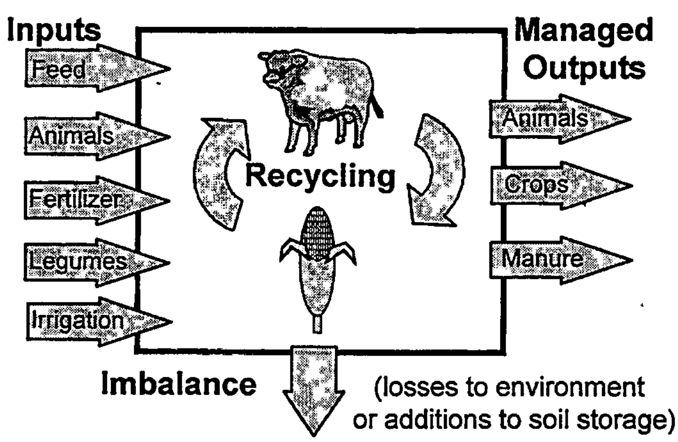

Figure 2. A whole farm nutrient balance considers all nutrient inputs, managed outputs, and losses for a livestock or poultry farm.

The “Imbalance” is the difference between the “Inputs” and the “Managed Outputs.” This “Imbalance” accounts for both the direct environmental loss and the accumulation of nutrients in the soil. Livestock operations with an imbalance produce an increasing risk to water quality. In contrast, livestock operations that have achieved a balance represent a potentially sustainable production system.

Sources of Nutrient Inputs

The source of nutrient inputs to livestock operations is important to understanding preferred management practices for reducing water quality risk. Commercial fertilizer can be a common source of nutrient inputs for many livestock operations, especially those with large cropping programs. Purchased animal feeds are often the most significant source of the nitrogen and phosphorus inputs even in regions that grow most animal feeds locally. Efforts to correct nutrient imbalances must focus on options for utilizing feed nutrients more efficiently and reducing purchased feed inputs. Other potential sources of nutrient inputs include purchased animals, legume-fixed nitrogen, and nitrates in irrigation water. These sources are typically insignificant or offer few options for input reduction. The one exception may be legume-fixed nitrogen grown on dairy operations.

Is My Livestock/Poultry Operation in Balance?

An understanding of nutrient balance and primary source of purchased nutrients is key to operating a livestock operation in an environmentally sustainable manner. Three methods for estimating whether a nutrient imbalance may be an issue on your farm are provided. Those methods include

(1) A checklist of potential indicators of nutrient imbalance (Table 2).

(2) Manure nutrient production vs. crop nutrient utilization. This method checks the ability of your land base to utilize the nutrients in manure. An excess of manure nutrients for crop production suggests a likely whole farm nutrient imbalance. This will be part of your CNMP.

(3) Whole Farm Nutrient Balance provides the "bottom line" answer to this issue. It also provides a measurement of progress made toward environmental sustainability following the implementation of changes. The producer must be willing to assemble information for animal purchases and sales, feed and grain purchases and sales, fertilizer purchases, manure sales, and possibly other contributors for a one-year period.

The indicators found in Table 1 may help producers identify if an accumulation of nutrients might be an issue on an individual farm. Increasing soil phosphorus levels is probably the best indicator of a potential imbalance. Most of the accumulation of phosphorus within a livestock and crop farm is likely to be stored in the soil. In addition, a livestock operation's reliance on purchased feed for the majority of feed nutrients is also an excellent indicator of a nutrient imbalance.

Table 1. Environmental Stewardship Inspection. Indicators of a possible imbalance that may exist on my farm (check those that apply). "Yes" response indicates that potential for nutrient imbalance is high.

Yes	No	Don't Know	
____	____	____	Soil phosphorus levels for the majority of fields are increasing with time.
____	____	____	Soil phosphorus levels for the majority of fields are identified as "High" or "Very High" on the soil test.
____	____	____	The majority (more than 50%) of the protein and phosphorus in the ration originates from off-farm sources.
____	____	____	Livestock feed programs routinely contain higher levels of protein and/or phosphorus than National Research Council or land-grant university recommendations.
____	____	____	A manure nutrient management plan is not currently in use for determining appropriate manure application rates to crops.
____	____	____	Less than 1 acre of crop land is available per animal (1,000 lbs. of live weight), and no manure is transported to off-farm users.

Comprehensive Nutrient Management Planning

Recently, the concept of Comprehensive Nutrient Management Planning (CNMP) was introduced by the U.S. Environmental Protection Agency (EPA) and U.S. Department of Agriculture's (USDA's) Natural Resources Conservation Service (NRCS). You may wonder why nutrient management was chosen as the essential regulatory element. This is partially due to the fact the nutrients create most of the water quality problems but also because the methods for controlling nutrient losses will also reduce the loss of other contaminants such as pathogens and organic matter. It is anticipated that the CNMP will serve as the cornerstone of environmental plans assembled by animal feeding operations to address federal and state regulations.

Currently the issues addressed by a CNMP are only broadly defined. However, EPA draft guidelines for CNMP provide some early indications of the key issues to be addressed (Table 2). In addition, the NRCS has a Field Office Technical Guide and Standards that state that the objective of a CNMP is to combine management activities and conservation practices into a system that, when implemented, will minimize the adverse impacts of animal feeding operations on water quality. CNMPs are to be developed in accordance with procedures contained in the NRCS National Planning Procedures Handbook. (http://www.epa.gov/owm/finafost.htm#3.2.) and should include the following elements: 1.Animal Outputs - Manure and Wastewater Collection, Handling, Storage, Treatment, and Transfer, 2.Evaluation and Treatment of Sites Proposed for Land Application, 3.Land Application, 4.Records of CNMP Implementation, 5.Inputs to Animals, and 6.Other Utilization Activities.

Table 2. Summary of issues addressed by a CNMP as initially defined by EPA's Guidance Manual and Example NPDES Permit for Concentrated Animal Feeding Operations (CAFOs)[1].

Planning components of CNMP	Issues addressed
A manure handling and storage plan	(1) Diversion of clean water, (2) prevention of leakage, (3) adequate storage, (4) manure treatment, and (5) management of mortality
Land application plan	(1) Proper nutrient application rates to achieve a crop nutrient balance and (2) Selection of timing and application methods to limit risk of runoff
Site management plan	Soil conservation practices that minimize movement of soil and manure components to surface and groundwater.
Recordkeeping	Manure production, utilization, and export to off-farm users.
Other utilization options plan	Alternative safe manure utilization strategies such as sale of manure, treatment technologies, or energy generation.
Feed management plan	Alternative feed programs to minimize the nutrients in manure.

[1]Reference is available from http://www.epa.gov/owm/afoguide.htm.

In Georgia, CNMP's are currently only required on swine operations but it is expected that all AFO's with more than 300 animal units will be required to have CNMP's in the near future. The form that a CNMP is likely to take will evolve over the next several years, however, a task force requested by the Environmental Protection Division and working with the NRCS in Georgia has recently completed a document outlining the components necessary in Georgia (Attached to the end of this chapter). It is important to note that a CNMP is different from a simple nutrient budget for a field. It looks at the entire farm and serves as both a planning and documentation tool. While plans that do not include all components are still excellent tools. We must recognize that regulatory agencies will be expecting more comprehensive plans as outlined in this document.

- A CNMP should carefully analyze nutrient issues from a (1) "whole farm" perspective, assessing concentration of nutrients within the farm (comparison of sources and quantities arriving on-farm and exported from the farm), as well as (2) the "individual component" perspective such as a crop nutrient balance or animal feeding program analysis. Historically, only the crop nutrient management component was considered in most environmental plans.

- A CNMP should integrate nutrient management planning with other environmental considerations such as soil conservation and odor management. Many proposed BMPs can positively affect some resources (e.g., manure incorporation can reduce odor concerns) while damaging other resources (e.g., manure incorporation can increase soil erosion). Balancing the protection of water, soil, and air resources should be the objective of a successful CNMP.

- A CNMP should establish a record-keeping system that will document the degree implementation and success of the proposed management practices and identify future changes to improve the plan.

Regulatory Compliance

The USDA and EPA have recently published a "Unified National Strategy for Animal Feeding Operations." The primary focus of this strategy is the implementation of comprehensive nutrient management planning. Although this strategy is not regulatory policy, it provides a framework for potential future federal regulation of nutrient related issues. Georgia has established requirements for nutrient management planning on swine operations and it is likely that other species will follow. It is likely that nutrient-related issues will also be the focal point of greater state and local regulation.

The Federal Clean Water Act states that no individual can intentionally pollute waters of the United States. In Georgia, the Environmental Protection Division of the Georgia Department of Natural Resources is authorized by the Federal EPA to carry out the Clean Water Act. This means that, regardless of your permitting status, every agricultural operation in Georgia is required to protect water quality. Since most agricultural operations do not have permits, regulatory enforcement of this act is often based on complaints. Under current law, point source discharges are illegal and most enforcement actions against AFO's have come as a result of spills and intentional discharges

Last year the Georgia Department of Natural Resources passed new rules and regulations for "Swine Feeding Operation Permit Requirements". The stated purpose for these rules was to provide for the uniform procedures and practices to be followed relating to the application for and the issuance or revocation of permits for swine feeding operations. The complete rules and proposed rules for non-swine species are available on the AWARE website at http://www.engr.uga.edu/service/extension/aware/policy.html.

Since these regulations are in the state of flux and it would be improper to circulation information that will not be widely applicable, we will not review these in this lesson. Some of the current regulations that we would expect all species of AFO's with more than 300 animal units to have to comply with at some point include:

1. There shall be no discharge of pollutants from the operation into surface waters of the State.
2. New operations must have waste storage and disposal systems in operation that have been designed and constructed in accordance with Natural Resource Conservation Service (NRCS) guidance.
3. The owner or operator shall submit to the EPD a Comprehensive Nutrient Management Plan (CNMP) for the operation. The CNMP shall be of sufficient substance and quality as to be approvable by the Division
4. The operation must have a certified operator.
5. New barns, new lagoons, and waste disposal systems will not be located within a 100-year flood plain.

Lesson 1
Principles of Environmental Stewardship

By Rick Koelsch, University of Nebraska, Lincoln

Intended Outcomes

The participants will

- Recognize key principles of environmental stewardship.
- Understand key environmental issues facing the livestock and poultry industry.
- Review those environmental and regulatory issues that are of local interest.

Outline

I. Introduction
- A. Is manure an environmental risk or benefit?
- B. Why are we here?

II. Principles of Environmental Stewardship
- A. Awareness of environmental risks
- B. No point source discharge
- C. Balance in the use of nutrients
- D. Nutrient plan for land application
- E. Be a good neighbor
- F. Know the rules
- G. Expansion without environmental compromise
- H. Differences between systems for managing livestock and poultry byproducts and human waste

III. Understanding Water Quality Issues
- A. Water Quality Contaminants
  1. Nitrogen
  2. Phosphorus
  3. Pathogens
  4. Organic Matter
- B. Contaminant Pathways
  1. Runoff
  2. Leaching
  3. Macropore flow
  4. Wells
  5. Ammonia volatilization and deposition

IV. Understanding Air Quality Issues
- A. Common compounds
- B. Environmental impacts

V. Issues of local concern

Activities

The participants will complete

- An assessment of the environmental stewardship principles that they have implemented with their own livestock/poultry operation.
- A prioritization of individual environmental issues within the local community.
- A review of applicable regulations.

Time Required: 1 hour

PROJECT STATEMENT
This educational program, Livestock and Poultry Environmental Stewardship, consists of lessons arranged into the following six modules:

- Introduction
- Animal Dietary Strategies
- Manure Storage and Treatment
- Land Application/Nutrient Management
- Outdoor Air Quality
- Related Issues

The project team appreciates the financial assistance of the U.S. Department of Agriculture and U.S. Environmental Protection Agency's Ag Center in the development of this educational program.

Introduction

Management of manure and other byproducts of livestock and poultry production is a complex environmental issue. Given the same facts, rational individuals can often arrive at distinctly different conclusions. Is manure …

A source of pathogens, oxygen-depleting compounds, and nutrients that degrades the quality of our water for drinking and recreational use?

OR

A source of organic matter that improves the quality and productivity of our soil resources?

One of our nation's largest remaining sources of water pollution?

OR

A source of plant nutrients required for growth that can replace commercial nutrients both finite in supply and energy intensive in their production?

A source of gaseous emissions that reduces the quality of life in rural communities and contributes to possible neighbor health concerns?

OR

A means of recycling and sequestering carbon in the soils, contributing to a reduction in atmospheric carbon and global warming?

Both sets of conclusions about manure can be true. Manure can produce both substantial benefits and severe environmental degradation. The actual environmental results often depend upon choices that the producer makes.

Why are we here?

The livestock and poultry industry is facing a growing scrutiny of its environmental stewardship. Emotion and lack of understanding by the general public contributes to this scrutiny. Problems also result from a few producers who have contributed to highly visible impacts on the environment due to ignorance or outright disregard for the environment. These situations create a negative and often biased public view of livestock and poultry's impact on the environment.

However, real environmental concerns also result from livestock and poultry operations owned or managed by well-intentioned producers. Animal production has the potential to negatively affect surface water quality (from pathogens, phosphorus, ammonia, and organic matter); groundwater quality (from nitrate); soil quality (from soluble salts, copper, arsenic, and zinc); and air quality (from odors, dust, pests, and aerial pathogens). Manure and other byproducts of animal production, if not carefully managed, can have a significant negative impact on the environment.

On May 5, 1998, Secretary of Agriculture Dan Glickman stated that animal waste is "the biggest conservation issue in agriculture today, bar

The livestock and poultry industry is facing a growing scrutiny of its environmental stewardship.

This educational program will assist you in

- Self-assessing your operation's current environmental strengths and weaknesses.
- Identifying choices that minimize manure's risk as a pollutant and enhance manure's value as a resource.
- Reviewing your operation's compliance with environmental standards established by regulatory processes.

Principles of Environmental Stewardship

Most producers are familiar with the benefits of stewardship of our soil resources. Practices such as reduced tillage, contour farming, terracing, and others have produced a dramatic improvement in agriculture's stewardship of those soil resources.

What stewardship principles apply to the management of manure? Stewardship of air and water resources will be fundamental to the future survival of animal production systems. Several fundamental principles of good stewardship must be considered in the future production of livestock and poultry.

Stewardship of air and water resources will be fundamental to the future survival of animal production systems.

Awareness of environmental risks

The potential impact of an individual operation on the environment varies with animal concentration, weather, terrain, soils, and a host of other conditions. What are the highest risk situations or practices for your livestock/poultry operations? Are you developing plans and investing resources to address the highest risk situations? Identification of critical environmental risks specific to your operation, is the starting point of any good stewardship program. This curriculum provides one set of tools for assessing risks. Many land-grant university cooperative extension programs and livestock and poultry commodity groups provide additional excellent resources for assessing environmental risk.

No point source discharge

Livestock and poultry production systems should be managed to allow no discharges to surface water from point sources such as animal housing and storage facilities. The "No Discharge" management standard for animal manure is distinctly different from our management of human waste, which commonly is discharged into surface waters following treatment. To attain this high environmental standard, livestock/poultry operations should be designed and managed to prevent discharges to waters of the state and United States except under the most unusual weather conditions.

Minimizing discharges from nonpoint sources (e.g., land application) is also central to good environmental stewardship. Decisions related to timing and site selection of land application should be made to minimize the risk of discharges.

Livestock and poultry systems must maintain a balance between the nutrients arriving on-farm ... and the nutrients leaving as managed products ...

Balance in the use of nutrients

Nitrogen and phosphorus represent a double-edged sword. These are essential nutrients for all life forms but can become water quality contaminants when mismanaged. Livestock and poultry systems must maintain a balance between the nutrients arriving on-farm as purchased feed and fertilizer and the nutrients leaving as managed products (crops, animals, or animal products). An excess of nutrients arriving on farms results in a concentration of those

Table 1-2. Environmental steward's checkup. Check response most appropriate to your livestock or poultry operation to identify areas that may need work on your farm.

Stewardship principle	Low risk	Medium risk	High risk	Don't know
"My livestock operation . . .	My operation fully attains this stewardship principle.	My operation is progressing toward this stewardship principle.	My operation requires significant changes to achieve this stewardship principle.	
"...has completed an environmental assessment and identified high-priority environmental risks."				
"...does not discharge from buildings or manure storage."				
"...maintains balance in nutrients entering and leaving (as managed products)."				
"...implements a nutrient plan for land application."				
"...is a good neighbor. "...complies with all environmental regulations."				
"...considers environmental issues before expansion."				

for land application, and balance in the use of nutrients are critical to the livestock industry's management of its byproducts.

(2) Biological, chemical, and physical processes occurring in the soil provide the primary treatment of livestock manure (Figure 1-2). Soil provides the opportunity for recycling nutrients, using carbon to improve soil quality, and filtering or treating pathogens. Typically, almost no recycling of nutrients and carbon occurs with human waste. If carbon and nutrients are successfully recycled, the benefits to soil quality, conservation of energy (N fertilizers are energy intensive), and reduction in use of resources with limited supplies (P fertilizers) can be substantial. However, livestock producers must recognize and operate within the recycling limitation of soil and cropping systems.

Manure contains the following four primary contaminants that impact water quality:
(1) Nitrogen
(2) Phosphorus
(3) Pathogens
(4) Organic matter

Understanding Water Quality Issues

Management of animal manure and other byproducts to minimize water quality impact represents a substantial challenge facing the livestock and poultry industry. The following discussion briefly summarizes the components of manure that are of greatest concern, their specific impact on water quality, and their common pathways to surface and/or groundwater. The role of land application of manure relative to these issues is addressed in detail in Lessons 30 through 35. Lessons 20 through 25 focuses on limiting the water quality impact associated with storage of manure and other byproducts.

Water quality contaminants

Manure contains the following four primary contaminants that impact water quality: (1) nitrogen, (2) phosphorus, (3) pathogens, and (4) organic

Table 1-3. Summary of potential manure contaminants of water quality, the associated environmental risk, and most common pathway to water.

Potential pollutant	Environmental risk	Most common pathway to water
Nitrate N	Blue baby syndrome	Leaching to groundwater
Ammonia-N	Fish kills	Surface water runoff
P	Eutrophication	Erosion and surface water runoff
Pathogens	Human health risk	Surface water runoff
Organic solids	Reduced oxygen level in water body–fish kills	Surface water runoff

result in fish lesions and fish kills. Pfiesteria and other related species have been identified in the estuaries of the Mid- and South Atlantic states as well as red tides and brown tides along the Florida and Texas coasts. Growing evidence exists that nutrient loading is a contributor to hypoxic conditions in coastal waters. While it has not been clearly established that nutrients from agriculture and other sources are responsible for outbreaks of Pfiesteria and other harmful alga blooms, there is some scientific consensus about this linkage. Therefore, controlling runoff from manured cropland may be part of the solution to these coastal water issues.

Most nitrogen in manure exists in an ammonium or organic nitrogen form (see Figure 1-3). In these forms, it is likely to be transported with surface water runoff and erosion. These forms of nitrogen are unlikely to leach through soils with the exception of macropore flow to shallow water tables or tile lines. In general, the filtering ability of soil restricts movement of organic compounds, and the negatively charged clay soil particles restrict the movement of positively charged ammonium-N (NH_4^+). Ammonium can also be transported by volatilization and deposition processes.

If sufficient oxygen is available, ammonium-N can be transformed into nitrate-N (nitrification), which is soluble in water, and can leach through soils to groundwater. Nitrate-N from manure is likely to exist only in soil and in mechanically aerated lagoons.

Phosphorus. Because it is essential to plant growth and development, phosphorus is essential for modern crop production. It plays many critical functions; the primary one being the storage and transfer of energy through the plant. In confined livestock production, supplemental phosphorus is often essential to bone development and optimum animal performance. Commercially mined phosphorus is a limited resource with only approximately 40 years in reserves remaining in the United States. Thus, better use of manure phosphorus provides an increasingly important alternative to commercial fertilizers.

Phosphorus transported from agricultural lands to surface waters can promote eutrophication. Eutrophication, one of the leading water quality issues facing the nation's lakes and reservoirs, refers to an abnormally high growth of algae and aquatic weeds in surface waters. As this organic material dies, natural oxygen levels decline, which can cause changes in fish population or fish kills. Other common problems associated with eutrophied water bodies include less desirable or restricted recreational use, unpalatable drinking water, and increased difficulty and cost of drinking water treatment. Eutrophic surface waters may also experience massive blooms of cyanobacteria, which can kill livestock and pose health hazards to humans.

Phosphorus transported from agricultural lands to surface waters can promote eutrophication, ... one of the leading water quality issues facing the nation's lakes and reservoirs....

Pathogens. A pathogen is typically considered any virus, bacterium, or protozoa capable of causing infection or disease in other animals or humans. For the purpose of this discussion, the focus will be on pathogens in livestock and poultry manure representing a risk to human health.

Cryptosporidium parvum (*C. parvum*) and giardia are the two pathogens shed in animal manure of greatest concern for transmission to humans. The concern about these organisms is a result of three factors: (1) A healthy adult human can become infected with relatively few oocytes; (2) These protozoa originate from a variety of domestic animals, wildlife, and humans; and (3) Commonly used water disinfectants such as chlorine are not effective in controlling these protozoa.

C. parvum and giardia are parasites that cause severe diarrhea, nausea, fever, vomiting, and fatigue in humans. In healthy humans, the infections from either organism are usually self-limiting and do not pose serious health risks. However, the risk can be much greater for the very young, elderly, and those with immune depressed systems (e.g., those receiving chemotherapy, those with AIDS, or those who have received organ transplants.

Livestock and poultry shed a number of viruses in feces. However, as a general rule, these viruses are not transmitted to humans. Influenza viruses from swine may be an exception. However, the route of transmission does not typically involve swine excrement. Several potential bacterial pathogens shed by livestock are also capable of infecting humans. However, unless bacteria in feces has direct access to a drinking water supply, it is relatively unlikely that bacteria originating from livestock will infect humans. In addition, bacteria can be controlled with common water disinfectants such as chlorine. Location of drinking water wells (no chlorine treatment) in close proximity to animal housing or manure storage has caused human illnesses and deaths due to bacteria such as *E. coli* from livestock feces.

Because of the human health risks associated with *C. parvum* and giardia and the challenges of removing these pathogens from public water supplies, much of the remaining discussion will focus on these two organisms.

Three potential reservoirs for *C. parvum* and giardia exist: wildlife, domestic animals, and humans. A recent national study of *C. parvum* in beef and dairy cattle found that 59% of dairy farms and 22.4% of heifers tested positive. *C. parvum* was greatest for calves between 1 and 3 weeks of age and was rare for animals older than 3 months. Generally, cattle testing positive for giardia were less than 6 months but older than those with *C. parvum*. Another study has suggested that *C. parvum* is common to cow calf herds supplying young stock for beef production but at lower rates than observed in dairies.

Additional studies have found unweaned foals and suckling lambs have the greatest risk of infection within these species. Among pigs, infection is not limited to young animals and is strongly affected by management practices such as sanitation. Dogs, cats, and rodents can all be affected and are partially responsible for pathogen transmission on many farms. Poultry is not a carrier of Cryptosporidium organisms that infect humans.

Most pathogens, including *C. parvum* and giardia, do not multiply outside a host organism and have a limited lifetime outside a host. The viability of these organisms can range from a few days to many months, depending upon a number of environmental factors. Those environmental factors include

- Temperature: Environmental temperatures above 100°F and especially those commonly achieved by composting will dramatically reduce pathogen survival.

***Cryptosporidium parvum*... and giardia are the two pathogens shed in animal manure of greatest concern for transmission to humans.**

Location of drinking water wells (no chlorine treatment) in close proximity to animal housing or manure storage has caused human illnesses and deaths due to bacteria such as *E. coli* from livestock feces.

matter in the form of manure, silage leachate, and milking center wastewater degrades rapidly and consumes considerable oxygen (often measured as biological oxygen demand, BOD, or chemical oxygen demand, COD). If this occurs in an aquatic environment, oxygen can be quickly depleted. Fish kills are often caused in part by this depletion of oxygen. Manure, silage leachate, and waste milk are extremely high in degradable organic matter. These products can be 50 to 250 times more concentrated than raw municipal sewage (primarily because livestock production does not add the large volume of fresh water that is used in dilution and transport of municipal waste).

Organic matter, like pathogens, P, and ammonia, is transported to water primarily by surface water runoff. Rarely does it leach through soils. Organic matter is unlikely to be transported in sufficient quantities to nearby surface waters unless one of the following situations occurs:

(1) A direct discharge from a livestock housing, manure storage, open lot, or other facilities is allowed to enter surface water drainage.
(2) A catastrophic failure such as an earthen storage break or continuous application by an irrigation system on the same location.
(3) Significant rainfall occurs immediately after the surface application of manure.
(4) Significant application is made on frozen, snow-covered, or saturated soils in close proximity to surface water.

Contaminant pathways

The potential pollutants discussed previously typically follow one or more of five possible pathways for reaching water, including runoff, leaching, macropore flow, wells, and ammonia volatilization and deposition (see Figure 1-4).

Runoff. Runoff from open lots, land application sites, and manure and feed storage units is a common pathway for contaminant transport. All contaminants in manure will travel with surface water runoff and soil erosion. Pollution associated with phosphorus, pathogens, ammonia, and organic matter are most commonly associated with runoff or erosion.

Leaching. Dissolved contaminants such as nitrate nitrogen will leach beyond a crop's root zone when the soil moisture exceeds its water-holding capacity and eventually contaminate groundwater. Most contaminants in manure and other byproducts (e.g., organic matter, pathogens, and typically phosphorus) are filtered by soil and will NOT leach to groundwater. Soil structure, chemical bonding with soil minerals, and negatively charged soil particles typically restrict the movement of most contaminants. However, it is possible to saturate the soils ability to restrict contaminant movement. For example, soils with low cation exchange capacity can allow ammonia movement of up to a few feet per year below manure storages.

Macropore flow. Most contaminants in manure can travel through soil to shallow groundwater tables or tile drains by macropore flow. Macropore flow (root holes, wormholes, and cracks due to soil drying) can provide pathways for contaminants to bypass the filtering capability of soils. Sinkholes and karst topography also provide opportunities for contaminants to directly reach groundwater.

Wells. Wells can provide a direct pathway for contaminants to reach groundwater. Abandoned wells, wells with poor well-casing designs, or wells located in close proximity to open lots or manure storage can provide a pathway for all manure contaminants to move to groundwater.

Pollution associated with phosphorus, pathogens, ammonia, and organic matter are most commonly associated with runoff or erosion.

sions are often the source of greatest environmental concern within a rural community often triggering greater environmental and public scrutiny of an individual operation.

Many of these volatile compounds contribute to observed odors. The primary groupings of odorous compounds are listed in Table 1-4. Because of the vast number of compounds contributing to an odor observation and the variation in the relative importance of individual gases for individual situations, attempts to identify a single indicator gas have not generally proven successful. In addition, other emissions are associated with livestock production. Dust emission from animal housing is gaining greater attention due to its health impact upon neighbors and its ability to serve as a carrier of odor compounds. Finally, the production of non-odorous gases including methane and carbon dioxide is gaining some attention as a potential contributor to global warming.

These compounds originate from a variety of sources. Metabolic processes within the gastrointestinal tract of livestock contribute some of these compounds. Anaerobic degradation of manure is an additional significant contributor of most compounds.

Anaerobic degradation involves the reduction of complex organic compounds to a variety of odorous volatile fatty acids (VFAs) by acid-forming bacteria. Methane-forming bacteria convert VFAs to odorless methane and carbon dioxide. If these anaerobic processes are in balance, most odorous compounds are eliminated. However, under certain conditions in manure storage or overloaded anaerobic treatment lagoons, acid-forming and methane-forming processes are not in balance, resulting in an accumulation of VFAs. In addition, sulfate-reducing bacteria found in anaerobic environments convert sulfate to hydrogen sulfide and other sulfur-containing compounds. Anaerobic degradation by sulfate-reducing bacteria and an imbalance of acid- and methane-forming bacteria are significant sources of odorous compounds.

More than 160 volatile compounds have been identified as contributing to the odor from confinement facilities.

Environmental Impacts

Odorous volatile compounds are commonly considered to be an unpleasant or nuisance experience by many neighbors. Neighbors' determination of odor nuisance is often related to a number of physical factors (frequency, duration, and intensity of odor experience) and social factors (neighbor's past experience with agriculture, neighbor's relationship with producer, and appearance of livestock or poultry operation). Neighbor's odor nuisance issues must be taken seriously. These experiences are commonly a critical driving force to discontent within a community, opposition to new or expanding facilities, and additional scrutiny of potential other environmental issues.

Table 1-4. Common odorous compounds associated with livestock manure.

Volatile fatty acids	Ammonia and amines	Phenolics/N heterocyles	Sulfur compounds
Acetic	Ammonia	Phenol	Hydrogen sulfide
Proprionic	Methylamine	P-cresol	Dimethyl sulfide
Butyric	Ethylamine	Indole	Methyl mercaptan
Isobutyric		Skatole	Ethyl mercaptan
Isovaleric			Diethyl sulfide

Open lots for livestock production will volatilize roughly half of the N, primarily as ammonia. As described previously in the water quality section, the primary problems associated with ammonia relate to its deposition on land or water.

Issues of Local Concern

The previous discussion introduced many potentially negative impacts of manure on the environment. Within your local community, it is likely that only a few of these potential issues are of critical concern. These high-priority issues may result from unique local conditions, a history of environmental concerns, and/or public policy and regulatory actions.

It is important that the producer's future investments of time and resources focus primarily on high-priority local environmental issues. Use the following tables to identify those high-priority issues based upon regulations (Table 1-5) and local community concerns (Table 1-6). These priorities should be considered in your livestock operation's future environmental stewardship efforts.

It is important that the producer's future investments of time and resources focus primarily on high-priority local environmental issues.

Table 1-6. Identification of primary environmental issues of local concern.

Environmental issue	Check importance of environmental issue locally			Is this issue regulated?		
	High	Medium	Low			
Water Quality						
Nitrate contamination of groundwater				Yes	No	Don't know
Eutrophication from nutrient movement to surface water				Yes	No	Don't know
Fish kills from discharges or spills to surface water				Yes	No	Don't know
Protection of community drinking water supplies				Yes	No	Don't know
Other:__________				Yes	No	Don't know
Air Quality						
Odors				Yes	No	Don't know
Dust				Yes	No	Don't know
Ammonia volatilization and deposition				Yes	No	Don't know
Hydrogen sulfide				Yes	No	Don't know
Other:__________				Yes	No	Don't know

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Nutrient Management for Georgia Agriculture

Developing a Comprehensive Nutrient Management Plan

Prepared by the Nutrient Management Task Force • Cooperative Extension Service • The University of Georgia College of Agricultural and Environmental Sciences

What is a Comprehensive Nutrient Management Plan?

A Comprehensive Nutrient Management Plan (CNMP) is a strategy for making wise use of plant nutrients to enhance farm profits while protecting water resources. It is a plan that looks at every part of your farming operation and helps you find better ways to use manures, fertilizers and other nutrient sources. Successful nutrient management requires thorough planning and recognizes that every farm is different. The type of farming you do and the lay of your land will affect your CNMP. For example, CNMPs on farms that do not have animals will not require as much detail as those that do. The best CNMP is one that is matched to the farming operation and the needs of the person implementing the plan—the Georgia farmer!

Who is Required to Have CNMPs?

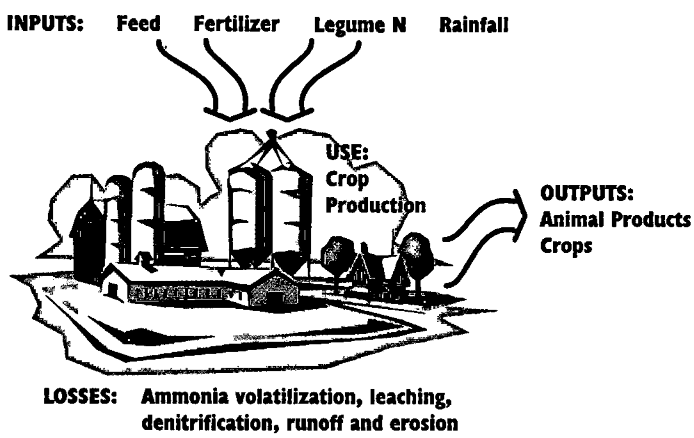
The United States Environmental Protection Agency and the United States Department of Agriculture have recently released a Unified National Strategy for managing animal feeding operations. This strategy sets a national goal for all animal feeding operations to have CNMPs. In Georgia, any animal feeding operation that receives a permit through the Georgia Environmental Protection Division is required to have a CNMP.

Other producers who are not required to have a permit are being encouraged to voluntarily adopt CNMPs. Many organizations such as the Georgia Poultry Federation and the Georgia Pork Producers have established initiatives to assist producers to better manage nutrients on the farm.

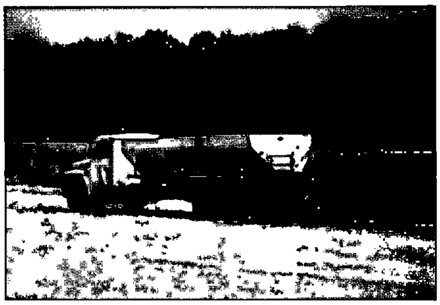
What Are the Parts of a Successful CNMP?

A Comprehensive Nutrient Management Plan looks at how nutrients are used and managed throughout the farm. It is more than a nutrient management plan that only looks at nutrient supply and needs for a particular field. Nutrients are brought to the farm through feeds, fertilizers, animal manures and other off-farm inputs. These inputs are used, and some are recycled by plants and animals on the farm. Nutrients leave the farm in harvested crops and animal products. These are nutrient outputs. Ideally, nutrient inputs and outputs should be roughly the same. When nutrient inputs to the farm greatly exceed nutrient outputs from the farm, the risk of nutrient losses to groundwater and surface water is greater. When you check nutrient inputs against nutrient outputs, you are creating a mass balance. This nutrient mass balance is an important part of a CNMP and important to understand for your farming operation.

Another important part of a successful CNMP is best management practices (BMPs). BMPs, such as soil testing and manure analysis, help you select the right nutrient rate and application strategy so that crops use nutrients efficiently. This not only reduces nutrient losses and protects the environment but also increases farm profitability. BMPs may also include managing the farm to reduce soil erosion and improve soil tilth through conservation tillage, planting cover crops to catch excess nutrients, or using filter strips and buffers to protect water quality. Preventative maintenance, record keeping, mortality management and emergency response plans must also be included in a CNMP for livestock and poultry operations.



sis of these products tells you the nutrient content so that you can match this with soil test recommendations and determine application rates. The lab results will

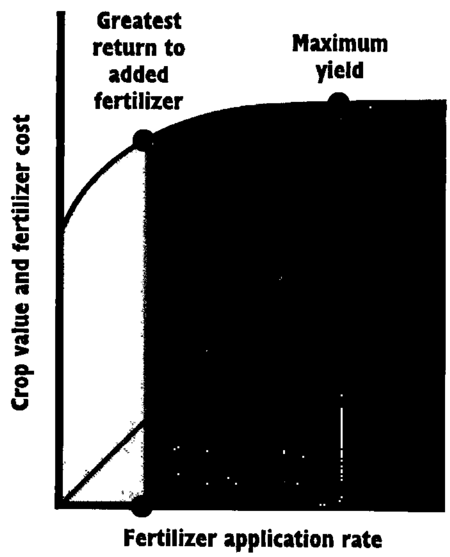


help you determine how much of the nutrients in the manure will be available to your crops. The amount credited to the nutrient budget should be based on plant available nutrient levels, which may be substantially different from the total nutrient content. The county Extension office has information on manure and litter testing.

Determining Nutrient Balance

Balance Between Supply and Need

Once you have determined both the supply and need of nutrients for each of your fields, a critical aspect of CNMPs is balancing the two. This can be done in several ways. Currently, most CNMPs are developed based on nitrogen; however, other factors such as phosphorus or metals could control how much poultry litter or manure you can put out under certain conditions. A phosphorus index is currently being developed to help producers determine when nutrient management based on phosphorus would be advisable.



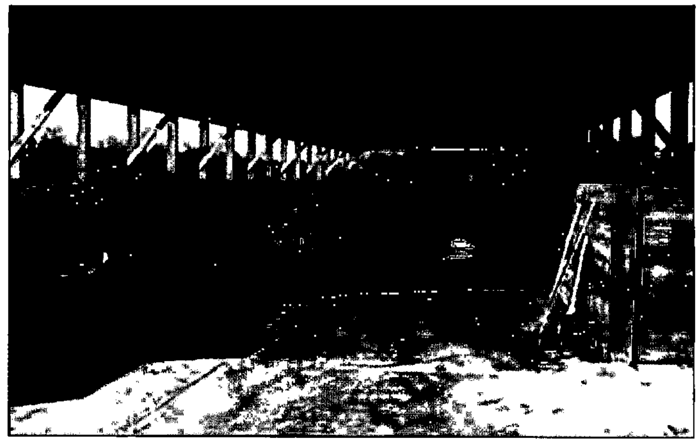
If your crop acreage is small relative to the number of animals, the nutrient balance will also allow you to evaluate how much manure or litter you may need to move off your farm to avoid over-application of nutrients.

Can the Nutrient Supply on Your Farm Be Managed or Changed?

After evaluation of the nutrient supply on your farm and the nutrient needs of your crops, you may find that the balance of nutrients is not ideal. You may have more of one or more nutrients (usually phosphorus) than you need. Many management practices can change the nutrient balance. These include:

- changes in storage practices,
- adjustments of animal feeds,
- modification of treatment methods, and
- chemical amendments.

For example, you may be able to reduce nutrient losses in your manure treatment and/or storage system. Sometimes reducing nitrogen losses can make manures a better-balanced fertilizer for your crops. In addition, animal diets can sometimes be changed to reduce nutrient excretion in their manure. Enzymes can be added to the diet to reduce nutrients in the manure. Phytase is a supplemental enzyme that allows better use of the phosphorus already present in grains, so less phosphorus has to be added to the animal's diet.



Manure Storage

Manure storage is critical. It effects both the quantity and quality of nutrients that will need to be land applied or exported from the farm. The storage structures and design capacities need to be identified as part of a CNMP. These structures also need to be managed to prevent nutrient losses and protect water quality. For example, clean water should always be diverted from barnyard and manure storage areas to reduce the potential for nutrients reaching ground or surface waters.

Manure Application to Fields

Manures should be applied near the time that crops need nutrients using calibrated spreaders or irrigation equipment. Solid or slurry manure should be incorporated into the soil when appropriate. Incorporation or mixing into the soil greatly reduces losses of nitrogen to the air and keeps more in the soil where it is needed. This reduces potential odor emissions. Slurry manure can also be injected into the soil so that incorporation is not required. Accurate records of application rates and times are also essential.

PERMIT COMPREHENSIVE NUTRIENT MANAGEMENT PLAN
to
MEET REGULATORY REQUIREMENTS

SITE DESCRIPTION

Farm Name: ____________________
Owner: ____________________
Address: ____________________
____
Telephone No. ____________________

Directions to Farm (if location map not provided below):

Farm Description:

No. and Type of Animals, Type of Buildings, etc. -

Attach:

Site Location Map (recommended)
Soils Map (recommended)
Farm Map (required with the following items, the NRCS toolkit can provide this)

- Farm property lines
- Land use - cropland, pasture, etc.
- Farm field boundaries with field identification
- Surface water locations including streams, rivers, ponds, ditches, etc.
- Arrows showing direction of stream or water flow
- Well locations
- Regulated Buffers
- Any residences or public gathering areas*
- Sensitive areas that may be buffered*
- North arrow
- Date prepared
- Road names or numbers
- Legend with map symbols
- Bar scale

*These items optional

Part A: NUTRIENTS PRODUCED

This section can be completed using actual data or worksheets. If actual manure generation amounts are know and manure analysis has been completed, then this data is preferred. If manure amounts and data from analysis are not available, use number of animals with book values for nutrient concentrations and storage/handling losses. Worksheets or spreadsheets used for calculations or records and analysis should be attached.

Nutrients Present after Storage and Handling Losses
Total nitrogen: ____________ lbs
Total phosphorus as P_2O_5: ____________ lbs
Total potassium as K_2O: ____________ lbs

Part B: NITROGEN AVAILABLE FOR LAND APPLICATION

All inputs on annual basis.

	Total Nitrogen (lbs) from Part A	Availability Coefficient (based on app. method)	Available Nutrients (lbs)
Lagoon wastewater or slurry			
Lagoon Sludge			
Dry Manure or Litter			

Comments:

Part C: LAND APPLICATION

<u>Application Methods</u>

Lagoon wastewater or slurry:
System type: ______________________________
Irrigation frequency: ___________ (weekly, monthly, etc)
Calibration frequency (annually, every 5 years, etc.): _______________

Lagoon sludge:
System type: ______________________________
Application frequency: ___________ (yearly, every 5 yrs etc)
Calibration frequency (annually, every 5 years, etc.): _______________
(Attach Calibration Records if available)

Dry Manure:
System type: ______________________________
Capacity: ______________________________
Application frequency: ___________ (annually, semiannually, etc)
Calibration frequency (annually, every 5 years, etc.): _______________

Complete Nutrient On-farm Nutrient Utilization Table and Nutrient Budget sheets for each field.

Table C2: Listing of BMP's used on Land Application Fields

1. Plant sampling/tissue analysis
2. Manure injection or incorporation
3. Manure treatments such as alum
4. Conservation or Reduced Tillage
5. Contour plantings
6. Terraces or other water control structures
7. Critical area plantings/vegetated waterways without manure applications
8. Upslope Water diversions or downslope ponds or retention structures
9. Riparian buffers or filter strips around field border
10. Winter "scavenger" or cover crops (without nutrient application)
11. Rotational Grazing

Part D: NUTRIENT BALANCE

A) Total Manure N Used On-farm ______lbs. (From Land Application Section)
B) Total Manure N Generated _______lbs. (From Nutrient Available Section)
C) Difference: (A-B) _________lbs.

Note: If difference is greater than zero, your nutrient balance is complete. If difference is less than zero (negative) then excess nitrogen will need to be transported off-farm. These off-farm uses need to be documented on off-farm utilization record sheets or through other manure utilization agreements.

Table D1: Off-farm Nutrient Utilization Records

Date	Amount Removed from Farm Amount	Total N (lbs)	Person or company that purchased or removed manure	Anticipated use

Part G: EMERGENCY RESPONSE PLAN

Describe emergency response plan or attach Emergency Response Sheet G1 for operations with just solid manure or Emergency Response Sheets 1 and 2 for operations with liquid manure:

Part H: CLOSURE PLAN

Closure plan required: Y N

If required, briefly describe closure plans or attach Closure plan worksheet:

SUMMARY OF ESSENTIAL INFORMATION

Environmental Stewardship and Regulations

Manure can be a benefit or a liability. It can fertilize and build soils or pollute waters and adversely impact health. The choices and management that a producer makes determine which it is.

According to the Environmental Protection Agency, agriculture is the leading source of water quality impairments in rivers and streams. Point source discharges of water or waste are those that come from a known source such as a ditch or pipe. Non-point source discharges are driven by rainfall and usually come from runoff over the land surface. Most agricultural operations and all swine housing and manure storage facilities in Georgia are subject to the "No Discharge" standard. This means that there can not be any direct point source discharges to waters of the state or nation and that non-point source discharges from the land application areas need to be minimized. It is nearly impossible to prevent all non-point source pollution as runoff and soil erosion are natural processes that occur on all landscapes.

Some stewardship principles include no discharge of pollutants, nutrient planning for land application, compliance with all regulations, consideration for environmental issues before expansion, and being a good neighbor.

Nitrogen, phosphorus, pathogens, and organic matter are the four primary contaminants that impact water quality. Nutrients, such as nitrogen and phosphorus, are essential for plant growth and make manure a good fertilizer. When nutrients reach rivers and lakes, they present environmental risks and can cause algal blooms, fish kills, and eutrophication. Nitrogen moves with water more easily than phosphorus and excess nitrates from nitrogen can cause health problems in animals and people. Pathogens are disease causing organisms. Manure can contain many pathogens including E. coli, C. parvum, and giardia. These organisms can present serious human health hazards but they usually can not survive long periods of time in lagoons or on land surfaces. Animal housing and manure storage should therefore be located away from surface water and wells to prevent transfer.

A Comprehensive Nutrient Management Plan (CNMP) is a strategy for making wise use of nutrients to enhance farm profits and protect water quality. It is an excellent management tool for insuring that nutrients from a livestock operation do not impair water quality. CNMP's include several components such as maps of your operation, soil and manure analysis, calculations of the nutrients needed on each field and the nutrients available in manure resources, a balance for the farm with suggestions for off-farm uses if excess nutrients are available, manure storage and handling strategies, BMP's and plans for land application, an emergency response plan, a mortality management plan, and some sort of record keeping system. CNMP's are living documents. They must be updated regularly and the owner/operator needs to understand all components of the plan.

A CNMP is NOT a fertilizer recommendation for a single field. In the past, nutrient management plans were developed to insure that nutrients were not over-applied to a given crop. This is not COMPREHENSIVE and does not cover the entire operation. Examples of nutrient inputs to a farm include feed, animals, fertilizer, legumes, and irrigation. Outputs can include animals, crops, and manure. Ideally, these should be equal but often the inputs far exceed the outputs. This imbalance causes problems such a losses to the environmental and elevated soil nutrient levels.

Strategies for improving the nutrient balance include 1) more efficient use of manure nutrients in crop production, 2) changing the livestock feeding program, 3) marketing the manure off the farm, and 4) changing the manure treatment method.

The University of Georgia Cooperative Extension Service, the USDA Natural Resources Conservation Service, Certified Crop Advisors, professional engineers, and other private consultants should be able to assist producers in developing CNMP's.

Maps for Comprehensive Nutrient Management Plans

Julia W. Gaskin, Biological & Agricultural Engineering Dept., University of Georgia
Vernon Jones, USDA Natural Resources Conservation Service

Introduction

A comprehensive nutrient management plan (CNMP) is a planning tool for making wise use of plant nutrients while protecting water resources. The basis of a CNMP is an accurate map of your farm. The map or maps will help you identify areas suitable for land application of manures and areas that need protection or that may need special management due to environmental sensitivity. The maps will also help you evaluate your crop rotation and calculate acreage you have available for using animal manures. Although a CNMP evaluates the use of all sources of nutrients, this document will focus on preparing maps for the management of nutrients from organic sources such as manures.

Maps for CNMP should be on a known scale and include:

- farm property lines
- land use - cropland, pasture, forest, etc
- farm field boundaries with field identification
- surface water locations, including streams, rivers, ponds, ditches, and wetlands
- arrows showing the direction of stream or river water flow
- well locations
- buffers around sensitive areas
- any residences or public gathering areas
- North arrow
- date prepared
- "Prepared with assistance from (NAME)"
- road names or numbers
- name of county
- legend with map symbols
- BAR SCALE on the map

Making a Base Map

How do you go about getting this information? First is the "old-fashioned way".

You will need:

- several copies of the Farm Service Agency (FSA) maps of your farm
- a copy of the county soil survey map of your farm from Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS)
- colored pencils
- a ruler
- a transparent dot grid or other method to determine acreage

Use the FSA map as your base map. Remember when maps are photocopied, the scale can change. You should use a bar scale to make sure your scale is accurate. Draw a 1-inch line

on a piece of paper and place it on the map before it is copied. Then measure the 1-inch line on the map copy to make sure it still measures one inch. If it does not, you will have to set up a ratio to determine the true scale of the map. An example of how to set up a ratio for a map follows. The original scale is 1 inch = 660 feet, and on the copy the 1-inch line measures 1.2 inches. The ratio looks like this: 1 in/1.2 in = 660 ft/ x ft.
You solve the ratio like this:

$$1x = 1.2(660)$$
$$x = 792 \text{ feet}$$

The new scale is 1 inch = 792 feet.

Because the FSA maps are aerial photographs, they will show land use and many surface water features, as well as roads with road names or numbers. It should show your property lines and field boundary lines. Your fields should be identified with a unique name or number and the acreage of each field shown. A sample map is shown in Figure 1. Review the map to make sure nothing has changed. If property lines or field lines have changed, make changes on the FSA map in black pencil.

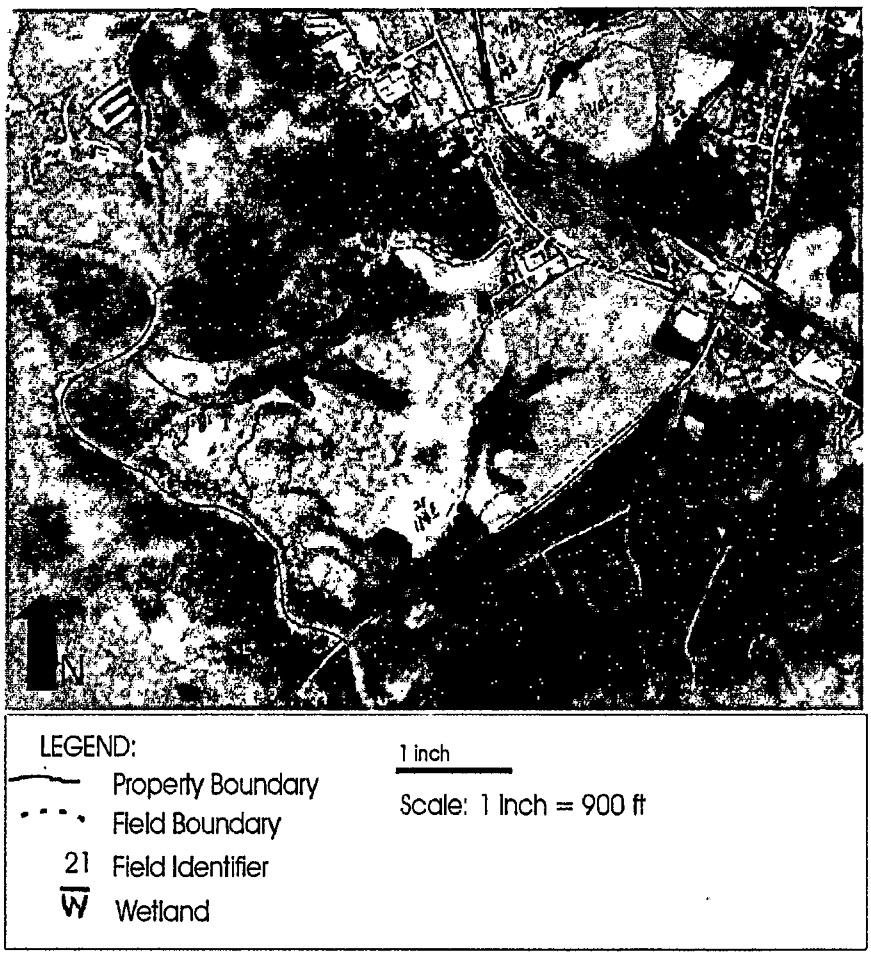


Figure 1. Sample of a base map from the Farm Service Agency

Take out the copy of the county soil survey map with your farm on it. Figure 2 shows the corresponding soils map for Figure 1. Locate your farm on the map. The soil survey map is <u>NOT</u> the same scale as the FSA map, but you should be able to use features such as roads, rivers, fields, etc to locate your property boundaries. The soils map will have streams marked on it in this symbol ~~~~ or this symbol ~~ ··· ~~. Use these markings, with your knowledge of your farm, to determine where streams are on the FSA map.

1 INCH

LEGEND:

Scale: 1 INCH = 733 FT.

—··—·— Stream

MG E2 Soil Map Unit

Figure 2. Corresponding soils map for Figure 1.

Using the symbols above or a solid blue line, mark the streams on the FSA map in blue pencil. Add arrows to the stream symbol to show the direction of stream flow. Outline other surface waterbodies such as ponds, rivers, and wetlands in blue. Your FSA map may already have wetlands marked on it. If it doesn't and you are unsure about whether an area on your farm is a wetland, contact the NRCS for a wetland determination. Finally, mark any wellhead locations in blue. Figure 3 shows the base FSA map with the water symbols added.

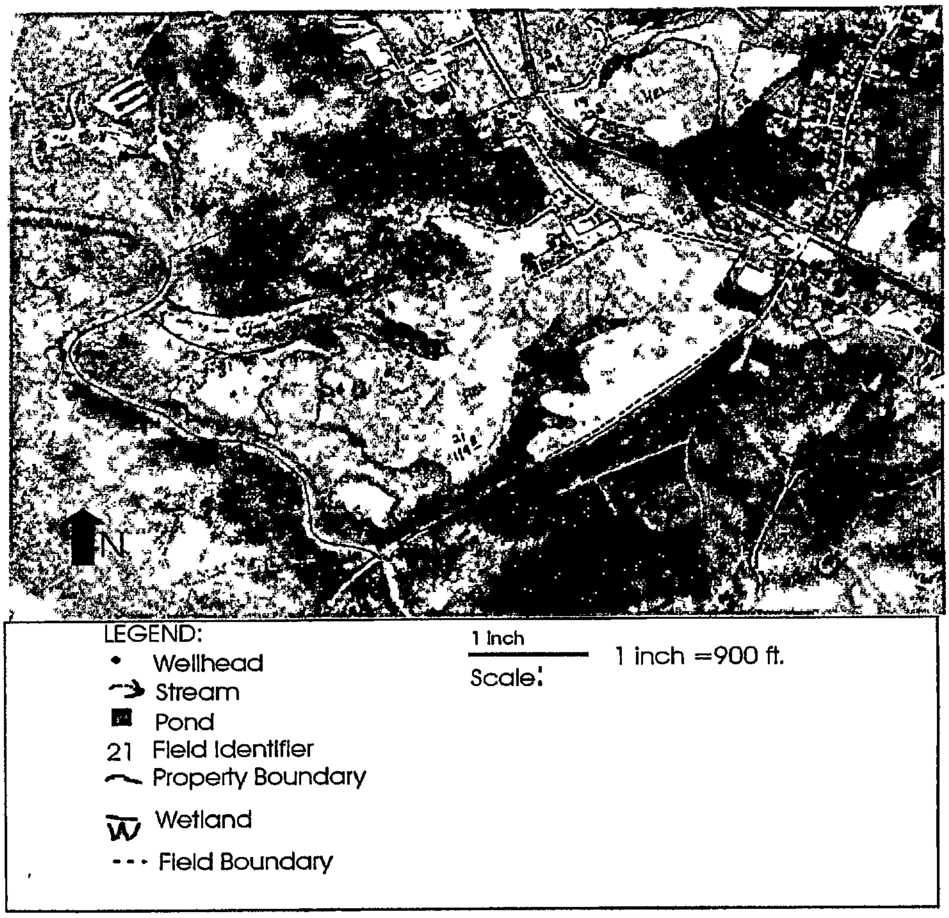


Figure 3. The FSA base map with water symbols added.

Suitable Areas - Site suitability for manure application is largely determined by the soils and topography, although you may want to consider how close a field is to public roads, public gathering areas or residences. The best sites for manure application are on level to gently sloping, deep, well-drained soils with some clay content. You should avoid:

Soils less than 24 inches to bedrock
Soils with water tables less than 36 inches below the soil surface
Slopes greater than 12 to 15%.

You should also be careful about irrigation with manure wastewater on deep sandy soils. Water moves very rapidly through these soils and they have a limited ability to hold nutrients.

You probably have a good idea where these types of soils occur on your farm, but you can obtain this soils information from the county soil survey. Your soils map will have symbols on it that indicates the type of soils you have. Look up the symbol in the Soil Legend to get the name of the soil and the range of slopes associated with that map unit. Then go to the Soil and Water Feature Table, where you can look up the water table depth and depth to bedrock for that map unit. Remember the county soil survey is on a large scale and maps the dominant soils on the site. This means that soils other than the one mapped can and most likely will exist in a given field. If you have questions about whether the soils on your farm have the above characteristics, contact the NRCS.

If you have fields or parts of fields that have the characteristics listed above, you may need to exclude them from manure or wastewater application. Mark these areas on your base map.

You should discuss these areas with NRCS or county extension personnel to determine if the need to be permanently excluded from your land application program or if they can be used seasonally or with special management.

You should keep the soils information you have developed with your CNMP. The information may prove useful if the CNMP needs to modified.

Buffering Sensitive Areas - Sensitive areas are things such as wellheads, streams, or wetlands that are sensitive to nutrient inputs. Buffers around wellheads will reduce the potential for groundwater contamination due to nutrients from manures, fertilizers or pesticides. Table 1 gives the distances required by law that you need to have separating wellheads from various potential contaminants. Table 2 gives recommendations for separation distances from potential contaminants.

Table 1. Minimum distances between wells and potential contaminants based on the Georgia Well Standards Act of 1985.

Distance from Well (feet)	Potential Contamination Source
10	Sewer line
50	Septic tank
100	Septic tank absorption field
150	Cesspool or Seepage pit
100	Animal or fowl enclosure

Table 2. Recommended separation distances from various potential contaminants.*

Distance from Well (feet)	Potential Contamination Source
150	Waste lagoon
50	Dead animal burial pits
100	Pesticide storage, mixing & loading facilties
100	Fertilizer storage
500	Petroleum tanks
250	Manure or chemical application

*Tyson, A. 1996.Improving Drinking Water Well Condition. Georgia Farm*A*Syst, Cooperative Extension Service Bulletin 1152-3.

Buffers around streams, rivers, ponds and wetlands reduce the chance these surface waters will become overloaded with nutrients. Most fresh waterbodies in Georgia are particularly sensitive to phosphorus. Phosphorus in runoff or in water moving through the soil into the surface water can cause excessive algae growth that creates problems for recreation and other uses. Table 3 gives some general guidelines for buffer widths. Effective buffers are highly site specific and depend on land use, slope, and vegetation. You should review any proposed buffers with NRCS or county extension personnel. Governmental rules and regulations may require specific buffer widths and these take precedence over any recommended buffer widths.

Table 2. Guidelines for surface water buffers. Animal manures should not be applied within these buffers. Fertilizers should be used carefully.

Distance from Surface Waterbody*	***Feature***
At least 50 feet	Ponds, sinkholes, wetlands
At least 90 feet if buffer slope is less than15%	Streams, rivers
At least 120 feet if buffer slope is greater than 15%	Streams, rivers
At least 35 feet	Ditches

* Gaskin, J. and G. Harris, 1999. Nutrient Management Farm*A*Syst University of Georgia,Cooperative Extension Service Bulletin 1152-16

Calculating Acreage - Now that you have determined the buffers needed around these sensitive areas, you need to mark them on your FSA map, determine the acreage and subtract the acreage from the total acreage of the field. Make sure you know the correct scale for your FSA map. First measure the correct buffer distance with your ruler and outline the buffer area in green pencil (Figure 4). You may want to shade or otherwise mark the buffer area.

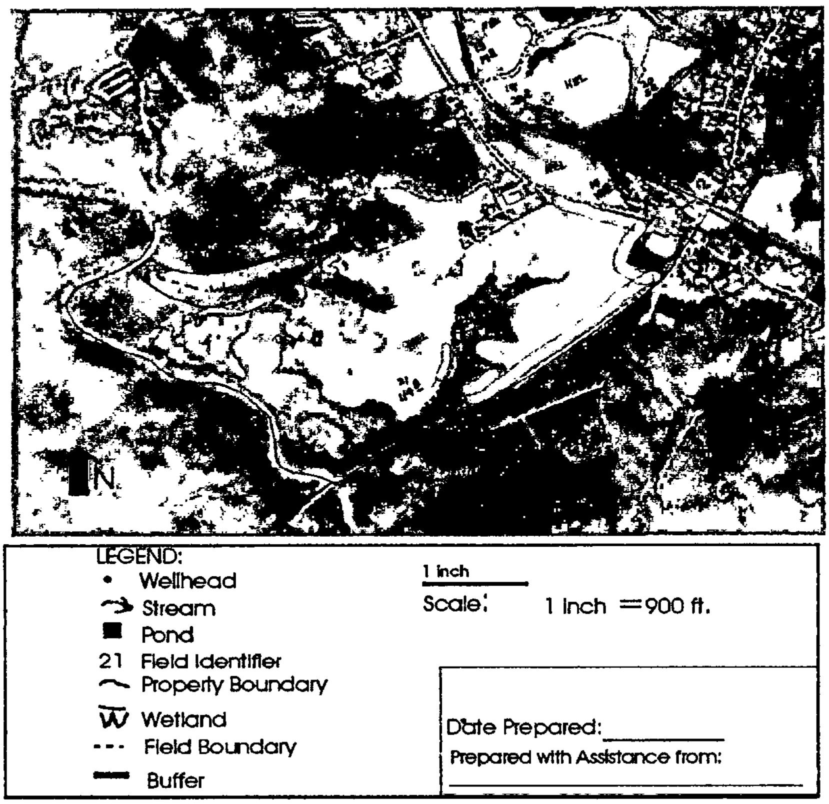


Figure 4. The FSA base map with buffers added. This map has all the information needed for a CNMP.

Now calculate the acreage in each field that is not useable for manure application due to the buffers, sensitive areas or unsuitable areas. Buffer areas can be calculated using a planimeter, measuring the area with a ruler, or a dot grid. A dot grid is a transparent piece of paper with a known number of dots per square inch. Place the dot grid over the buffer area and count the number of dots within the buffer. If a dots fall on the buffer line, include every other dots in your count for the buffer area. Divide the total number of dots by the number of dots per square inch to get the square inches of land in the buffer. Now find the scale of your map. Multiply the number of feet per inch by itself to get square feet per square inch. Then multiply the number of square inches from your dot grid by the square feet for your base map, convert to acres, and you're done. The example below may help you remember this procedure.

Find Field 21 on Figure 4. This field has buffers drawn around public roads, the property boundary and along a wetland area. The buffer along the public road is 150 feet, and those around streams, wetlands and the pond are 100 feet. Using a dot grid with 40 dots per square inch, we counted 19 dots within the buffer area. We divided the 19 dots by 40 dots per square inch to get 0.48 square inches. Our map in Figure 4 has a scale of 1 inch = 900 feet, which is equivalent to 810,000 square feet per square inch. Dividing 810,000 by 43,560 square feet, we get 19 acres per square inch. If we multiply 0.48 square inches by 19 acres per square inch, we find we have 9.1 acres in buffers. We have to subtract this 9.1 acres from the total field acreage of 119.8 acres to get the number of "spreadable" acres. Remember to subtract all the buffer areas or other areas unsuitable for manure application from the field acreage, so you have an good idea about how much land is available for use.

You may also want to limit your use of manures in areas close to houses or public gathering places, if there is a potential for odor complaints. These areas should also be marked on your map, and subtracted from your useable land acres. Note Fields 16 and 17 in Figure 4. These fields border a busy public road. If a 150 -foot buffers is used to reduce possibility of complaints, the useable area in the fields is too small to use. So these fields will not be included in the land to be used for manure application.

Computer Generated Maps

NRCS Toolkit - A second way to acquire the map information needed for a CNMP is to use the NRCS Toolkit. USDA Service Center Offices are equipped with computers and technology that can generate a similar map for you. A conservationist can come to your farm, and use an electronic aerial photo of the farm with the FSA property lines and field lines. You can work with the conservationist to add streams, as well as other water bodies, and locate buffers. This technology is in place in several district offices and should be available throughout the state in the near future. To read more about the NRCS Toolkit go to *http://www.ga.nrcs.usda.gov/ga/gapas/index.html.*

Figures 5, 6, and 7are examples of computer generated maps. Figure 5 is an electronic aerial photo with the farm boundaries (black line), field boundaries (red line), 150 foot setback around the property line (green line), 100-foot buffer around surface water and wetlands (light violet) well (small circle), streams and pond (blue) overlain on the photo. Figure 6 is the electronic version of a USGS topographic map with the same information as Figure 5 on it. Figure 7 is the base map (Figure 5) with electronic topographic information overlain. The computer will calculate the area of the fields, buffers and any other area that is desired. As more soil surveys are digitized, the soil map will be available for overlaying on the base aerial photo.

The maps labeled "Jon Doe" (Figure 8) and "Nutrient Mgt. Plan Map" (Figure 9)are examples of actual maps from nutrient management plans prepared using the NRCS Toolkit. Having the electronic maps permits revision or update with minimal time and effort. These maps show the basics for nutrient management plans. They include the property boundaries, field numbers, size and boundaries, the lagoon or holding pond, sensitive areas and buffering, setbacks required by the EPD rules, and SCALE. Please note that on the Jon Doe map (Figure 8) the 150-foot setback from the property line is continuous around the farm. This 150-foot setback could be placed only on fields that are going to be used for manure application similar to Figure 4 and Figure 5.

Online Maps - The Georgia Spatial Data Infrastructure web site has electronic maps of the state of Georgia. The internet (URL) address is: http://gis.state.ga.us/. These can also be used to make the base map for your CNMP. To locate the maps, click on the button labeled 'Clearinghouse'. Now click on the button labeled 'Online maps'. There are many choices of maps available on this page. The button labeled 'orthophotography viewer' contains the 1993 aerial photographs. Click on the Georgia map as close as possible to where your farm is located. You will be able to move around on the aerial photographs and locate your farm. You can then print out the aerial photograph or save it electronically. After you have obtained the aerial photograph of your farm, you can hand draw the property boundaries, streams , fields, etc. or use computer software to add the needed features.

Summary

You have now developed the basis for your CNMP. These maps are critical for conservation, planning land application of manures, and crop rotations. You should keep them as accurate as possible.

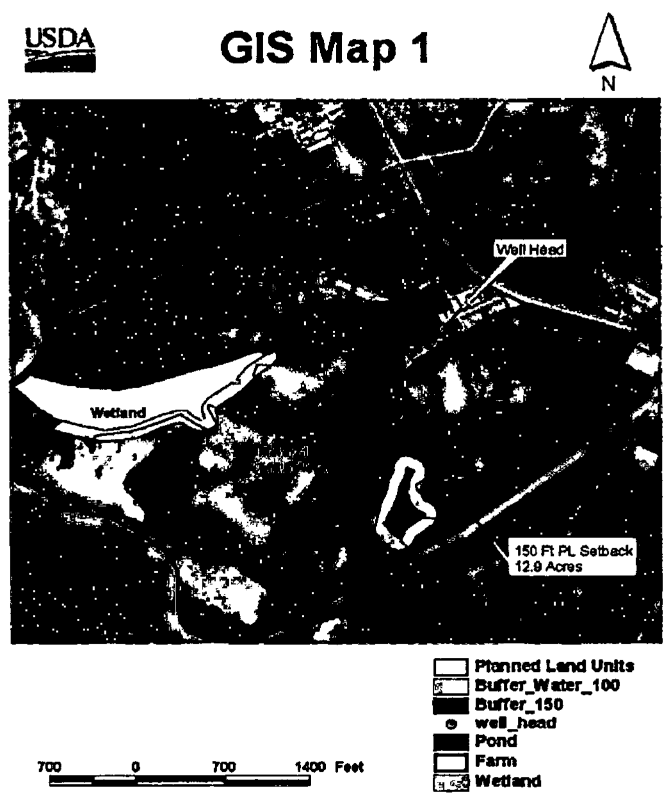


Figure 5. Electronic aerial photo used as a base map for a CNMP.

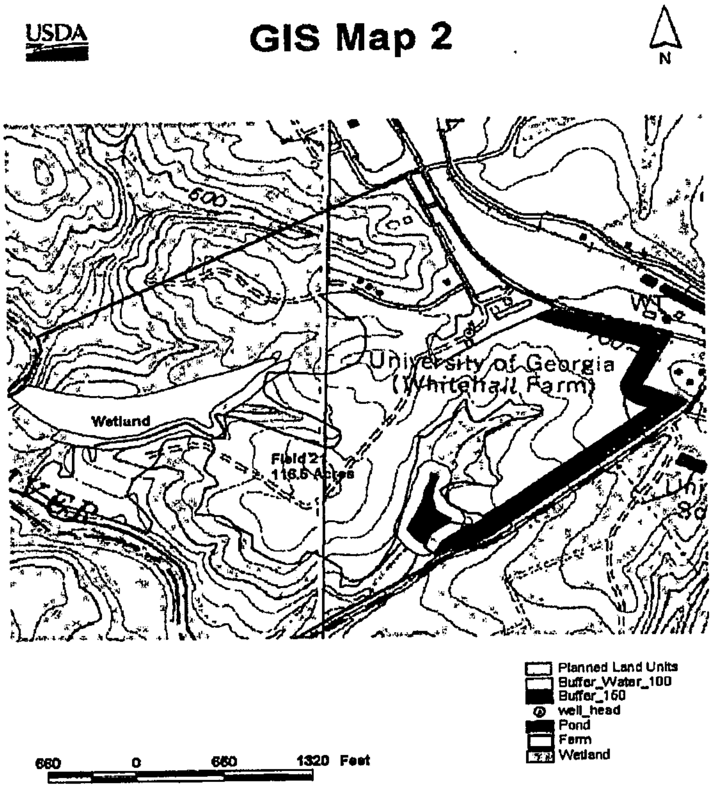


Figure 6. Electronic topographic map.

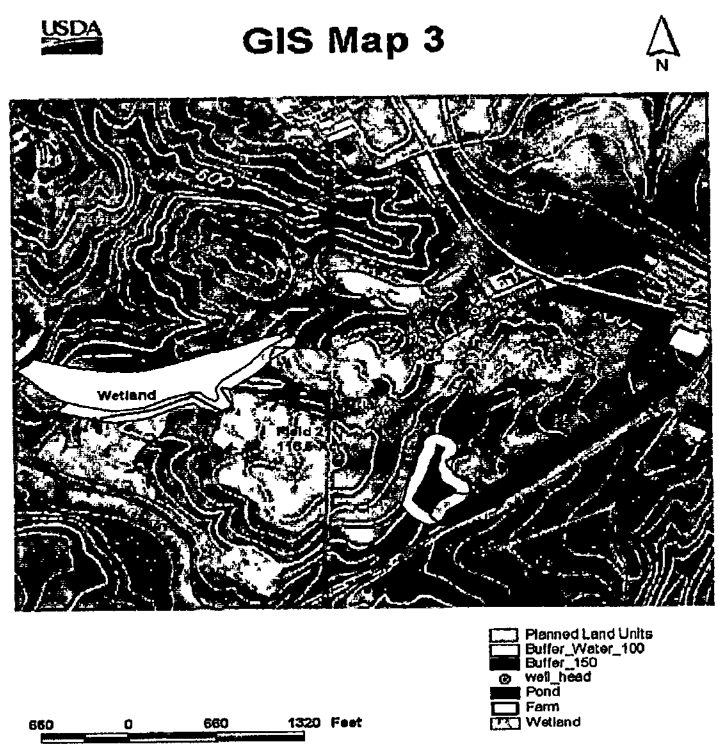


Figure 7. Electronic base map with topographic features overlain.

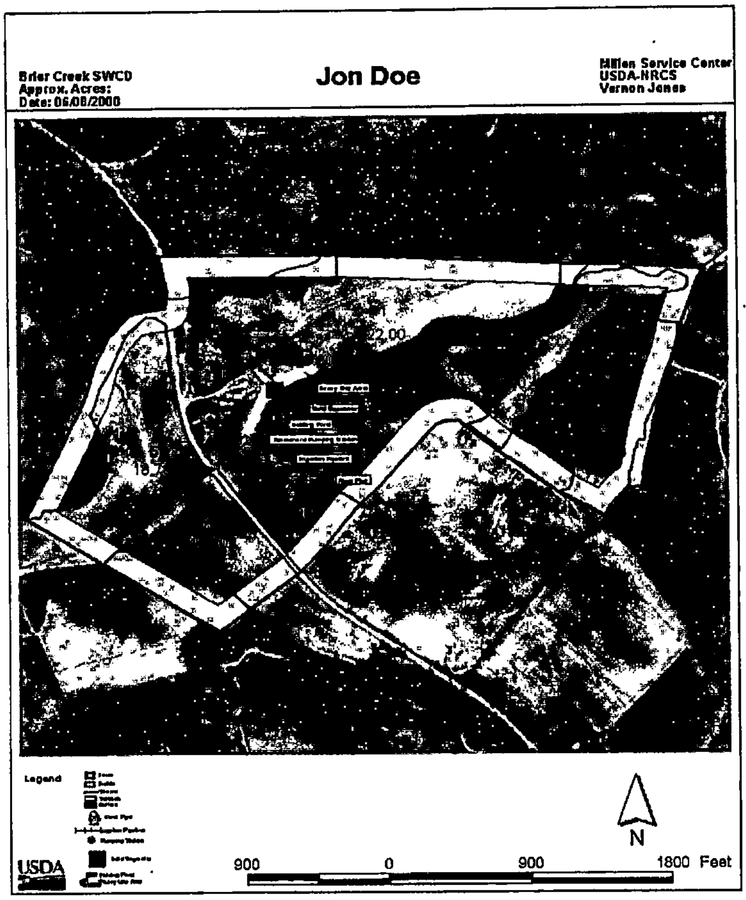


Figure 8. Example of CNMP map.

Figure 9. Example of CNMP map.

SOIL AND MANURE SAMPLING AND ANALYSIS

by
Paul Vendrell, Parshall Bush, and David Kissel

Acknowledgements: This training lesson was modified and adapted in part from the materials prepared for Lesson 34 from the Livestock and Poultry Environmental Stewardship Curriculum Project by Karl Shaffer[1] and Ron Sheffield[1] and other material prepared by Owen Plank[2] and Wayne Jordan[3].

OUTLINE

I. Introduction
II. Manure Testing
  A. Manure Sample Collection
    1. Liquid manure
      a. Lagoon effluent
      b. Liquid slurry
      c. Lagoon sludge
    2. Solid manure
      a. Stockpiled manure or litter
      b. Surface-scraped manure
      c. Composted manure
      d. In-house litter
  B. Test to Request
    1. Basic UGA manure test package
    2. Additional test on liquid manure for CNMP
  C. Manure Report
III. Soil Testing
  A. Soil Sample Collection
    1. When
    2. Where
    3. How
  B. Soil Test Parameters
  C. Soil Test Report

[1] Shafer, K. and R. Sheffield, 2000, Lesson 34, Land application records and sampling, USDA/EPA National Curriculum Project, http://www.mwpshq.org/curriculum_project/currproj.htm .

[2] Plank, C. O., 2000, Soil testing, Leaflet 99,Cooperative Extension Service Publication, University of Georgia, College of Agriculture and Environmental Sciences, http://www.ces.uga.edu/pubcd/L99.htm .

[3] Jordon, C. W., 2000, Soil and manure sampling and analysis, Unpublished information, Agricultural and Environmental Services Laboratories, University of Georgia, Cooperative Extension Service, College of Agriculture and Environmental Sciences.

MANURE TESTING

Manures can be quite variable in nutrient content. This variability may be due to different animal species, feed composition, bedding material, storage and handling as well as other factors. Testing at or near the time of application tells you the fertilizer value to make decisions about rates to apply. Some livestock producers are faced with nutrient management regulations that require manure testing. Also, if buying or selling litter/manure for fertilizer use, testing will help both buyer and seller establish the fertilizer value.

Manure Sample Collection

According to the Georgia Environmental Protection Division (EPD) "Swine Feeding Operation Permit Requirements", lagoon effluent is to be sampled semiannually. Preferably, the sample should be taken as near the application time as possible prior to the manure 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 the need for additional nutrients to complete crop production.

Manures should be sampled and tested near the time of application because the nutrient content can change considerably over time, particularly if stockpiled and unprotected from the weather. Nitrogen (N) is the nutrient that is the most likely to be affected. The frequency for testing your manure will depend upon several factors, but, as noted above, lagoon effluent needs to be tested at least semiannually. The type of manure and overall management system will also be factors. Animal producers using lagoon manure storage systems should sample every time that the liquid or slurry will be pumped and applied to the land. Proper sampling is the key to reliable manure analysis. Although laboratory procedures are accurate, they have little value if the sample fails to represent the manure product. Manure samples submitted to a laboratory should represent the average composition of the material that will be applied to the field. Reliable samples typically consist of material collected from a number of locations. Precise sampling methods vary according to the type of manure. The laboratory, County Extension Agent, or crop consultant should have specific instructions on sampling.

pipe into the pit with ball plug open, pull up the ball plug (or press your thumb over the end to form an air lock), and remove the pipe from the manure, releasing the air lock to deposit the manure into the plastic container.

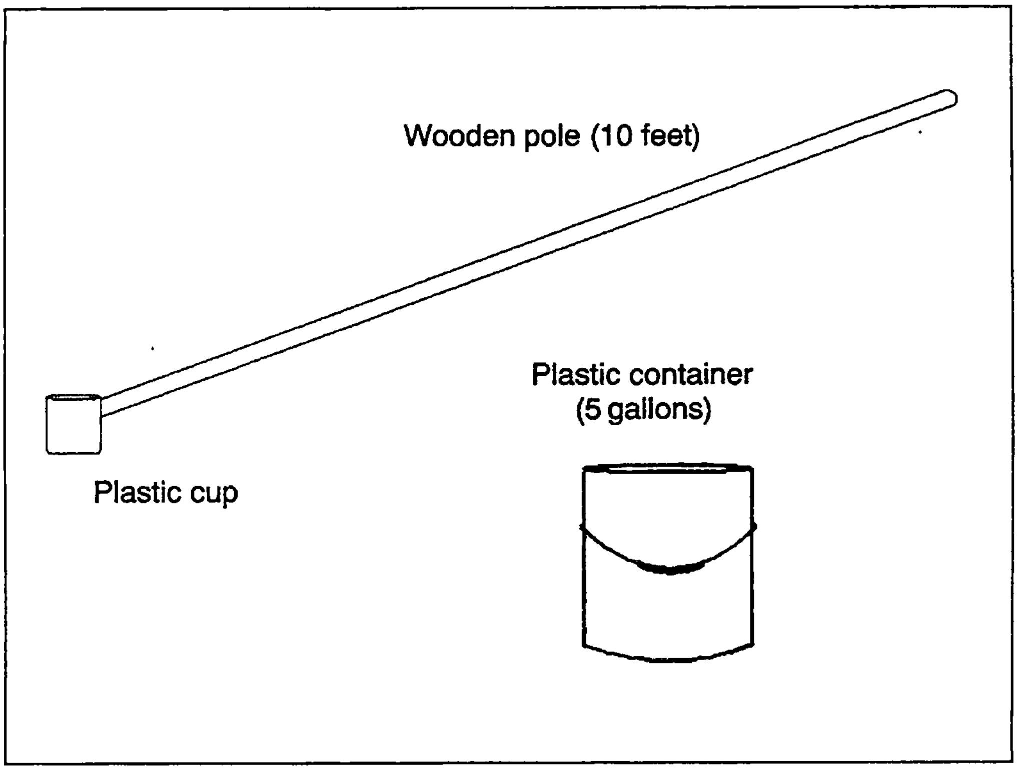


Figure 1. Liquid manure sampling device

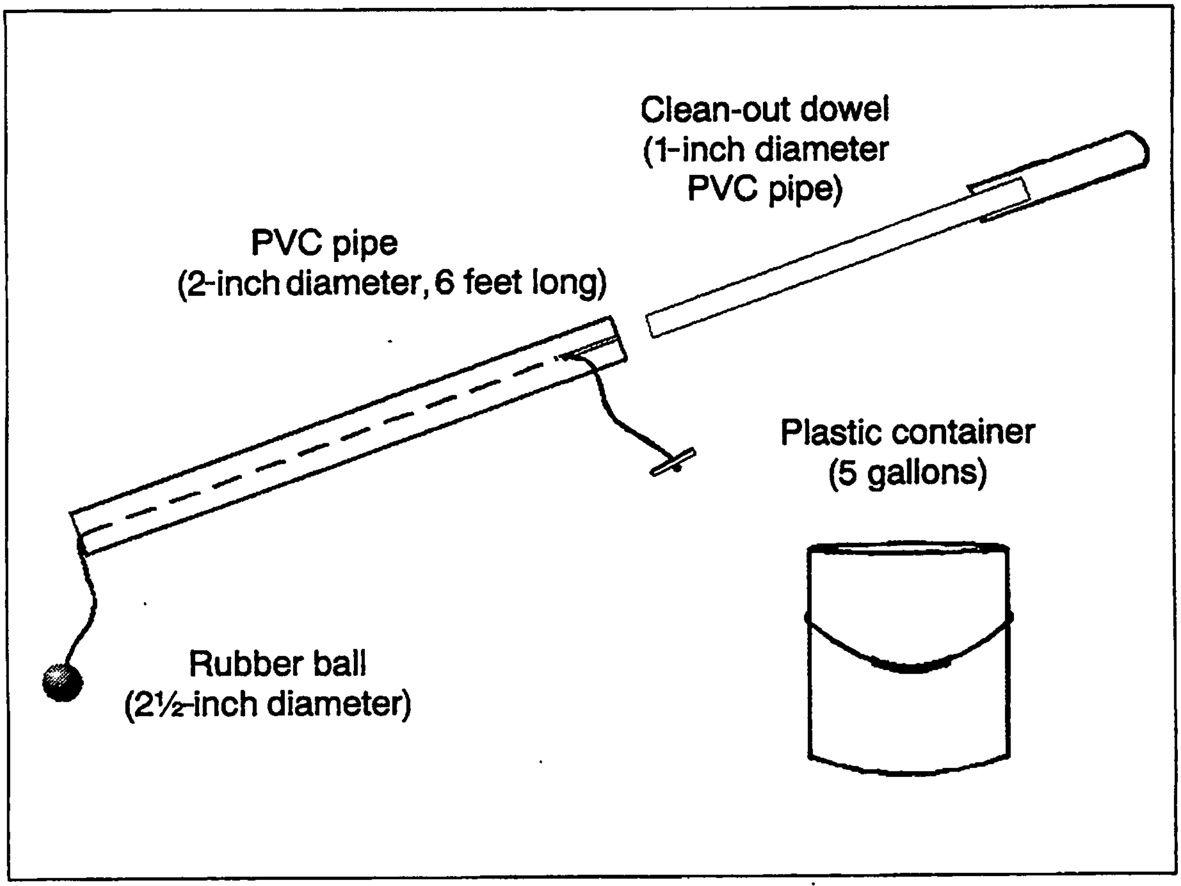


Figure 3. Composite sampling device

Lagoon sludge: Representative samples of lagoon sludge are more difficult to obtain than samples with lower solid contents. Two common methods are used. One method requires lagoon pump-down to the sludge layers. Then, during sludge agitation, a liquid or slurry type of sample described above may be collected. The other method requires insertion of a probe into the lagoon to the bottom to obtain a column of material. A "sludge-judge" is a device commonly used for this type of sampling. The sludge component of this column is then released into a clean plastic bucket, and several (12-20) other sampling points around the lagoon are likewise collected to obtain a composite, representative sample. This procedure must be performed with a boat or mobile floating dock.

For analysis, most laboratories require at least 1 pint of material in a plastic container. The sample should not be rinsed into the container because doing so dilutes the mixture and distorts nutrient evaluations. However, if water is typically added to the manure prior to land application, a proportionate quantity of water should be added to the sample.

Stockpiled manure or litter: Ideally, stockpiled manure and litter should be stored under cover on an impervious surface. The weathered exterior of uncovered waste may not accurately represent the majority of the material. Rainfall generally moves water-soluble nutrients down into the pile. If an unprotected stockpile is used over an extended period, it should be sampled before each application.

Stockpiled manure should be sampled at a depth of at least 18 inches at six or more locations. The collected material should be combined in a plastic container and mixed thoroughly. The one-quart laboratory sample should be taken from this mixture, placed in a plastic bag, sealed, and shipped to the laboratory for analysis. If the sample cannot be shipped within one day of sampling, it should be refrigerated.

Surface-scraped manure: Surface-scraped and piled materials should be treated like stockpiled manure. Follow the same procedures for taking samples. Ideally, surface-scraped materials should be protected from the weather unless they are used immediately.

Composted manure: Ideally, composted manure should be stored under cover on an impervious surface. Although nutrients are somewhat stabilized in these materials, some nutrients can leach out during rains. When compost is left unprotected, samples should be submitted to the laboratory each time the material is applied. Sampling procedures are the same as those described for stockpiled waste.

In-house Litter: Litter in the poultry house can vary considerably depending on location within the house. Litter around watering systems, feeders, and brooders should be sampled proportionate to the entire house floor. Special attention should be given to sampling in-house litter by making every effort to representatively sample the entire volume of litter that will be cleaned out and land applied. Collect at least 10 to 12 one-pint samples throughout the house and combine these samples into a plastic bucket. Take care to sample the entire depth of litter without including soil from the house floor. After thoroughly mixing the individual samples in the bucket, place approximately one quart of this mixture into a plastic bag or plastic wide-mouth jar.

Manure Tests to Request

The County Extension Office has sample submission forms and information on tests that are most often needed and can assist with shipping samples to the University of Georgia (UGA)

The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

SOIL, PLANT, AND WATER LABORATORY
2400 College Station Road

ANIMAL WASTE
SUBMISSION FORM FOR LAND APPLICATION

Please Note - Retain a copy of this form for your files. Submit one copy per sample.

Name: ______________________ **Sample #:** ______________
Mailing address: ______________________ **County:** ______________
City,State,Zip: ______________________
Phone #: ______________________ **Date Received:** ______________

Check kind and Condition

	Kind	Condition
LITTER	A Broiler ___	E Fresh/Stackhouse ___
	B Layer ___	F Deep Stacked ___
	C Breeder ___	G Composted ___
	D Pullet ___	D Other ___
MANURE	I Dairy ___	
	J Swine ___	N Slurry ___
	K Beef ___	O Solid ___
	L Horse ___	P Composted ___
	M Other ___	
LAGOON	Q Swine ___	S Layer ___
	R Dairy ___	T Other ___

Application Method:
(Check One)

Broadcast Surface ___

Broadcast Incorporated ___

Soil Injected ___

Irrigation applied ___

Other ___

TEST REQUESTED (Check all that apply and consult schedule for fees):

Total Minerals: ___ (Includes: total Kjeldahl nitrogen (excluding nitrate nitrogen),phosphorus,potassium, calcium,magnesium,sulfur,manganese,iron,aluminum,boron,copper,zinc,sodium)

Total Kjeldahl Nitrogen only ___ (excluding nitrate nitrogen)

Nitrate Nitrogen ___ (important for lagoons)

Ammonium Nitrogen ___ Moisture or Solids ___ Other ___

****

FOR LAB USE ONLY

Date Received: ___________ **Date Returned:** ___________
Payment Received: ___________ **Invoice #:** ___________

NH_4-N ___ **Moisture** ___ NO_3-N ___ **Total Nitrogen:** ___ **Other** ___

Figure 5. The UGA "Animal Waste Submission Form for Land Application"

Manure Report

The UGA Ag and Environmental Services Laboratories reports results for solid manures in both percentages and pounds of nutrients per ton on an "as received" basis since this is how you will be applying the material. Liquid sample results are reported as parts per million (ppm) and converted into both pounds per 1,000 gallons and pounds per acre inch of application for your convenience in determining rates (Figure 7). The phosphorus and potassium are reported in the fertilizer basis as P_2O_5 and K_2O respectively. Other laboratories may report their results differently. If a lab reports phosphorus and potassium as elemental P or K, you must convert them into the fertilizer basis of P_2O_5 or K_2O. This can be done with the following conversions:

P multiplied by 2.29 = P_2O_5

K multiplied by1.20 = K_2O

The amount of the total nutrients in manure that will be available to plants varies depending on the type of manure and whether it will be applied to the surface of the soil, incorporated or injected. County Extension Agents and other qualified professionals can assist with the calculation of manure nutrient availability based on when and how you will make application. This information, combined with the soil test report and other information, is necessary to develop a CNMP.

SOIL TESTING

Presently, manure application rates are based on nitrogen requirement of a crop or forage and according to a CNMP, sufficient animal waste can be applied to satisfy that need. In the southern United States, soil test nitrogen does not accurately predict the response of crops and forages to residual soil nitrogen; consequently, soil nitrogen is not measured. In Georgia, nitrogen fertilizer recommendations are based on long-term experiments conducted to determine the rates of N fertilizers needed for specific crops. In a CNMP, the rate of animal waste applied is based on nitrogen requirements. Therefore, why do soil testing if nitrogen is the regulating nutrient? Crop yield and nitrogen uptake will increase when other nutrient deficiencies are corrected, such as low pH, other macronutrients, or micronutrients. Nitrogen fertilizer recommendations are made on the assumption that all other nutrients are at optimum levels and soil testing is the way to detect nutrient deficiencies other that nitrogen. Another reason for soil testing is that repeated manure applications can lead to over applications of nutrients, especially phosphorus (P). Soil testing can track the build-up of P and assist with management decisions to utilize this high phosphorus animal waste on soils with lower soil test P.

Soil Sample Collection

When: Soils should be tested annually. Fall is a good time to take samples, but samples can be taken at any time of the year. To make good comparisons from year to year it is important to sample at approximately the same time each year.

Where: There can be considerable variation in nutrient and pH levels within a field. For most accurate results the sample must be representative of the field or area from which it is collected. Areas within a field that have obviously different soil type, drainage, crop growth, or slope characteristics should be sampled separately. Figure 8 illustrates the recommended zigzag pattern for soil core collection and the logic behind collecting separate samples due to changing field conditions. Figure 9 illustrates an example of taking separate soil samples based on topography and differing management practices. Avoid areas where fertilizer or lime has been spilled or stockpiled as well as areas around old house or barn locations.

How: The depth of sampling depends on management practices. From plowed fields take the sample to 6 inches or to plow depth. No-till fields or pastures should be sampled to 4-inches depth (Figure 10). From each area to be sampled take 10 to 20 cores at random, place in clean, plastic container and thoroughly mix. Remove about a pint of the composite soil for submission to the laboratory. Be sure to clearly mark each sample so that you know which field and area of field it represents.

For submission to the UGA Agricultural and Environmental Services Laboratories, contact the local County Extension Agent for more information on soil sampling, submission forms, and sample bags. Private laboratories can also provide information on these topics and the services offered.

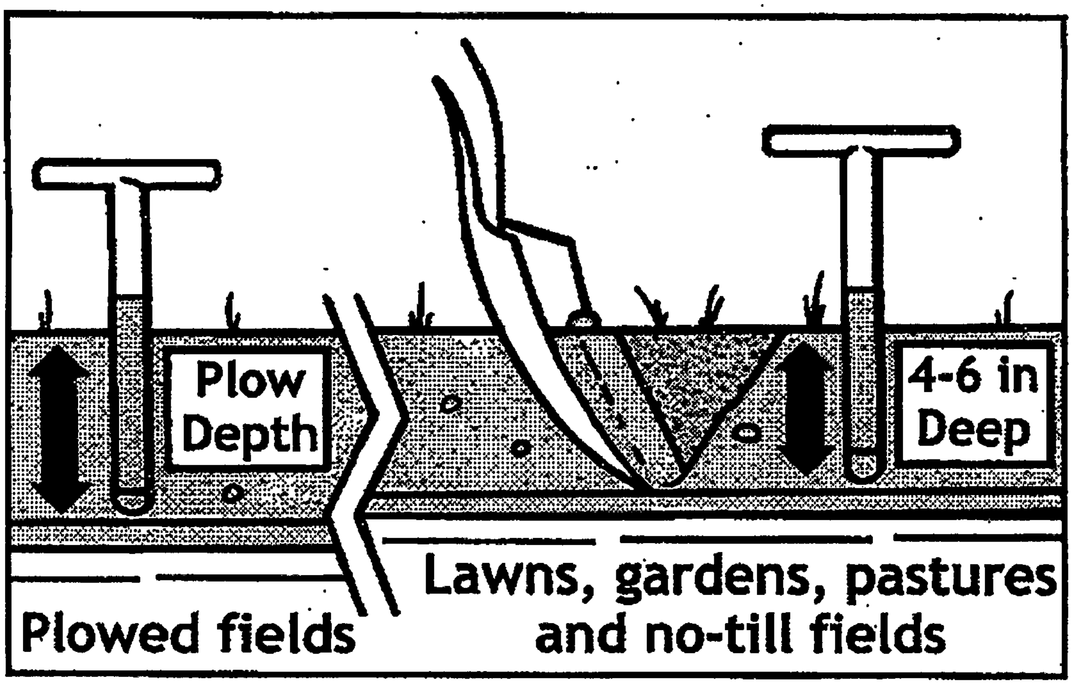


Figure 10. Soil sampling depths for plowed fields (6 inches or plow depth) and no-till or pastures (4 inches)

Soil Test Parameters

The routine soil test conducted by the UGA Ag and Environmental Services Laboratories include:

- phosphorus (P),

the fertilizer source it is essential to also know the nutrient content of the manure so appropriate rates can be applied.

The University of Georgia
College of Agricultural and Environmental Sciences
Cooperative Extension Service

1785

Soil Test Report

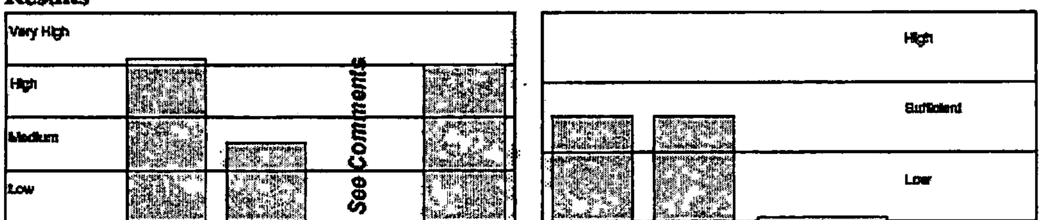
Soil, Plant and Water Laboratory

(CEC/CEA Signature)

Sample ID

Grower Information	*Lab Information*	*County Information*
Client: **John Doe** 123 McIntosh Street Athens, GA 30605 Sample: 1 Crop: Peanuts	Lab #JD Completed: 06/09/2000 Printed: 06/12/2000	**Clarke County** 2152 W. Broad Street Athens, GA 30606

Results



	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Zinc (Zn)	Manganese (Mn)	Soil pH	
Soil Test Index	42 lbs/Acre	76 lbs/Acre	723 lbs/Acre	229 lbs/Acre	3 lbs/Acre	33 lbs/Acre	5.3 (7.20 Lime Index)	Soil Test Index

Recommendations

Limestone	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulfur (S)	Boron (B)	Manganese (Mn)	Zinc (Zn)
2.5 tons/Acre	0 lbs/Acre	0 lbs/Acre	50 lbs/Acre	0 lbs/Acre	0.5 lbs/Acre	0 lbs/Acre	0 lbs/Acre

Apply inoculum when field has not been planted in peanuts for more than 5 years.

Calcium should be applied to all peanuts saved for seed purposes and to all large-seeded Virginia type varieties regardless of soil test levels. The broadcast rates for Runner or Spanish type saved for seed are 160 to 200 pounds calcium per acre as gypsum and for large-seeded Virginia type 320 to 400 pounds calcium per acre as gypsum. When banding over the row reduce the broadcast rates proportionately.

For Runner and Spanish types for market production, lime that is recommended and applied after deep turning and incorporated no more than 3-inches prior to planting should supply adequate calcium. When lime is not applied or when large amounts of rainfall occur between application of lime and planting, a soil sample should be taken 10 - 14 days after planting to determine calcium level in the pegging zone. Take pegging zone samples 3-inches deep and request the special calcium test to determine if gypsum should be applied.

When applying boron it may be applied with the fertilizer, preplant incorporated herbicides, or split in two early fungicide applications (prior to early bloom).

If plant residues are removed from the field, soil test prior to planting the next crop.

NOTE: The amount of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) actually applied may deviate 10 pounds per acre from that recommended without appreciably affecting yields.

PUTTING KNOWLEDGE TO WORK

Figure 12. The UGA soil test report and fertilizer recommendations for peanuts

Assessment of the Nutrient Supply on Livestock and Poultry Farms

G. Larry Newton, Animal & Dairy Science Department

Introduction

A manure utilization plan is a plan that addresses manure production and how manure nutrients are utilized on the farm . Typically, the manure is used as a nutrient and organic matter source in a cropping system. However, there are other possible end uses of manure. The plan must describe all manure nutrients and the ultimate end use of all manure (crops, local landowners, composted and bagged, re-feeding blends, incineration, etc.). Manure nutrients must be tracked because livestock and poultry use only a small portion of the nutrients fed to them to produce meat, milk, and eggs. The remaining nutrients are excreted in the urine and feces. Depending on the species of livestock, about 70% to 80% of the nitrogen (N), 60% to 85% of the phosphorus (P), and 80% to 90% of the potassium (K) is returned in the manure.

Manure utilization planning is a two-part process. The first component can be termed *strategic planning*, because it focuses on average manure generation volumes, manure storage times, and average manure nutrient contents to develop a general cropping plan and to estimate the number of acres needed to properly land apply the manure. The second component can be referred to as the *annual plan*. The annual plan refers to the actual implementation of the strategic plan. It covers such things as how many acres of which crops will be grown during the year, the planned times for manure applications, results from periodic soil tests and manure analyses, and records of manure applications and crop yields. Once manure begins to be produced on the farm, the manure utilization plan must be implemented. A manure utilization plan requires careful attention to make it work properly. The farm owner or manager will need to understand how to use the information in the plan, along with monitoring information and equipment calibration to make the plan work. Accurate crediting of manure nutrients within a total crop nutrient program is fundamental to utilizing manure as a resource.

Components of a Manure Utilization Plan

Manure utilization plans can vary a great deal in the components and the way in which they are organized. However written, all plans should address the following basic components:

1) Manure generation and other sources of nutrients (can be referred to as Sources)
2) Manure nutrient availability (can also include Placement and Timing)
3) Crop selection and crop nutrient requirements (can be referred to as Amounts or Needs)
4) Best management practices (BMPs)
5) Summary of laws, rules, and regulations that must be followed.

While the first three components must be considered together to ensure that the manure nutrients generated on the farm are applied in harmony with crop needs and soil characteristics, this lesson will concentrate on the first component, nutrient sources and quantities.

Manure utilization plans may be written for one primary nutrient (often nitrogen) or several plant nutrients. Generally, two major plant nutrients (nitrogen and phosphorus) are the ones targeted in manure utilization plans because they are required in relatively large quantities for plant growth, and if mismanaged are likely to have the most adverse affect on the environment. Other nutrients, system is used. When lagoons are used, much of the P may accumulate in sludge on the bottom, where it is usually not available for the annual cropping plan. In those cases, the difference between the estimated P excretion and the amount of P calculated from manure volumes and concentrations pumped from a lagoon is likely to be present in the sludge, and it will have to be managed when the lagoon is emptied.

Other nutrient sources
When developing manure utilization plans, all sources of nutrients on the farm need to be considered. Sources of nutrients include nutrients already in the soil, commercial fertilizers, crop residues, and other manure or by-product applications. To account for these nutrients, manure and soil analysis should be used. Examples of other sources would include legumes and crop residues which can leave plant-available nitrogen (PAN, discussed in another lesson) for the following crop. Manure and soil sampling and analysis will be covered in other lessons. When planning manure applications, the producer should account for all nutrient sources when determining manure application rates to fields.

What Are the Amounts of Manure Nutrients Produced on a Farm.

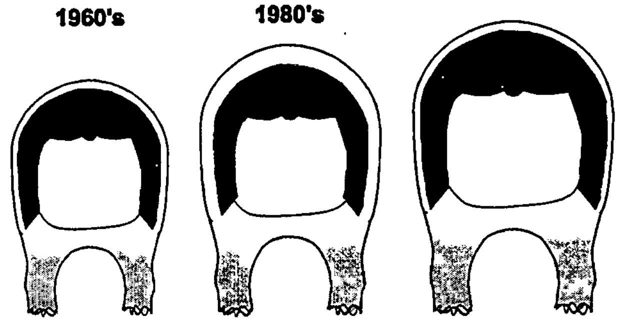
The nutrient value of manure can vary from farm to farm and from time to time on the same farm. Factors that affect the nutrient levels include:

The lean growth potential or other production characteristics of the animals.
The animal diets fed (ration composition).
The amounts of feed wastage.
Time of year (season, temperatures).
The handling and treatment of the manure between animal excretion and land application.
Length of time manure is in a storage structure and/or the level of sludge buildup.
The timing of land application and the method used.

On a per unit of body weight basis, animals with greater lean gain, or other product production potential will require greater protein intakes and will excrete larger amounts of N than less productive animals. However, on a per pound of lean growth (or unit of other product), their excretion of N may be no more, and usually less, than that of animals with lower potential. Manure nutrient excretion can be minimized by feeding animals according to their needs at any given time. In addition to balancing diets with needs, the availability or digestibility of the feed nutrients will affect excretion. These concepts will be covered in more detail in another lesson.

Feed wastage can be a significant contribution to waste nutrients in some cases. For example, if properly adjusted, most modern swine feeders are capable of limiting feed wastage to 5% or less (and others, especially some wet/dry feeders, to 1%), while some older feeders allowed feed wastage as high as 20%, which can be especially important in slotted floor housing. A 20% feed wastage can result in an increase of 30% or more in the manure N and P. Pelleting or crumbling feed also generally reduces feed wastage and reduces separation of nutrients during handling, contributing to improved animal feed efficiency. Season differences in manure nutrient excretion are related to the increased feed intake, decreased water intake associated with cold conditions and the decreased feed intake, increased water intake associated with hot environments. These fluctuations can be minimized by formulating diets to counteract part of these effects. Manure nutrient losses related

Figure 1. Some Changes in Pigs Over the Past 30 Years



	Mid to Late 1960's	Mid to Late 1980's	Late 1990's
Market Wt (lb)	210	225	255
<u>lb/lb body wt/yr</u>			
N Excretion	0.164	0.153	?
P Excretion	0.125	0.134	?

to 1960's levels, or lower. Since it is difficult and cumbersome to have tables which list estimated excretion factors for a large number of animal and feeding alternatives and provide space for calculations, a computer aided excretion estimator has been developed which should provide improved nutrient excretion estimates compared to those derived from Table 1. This program will be available at training sessions, and after testing and further review, at County Extension Offices and on the Web. In addition, a number of other manure nutrient calculating programs and models are available. A good place to start looking for other manure software is the UGA AWARE web page (www.bae.uga/outreach/aware/). Other animal and farm management models are also available which calculate estimated nutrient excretion, and some ration balancing programs are also useful when using the nutrient balance method of estimating nutrient excretion.

Calculating Manure Nutrient Excretion using Nutrient Balance Estimates.

Tables 2a, b, and c illustrate the procedures for calculating manure nutrient excretion estimates using nutrient balance procedures. It has been shown that calculating manure nutrients by subtracting the nutrient content of the animals or animal products moved off the farm from the feed nutrients fed to the animals generally provides a more accurate estimate of nutrient excretion than does the use of standard excretion estimates. Table 2a list the factors which are used to convert feed protein, phosphorus, and potassium to amounts of N, P_2O_5, and K_2O and the average composition values of whole animals and products necessary to convert animal live weights and products to amounts of N, P_2O_5, and K_2O.

Table 2b contains an example calculation for a swine finishing farm marketing 6,000 pigs per year. In that example it was assumed that the feeds were purchased and that only two diets were fed, in order to make the example shorter and simpler. Any number of diets could be included, or if diets are mixed on-farm, it is usually simpler to calculate from ingredients. In that case, the total quantity of corn, soybean meal, other protein supplements (milk by-products in nursery diets, amino acids, etc.), and phosphorus supplements would be entered on a separate line for each. Purchased animals moving onto the farm would complete the nutrient inputs. Nutrient outputs from the swine operation calculator mentioned above includes calculations for nutrient losses during treatment and storage, but does not include separating lagoon P between sludge and effluent, since it will likely vary from farm to farm, depending upon effluent removal practices. If lagoons are not agitated and only effluent is removed, P_2O_5 calculations from the computer calculation should be factored as in Table 5. In addition, the computer estimate will provide a ranges for N losses. If the treatment and storage time are relatively short (90 days or less) the N values will likely be near the larger amount, whereas if manure is applied only once per year, the N value will likely be nearer the lower value.

Calculating Manure Nutrients from Measured Quantities and Sample Analyses.

If amounts of manure handled on the farm each year are known, plus there are manure nutrient analyses, calculation of manure nutrients available for use as fertilizer can be calculated in a straight forward manner. For farms that handle slurry and dry manures, the manure quantity may be estimated from the number of loads handled during a typical clean-out operation along with the number of clean-outs per year. For operations that use a liquid manure management option such as flush floors and lagoons, the volume of manure generated is more difficult to determine. Liquid system manure generation can be estimated if good records on irrigation applications (from a meter, pump capacity X run times, or rain gauges in the field) are maintained. These quantities will need to be multiplied by concentration values obtained from samples submitted to a laboratory, in order to obtain total yearly nutrient estimates. Manure sampling procedures are covered in another lesson. In some cases there may be a need or desire to estimate micronutrient (such as copper or zinc) production and land application. Manure sampling and analysis is a logical way of obtaining those values. Table 6a and b are provided for making manure nutrient calculations from measured quantities and nutrient concentrations. If the concentration of nutrients in manure from the animals varies with the time of year, an average composition should be used or calculate an amount for each clean out by season of the year and add them for a yearly total, or develop seasonal land application plans. Table 6a contains an example to illustrate how the calculations are made and Table 6b is a blank table for additional calculations.

If there is a good handle on manure generation and manure composition, this is likely the most accurate estimate of manure nutrients available for use as crop fertilizer. This estimate will include animal effects, diet effects, feed wastage effects, and, most importantly, treatment and storage losses. It should be a goal of the plan to arrive at this point, in order to more accurately manage nutrients on the farm. However, if the farm uses lagoons, one of the first two methods should also be used in order to estimate the quantity of P_2O_5 accumulating in lagoon sludge, that will have to be managed at some point in time.

Results from either method of manure nutrient estimation may be used for planning purposes (strategic plan). As records of manure quantities are developed and manure samples are submitted to a laboratory to determine the actual nutrient content, the plan will be updated and modified to reflect these more accurate estimates. *Where manure analyses and quantities are available, they should be used to develop the initial manure utilization plans and application rates.*

Other Nutrient Sources

Note that Table 6 includes a line (6) used to enter other on-farm nutrient sources. This could be mortality compost (an amount and nutrient analysis will be needed) or possibly nitrogen fixed by

Table 1. Total manure nutrients produced by livestock. Nitrogen, P_2O_5, and K_2O production can be calculated by entering a livestock operation's information into Columns 2 and 3 for the appropriate animal species and class and multiplying by the relevant factors.

1. Livestock or Poultry Species	2. Number of animals (average capacity)	3. Average Weight, lbs.	4. Total Animal Weight (Col 2 X Col 3)	5. Lbs. of N/ lb. of animal weight per year	6. Lbs. N/ yr. (Col 4XCol 5)	7. Lbs. of P_2O_5 /lbs. of animal weight per year	8. Lbs. P_2O_5 /yr. (Col 4X Col7)	9. Lbs. of K_2O/lbs. of animal weight per year	10. Lbs. K_2O/ yr. (Col 4XCol 9)
Example: Swine... Finish	*2,000*	*150*	*300, 000*	*0.15*	*45,000*	*0.13*	*39,000*	*0.10*	*30,000*
Swine: Nursery				0.22		0.21		0.15	
Grow				0.15		0.13		0.10	
Finish				0.15		0.13		0.10	
Sows & Litter				0.17		0.12		0.13	
Sows (Gestation)				0.07		0.05		0.05	
Gilts				0.088		0. 066		0.058	
Boars				0.055		0. 042		0.044	
Beef (450- 750 lbs)				0.11		0.083		0. 088	
Beef feeder (high- energy diet)				0.11		0.078		0. 092	
Beef feeder (high- forage diet)				0.11		0.091		0. 11	
Beef Cow				0.12		0.10		0.11	
Dairy Cow... 50 lbs/ d milk				0.18		0.087		0. 100	
Dairy Cow... 70 lbs/ d milk				0.22		0.096		0. 110	
Dairy Cow... 100 lbs/ d milk				0.27		0.110		0. 130	
Dairy Dry Cow				0.11		0.074		0. 079	
Dairy Heifers/ Calves				0.11		0.033		0. 11	
Layer				0.30		0.26		0.15	
Pullet				0.23		0.20		0.11	
Broiler				0.40		0.28		0.20	
Turkey				0.27		0.23		0.12	
Total: If more than one manure storage or treatment system is used for different groups of animals, it is best to separate the groupings of animals and their nutrient excretion totals for each manure system.			System 1:						
			System 2:						

Source: NRCS Agricultural Waste Management Handbook, 4/ 92 with exception of lactating and dry dairy cows. Dairy estimates are from H. H. Van Horn 1991, Achieving environmental balance of nutrient flow through animal production systems. *The Professional Animal Scientist* . 7(3): 22- 33.

Table 2a. Calculating Nutrient Excretion Using Input-Output Balance: Nutrient factors.

Feed and Animal Factors for determining N, P_2O_5, K_2O Content of Inputs and Outputs of an Animal Enterprise.

Material	Multiplication Factor for:		
	N	P_2O_5	K_2O
Feeds, Grains, Protein Supplements, Minerals	Multiply % Protein by 0.0016	Multiply % Phosphorus by 0.0229	Multiply % Potassium by 0.012
Pigs less than 100 lbs.	Use 0.025	Use 0.0128	Use 0.003
Swine from 100 to 300 lbs.	Use 0.024	Use 0.0108	Use 0.0029
Swine over 300 lbs.	Use 0.023	Use 0.0108	Use 0.0028
Dairy Cattle	Use 0.012	Use 0.016	Use 0.0024
Milk	Multiply % Protein by 0.0015	Use 0.0023	Use 0.0018
Beef Cattle, 400 lbs.	Use 0.029	Use 0.0071	Use 0.0023
Beef Cattle, 600 lbs.	Use 0.024	Use 0.0058	Use 0.0023
Beef Cattle, 800 lbs.	Use 0.02	Use 0.0051	Use 0.0023
Beef Cattle, 1000 lbs.	Use 0.015	Use 0.0038	Use 0.0023
Broiler Chickens	Use 0.029	Use 0.0046	?
Layer Hens	Use 0.026	Use 0 .0141	?
Chicken Eggs	Use 0.019	Use 0.0048	Use 0.0021
Turkey	Use 0.028	?	?

Table 2b. Calculating Nutrient Excretion Using Input-Output. Example Calculations for a 2000 Head Swine Finisher Farm Using Purchased Feed.

Inputs - Outputs / **Inputs**	1. Quantity	2. Percent Protein	3. X 0.0016 (Feed N factor)	4. N Quantity (Col 1 X Col 3)	5. Percent Phosphorus	6. X 0.0229 (Feed P_2O_5 factor)	7. P_2O_5 Quantity (Col 1 X Col 6)	8. Percent Potassium	9. X 0.012 (Feed K_2O factor)	10. K_2O Quantity (Col 1 X Col 9)
Example: Grower Feed	*537 tons*	*16.78*	*0.02685*	*14.417 tons*	*0.66*	*0.01511*	*8.116 tons*	*0.72*	*0.00864*	*4.639 tons*
Example: Finisher Feed	*1,035 tons*	*14.20*	*0.02272*	*23.515 tons*	*0.55*	*0.0126*	*13.036 tons*	*0.60*	*0.0072*	*7.452 tons*
Example: Total Feed Inputs	*1,572 tons*			*37.932 tons*			*21.152 tons*			*12.091 tons*
Example: 6,060 pigs @ 50 lbs	*151.5 tons*		0.025	*3.787 tons*		.0128	*1.939 tons*		0.003	*0.455 tons*
Example: Total Inputs				*41.719 tons*			*23.091 tons*			*12.546 tons*
Outputs										
Example: 6.000 pigs @ 255 lb	*765 tons*		0.024	*18.360 tons*		0.0108	*8.262 tons*		0.0029	*2.219 tons*
Balance										
Example: Nutrient Excretion				*23.359 tons*			*14.829 tons*			*10.327 tons*

Table 2c. Calculating Nutrient Excretion Using Input-Output. Table for doing Your Calculations, Following Example Above.

Inputs - Outputs	1. Quantity	2. Percent Protein	3. X 0.0016 (Feed N factor)	4. N Quantity (Col 1 X Col 3)	5. Percent Phosphorus	6. X 0.0229 (Feed P_2O_5 factor)	7. P_2O_5 Quantity (Col 1 X Col 6)	8. Percent Potassium	9. X 0.012 (Feed K_2O factor)	10. K_2O Quantity (Col 1 X Col 9)
Inputs										
Outputs										
Balance										

Table 3a. Typical Amount And Nutrient Composition For Poultry Manures Handled As Solids[a].

Manure Type	Pounds of Manure per Bird Produced or Maintained per Year	Nutrient		
		Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
		Pounds / Ton of Litter or Manure		
Broilers (litter)	2.5	66	50	40
Breeders (litter)	44.0	31	40	35
Pullets (litter)	8.0	(68)	(53)	(41)
Layers (highrise)	40.0	38	56	30
Stockpiled Litter		36	55	35

[a]Adapted from L. Vest, B. Merka, and W.L. Segars, 1998.

Table 3b. Calculating Manure Quantities For Poultry Farms Using Dry Manure Handling.

Type of Bird	1. Number of birds housed	2. Turns per year	3.[a] Total birds per year	4. Manure per bird, lbs	5. Total manure per year, lbs.	6. Tons of manure / year
Examples			*(Col 1 X Col 2)*	*(from Table 3a)*	*(Col 3 X Col 4)*	*(Col 5 / 2,000)*
Broilers	*40,000*	*6*	*240,000*	*2.5*	*600,000*	*300*
Layers	*70,000*	*1*	*70,000*	*40*	*2,800,000*	*1,400*
Additional Lines For Your Use:						

[a]You may also start in this column.

Table 3c. Calculating Nutrient Quantities For Dry Poultry Manure Systems.

Bird or Manure Type	1. Tons of manure / year	2. Pounds N / ton	3. Total pounds N	4. Pounds P_2O_5 / ton	5. Total pounds P_2O_5	6. Pounds K_2O / ton	7. Total pounds K_2O
Example:	*(Table 3b)*	*(Table 3a)*	*(Col 1 X Col 2)*	*(Table 3a)*	*(Col 1 X Col 4)*	*(Table 3a)*	*(Col 1 X Col 6)*
Broilers	*300*	*66*	*19,800*	*50*	*15,000*	*40*	*12,000*
Layers	*1,400*	*38*	*53,200*	*56*	*78,400*	*30*	*42,000*
Additional Lines For Your Use:							

Table 4. Nutrients available (annually) after losses from open lot, storage, or lagoon [1]. Locate your storage/treatment system in column 1, then enter the total manure nutrients produced (from Table 1 or 2) in Columns 2, 5, and 8 and multiply by the relevant factors listed for your manure management system..

	Nitrogen			P_2O_5			K_2O		
1. Manure Storage/ Treatment System	2. N Produced, Table 1 or 2	3. Multiplication Factor	4. Available N After Losses	5. P_2O_5 Produced, Table 1 or 2	6. Multiplication Factor	7. Available P_2O_5 After Losses	8. K_2O Produced, Table 1 or 2	9. Multiplication Factor	10. Available K_2O After Losses
Example: Storage (liquid swine manure, top loaded storage)	*45,000*	*X 0.70 =*	*31,500*	*39,000*	*X 1.0 =*	*= 39,000*	*30,000*	*X 1.0 =*	*= 30,000*
Open lot or feedlot		X 0.6 =			X 0.95 =			X 0.7 =	
Manure pack under roof		X 0.70 =			X 1.0 =			X 1.0 =	
Bedded pack for swine (e. g., hoop building)		X 0.50 =			X 1.0 =			X 1.0 =	
Bedded pack & compost for swine (e. g., hoop building)		X 0.35 =			X 1.0 =			X 1.0 =	
Solid/ semi- solid manure & bedding held in roofed storage		X 0.75 =			X 1.0 =			X 1.0 =	
Solid/ semi- solid manure & bedding held in unroofed storage		X 0.65 =			X 0.95 =			X 0.9 =	
Liquid/ slurry storage in covered storage		X 0.90 =			X 1.0 =			X 1.0 =	
Liquid/ slurry storage in uncovered storage		X 0.75 =			X 1.0 =			X 1.0 =	
Storage (pit beneath slatted floor)		X 0.85 =			X 1.0 =			X 1.0 =	
Poultry manure stored in pit beneath slatted floor		X 0.85 =			X 1.0 =			X 1.0 =	
Poultry manure on shavings or sawdust held in housing		X 0.70 =			X 1.0 =			X 1.0 =	
Compost		X 0.70 =			X 0.95 =			X 0.9 =	
One - cell anaerobic treatment lagoon		X 0.20 =			X 0.35 =			X 0.65 =	
Multi- cell anaerobic treatment lagoon		X 0.10 =			X 0.35 =			X 0.65 =	

1 Multiplication factor is portion of nutrients retained in the manure. Remaining N volatilizes into air as ammonia and remaining phosphate settles to lagoon bottom as solids or is lost as runoff in open lot. Actual losses for individual situations may vary substantially from listed values .

Table 5. Phosphorus retained as settled solids by an anaerobic treatment lagoon [1].

Enter quantity of total manure phosphorus estimated from Tables 1 or 2, interval (years) between when settled solids are removed, and complete the calculation.

Total Pounds P_2O_5 Produced Annually, from Tables 1 or 2	Single or Multiple Cell Treatment Lagoon		
	Years Between Solids Removal	Portion Retained in Lagoon	Total P_2O_5 in Settled Solids
Example: 39,000 lbs	*X 5*	*X 0.65 =*	*126,750 lbs.*
	X	X 0.65 =	
	X	X 0.65 =	

[1] This applies to an anaerobic treatment lagoon with a permanent liquid pool and no agitation at the time of effluent removal.

Table 6a. Example of Calculating Manure Nutrient Generation Using Measured Quantities and Analyses.
Example: You operate a swine-finishing operation with a 4,000-head capacity. Your manure-handling system is a slurry system, and the manure analysis shows 25.2 pounds of N, 23.7 pounds of P_2O_5, and 16.8 pounds of K_2O per 1,000 gallons of manure. Your application system is a honeywagon with incorporation. Manure generation is (4,000 head X 751 gal/animal =) 3,004,000 gal/year.

Use this worksheet when you know the volume of manure that is handled based on cleanout or pumping records.				
1	Manure generation, tons or thousands of gallons/year	*3,004 thousand gal.*		
		N	P_2O_5	K_2O
2	Manure analysis, lb/ton or lb/1,000 gallons	*25.2*	*23.7*	*16.8*
3	Manure nutrient availability coefficients*	*0.7*	*0.8*	*0.8*
4	Corrected manure analysis* (multiply above two rows, 2 X 3, for each column)	*17.64*	*18.96*	*13.44*
5	Total manure nutrients to handle (manure generation X corrected manure analysis)	*52,990 lbs.*	*56,956 lbs.*	*40,374 lbs.*
6	Total other nutrients on the farm (includes starter fertilizer, residual N credits, other waste sources, N from recent soil test. Note: These are on a field-by-field basis.)	*625 lbs.[a]*	*0*	*0*
7	Total nutrients to handle in cropping system	*53,615*	*56,956*	*40,374*

*These are needed if lab results are not in plant-available nutrients (discussed in another lesson). If lab results are plant-available nutrients, skip this part.
[a]Based on 25 acres of soybeans at 25 pounds of residual N per acre.

Table 6b. Calculating Manure Nutrient Generation Using Measured Quantities and Analyses.

Table for Your Use.

Use this worksheet when you know the volume of manure that is handled based on cleanout or pumping records.				
1	Manure generation, tons or thousands of gallons/year			
		N	P_2O_5	K_2O
2	Manure analysis, lb/ton or lb/1,000 gallons			
3	Manure nutrient availability coefficients*			
4	Corrected manure analysis* (multiply above two rows, 2 X 3, for each column)			
5	Total manure nutrients to handle (manure generation X corrected manure analysis)			
6	Total other nutrients on the farm (includes starter fertilizer, residual N credits, other waste sources, N from recent soil test. Note: These are on a field-by-field basis.)			
7	Total nutrients to handle in cropping system			

*These are needed if lab results are not in plant-available nutrients (discussed in another lesson). If lab results are plant-available nutrients, skip this part.

Table 7. Nitrogen residual following some legume crops.

Legume Crop Type	N Available for Next Crop, Pounds Per Acre
Peanuts	20 - 40
Soybeans	30 - 45
Clovers[1]	40 - 100
Alfalfa[1]	50 - 125
Lupin[1]	50 - 150
Hairy vetch	80 - 110

[1] For forage crops, N remaining for next crop depends upon amount of top growth harvested and the stage of growth at termination; for lupin it is assumed that termination is before significant seed development.

Summary

The manure nutrient supply on an animal farm originally came from the feed which was fed to the animals. Therefore the quantity of manure nutrients is affected by the productivity of the animals (the proportion of the feed nutrients converted into growth or other products). This conversion efficiency is affected by the nutritional balance of the diets fed relative to the nutritional needs of the animals at their current productivity stage. In addition, feed wastage often contributes nutrients directly to manure management systems, without the reduction in amounts associated with animal digestion. Two of the easiest and least costly (often profitable) methods of reducing manure nutrient production are to more closely balance the diets to the needs of the animals and to take steps to minimize feed wastage (such as frequent feeder adjustment, use of pelleted feeds, or installing feeders of newer design).

There are four basic methods for estimating the production of manure nutrients on farms. The first involves multiplying animal weight by excretion factors for nitrogen (N), phosphorus (P), and potassium (K). For pigs, and likely other animals, as their feeding and management have changed, the published standard excretion factors currently in use most likely underestimate N excretion and overestimate P excretion, as leaner pigs tend to excrete more N and less P than fatter pigs. The second method involves subtracting the estimated nutrient content of animals and animal products leaving the farm from the nutrient content of the feeds used on the farm. Manure N is derived from the protein and amino acids in the feed and manure P and K are derived from minerals in the feedstuffs and mineral supplements. Since all of the nutrients in the feed must go somewhere, if the amounts fed are known, this procedure will generally produce a more accurate estimate than the use of standard excretion estimates.

For both of these nutrient excretion estimation methods, nutrient losses which occur during treatment and storage of manure must be taken into account in order to estimate the quantities of nutrients available for use as fertilizer. Nitrogen voided in the urine (about half of the N excretion in most animals) is quickly converted to ammonia. Loss of this ammonia to the air can occur quickly under some conditions. During treatment and storage of manure, additional N is often converted to ammonia (and in some cases to nitrate, which is subject to denitrification and loss to the atmosphere as well). Nitrogen losses will often have larger effects on the amount of manure N available for use as plant fertilizer than the amount actually excreted.

The third method for estimating manure nutrient quantities is to calculate the expected manure production and multiply it by standard nutrient concentration values. These concentration values are usually for manures as they are removed from storage, thus this method does account for an average nutrient loss. The fourth method is to measure the quantity of manure removed from storage each year, sample and analyze it to determine the nutrient concentration of the manure, and multiply the concentrations by the quantity to estimate the total manure nutrients. This method automatically accounts for everything from wasted feed to treatment and storage losses, but it does not account for some nutrient separations, such as P in lagoon sludge, which will eventually have to be managed. It should be a goal of the nutrient management plan to develop a measurement and sampling procedure for calculating nutrient quantities, since it will be less likely that manure nutrients will be under or over applied to fields, since either could be uneconomic and over application could also be environmentally unsound. With either calculation method, other on-farm nutrient sources may also need to be accounted, such as mortality compost, or, on a field by field basis, legume N fixation.

Nutrient Budgeting of Manure
Glen Harris

Introduction

Animal manures have been used as a fertilizer and soil amendment for crop land since man first domesticated animals. Used properly and at appropriate rates, animal manures can recycle and supply valuable plant nutrients and improve soil quality. Used improperly and at rates that exceed crop nutrient needs, animal waste can be an environmental and true waste disposal problem.

Animal waste come in a variety of forms and are applied in a variety of methods. Solid manure, liquid manure, litters, composts, and lagoon effluents represent the most common types of manure that are now applied to soils through a variety of spreading, tillage, and irrigation practices. Compared to inorganic commercial fertilizers, animal manures are generally bulky, highly variable in composition and low in nutrient content. The amount of a manure required to supply nutrients to a crop can easily be 10- to 100-fold the amount of commercial fertilizer needed by the same crop. Although low in nutrient content, the large volume of manure normally generated on a farm can represent a significant amount of fertilizer value. For these reasons, land application is the most common usage of animal manures. The economics of hauling animal manures great distances or using manures for alternative purposes such as feed or fuel are not currently feasible. Until the economic feasibility and practicality of transporting manures long distances or alternative usage improves, land application will continue to be the primary way animal manures are handled. Also, the potential to over apply animal manures on land close to concentrated animal feeding operations will remain.

Animal manures usually contain significant amounts of the primary nutrients (N, P and K) and lesser amounts of secondary (Ca, Mg, S) and micronutrients (Zn, Mn, etc) essential for plant growth. Balancing the nutrients contained in animal manures with crop needs and determining an appropriate application rate for agronomic purposes used to be referred to as a "nutrient management plan". Now it is more common to view this exercise as a key component of a larger "comprehensive nutrient management plan". Traditionally, manure application rates are calculated to provide nitrogen (N) to crops. This is due to the fact that most crops demand more N than any other fertilizer element. Nitrogen is also usually the most expensive fertilizer nutrient to purchase. Balancing manure rates with a crop's need for N is also known as using N as a "priority nutrient" or using an "N-based plan". For many years, the environmental concern associated with excessive nitrogen applications from manure was nitrate leaching into groundwater. N-based nutrient management plans are a way to deal with this concern. Recently, environmental concerns have focused more on excessive phosphorous applications from manures and the adverse effect on surface water quality. Although using P as the priority nutrient, or "P-based" plans, are not currently required, they may be in the future and they need to be considered.

Nutrient budgets or balances can be either calculated by hand or by using a computer program. A "Nutrient Budget Worksheet" is provided at the end of this chapter for hand calculations (Appendix A). This worksheet was originally developed for dairy manure nutrient management in Georgia. Space for calculations based on only one priority nutrient (N or P, not both) is provided however. The preferred method of calculating nutrient balances of manure is to use the "Georgia Field Level Nutrient Budget Worksheet" (Appendix B). This spreadsheet can be downloaded as either an Excel or Quattro Pro program by going to the AWARE homepage at http://www.engr.uga.edu/service/extension/aware . Simply click where instructed under "Nutrient Management Planning in Georgia" in the upper right hand corner of the page.

Nutrient budgeting, either by hand or using the computer, can serve a number of different purposes. The most common purpose will be to determine the proper application rate for a given field in a real situation using real numbers for crop needs and nutrients in manure. Nutrient budgeting can also be used as a planning tool at the farm level to determine if adequate land base is present for the cropping system planned. Finally, nutrient budgeting can be used as an educational tool to calculate application rates based on various "simulated" scenarios, for example, how much manure can I apply if I have this particular soil test phosphorous level?

Regardless if done by hand or by computer, nutrient budgeting or balances contain three basic steps:

1) Determine Crop Nutrient Needs,
2) Determine Nutrients Supplied by Manure
3) Balance Crop Nutrient Needs with Nutrients Supplied by Manure

Determine Crop Nutrient Needs

The first step of any nutrient budgeting plan is to determine the nutrient requirements of the crop to be grown. Crops are an integral part of the system. Without a crop to actively utilize nutrients and prevent erosion, nutrients applied in manure could be washed directly into surface streams or leached into the groundwater. The vegetative cover also reduces the potential for runoff and erosion from an area.

When selecting a crop, there are numerous considerations other than nutrient requirement. Two important considerations are the suitability and adaptation of the crop to the local environment and the economic value of the crop. The crop must also be able to absorb nutrients when manure applications are made as well as produce adequate yields.

Insufficient nutrient supply from manure applications can result in deficiencies, which can reduce crop yield and quality, and decrease utilization of manure nutrients. Excessive applications can negatively affect both the plant and the environment. The effect of too much fertilization on plant growth depends on the crop and nutrients involved. In most cases, too much phosphorus (P) and potassium (K) have little effect on plant growth and yield unless so much is applied that salt injury results. However, too much P in the soil may have negative environmental consequences if significant amounts of P exit the site.

Too much nitrogen (N) can reduce yields by making plants more susceptible to diseases and insects, increasing lodging, and stimulating vegetative growth at the expense of fruit or grain production. Excess metals, such as copper and zinc, can be also be toxic to plants. In extreme cases, soil concentrations of these metals can be high enough to limit or prevent the growth of certain crops.

Crops vary in their ability to use nutrients. Some examples of the nutrient uptake by common crops are shown in Table A.

Table A. Plant nutrient uptake by specified crop and removed with the harvested part of the crop. Table A represents U.S. Averages.

Crop	N	P_2O_5	K_2O	Units
Grain Crops				
Barley (Grain)	0.87	0.37	0.25	lbs./bu.
(Straw)	15.00	5.04	30.12	lbs./ton
Buckwheat (Grain)	0.79	0.34	0.26	lbs./bu.
(Straw)	15.60	2.29	54.46	lbs./ton
Corn Grain (Grain)	0.90	0.36	0.27	lbs./bu.
(Stover)	22.20	9.16	32.29	lbs./ton
Oats (Grain)	1.27	0.51	0.38	lbs./bu.
(Straw)	12.60	7.33	40.00	lbs./ton
Rice (Grain)	0.63	0.25	0.12	lbs./bu.
(Straw)	12.00	4.12	27.95	lbs./ton
Rye (Grain)	1.16	0.33	0.33	lbs./bu.
(Straw)	10.00	5.50	16.63	lbs./ton
Sorghum (Grain)	0.94	0.46	0.28	lbs./bu.
(Stover)	21.60	6.87	31.57	lbs./ton
Wheat (Grain)	1.25	0.85	0.38	lbs./bu.
(Straw)	13.40	3.21	23.37	lbs./ton
Oil Crops				
Flax (Grain)	2.29	0.71	0.57	
(Straw)	24.80	5.04	42.17	lbs./ton
Peanuts (Grain)	36.00	3.89	6.02	lbs./1000 lbs.
(Vines)	46.60	10.99	42.17	lbs./ton
Rapeseed (Grain)	1.80	0.90	0.46	lbs./bu.
(Straw)	89.60	19.69	81.20	lbs./ton
Soybeans (Grain)	3.75	0.88	1.37	lbs./bu.
(Stover)	45.00	10.08	25.06	lbs./ton
Sunflower (Grain)	35.70	39.16	13.37	lbs./1000 lbs.
(Stover)	30.00	8.24	70.36	lbs./ton
Fiber Crops				
Cotton	26.70	13.28	10.00	lbs./1000 lbs.
(Seed Stalk)	17.50	5.04	17.47	lbs./1000 lbs.
Pulpwood	0.12	0.05	0.07	%
(Bark & branches)	0.12	0.05	0.07	%
Forage Crops				
Alfalfa	45.00	10.08	45.06	lbs./ton
Bahiagrass	25.40	5.95	41.69	lbs./ton
Big bluestem	19.80	38.93	42.17	lbs./ton
Birdsfoot trefoil	49.80	10.08	43.86	lbs./ton
Bluegrass-pastd.	58.20	19.69	46.99	lbs./ton
Bromegrass	37.40	9.62	61.45	lbs./ton
Clover-grass	30.40	12.37	40.72	lbs./ton
Dallisgrass	38.40	9.16	41.45	lbs./ton
Guineagrass	25.00	20.15	45.54	lbs./ton

Crop	N	P_2O_5	K_2O	Units
Forage Crops (continued)				
Bermudagrass	37.60	8.70	33.73	lbs./ton
Indiangrass	20.00	38.93	28.92	lbs./ton
Lespedeza	46.60	9.62	25.54	lbs./ton
Little bluestem	22.00	38.93	34.94	lbs./ton
Orchardgrass	29.40	9.16	52.05	lbs./ton
Panagolagrass	26.00	21.53	45.06	lbs./ton
Paragrass	16.40	17.86	38.31	lbs./ton
Red clover	40.00	10.08	40.00	lbs./ton
Reed canarygrass	27.00	8.24	-	lbs./ton
Ryegrass	33.40	12.37	34.22	lbs./ton
Switchgrass	23.00	4.58	45.78	lbs./ton
Tall fescue	39.40	9.16	48.19	lbs./ton
Timothy	24.00	10.08	38.07	lbs./ton
Wheatgrass	28.40	12.37	64.58	lbs./ton
Silage Crops				
Alfalfa haylage	27.90	7.56	27.95	lbs./ton
Corn silage	7.70	4.01	9.19	lbs./ton
Forage sorghum	8.64	2.61	7.37	lbs./ton
Oat haylage	12.80	5.13	9.06	lbs./ton
Sorghum-sudan	13.60	3.66	17.47	lbs./ton
Sugar Crops				
Sugarcane	3.20	1.83	8.92	lbs./ton
Sugar beets	4.00	1.37	3.37	lbs./ton
Sugar beet tops	8.60	1.83	24.82	lbs./ton
Tobacco				
All types	37.50	7.56	60.00	Lbs./1000 lbs.
Vegetable Crops				
Bell peppers	8.00	5.50	11.81	lbs./ton
Beans, dry	62.60	20.61	20.72	lbs./ton
Cabbage	6.60	1.83	6.51	lbs./ton
Carrots	3.80	1.83	6.02	lbs./ton
Cassava	8.00	5.95	15.18	lbs./ton
Celery	3.40	4.12	10.84	lbs./ton
Cucumbers	4.00	3.21	7.95	lbs./ton
Lettuce (heads)	4.60	3.66	11.08	lbs./ton
Onions	6.00	2.75	5.30	lbs./ton
Peas	73.60	18.32	21.69	lbs./ton
Potatoes	6.60	2.75	12.53	lbs./ton
Snap beans	17.60	11.91	23.13	lbs./ton
Sweet corn	17.80	10.99	13.98	lbs./ton
Sweet potatoes	6.00	1.83	10.12	lbs./ton
Table beets	5.20	1.83	6.75	lbs./ton

Source: NRCS Agricultural Waste Management Field Handbook 1992.

Please note that Table A is generalized for the U.S., and specific data for your region should be obtained from local experts. These values can be used to determine crop nutrient needs. However, the best way and preferred method of determining crop nutrient needs is through soil testing. Public or private services can be used as long as the laboratories are considered reputable and use methods adapted for your local region. Most soil testing laboratories give results and recommendations for the major plant nutrients (N, P, K), secondary plant nutrients (Ca, Mg, S), micronutrients (Mn, Zn) and pH. Even though most manure budgets will be based on either N or P, it is important always soil test and keep good records of all of these essential plant nutrients in order to provide an overall proper balance of soil fertility to the crop.

Another important reason for soil sampling on a routine basis is to track soil pH and follow appropriate lime recommendations. Some animal manures such as poultry litter have a slight liming capacity. Therefore, where poultry manures are used, liming may not be recommended as frequently compared to where they are not used. In addition, nutrient availability in soils is very dependent on proper soil pH. If soil pH is not closely monitored (recommend annually for fields receiving manure applications), nutrient availability and uptake may be very different from expected results. Not only is liming important for proper availability of essential plant nutrients, but liming can also render certain nutrients that are toxic to most plants, like aluminum for example, unavailable.

Even though soils are not tested for N content, N recommendations for crop growth are included on soil test reports. The reason soil N is not analyzed is that this element is highly mobile in the soil and is constantly going through transformations such as mineralization, leaching, volatilization, and immobilization. Some areas in the U.S. are able to utilize soil nitrate testing for pre-plant or pre-sidedress N recommendations. However, on highly weathered, low organic matter, sandy soils of the Southeast, these testing procedures have not been deemed successful. Therefore, N recommendations as found on the soil test reports in the Southeastern U.S. are based on field studies where varying rates of N fertilizer were applied and crop yield response was measured.

Legume plants, such as peanuts, soybeans, clovers and vetches, are not good candidates for receiving manure applications since they fix their own N. When non-legume plants like corn or cotton follow these plants in rotation, the "residual" nitrogen must be accounted for in the nutrient budget. Alfalfa, vetch and clover give an N "credit" of 80 lb/a to the following crop, whereas soybeans and peanuts are worth 30 lb N/a. These values can also be easily referenced in a Table 2 in the UGA computer spreadsheet program.

Fertilizer credits, not only N but P and maybe K too, also need to be accounted for when using commercial fertilizer or any other nutrient source in conjunction with animal manure. A good example of this would be the use of starter fertilizer such as 10-34-0 on corn or cotton. Both the hand and computer versions of the nutrient budget sheets have space just under the input line for "crop needs" to factor in both other fertilizer and residual N credits from legumes. In the computer version, once you enter the values for "Commercial Fertilizer Applications" and "Residual N from Legumes" the final crop nutrient needs of the plant are automatically calculated and appear in the "Net Manure Nutrient Needs of Crop" columns for N, P_2O_5 and K_2O.

Final crop yields are not determined by soil fertility alone. Other factors such as soil management, climate, plant population, timing, pest control, and variety selection are also important. Because the amount of nutrients required by a crop usually varies directly with the yield, expected yields must be considered. Fortunately, soil test reports from reputable laboratories in your area should already account for yield goals. In some cases, for example cotton fertilizer recommendations in Georgia, most labs request input on yield goal and adjust accordingly. In other cases, for example corn recommendations from the University of Georgia, different yield goals are used for dryland vs. irrigated. Guidelines are also given to adjust for higher yields. Where yield records are available, you can average the three highest yields in five consecutive crop years to calculate a realistic yield goal for a given field. Using an unrealistic yield goal that is too high, can result in overapplication of nutrients in manure. On the otherhand, underestimating yield goal or potential can result in under application of nutrient and possibly crop nutrient deficiencies.

Determine Nutrients Supplied by Manure

The second basic step in developing a nutrient budgeting plan is very similar to the first. In this case instead of having soil analyzed to determine crop nutrient needs, the animal manure is analyzed to determine the nutrient supplying power of the manure. Like with soil sampling, taking a representative sample is important to get an accurate estimate of the nutrient content. Also as with a soil sample, the manure sample should be analyzed by a reputable laboratory. Using "book values" to estimate nutrient content of manure should be avoided whenever possible.

Most laboratories will analyze manure samples for primary nutrients (N, P and K), secondary nutrients (Ca, Mg and S) and micronutrients. Primary and secondary nutrients are often reported as % and micronutrients as parts per million (ppm). Most laboratories also report results on an "as is" or "wet basis" so the moisture does not have to be factored back in. Laboratories such as the UGA lab also report P as P_2O_5 and K as K_2O so they are already on a "fertilizer" basis. The UGA lab also converts and reports each nutrient from % or ppm to lb/ton for "dry" manures to lbs/1000 gal for liquid manures.

In case these conversions are not already made by the laboratory that analyzed the manure, the following conversion factors prove to be useful:

lbs of P x 2.29 = lbs of P_2O_5
lbs of K x 1.2 = lbs of K_2O
parts per million (ppm) and milligrams per liter (mg/l) are assumed to be equal since (1 ppm = 1 mg/l)
ppm or mg/l x 0.002 = lbs/ton
ppm or mg/l x 0.226 = lbs/acre-inch
ppm or mg/l x 0.008 = lbs/thousand gallons
one acre-inch = 27,000 gallons

The nutrients contained in manures and reported as "total" N, P_2O_5 or K_2O are <u>not</u> usually considered to be 100 % available for crop uptake like inorganic commercial fertilizers. This is due to some of the nutrients being in "organic" forms and is especially important for N. Inorganic nutrients are readily available to growing plants; in other words, they are already in a form for plant uptake. Organic nutrients, on the other hand, must go through a mineralization process to become plant available.

Mineralization is the conversion from an organic form to an inorganic form so that nutrients become plant available. Mineralization is performed by soil microbes and takes place over time.

Some labs report manure nutrient results on a "plant-available" basis and some don't. The UGA lab for example, reports total N, P_2O_5 and K_2O. In this case, availability coefficients must be used to calculate the true nutrient supplying capacity of the manure. The availability coefficients that should be used can be found in Table B. This table is also identical to Table 1 provided with the UGA computer spreadsheet for manure nutrient budgeting.

Table B. Livestock manure nutrient first-year availability coefficients

TYPE OF MANURE	APPLICATION METHOD								
	Soil incorporation			Broadcast			Irrigation		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Scraped manure									
Dairy	0.6	0.8	1.0	0.5	0.7	0.9	*	*	*
Beef	0.6	0.8	1.0	0.5	0.7	0.9	*	*	*
Swine	0.6	0.8	1.0	0.5	0.7	0.9	*	*	*
Sheep/Goat	0.6	0.8	1.0	0.5	0.7	0.9	*	*	*
Horse, stable	0.5	0.8	1.0	0.5	0.7	0.9	*	*	*
Poultry House Litter									
All poultry litters	0.7	0.8	1.0	0.5	0.7	0.9	*	*	*
Liquid manure slurry									
Dairy	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Beef	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Swine	0.7	0.8	1.0	0.4	0.7	1.0	0.3	0.7	1.0
Layer	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Lagoon liquid									
Dairy	0.8	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Beef	0.8	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Swine	0.9	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Layer	0.9	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0

* Not applicable

You need to know two pieces of information in order to choose the correct availability coefficient 1) type of manure and 2) application method. For example, if you are dealing with poultry (broiler) litter that will be broadcast and then soil incorporated within two days, the availability coefficients for N, P_2O_5 and K_2O will be 0.7, 0.8 and 1.0 respectively. If calculating a nutrient budget by hand, you would multiply the values given for total N, P_2O_5 and K_2O by these coefficients to come up with "available" nutrients supplied by the manure. In the case of the computer program, you simply enter the coefficients on the appropriate line and "Manure Nutrients Available to crop" are automatically calculated.

The method of manure application affect nutrient availability in a number of ways. Manure placement affects the ability of crops to utilize most of the applied nutrients and the likelihood of manure runoff from the site. Application to the soil surface typically results in greater potential for

N loss through volatilization (escape as a gas) and runoff than where manures are incorporated (mixed with the topsoil) or injected. Uniformity of nutrient applications and distance from the root system can also influence crop response to nutrient applications. The method of application can also affect odor. Careful placement also means irrigating at rates that prevent runoff.

The application method for manures often depends on the type of application equipment that is available or is the method that is most cost or time effective. Many growers choose broadcast nutrient application because of fewer time constraints and lower cost.. Again, incorporating manures into soils where possible increases the availability coefficient. Where nutrient utilization is a prime consideration, the handling system may dictate the method of application. For example, solid or semisolid materials cannot be effectively injected into the soil or applied through an irrigation system, while lagoon liquids are most economically applied through an irrigation system. The application rate of the irrigation equipment will also determine if the manure moves into the soil or runs off.

Some labs will convert manure nutrient analyses to a "plant-available"basis, so that no calculations at all are necessary prior to manure application. However, in order for the lab to do this, you must supply them with information concerning type of manure and application method. If you provide this information and a lab does report the nutrients in manure on a "plant available" basis, still check their plant available factors to be sure it fits your situation and corresponds to the values listed in Table 2.

Another term that is reported by some labs and may lead to some confusion is plant available nitrogen or "PAN". This term is usually calculated by multiplying the organic N fraction of manure by a mineralization factor and adding that value to analyzed values for the inorganic forms of nitrogen in manure (ammonium-N and nitrate-N). In fact, the UGA lab analyzes manures for ammonium and nitrate N. However, PAN is basically used to describe the portion of the total N that is available for crop uptake just like the N availability factors in Table B. **For simplicity, the N supplying capacity of manures should be calculated by multiplying total N by the appropriate availability coefficient, and <u>not</u> by using a "PAN" value.**

Balance Crop Nutrient Needs with Nutrients Supplied by Manure

The third and final step in calculating a nutrient budget for animal manures is to simply match the nutrient needs by the crop to be grown in step 1 (based on a soil test) with the nutrient supplying capacity of the manure calculated in step 2 (total N-P_2O_5-K_2O from a manure analysis times appropriate availability coefficients.

The best way to demonstrate how this would be done is with the following examples.

Example #1 - Using broiler litter for cotton production on a medium P testing soil in South Georgia

Given: 100 acres of cotton
Crop Needs based on soil test of 90-60-35 (lbs $N-P_2O_5-K_2O$ per acre)
Manure analysis shows 60-60-40 (total $N-P_2O_5-K_2O$ per ton "as is")
Application method = Soil Incorporated (availability coefficients for $N-P_2O_5-K_2O$ = 0.7-0.8-1.0)

Calculate: 1) Appropriate application rate in ton/a for an N-based plan
2) Appropriate application rate in ton/a for an P-based plan

Answers: 1) 2.14 ton/a (90 lb N/a divided by 60 x 0.7 lb N/ton)
2) 1.25 ton/a (60 lb P_2O_5/a divided by 60 x 0.8)

Notice that a higher application rate of manure is recommended when N-based compared to P-based. This is very common and is due to the fact that most crops require less P than N, plus most manures contain about as much P as N. Based on these rates and since there is 100 acres available, the cotton farmer will be able to utilize 214 tons of litter if N-based (2.14 tons/a x 100 acres), but only 125 tons if P-based (1.25 x 100).

The example above is based on a soil testing in the "medium" range for P using the UGA lab. If the soil test P rating changes, either up or down, the application rate if using an N-based budget will not change. However, if a P-based budget is used and the soil test P is lower, then an application rate higher than 1.25 ton/a will be recommended. On the other hand, if the soil test rating for P increases into the high range, less manure than 1.25 ton/a will be recommended. Once the soil test rating for P increases into the "very high" range, a manure application rate of 0 ton/a will be recommended for the P-based budget. At this point, this recommendation is for agronomic purposes only, not environmental purposes.

Example # 2 - Using broiler litter for tall fescue pasture on a medium P testing soil in North Georgia

Given: 100 acres of tall fescue pasture
Crop Needs based on soil test of 50-30-25 (lbs $N-P_2O_5-K_2O$ per acre)
Manure analysis shows 60-60-40 (total $N-P_2O_5$ K_2O per ton "as is")
Application method = Broadcast (availability coefficients for $N-P_2O_5-K_2O$ = 0.5-0.7-0.9)

Calculate: 1) Appropriate application rate in ton/a for an N-based plan
2) Appropriate application rate in ton/a for an P-based plan

Answers: 1) 1.67 ton/a (50 lb N/a divided by 60 x 0.5 lb N/ton)
2) 0.7 ton/a (30 lb P_2O_5/a divided by 60 x 0.7)

Notice that the both the N-based and P-based application rates are lower than in the South Georgia cotton example above. This is basically due to the lower nutrient demand by tall fescue pasture and despite the fact that less nutrients from manure are available (lower availability coefficients) due to broadcasting rather than incorporating the litter. Based on these recommended application rate, this livestock producer would only be able to utilize 167 tons (1.67 tons/a x 100 acres) of litter if N-based and 70 (0.7 x 100)tons if P-based.

How To Use The UGA Computer Program

Both the "hand" (Appendix A) and computer (Appendix B) spreadsheets use the basic calculations and procedures as used in the two examples above. In addition, they both require some additional and useful record keeping information (for example farmer name, soil type, yield goal) that is not directly used in calculating the nutrient budget.

The main disadvantages of the "hand" spreadsheet is that all figures have to be recorded by hand, all calculations have to bee done using a calculator, and the nutrient budget can only be calculated using either N or P (but not both) as the priority nutrient.

The UGA computer spreadsheet is the preferred method of calculating nutrient budgets for manure because it makes a number of calculations automatically and includes a fertilizer value of manure used in $/ton or 1000 gallons.

Once you've downloaded the spreadsheet, you can enter information for a given field or situation into the spaces provided in the blue shaded area. All information recorded in the top half of the blue section, from the producer's name to the manure application method is important for record keeping but is not used in any of the calculations.

The key information is entered on the "Crop Nutrient Needs", "Manure Nutrient Concentrations" and "Availability Coefficients" lines. The "Commercial Fertilizer Applications" and Residual N from Legumes" (use the "Legume" tab to go to Table 2) are used to calculate "Net Manure Nutrient Needs of Crop". Default values of 34 cents/lb N, 25 cents/lb P_2O_5 and 16 cents/lb K_2O are automatically entered on the "Equivalent Fertilizer Price" line. These values can be changed to reflect local prices of the fertilizer to be used by your farmer. They are then used to calculate the "Fertilizer Value" of the manure.

Anytime a value in the blue box that is used in a calculation is changed, the affected values below should change. For example, if the "Crop Nutrient Needs" for N is changed, then the recommended manure application rate found in the yellow box below should change.
Use both the "Legume" and more importantly the "Availability" tabs for easy reference for input onto the "Residual N from Legumes" and "Availability Coefficients" lines in the blue box. There is also a series of tabs with helpful information for most of the inputs. These can be found in Appendix B as "Additional Instructions on NBW Data Entry". Notice also that there is a "units/a" button for the "Manure Nutrient Concentration" input line that guides the user to lb/ton for dry manure and either lb/ac-in or lb/thousand gallons for liquid manures.

Once you have completed a "worksheet" it can be printed either using the "print" button or by highlighting the desired cells on the spreadsheet and using the print command on the main "File" pulldown menu. The individual record can also be saved, using the "save as" command under the "File" menu. Each time you can save the new record with a different and unique filename.

To show what a completed Nutrient Budget Worksheet using the UGA computer program would look like, Examples # 1 and #2 discussed earlier can be found on the last two pages of this chapter.

Appendix A

NUTRIENT BUDGET WORKSHEET

1. Producer_________________ . County_______________ 3. Date_________________
4. Farm #___1___ 5. Tract #__________ 6. Field #__________ 7. Acres_________________
8. Soil Series_____________________ 9. Leaching Potential _____________________
10. Tillage Practices____
11. Planned Crop_______________ 12. Yield Expectations_____________________
13. Soil Test Rating: (a) P_____________ (b) K_____________ (c) pH_____________
14. Nutrients recommended (lbs/ac): (a) N_______; (b) P_2O_5___________; (c) K_2O___________
15. Lbs/ac starter fertilizer used: (a) N_________; (b) P_2O_5___________; (c) K_2O___________
16. Residual nitrogen credit from legumes (see back) ____________________lbs/ac
17. Net N needs of crop (14a minus 15a and 16)____________________lbs/ac
18. Net P_2O_5 needs of crop (14b minus 15b)____________________lbs/ac
19. Net K_2O needs of crop (14c minus 15c)____________________lbs/ac
20. Type of manure____
21. Manure nutrient content: (a) N ____________________(lbs/ton) (lbs/ac-in)
(b) P_2O_5 ____________________(lbs/ton) (lbs/ac-in)
(c) K_2O ____________________(lbs/ton) (lbs/ac-in)
22. Manure application method (see back)____
23. Nutrients in manure available to crop: (21a, b & c multiplied times the availability coefficient)(see back)
(a) Available N ____________________(lbs/ton) (lbs/ac-in)
(b) Available P_2O_5 ____________________(lbs/ton) (lbs/ac-in)
(c) AvailableK_2O ____________________(lbs/ton) (lbs/ac-in)
24. Manure application rate to supply the priority nutrient:
(a) Priority nutrient ___________ ________
(b) Amount of priority nutrient needed (17, 18 or 19) ______________lbs/ac
(c) Rate of manure needed (24b divided by 23a, 23b, or 23c) ___________ _(tons/ac) (in/ac)
25. Pounds per acre of available nutrients supplied at the manure application rate needed to supply the priority nutrient:
(a) N ______________________________lb/ac
(23a) (24c) (tons/ac or in/ac)
(b) P_2O_5 ______________________________lb/ac
(23b) (24c) (tons/ac or in/ac)
(c) K_2O ______________________________b/ac
(23c) (24c) (tons/ac or in/ac)
26. Nutrient balance: (Net nutrient need (-) or excess (+) after the application of manure at the calculated rate)
(a) N balance __________ - __________ = __________lb/ac
(25a) (17)
(b) P_2O_5 balance__________ - __________ = __________lb/ac
(25b) (18)
(c) K_2O balance__________ - __________ = __________lb/ac

a

27. Completed by______________________ Title______________________
Agency______The University of Georgia Cooperative Extension Service______

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer: **County:** **Date:** 01/01/00
Farm #: **Tract #:** 0 **Field #:** 0 **Acres:** 0.0
Soil Series: **Surface Soil Texture:**
Planned Crop: **Realistic Yield Expectation:** 0.0 Tons/A
Soil Test Index: **P =** 0 (Lb/A) **K =** 0 (Lb/A) **pH =** 0.0
Manure Type: **Application Method:**

	N	P2O5	K2O	
Crop Nutrients Needs:	0	0	0	Lb/A
Commercial Fertilizer Applications:	0	0	[illegible]	Lb/A
Residual N from Legumes:	0	NA	NA	Lb/A
Manure Nutrient Concentration:	0.0	0.0	0.0	Lb/Ton
Availability Coefficients:	0.0	0.0	0.0	NA
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb
Net Manure Nutrient Needs of Crop:	0.0	0.0	0.0	Lb/A
Manure Nutrients Available to Crop:	0.0	0.0	0.0	Lb/Ton
Fertilizer Value:	0.00	0.00	0.00	Total = 0.00 $/Ton

Manure application rate for supplying crop :			
	N needs =	ERR	Ton/A
	P2O5 needs =	ERR	

	N based Application		P2O5 based Application		
	Nutrients Applied	Balance	Nutrients Applied	Balance	
N	ERR	ERR	ERR	ERR	Lb/A
P2O5	ERR	ERR	ERR	ERR	Lb/A
K2O	ERR	ERR	ERR	ERR	Lb/A

Total manure applied to field based on:			
	N needs =	ERR	Ton
	P2O5 needs =	ERR	

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure application for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micronutrients.

* See Farm*A*Syst Publications for information on applying animal waste, especially around streams, wells and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to prevent manure liquids from nutrient runninng off into surface water or leaching into groundwater.

Sincerely,

Name
Title
County, District, etc.

Manure Type and Application Method are both used to determine the availability of nutrients in manure. You should enter your manure type and application method based on the selections given below. Table 1 then gives details on Manure Availability Coefficients based on the selected manure type and application method.

Table 1. Livestock Manure Nutrient First-Year Availability Coefficients

MANURE TYPE	APPLICATION METHOD								
	Soil Incorporated[1]			Broadcast[2]			Irrigation[3]		
	N	P2O5	K2O	N	P2O5	K2O	N	P2O5	K2O
Scraped manure									
Dairy	0.6	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Beef	0.6	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Swine	0.6	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Sheep/Goat	0.6	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Horse, Stable	0.5	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Poultry house litter									
All Poultry Litters	0.7	0.8	1.0	0.5	0.7	0.9	NA	NA	NA
Liquid manure slurry									
Dairy	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Beef	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Swine	0.7	0.8	1.0	0.4	0.7	1.0	0.3	0.7	1.0
Layer	0.7	0.8	1.0	0.5	0.7	1.0	0.4	0.7	1.0
Anaerobic lagoon liquid									
Dairy	0.8	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Beef	0.8	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Swine	0.9	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Layer	0.9	0.9	1.0	0.5	0.8	1.0	0.5	0.8	1.0
Anaerobic lagoon sludge									
All	* See Lagoon Clean-out and Closure publication								

[1] Surface spread manure plowed or disked into soil within 2 days
[2] Surface spread manure uncovered for one month or longer
[3] Sprinkler irrigated liquid uncovered for one month or longer

Estimates for Residual Nitrogen provided by legumes grown in rotation can be found in Table 2. Legume crops have the ability to fix N, or convert atmospheric N into a plant available form. Some of this fixed N is available to crops planted behind legumes. As a result, N fixed by legumes must be accounted for in a NBW to accurately manage this nutrient.

Table 2. Estimated Residual Nitrogen Provided by a Good Stand of Legumes Grown in Rotation

Legume	Residual Nitrogen Available
Alfalfa, Vetch, or Clover[1]	80 Lb/A
Soybeans, or Peanuts[2]	30 Lb/A

[1] Killed before planting current spring crop.
[2] Legume is planted in previous year/season. More nitrogen will be available if the fall planted crop immediately follows the legume. On sandy soils and in years with normally high precipitation, less nitrogen will be available to spring-planted crops.

Additional Instructions on NBW Data Entry

Producer is either the name of the farm or the name of the producer who owns and/or opperates the farm

Farm #, Tract #, Field#, and Acreage are all available from local Farm Service Agency Office. These are records and do not affect the manure application rates.

Soil Series and Surface Soil Texture are both available from local NRCS Office. These records can be h determining runoff and leaching potential. If unknown, they may be left blank.

Planned Crop is the crop that will be growing when manure applications are being made.
Realistic Yield Expectations are based on the production history of each field - be sure to indicate units.

Soil Test Index values are listed on the Soil Test Report for each field tested. For more information on soi testing, consult with your local UGA County Extension Agent.

Crop Nutrient Needs are listed in the Recommendations section of a Soil Test Report.

Fertilizer Applications are those which have already been made, or any planned for fields receiving man application(s). In other words, fertilizer application is the sum total of each nutrient (N, P2O5 and K2O) ap as starter fertilizer, mid-season side dress, etc.

Manure Nutrient Concentration values can be found on Animal Waste Analysis Reports.
Use the Unit/A button to choose the appropriate manure nutrient concentration uni Units/A

Equivalent Fertilizer Price is the price per pound of Elemental Nitrogen, Phosphate (P2O5), or Potash (K These values are available through local fertilizer dealers.

Print Worksheet Data Entry Instructions Sheet.

Example #1

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer:	Joe Farmer	**County:**	Tift	**Date:**	10/20/00
Farm #:	1 **Tract #:** 1	**Field #:**	1	**Acres:**	100.0
Soil Series:	Tifton	**Surface Soil Texture:**	Loamy Sand		
Planned Crop:	Cotton	**Realistic Yield Expectation:**	1250.0 lb/a		
Soil Test Index:	P = 60 (Lb/A)	K =	170 (Lb/A)	pH =	6.2
Manure Type:		**Application Method:**	Soil Incorporated		

	N	P2O5	K2O	
Crop Nutrients Needs:	90	60	35	Lb/A
Commercial Fertilizer Applications:	0	0	0	Lb/A
Residual N from Legumes:	0	NA	NA	Lb/A
Manure Nutrient Concentration:	60.0	60.0	40.0	Lb/Ton
Availability Coefficients:	0.7	0.8	1.0	NA
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb
Net Manure Nutrient Needs of Crop:	90.0	60.0	35.0	Lb/A
Manure Nutrients Available to Crop:	42.0	48.0	40.0	Lb/Ton
Fertilizer Value:	14.28	12.00	6.40	Total = 32.68 $/Ton

Manure application rate for supplying crop :	N needs =	2.1	Ton/A
	P2O5 needs =	1.2	

	N based Application		P2O5 based Application		
	Nutrients Applied	Balance	Nutrients Applied	Balance	
N	88	-2	50	-40	Lb/A
P2O5	101	41	58	-2	Lb/A
K2O	84	49	48	13	Lb/A

Total manure applied to field based on:	N needs =	210.0	Ton
	P2O5 needs =	120.0	

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure application for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micronutrients.

* See Farm*A*Syst Publications for information on applying animal waste, especially around streams, wells and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to prevent manure liquids from nutrient runninng off into surface water or leaching into groundwater.

Sincerely,

Name
Title
County, District, etc.

Example # 2

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer:	Joe Farmer	**County:**	Clarke	**Date:**	10/20/00
Farm #:	1 **Tract #:** 1	**Field #:**	1	**Acres:**	100.0
Soil Series:	Cecil	**Surface Soil Texture:**	Sandy Loam		
Planned Crop:	Fescue Pasture	**Realistic Yield Expectation:**	2.0 acres/cow		
Soil Test Index:	P = 40 (Lb/A)	K =	200 (Lb/A)	pH = 6.2	
Manure Type:		**Application Method:**	Broadcast		

	N	P2O5	K2O	
Crop Nutrients Needs:	50	30	25	Lb/A
Commercial Fertilizer Applications:	0	0	0	Lb/A
Residual N from Legumes:	0	NA	NA	Lb/A
Manure Nutrient Concentration:	60.0	60.0	40.0	Lb/Ton
Availability Coefficients:	0.5	0.7	0.9	NA
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb
Net Manure Nutrient Needs of Crop:	50.0	30.0	25.0	Lb/A
Manure Nutrients Available to Crop:	30.0	42.0	36.0	Lb/Ton
Fertilizer Value:	10.20	10.50	5.76	Total = 26.46

Manure application rate for supplying crop :	N needs =	1.6	Ton/A
	P2O5 needs =	0.7	

	N based Application		P2O5 based Application		
	Nutrients Applied	Balance	Nutrients Applied	Balance	
N	48	-2	21	-29	Lb/A
P2O5	67	37	29	-1	Lb/A
K2O	58	33	25	0	Lb/A

Total manure applied to field based on:	N needs =	160.0	Ton
	P2O5 needs =	70.0	

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micr

* See Farm*A*Syst Publications for information on applying animal waste, especially around stream and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to prevent manure liquids from nutrient runninng off into surface water or leaching into groundwater.

Sincerely,

Name
Title
County, District, etc.

Phosphorus Issues

Dr. David Radcliffe and Miguel Cabrera
Crop and Soil Sciences Department, University of Georgia

Intended Outcomes

The participants will

- Understand how P affects water quality
- Understand why manures present a special problem with P
- Understand how to assess risk of P loss from a field

Regulatory Background

The new Georgia swine regulations and the proposed dairy and layer regulations require that Comprehensive Nutrient Management Plans (CNMP) be developed that meet NRCS standards. NRCS standards currently specify that the amount of manure being applied be determined by the nitrogen (N) content. Starting in September of 2001, the NRCS standard will require that CMNP consider the risk that P losses from a field will reach sensitive waters and, if the risk is high, require that the amount of manure being applied be determined by the crop need for P, instead of the crop need for N (NRCS, 1999).

How P Affects Water Quality

According to a recent survey by the U.S. EPA, accelerated *eutrophication* is the main cause of water quality "impairment" in the U.S. (U.S. EPA, 1996). Eutrophication is the natural aging of lakes or streams brought on by nutrient enrichment. This process is accelerated by human activities which increase nutrient loading rates to water. While both P and N contribute to eutrophication, P is the primary agent in freshwater eutrophication. In salt water estuaries, N is the primary nutrient controlling eutrophication.

Eutrophication restricts water use for fisheries, recreation, industry, and drinking, due to the increased growth of undesirable algae and aquatic weeds and oxygen shortages caused by their death and decomposition. Also, an increasing number of water resources are experiencing periodic algal blooms. These blooms contribute to a wide range of water-related problems including summer fish kills, unpalatability of drinking water, and formation of carcinogens during drinking water chlorination. This has increased the public awareness of eutrophication and the need for solutions.

Lakes are more sensitive to P than streams and rivers. A trophic index is used to measure the level of eutrophication in lakes and is based on P concentrations, chlorophyll-a content), and depth of visibility. Lakes with a trophic index above 60 are considered eutrophic. According to a survey by the Georgia Department of Natural Resources (DNR), several of the large lakes in Georgia show signs of eutrophication (Table 1). Due to accelerated eutrophication, the DNR has set limitations for three lakes in Georgia on the amount of P that can enter from tributaries. These lakes are Jackson, on the soil surface. In very sandy soils which are low in iron and aluminum oxides, P can move into the subsoil.

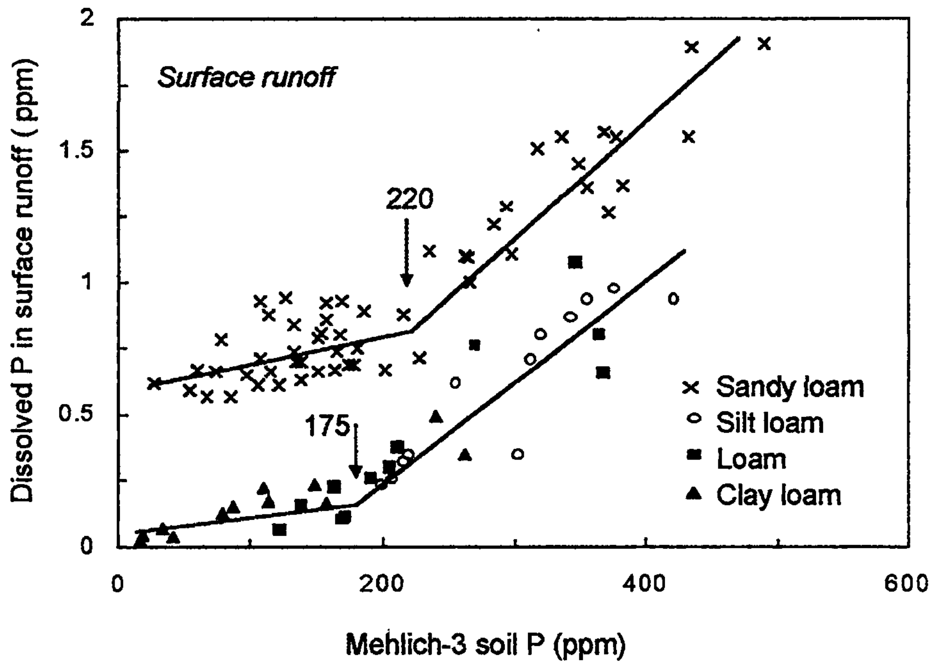


Figure 2. Dissolved P as a function of soil test P in four soils.

In recent years, we have learned that the concentration of P in runoff from agricultural fields increases as the soil test P level goes up. Part of the reason for this can be soil erosion where soil particles with high concentrations of adsorbed P are being washed off the field. But even in grass fields, where there is almost no erosion, research has shown that dissolved P concentrations in runoff increase with soil test P (Fig. 2). The reason why P concentrations in runoff increase with soil test P levels is that when rain occurs there is a thin layer of water near the surface that mixes with the soil water and can run off. If the concentration of P in the soil water is high (because most of the adsorption sites near the surface are filled with P), then the concentration in the runoff water will also be high. In Fig. 2, all soils show that P concentrations in runoff increase more sharply beyond a certain level of soil test P. This probably represents the level where most of the adsorption sites near the soil surface are filled.

There is no clear answer to what is an unacceptable concentration for P in runoff. The concentration of total P (adsorbed and dissolved) that is thought to trigger eutrophication in lakes is only 0.05 ppm. In Fig. 2, even the lowest levels of soil test P produce concentrations in this range. Most researchers agree that a realistic target is to try and keep agricultural runoff P concentrations below 1.0 ppm. The level of soil test P above which runoff concentrations exceed 1.0 ppm is sometimes referred to as the *environmental threshold* soil test P. In Fig. 2, the environmental threshold level would be approximately 300 ppm soil test P for the sandy loam and 400 ppm soil test P for the silt loam. By

Laboratory tested High or Very High in soil test P.

Dry manures present a special additional problem when they are applied to grass fields and not incorporated. Under these circumstances, there is very little contact between the manure P and the oxides in soils. Rain water mixes directly with the manure causing a high concentration of dissolved P in the runoff. Some of adsorbed organic P also enters runoff as the manure is eroded from the site. Research has shown that runoff P concentrations are unrelated to soil test P in these situations. Runoff P concentrations can be quite high (> 25 ppm) when runoff occurs within a few weeks of manure application.

Best Management Practices to Reduce P Runoff Losses

There are a number of best management practices (BMP's) that can be adopted to reduce the risk of P contamination of surface waters. Some of these reduce the source of P and others inhibit transport.

The most obvious BMP for reducing the P source is to base nutrient management plans (NMP) on the crop's need for P rather than N (a P-based vs. a N-based NMP). This means that additional land must be found for manure application or livestock numbers must be reduced. Another way to reduce the P source is to make P in the feed more digestible so that lower levels can fed. This can be done by adding phytase enzyme to feed or through the use of new hybrids of corn that have a highly digestible form of P (Ertl et al., 1998). The P source can also be reduced by adding a compound called *alum* to the manure. The aluminum in alum combines with P in the manure and forms an insoluble compound. As a result, the dissolved P levels in runoff are lower when alum-treated manure is applied to fields (Moore and Miller, 1994). A simple way to reduce the source is not to apply manure during periods when runoff-producing rains are expected, for example in the winter months. If it's possible to incorporate dry manure or inject lagoon slurries, this will also reduce the source.

One of the most important BMP that affect transport is the use of grass filter strips and stream-side buffers. Grass filter strips are very effective in filtering out P adsorbed to sediment because they slow down the flow of water and cause the sediment to settle out. They have less of an effect on the P dissolved in runoff. Artificially drained fields (tile drains or ditches) present a special danger in that transport from the field to the stream is enhanced. High concentration P water may move to the drains in sandy soils where there is little adsorption. Avoiding manure application to artificially drained fields is the best practice. Transport of P can also be reduced by any BMP that reduces runoff and erosion. Examples would be conservation tillage, terracing, contour plowing, and impoundments.

Determining the Risk for P Loss in a Field

If the risk for P loss to a sensitive water body is sufficiently high, then a P-based plan should be adopted. But how do we determine the risk and what is *sufficiently high*? The NRCS has directed their state offices that they may use one of three different approaches to assess the risk for P loss (NRCS, 1999). They can use the agronomic threshold level of soil test P as the dividing line between

Factor	P-index Rating					Value
STP (ppm)	0.1 X Mehlich-1 STP					
Fertilizer Application	0.1 X lbs P_2O_5/acre					
Application Method	No application **0**	Injected **2**	Incorp. within 5d **4**	Surface Apr-Nov **8**	Surface Dec-Mar **16**	
Organic P	0.1 X lbs P_2O_5/acre manure or compost 0.05 X lbs P_2O_5/acre sludge					
Application Method	No application **0**	Injected **2**	Incorp. within 5d **4**	Surface Apr-Nov **8**	Surface Dec-Mar **16**	
					Sum Source Value	

Figure 3. Source factors in Maryland P-index.

Factor	P-index Rating					Value
Erosion	2 X tons soil loss/acre-yr					
Runoff Class	Very Low **0**	Low **2**	Medium **4**	High **8**	Very High **16**	
Tile Drainage	Very Low **0**	Low **2**	Medium **4**	High **8**	Very High **16**	
Vegetated Buffer	> 30 ft permanent **0**	10-30 ft no P <30 ft **2**	10-30 ft **4**	< 10 ft no P <30ft **8**	< 10 ft **16**	
Waterbody Sensitivity	Very Low **0**	Low **2**	Medium **4**	High **8**	Very High **16**	
					Sum Transport Value	

Figure 4. Transport factors in Maryland P-index.

Factor	P-index Rating					Value
STP (ppm)	0.1 X 25 ppm					2.5
Fertilizer Application	0.1 X 0 lbs P_2O_5/acre					0
Application Method	No application 0	Injected 2	Incorp. within 5d 4	Surface Apr-Nov 8	Surface Dec-Mar 16	0
Organic P	0.1 X 280 lbs P_2O_5/acre manure or compost					28
Application Method	No application 0	Injected 2	Incorp. within 5d 4	Surface Apr-Nov 8	Surface Dec-Mar 16	16
					Total Site Value	46.5

Figure 6. Source factors in Maryland's P-index with values assigned (last column) based on the particular example

Factor	P-index Rating					Value
Erosion	2 X 0 tons soil loss/acre-yr					0
Runoff Class	Very Low 0	Low 2	Medium 4	High 8	Very High 16	4
Tile Drainage	Very Low 0	Low 2	Medium 4	High 8	Very High 16	0
Vegetated Buffer	> 30 ft permanent 0	10-30 ft no P <30 ft 2	10-30 ft 4	< 10 ft no P <30ft 8	< 10 ft 16	16
Waterbody Sensitivity	Very Low 0	Low 2	Medium 4	High 8	Very High 16	8
					Total Site Value	28

Figure 7. Transport factors in Maryland's P-indes with values assigned (last column) based on the particular example.

http://www.ga.nrcs.usda.gov/ga/gapas/cps_ga.htm.

Peterjohn, W.T. and D.L. Correl. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. Ecology 65:1466-1475.

U.S. EPA. 1996. Environmental indicators of water quality in the United States. EPA 841-R-94-002. USEPA. Office of Water (4503F). U.S. Govt. Printing Office. Washington, D.C.

Manure Storage and Treatment Systems

John W. Worley

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minimize seepage of nutrients into the ground below, and will present a minimum risk of overflow into surface waters.

Advantages of lagoon storage of manure may include cost per animal unit, ability to store large amounts of manure and/or runoff, treatment of manure to reduce odors, and potential to handle manure with conventional pumping and irrigating equipment. Disadvantages of lagoons may include lack of appropriate soil materials for construction, the need for solids separation or sludge removal equipment if bedding or other non-biodegradable materials are present, aesthetic appearance and/or public perception. In addition, the effluent from a lagoon is less well balanced with crop needs, since nitrogen is released, and phosphorus and potassium remain in the lagoon.

Manure Slurry Storage Systems

Manure slurry storage systems tend to be used when the need for nutrients for crop growth in the area is high since these systems tend to maintain higher levels of nutrients (particularly nitrogen) than do lagoons. Many types of facilities are used to store manure in the slurry form. One type is the under-floor pit in which manure is deposited directly into the pit (usually 6 ft deep or more) through slatted floors. Other slurry manure storage facilities include fabricated or earthen structures. Fabricated manure storage tanks are usually either concrete or coated metal (glass-lined steel). Such tanks may be above ground, or partially or fully below ground. Manure is usually scraped or flushed from the production buildings and may flow into these tanks by gravity or be pumped into the tank from a collection sump or reception pit. Adequate agitation is necessary to suspend solids and facilitate complete removal of the contents of these manure tanks. If needed for odor control, fabricated tanks are usually the least costly to cover.

Slurry manure may also be stored in earthen structures or basins. Because storage volume can usually be obtained at less cost in an earthen basin than in a fabricated facility, these facilities are often used when manure and wastewater volumes are relatively large due to wash-water use or lot runoff. Earthen structures require a relatively high degree of planning and preliminary investigation to ensure that proper soil materials are available to create a seal and that the seal is constructed properly. These facilities are basically similar to lagoons, but smaller since less water is added to the manure. Space requirements are greater with earthen structures than fabricated manure storage tanks due to the required berms and front/back slopes that have structural integrity and can be properly maintained. Maintenance requirements may be greater with earthen structures due to the need for maintaining and mowing a vegetative cover on the berm area and keeping it free of weeds, trees, and shrubs. Agitation is equally important in earthen structures, and access points for agitation and pumping should be part of the design plan. Some earthen storage units are partially or completely lined with concrete and built with an access ramp so that loading and hauling equipment can enter the basin. Earthen storage structures are more difficult to cover than tanks if odor control is needed. Odor is generally a greater problem in slurry storage structures than in a properly operating lagoon, but if coverage is necessary, it is less costly in a slurry storage facility because of the smaller size.

Advantages of storing manure in the slurry form may include less volume (higher solids content compared to a lagoon), adaptability to tank storage either under floor or above ground, possibility of covering the manure storage facility to reduce odors, higher nutrient retention, and the lagoon on a uniform basis, maintaining proper vegetation on berms, regular inspections and maintaining safe levels in the lagoon are necessary to provide safe, efficient operation.

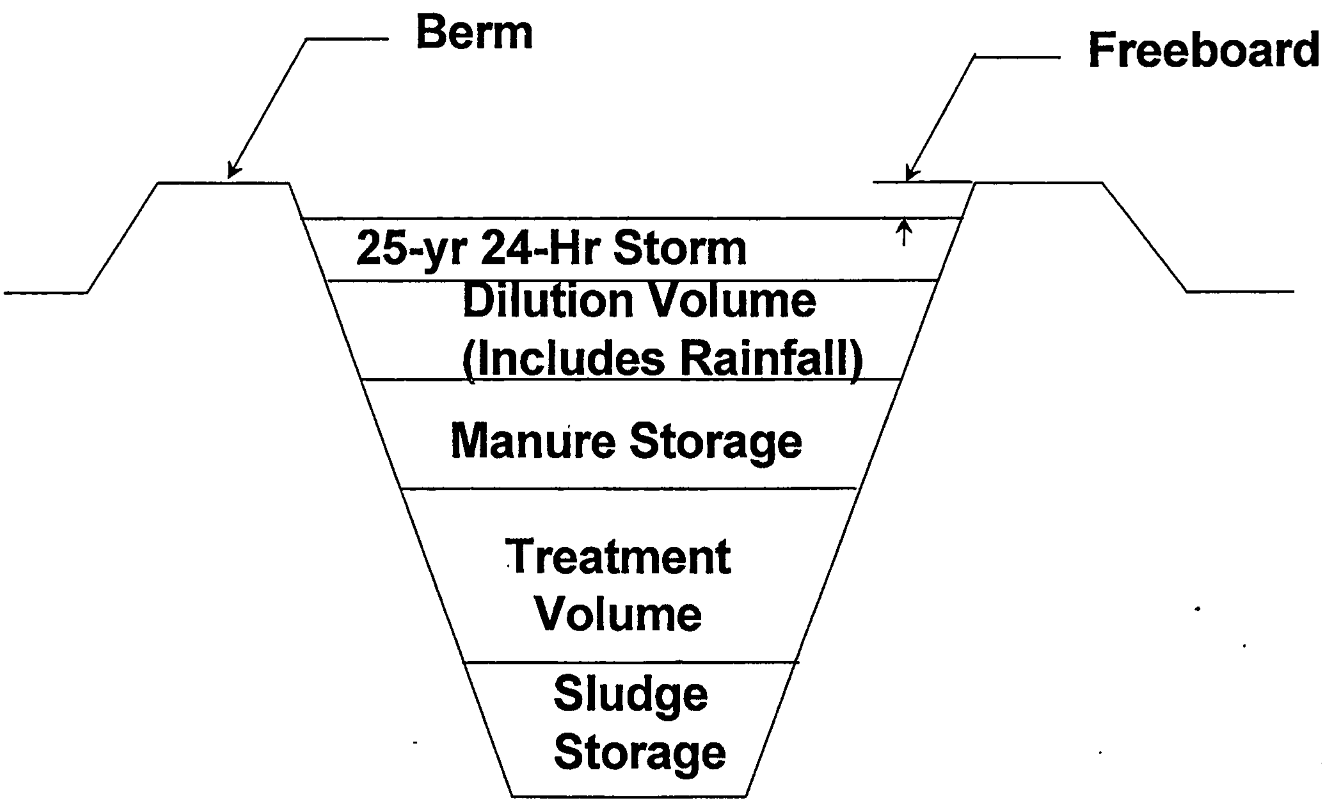


Figure 1. Capacities that must be included in a proper lagoon design.

Lagoons must be designed by a properly trained engineer (NRCS or consulting engineer). The berms (walls) must be designed to be stable under load and the lagoon must be properly lined with either a compacted clay or synthetic liner to prevent leakage into ground water. The owner/operator should understand the limitations of the system, and how the expansion of animal numbers will prevent the lagoon from operating properly. He/she should know the capacity of the lagoon, how many animals it is supposed to handle, how often it should be pumped down, and to what level it should be pumped down. Any major expansion or change in the operation of a facility would require a reassessment by the design engineer.

Manure Slurry Storage

The actual size of a manure slurry storage structure needed depends upon the same factors used in sizing a lagoon with the notable exception that no treatment volume of water must in it. Assistance on building design is available from the NRCS or the Cooperative Extension Service Plan Service. Concrete floors are recommended, but clay floors are acceptable if mortality composting is not to be done in the facility.

Storage of manure in stacks outside a building should be avoided. Stacks can be covered with plastic which will protect them from leaching while in place, but when the stack is removed and spread on a field, it is almost impossible to remove all of the material, and the remaining manure can leach into the soil. Experience has shown that the most highly contaminated areas on a poultry farm is around old stacks and at the entrance to the houses where spillage occurs when houses are cleaned out.

Settling basins for separating solids should be designed to be structurally sound and to be large enough to provide flexibility in the timing of manure application from the basin. Again, assistance can be gained from the NRCS or Cooperative Extension Service Plan Service.

Effects on Nutrient Management

The amount of nutrients available for use on crops is affected by the method used to store manure, as well as the application method. In estimating the total amount of nutrients available for use annually, the total nutrients excreted must be adjusted for storage and application losses. When applying material from an aerobic lagoon for instance, up to 90% of the excreted nitrogen can be lost during the anaerobic treatment of the waste. This nitrogen is lost to the atmosphere primarily in the forms of nitrogen gas and ammonia. There are also losses of phosphorus and potassium, but unlike nitrogen, these nutrients (especially phosphorus) accumulate in the sludge layer of the lagoon, which must eventually be removed and applied to the land unless some arrangements can be made to remove the sludge from the farm. For this reason, 90 to 95% of excreted phosphorus and potassium should be accounted for in the overall farm nutrient management plan. Five to 10% may be lost in moving the waste material (spillage when loading, leaching when stored outside, etc.) Table 1 shows estimated available nitrogen after storage losses as a percentage of total nitrogen produced for various species and storage methods.

Table 1. Estimated available nitrogen after storage losses (% of total nitrogen produced) for different systems.

Management System	Dairy	Poultry	Swine
Anaerobic Lagoon	20-35	20-30	20-30
Manure Slurry Storage	65-80		70-75
Manure Stored in Pit Beneath Slats	70-85	80-90	70-85
Manure and Bedding in Covered Storage	65-80	55-70	
Manure stored in open lot	70-85		55-70

Operation and Monitoring of Lagoons and Slurry Storages

Lagoons combine storage and treatment functions and thus are more sensitive to management inputs than are solid or slurry facilities. The establishment and maintenance of desirable microbiological populations in lagoons requires more specific procedures in the way lagoons are loaded and monitored.

Startup and loading procedures

Lagoon startup is a very important factor in developing a mature lagoon that has an acceptable odor level and will perform in the expected manner over the long term. Lagoons are designed with a "treatment volume" that provides an environment for development and maintenance of a bacterial population that degrades and stabilizes manure. The size of the treatment volume is based on a volatile solids (VS) loading rate, which depends primarily upon temperature. Volatile solids are the "non-mineral" or organic solids in manure that are subject to bacterial degradation. At warmer temperatures, bacteria are more active and VS loading rates are higher. The converse is true for cooler temperatures. For the bacteria to develop and function properly, the actual VS loading rate should be as designed. The proper VS loading rate is achieved only if the lagoon contains a volume of water equal to the treatment volume at startup. A lagoon with only one-tenth of the treatment volume filled at startup will experience an "overload" by a factor of 10 (VS loading rate is ten times greater than designed). Therefore, it is very important to plan a procedure to have sufficient water in a lagoon at startup. The treatment volume should be used as a target. Achieving this goal may require identifying a water source (pond, lake) and implementing the needed pumping procedures to transfer the desired volume of water to the lagoon. Since bacteria are more active at warmer temperatures, consideration should be given to starting a lagoon in the spring or early summer. In this way, bacteria will have a warm season to establish themselves before activity slows during the winter. Spring startup of lagoons often requires special planning of construction schedules and animal procurement.

Problems associated with insufficient volume at startup include excessive odor and high rates of sludge buildup. A lagoon that is started with insufficient volume may take years to recover and may never attain an operating state equal to a lagoon that is started properly.

In addition to startup, long-term loading procedures are critical to lagoon performance. A somewhat common and unfortunate practice in the livestock industry is to expand animal numbers without expanding lagoon size. This results in a proportionate increase in VS loading, and the associated problems can be expected to develop. Volatile solids loading should not be increased beyond the design loading. Alternatives to reduce VS loading (or expand animal numbers) include solids separation, construction of additional lagoon volume, or pretreatment of manure. Lagoons should also receive manure in a consistent manner (no "slug" loading). This is usually accomplished in modern production systems utilizing hydraulic transport of the manure to the lagoon.

Salt and Nutrient Levels, Testing

Bacterial activity is somewhat sensitive to salt levels in the lagoon. Salts are a natural byproduct of the biological degradation of manure. The removal of some salts as the lagoon is discharge into at least 4 feet of liquid, which may require a supporting structure for the end of the pipe. Concrete or rock chutes should be used with inlet pipes that discharge onto the liner surface. Agitation is also an activity that can damage liners. Care should be taken to operate agitators a sufficient distance above the liner so that liquid velocities are reduced enough to ensure that erosion does not occur. Heavy or unusual rainfall events can also erode liners, and special attention should be given to liner inspection after such storm events.

Logbooks and record keeping

Certain data and record keeping involving manure storage structures can aid in overall maintenance and management, and is also evidence of responsible operation and good record keeping. In addition to the periodic inspections, manure levels in a storage structure should be monitored and recorded. This data can illustrate the effects of excessive rainfall and lot runoff, and help in planning pump-down or other land application activities. Manure levels should be observed and recorded frequently enough to provide a "feel' for the rate of accumulation, and pumping activities should be scheduled accordingly.

When a lagoon is pumped or other manure storage structure is emptied, the date of the activity should be recorded along with the volume or amount of manure removed, locations where the manure is spread, and the nutrient content (lab analysis) of the manure. Calibration of pumping equipment is necessary to accurately estimate amounts pumped. This information may be required by the regulatory agency for interim or year-end reports, or may be useful in the event of litigation.

Pump-down or Manure-Level Markers

Pump-down or manure-level markers, or indicators, are a simple but important component of a manure storage facility. Such a marker enables the operator to ascertain quickly and easily the degree of fill of the manure storage facility, the point at which pumping or emptying should begin, and the point at which it should end. The presence of a durable, easily read marker gives inspection or regulatory personnel confidence that a manure storage facility is being managed properly.

Experience has shown that pump-down markers must be made of durable materials and properly installed to afford the long life needed. The operator or inspector should be able to ascertain the following information when observing a pump-down marker:

- When pumping operations should begin and end
- Level at which overflow will occur
- Fraction of total storage that is currently filled

A common practice is to install steel fence posts at the upper and lower pump-down levels for earthen impoundments. While this approach provides basic information on beginning and ending pump-down, experience has shown that more knowledge is needed. Also, fence posts installed in this manner are subject to damage and displacement. A good pump-down marker will indicate the level, or elevation, of manure throughout the possible range (from lower pump-down level to overflow, or spillway) in the storage facility. Experience has shown that a 6" x 6" treated wood pole properly imbedded makes a good pump-down marker. Notches or

Aesthetics and appearance

Aesthetics and appearance may not be critical factors in protecting the environment or complying with environmental regulations. However, these characteristics are major factors in the perceptions formed by the general public, tour groups, regulatory or inspection personnel, and others who may not be intimately associated or familiar with the livestock industry. Therefore, aesthetics and appearance should be given major priority for the overall benefit and viability of animal agriculture.

The general cleanliness and sanitation characteristics of a livestock enterprise are often perceived as a measure of the concern of that enterprise for environmental stewardship and environmental compliance. A clean, well-landscaped production area will project a positive image for the operation, while the presence of debris, litter, and poorly maintained buildings will project a negative image. Typical items of concern for livestock production enterprises include leftover construction debris or refuse; old, unused vehicles; worn-out equipment; rusted equipment from the buildings (farrowing crates, pen dividers, feeders); torn and worn-out ventilation curtains; and loose roofing panels, etc. All livestock production operations experience animal death loss. A specific plan managing animal mortalities should be developed and implemented. The visual and olfactory perceptions generated by the presence of dead animals in or around the production facility are highly offensive and likely will be attributed to the industry as a whole by the general public. Additionally, poorly managed mortalities represent a very real health and disease risk to the enterprise.

Few activities undertaken by the producer are as effective as frequent mowing in conveying a positive image of livestock production. Producers who maintain "front yard quality" around the production and manure storage facilities provide a powerful first impression of pride and responsibility. Conversely, the presence of tall grass, weeds, shrubs, and trees in undesirable locations creates an impression of laxity and disrespect for environmental responsibility. Regulatory personnel inspect most livestock production and manure storage facilities at some interval. If tall grass, weeds, brush, and trees hamper the inspector, a positive report is an unlikely outcome. Routine inspections for seepage, rodent burrowing, erosion, or other damage are much more effective if the areas have been mowed at regular intervals.

Control of Surface Water

As confined production units become larger, control of surface water in the production area is a primary concern. Wider, longer buildings, placed relatively close together, create high rates of discharge from roof and paved areas. Special considerations and landscaping are needed to manage this water in a manner that does not create erosion and unwanted ditches and washed-out culverts or waterways. A surface water management plan should be developed based on a design storm event, expected runoff rates, soil types and erosive velocities, and properly designed and vegetated channels for carrying surface water away from the production area. Some states may require that surface water from production areas be contained and/or checked for contaminant levels before discharge to a watercourse.

Management Options

After emptying, there are three options available:

1. The structure can be refilled and reclaimed for other uses. In this case, berms should be removed and the land restored to approximately its original contours. Fill material and compaction should be sufficient so settling and ponding does not occur. Surface water should be diverted from the site, and a growing crop or sod should be established on the fill's surface.
2. The berm can be breached. In this case, the sides of the breach should have at least a 3 to 1 (horizontal to vertical) side slope and the breach must be deep enough to prevent ponding inside the structure. A cover crop should also be planted and maintained on all exposed areas.
3. The structure can be converted to a pond for use as temporary irrigation storage, aquaculture, or for livestock watering if the structure of the berms is adequate for these purposes. The NRCS can be contacted for help in assessing the adequacy of the design. If they did the original design, this should be a relatively simple matter. For fish production or livestock watering, water quality tests should be done to assure safety before using the structure for these purposes. Nitrate nitrogen levels should be below 30 ppm before allowing livestock to drink the water. It may be necessary to install an emergency spillway if this was not included in the original design.

Summary

Lagoons, manure slurry storage structures, and dry systems each have advantages and disadvantages. Lagoons reduce the nitrogen and organic matter in the waste stream by volatilizing them (converting them to gases and moving them into the air.) They also reduce the odor released compared to a slurry storage, but they are more expensive because of their larger size and must be carefully managed to maintain a healthy bacterial population. Slurry storage structures are smaller (do not include treatment volume or sludge storage), conserve more nutrients in the waste, and are easier to cover if necessary, but they tend to produce more odor if not covered. Dry systems keep manure in a concentrated form making it more transportable and less likely to flow into surface waters, but it must be handled as a solid which usually requires more labor than liquid systems which can use automated pumps. Solids separation devices remove much of the solids going into a liquid system and thus reduce the required volume for treating the waste, but they do require a large financial investment and require two types of manure handling equipment (liquid and dry). Whichever type of system is used, it is important to understand that it cannot perform as designed unless it is managed properly. For a lagoon, that includes starting it about 1/3 full of water before waste is added, preferably in the Spring, loading it evenly, and maintaining the level between the minimum and maximum levels. For a slurry storage, it includes cleaning it out on a regular schedule, according to crop needs, and minimizing the amount of water entering the storage. Solids separating systems must have the solid fraction removed regularly (within the flexibility provided in the design) in order to keep them operating properly, and mechanical systems must be regularly maintained to avoid break downs.

Appendix A
Monthly Manure Storage Facility Checklist

Farm:____________________________ Facility ID:____________________________

Inspected by:______________________________________ Date:________________

Manure Level

Manure level today: (Distance below maximum fill level)__________ft.

Last observation:______________ft. Date:________

Earthen Storage Facilities

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Are embankments well-sodded with no bare areas?	Yes	No	
Are embankments free of trees or woody shrubs?	Yes	No	
Does the berm or embankment have a consistent elevation (i.e., no low or settled areas other than the planned spillway)?	Yes	No	
Is the spillway free of erosion?	Yes	No	
Are all berms and embankments free of erosion?	Yes	No	
Is the base of the embankment free of soggy, damp areas and other evidence of seepage or leaks?	Yes	No	
Are the embankments free of burrowing or other rodent damage?	Yes	No	
Is the liner free of damage due to rainfall, wind, or wave action?	Yes	No	
Is the liner free of erosion damage around inlet/outlet pipes and agitation points?	Yes	No	
Does the lagoon contain at least the minimum volume for treatment?	Yes	No	

Concrete/Steel Tanks

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Are tanks free of visible cracks or structural damage in walls or foundation?	Yes	No	
Is the area around the tank free of seepage or other evidence of leakage?	Yes	No	
Is the manure loadout area free of spills or accumulations of manure?	Yes	No	
Does surface water properly drain away from the manure tank?	Yes	No	

Diversions

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Is roof water and field runoff diverted?	Yes	No	
Are diversion ditches adequately sized to handle runoff without overtopping?	Yes	No	
Are diversion channels vegetated and free of erosion?	Yes	No	
Is storage available in secondary containment structures if required?	Yes	No	
Is there adequate drainage of surface water around production buildings and manure storage facilities?	Yes	No	

Components

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Are level markers properly installed and easy to read?	Yes	No	
Are manure inlet pipes submerged and properly supported?	Yes	No	
Are drains, sewer lines, and cleanouts in good condition and operating properly?	Yes	No	
Are perimeter drains or tiles open and functioning?	Yes	No	
Are recycle pumps, valves, controls, and pressure lines operating properly?	Yes	No	

Appearance

Item	Low Risk	Potential Problem	Corrective Measures Taken/Planned
Is the manure storage site neat and recently mowed?	Yes	No	
Is the manure storage site free of refuse, debris, unused materials, and junk?	Yes	No	
Is the manure storage site screened by visual barriers, and are these barriers maintained?	Yes	No	
Is the manure storage site free of carcasses, afterbirth, or medical wastes?	Yes	No	
Is the manure storage site properly fenced and marked?	Yes	No	
Is the lagoon purple and actively bubbling?	Yes	No	
Is the manure storage surface free of excessive floating materials or vegetation growth?	Yes	No	

Land Application of Animal Manure

Dr. Mark Risse

This lesson and the material in it are adapted from the National Animal and Poultry Waste Management Curriculum Lessons 30 through 36.

Intended Outcomes

The participant will:

- Understand key considerations in selecting and managing land application sites
- Identify activities related to timing of applications that may lead to higher environmental risk
- Become familiar with various land application systems and methods
- Understand the importance of equipment calibration
- Identify appropriate land application BMPs for their farm
- Develop procedures for proper record keeping for land application systems

Introduction

As agricultural producers strive to develop a more sustainable agriculture, the potential of animal manure to recycle nutrients, build soil quality, and maintain crop productivity becomes more important. At the same time, however, the nature of modern animal agriculture, with its highly concentrated production facilities and reliance upon feed supplements to maintain animal health and productivity, has raised serious questions about the effects of animal manure on the quality of our soil, water, atmosphere, and food supply. Because land application is the only practical alternative for much of animal-based agriculture, the cornerstone of most manure management programs will be a solid understanding of how animal manure and manure-amended soils affect agricultural production and the surrounding environment. The soil is a very effective manure treatment system if manure is applied at the proper rate, time, and location. While farm operators that need the nutrient resource in manure tend to use it better, even those that are using land application as a waste disposal practice can do it in an environmentally sound manner provided they know the impacts of their practices.

Manure utilization planning is a two-part process. In the last section we covered the first component which focused on developing a general cropping plan and estimate the number of acres needed to properly land apply the manure. The second component can be referred to as the *annual plan.* The annual plan refers to the actual implementation of the strategic plan. It covers such things as the planned times for manure applications, the manure application methods, best management practices, and records of manure applications and crop yields.

Selecting and Managing Land Application Sites

The importance of selecting the best site to apply manure cannot be over emphasized. Site selection is one of the major factors that directly affect the success of an operation. Spend the time up front selecting the best sites so that future, potentially expensive environmental problems and adverse public relations can be avoided. Even though the site may look good initially, its use may result in problems that could easily have been avoided by choosing another site.

Animal manure should not reach wetlands or surface waters of the state by runoff, drift, manmade conveyances (such as pipes or ditches), direct application, or direct discharge during operation or land application. Manure should not be applied to saturated soils, during rainfall events, or when the soil surface is frozen. Slopes steeper than 6% should also be unless there is

Table 1 Field assessment for manure application.

CATEGORY		Field # ____ *Points*
1. Planned crop (check one)		
a. Continuous corn or corn not following legume	10	
b. Second-year corn following legume	8	
c. First-year corn following legume	1	
d. First-year corn following nonforage legume	8	
e. Nonforage legume	2	
f. Small grains (for grain)	6	
g. Small grain with seeding (removed as grain)	2	
h. Small grain with seeding (removed as hay or silage)	4	
i. Prior to direct seeding legume forage	8	
j. Topdress (good legume stand)	1	
k. Topdress (fair legume stand)	2	
l. Topdress (poor legume stand)	3	
m. Grass pasture or other nonlegumes	6	____
2. Soil test P (check one for each category)		
1. > 200 lbs/acre	1	
2. 100–200 lbs/acre	3	
3. 30–100 lbs/acre	5	
4. < 30 lbs/acre	10	
3. Site/soil limitations (check one for each category)		
a. Surface or groundwater proximity		
1. Applied and incorporated within 10-year floodplain or within 200 feet of surface water or groundwater access	1	
2. Application outside these restrictions	5	
b. Slope		
1. Slope > 12%	1	
2. Slope 6-12%; > 12% (incorporated, contoured, or terraced)	3	
3. Slope 2–6 %; 6-12% (incorporated, contoured, or terraced)	5	
4. Slope < 2%; <6% (incorporated, contoured, or terraced)	10	
c. Soil texture		
1. Sands, loamy sands	1	
2. Sandy loams, loams/sands, loamy sands; spring applied	3	
3. Other soils/sandy loams, loams, clays, spring applied	5	
d. Depth to bedrock		
1. 0–10 inches	0	
2. 10–20 inches	1	
3. > 20 inches	5	+ ____
4. Total Points (higher field score = higher priority for land application)		= ____

applied to an actively growing crop or within 30 days of planting a crop. If crops for human consumption are to be grown, manure should not be applied in the three weeks before harvest. Timing is most important for nutrients applied to soils with a high leaching potential. Applying nitrogen to a sandy soil when there is no crop to remove it will almost certainly result in loss of nitrogen to the shallow groundwater. Recommendations that are used for fertilizer nitrogen conservation (reduced leaching) should also be used for manure nitrogen. Manure that has primarily organic N can be successfully applied in the fall, prior to spring planting, if erosion and runoff control measures are in place but the losses will be greater.

In some cases, manure storage capacity dictates the frequency of manure applications. Low manure storage capacity will require frequent applications and year-round cropping systems, while larger storage volumes may allow less frequent applications to a single crop. Many storage structures are designed for 180-270 days of temporary storage. If the same fields are to be used, this means an actively growing crop must be present in both summer and winter. Double cropping or overseeding of perennial forages can be used to accomplish this, but a higher level of management is required to make this system work properly. For existing facilities, the temporary storage volume should be known, or can be calculated, and used to determine the number of days of temporary storage. Because manure production and storage capacity determine the maximum amount of time between manure applications, these factors strongly influence crop selection.

As seen in Figure 1, there are several months during the year when most crops are dormant. For example, bermudagrass is dormant in January and February, and growth is "slow" during March, November, and December. If the crop is not actively growing, there is little or no nutrient uptake. In this situation, any nitrogen applied to the bermudagrass field could leach through the soil and move down towards the water table. Consequently, land application is not generally recommended during dormant periods.

The risk of encountering an emergency situation can be significantly reduced by utilizing a cropping system that provides the flexibility of extending the application season throughout most of the year. For example, if bermudagrass is overseeded with rye in the winter, you have a cropping system in place that can accept some manure during every month in most years. There may still be one or two consecutive months when fields are too wet to apply manure. In a bermudagrass/rye cropping system, the peak storage duration in the lagoon is only for the wet weather period, rather than the five months or longer required if only bermudagrass is being grown.

Selecting the Appropriate Application Method

An environmentally friendly land application system for manure will require careful review of the equipment and management procedures previously used. Critical to this approach is the producer's willingness to treat manure or other livestock by-products as a nutrient resource and not as a waste. Manure application equipment must be selected and managed as fertilizer-spreading equipment as opposed to waste disposal equipment. Efficiency of manure nutrient use will need to be a producer's primary objective.

The proper location and selection of application sites and equipment are no assurance that problems will be eliminated. Manure spreading or spraying activities must be planned and managed to prevent adverse impact on the groundwater, surface water, nuisances, public health, and plants. Here are some considerations in selecting application equipment.

of manure. The ammonium fraction, originally representing roughly half of the potentially available nitrogen, is lost by long-term open lot storage of manure, anaerobic lagoons, and surface spreading of manure. Systems that conserve ammonium nitrogen and provide nutrients more in balance with crop needs increase the economic value of manure.

Odor Nuisances. Odor nuisances are the primary driving factor of more restrictive local zoning laws for agriculture. Application systems that allow you more flexibility in application timing and location can reduce odor nuisances. Manure application systems that minimize odor deserve consideration and preference where neighbors live close to application sites.

Soil Compaction. Manure spreaders are heavy. The manure alone in a 3,000-gallon liquid manure tank weighs more than 12 tons. In addition, manure is often applied at times of the year, late fall and early spring, when high soil moisture levels and the potential for compaction are common. Impact of manure application on potential soil compaction deserves consideration.

Table 3. Environmental rating of various manure application systems.

	Uniformity of Application	Conservation of Ammonium	Odor	Compaction	Timeliness of Manure Application
Solid Systems					
Box spreader: tractor pulled	Poor	very poor	fair	fair	poor
Box spreader: truck mounted	Poor	very poor	fair	fair	fair
Flail-type spreader	Fair	very poor	fair	fair	poor
Side-discharge spreader	Fair	very poor	fair	fair	poor
Spinner Spreader	Fair	very poor	fair	fair	fair
Dump truck	very poor	very poor	fair	poor	fair
Liquid Systems: Surface Spread					
Liquid tanker with splash plate	Poor	poor	poor	poor	fair
Liquid tanker with drop hoses	Fair	fair	good	poor	fair
Big gun irrigation system	Good	very poor	very poor	excellent	excellent
Center pivot irrigation system	Excellent	very poor	very poor	excellent	excellent
Liquid Systems: Incorporation					
Tanker with knife injectors	Good	excellent	excellent	poor	fair
Tanker with shallow incorporation	Good	excellent	excellent	poor	fair
Drag hose with shallow incorporation	Good	excellent	excellent	good	good

Equipment Calibration

You can avoid the potential adverse effect on ground and surface water caused by over fertilization by applying only the amount of manure, effluent, or wastewater necessary to maintain soil fertility for crop production. A nutrient management plan is of little use if the designed application rate can not be met. Calibration of manure-application equipment is

- Uniformity of manure application is critical for fertilizer applicators. Variations in application rate both perpendicular and parallel to the direction of travel are common.
- Transport speed and box or tank capacity impact timely delivery of manure. Often 50% or more of the time hauling manure is for transit between the feedlot or animal housing and field. Truck-mounted spreaders can provide substantial time savings over -pulled units for medium- and long-distance hauls. Trucks used for manure application must also be designed to travel in agriculture fields. Available four-wheel drive and duel or flotation-type tires should be considered for trucks that will apply manure. Increased box or tank capacities speed delivery. Spreaders must be selected to move and apply manure quickly.
- Ammonia losses are substantial for solid manure application that is not incorporated. Most of the ammonia nitrogen, representing between 20% and 65% of the total available nitrogen in manure, will be lost if not incorporated within a few days. Practices that allow for incorporating manure into the soil on the same day as applied will reduce ammonia losses and increase nitrogen available to crops.

Calibrating Manure Spreaders

Calibration of your spreader is a simple, effective way of improving utilization of nutrients in manure more effectively. Only by knowing the application rate of your spreader can you correctly apply manure to correspond to your crop needs and prevent water quality problems. Applicators can apply manure, bedding, and wastewater at varying rates and patterns, depending on forward travel and/or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. Calibration defines the combination of settings and travel speed needed to apply manure, bedding, or wastewater at a desired rate and to ensure uniform application. A brief calibration procedure is given below. An extension publication is also available at: http://www.ces.uga.edu/pubcd/C825-W.HTML

Solid and Semisolid Manure Spreaders

To calibrate a spreader for solid manure (20% or more solids), the following materials are needed:

1. Bucket
2. Plastic sheet, tarp, or old bed sheet. An even size, 8 feet by 8 feet, 10 feet by 10 feet, or 12 feet by 12 feet, will make calculations easier.
3. Scales

Solid and semisolid spreaders are rated by the manufacturer either in bushels or cubic feet (multiply bushels by 1.25 to get cubic feet). Most spreaders have two rating capacities: (1) struck or level full and (2) heaped. Calibration of solid manure spreaders based on its capacity (volume) is difficult to estimate accurately because the density of solid and semisolid manure is quite variable. Density is the weight of the manure per volume of manure (pounds per cubic foot). Manure density varies depending on the type and amount of bedding used as well as its storage method. Therefore, if you estimate spreader application rates as the volume of the manure the spreader holds, you are overlooking the fact that some manure weighs more than other manure. This can cause a significant error when calculating manure application rates.

Since manure and litters have different densities, an on-farm test should be done. To determine the load (tons) of a manure spreader,

Table 4. Calibration of solid manure spreaders.

Pounds of Manure Applied to Sheet	Tons of Manure Applied/Acre		
	Size of Ground Sheet		
	8' × 8'	10' × 10'	12' × 12'
1	0.34	0.22	0.15
2	0.68	0.44	0.30
3	1.02	0.65	0.45
4	1.36	0.87	0.61
5	1.70	1.09	0.76
6	2.04	1.31	0.91
7	2.38	1.52	1.06
8	2.72	1.74	1.21
9	3.06	1.96	1.36
10	3.40	2.18	1.51
15	5.10	3.27	2.27
20	6.81	4.36	3.03

Many times it may be necessary to adjust the rate in which waste is applied from the way it is normally spread. Changes in application rate can be accomplished by increasing or decreasing the speed at which the waste is being applied. To perform these calculations, the spreader load (tons), duration of application (minutes), and the average width (feet) of a normal application needs to be known. The application rate and travel speed can be found using the following equations:

$$\text{Application rate (tons/acre)} = \frac{\text{spreader load (tons)} \times 495}{\text{time (min)} \times \text{width (ft)} \times \text{travel speed (mph)}}$$

$$\text{Travel speed (mph)} = \frac{\text{spreader load (tons)} \times 495}{\text{time (min)} \times \text{width (ft)} \times \text{application rate (tons/acre)}}$$

Example #1:
What is the application rate (tons per acre) if you collect 8.5 pounds of manure on a 10-foot by 10-foot tarp during a calibration run?

$$\text{Application rate (tons/acre)} = \frac{8.5 \text{ lb manure} \times 21.78}{10 \text{ ft} \times 10 \text{ ft}} = 1.85 \text{ tons/acre}$$

Example #2:
What speed should you run if you wish to apply 4 tons of manure per acre with a 3-ton spreader? Your spreader application width is 20 feet, and your spreader empties in 6 minutes.

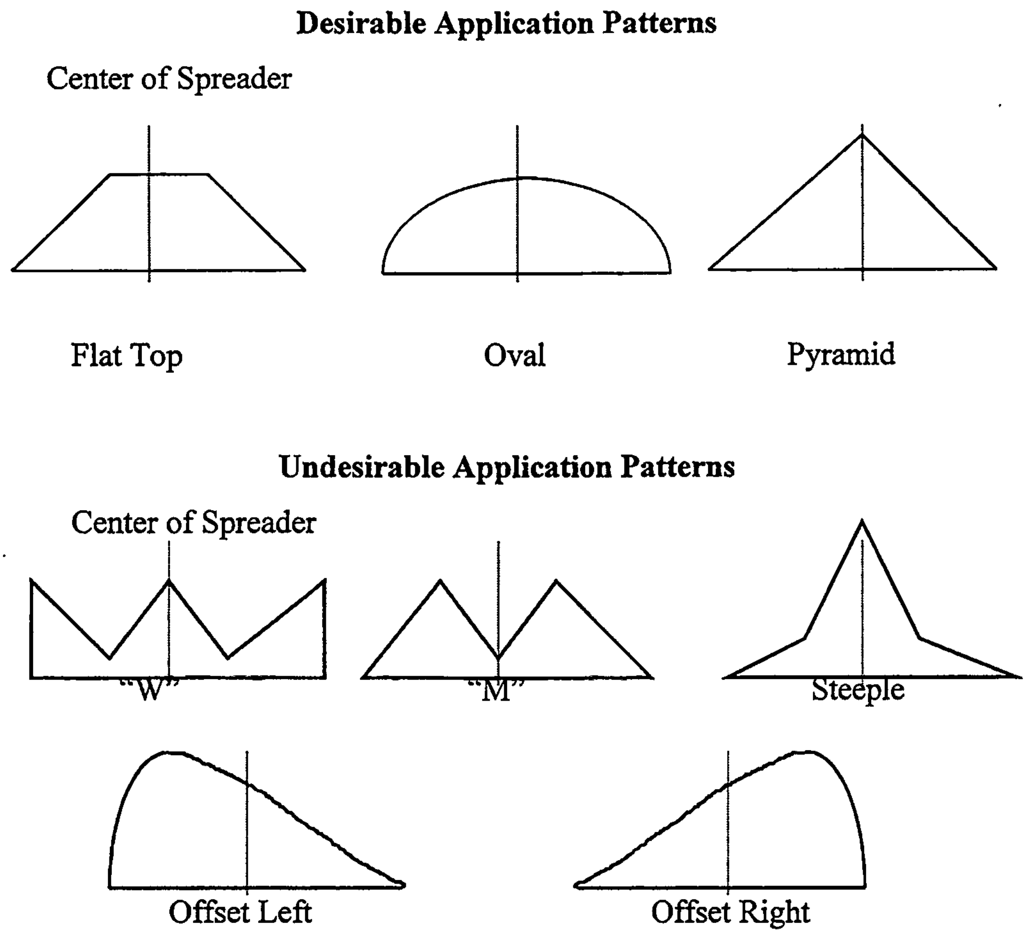


Figure 2. Desirable and undesirable application uniformity.

Hauling Liquid Manure

The standard 2,000- to 4,000-gallon tractor-pulled tanker cannot move manure fast enough for some livestock operations. In some regions, over-the-road tankers are being employed to shuttle manure from the manure storage to the edge of the field. Manure is then transferred to separate liquid application equipment or remote storage. Often, used semi-tractor milk or fuel tankers with capacities of 6,000 gallons or more are purchased for shuttle duty. Prior to implementing this approach, an individual should check licensing and inspection requirements and carrying capacity of local bridges.

Flexible Hose Systems

Pumping of liquid manure from the manure storage to the field is becoming increasingly common. Manure of up to 8% solids is being pumped several miles to a remote storage or field application equipment. Pipe friction is the primary limiting factor. Manure at solids content below 4% can be treated as water in estimating friction losses. An additional allowance for friction loss is required for pumping manure with a solids content above 4%. Manure handling systems that involve addition of significant dilution water or liquid-solids separation equipment provides a slurry that is most appropriate for this application.

Surface Broadcast of Liquid Manure

Surface application of liquid slurries provides a low-cost means of handling the manure stream from many modern confinement systems. Tank wagons equipped with splash plates are commonly used to spread a lot of manure. However, surface application suffers from several disadvantages including

- Ammonia losses. Surface application of slurries results in losses of 10% to 25% of the available nitrogen, due to ammonia volatilization (Table 5).
- Odor. Aerosol sprays produced by mixing manure and air carry odors considerable distances.
- Uniformity. Splash plates and nozzles provide poor distribution of manure nutrients.

A few recent developments attempt to address these concerns. Boom-style application units for attachment to tank wagons or towed irrigation systems are appearing commercially for the first time. These systems use nozzles or drop hoses for distributing a slurry. They offer the opportunity to reduce odor concerns and improve uniformity of distribution.

Table 5. Nitrogen losses during land application. Percent of total nitrogen lost within 4 days of application.

Application Method	Type of Waste	Nitrogen Lost, %
Broadcast	Solid	15-30
	Liquid	10-25
Broadcast with	Solid	1-5
immediate incorporation	Liquid	1-5
Knifing	Liquid	0-1
Sprinkler irrigation	Liquid	0-1

Direct Incorporation of Liquid Manure

Options for direct incorporation of liquid manure are growing (Figure 4). Injector knives have been the traditional option. Knives, often placed on 20- to 25-inch centers, cut 12- to 14-inch deep grooves in the soil into which the manure is placed. Limited mixing of the soil and manure and high power requirements are commonly reported concerns.

Injector knives with sweeps that run four to six inches below the soil surface allow manure placement in a wider band at a shallower depth. Manure is placed immediately beneath a sweep (up to 18 inches wide), improving mixing of soil and manure. Location of the manure higher in the profile minimizes potential leaching and reduces power requirements. Sweeps can be used to apply a higher rate of manure than a conventional injector knife.

Other shallow incorporation tillage implements (s-tine cultivators and concave disks) are increasingly available options on many liquid manure tank wagons. These systems are most commonly used for pre-plant application of manure. Manure is applied near the tillage tool, which immediately mixes the manure into the soil. Speed of application, low power requirements, and uniform mixing of soil and manure have contributed to the growing popularity of this approach. In addition such systems are being used to side dress manure on row crops without foliage damage. Side dressing expands the season during which manure can be applied and improves the use of manure nutrients. All soil incorporation systems also offer the advantage of ammonia conservation and minimal odors.

Example #3:
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 280-feet long. What is the application rate in gallons per acre?

First, figure the coverage area:

$$\text{Coverage area (acres)} = \frac{280\text{ ft} \times 22\text{ ft}}{43{,}560\text{ ft}^2} = 0.14\text{ acre}$$

Then figure the application rate:

$$\text{Application rate for spreader (gal/acre)} = \frac{2{,}500\text{ gal}}{0.14\text{ acre}} = 17{,}857\text{ gal/acre}$$

Drag-Hose Injectors

This method calculates the required speed to travel when pulling a drag hose application system (Figure 5) around the field. If you are not using a flow meter, you will have to operate the system for at least one hour before you can get an accurate reading of what you have removed from the storage tank or basin.

To calculate the required speed, you need to know

- The **volume** applied per hour (in gallons per hour) from a flow meter, the manufacturer's information or the amount removed from manure storage.
- The desired application **rate**, in gallons/acre
- The **width** of application, in feet

$$\text{Speed (miles/hr)} = \frac{8.25 \text{ x Volume/hr.}}{\text{Rate x Width}}$$

Select the appropriate gear in the field tractor to match the calculated speed. If the calculated speed is too fast, you could reduce the volume applied per hour by decreasing the power to the main pump. At the same time, you may also have to reduce the nozzle (or orifice) size to keep adequate pressure in the drag hose. Another way to compensate for an excessive calculated tractor speed is to increase the width of application. This could be accomplished by using a boom-style application.

Example #4:
A custom manure applicator measured pumped manure at a rate of 24,000 gallons per hour. His injector boom is 22 feet wide. He wants to apply 5,500 gallons per acre.

$$Speed = \frac{8.25 \text{ x } 24{,}000 \text{ gal./hr.}}{5{,}500 \text{ gal/acre x } 22 \text{ ft.}}$$

$$Speed = 1.6 \text{ miles/hr.}$$

He selected a gear giving a speed of 1.8 miles per hour.

irrigation lines be flushed with clean water after slurry pumping. With proper management, slurry manure up to 7% total solids can be irrigated.

Over application of nutrients is a concern with slurry irrigation systems. Moving sprinklers frequently helps to avoid this. Thus, traveling irrigators are usually recommended. A properly designed irrigation system provides uniform wastewater application at agronomic rates without direct runoff from the site. However, a "good design" does not guarantee proper land application. Management is also critical. You should be familiar with the system components, range of operating conditions, and maintenance procedures and schedules to keep your system in proper operating condition.

Types of Systems

As with water irrigation, there is no one system that is superior over another system. The following systems can be used for effluent irrigation:

- Stationary volume gun
- Solid set sprinkler
- Traveler
- Center pivot and linear move systems
- Hand-move sprinkler
- Side roll
- Furrow/Flood irrigation

Each of these systems are described in the next few pages. Although the equipment required for pumping and distributing lagoon effluent may be similar to conventional irrigation equipment, the smaller volume of water handled in most livestock lagoons and holding basins generally allows the use of smaller, less costly systems. It also is possible to use an application system for both effluent and fresh water irrigation. The type of irrigation system chosen depends on many farm specific parameters including the particle size of the solids in the effluent, the amount of available capital and how much time and labor is available for pumping, and the land available for application. Nevertheless, knowledge of the potential options available and their advantages and disadvantages could lead you to better decisions.

Stationary Volume Gun

This system can be used in many small effluent application systems. The system includes a pump and a main line similar to the hand-move systems, but with a single or multiple large-volume gun sprinklers. Advantages of the volume gun systems include larger flow rates and a larger wetted area so less labor is required in moving the sprinkler. Some volume guns are wheel mounted to facilitate moving the unit. Stationary volume guns typically have nozzle sizes that range from 0.5 to 2 inches, and operate best at pressures of 50 to 120 psi. Coverage areas of 1 to 4 acres can be obtained with proper selection of nozzle size and operating pressure. Gun sprinklers typically have higher application rates; therefore, adjacent guns should not be operated at the same time (referred to as "head to head"). Although stationary volume guns cost more than smaller hand-carry systems, the reduced labor cost and higher flow rates may offset the higher cost.

A typical volume gun that discharges 330 gpm at 90 psi pressure wets a 350-foot diameter circle (2.2 acres) with an application rate of 0.33 inches per hour. The power requirement is about 30 horsepower. This system requires labor for movement from one set or location to another to ensure that the soil does not become saturated resulting in runoff.

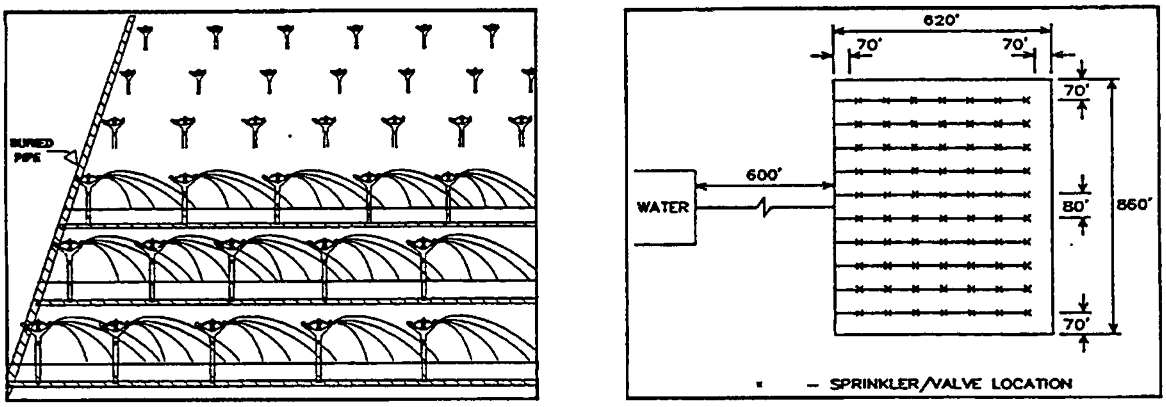


Figure 6. Stationary Sprinkler System

Traveling Sprinklers

Traveling sprinkler systems can be cable-tow traveler, hard-hose traveler, center pivot, or linear-move systems. The cable-tow traveler consists of a single-gun sprinkler mounted on a trailer with water being supplied through a flexible, synthetic fabric, rubber, or PVC-coated hose. Pressure rating on the hose is normally 160 PSI. A steel cable is used to guide the gun cart. The hose-drag 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. Normally, only one gun is mounted on the gun cart. The hose supplies wastewater 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 normally 70% to 80% of the gun-wetted diameter.

The hose drum is rotated by a water turbine, water piston, water bellows, or an internal combustion engine commonly referred to as an auxillary drive unit. 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%, an engine drive should be used.

Nozzle sizes on gun-type travelers are 1/2 to 2 inches in diameter and require operating pressures of 75 to 100 PSI at the gun for uniform distribution. The gun sprinkler has either a taper bore nozzle or a ring nozzle. The ring nozzle provides better breakup of the wastewater stream, which results in smaller droplets with less impact energy (less soil compaction) and also provides better application uniformity throughout the wetted radius. But, for the same operating pressure and flow rate, the taper bore nozzle throws water about 5% further than the ring nozzle, i.e., the wetted diameter of a taper bore nozzle is 5% wider than the wetted diameter of a ring nozzle. This results in about a 10% larger wetted area such that the precipitation rate of a taper bore nozzle is approximately 10% less than that of a ring nozzle.

A gun sprinkler with a taper bore nozzle is normally sold with only one size nozzle, while a ring nozzle is often provided with a set of rings ranging in size from 1/2 to 2 inches in diameter. This allows the operator flexibility to adjust flow rate and diameter of throw without sacrificing application uniformity. However, there is confusion that using a smaller ring with a lower flow rate will reduce the precipitation rate. This is not normally the case. Rather, the precipitation rate remains about the same because while a smaller nozzle results in a lower flow, it also results in a smaller wetted radius or diameter. The net effect is little or no change in the

Furrow or Gated Pipe Irrigation

These systems consist of a pump or gravity flow arrangement from a lagoon storage basin to a distribution pipe that has holes at intervals along its length. Effluent is discharged through the holes at a rate compatible with the land slope and soil infiltration rate. The gated distribution pipe usually is laid as level as possible across the upper end of a sloped soil-plant filter or manure receiving area. Gate pipe systems are suitable for lands from 0.2% to 5.0% slope. Flatter slopes result in ponding or manure at the discharge point of the gated pipe, while steeper slopes cause effluent runoff with little opportunity for infiltration into the soil.

The advantages of gated pipe systems are relatively low cost, low operating pressures, and even distribution of effluent if the holes in the pipe are properly located and sized. The disadvantages of the gated pipe systems are high labor and management to ensure the proper operation of the systems. Gated pipe systems do not perform well on uneven or steeply sloped land. Traditionally, gated pipe has been used to irrigate row crops. However, properly designed and managed gated pipe systems have been successfully used to apply lagoon effluent to grassed areas.

Calibrating Irrigation Systems

Operating an irrigation system differently than assumed in the design will alter the application rate, uniformity of coverage, and subsequently the application uniformity. Operating with excessive pressure results in smaller droplets, greater potential for drift, and accelerates wear of the sprinkler nozzle. 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 wetted diameter. Clogging of nozzles or crystallization of main lines can result in increased pump pressure but reduced flow at the gun. Plugged intakes will reduce operating pressure. An operating pressure below design pressure greatly reduces the coverage diameter and application uniformity. Field calibration helps ensure that nutrients from liquid manure or lagoon effluent are applied uniformly and at proper rates.

The calibration of a hard hose or cable tow system involves setting out collection containers, operating the system, measuring the amount of wastewater collected in each container, and then computing the average application volume and application uniformity.

An in-line flow meter installed in the main irrigation line provides a good estimate of the total volume pumped from the lagoon during each irrigation cycle. The average application depth can be determined by dividing the pumped volume by the application area. The average application depth is computed from the following formula:

$$\text{Average application depth, inches} = \frac{\text{Volume pumped, gallons}}{\text{27,154 (gal/ac-in) x Application area, acres}}$$

The average application depth is the average amount applied throughout the field. Unfortunately, sprinklers do not apply the same depth of water throughout their wetted diameter. Under normal operating conditions, application depth decreases toward the outer perimeter of the wetted diameter. Big gun sprinkler systems typically have overlap based on a design sprinkler spacing of 70% to 80% of the wetted sprinkler diameter to compensate for the declining

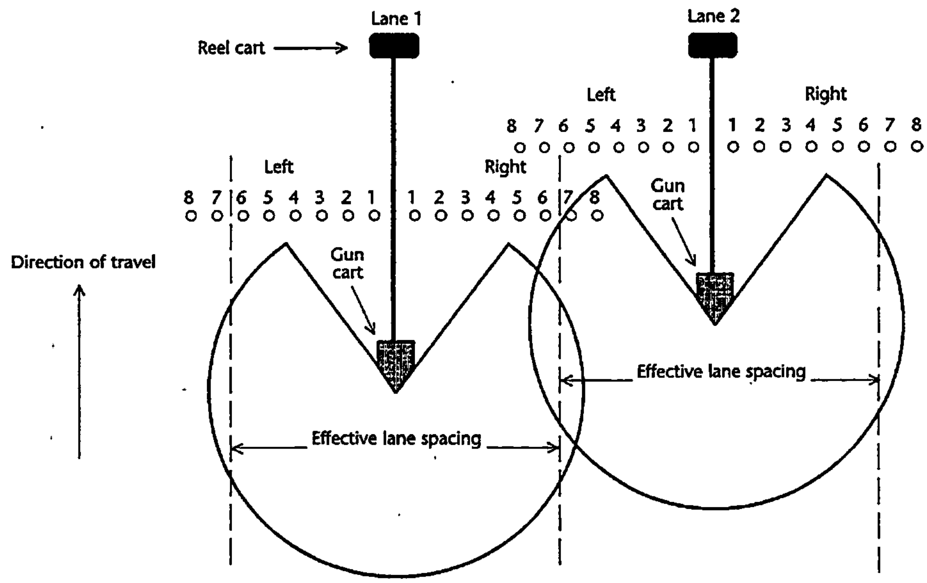


Figure 7. Calibration setup for hard hose travelers.

Calibration Method

1. Estimate the wetted diameter of the gun. Check the actual operating pressure at the sprinkler and verify the nozzle type and size. Determine wetted diameter from manufacturer's charts.
2. Determine the number of collection gauges and spacing between gauges. For a wetted diameter of 320 feet, the rain gauge spacing should not exceed 20 feet (320 ft/16 ≐ 20 ft).
3. Label gauges outward from the gun cart as either left or right (L1, L2, L3, etc; R1, R2, R3, etc.)
4. Set out gauges along a row as labeled and shown in Figure 6, equally spaced at the distance determined in item 2 (20 feet). The row should be at least one wetted diameter from either end of the pull. The first gauge on each side of the travel lane should be ½ the gauge spacing from the center of the lane. For a gauge spacing of 20 feet, L1 and R1 should be 10 feet from the center of the lane.
5. Operate the system for the time required for the gun to completely pass all collection containers. Record the "starting" time when wastewater begins to be applied along the row of gauges, and the "ending" time when wastewater no longer is being applied anywhere along the row. Also record the distance traveled in feet for the time of operation.
6. Immediately record the amounts collected in each gauge.
7. Identify those gauges that fall outside the effective lane spacing. This volume is the overlap volume that would be collected when operating the system on the adjacent lane.

14. Determine the application uniformity. The application uniformity is often computed using the mathematical formula referred to as the Christiansen Uniformity Coefficient (U_c). It is computed as follows:

$$U_c = \frac{\text{Average depth (\#9)} - \text{Average deviation (\#11)}}{\text{Average depth (\#9)}} \times 100$$

15. Interpret the calibration results. The higher the Uniformity Coefficient, the more uniform the application. A value of 100 would mean that the uniformity is perfect; the exact same amount was collected in every gauge.

For travelers with proper overlap and operated in light wind, an application uniformity greater than 85 is outstanding and very rare. Application uniformity between 70 to 85 is in the "good" range and is acceptable for wastewater application. Generally, an application uniformity below 70 is considered unacceptable for wastewater irrigation using travelers. If the computed U_c is less than 70, system adjustments are required. Contact your irrigation dealer or technical specialist for assistance.

Center Pivot

As Figures 8 and 9 show, center pivot and linear move irrigation systems are calibrated by placing one or more rows (transect) of collection containers parallel to the system. For center pivot systems with multiple towers, place the first collection container beside the first moving tower (140 to 180 feet from the pivot point). This will miss the area between the pivot point and first tower, but it is necessary to omit this system through this zone. The area missed will be less than 3 acres and will usually represent less than 10% of a typical sized system. If the system has only one moving tower, place the first container 100 feet from the pivot point tower. Place containers equally spaced to the end of the system. For lateral move systems, place containers throughout the entire length of the system.

Containers should be spaced no further apart than 1/2 the wetted diameter of rotary impact sprinklers, 1/4 the diameter of gun sprinklers, or 50 feet, whichever is less. On systems with spray nozzles, collection containers should be spaced no further than 30 feet. A 20- to 25-foot spacing is generally recommended for all types of sprinklers, which will result in six to eight collection containers between each tower. Collection containers should be placed such that they intercept discharge from a range of lateral distances from the sprinkler (midpoint, quarter point, directly under sprinkler, etc.). This can be accomplished by selecting a catch can spacing different from a multiple of the sprinkler spacing along the lateral. Where end guns are used, the transect of collection containers should extend beyond the throw of the gun.

The system should be operated so that the minimum travel distance exceeds the sprinkler wetted diameter for the containers closest to the pivot point tower. Application volumes should be read as soon as all gauges stop being wetted.

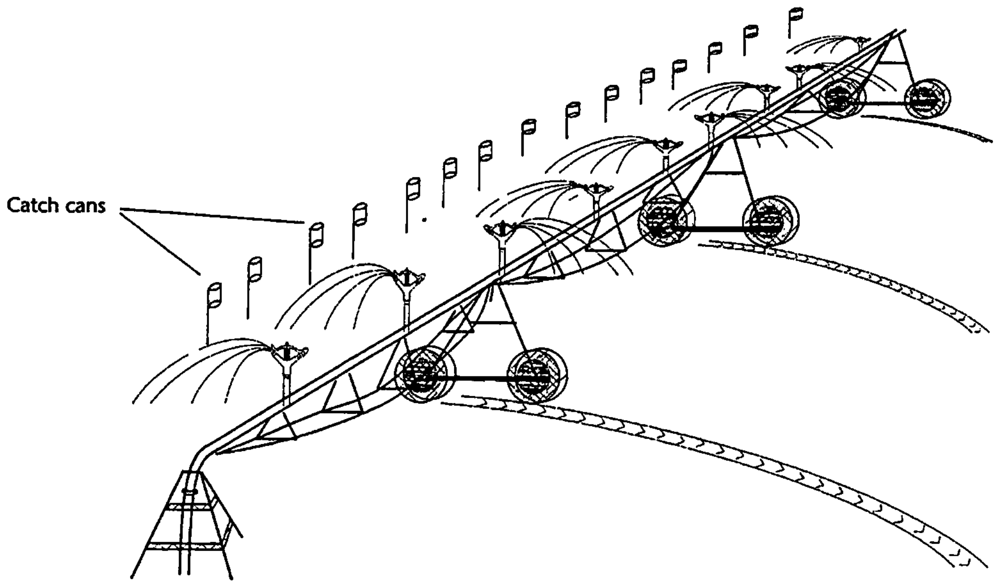


Figure 9. Calibration layout for center pivot irrigation systems.

9. Recompute the average application depth for the "usable" gauges identified in item 8 that fall within the effective width of the system. (Eliminate gauges on the outer end of the system where the depth caught is less than half the average application depth.)

Note: All gauges interior to the "effective width" of the system are included in the computations regardless of the amount caught in them.

10. Compute the reference travel speed and compare to the manufacturer's chart.

$$\text{Travel speed, ft/min} = \frac{\text{Distance traveled, ft}}{\text{Time, min}}$$

11. Calculate the deviation depth for each "usable" gauge. The deviation depth is the difference between each individual gauge value and the average value of all gauges (item 9). Record the absolute value of each deviation depth. (Absolute value means the sign of the number [negative sign] is dropped, and all values are treated as positive).

    Deviation depth = |Depth collected in gauge I – average application depth|

    "I" refers to the gauge number

12. Add amounts in item 11 to get the "sum of the deviations" from the average depth and divide by the number of gauges to get the average deviation.

$$\text{Average deviation depth} = \frac{\text{Sum of deviations (add amounts computed in item11)}}{\text{Number of usable gauges}}$$

13. Determine the application uniformity. The application uniformity is often computed using the mathematical formula referred to as the Christiansen Uniformity Coefficient. It is computed as follows:

$$U_c = \frac{\text{Average depth (item 7)} - \text{Average deviation (item12)}}{\text{Average depth (item 7)}} \times 100$$

All activities within a watershed affect NPS pollution but control of soil erosion is probably the best opportunity for preventing pollution since sediment is not only a pollutant itself, but also carries nutrients and pesticides with it. While soil erosion is a natural process, it is accelerated by any activity that disturbs the soil surface. The amount of soil erosion that occurs is related to five factors; the rainfall and runoff, the soil erodibility, the slope length and steepness, the cropping and management of the soil, and any support practices that are implemented to prevent erosion. Man can do very little to change the rainfall a location receives and has little effect on the natural properties of the soil that affect erosion. However, man can manage to reduce the impact of these factors. For example, increasing the amount of rainfall the goes into the soil (infiltration) is an indirect means of reducing erosion. Knowledge of rainfall patterns will also allow farmers to insure that the soil is protected during the periods of the year when they receive the largest amounts of rainfall. Traditionally, farmers have controlled soil erosion through modifications in slope steepness and slope length and in cropping and management. Since the dawn of agriculture, man has known that longer and steeper slopes produce more soil erosion and has used methods such as the construction of levies and terraces to reduce slope length and steepness. More recently, practices such as strip cropping and vegetated waterway construction have been used to reduce runoff velocities and slope length. Crop canopy and surface cover or residue acts as a buffer between the soil surface and the raindrops, absorbing much of the rainfall energy and ultimately reducing soil erosion. Therefore, crops that produce more vegetative cover, have longer growing seasons, or produce a persistent residue will have less soil erosion. Any cropping system with less tillage or greater amounts of vegetative production, such as perennial systems, will result is less sediment leaving the field.

While most BMPs reduce soil erosion and transport, some BMPs use other mechanisms to reduce the impact of a pollutant. There are three stages to the pollutant delivery process: availability, detachment, and transport. BMPs may be effective by addressing any of these three factors. Availability is a measure of how much of a substance in the environment can become a pollutant. For example, an effective BMP for reducing the amount of animal waste entering surface water may be to simply decrease the amount that you are land applying to an area so that less is available. Once a substance is available; however, it must be detached from the target site to become a pollutant. Pollutants may be detached as individual particles in the water or attached to soil particles. If a pollutant is soluble, then detachment occurs when it is dissolved in water. For example, dry manures applied to the surface are more easily detached than the same amount of liquid manure that has soaked into the soil. Transport is the final link in the pollutant delivery chain. To become a pollutant, the element must travel from the point where it was applied to the surface or ground water. Pollutants are often transported by surface runoff or infiltration, however, this transport can often be reduced through BMPs. For example, using a filter strip to collect sediment before entering a stream is an example of reducing the amount of pollutant transport.

BMPs, when properly carried out, improve water quality. Generally, an animal operation will have a combination of several BMPs. Best management practices relating to manure management are those practices that optimize nutrient uptake by plants and minimize nutrient impact on the environment. They will change over time as technology and understanding of the complex environment improve. Likewise, BMPs are very site specific, and a BMP in one place may not be useful for another location. Key BMPs for land application are listed in Table 10.

A summary of the major nutrient management practices to enhance surface water and groundwater quality includes

1. Application of nutrients at rates commensurate with crop uptake requirements is one of the single most important management practices used for reduction of off site transport of nutrients.
2. Maintaining good crop growing conditions will reduce both surface runoff losses and subsurface losses of plant nutrients. Preventing pest damage to the crop, adjusting soil pH for optimum growth, providing good soil tilth for root development, planting suitable crop varieties, and improving water management practices will increase crop efficiency in nutrient uptake.
3. Timing of nutrient application to coincide with plant growth requirements increases uptake efficiency and reduces exposure of applied nutrients to surface runoff and subsurface leaching. Optimum time of application depends on the type of crop, climate, soil conditions, and chemical formulation of fertilizer or manure. Consult a certified crop advisor or professional agronomist to discuss when manure/nutrients should be applied to maximize crop uptake.
4. Certain soil and water conservation practices will reduce sediment-associated nutrient losses. Contouring, terraces, sod-based rotations, conservation tillage, and no-tillage reduce edge-of-field losses of sediment-bound-nitrogen and sediment-bound-phosphorus by reducing sediment transport.
5. Proper selection and calibration of equipment will ensure proper placement and rate of nutrient delivery. Improper calibration and equipment maintenance will result in over or under application of nutrients or uneven nutrient distribution. Appropriate handling and loading procedures will prevent localized spills and concentration of manure nutrients.
6. Crop sequences, cover crops, and surface crop residues are useful tools for reducing runoff and leaching losses of soluble nutrients. Winter cover crops may theoretically capture residual nutrients after harvest of a summer crop. Nutrient credits for "green manures" and cover crops must be taken to determine the appropriate rate of additional manure application. A suitable cover crop should be planted to scavenge nutrients especially in sandy, leachable soils. On soils with a high potential for leaching, multiple applications at lower rates should be used.
7. Deep-rooted crops, including alfalfa and to a lesser extent, soybeans, will scavenge nitrate leached past the usual soil-rooting zone. Used in crop rotation following shallow-rooted or heavily fertilized row crops, deep-rooted crops will recover excess nitrate from the soil and reduce the amount available for leaching to groundwater.
8. Use commercial fertilizer only when manure does not meet crop requirements.
9. Manure should not be applied more than 30 days prior to planting of the crop or forages breaking dormancy. Incorporate manure to reduce N loss, odors, and nutrient runoff for crops where tillage is normally used.
10. Applications of animal manure should not be made to grassed waterways. If applications are made, they should be conducted at agronomic rates and during periods of low rainfall to minimize runoff from the site.
11. On manure application sites that are grazed, reduce nitrogen rate by 25% or more to account for nutrient cycling through the grazing animals.

address the importance of application records as a vital part of an manure management system. A certain amount of record keeping is needed to keep up with the management of the manure application system. The record keeping forms provided here will help you document site-specific data that is currently limited on many animal operations. These forms will allow you to easily track your applications and provide you with an easy resource to ensure that you do not exceed manure applications to any fields. When combined with such site-specific data as your waste analysis, plant analysis, soils analysis, crop yields, and other farm plan items, these forms will provide evidence that you are managing your manure application properly and not exceeding agronomic rates.

Keeping accurate records, along with the implementation of proper BMPs on your farm, is the primary way you prove to state water quality agencies and to the general public that your manure management system is not causing an environmental impact. Assistance with record keeping can be obtained from Certified Crop Advisors and other technical specialists, the local Cooperative Extension Service, the Natural Resources Conservation Service, and the local Soil and Water Conservation District.

Record keeping is a major component of farm inspections that are conducted by state water quality agencies or local soil and water conservation districts. Often a complaint leading to an inspection can easily be dealt with if proper records are available. The following items should be available at an individual farm:

1. Manure application records
2. Map of farm fields including waste application fields and acreage
3. Manure Management Plan
4. Waste sample analysis
5. Annual soil analysis for each field receiving waste applications

Most of these records should be part of your comprehensive nutrient management plan. These records should be maintained for five years at the individual farm. It may be beneficial for you to maintain the additional following records for verification of conditions on your farm.

1. Daily farm rainfall records
2. Weekly lagoon level (freeboard) records
3. Animal population
4. Crop yields
5. Surface water and groundwater quality records

Forms included here are as follows:

1. **IRR-1**: Irrigation Field Record is used to record each irrigation event. The IRR–1 or 2 forms can be used with all types of irrigation systems including solid-set sprinklers, solid-set volume guns, hard hose travelers, center pivots, and liner move irrigation systems. The irrigation field record forms would also be used to record applications with a drag-hose injector.
2. **IRR-2:** Cumulative Irrigation Field Record is to record the total annual waste application to one field per crop cycle. It enables the operator to calculate the total nitrogen application to the field and compare it to the recommended nitrogen loading rate.

Form IRR-1

Irrigation Field Record
For Recording Irrigation Events on Different Fields

Farm Owner ____________________

Irrigation Operator ____________________

Facility Number __________ - __________

Tract #	Field #	Date (mm/dd/yr)	Crop Type	Field Size, acres	Irrigation Time			Number of Sprinklers Operating
					Start Time	End Time	Total Minutes	

Form IRR-2

Irrigation Field Record
One Form for Each Field Per Crop Cycle

Tract # ______ Field # ______

Field Size (acres) = **(A)** ______

Farm Owner ______

Facility Number ______ - ______

Irrigation Operator ______

From Manure Utilization Plan

Crop Type ______

Recommended PAN Loading, lb/acre = **(B)** ______

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Irrigation									
Date (mm/dd/yr)	Start Time (hr:min)	End Time (hr:min)	Total Minutes (3) - (2)	# of Sprinklers Operating	Flow Rate, gal/min	Total Volume, gallons (4) × (5) × (6)	Volume Per Acre, gal/ac (7) ÷ (A)	Waste Analysis [1] PAN, lb/1,000 gal	PAN Applied, lb/ac [(8) × (9)] ÷ 1,000	Nitrogen Balance [2], lb/ac (B) - (10)
					Crop Cycle Totals					

Owner's Signature ______ Operator's Signature ______

[1] See your manure management plan for sampling frequency. A recent manure analysis is your best method of properly utilizing your manure nutrients.
[2] Enter the value received by subtracting column (10) from **(B)**. Continue subtracting column (10) from column (11) following each application event.

Form SLUR-1

Slurry and Sludge Application Field Record
For Recording Slurry Application Events on Different Fields

Farm Owner: ____________________

Spreader Operator: ____________________

Facility Number: __________ - __________

Tract #	Field #	Date (mm/dd/yr)	Crop Type	Field Size, acres	Application Method [3]	# of Loads Per Field	Volume of Loads [4], gallons

[3] SI = soil incorporated (disked); BR = broadcast (surface applied)
[4] Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

Form SLUR-2

Slurry and Sludge Application Field Record
One Form for Each Field Per Crop Cycle

Tract # ______ Field # ______

Field Size (acres) = **(A)** ______

Farm Owner ______

Facility Number ______ - ______

Spreader Operator ______

From Manure Utilization Plan

Crop Type ______

Recommended PAN Loading (lb/acre) = **(B)** ______

(1) Date (mm/dd/yr)	(2) # of Loads Per Field	(3) Volume of Loads [5]	(4) Total Volume (gallons) (2) × (3)	(5) Volume Per Acre (gal/ac) (4) + (A)	(6) Waste Analysis [6] PAN (lb/1000 gal)	(7) PAN Applied (lb/ac) [(5) × (6)] + 1,000	(8) Nitrogen Balance [7] (lb/ac) **(B)** - (7)
			Crop Cycle Totals				

Owner's Signature

Operator's Signature

[5] Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

[6] See your manure management plan for sampling frequency. A recent manure analysis is your best method of properly utilizing your manure nutrients.

[7] Enter the value received by subtracting column (7) from **(B)**. Continue subtracting column (7) from column (8) following each application event.

Form SLD-1

Solid Manure Application Field Record
For Recording Solid Manure Application Events on Different Fields

Farm Owner ______________________

Spreader Operator ______________________

Facility Number __________ - __________

Tract #	Field #	Date (mm/dd/yr)	Crop Type	Field Size (acres)	Application Method [8]	# of Loads Per Field	Volume of Loads [9] (tons)

[8] SI = soil incorporated (disked); BR = broadcast (surface applied)
[9] Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

Form SLD-2

Solid Manure Application Field Record
One Form for Each Field Per Crop Cycle

Tract # ______ Field # ______

Field Size (acres) = **(A)** ______

Farm Owner ______

Facility Number ______ - ______

Spreader Operator ______

From Manure Utilization Plan

Crop Type ______

Recommended PAN Loading (lb/acre) = **(B)** ______

(1) Date (mm/dd/yr)	(2) # of Loads Per Field	(3) Weight of Loads [10] (tons)	(4) Total Weight (tons) (2) × (3)	(5) *Weight Per Acre (tons/ac)* (4) ÷ (A)	(6) Waste Analysis [11] PAN (lb/ton)	(7) PAN Applied (lb/ac) (6) × (5)	(8) Nitrogen Balance [12] (lb/ac) (B) - (7)
		Crop Cycle Totals					

Owner's Signature

Operator's Signature

[10] Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
[11] See your manure management plan for sampling frequency. A recent manure analysis is your best method of properly utilizing your manure nutrients.
[12] Enter the value received by subtracting column (7) from **(B)**. Continue subtracting column (7) from column (8) following each application event.

Example of Manure Agreement

MANURE UTILIZATION AGREEMENT FOR LEASED LAND

I, ______________________________, hereby give _____________________ permission to apply waste from his poultry production facility on ________ acres of my land for the duration of the time shown below.

I understand that this manure contains nitrogen, phosphorus, potassium, and trace elements, and when properly applied should not harm my land or crops. I also understand that the use of animal manure will reduce my need for commercial fertilizer.

Adjacent Landowner: ___________________________________ Date: _________

Manure Producer: ______________________________________ Date: _________

Technical Representatives: ______________________________ Date: _________

Term of Agreement: ______________________,2000___ to __________, ____.

Example of third party form

Manure Utilization - Third Party Applicator Agreement

I, _______________________________ hereby acknowledge that I have received a copy, have read, and understand the Nutrient Management Plan dated ________________ that was developed for/by ____________________________________ for their facility located at ____

____

in ___________________ County.

I hereby agree to manage and land apply the manure that I received from this facility in a manner consistent with all Federal, State and local laws.

Third Party Receiver: __________________________________ Date: _________

Manure Producer: ______________________________________ Date: _________

Technical Representatives:

Term of Agreement: ______________________,20___ to __________, _20___

Summary of Essential Information

Site Selection is critical to preventing environmental problems with dedicated land application sites. Ideal sites should be isolated, on slopes less than 7% slope, away from streams, rivers and wells, have deep seasonal groundwater tables, with soils that are suitable for maintaining good vegetative growth.

Best Management Practices are effective economical approaches for preventing or reducing pollution generated from non-point sources. To be effective, BMP's must be properly planned, designed, and implemented or installed. This requires knowledge of the sources of pollutants, their transport mechanisms, and the effects on water quality. These are the tools that the agricultural community has to protect water quality. While the tools can be effective, good management and desire are the most important aspects of preventing agricultural nonpoint source pollution. These principles can not be mandated or implemented by anyone other than the landowner so it is ultimately their responsibility to become an environmental steward and protect our water for future generations.

Reducing soil erosion is critical because sediment is a pollutant and also because it often carries nutrients and other pollutants with it. The amount of runoff and soil erosion at a given point is dependent on the climate (rainfall), soil type, cover and management and the slope length and steepness. Anything you can do to increase vegetative or residue cover, increase infiltration into the soil, or slow down the runoff coming off a field will decrease pollutant transport off the field.

Some BMP's like filter strips and buffers are effective at trapping pollutants and limiting transport offsite. Farm ponds and sedimentation basins are also excellent traps

Keys to limiting nutrient movement include placing the right amount of nutrient, in the right time, and at the right spot. This will minimize losses and maximize nutrient use. The right amount is determined through soil and manure analysis and nutrient management budgeting. The right time is when the plants can use the nutrients and when the risk of pollution is lowest (ie. Avoiding applications prior to large storms and periods of high rainfall). The right place is in a location where plant roots can reach the nutrients and buffering critical areas such as stream banks and wells.

When determining which manure to place on which fields, remember, manure with the highest nutrient content should go to fields that are further away and have the highest nutrient demand. High P manure should be placed on fields with the lowest soil test P.

When choosing an application method, you should consider initial cost, labor and operating costs, uniformity and precision of application equipment, timeliness of use, conservation of nutrients, odor, and soil compaction. Reliability is also important. Which systems handles equipment failures better?

Calibration of application equipment is essential. It will verify actual application rates, troubleshoot equipment problems, determine appropriate overlaps, evaluate application uniformity, and monitor changes in equipment operation and manure properties.

Solid treatment and application methods are generally preferred to liquid and slurry systems because there are usually great utilization options and lower transportation and handling costs.

To determine actual application rates, you need to know the amount applied and the area it was applied on. This can be accomplished at various scales from field scale to collection in a rain gage. Application uniformity requires measurement of the distribution and requires several measurements of application rates at specific points. Knowledge of uniformity is essential for determining proper overlap and also for evaluating application system capabilities.

Surface applications of manure result in much greater nitrogen losses. Manure broadcast as a solid generally loses 15 to 30% of its nitrogen while liquids lose 10 to 25%. Immediate incorporation can reduce this to 1 to 5%. Nitrogen losses and odor are much lower with injection or low pressure irrigation.

Keeping proper records of manure application can improve utilization, reduce liability, and document compliance with regulations. At a minimum, you should have records of soil and manure analysis, waste application fields and acreages, and application rates and times. These should be kept as part of your comprehensive nutrient management plan.

Emergency Action Plans

Dr. Mark Risse
Adapted from Lesson 50 of National Animal and Poultry Waste Management Curriculum

Manure spills and discharges largely just don't happen, they are caused. Behind most spills is a chain of events that leads up to an unsafe act, improper judgement, unsafe conditions, or a combination of factors. Manure spills and discharges are the most common cause of regulatory penalties in Georgia and the Nation. Preventing and properly responding to discharges on the farm is everyone's concern. Communication between the farm owner, supervisors, agencies with emergency response responsibilities and employees generates ideas and awareness that leads to accident prevention and quick response in the event a spill occurs. Education programs, response plans, and regular inspections of your manure management and application system are essential in providing the lines of communication that lead to a safe, accident-free operation.

Intended Outcomes

The producer will:

- Recognize the need for developing an Emergency Action Plan
- Identify the steps involved in reporting and responding to a manure spill
- Identify activities related to their manure management system that may lead to higher environmental or human health risk
- Be prepared to develop an Emergency Action Plan for their facility

What is an Emergency Action Plan?

A basic, yet thorough, common-sense plan that will help you make the right decision during an emergency.

Why have an Emergency Action Plan?

Murphy's Law: accidents will happen.
If it is written down, you will use it.
Plan before potential emergencies.
To protect you and other against environmental damage.
It should be part of a Comprehensive Farm Plan.

Emergency action plans are needed to minimize the environmental impact in the event of manure spills, discharges or mishaps. In several states these plans are required on all livestock operations, especially those with liquid manure management systems. According to Georgia swine regulations, an emergency action plan is a required component of a CNMP. The plan should be available to all employees and they should be trained in its use. This plan will be implemented in the event that manure or other wastes from your operation are leaking, overflowing, or running off the site. You should NOT wait until manure or wastewater reaches a stream or leaves your property. You should make every effort to ensure that this does not happen.

Prevention

The most important part of the plan is preventing spills from occurring in the first place.

down according to three stages of emergency defined as imminent pollution or emergency, pollution in progress, and pollution discovered after the fact. These instructions should be available to all employees at the facility, as accidents, leaks, and breaks can happen at any time.

Imminent Pollution
In this type of situation, there have not yet been any leaks or spills. However, ignoring the fact that an emergency exists will probably result in a spill or leak within a short time. The main sources of this type of emergency are when lagoons, holding ponds, or pits are nearing capacity, or when there is potential for wastes to run off an application field.

Storage capacity about to be exceeded. Long periods of excessive rain or malfunctioning livestock water systems may cause your storage to unexpectedly reach capacity. Your response should be to prevent the release of wastes. Depending on your situation, this may or may not be possible, but suggested responses to this type of problem include:

- Add soil to the berm to increase the elevation of the dam.
- Planned emergency utilization of manure by pumping onto fields at acceptable rates.
- Stop all additional flow to the storage (waterers).
- Call a pumping contractor.
- Make sure no surface water is entering the storage.
- Consider maintaining some grassland near the storage for emergency manure application.

These activities should be started when your lagoon has exceeded the temporary storage level as defined for the lagoon. Waiting for the lagoon to reach the freeboard level may result in spills as you never know when the pumping equipment will malfunction. Start early!

Potential runoff from application field. This situation could result from unexpected rains during field application of manure. Again, the response is to prevent the release of wastes to neighboring areas. Possible solutions include:

- Immediately stop additional waste application.
- Create a temporary diversion or berm to contain the waste on the field.
- Incorporate waste to prevent further runoff.

Hurricanes and tropical storms. These severe storms are unpredictable in nature, and depending on their intensity, they can cause a great deal of damage to an area. They normally occur from June 1 to November 30 and can produce tornadoes and cause severe flash flooding. Tropical storms and hurricanes can also deliver large amounts of rainfall in very short periods of time. Areas that are prone to these storms should prepare for their possibility months beforehand. Before the hurricane season begins, temporary storage levels in lagoons and storage basins should be as low as possible. Be prepared for multiple storms. In September 1999 many livestock producers in the coastal regions of North Carolina, South Carolina, and Virginia received over 30 inches of rainfall from two hurricanes and one tropical storm.
Regardless of their size, hurricanes should be respected! The National Hurricane Center issues a hurricane watch when there is a threat of hurricane conditions within 24-36 hours. Hurricane warnings are issued when hurricane conditions (winds of 74 miles per hour or greater) are expected in 24 hours or less.

Pollution Discovered After the Fact

This situation occurs when a leak or spill is discovered several days after it occurs. There is a potential for increased environmental impact due to the late discovery of waste leakage. Response should be swift in order to minimize damage as much as possible. Responses should include:

- Stop additional leakage.
- Contain spilled wastes.
- Attempt application of spilled wastes on cropland.
- Notify agencies and local authorities.
- Assess environmental impact of fish kill, surface water pollution, well or ground water impact, and amount of waste released and for what duration.

Components of Emergency Action Plans

While every emergency is different, response actions should be similar. As stated earlier, human health and injuries take precedence and should be dealt with first. Also, you should never put someone in life threatening or risky situations as part of your response plan. These following steps should provide a framework for developing your plan.

1. Eliminate the source. Depending on the situation, this may or may not be possible.

2. Contain the spill and minimize manure movement off the farm or downstream.

3. Assess the extent of the spill and note any obvious damages.

- Did the waste reach any surface waters?
- Approximately how much was released and for what duration?
- Any damage noted, such as employee injury, fish kills, or property damage?
- Distance and direction to nearest neighbor or town or public well of the release?
- Did the spill leave the property?
- Does the spill have the potential to reach surface waters?
- Could a future rain event cause the spill to reach surface waters?
- Are potable water wells, spring, or groundwater recharge areas in danger?

Review any actions that were taken to contain or minimize the spill or discharge.

4. Contact appropriate agencies.

State law requires that "Whenever, because of an accident or otherwise, any toxic or taste and color producing substance, or any other substance which would endanger downstream users of the waters of the State or would damage property, is discharged into water, or is so placed that it might flow, be washed, or fall into them, it shall be the duty of the person in charge of such substances at the time to forthwith notify the Environmental Protection Division in person or by telephone of the location and nature of the danger, and it shall be such person's further duty to immediately take all reasonable and necessary steps to prevent injury to property and downstream users of said water." This means that you must notify the EPD as soon as possible. Your phone call should include: your name, facility, telephone number, the details of the incident from item 2 above, the exact location of the facility, and the location or direction of movement of the spill, weather and wind conditions, what corrective measures have been undertaken, and the seriousness of the situation.

Post-Spill Assessment and Reporting

State law requires that "Whenever, spills occur which would endanger downstream users of the waters of the State or would damage property, it shall be the duty of the person in charge at the time to notify the Environmental Protection Division (EPD) in person or by telephone of the location and nature of the danger, and it shall be such person's further duty to immediately take all reasonable and necessary steps to prevent injury to property and downstream users of said water." This means that you must notify the EPD as soon as possible. Your phone call should include: your name, facility, telephone number, the details of the incident from item 2 above, the exact location of the facility, and the location or direction of movement of the spill, weather and wind conditions, what corrective measures have been undertaken, and the seriousness of the situation.

THE GEORGIA STATEWIDE NUMBER FOR REPORTING SPILLS IS: 800-241-4113
THE STATE OPERATIONS CENTER IN ATLANTA IS: 404-656-4300

On permitted operations, the reporting requirements will be specified in the permit. In most cases, reporting of spills or any other non-compliance that would endanger human health or the environment is required by telephone within 24 hours and in writing within five working days of the discharge. The reports will need to include:

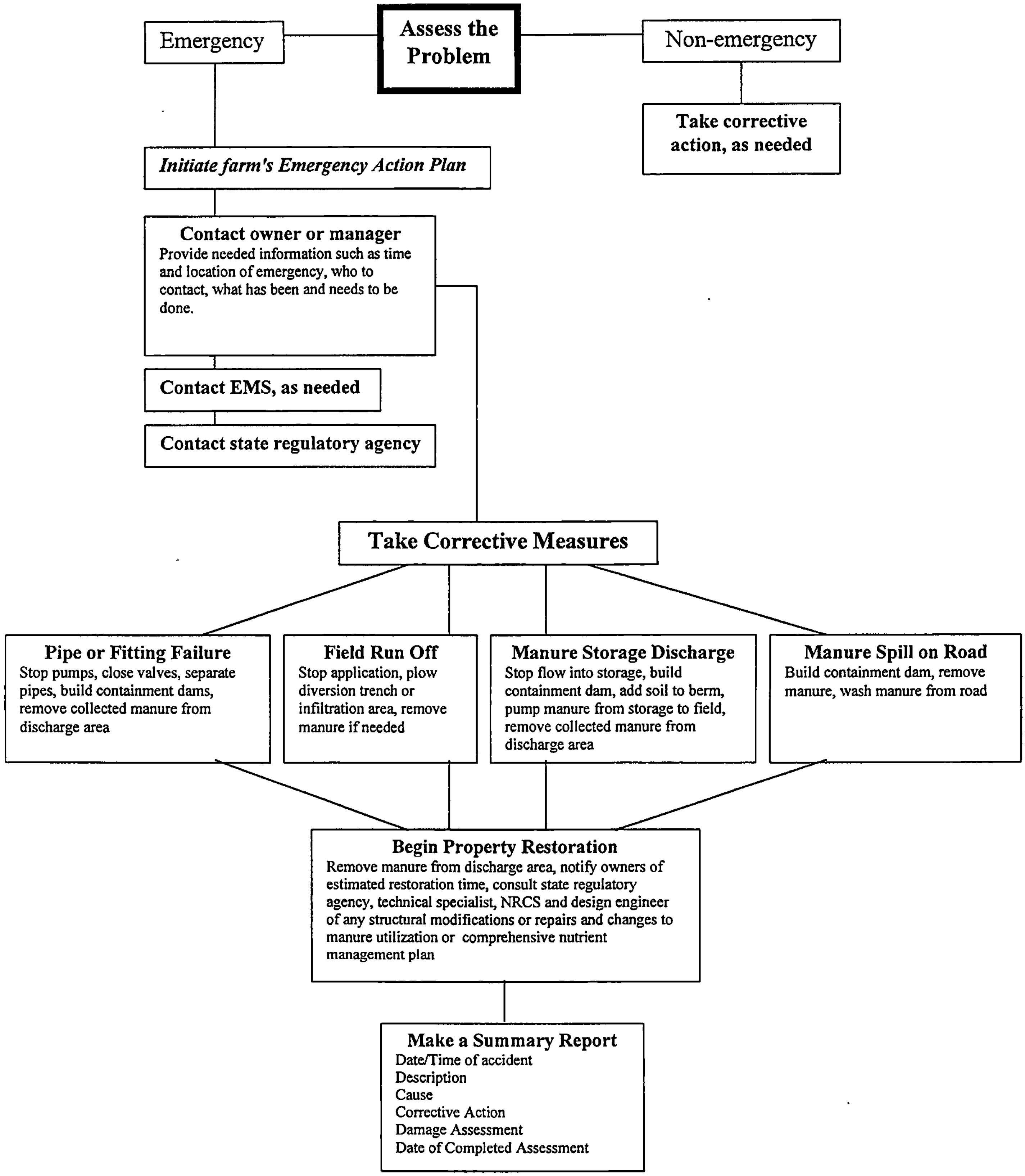
- Description of the discharge including its cause, flow path, receiving water body, and an estimate of the amount discharged.
- Time and location of discharge
- Analysis of discharge for chemical and biological parameters or valid reasons for not sampling
- Steps taken or planned to reduce, eliminate, and prevent the recurrence of the discharge.

Assessments or "follow-up" reports give you and the regulatory agency an opportunity to reflect and learn from the events that lead up to the spill and those actions that were taken following the spill. Some of the questions you should consider answering in the report are listed below.

- Assess the extent of the spill and note any obvious damages.
- Did the waste reach any surface waters, wetlands, tile drains or wells?
- Approximately how much manure was released and for what duration?
- Any damage noted, such as employee injury, fish kills, habitat degradation or property damage?
- Response to spill.
- When and where was the spill contained?
- What measures were taken to avoid additional contamination?
- Did a technical specialist or any local group assist in the clean-up?
- What specific corrective actions are necessary to repair any damage to your storage structure, manure transfer or application equipment to prevent another spill?
- Can you determine the cause of the spill or discharge?
- If appropriate, were signs present of the condition before the accident occurred?
- When were local and state agencies contacted notifying them of the spill?
- Did a representative of the state water quality agency or health department respond to the notification? List names, titles and agencies.
- Were you given and "special" instructions from state or local representatives?

Typical Steps in Responding to Manure Spill or Discharge

Adopted from the NPPC Environmental Assurance Program



Case Study #2

.... Improper Modification of Storage Structure

Location: Southeastern North Carolina
Operation: Swine

Background:

- 7.3 Acre lagoon exceeded its temporary liquid storage
- Irrigation equipment was not on site nor was sufficient land cleared for application if a pump and equipment was available
- Approximately a week before the spill, farm workers improperly installed a pipe in the lagoon embankment
- Rainwater from a tropical storm ponded above then scoured out the embankment near where the pipe was installed
- The lagoon breached releasing lagoon effluent and sludge

Result:

- Over 22 million gallons of effluent and sludge were discharged into a river nearby.
- Approximately 4,000 fish were killed in the river downstream of the spill.

Response:

- Television and print media reported the lagoon spill all over the state and country. The spill was reported in newspapers as far away as Den Hague, Netherlands.
- State water quality investigators confirmed the spill had caused the fish kill in the creek..
- Charges were laid onto the farmer for violating state water quality standards.

Action:

- The farm was required to depopulate until repairs were made to the lagoon, irrigation equipment was purchased and sufficient land application field were cleared and planted.
- The farmer was convicted and fined.
- Repairs and land clearing were completed approximately one and a half years after the lagoon breach.

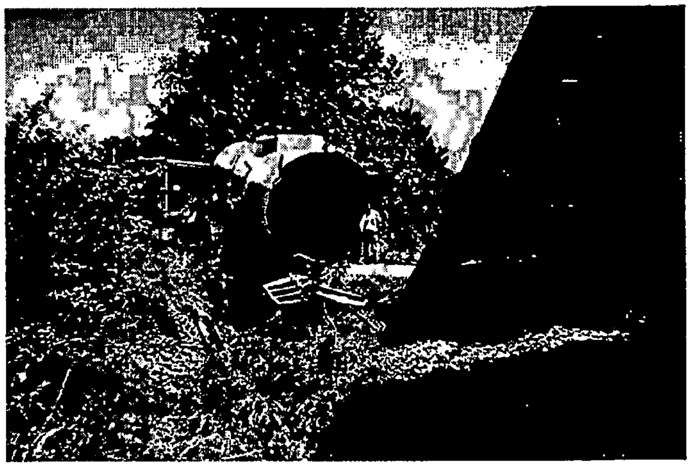
How Could this Spill have been Avoided?

- Consult and follow plans provided by NRCS or a professional engineer before installing any pipe or electrical line on a lagoon embankment
- Ensure trenches on embankment are dug in a "V" shape and backfill soil should be mechanically tamped. Excess soil should be placed over the backfilled trench to allow for any settling.
- Ensure land application fields are cleared and planted prior to populating a new farm or delivering manure to a new storage basin or lagoon.
- More frequent inspections by farm personnel, technical specialists and regulatory agencies.
- Implementation of Emergency Action Plan and notification of spill to local emergency services

Case Study #4

.... Lack of Storage Capacity

Location: Southeastern Virginia
Operation: Poultry Layer



- An 8,500-gallon tanker was hauling sludge from a poultry layer lagoon to an application site three miles from the farm.
- The tanker failed to check for on-coming train as it crossed a railroad track beside the application field.
- A slow moving train severed the tanker, releasing the high strength sludge into a ditch.
- The startled but unharmed driver immediately contacted company supervisors and the local fire department.

Result:

- Lagoon sludge released from the tanker flowed directly into a nearby stream.
- Fish were killed in the stream downstream of the spill.

Response:

- Supervisors from the sludge application contractor contacted state water quality agents.
- The soil was placed into the stream to contain the spilled sludge and contaminated water. Vacuum tanker, already on site, pumped and applied the material to the application field.
- The spill was confirmed to have caused a fish kill in the stream.

Action:

- The contractor received only a warning due to the company's quick response to mitigating the spill.

How Could this Spill have been Avoided?

- Special care should be taken when transporting manure and sludge in on public roads.
- Minimize transport of manure in areas of high traffic, high speeds or railroad crossings.

G1: General Emergency Action Plan

Farm Name:
Owner/Operator: **Phone Number:**
2nd Contact Person if owner/operator is not available:
Name: **Phone Number:**
Permit Number (if applicable):
Size and type of operation:

Fire Emergency Response Information
Farm Fire Protection District:
911 Coordinates for farm:
Electrical Power Company Name:
Electrical Power Company Phone Number:
Is there a disconnect between the meter base and the buildings? Y N
If so, where?
Size of Electrical Service:
Do you have a standby alternator? Y N
Give the location (sketch preferable) of electrical panels in buildings:

Propane Company Name:
Propane Company Phone Number:
Location and size of propane tanks:

Other fuels and locations:

Are there hazardous materials stored in facilities: Y N
If yes, provide the location(s) and list of materials:

(If you have any medical conditions the EMS personnel should know about, please list them below):
Name: Condition:
Name: Condition:
Name: Condition:

Emergency Action Plan Checklist

As part of this plan, the following is made available and each employee is trained and aware of the following procedures.

- ☐ **Emergency Phone Number List Posted at Each Phone**: An emergency phone notification list, *which includes telephone number of the operator, local offices for fire dept, sheriff dept., EMS, Public Health Office, State Water Quality Agency and State Dept of Agriculture.*

- ☐ **General Farm Information Sheet** and **Facility Map**: *Draw facility layout including location of: telephone locations, location of shutoffs for water, electric, natural gas and propane tanks, re-cycle systems, schematic of waste management system, pumping pits,* ***areas of no entrance without assisted breathing devices****, hazardous materials, ingress/egress for emergency vehicles, identity of immediately adjacent landowners with emergency phone numbers.*

- ☐ **Location of Pre-Arranged Emergency Supply Equipment and Supplies**: List of equipment owners, phone numbers and location of individuals and equipment that may be used in an emergency.

- ☐ **Runoff Retention Plan**: Instructions detailing the ACTION PLAN to be taken in an emergency involving runoff of contaminanted water that may result from fire or other emergency. *Maps of the facility and surrounding areas including drainage patterns and locations of spoil materials for forming emergency dikes, location of surface waters, waterways, wells, and any other environmentally sensitive areas should also be included.*

- ☐ **Fire Emergency Information and Response Plan**

- ☐ **Power Outage Information**

- ☐ **Personal Information and Medical Emergency Response Procedures**: *Any medical conditions you or your farm personnel may have that emergency medical personnel should be made aware (i.e., diabetes, heart or respiratory problems, medications, etc.).*

G2: Emergency Action Plan (Liquid Manure)

The following is posted, clearly by every phone on farm:

IF There is an EMERGENCY.......

1) **Shut off all flow into storage area or lagoon or going out to land application areas**

2) **Assess the extent of the emergency and determine how much help is needed**

3) **Contact Farm Supervisors**

Name:	Phone #:
Name:	Phone #:

4) **Give supervisor the following information:**

Your name
Description of Emergency
Estimates of the amounts, area covered, and distance traveled from manure storage
Whether manure has reached ditches, waterways, streams or crossed property lines
Any obvious damage: employee injury, fish kill, or property damage?
What is being done, any assistance needed

5) **Contact state environmental protection division, contractors, emergency officials, technical specialists and media, as needed.**
   a) Georgia Environmental Protection Division-
      i) SPILL REPORTING: 800-241-4113
      ii) LOCAL OFFICE Phone______________

b) Local County Health Department			Phone______________
c) Pumping-	Name__________________		Phone______________
d) NRCS-	Name__________________		Phone______________
e) Extension Office-	Name__________________		Phone______________
f) Consultants-	Name__________________		Phone______________

Provide directions that anybody can direct someone to the site by telephone.

Build a containment dam downstream of discharge area, then progressively build additional dams upstream

- Add soil to the berm of the manure storage area/basin
- Remove manure from the discharge area with a trash pump if necessary

Pump manure and wastewater from the manure storage to lower the volume in basin

Complete Post-Emergency Assessment and Documentation or other State reporting requirements.

Pre-arranged Emergency Response Agreements

List any arrangements made with other producers to share personnel and/or equipment and supplies and land access during an emergency.

Pre-arranged land access agreements

Contact #1 ______________________________

Contact #2 ______________________________

Location of Pre-Arranged Emergency Supply Equipment and Supplies

Available 24 hours a day. Include phone numbers and primary contacts. Put list in the order you want equipment operators contacted. Copy posted in each animal building on site, in site office and owners residence. Preferably posted by a phone or main doorway if no phone.

Owner	**Phone**	**Location**
Irrigation Pumps		
Dozer/Track Loader		
Backhoe		
Vacuum Slurry Tank		

Post-Emergency Assessment and Documentation

1.) Assess the extent of the spill and note any obvious damages.
Did the waste reach any surface waters?
Approximately how much was released and for what duration?
Any damage noted, such as employee injury, fish kills, or property damage?

2.) Contact appropriate agencies:
Reporting a Release of Livestock Waste from a Lagoon

a) Reports of releases to surface waters, including to sinkholes, drain inlets, broken subsurface drains or other conduits to groundwater or surface waters, shall be made upon discovery of the release, except when such immediate notification will impede the owner's or operator's response to correct the cause of the release or to contain the livestock waste, in which case the report shall be made as soon as possible but no later than 24 hours after discovery.

b) The report required under subsection (a) shall be given to the State Water Quality Agency by calling: *(800) 241-4113*

Contents of Report
The report should include, as a minimum, each of the following to the extent that it is known at the time of the report:

a) name and telephone number of the person reporting the release;
b) county, distance and direction from nearest town, village or municipality of the release;
c) an estimate of the quantity in gallons that was released, and an estimate of the flow rate if the release is ongoing;
d) area into which the release occurred (field, ditch, stream, or other description) and apparent environmental impacts of the release;
e) time and duration of the release;
f) the names and telephone numbers of persons who may be contacted for further information;
g) dangers to health or the environment resulting from the release;
h) actions taken to respond to, contain and mitigate the release; and
i) name of facility and mailing address.

3.) Implement procedures to prevent similar occurrences. Seek professional assistance if problem is berm or structure related.

Documentation of Clean-Up Efforts

All responses to emergencies should be documented and kept with the manure management plan. This documentation should include all agency and local authority contacts made during the response phase. This information can be used to assess response to the emergency, prepare for future problems, and train employees.

Review of Essential Information

An Emergency Action Plan is a basic, yet through, common sense plan that will help you make the right decisions in an emergency.

You should have an Emergency Action Plan because:

- accidents will happen,
- writing the plan requires you to plan for emergencies
- it makes you more likely to remember appropriate responses during emergencies
- they minimize environmental and human health impacts
- it is required as part of a CNMP
- it is a great pollution prevention strategy.

The format for an Emergency Action Plan consists of the following five steps:

1) Eliminate the source
   Shutting down pumps, building diversions or berms, closing valves, repairing leaks
2) Contain the spill
   Building berms, diversions, dams, or basins
3) Assess the extent of the spill and note damages
4) Contact appropriate agencies
5) Clean up and make repairs
   Modifications and plans for prevention of future accidents.

The most important part of a plan is preventing spills from occurring in the first place.

Prevention measures include regular inspection, monitoring and record keeping, automatic cut-offs, and secondary containment.

Three types of emergencies are imminent pollution (where you know its coming), pollution in progress (actively occurring), and pollution discovered after the fact.

In an emergency situation, human health and well being takes precedence. It should always be assessed first and corrective actions should not put human well being in jeopardy.

In the event of a spill or manure release that could endanger downstream users of water of the State or could damage property, Georgia law requires that you notify the Environmental Protection Division of the Georgia Department of Natural Resources.

Post Spill assessment and reporting is important because it is required by law, it helps you examine your response, determine causes and assess damages, and should lead to plans for prevention in the future.

All employees of the farm should be made aware of the emergency action plan and it should be posted in a visible location, preferably near the phone.

Community and neighbors should be made aware of emergency response plans. They can provide access to needed emergency equipment, provide access to property that may be needed for corrective action, help you in plan development, and make you aware of additional resources in your community.

Lesson 51
Mortality Management

By Don Stettler, USDA Natural Resources Conservation Service

Intended Outcomes

The participants will be able to

- Explain why timely management of mortality is important.
- List the different methods for managing mortality.
- List the advantages and disadvantages of different methods for managing mortality.
- Explain conceptually the sizing of mortality composting facilities.

Outline

I. Introduction
II. Rendering
III. Composting
A. Composting principles
B. Dead animal composting
C. Composter operation
D. Compost end use
IV. Incineration
V. Sanitary Landfills
VI. Burial
VII. Disposal Pits
VIII. Regulatory Compliance Issues
Appendix A. Livestock Mortality Rates (Percentage)
Appendix B. Procedures for Sizing of Structures and Windrows for Composting Animal Mortalities using Universal Sizing Equations
—Worksheet for Determining Compost Bin or Windrow Volume Requirements
—Equations for universal sizing of composting bins and windrows

Activities

Estimate

- Composter bin volume requirements.
- The size of a manure storage facility.

Time Required: 2 hours

PROJECT STATEMENT

This educational program, Livestock and Poultry Environmental Stewardship, consists of lessons arranged into the following six modules:

- Introduction
- Animal Dietary Strategies
- Manure Storage and Treatment
- Land Application/Nutrient Management
- Outdoor Air Quality
- Related Issues

The project team appreciates the financial assistance of the U.S. Department of Agriculture and U.S. Environmental Protection Agency's Ag Center in the development of this educational program.

Mortality must be managed for at least three reasons:
(1) Hygienic
(2) Environmental protection
(3) Aesthetics

Mortality must be managed for at least three reasons:

(1) Hygienic. Timely removal and appropriate handling of dead animals can prevent other animals in the operation from becoming ill and may prevent spread of the disease to other operations. This is especially true for the removal of those animals that have succumbed to contagious disease.
(2) Environmental protection. Nutrients and other contaminants that are released as the dead animal decomposes can be carried away in run off or leached to groundwater resources.
(3) Aesthetics. Perhaps those who work on the farm or ranch may be come accustomed to the sight of dead animals. However, visitors and others may find it very offensive and use it as a basis for judging the level of management being given the operation even though this may be unfair.

In the past, dead animals were frequently taken to a remote area, allowing carcasses to decompose and be eaten by scavengers. This practice is now illegal in virtually all of the United States. In addition, it is a highly irresponsible method and may encourage the spread of disease from one operation to another. It may also contribute to both surface and groundwater contamination.

Acceptable ways for managing mortality include

- Rendering
- Composting
- Incineration
- Sanitary landfills
- Burial
- Disposal pits

Of these methods, only the rendering and composting methods recycle the nutrients, a concept that has been promoted since Lesson 1 of this training.

Although incineration, sanitary landfills, burial, and disposal pits may be acceptable methods from an environmental protection viewpoint, they are disposal methods, and in essence, waste the nutrients. In the following paragraphs, each of the acceptable methods will be discussed, beginning with rendering.

Rendering

Use of rendering services recycles the nutrients contained in dead animals, most often as an ingredient in animal food, especially for pets. The primary disadvantage of rendering is that the dead animals must be preserved or promptly transported to a rendering plant. This disadvantage has been intensified in recent years by a reduction in the number of facilities that provide rendering services. The outbreak of "mad cow disease" in the United Kingdom (UK) in 1986 has led to restrictions on how rendered products may be used in the United States. More properly described as Bovine Spongiform Encephalopathy (BSE), it is a degenerative brain disease that ultimately results in animal death. BSE is a member of the transmissible spongiform encephalopathy (TSE) group of diseases and is manifested as

Table 51-3. Mortality management by rendering.

Advantages	Disadvantages
1. Conserves nutrients contained in the dead animals 2. Minimal capital investment unless preservation is used 3. Low maintenance	1. Increases sanitary precautions to prevent disease transmission 2. Storage of animals is required until pickup 3. Fees charged for pickup 4. Rendering service may not be available

Composting

Composting principles

Composting ... is essentially the same process as natural decomposition except that it is enhanced and accelerated by mixing organic waste with other ingredients in a manner that optimizes microbial growth.

Composting is the controlled aerobic biological decomposition of organic matter into a stable, humus-like product, called compost (Figure 51-1). It is essentially the same process as natural decomposition except that it is enhanced and accelerated by mixing organic waste with other ingredients in a manner that optimizes microbial growth.

The compost pile will pass through a wide range of temperatures over the course of the active composting period (Figure 51-2). As the temperature varies, conditions will become unsuitable for some microorganisms while at the same time become ideal for others.

Initially, as the microbial population begins to consume the most readily degradable material in the compost pile and grow in size, the heat generated by the microbial activity will be trapped by the self-insulating compost material. As the heat within the pile accumulates, the temperature of the compost pile will begin to rise. As the pile temperatures increase, the pile will become inhabited by a diverse population of microorganisms operating at peak growth and efficiency. This intense microbial activity sustains the vigorous heating that is necessary for the destruction of pathogens, fly larvae,

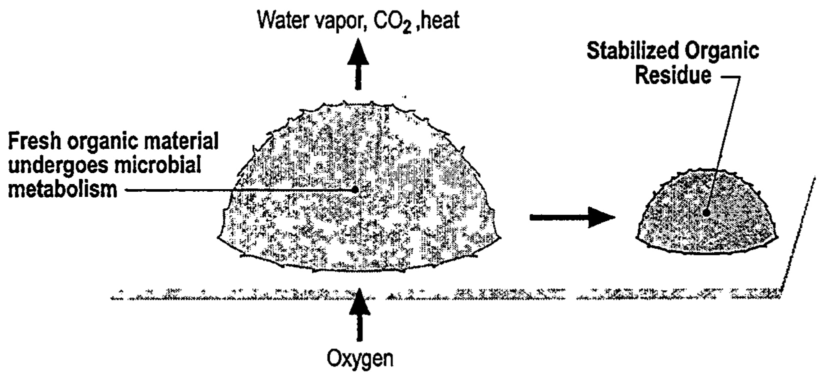


Figure 51-1. Composting process.

A number of methods are used to compost organic wastes including
- Passive composting pile
- Windrow
- Passively aerated windrow
- Aerated static pile
- In-vessel

is used primarily to improve the ability of the compost to be self-supporting or have structure and to allow internal air movement. Some bulking agents may alter the moisture content and/or C:N ratio. This type of material would serve as both an amendment and a bulking agent.

Recipe recommendations are available for composting many types of organic wastes. However, when it is necessary to determine the recipe from scratch, the characteristics of the waste, amendments, and bulking agents must be known. The characteristics that are the most important in determining the recipe are moisture content, carbon content, nitrogen content, and C:N ratio. If any two of the last three components are known, the remaining one can be calculated. The determination of the recipe is normally an iterative process of adjusting the C:N ratio and moisture content by adding amendments. If the C:N ratio is out of the acceptable range, then amendments are added to adjust it. If this results in high or low moisture content, amendments are added to adjust the moisture content. The C:N ratio is again checked, and the process may be repeated. After a couple of iterations, the mixture is normally acceptable.

A number of methods are used to compost organic wastes including
- Passive composting pile
- Windrow
- Passively aerated windrow
- Aerated static pile
- In-vessel

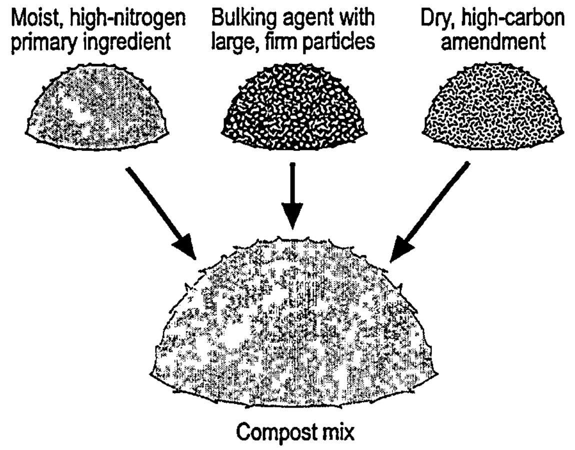


Figure 51-3. Components of the compost mix.

Composting mortality can be likened to aboveground burial in a biomass filter with the pathogens killed by high temperatures.

composted is an inconsistent, nonhomogeneous mixture. Figure 51-6 illustrates how two amendments, straw and chicken litter, are layered with dead broiler poultry in bin composting. Regulations in some states do not allow including chicken litter in the compost mix. Where chicken litter is not allowed, dead animals can be composted with sawdust as the only amendment. However, where use of chicken litter is allowed and it is conveniently available, its use will allow the compost process to be more efficient because the C:N ratio is adjusted.

Composting mortality can be likened to aboveground burial in a biomass filter with the pathogens killed by high temperatures (Figure 51-7). At least one foot of biofilter should be provided between the dead animals and the sides of the bin or the outside surface of the windrow. For large animals, this distance should be increased to two feet. The composting process for mortality is shown schematically in Figure 51-8.

For bin composting, a permanent structure, such as bins constructed of treated lumber or concrete within a pole-frame building with concrete floors (Figure 51-9), is the most desirable. This type of facility offers easier overall operation and management especially during inclement weather and for improved aesthetics. Some states may require that composters be roofed and/or be located on impermeable surfaces, such as concrete or compacted clay. Consult the Natural Resources Conservation Service, Extension Service, MidWest Plan Service, or Northeast Regional Agricultural Engineering Service for composter plans that will meet your needs.

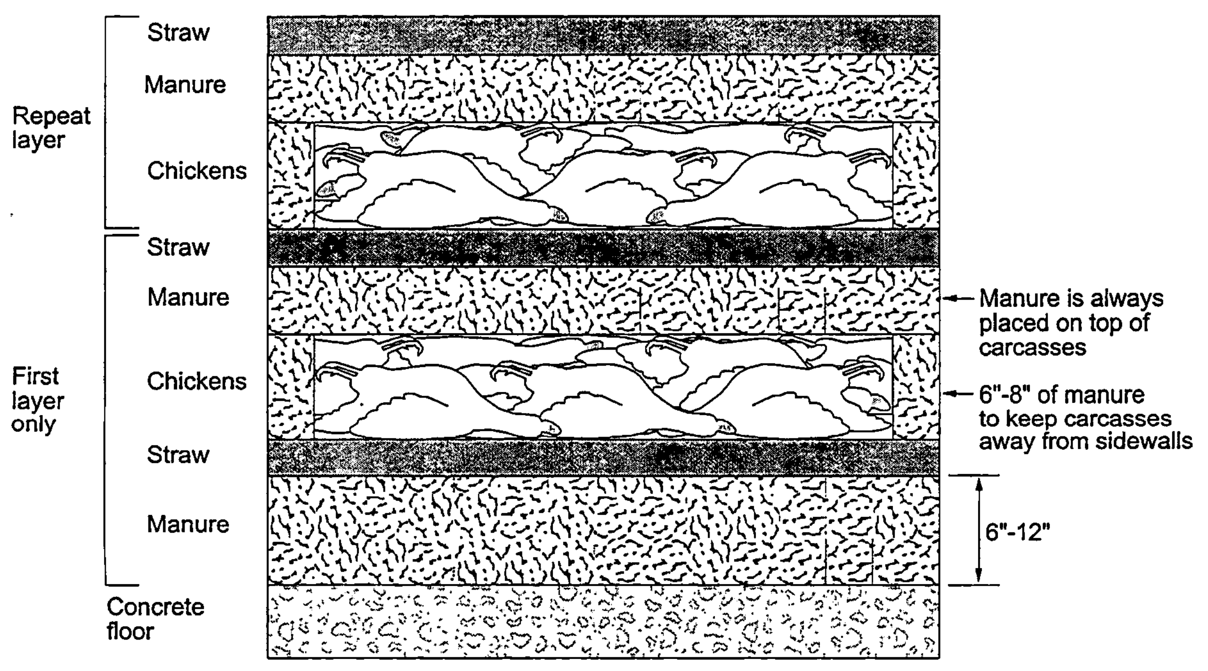


Figure 51-6. Initial layering of the mix for composting dead broiler chickens.
Source: Agricultural Waste Management Field Handbook, Part 651, p. 10-61.

Temporary bins can also be constructed with bales of low-quality hay or straw (Figure 51-10). This type of construction is less expensive and provides the flexibility, such as the number of bins and their location, that a permanent structure would not. When the need arises, bale bins can also be used along with a permanent structure facility to provide additional composting capacity. Straw bale composters, for example, could be used for catastrophic mortality.

The correct sizing of the composting facility is critical for its successful operation and depends on the size of the animals and the amount of material to be composted on a daily basis. Proper sizing makes the management and operation of the composting process easier. For example, composting facilities that are undersized can lead to problems with odor and flies. Sizing is fairly easy, using the universal sizing procedure. The steps of this procedure are given in Table 51-4. It is applicable to the sizing of either bins or windrows and for any type of dead animal.

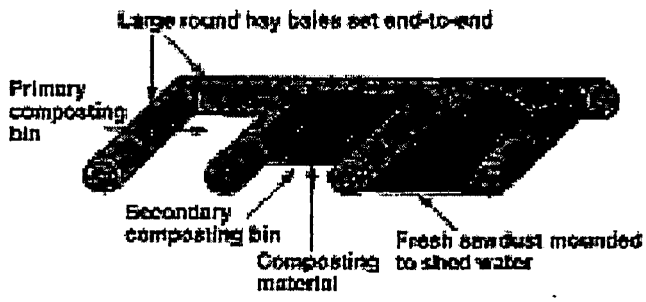


Figure 51-10. Straw bale composter.

Proper sizing makes the management and operation of the composting process easier.

Table 51-4. Universal sizing procedure.

Step	Description
A	Determine the average daily weight of animal carcasses to be composted.
B	Determine the composting cycle times for the **"design weight"** to be composted in each windrow or bin. 1. Primary cycle time (days) = 5.00 x (design animal weight, lb)$^{0.5}$, minimum time ≥10 days 2. Secondary cycle time (days) = 1/3 Primary cycle time, minimum time ≥ 10 days 3. Storage time (days) = Year's maximum period of time between land applica tion events. Must be in keeping with the timing requirements of the nutrient management plan.
C	Determine the needed composter volumes. 1. Primary composter volume (ft^3) = 0.2 x Average daily loss (lb/day) x Primary cycle time (in days) 2. Secondary composter volume (ft^3) = 0.2 x Average daily loss (lb/day) x Secondary cycle time (in days) 3. Storage volume (ft^3) = 0.2 x Average daily loss (lb/day) x Storage time (days)
D	Determine the dimensions of the compost facility including bin dimensions and number of bins or windrow size and area requirements.
E	Determine the annual sawdust requirement for the composting system. Annual sawdust needs (yd^3/yr) = Annual loss (lb/yr) x 0.0069.

[1]Adapted from Ohio Livestock Mortality Handbook 1999.

Step C—
Determine the composter volumes.

Step D—
Determine the dimensions of the compost facility, bin dimensions, and windrow size or number of bins.

Step E—Determine the annual amount of sawdust required for the composting.

Step C—Determine the composter volumes. The following equations are used to determine the needed composter volumes (ft^3).

1. Primary composter volume (ft^3) = 0.2 x Average daily loss (lb/day) x Primary cycle time (in days)
2. Secondary composter volume (ft^3) = 0.2 x Average daily loss (lb/day) x Secondary cycle time (in days)
3. Storage volume (ft^3) = 0.2 x Average daily loss (lb/day) x storage time (days)

Step D—Determine the dimensions of the compost facility, bin dimensions, and windrow size or number of bins. For a bin system, the minimum front dimension should be 2 ft greater than the loading bucket width. A minimum of two primary bins is required. An alternative to individual secondary bins is an area or areas large enough to accommodate the contents of the primary bins. Secondary bins/areas are generally directly behind the primary bins.

Step E—Determine the annual amount of sawdust required for the composting. The following equation estimates the total annual amount of fresh sawdust needed. In practice, it is recommended that up to 50% of the fresh sawdust needs be met with finished compost. The equation allows for a 1-foot sawdust base in the bin on which to begin placing the dead animals, 1-foot of sawdust between layers, 1 foot of sawdust clearance between the dead animals and the sides of the bin, and a 1-foot cover depth. Of course, if values different than these are used in the construction of the pile, either more or less sawdust will be required.

Annual sawdust needs (yd^3/yr) = Annual loss (lb/yr) x 0.0069

The universal sizing procedure sizes the facilities. It does not prescribe the materials or recipe. The recipe used to compost mortality depends on the raw material that is available and especially on the material that is available onfarm. The recipe may also depend on what state and county regulations allow. For example, some states do not permit the use of chicken litter as an amendment in the recipe for composting dead animals. In these states, it is necessary to compost without chicken litter even though it is an effective amendment and may be readily available at low cost. Composting is a combination of art and science. Therefore, it is necessary to adjust the recipe using trial and error until the desired results are achieved.

Straw can be used instead of or to replace a portion of the volume of sawdust computed in the universal sizing equations. Sawdust generally provides superior structure to the compost pile. However, if sawdust is not available or is very expensive, it may be advantageous to use straw. The straw used must yield the same compressed volume as the sawdust to provide clearance and cover equal to that of sawdust. Straw will generally compress to over one-half its loose volume. For this reason, straw must be chopped and initially layered to twice its desired final depth.

Chicken litter can be used to replace a portion of the sawdust, if regulations permit, to improve the C:N ratio of the pile and enhance the compost process. Up to two-thirds of the required sawdust can be replaced with

A convenient and meaningful compost parameter to monitor is temperature; it is an indicator of microbial activitity.

chicken litter. Studies have shown that dead broiler chickens can be successfully composted with only chicken litter (McCaskey 1994).

Composter operation

The compost pile must be monitored and the appropriate adjustments made throughout the composting period to sustain a high rate of aerobic microbial activity for complete decomposition with a minimum of odors as well as maximum destruction of pathogens. A convenient and meaningful compost parameter to monitor is temperature; it is an indicator of microbial activity. By recording temperatures daily, a normal pattern of temperature development can be established. Deviation from the normal pattern of temperature increase indicates a slowing of or unexpected change in microbial activity. Temperatures should begin to rise fairly steadily as the microbial population begins to develop. If the temperatures do not begin to rise within the first several days, adjustments must be made in the compost mix. A lack of heating indicates that aerobic decomposition has not been established. This state can be caused by any number of factors such as a lack of aeration, inadequate carbon or nitrogen source, low moisture, or low pH. Poor aeration is caused by inadequate porosity that, in turn, can result from material characteristics or excessive moisture.

Specific guidelines for the operation of a compost facility include

- Use only approved plans to construct compost facilities.
- Remove mortalities daily from housing facilities.
- Shape piles and windrows so that precipitation will run off.
- Add fresh carbon amendment to outside of the pile for biofilter and to absorb leachate and odors.
- Monitor the compost pile temperature. To eliminate pathogens, an average temperature greater than 122°F must be achieved throughout the compost for at least 5 days during either the primary or secondary composting stages or as the cumulative time with temperatures greater than 122°F in both stages.
- Leave primary compost in the bin until the temperature reaches its maximum and then shows a steady decline for one week. Use care to avoid short circuiting the primary cycle time.
- Mix and aerate the compost by moving the compost to the secondary bin.
- Store stabilized compost until it can be applied in accordance with the timing prescribed by the nutrient management plan or prepared for sale to others.

Compost end use

The primary final use of finished compost is for land application. While the main value of applying compost to land is to improve the soil's structure and water-holding capacity, compost does contain many nutrients. These nutrients are generally not present in the same quantities per unit of volume as inorganic fertilizer. For this reason, a high-rate application of compost will be needed to meet crop nutrient needs. Regardless, the application rate must be based on soil testing and compost nutrient content testing and be applied in keeping with a nutrient management plan.

The advantage of using compost as a fertilizer is that it releases nutrients slowly, usually under the same warm, moist soil conditions required for plant

To summarize, the incineration method for managing mortality has the following advantages and disadvantages (Table 51-7).

Table 51-7. Mortality management by incineration.

Advantages	Disadvantages
1. Sanitary 2. Final except for ashes wasted	1. Nutrients contained in the dead animals is 2. Initial cost 3. Fuel costs 4. Equipment operation and maintenance costs 5. Potential air quality impairment

The incinerator should be sited in a convenient location that will avoid potential problems and be downwind of livestock housing, farm residences, and neighbors.

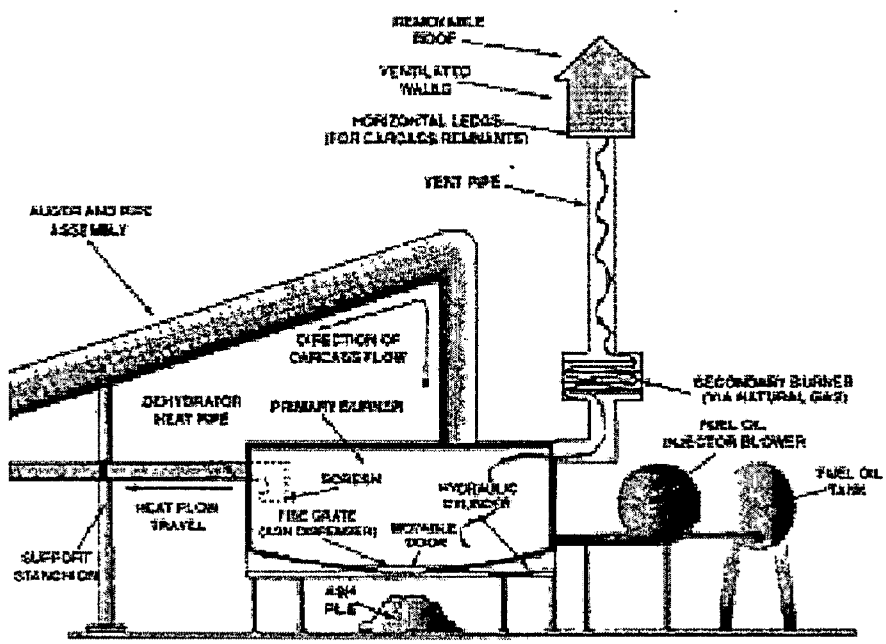


Figure 51-11. Incineration system.
Source: Severincinerator, Global WasteTransformation, Inc., Adairsville, GA.

Burial

Burial is a common method of handling dead animals. This method involves excavating a grave or pit, filling the bulk of the excavation with dead animals, and then covering them with soil until the grave or pit is filled. The fill over the dead animals should be heaped to allow for settling. In time, the carcasses will decompose. In cold climates, burial is difficult when the ground is frozen.

At some locations, regulations may allow disposal by burial only for a massive die-off. For this reason, it is important to contact the appropriate regulatory agency for assistance and/or guidelines if this method is under consideration for day-to-day mortality. Where regulations allow burial, there are generally strict siting requirements. Common siting requirements include locating the burial

- Where it will not create an actual or potential public health hazard.
- In soils having a moderate to slow permeability.
- Where there is a specified minimum separation distance from wells and surface water bodies.
- Where there is no evidence of a seasonal high-water table above the bottom of the grave/pit.
- Outside the 100-year floodplain.

Where regulations allow burial, there are generally strict siting requirements.

Sites that have permeable soils, fractured or cavernous bedrock, and a seasonal high-water table must be avoided.

Construction requirements for burial graves or pits limit the depth to less than 8 feet and demand that the sides of the excavation be sloped to a stable angle. If burial is used, it is important to protect the site from scavengers and rodents before and after burial. For poultry, a 12-inch compacted soil cover is considered minimum with 24 inches being the recommended depth. For larger animals, the cover depth should be at least 36 inches of compacted soil. The completed burial should be seeded with grass to prevent erosion. Check with local officials for specific regulations.

In summary, the burial method of managing mortality has the following advantages and disadvantages (Table 51-9).

Table 51-9. Mortality management using burial.

Advantages	Disadvantages
1.Capital limited to land and excavating equipment	1. Nutrients contained in the dead animals are wasted. 2. Increases sanitary precautions to pre vent disease transmission. 3. Storage of carcasses until burial may be necessary. Difficult if ground is frozen 4. Land area becomes significant for large operations 5. Impossible when ground is frozen

Regulatory Compliance Issues

Regulations relating to livestock and poultry mortality vary from state to state. Most, if not all, states require timely management. It is essential that you research the regulations for your state and locality. You may use Table 51-11 as a checklist for conducting research on the different aspects of mortality management.

Appendix A
Poultry and Livestock Mortality Rates

Poultry

Poultry Type	Average Weight, lb	Mortality Rate, %	Flock Life, days	Design Weight, lb
Broiler	4.2	4.5-5	42-49	4.5
Layers	4.5	14	440	4.5
Breeding Hens	7-8	10-12	440	8
Turkey, females	14	5-6	95	14
Turkey, males	24	9	112	24

Swine

Growth	Average Weight, lb	Mortality Rate,%			Design Weight, lb
		Low	Average	High	
Birth to Weaning	6	< 10	10-12	> 12	10
Nursery	24	< 2	2-4	> 4	35
Growing-Finishing	140	< 2	2-4	> 4	210
Breeding Herd	350	< 2	2-5	> 5	350

Cattle/Horses

Growth Stage	Average Weight, lb	Mortality Rate,%			Design Weight, lb
		Low	Average	High	
Birth	70-130	< 8	8-10	> 10	130
Weanling	600	< 2	2-3	> 3	600
Yearling	900	< 1	1	> 1	900
Mature	1,400	< 0.5	0.5-1	> 1	1,400

Sheep/Goats

Growth Stage	Average Weight, lb	Mortality Rate,%			Design Weight, lb
		Low	Average	High	
Birth	8	< 8	8-10	> 10	10
Lambs	50-80	< 4	4-6	> 6	80
Mature	170	< 2	3-5	> 8	170

Source: Ohio Livestock and Poultry Composting Handboo, December 1999.

Equations for universal sizing of composting bins and windrows

$T_1 = 5 \times W_1^{0.5}$ — days
≥ 10 days

$V_1 \geq 0.2 \times ADL \times T_1$ — ft^3

$T_2 = 1/3 \times T_1$ — days
≥ 10 days

$V_2 \geq 0.2 \times ADL \times T_2$ — ft^3

T_3 = storage — days
= Year's maximum period of time between land application events in keeping with the timing requirements of the nutrient management plan

$V_3 \geq 0.2 \times ADL \times T_3$ — ft^3
Annual sawdust needs = ADL x 0.0069 — yd^3/yr

Where
ADL = average daily mortality (lb/day)
W_1 = design mortality weight (lb)
T_1 = Primary cycle time (days)
V_1 = Primary compost bin or windrow volume (ft^3)
T_2 = Secondary cycle time (days)
V_2 = Secondary compost bin or windrow volume (ft^3)
T_3 = Storage period (days)
V_3 = Storage volume requirement (ft^3)

Grinding. Operation that reduces the particle size of material. Grinding implies that particles are broken apart largely by smashing and crushing rather than tearing or slicing.

Humus. The dark or black carbon-rich relatively stable residue resulting from the decomposition of organic matter.

Incineration. A method for managing mortality that involves burning dead animals with a very hot flame, reducing them to ashes. It is considered the most environmentally benign method for managing mortality.

In-vessel composting. A diverse group of composting methods in which composting material is contained in a building, reactor, or vessel.

Land application. Application of compost, manure, sewage sludge, municipal wastewater, and industrial wastes to land either for ultimate disposal or for reuse of the nutrients and organic matter for their fertilizer value.

Leaching. The removal of soluble material from one zone in soil to another via water movement in the profile.

Litter, poultry. Dry absorbent bedding material such as straw, sawdust, and wood shavings that is spread on the floor of poultry barns to absorb and condition manure. Sometimes the manure-litter combination from the barn is also referred to as litter.

Microorganism. An organism requiring magnification for observation.

Moisture content. The fraction or percentage of a substance comprised of water. Moisture content equals the weight of the water portion divided by the total weight (water plus dry matter portion). Moisture content is sometimes reported on a dry basis. Dry-basis moisture content equals the weight of the water divided by the weight of the dry matter.

Mortality. Animals that die prematurely because of disease, injury, or other causes.

N. Chemical symbol for nitrogen.

Organic matter. Chemical substances of animal or vegetable origin, consisting of hydrocarbons and their derivatives.

Pathogen. Any organism capable of producing disease or infection. Often found in waste material, most pathogens are killed by the high temperatures of the composting process.

pH. A measure of the concentration of hydrogen ions in a solution. pH is expressed as a negative exponent. Thus, something that has a pH of 8 has ten times fewer hydrogen ions than something with a pH of 7.The lower the pH, the more hydrogen ions present, and the more acidic the material is. The higher the pH, the fewer hydrogen ions present, and the more basic it is. A pH of 7 is considered neutral.

Porosity. A measure of the pore space of a material or pile of material. Porosity is equal to the volume of the pores divided by the total volume. In composting, the term porosity is sometimes used loosely, referring to the volume of the pores occupied by air only (without including the pore space occupied by water).

Recipe. The ingredients and proportions used in blending together several raw materials for composting.

Rendering. A method for managing mortality that converts the dead animals into useful products, such as pet food and fertilizer.

Sanitary landfill. An engineered burial facility for disposal of solid waste that is located, designed, constructed, and operated in a manner that will contain the waste so it will not cause a present or potential hazard to public health or to the environment.

Georgia Department of Agriculture
Swine Mortality Disposal
Guy Selph

Purpose: To prevent the spread of infectious, contagious, and communicable diseases from dead animals.

Authority: Dead Animal Disposal Act (O.C.G.A. Sec. 4-5) passed 1969. Rules of the Georgia Department of Agriculture (Chapter 40-16-2) adopted April 1970 and amended May 1984 and October 1985.

I. Definition of Dead Animal:

Carcass, parts of carcass, effluent blood, intestinal or stomach content, and waste material involved in handling the carcass of farm livestock including but not limited to swine, cattle, poultry, equine, sheep, goats, ratites, etc.

II. Violations:

a. To abandon dead animals on personal, private or public land;
b. To properly dispose of dead animals on another person's property without his permission;
c. To dispose of dead animals in a city or county landfill without making arrangements with the city of county officials for proper disposal;
d. To abandon dead animals in wells or open pits on personal, private or public land.

III. Methods of Disposal:

a. Incineration or Burning

(1) Within twelve (12) hours of death or discovery;
(2) Entire carcass reduced to ashes;
(3) Under conditions approved by the U.S. Environmental Protection Agency and the Georgia Environmental Protection Division.
(4) Special conditions (emergency) approved by State Veterinarian on case-by-case basis.

b. Burial

(1) Within twelve (12) hours of death or discovery;
(2) At least three (3) feet below ground level;
(3) No more than eight (8) feet deep;
(4) Three (3) feet of soil on top.

Georgia Department of Agriculture

Capitol Square • Atlanta, Georgia 30334-4201

Tommy Irvin
Commissioner

RULES
OF
GEORGIA DEPARTMENT OF AGRICULTURE
ERADICATION, CONTROL AND SUPPRESSION OF ANIMAL AND POULTRY DISEASES

CHAPTER 40-16-2
DEAD ANIMALS

TABLE OF CONTENTS

40-16-2-.01 Purposes of the Regulations. Amended. In order to halt the spread of infectious, contagious, and communicable disease from the carcass of any animal which has died or been killed, Rules are hereby promulgated controlling the disposal of livestock carcasses.

Authority O.C.G.A. Sec. 4-5. Administrative History. Original Rule entitled "Purposes of the Regulations" was filed on April 1, 1970; effective April 20, 1970. Amended: Authority changed. Filed May 2, 1984; effective May 22, 1984. Amended: Rule repealed and a new Rule of the same title adopted. Filed October 3, 1985; effective October 23, 1985.

40-16-2-.02 Definitions. Amended. The following words of terms shall have the meaning set forth herein when used in these Rules and Regulations:

(a) The term "Department" shall mean the Department of Agriculture.

(b) The term "Commissioner" shall mean the Commissioner of Agriculture.

(c) Dead Animals are defined as:

(1) Carcasses or parts of carcasses of those animals which are considered farm livestock, including poultry, equine, and

(2) It shall further include any effluent, blood, intestinal or stomach contents and all necessary waste material involved in handling such carcasses.

Authority O.C.G.A. Sec. 4-5. Administrative History. Original Rule entitled "Definitions" was filed on April 1, 1970; effective April 20, 1970. Authority changed. Filed May 2, 1984; effective May 22, 1984.

another approved method. Composting is approved only for handling the normal daily mortality of broiler, layer or breeder operations. The procedure used must be one approved by the Commissioner.

(e) Acid Fermentation: Carcasses disposed of by acid fermentation must be subject to the fermentation process within twelve (12) hours after death or discovery of the carcasses. The procedure must be approved by a letter of permit from the State Veterinarian's Office.

Authority O.C.G.A. Sec. 4-5-1 et seq.

40-16-2-.06 Poultry Carcass Disposal. Amended.

(1) The premises of each person growing poultry for himself or others, including turkeys, commercial eggs, hatching eggs and broilers for commercial purposes is hereby quarantined upon the placing of any dead poultry carcass (when death results from other than in connection with the slaughter thereof) in other than a disposal pit or incinerator approved by the Commissioner of Agriculture. Such quarantine shall not be applicable to any person growing poultry who provides and maintains a method of disposal of dead poultry who provides and maintains a method of disposal of dead poultry carcasses that has been approved by the Commissioner of Agriculture as satisfactory to him to prevent the spread of disease.

(2) To aid in the enforcement of the laws of this State, and these regulations, the Commissioner of Agriculture shall issue to each person growing poultry, for himself or others, a certificate of compliance with the provisions of the laws relating to disease prevention and these regulations, when the grower:

(a) Provides and maintains a disposal pit of a size and design adequate to dispose of dead poultry carcasses wherein all dead poultry carcasses are disposed of in a manner approved by the Commissioner of Agriculture to prevent the spread of disease; or

(b) Provides and maintains a method of disposal of dead poultry carcasses that has been approved by the Commissioner of Agriculture as satisfactory to him to prevent the spread of disease.

(c) The Commissioner shall determine the form and contents of the certificate issued to the grower. The certificate shall be numbered and shall be valid until cancelled or revoked by the Commissioner. The violation of any of these regulations shall be sufficient grounds for the revocation or cancellation, revocation or suspension of the certificate provided herein or the license of the poultry processing plant, after notice and hearing.

(d) Disposal pits or incinerators shall be constructed in a manner and be capable of providing a method of disposal of dead birds poultry carcasses in a manner to prevent the spread of disease. Each pit shall be utilized in such a manner as to dispose of the contents thereof effectively. Disposal pits shall be of a design and constructed in a manner approved by the Commissioner. The top of the poultry pit should be of solid construction with all sides covered (sealed with sufficient soil to prevent the entry of rodents, insects and rainwater and the exit of odors). The top should have a tight fitting lid or cap to prevent the entrance of flies. The pit should be located a minimum of 100 feet from wells and water supplies and it should be covered in a manner to allow surface water to drain away from water supplies.

40-16-2-.11 Conflicting Rules and Regulations Repealed. Amended. All rules and regulations and parts in conflict with these rules and regulations are hereby repealed.

Authority O.C.G.A. Sec. 4-5. Administrative History. Original Rule entitled "Conflicting Rules and Regulations Repealed" was filed on April 1, 1970; effective April 20, 1970. Amended: Authority changed. Filed May 2, 1984; effective May 22, 1984.

40-16-2-.12 Severability. Amended. Each of these regulations contained herein, is adopted individually, and without reference to each other, and if any one or more of said regulations is declared invalid, it shall not affect the validity of any other regulation.

Authority O.C.G.A. Sec. 4-5. Administrative History. Original Rule entitled "Severability" was filed on April 1, 1970; effective April 20,1970. Amended: Authority changed. Filed May 2, 1984; effective May 22, 1984.

Nutrient Management Planning
Proper Dead Bird Disposal

D.P. Smith
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The traditional method of dead bird disposal in Georgia has been burial pits. The area where most of the broiler industry originally developed and is still heavily concentrated (Northeast) happens to have soil characteristics that are beneficial for pits (clay). As the industry has expanded to other areas of the state where limestone or sandy soils are prevalent, especially when high water tables are present, pits generally do not work well and may have the potential for contaminating water outside the pits. Concern over potential problems associated with pits have led to development of alternative disposal methods, including composting, incineration, and other methods.

The pit is the simplest and cheapest method currently available to dispose of mortality. The most common method of construction involves using a backhoe to dig a trench approximately 3 feet wide by 10 feet long by 6-8 feet deep. A prefabricated concrete slab with one or two openings is placed over the trench, and the pit is ready for use. The rough cost for the digging ($75) plus the slab ($150) is minimal, especially as the slab is reusable on a new pit once the old one is filled and covered (using dirt from the new pit). The life of the pit is variable, depending on soil conditions, number of birds loaded into it, and other management factors, but 1 to 4 years is common. Although guidelines have been issued by some states regarding pit construction that recommend lining the walls and/or floor with wood or concrete blocks, most pits in North Georgia do not. Over 90% of poultry growers in Georgia have pits as a primary or backup disposal method. There are nearly 4000 active pits and many thousands of inactive pits in the state. There have been no documented cases of soil or water contamination from poultry pits in Georgia.

Problems associated with pits are minimal in North Georgia. If properly located away from a spring area or where ground water collects and then sealed by the slab, mortality decomposes at a good rate and larger animals are prevented from removing contents. The clay soils do not appear to allow leakage of microbial or chemical pit contents very far from the pit into surrounding soil or water. Problems may occur in other areas with little or no clay soils, where pit contents may escape into surrounding soil or water. This concern has prompted many states to ban pits statewide or regionally within a state. Unfortunately, bans have been instituted with little or no scientific data regarding either the escape of pit contents or of soil types within those states. The bans have had a positive effect by forcing research on alternative disposal methods.

The two most common alternative disposal methods have been composting and incineration. Composting is the most widespread method used in states that have banned pits in the past ten years, but correct operation requires a covered area with a concrete floor, plus continued management. Incineration requires an incineration device plus a fuel supply; future

GEORGIA FARM*A*SYST

FARM ASSESSMENT SYSTEM

COMPOSTING POULTRY MORTALITIES

Frank Henning & William Segars, Crop & Soil Sciences
Mark Risse, John Worley & Lisa Ann Kelley, Biological & Agricultural

Cooperative Extension Service, The University of Georgia, College of Agricultural and Environmental Sciences, Athens

PRE-ASSESSMENT:

Why Should I Be Concerned?

Farmers are concerned with soil and water quality. With a rapidly expanding poultry industry and equally rapid urban growth, it is becoming more difficult for farmers to safely dispose of poultry *mortalities**.

An acceptable system for the disposal of dead birds is essential to any well run poultry operation. Current practices include incineration, burial pits, land filling, digestion/fermentation, rendering and *composting*. *Composting* of dead birds is a more recent disposal alternative that is environmentally sound. This process converts dead birds into a humus-like material that can be spread on land for crop utilization and/or soil improvement. This relatively inexpensive method of dead bird disposal is rapidly gaining acceptance in the poultry industry.

Assessment Objective

Unlike the other Farm*A*Syst assessments that focus on farmer stewardship and the environmental soundness of facilities and management practices, this assessment focuses on your *composting* facilities and procedures to ensure that the process prevents health risk or soil and water contamination. This assessment should be used in conjunction with the Broiler or Layer Production Farm*A*Syst assessments that address other environmental concerns pertaining to your operation.

How Does This Assessment Improve the Composting Facility On My Farm?

- This assessment is designed to ensure that your *composting* facilities, tools and techniques are part of a sound waste management plan.
- If you are a contract farmer, it is recommended that you involve your integrator in this farm assessment. Your company has recommendations on carcass disposal and *litter* clean-out pertinent to this process.
- Do not make any management changes based on this assessment that may affect your animals without consulting your integrator.
- You are encouraged to complete the entire document.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment.
- You are encouraged to develop an action plan.
- Farm*A*Syst is a voluntary program.
- No information from this assessment needs to leave your farm.

**Words found in italics are defined in the glossary.*

POULTRY MORTALITY COMPOSTING PRACTICES					
	LOW RISK (rank 4)	**LOW-MOD RISK (rank 3)**	**MOD-HIGH RISK (rank 2)**	**HIGH RISK (rank 1)**	**RANK**
COMPOSTER OPERATION					
Employee training in dead bird composting methods	All employees associated with *composting* are thoroughly trained in dead bird *composting* procedures.	Employees who regularly compost are thoroughly trained in dead bird *composting* procedures.	Employees associated with *composting* re-ceive limited training on dead bird *composting*.	Employees associated with *composting* re-ceive no training on dead bird *composting*.	
Composting procedures	Are outlined in an easy-to-follow recipe, available to all composters, which de-scribes amount, order, placement and treatment of all ingredients being composted.	Recipe is used, but does not contain all needed information.	Operator has a quality recipe for *compost*, but recipe is seldom used.	Operator either does not have a *compost* recipe or never uses a recipe for *composting*.	
Microorganisms responsible for composting are supplied by	A double layer of fresh active (warm) *litter/litter cake* with 40-60% moisture, reactivated litter or active compost.	A double layer of dry *litter*/dry *litter cake*, or less than a double layer of active *litter/litter cake*.	Less than a double layer of dry *litter* or dry *litter cake* used as starter.	No starter used.	
Carcass placement	Carcasses are never placed closer than 6 inches from side-walls or top of bins.	Carcasses are never placed closer than 6 inches from bin sidewalls, but are sometimes left uncapped overnight.	Carcasses are sometimes placed within 6 inches of bin side walls.	No attempt is made to keep carcasses away from top or sides of bins.	
Filling birds	Birds are covered daily with at least a double layer of *litter cake* or 1.5 parts by weight of *litter* for each volume/weight of birds. When full, bins area capped off with a double layer of litter.	Birds are sometimes left uncovered overnight.	Less than two volumes of *litter cake* are added for each volume of birds or less than 1.5 parts by weight of litter per bird weight.	When compost bin is filled to a height of 4 to 4 1/2 feet, *compost* is either left uncapped, or is capped with less than a double layer of *litter*.	
How is the moisture content of compost determined?	Moisture meter.	Estimated by hand.	Estimated visually.	No attempt made to monitor or adjust moisture.	

POULTRY MORTALITY COMPOSTING PRACTICES

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	RANK
Application rates	*Compost* applied to fields at rates that meet crop *nutrient* requirements based on a *nutrient management plan* (NMP). Litter and soils are tested.	*Compost* applied to cropped fields at rates that do not exceed 2.5 tons/acre/application, and do not exceed 5 tons/acre/year. Soils in application areas tested.	*Compost* applied to cropped fields at rates that do not exceed 2.5 tons/acre/application, and do not exceed 5 tons/acre/year. Soils in the application areas are not tested.	*Compost* applied to cropped lands at rates that exceed 2.5 tons/acre/application, or exceed 5 tons/acre/year or materials applied to uncropped lands at any rate.	
Application timing	According to accurate *nutrient* accounting or NMP. Never applied in wet conditions.	Based on when crop is at growth stage that usually needs fertilizing. Try to avoid applying in wet conditions.	Based on convenience. When manure cleaned out of houses, and *compost* are available. Try to avoid applying in wet conditions.	Based on convenience. When *litter* cleaned out of houses and *compost* are available. Often applied when soil is wet.	
Application areas	All areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwell-ings or sinkholes and have slopes of 15% or less. Or all areas are approved by an NMP.	Most areas are more than 25 feet from rock outcrops, 100 feet from surface water sources, wells, dwell-ings or sinkholes and have slopes of 15% or less. Or most areas are approved by an NMP.	*Litter* is occasionally spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings or sinkholes or have slopes greater than 15%.	*Litter* is routinely spread over areas that are less than 25 feet from rock outcrops or less than 100 feet from surface water sources, wells, dwellings, or sinkholes or that have slopes greater than 15%.	
Record keeping	Complete records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications and *nutrients* leaving farm through sales or giveaways.	Partial records kept on farm applications but no records on *nutrients* leaving farm.	No records kept.	
Calibration	*Nutrient* application equipment calibrated to proper application rate before each application. Uniform application over the area is assured.	*Nutrient* equipment calibrated annually. No effort to assure uniform *nutrient* application over the area.	Use custom *nutrient* hauler and applicator that does not calibrate equipment, or calibrates equipment less than once a year.	Never calibrate *nutrient* application equipment or ask custom applicator about calibration procedure.	

Number of Areas Ranked ________
(Number of questions answered. There are a total of 22 questions.)

Ranking Total ________
(Sum of all numbers in the "Rank" Column)

COMPOSTING FACTS:

Composting is a natural, biological process by which organic material is broken down and decomposed because of the bacteria and fungi that digest the organic material and reduce it to a stable humus. The principles of *composting* are quite simple: just provide the microorganisms with an environment conducive to their growth—a balanced diet, water and oxygen.

In order for composting to be successful as a method of dead bird disposal, the following must take place:

- All birds must be decomposed beyond recognition.
- Risk from disease transmission must be eliminated.
- Fire hazards must be minimized.
- Any threats to water resources must be prevented.

Permitting for Poultry Mortality Composting Facilities

All methods for the disposal of dead animal carcasses require permits from the Georgia Department of Agriculture (GDA). Growers must submit a written request to the state veterinarian at the following address:

Georgia Department of Agriculture
Animal Industry
19 M.L. King Jr. Drive
Room 106
Atlanta, GA 30334
404-656-3671

The letter requesting the permit should state the name that the producer wants to appear on the certificate of compliance and describe the *composting* procedures and the type of facility to be used. It must also include the producer's pit number, if he or she has one. If this is a new farm, this should be stated at the time of request.

If the producer plans to have a *composting* facility inside the poultry house, approval from the poultry contracting company is required. A form is available from the Georgia Poultry Federation.

Interested growers should first contact their local Natural Resources Conservation Service (NRCS) to obtain information on *composting* and *compost* facilities.

Composting procedures (or recipes) developed by the Cooperative Extension Service (CES), NRCS, Farm Service Agency (FSA), or the Resource Conservation Development Council (RC&D) must be used.

COMPOSTER CAPACITY

In order to meet peak disposal requirements, *compost* facilities must be properly sized.

Primary Bin Capacity:
The total minimum volume of the primary bins of composters can be calculated from the expression below:

$$\mathbf{V = B \times (M/T) \times W_B \times 2.5}$$

- **V** is the total minimum volume in the primary bin in cubic feet
- **B** is the total number of birds on the farm
- **T** is the days of flock life
- $\mathbf{W_B}$ is the average market weight of the birds in pounds
- **M** is the percent mortality expressed as a decimal (example 5% = 0.05)
- The factor of 2.5 in this equation represents 2.5 cubic feet of composter volume required per pound of dead birds.

Secondary Bin Capacity:
The total volume of the secondary bins should be the same as the primary composter capacity.

COMPOST FACILITY DESIGN AND CONSTRUCTION

Roof Design

Some materials are composted outside. However, this is not recommended for dead bird composters. A roof ensures all-weather operation and helps control rain, snow, runoff and percolation which can be major concerns. In order to prevent excessive moisture in *compost*, the roof over *compost* bins must poster. (The base layer should not be placed more than a few days prior to use for *composting* birds or it will cool as bacterial numbers reduce when moisture or oxygen becomes limited.)

- Unless *litter cake* is used which is bulky with much air-holding ability, a thin layer of peanut hulls, coarse shavings or straw is added next.

- A layer of dead bird carcasses is then added. The carcasses should be arranged in a single layer side by side, touching each other. Carcasses should be placed no closer than 6 inches from the walls of the composter. Carcasses placed too near the walls will not compost as rapidly, since the temperature is cooler near the walls.

- A layer of *litter cake* (40 to 60 percent moisture content) twice as thick as the layer of carcasses underneath or litter (1.5 parts by weight) is added next. This layer should be twice as thick as the layer of carcasses underneath.

- If only a partial layer is needed for a day's mortality, the portion should be covered with *litter.* The rest of that layer can be used with subsequent mortality.

- A small amount of water may be needed after each layer. If much water is required, the *litter* is too dry and probably low in live bacteria.

- After completing the initial layer, subsequent layers of either *litter cake* and carcasses or *litter,* bulking ingredient and carcasses follow. Keep adding layers until compost height approaches 4 to 4½ feet.

- Cap off with a double layer of litter, so that the height of compost in the bin does not exceed 5 feet. Excessive height increases the chance that the composter temperature will exceed 160°F which increases the risk of spontaneous combustion.

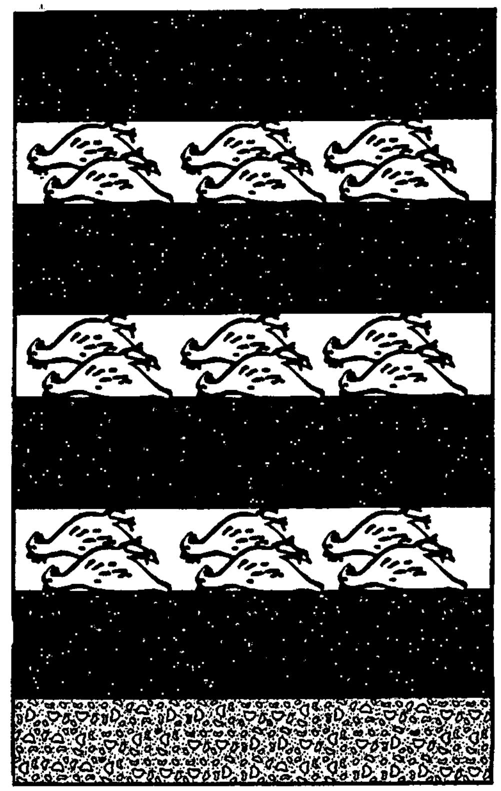


Figure 1: Composter Bin

Table 3. C:N Ratio

Ingredient	**C:N Ratio**
Birds	5:1
Litter	7:1 to 25:1
Straw	80:1
Peanut hulls	50:1
Shavings	300-700:1

If 2 parts by volume of *litter,* 1 volume of dead birds, and adequate bulking agent is either contained in the *litter,* or added prior to the carcasses, the C:N ratio should be adequate. If moisture and aeration are adequate, materials with lower C:N ratios usually compost at higher temperatures.

Microorganisms

Starter:

The microorganisms responsible for *composting* are initially supplied by active *litter* or *litter cake.* The microbes in the *litter* used in the *composting* process need to be kept alive and in sufficient numbers so that *composting* can begin immediately to break down the carcasses and the *litter. Litter* that is cade" from the loader bucket to provide good turning and re-aeration as it is deposited in the secondary treatment area. The movement to a second cell will probably be necessary to get adequate *decomposition* if the birds exceed 4 to 5 pounds or if material is removed from below and added above (see package composters on next page).

The product temperature should again rise to 150°F within days. Delayed movement, poor aeration, poor mixing or moisture above 60 percent or below 40 percent will cause the mass not to heat properly.

Once the temperature (determined by daily monitoring) drops from 150° to 130°F (7 to 21 days), the product is ready to be used as a fertilizer.

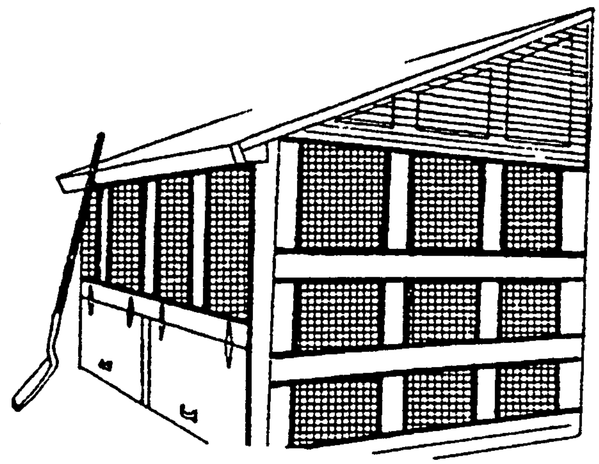


Figure 2. Package Composter

Flies and Odor

Flies and odor are not a problem where composters are operating properly. The heat destroys the habitat for flies and since the process is *aerobic* (in the presence of oxygen) very little odor is produced. Improved management is usually the best solution to odor and fly problems.

Composter Types and Layouts

Composters presently used for dead birds consist of four types.

- **Package composters:** These composters are commercially available. The composted by-products fall to the bottom of the composter down to the concrete slab where they are then shoveled by hand back to the top to *compost* new dead birds. A 5-gallon bucket of new *litter* material is normally added to each *composter* each week. A few operators will add a small amount of bulking agent such as peanut hulls or cotton seed hulls to trap oxygen and promote heating.

- **Delmarva (small bin):** The front wall of these bins consists of 2-inch thick boards which are mobile to help with filling and removing the material to be composted. The material in the composters is moved with some type of end loader or skid steer loader. Therefore, the width of the small bin composter must allow the loader bucket to get into the bin. Normally these small bin composters are 8 to10 feet wide by 5 feet high and 5 feet deep. The depth is limited to 5 feet due to the reach required to drop the composted material into the secondary bin which is immediately behind the primary or small bin. Moving the material from the primary bin to the secondary bin after 10 to 21 days is common for Delmarva type composters to mix in oxygen in the mass to promote heating. The oxygen is added as the mixture is dropped or moved from the primary bin to the secondary bin.

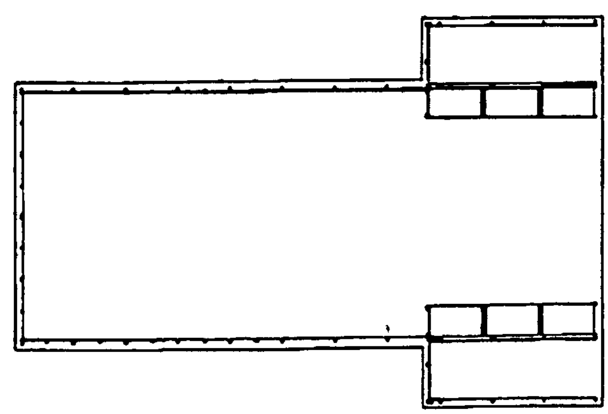


Figure 3. Small Bin Composter—Plan View

- **Big bin (adaptation of the Delmarva):** The big bin uses a primary bin which does not have a removable front. In fact, the front is totally open and the *compost* material slopes back slightly with the front face of the composted material

At this writing, there are no state of Georgia regulations governing the land application of poultry *litter*. However, some counties do have regulations. Contact your county extension office to determine if such regulations exist.

Dead Bird Compost Application

Application rates, calibration and timing, and record keeping should be handled like manure. The Georgia Cooperative Extension Service, NRCS county offices and Georgia Department of Agriculture (GDA) can provide information on *composting* as well as other disposal methods. *Compost* should go through at least two decomposing cycles (primary and secondary treatment) before being land applied.

Soil Testing of Application Sites

Compost can be sampled and tested to determine their nitrogen, phosphorus and potassium content. These *nutrient* values combined with values for manures, crop residues and starter fertilizer help determine whether more commercial fertilizer should be added for desired crop production.

All land applications of poultry *mortality* compost should be based on soil test, *compost* analysis, and realistic crop yield goals.

Record Keeping

Keep records of the dates, quantity and specific application sites. If you sell the *litter*, keep a record of buyers, dates, amounts and the farm sites where buyers apply or use the *litter*. These records can assist you with management and protect you from liability.

Application Rates

The best application rate depends on the crop being produced, the soil's *nutrient* content and the *nutrient* content of the applied material. Soil testing and *litter nutrient* analyses are recommended procedures for best determining *litter* application amounts. Application equipment should be calibrated for accurate and even distribution.

Poultry *compost* should be evenly distributed over application sites at a rate not to exceed 5 tons per acre per year, with no more than 2.5 tons/acre in each application or according to a site-specific *nutrient* management plan.

Vehicles must be covered or tarped for transporting poultry *compost* on state or federally maintained roads or any public road.

Your county extension office can provide more information on soil testing, *litter* analyses, equipment calibration, record keeping and other areas related to poultry *compost* land application.

Application Timing

Surface land application of poultry manure and *compost* residue should not be undertaken when soil is saturated, during rainy weather or when rain is in the immediate forecast.

Application Areas

Consider unique features of the farm and make your management plan specific for these features. Do not apply poultry *compost* to the surface and subsurface within 100 feet of streams, ponds, lakes, springs, sinkholes, wells, water supplies and dwellings. Grass, vegetative and/or forest buffer strips along stream, pond or lake banks are helpful in preventing *nutrient* runoff from adjacent fields and pastures.

Do not apply *nutrients* on slopes with a grade of more than 15 percent or in any manner that will allow *nutrients* to enter the waters of the state.

Calibrating

Calibration of waste application equipment, such as irrigation systems, tank wagons and manure spreaders is needed to ensure safe and efficient distribution of waste materials. Equipment should be calibrated and rechecked at least once during the application period since the consistency of the *compost* can vary greatly. For more information about calibration of waste-spreading equipment, contact your county extension office.

NOTES:

ACTION PLAN:

An action plan is a tool that allows you to take the needed steps to modify the areas of concern as identified by your assessment. The outline provided below is a basic guide for developing an action plan. Feel free to expand your plan if you feel the need for detail or additional areas not included. Consult the list of references on the next page if additional assistance is needed to develop a detailed action plan.

Area of Concern	Risk Ranking	Planned Action to Address Concern	Time Frame	Estimated Cost

PUBLICATIONS:

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, GA 3063

- Agricultural Best Management Practices for Protecting Water in Georgia

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Georgia's Ground Water Resources, Bulletin 1096
- Well Head Protection for Farm Wells, Circular 819-3
- Animal Waste and the Environment, Circular 827
- Poultry Waste, Georgia's 50 Million Dollar Forgotten Crop, Leaflet 206
- Calibration of Manure Spreaders, Circular 825
- Land Application of Livestock Manures, Leaflet 378
- Composting Poultry Mortalities, Circular 819-5
- Poultry Composting Facilities, Circular 828
- Facilities for Storing and Handling Broiler Litter, Newsletter

Poultry Water Quality Consortium
TVA, Suite 4300
5700 Brainerd Rd., 6100 Building
Chattanooga, TN 37402-2801

Poultry Water Quality Handbook

NOTES:

PERMIT COMPREHENSIVE NUTRIENT MANAGEMENT PLAN
to
MEET REGULATORY REQUIREMENTS

SITE DESCRIPTION

Farm Name: Pork Chop Acres
Owner: Ima Hogg
Address: 999 Nowhere Rd.
Anyplace, GA

Telephone No. 706 222-2222

Directions to Farm (if location map not provided below):
See location map

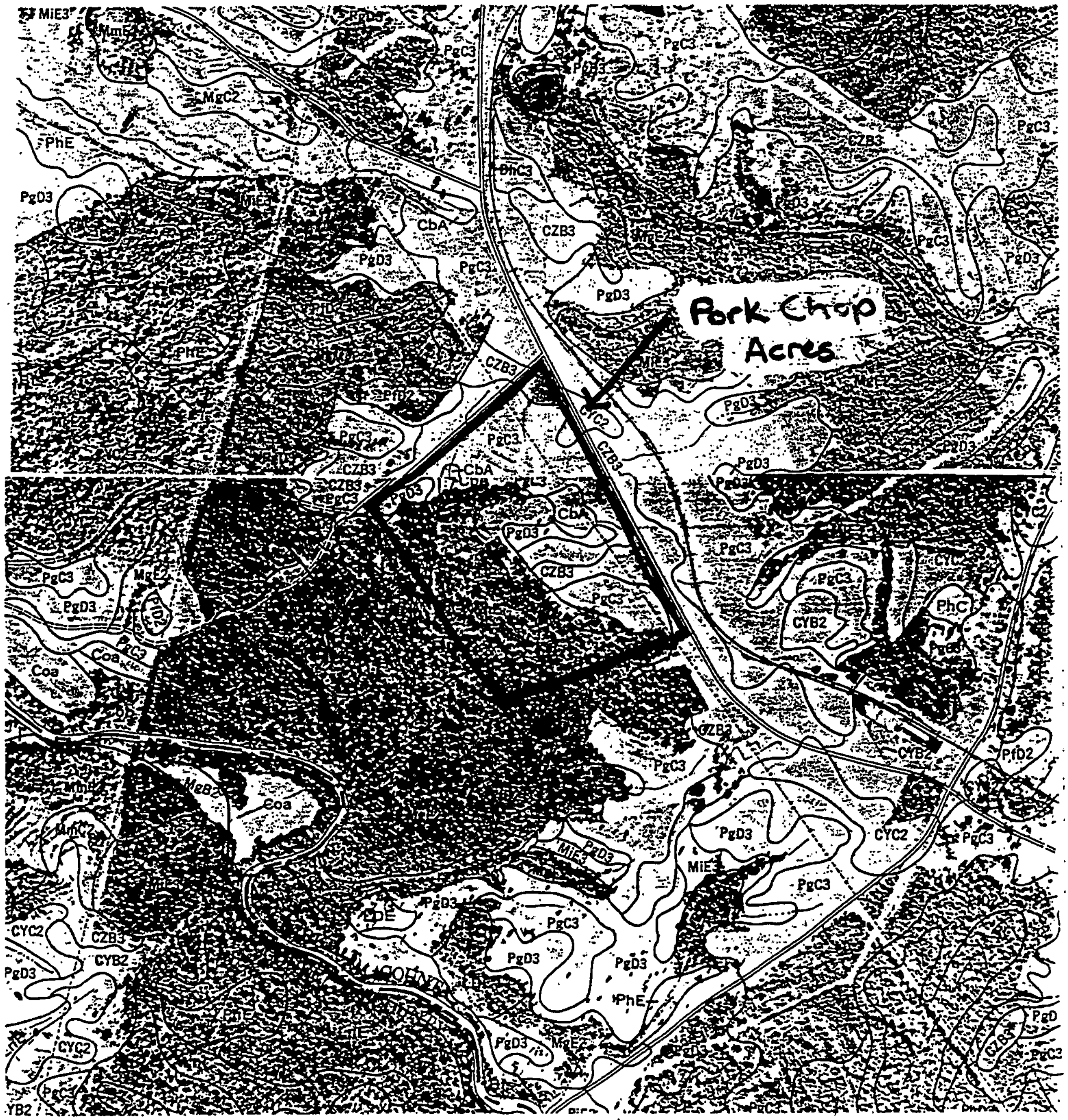
Farm Description:
No. of Animals - about 500 AU; 133 sows, 2 boars, 60 gilts, 3060 nursery pigs about 2,000 pigs finished per year

Manure Storage Facilities and estimated capacity -
Four cell lagoon system
Estimated capacity assuming 8-foot depth - 3.4 million gallons

Attach:
- Site Location Map (recommended)
- Soils Map (recommended)
- Farm Map (required with the following items, the NRCS toolkit can provide this)
  - Farm property lines
  - Land use - cropland, pasture, etc.
  - Farm field boundaries with field identification
  - Surface water locations including streams, rivers, ponds, ditches, etc.
  - Arrows showing direction of stream or water flow
  - Well locations
  - Regulated Buffers
  - Any residences or public gathering areas*
  - Sensitive areas that may be buffered*
  - North arrow
  - Date prepared
  - Road names or numbers
  - Legend with map symbols
  - Bar scale

*These items optional

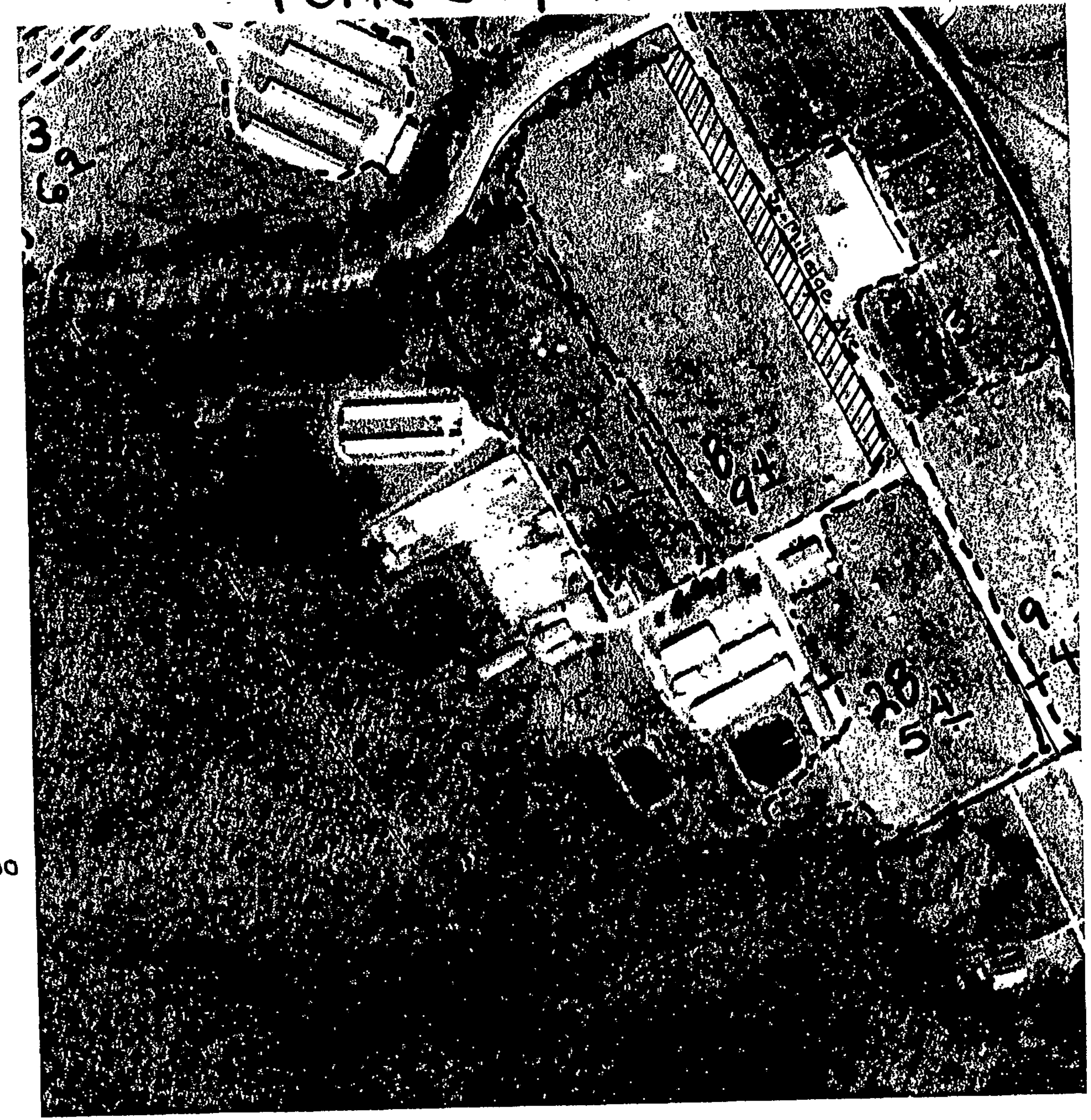
Location Map


Pork Chop Acres
MiE3
MgC2
PhE
PgD3
PgC3
CbA
CZB3
DhC3
CYC2
PfD2
Coa
MeB2
MnC2
CYB2
PhC
PgD

Soils Map

Farm Map.

Pork Chop Acres



N

LEGEND

- —— Property line
- - - - Field boundary
- ▨ Buffer - 50'
- 8 Field name
- 9½ Acreage

Date prepared: 7/6/00

Prepared by: JWG

660 feet

1 inch = 347 feet

Part A: NUTRIENTS PRODUCED

This section can be completed using actual data or worksheets. If actual manure generation amounts are know and manure analysis has been completed, then this data is preferred. If manure amounts and data from analysis are not available, use number of animals with book values for nutrient concentrations and storage/handling losses. Worksheets or spreadsheets used for calculations or records and analysis should be attached.

Nutrients Present after Storage and Handling Losses
Total nitrogen: 2,221 lbs
Total phosphorus as P_2O_5: 12,239 lbs
Total potassium as K_2O: 10533 lbs

Part B: NITROGEN AVAILABLE FOR LAND APPLICATION

All inputs on annual basis.

	Total Nitrogen (lbs) from Part A	Availability Coefficient (based on app. method)	Available Nutrients (lbs)
Lagoon wastewater or slurry	2,221	0.5	1,111
Lagoon Sludge	N/A sludge applied off-farm		
Dry Manure or Litter	N/A		

Comments:

Part C: LAND APPLICATION

Application Methods

Lagoon wastewater or slurry:
System type: low-pressure reel
Irrigation frequency: monthly (weekly, monthly, etc)
Calibration frequency (annually, every 5 years, etc.): annually

Lagoon sludge:
System type: _N/A____________
Application frequency: ___________ (yearly, every 5 yrs etc)
Calibration frequency (annually, every 5 years, etc.): ___________
(Attach Calibration Records if available)

Dry Manure:
System type: N/A____________
Capacity: ___________
Application frequency: ___________ (annually, semiannually, etc)
Calibration frequency (annually, every 5 years, etc.): ___________

Complete Nutrient On-farm Nutrient Utilization Table and Nutrient Budget sheets for each field.

Estimated Manure Nutrients Excreted and Remaining for Use as Fertilizer for:

Pork Chop Acres 07/18/00

133 **Sows** 2 **Boars** 60 **Gilts**

3060 **Nursery Pigs/yr** 2000 **Pigs Finished/yr**

Phytase Enzyme?

	Breeding/Farrowing	No
	Nursery	No
	Grow/Finish	No

Nutrients Excreted:

	Pounds per Year
Nitrogen Excretion (as **N**)	22208
Phosphate Excretion (as P_2O_5)	13599
Potash Excretion (as K_2O)	11703

Treatment and Storage System:
Lagoon System With Two Or More Cells

Nutrients Remaining After Treatment and Storage:

	Pounds per Year		
Nitrogen (as **N**)	2221	To	4442
Phosphate (as P_2O_5)	12239		
Potash (as K_2O)	10533		

Based on information supplied by: jw

(Excretion and Loss estimates are approximate averages, actual values may vary.)

Table C1 . Annual On-Farm Nutrient Utilization: This Table is for planning and not actual applications. Please record all fields that you intend to use manure on. For each field there should be a corresponding Nutrient Budget Sheet.

Field #	Crop (or rotation if two crops grown in one year)	BMP's used[1]	Annual Manure N Use (lbs)[2]	Application Method	Application timing (record season and splits)
8	bermudagrass hay/ annual ryegrass	voluntary 50ft buffer along road,4,10	300	low pressure reel	monthly
Total					

[1]: Insert BMP numbers from listing of BMP's in Table C2 or write in additional practices.
[2]: From Nutrient Budget Worksheets, spreadsheet, or other recommendations.

Spreadsheet —

Acreage Requirement For Nutrient Utilization

Producer: UGA Swine Unit **County:** Clarke **Date:**
Farm # : 235 **Tract # :** 252 **Field # :** 8 **Acres:**
Manure Type: Swine lagoon liquid **Irrigation Method:** Irrigation from lagoon #2

Annual Crop Rotation & Nutrient Utilization					
		Nutrient Recommendation			
Rotation	Planned Crop	N	P2O5	K2O	
1	Coastal Bermuda Hay	300	20	0	Lb/A
2	Annual Ryegrass	150	0	0	Lb/A
3	none	0	0	0	Lb/A
4	none	0	0	0	Lb/A
5	none	0	0	0	Lb/A
Total		450	20	0	Lb/A

Nutrient Content of Waste After Treatment and Storage				
	N	P2O5	K2O	
Nutrients Remaining	2221.0	1224.0	1053.0	Lb/A
Availability Coefficients of Waste	0.5	0.8	1.0	Lb/A
Available Nutrients Remaining	1110.5	979.2	1053	Lb/A

Minimum Acreage Required for Nutrient Utilization				
	N	P2O5	K2O	
	2.47	48.96	ERR	Acres

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer:	UGA Swine Unit	**County:** Clarke		**Date:**	07/11/00
Farm #:	235 **Tract #:** 252.0	**Field #:**	8.0	**Acres:**	8.50
Soil Series:	Louisburg	**Surface Soil Texture:**	Loamy Sand		
Planned Crop:	Coastal Bermuda Hay	**Realistic Yield Expectation:**		0.0	Tons/A
Soil Test Index:	P = 93.2 (Lb/A)	K =	462.3 (Lb/A)	pH =	5.6
Manure Type:	Swine Lagoon Liquid	**Application Method:**	Irrigation From Lagoon #2		

	N	P2O5	K2O		
Crop Nutrients Needs:	300.00	20.00	0.00	Lb/A	
Commercial Fertilizer Applications:	0.00	0.00	0.00	Lb/A	
Residual N from Legumes:	0.00	NA	NA	Lb/A	
Manure Nutrient Concentration:	48.70	19.90	60.90	Lb/A-In	
Availability Coefficients:	0.50	0.80	1.00	NA	
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb	
Net Manure Nutrient Needs of Crop:	300.00	20.00	0.00	Lb/A	
Manure Nutrients Available to Crop:	24.35	15.92	60.90	Lb/A-In	
Fertilizer Value:	8.28	3.98	9.74	Total = 22.00	$/A-In

Manure application rate for supplying crop :	N needs =	12.3	In/A
	P2O5 needs =	1.2	

	N based Application		P2O5 based Application		
	Nutrients Applied	Balance	Nutrients Applied	Balance	
N	300	-0	29	-271	Lb/A
P2O5	196	176	19	-1	Lb/A
K2O	749	749	73	73	Lb/A

Total manure applied to field based on:	N needs =	104.6	Acre Inches
	P2O5 needs =	10.2	

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure application for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micronutrients.

* See Farm*A*Syst Publications for information on applying animal waste, especially around streams, wells and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to prevent manure liquids from nutrient runninng off into surface water or leaching into groundwater.

Sincerely,

Name
Title
County, District, etc.

Georgia Field Level Nutrient Budget Worksheet

A Worksheet for Managing the Nutrients in Manures from Georgia's Farms

Producer:	UGA Swine Unit	**County:**	Clarke		**Date:**	07/11/00
Farm #:	235 **Tract #:** 252.0	**Field #:**	8.0		**Acres:**	8.50
Soil Series:	Louisburg	**Surface Soil Texture:**	Loamy sand			
Planned Crop:	Winter Grazing	**Realistic Yield Expectation:**			0.0	Tons/A
Soil Test Index:	P = 93.2 (Lb/A)	K =	462.3 (Lb/A)		pH =	5.6
Manure Type:	Swine Lagoon Liquid	**Application Method:**	Irrigation from lagoon #2			

	N	P2O5	K2O			
Crop Nutrients Needs:	150.00	0.00	0.00	Lb/A		
Commercial Fertilizer Applications:	0.00	0.00	0.00	Lb/A		
Residual N from Legumes:	0.00	NA	NA	Lb/A		
Manure Nutrient Concentration:	48.70	19.90	60.90	Lb/A-In		
Availability Coefficients:	0.50	0.80	1.00	NA		
Equivalent Fertilizer Price:	0.34	0.25	0.16	$/Lb		
Net Manure Nutrient Needs of Crop:	150.00	0.00	0.00	Lb/A		
Manure Nutrients Available to Crop:	24.35	15.92	60.90	Lb/A-In		
Fertilizer Value:	8.28	3.98	9.74	Total =	22.00	$/A-In

Manure application rate for supplying crop :	N needs =	6.1	In/A
	P2O5 needs =	0.0	

	N based Application		P2O5 based Application		
	Nutrients Applied	Balance	Nutrients Applied	Balance	
N	149	-1	0	-150	Lb/A
P2O5	97	97	0	0	Lb/A
K2O	371	371	0	0	Lb/A

Total manure applied to field based on:	N needs =	51.9	Acre Inches
	P2O5 needs =	0.0	

* If peanuts or tobacco are included in your crop rotation be sure to test soil following each manure application for recommendations on avoiding nutrient toxicity from high soil concentrations of Zn, or other micronutrients.

* See Farm*A*Syst Publications for information on applying animal waste, especially around streams, wells and on other environmentally sensitive areas.

* When making liquid manure applications, proper irrigation techniques must be used to prevent manure liquids from nutrient runninng off into surface water or leaching into groundwater.

Sincerely,

Name
Title
County, District, etc.

Table C2: Listing of BMP's used on Land Application Fields

1. Plant sampling/tissue analysis
2. Manure injection or incorporation
3. Manure treatments such as alum
4. Conservation or Reduced Tillage
5. Contour plantings
6. Terraces or other water control structures
7. Critical area plantings/vegetated waterways without manure applications
8. Upslope Water diversions or downslope ponds or retention structures
9. Riparian buffers or filter strips around field border
10. Winter "scavenger" or cover crops (without nutrient application)
11. Rotational Grazing

Part D: NUTRIENT BALANCE

A) Total Manure N Used On-farm 2,550 lbs. (From Land Application Section)
B) Total Manure N Generated 1,111 lbs. (From Nutrient Available Section)
C) Difference: (A-B) 1,439 lbs.

Note: If difference is greater than zero, your nutrient balance is complete. If difference is less than zero (negative) then excess nitrogen will need to be transported off-farm. These off-farm uses need to be documented on off-farm utilization record sheets or through other manure utilization agreements.

Table D1: Off-farm Nutrient Utilization Records

Date	Amount Removed from Farm Amount	 Total N (lbs)	Person or company that purchased or removed manure	Anticipated use
10/8/00	lagoon sludge 30,000 gals	N/A	Joe Pumper	adjacent farm

Part E: MORTALITY MANAGEMENT

Typical annual mortality rates: ____50_ animals/yr
* Attach or show calculations used to obtain estimate.

Typical disposal practices:

Burial/Pit	__________%
Composting	____100 __%
Incineration	__________%
Rendering	__________%
Other	__________%

Please Describe Other methods:

Catastrophic mortality plan:

Dept. Agriculture Permit/ contact: ____Permit # 000000135____

Part F: RECORD KEEPING

Records kept on farm:

Yields	Y	<u>N</u>	NA
Soil tests	<u>Y</u>	N	NA
Manure Analysis	<u>Y</u>	N	NA
Water Quality Monitoring (if required)	Y	<u>N</u>	NA
Land application(IRR1&2,SLUR1&2, or SLD1&2)	<u>Y</u>	N	NA
Monthly lagoon/storage inspection checklist	<u>Y</u>	N	NA
Equipment calibration	<u>Y</u>	N	NA
Equipment maintenance	<u>Y</u>	N	NA
Farm*A*Syst or other environmental assessments	Y	<u>N</u>	NA

Comments or additional records kept on farm:

Part G: EMERGENCY RESPONSE PLAN

Describe emergency response plan or attach Emergency Response Sheet G1 for operations with just solid manure or Emergency Response Sheets 1 and 2 for operations with liquid manure:

See Attachment

Part H: CLOSURE PLAN

Closure plan required: Y <u>N</u>

If required, briefly describe closure plans or attach Closure plan worksheet:

Emergency Action Plan

Post, clearly by every phone on farm

Farm Name:
Permit Number:

IF There is an EMERGENCY.......

1) **Shut off all flow into storage area**

2) **Assess the extent of the emergency and determine how much help is needed**

3) **Contact Farm Supervisors**
   Name: Mike Daniel Phone #: BR549
   Name: Cathy Zier Phone #: BR550

4) **Give supervisor the following information:**
   Your name
   Farm ID/Permit Number
   Description of Emergency
   Estimates of the amounts, area covered, and distance traveled from manure storage
   Whether manure has reached ditches, waterways, streams or crossed property lines
   Any obvious damage: employee injury, fish kill, or property damage?
   What is being done, any assistance needed

5) **Contact state water resources division, contractors, emergency officials, technical specialists and media, as needed.**
   a) **Georgia Environmental Protection Division-** 800-241-4113
   b) **Emergency Response-** Name________ Phone 911
   c) **Pumping-** Name EZ Pumper Phone 555-9112
   d) **NRCS-** Name Jose Pagan Phone 706-5480 2878
   e) **County Extension Office-** Name Frank Henning Phone 542-9067
   f) **Consultants-** Name Joe Blow Phone 412 9372

Build a containment dam downstream of discharge area, then progressively build additional dams upstream

- Add soil to the berm of the manure storage area/basin
- Remove manure from the discharge are with a trash pump if necessary
- Pump manure and wastewater from the manure storage at a lower rate to lower the volume in basin

Fire Emergency Response Information Sheet

Farm Name: UGA Swine Center
Farm Fire Protection District:
911 Coordinates for farm:
Size and type of operation: 135 sow farrow-to-finish

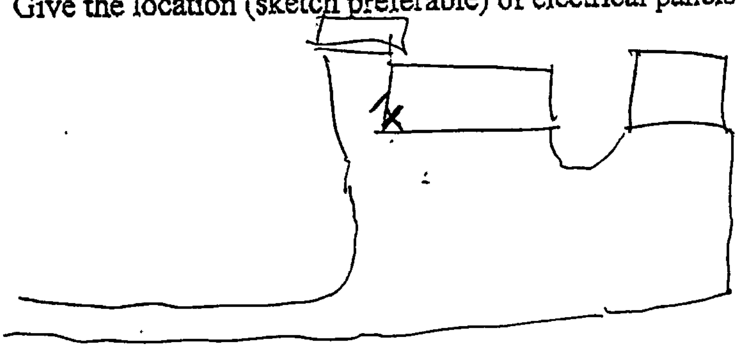
Owner/Operator: UGA Animal Science Dept /Mike Daniel Phone Number: ~~706 369 5925~~ BR549

2nd Contact Person if owner/operator is not available:
Name: Cathy Zier Phone Number: BR 558

3rd Contact Person if owner/operator and 2nd contact person is not available:
Name: Rick Jones Phone Number: BR551

Electrical Power Company Name: Ga Power
Electrical Power Company Phone Number: 888-660-5890
Is there a disconnect between the meter base and the buildings? (Y) N
If so, where? main circuit on farrowing house

Give the location (sketch preferable) of electrical panels in buildings.



Propane Company Name: Use-it gas company
Propane Company Phone Number: 412 937 9218
Location and size of propane tanks:
One thousand tank at entrance next to farrowing barn

Other fuels and locations:

Are there hazardous materials stored in facilities: Y (N)
If yes, provide the location(s) and list of materials:

Emergency Action Plan for:
Facility Fire:
Emergency Actions
Call 911, notify farm manager, release livestock, notify emergency personel of chemical and fuel storage.

Pre-arranged Emergency Response Agreements

List any arrangements made with other producers to share personnel and/or equipment and supplies and land access during an emergency.

Pre-arranged land access agreements

Contact #1 Wes Pope 369 5722

Contact #2 ______

Location of Pre-Arranged Emergency Supply Equipment and Supplies

Available 24 hours a day. Include phone numbers and primary contacts. Put list in the order you want equipment operators contacted. Copy posted in each animal building on site, in site office and owners residence. Preferably posted by a phone or main doorway if no phone.

Owner	Phone	Location
Irrigation Pumps		On Site
Dozer/Track Loader 706	369 5715	ADS Farm Crew
		Exum Worrell
Backhoe 706	542 7456	Physical Plant
		Brent Fowler
Vacuum Slurry Tank		

Lagoon/Basin Pumping Services

Name: Oconee River RC&D
Address: 1291 Greensboro Hwy Room A107, Watkinsville GA
Phone #: 706-769-7922

Name:
Address:
Phone #:

EMERGENCY PHONE NUMBERS

Site Location[1]: 250 S. Milledge Athens Ga
Exit — Athens Loop 10 Milledge Ave

Owner's name: University of Georgia Animal Science Dept Phone #: 706-542-0962

Livestock Manager: Mike Daniel Phone #: 706-~~542~~ 769-5721

Ambulance (EMS) Phone #: 911

Fire Dept. Phone #: 911

County Sheriff # 706-613-3270

STATE Emergency Management Agency Phone # GEMA XXX-XXX-XXXX

STATE WATER QUALITY AGENCY Phone #: EPD 800-241-4113

STATE Department of Agriculture Phone #: 404-656-3671

LOCAL/COUNTY Public Health Department Phone #: 706-542-8600 (Clarke)

Natural Resources Conservation Service Phone #: 706-769-3990 (Watkinsville)

Soil and Water Conservation District Phone #: 706 542 3030 (Athens)

Technical Specialist/Comprehensive Nutrient Management Planner Phone #:

[1] Provide directions that anybody can direct someone to the site by telephone.

PERMIT COMPREHENSIVE NUTRIENT MANAGEMENT PLAN
to
MEET REGULATORY REQUIREMENTS

SITE DESCRIPTION

Farm Name:	Tifton Campus Dairy Center
Owner:	UGA College of Agricultural & Environmental Sciences Animal & Dairy Science Department
Address:	PO Box 748 Tifton, GA 31793
Telephone No.:	229-386-3364

Directions to Farm: Located northwest of Tifton, as shown on attached location map.

Farm Description:

The farm includes an average of 150 lactating cows, 30 dry cows, 65 heifers over 1 year of age, and 75 heifers less than 1 year of age. Facilities include a flush cleaned, free-stall barn using sand bedding where lactating cows are housed, with an attached, flush cleaned milking parlor; a flush cleaned calf barn where calves are housed until 2 months of age; and various pastures and lots where heifers and dry cows are maintained. The farm occupies a block of the Coastal Plain Station main farm, which includes approximately 1,600 acres.

The free-stall barn is flushed with liquid recycled from the third stage manure holding pond, while the milking parlor and calf barn are flushed with well water. All wastes are flushed to a common sump. The waste management system includes a gravity settling basin for solids reduction, three manure storage ponds in series with a total storage capacity of 9.6 ac. ft. (3,128,000 gallons), and manure pumps and pipelines connected to three pivot irrigation systems.

Attachments: Maps (prepared by Mary Leidner, Tift Co. NRCS)

- Site Location map, Soils Map
- Farm Area Map with:
  - North Arrow
  - Relevant Property Lines
  - Land use
  - Field boundaries and identification
  - Surface water locations and flow direction
  - Buffer areas
  - Well locations
  - Residences
  - Legends and scales
- Manure nutrient printout
- Field nutrient budget sheet
- Emergency Action Plan
- Emergency Phone Sheet
- Emergency Handbook

Manure Storage Facilities Description - Storage Pond 2
(Use one form for each structure that holds manure or waste water)

Date Structure was installed and engineer or design agency (if available)

Unknown

Type of Structure (Circle One) (Manure Slurry Storage) Anaerobic Lagoon

Solids Settling Basin Dry Litter Storage Above Ground Tank

Other (Describe) ______________________________

____

For earthen storage, describe the type of liner used. (Synthetic, compacted clay) and give design information if available (permeability rate, etc.)

Compacted Clay Liner (Permeability unknown)

Estimated Capacity (gallons, cubic feet, or tons [if dry storage])
4.97 ac. ft. (216,500 cu. ft, or 1,619,500 gal)

Surface Water Diversions (Circle One)

(All surface water diverted) Some surface water allowed into storage

Explain if surface water allowed into storage. (Give roof area, animal lot area, grassed area, etc.)

Leakage (Prevention and Inspection)

Are all berms inspected for leaks, proper vegetative cover, tree growth, and rodent damage at least monthly? (Yes) No

Operating Levels (Lagoons)

Maximum fill level (ft below overflow) ____

Minimum Pump-down level ____

Is a staff gauge present in the lagoon which clearly indicates these levels? Yes No

Manure Storage Facilities Description - Storage Pond 3
(Use one form for each structure that holds manure or waste water)

Date Structure was installed and engineer or design agency (if available)

Unknown

Type of Structure (Circle One) Manure Slurry Storage Anaerobic Lagoon

(Solids Settling Basin) Dry Litter Storage Above Ground Tank

Other (Describe) ____________________

____

For earthen storage, describe the type of liner used. (Synthetic, compacted clay) and give design information if available (permeability rate, etc.)

Compacted Clay Liner (Permeability unknown)

Estimated Capacity (gallons, cubic feet, or tons [if dry storage])
3.10 ac. ft. (135,036 cu. ft or 1,010,200 gal)

Surface Water Diversions (Circle One)

All surface water diverted (Some surface water allowed into storage)

Explain if surface water allowed into storage. (Give roof area, animal lot area, grassed area, etc.) Small (approx. 0.1 acre) grassed area drains into pond. Difficult to divert because of layout of ponds.

Leakage (Prevention and Inspection)

Are all berms inspected for leaks, proper vegetative cover, tree growth, and rodent damage at least monthly? (Yes) No

Operating Levels (Lagoons)

Maximum fill level (ft below overflow) ____

Minimum Pump-down level ____

Is a staff gauge present in the lagoon which clearly indicates these levels? Yes No

Table C1. Annual On-Farm Nutrient Utilization: This Table is for planning and not actual applications. Please record all fields that you intend to use manure on. For each field there should be a corresponding Nutrient Budget Sheet.

Field #	Crop (or rotation if two crops grown in one year)	BMP's used[1]	Annual Manure N Use (lbs)[2]	Application Method	Application timing (record season and splits)
2C (N)	corn-bermuda-rye (forage)	4,5,8,9	2,420	irrigation	biweekly
2C (E)	corn-corn-rye (forage)	4,5,9	1,430	irrigation	biweekly
1C	corn-millet-ryegrass (forage)	4,5,6,9	8,970	irrigation	biweekly
3C	corn-rye (forage)	4,5,6,7,8,9	3,580	irrigation	as needed to maintain storage basin levels
P1	bermuda (grazing)	4,6	900	spreader	3 X per year
P2	bernuda (hay & grazing)	4,9	1,200	spreader	4 X per year
C8	bermuda (hay)	4	1,600	spreader	5 X per year
C9	bermuda (hay)	4,9	60	spreader	summer/fall
Total			20,160		

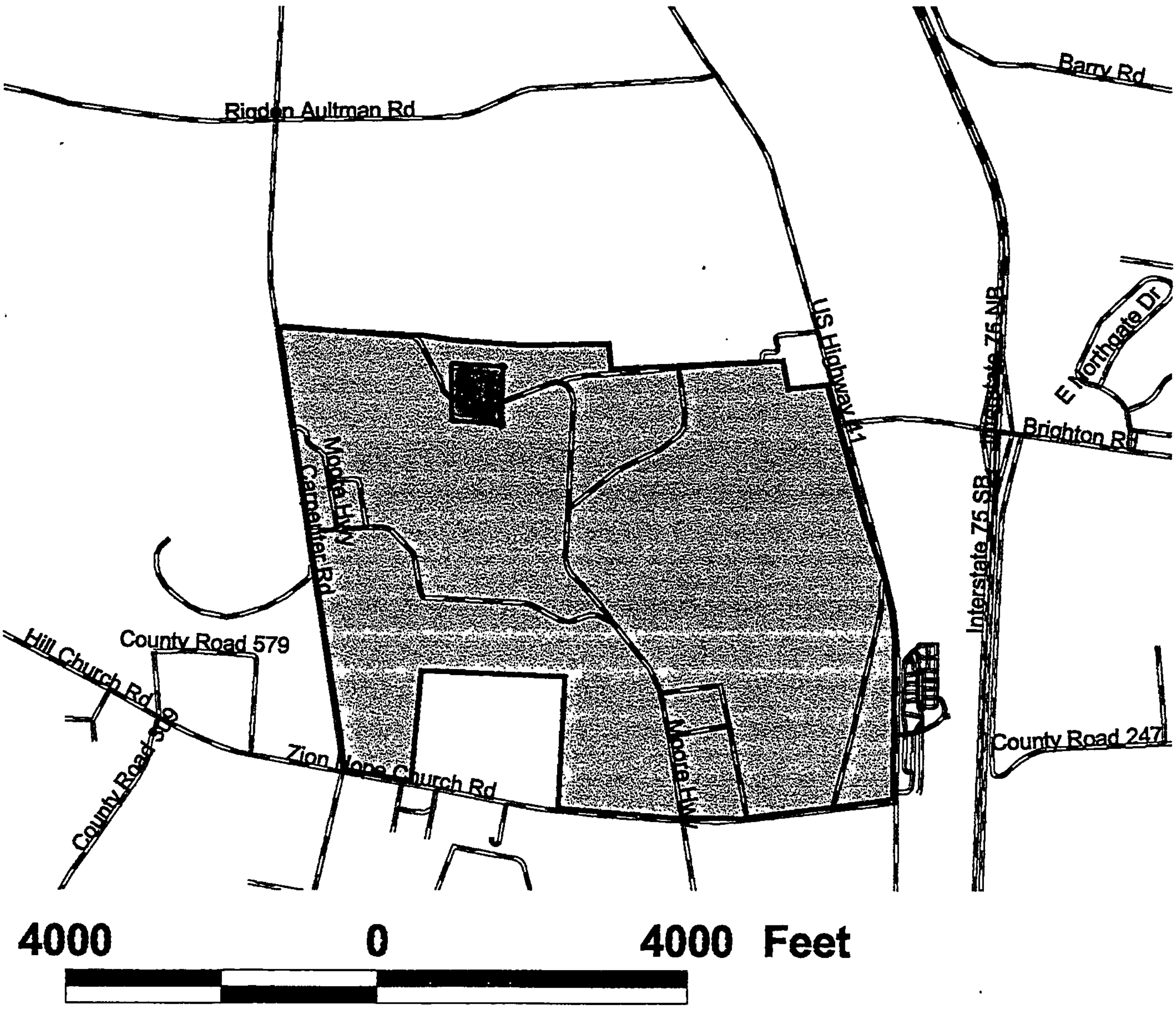
[1] Insert BMP numbers from listing of BMP's in Table C2 or write in additional practices.
[2] From Nutrient Budget Worksheets, spreadsheet, or other recommendations.

Field Nutrient Budget Sheet

Field #	Acreage	Nutrient Source or Crops	N need/ac (lbs)[1]	Total N need (lbs)	Manure N (lbs)	Balance (lbs)
		Liquid Manure			16,400	
C2 (N)	5.26	Corn silage/bermuda hay/rye haylage	460	2,420	2,420	13,980
C2 (E)	3.18	Corn silage/corn silage/rye haylage	450	1,430	1,430	12,550
C1	23	Corn silage/millet grazing/ryegrass	390	8,970	8,970	3,580
C4	50	Corn silage/rye	320	16,000	3,580	-12,420
		Settled Manure Solids			3,700	
P1	10.1	Bermuda grazing (T-44)	200	2020	900	2,800
P2	15.7	Bermuda hay & grazing (T-44)	200	3140	1,200	1,600
C8	14.1	Bermuda hay (T-85)	400	5640	1,600	-4,040
		Thickened Sludge			60	
C9	3.3	Bermuda hay (mixed)	300	990	60	-930

[1] Sum for various crops from "Soil Test Handbook For Georgia".

UGA Coastal Plain Experiment Station
Dairy Farm
Location Map



Road

CPES dairy site

N

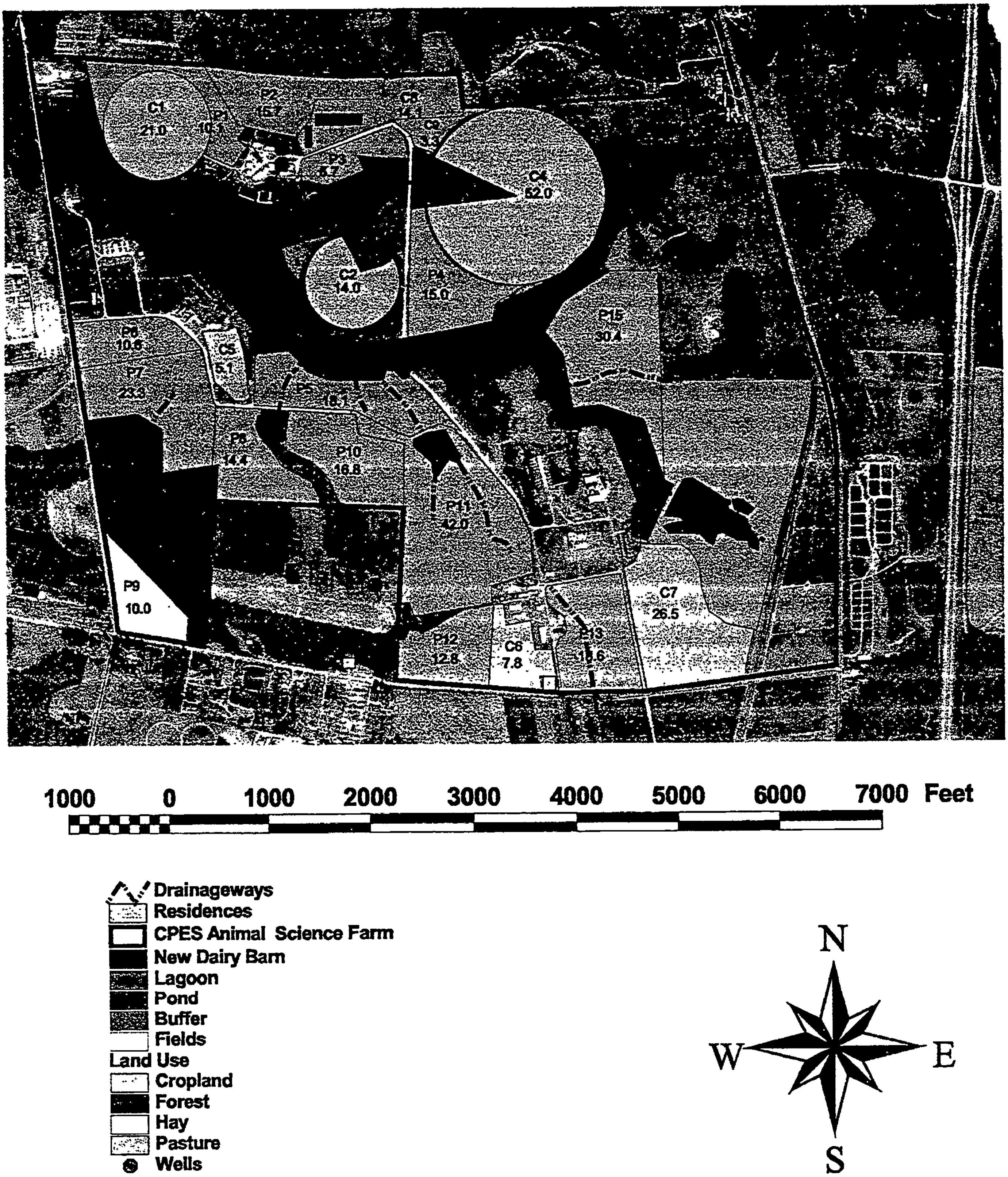
UGA Coastal Plain Experiment Station
Dairy Farm
Soils Map

1" = 1667'

SOIL MAP LEGEND
CPES Dairy

Map symbol	Soil name
Ah	Alapaha loamy sand
ArA	Ardilla loamy sand
CaC2	Carnegie sandy loam, 5 to 8 percent slopes, eroded
Cn	Clarendon loamy sand
CoB	Cowarts loamy sand, 2 to 5 percent slopes
CrC2	Cowarts sandy loam, 5 to 8 percent slopes, eroded
FsB	Fuquay loamy sand, 0 to 5 percent slopes
KO	Kinston and Osier fine sandy loams
LaB	Lakeland sand, 0 to 5 percent slopes
Oc	Ocilla loamy sand
Pe	Pelham loamy sand
Se	Stilson loamy sand
TfA	Tifton loamy sand, 0 to 2 percent slopes
TfB	Tifton loamy sand, 2 to 5 percent slopes
TsC2	Tifton sandy loam, 5 to 8 percent slopes, eroded

UGA-Coastal Plain Experiment Station
Animal Science Farm Tifton, Georgia



G2: Emergency Action Plan (Liquid Manure)

The following is posted, clearly by every phone on farm:

IF There is an EMERGENCY.......

1) **Shut off all flow into storage area or lagoon or going out to land application areas**

2) **Assess the extent of the emergency and determine how much help is needed**

3) **Contact Farm Supervisors**

Name:	Harmon Tawzer	Phone #:	(W) 386-7094
Name:	Dr. Jerry Baker	Phone #:	(W) 386-3367

4) **Give supervisor the following information:**

Your name
Description of Emergency
Estimates of the amounts, area covered, and distance traveled from manure storage
Whether manure has reached ditches, waterways, streams or crossed property lines
Any obvious damage: employee injury, fish kill, or property damage?
What is being done, any assistance needed

5) **Contact state environmental protection division, contractors, emergency officials, technical specialists and media, as needed.**

a) Georgia Environmental Protection Division-
   i) SPILL REPORTING: 800-241-4113
   ii) LOCAL OFFICE Phone (Albany Office) 229-430-4144

b) Local County Health Department		Phone	386-7965
c) Pumping-	Name Harmon Tawzer	Phone	386-7094
d) NRCS-	-Name Mary Leidner	Phone	382-4776
e) Extension Office-	Name	Phone	391-7980
f) Consultants-	Name Larry Newton	Phone	386-3214

Provide directions that anybody can direct someone to the site by telephone.

Build a containment dam downstream of discharge area, then progressively build additional dams upstream

- Add soil to the berm of the manure storage area/basin
- Remove manure from the discharge area with a trash pump if necessary

Pump manure and wastewater from the manure storage to lower the volume in basin

Complete Post-Emergency Assessment and Documentation or other State reporting requirements.

EMERGENCY PHONE NUMBERS

POISON CONTROL CENTER (HUMAN OR ANIMAL)
(800) 282-5846

Ambulance 382-2323 **City Police** 382-3131 **Fire Department** 382-1211

County Sheriff 386-7800 **Georgia Highway Patrol** 386-3333

Local Phone Number -

Security	387-1608	387-1604
Jim Graham	386-3337	
Dr. C. R. Dove	386-3089	[redacted]
Melissa Tawzer	386-3859	[redacted]
[redacted]		
Dr. J. F. Baker	386-3367	[redacted]

FIRES, SPILLS, LEAKS, ETC.

Georgia DNR Environmental Protection Division Response Team
(pesticide fires, spills, leaks) (800) 241-4113

Chemtrec (technical assistance 24 hrs. a day for fires, spills, and medical emergency) (800) 424-9300

SARA Title III, Right-to-Know Emergency Operations Center
(404) 635-7215 or 7216

ENDANGERMENT OF GAME OR FISH

Georgia Department of Natural Resources (Non game endangered species)
(912) 994-1438

U.S. Fish and Wildlife Service (912) 265-9336

Handbook of Emergency Procedures

University of Georgia, Tifton Campus

Key Emergency Phone Numbers to Know
All Emergencies: 911

Poison Control Center: 1-800-282-5846
Tift General Hospital: 382-7120
After hours Med Choice: 388-5743

Tifton Campus, University of Georgia
Director's Office: 386-3338
Physical Plant: 386-3337
After Hours: 387-1608

Georgia Power: 387-3302 or 1-888-891-0938
Colquitt EMC: 926-2278 or 1-800-342-8694
Railroad Emergencies: 1-800-232-0144
Forest Fire: 386-3346
GEMA: 1-800-241-4113
State Patrol: 386-3333
Local Emergency Management: 386-7910
Board of Regents: 404-656-2247
UGA Environmental Safety: 706-542-6949

ACCIDENT, SERIOUS INJURY OR ILLNESS

DEFINITION:
Emergency where one may be sick or injured.
Immediate concern is to aid the sick or injured employee.

STEPS OF ACTION:
1. Ask the victim if he/she is OK, check for breathing.
2. Get someone to call 911 for help.
3. Provide first aid/CPR if trained and if needed. Stay with the victim until emergency response personnel arrive.
4. Contact family members.
5. Inform staff as needed.
6. Disperse the crowd, if necessary.
7. Complete accident report form and file in office if appropriate.

AFTER-HOURS BUILDING EMERGENCY

DEFINITION:
An emergency occurring before or after regular business hours.

STEPS OF ACTION:
See specific emergency and use those procedures.

ROLES:
Staff member in building should contact emergency people and perform the following acts:

1. Follow procedures appropriate for the specific emergency.
2. Contact appropriate administrative personnel.
3. If groups are present, alert personnel of emergency and follow *Steps of Action* for that emergency.

PHONE NUMBERS:

If emergency: 911
Physical Plant (after hours - Security): 387-1608
Director's Office: 386-3338
Physical Plant: 386-3337

FIRE

DEFINITION:
A fire in the building or on the premises requiring the evacuation of the building.
For small fires, no larger than a waste basket, attempt to extinguish with a fire extinguisher.
For all fires call 911 and have the fire department respond.

STEPS OF ACTION:

1. **Pull fire alarm**, where available.
2. **Call 911**, then notify personnel in surrounding buildings.
3. **Close all windows** and doors to confine fire, if possible. Turn off open flames and lights.
4. **Evacuate building** to assigned places at least 500 feet from building.
5. **Supervise** evacuation and check for injuries.
   - Administer first aid if necessary.
   - Call Directors office and Physical Plant.
   - Assign roles to auxiliary persons as needed.
   - Keep access roads open.
   - Take head count to include names of staff in the affected building or buildings.

PHONE NUMBERS:
Emergency: 911
Physical Plant: 386-3337
Director's Office: 386-3338
After hours (Security): 387-1608

TORNADO WATCH OR WARNING

DEFINITIONS:
Tornado Watch: Conditions are favorable for a tornado or severe weather. Make staff aware, but take no action.

Tornado Warning: Tornado has been sighted; take shelter immediately.

Steps of Action:
1. Alarm at ABAC should sound.
2. Each office will have the weather radio on. Have it programmed for local area.
3. Departments will be alerted of a tornado watch and warning by telephone from Physical Plant or Director's Office.
4. If warning is issued, activate phone tree to all buildings and alert personnel to get to designated areas.
5. Employees should proceed to their designated positions facing the wall and assume a kneeling position (or sit cross-legged), head down, hands covering head.
6. Employees in unsafe locations at the time of the alarm will go to a pre-designated safe location.
7. Keep windows closed.
8. Remain in a safe location until the danger has passed.

NATURAL DISASTERS - THUNDERSTORMS, FLOODS, HURRICANES, EARTHQUAKES, AND WINTER STORMS

DEFINITION:
Weather conditions are favorable for the above listed natural disasters.

STEPS OF ACTION:
1. Regular scheduling may be suspended. Advance preparation enables the UGA Tifton Campus to cope with such situations.

2. The first condition for making a decision to suspend operations is safety. Final decisions for closing the campus will be made by the Director. He is in contact with the U.S. Weather Bureau, the police department, Civil Defense, the Georgia Patrol and others who monitor reports of existing weather hazards.

3. When severe weather watches are announced, immediate emergency procedures need to be followed for safety of the employees to vacate the premises.

4. Closure notices will be reported on the local radio station for faculty and staff.

UTILITY EMERGENCY

DEFINITION:
Electrical power failure, gas line break, water main or sewer break, and/or electrical power break.

SIGNALS:
Should building need to be evacuated, follow fire drill procedures. In the event of electrical failure and need to evacuate, verbal notification would be given on a building-by-building basis. A visual check of all affected areas would be conducted by designated Physical Plant personnel.

ACTIONS FOR SPECIFIC EMERGENCIES:

Electrical Power Failure
Call Georgia Power: 387-3302
Call Physical Plant: 386-3337

Power Line Down
Clear area immediately, and avoid live wires
Call 911 if emergency exists
Call Physical Plant: 386-3337
Call Georgia Power: 386-3302

Gas Line Break
Clear area immediately; evacuate building, if necessary
Call 911 if emergency exists
Call Physical Plant: 386-3337

After-Hours Utility Emergency
Call Physical Plant after hours number: 387-1608

Water Line Break or Sewer Break
Call Physical Plant:
Call 911 if emergency exists

HAZARDOUS MATERIALS INCIDENT

DEFINITION:
Hazardous materials incident involves fire/explosions, chemical spills, chemical leaks, or releases from a fume hood.

STEPS OF ACTION:
1. Call 911, if emergency. Call Physical Plant 386-3337 (387-1608 if after hours) and Director's Office 386-3338.
2. Evacuate the building.
3. Provide MSDS or similar information.
4. Provide first aid kits if necessary.
5. Contain spill where appropriate.
6. Act as liaison with emergency organizations.
7. Coordinate communication within departments.
8. Assist in traffic control into and out of affected area.

Reporting Information
Name of material spilled
Amount of material
Exact location
Injuries or damage

Resource Material:
UGA Enviromental Safety Division. Responsible management of hazardous waste training manual.

BOMB OR BOMB THREAT

DEFINITION:
A device present in the building or on the premises which may or may not have exploded.

Steps of Action:
1. Call 911. Work cooperatively with law enforcement agency responding to call.
2. Obtain as many details as possible if a bomb threat is made. Record identifying information (bottom of page).
3. Evacuate the building and move to safe area.
4. Have staff look for unusual or suspicious noises, devices or disturbances while searching and evacuating the building. Report suspicious items to the bomb squad.
5. Protect face and head with arms, books, coats, etc. from flying debris.
6. Leave door open; do not use switches.
7. **Do not use walkie talkies, cellular phones, car phones, other electronic devices.**

BOMB THREAT CALL CHECKLIST

Try to keep caller on the line and ask the following questions:

1. When is bomb going to explode?
2. Where did you place the bomb?
3. What does the bomb look like?
4. What kind of bomb is it?
5. What will cause the bomb to explode?
6. Did you place the bomb?
7. What is your name?
8. What is your address?

IDENTIFYING INFORMATION

Sex of the caller______________________________
Accent (if detectable)__________________________
Time of call__________________________________
Did voice sound like an adult?______________________
Child?______________________________________
Record as many of caller's exact words as possible.

HOSTAGE, TERRORIST, OR CRIMINAL BEHAVIOR

DEFINITION:
Persons who enters campus, apprehend employees and/or threatens violence.

STEPS OF ACTION:
1. Dial 911.
2. Call Director's Office (386-3338) and Physical Plant (386-3337).
3. If after hours, call campus security 387-1608.
4. Secure immediate area to confine problem.
5. Secure building by locking appropriate doors (labs, offices, and entrances).
6. Await assistance.

Key Hostage Tips:
1. Be patient. Avoid drastic action.
2. The initital 45 minutes are the most dangerous. Follow instructions, be alert and stay alive.
3. Don't speak unless spoken to and then only when necessary. Don't attempt to rationalize with the captor.
4. Expect the unexpected, i.e., mood swings, irrational actions.
5. Do not make quick or sudden moves.
6. Be observant. The safety of others may depend on what you remember about the situation.

UNIVERSAL PRECAUTIONS FOR ADMINISTERING FIRST AID

1. Most approaches to infection control are based on a concept called Universal Precautions. It requires that persons administering aid consider every person, all blood and body fluids to be a potential carrier of infectious disease. When administering first aid the following standards of practice should be followed:

2. Wash hands with antiseptic towelettes if there is any possibility of contact with blood, body fluids or human tissues from an injured worker. Wash hands with soap and water as soon as possible.

3. Wear gloves when anticipating contact with blood, body fluids, tissues, mucous membranes or contaminated surfaces, or if breaks in the skin are present.

4. Wear an impervious gown or apron if splattering of clothes is likely.

5. Wear a mask if there is to be contact with an infectious disease spread by splatter droplets.

6. Wear appropriate protective equipment at all times including a mask and eye protection if aerosolization or splattering is likely to occur when attending to an injured person.

7. Make mouthpieces, resuscitation bags and other resuscitation devices readily available for use in areas where the need for resuscitation is likely and carry appropriate devices in emergency response kits.

8. Handle sharp objects carefully.
   - Do not cut, bend, break or reinsert used needles into original sheath by hand.
   - Discard sharp objects intact, immediately after use into an impervious sharps disposal box which should be carried whenever needles are in the emergency response kit.
   - Report immediately all needle stick accidents, mucosal splashes or contamination of open wounds with blood or body fluids.

9. Dispose of all spills which contain or may contain biological contaminants in accordance with policies for hazardous waste disposal. Until clean up is complete, the accident area should be roped off to other workers.

10. Post Universal Precaution signs in all areas designated for first aid and on emergency response boxes and first aid kits.

Participant Evaluation

Livestock and Poultry Environmental Stewardship Curriculum

Purpose: The "Livestock and Poultry Environmental Stewardship" curriculum is a new educational program for producers and their advisors. Your evaluation of this resource is important to us.

Date: ____________________

About You

I am a:	My primary farm income is from:	Compared to other animal operations in my industry, I consider my farm to be:
☐ Livestock or poultry producer. ☐ Private sector advisor or agribusiness representative. ☐ Public sector advisor, regulator, or policymaker.	☐ Beef. ☐ Poultry. ☐ Dairy. ☐ Field crops. ☐ Pork. ☐ Other: ____________	☐ Small. ☐ Medium. ☐ Large.

About Two of the Lessons Presented at the Workshop

Select two lessons to evaluate:	Lesson #______				Lesson #______			
Please rate the quality of the	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Written information:	☐	☐	☐	☐	☐	☐	☐	☐
Visual presentation:.	☐	☐	☐	☐	☐	☐	☐	☐
Did you use the Self-Assessment tools?................................	☐Yes	☐No			☐Yes	☐No		
If "Yes," rate their value:........	☐	☐	☐	☐	☐	☐	☐	☐
Please rate the lesson's value in helping you understand:	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Principles of environmental stewardship?	☐	☐	☐	☐	☐	☐	☐	☐
Your operation's strengths and weaknesses?..................	☐	☐	☐	☐	☐	☐	☐	☐
Environmental regulations?	☐	☐	☐	☐	☐	☐	☐	☐

About the Workshop

Based on the information you received from this workshop, do you anticipate:

Making changes that benefit the environment?	Making changes that improve your compliance with regulations?	Investing financial resources in changes?
☐ Yes ☐ No ☐ Unsure	☐ Yes ☐ Unsure ☐ No ☐ No, already in full compliance	☐ No ☐ $5,001-$10,000 ☐ < $1,000 ☐ >$10,000 ☐ $1,001-$5,000

Comments or suggestions (additional comments can be written on the back):

____

____

Module A. Introduction

1. Principles of Environmental Stewardship
2. Whole Farm Nutrient Planning

Module B. Animal Dietary Strategies

10. Reducing Pig Waste and Odor Through Nutritional Means
11. Reducing Poultry Waste and Odor Through Nutritional Means
12. Feeding Dairy Cows to Reduce N, P, and K Excretion into the Environment
13. Feeding Beef Cattle to Reduce N and P Excretion into the Environment

Module C. Manure Storage and Treatment

20. Planning and Evaluation of Manure Storage
21. Sizing Manure Storage, Typical Nutrient Characteristics
22. Open Lot Runoff Management Options
23. Manure Storage Construction and Safety, New Facility Considerations
24. Operation and Maintenance of Manure Storage Facilities
25. Manure Treatment Options

Module D. Land Application and Nutrient Management

30. Soil Utilization of Manure
31. Manure Utilization Plans
32. Land Application Best Management Practices
33. Selecting Land Application Sites
34. Phosphorus Management
35. Land Application Records and Sampling
36. Land Application Equipment

Module E. Outdoor Air Quality

40. Emissions from Animal Production Systems
41. Emission Control Strategies for Building Sources
42. Controlling Dust and Odor from Livestock Facilities
43. Emission Control Strategies for Manure Storage Facilities
44. Emission Control Strategies for Land Application

Module F. Related Issues

50. Emergency Action Plans
51. Mortality Management
52. Environmental Risk and Regulatory Assessment Workbook

Curriculum Project Lesson Plan

Module A, Introduction

Lesson	Intended Outcomes The participant will	Topics	Activities	Time
1. Principles of Environmental Stewardship Rick Koelsch	• Recognize key principles of environmental stewardship • Understand key environmental issues facing industry • Review environmental & regulatory issues of local interest	• Key environmental issues facing industry • What does environmental stewardship mean? • Define principles of environmental stewardship for industry.	• How does my environmental stewardship rate (checklist)? • Establish environmental stewardship goals • Review of applicable regulations	1 hour
2. Whole Farm Nutrient Balance Rick Koelsch	• Identify if nutrient inventories are increasing within farm • Recognize key strategies for reducing nutrient imbalance	• Explanation of nutrient balance and impact on issues • Review own operation for nutrient imbalance • Relationship to TMDLs	• Environmental Stewardship Inspection • Nutrient Balance Indicators (checklist) • Estimate of whole farm nutrient balance	1 hour (Appendix A 2-4 hours)

Module B, Animal Dietary Strategies (continued)				
12. Feeding Dairy Cows to Reduce N, P, and K Excretion into the Environment Rick Grant	• Understand the impact of dietary nutrient content on N, P, and K excretion by dairy cows. • Learn what the recommended requirements are for N, P, and K for dairy cows. • Learn feeding practices that will maximize animal performance and minimize nutrient excretion	I. Reducing N, P, and K Excretion: the Challenge for Dairy Producers II. How Much N, P, and K does a Dairy Cow Excrete? III. Phosphorus Requirements, IV. Sources, and Excretion in Dairy Cows IV. Potassium Requirements, Sources, and Excretion in Dairy Cows V. Nitrogen Requirements, Feeding Strategies, and Excretion in Dairy Cows VI. Self-Assessment of Your Dairy's Feeding Program VII. The Bottom Line: Are High Milk Yield and Minimal Nutrient Excretion Mutually Exclusive?	• Calculate amount of N and P that their herd excretes. • Assess how well they minimize nutrient excretion and evaluate approaches to improve feeding program. • Learn about several websites with useful information to help them calculate their herd's nutrient excretion and to understand the consequences of overfeeding N, P, or K.	3 hours
13. Feeding Beef Cattle to Reduce N and P Excretion into the Environment Todd Milton	• Develop a general understanding of N (protein) and P metabolism in finishing cattle • Learn what the recommended N and P requirements are for feedlot cattle to minimize overfeeding of these nutrients • Develop an understanding of potential feeding strategies that will maintain or maximize animal performance and minimize total nutrient excretion	I. Introduction II. How much N and P are excreted, and what is the fate of N and P excreted by feedlot cattle? III. N and P utilization by finishing cattle IV. Feeding management strategies to reduce N and P excretion in feedlot cattle	• Calculate amount of N and P excreted by feedlot cattle. • Evaluate the effects of ration formulation changes on N and P excretion.	1 hour

Module C. Manure Storage and Treatment (continued)

Lesson	Intended Outcomes The participant will	Topics	Activities	Time
23. Manure Storage Construction and Safety, New Facility Considerations Charles Fulhage and John Hoehne	- Understand sealing concepts, compaction, and practices necessary to obtain a target permeability rate in earthen manure storage structures. - Understand basic structural considerations for constructed manure storage - Appreciate need for safety plans and considerations in manure storage.	- Regulatory considerations for siting and constructing manure storage facilities - Siting and soils considerations for earthen impoundments - Constructed manure storage facilities - Manure storage facility checklist - Using county soil surveys to evaluate suitability of soils for earthen impoundments	- Review/identify acceptable soil types for earthen impoundments. - Identify applicable NRCS soil permeability group. - Identify and discuss standard practices and testing for obtain sealing and structural integrity. - Complete a compliance checklist for applicable seepage/permeability requirements, safety aspects, fencing, and signage requirements.	2 hours
24. Operation & Maintenance of Manure Storage Facilities Charles Fulhage and John Hoehne	- Understand practices and operations necessary to maintain environmentally sound manure storage facilities. - Understand significance of pumpdown marker and maintaining a liner.	I. Regulatory and Compliance Considerations II. Annual Manure Removal and Methods III. The Importance of Agitation IV. Lagoon Monitoring and Condition Parameters V. Overall Monitoring Activities VI. Aesthetics and Appearance VII. Closure of Earthen Impoundments	• Estimate manure handling requirements (pumpdown/hauling time and frequency). • Develop manure storage inspection checklist. • Develop a record-keeping plan for self assessment or as required by regulation.	2 hours
25. Manure Treatment Options Frank Humenik	• Identify desired outcomes of manure treatment and ability of individual systems to accomplish these outcomes. • Understand basic principles of manure treatment to evaluate validity of commercial claims.	I. Goals/Objectives of Treatment Systems and Alternative Technologies II. Manure Conservation and Utilization III. Basic Principles of Manure Treatment IV. Alternative Manure Treatment Technologies	• Participants will determine which system may meet current or future needs.	2 hours

Module D. Land Application/Nutrient Management (continued)

Lesson	Intended Outcomes The participant will	Topics	Activities	Time
34. Land Application Records and Sampling Karl Shaffer and Ron Sheffield	• Identify the need and describe how to properly sample different types of manure • Demonstrate a familiarity with completing manure application record forms	• Manure sampling • Soil testing • Tissue testing • Application recordkeeping	• Record-keeping exercise • Field demonstrations of equipment calibration procedures	1 hour
35. Land Application Equipment Ron Sheffield	• Review strengths/weaknesses of alternative land application systems. • Explain reasons for calibrating application equipment • Demonstrate how to calibrate application equipment	• Strengths/weakness of alternative land application systems • Application equipment calibration procedures	• Calibration techniques	1+ hours

Module F. Related Issues

50. Emergency Action Plans Ron Sheffield	• Demonstrate the ability to complete an Emergency Action Plan	• Developing an Emergency Action Plan	• Develop an actual plan for one scenario.	0.5 hour
51. Mortality Management Don Stettler	• Explain why timely management of mortality is important • List the different methods for managing mortality • List the advantages and disadvantages of different methods for managing mortality • Explain conceptually the sizing of mortality composting facilities.	I. Introduction II. Rendering III. Composting IV. Incineration V. Sanitary Landfills VI. Burial VII. Disposal Pits VIII. Regulatory Compliance Issues	Estimate • Composter bin volume requirements. • The size of a manure storage facility.	2 hours
52. Environmental Risk and Regulatory Assessment Workbook *Rick Koelsch* *Draft 1*	• *Compile all risk assessment and compliance assessment worksheets into one workbook for use with curriculum. These worksheets will also appear in individual lessons.*	• *Environmental risk assessment worksheets* • *Regulation compliance worksheets* • *Key reference tables.*	• *Evaluation of environmental risk assessment* • *Awareness and evaluation of regulation compliance*	*Part of individual lessons*

Common Abbreviations—Type B

ac = acre(s)
ac-in. = acre-inch
bu = bushel(s)
Cu = copper
dia = diameter
ft = feet or foot
ft^2 = square feet or sq ft
ft^3 = cubic feet or cu ft
gal = gallon(s)
gal/ft^2 = gallons per square foot
gpm = gallons per minute
hr = hour(s)
in. = inch(es)
in./hr = inches per hour
in./min = inches per minute
lb = pound(s)
lb/1,000 gal = pounds per thousand gallons
lb/ac = pounds per acre
mg/l = milligrams per liter
min = minute(s)
mph = miles per hour
N = nitrogen
PAN = plant-available nitrogen
psi = pounds per square inch
Zn = zinc

Conversion Factors

1 acre = 43,560 square feet

1 acre-inch = 27,154 gallons

Lane spacing for traveling gun = 70% to 80% wetted area

Lane spacing for stationary gun = 50% to 65% wetted area

$\frac{mg/l}{120}$ = pounds per 1,000 gallons

1 cubic foot (ft^3) = 7.48 gallons

Gallons × 0.0042 = tons

Bushels × 1.25 = cubic feet

1 bushel of manure = 75 pounds

IMPORTANT FORMULAS—TYPE B (CONTINUED)

10. *Precipitation (application) rate for traveling gun; inches per hour, where "w" is the angle of rotation expressed in degrees*

$$\text{Precipitation rate (in./hr)} = \frac{96.3 \times \text{sprinkler flow rate (gpm)}}{3.14 \times [0.9 \times \text{sprinkler radius (ft)}]^2} \times \frac{360}{\text{w}}$$

11. *Application volume (depth) for traveling gun; inches*

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

12. *Travel speed for traveling gun; inches per minute*

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

13. *Area of a rectangle*

$$\text{Area of rectangle (ft}^2\text{)} = \text{length (ft)} \times \text{width (ft)}$$

Area of a circle

$$\text{Area of circle (ft}^2\text{)} = 3.14 \times (\text{circle radius})^2$$

14. *Coverage area for application*

$$\text{Coverage area (acres)} = \frac{\text{length (ft)} \times \text{width (ft)}}{43{,}560\ \text{ft}^2\text{/acre}}$$

15. *Application rate for spreader*

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

16. *Determination of spreader capacity*

$$\text{Spreader load (tons)} = \frac{\text{weight of 5 gal manure} \times 1.5 \times \text{spreader capacity (ft}^3\text{)}}{2{,}000}$$

The University of Georgia

College of Agricultural & Environmental Sciences
Department of Biological & Agricultural Engineering

Programs that can help Producers meet the New Regulations

Dr. Mark Risse, Biological and Agricultural Engineering

The University of Georgia Cooperative Extension Service has several resources to assist Animal Feeding Operations attempting to comply with the new regulations. These are all voluntary programs that can help you to lower your risk of non-compliance or environmental problems.

AWARE team: The overall objective of the AWARE Team is: "To facilitate awareness of animal waste issues to research scientists, Extension personnel, industry representatives, and producers and to serve as a catalyst for providing economically and environmentally sound waste utilization solutions to Georgia's animal production industry." It's web page, newsletter, and list serve are valuable sources of information.

- Newsletter: The AWARE team has a quarterly newsletter that is distributed to a mailing list of all county agents and over 300 other individuals. These newsletters are also available via the internet and are downloaded by individuals around the world. The newsletter comes out about four times a year and keeps you up to date on research, extension, and current happenings in the waste management area. This will also be your best method of finding out about field days and workshops that the team will be sponsoring. To subscribe, contact Cathy Felton at 706-542-3086.
- Webpage: All of the information that the group disseminates is available via the Internet at http://www.bae.uga.edu/outreach/aware. Our website averages over 500 visits per month and has copies of all UGA publications as well as many links to other waste management internet sites around the world.
- List Serve: Our electronic list serve is probably one of the best uses of technology by the team. This list serve allows agents or producers to send questions to a large group of people in one mailing and usually results in questions being answered quicker than normal as well as producing quite a bit of interesting discussion. To subscribe to the listserve send e-mail to listserv@listserv.uga.edu with the message "subscribe aware" in the body of the e-mail.

Environmental Assessments: There are two excellent programs that are available for you to conduct on-farm assessments. The National Pork Producers Council offers On-Farm Odor/Environmental Assessments that are very detailed. During these assessments, an assessor from both the private and public sector will visit and tour your operation and provide you with written details of changes that could be made to

Driftmier Engineering Center • Athens, Georgia 30602-4435 • (706) 542-1653 • FAX (706) 542-8806

GEORGIA FARM*A*SYST PUBLICATIONS ORDER FORM

The Georgia Farm Assessment System (Farm*A*Syst) provides Georgia's farmers with information and a voluntary means to become environmentally pro-active in managing their farm to prevent pollution. Please indicate any of the assessments you would like to receive. The publications are free and will be mailed in approximately one week. Thank you for your interest.

Please indicate the number of each assessment you would like mailed.	GEORGIA FARM*A*SYST ASSESSMENTS
	What is Farm*A*Syst?
	Site Evaluation
	Water Quality
	Improving Drinking Water Well Condition
	Improving Drinking Water for the Rural Resident
	Improving Household Waste Water Treatment
	Management of Irrigation Systems
	Storage & Handling Practices
	Pesticide Storage & Handling
	Petroleum Storage & Handling
	Hazardous Products Storage Handling and Waste Disposal
	Fertilizer Storage & Handling
	Animal Production
	Layer Production
	Broiler Production
	Swine Production
	Dairy Production
	Beef Production
	Composting Poultry Mortalities
	Land Management
	Managing Runoff and Erosion on Croplands and Pastures
	Nutrient Management
	Managing Pests on Croplands and Pastures
	Forest Resources Management (Forest*A*Syst)
	Cotton IPM
	Pesticide Storage and Handling for Ornamental/Turf Professionals
	Managing Pesticides for Ornamental/Turf Professionals
	Other Assessments
	Overall Assessment

Please provide the following information.

NAME: ______________________________ PHONE NUMBER: ______________

ADDRESS: ____________________________ FAX NUMBER: ______________

______________________________ E-MAIL: ______________________

Please mail this form to :

Tina Williams
College of Agricultural and Environmental Sciences
Driftmier Engineering Center
University of Georgia
Athens, Georgia 30602

or e-mail your request to twilliam@bae.uga.edu
or fax your request to (706) 542-1886

or call (706) 542-7661

GEORGIA FARM*A*SYST

FARM ASSESSMENT SYSTEM

NUTRIENT MANAGEMENT

Julia Gaskin, Educational Program Specialist
Biological & Agricultural Engineering
Glen Harris, Assistant Professor
Crop & Soil Science

Cooperative Extension Service, The University of Georgia, College of Agricultural and Environmental Sciences, Athens

PRE-ASSESSMENT:

Why Should I Be Concerned?

Nitrogen, phosphorus and other nutrients are essential to good crop production. But, the nutrients that are beneficial for plant growth can be harmful if they are present above certain *concentrations** in streams, ponds, coastal waters, or groundwater. In most of our fresh *waterbodies*, phosphorus is the nutrient in shortest supply. When excess phosphorus from animal manures, fertilizers or other sources enters these waters, it causes *algae* to grow faster and turn water a green color. This process is called *eutrophication*. It can prevent recreational uses such as fishing and swimming. In brackish waters such as marshes and estuaries, a similar situation can occur when too much nitrogen is present.

Excess nitrogen can also be a problem in groundwater. Nitrate is a form of nitrogen that can pose health problems for both humans and animals if concentrations are too high in the drinking water. The drinking water standard for nitrate-nitrogen is 10 parts per million (ppm). When concentrations are above this limit, infants younger than six months can develop a disorder called methemoglobinemia or blue baby syndrome. Nitrate-nitrogen concentrations in the range of 20-40 ppm can cause reproductive problems or other health problems in ruminants, horses or baby animals.

Because we need clean drinking water and enjoy water-based recreational activities, excess nutrients in water are a concern to everyone. As a farmer, you are paying to supply your crops with nutrients, so it also makes economic sense to manage these resources as efficiently as possible. Good nutrient management can improve your profitability as well as protect the environment.

How Does This Assessment Help Protect Drinking Water and the Environment?

- This assessment allows you to evaluate your potential impact on the water quality on your farm and in nearby *waterbodies*.
- The assessment uses your answers (rankings) to identify high risk practices that should be modified.
- The nutrient management facts provide an overview of practices to prevent pollution.
- The assessment assists you in writing an action plan based on your needs as identified by the assessment.

How Do I Use This Farm*A*Syst Assessment?

- The assessment asks a series of questions about your nutrient management practices.
- You are encouraged to complete the entire document.
- Farm*A*Syst is a voluntary program.
- No information from this assessment needs to leave your farm.
- The assessment should be conducted by you for your use. If needed, a professional from the Georgia Cooperative Extension Service or one of the other partnership organizations can provide assistance in completing the assessment or action plan.

**Words found in italics are defined in the glossary.*

NUTRIENT MANAGEMENT PRACTICES					
	LOW RISK (rank 4)	**LOW-MOD RISK (rank 3)**	**MOD-HIGH RISK (rank 2)**	**HIGH RISK (rank 1)**	**RANK**
POTENTIAL FOR GROUNDWATER POLLUTION					
Main *soil textures* throughout the profile	Fine textures such as clays, silty clay loams, and clay loams	Textures such as silt, silt loams, and sandy clay loams	Textures such as sandy loams, and loams	Coarse textures such as sands and loamy sands	
Depth to *water table*	Greater than 50 feet	Between 10 to 50 feet	Between 5 and 10 feet	Less than 5 feet	
Presence of a *restrictive layer* or *hardpan* under the surface stopping downward water movement	*Restrictive layer* present	———	———	No *restrictive layers*	
***Buffers* around ponds, wells, sinkholes or other water-related areas**	*Buffers* greater than 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* 10 to 50 feet around all wells, ponds, sinkholes or other water-related areas	*Buffers* around some wells, ponds, sinkholes or other water-related areas	No *buffers* in place	
NUTRIENT MANAGEMENT					
Frequency of soil testing	Yearly	Every 2 years	Every 3 years	Less frequently than every 3 years	
Soil sampling	At least 15 cores or slices mixed together for a representative sample from fields or areas no bigger than 15 acres, according to *CES guidelines*	At least 7 cores or slices mixed together for a representative sample from fields or areas bigger than 15 acres	Single soil samples taken from areas greater than 15 acres	No soil samples taken	
Realistic yield goals	Yield averages from 5 or more recent years used to set yield goals	Yield goals based on 3 to 5 recent years averages	Yield goals based on 1 to 2 years averages, or old yield information	Yield goals not based on farm performance	
***Nutrient credits* for manure and legumes**	*Nutrient credits* calculated and deducted from nutrient application rate using *CES guidelines*	———	*Nutrient credits* are calculated and partially deducted from nutrient application rate	No deductions for using legumes or manures	
Fertilizer application rates	Fertilizer is applied at recommended rate based on soil tests and realistic yield goals	———	Fertilizer application exceeds recommendation by one-half times rate	Fertilizer application exceeds recommendation by two times rate or fertilization with no guidance	

NUTRIENT MANAGEMENT PRACTICES					
	LOW RISK (rank 4)	**LOW-MOD RISK (rank 3)**	**MOD-HIGH RISK (rank 2)**	**HIGH RISK (rank 1)**	**RANK**
Soil phosphorus (P) levels in fields	Have identified the soil P level in each field and do not apply P to very high soil test P fields	Have identified the soil P level in each field and only apply what crop needs	Soil phosphorus in fields is unknown	Soil test P is very high but there is no management to reduce excess P loss	
Manure application rates	Manure application to meet plant phosphorus needs based on soil test	———	Manure application is based on nitrogen without regard to P	Manure application is not based on nutrients	
Manure application timing	Manure applied during active crop growth and avoided during wet weather	Manure applied as near as possible to times when crops need fertilization	———	Manure applied nearly every day, or when lagoon or manure storage facility needs emptying or applied during wet weather	
PLANNING AND RECORDKEEPING					
Record-keeping	Good records are kept on fertilizer and manure applications, soil, plant and manure tests, and yields. Maps of fields and soil types for the farm are available	Records are kept on soil tests, some manure or plant tests; information is organized enough to be used for management decisions	Some records kept, but information is not complete or organized enough to make most management decisions	No records kept	
Nutrient management plan	Current (within last two years) *nutrient management plan*	———	*Nutrient management plan* prepared within last five years and not updated	No *nutrient management plan*	

Number of Areas Ranked ________
(Number of questions answered, if all answered should total 28)

Ranking Total ________
(Sum of all numbers in the "RANK" Column)

NUTRIENT MANAGEMENT FACTS:
Improving Nutrient Management on Your Farm

The goal of nutrient management is to maximize farm productivity while minimizing the movement of nutrients into surface and ground water. Nutrient management includes developing a nutrient budget and site management practices. The goal of a nutrient budget is to only put out the nutrients that crops need and thereby reducing excess nutrients. The goal of site management practices is to reduce the potential of any excess nutrients reaching either surface or ground water. Both nutrient budgets and site management practices have to be developed for a particular farm. What works on one farm may not be appropriate for another. Soil characteristics, crops, use of manures or other organic sources, the lay of the land, and closeness of surface water are a few of the things that can influence what the best site management practices may be.

SITE CHARACTERISTICS

Looking at the soils on your farm can help you identify whether you are at risk for polluting surface water or groundwater. Surface water, including streams and ponds, can become contaminated by water flowing over the surface (*surface runoff*) and water flowing through the soil. Surface runoff most often occurs when the soil surface has a high clay content so that rainfall tends to collect on the surface rather than move into the soil. In sandy soils, surface runoff can also occur when the soil surface forms crusts. Surface runoff may carry eroded sediments as well as excess nutrients. Using *cover crops* and leaving *crop residues* can help reduce surface runoff. There is a higher risk of runoff in fields with steeper slopes. Traffic patterns in the field can create soil compaction that promotes surface runoff. *Restrictive soil layers* or bedrock that stop the downward movement of water can cause water to flow through the upper soil layers into nearby streams and ponds. This water flow can carry excess nutrients, such as nitrate or phosphorus, into these surface *waterbodies*.

Buffers are areas near water that are either left in a natural state or carefully managed to keep vegetation. Buffers can be either grassed or wooded areas. These are very important for reducing the amount of nutrients and sediments entering a stream or pond. Buffers help spread out and filter surface runoff. Spreading out the surface runoff allows it a chance to infiltrate into the soils rather than move directly into the stream. Most sediments are trapped by vegetation in the buffer and the plants can use the excess nutrients. Plants growing in buffer zones can also take up nitrogen and phosphorus from water flowing in the soil. Research is showing that the *slope* of the buffer as well as its width is important for protection of surface water. Buffers work best when they have slopes less than 15% or 15 feet of drop in 100 feet. If the buffer slope is greater than 15% then a wider buffer is needed to protect the surface water.

Groundwater pollution is more common in sandy soils, particularly where the *water table* is shallow (less than 10 feet). Water moves quickly through sandy soils and the soils have little ability to retain nutrients. But, groundwater contamination can also occur anywhere excessive nutrients are applied next to wells, sinkholes, or other areas with direct connections to groundwater. Buffers around these types of areas are the best method for protecting groundwater.

NUTRIENT MANAGEMENT

A number of practices can be used to make sure the nutrients needed for realistic yield goals are applied to the site. The first and maybe most important is regular soil testing to determine the nutrient status of the soil. Soil testing allows fertilizer recommendations to be tailored to your field and crop. In order to get good results from the soil tests, fields should be sampled using Cooperative Extension Service (CES) guidelines found in Soil Testing (Leaflet No. 99). These guidelines show you how to take many small samples in fields with fairly uniform soils and mix them to obtain one sample per field or soil type. For a sample to represent the conditions in a field, it is important to take many small subsamples to create a sample that is representative of the entire area. Soils have a lot of variation and water or through shallow subsurface flow into surface water. This process is called leaching. Consequently, nitrogen fertilizer should be applied when plants are actively growing and using it. Crops with heavy nitrogen demands or those grown in sandy soils should receive split applications. This will reduce nitrate-nitrogen leaching and provide a more even supply of nitrogen for plant growth. In the Coastal Plain, where irrigation is used extensively, *fertigation* can be a cost-effective and environmentally safe way of supplying nitrogen and potassium.

Regardless of the application method, calibration of your equipment is critical. *Equipment calibration* includes measuring the application rate and determining the spread pattern. Spread patterns that are uneven can create areas with too little fertilizer that can reduce yields and areas with too much fertilizer that can become a potential pollution source. Information such as Extension Circular 825 "Calibration of Manure Spreader Including Swath Width can be used to calibrate manure spreaders or dry fertilizer spreaders.

ORGANIC SOURCES OF FERTILITY

Using organic sources of nutrients can have many benefits. First, as a fertilizer, the nutrients in organic matter are released over time. This can provide a more constant nutrient source for the plants and reduce the likelihood of excess nutrients moving into ground or surface water. Second, organic matter itself can improve soil tilth. Better soil tilth can increase the amount of water that moves into the soil and reduce erosion. The additional organic matter can also hold more water in the soil and decrease droughtiness. Third, organic sources usually contain many of the micronutrients crops need for maximum yield. Some studies indicate improved yields and pest resistence in fields with higher organic matter. Use of organic sources can decrease the costs for fertilizer, improving your profitability.

The first step in adding organic matter to the soil is using all available on-farm sources. This includes the use of cover crops, *green manures*, and animal manures. Cover crops are grown in the winter and killed in the spring. These crops decrease erosion and add organic matter to the soil. Common cover crops in Georgia are rye and winter wheat. Green manures are legumes that are grown in the winter and killed in the spring to increase the organic matter content of the soil and supply nitrogen. Some green manures used in Georgia are vetch and crimson clover. The nitrogen supplied by legumes should be subtracted from the total amount of nitrogen needed for your crop.

There are other sources of organic matter that can be beneficial. Composts are good sources of organic material. *Biosolids* are a good source of both organic matter and a slow-release nitrogen fertilizer. When properly applied, biosolids can provide the benefits of organic matter and nutrients as well as lower fertilizer costs. Cotton gin trash is another off-farm organic material that can add organic matter and nutrients. There are also by-products from food processing, textiles or other industries that can supply some organic matter and nutrients. These by-products should be tested for safety and value before use on the farm. Most suppliers of these by-products should be able to show you that the product is not hazardous, does not present growth problems, and has low metals content. In addition, they should tell you the amount of nitrogen, phosphorus and potassium supplied by the by-product.

The most common source of organic matter is animal manures, including poultry litter. Animal wastes are a good source of nitrogen, phosphorus and potassium. They also contain many essential micronutrients, and can be an important component of your fertilizer program. Although manures are a good source of nutrients, they often do not supply nutrients in the same amounts that crops need. Animal manures are typically high in phosphorus compared to the amount of nitrogen needed for crops, so they are excellent for building phosphorus fertility in the soil. But if they are applied to meet the nitrogen needs of the crop, phosphorus is often over-applied. Over time, excess phosphorus can build up in the soil. This excess phosphorus can then move into nearby water and create pollution. Phosphorus can also be moved from manures that are surface applied into surface water by rainfall.

Animal manures vary widely in nutrient content. The amount of nitrogen and other nutrients present in the manure depends on the type of animal, the

GLOSSARY:
Nutrient Management

Algae: A plant that lives in water. These plants contain chlorophyll but lack true stems, leaves, or roots. Algae imparts a green color to water.

Biosolids: Municipal sludge that has been treated to stabilize organic matter and reduce pathogens.

Buffers: A strip of uncultivated land between farmed land and a sensitive area. Buffers can be grassed but often contain shrubs or trees. These are used to spread out water and sediments leaving the farmed area and help remove excess nutrients or other farm chemicals.

CES Guidelines: Cooperative Extension Service guidelines.

Concentrations: The amount of an element or compound found in a specified amount of another substance. For example, nitrate-nitrogen in water is expressed as milligrams per liter (mg/L) or parts per million (ppm). In solids, concentrations are expressed as milligrams per kilograms (mg/kg) or ppm.

Cover crop: Crops grown for ground cover to reduce erosion and add organic matter.

Crop residues: Leaves, stems or other plant parts left on the soil surface.

Dormant phase: A inactive phase for a plant where nutrient uptake and growth are slow or non-existent.

Equipment calibration: Checking or standardizing equipment so that application rates are even and at a known amount.

Eutrophication: The process by which increasing nutrients in a waterbody promotes plant over animal life, often creating conditions with very low oxygen in the water.

Fertigation: Fertilizing crops through the irrigation system.

Green manures: Legume crops that are grown to supply nitrogen and organic matter.

Hardpan: A soil layer that limits root growth or water movement.

Nutrient credits: An addition of nutrients from legumes, animal manures or other sources that should be subtracted from the total amount of fertilizer needed.

Nutrient Management Plan: A plan for managing animal wastes to maximize economic benefit for the farmer and protection of the environment.

Restrictive layer: A soil layer that limits root growth or water movement.

Slope: Change in elevation across a horizontal distance. (Example: 2:1, first number is the horizontal distance and second number is the vertical distance.)

Soil texture: Classes of soil with differing proportions of sand, silt, and clay. For example - loams, silts, sandy clay loams.

Surface runoff: Rainfall that moves over the soil surface into water.

Waterbodies: All surface water, including streams, rivers, ponds, lakes.

Water table: The level in the ground where the soil or bedrock is saturated; the upper surface of groundwater.

EXAMPLE RECORDS

Field Number _____ **Sample Area** ______________ **Soil Series** ______________

Crop	Date Planted	Soil Test Date	Soil Test Results										Fertilizer Recommended (lbs/ac)					Fertilizer Applied (lbs/ac)				
			pH	Lime Index	P	K	Ca	Mg	Zn	Mn	B	Other	N	P_2O_5	K_2O	Lime	Other	N	P_2O_5	K_2O	Lime	Other

Crop	Date Planted	Application 1			Application 2			Application 3			Application 4			Application 5			Application 6		
		Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date	Chem.	Rate	Date

EXAMPLE RECORDS

FARM CROPPING PLAN (Specify crop, variety, plant population, etc.)

CROP	FIELD 1	FIELD 2	FIELD 3	FILED 4	FIELD 5	FIELD 6
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

PUBLICATIONS:

University of Georgia, Cooperative Extension Service
Athens, Georgia 30602

- Your Drinking Water: Nitrates, Circular 819-5
- Animal Waste and the Environment, Circular 827
- Land Application of Livestock and Poultry Manure, Leaflet 378
- Georgia's Agricultural Waste Regulations, Circular 819-11
- Developing a Nutrient Management Plan for the Dairy Farm, Circular 819-16
- Soil Testing, Leaflet 99
- Calibration of Manure Spreader Including Swath Width, Circular 825
- Beneficial Reuse of Municipal Biosolids in Agriculture, Special Bulletin 27
- Soil Saving Practices - Sediment Erosion Control, Bulletin 916-6
- Soil Saving Practices - Conservation Tillage, Bulletin 916

State Soil and Water Conservation Commission
P.O. Box 8024
Athens, Ga 30603

- Agricultural Best Management Practices for Protecting Water in Georgia
- Planning Considerations for Animal Waste Systems for Protecting Water Quality in Georgia

NOTES

Georgia Department of Agriculture

Capitol Square • Atlanta, Georgia 30334-4201

Tommy Irvin
Commissioner

Respond to.....
Telephone: 404-656-3665
Fax: 404-656-9383
E-Mail: jpeacock@agr.state.ga.us

MEMORANDUM

TO: All Interested Parties

FROM: John J. Peacock JJP

DATE: October 2, 2000

SUBJECT: Continuing Education for Certified Swine Feeding Operators

Attached are forms for pre-approval of Continuing Education courses for Certified Swine Feeding Operators. These forms are being provided to the Georgia Pork Producers Association, Georgia Farm Bureau, the University of Georgia, and the Cooperative Extension Service. Please feel free to copy and distribute to anyone that you think may offer courses that may qualify for Continuing Education for Certified Swine Feeding Operators.

For your information, I have also attached a Continuing Education Record form to be used by Certified Swine Feeding Operators. Copies of these forms are being mailed to all Certified Swine Feeding Operators.

If you have any questions or comments, please let me know.

Thanks.

JJP/slp

Enclosure

Tommy Irvin, Commissioner

Georgia Department of Agriculture
Certified Swine Feeding Operator
Continuing Education Record

Name ______________________________ Certificate Number ____________________

Address ____

City ____________________ County ________________ State ____________ Zip Code __________

I hereby submit the following for Continuing Education credit(s) toward my Swine Feeding Operator Certification:

SUBJECT/TITLE	MAIN INSTRUCTOR	EVENT AND LOCATION	DATE	LENGTH (IN HALF HOURS)
1.				
2.				
3.				
4.				
5.				
6.				

If subject has not been pre-approved, please provide a brief description of the subject on the back of this form.

I certify that this is a true and accurate record of my Continuing Education.

____
Certified Swine Feeding Operator
(Signature)

____
Date

Georgia Department of Agriculture Use Only

CE Pre-approved: ☐ yes ☐ no

CE Reviewed and Approved by: ____________________ Title: ________________ Date: ____________

Mail or fax this completed form to:
Georgia Department of Agriculture, Capitol Square, Room 112, Livestock/Poultry Manager, Atlanta, Georgia 30334-4201,
Phone (800) 282-5855, ext. 3665, Fax (404) 656-9383

9/07/00

Georgia Department of Agriculture
Certified Swine Feeding Operator
Application for Continuing Education Course(s)
Pre-Approval

Tommy Irvin, Commissioner

Name ____

Title and Organization __________________________________

Address ____

City ________________ County ____________ State __________ Zip Code ________

I hereby submit the following for approval as Continuing Education credit for Swine Feeding Operator Certification:

Subject (Title) ______________________________________

Description (Brief) ___________________________________

____

____

Instructor(s) ____________________ Agency, Company, etc. ____________________

Method of Presentation: ☐ Lecture ☐ Video ☐ Written material ☐ On farm activities ☐ Other (explain) __________

Length (in nearest half hour) ______________ Event and Location ____________________

________________________ ________________________

Submitted By Date

Georgia Department of Agriculture Use Only

Subject Approved ☐yes ☐no Method Approved ☐yes ☐no

Instructor Approved ☐yes ☐no # CE Hrs Approved ____________

Approved by: ________________ Title: ________________ Date: __________

Mail or fax this completed form to:
Georgia Department of Agriculture, Capitol Square, Room 112, Livestock/Poultry Manager
Atlanta, Georgia 30334-4201, Phone (800) 282-5855, Fax (404) 656-9383

9/07/00

RULES AND REGULATIONS FOR WATER QUALITY CONTROL

CHAPTER 391-3-6

REVISED - April 2000

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
205 BUTLER STREET, SE
FLOYD TOWERS EAST
ATLANTA, GEORGIA 3033

(ii) Mailing of the public notice to any person or group upon written request shall be done in accordance with subparagraph 391-3-6-.11(6)(b)(iii).

(iv) The EPD shall provide a period of not less than thirty (30) days following the date of the public notice in which interested persons may submit their written views on the tentative determination with respect to the draft general LAS permit. All written comments submitted during the thirty (30) day comment period will be retained by the EPD and considered in the final determination with respect to the draft general LAS permit. The comment period may be extended at the discretion of the Director.

(c) Public Hearings.

1. Public hearings shall be in accordance with subparagraph 391-3-6-.11(6)(c).

(d) Public Access to Information.

1. A copy of the draft general LAS permit, public notice, fact sheet, statement of basis, and other LAS forms related thereto, including written public comments and comments of all governmental agencies thereon and other reports, files and information not involving methods of processes entitled to protection as trade secrets, shall be available for public inspection and copying during normal business hours at the EPD office in Atlanta. Notice of Intent forms shall not be considered as information entitled to protection.

(7) **Schedules of Compliance.** Any person who obtains a General LAS Permit and who is not in compliance with the permit shall be required to achieve compliance in accordance with a schedule as set forth in subparagraph 391-3-6-.11(7).

(8) **Monitoring, Recording, and Reporting Requirements.**

(a) Monitoring, recording, and reporting requirements shall be in accordance with those outlined in subparagraph 391-3-6-.11(8) of this Chapter.

(b) General LAS permits that do not require submittal of monitoring reports at least annually shall report to the Director in writing all instances of noncompliance at least annually.

(9) **Duration, Continuation, and Transferability of Permits.**

(a) Any general LAS permit issued under O.C.G.A. Section 12-5-30 shall have a fixed term not to exceed five (5) years. Upon expiration of such permit, a new permit may be issued by the Director in accordance with O.C.G.A. Section 12-5-30. The issuance of such new permit shall likewise have a fixed term not to exceed five (5) years.

(b) Any owner or operator authorized by a general LAS permit may request that coverage under the general LAS permit be terminated by submitting a written Notice of Termination. The contents of the Notice of Termination shall be specified in the general LAS permit and shall be signed in accordance with subparagraph 391-3-6-.11 5 (d). Subparagraph 391-3-6-.11(11)(b) is not applicable to general LAS permits.

(c) When the permittee has submitted a timely and sufficient application for a new individual LAS permit or a notice of intent for a general LAS permit and the Director is unable, through no fault of the permittee, to issue the new permit before the expiration date of the existing permit, then the Director shall extend the existing permit until a new permit is issued.

(10) **Enforcement.** Any person who violates any provision of the Act, any rule promulgated and adopted pursuant thereto, or any term, condition, schedule of compliance or other requirement contained in a permit issued pursuant to the Act shall be subject to enforcement proceedings pursuant to the Act.

(11) **Effective Date.** This Paragraph shall become effective twenty days after filing with the Secretary of State's office.

Authority: O.C.G.A. Section 12-5-20 et. seq. History: Original Rule entitled "General Permit - Land Application System Requirements: Filed: Aug. 30, 1996; eff. Sept. 19, 1995; **Amended:** E.R. 391-3-6 was filed May. 1,1996, eff. April 25, 1996, the date of adoption to remain in effect for a period of 120 days or until the effective date of a permanent Rule covering the same subject matter superseding this ER, as specified by the Agency. Amended: F. July 10, 1996. Eff. July 30, 1996.

391-3-6-.20 Swine Feeding Operation Permit Requirements

(1) **Purpose.**

The purpose of this paragraph 391-3-6-.20 is to provide for the uniform procedures and practices to be followed relating to the application for and the issuance or revocation of permits for swine feeding operations. Nothing in this paragraph shall be construed to preclude the modification of any requirement of this paragraph when the Division determines that the requirement is not protective of the environment.

(2) **Definitions.**

All terms used in this paragraph shall be interpreted in accordance with the definitions as set forth in the Act unless otherwise defined in this paragraph or in any other paragraph of these Rules:

(a) "Act" means the Georgia Water Quality Control Act, as amended;

(b) "Swine feeding operation" or "operation" means a lot or facility where swine have been, are, or will be stabled or confined or fed or maintained for a total of at least 45 days in any 12-month period, and the confinement areas do not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season.

(c) "Animal Unit" (AU) is a unit of measurement for any swine feeding operation calculated by the number of swine weighing over 25 kilograms (approximately 55 pounds) multiplied by 0.4.

(a) Any person who owns or operates a swine feeding operation with 301 to 1000 AU in conformance with all provisions of this subparagraph is deemed to be permitted pursuant to this paragraph and shall not be required to obtain an individual permit from the Division.

(b) There shall be no discharge of pollutants from the operation into surface waters of the State.

(c) By October 31, 2002, new operations must have waste storage and disposal systems in operation that have been designed and constructed in accordance with NRCS guidance.

(d) By October 31 2001, the owner or operator shall submit to the Division a CNMP for the swine feeding operation. The CNMP shall be of sufficient substance and quality as to be approvable by the Division. The owner or operator shall receive the Divisions approval of the CNMP by July 1, 2002, and shall begin implementing the approved CNMP not later than October 31, 2002.

(e) The operation must have a certified operator by October 31, 2001. The operator must be trained and certified, in accordance with 391-3-6-.20(13).

(f) New operations must be designed and constructed to handle the runoff from a 25-year, 24-hour storm event without an overflow from the storage lagoon.

(g) New operations located within significant ground water recharge areas which fall within the categories defined in the Georgia Department of Natural Resources Rules for Environmental Planning Criteria, Chapter 391-3-15-.02, Paragraph 3.(e) must be provided with either a compacted clay or synthetic liner such that the vertical hydraulic conductivity does not exceed 5 x 10^7 cm/sec or other criteria as determined by the Division. If it is determined that an existing lagoon is creating a ground water contamination problem, the Division may require the lagoon to be repaired.

(h) New barns, new lagoons, and new waste disposal systems for new swine feeding operations started after the effective date of this rule with 301 to 1000 AU, or for existing swine feeding operations that are expanding production so that they will have 301 to 1000 AU after the effective date of this rule, shall not be located within a 100-year flood plain.

(I) All existing, new, or expanding swine feeding operations with 301 to 1000 AU, must submit a registration form to the Division, on or before October 31, 2000.

(j) Any failure to comply with any condition of (a) through (h) above shall be deemed a violation of the Act and may be punishable in accordance with the penalties provided for in the Act.

(5) Permit for Existing Operations 1001 to 3000 AU.

(a) Any person who owns or operates an existing swine feeding operation with 1001 to 3000 AU must obtain an individual permit from the Division by October 31, 2000, in accordance with this paragraph. Permit applications should be submitted 180 days in advance. Any person who expands an existing operation to include 1001 to 3000 AU becomes subject tothe requirements of paragraph (6), "Permit for New or Expanding Operations 1001 to 3000 AU".

(b) There shall be no discharge of pollutants from the operation into surface waters of the State.

(c) By October 31 2001, the owner or operator shall submit to the Division a CNMP for the swine feeding operation. The CNMP shall be of sufficient substance and quality as to be approvable by the Division. The owner or operator shall receive the Divisions approval of the CNMP by July 1, 2002, and shall begin implementing the approved CNMP not later than October 31, 2002.

(d) The operation must have a certified operator by October 31, 2001. The operator must be trained and certified, in accordance with 391-3-6-.20(13).

(e) Prior public notice of the completed application and proposed draft permit will be prepared and circulated in accordance with 391-3-6-.06(7).

(f) If it is determined that an existing lagoon is creating a ground water contamination problem, the Division shall require the owner or operator to repair the lagoon, to close the lagoon, or to take other actions to protect the ground water.

(g) The wastewater disposal system shall be designed and operated such that nitrates in the ground water at the operation's property line do not exceed 10 mg/1. The Division will require the owner or operator to implement corrective actions if the nitrates exceed 10 mg/1.

(h) At least one up-gradient and at least two down-gradient ground water monitoring wells shall be installed for the spray irrigation fields and one down gradient ground water monitoring well shall be installed for each lagoon or series of lagoons. The number, location, design and construction specifications of the monitoring wells shall be reviewed and approved by the Division, prior to issuance of a permit. Existing wells that are approved by the Division can be used for testing. Monitoring wells shall be properly installed within 24 months of permit issuance.

(I) The permit will contain specific requirements for monitoring the storage lagoon effluent to be land applied, and for the ground water monitoring wells. This will usually consist of semiannual monitoring of the effluent for 5-day Biochemical Oxygen Demand (BOD_5) Total Suspended Solids (TSS), Total Kjeldahl Nitrogen (TKN), Ammonia Nitrogen (NH_3), Nitrate Nitrogen (NO_3), and pH, as well as semiannual monitoring of the wells for specific conductivity, NO_3, pH and depth to ground water. Monitoring may be required to determine soil phosphorus adsorption, sodium adsorption ratio, cation exchange capacity, and cumulative loading of copper and zinc.

(j) When the owner or operator ceases raising swine, he must notify the Division of that fact within three months, and he must properly close all wastewater lagoons within eighteen months. Proper closure of a lagoon entails removing all wastewater from the lagoon and land applying it on the owner or operator's fields at agronomic rates, and in a manner so as not discharge to any surface water stream.

(7) **Permit for Existing Operations with more than 3000 AU.**

(a) Any person who owns or operates an existing swine feeding operation with more than 3000 AU must obtain an individual permit from the Division by October 31, 2000, in accordance with this paragraph. Permit applications should be submitted 180 days in advance. If the individual permit has not been obtained by October 31, 2000, the operation shall be closed, or the operation shall be reduced to 1000 AU or less and shall be in compliance with 391-3-6-.20(4).

(b) There shall be no discharge of pollutants from the operation into the surface waters of the State, as defined in the Act, § O.C.G.A. 12-5-22(13). There shall be no discharge of pollutants into ground water which would cause ground water quality not to comply with the maximum contaminant levels established in Georgia's Rules for Safe Drinking Water 391-3-5.

(c) By October 31, 2002, the operation must have waste storage and disposal systems in operation that have been designed and constructed in accordance with NRCS guidance, or as otherwise determined by the Division.

(d) By October 31 2001, the owner or operator shall submit to the Division a CNMP for the swine feeding operation. The CNMP shall be of sufficient substance and quality as to be approvable by the Division. The owner or operator shall receive the Division's approval of the CNMP by July 1, 2002, and shall begin implementing the approved CNMP not later than October 31, 2002.

(e) The operation must have a certified operator by October 31, 2001. The operator must be trained and certified, in accordance with 391-3-6-.20(13).

(f) Public notice of the completed application and proposed draft permit will be prepared and circulated in accordance with 391-3-6-.06(7)

(g) The system must be designed to handle the runoff from a 25-year, 24-hour storm event without an overflow from the storage lagoon.

(h) If it is determined that an existing lagoon is creating a ground water contamination problem, the Division may require owner or operator to repair the lagoon to meet NRCS standards, to close the lagoon, or to take other actions to protect the ground water.

(I) It is required that a minimum of 2 feet of freeboard be maintained in the lagoons at all times.

(j) The wastewater disposal system shall not be located within a flood plain unless it protected from inundation or damage from a 25-year, 24-hour storm event.

(k) The wastewater disposal system shall be designed and operated such that nitrates in the ground water at the operation's property line do not exceed 10 mg/1. The Division will require the owner or operator to implement corrective actions if the nitrates exceed 10 mg/1.

(l) At least one up-gradient and at least two down-gradient ground water monitoring wells shall be installed for the spray irrigation fields and one down gradient ground water monitoring well shall be installed for each lagoon or series of lagoons. The number, location, design and construction specifications of the monitoring wells shall be reviewed and approved by the Division, prior to issuance of a permit. Existing wells that are approved by the Division can be used for testing. Monitoring wells shall be properly installed within 24 months of permit issuance.

(m) The permit will contain specific requirements for monitoring the storage lagoon effluent to be land applied, and for the ground water monitoring wells. This will usually consist of semiannual monitoring of the effluent for 5-day Biochemical Oxygen Demand (BOD_5) Total Suspended Solids (TSS), Total Kjeldahl Nitrogen (TKN), Ammonia Nitrogen (NH_3), Nitrate Nitrogen (NO_3), and pH, as well as semiannual monitoring of the wells for specific conductivity, NO_3, pH and depth to ground water. Monitoring may be required to determine soil phosphorus adsorption, sodium adsorption ratio, cation exchange capacity, and cumulative loading of copper and zinc

(n) The permit may require periodic monitoring of any wet weather ditches or perennial streams which are in close proximity to spray irrigation fields.

(o) When the owner or operator ceases raising swine, he must notify the Division of that fact within three months, and he must properly close all wastewater lagoons within eighteen months. Proper closure of a lagoon entails removing all wastewater from the lagoon and land applying it on the owner or operator's fields at agronomic rates, and in a manner so as not discharge to any surface water stream.

(p) Any failure to comply with any condition of (a) through (o) above or any condition of any individual permit issued for the operation shall be deemed a violation of the Act and may be punishable in accordance with the penalties provided in the Act.

(q) In the event of any expansion of an existing operation with more than 3000 AU which expansion requires the construction or use of new lagoons and/or disposal areas, or the expansion of existing lagoons and/or disposal areas, the operator shall comply with the requirements of paragraph (8), (e), (f), (g), (I), (j). (k), (o), and (p), with respect to such new or expanded lagoons or disposal areas. In the event of an expansion sufficient to necessitate the construction of new lagoons or disposal areas, or the expansion of existing lagoons or disposal areas, the entire operation shall comply with paragraph (8) (n) and (q) and (9), (10), (11), and (12).

(8) **Permit for New or Expanding Operations with more than 3000 AU.**

(a) New swine feeding operations with more than 3000 AU, or existing operations that are expanding production so that they will have more than 3000 AU which propose to commence operation after the effective date of this rule must obtain an individual permit in accordance with this paragraph prior to commencing construction for the operation. Permit applications should be submitted 180 days in advance. Any existing swine feeding operation which proposes to expand to more than 3000 AU must obtain an individual permit and comply with the requirements of this paragraph prior to any such expansion or operation of such an expanded facility.

for specific conductivity, NO_3, pH and depth to ground water. Monitoring will also be required to determine soil phosphorus adsorption, sodium adsorption ratio, cation exchange capacity, and cumulative loading of copper and zinc.

(m) The permit may require periodic monitoring of any wet weather ditches or perennial streams which are in close proximity to disposal fields.

(n) The owner or operator shall provide the evidence of financial responsibility in accordance with paragraph 391-3-6-.20 (11) prior to permit issuance. A closure plan in accordance with paragraph 391-3-6-.20(12) shall be provided with the permit application. The sum of the following costs must also be included in the evidence of financial responsibility:

1. Ten percent of the initial capital costs for constuction of the entire hog-growing facility swine feeding operation (barns, pens, feed storage, waste management, etc.)

2. $100,000 to cover the costs of any fines that may be imposed by the Division for violations of the laws, rules, regulations, and permits associated with the facility.

(o) These operations are prohibited from using open lagoons. Lagoons and waste storage facilities must be provided with airtight covers. Air pollution control devices using best available technology must be installed on all lagoon cover vents and openings to remove ammonia, hydrogen sulfide, methane, formaldehyde, and any other organic and inorganic air pollutants which may be required by the Division. Such air pollution control devices must meet all requirements of the Division and Georgia's Rules for Air Quality Control (391-3-1), and no swine feeding operation NPDES permit for new or expanding operations with more than 3000 AU shall be issued by the Division unless an appropriate air quality control permit can be issued simultaneously.

(p) These operations are prohibited from using spray irrigation of lagoon effluent. Lagoon effluent must be incorporated into the disposal fields using subsurface injection at a depth not less than 6 inches.

(q) These operations shall be assessed penalties for failure to comply with the terms of this paragraph, the Act or the individual permit according to the following schedule:

1. Lagoon breach or loss of containment, $50,000 for the first day and $100,000 per day for each day within a 12 month period thereafter during which a release occurs.

2. Land disposal field runoff, $25,000 per day.

3. Discharge to ground water on site causing ground water to exceed any maximum contaminant limits in Georgia's Rules for Safe Drinking Water, $5,000 per day.

4. Discharge to ground water causing increases of pollutant concentrations at the property line above ambient levels, $5,000 per day and immediate cessation of land disposal.

5. Second occurrence of any of the failures to comply specified above in paragraph 391-3-6-.20 8. (s) (1), (2), (3), or (4), immediate revocation of the individual permit and assessment of the appropriate penalty.

(r) These operations shall submit a compliance history and other information with the permit application in accordance with paragraph (10) of this rule.

(9) Degree of Pollutant Treatment Required and Alternative Technology

(a) The owner or operator of any swine feeding operation covered by rule 391-3-6-.20 shall ensure that all wastes from a swine feeding operation shall receive such treatment or corrective action so as to ensure compliance with the terms and conditions of the permit by rule or individual permit.

(b) If retrofitting the waste handling storage and disposal system of any swine feeding operation covered by 391-3-6-.20 with alternative technology becomes economically achievable, the Director may require any swine feeding operation to eliminate lagoons or spray fields. Alternative technologies may include, but are not limited to:

1. Drying/dewatering in greenhouse - type facilities

2. Composting by in-vessel method

3. Mechanical separation

4. Biogas production

5. Soil incorporation

6. Soil injection

(10) Refusal to Grant Certain Permits in accordance with § O.C.G.A. 12-5-23 (d), (e), (f), and (g).

(a) An applicant for a permit for a new or expanding swine feeding operation with more than 3000 AU shall submit the following information to the Director as it pertains to the applicant and, in the case of a corporation or partnership, to the corporation, partnership, officer, director, manager, partner and each shareholder of five percent or more of the stock or financial interest in the corporation or partnership:

1. The name, social security number, taxpayer identification number and business address.

Owners of new swine feeding operations with more than 3000 AU at any one time shall establish and maintain evidence of financial responsibility to provide for the closure of their waste treatment facilities and the proper disposal of their contents after closure of the facility.

(a) The owner must have a detailed written estimate, in current dollars, of the cost of hiring a third party to clean up and close the swine feeding operation. The owner must obtain a letter from the Division stating its concurrence that the owner's estimate of clean up and closure costs is reasonable. The owner must notify the Director that the estimate has been placed in the operating record.

1. During the active life of the facility, the owner must annually adjust the closure cost estimate for inflation.

2. The owner must increase the closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes to the closure plan increase the maximum cost of closure at any time during the remaining active life.

3. The owner may reduce the closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum cost of closure. The owner must notify the Director that the justification for the reduction of the closure cost estimate and the amount of financial assurance has been placed in the operating record.

(b) Financial assurance for closure: The owner of each swine feeding operation with an annual average of greater than 3000 AU must establish financial assurance for closure of the facility. The owner must provide continuous coverage for closure until released from financial assurance requirements by the Director. The owner must choose from the options as specified in paragraphs (c) through (f) of this section. The mechanism for financial assurance must be submitted to the Division for approval and must also allow the Director access to the funds in the event of failure of the owner to close the facility in accordance with 12 (c).

(c) Closure trust fund.

1. An owner may satisfy the requirements of this section by establishing a closure trust fund and submitting an originally signed duplicate of the trust agreement to the Director. The trustee must be an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency.

2. After the trust fund is established, whenever the current closure cost estimate changes, the owner must compare the new estimate with the trustee's most recent annual valuation of the trust fund. If the value of the fund is less than the amount of the new estimate, the owner, within 60 days after the change in the cost estimate, must either deposit an amount into the fund so that its value after this deposit at least equals the amount of the current closure cost estimate, or obtain other financial assurance as specified in this section to cover the difference.

3. If the value of the trust fund is greater than the total amount of the current closure cost estimate, the owner may submit a written request to the Director for release of the amount in excess of the current closure cost estimate.

4. If an owner substitutes other financial assurance asspecified in this section for all or part of the trust fund, he may submit a written request to the Director for release of the amount in excess of the current closure cost estimate covered by the trust fund.

5. After beginning partial or final closure, an owner or another person authorized to conduct partial or final closure may request reimbursements for partial or final closure expenditures by submitting itemized bills to the Director. The owner may request reimbursements for partial closure only if sufficient funds are remaining in the trust fund to cover the maximum costs of closing the facility over its remaining operating life. No later than 60 days after receiving bills for partial or final closure activities, the Director will instruct the trustee to make reimbursements in those amounts as the Director specifies in writing, if the Director determines that the partial or final closure expenditures are in accordance with the approved closure plan, or otherwise justified. If the Director does not instruct the trustee to make such reimbursements, he will provide to the owner or operator a detailed written statement of reasons.

6. The Director will agree to termination of the trust when:

(I) An owner substitutes alternate financial assurance as specified in this section; or

(ii) The Director releases the owner from the requirements of this section.

(d) Closure letter of credit.

1. An owner may satisfy the requirements of this section by obtaining an irrevocable standby letter of credit and submitting the letter to the Director. The issuing institution must be an entity which has the authority to issue letters of credit and whose letter-of-credit operations are regulated and examined by a Federal or state agency.

2. The letter of credit must be accompanied by a letter from the owner referring to the letter of credit by number, issuing institution, and date, and providing the following information: The type of facility, name, and address of the facility, and the amount of funds assured for closure of the facility by the letter of credit.

3. The letter of credit must be irrevocable and issued for a period of at least 1 year. The letter of credit must provide that the expiration date will be automatically extended for a period of at least 1 year unless, at least 120 days before the current expiration date, the issuing institution notifies both the owner or operator and the Director by certified mail of a decision not to extend the expiration date. Under the terms of the letter of credit, the 120 days will begin on the date when both the owner or operator and the Director have received the notice, as evidenced by the return receipts.

4. The letter of credit must be issued in an amount at least equal to the current closure cost estimate.

5. Whenever the current closure cost estimate increases to an amount greater than the amount of the credit, the owner, within 60 days after the increase, must either cause the amount ofthe credit to be increased so that it at least equals the current closure cost estimate and submit evidence of such increase to the Director, or obtain other financial assurance as specified in this section to

United States
Environmental Protection
Agency

Office of
Enforcement
Washington, DC 20460

EPA Form 3510-1
Revised August 1990

Permits Division

Application Form 1 - General Information

Consolidated Permits Program

This form must be completed by all persons applying for a permit under EPA's Consolidated Permits Program. See the general instructions to Form 1 to determine which other application forms you will need.

(fill–in areas are spaced for elite type, i.e., 12 characters/inch).

FORM 1 GENERAL

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERAL INFORMATION

Consolidated Permits Program

(Read the "General Instructions" before starting.)

I. EPA I.D. NUMBER

F | | D

LABEL ITEMS

I. EPA I.D. NUMBER

III. FACILITY NAME

V. FACILITY MAILING ADDRESS

VI. FACILITY LOCATION

PLEASE PLACE LABEL IN THIS SPACE

GENERAL INSTRUCTIONS

If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, cross through it and enter the correct data in the appropriate fill–in area below. Also, if any of the preprinted data is absent *(the area to the left of the label space lists the information that should appear)*, please provide it in the proper fill–in area(s) below. If the label is complete and correct, you need not complete Items I, III, V, and VI *(except VI-B which must be completed regardless)*. Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold–faced terms.

SPECIFIC QUESTIONS	MARK 'X' YES	NO	FORM ATTACHED	SPECIFIC QUESTIONS	MARK 'X' YES	NO	FORM ATTACHED
A. Is this facility a **publicly owned treatment works** which results in a discharge to **waters of the U.S.**? (FORM 2A)	16	17	18	B. Does or will this facility *(either existing or proposed)* include a **concentrated animal feeding operation** or **aquatic animal production facility** which results in a discharge to waters of the U.S.? (FORM 2B)	19	20	21
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)	22	23	24	D. Is this a proposed facility *(other than those described in A or B above)* which will result in a **discharge** to waters of the U.S.? (FORM 2D)	25	26	27
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	28	29	30	F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)	31	32	33
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)	34	35	36	H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)	37	38	39
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)	40	41	42	J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)	43	44	45

III. NAME OF FACILITY

C 1 SKIP

15 16–29 30 69

IV. FACILITY CONTACT

A. NAME & TITLE *(last, first, & title)* | B. PHONE *(area code & no.)*

C 2

15 16 45 46 – 48 49 – 51 52 – 55

V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX

C 3

15 16 45

B. CITY OR TOWN | C. STATE | D. ZIP CODE

C 4

15 16 40 41 42 47 – 51

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

C 5

15 16 45

B. COUNTY NAME

46 70

C. CITY OR TOWN | D. STATE | E. ZIP CODE | F. COUNTY CODE *(if known)*

C 6

15 16 40 41 42 47 – 51 52 – 54

CONTINUE ON REVERSE

DESCRIPTION OF CONSOLIDATED PERMIT APPLICATION FORMS

The Consolidated Permit Application Forms are:

Form 1 — General Information *(included in this part)*;

Form 2 — Discharges to Surface Water *(NPDES Permits)*:

2A. Publicly Owned Treatment Works *(Reserved — not included in this package)*,

2B. Concentrated Animal Feeding Operations and Aquatic Animal Production Facilities *(not included in this package)*,

2C. Existing Manufacturing, Commercial, Mining, and Silvicultural Operations *(not included in this package)*, and

2D. New Manufacturing, Commercial, Mining, and Silvicultural Operations *(Reserved — not included in this package)*;

Form 3 — Hazardous Waste Application Form *(RCRA Permits — not included in this package)*;

Form 4 — Underground Injection of Fluids *(UIC Permits — Reserved — not included in this package)*; and

Form 5 — Air Emissions in Attainment Areas *(PSD Permits — Reserved — not included in this package)*.

FORM 1 PACKAGE TABLE OF CONTENTS

SECTION A — GENERAL INSTRUCTIONS

Who Must Apply

With the exceptions described in Section C of these instructions, Federal laws prohibit you from conducting any of the following activities without a permit.

NPDES *(National Pollutant Discharge Elimination System Under the Clean Water Act, 33 U.S.C. 1251)*. Discharge of pollutants into the waters of the United States.

RCRA *(Resource Conservation and Recovery Act, 42 U.S.C. 6901)*. Treatment, storage, or disposal of hazardous wastes.

UIC *(Underground Injection Control Under the Safe Drinking Water Act, 42 U.S.C. 300f)*. Injection of fluids underground by gravity flow or pumping.

PSD *(Prevention of Significant Deterioration Under the Clean Air Act, 72 U.S.C. 7401)*. Emission of an air pollutant by a new or modified facility in or near an area which has attained the National Ambient Air Quality Standards for that pollutant.

Each of the above permit programs is operated in any particular State by either the United States Environmental Protection Agency *(EPA)* or by an approved State agency. You must use this application form to apply for a permit for those programs administered by EPA. For those programs administered by approved States, contact the State environmental agency for the proper forms.

If you have any questions about whether you need a permit under any of the above programs, or if you need information as to whether a particular program is administered by EPA or a State agency, or if you need to obtain application forms, contact your EPA Regional office *(listed in Table 1)*.

Upon your request, and based upon information supplied by you, EPA will determine whether you are required to obtain a permit for a particular facility. Be sure to contact EPA if you have a question, because Federal laws provide that you may be heavily penalized if you do not apply for a permit when a permit is required.

Form 1 of the EPA consolidated application forms collects general information applying to all programs. You must fill out Form 1 regardless of which permit you are applying for. In addition, you must fill out one of the supplementary forms *(Forms 2 — 5)* for each permit needed under each of the above programs. Item II of Form 1 will guide you to the appropriate supplementary forms.

You should note that there are certain exclusions to the permit requirements listed above. The exclusions are described in detail in Section C of these instructions. If your activities are excluded from permit requirements then you do not need to complete and return any forms.

NOTE: Certain activities not listed above also are subject to EPA administered environmental permit requirements. These include permits for ocean dumping, dredged or fill material discharging, and certain types of air emissions. Contact your EPA Regional office for further information.

Table 1. Addresses of EPA Regional Contacts and States Within the Regional Office Jurisdictions

REGION I

Permit Contact, Environmental and Economic Impact Office, U.S. Environmental Protection Agency, John F. Kennedy Building, Boston, Massachusetts 02203, (617) 223—4635, FTS 223—4635.
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

REGION II

Permit Contact, Permits Administration Branch, Room 432, U.S. Environmental Protection Agency, 26 Federal Plaza, New York, New York 10007, (212) 264—9880, FTS 264—9880.
New Jersey, New York, Virgin Islands, and Puerto Rico.

REGION III

Permit Contact *(3 EN 23)*, U.S. Environmental Protection Agency, 6th & Walnut Streets, Philadelphia, Pennsylvania 19106, (215) 597—8816, FTS 597—8816.
Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.

REGION IV

Permit Contact, Permits Section, U.S. Environmental Protection Agency, 345 Courtland Street, N.E., Atlanta, Georgia 30365, (404) 881—2017, FTS 257—2017.
Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

REGION V

Permit Contact *(5EP)*, U.S. Environmental Protection Agency, 230 South Dearborn Street, Chicage, Illinois 60604, (312) 353—2105, FTS 353—2105.
Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.

This form must be completed by all applicants.

Completing This Form

Please type or print in the unshaded areas only. Some items have small graduation marks in the fill–in spaces. These marks indicate the number of characters that may be entered into our data system. The marks are spaced at 1/6" intervals which accommodate elite type *(12 characters per inch)*. If you use another type you may ignore the marks. If you print, place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response.

Item I

Space is provided at the upper right hand corner of Form 1 for insertion of your EPA Identification Number. If you have an existing facility, enter your Identification Number. If you don't know your EPA Identification Number, please contact your EPA Regional office *(Table 1)*, which will provide you with your number. If your facility is new *(not yet constructed)*, leave this item blank.

Item II

Answer each question to determine which supplementary forms you need to fill out. Be sure to check the glossary in Section D of these instructions for the legal definitions of the **bold faced words**. Check Section C of these instructions to determine whether your activity is excluded from permit requirements.

If you answer "no" to every question, then you do not need a permit, and you do not need to complete and return any of these forms.

If you answer "yes" to any question, then you must complete and file the supplementary form by the deadline listed in Table 2 along with this form. *(The applicable form number follows each question and is enclosed in parentheses.)* You need not submit a supplementary form if you already have a permit under the appropriate Federal program, unless your permit is due to expire and you wish to renew your permit.

Questions (I) and (J) of Item II refer to major new or modified sources subject to Prevention of Significant Deterioration *(PSD)* requirements under the Clean Air Act. For the purpose of the PSD program, major sources are defined as: (A) Sources listed in Table 3 which have the potential to emit 100 tons or more per year emissions; and (B) All other sources with the potential to emit 250 tons or more per year. See Section C of these instructions for discussion of exclusions of certain modified sources.

Table 3. 28 Industrial Categories Listed in Section 169(1) of the Clean Air Act of 1977

Fossil fuel–fired steam generators of more than 250 million BTU per hour heat input;
Coal cleaning plants *(with thermal dryers)*;
Kraft pulp mills;
Portland cement plants;
Primary zinc smelters;
Iron and steel mill plants;
Primary aluminum ore reduction plants;
Primary copper smelters;
Municipal incinerators capable of charging more than 250 tons of refuse per day;
Hydrofluoric acid plants;
Nitric acid plants;
Sulfuric acid plants;
Petroleum refineries;
Lime plants;
Phosphate rock processing plants;
Coke oven batteries;
Sulfur recovery plants;
Carbon black plants *(furnace process)*;
Primary lead smelters;
Fuel conversion plants;
Sintering plants;
Secondary metal production plants;
Chemical process plants;
Fossil fuel boilers *(or combination thereof)* totaling more than 250 million BTU per hour heat input;

Table 3 *(continued)*

Petroleum storage and transfer units with a total storage capacity exceeding 300,000 barrels;
Taconite ore processing plants;
Glass fiber processing plants; and
Charcoal production plants.

Item III

Enter the facility's official or legal name. Do not use a colloquial name.

Item IV

Give the name, title, and work telephone number of a person who is thoroughly familiar with the operation of the facility and with the facts reported in this application and who can be contacted by reviewing offices if necessary.

Item V

Give the complete mailing address of the office where correspondence should be sent. This often is not the address used to designate the location of the facility or activity.

Item VI

Give the address or location of the facility identified in Item III of this form. If the facility lacks a street name or route number, give the most accurate alternative geographic information *(e.g., section number or quarter section number from county records or at intersection of Rts. 425 and 22)*.

Item VII

List, in descending order of significance, the four 4–digit standard industrial classification *(SIC)* codes which best describe your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words. These classifications may differ from the SIC codes describing the operation generating the discharge, air emissions, or hazardous wastes.

SIC code numbers are descriptions which may be found in the "Standard Industrial Classification Manual" prepared by the Executive Office of the President, Office of Management and Budget, which is available from the Government Printing Office, Washington, D.C. Use the current edition of the manual. If you have any questions concerning the appropriate SIC code for your facility, contact your EPA Regional office *(see Table 1)*.

Item VIII–A

Give the name, as it is legally referred to, of the person, firm, public organization, or any other entity which operates the facility described in this application. This may or may not be the same name as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. Do not use a colloquial name.

Item VIII–B

Indicate whether the entity which operates the facility also owns it by marking the appropriate box.

Item VIII–C

Enter the appropriate letter to indicate the legal status of the operator of the facility. Indicate "public" for a facility solely owned by local government*(s)* such as a city, town, county, parish, etc.

Items VIII–D – H

Enter the telephone number and address of the operator identified in Item VIII–A.

SECTION C – ACTIVITIES WHICH DO NOT REQUIRE PERMITS

I. National Pollutant Discharge Elimination System Permits Under the Clean Water Act. You are not required to obtain an NPDES permit if your discharge is in one of the following categories, as provided by the Clean Water Act *(CWA)* and by the NPDES regulations *(40 CFR Parts 122–125)*. However, under Section 510 of CWA a discharge exempted from the federal NPDES requirements may still be regulated by a State authority; contact your State environmental agency to determine whether you need a State permit.

A. DISCHARGES FROM VESSELS. Discharges of sewage from vessels, effluent from properly functioning marine engines, laundry, shower, and galley sink wastes, and any other discharge incidental to the normal operation of a vessel do not require NPDES permits. However, discharges of rubbish, trash, garbage, or other such materials discharged overboard require permits, and so do other discharges when the vessel is operating in a capacity other than as a means of transportation, such as when the vessel is being used as an energy or mining facility, a storage facility, or a seafood processing facility, or is secured to the bed of the ocean, contiguous zone, or waters of the United States for the purpose of mineral or oil exploration or development.

B. DREDGED OR FILL MATERIAL. Discharges of dredged or fill material into waters of the United States do not need NPDES permits if the dredging or filling is authorized by a permit issued by the U.S. Army Corps of Engineers or an EPA approved State under Section 404 of CWA.

C. DISCHARGES INTO PUBLICLY OWNED TREATMENT WORKS *(POTW)*. The introduction of sewage, industrial wastes, or other pollutants into a POTW does not need an NPDES permit. You must comply with all applicable pretreatment standards promulgated under Section 307(b) of CWA, which may be included in the permit issued to the POTW. If you have a plan or an agreement to switch to a POTW in the future, this does not relieve you of the obligation to apply for and receive an NPDES permit until you have stopped discharging pollutants into waters of the United States.

(NOTE: Dischargers into privately owned treatment works do not have to apply for or obtain NPDES permits except as otherwise required by the EPA Regional Administrator. The owner or operator of the treatment works itself, however, must apply for a permit and identify all users in its application. Users so identified will receive public notice of actions taken on the permit for the treatment works.)

D. DISCHARGES FROM AGRICULTURAL AND SILVICULTURAL ACTIVITIES. Most discharges from agricultural and silvicultural activities to waters of the United States do not require NPDES permits. These include runoff from orchards, cultivated crops, pastures, range lands, and forest lands. However, the discharges listed below do require NPDES permits. Definitions of the terms listed below are contained in the Glossary section of these instructions.

1. Discharges from Concentrated Animal Feeding Operations. *(See Glossary for definitions of "animal feeding operations" and "concentrated animal feeding operations." Only the latter require permits.)*

2. Discharges from Concentrated Aquatic Animal Production Facilities. *(See Glossary for size cutoffs.)*

3. Discharges associated with approved Aquaculture Projects.

4. Discharges from Silvicultural Point Sources. *(See Glossary for the definition of "silvicultural point source.")* Nonpoint source silvicultural activities are excluded from NPDES permit requirements. However, some of these activities, such as stream crossings for roads, may involve point source discharges of dredged or fill material which may require a Section 404 permit. See 33 CFR 209.120.

E. DISCHARGES IN COMPLIANCE WITH AN ON–SCENE COORDINATOR'S INSTRUCTIONS.

II. Hazardous Waste Permits Under the Resource Conservation and Recovery Act. You may be excluded from the requirement to obtain a permit under this program if you fall into one of the following categories:

Generators who accumulate their own hazardous waste on–site for less than 90 days as provided in 40 CFR 262.34;

Farmers who dispose of hazardous waste pesticide from their own use as provided in 40 CFR 262.51;

Certain persons treating, storing, or disposing of small quantities of hazardous waste as provided in 40 CFR 261.4 or 261.5; and

Owners and operators of totally enclosed treatment facilities as defined in 40 CFR 260.10.

Check with your Regional office for details. Please note that even if you are excluded from permit requirements, you may be required by Federal regulations to handle your waste in a particular manner.

III. Underground Injection Control Permits Under the Safe Drinking Water Act. You are not required to obtain a permit under this program if you:

Inject into existing wells used to enhance recovery of oil and gas or to store hydrocarbons *(note, however, that these underground injections are regulated by Federal rules)*; or

Inject into or above a stratum which contains, within 1/4 mile of the well bore, an underground source of drinking water *(unless your injection is the type identified in Item II-H, for which you do need a permit)*. However, you must notify EPA of your injection and submit certain required information on forms supplied by the Agency, and your operation may be phased out if you are a generator of hazardous wastes or a hazardous waste management facility which uses wells or septic tanks to dispose of hazardous waste.

IV. Prevention of Significant Deterioration Permits Under the Clean Air Act. The PSD program applies to newly constructed or modified facilities *(both of which are referred to as "new sources")* which increase air emissions. The Clean Air Act Amendments of 1977 exclude small new sources of air emissions from the PSD review program. Any new source in an industrial category listed in Table 3 of these instructions whose potential to emit is less than 100 tons per year is not required to get a PSD permit. In addition, any new source in an industrial category not listed in Table 3 whose potential to emit is less than 250 tons per year is exempted from the PSD requirements.

Modified sources which increase their net emissions *(the difference between the total emission increases and total emission decreases at the source)* less than the significant amount set forth in EPA regulations are also exempt from PSD requirements. Contact your EPA Regional office *(Table 1)* for further information.

CONCENTRATED ANIMAL FEEDING OPERATION *(continued)*

5. 3,000 sheep or lambs,

6. 16,500 turkeys,

7. 30,000 laying hens or broilers *(if the facility has continuous overflow watering)*,

8. 9,000 laying hens or broilers *(if the facility has a liquid manure handling system)*,

9. 1,500 ducks, or

10. 300 animal units; AND

Either one of the following conditions are met: Pollutants are discharged into waters of the United States through a manmade ditch, flushing system or other similar manmade device *("manmade" means constructed by man and used for the purpose of transporting wastes)*; or Pollutants are discharged directly into waters of the Unites States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.

Provided, however, that no animal feeding operation is a concentrated animal feeding operation as defined above if such animal feeding operation discharges only in the event of a 25 year, 24 hour storm event.

CONCENTRATED AQUATIC ANIMAL PRODUCTION FACILITY means a hatchery, fish farm, or other facility which contains, grows or holds aquatic animals in either of the following categories, or which the Director designates as such on a case–by–case basis:

A. Cold water fish species or other cold water aquatic animals including, but not limited to, the Salmonidae family of fish *(e.g., trout and salmon)* in ponds, raceways or other similar structures which discharge at least 30 days per year but does not include:

1. Facilities which produce less than 9,090 harvest weight kilograms *(approximately 20,000 pounds)* of aquatic animals per year; and

2. Facilities which feed less than 2,272 kilograms *(approximately 5,000 pounds)* of food during the calendar month of maximum feeding.

B. Warm water fish species or other warm water aquatic animals including, but not limited to, the Ameiuridae, Cetrarchidae, and Cyprinidae families of fish *(e.g., respectively, catfish, sunfish, and minnows)* in ponds, raceways, or other similar structures which discharge at least 30 days per year, but does not include:

1. Closed ponds which discharge only during periods of excess runoff; or

2. Facilities which produce less than 45,454 harvest weight kilograms *(approximately 100,000 pounds)* of aquatic animals per year.

CONTACT COOLING WATER means water used to reduce temperature which comes into contact with a raw material, intermediate product, waste product other than heat, or finished product.

CONTAINER means any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.

CONTIGUOUS ZONE means the entire zone established by the United States under article 24 of the convention of the Territorial Sea and the Contiguous Zone.

CWA means the Clean Water Act *(formerly referred to the Federal Water Pollution Control Act)* Pub. L. 92–500, as amended by Pub. L. 95–217 and Pub. L. 95–576, 33 U.S.C. 1251 *et seq.*

DIKE means any embankment or ridge of either natural or manmade materials used to prevent the movement of liquids, sludges, solids, or other materials.

DIRECT DISCHARGE means the discharge of a pollutant as defined below.

DIRECTOR means the EPA Regional Administrator or the State Director as the context requires.

DISCHARGE *(OF A POLLUTANT)* means:

A. Any addition of any pollutant or combination of pollutants to waters of the United States from any point source; or

B. Any addition of any pollutant or combination of pollutants to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation.

This definition includes discharges into waters of the United States from: Surface runoff which is collected or channelled by man; Discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to POTW's; and Discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works. This term does not include an addition of pollutants by any indirect discharger.

DISPOSAL *(in the RCRA program)* means the discharge, deposit, injection, dumping, spilling, leaking, or placing of any hazardous waste into or on any land or water so that the hazardous waste or any constituent of it may enter the environment or be emitted into the air or discharged into any waters, including ground water.

DISPOSAL FACILITY means a facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which hazardous waste will remain after closure.

EFFLUENT LIMITATION means any restriction imposed by the Director on quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into waters of the United States, the waters of the continguous zone, or the ocean.

EFFLUENT LIMITATION GUIDELINE means a regulation published by the Administrator under Section 304(b) of the Clean Water Act to adopt or revise effluent limitations.

ENVIRONMENTAL PROTECTION AGENCY *(EPA)* means the United States Environmental Protection Agency.

EPA IDENTIFICATION NUMBER means the number assigned by EPA to each generator, transporter, and facility.

EXEMPTED AQUIFER means an aquifer or its portion that meets the criteria in the definition of USDW, but which has been exempted according to the procedures in 40 CFR Section 122.35(b).

EXISTING HWM FACILITY means a Hazardous Waste Management facility which was in operation, or for which construction had commenced, on or before October 21, 1976. Construction had commenced if (A) the owner or operator had obtained all necessary Federal, State, and local preconstruction approvals or permits, and either (B1) a continuous on–site, physical construction program had begun, or (B2) the owner or operator had entered into contractual obligations, which could not be cancelled or modified without substantial loss, for construction of the facility to be completed within a reasonable time.

(NOTE: This definition reflects the literal language of the statute. However, EPA believes that amendments to RCRA now in conference will shortly be enacted and will change the date for determining when a facility is an "existing facility" to one no earlier than May of 1980; indications are the conferees are considering October 30, 1980. Accordingly, EPA encourages every owner or operator of a facility which was built or under construction as of the promulgation date of the RCRA program regulations to file Part A of its permit application so that it can be quickly processed for interim status when the change in the law takes effect. When those amendments are enacted, EPA will amend this definition.)

EXISTING SOURCE or EXISTING DISCHARGER *(in the NPDES program)* means any source which is not a new source or a new discharger.

PERMIT means an authorization, license, or equivalent control document issued by EPA or an approved State to implement the requirements of 40 CFR Parts 122, 123, and 124.

PHYSICAL CONSTRUCTION *(in the RCRA program)* means excavation, movement of earth, erection of forms or structures, or similar activity to prepare a HWM facility to accept hazardous waste.

PILE means any noncontainerized accumulation of solid, nonflowing hazardous waste that is used for treatment or storage.

POINT SOURCE means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

POLLUTANT means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical waste, biological materials, radioactive materials *(except those regulated under the Atomic Energy Act of 1954, as amended [42 U.S.C. Section 2011 et seq.])*, heat, wrecked or discarded equipment, rocks, sand, cellar dirt and industrial, municipal, and agriculture waste discharged into water. It does not mean:

A. Sewage from vessels; or

B. Water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil and gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if the State determines that the injection or disposal will not result in the degradation of ground or surface water resources.

(NOTE: Radioactive materials covered by the Atomic Energy Act are those encompassed in its definition of source, byproduct, or special nuclear materials. Examples of materials not covered include radium and accelerator produced isotopes. See Train v. Colorado Public Interest Research Group, Inc., 426 U.S. 1 [1976].)

PREVENTION OF SIGNIFICANT DETERIORATION *(PSD)* means the national permitting program under 40 CFR 52.21 to prevent emissions of certain pollutants regulated under the Clean Air Act from significantly deteriorating air quality in attainment areas.

PRIMARY INDUSTRY CATEGORY means any industry category listed in the NRDC Settlement Agreement *(Natural Resources Defense Council v. Train, 8 ERC 2120 [D.D.C. 1976], modified 12 ERC 1833 [D.D.C. 1979])*.

PRIVATELY OWNED TREATMENT WORKS means any device or system which is: (A) Used to treat wastes from any facility whose operator is not the operator of the treatment works; and (B) Not a POTW.

PROCESS WASTEWATER means any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

PUBLICLY OWNED TREATMENT WORKS or POTW means any device or system used in the treatment *(including recycling and reclamation)* of municipal sewage or industrial wastes of a liquid nature which is owned by a State or municipality. This definition includes any sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

RENT means use of another's property in return for regular payment.

RCRA means the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 *(Pub. L. 94–580, as amended by Pub. L. 95–609, 42 U.S.C. Section 6901 et seq.)*.

ROCK CRUSHING AND GRAVEL WASHING FACILITIES are facilities which process crushed and broken stone, gravel, and riprap *(see 40 CFR Part 436, Subpart B, and the effluent limitations guidelines for these facilities)*.

SDWA means the Safe Drinking Water Act *(Pub. L. 95–523, as amended by Pub. L. 95–1900, 42 U.S.C. Section 300[f] et seq.)*.

SECONDARY INDUSTRY CATEGORY means any industry category which is not a primary industry category.

SEWAGE FROM VESSELS means human body wastes and the wastes from tiolets and other receptacles intended to receive or retain body wastes that are discharged from vessels and regulated under Section 312 of CWA, except that with respect to commercial vessels on the Great Lakes this term includes graywater. For the purposes of this definition, "graywater" means galley, bath, and shower water.

SEWAGE SLUDGE means the solids, residues, and precipitate separated from or created in sewage by the unit processes of a POTW. "Sewage" as used in this definition means any wastes, including wastes from humans, households, commercial establishments, industries, and storm water runoff, that are discharged to or otherwise enter a publicly owned treatment works.

SILVICULTURAL POINT SOURCE means any discernable, confined, and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States. This term does not include nonpoint source silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance from which there is natural runoff. However, some of these activities *(such as stream crossing for roads)* may involve point source discharges of dredged or fill material which may require a CWA Section 404 permit. "Log sorting and log storage facilities" are facilities whose discharges result from the holding of unprocessed wood, e.g., logs or roundwood with bark or after removal of bark in self—contained bodies of water *(mill ponds or log ponds)* or stored on land where water is applied intentionally on the logs *(wet decking)*. *(See 40 CFR Part 429, Subpart J, and the effluent limitations guidelines for these facilities.)*

STATE means any of the 50 States, the District of Columbia, Guam, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, the Trust Territory of the Pacific Islands *(except in the case of RCRA)*, and the Commonwealth of the Northern Mariana Islands *(except in the case of CWA)*.

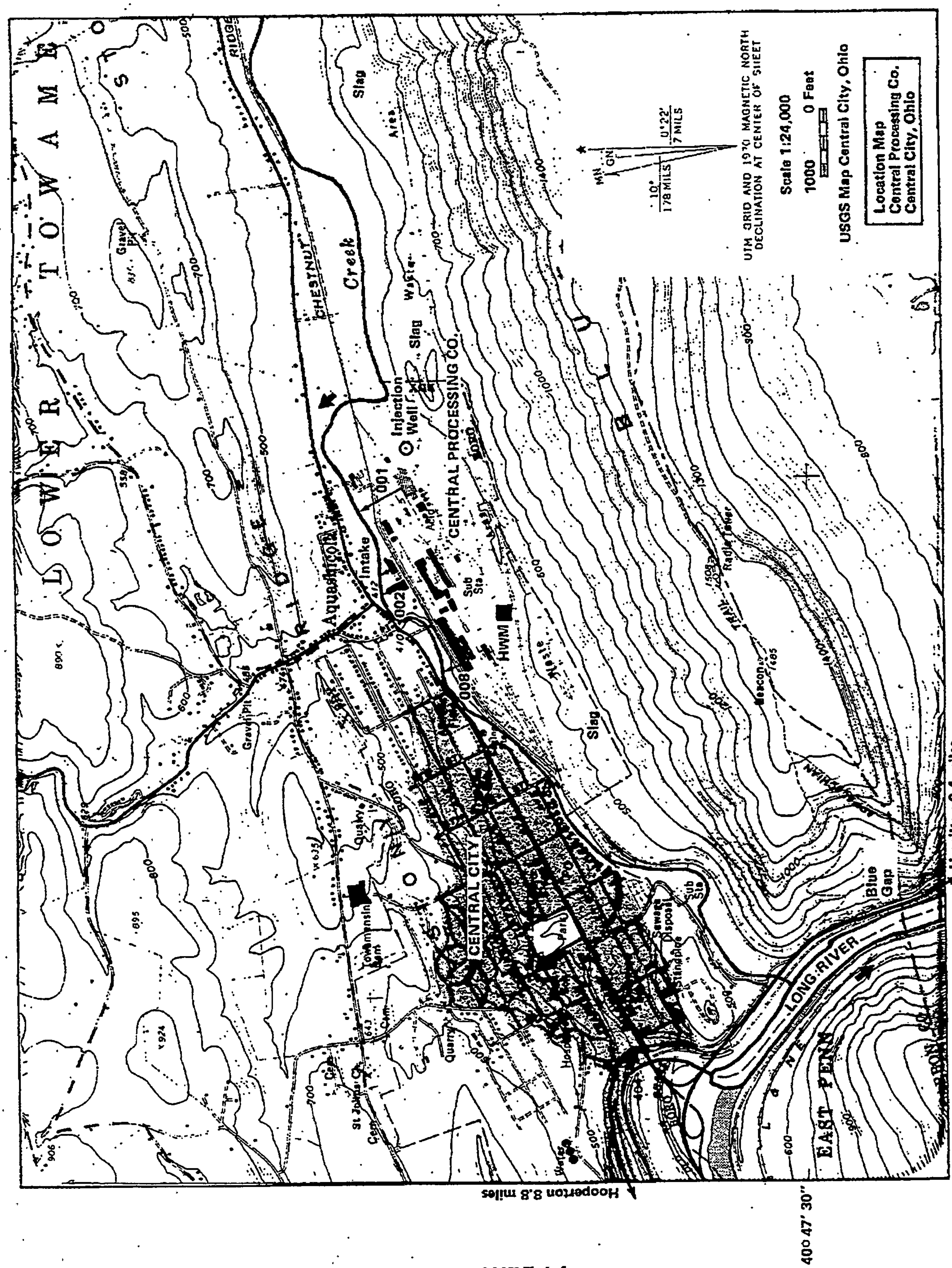
STATIONARY SOURCE *(in the PSD program)* means any building, structure, facility, or installation which emits or may emit any air pollutant regulated under the Clean Air Act. "Building, structure, facility, or installation" means any grouping of pollutant—emitting activities which are located on one or more contiguous or adjacent properties and which are owned or operated by the same person *(or by persons under common control)*.

STORAGE *(in the RCRA program)* means the holding of hazardous waste for a temporary period at the end of which the hazardous waste is treated, disposed, or stored elsewhere.

STORM WATER RUNOFF means water discharged as a result of rain, snow, or other precipitation.

SURFACE IMPOUNDMENT or IMPOUNDMENT means a facility or part of a facility which is a natural topographic depression, manmade excavation, or diked area formed primarily of earthen materials *(although it may be lined with manmade materials)*, which is designed to hold an accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons.

TANK *(in the RCRA program)* means a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non—earthen materials *(e.g., wood, concrete, steel, plastic)* which provide structural support.



CENTRAL PROCESSING CO.
Injection Well
Slag
Waste
Creek
CHESTNUT
RIDGE
Aquashicola
Intake
001
002
Sub Sta
HWM
CENTRAL CITY
Park
Sewage Disposal
Standpipe
Gravel Pit
Quarry
Radio Tower
Beacon
LONG RIVER
Blue Gap
EAST PENN
Hamilton 9.4 miles
Hooperton 8.8 miles
40° 47' 30"
75° 37' 30"
MN
GN
10°
178 MILS
0°22'
7 MILS
UTM GRID AND 1970 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
Scale 1:24,000
1000 0 Feet
USGS Map Central City, Ohio
Location Map
Central Processing Co.
Central City, Ohio

FIGURE 1-1

INSTRUCTIONS

General

This form must be completed by all applicants who check "yes" to Item II-B in Form 1. Not all animal feeding operations or fish farms are required to obtain NPDES permits. Exclusions are based on size and occurrence of discharge. See the description of these statutory and regulatory exclusions in the General Instructions which accompany Form 1. In particular, for animal feeding operations, the size cutoffs depend on whether or not pollutants are discharged through a manmade device or by direct contact with the facility or animals. A facility for laying hens or broilers is not required to have a permit unless it has a liquid manure handling system or continuous overflow watering. Also, facilities which discharge only in the case of a 25 year, 24 hour storm event are not required to have a permit.

For aquatic animal production facilities, the size cutoffs are based on whether the species are warm water or cold water, on the production weight per year in harvestable pounds, and on the amount of feeding in pounds of food *(for cold water species)*. Also, facilities which discharge less than 30 days per year, or only during periods of excess runoff *(for warm water fish)* are not required to have a permit.

Refer to the Form 1 instructions to determine where to file this form.

Item I-A

See the note above and the General Instructions which accompany Form 1 to be sure that your facility is "concentrated."

Item I-B

If your answer to Item VI of Form 1 does not give a complete legal description of your facility's location, use this space to provide a complete description, such as quarter, section, township, and range.

Item I-C

Check "proposed" if your facility is not now in operation, or not now "concentrated" under the definition in the glossary found in the General Instructions which accompany Form 1.

Item II

Supply all information in Item II if you checked *(1)* in Item I-A.

ITEM II-A

Give the maximum number of each type of animal in open confinement or housed under roof *(either partially or totally)* which are held at your facility for a total of 45 days or more in any 12 month period.

Use the following categories for types of animal:

Slaughter Cattle; Feeder Cattle; Mature Dairy Cattle *(milked or dry)*; Swine *(each weighing over 55 pounds)*; Horses; Sheep; Lambs; Turkeys; Laying Hens[1]; Broilers[1]; Ducks.

[1]A permit is not required unless the facility has a liquid manure handling system or continuous overflow watering.

Item II-B

Give only the area used for the animal confinement or feeding facility. Do not include any area used for growing or operating feed.

Item II-C

Check "yes" if any system for collection of runoff has been constructed. Supply the information under *(1)*, *(2)*, and *(3)* to the best of your knowledge.

Item III

Supply all information in Item III if you checked *(2)* in Item I-A.

Item III-A

Outfalls should be numbered to correspond with the map submitted in Item XI of Form 1. Values given for flow should be representative of your normal operation. The maximum daily flow is the maximum measured flow occurring over a calendar day. The maximum 30 day flow is the average of measured daily flows over the calendar month of highest flow. The long term average flow is the average of measured daily flows over a calendar year.

Item III-B

Give the total number of discrete ponds or raceways in your facility. Under "other," give a descriptive name of any structure which is not a pond or a raceway but which results in discharge to waters of the United States.

Item III-C

Use names for the receiving water and source of water which correspond to the map submitted in Item XI of Form 1.

Item III-D

The names of fish species should be proper, common, or scientific names as given in special Publication No. 6 of the American Fisheries Society, "A List of Common and Scientific Names of Fishes from the United States and Canada." The values given for total weight produced by your facility per year and the maximum weight present at any one time should be representative of your normal operation.

Item III-E

The value given for maximum monthly pounds of food should be representative of your normal operation.

Item IV

The Clean Water Act provides for severe penalties for submitting false information on this application form.

Section 309(c)(2) of the Clean Water Act provides that "Any person who knowingly makes any false statement, representation, or certification in any application, . . . shall upon conviction, be punished by a fine of no more than $10,000 or by imprisonment for not more than six months, or both,"

Federal regulations require the certification to be signed as follows:

A. For corporation, by a principal executive officer of at least the level of vice president;

B. For a partnership or sole proprietorship, by a general partner or the proprietor, respectively; or

C. For a municipality, State, Federal, or other public facility, by either a principal executive officer or ranking elected official.

Paper Reduction Act Notice

The Public reporting burden for this collection of information ... estimated to average 6 hours per response. This estimate includes time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information to the chief, Information Policy Branch (PM-223), US Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked Attention : Desk Officer for EPA

For Official Use Only

State of Georgia
Department of Natural Resources

Registration

For Coverage Under Permit By Rule
Chapter 391-3-6-.20(4)

SWINE FEEDING OPERATIONS

☐ Existing Facility ☐ Proposed New Facility

I. FACILITY LOCATION INFORMATION

FACILITY NAME: ______________________ PHONE: ____________

MAILING ADDRESS: ______________________ CITY: ____________ ZIP CODE: ____________

STREET/LOCATION ADDRESS: ______________________

CITY: ____________ COUNTY: ____________ ZIP CODE: ____________

II. FACILITY OWNER-OPERATOR INFORMATION

LEGAL NAME: ______________________ PHONE: ____________

ADDRESS: ______________________

CITY: ____________ STATE: ____________ ZIP CODE: ____________

III. SITE ACTIVITY INFORMATION

Maximum Number of Swine Weighing More Than 55 Pounds That Will Be Confined or Fed for Total of 45 Days in any 12 month Period. ____________

Describe the Swine Feeding/Growing Operation. ______________________

____

____

Does any other swine feeding operation adjoin this facility or utilize a common area for disposal of wastes from this facility? ____________

If yes, then attach size and ownership information for the other facilities.

IV. COMMENTS

V. CERTIFICATION: 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 gathered and evaluated the information submitted. Based upon 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 fine and imprisonment for knowing violations.

Printed Name: ______________________ Title: ____________

Signature: ______________________ Date: ____________