Soil, Manure, and Monitoring Well Testing in Georgia

by:
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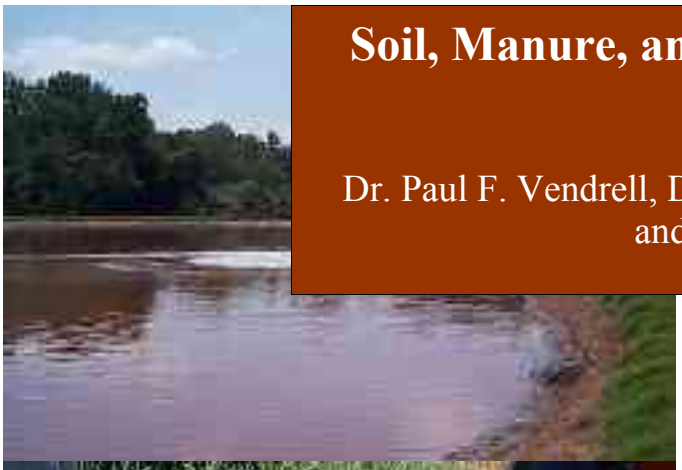


SOIL, MANURE, AND MONITORING WELL TESTING

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
    B. Test to Request
        1. Basic UGA manure test package
        2. Additional test on liquid manure for CNMP
        3. Georgia regulations for testing lagoon effluent
    C. Manure Report
II. Soil Testing
    A. Soil Sample Collection
        1. When
        2. Where
        3. How
    B. Soil Test Parameters
    C. Soil Test Report
III. Monitoring Well Testing
    A. Monitoring Well Location
    B. Monitoring Well Construction
    C. Groundwater Monitoring Requirement

D. Sampling and Analysis
E. Guidance Documents

IV. Review Questions

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[3] Jordan, C. W., 2000, Soil and manure sampling and analysis, Unpublished information, Agricultural and Environmental Services Laboratories, University of Georgia, Cooperative Extension Service, College of Agriculture and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

INTRODUCTION

The collection and analysis of soil, manure, and monitoring well water are addressed in this training. Soil and manure testing are needed to perform comprehensive nutrient management planning (CNMP). Utilization of manure or lagoon effluent within a CNMP requires soil and manure testing for measurement of plant available nutrients. Soil test reports give the level of available plant nutrients and provide recommendations for any additional lime and fertilizer nutrients needed to achieve optimum crop yields. Animal manure is a valuable resource and can be used to provide the additional soil nutrients prescribed in the soil test recommendations. Growers should not base application rates on laboratory test results from previous years because nutrient concentrations can change significantly, particularly when the manure has been exposed to the environment. For example, nutrient levels in a lagoon or storage pond can be greatly influenced by rainfall.

For regulatory purposes the lagoon effluent and water from the monitoring wells need to be sampled semiannually and tested. Total Kjeldahl nitrogen (TKN) and nitrate-nitrogen (NO_3-N) are required for the lagoon effluent. However, in order to use the lagoon effluent as a fertilizer source in nutrient management, additional testing for phosphorus, potassium, and micronutrients will be necessary. Monitoring wells require TKN and NO_3-N and possibly other primary drinking water parameters may be advisable.

Utilization of swine manure or lagoon effluent within a CNMP requires soil and manure testing. Soil test reports give the level of available plant nutrients and provide recommendations for any additional lime and fertilizer nutrients needed to achieve optimum crops yield. Animal manure is a valuable resource and can be used to provide

the additional soil nutrients prescribed in the soil test recommendations. Growers should not base application rates on laboratory test results from previous years because nutrient concentrations can change significantly, particularly when the manure has been exposed to the environment. For example, nutrient levels in a lagoon or storage pond can be greatly influenced by rainfall.

Producers who fail to test each manure source before or just after land application are faced with a number of questions they simply may not be able to answer: Are they supplying plants with adequate nutrients? Are they building up excess nutrients that may ultimately move into surface water or groundwater? Are they applying heavy metals at levels that may be toxic to plants and permanently alter soil productivity?

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) "Animal Non-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.

Liquid Manure

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

- Place sample in a sealed, clean plastic container with about a 1-pint volume. Glass is not suitable because it is breakable and may contain contaminants.
- Leave at least 1 inch of air space in the plastic container to allow for expansion caused by the release of gas from the manure material.
- Refrigerate or freeze samples that cannot be shipped on the day they are collected. This will minimize chemical reactions and pressure buildup from gases.

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

Lagoon effluent: Premixing the surface liquid in the lagoon is not needed, provided it is the only component that is being pumped. Growers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation.

Samples should be collected using a clean, plastic container similar to the one shown in Figure 1. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger clean, plastic container. Effluent should be collected at least 6 feet from the edge of the lagoon at a depth of about a foot. Shallower samples from anaerobic lagoons may be less representative than deep samples because oxygen transfer near the surface sometimes alters the chemistry of the solution. Floating debris and scum should be avoided. One pint of the mixed material should be sent to the laboratory. Galvanized containers should never be used for collection, mixing, or storage due to the risk of contamination from metals like zinc in the container.

Liquid slurry: Manure slurries that are applied from a pit or storage pond should be mixed prior to sampling. If you agitate your pit or basin prior to sampling, a sampling device pictured in Figure 1 can be used. If you wish to sample a storage structure without

agitation, you must use a composite sampling device as shown in Figure 2. Manure should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of 0.5- to 0.75-inch plastic pipe can also be used: extend the 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.

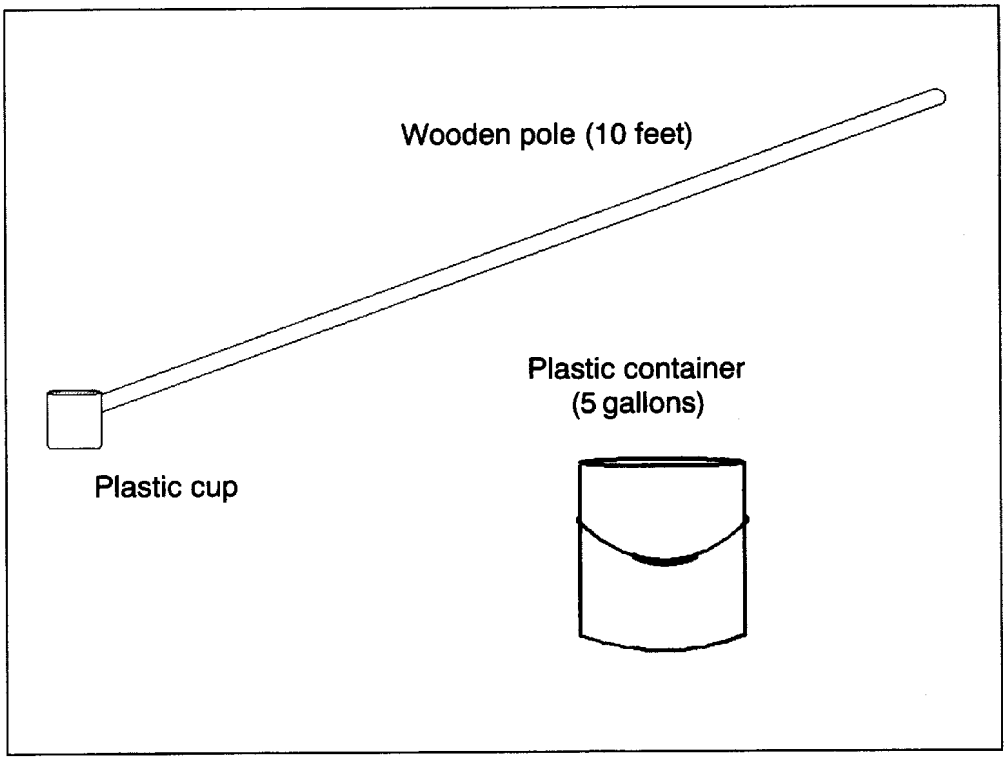


Figure 1. Liquid manure sampling device

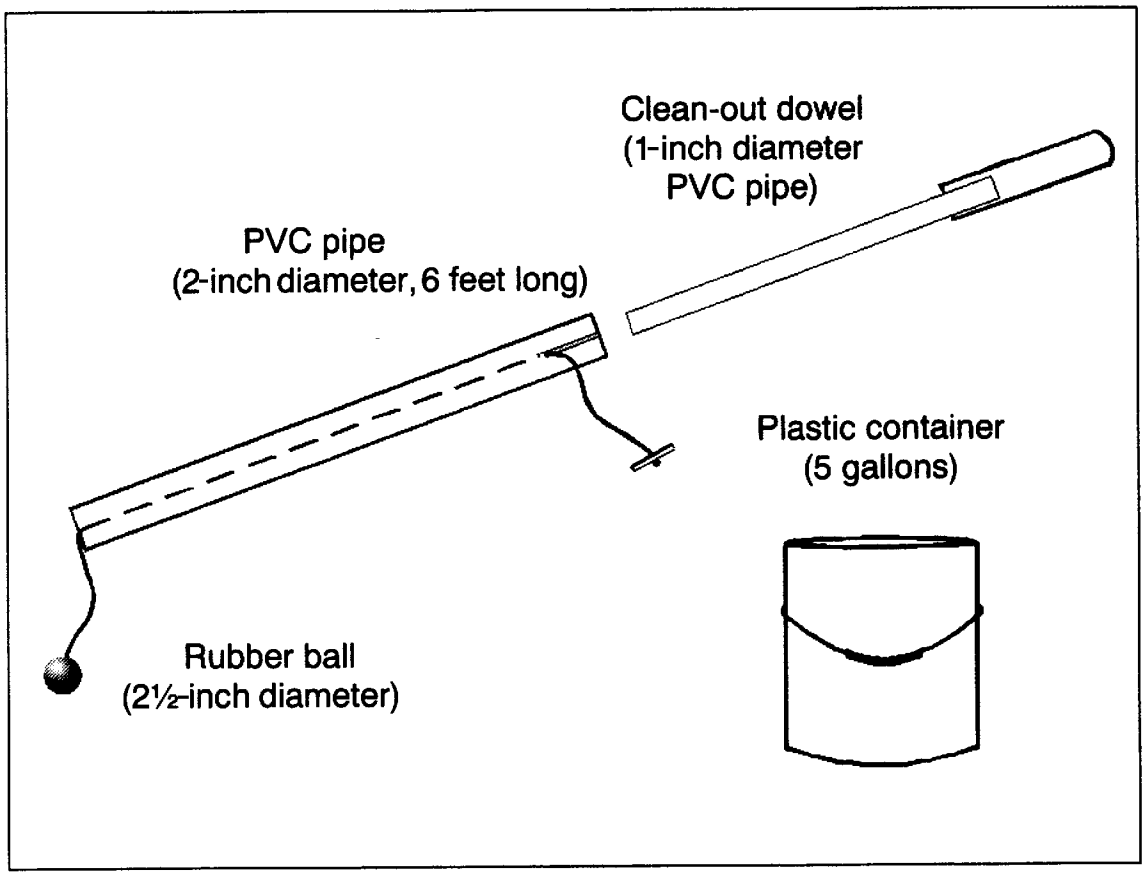


Figure 2. Composite sampling device

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.

Solid Manure

Solid manure samples should represent the average moisture content of the manure. A one-quart sample is adequate for analysis. Samples should be taken from approximately eight different areas in the manure pile, placed in a clean, plastic container, and thoroughly mixed. Approximately one quart of the mixed sample should be placed in a plastic bag, sealed, and shipped directly to the laboratory. Samples stored for more than two days should be refrigerated. Figure 3 shows a device for sampling solid manure.

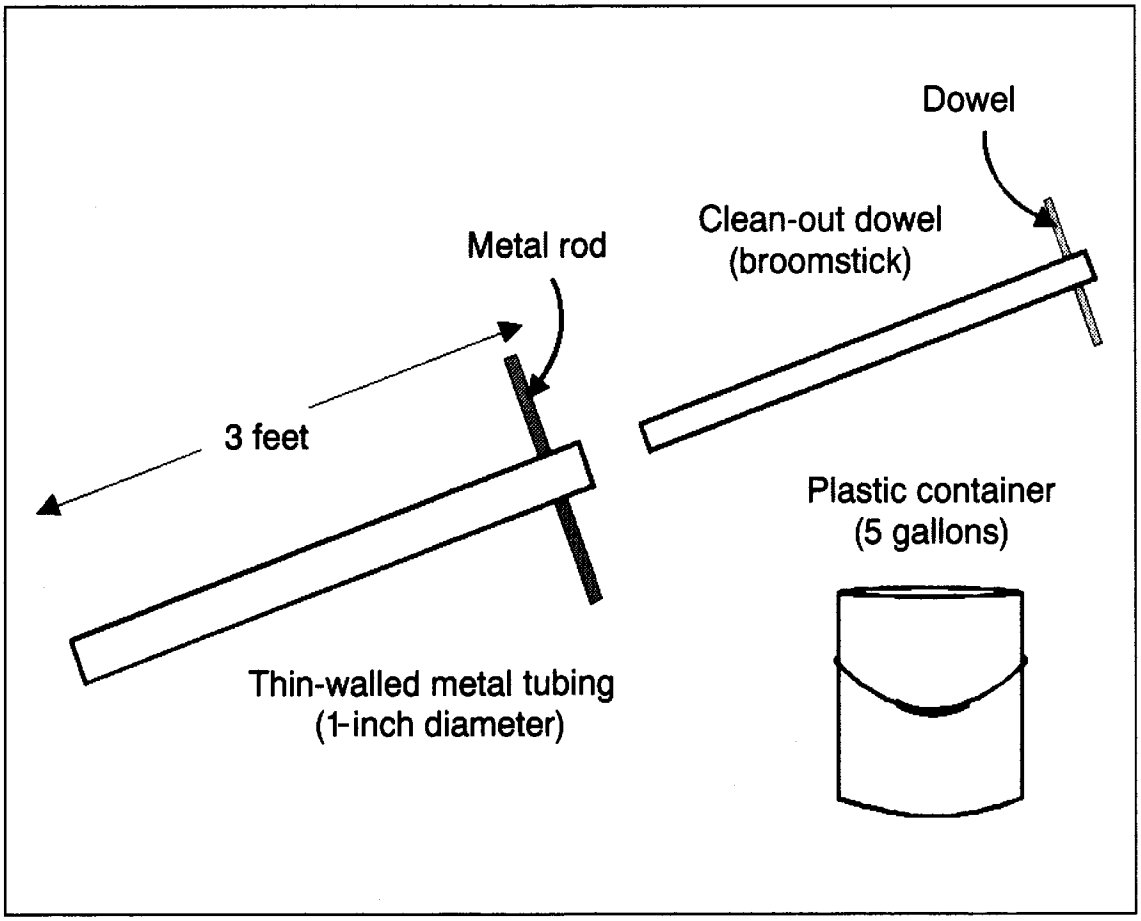


Figure 3. Solid manure sampling device

SAMPLING TECHNIQUES FOR DETERMINING
BROILER LITTER NUTRIENT CONTENT

In-house Litter: The nutrient content of litter in a poultry house can vary considerably depending on location within the house. For example, in a recent study, we found the nitrogen content of 30 uniformly spaced broiler litter samples from within a house to vary as shown in the following table:

	Center of the house	Around feeder	Around drinkers
	----------(%)----------		
Average	3.31	4.44	3.49
Minimum	2.83	4.15	2.35
Maximum	3.68	4.75	4.50

The average % N of samples taken around feeders was 25% higher than samples taken from the center of the house and 21% higher than the average around drinkers. Samples taken around drinkers varied as much as 48% (range 2.35 to 4.50 %N). Therefore, **it is not recommended** to sample litter while still being used as a bedding layer in the poultry house. Wait until clean out to sample after mixing the litter by scraping it into a pile. Then, follow the procedure given below for sampling litter from piles, stockpiles, or spreader trucks. If sampling of litter is necessary in the house prior to clean out, use the sampling procedures as originally provided.

Piled manure, litter, or from a spreader truck: This procedure is for manure or litter temporarily collected into piles during clean out. To obtain a representative sample, collect at least 10 shovelfuls of manure or litter from the piles or from the spreaders, so that it represent all of the manure or litter, which is hauled or spread. Combine the collected portions in a clean 5-gallon plastic bucket or wheelbarrow, and mix thoroughly. Place a one-quart portion from this mixture in a plastic bag, seal it securely, and ship it to the laboratory as soon as possible. For wet manure, refrigerate the sample if it will not be shipped within one day of sampling. Unless hauling or spreading immediately, protect

surface-scraped manure or litter from the weather. Sample stockpiled litter or manure according to the guidelines given below.

Stockpiled manure or litter: A stockpile consists of manure or litter stored in a pile for later use. Store stockpiled manure or litter under cover on an impervious surface. The weathered exterior of uncovered waste may not accurately represent the majority of the material, since rainfall generally moves water-soluble nutrients down into the pile. Sample stockpiles using the same method for piles described above except collect at a depth of 18 inches from the surface of the pile, and as close as possible to its application date.

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) Ag and Environmental Services Laboratories. The UGA manure sample submission forms are displayed in Figures 4 and 5. Poultry producers should use the form illustrated in Figure 5, Poultry Litter/Manure Submission Form for Nutrient Management Plans. All others should use the form illustrated in Figure 4, Animal Waste Submission Form for Land Application. If using an independent or company laboratory, contact them directly about services and prices.

Basic UGA manure test package: Your individual permits will dictate the frequency and kinds of testing. The basic manure test package at the UGA Ag and Environmental Services Laboratories includes: (all are as total elemental nutrient)

- nitrogen (N)
- phosphorus (P)
- potassium (K)
- calcium (Ca)
- magnesium (Mg)
- sodium (Na)
- sulfur (S)
- aluminum (Al)
- iron (Fe)

- boron (B)
- copper (Cu)
- manganese (Mn)
- zinc (Zn)

Additional test on liquid manure for CNMP: Lagoon effluent samples submitted for basic manure testing at the UGA Ag Services Labs will have additional analyses that include:

- total Kjeldahl nitrogen (TKN), (for permit)
- nitrate nitrogen, (for permit).
- Ammonium nitrogen (not required for permit but used for nutrient management)

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/Stockhouse_____
	B. Layer_____	F. Deep Stacked_____
	C. Incubator_____	G. Composted_____
	D. Pullet_____	H. 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/Solid_____

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_____ Nitrate Nitrogen _____
(excluding nitrate nitrogen) (important for lagoons)

Ammonium Nitrogen_____ Moisture (Solids)_____ Other _____

FOR LAB USE ONLY

Date Received: _____ Date Returned: _____
Payment Received: _____ Invoice #: _____

NH_4-N _____ Moisture _____ NO_3-N _____ Total Nitrogen _____ Other _____

Figure 4. Example of the UGA "Animal Waste Submission Form for Land Application"

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

SOIL, PLANT, AND WATER LABORATORY
2400 College Station Road

Lab #: _____
(Lab use only)

POULTRY LITTER/MANURE SUBMISSION FORM

FOR NUTRIENT MANAGEMENT PLANS

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

Name: _____ **Sample #:** _____ (One form per sample)
Mailing address: _____ **County:** _____
City,State,Zip: _____ **Date:** _____
Phone #: _____

For First Time Users please answer the following:

1. Have you attended Nutrient Management Training?: Yes___ No___
   *If you have not received training check with your County Extension Agent.
2. Will these results be used for Nutrient Management Planning?: Yes___ No___
3. How many floors were produced on this litter?: ____
4. Was the litter taken: a) Fall clean-out *(Check One)

Please check all that apply:

Kind	Condition
Broiler	Fresh
Layer_____	Stockpiled_____
Breeder_____	Composted_____
Pullet_____	Lagoon_____

Application Method:
(Check One)
Surface_____
Incorporated
(within 2 days)
Sub injected
Irrigation applied_____

TESTS REQUESTED:

_____ Total Minerals (Free basic test)
(Includes: total nitrogen,phosphorus,potassium,calcium,magnesium,sulfur,manganese, iron,aluminum,boron,copper,zinc,sodium)

Extra Tests (price per test schedule)
Nitrate Nitrogen _____ Ammonium Nitrogen _____
Moisture Solids Other

FOR LAB USE ONLY

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

NH_4-N_____ **Moisture/Solids** _____ **NO_3-N**_____ **Total Nitrogen:** _____ **Other** _____

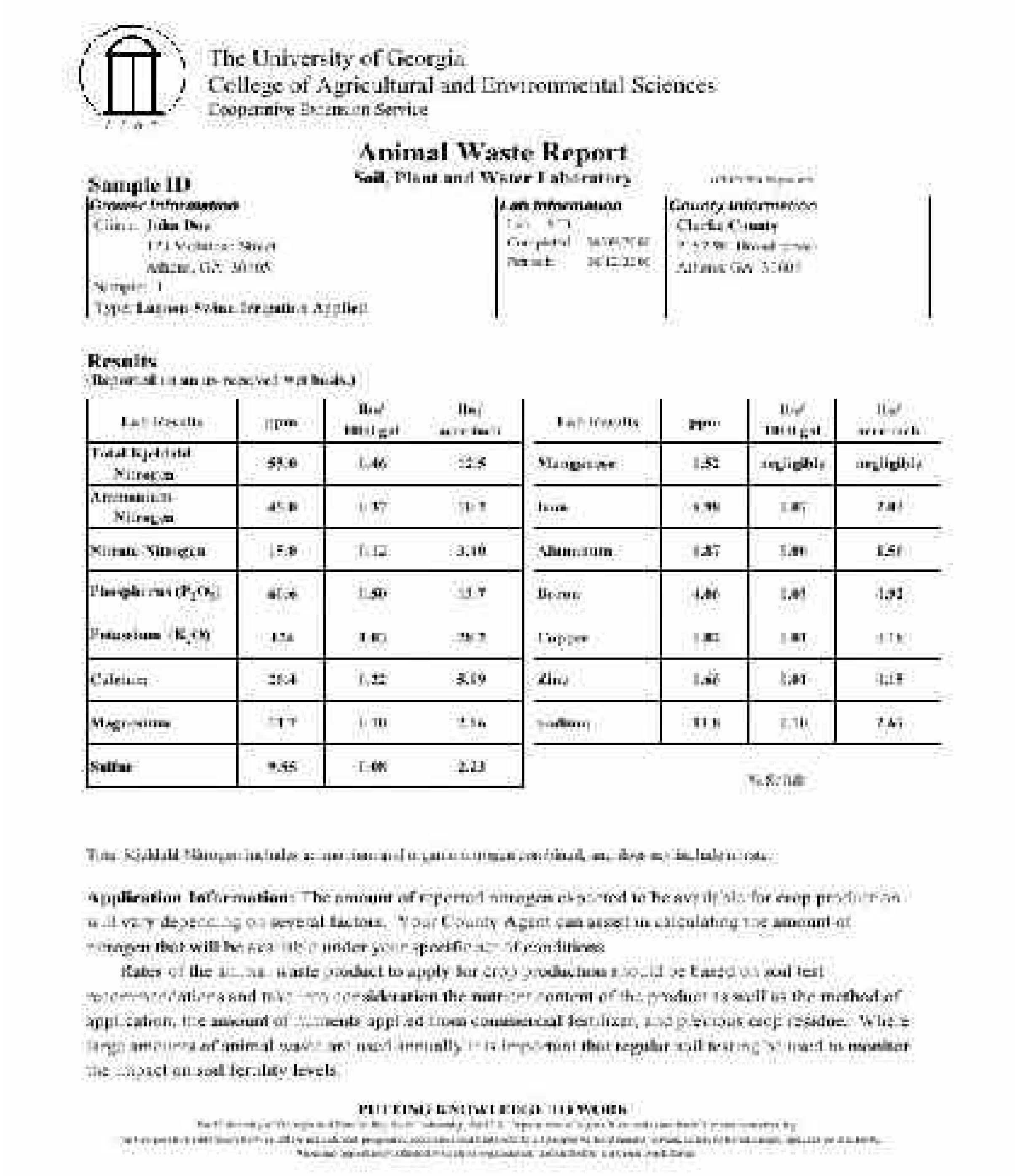
Manure Report

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. In the Animal Waste Report (Figure 6), 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 per acre. 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.



The University of Georgia
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Cooperative Extension Service

Animal Waste Report

Soil, Plant and Water Laboratory

Sample ID

Grower Information	Lab Information	County Information
Client: John Doe [illegible] Street [illegible] GA [illegible] Sample: 1 Type: Lagoon Swine Irrigation Applied	[illegible] Completed [illegible] Printed [illegible]	Clarke County [illegible] Athens GA [illegible]

Results
(Reported on an as-received wet basis.)

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre-inch
Total Kjeldahl Nitrogen	55.0	0.46	12.5
Ammonium-Nitrogen	45.0	0.37	[illegible]
Nitrate Nitrogen	15.0	0.12	3.10
Phosphorus (P_2O_5)	61.6	0.50	13.9
Potassium (K_2O)	126	[illegible]	[illegible]
Calcium	20.4	0.22	5.19
Magnesium	[illegible]	[illegible]	[illegible]
Sulfur	9.55	0.08	2.23

Lab Results	ppm	lbs/ 1000 gal	lbs/ acre-inch
Manganese	1.52	negligible	negligible
Iron	[illegible]	[illegible]	[illegible]
Aluminum	[illegible]	[illegible]	[illegible]
Boron	[illegible]	[illegible]	[illegible]
Copper	[illegible]	[illegible]	[illegible]
Zinc	[illegible]	[illegible]	[illegible]
Sodium	[illegible]	[illegible]	[illegible]

[illegible]

Total Kjeldahl Nitrogen includes ammonium and organic nitrogen combined, and does not include nitrate.

Application Information: The amount of reported nitrogen expected to be available for crop production will vary depending on several factors. Your County Agent can assist in calculating the amount of nitrogen that will be available under your specific set of conditions.

Rates of the animal waste product to apply for crop production should be based on soil test recommendations and take into consideration the nutrient content of the product as well as the method of application, the amount of nutrients applied from commercial fertilizer, and previous crop residue. Where large amounts of animal waste are used annually, it is important that regular soil testing be used to monitor the impact on soil fertility levels.

PUTTING KNOWLEDGE TO WORK

Figure 6. Example of a liquid manure report form the UGA Ag and Environmental Services Laboratories

Soil Testing

Presently, manure application rates are based on the 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 testing can also monitor any build-up of zinc, which could possibly increase to toxic levels (for sensitive crops like peanuts) from long-term and heavy applications of poultry litter.

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 7 illustrates the recommended zigzag pattern for soil core collection and the logic behind collecting separate samples due to changing field conditions. Figure 8 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.

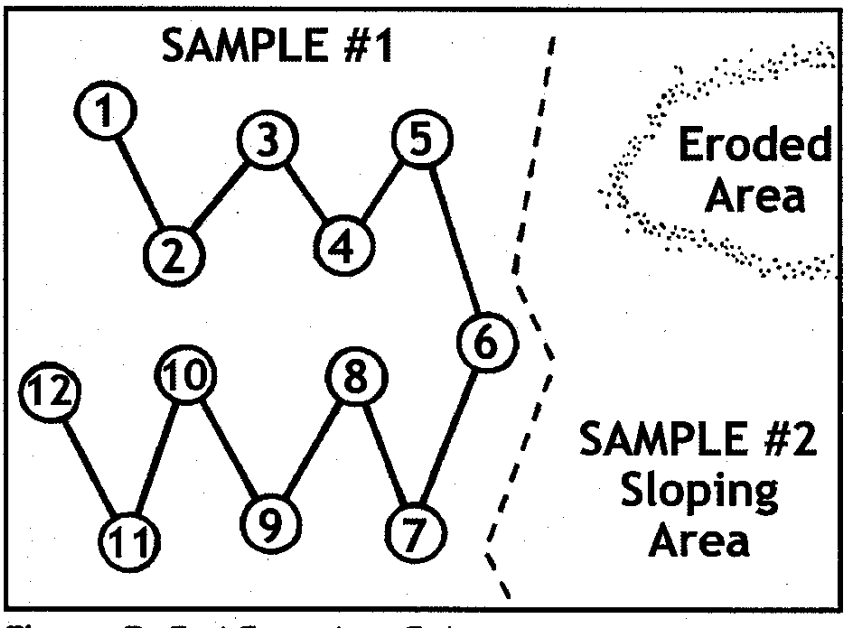

Figure 7. Zigzag pattern for collecting soil samples

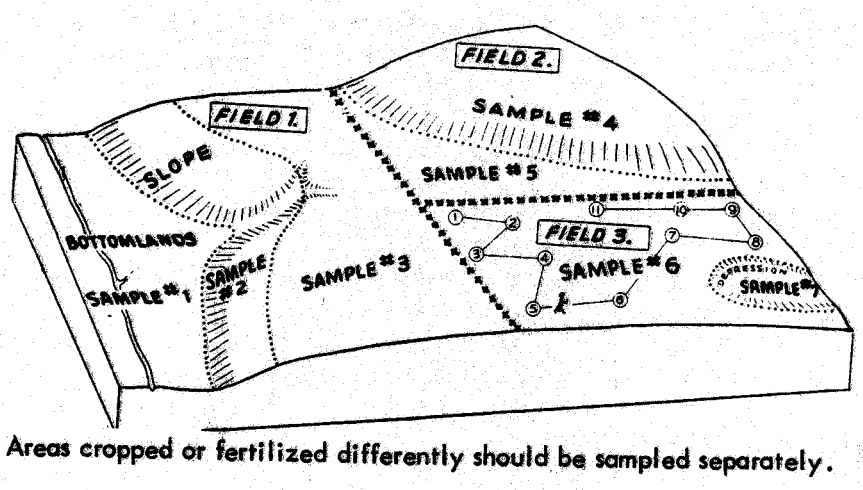

Figure 8. Collection of separate samples based on topography and differing management practices

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 9). 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.

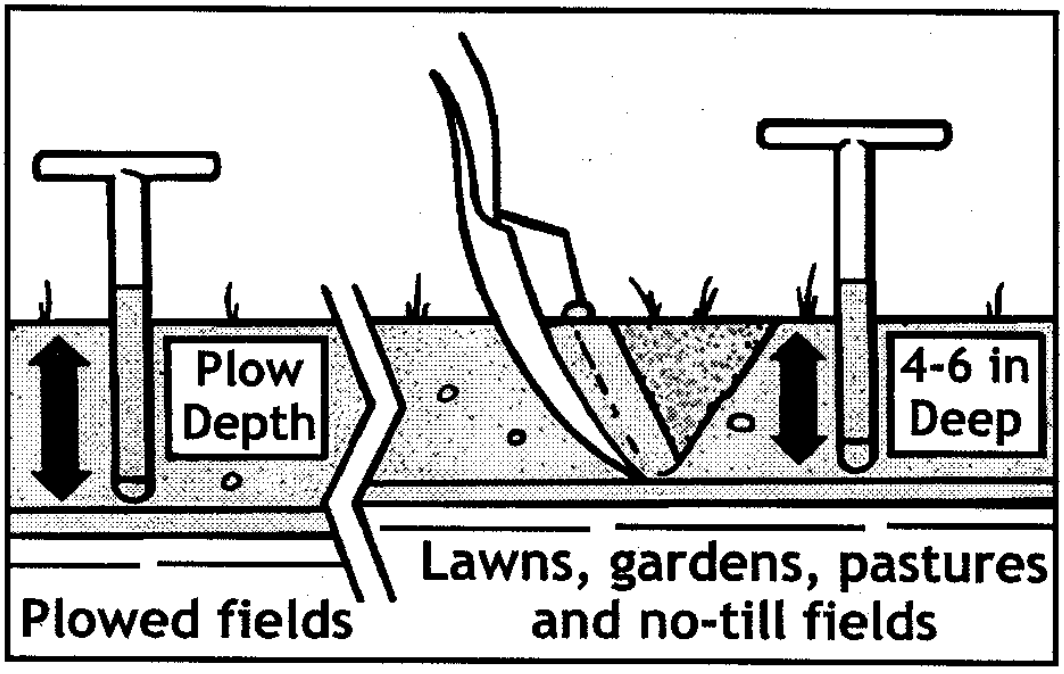

Figure 9. Soil sampling depths for plowed fields (6 inches or plow depth) and no-till or pastures (4 inches)

Soil Test Parameters

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

- phosphorus (P)
- potassium (K)
- calcium (Ca)
- magnesium (Mg)
- manganese (Mn)
- zinc (Zn)
- pH
- lime requirement

Soil tests for nitrogen (N) are generally not reliable for predicting crop response due primarily to the high rainfall of the southeastern U.S.; therefore, recommendations given in soil test reports are based on long-term experiments conducted to determine the rates of N fertilizers needed for specific crops. Other tests like cation exchange capacity (CEC), organic matter, copper (Cu), and boron (B) are available on request. The UGA Ag and Environmental Services Laboratories methods are well correlated with Georgia soils. Various independent laboratories also provide soil-testing services. It is important that the laboratory of your choice uses methods and makes recommendations based on Georgia conditions.

Soil Test Report

The laboratory report will show the test results and give a recommendation for fertilizer nutrients and lime if needed. The recommended rates of nutrients may be supplied from commercial fertilizers, animal manures, lagoon effluents or a combination of sources.

Soil test results are usually reported in pounds of nutrients per acre but some laboratories may give the results as parts per million (ppm). These numbers are merely an index of the nutrients in the soil and are not the actual amounts available for plant uptake. To simplify the interpretation, soil test results are classified into low, medium, high and very high categories. These categories refer to the relative nutrient-supplying

power of the soil. Little or no fertilizer nutrients are recommended when soil test levels are rated as high and very high. Examples of UGA soil test reports and recommendations are given in Figures 10 and 11. Nutrient application to soils with very high soil tests could lead to a nutrient imbalance as well as contribute to surface water quality problems.

In summary, a soil test report tells you the fertility status of the soil and how much, if any, additional nutrients are needed for the particular crop. When animal manure will be used as 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
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Soil Test Report

Soil, Plant and Water Laboratory

[illegible]

Sample ID

Grower Information

Client: **Jane Doe**
123 McIntosh Street
Athens, GA 30605
Sample: 1
Crop: Common Bermuda Pasture

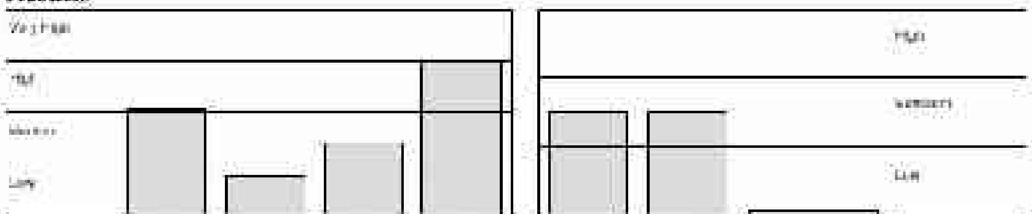
Lab Information

Lab: [illegible]
Completed: [illegible]
Printed: [illegible]

County Information

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	45 lbs/Acre	70 lbs/Acre	720 lbs/Acre	220 lbs/Acre	3 lbs/Acre	31 lbs/Acre	5.3 (7.23 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	*	20 lbs/Acre	70 lbs/Acre	--	--	--	--

*For pastures not intensively grazed apply 75 to 125 pounds nitrogen per acre. For intensively grazed pastures apply 125 to 175 pounds nitrogen per acre.

If excess forage is common under grazing conditions, split the pasture in half and apply nitrogen to only one section in March, and to the remaining apply nitrogen in July or August, dependent upon the amount of forage that will be utilized.

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.

Figure 10. Example of a UGA soil test report and fertilizer recommendations for common Bermuda pasture

Figure 11. Example of UGA soil test report and fertilizer recommendations for small grain silage,

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

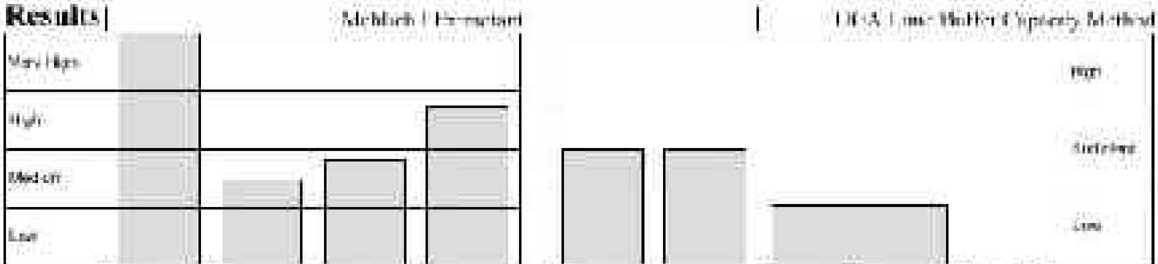
Soil Test Report

Soil, Plant, and Water Laboratory

Sample ID

Grower Information	Lab Information	County Information
Client: Jane Doe 2340 Sanford Street [illegible], GA 30621 Sample: [illegible] Crop: Small Grain Silage	Lab: [illegible] Completed: [illegible] Printed: [illegible]	Microsoft County 2000 Easy Lane [illegible], GA [illegible] 305-123-4567

Results | Mehlich I Extractant | UGA Lime Buffer Capacity Method



	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Zinc (Zn)	Manganese (Mn)	pH_{CaCl_2}	Equivalent Water pH	Lime Buffer Capacity (LBC)	
Soil Test Index	206 lbs/Acre	105 lbs/Acre	672 lbs/Acre	165 lbs/Acre	18 lbs/Acre	34 lbs/Acre	5.3	5.9	189	Soil Test Index

Recommendations

Limestone Target pH 6.0 (recommended)	Limestone Target pH 6.5	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulfur (S)	Boron (B)	Manganese (Mn)	Zinc (Zn)
0.5 tons/Acre	0.75 tons/Acre	120-160 lbs/Acre	0 lbs/Acre	120 lbs/Acre	–	–	–	–

A target pH of 6.0 (pH_{CaCl_2} of 5.4) is recommended for most Agronomic crops. However, a lime recommendation for pH 6.5 (pH_{CaCl_2} of 5.9) is also provided on this soil test report. Liming to pH 6.5 helps reduce low pH areas in highly variable fields.

*For small grain following a legume apply 120 pounds nitrogen (N) per acre; for small grain following cotton, corn, etc. apply 140 pounds nitrogen per acre; for small grain following grain sorghum apply 160 pounds nitrogen per acre. Apply 20 to 40 pounds of the recommended nitrogen per acre in the fall and the remainder in February.

On deep sandy soils, apply 10 pounds of sulfur (S) per acre. The sulfur should be applied when the topdress nitrogen application is made.

If no phosphate (P_2O_5) or potash (K_2O) is recommended and none is applied, sample soil again next year.

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

Water quality monitoring is required by the Georgia Environmental Protection Division (EPD) to detect and quantify contamination, as well as to measure the effectiveness of waste holding systems for animal feeding operations over 1000 animal units. Monitoring should be thought of as a tool used to measure the efficiency of site design and location factors affecting ground water quality. It is beyond the scope of this training to give detailed instructions on well installation and monitoring and we recommend that you contract a professional that has the skills and experience with this type of monitoring.

Monitoring Well Location

Monitoring points should be located so that they detect contamination as early as possible, while observing standards of good practice and common sense. The monitoring wells should be as close as possible to the outer down-gradient edge of the lagoon. At existing lagoons with less certainty on design features and past waste disposal practices, the monitoring well should be located no closer than 25 feet from the toe of the lagoon dike in undisturbed soil. The well should not be located in fill material.

In most cases, the focus of monitoring will be the shallowest saturated zone, which is likely to be the first area impacted. Monitoring wells should be no deeper than is absolutely necessary to monitor the first year-round water-bearing unit encountered. Existing wells can be used if approved by GA-EPD. However, pre-existing wells are usually not located down-gradient of lagoons.

In order to reduce the chances of an accidental spill in the vicinity of a monitoring well, or contamination of soil around a well, certain minimum horizontal distances should be maintained between the well and sources of unrelated contamination. The following are recommended minimum distances:

a. Septic tank - 50 feet

b. Septic tank absorption field - 100 feet

c. Dead animal burial pits - 150 feet

d. Animal or fowl enclosure - 100 feet

e. Pesticide storage, mixing and loading facilities - 100 feet

f. Fertilizer storage - 100 feet

g. Petroleum storage -100 feet

Monitoring Well Construction

The actual placement and construction details of the monitoring wells are based on the hydrogeology of the site. Down-gradient wells must be located, and screened to insure that releases from the waste management unit will be detected. Down-gradient wells must be located at the edge of the waste management unit. Minimums of three wells are needed to calculate a hydrologic gradient and designate a down-gradient well. Determining the down-gradient location without additional wells to measure water elevations will be the “best-guess” of the well driller, geologist, or professional engineer based on surface topography. It is advisable to install two other temporary wells to monitor water elevations and confirm that the permanent well is actually down-gradient during the semiannual monitoring.

Details for well construction are given in EPD's "Manual for Groundwater Monitoring”. In accordance with the Water Well Standards Act, a licensed well driller under the supervision of a licensed geologist or professional engineer must install monitoring wells. At the completion of the fieldwork and well installation, a land surface contour map and potentiometer surface maps should be prepared.

Groundwater Monitoring Requirements

Table 1. Groundwater monitoring parameters under non-swine swine feeding operation permit requirements.

Parameter	Measurement Frequency	Tolerances	Sample Holding Time
Nitrate-Nitrogen (mg/l as N)	Semiannually	10 ppm nitrate-N	14 days
Total Kjeldahl-N (mg/l TKN)	Semiannually	-	28 Days
Depth to Groundwater	Semiannually	-	On-site

Note 1: Sampling container: plastic or glass.

Note 2: Semiannual monitoring results are either submitted with the June and December reports to the EPD**,** or retained on site. Check your permit**.**

Note 3: Most permits will contain the statement, "Groundwater leaving the land application system boundaries must not exceed primary maximum contaminate levels for drinking water" (Table 2). At the initiation of well water monitoring program, it is a good idea to have samples analyzed for primary drinking water parameters plus chloride and sulfates. These parameters need not be measured again unless a problem develops.

Table 2. Primary drinking water standards

Contaminant	Maximum Contaminant Level
Primary	**(ppm)**
Arsenic	0.05*
Barium	2.0
Cadmium	0.005
Chromium	0.10
Fluoride	4.0
Lead	0.015
Mercury	0.002
Nitrate	10.0
Nitrite	1.0
Total Nitrate and Nitrite	10.0
Selenium	0.05

*Note: EPA is currently proposing to lower value to 0.005 ppm.

Contaminant	Maximum Contaminant Level
Secondary	**(ppm)**
Chloride	250
Copper	1.0
Sulfate	250
Zinc	5.0

Sampling and Analysis

An effective groundwater sampling and analysis program requires a written plan to include: procedures for sample collection, sample preparation and collection, analytical procedures and chain-of-custody control.

To meet the current parameter requirements (Table 1), the depth to groundwater must be determined semiannually (Figure 12). Following determination of the depth to water table, the well should be purged. For shallow low yielding wells, the well is usually purged (bailed dry) with a dedicated bailer. Disposable Teflon bailers are recommended (Figure 13). If the well cannot be bailed dry, then 3 well volumes should be removed prior to sampling. The well is allowed to recharge and the well is sampled for TKN and nitrate-N. Table 3 contains a list of equipment available from several sources and estimated prices.

Figure 12. Measuring the depth to groundwater

Figure 13. Teflon well bailer

Sampling personnel should wear clean plastic gloves and an effort should be made to minimize contact of the bailing equipment with the ground. Cleanliness and attention to detail minimize cross contamination. A distilled water blank should be carried to the field and put through the entire sampling procedure.

Samples for nitrate-N and TKN determination should be stabilized and collected in a glass or plastic container, stabilized to pH <2 with sulfuric acid and shipped to the laboratory as soon as possible. Samples can be held on ice (4 C) until stabilization. A chain-of-custody form that documents the sample handling from sampling to analysis should be maintained (Figure 14).

Table 3. Equipment and supplies available from Ben Meadows, Forestry Suppliers, Fisher Scientific, VWR Scientific and other scientific supply houses

Parameter	Instrument	Estimated Price
Well purging	Bailer (disposable, Teflon)	$250/case of 12
Depth to water table	Conductivity tape	$250
Nitrate	Laboratory analysis	$8-20/sample

Action Plan When Nitrate-N Exceeds 10 ppm

When a water sample from a monitoring well exceeds the 10 ppm nitrate-N tolerance or when the sum of nitrate-N (NO_3-N) plus TKN exceeds 10 ppm, the actions listed in Table 4. should be followed before taking more serious action.

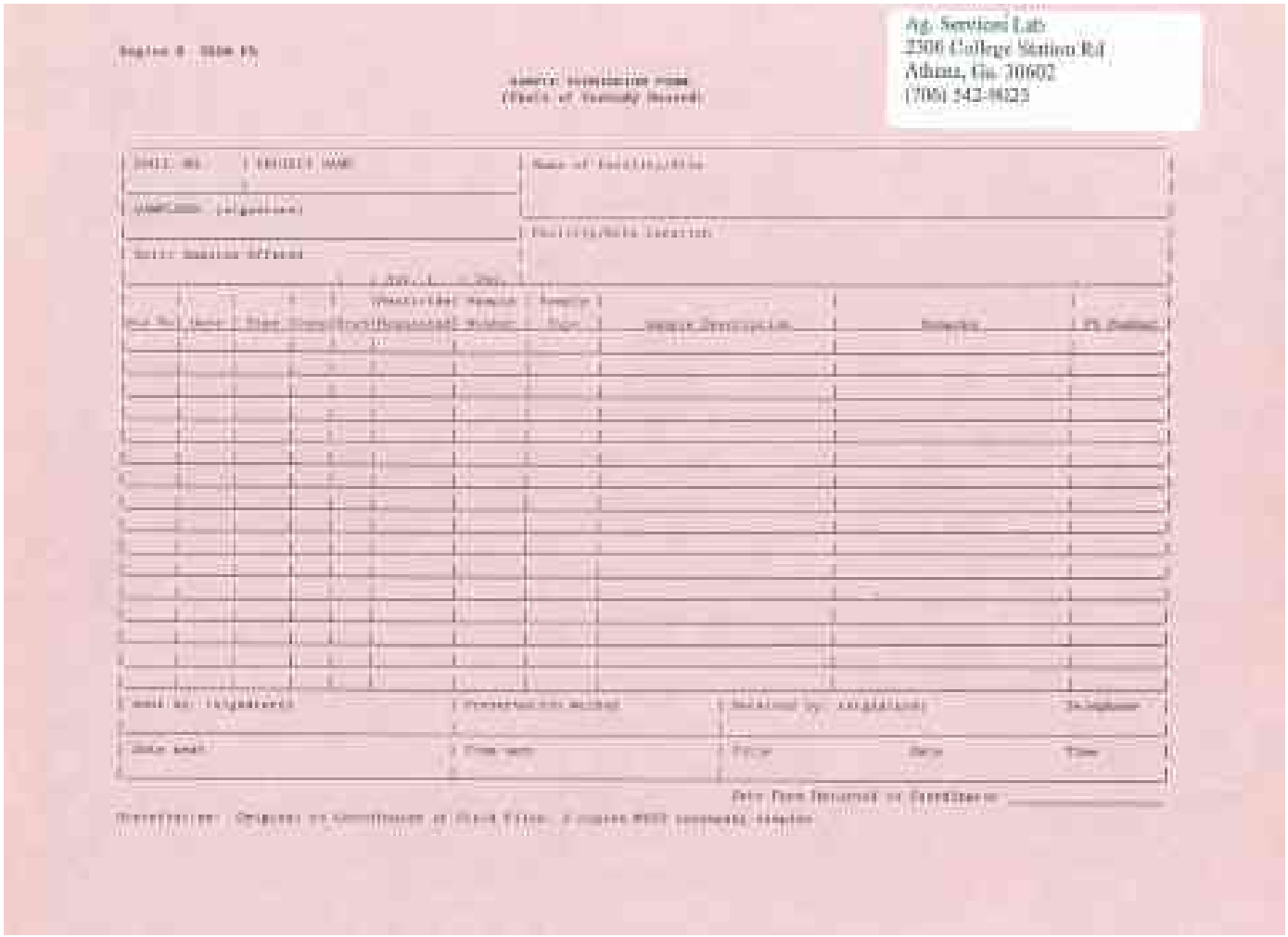
Table 4. Recommended actions when nitrate-N or nitrate-N plus TKN exceed the 10 ppm tolerance

Case	Sample	NO_3-N	NO_3-N + TKN	Action
1.1	Sample taken during routine compliance monitoring schedule	<10 ppm	<10 ppm	Continue collecting samples semiannually
1.2	Sample taken during routine compliance monitoring schedule	>10 ppm	<10 ppm	Take another (second) sample making sure to follow the instructions for "Sampling and Analysis". It is critical to purging the well dry or a minimum of three well volumes, allowing the water level to recover, before collecting the sample. Have this sample analyzed as soon as possible for TKN, nitrate-N, and specific conductance.
1.3	Same as 2.1	>10 ppm	<10 ppm	Same as 1.2
1.4	Same as 2.1	>10 ppm	>10 ppm	Same as 1.2
2.1	Confirming (second) sample collected in cases 1.2, 1.3, or 1.4	<10 ppm	<10 ppm	Return to collecting samples semiannually. Review historical data and watch for increasing trends
2.2	Same as 2.1	>10 ppm	<10 ppm	Collect another confirming (third) sample by repeating action 1.2
2.3	Same as 2.1	<10 ppm	>10 ppm	Same as 2.2

2.4	Same as 2.1	>10 ppm	>10 ppm	Same as 2.2
3.1	Confirming (third) sample collected in cases 2.2, 2.3, or 2.4	<10 ppm	<10 ppm	Return to collecting samples semiannually. Review historical data and watch for increasing trends. Consider installing more monitoring wells up-gradient and down-gradient, halfway between the lagoon and the property line.
3.2	Same as 3.1	>10 ppm	<10 ppm	Contact a trained professional and discuss initiating a more detailed investigation
3.3	Same as 3.1	<10 ppm	>10 ppm	Same as 3.2
3.4	Same as 3.1	>10 ppm	>10 ppm	Same as 3.2

In cases where there is already a history of repeated nitrate-N levels above 10 ppm, it is important to prevent those high levels from reaching a neighbors property, especially when a shallow drinking water well is down-gradient.

Figure 14. Chain-of-custody form



Ag. Services Lab
2300 College Station Rd
Athens, Ga. 30602
(706) 542-9023

Guidance Documents

1. Georgia DNR. 1991. Manual for Groundwater Monitoring. Environmental Protection Division. Atlanta Georgia.

2. McLemore, W. H. 1981. Monitoring Well Construction for Hazardous-Waste Sites in Georgia. (Georgia Geologic Survey Circular No. 5) Georgia Department of Natural Resources, Environmental Protection Division. Atlanta Georgia.

3. Georgia DNR. 2000. Rules and Regulations for Water Quality Control Chapter 391-3-6. Revised April 2000. Environmental Protection Division. Atlanta Georgia.

4. Georgia DNR. 1991. The Water Well Standards Act of 1991 Official Code of Georgia 12-5-120 through 12-5-138. Environmental Protection Division. Atlanta Georgia.

These documents can be found at the Georgia Department of Natural Resources.
Contact: Tom Hopkins, 4220 International Parkway, Atlanta, GA 30354.
Phone: (404) 362-4916 or (404) 362-2680
Email: Tom_Hopkins@dnr.mail.state.ga.us

5. Wellhead Protection for Farm Wells, UGA Cooperative Extension Service Circular 819-13/Revised January 1993 (http://www.ces.uga.edu/pubcd/c819w.html).

REVIEW QUESTIONS*

1. Why is manure tested for developing a CNMP?
2. When should manures be sampled for laboratory analysis?
3. How should manure be sampled?
4. How do you convert elemental P and K to fertilizer basis (P_2O_5 and K_2O)?
5. Why should soil be tested when developing a CNMP?
6. How should soil samples be taken in the field? Sampling zones, sampling depths, number of samples, walking patterns.
7. Which nutrients are measured in the routine soil test?
8. Which nutrients are of primary environmental concern and why?
9. What monitoring parameters are required by the Animal (Non-Swine) Feeding Operations Permit on lagoon effluent and groundwater? How frequently must wells be sampled?
10. What well monitoring parameter is determined on-site?
11. Where is the proper location for the monitoring well?
12. Who should be responsible for constructing the monitoring wells?

*** For Planners only (Review questions 1-12).**
For Operators (Review questions 1-8 only).