Chapter 4: Tools for the Plan

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

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

Nutrient concentrations vary in most wastes. A review of samples analyzed by the NCDA Agronomic Division shows the available nitrogen in animal waste can vary greatly. For example, in swine lagoon liquids, available nitrogen can range from 0.03 to 617 pounds per 1,000 gallons, in dairy slurry the range is 0.1 to 250 pounds per 1,000 gallons, and in a lagoon on a poultry operation with a liquid waste management system the range is 0.1 to 328 pounds per 1,000 gallons. This is a broad range of nutrient levels with the maximum and minimum values differing by more than a hundredfold. These numbers should send a clear message to waste users: Average nutrient estimates may be suitable for the purposes of developing a waste utilization plan, but these averages are not adequate for calculating proper application rates.

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

New regulations require that waste sampling be performed within 60 days of a waste application. Preferably, the sample should be taken as near the application time as possible prior to the waste application. However, if it is urgent to pump down a full lagoon or storage pond, you should not wait until you can sample and obtain the results. You should sample the day of irrigation. The results can later be used to determine the nutrients applied to the fields and identify the need for additional nutrients to complete crop production.

Waste users who fail to test each waste 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 to surface waters?
waters or groundwater? Are they applying heavy metals at levels that may be toxic to plants and permanently alter soil productivity?

Because environmental damage and losses in plant yield and quality often happen before visible plant symptoms, growers should always have their wastes analyzed by a competent laboratory. The NCDA Agronomic Division can analyze waste samples and make agronomic recommendations regarding the use of the waste as a fertilizer. However, your animal waste management plan or general permit may require that you use a North Carolina certified laboratory to satisfy monitoring requirements. This chapter will not address sampling for the purpose of monitoring; instead it will address the use of a lab that provides agronomic recommendations similar to those provided by the NCDA Agronomic Division.

WASTE SAMPLING

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

Waste 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 waste. The laboratory you use should have specific instructions on sampling, including proper containers to use and maximum holding or shipping times.

Liquid Wastes

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

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

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

**Lagoon Liquid:**
Premixing the surface liquid in the lagoon is not 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 4-1. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger clean, plastic container. Waste should be collected at least 6 feet from the edge of the lagoon at a depth of about 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 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:
Waste materials applied as a slurry from a pit or storage pond should be mixed prior to sampling. If you mix prior to sampling, the liquid sampling device pictured in Figure 4-1 can be used. If you wish to sample a storage structure without agitation, you must use a composite sampling device as shown in Figure 4-2. Waste should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of 0.5- to 0.75-inch plastic pipe can also be used: extend the pipe into the pit; pull up the ball plug (or press your thumb over the end to form an air lock); and remove the pipe from the waste and release the air lock to deposit the waste in the plastic container.

Figure 4-1. Liquid waste sampling device.
Figure 4-2. Composite sampling device.

For analysis, the laboratory requires 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 waste prior to land application, a proportionate quantity of water should be added to the sample.

Solid Wastes

Solid waste samples should represent the average moisture content of the waste. A 1-quart sample is required for analysis. Samples should be taken from approximately eight different areas in the waste, placed in a clean, plastic container, and thoroughly mixed. Approximately 1 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 4-3 shows a device for sampling solid waste.
Figure 4-3. Solid waste sampling device.

**WHO CAN ANALYZE MY WASTE SAMPLE?**

The Waste Advisory Section of the NCDA Agronomic Division analyzes wastes, interprets analytical results, and provides management recommendations for citizens of North Carolina. Each sample must be accompanied by a completed copy of Form AD9 (Appendix C), the Waste Analysis Information Sheet, and a $4.00 fee. These forms are available from your county Cooperative Extension center, NCDA Regional Agronomist, or can be obtained from the NCDA Waste Advisory Section of Agronomic Division, 4300 Reedy Creek Road, Raleigh, NC 27607-6465. Make checks payable to NCDA.

Directions for filling out form AD9 are printed on the bottom left corner of the form. To get the most value from your waste analysis, please take the time to fill out form AD9 completely and accurately. Contact your county Cooperative Extension Service center, NCDA Regional Agronomist, or a technical specialist with the local Soil and Water
Conservation District or Natural Resources Conservation Service for assistance in filling out form AD9. Be sure that the lagoon samples are labeled with your name, phone number, date, and sample identification number. This is especially important when submitting several samples at one time.

Private laboratories also offer some of these services and their fees vary. A good analytical service should always determine the concentrations of essential plant nutrients, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (B).

**WHAT DOES MY WASTE ANALYSIS REPORT TELL ME?**

Samples submitted to the NCDA Agronomic Division will be analyzed and the sender will receive a report that lists the concentration of each plant nutrient and several potentially harmful elements. Specific concentrations of nutrients and other elements are reported on a weight basis for solid wastes; results for liquid wastes are reported on a volume basis.

The most useful information is predicted nutrients available for the first crop. These levels are predicted on an as-is or wet basis. Nutrient availability is predicted based on estimates of breakdown of the waste and nutrient loss according to application method. Of the total nutrients predicted to be released for the first crop, 50 to 75 percent likely will become available during the first month. It is, therefore, important to apply wastes near the time required by plants. The remaining nutrients gradually become available over the next three months. Nutrients not available for the first crop are slowly released to available forms over time. For soils that do not readily leach with heavy rainfall, it is possible for nutrients to accumulate to significant quantities over time.

You should review the report to see if the analysis is within expected ranges for your waste. It is common for waste analyses to vary somewhat between seasons, due to excess rainfall or drought, or due to changes in management practices. However, you should compare your results to the results from previous waste reports to ensure that the results appear reasonable. If your results are significantly different from what you would expect, it is advisable to resample the waste. It is possible that the original sample may have been mislabeled or improperly collected, and not be representative of the waste.
Nutrients listed in the report as “available for the first crop” should be used in determining the actual application rate to meet a specific plant nutrient requirement. For the availability prediction to be reliable, growers must have properly identified the type of waste and the application method on the information sheet submitted to the laboratory.

It is important to understand that nutrient availability cannot be determined with 100 percent accuracy. Many variables, including the type of waste product and environmental factors (i.e., soil type, rainfall, temperature, and general soil conditions) influence the break down of the waste and nutrient loss. NCDA waste analysis reports provide a realistic estimation of nutrient availability based on type of waste and application method.

New animal waste management regulations require you to maintain your waste analysis reports for a minimum of five years. This is to see if there is consistency in nutrient content and to justify your application rates.

A copy of your waste analysis reports will be kept on file at the appropriate county Cooperative Extension Service center and at the Agronomic Division, NCDA. Please consult your county Cooperative Extension Service center or NCDA Regional Agronomist if you need assistance in interpreting your waste analysis results.
### Waste Analysis Report

**Farm:** Swine Lagoon/Sludge

#### Nutrients Available for First Crop (lbs/1000 gallons)

| Nutrient | N  | P  | K  | Ca | Mg | S  | Fe | Mn | Zn | Cu | B  | Mo | Cl | Na | Ni | Cd | Pb |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Irrigation | 1.5 | 0.78 | 2.8 | 0.80 | 0.31 | 0.18 | 0.02 | T  | T  | T  | T  | T  | T  | T  | T  |
| Soil Incorp | 2.3 | 0.90 | 3.2 | 0.91 | 0.35 | 0.21 | 0.02 | T  | 0.01 | T  | T  | T  | T  | T  | T  |

#### Other Elements (lbs/1000 gallons)

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Ni</th>
<th>Cd</th>
<th>Pb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Incorp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Recommendations:

Nutrients available for the first crop are based on estimates of mineralization rate and projected loss for the application method listed. Concentrations of zinc and other metals are not excessive. The waste product should not cause production or environmental problems if utilized according to recommended practices. Monitor nutrient buildup and soil pH with a soil test no less than every two years. I would apply the waste at rates needed to supply nitrogen for crop production.

---

#### Nutrients Available for Second Crop (lbs/1000 gallons)

| Nutrient | N  | P  | K  | Ca | Mg | S  | Fe | Mn | Zn | Cu | B  | Mo | Cl | Na | Ni | Cd | Pb |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Broadcast | 9.9 | 68.2 | 2.9 | 30.1 | 12.8 | 6.1 | 6.5 | 0.40 | 1.4 | 1.3 | 0.01 | T  | T  | T  | T  |
| Irrigation | 13.0 | 77.9 | 3.3 | 34.4 | 14.7 | 6.9 | 7.1 | 0.46 | 1.5 | 1.5 | 0.01 |     |     |     |     |

#### Other Elements (lbs/1000 gallons)

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Ni</th>
<th>Cd</th>
<th>Pb</th>
</tr>
</thead>
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<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Recommendations:

Nutrients available for the second crop are based on estimates of mineralization rate and projected loss for the application method listed. Concentrations of phosphorus, zinc, and copper are high enough to warrant an annual soil test to monitor buildup of these elements where the waste is applied. I would apply the waste at rates needed to supply a reasonable amount of phosphorus and avoid excessive buildup of phosphorus, zinc, and copper in the soil.
While experienced growers can usually recognize a well nourished crop, it is not possible to look at a soil and predict if the soil is too acid or if there are proper amounts of the essential nutrients present. Soils in North Carolina vary in their need for lime and other nutrients, depending on soil characteristics, previous fertilization levels, and nutrient requirements of the crop. The goal of soil testing is to find out enough about the soil to provide economically and environmentally sound nutrient and lime recommendations. Soil testing is not a perfect science, but it provides the most reasonable approach for growers to assess soil pH and plant-available nutrients, to determine the need for lime and fertilizers, and to avoid losses and environmental damage from improper lime and fertilization practices.

Animal waste management regulations require soil sampling one time per year for every field on which waste is applied. The NCDA Agronomic Division can analyze soil samples and make agronomic recommendations for lime and fertilizer applications. However, your animal waste management plan or general permit may require that you use a North Carolina certified laboratory to satisfy monitoring requirements. This chapter will not address sampling for the purpose of monitoring, instead it will address the use of a lab that provides agronomic recommendations similar to those provided by the NCDA Agronomic Division.

In North Carolina, soil analysis is provided as a free service by the NCDA Agronomic Division. Sampling instructions, information sheets, and boxes are provided at no charge and can be obtained from county Cooperative Extension Service centers, from Regional Agronomists of the Agronomic Division, and from many businesses selling lime or fertilizer. Samples and completed information sheets should be sent to the Agronomic Division, NCDA, 4300 Reedy Creek Road, Raleigh, NC 27607-6465.

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

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

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

Collect your samples with stainless steel or chrome-plated sampling tools and plastic buckets to avoid contaminating the samples. Avoid brass, bronze, or galvanized tools. Make sure that the buckets and sampling tools are clean and free of lime and fertilizer residues. Even a small amount of lime or fertilizer transferred from the sampling tools to the soil can seriously contaminate the sample and produce inaccurate results.
For areas in which field crops are grown, collect samples to the same depth that the field is plowed (usually about 8 inches) because this is the zone in which lime and fertilizer have been incorporated. For fields where perennial crops such as fescue, alfalfa, and turf are being maintained, samples taken to a depth of 4 inches will best represent the crop’s lime and fertilizer needs. Where these perennial crops are to be established, however, sample to the regular plow depth.

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

Once the soil test levels are measured, the final fertilizer and lime suggestions must be made. Recommendations for commercial users are given on an acre basis, nutrient by nutrient.

**WHAT DOES MY SOIL TEST REPORT TELL ME?**

Your waste utilization plan is designed to apply nitrogen at agronomic rates. In North Carolina, generally, nitrogen is not measured by the soil testing laboratory. But a soil test is still an essential tool in implementing a waste utilization plan. The most immediate need for a soil test is to ensure that soil pH is within the desired range for the soil and crops you are growing. In addition, a soil test can be used to monitor nutrient accumulation, and provides information that will help you do a better job.
of managing the land application site. Only the most essential items will be discussed here. For more information, see your Cooperative Extension Service Agent or an NCDA Agronomist.

**Soil pH and Lime**

Soil pH affects the availability of nutrients required for plant growth. An incorrect soil pH will reduce crop growth and yield, resulting in less nutrient uptake and more potential for environmental problems. Soils in North Carolina are naturally acidic, meaning that they have a low pH. Adding high amounts of nitrogen will also quickly acidify the soil. Low pH increases the availability of metals such as aluminum, zinc, copper, and manganese, all of which can become toxic to plants at high concentrations. Depending on the amount of nitrogen applied, soils with high metal concentrations and low pH may require annual additions of lime in order to maintain the pH in a range suitable for plant growth. Lime also supplies calcium and magnesium, which are essential for crop growth.

The soil test report indicates the amount of lime required, in tons, to achieve the target pH for your soil type and crop. Soils with high amounts of organic matter require a much lower pH than soils with low organic matter contents. For this reason, soil samples received at the lab are separated into Mineral, Mineral-Organic, and Organic classes based on their Humic Matter content (HM% on the report), weight per volume (W/V) and color. For most crops, the desired pH is 6.0 for Mineral soils, 5.5 for Mineral-Organic soils, and 5.0 for Organic soil classes.
# Tools for the Plan

## Chapter 4: Tools for the Plan

### Figure 4-7. NCDA Agronomic Division Soil Test Report for two forage fields.

**Soil Test Report**

**North Carolina Cooperative Extension Service**

SERVING N.C. CITIZENS FOR OVER 50 YEARS

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Last Crop</th>
<th>Mo</th>
<th>Yr</th>
<th>T/A</th>
<th>Recommendations</th>
<th>Crop or Year</th>
<th>Lime</th>
<th>N</th>
<th>P0s</th>
<th>K0</th>
<th>Mg</th>
<th>Cu</th>
<th>Zn</th>
<th>B</th>
<th>Mn</th>
<th>See Note</th>
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<tbody>
<tr>
<td>NB1</td>
<td>Bahiagrass</td>
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<td></td>
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<td>1st Crop: Berm Hay/Passas,E</td>
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<td>90-110</td>
<td>40-60</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
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<td>W/V</td>
<td>CEC</td>
<td>BS%</td>
<td>Ac</td>
<td>pH</td>
<td>P-I</td>
<td>K-I</td>
<td>Ca%</td>
<td>Mg%</td>
<td>Mn-I</td>
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<td>Mn-Al (2)</td>
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<td>Field Information</td>
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<td>Recommendations</td>
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<td>P0s</td>
<td>K0</td>
<td>Mg</td>
<td>Cu</td>
<td>Zn</td>
<td>B</td>
<td>Mn</td>
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<tr>
<td>Sample No.</td>
<td>Last Crop</td>
<td>Mo</td>
<td>Yr</td>
<td>T/A</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>2nd Crop: Alfalfa, E</td>
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<td>Test Results</td>
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<td>P-I</td>
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<td>Ca%</td>
<td>Mg%</td>
<td>Mn-I</td>
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<td>683</td>
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</table>
CEC

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

Nutrient Index Values

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

<table>
<thead>
<tr>
<th>Soil Test Index</th>
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<tr>
<td>Range</td>
<td>Rating</td>
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<tr>
<td>0 to 25</td>
<td>Low</td>
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<tr>
<td>26 to 50</td>
<td>Medium</td>
</tr>
<tr>
<td>51 to 100</td>
<td>High</td>
</tr>
<tr>
<td>100+</td>
<td>Very High</td>
</tr>
</tbody>
</table>

* For soils in the ORG class, the range for P Ratings are: Low 0 to 16, Medium 16 to 30, and High 30+.

** Phosphate recommendations above the 50 index are designed to replenish nutrients removed by crops and for building purposes.

Note: Soil test index values above 100 indicate excessive amounts are present in soil.
**Chapter 4: Tools for the Plan**

**HOW CAN A SOIL TEST BE USED TO ADJUST AND MONITOR WASTE UTILIZATION PLANS?**

Soil tests are used to help determine the priority nutrient. The priority nutrient is the nutrient most likely to cause an adverse environmental or plant health effect. Nitrogen is the priority nutrient most often. As a result, most waste application rates are based on supplying crop nitrogen (N) needs. The idea is to not apply N at rates greater than the crop can use, because the nitrate form of nitrogen can move through the soil and threaten groundwater quality. Some nutrients may be stored in the soil just as one stores money in a bank. These nutrients will generally remain in the soil until needed by plants. The waste also supplies other nutrients, such as P, Cu, and Zn, that may not be required by plants. Phosphorus, copper, and zinc are not subject to leaching at a soil pH normally used to grow crops, and remain in the soil until taken up by plants. As nutrients continue to accumulate they may become toxic to plants. The level at which toxicity occurs depends on the concentration of the element in the soil, sensitivity of the crop, soil pH, and the cation exchange capacity (CEC). These unneeded nutrients can also become a source of nonpoint pollution if soil erodes from the site and moves into nearby surface waters.

**RANKING FIELDS FOR WASTE APPLICATIONS**

By monitoring soil test index values for various nutrients, you can take steps to avoid soil buildup to undesirable levels. In general, waste products should be applied as a priority in fields where there is evidence of the greatest need for nutrients. The upper limits indicated on the following page should be considered as guidelines. With so many factors involved, there is no certainty that crops or surface waters will be affected by levels even higher than these guidelines. On the other hand, sensitive crops such as peanuts and some vegetables may be affected at much lower values than shown here. Peanuts are sensitive to zinc at a 500 index if pH decreases below 6.0. Growers should take precautions to preserve the productivity of their soil resources.

*North Carolina Cooperative Extension Service*
Priority should be given to applying lagoon liquids and sludge to fields that meet the following criteria:

- soil test Zn-I (NCDA) less than 700
- soil test Cu-I (NCDA) less than 700
- soil test P-I (NCDA) less than 150

If land applications of waste must be made to fields that exceed the above criteria then consider these options:

- If the soil test Zn-I is greater than 700, meet with a Certified Technical Specialist to select a crop that is tolerant of high zinc soils.
- If the soil test Cu-I is greater than 700, meet with a Certified Technical Specialist to select a crop that is tolerant of high copper soils.
- If the soil test P-I is greater than 150, then potential for erosion and distance to surface water becomes important. Where soil movement from the field into nearby waters is likely, apply no more P to the site than the crop will remove to avoid further accumulation of P. A certified Technical Specialist can help you with adjusting your application rates; however, be aware that these rates may be one-half to one-fifth of your current application rates meaning that you will need two to five times more land.

Nutrient elements required for plant growth are termed “essential.” Healthy plants contain predictable concentrations of these elements. Major elements (nitrogen, phosphorus, and potassium) are required in larger amounts. Secondary elements (calcium, magnesium, and sulfur) are required in smaller amounts. Micronutrients (iron, manganese, zinc, copper, boron, molybdenum, and chlorine) are required in much smaller amounts. If these elements are present in inadequate levels then the plant suffers from a nutrient deficiency. In some cases, if these nutrients are present in higher concentrations than required the plant will suffer from a nutrient toxicity. In either case, the plant is not healthy and therefore is not...
removing nutrients from the soil at its fullest capabilities. Plant analysis can be used to distinguish between nutrient deficiency and toxicity as compared to sufficiency.

A plant analysis has three main applications:

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

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

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

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

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

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

A recent soil test result can be helpful when interpreting a plant analysis. When visual symptoms of a suspected nutrient deficiency are present, take a soil sample at the same time from root zones of plants sampled. In this way, an evaluation of the soil in the affected area can be made along with the plant analysis result. Sampling healthy and unhealthy plants, and their respective soil, is very effective in problem solving. Sampling instructions, information sheets, and shipping envelopes are provided at no charge and can be obtained at county Cooperative Extension Service centers or from Regional Agronomists of the Agronomic Division. Samples, the completed information sheets (Form AD4, Appendix C), and a $4 fee should be sent to the Agronomic Division, NCDA, 4300 Reedy Creek Road, Raleigh, NC 27607-6465.

**HOW CAN PLANT ANALYSIS BE A PREDICTIVE AND DIAGNOSTIC TOOL?**

Additional nutrient applications may be needed based on nutrient deficiencies indicated in a plant analysis report. Repeated plant analyses, during the growth cycle of a plant or from one season to another, can show changes that occur with time as a result of applied fertilizer treatments. These analyses can provide a guide for corrective treatments. Supplemental treatments can be scheduled based on a series of analyses. Such analyses and the maintenance of leaf analysis result logs are invaluable. Base supplemental applications of N on a plant analysis, particularly when there is a suspected or anticipated N deficiency. If assistance is needed, contact a designated Technical Specialist prior to making additional waste applications based on the results of a plant analysis.

Nitrate poisoning in animals is an increasing problem in North Carolina due to the high levels of nitrogen applied to forages, which can commonly result in levels of nitrate above what is normally considered safe. Many factors affect pasture and forage quality, including type of species, stage
of maturity, soil condition, climate, storage, and handling. Laboratory analysis is the best way to determine a forage's nutrient content and the potential for nitrate toxicity. Producers should periodically monitor the quality of their pastures to make sure animal nutrient requirements are being met and that fertilization practices are appropriate. Forage sampling differs from plant analysis used to determine nutrient status for crops. Forage sampling is a test to help determine if there are potential problems with using a crop for animal feed.

Mailing kits for forage analysis samples are available from the North Carolina Department of Agriculture and from county Extension centers. Complete the form clearly and accurately and enclose a check for $10 per sample. Deliver samples to the Constable Laboratory, 4000 Reedy Creek Road, Raleigh, NC 27607, or mail them to the Forage Testing Facility, Constable Laboratory, NCDA, PO Box 30600, Raleigh, NC 27622. For more information, contact the Food & Drug Protection Division, North Carolina Department of Agriculture, PO Box 27647, Raleigh, NC 27611-7647, (919) 733-7366.

**HOW TO SAMPLE PASTURES FOR FEED TESTING**

1. Use a bag supplied in a kit by NCDA to hold the collected tissue. Be sure there are no contaminants on your hands or on the collected tissue.

2. Walk the pasture much the same way you would for soil sampling or scouting for insects. Take a sample of grazeable vegetation by plucking or grabbing a few leaves between the thumb and index and middle finger. Snap the leaves at the same height as the animals are grazing, especially if you want to know what is being consumed at the time.

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

1. How do you obtain the nutrient value of your lagoon liquid or animal waste? ............................................................. see page 4-1

2. What is meant by the term “representative sample?” ................................................................. see page 4-2

3. What types of tools should be used for waste and soil analysis? ................................................................. see pages 4-3 and 4-11

4. Who should you contact for assistance with soil, waste, or plant tissue sampling? ................................................................. see page 4-8

5. Under what conditions should you consider NOT using a field for waste application? ................................................................. see page 4-17

6. When would you consider using plant analysis to help with your waste management program? ................................................................. see page 4-18