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CHAPTER 4: OPERATION, MAINTENANCE, AND RECORDKEEPING REQUIREMENTS FOR THE LAND APPLICATION AREA

The requirements discussed in this chapter apply when manure, litter, or process wastewater is applied to the land application area. A *land application area* is the land under the CAFO owner or operator's control, whether it is owned, rented or leased, to which manure, litter, or process wastewater from the production area is or may be applied (40 CFR 122.23(b)(3) and 412.2(e)). Operational control of land includes ownership, rental agreements, leases, and access agreements. This may also include situations where a farmer releases control over the land application area and the CAFO determines when and how much manure is applied to fields not otherwise owned, rented, or leased by the CAFO to another entity.

CAFOs must develop and implement a Nutrient Management Plan to help manage manure, including setting forth a plan for land application. Requirements for developing and implementing a Nutrient Management Plan can be found in 40 CFR 122.42 and 412.4. Among these are the requirements to address the form, source, amount, timing, and method of application of nutrients on each filed to achieve realistic production goals, while minimizing nitrogen and phosphorus movement to surface waters. Furthermore, CAFOs should routinely re-evaluate the environmental impacts of the land application of nutrients from animal manure, wastes, commercial fertilizers, biosolids, and any other nutrient sources.

EPA recommends all AFOs (including Large CAFOs) implement the practices discussed in this manual for all land on which manure, litter, or process wastewater is placed to maximize the value of manure and to minimize the potential for runoff of pollutants from the land application area. The following activities are required by the CAFO rules for land application of manure and are discussed in this chapter:

- Identify testing protocols for manure, litter, process wastewater, and soil;
- Establish protocols to land apply manure (including development and implementation of a Nutrient Management Plan);
- Maintain records; and
- Identify appropriate site-specific conservation practices to control runoff.

Section E of this chapter discusses voluntary conservation and pollution prevention strategies.

A. Testing Protocols for Manure, Litter, and Soil

> **Additional Conditions Applicable to Specified Categories of NPDES Permits**
>
> **§122.42(e)(1)(vii)** Identify protocols for appropriate testing of manure, litter, process wastewater, and soil.

To manage manure, litter, and process wastewater properly, applicators must know how much manure is produced and its composition. CAFOs must also know the composition of the soil where manure is to be land applied to calculate an appropriate application rate for the manure. The rate and method of application should consider the soil holding capacity, the nutrient requirements of the crops, slope of the field, nutrients available to the crops from other sources (e.g., nutrients in the soil, nutrients from commercial fertilizer), the physical state of the manure, litter, and process wastewater (e.g., solid, liquid, semi-solid), and the potential for leaching and runoff of any pollutants (including nutrients).

1. Collecting Manure for Land Application

Before samples can be collected that are representative of what will be land applied, and before the CAFO can estimate the total quantity of manure nutrients to be land applied, the CAFO should consider the complete system of manure collection in place at the production area. The ease of collecting all livestock and poultry waste often depends on the amount of freedom given to the animals. If animals are allowed to move freely within a given space, manure will be deposited randomly; animals confined to an area are more likely to defecate in the same places. Waste collection can be automated (e.g., scrape and flush dairy barns) or manual (e.g., removal of waste from a dry lot with a front-end loader). Some CAFOs improve the efficiency of manure collection (i.e., decrease losses) by paving alleys and by installing gutters and slotted floors with mechanical and hydraulic equipment.

CAFOs should implement pollution prevention practices to keep production and collection of unnecessary waste to a minimum. For example, many CAFOs reduce the volume of contaminated runoff from open holding areas by restricting the size of the open holding areas, roofing part of the holding area, and installing gutters and diversions to direct uncontaminated water away from the holding areas. See Chapter 2.1 of this document for more information on clean water diversions. CAFOs may also cover manure stockpiles in the feedlot to reduce nutrient losses and reduce contaminants in runoff. CAFOs can further reduce the generation of waste by minimizing the amount of fresh water used to flush milking parlors and eggwash areas, and using recycled water from a lagoon or holding basin to flush animal housing areas. In addition, a few CAFOs have retrofit flush systems with dry manure handling systems (such as belts, dry bedding systems, scrapers, or v-shaped pits) to significantly reduce the amount of water used in manure handling. This can significantly reduce the costs for CAFOs to both haul and land apply manure.

For unroofed confinement areas such as dry lots, CAFOs must have a system for collecting and containing contaminated runoff. CAFOs can accomplish this by using curbs at the edge of paved lots and reception pits where the runoff exits the lots, or by using diversions, sediment basins, and underground outlets at unpaved lots. At unpaved beef feedlots, operators can carefully remove manure so as not to break the partial seal on the soil the manure has created. This seal, though not completely impermeable, does help reduce the downward movement (leaching) of contaminated water. CAFOs should routinely add soil to earthen lots to fill in holes and to assist with retaining the originally designed grade of the lot.

The amount of manure generated at a CAFO is linked directly to the number of animals maintained. However, because the composition and concentration of manure changes as it ages, the amount collected and applied to the land is often less than the amount initially generated by the animals. To estimate the amount of manure, litter, and other process wastewater that will be available for land application, CAFOs should calculate the quantity of manure, litter, and other process wastewater stored on site and the quantity of manure, litter, and process wastewater removed from the production area for uses other than application to the CAFO's land application areas. Any estimates should include all process wastewater such as milk parlor wash water and egg wash water, if appropriate. See Appendix D for methods for estimating the amount of animal waste in a pile, pond, or lagoon.

2. Manure Sampling and Testing

The CAFO rules require that samples of manure be collected and analyzed for nitrogen and phosphorus a minimum of once per year (412.4(c)(3)). Because the nutrient content of manure may vary throughout the year and depends on many site-specific factors (e.g., composition of feed ration, number of different rations, type and amount of bedding, amount of water added or lost), results of representative annual nutrient sampling helps the CAFO develop the appropriate rate at which to land apply manure. Although the CAFO rules require that manure be analyzed only for nitrogen and phosphorus, CAFOs should consider analyzing the manure for percentage of dry matter, ammonium nitrogen, calcium, manganese, magnesium, sulfur, zinc, copper, pH, and electrical conductivity (a common measurement of total dissolved salts) to better assess the resource value of the manure. CAFOs can also conduct additional analyses on pathogen levels. CAFOs should check with their permitting authority for the list of analyses to be conducted and with their state and local Cooperative Extension Offices for acceptable procedures and sources of analysis.

Note that a CAFO should collect samples from all manure storage areas, both liquid and dry, as well as any wastewater or storm water storage areas, in order to obtain representative test results.


Photo by USDA NRCS

To develop better estimates of the nutrient content of manure, ideally CAFOs should sample manure each time it is removed from the production area. Collect samples as close to the time of land application as possible, leaving sufficient time between sampling and land application to obtain and interpret the results of the analyses. If bedding is provided for the animals, CAFOs should include both spent bedding and manure in the representative samples. CAFOs should sample each form of animal waste stored on site (e.g., stockpiled solids, separated solids, lagoon or pond liquid, lagoon or pond sludge) not only because the composition of each will be different, but because they often are applied to the land separately from each other. For example, liquids from a holding pond may be irrigated weekly to a neighboring field, whereas the solids may be land applied just once or twice per year to remotely located fields. See Appendix E for a description and examples of commonly used sampling procedures for solid waste, semi-solid waste, liquid waste, and poultry litter.

3. Soil Sampling and Testing

> **Soil Sampling**
>
> ANSI GELPP 004-2002, *Manure Utilization,* standard recommends sampling soils every three years and analyzing them for, at minimum, nitrate content, available phosphorus content, pH, and buffer pH.
>
> EPA also recommends periodically analyzing the soil sample for nitrogen, potassium, pH, salinity, metals, micronutrients, and organic matte to better assess the soil conditions at a land application site.

Soil testing is an important tool for estimating nutrients available for uptake by a crop. A soil test is a laboratory procedure that measures the plant-available portion of soil nutrients. This measurement is used to predict the amount of nutrients that will be available during the growing season. In a traditional soil test, analyses are conducted for pH, nitrogen, phosphorus, potassium, soil organic matter, and electrical conductivity. The CAFO rules require that soil be analyzed for phosphorus at least once every five years. When conducting soil sampling, a representative soil sample should be collected at each land application site and analyzed.

Generally, the soil test report contains the laboratory test results and fertilizer and liming recommendations for the next two crops in the rotation. The report also includes information regarding the recommended time and method of fertilizer and lime applications. In certain parts of the country, the pre-plant nitrate test and pre-side-dress nitrate test are used to determine whether additional nitrogen is necessary after the crop begins growing.

Pre-Sidedress Soil Nitrate Test (PSNT)

The PSNT is a widely used tool for optimizing nitrogen fertilizer use efficiency for corn production. The test relies on timely measurement of mineralized soil nitrate in the top layer of soil just prior to corn's period of rapid nitrogen uptake. The PSNT is highly recommended for corn fields where manure (and other organic sources of nitrogen) have been applied recently. The PSNT may be less reliable when total nitrogen application prior to sidedress exceeds 50 pounds nitrogen per acre. CAFOs should consult their local Extension Service for more information.

CAFOs should sample each field management unit where manure is applied. Different field areas may have different soil types, past cropping histories, or different production potentials, so each field should be sampled and managed separately. To ensure a *representative* soil sample from each field, CAFOs should collect several samples around the field at the appropriate depth and thoroughly mix all samples; see Example 4-1. Part of this mixed soil should be apportioned as a representative sample for the entire field management unit. Next, samples for each field should be sent to an accredited laboratory for analyses. An accredited laboratory is one that has been accepted in one or more of the following programs:

Soil P Test

A soil sample from the site is necessary to assess the level of "available P" in the surface layer of the soil. The available P is the level customarily given in a soil test analysis by the Cooperative Extension Service or commercial soil test laboratories. These ranges of soil test P values will vary by soil test method and region. The soil test level for "available P" does not ascertain the total P in the surface soil. It does however, give an indication of the amount of total P that may be present because of the general relationship between the forms of P (organic, adsorbed, and labile P) and the solution P available for crop uptake.

- A state-certified program;
- The North American Proficiency Testing Program (Soil Science Society of America); or
- Laboratories participating in other programs whose tests are accepted by the Land Grant University in the CAFO's state.

Example 4-1: Soil Sampling Depths

According to USDA-ARS publication *Agricultural Phosphorus and Eutrophication*, it is the surface inch or two in direct contact with runoff that are important when using soil testing to estimate phosphorus loss. At the same time, phosphorus may be transported to drain tiles or ground water by leaching. Soil samples should be collected to 2 inches when the subsurface drainage tiles are not present and the CAFO owner or operator intends to surface apply manure without incorporation.

Soil fertility specialists at state Land Grant Universities have conducted extensive research to determine the most suitable extraction solutions for the local soils, to correlate soil tests and crop yields, and to calibrate soil tests with nutrient recommendations. These specialists can provide valuable information and services to ensure accurate testing.

The analytical results from a soil test extraction are relatively meaningless by themselves. Soil nutrient levels should be interpreted by the CAFO or a certified nutrient management specialist to determine the plant-available nutrients in the soil. Most soil test laboratories use qualitative terms such as "low," "medium or optimum," and "high or very high" to describe the results, which are related to quantities of nutrients extracted. When several samples are collected from the same field, the soil test results for all samples should be compared to determine the best application rate for the manure. See Appendix F of this manual and NRCS Practice Standard 590, *Nutrient Management* for information on soil sampling, soil testing, and soil analysis interpretations.

B. Protocols to Land Apply Manure

The CAFO rules require CAFOs to determine and implement site-specific nutrient application rates that comply with the technical standards for nutrient management established by the permitting authority. These standards must, among other things, address the form, source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing phosphorus and nitrogen transport to waters of the U.S. Chapter 6 of this manual discusses technical standards for land application.

> **Protocols for Land Application**
>
> **§122.42(e)(1)(viii)** Establish protocols to land apply manure, litter or process wastewater in accordance with site specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure, litter or process wastewater.

CAFOs should use the following process to help ensure land application practices are appropriate:

- Review the latest state technical standards;
- Conduct a field specific assessment;
- Identify planned crop rotations and document crop nutrient requirements;
- Calculate the appropriate nutrient (manure) application rate;
- Use an appropriate manure application method;
- Evaluate the timing of all animal manure applications as specified in the technical standards;
- Understand restrictions to manure application; and
- Calibrate and inspect land application equipment.

Part of the protocol to land apply manure is the preparation of a Nutrient Management Plan. The requirements for a nutrient management plan are discussed in more detail below. NRCS Practice Standard 590, *Nutrient Management*, also recommends that nutrient management plans be used whenever plant nutrients and soil amendments are applied to the land, and the plan should not be limited to manure applications.

1. Nutrient Management Plan

All CAFOs that apply manure, litter, or process wastewater to a land application area must develop and implement a Nutrient Management Plan (NMP) that addresses each land application area. For Large CAFOs the NMPs must address the following[1]:

- Protocols for testing manure, litter, process wastewater, and soil (see Section A of this chapter);
- The land application protocol consistent with the technical standards established by the permitting authority;
- The manure, litter, or process wastewater application rate calculations (see Section B.5 of this chapter);
- Calibration and inspection of land application equipment (see Section B.8 of this chapter);
- Recordkeeping (see Section C of this chapter); and
- Site-specific conservation practices (e.g., practices to control erosion less than or equal to "T") to control runoff of pollutants into surface water bodies (see Section D of this chapter).

> **Additional Conditions Applicable to Specified Categories of NPDES Permits**
>
> **§122.42(e)(1)** At a minimum, a nutrient management plan must include best management practices and procedures necessary to implement applicable effluent limitations and standards.
>
> **Best Management Practices (BMPs) for Land Application of Manure, Litter, and Process Wastewater**
>
> **§412.4(c)(1)** The CAFO must develop and implement a nutrient management plan that incorporates the requirements of paragraphs (c)(2) through (c)(5) of this section based on a field-specific assessment of the potential for nitrogen and phosphorus transport from the field and that addresses the form, source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and phosphorus movement to surface waters.

The development of a NMP involves the assessment of manure nutrients generated on the CAFO and the land available (owned or under operational control by the CAFO owner/operator) to apply those nutrients at the proper application rate. By requiring CAFOs to apply manure at the appropriate nutrient application rate, EPA expects that some commercial fertilizer application will be replaced by manure application (for additional discussion refer to EPA's *Development of Pollutant Loading Reductions from Revised Effluent Limitation Guidelines for Concentrated Animal Feeding Operations*). All excess nutrients beyond the amount needed for appropriate land application at the CAFO must be transported off site for land application, properly used or properly disposed of.

The NMP must address the nine minimum elements EPA has determined are needed to protect water quality. These minimum elements require a description of how CAFOs will achieve each of the following (also see Chapter 2 of this document):

- Adequate storage capacity;
- Proper management (handling and disposing) of dead animals;
- Diverting clean water from the production area (clean water management);
- Preventing animals from contacting waters of the U.S.;
- Proper chemical handling;

[1]Some of the listed requirements apply to all CAFOs under 40 CFR 122.42 while others apply only to Large CAFOs under the Effluent Guidelines at 40 CFR 412.4.

- Implementing conservation practices to control nutrient loss;
- Testing manure, litter, process wastewater, and soil;
- Methods for the land application of manure, litter, and process wastewater; and
- Keeping records.

EPA's *Producers' Compliance Guide* for CAFOs and the *Permit Guidance* provide additional discussion of these minimum elements. In addition, see Chapter 6 for more information on developing and using technical standards for the land application of manure, litter, and process wastewater.

2. Required Nutrient Management Plan Format

NMPs do not need to be written in a particular scheme or format. This provides flexibility in developing a plan to meet the CAFO rule minimum measures and practices and other requirements. If a state already requires a NMP that includes some, but not all of the minimum elements, then only the missing elements would need to be incorporated into the existing plan. Some states may already require NMPs that meet the requirements of this rule, therefore, some CAFOs may not need to develop a new plan. For example, some states already require a Manure Management Plan (MMP). CAFOs must ensure that their MMP, NMP, CNMP, or equivalent plan contains all of the elements required by the CAFO regulations.

3. Plan Certification

The CAFO regulations encourage, but do not require, NMPs to be developed by certified planners. However, due to the complexity of the plans and the variety of expertise that is needed to develop a sound NMP, EPA expects that CAFO owners/operators will seek technical advice from local NRCS, Cooperative Extension, and Land Grant University staff as well as private technical planners. These certified specialists are available nationwide to help CAFOs prepare NMPs. Generally, nutrient management specialists must complete a precertification training course, pass an examination, and receive continuing education on a variety of topics. To earn certification, nutrient management planners have competence in or an understanding of soil science and soil fertility, nutrient application and management, crop production, soil and manure testing and result interpretation, fertilizer materials and their characteristics, best management practices for use of nutrients and water management, environmental and economic impacts associated with improper nutrient management, and all applicable laws and regulations.

4. Comprehensive Nutrient Management Plans

EPA encourages all CAFOs to go beyond the minimum regulatory requirement to develop a nutrient management plan and to develop a full-fledged Comprehensive Nutrient Management Plan. Whether a CAFO develops a CNMP or not, EPA recommends that CAFOs and their consultants use USDA's CNMP Guidance to assist in developing the NMP. However, it should be noted that following this CNMP Guidance does not guarantee that a CAFO's CNMP will adequately address all of the minimum elements that are required by the regulations for a nutrient management plan. Each CAFO that develops a CNMP as a way to meet their regulatory requirement for a nutrient management plan is responsible for ensuring that its CNMP has all of the required minimum elements for a nutrient management plan.

Accredited NMP Organizations

Approved organizations for certifying nutrient management specialists include:
- USDA;
- Certified Crop Advisor Program of the Amercian Society of Agronomy;
- Land Grant University Certification Programs;
- National Alliance of Independent Crop Consultants;
- State Certification Programs; and
- American Registry of Professional Animal Scientists.

5. Crop Rotations and Crop Nutrient Requirements

To develop appropriate land application practices, CAFOs should identify planned crop rotations. A rotation is the growing of a sequence of crops to optimize yield and crop quality, minimize the cost of production, and maintain or improve soil productivity. CAFOs should describe their planned sequence of crops (e.g., corn for silage, soybeans), preferably for 5 years. This should include planting and harvesting dates and residue management practices. When developing NMPs, CAFOs should start with last year's crop and project the crop rotation for the next four years. Crop rotation is important in calculating total nutrient needs over the period of the rotation, nutrient buildup, and nutrient removal via harvesting.

Benefits of Crop Rotations

A cropping sequence with a variety of crop types (grasses, legumes) and rooting characteristics (shallow roots, deep roots, tap roots) better uses available soil nutrients. Following a shallow-rooted crop with a deep-rooted crop helps scavenge nutrients that might have moved below the root zone of the first crop.

Source: CORE4 Conservation Practices, August 1999

After identifying crop rotation, CAFOs should determine and document the crops' nutrient requirements (i.e., nitrogen, phosphorus, and potassium) and include a description of the expected crop yield. Plant growth can require more than 20 chemical elements; 16 of these elements are considered essential for plant growth. The primary essential elements include nitrogen, phosphorus, and potassium. Nutrient requirements of specific crops are readily available from state and local Cooperative Extension Offices.

Sixteen Essential Elements for Plant Growth

Carbon	Iron
Hydrogen	Manganese
Oxygen	Boron
Nitrogen	Molybdenum
Phosphorus	Copper
Potassium	Zinc
Calcium	Chlorine
Magnesium	Sulfur

Source: Chesapeake Bay Region Nutrient Management Training Manual

The total nutrient requirements for fields are largely based on the CAFO's expected crop yields. Generally, the higher the yield expectation, the higher the nutrient requirement. Methods for calculating expected yield goals include using past crop yields for that field, county yield records, soil productivity tables, or local research. Expected yields should be based on realistic soil, climate, and management parameters. An unrealistic estimate can result in either too many or too few nutrients being applied. Because climate can significantly affect yields, CAFOs should base expectations on data from at least the last 5 years. Given a crop rotation, Cooperative Extension Offices and/or soil laboratories can and often do provide recommended quantities of nutrients/amendments to meet the expected yield. This recommendation usually takes the current soil test for that field into consideration, and may be used as the calculated crop nutrient requirements for that year.

Phosphorus Index

The ranking of a Phosphorus Index (PI) identifies sites where the risk of phosphorus movement may be relatively higher than that of other sites. When the parameters of the index are analyzed, it will become apparent that an individual parameter or parameters may be influencing the index disproportionately. These identified parameters can be the basis for planning corrective soil and water conservation practices and management techniques. If successful in reducing the movement of phosphorus, the concern of phosphorus enrichment will also be reduced. The PI provides a method for developing management guidelines for phosphorus at the site to lessen their impact on water quality. See Appendix H for more details.

6. Application Rate

The effluent guidelines require that application rates for manure, litter, and other process wastewater must minimize P and N transport from the field to waters of the U.S. in compliance with technical standards for nutrient management established by the permitting authority (40 CFR 412.4(c)(2)). Under these regulations, the State's technical standards must include a field-specific assessment that in general will provide information needed to determine whether land application of manure is appropriate for a site and the basis (e.g. nitrogen or phosphorus) for the application rate. EPA anticipates that most states will use the results from the Phosphorus Index to determine whether animal waste should be applied on a nitrogen or phosphorus basis. See Chapter 3 of the *Permit Guidance* for more information on technical standards for nutrient management. See Chapter 6 of this document for example technical standards and their use in developing a NMP.

Nitrogen-based application rates are generally based on the following factors: (1) the nitrogen requirement of the crop to be grown based on the operation's soil type and crop; and (2) realistic crop yields that reflect the yields obtained for the given field in prior years or, if not available, from fields obtained for the same crop at nearby farms or county records. Once the nitrogen requirement for the crop is established, the manure application rate is generally determined by subtracting any other sources of nitrogen available to the crop from the crop's nitrogen requirement. These other sources of nitrogen can include residual nitrogen in the soil, nitrogen credits from legumes, crop residues, irrigation water, and biosolids. Application rates are based on the nitrogen content in the manure and should also account for application methods, such as incorporation, and other site-specific practices. Phosphorus-based application rates generally take into account the phosphorus requirements of the crop, as well as the amount of phosphorus that will be removed from the field when the crop is harvested.

The current NRCS Nutrient Management technical standard describes three field-specific risk assessment methods to determine whether the land application rate is to be based on nitrogen or phosphorus, or whether land application is to be avoided. These three methods are: (1) Phosphorus Index; (2) Soil Phosphorus Threshold Level; and (3) Soil Test Phosphorus Level. The permitting authority has the discretion to determine which of these methods, or other State-approved alternative method, is to be used. EPA anticipates that State standards will generally provide CAFOs the flexibility to determine, separately for each field, whether manure is to be applied at the nitrogen- or the phosphorus-based rate. Thus, EPA expects that as the requirements are implemented, some CAFOs will be able to apply manure at the nitrogen-based rate for all of their fields; some CAFOs will be limited to the phosphorus-based rate on all of their fields; and the remaining CAFOs will have some fields that are limited to the phosphorus-based rate and some fields where manure can be applied at the nitrogen-based rate. In making these field-specific determinations, CAFOs must use the method authorized by the permitting authority.

The objective of determining an application rate is to match, as closely as possible, the amount of available nutrients in animal manure with the amount required by the crop. The basic equation for calculating agronomic application rates for manure is:

Agronomic application rate	=	Crop nutrient requirement – nutrient credits
Crop nutrient requirement	=	Crop nutrient uptake × crop yield
Nitrogen credits	=	Legume nitrogen credits + nitrogen residual from past manure applications + nutrients from commercial fertilizer applications + irrigation water nitrate nitrogen + crop residues + other nitrogen credits

Essentially, nutrient credits are all other nutrients available to the crop in addition to the nutrients in the manure. Each of these credits is described further below.

- **Credits from previous legume crops**. Atmospheric nitrogen is fixed by legume plants and brought into the soil. Amounts of nitrogen added by legume production vary by plant species and growing conditions. CAFOs should check with their local Cooperative Extension Office or Land Grant University to determine appropriate legume credits for crop rotations.

- **Residuals from past manure applications.** Nitrogen is a mobile nutrient that occurs in the soil and plants in many forms. Not all nitrogen in manure that CAFOs apply is available to the crop during the year of application. Some of the nutrients require organic material decomposition before they are made available for plants. A percentage of last year's nitrogen and a smaller percentage of previous year's nitrogen will become plant-available during the current crop season. For example, 12 percent of organic nitrogen might be available from one year ago, 5 percent might be available from two years ago, and 2 percent might be available from 3 years ago. Because these values depend on type of animal waste and local climate, CAFOs should use mineralization rates from their local Cooperative Extension Office to determine the amount of nitrogen available from previous manure application. Even though phosphorus also undergoes a mineralization process, phosphorus and potassium are typically considered 100 percent plant-available the year of application. The phosphorus in the soil is also reflected by the current soil test. Therefore, typically little or no residual amounts of phosphorus and potassium are calculated.

- **Nutrients supplied by commercial fertilizer and biosolids.** Pound-for-pound, animal manure does not have the same nutrient value as commercial fertilizer, and commercial fertilizer can be customized and blended to meet specifications. Farmers often supplement animal manure applications with commercial fertilizer or biosolids. Furthermore, because animal manure contains relatively high concentrations of phosphorus, crops generally are not supplied with enough nitrogen when manure is applied on a phosphorus basis. Therefore, CAFOs may need commercial nitrogen fertilizer to meet the crop's total nitrogen requirements when manure is applied at less than the nitrogen rate. CAFOs must include the nutrient contribution from these other sources in the manure application rate calculations.

- **Irrigation water.** Irrigation water, especially from shallow aquifers, contains some nitrogen in the form of nitrate nitrogen. Also, water from runoff ponds and storage lagoons contains nutrients. CAFOs must include these nutrient sources in the NMP. To calculate the amount of nitrogen applied with irrigation water, CAFOs must conduct a nutrient analysis to determine the concentration of nitrogen and phosphorus in the water typically reported as nitrate nitrogen and soluble phosphorus in parts per million (ppm), or milligrams per liter (mg/l).

The use of animal manure as a nutrient source requires careful planning because the nutrients contained in the manure are generally not in the proportion needed by crops. While most animal manure has a nitrogen-phosphorus-potassium ratio from 3-2-3 to 2-1-2, crops typically require nutrients in a ratio ranging from 3-1-2 to 8-1-3. For this reason, applying animal manure based on one of the crops' nutrient requirements usually creates either a nutrient deficiency or excess for the other two nutrients.

Most state guidelines/policies already allow animal manure applications at rates sufficient to meet, but not exceed, the nitrogen needs of agronomic crops. In areas with relatively high soil phosphorus levels, states should recommend that animal manure be applied at rates sufficient to meet, but not exceed, the phosphorus needs of agronomic crops.

Excess levels of phosphorus build up in the soil at a rate that depends on the soil

> **Soil Nitrogen Leaching Index**
>
> Field staff, watershed planners, and land owners/operators use the Leaching Index (LI) to assist in evaluating various land forms and management practices for potential risk of nitrogen movement to water bodes. Appendix G provides more details.

type, soil test method, and excess level of phosphorus application. According to NRCS's CORE4 Conservation Practices Training Guide, it takes between 8 to 16 pounds of excess phosphorus to raise the soil test level of phosphorus by 1 pound. Many states have developed a relationship between soil test levels of phosphorus and the potential for significant phosphorus movement to surface or groundwater. States should set threshold soil test levels of phosphorus at which either animal waste application rates should be based on the crops' phosphorus requirements or management practices should be put into place to control runoff and erosion. For very high soil test phosphorus levels, this should include a total restriction of additional phosphorus application to the field; see examples 4-2 through 4-4 for example State regulations setting specific limits for phosphorus applications and erosion.

Example 4-2: Example State Restriction of Additional Phosphorus Applications

Livestock waste must not be applied to land where the Bray P1 or Mehlich soil test for elemental Phosphorus is greater than 300 pounds per acre for the top 7 inches of the soil profile.

Example 4-3: Sample State Technical Standard to Minimize Transport of Insoluble Pollutants

Based on a soil test for elemental Phosphorus, the following limitations apply:

soil test P > 150 ppm: no manure application
soil test P > 75 ppm: manure application containing up to 2 years crop needs
soil test P < 75 ppm: nitrogen based rates

Example 4-4: Sample State Technical Standard to Minimize Transport of Insoluble Pollutants

Adequate erosion and runoff controls to meet soil loss tolerance level or “T” must be used to prevent discharge of livestock waste to waters of the state.

Phosphorus Transport Factors

According to USDA planning guidance, the factors influencing phosphorus movement include transport, phosphorus source, and management factors. Transport factors are the mechanism by which phosphorus moves within the landscape, such as rainfall, irrigation, erosion and runoff. Factors which influence the source and amount of phosphorus available to be transported are soil content and form of phosphorus applied. Phosphorus management factors include the method and timing of application such as application equipment and tillage practices.

Phosphorus movement in runoff occurs in both particulate and dissolved forms. Particulate phosphorus is attached to mineral and organic sediment as it moves with the runoff. Dissolved phosphorus is in the water solution. In general, particulate phosphorus is the major portion (75-90 percent) of the phosphorus transported in runoff from cultivated land. Dissolved phosphorus makes up a larger portion of the total phosphorus in runoff from non-cultivated lands such as pastures and fields with reduced tillage. In terms of their impact on eutrophication of water bodies, particulate phosphorus becomes less available to algae and plant uptake than dissolved phosphorus because of the chemical form it has with the mineral (particularly iron, aluminum, and calcium) and organic compounds. Dissolved phosphorus is 100 percent available to plants. Added together, the available portion of particulate phosphorus and the dissolved phosphorus represents the phosphorus that promotes eutrophication of surface waters. The interaction between the particulate and dissolved phosphorus in the runoff is very dynamic and the mechanism of transport is complex.

Multi-Year Phosphorus Application Rate

In some situations, the application equipment may not be able to apply manure at the recommended phosphorus application rate because that rate is lower than the spreading capability of the equipment. Therefore, when permissible under the State's technical standards, CAFOs may elect to use a multi-year phosphorus application rate until the equipment is replaced. In other cases, the risk of runoff is low and it may be more practical and economical to "bank" phosphorus by applying manure at rates higher than the crop's phosphorus needs for that year, again, where appropriate under the State standards. In both examples, the *multi-year phosphorus application rate* consists of applying a single application of manure at a rate equal to the recommended phosphorus application rate or estimated phosphorus removal in harvested plant biomass for the crop rotation for multiple years in the crop sequence. These applications may provide the phosphorus needed for multiple years. In this situation, CAFOs must not apply additional phosphorus to these fields until the amount applied in the single year had been removed through plant uptake and harvest. However, even under the multi-year application rate for phosphorus, CAFOs cannot exceed the annual nitrogen rate for the year of application. State standards generally will not allow this method at land application areas with a high potential for phosphorus runoff to surface water. CAFOs should check with their permitting authority to determine the appropriateness of using a multi-year phosphorus application rate.

Application Rates Based on Other Parameters

In some areas, animal waste application rates might need to be based on parameters other than nutrients. For example, trace metals present in animal wastes, when applied at either nitrogen- or phosphorus-based rates, are made available to plants in sufficient quantities that they provide many of the micronutrients necessary for plant growth. Excessively high levels of these trace metals, however, can inhibit plant growth. By limiting manure applications to the nitrogen- or phosphorus-based rate, CAFOs will also be limiting the rate at which metals are applied to fields and thus reduce the potential for applying excessive amounts of the trace metals. In other regions of the country where farmlands are overloaded with salt, the salt content of animal waste, often measured as electrical conductivity, might be the appropriate parameter for limiting land application rates. When using any of these alternative application rates, CAFOs must ensure appropriate agricultural utilization of the nutrients in the manure as discussed above (see 40 CFR 122.42(e)) and 412.4(c)]. In no case may manure be applied at rates greater than the annual nitrogen needs of the crop(s). See Appendix I for information on calculating nutrient application rates.

7. <u>Application Method</u>

CAFOs should always apply manure uniformly and at the approved application rates. Under the effluent guidelines, CAFOs must record the date (day, month, year) and method of each manure application (see 40 CFR 412.37(c)). Although many equipment options exist, there are basically two general methods of application: subsurface application and surface application. The method of application is generally dictated by the form of the waste (i.e., solid, semisolid, liquid).

- <u>Subsurface application</u>. Solid, semisolid, and liquid waste can all be applied using this method. When feasible, this is the preferred method of manure application. CAFOs use this method by mechanically incorporating or injecting the manure into the soil. Mechanical incorporation can be performed using moldboard plows, chisel plows, or heavy discs. To reduce nutrient losses, CAFOs should incorporate wastes applied to the land surface before it dries, usually within two days of application. Injection requires a liquid manure spreader and equipment to inject manure below the soil surface. To prevent nutrient losses, CAFOs should close the openings made by the injectors following application.

Immediately incorporating manure in the spring will increase the amount of plant-available nitrogen by reducing ammonia loss. Incorporation in soils with low runoff potential can help prevent the movement of nutrients and pathogens from animal manure to surface waters. Where soil erosion is a problem, however, tillage might result in unacceptable losses of soil and nutrients.

Injection is likely the best method of incorporating liquid and semisolid animal manure in reduced-till or no-till cropping systems because crop residues left on the surface act as a mulch, and the exposed soil surface is minimal.

- Surface application of liquid waste (irrigation). The three predominant systems used for surface application of liquid animal wastes (irrigation) are solid sets, center pivots, and traveling guns. Solid set systems are a series of sprinklers generally supplied by underground pipe. Center pivot systems are generally used in large fields and must be able to travel in a circle. Traveling guns are high-pressure, high-output, single-nozzle systems that crawl down travel lanes in the field. Liquid wastes also can be surface applied with tank spreaders.

Irrigation can save considerable amounts of time and labor when applying large volumes of wastewater or liquid animal waste. Sometimes CAFOs may need to dilute liquid animal wastes with fresh water for salinity or other plant requirements, or to facilitate application via irrigation. Irrigation provides flexibility in applying animal wastes during the growing season and has the added advantage of supplying water during the growing season’s drier periods. Infiltrating liquid can carry much of the easily volatilized ammonia into the soil, although some ammonia will still be lost from the spray before it reaches the soil.

The irrigation system should, however, be matched to the topography, cropping program, nutrient, and water needs of the crops, as well as infiltration, percolation rate, and water holding capacity of the soil. CAFOs should not use irrigation to apply animal wastes unless solids have been removed or chopped very fine. If solids are present, the nozzles will clog and the system will not operate properly. Irrigation also may produce aerosol sprays that can cause odor problems.

- Surface application of dry, solid manure. This application method is very effective at applying dry, bulky animal wastes such as poultry litter. Box spreaders with a chain-drag delivery to a fan or beater spreader mechanism, or tank wagons equipped with splash plates typically are used for surface applications.

Although this is a relatively easy method for applying animal manure and wastes to the land, it has several disadvantages. First, when manure is applied to the surface of the soil without incorporation, most of the unstable, rapidly mineralized organic nitrogen from the manure is lost through the volatilization of ammonia gas. Volatilization increases with time, temperature, wind, and low humidity. Surface application without incorporation also increases the likelihood of nutrient losses via surface runoff. Surface runoff losses are more likely on soils with high runoff potential, soils subject to flooding, soils that are snow-covered or frozen (via runoff once the snow melts or soil thaws), and soils with little or no vegetative cover. Second, aerosol sprays produced by mixing manure and air during this type of application can carry odors considerable distances. Third, this application method provides poor distribution of nutrients, which can be aggravated by heavy winds. In addition, precision application of manure and waste, such as poultry litter, with a geared box spreader can be difficult.

CAFOs can reduce nutrient losses when using surface application by implementing soil conservation practices such as contour strip cropping, crop residue management, cover crops, diversion terraces, vegetative buffer strips, and grass waterways. More information about conservation practices is available from the local soil and water conservation district and USDA's Natural Resources Conservation Service.

CAFOs must record weather conditions (e.g., rainfall amounts) at the time of application and for the 24-hour period before and after application (40 CFR 412.37(c)).

Irrigation Technologies

Irrigation application systems may be grouped under two broad system types: gravity flow and pressurized. Gravity-flow systems are particularly predominant in the arid West. Many irrigation systems rely on gravity to distribute water across the field. Land treatments (such as soil borders and furrows) are used to help control lateral water movement and channel water flow down the field. Water losses are comparatively high under traditional gravity-flow systems due to percolation losses below the crop-root zone and water runoff at the end of the field. See the text box at right for potential challenges of gravity-flow irrigation in meeting the CAFO requirements.

Gravity-Flow Irrigation

Water is conveyed to the field by means of open ditches, above-ground pipe (including gated pipe) or underground pipe, and released along the upper end of the field through siphon tubes, ditch gates, or pipe valves. Such systems are generally designed for irrigation water, and many CAFOs have not traditionally accounted for the irrigated manure nutrients. Some irrigation systems may offer nutrient management challenges to CAFOs including: uneven nutrient distribution, flooding and pooling, excessive volatilization of nitrogen, excessive leaching, and other potential difficulties in meeting technical standards established in their state.

Pressurized systems-including sprinkler and low-flow irrigation systems-use pressure to distribute water. Sprinkler system use is highest in the Pacific Northwest, Northern Plains, and in Eastern States. Center-pivot technology serves as the foundation for many technological innovations—such as low-pressure center pivot, linear-move, and low-energy precision application systems—that combine high application efficiencies with reduced energy and labor requirements. For more detail on irrigation water application technologies and a discussion of irrigation water management, see ARS' Irrigation Water Management in *Agricultural Resources and Environmental Indicators at http://www.ers.usda.gov/publications/ah712/AH7124-6.PDF*.

Low spot where water is ponding will reduce efficiency. Photo by USDA

8. Application Timing

Timing of manure application is an important consideration for nutrient availability. The longer manure nutrients are in the soil before crops take up the nutrients, the more those nutrients, especially nitrogen, can be lost through volatilization, denitrification, leaching, and surface runoff. CAFOs should consider the hydrological cycle and hydrological sensitivity of each field when making management decisions.

Best Management Practices (BMPs) for Land Application of Manure, Litter, and Process Wastewater

§412.4(c)(2)(i)) Include a field-specific assessment of the potential for nitrogen and phosphorus transport from the field to surface waters, and address the form, source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and phosphorus movement to surface waters.

- Spring applications. Applications made during this time are best for conserving nutrients because the threat of surface runoff and leaching diminish in late spring. This time period also is favorable because it is just before the period of maximum crop uptake, allowing for more efficient nutrient utilization.

- Summer applications. Early summer is a good time to apply manure because it is generally the time of maximum crop uptake. One consideration is improper manure application rates and methods can damage growing crops. Options for applying manure in the early summer include side-dressing manure by injecting it between crop rows, irrigating liquid manure over corn rows when the corn is 3 to 12 inches tall (taller corn stalks can suffer more leaf damage), or applying manure to forages such as hay fields and grasses after the first and second cuttings or to pastures with small stubble. CAFOs can also apply nutrients to harvested stubble fields in mid- to late-summer. Nitrogen in the manure stimulates more growth of cover crops, especially non-legume species that require nitrogen. The cover crop takes up the nutrients and holds them in an organic form in the plant, preventing them from leaching or being tied up in the soil complex. These nutrients are then more available for subsequent year's crops when the crop residue breaks down.

- Fall applications. Fall application of manure generally results in greater nutrient losses than occur from spring application regardless of the application method, but especially if the manure is not incorporated into the soil. Increased nutrient losses occur because mobile nutrients such as nitrogen leach out of the soil during this period. Many of the non-leachable nutrients react with the soil to form insoluble compounds that build soil fertility, but some are bound so tightly that they might not be available for the next crop. In fall, manure is best applied at low rates to fields that will be planted in winter grains or cover crops. If winter crops are not planted, CAFOs should apply manure to the fields containing the most vegetation or crop residues. Sod fields to be plowed the next spring are also acceptable, but fields where corn silage is removed and a cover crop not planted are undesirable sites.

- Winter applications. The greatest nutrient losses typically occur with winter manure applications. Research indicates that winter applications increase pollutants in runoff during spring thaw and rainfall events. Most of the seasonal runoff occurs during snowmelt in late winter or early spring. Manure applied in winter generally does not have the opportunity to dry and anchor to the soil surface or to be incorporated into the soil. CAFOs that apply manure during the winter must do so in compliance with the State's technical standards. Such protocols must account for the form of material that would be applied (e.g. liquid, semi-solid, or dry manure). In addition, such standards should address the time at which the materials would be applied relative to periods when runoff may occur, the fraction of precipitation that runs off the land in meltwater and in response to winter rains (as affected, in part, whether soil is frozen or not), the time it takes runoff to travel to waters of the United States (as affected by slope, distance to waters, roughness of the land surface, and whether or not runoff is in contact with the land surface), and other relevant factors, as appropriate. See Example 4-5 and Example 4-6 for sample State Technical Standards addressing timing of manure applications, and Appendix L for example technical standards addressing winter application of manure and waste water. Note manure, litter, and wastewater storage structures should include adequate capacity to store materials that accumulate during those times when, under the technical standards for nutrient management, land application would be prohibited.

Example 4-5: Sample State Technical Standard for Winter Application of Manure

CAFOs may only apply manure between November 15 and March 15 to those fields with less than 2% slope and not located closer than 2 miles to waters of the U.S.

The fields must not be subject to spring flooding. The manure should be incorporated into the soil unless a cover crop or 30% crop residue is maintained.

Example 4-6: Sample State Technical Standard for Application of Manure During a High Probability of Runoff

The owner of a dairy CAFO wants to surface apply liquid manure on a field tomorrow, October 20. Manure was last applied on the field in the spring and measurable rain has not fallen in the area for seven days. The field contains Lenawee silty clay loam and 30 percent residue from the harvested corn crop. When last completed, tillage was done on the contour. Subsurface drainage tiles are present in the field. The CAFO's permit prohibits surface application of manure if the National Weather Service forecasts a 50 or more percent chance of rainfall exceeding one inch, or less if a lesser rainfall event is capable of producing runoff, within 24 hours of the time of the planned application.

According to this state Technical Standard, can the CAFO owner apply manure on the field on October 20?

In the course of preparing his nutrient management plan, the producer previously determined that the field has a runoff curve number of 74 under average antecedent soil moisture conditions. The producer made this determination after consulting Table 2-2b and Appendix A in *Urban Hydrology for Small Watersheds* (USDA-NRCS 1986)(see Appendix M for these references). For the field in question, the producer also determined that 0.7 inches is the minimum quantity of water that is required to produce runoff from the field under average antecedent soil moisture conditions. The producer made this determination after consulting column 5 in Table 10.1 of the *National Engineering Handbook, Part 630, Hydrology* (USDA-NRCS 1993). On the morning of October 20, the producer goes to the following internet address: http://www.nws.noaa.gov/mdl/forecast/graphics/MAV/. The producer views the map that appears after selecting the precipitation product labeled, "24H Prob.>=0.5 in." According to the map, there is a 10 percent or less chance of 0.5 or more inches of rain in the upcoming 24-hour period. With this information, the producer has correctly concluded manure can be applied in this instance while remaining in compliance with his permit.

CAFOs should check their state regulations to determine whether fall or winter land application is allowed.

9. Equipment Calibration and Inspection

Inspect Land Application Equipment for Leaks

§412.4(c)(4) The operator must periodically inspect equipment used for land application of manure, litter, or process wastewater.

Operators of Large CAFOs must periodically inspect land application equipment for leaks (40 CFR 412.4(c)(4)). CAFOs must ensure land application equipment is operating properly (see standard permit conditions for operation and maintenance discussed in Chapter 2). CAFOs should calibrate land application equipment before each application to ensure that manure is delivered at the proper rate of application. Calibration defines the combination of settings and travel speed needed to apply animal waste at a desired rate. For example, spreaders can apply manure at varying rates depending on forward travel speed, power takeoff speed, gear box settings, discharge opening, swath width, overlap patterns, wind conditions, manure particle size, and many other parameters. There are two basic calibration techniques:

- The load-area method, which involves measuring the waste amount in a loaded spreader and then calculating the number of spreader loads required to cover a known land area; and
- The weight-area method, which requires weighing manure spread over a small surface area and computing the quantity of manure applied per acre.

The best calibration method depends on the type of spreader used. Soil-injection liquid spreaders should be calibrated using the load-area method because soil-injected waste cannot be collected. Liquid waste that is surface applied through a tank spreader is best measured by the load-area method because of the difficulty in collecting the liquid waste. CAFOs can successfully use either method to measure solid and semisolid waste. NRCS Practice Standard 590, *Nutrient Management*, recommends that land application equipment be calibrated to ensure uniform distribution of material at planned rates and ANSI GELPP 0004-2002, *Manure Utilization*, recommends annual calibration of manure application equipment. See Appendix J for more information on calibration of animal waste spreaders and irrigation equipment.

Though the CAFO rules do not specify the frequency of the inspections, EPA recommends inspections every time the equipment is used. This allows CAFOs to detect and then correct any potential problems before they cause adverse environmental impacts.

10. Additional Land Application Considerations

Although manure, litter, and process wastewater are valuable resources, they can also cause extensive damage if placed in environmentally sensitive areas or applied at inappropriate times. To protect water quality, CAFOs must not apply manure closer than 100 feet to any down-gradient waters of the U.S., open tile line intake structure, sinkhole, or agricultural well head, or other conduits to waters of the U.S. (unless the CAFO qualifies for a compliance alternative based on vegetated buffers or other alternative practices) (40 CFR 412.4(c)(5)). In addition, CAFOs should not apply manure in the following areas or under the following conditions:

- Near or in wetlands, riparian buffer areas, water sources, wells, drinking water supplies, high slope areas, and high erosion areas;
- Within concentrated water flow areas (vegetated or non-vegetated) such as ditches, waterways, gullies, swales, and intermittent streams[2];
- When the hydraulic load/irrigation water exceeds the infiltration rate of the soil;
- When crops are not being grown;
- When the ground is frozen or snow-covered (as described in Section 8); and
- When measurable precipitation is occurring on the day of application.

See Section 8 for a more detailed discussion of timing. The permit authority may include these types of requirements as technology-based standards.

11. NMP Review and Revision

CAFOs must keep a copy of the NMP on site (40 CFR 122.42(e)(2)). The NMP should be reviewed annually and revised every five years. Ideally, the NMP is re-certified every five years. CAFOs should review and modify NMPs, at a minimum, when the following events occur:

- Change in manure nutrients produced;
- Change in crop rotation;
- Change in farming operations or management systems;
- Change in technology or available data that affects land application; or
- New soil test analyses with revised recommendations.

[2] Note some of these features may be defined as waters of the U.S. If so, unpermitted discharges into them is directly prohibited. See the *Permit Guidance* for further discussion.

C. Records

The CAFO rules require CAFOs to maintain the following records for each site on which manure, litter, or process wastewater is applied(40 CFR 412.37(c) and 122.42):

- The Nutrient Management Plan for each site;
- Expected yield for each crop grown on the site;
- The date manure is applied to each site;
- Weather conditions at the time of application and for 24 hours prior to and following application;
- Test methods used to collect and analyze manure, litter, process waste water, and soil samples;
- Results of annual nitrogen and phosphorus manure analyses;
- Results of the phosphorus soil analysis required every five years;
- Explanation of the basis for determining the manure application rates, as provided in the technical standards established by the Director;
- The calculations for the amount of total nitrogen and total phosphorus to be applied to each field and the amount from all sources, including sources other than manure, litter, and process wastewater;
- The total amount of nitrogen and phosphorus actually applied to each field including documentation of calculations for the total amount applied;
- The method used to land apply the manure, litter or process waste water; and
- The dates of the inspections of the land application equipment.

Appendix C contains a sample checklist for the records that must be kept for a CAFO land application area.

D. Site-Specific Conservation Practices

Although animal manure is a valuable resource, it also can cause extensive damage if placed in environmentally sensitive areas or applied at inappropriate times. The effluent guidelines prohibit Large CAFOs from applying manure, litter, or process wastewaters within 100 feet of any down-gradient waters of the U.S., open tile line intake structures, sinkholes, agricultural well heads, or other conduits to waters of the U.S.

The rules also allow alternative ways to comply with this setback requirement as described below:

1. Required Setback or Buffer

A setback is an area where manure, litter, or process wastewater is not applied, but crops continue to be grown. A setback reduces pollution by increasing the distance pollutants in land-applied manure, litter, or process wastewater have to travel to reach surface water bodies. The CAFO rules require that manure, litter, and process wastewater not be applied closer than 100 feet to any down-gradient surface water, open tile line intake structure, sinkhole, agricultural well head, or other conduit to surface waters except under the two situations discussed below. This setback requirement helps ensure that nitrogen, phosphorus, and other pollutants (e.g., metals and pathogens) in manure do not reach waters of the U.S. after it is applied to the land. CAFOs may apply commercial fertilizer in the setback zone, and may grow crops in the setback zones, but CAFOs are encouraged to implement conservation practices in these areas.

2. Alternatives to Setbacks

There are two alternatives to the 100-foot setback requirement in the rule. First, the CAFO may establish a 35-foot wide vegetated buffer between the land application site and waters of the U.S. Second, the CAFO may demonstrate that the setback or the 35-foot vegetated buffer is not necessary due to the implementation of an alternative practice. Both of these alternatives are described below.

35-Foot Vegetated Buffer

A vegetated buffer is a permanent strip of dense perennial vegetation established parallel to the contours of and perpendicular to the dominant slope of the land application field. NRCS standards such as Practice 393 recommend appropriate species for cover. This generally includes native species. If the native species includes hay or alfalfa, CAFOs may choose such species in the vegetated buffer; however, for the area to continue to be considered "vegetated," CAFOs should not harvest it. The purpose of a vegetated buffer is to slow the runoff from a land application site, enhance the filtration of the runoff, and minimize the risk of nutrients and other pollutants leaving the land application site and reaching surface waters. CAFOs may not grow crops in the buffer or apply manure, litter, or other process waste waters to the buffer. NRCS standards recommend appropriate maintenance of the buffer, such as periodic sediment removal, nutrient removal, and vegetation trimming. Vegetated buffers are generally eligible for funding under USDA's Conservation Reserve Program continuous sign-up. In general, CAFOs can enroll in this program at any time and can receive incentive payments for the installation of the buffer and annual rental payments for the duration of the 10 to 15 year contract. For more information on USDA's Conservation Reserve Program see: http://www.fsa.usda.gov/pas/publications/facts/html/crpcont03.htm

Demonstration that the Setback is Not Necessary

CAFOs may demonstrate that the setback is not necessary due to implementation of alternative conservation practices or field specific conditions. Note that in the examples provided, it is the CAFO that must ultimately make the demonstration, even if the CAFO uses information generated by others. The CAFO should demonstrate that the alternative conservation practices or field-specific conditions will provide pollutant reductions of nitrogen, phosphorus, biochemical oxygen demand (BOD) and total suspended solids (TSS) equal to or greater than the reductions achieved by the 100-foot setback; see Example 4-7. EPA anticipates that some CAFOs will select this alternative as a proactive approach to protecting water quality. The regulations do not prescribe how the CAFO should make this demonstration; however, in general, CAFOs should not be allowed to use a small setback without implementing some additional controls. The demonstration of pollutant reductions should at a minimum address the runoff, leaching, and erosion of nutrients (nitrogen and phosphorus), BOD_5 (five-day biochemical oxygen demand), and solids.

Example 4-7: Setback Compliance

A Large CAFO has decided only a 5-foot setback is necessary because the field slope is less than 2 percent.

Did the CAFOs demonstrate that the setback is not necessary?

No, this does not meet the requirements of the effluent guidelines. The CAFO has not made any demonstration that the setback is not necessary by showing that the pollutant reductions of the site's 5-foot setback would equal those of a 100-foot setback. Indeed, it is highly unlikely that pollutant reductions from a 5-foot setback could be deemed equal to reductions from a 100-foot setback without implementation of additional practices.

CAFOs should not assume that meeting state best management practices (BMP) requirements or that all commonly used conservation practices (such as those discussed below) will always meet the demonstration requirement. For example, incorporation (i.e., tilling the manure into the soil) is a common and frequently encouraged management practice to minimize runoff. However, incorporating manure within 60 days before growing a crop may increase erosion such that a field no longer meets the equivalent of the 100-foot setback requirement. Appendix K includes a formula for calculating soil loss (erosion). CAFOs meeting current state requirements do not necessarily meet the 100-foot setback requirements; see Example 4-8.

Example 4-8: Incorrectly Assuming State Requirements Equals Setback

A state has requirements that all manure be injected or incorporated within 24 hours after land application. The CAFO injects all manure and decides no setback is necessary.

Did the CAFOs demonstrate that the setback is not necessary?

No, this does not meet the requirements of the effluent guildeline. The CAFO has not made any demonstration that the setback is not necessary. CAFOs should not assume conservation practices or best management practices already required by the state or locality are automatically equivalent to the 100-foot setback requirement.

State-Developed Alternative Conservation Practices. In some cases, a state may develop a list of alternative conservation practices that, in tandem with phosphorus-based technical standards for land application, have been evaluated and demonstrated to provide pollutant reductions better than the 100-foot setback. CAFOs should check to see whether their permitting authority has collected data and information that could be used to demonstrate that certain conservation practices provide pollutant reductions equivalent to or better than the reductions that would be achieved by the 100-foot setback. A state may also provide CAFOs with information or may specify suitable methods to facilitate the CAFO's demonstration; see Example 4-9.

Example 4-9: State-Developed Alternatives to Demonstrate Setback is Not Necessary

A Land Grant University has conducted extensive research in terraces and conservation tillage on many soil types native to the state and shown pollutant reductions better than that achieved by the 100 foot setback. The CAFO has soils and field conditions, and uses conservation practices, that are similar to those on which the Land Grant University has conducted the extensive research. The CAFO uses this information as the basis for its demonstration.

Did the CAFOs demonstrate that the setback is not necessary?

It is up to the permit authority to determine whether by relying on this information the CAFO has sufficiently demonstrated the setback is not necessary.

Soil Loss Tolerance (T)

Soil loss tolerance (T) is the maximum amount of soil loss in tons per acre per year, that can be tolerated and still permit a high level of crop productivity to be sustained economically and indefinitely. See Appendix K for more details.

NRCS Conservation Plan. EPA encourages CAFOs to implement a combination of NRCS recommended practices in conjunction with the NRCS Practice Standard 590, *Nutrient Management*, for a given field. NRCS follows a 9-step process to develop a conservation plan; this process is described in detail in the USDA-NRCS *National Planning Procedures Handbook (NPPH)*, and may be found at: <http://policy.nrcs.usda.gov/>. An NRCS Conservation Plan is essentially a set of conservation practices that are designed to work in an integrated manner to accomplish an identified level of resource treatment. The development of a Conservation Plan includes determination of the baseline erosion and other associated losses, along with an evaluation of the practices that would meet the Tolerable Soil Loss "T." Some Conservation Plans might call for additional efforts to achieve smaller erosion losses (i.e., if water quality standards are not met or the maximum amount of soil loss (T) is unacceptable for the site.) Therefore, an USDA Conservation Plan may be used to demonstrate pollutant reductions better than the 100 foot setback; see Example 4-10.

Example 4-10: Using a CNMP to Meet the Setback Requirements

A CAFO voluntarily develops a USDA-prepared CNMP. The CNMP includes a conservation planning component. This component includes modeling of baseline and calculation of improvements resulting from following the suggested practices. The CAFO refers to the calculations and modeling from the conservation planning component in the CNMP to make the demonstration of improved pollutant reductions over a 100 foot setback, and implements the conservation planning measures in lieu of the setback.

Did the CAFOs demonstrate that the setback is not necessary?

It is up to the permit authority to determine whether by relying on this information the CAFO has sufficiently demonstrated the setback is not necessary. EPA anticipates the Permitting Authority will find, in general, a certified CNMP will satisfy the requirement to demonstrate pollutant reductions better than the 100 foot setback.

E. Voluntary Conservation and Pollution Prevention Practices

Reducing the amount of runoff and eroded sediment that can reach surface water will in turn reduce the amount of nutrients that can reach the surface water. Numerous management practices to control runoff and soil erosion have been researched, developed, and implemented. Runoff and erosion control practices range from changes in agricultural land management (e.g., cover crops, diverse rotations, conservation tillage, contour farming, contour strip cropping) to the installation of structural devices (e.g., diversions, grade stabilization structures, grassed waterways, terraces). In addition to the required NMP, EPA strongly encourages all CAFOs to implement an approved USDA/NRCS conservation plan on all fields. Practices discussed in this section include: feeding strategies, and water conservation.

1. <u>Feeding Strategies</u>

Feeding strategies increase the efficiency with which animals use the nutrients in their feed, which decreases the amount of nutrients excreted in their waste. Example feeding strategies include, but are not limited to:

- Formulating feed to meet the animal's nutrient requirements (i.e., precision nutrition). This results in more of the nutrients being metabolized, thereby reducing the amount of nutrients excreted. This strategy has been successfully used for both swine and poultry.
- Multiphase feeding for cows and swine. This involves frequently changing the diet composition (such as weekly) for different groups of animals (e.g., lactating cows) to better match the changing nutritional requirements of the animal due to age, size, weight, or productivity.
- Reducing the particle size of the feed for swine by milling and pelleting. Note that this may decrease total nutrient excretion, but may require different approaches to manure handling and treatment. For example, solids separation is less efficient with manures where animals are fed a small pellet size.
- Use of phytase as a feed supplement for poultry and swine to help the animal birds digest phosphorus and reduce the amount of phosphorus they excrete.
- Using genetically modified feed for poultry and swine to make phosphorus more available for consumption, such as high available phytate corn.
- Reducing the dietary supplements, such as reduced phosphorus supplements added to grains fed to dairy cattle.

Because the manure generated when the various feeding strategies are used has lower nutrient content, more of the material can be applied to the land. As a result, CAFOs can use less land to apply all of the manure and, in some cases, transport smaller amounts of the material off-site for land application. In addition, strategies that focus on reducing the phosphorus concentration can turn the manure into a more balanced fertilizer in terms of plant nutrient requirements. Using these feeding strategies can result in potential cost savings in the form of reduced feed costs and reduced hauling/disposal costs since there is less manure to be transported for off-site land application.

2. <u>Water Conservation</u>

Water conservation is one way of reducing the volume of wastewater that is generated. EPA strongly encourages CAFOs to use a variety of practices to conserve water. These include, but are not limited to, using advanced watering systems, recycling flush water, and using dry scrape systems instead of wet flush systems.

Nipple water delivery systems reduce the volume of wastewater generated by only delivering water when the animals suck on the nipple. This reduces the spillage that occurs typically with trough and cup water systems and also reduces the contamination of the standing water in those systems by the animals. CAFOs can also use pressure sensors and automatic shutoff valves to reduce spillage in a watering system. A sensor can detect a sustained drop in water pressure resulting from a leak or break in a water line and shut off the flow to the broken line until it is repaired.

CAFOs can also conserve water by recycling the wastewater generated when waste collection gutters and alleys are flushed with water. CAFOs may need to treat the wastewater from the flushing operation prior to being recycled to remove pollutants and make the water acceptable for recycling.

Another water conservation method is a dry scrape system. In a dry scrape system, scrapers are used to push the manure through the collection gutters and alleys instead of water. This reduces the volume of water used in manure handling, which in turn reduces the volume of wastewater that has to be handled. Dry scrape systems are used for dry solid manure, semisolid manure, and for slurry manure while flush systems typically are used only for semisolid and slurry manure.