



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

This practice may be applied for one or more of the following purposes:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by- products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates; and
- To maintain or improve the physical, chemical, and biological condition of the soil

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

CRITERIA

General Criteria Applicable to All Purposes

Nutrient management planning relies heavily upon regular soil and manure testing, using proper sampling techniques and analytical methods, realistic expected yield goals, the effects of cover crops and/or crop rotations on nutrient cycling and availability for plant uptake, and the timing and placement of plant nutrients.

Plans for nutrient management shall comply with all applicable federal, state, and local laws and regulations.

Persons who review or approve plans for nutrient management shall be certified through the Delaware Department of Agriculture – Nutrient Management Certification Program. NRCS may require that additional training be taken to implement current or future NRCS or state policy.

Plans for nutrient management that are elements of a more comprehensive conservation plan, shall be compatible with the conservation plan requirements.

A crop nutrient budget shall be developed that accounts for all for nitrogen, phosphorus, and potassium that enters the soil surface and leaves through crop uptake. The budget shall include all potential sources

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at <https://www.nrcs.usda.gov/> and type FOTG in the search field.

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of N, P and K including, but not limited to animal manure and organic by-products, green manure, wastewater, commercial fertilizer, crop residues, legume credits, and irrigation water, as appropriate.

Enhanced efficiency fertilizers, used in the state must be defined by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the State Fertilizer Control Official of the Delaware Department of Agriculture (DDA) with responsibility for verification of product guarantees, ingredients (by AAPFCO definition), and label claims.

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program.

Areas contained within minimum application setbacks (e.g., surface waters or conduits to surface waters) must receive manure and processes waste water consistent with the setback restrictions required by state laws and regulations, as applicable.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in fertilizer applied near the seed must be consistent with the University of Delaware guidelines.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater. The application rate (in/hr) for material applied through irrigation shall not exceed the soil intake/infiltration rate. The total application shall not exceed the field capacity of the soil.

Soil pH must be maintained in a range that optimizes crop growth and plant nutrient availability and utilization. Refer to the University of Delaware guidelines for information on adjusting soil pH to desired values for crop production.

Field Risk Assessments

For nutrient risk assessment policy and procedures, see Title 190, General Manual (GM), Part 402, Nutrient Management, and Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation.

The nutrient risk assessment for nitrogen, the Nitrogen Index (NI), must be completed on all sites utilizing the predominant soil type.

The nutrient risk assessment for phosphorus, the Phosphorous Site Index (PSI), must be completed on all sites where the planned phosphorus application rate exceeds University of Delaware nutrient recommendations based on the results of a soil test for the planned crop(s) and/or where manure is applied.

The PSI is not required on fields with a documented agronomic need for phosphorus based on a soil test and when phosphorus application is based on the University of Delaware soil test phosphorus (STP) nutrient recommendations for the planned crop(s).

Soil, Manure, and Tissue Sampling and Laboratory Analysis (Testing)

Nutrient management planning shall be based on current soil, manure, and plant tissue test results (if applicable), in accordance with University of Delaware guidance and recommendations.

Soil Testing

Soil samples shall be collected and prepared according to the University of Delaware guidelines and recommendations. Current soil tests are ones that are no older than three years.

Where a field is being split into management units, sampling units should have similar soil types, cropping history, and management practices.

Areas that are very different in soil type, which have been managed or cropped differently, or that clearly have some type of problem should be sampled separately, including separate sampling for manured and non-manured sections of a large field.

Soil testing shall include, as a minimum, analysis for organic matter, pH, lime requirement, and plant available phosphorus and potassium. Soil testing also shall include analysis for any other nutrients for which specific information is needed to develop the nutrient management plan.

Soil test analyses shall be performed by laboratories who:

1. Use methods appropriate for Delaware soils as recommended by the USDA Northeast Regional workgroup on soil testing and included in the Northeastern and Southern regional bulletins, which are available in the following publications:

Recommended Soil Testing Procedures for the Northeastern United States.

<http://extension.udel.edu/lawngarden/NE-soiltesting>

Reference Soil and Media Diagnostic Procedures for the Southern Region of the United States. <http://www.clemson.edu/sera6/bulletinNo.374.pdf>

2. Are enrolled in: (i) the North American Proficiency Testing Program (NAPT) of the Soil Science Society of America in the year samples are analyzed and are actively submitting results to the NAPT for the methods and analyses included on the soil test report used in the nutrient management plan; or (ii) other equivalent/comparable proficiency testing programs having solid stakeholder support that consider laboratory performance and proficiency to assure accuracy of soil test results.
3. Provide soil test results for nutrients in units that are convertible to the University of Delaware's Fertility Index Values (FIV). Equations for converting soil test results from other laboratories to equivalent University of Delaware FIVs are available at the following site: <http://ag.udel.edu/dstp/UDNMH/Appendix-5.pdf>

Manure/Organic Amendment Testing

Nutrient values of manure and organic amendments shall be determined prior to land application.

Manure, organic by-products, and biosolids samples must be collected and analyzed at least annually, or more frequently if needed to account for operational changes impacting manure nutrient concentrations.

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or P₂O₅, total potassium (K) or K₂O, and percent solids.

Samples should be taken in accordance with the publication, Recommended Methods of Manure Analysis (reference below), and as close to the application date as feasible. Adequate time should be allowed for the analyses, clean-out, spreader calibration, and field application.

Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification Program (MTLCP) under the auspices of the Minnesota Department of Agriculture.

Manure testing analyses must be performed by laboratories that use nationally recognized standard methods for manure analysis, which are available in the following publication:

Recommended Methods of Manure Analysis, <http://uwlab.soils.wisc.edu/pubs/A3769.pdf>

When planning a new or modified livestock operation, an NRCS acceptable "book value" may be used for planning purposes. In the first year, actual samples shall be obtained and analyzed periodically, and the plan revised to reflect the test results. Book values recognized by NRCS may be found in the Agricultural

Waste Management Field Handbook, Chapter 4 – Agricultural Waste Characteristics. For acceptable book values for poultry, utilize University of Delaware data.

Plant Tissue Testing

Tissue sampling and testing, where used, shall be conducted in conjunction with a current soil test, and in accordance with University of Delaware guidelines and recommendations.

Inorganic Nutrient Application Rates

Recommended nutrient application rates shall be based on University of Delaware recommendations that consider crop/cropping sequence, current soil test results, soil productivity class, expected realistic yield goals, climate, management capabilities, and nutrient risk assessments. For grain and forage crops, refer to the University of Delaware Nutrient Management Handbook for crop specific nutrient recommendations. <http://ag.udel.edu/dstp/UDNMHandbook%20Title.html>

For vegetables, refer to the Commercial Vegetable Production Recommendations for Delaware. <http://extension.udel.edu/ag/vegetable-fruit-resources/commercial-vegetable-production-recommendations/>

Delaware Nutrient Management regulations require crop yield goals to be based on the average of the best 4 yields in the past 7 years. Realistic yield goals should be established based on climate conditions, soil productivity information, historical yield data, level of management, and/or local research on similar soil and cropping systems.

For new crops or varieties, industry estimates of realistic yield goals and nutrient utilization may be used until documented yield information is available.

The planned rates of nutrient application, as documented in the nutrient management plan, shall be determined based on the following guidance:

1. **Inorganic/Commercial Fertilizer Applications.** Nitrogen, phosphorus, potassium, sulfur, and micronutrient application rates shall not exceed the recommended rates established by the University of Delaware and written in the nutrient management plan for each field or management unit.
When forage quality is an issue associated with excess potassium application or potassium imbalances in soils, state standards shall be used to set forage quality guidelines.
2. **Liming Material.** Soil amendments should be applied, as needed, to adjust soil pH to the specific range of the crop for optimum availability and utilization of nutrients. Such applications shall be in accordance with the University of Delaware guidelines and recommendations. If the liming material also provides plant nutrients (e.g., as with lime-stabilized biosolids), especially N and P, the application rates of these nutrients must be considered in the nutrient management plan.
3. **Other Plant Nutrients.** The planned rates of application for other nutrients shall be consistent with University of Delaware guidelines and recommendations.
4. **Starter Fertilizers.** Starter fertilizers may be applied when recommended by a nutrient management consultant. Follow the University of Delaware Commercial Vegetable Production Recommendations for starter P on vegetables. When starter fertilizers are used, they shall be considered in the overall crop nutrient budget and included in the nutrient management plan.

Nutrient Sources

Nutrient sources utilized must be compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

Nutrient Application Timing and Placement

Timing, placement, and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, soil properties, weather conditions, field accessibility, and nutrient risk assessment results.

Nutrients shall not be applied to frozen and/or snow-covered, or when the top two inches are saturated from rainfall or snow melt. Winter application must also be in compliance with the Delaware Nutrient Management certification program.

Exceptions for the above criteria can be made for surface-applied liquid manure when specified conditions are met and adequate conservation measures are installed to prevent the offsite delivery of nutrients. The specified conditions for winter applications of liquid manure are:

1. The application of liquid manure shall be done at the recommendation of a nutrient consultant.
2. Manure application shall be consistent with the setback restrictions required by state regulations.
3. Fields must have 30% residue or an established cover crop or vegetative cover. Vegetative cover shall be adequate to accommodate applications necessary due to inadequate storage.
4. Application rates shall be minimized and available crop acreage used to the extent practical.
5. Application shall not exceed the nutrient need of the crop for which nutrients are being managed. In no case shall the application rate per acre exceed the crops' phosphorus removal rate or 50% of the crops' nitrogen removal rate.
6. Application shall be on the flattest ground available, meeting the above criteria.

Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater

Planners must use the current NRCS-approved nitrogen, phosphorus, and soil erosion risk assessment tools, as applicable, to assess the risk of nutrient and soil loss. Identified resource concerns must be addressed to meet current planning criteria.

Field Risk Assessment - Phosphorus Site Index (PSI)

The current Phosphorus Site Index assessment rating for a field, approved for use in Delaware by NRCS, is based on phosphorus loss potential due to site and transport characteristics (Part A) and phosphorus loss potential due to management practices and P source characteristics (Part B). Details on the proper method to conduct a PSI assessment are available from the University of Delaware and NRCS.

When the PSI assessment is completed, the results of the assessment and recommendations shall be discussed with the producer during the development of the nutrient management plan.

Phosphorus Site Index (PSI) Rating

The following PSI ratings are used in Delaware to determine appropriate P application rates for manure and other organic amendments. Nitrogen cannot exceed the recommended rate during the year of application.

1. **Phosphorus Site Index < 50.** Low potential for P movement from the site given current management practices and site characteristics. There is a low probability of an adverse impact to surface waters from P losses from this site. Nitrogen-based nutrient management planning is satisfactory for this site. Soil P levels and P loss potential may increase in the future due to N-based nutrient management.
2. **Phosphorus Site Index = 50 – 75.** Medium potential for P movement from the site given current management practices and site characteristics. Practices should be implemented to reduce P losses. Nitrogen-based nutrient management should be implemented no more than one year out of three. Phosphorus-based nutrient management should be implemented two years out of three, during which time P applications should be limited to the amount expected to be removed from the field by crop harvest or soil test P based application recommendations, whichever is greater.
3. **Phosphorus Site Index = 76 – 100.** High potential for P movement from the site given current management practices and site characteristics. Phosphorus-based nutrient management planning should be used for this site. Phosphorus applications should be limited to the amount expected to be removed from the field by crop harvest or soil test P based application recommendations.

To be consistent with the Delaware Nutrient Management Law, P applications cannot exceed the amount of P removed in the harvested portion of the crops grown for the next three years. When P is applied at the “three-year crop removal rate”, no additional P can be applied in the three year crop cycle. All practical management practices for reducing P losses should be implemented.

Phosphorus Site Index > 100. Very high potential for P movement from the site given current management practices and site characteristics. No phosphorus should be applied to this site, with the exception of starter P in select cases. The initiation of active remediation techniques are recommended to be implemented to reduce the P loss potential from the site.

Plans developed to minimize agricultural nonpoint source pollution of surface or ground water resources shall include practices and/or management activities that can reduce the risk of phosphorus movement from the field.

Note: *The use of certain conservation practices can reduce the risk of phosphorus movement, thereby lowering the risk level from a higher category to a lower category.*

Nitrogen Leaching Index (LI) Rating

The following LI ratings will be used in Delaware to determine appropriate N application rates for manure and other organic amendments:

1. LI is low, medium, or high for the predominate soil type in the field or management unit. The University of Delaware recommendations on nitrogen timing should be followed.
2. LI is Very High and/or the predominant soil type is located over an area of excellent groundwater recharge, producers shall employ management practices to reduce risk. The University of Delaware recommendations on nitrogen source, rate timing, and method of application shall be followed.

A single application of manure can still be applied as close to planting as feasible, but a producer would have to conduct an additional test/s to determine agronomic need, such as PSNTs or tissue testing if he/she wanted to apply additional fertilizer later in the season at rates that exceed University of Delaware recommendations.

Avoid, Control, or Trap Nutrients

When there is a high risk of offsite transport of nutrients, conservation practices must be coordinated to avoid, control, or trap nutrients applied in fertilizers and manures before they can leave the field by surface or subsurface drainage.

Nutrients must be applied in the right place, at the right amount, at the right time, and using the right source to minimize nutrient losses to surface and groundwater.

University of Delaware recommended practice, technologies, or systems that improve nutrient use efficiency and minimize surface or groundwater resource concerns should be considered and implemented as appropriate.

Additional Criteria Applicable to Manure or Organic By-Products Applied as a Plant Nutrient Source

When manures are applied, and soil salinity is a concern, salt concentrations must be monitored to prevent potential crop damage and/or reduced soil quality.

A total single application of liquid manure must not exceed the soil's infiltration or water holding capacity; be based on crop rooting depth; and must be adjusted to avoid runoff or loss to subsurface tile drains.

Crop production activities and nutrient use efficiency technologies must be coordinated to take advantage of mineralized plant-available nitrogen to minimize the potential for nitrogen losses due to denitrification or ammonia volatilization.

Manure/Organics Applications

The planned rates of manure/organics application, as documented in the nutrient management plan, shall be determined based on the following guidance:

1. **Nitrogen Application.** Planned nitrogen application rates shall not exceed the recommended rates established by the University of Delaware and written in the nutrient management plan.
2. **Phosphorus Application.** Phosphorus applications should be consistent with the rates recommended based on the soil test and/or the P Site Index assessment of the field or management unit.
When the nutrient management plan is determined by the PSI results to be phosphorus based, the application rate of any manure/organic by-product shall not exceed the recommended nitrogen application rate. An additional nitrogen application, from inorganic sources may be needed, if justified, to supply recommended amounts of nitrogen.
3. **Potassium Application.** Excess potassium shall not be applied in situations in which it causes unacceptable nutrient imbalances in crops and forages.

Manure or organic by products should not be applied on legumes since leguminous plants are capable of fixing sufficient nitrogen to meet crop needs.

Calculating Manure Production

To calculate the amount of manure available for crop utilization from different animal types and production systems, use the Manure Generation Excel spreadsheets, the University of Maryland located at: http://anmp.umd.edu/Advisors/Manure_Gen.cfm

Biosolids (Sewage Sludge)

Where non-farm organic waste (e.g. municipal sewage sludge) is to be utilized, recommended application rates will be determined by using current University of Delaware recommendations and the 590 nutrient management standard and specifications. Biosolids are not recommended on vegetables.

These materials must also be applied to meet federal, state, or local regulations. Appropriate documentation of amounts applied must be maintained by the applicator according to state regulations. The Delaware Department of Natural Resources and Environmental Control regulates the land treatment of biosolids.

When sewage sludge is applied, the accumulation of potential pollutants, including arsenic, cadmium, copper, lead, mercury, selenium, and zinc, in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws and regulations.

Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates

To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impact of these emissions on the environment and human health. The following practices may be considered and implemented as appropriate:

1. incorporation or injection;
2. residue and tillage management; and
3. other technologies that minimize the impact of these emissions.

Do not apply poultry litter, manure or organic by-products of similar dryness/density, when there is a high probability that wind will blow the material offsite.

Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection

Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological conditions. Nutrients shall not be applied to flooded or saturated soils when there is potential for soil compaction.

Note: Specific program requirements may dictate criteria in addition to, or more restrictive than, those specified above.

CONSIDERATIONS

Annual soil testing can improve nutrient recommendations. Soil test information should be no older than 1 year when developing new plans.

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient deficiencies or toxicity that may impact plant growth or availability of the primary nutrients.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus levels can result in zinc deficiency in corn.

Use variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrate or organic N supply levels, or chlorophyll concentration.

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low and high yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

While groundwater nitrogen applied through irrigation contributes to the overall seasonal application, there are significant challenges to determine the effective nitrogen contribution to the crop. First and foremost, the typical amount of irrigation applied in any given season varies from as little as 4 inches in years of high precipitation to over 12 inches in dry years. Furthermore, irrigation is applied to crops where no nitrogen applications are recommended or crops where the nitrogen demand doesn't coincide with the irrigation demand. Finally, the concentration of nitrogen found in groundwater varies throughout the growing season and within any given irrigation event.

In the event that the groundwater nitrogen concentration is known to be constant, the volume of irrigation to be applied is defined prior to planting, and the irrigation timing coincides with the crop nitrogen demand, the nitrogen content of the irrigation water should be included in the nutrient management plan.

Use conservation practices that can slow runoff, reduce erosion, reduce the transport and leaching of dissolved and attached nutrients, improve soil nutrient and water storage, improve aeration and soil tilth, and protect or improve water quality.

Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as drainage water management.

When appropriate, use no-till in combination with cover crops, to sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency.

When no-till is not practiced, incorporate surface-applied manures or other organic by-products or delaying field application if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.

Ammonia nitrogen volatilization losses from land application of fertilizers and animal manures losses can become significant if available nutrients are not incorporated into the soil in a timely manner after application. Consult the Mid-Atlantic Nutrient Management Handbook, Table 9.10, Manure

ammonium-N availability factors for Virginia, available at: www.mawaterquality.org/capacity_building/mid-atlantic_nutrient_management_handbook/chapter9.pdf

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

Minimize the impact of odors of land-applied animal manure or organic amendments by applying when temperatures are cool and when wind direction is away from neighbors. Consider injection or incorporation of manure or other organic by-products as a means to minimize odors.

Consider the effects of the seasonal water budget and water table management on nutrient balance and on potential nutrient losses to surface or ground water or to the atmosphere.

Consider the limitations of the equipment when recommending application rates. For information on equipment for poultry manure application, see Delaware Nutrient Management Notes, Vol. II, No. I, Spring 2000 – Equipment for Effective Poultry Litter Application.

Consider waste management system planning, storage, and treatment needs to ensure efficient timings of waste application to crops as well as acreage needed for proper waste utilization.

Modify animal feed diets to reduce the nutrient content of manure following guidance contained in Conservation Practice Standard (CPS) Code 592, Feed Management.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in the NRCS' National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Workers should be protected from and avoid unnecessary contact with chemical fertilizers and organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with state and local guidelines or regulations.

PLANS AND SPECIFICATIONS

Specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan:

1. Aerial photograph and a soil map of the site;
2. Soil information including – drainage class, permeability, available water capacity, depth to water table, and flooding and/or ponding frequency;
3. Location of designated sensitive areas and the associated nutrient application restrictions and setback;
4. Current and/or planned crop rotation;
5. Results of applicable soil, plant, water, manure, or organic by-products analyses;
6. Realistic yield goals for the crops in the rotation and the method used to estimate the goals;
7. Complete nutrient budget for nitrogen, phosphorus, and potassium for the annual crop or crop rotation;
8. Quantification of the amount and total nutrient content of all nutrient sources;
9. Recommended nutrient rates, timing, form, and method of application and incorporation;

10. Results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses, if applicable;

In addition, the following components shall be included when manure is utilized:

1. Type, number, and average size of animals;
2. Quantities of manure generated annually, total amount of manure used on the farm each year, including any imported manure, and amount and destination of all manure exported;
3. Location of nearby residences;
4. Conservation practices and management activities needed to reduce the potential for nutrient movement from the site; and
5. Other practices or management activities, as determined by specific regulation, program requirements, or producer goals.

In addition, if increases in soil phosphorus levels are expected because P is being applied above crop removal rates, the nutrient management plans shall include:

1. The soil phosphorus levels at which it is desirable to convert to a phosphorus based nutrient management plan, based on the PSI evaluation;
2. Management activities or techniques used to reduce the potential for phosphorus transport and loss;
3. Record the amount of acreage that would be needed if the manure was applied at rates based on crop P requirements as determined by a soil test;
4. For AFOs, a quantification of manure produced in excess of crop nutrient requirements; and
5. Include the following statement in nutrient management plans that apply manure:

Consider only applying manure at P based crop removal rates and not applying manure on soils above 150 FIV for phosphorus.

In addition, the following components must be included in a precision/variable rate nutrient management plan:

1. The geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer/s to generate nutrient or soil amendment recommendations;
2. The nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer/s to a nutrient source material recommendation GIS layer or layers;

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location of the practice on the conservation map.
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom.
3. Field risk assessment for each management unit; and
4. Dates of review and person performing the review and an actions taken.

OPERATION AND MAINTENANCE

The owner/client is responsible for the operation and maintenance of this practice. Operation and maintenance addresses the following:

1. Periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised every 3 years. More frequent revisions may be

needed, depending on changes in the operation.

Dates of the review, recommendations, and person performing the review.

Fields receiving biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with state law.

2. Calibration of application equipment to ensure uniform distribution of material at planned rates.
3. Maintaining records to document plan implementation is the responsibility of the owner/client. Records must be maintained for at least 6 years. As applicable, records include:
 - a. Soil, plant tissue, water, manure, and organic byproduct analysis;
 - b. Quantities, analyses, and sources of nutrients applied;
 - c. Dates (month and year) and method of nutrient applications, including type of incorporation, if applicable;
 - d. Documentation of the actual rate at which nutrients were applied, if rate differs from the planned rate. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences;
 - e. Weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event;
 - f. Crops planted, planting and harvest dates, yields, and crop residues removed; and
 - g. Amount and type of manure exported from the farm and the name and address receiving the exported manure.

Additional records for nutrient management plans with animals and/or manure must include:

1. Type, number, and average size of animals; and
2. Quantities of manure generated annually, total amount of manure used on the farm each year, including any imported manure, and amount and destination of all manure exported.

Additional records for precision/variable rate sites must include:

1. Maps per management unit documenting the variable application source, timing, amount, and placement of all plant nutrients applied; and
2. GPS-based yield maps for crops where yields can be digitally collected.

REFERENCES

1. Delaware Department of Agriculture. Title 3 of Delaware Code, Chapter 22, Nutrient Management.
2. Delaware Department of Agriculture. Delaware Nutrient Management Notes. <http://www.state.de.us/deptagri/announcements/announce.htm>
3. Mid-Atlantic Regional Water Program. 2006. The Mid-Atlantic Nutrient Management Handbook.
4. The Northeast Coordinating Committee for Soil Testing. July 2011. Recommended Soil Testing Procedures for the Northeastern United States (NEC 1012).
5. University of Delaware, January, 2002. Interpreting Soil Phosphorus Tests (NM-04)
6. University of Delaware, January, 2002. The Phosphorus Site Index: A Phosphorus Management Strategy of Delaware's Agricultural Soils (ST-05).
7. University of Delaware, November, 2012. Phosphorus Removal by Delaware Crop.
8. University of Delaware, 2003 Nutrient Management Handbook.
9. University of Maryland. 2010. Manure Generation Excel Spreadsheets.
10. University of Wisconsin. 2003. Recommended Methods for Manure Analysis (A3769).
11. USDA, Natural Resources Conservation Service, April, 1992. Agricultural Waste Management Field Handbook.

12. USDA, Natural Resources Conservation Service. 2010. Agronomy Technical Note, (TN) 190-AGR-3, Precision Nutrient Management Planning. Washington, DC.
13. USDA, Natural Resources Conservation Service. 2011. Title 190, General Manual, (GM), Part 402, Nutrient Management. Washington, DC.
14. USDA Natural Resources Conservation Service. 2011, Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation. Washington, DC.
15. Virginia Agricultural Experiment Station. July 1992. Reference Soil and Media Diagnostic Procedures for the Southern Region of the United States.