Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

CODE 590

(ac)

DEFINITION

Manage the rate, source, placement, and timing of plant nutrients and soil amendments while reducing environmental impacts.

PURPOSE

This practice is used to accomplish one (1) or more of the following purposes:

- Improve plant health and productivity
- Reduce excess nutrients in surface and ground water
- Reduce emissions of objectionable odors
- Reduce emissions of particulate matter (PM) and PM precursors
- Reduce emissions of greenhouse gases (GHG)
- Reduce emissions of ozone precursors
- Reduce the risk of potential pathogens from manure, biosolids, or compost application from reaching surface and ground water
- Improve or maintain soil organic matter

CONDITIONS WHERE PRACTICE APPLIES

This concerns all fields where plant nutrients and soil amendments are applied. However, it does not apply to a one-time nutrient application at establishment of permanent vegetation.

CRITERIA

General Criteria Applicable to All Purposes

Develop a nutrient management plan for nitrogen (N), phosphorus (P), and potassium (K), which accounts for all known measurable sources and removal of these nutrients.

Sources of nutrients include, but are not limited to, commercial fertilizers (including starter and in-furrow starter/pop-up fertilizer), animal manures, legume fixation credits, green manures, plant or crop residues, compost, organic by-products, municipal and industrial biosolids, wastewater, organic materials, estimated plant available soils nutrients, and irrigation water.

When irrigating, apply irrigation water in a manner that reduces the risk of nutrient loss to surface and ground water.

Follow all applicable State requirements and regulations when applying nutrients near areas prone to contamination, such as designated water quality sensitive areas (lakes, ponds, rivers, streams, sinkholes, wellheads, classic gullies, ditches, and surface inlets) that run unmitigated to surface or groundwater.

Soil and Tissue Testing and Analysis
Base the nutrient management plan on current soil test results in accordance with land grand university (Kansas State University) guidance. Use soil tests no older than two (2) years when developing new nutrient management plans. Use tissue testing, when applicable, for monitoring or adjusting the nutrient management plan in accordance with Kansas State University guidance.

For nutrient management plan revisions and maintenance, soil tests will be taken on a three (3) year interval for whole field plans and every four (4) years for precision nutrient application plans, or as required by local rules and regulations.

Collect, prepare, store, and ship all soil and tissue samples following Kansas State University guidance. See the Kansas Conservation Practice Standard 590, Nutrient Management, Construction Specifications, "Guidelines for Soil Sampling" section or Kansas State University Guidance MF-2586 "Soil Test Interpretations and Fertilizer Recommendations." The soil and tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget (such as pH, electrical conductivity [EC], and sodicity where salts are a concern, soil organic matter, phosphorus [P], potassium (K), or other nutrients, and test for nitrogen [N] where applicable.) Follow Kansas State University guidelines regarding required analyses and test interpretations.

For soil test analyses, use laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program under the auspices of the Soil Science Society of America and the Natural Resources Conservation Service (NRCS), or use an alternative NRCS approved or State approved certification program that considers laboratory performance and proficiency to assure the accuracy of soil test results. Alternative certification programs must have solid stakeholder support (such as the Kansas State Department of Agriculture, Kansas State University, a water quality control entity, NRCS State staff, growers, and others), and be State or regional in scope.

Maintain soil pH within ranges which enhance the adequate level for plant or crop nutrient availability and utilization. Refer to "Soil Test Interpretations and Fertilizer Recommendations" for guidance.

Manure, Organic By Product, and Biosolids Testing and Analysis
Samples must be collected, prepared, stored, and shipped according to Kansas State University Guidance MF-2562 "Estimating Manure Nutrient Availability." In the absence of such guidance, test at least annually (or more frequently if needed) to account for operational changes that impact manure nutrient concentrations (such as feed management, animal type, manure handling strategy, etc.). If no operation changes occur and operations can document a stable level of nutrient concentrations for the preceding three (3) consecutive years, manure may be tested less frequently, unless federal, State, or local regulations require more frequent testing. Follow Kansas State University guidelines regarding required analyses and test interpretations. At a minimum, analyze all of the following:

- total nitrogen (N)
- total phosphorus (P) or phosphorus pentoxide (P_2O_5)
- total potassium (K) or potassium oxide (K2O)
- percent solids

When planning for new or modified livestock operations (and manure tests are not available yet), use the output and analyses from similar operations in the geographical area, if they accurately estimate nutrient output from the proposed operation or use "book values" recognized by NRCS (such as the USDA NRCS National Engineering Handbook [NEH], Part 651–Agricultural Waste Management Field Handbook) and Kansas State University.

For manure analyses, use laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification program.

For nutrient management plans developed as a component of a comprehensive nutrient management plan for an animal feeding operation (AFO), follow the policy in the NRCS Directive, General Manual (GM)

Title 190, Part 405–Comprehensive Nutrient Management Plans. These plans must include documentation of all nutrient imports, exports, and on-farm transfers.

Nutrient Loss Risk Assessments
Use current NRCS approved nitrogen (N), phosphorus (P), and soil erosion risk assessment tools to assess the site-specific risk of nutrient and soil loss.

Complete an NRCS approved nutrient risk assessment for nitrogen (N) on all fields where nutrient management is planned, unless the State NRCS (in cooperation with the State water quality control authorities) has determined specific conditions where nitrogen (N) leaching is not a risk to water quality, including drinking water.

Complete an NRCS approved nutrient risk assessment for phosphorus (P) when any of the following conditions are met:

- Phosphorus (P) application rate exceeds Kansas State University's fertility rate guidelines for the planned rotation.
- The planned area is within a phosphorus (P) impaired watershed.
- The site-specific conditions equating to low risk of phosphorus (P) loss have not been determined by NRCS in cooperation with the State water quality control authority.

Any fields excluded from a phosphorus (P) risk assessment must have a document agronomic need for phosphorus (P), based on soil test phosphorus (P) and Kansas State University nutrient recommendations.

For fields receiving manure, where phosphorus (P) risk assessment results equate to:

TABLE 1:	**BASIS FOR NUTRIENT APPLICATION RATES FOR LIVESTOCK MANURE**		
Soil Test P (ppm P)			**N and P Nutrient Application Rates**
Bray-1 or Mehlich-3	**Olsen**	**P Index Rating Category**	
0-50	**0-33**	**All**	**Legume Crops -- Agronomic P Rate or 1.5 X Crop Removal**
0-50	**0-33**	**All**	**Non-Legume Crops -- Agronomic N Rate**
			All Crops
51-150	**34-100**	**Very Low, Low, Medium**	**1.5 X Crop P Removal**
		High, Very High	**1.0 X Crop P Removal**
151-200	**101-133**	**Very Low, Low, Medium**	**1.5 X Crop P Removal**
		High, Very High	**None**
201+	**134+**	**Very Low, Low, Medium**	**1.0 X Crop P Removal**
		High, Very High	**None**

- Manure that is applied at rates not to exceed crop phosphorus (P) removal rate, if the following requirements are met:
  - A soil phosphorus (P) drawdown strategy has been developed, documented, and implemented for the crop rotation.
  - Implementation of all migration practices determined to be needed by site-specific assessments for nutrients and soil loss to protect water quality.

- Any deviation from these high risk requirements that would increase the risk of phosphorus (P) runoff requires the approval of the Chief of NRCS.

The 4Rs of Nutrient Stewardship
Manage nutrients based on the 4Rs of nutrient stewardship (apply the right nutrient source at the right rate, at the right time, and in the right place) to improve nutrient use efficiency by the crop and to reduce nutrient losses to surface and groundwater and to the atmosphere.

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

Determine nutrient values of all nutrient sources (such as commercial fertilizers, manure, organic by-products, and biosolids) prior to land application.

Determine nutrient contribution of cover crops, previous crop residues, and soil organic matter.

For operations following USDA's National Organic Program, apply and manage nutrient sources according to program regulations.

For enhanced efficiency fertilizer (EEF) products, use products defined by the Association of American Plant Food Control Officials as EEF and recommended for use by Kansas State University.

In areas where salinity is a concern, select nutrient sources that limit the buildup of soil salts. When manures are applied and soil salinity is a concern, monitor salt concentrations to prevent potential plant or crop damage and reduced soil quality.

Apply manure or organic by-products on legumes at rates no greater than Kansas State University's estimated nitrogen (N) removal rates in harvested plant biomass, not to exceed phosphorus (P) risk assessment limitations.

For any single application of nutrients applied as liquid (such as liquid manure, nutrients in irrigation water, and fertigation):

- Do not exceed the soil's infiltration rate or water holding capacity.
- Apply so that nutrients move no deeper than the current crop rooting depth.
- Avoid runoff or loss to subsurface tile drains.

Nutrient Rate
Plan nutrient application rates for nitrogen (N), phosphorus (P), and potassium (K) using Kansas State University's recommendations. Lower than recommended nutrient application rates are permissible, if the producer's objectives are met.

At a minimum, determine the rate based on crop/cropping sequence, current soil test results, and NRCS approved nutrient risk assessments. Where applicable, use realistic yield goals.

For new crops or varieties in which Kansas State University guidance is unavailable, industry-demonstrated yield and nutrient uptake information may be used.

Realistic yield goals must be clearly documented for each field (such as scale tickets, yield monitors, insurance yield documentation, or Farm Service Agency [FSA] certified yields). Per Kansas State University Guidance MF-2586 "Soil Test Interpretations and Fertilizer Recommendations,":

"appropriate yield goals fall between the average yield obtained in a field over the past three (3) to five (5) years and is the highest yield ever obtained in a particular field."

Nitrogen (N) Application – Planned nitrogen (N) application rates shall match the recommended rates as closely as possible. Applied nitrogen (N) shall not exceed the recommended amounts in the nutrient

management portion of the conservation plan by the greater of ten (10) percent or ten (10) pounds per acre.

- If, after following well-planned nitrogen (N) management, a nitrogen (N) deficiency can be documented, supplemental nitrogen (N) fertilizer is allowed. Documenting nitrogen (N) deficiency requires comparison of a nitrogen (N) sufficient part of the field with the deficient area using tissue-nitrogen (N) testing through either chlorophyll meter or crop canopy color sensing. If tissue-nitrogen (N) sensed using chlorophyll meter or crop canopy color on the deficient areas are less than 95% of the sufficient area, supplemental nitrogen (N) may be applied.
- Phosphorus (P) Application – Planned phosphorus (P) application rates for the soil test cycle shall match the recommended rates as closely as possible.
- Applications of phosphorus (P) may be made for soil buildup (the buildup period shall not exceed six [6] years) and maintenance needs as annual or multi-year treatments. A single application to meet the recommended phosphorus (P) for multiple years in a cropping sequence may supply the calculated phosphorus (P) need for the soil test cycle, not to exceed two (2) years. Phosphorus

  (P) applications shall not exceed the target application rate by the greater of ten (10) percent or five (5) pounds per acre for the soil test cycle.

Agricultural Lime – Soil amendments shall be applied based on soil test results to adjust soil pH to an adequate level for crop nutrient availability and utilization.

- Application of the recommended amount of liming material shall be planned and made during the current soil testing cycle. Refer to Kansas State University Guidance MF-2586 “Soil Test Interpretations and Fertilizer Recommendations” for the desired rates.

Nutrient Application Timing and Placement
Consider the nutrient source, management and production system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment to develop optimal timing of nutrients. For nitrogen (N), time the application as closely as practical with plant and crop uptake. For phosphorus (P), time planned surface application when runoff potential is low. Time the application of all nutrients to minimize potential for soil compaction.

For crop rotations or multiple crops grown within a 12 month period, do not apply additional phosphorus (p) if it was already added in an amount sufficient to supply all crop nutrient needs.

To avoid salt damage, follow Kansas State University’s recommendations for the timing, placement, and rate of applied nitrogen (N) and potassium (K) in starter fertilizer.

Do not surface apply nutrients when there is a risk of runoff, including when:

- Soils are frozen.
- Soils are snow covered.
- The top two (2) inches of the soil are saturated.

Exceptions for the above criteria related to surface applied nutrients (when there is a risk of runoff) can be made when specified conditions are met and adequate conservation measures are installed to prevent the offsite delivery of nutrients. NRCS, in cooperation with the State water quality control authority, will define adequate treatment levels and specified conditions for applications of manure if soils are frozen and/or snow covered, or if the top two (2) inches of soil are saturated. At a minimum, consider the following site and management factors:

- Climate (long term)
- Weather (short term)
- Soil characteristics

- Slope
- Areas of concentrated flow
- Organic residue and living covers
- Amount and source of nutrients to be applied
- Setback distances to protect local water quality

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

Apply conservation practices to avoid nutrient loss and to control and trap nutrients before they can leave the field(s) by surface, leaching, or subsurface drainage (such as tile, karst, and sand) when there is a significant risk of transport of nutrients.

On each field, calculate the risk to soil and water resources using the:

- Approved erosion technology to estimate erosion.
- Leaching Index (LI) to determine the relative risk of nitrogen (N) leaching to ground or surface water.
- Phosphorus Index (PI) to estimate the risk that phosphorus (P) will contaminate surface water. The PI is required when one (1) or more of the following applies:
    - The phosphorus (P) application rate exceeds Kansas State University's fertility rate guidelines for planned crop(s) in the rotation
    - Manure, municipal or industrial biosolids, and/or organic by-products are applied
    - Phosphorus (P) sources are applied to soils where soil loss exceeds the tolerable level
    - Phosphorus (P) sources are applied to soils where the average soil test phosphorus (P) in the field is greater than 50 parts per million (ppm) Mehlich 3 P

When there is a high risk of transport of nutrients, conservation practices must be coordinated to avoid, control, or trap manure and nutrients, before they can leave the field by surface or subsurface drainage (such as tile). The number of applications and the application rates must also be considered to limit the transport of nutrients to tile.

For fields receiving manure where phosphorus (P) risk assessment results equate to VERY LOW or LOW risk, additional phosphorus (P) can be applied at rates greater than crop requirement, not to exceed the nitrogen (N) requirement for the succeeding crop.

For fields receiving manure where phosphorus (P) risk assessment results equal to MODERATE risk, additional phosphorus (P) may be applied at a phosphorus (P) crop requirement rate for the planned crops in the rotation.

For fields receiving manure where phosphorus (P) risk assessment results equate to HIGH or VERY HIGH risk, additional phosphorus (P) may be applied at phosphorus (P) crop removal rates, if the following requirements are met:

- A soil phosphorus (P) drawdown strategy has been implemented, **and**
- A site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality
- Any deviation from these high risk requirements must have the approval of the Chief of NRCS

Nutrient Management Strategies to Reduce Nonpoint Source Pollution

Consider using the following nutrient-use efficiency strategies or technologies:

- Include crops in the rotation and manage the crop sequence to require less added nitrogen (N) and phosphorus (P).
- More efficient timing and number of applications.

- Incorporation or injection.
- Calibrate application equipment and apply nutrient materials uniformly.
- Coordinate nutrient applications with optimum crop nutrient uptake.
- Slow and controlled release fertilizers.
- Nitrification and urease inhibitors.
- Late spring soil nitrate test and chlorophyll meter (SPAD) for in-season nitrogen (N) evaluation and to determine side-dress rates.
- End of season corn stalk nitrate test to evaluate nitrogen (N) management.
- Other Kansas State University demonstrated and/or accepted technologies that improve nutrient use efficiency and minimize surface or ground water resource concerns.

Additional Criteria to Reduce the Risk of Potential Pathogens from Manure, Biosolids, or Compost Application from Reaching Surface and Groundwater

When applicable, follow proper biosecurity measures as provided in NRCS Directives, GM Title 130–Agency General, Part 403–Homeland Security and Crisis Responsibilities, Subpart H–Biosecurity Preparedness and Response.

Follow all applicable federal, tribal, State, and local laws and policies concerning the application of manure, biosolids, or compost in the production of fresh, edible crops.

Apply manure, biosolids, or compost with minimal soil disturbance or by injection into the soil, unless it is being applied to an actively growing crop, if a minimum of 30 percent residue exists, or if there is a living cover that has a fibrous root system with 75 percent or more cover. Do not surface apply manure if a storm event is forecast within 24 hours.

Additional Criteria to Reduce Emissions of Objectionable Odors, PM and PM Precursors, and GHG and Ozone Precursors

To address air quality concerns (caused by odor, nitrogen [N], sulfur, and particulate emissions), adjust the source, timing, amount, and placement of nutrients to reduce the negative impact of these emissions on the environment and human health. One (1) or more of the following may be used:

- Slow or controlled release fertilizers.
- Nitrification inhibitors.
- Urease inhibitors.
- Nutrient enhancement technologies.
- Incorporation.
- Injection.
- Residue and tillage management.
- No-till or strip-till.

Do not surface apply solid nutrient sources (including commercial fertilizers, manure, or organic by-products of similar dryness and density) when there is a high probability that wind will blow the material and emissions offsite. Do not surface apply liquid nutrient sources when there is a high probability that wind will blow the liquid droplets applied from sprinklers or other applicable methods offsite.

Reduce the potential for volatilization by applying sources to volatilization during cooler, higher humidity conditions or by placement that minimizes vulnerability to volatilization.

Additional Criteria to Improve or Maintain Organic Matter

Design the plant or crop management systems so that the soil conditioning index (SCI) organic matter subfactor is positive.

Apply manure, compost, or other organic nutrient sources at a rate and with minimal disturbance that will improve soil organic matter without exceeding acceptable risk of nitrogen (N) or phosphorus (P) loss.

For low residue plant or cropping systems, apply adequate nutrients to optimize plant or crop residue production to maintain or increase soil organic matter.

CONSIDERATIONS

General Considerations

Consider the development of nutrient management plans by a conservation management unit (CMU). A CMU is a field, group of fields, or other land units of the same land use and has similar treatment needs and planned management. A CMU is a grouping by the planner to simplify planning activities and facilitate the development of conservation management systems. A CMU has definitive boundaries (such as fencing, drainage, vegetation, topography, or soil lines).

Develop site-specific yield maps using a yield monitoring system, multispectral imagery, or other methods. Use the data to further delineate low yield and high yield areas (or zones) and make the necessary management changes. Use variable rate nutrient application based on site-specific factor variability. See NRCS Directive, Agronomy Technical Note (TN) 190–AGR–3–Precision Nutrient Management Planning.

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

Consider using an adaptive approach to adjust nutrient rate, timing, form, and placement as soil biologic functions and soil organic matter changes over time. See NRCS Directive, Agronomy TN 190–AGR–7–Adaptive Nutrient Management Process.

When developing new nutrient management plans, consider using soil test information no older than one (1) year, rather than two (2) years.

Develop a whole farm nutrient budget (nutrient mass balance), including all imported and exported nutrients. Imports may include feed, fertilizer, animals and bedding, while exports may include crop removal, animal products, animal sales, manure, and compost.

Provide a nutrient analysis of all nutrient source exports (manure or other materials).

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

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.

Do not apply potassium (K) in situations where an excess (greater than soil test potassium [K] recommendation) may cause nutrient imbalances in crops or forages.

Use bioreactors and multistage drainage strategies to mitigate nutrient loss pathways, as applicable.

Use legume crops and cover crops to provide nitrogen (N) through biological fixation. Cover crops with a carbon (C) to nitrogen (N) ratio below 20:1 can release a large amount of soluble nitrogen (N) after being plowed or tilled into the soil when an actively growing crop is not present to take up nutrients. This leads to increased risks of nitrate movement and nitrous oxide emissions. The nitrous oxide emissions often occur in high soil moisture conditions (such as when a legume cover crop is plowed down in the fall or early spring). To avoid these losses, use grass-legume or grass-legume-forbs mixtures with a more balanced carbon (C) to nitrogen (N) ratio.

Use winter hardy grass cover crops to take up excess nitrogen (N) after the cash crop growing season and promote contribution of the nitrogen (N) to the next plant or crop.

Use conservation practices that slow runoff, reduce erosion, and increase infiltration.

Use application methods, timing, technologies, or strategies to reduce the risk of nutrient movement or loss, such as:

- Split nutrient applications.
- Banded applications.
- Injection of nutrients below the soil surface.
- Incorporate surface applied nutrient sources when precipitation is capable of producing runoff or erosion is forecast within the time of a planned application.
- High efficiency irrigation systems and technology.
- Enhanced efficiency fertilizers.
    - Slow or controlled release fertilizers
    - Nitrification inhibitors
    - Urease inhibitors
- Drainage water management.
- Tissue testing, chlorophyll meters, or real-time sensors.
- Pathogen management considerations.

When a recycled product (such as compost) is to be used as a nutrient source on food crops or as food for humans or animals, make sure that pathogen levels have been reduced to acceptable levels (reference the Food and Drug Administration's Food Safety Modernization Act [FSMA]). When the recycled product has come from another farming operation, implement biosecurity measures and evaluate the risk of pathogen transfer that could cause plant or animal diseases.

Use manure treatment systems that reduce pathogen content from manure.

Implementing a soil health management system (that reduces tillage or other soil disturbance) includes a diverse rotation of crops and cover crops, which keeps roots growing throughout the year, keeps the soils covered to reduce nutrient losses, and improves the following:

- Nutrient use efficiency, rooting depth, and availability of nutrients.
- Soil organic matter levels.
- Availability of nutrients from organic sources.
- Aggregate stability and soil structure.
- Infiltration, drainage, and aeration of the soil profile.
- Soil biological activity.
- Water use efficiency and available moisture.

Use targeted or prescribed livestock grazing to enhance nutrient cycling and improve soil nutrient cycling functions.

Elevated soil test phosphorus (P) levels may lead to reduced mycorrhizal fungal associations and immobilize some micronutrients (such as iron, zinc, and copper), and increase the susceptibility of phosphorus (P) loss.

Apply manure, compost, or other nutrient sources with minimal soil disturbance and at a rate that will improve soil organic matter without exceeding acceptable risk of nitrogen (N) or phosphorus (P) loss.

PLANS AND SPECIFICATIONS

In the nutrient management plan, document the following:

- Aerial site photograph(s), imagery, topography, or site map(s).
- Soil survey map of the site.
- Soil information, including:
  - Flooding and ponding frequency
  - Restrictive features
  - Depth to water table
  - Available water capacity
  - Permeability
  - Drainage class
  - Surface texture
  - Soil type
- Location of designated sensitive areas and the associated nutrient application restricts and setbacks.
- Location of nearby residences or other locations where humans may be present on a regular basis and may be impacted if odors or PM are transported to those locations.
- Results of approved risk assessment tools for nitrogen (N), phosphorus (P), and erosion losses.
- Documentation establishing the application site presents a low risk for phosphorus (P) transport to local water, if phosphorus (P) is applied in excess of crop requirement.
- Current and planned plant production sequence or crop rotation.
- All applicable test results (such as soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient budget and management plan are based.
- When soil phosphorus (P) levels are increasing above an agronomic level, include a discussion of the risk associated with phosphorus (P) accumulation and a proposed phosphorus (P) drawdown strategy.
- Realistic yield goals for the crops (where applicable for developing the nutrient management plan).
- Nutrient recommendations for nitrogen (N), phosphorus (P), and potassium (K) for the entire plant production sequence or crop rotation.
- Listing, quantification, application method, and timing for all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use, and the documentation of all nutrient imports, exports, and onsite transfers.
- Guidance for implementation, operation and maintenance, and recordkeeping.

For variable rate nutrient management plans, also include the following:

- Geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer (or layers) to generate nutrient or soil amendment recommendations per management zone. This must include:
  - Using soils data
  - Current soil test results
  - Yield monitoring system with GPS receiver to correlate field location with yield

See Agronomy TN 190–AGR–3–Precision Nutrient Management Planning.

- Nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer (or layers) to a nutrient source material recommendation GIS layer (or layers).
- After implementation, provide application records per management zone or as applied map within individual field boundaries (or electronic records), documenting source, timing, method, and rate of all nutrient or soil amendment applications.

If increases in soil phosphorus (P) levels are expected above an agronomic level (i.e., when nitrogen [N] based rates are used), document the following:

- Soil phosphorus (P) levels at which it is desirable to convert to phosphorus (P) based planning.
- A long-term strategy and proposed implementation timeline for soil test phosphorus (P) drawdown from the production and harvesting of crops.
- Management activities or techniques used to reduce the potential for phosphorus (P) transport and loss.
- For AFOs, a quantification of manure produced in excess of crop nutrient requirements.

OPERATION AND MAINTENANCE

Review or revise plans periodically to determine if adjustments or modifications are needed. At a minimum, review and revise plans as needed with each soil test cycle, changes in manure management, volume or analysis, plants and crops, or plant and crop management.

Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and phosphorus (P) in accordance with Kansas State University guidance and State law.

For an animal feeding operation, significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content.

Calibrate application equipment to ensure accurate distribution of material at planned rates. For products too dangerous to calibrate, follow Kansas State University or equipment manufacturer guidance on proper equipment design, plumbing, and maintenance.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation to explain the difference.

Protect the workers from harm and avoid unnecessary contact with nutrient sources. Take extra caution when handling anhydrous ammonia or when managing organic wastes stored in unventilated tanks, impoundments, or other enclosures.

Use material generated from cleaning nutrient application equipment in an environmentally safe manner. Collect, store, or field apply excess material in an appropriate manner.

Recycle or dispose of nutrient containers in compliance with State and local guidelines or regulations.

Maintain records for at least five (5) years to document plan implementation and maintenance. Records must include the following:

- All test results (soil, water, compost, manure, organic by-product, and plant tissue sample analyses) upon which the nutrient management plan is based.Listing and quantification of all nutrient sources (including all enhanced efficiency fertilizer products) that are planned for use and documentation of all nutrient imports, exports, and onsite transfers.
- Date(s), method(s), and location(s) of all nutrient applications.
- Weather conditions and soil moisture at the time of the application, elapsed time from manure application to rainfall or irrigation event(s).
- Plants and crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and plant or crop residues removed.
- Dates of plan review, name of reviewer, and recommended adjustments resulting from the review.

For variable rate nutrient management plans, also include the following:

- Maps identifying the variable application location, source, timing, amount, and placement of all plant

and crop nutrients applied.

- GPS-based yield maps for crops where yields can be digitally collected.

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