NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount, source, placement, form and timing of the application of plant nutrients and soil amendments.

PURPOSE

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

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied.

CRITERIA

General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to inorganic by-products (e.g., fly ash), animal manure and organic by-products, waste water, commercial fertilizer, legume crops, irrigation water, and soil organic matter.

Plans for nutrient management shall specify the source, amount, timing, and method of application of nutrients on each field to achieve realistic production goals, while minimizing movement of nutrients and other potential contaminants to surface and/or ground waters, and to the air.

Realistic yield goals shall be clearly documented and shall be established using the best available records and information from similar fields and management systems in the location of interest. Potential sources that may provide yield potential documentation include one of the following:

1. Yield data collected from the field for five (5) or more crop years. Ignore the highest and lowest years and calculate the mean of the remaining three. Add 10 percent to the mean yield to allow for potential to improve yield.
2. Crop yield estimates from county soil survey adjusted by soil-based crop productivity indices. Crop productivity indices can be found in “Productivity of Missouri Soils”, published by NRCS.
3. County average yield data collected by the National Agricultural Statistics Service.
4. Fully documented alternative systems to determine yield goals.

For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

The amount of nutrients lost to erosion, runoff, and drainage shall be addressed as needed. When soil loss exceeds the tolerable soil loss level (T), a risk assessment for phosphorus

transport potential shall be documented using the Missouri Phosphorus Index (refer to Appendix D, Table 2). Phosphorus applications where soil loss exceeds T shall be based on recommendations from this risk assessment.

Soil and Tissue Sampling and Laboratory Analyses (Testing). Nutrient planning shall be based on current soil and tissue (where used as a supplement) test results. Soil tests used to develop a nutrient plan shall be less than two years old. The soil sampling schedule developed for the nutrient plan will then ensure that fields are sampled at least once every four years. More frequent sampling will be required if fertilizer recommendations use a nutrient buildup period of less than four years.

When possible, avoid soil sampling within six months following the application of a phosphorus nutrient source or an agricultural lime application.

All procedures for the collection, analysis, and recommendations related to soil and tissue testing shall follow guidance from the University of Missouri when available.

Soil and tissue sample collection – Soil and tissue samples shall be collected and prepared according to University of Missouri guidance. For specific guidance, refer to University of Missouri Extension Guide Sheets G9131 – "Sampling Plant Tissue and Soil for Analysis", G9217 – "Soil Sampling Hayfields and Row Crops", and G9215 – "Soil Sampling Pastures".

A composite soil sample will be collected to represent approximately 20 acres or less. Composite samples shall consist of no fewer than 10 soil cores. Recommended sampling intensity is 10 to 15 soil cores on fields with little expected variability (e.g., row crop and hayfields receiving broadcast fertilizer applications) and 15 to 20 soil cores on fields expected to have significant variability (e.g., pastures and field with a history of banded fertilizer or manure applications). Grid sampling representing 3-acre areas or less will be accepted in lieu of composite analyses. Grid soil samples shall consist of approximately 10 soil cores collected within a 30-ft diameter of a central geo-referenced sampling point. Grid sampling strategies that differ significantly from this guidance should be documented as part of the nutrient management component of the conservation plan.

The soil sampling method will be modified to address special production or environmental concerns when permanent vegetative cover or long-term no-till is used in combination with surface-applied nutrients. Shallow sampling for pH and phosphorus may be warranted.

Tissue sampling and testing may be used to determine crop-specific nutrient deficiencies. Sampling methods shall be completed according to University of Missouri recommendations. For specific guidance, refer to University of Missouri Extension Guide Sheet IPM1016 – "Crop Nutrient Deficiencies and Toxicities."

Soil and tissue sample analyses – Soil and tissue sample analyses shall follow University of Missouri guidance when available. A list of currently acceptable analysis methods can be found at http://soilplantlab.missouri.edu/soil/procedures.htm. Analyses of soil samples shall be performed by laboratories using acceptable analysis methods, and that are accepted by the Missouri Soil Testing Association (see a current listing of accredited laboratories at http://soilplantlab.missouri.edu/soil/mstacertified.htm).

Fertilizer recommendations – The fertilizer recommendation system for all nutrients shall follow University of Missouri guidelines when available. Current recommendation guidance is provided by the "Recommendations Online" tool located at http://soilplantlab.missouri.edu/soil/scripts/manualentry.aspx. Fertilizer recommendations shall be based on nutrient sufficiency categories supplied by the University of Missouri. When the University of Missouri does not provide specific guidance for a nutrient and (or) crop, guidance from another land-grant university may be followed.

Crop nutrient removal (nutrients removed in harvested plant materials) is an important component of the maintenance portion of the fertilizer recommendation. Acceptable crop removal rates can be found in Appendix B.

The nutrient management component of the conservation plan may be modified to correct any nutrient deficiencies identified by tissue testing. For example, tests such as crop can-

opy color sensing for nitrogen status may be used to evaluate and adjust nitrogen application rates.

Nutrient Application Rates. Recommended nutrient application rates shall be based on University of Missouri recommendations that consider current soil test results, plant tissue tests where relevant, realistic yield goals, and management capabilities. If the University of Missouri does not provide specific guidance, recommendations from other land grant universities are acceptable, or application based on realistic yield goals and associated plant nutrient utilization rates is acceptable. When manure and organic by-products are used as a nutrient source see "Additional Criteria for Manure and Organic By-Products."

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

- Nitrogen Application – Planned nitrogen application rates shall match the recommended rates as closely as possible. Applied nitrogen shall not exceed the recommended amounts in the nutrient management portion of the conservation plan by the greater of 10 percent or 10 pounds per acre.

  If, after following well-planned nitrogen management, a nitrogen deficiency can be documented, supplemental nitrogen fertilizer is allowed. Documenting nitrogen deficiency requires comparison of a nitrogen-sufficient part of the field with the deficient area. If tissue-N or chlorophyll meter readings on the deficient areas are less than 95% of the sufficient area, supplemental nitrogen may be applied. Guidance for implementing supplemental nitrogen applications can be found in NRCS Agronomy Technical Guide No. 35.

- Phosphorus Application – Planned phosphorus application rates shall match the recommended rates as closely as possible.

  Applications of phosphorus may be made for soil buildup (the buildup period shall not exceed 12 years) and maintenance needs as annual or multi-year treatments. An application to meet the recommended phosphorus for multiple years in a cropping sequence may supply the calculated phosphorus need for the soil test cycle. Phosphorus applications shall not exceed the target application rate by the greater of 10 percent or 10 pounds per acre for the soil test cycle.

  Missouri Phosphorus Index – When the soil test phosphorus level is "High" or "Very High" the current Missouri Phosphorus Index shall be used to assess the risk of phosphorus transport and loss. If the Phosphorus Index rating is "High" or "Very High", information shall be included in the conservation plan concerning conservation practices and management activities that can reduce the potential for phosphorus movement from the application site.

- Potassium Application – Potassium shall not be applied in situations where excess (greater than soil test potassium recommendation) causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, University of Missouri guidelines shall be used to set forage quality criteria.

- Other Plant Nutrients – Other plant nutrients shall not be applied in situations where amounts greater than soil test recommendation cause unacceptable environmental impact.

- Starter Fertilizers – When starter fertilizers are used, they shall be included in the overall nutrient budget and applied in accordance with University of Missouri recommendations.

- Field-Level Fertilizer Applications – Fertilizer recommendations used to develop nutrient budgets shall be based on 20-acre field areas. When fertilizer recommendations are similar (within 10%) for adjoining 20-acre field areas, they may be combined for purposes of fertilizer application and nutrient budgeting. Field areas of up to 80 acres may be combined using this guidance. Larger field areas may be combined if a justification for this decision in documented in the nutrient management plan.

- Incidental Nutrient Applications – Commercially available fertilizer formula-

tions sometimes contain secondary amounts of nutrients in addition to a primary nutrient. Examples include the common phosphorus fertilizers MAP (monoammonium phosphate [$NH_4H_2PO_4$]) and DAP (diammonium phosphate [$(NH_4)_2HPO_4$]). All nitrogen, phosphorus, and potassium applied in a fertilizer formulation must be included in the nutrient budget and the application from all sources shall not exceed the annual utilization of nitrogen.

- Agricultural Lime – Soil amendments shall be applied, as needed, 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 University of Missouri Extension Guide Sheet G9102 – "Liming Missouri Soils" for the desired soil $pH_{(salt)}$ ranges for Missouri crops.

  Liming materials shall be applied according to soil test results; however, if the recommended amount of liming material is less than 600 lbs ENM, application may be deferred until the next soil testing cycle. Acceptable liming materials are those approved by the Missouri AgLime Control Service (see http://aes.missouri.edu/pfcs/aglime/index.stm).

  Liming materials will be applied and incorporated prior to planting when inversion tillage is used to prepare a seedbed. Deep incorporation of agricultural lime will improve crop rooting depths, increase available nutrients, and improve crop yields. To establish a legume crop, lime should be applied at least three months prior to planting. Liming materials will be applied to established forages or no-till crop rotations as a surface application without incorporation.

Nutrient Application Timing. Timing of nitrogen application shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, risk assessment tools (i.e., Leaching Index), and field accessibility. Options for timing of nitrogen application may be expanded if steps are taken to adequately minimize leaching of nitrate. Fall applications of nitrogen for spring-seeded crops are not recommended. However, if fall nitrogen applications are made, follow guidance given in Appendix E.

To minimize nitrogen and phosphorus losses in runoff, surface applications of manure and organic nutrients shall not be made on saturated, frozen, or snow-covered ground. Surface applications should be avoided when heavy rainfall likely to result in runoff is expected within 24 hours.

Nutrient Application Methods. Application methods to reduce the risk of nutrient transport to surface and ground water, or into the atmosphere shall be employed.

To minimize nutrient losses:

- Apply nutrient materials uniformly to application area(s), except when variable-rate application is employed using site-specific management.
- On irrigated farms, incorporate water management to conform to the IRRIGATION WATER MANAGEMENT (449) conservation practice standard. The nutrient content of the irrigation water shall be determined by periodic water analysis and considered when balancing nutrient needs. An annual water analysis will be required when the water supply contributes 10 percent or more of the crop or forage need of at least one primary nutrient (nitrogen, phosphorus, or potassium).
- Calibrate equipment to apply fertilizer products uniformly and at acceptable rates. Design a system to apply fertilizer blends at rates that are efficient for the application equipment and require minimal changes or adjustments between fields.
- Avoid application of anhydrous ammonia on wet soils or other situations where application slots will not seal adequately.
- Avoid surface application of urea-based fertilizers in no-till unless steps are taken to minimize loss as ammonia.

Conservation Management Unit (CMU) Risk Assessment. In areas with an identified or designated nutrient-related water quality impairment, a CMU-specific risk assessment of

the potential for nutrient transport from the area shall be completed. An area having an identified or designated nutrient-related water quality impairment is:

1. A watershed having at least one current nutrient-related water quality impairment identified by the Missouri Department of Natural Resources. The impairment may identified as:
    - a water body with Total Maximum Daily Load (TMDL) calculation related to agricultural nutrients, OR
    - a 303(d)-listed water body with an impairment related to agricultural nutrients.
2. The current TMDL or 303(d)-listed nutrient-related water quality impairment must result from agricultural nonpoint source (AgNPS) nutrients or from nutrients derived from livestock production.
3. An area with a nutrient-related water quality impairment may be designated for programmatic purposes. In Missouri, examples of programs that may designate nutrient-impaired areas include the Special Area Land Treatment (SALT) Program administered by the Missouri Department of Natural Resources, and the Section 319 Nonpoint Source Grant program, funded by the USEPA and administered by the Missouri Department of Natural Resources.

Risk assessments may be waived when documentation is included in the conservation plan showing that the CMU is not part of the contributing area for the impaired water body.

Assessment tools that evaluate the potential for nitrogen and phosphorus transport from the field include the Leaching Index and the Missouri Phosphorus Index (eFOTG Section II B-3). The results of assessments from these tools shall be discussed with the landowner and decisions regarding actions to mitigate nitrogen and phosphorus losses will be included in the conservation system and nutrient management planning. Possible actions to mitigate nutrient losses include:

- Apply only the nitrogen needed to meet the planned realistic yield goal and as close to the time of plant utilization as possible.
    - Do not apply nitrogen before February 1 south of I-70 and March 1 north of I-70 for spring-seeded row crops.
    - Fall nitrogen applications on fall-seeded grain crops shall not exceed 50 lbs N/acre.
    - Fall nitrogen applications on forage crops shall not exceed 60% of annual need.
- Use split applications, slow-release fertilizers, and/or nitrification inhibitors where runoff or leaching are a concern.
- Injection of nutrients on the contour can reduce soluble nutrient losses in runoff. Consider incorporating nutrients if the impact on soil loss is compatible with soil conservation goals.
- Use the stalk nitrate tissue test to assess the accuracy of nitrogen fertilizer applications.
- Use local water budgets as a guide to determine when the greatest likelihood for runoff or deep percolation will occur.

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

When animal manures or organic by-products are applied, a risk assessment of the potential for phosphorus transport from the CMU shall be completed to adjust the amount, placement, form, and timing of application of phosphorus. The phosphorus risk assessment shall be performed using either the Missouri Soil Test Phosphorus method or the Missouri Phosphorus Index. See Appendix D for ratings. Include:

- A record of the assessment method selected and the assessment rating for each field or subfield, and
- Information concerning the conservation practices and management activities that can reduce the potential for phosphorus movement from the application site.

The results of the risk assessment and any specific recommendations shall be discussed with the producer during the development of the nutrient management portion of the conservation plan.

Areas contained within established minimum application setbacks shall not receive direct application of manure nutrients. Minimum setback distances established by Missouri state law include:

1. 300 feet from losing streams, sinkholes, caves, wells, abandoned wells, water supply structures or impoundments and any other connection between surface and groundwater.
2. 150 feet from dwellings or public use areas if applied with spray irrigation systems.
3. 100 feet from permanent flowing streams, intermittent flowing streams, privately-owned impoundments not used as a water supply and surface waters down-gradient to land application.
4. 50 feet for application by tank wagon or solid spreader from dwellings or public use areas.
5. 50 feet from property lines or public roads.

More specific information for minimum setback distances is contained in Appendix C. Local laws may extend state-specified minimum setback distances.

Manure and organic by-products shall not be applied on land having a slope greater than 20 percent.

Manure and Organic By-Product Nutrient Application Rates. All unique sources of land-applied manure must be sampled at least once per year and tested for the following elements: total nitrogen, ammonium-nitrogen, total phosphorus, total potassium, and percent moisture or dry matter. If excessive salt concentrations are a concern, analyze the manure sample's electrical conductivity. In some cases substantial annual variation in nutrient concentrations may require sampling a manure source more than once per year. For example, unagitated lagoons can have significantly higher total nitrogen concentrations in spring compared to fall.

When possible, sample and analyze manure just prior to the primary time for land application of manure so the results are available for calculating manure application rates. In some cases it is only possible to get a representative sample during land application (for example, agitated manure pits). In these cases, historic values should be used to calculate application rates and the manure sampled during application should be used to contribute to the historic record of sample results.

Samples shall be collected and prepared according to University of Missouri recommendations (see University of Missouri Extension Guide Sheets EQ215 -- "Laboratory analysis of manure" and G9340 -- "Sampling poultry litter for manure testing") and according to state and local regulations. Land Grant University guidance or industry practice.

When writing a nutrient management plan use professional judgment to determine if the most recent manure test or some summary of past tests best estimates the nutrient concentration in the manure storage. When planning for new operations use professional judgment to determine if "book values", feed-based, or manure test results from similar storage facilities provides the best estimate of manure nutrient concentration. For book values refer to the "NRCS Agricultural Waste Management Field Handbook" and Midwest Plan Service No. 18, Section 1 (2^{nd} Edition), "Manure Characteristics". For book values and feed-based estimates of nutrient generation refer to ASAE D384, "Manure Production and Characteristics".

The planned rates of nitrogen and phosphorus applied recorded in the plan shall be determined based on the following guidance:

<u>Nitrogen Application Rates</u>

When animal manures or organic by-products are applied, the planned rates of nitrogen application shall consider:

- Plant-available nitrogen (PAN). For most sources of manure not all the nitrogen is available to the plant in the year of application. PAN in the manure must be de-

terminted according to the methods approved by the Missouri Department of Natural Resources for all manure applications. Manure application rate should be based on the PAN in the manure and should not exceed the annual nitrogen need of the crop adjusted for other sources of nitrogen applied to the crop. Nitrogen rates in the years following manure application must be adjusted for residual nitrogen available from manure.

- Plant uptake characteristics. When animal manures or organic by-products are used, the nitrogen availability of the planned application rates shall match plant uptake characteristics as closely as possible, taking into consideration the timing of nutrient application(s) in order to minimize leaching and atmospheric losses.
- Management activities and technologies that effectively utilize mineralized nitrogen and that minimize nitrogen losses through denitrification and ammonia volatilization.
- Application on legumes. Manure or organic by-products may be applied on legumes at rates not to exceed the estimated removal of nitrogen in harvested plant biomass. When manure or organic by-products are applied to legumes, the Leaching Index shall be used as a risk assessment for nitrate leaching.
- Supplemental inorganic nitrogen fertilizer. In some situations manure nitrogen is not applied at rates high enough to meet plant need. When required, an additional nitrogen application from non-organic sources may supplement manure plant-available nitrogen to produce the recommended total amount of nitrogen. Planned total nitrogen (plant-available organic plus inorganic fertilizer nitrogen) application rates shall not exceed annual crop nitrogen need by the greater of 10 percent or 10 pounds per acre in any given year.

Phosphorus Application Rates

When manure or organic by-products are used, the planned rates of phosphorus application shall be consistent with any one of the following options:

- Soil Test. Apply manure at nitrogen-based rates when additional phosphorus is needed and likely will increase crop yield. A soil test phosphorus rating of “Very Low”, “Low”, or “Medium” will allow organic nutrients to be applied on a nitrogen basis. When soil test phosphorus is “High” (adequate for crop production and buildup is not necessary), phosphorus-based manure application is allowed. When the soil test phosphorus rating is “Very High”, phosphorus should not be applied. Refer to Appendix D, Table 1.
- Missouri Phosphorus Index Rating. Nitrogen-based manure application on “Low” or “Medium” risk sites; phosphorus-based manure application on “High” risk sites, and no manure application on “Very High” risk sites. Refer to Appendix D, Table 2 for guidance on using the Missouri Phosphorus Index. Manure application on fields that have Very High soil test phosphorus and when the phosphorus index is medium or lower is not a sustainable practice. Use the phosphorus index to transition from nitrogen-based to phosphorus-based management.
- Phosphorus-based manure applications may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence. When such applications are made, the application rate shall:
  - ♦ not exceed the recommended nitrogen application rate during the year of application, or
  - ♦ not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when there is no recommended nitrogen application, and
  - ♦ ensure that the amount of phosphorus banked in the soil in excess of crop annual removal will not exceed four years of crop removal.

Additional Requirements

- Biosolids (sewage sludge) shall be applied in accordance with USEPA regulations [40 CFR Parts 403 (Pretreatment) and 503 (Biosolids)] and other state and/or local regulations regarding the use of biosolids as a nutrient source.
- When sewage sludge (biosolids) 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 or regulations.
- The application rate (in/hr) of liquid materials applied shall not exceed the soil intake/infiltration rate and shall be adjusted to minimize ponding and to avoid runoff. The total application shall not exceed the field capacity of the soil and shall be adjusted, as needed, to minimize loss to subsurface tile drains.

Additional Criteria to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere

USEPA-designated non-attainment areas for criteria atmospheric pollutants that are nutrient management-related can be found at http://www.epa.gov/oar/oaqps/greenbk/. Within these areas any component(s) of nutrient management (i.e., amount, source, placement, form, timing of application) identified by NRCS-approved risk assessment tools as a potential source of atmospheric pollutants shall be adjusted, as necessary, to minimize the losses.

When tillage can be performed without adverse effects on water quality, surface applications of manure and fertilizer nitrogen formulations that are subject to volatilization on the soil surface (e.g., urea) shall be incorporated into the soil within 24 hours after application.

When manure or organic by-products are applied to grassland, hayland, pasture, or minimum-till areas, the rate, form, and timing of application(s) shall be managed to minimize volatilization losses.

When liquid forms of manure are applied with irrigation equipment, operators will select weather conditions during application that will minimize volatilization losses.

Operators will handle and apply poultry litter or other dry types of animal manures when the potential for wind-driven loss is low and there is less potential for transport of particulates into the atmosphere.

Weather and climatic conditions during manure or organic by-product application(s) shall be recorded and maintained in accordance with the operation and maintenance section of this standard.

Additional Criteria to Improve the Physical, Chemical, and Biological Condition of the Soil

Nutrients shall be applied and managed in a manner that maintains or improves the physical, chemical, and biological condition of the soil.

Minimize the use of nutrient sources with high salt content unless provisions are made to leach salts below the crop root zone.

To the extent practicable nutrients shall not be applied when the potential for soil compaction and/or rutting is high.

CONSIDERATIONS

The use of management activities and technologies listed in this section may improve both the production and environmental performance of nutrient management systems.

The addition of these management activities, when applicable, increases the management intensity of the system and is recommended in a nutrient management system.

The nutrient budget should be reviewed annually to determine if any changes are needed for the next planned crop.

Soil test information should be no older than one year when developing new plans, particularly if animal manures are to be used as a nutrient source.

Following the application of any nutrient applied at rates exceeding soil test recommendations or crop removal rate, an updated soil test should be evaluated prior to applying additional fertilizer or organic nutrients in future years.

If increases in soil phosphorus levels are expected, consider a more frequent (annual) soil testing interval.

For sites on which there are special environmental concerns, other sampling techniques may be appropriate. These include soil profile sampling for inorganic nitrogen, Pre-Sidedress Nitrate Test (PSNT), Pre-Plant Soil Nitrate Test (PPSN), and soil surface sampling (0 to 2 inches) for phosphorus accumulation or pH changes.

Additional practices that may enhance the producer's ability to manage manure effectively include modification of the animal's diet to reduce the manure nutrient content, or utilization of manure amendments that stabilize or tie up nutrients.

To manage the conversion of nitrogen in manure or fertilizer, use products or materials (e.g. nitrification inhibitors, urease inhibitors and slow- or controlled-release fertilizers) that more closely match nutrient release and availability for plant uptake. These materials may improve the nitrogen use efficiency of the nutrient management system by reducing losses of nitrogen into water and/or air.

Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Ground Water.

Erosion control and runoff reduction practices can improve soil nutrient and water storage, infiltration, aeration, tilth, diversity of soil organisms, and protect or improve water and air quality. Evaluate the conservation system and consider the benefit of additional conservation practices.

Cover crops can effectively utilize and/or recycle residual nitrogen.

Apply nutrient materials uniformly to the management area, except when variable-rate application techniques are utilized. Application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere include:

- split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- nitrification inhibitors when applying nitrogen prior to planting the crop to reduce the risk of nitrate losses through leaching and denitrification,
- no winter nutrient application for spring-seeded crops,
- band applications of phosphorus near the seed row, and
- incorporating surface-applied manures or organic by-products as soon as possible after application to minimize nutrient losses where appropriate.

Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere.

Odors associated with the land application of manures, organic by-products, and/or commercial fertilizers can be offensive to the occupants of nearby homes. Avoid applying these materials upwind of occupied structures when residents are likely to be home (evenings, weekends, and holidays).

When applying manure with irrigation equipment, modifying the equipment can reduce the potential for volatilization of nitrogen from the time the manure leaves the application equipment until it reaches the surface of the soil (e.g., reduced pressure, drop-down tubes for center pivots). Nitrogen volatilization from manure in a surface irrigation system will be reduced when applied under a crop canopy.

Nitrogen lost to the atmosphere as ammonia may be reduced by adding urease inhibitor when urea fertilizer is surface-applied.

When planning nutrient applications, use reduced tillage operations that encourage soil carbon buildup while discouraging greenhouse gas emissions [e.g., nitrous oxide (N_2O) and carbon dioxide (CO_2)].

PLANS AND SPECIFICATIONS

Plans and specifications for nutrient management 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 resource impairment.

Nutrient management portions of conservation plans shall include a statement that the plan was developed based on requirements of the current standard and any applicable Federal, state, or local regulations, policies, or programs, which may include the implementation of other practices and/or management activities. Changes in any of these requirements may necessitate a revision of the plan.

The following components shall be included in the nutrient management portion of a conservation plan:

- aerial site photographs or field maps and a soil map along with soil descriptions specific to this use;
- current and/or planned plant production sequence or crop rotation;
- soil test results and recommended nutrient application rates based on realistic production;
- manure, litter, compost, and /or effluent tests; and any special nutrient tests such as water analysis, plant tissue tests, late-season cornstalk nitrate test;
- the location of sensitive areas or critical resource areas if present on the Conservation Management Unit where special attention will be required when applying nutrients;
- a description of the size and kind of livestock present including the quantity of manure materials produced during the planning period;
- a description of the waste management system including production, storage, transfer, and handling system including the application equipment and labor required to land-apply the manure products;
- a schedule of manure product application based on the maximum nutrient efficiency to include annual rates, frequency of application, anticipated timing of applications, length of time to incorporate after application, and amounts of nitrogen, phosphorus, and potassium applied at the planned rates;
- a quantification of all important nutrient sources and losses to be considered;
- the recommended rates, methods, incorporation, and timing of all nutrient applications;
- a complete nutrient budget for nitrogen, phosphorus, and potassium for the crop or forage production system; and
- specific guidance for implementation, operation, maintenance, and recordkeeping including periodic reviews and revisions.

If increased soil phosphorus levels are expected, or manure/organic by-products are land-applied, the nutrient management component of a conservation plan shall document:

- the soil phosphorus levels at which it may be desirable to convert to phosphorus-based planning,
- results of appropriate risk assessment tools (Missouri Phosphorus Index) to document the relationship between soil phosphorus levels and potential for phosphorus transport from the field,
- the potential for soil phosphorus drawdown from the production and harvesting of crops, and
- management activities or techniques used to reduce the potential for phosphorus loss.

OPERATION AND MAINTENANCE

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

- periodic plan review (annual review recommended) to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle;
- significant changes in manure storage capacity and methods, animal numbers, and/or feed management will necessitate additional manure sampling and analyses to establish a revised average nutrient content;

- provisions for protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage;
- calibration procedures for application equipment to ensure uniform distribution of material at planned rates;
- the actual rate at which nutrients were applied. When the actual rates used differ from the recommended and planned rates, records will indicate the reasons for the differences;
- plan implementation. As applicable, records include:
    - soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application;
    - quantities, analyses, and sources of nutrients applied;
    - dates and method(s) of nutrient application and incorporation;
    - weather conditions and soil moisture at the time of application; lapsed time between manure incorporation, rainfall, or irrigation event;
    - crops planted, planting and harvest dates, yields, and crop residues removed; and
    - dates of plan review, name of reviewer, and recommended changes resulting from the review.

Records should be maintained for five years, or for a period longer than five years if required by other Federal, state, or local ordinances, or program or contract requirements.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources. Extra caution must be taken when handling ammoniacal nutrient sources 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.

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APPENDIX A
MISSOURI RESOURCES AND LINKS

QUICK REFERENCE--INTERNET LINKS

Missouri Fertilizer Recommendation Tool

- http://soilplantlab.missouri.edu/soil/recommendationsonline.asp

Approved Soil Testing Laboratories for Missouri

- http://soilplantlab.missouri.edu/soil/mstacertified.htm

Missouri Phosphorus Index

- http://www.mo.nrcs.usda.gov/technical/nut_mgmt_index.html

Resources for Nutrient Management Planners

- http://www.nmplanner.missouri.edu/

Technical References for NRCS Nutrient Management Planners

- http://www.mo.nrcs.usda.gov/technical/technotes_index.html

APPENDIX B
AGRONOMIC CROP NUTRIENT REMOVAL ESTIMATES

Crop code[1]	Crop	Source	Yield unit	Yield wt.	Moisture content	Nitrogen removal	P_2O_5 removal	K_2O_5 removal
					%	*Pounds per yield unit*		
100	Barley	Beef NRC, 2000[2]	bushel	48	14.5	0.87	0.33	0.29
101	Buckwheat	Other[4]	pound	1		0.05	0.007	0.003
102	Cotton	Other[4]	pound	1		-	0.038	0.035
103	Corn Grain	Beef NRC, 2000[2]	bushel	56	15.5	0.74	0.32	0.25
104	Corn Silage	Dairy NRC, 2001[3]	ton	2000	65	10	4.1	10
109	Oats	Beef NRC, 2000[2]	bushel	32	14	0.60	0.26	0.17
110	Popcorn	Other[4]	pound	1		0.64	0.008	0.005
111	Rice	Other[4]	pound	1		0.013	0.0065	0.004
112	Rye	Other[4]	bushel	56	14	1.2	0.34	0.34
113	Sorghum grain	Beef NRC, 2000[2]	pound	56	13	0.98	0.38	0.26
114	Sorghum silage	Dairy NRC, 2001[3]	ton	2000	65	10	3.3	15
115	Soybean	Beef NRC, 2000[2]	bushel	60	13	3.4	0.80	1.30
116	Sugar beets	Other[4]	ton	2000		4	1.33	3.33
117	Sunflowers	Dairy NRC, 2001[3]	pound	1	10	0.028	0.010	0.012
118	Tobacco	Other[4]	bushel			0.036	0.004	0.007
119	Wheat	Dairy NRC, 2001[3]	bushel	60	13.5	1.18	0.50	0.30
10	Alfalfa-grass hay	Beef NRC, 2000[2]	ton	2000	10	54	11	53
14	Bermudagrass hay	Dairy NRC, 2001[3]	ton	2000	10	30	11	40
16	Clover-grass hay	Dairy NRC, 2001[3]	ton	2000	10	55	13	57
18	Cool season grass hay	Dairy NRC, 2001[3]	ton	2000	10	38	12	47
22	Lespedeza-grass hay	Other[4]	ton	2000	10	-	8.8	20
24	Sudangrass hay	Dairy NRC, 2001[3]	ton	2000	10	27	8	52
26	Warm season grass hay	Other[4]	ton	2000	10	-	-	-

[1]Crop codes are used by the University of Missouri Recommendations Online Tool (http://soilplantlab.missouri.edu/soil/scripts/manualentry.aspx).

[2]Beef NRC, 2000—"Nutrient Requirements of Beef Cattle", Seventh Revised Edition, (Update), National Research Council, National Academy Press, Washington, D.C. 2000.

[3]Dairy NRC, 2001—"Nutrient Requirements of Dairy Cattle", Seventh Revised Edition", National Research Council, National Academy Press, Washington, D.C. 2001.

[4]Other, currently based on the previous Soil Test Interpretations Handbook (5/2006).

APPENDIX C
MINIMUM SETBACK DISTANCES FOR LAND-APPLICATION OF MANURE NUTRIENTS

NOTE: Some counties and townships have additional restrictions (health and zoning ordinances) that may require larger setback distances.

Manure and organic by-products shall not be directly applied to environmentally sensitive land features. Setback distances (a zero-application zone) shall be maintained between the land application site and sensitive features as follows:

	Spray Irrigation		All other methods of application	
Feature	**Manure applied up-gradient**	**Manure applied down-gradient**	**Manure applied up-gradient**	**Manure applied down-gradient**
Public drinking water well	300	300	300	300
Public drinking water lake/impoundment	300	300	300	300
Public drinking water intake structure	300	300	300	300
Private drinking water well	300	300	300	300
Private drinking water lake/impoundment	300	300	300	300
Private drinking water intake structure	300	300	300	300
Agricultural well	300	300	300	300
Plugged well	0	0	0	0
Abandon well	300	300	300	300
Other wells	300	300	300	300
Open tile/drainage inlet	100	0	100	0
Plugged tile/drainage inlet	0	0	0	0
Agricultural drainage well	0	0	0	0
Developed spring	300	300	300	300
Undeveloped spring	300	300	300	300
Intermittent stream/arroyo	100	0	100	0
Perennial stream	100	0	100	0
River/waterway/canal	100	0	100	0
Drainage ditch	0	0	0	0
Roadside ditch	0	0	0	0
Grassed waterway centerline	0	0	0	0
Sinkhole	300	300	300	300
Losing stream	300	300	300	300
Cave	300	300	300	300
Rock outcrop	0	0	0	0
Mine or quarry	0	0	0	0
Other surface-groundwater connections	300	300	300	300
Lake	100	0	100	0
Water impoundment	100	0	100	0
Private impoundment, no outlet	100	0	100	0
Ag. drinking water lake/impoundment	100	0	100	0
Water/sediment control basin	0	0	0	0
Designated wetland	0	0	0	0
Other wetland	0	0	0	0
Ocean	0	0	0	0
Estuary	0	0	0	0
Public road	50	50	50	50
Property boundary	50	50	50	50
Residence (owned)	0	0	0	0
Residence (non-owned)	150	150	50	50
Business (owned)	0	0	0	0
Business (non-owned)	150	150	50	50
Public use area	150	150	50	50
Public use facility	150	150	50	50
Incorporated area	0	0	0	0

APPENDIX D

PHOSPHORUS ASSESSMENT RATINGS

In Missouri one of two options shall be used for phosphorus loss assessment for fields receiving manures and organic by-products.

(1) Soil Test Phosphorus Method --

When soil test phosphorus levels are used, phosphorus may be applied at rates consistent with Table 1.

Table 1. Soil Test Phosphorus Values

Soil Test Phosphorus Level[†]	Phosphorus Application
Very low	Nitrogen-Based
Low	Nitrogen-Based
Medium	Nitrogen-Based
High	Phosphorus Based on Crop Removal
Very High	Phosphorus Should Not Be Recommended

[†]**Use methods and interpretations accepted by the University of Missouri.**

(2) Missouri Phosphorus Index Method –

When the Phosphorus Index method is used, phosphorus may be applied at rates consistent with Table 2. The Missouri Phosphorus Index may be obtained at http://www.mo.nrcs.usda.gov/technical/nut_mgmt_index.html.

Table 2. Phosphorus Index Interpretations

Phosphorus Index Rating	For Manure and Organic By-product Applications[†]	For Commercial Fertilizer Applications[‡]
Low Risk	Nitrogen-Based	Phosphorus fertilizer permitted
Medium Risk	Nitrogen-Based	Phosphorus fertilizer permitted
High Risk	Phosphorus Based on Crop Removal	Phosphorus Should Not Be Recommended
Very High Risk	Phosphorus Should Not Be Recommended	Phosphorus Should Not Be Recommended

[†]Use for all manure and organic by-products applications
[‡]Use when soil loss estimate from RUSLE2 predicts soil loss in excess of the tolerable soil loss (“T”)

APPENDIX E

GUIDANCE FOR APPLICATION OF NITRIFICATION INHIBITORS IN MISSOURI

NOTE: This guidance is condensed from Agronomy Technical Guide No. 34 (http://www.mo.nrcs.usda.gov/technical/technotes_index.html)

Nitrification inhibitors are bactericides applied with anhydrous ammonia fertilizers to slow the conversion of ammonium to nitrate. To reduce the rate of conversion of ammonium to nitrate, it is recommended that anhydrous ammonia with nitrification inhibitor be applied only after the 6-inch soil temperature falls below 50ºF in autumn and winter.

Permissible application dates for anhydrous ammonia with nitrification inhibitor in Missouri are shown in the map below. The state has been divided into three climatic zones that estimate the date when 6-inch soil temperature will stay below 50ºF. For Zone 1, anhydrous ammonia with nitrification inhibitor can be applied any time after November 15. For Zone 2, anhydrous ammonia with nitrification inhibitor can be applied anytime after December 1. For Zone 3, anhydrous with nitrification inhibitor should be delayed until after January 1.