



MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Missouri Concentrated Animal Feeding Operation Nutrient Management Technical Standard

March 4, 2009

Division of Environmental Quality

Water Protection Program

I Introduction

A. Authority and Purpose

Missouri statutory requirements for Concentrated Animal Feeding Operations (CAFOs), located within 640.700 to 640.758 RSMo., grants the Missouri Department of Natural Resources and the Missouri Clean Water Commission authority and jurisdiction to promulgate rules regulating the establishment, permitting, design, construction, operation and management of Class I CAFOs. The department's CAFO regulations require the development and implementation of a field specific Nutrient Management Plan (NMP), meeting the criteria prescribed in 10 CSR 20-6.300(5)(A)-(I), at all Class I CAFOs.

In accordance with 10 CSR 20-6.300(3)(G)3., this Nutrient Management Technical Standard (NMTS) has been developed to provide a framework for the protocol(s) and method(s) that CAFOs should utilize when determining the form, source, amount, timing, and method of application on individual land application fields. Furthermore, this NMTS represents the department's best professional judgment regarding how to satisfy and/or implement the specific NMP criteria G, H and I within 10 CSR 20-6.300(5)(A). This framework seeks to achieve realistic production goals while ensuring appropriate agricultural utilization of the nutrients in the manure, litter, or process wastewater while also minimizing movement of nitrogen, phosphorus, and other potential water contaminants into surface and/or ground water.

This NMTS will be used by the department and partnering federal agencies as a guide for determining when precipitation-related discharges from CAFO land application fields are exempted as "Agriculture Stormwater Discharge" as allowed within 10 CSR 20-6.300(2)(B)7. CAFOs will qualify for the Agriculture Stormwater Discharge exemption when they can demonstrate compliance with this NMTS at the time of a precipitation-related discharge from land application areas.

B. Applicability

In Missouri, all confinement operations with 1,000 animal units or greater are Class I CAFOs and must follow the requirements set forth in this NMTS in accordance with the regulations found in 10 CSR 20-6.300. New and expanding CAFOs that apply for a construction permit after February 26, 2009 must have a nutrient management plan that complies with this NMTS developed prior to issuance of an operating permit. For purposes of this paragraph, an expanding CAFO is a CAFO that is adding a manure storage structure or confinement barn and expanding the total animal capacity of the operation. All other CAFOs must develop nutrient management plans that meet this NMTS prior to renewal of their permit.

NOTE: An operation may choose to use alternative protocols other than those established in this standard, however, it must be able to demonstrate that such alternative protocols provide both a reliable and a technically valid basis for achieving the nutrient management objectives.

II. Definitions

Manure - For the purposes of this document the term “manure” will refer to any form of litter, manure, wastewater, animal mortality byproduct or other organic residuals collected from the production areas of animal feeding operations.

Missouri Phosphorus (P) Index – The Missouri P-index is designed to help identify fields that have a high probability of phosphorus loss from the combined effects of erosion and high soil test phosphorus. The Missouri P-index integrates field information including current soil test phosphorus level, tillage type, anticipated land cover, soil hydrologic category, distance of the field from a receiving body of water along with an estimate of soil loss derived from the NRCS erosion prediction software, RUSLE2 (Revised Universal Soil Loss Equation Version 2). The Missouri P-index may be utilized when the soil test phosphorus level is “High” or “Very High” and must be conducted in accordance with the University of Missouri (MU) Guide G9184. The Missouri P-index is currently distributed as a Microsoft Office Excel spreadsheet available on the Web at www.nmplanner.missouri.edu

Missouri Soil Test Phosphorus Rating - The soil test phosphorus rating is found on a Missouri Soil Test laboratory report and indicates the relative level of plant-available phosphorus in the soil for a particular field. The soil test rating will indicate the probability that an application of phosphate on a particular field is likely to result in an increase in crop yield. A soil test phosphorus rating must be obtained from a lab accredited by the Missouri Soil Testing Association (list of accredited labs can be found at <http://soilplantlab.missouri.edu/soil/mstacertified.htm>) using procedures recommended by the University of Missouri Soil Testing Laboratory.

Surface Application – Land application method by which manure is broadcast or sprayed via mechanical equipment onto the ground surface. Surface application does not include manure that is injected into the soil profile.

Vegetated Buffer - A permanent strip of dense perennial vegetation established parallel to the contours of and perpendicular to the dominant slope of the field for the purposes of effectively slowing water runoff, enhancing water infiltration, and minimizing the risk of any potential nutrients or pollutants from leaving the field and reaching surface waters.

III. Nutrient Management Requirements:

Objective A. Land application fields in the nutrient management plan shall use the following protocols to determine the field-specific placement, timing and rate of manure application so that (a) they do not exceed the annual plant available nitrogen need of the crop, and (b) they are in accordance with the results of a field-specific phosphorus assessment.

A1. Soil and manure testing and fertilizer recommendation protocols.

- (1) Soil sampling protocols to determine soil test phosphorus, cation exchange capacity (CEC) and soil organic matter should be based on the following criteria:
 - a. MU Guides G9215 (for pastures) and G9217 (for row and hay crops);
 - b. The average field area represented by a soil sample should be approximately 20 acres or less;
 - c. Each soil sample should be comprised of a well-mixed subsample derived from at least 15 representative cores from the sampled field area; more cores are recommended on pastures or where phosphorus has been band applied;
 - d. As an alternative to the conventional soil sampling approach in A1(1)c., operations may elect to use a geo-referenced grid soil sampling method instead. Grid size should be less than three acres and at least 10 cores should be obtained from within 15 feet of the central grid point;
 - e. Soil sampling depth should be six to eight inches;
 - f. Fields should be re-sampled before manure application when:
 - i. The soil test is greater than five years old; or
 - ii. Phosphate surplus (actual applied phosphate minus actual removed phosphate) for the field has exceeded 500 lbs/acre since the last soil test;
 - g. Soil samples should be analyzed at soil testing laboratories accredited by the Missouri Soil Testing Association (see a current list of accredited labs at <http://soilplantlab.missouri.edu/soil/mstacertified.htm>) using procedures recommended by the University of Missouri Soil Testing Laboratory.

Note: Soil sample results that meet all of the above criteria shall be considered “current soil test results”.

- (2) Fertilizer recommendations should be based on the following:
 - a. Justified field-specific yield goals. Yield goals should be based on crop yield records from multiple years for the field. Good judgment should be used to adjust yield goals to counteract unusually low or high yields. When a field’s yield history is not available another referenced source may be used to estimate yield goal;
 - b. Current soil test results;
 - c. University of Missouri fertilizer recommendations should be utilized. University of Missouri recommendations can be obtained on-line using current soil sample results at <http://soilplantlab.missouri.edu/soil/scripts/manualentry.aspx>;
 - d. When necessary, nutrient removal rates should be based on MU Guide G9120 or alternatively can be based on measured plant analysis records from the farm. If nutrient removal rates are based on

- plant analysis records, document how the crop is sampled and how plant analysis records are used to estimate nutrient removal for a crop;
- e. Published nutrient removal estimates from other land grant universities in adjoining states are also acceptable.
 - f. 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% or 10 pounds per acre, whichever is greater) 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 justification for this decision is documented in the nutrient management plan.
- (3) The following protocols describe how and when sources of manure should be sampled and how manure testing results will be used to estimate nutrient concentration in manure.
- a. CAFOs are required to sample each unique source of land-applied manure at least once per year;
 - b. All manure samples should be tested for total nitrogen, ammonium nitrogen, total phosphorus, and total potassium. When lab results are reported on a dry basis manure samples should also be tested for dry matter or total solids (moisture content). Nitrate nitrogen is typically not present in manure samples but should be tested for if an innovative manure handling system is likely to create aerobic conditions where nitrate will persist in manure;
 - c. Samples should be collected and handled following the guidelines outlined in MU Guide Publications EQ215 and G9340 (for poultry litter);
 - d. When possible, sample and analyze manure just prior to the time for land application of manure so current results are available for calculating manure application rates.

A2. All manure applications on land application area(s) shall meet all three of the following criteria:

- (1) Annual nitrogen application from all sources should not exceed the recommended nitrogen application rate for non-legume crops and the nitrogen removal capacity of legume crops by more than 10 pounds per acre or 10 percent, whichever is greater.
- a. The recommended nitrogen application rate for non-legume crops should be based on University of Missouri nitrogen fertilizer recommendations derived from a current soil test result for the field and a realistic yield goal. The nitrogen fertilizer recommendation must be adjusted using nitrogen credits for a preceding legume crop, residual fertilizer nitrogen value of manure applications from the previous year and, when appropriate, excessive residual inorganic nitrogen in the soil profile as quantified by the preplant soil nitrogen test. If University of Missouri does not provide a specific nitrogen recommendation for a non-legume crop, recommendations from other land grant universities should be used. Information on calculating residual fertilizer value of manure applications is available in MU Guide Publication G9186. Information on the appropriate use of the preplant soil nitrogen test is in MU Guide Publication G9177;
 - b. The nitrogen removal capacity of legume crops should be based on the estimated nitrogen content of the harvested crop as defined in MU Guide G9120 and a realistic yield goal. The estimated nitrogen content of the crop must be adjusted using nitrogen credits for residual fertilizer nitrogen value of manure applications from the previous year and, when appropriate, excessive residual

- inorganic nitrogen in the soil profile as quantified by the preplant soil nitrogen test. If MU Guide G9120 does not provide an estimate of the nitrogen content of legume crop, recommendations from other land grant universities should be used. Information on calculating residual fertilizer value of manure applications is available in MU Guide Publication G9186. Information on the appropriate use of the preplant soil nitrogen test is in MU Guide Publication G9177;
- c. The nitrogen contribution of manure should be based on a calculation of plant-available nitrogen (PAN). Plant-available nitrogen is calculated by adjusting the inorganic and organic nitrogen concentrations using procedures outlined in MU Guide Publication G9186, and is available on the Web at http://nmplanner.missouri.edu/tools/pan_calculator.asp
- (2) Manure application rates must comply with the results of a field-specific phosphorus loss assessment.
- a. Manure application rates can be based solely on nitrogen criteria (nitrogen-based management) if:
 - i. The Missouri soil test phosphorus rating from a current soil test is very low, low, medium or optimum; or
 - ii. The Missouri P-Index rating is low or medium.
 - b. Manure application rates cannot exceed the annual planned phosphate removal capacity of the crop by more than 10 pounds per acre or 10 percent, whichever is greater (phosphorus-based management) if:
 - i. The Missouri P-index rating is high; or
 - ii. The Missouri soil test phosphorus rating from a current soil test is high and the field has not been assessed using the Missouri P-index.
 - c. Multi-year phosphorus application – When phosphorus-based management is necessary, manure applications can exceed the annual planned phosphate removal capacity of the crop. However, application rates must comply with the following conditions:
 - i. Rates shall not exceed the recommended nitrogen application rate during the year of application, or estimated nitrogen removal capacity in the harvested crop during the year of application when there is no recommended nitrogen application, and
 - ii. the amount of phosphorus banked in the soil will not exceed four years of crop removal for the planned rotation using the criteria found in section A1.(2) above, and
 - iii. the actual application rate shall not exceed 10 pounds per acre or 10 percent of the planned multi-year phosphorus application rate, whichever is greater.
 - d. No manure will be applied on a land application field if:
 - i. The Missouri P-index rating for the field is very high; or
 - ii. the University of Missouri soil test phosphorus rating from a current soil test is very high or excess and the field has not been assessed using the Missouri P-index.

The Missouri P Index is described in MU Guide Publication G9184 and is available as a Microsoft Office Excel spreadsheet at <http://nmplanner.missouri.edu/tools/pindex.asp>

- (3) The timing, soil conditions and placement of all manure applications shall meet the following criteria:
- a. Manure applications shall comply with all manure application setbacks defined in Table A1;
 - b. No surface application of manure is allowed if precipitation, likely to create runoff, is forecasted to occur within 24 hours of the planned application;

- c. Manure will not be applied on land with a slope greater than 20 percent;
- d. Manure will not be surface applied to frozen, snow-covered or saturated soils;
- e. Manure applications must be monitored such that target application rates are met and any malfunction in the operation of the equipment is detected and corrected before any over-application of manure occurs on the land-application site;
- i. Wastewater and liquid manure applications must be conducted so as to prevent surface runoff of wastewater and liquid manure beyond the edge of the field during land application. Steps to insure no runoff of manure during land application include:
 1. Adjusting surface application rates to meet infiltration rate and water holding capacity of the soil;
 2. Irrigation systems must have automatic shut-off devices in case of pressure loss and/or an operator on-site at all times during operation to monitor application equipment.
- ii. All land application equipment should be calibrated at least annually;
- iii. The perimeter of all fields receiving manure should be checked regularly during operation of land application equipment to confirm manure is not running off the field or entering waters of the state.

Table A1. Manure application setback distances. For streams, lakes and wetlands the setback distance is measured from the defined edge of the water feature.

Setback Feature	Application Conditions	Setback Distance (feet)
Public or private drinking water well or other wells including un-plugged abandon wells	All applications methods	300
Public or private drinking water lake or impoundment	All applications methods	300
Public or private drinking water intake structure	All applications methods	300
Classified waters of the state not used as a water supply as defined in 10 CSR 20-7.031(1)F	Permanently vegetated buffer ¹	35
	No or insufficient vegetated buffer	100
Other public and privately owned lakes and impoundments not used as a water supply including impoundments with no outlet	Permanently vegetated buffer ¹	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient, no or insufficient vegetated buffer	35
Other perennial streams, other intermittent streams, canals, drainage ditches and wetlands	Permanently vegetated buffer ¹	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient, no or insufficient vegetated buffer	35
Tile line inlet (if left un-plugged during manure application)	Up-gradient, permanently vegetated buffer ¹	35
	Up-gradient, no or insufficient vegetated buffer	100
	Down-gradient	0
Losing stream	All applications methods	300
Cave entrance	All applications methods	300
Spring	All applications methods	300
Active sinkhole	All applications methods	300
Non-owned occupied residence	Spray irrigation only	150
Public use area including non-owned businesses	Spray irrigation only	150
Public road	All applications methods	50
Property boundary	All applications methods	50

¹See definition of vegetative buffer in the definitions section of this document.

Objective B. Operations shall maintain the following records to document implementation of appropriate nutrient management plan protocols.

B1. Annual nutrient management monitoring and record keeping requirements.

(1) **Manure Storage Operational Monitoring**– Record the following information for each manure storage structure:

- a. Weekly records of the depth of manure and process wastewater in liquid storage structure(s).
- b. The date, time, and estimated volume (gallons) of any overflow(s) from the storage structure.
- c. Record the following information for every manure application event from a manure storage structure:
 - i. Date of manure application
 - ii. Source of manure (indentify the storage structure)
 - iii. Weather and soil condition at time of application
 - iv. Field ID receiving manure
 - v. Rate of manure application per acre (tons/acre, gallons/acre, or acre-inch).
 - vi. Plant Available Nitrogen (PAN) and phosphate in manure applied to field (pounds/acre).
 - vii. Method of application (injection, surface applied, etc)
 - viii. Acres receiving manure
 - ix. Total tonnage or volume of manure applied (tons or gallons)
- d. For all manure transfers (sales or giveaway) off the farm record the following:
 - i. Date of transfer
 - ii. Name and address of recipient
 - iii. Storage source of manure transferred
 - iv. Amount of manure transferred (tons or gallons)

(2) **Manure Nutrient Monitoring** - For each unique source of manure.

- a. Date(s) for manure sampling
- b. For each sampling date report total nitrogen, ammonium nitrogen, total phosphate (P_2O_5), total potash (K_2O); report percent moisture or dry matter and nitrate nitrogen when appropriate and relevant
- c. Report or identify the actual manure nutrient concentration used for calculating manure application rates. If different manure sampling results were used for different parts of the year then provide the range of dates when each sample result was used. If estimates are used, provide information as needed to justify the use of estimate(s) of manure nutrient concentrations

(3) **Field Soil Test Monitoring** - For each individual field in the land application area that receives manure record the following:

- a. Year of the last soil test
- b. Current soil test results reporting at a minimum soil test phosphorus, cation exchange capacity (CEC) and soil organic matter (%)

- c. Fertilizer nitrogen and phosphate recommendations (pounds/acre)
- (4) **Land Application Operational Monitoring** - For each individual field in the land application area that receives manure record the following:
- a. Field ID receiving manure
 - b. Total acres in each field receiving manure
 - c. Planned crop(s) (corn, soybeans, fescue, pasture,...etc)
 - d. Projected yield
 - e. Actual yield
 - f. For each field complete an annual nitrogen inventory including:
 - i. Total Planned Fertilizer Nitrogen Requirement for the crop in pounds/acre (fertilizer nitrogen for non-legumes or the nitrogen removal capacity for legumes as described in section A2 (1) of this standard)
 - ii. Plant Available Nitrogen (PAN) from manure applied to field (lbs N/acre)
 - iii. Nitrogen applied from other sources (lbs N/acre)
 - iv. Total applied plant available nitrogen from all sources (lbs N/acre)
 - v. Difference between total applied plant available nitrogen from all sources and planned crop nitrogen requirement (lbs N/acre)
 - g) For each field complete an annual phosphate inventory including:
 - i. The soil test phosphorus rating for the field
 - ii. The Missouri Phosphorus Index (P-index) rating, if applicable
 - iii. Actual phosphate applied as manure (lbs phosphate/acre)
 - iv. Actual phosphate applied from other sources (lbs phosphate/acre)
 - v. Planned phosphate removal from crops harvested this year (lbs phosphate /acre)
 - vi. Actual phosphate removal from crops harvested this year (lbs phosphate /acre)
 - vii. Phosphate balance for the year (actual applied minus planned removal; lbs phosphate /acre)
 - viii. On fields where “multi-year phosphorus application” is utilized, report the cumulative phosphate balance for the multi-year planning period. (the cumulative balance equals the actual phosphate applied minus planned phosphate removed in lbs phosphate /acre)

References:

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