Appendix O

Sample Site-Specific NPDES General Permit

SAMPLE
NPDES GENERAL PERMIT
FOR
CONCENTRATED ANIMAL FEEDING OPERATIONS (CAFOs)

[US ENVIRONMENTAL PROTECTION AGENCY]

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

[The intent of this sample NPDES General Permit for CAFOs is to recommend specific permit requirements that are consistent with the NPDES CAFO regulations, CAFO ELG, the NPDES CAFO Permit Writers' Guidance including the sample Nutrient Management Plan and Technical Standard. U.S. Environmental Protection Agency encourages permitting authorities to use the recommendations of the guidance manual and this example permit as appropriate. Minimum NPDES permitting requirements for CAFOs are defined at 40 CFR Parts 122, 123, and 412 and all other applicable CWA regulations.]

In compliance with provisions of the Clean Water Act, 33 United States Code (U.S.C.) 1251 *et seq.* (the Act), owners and operators of concentrated animal feeding operations (CAFOs) in [State], except those CAFOs excluded from coverage in Part I of this permit, are authorized to discharge and must operate their facility in accordance with effluent limitations, monitoring requirements, and other provisions set forth herein.

A copy of this permit must be kept by the permittee at the site of the permitted activity.

This permit will become effective July 1, 2009.

This permit and the authorization to discharge under the NPDES permit shall expire at midnight June 30, 2014

Signed this **[DAY]** of **[MONTH]** and **[YEAR]**

[PERMITTING AUTHORITY—OFFICIAL]

Contents

Part I. Permit Area and Coverage O-3
A. Permit Area O-3
B. Permit Coverage O-3
C. Eligibility for Coverage O-3
D. Limitations on Coverage O-3
E. Application for Coverage O-5
F. Requiring an Individual Permit O-6
G. Permit Expiration O-7
H. Change in Ownership O-7
I. Termination of Permit Coverage O-7

Part II. Effluent Limitations and Standards and Other Legal Requirements O-8
A. Effluent Limitations and Standards O-8
B. Other Legal Requirements O-14

Part III. Effluent Limitations and Standards of the Nutrient Management Plan O-14
A. Procedural Requirements for Implementing the Terms of the Nutrient Management Plan O-14
B. Site-Specific Terms of the Nutrient Management Plan O-21

Part IV. Special Conditions O-24
A. Facility Closure O-24
B. Additional Special Conditions O-25

Part V. Discharge Monitoring and Notification Requirements O-27
A. Notification of Discharges Resulting from Manure, Litter, and Process Wastewater Storage, Handling, On-site Transport and Application O-27
B. Monitoring Requirements for All Discharges from Retention Structures O-27
C. General Inspection, Monitoring, and Record-Keeping Requirements O-28

Part VI. Annual Reporting Requirements O-31

Part VII. Standard Permit Conditions O-32
A. General Conditions O-32
B. Proper Operation and Maintenance O-35
C. Monitoring and Records O-35
D. Reporting Requirements O-36
E. Signatory requirements O-38
F. Availability of Reports O-39
G. Penalties for Violations of Permit Conditions O-39

Part VIII. Definitions O-40

Appendix A. Form 2B/Notice of Intent or Appropriate State Form O-43

Appendix B. Technical Standards for Nutrient Management O-44

Appendix C. Historic Properties Requirements O-119

Appendix D. Notice of Termination Form O-120

Part I. Permit Area and Coverage

A. Permit Area

This permit offers statewide NPDES permit coverage for discharges from operations defined as concentrated animal feeding operations (CAFOs) in [State X].

B. Permit Coverage

This permit covers any operation that meets the following criteria:

1. Is located in the permit area as defined by Part I.A. of this permit,
2. That meets the definition of a CAFO at 40 CFR part 122.23(b)(4) *large concentrated animal feeding operation* (see Part VIII, Definitions, *large CAFO* of this permit).
3. Discharges pollutants to waters of the United States. Once an operation is defined as a CAFO, the NPDES requirements for CAFOs apply with respect to all animals in confinement at the operation and all manure, litter and process wastewater generated by those animals or the production of those animals, regardless of the type of animal.
4. Is eligible for permit coverage as defined in Part I.C of this permit.
5. Is authorized for permit coverage by the permitting authority as specified in Part I.F of this permit.

C. Eligibility for Coverage

Unless excluded from coverage in accordance with Paragraph D or F below, owners/operators of existing, currently operating animal feeding operations that are defined as CAFOs or designated as CAFOs by the Permitting Authority (See Part VIII Definitions, *CAFOs* of this permit) and that are subject to 40 CFR part 412, subpart C (Dairy Cows and Cattle Other than Veal Calves) are eligible for coverage under this permit. Eligible CAFOs may apply for authorization under the terms and conditions of this permit, by submitting a Notice of Intent (NOI) to be covered by this permit (see Appendix A of this permit).

CAFO owners/operators may also seek to be excluded from coverage under this permit by (1) submitting to the permitting authority a Notice of Termination form (see Appendix D of this permit) or (2) by applying for an individual NPDES Permit in accordance with Part I.F of this permit.

D. Limitations on Coverage

The following CAFOs are not eligible for coverage under this NPDES general permit and must apply for an individual permit:

1. CAFOs that have been notified by the permitting authority to apply for an individual NPDES permit in accordance with Part I.F (below) of this permit.

2. CAFOs that have been notified by the permitting authority that they are ineligible for coverage because of a past history of non-compliance.

3. Horse, Sheep, Duck, Veal, Poultry or Swine CAFOs.

4. Discharges that will adversely affect any species that are federally-listed as endangered or threatened ("listed") under the Endangered Species Act (ESA) and will result in the adverse modification or destruction of habitat that is federally-designated as "critical habitat" under the ESA. CAFOs seeking coverage under this general permit must follow the conditions outlined in Part IV.B.5 of this permit.

5. CAFOs that do not meet the National Historic Preservation Act eligibility provisions contained in Appendix C of this permit.

6. New dischargers to water quality impaired water (CWA, 303d list) unless the operator performs one of the following:
   a. Prevents any discharge that contains pollutant(s) for which the waterbody is impaired, and includes documentation of procedures taken to prevent such discharge in the NMP.
   b. Documents that the pollutant(s) for which the waterbody is impaired is not present at the facility, and retains documentation of this finding with the NMP.
   c. In advance of submitting the NOI, provides to the permitting authority data to support a showing that the discharge is not expected to cause or contribute to an exceedance of a water quality standard, and retains such data onsite with the NMP. To do this, the operator must provide data and other technical information to the permitting authority sufficient to demonstrate one of the following:
      i. For discharges to waters without an U.S. Environmental Protection Agency approved or established TMDL, that the discharge of the pollutant for which the water is impaired will meet in-stream water quality criteria at the point of discharge to the waterbody.
      ii. For discharges to waters with an U.S. Environmental Protection Agency approved or established TMDL, that there are sufficient remaining wasteload allocations in an U.S. Environmental Protection Agency approved or established TMDL to allow the facility's discharge and that existing dischargers to the waterbody are subject to compliance schedules designed to bring the waterbody into attainment with water quality standards.

   Operators are eligible under this section if they receive an affirmative determination from the permitting authority that the discharge will not contribute to the existing impairment, in which case the operator must maintain such determination onsite with the NMP.

7. CAFOs with discharges subject to New Source Performance Standards (NSPS) at 40 CFR part 412.

E. Application for Coverage

1. Owners/operators of CAFOs seeking to be covered by this permit must:
   a. For facilities covered by and/or expired permit that wish to have continuous permit coverage, submit an NOI to the permitting authority by [DATE].
   b. Submit a Nutrient Management Plan (NMP) with the NOI that meets the requirements of 40 CFR parts 122 and 412, where applicable.
   c. CAFO owners/operators may submit an NOI after the applicable date in Part I.E.1.a. of this permit. Regardless of when the NOI is submitted, the CAFO's authorization under this permit is only for discharges that occur after permit coverage is granted. The permitting authority reserves the right to take appropriate enforcement actions for any unpermitted discharges.
   d. If a CAFO has submitted an application for coverage under an individual permit prior to issuance of the general permit and is seeking to be covered by this general permit, the CAFO must submit an NOI for coverage.
2. Contents of the NOI: The NOI submitted for coverage under this permit must include the following information:
   a. Name of the owner or operator.
   b. Facility location and mailing addresses.
   c. Latitude and longitude of the production area (entrance to production area).
   d. Topographic map of the geographic area in which the CAFO is located showing the specific locations of the production area, land application area, and the name and location of the nearest surface waters.
   e. A diagram of the production area.
   f. Number and type of animals, whether in open confinement or housed under roof (beef cattle, broilers, layers, swine weighing 55 pounds or more, swine weighing less than 55 pounds, mature dairy cows, dairy heifers, veal calves, sheep and lambs, horses, ducks, turkeys, other).
   g. Type of containment and storage (anaerobic lagoon, roofed storage shed, storage ponds, under floor pits, aboveground storage tanks, belowground storage tanks, concrete pad, impervious soil pad, other) and total capacity for manure, litter, and process wastewater storage (tons/gallons).
   h. Total number of acres under control of the applicant available for land application of manure, litter, or process wastewater.
   i. Estimated amounts of manure, litter, and process wastewater generated per year (tons/gallons).

j. Estimated amounts of manure, litter and process wastewater transferred to other persons per year (tons/gallons).

k. An NMP that meets the requirements of the provisions of 40 CFR part 122.42(e) (including, for all CAFOs subject to 40 CFR part 412, subpart C or subpart D, the requirements of 40 CFR part 412.4(c), as applicable) and Part III of this permit.

3. Signature Requirements: The NOI must be signed by the owner/operator or other authorized person in accordance with Part VII.E of this permit.

4. Where to Submit: Signed copies of the NOI or individual permit application must be sent to: [PERMITTING AUTHORITY MAILING ADDRESS]

5. Upon receipt, the permitting authority will review the NOI and NMP to ensure that the NOI and NMP are complete. The permitting authority may request additional information from the CAFO owner or operator if additional information is necessary to complete the NOI and NMP or to clarify, modify, or supplement previously submitted material. If the permitting authority makes a preliminary determination that the NOI is complete, the NOI, NMP and draft terms for the NMP to be incorporated into the permit will be made available for a thirty (30) day public review and comment period. The process for submitting public comments and requests of hearing will follow the procedures applicable to draft permits as specified by 40 CFR parts 124.11 through 124.13. The permitting authority will respond to comments received during the comment period as specified in 40 CFR part 124.17 and, if necessary, require the CAFO owner or operator to revise the NMP in order to granted permit coverage. If determined appropriate by the permitting authority, CAFOs will be granted coverage under this general permit upon written notification by the permitting authority. The permitting authority will identify the terms of the NMP to be incorporated into the permit in the written notification.

F. Requiring an Individual Permit

1. The permitting authority may at any time require any facility authorized by this permit to apply for, and obtain, an individual NPDES permit. The permitting authority will notify the operator, in writing, that an application for an individual permit is required and will set a time for submission of the application. Coverage of the facility under this general NPDES permit is automatically terminated when (1) the operator fails to submit the required individual NPDES permit application within the defined time frame; or (2) the individual NPDES permit is issued by the permitting authority.

2. Any owner/operator covered under this permit may request to be excluded from the coverage of this permit by applying for an individual permit. The owner/operator shall submit an application for an individual permit (Form 1 and Form 2B) with the reasons supporting the application to the permitting authority. If a final, individual NPDES permit is issued to an owner/operator otherwise subject to this general permit,

the applicability of this NPDES CAFO general permit to the facility is automatically terminated on the effective date of the individual NPDES permit. Otherwise, the applicability of this general permit to the facility remains in full force and effect (for example, if an individual NPDES permit is denied to an owner/operator otherwise subject to this general permit).

G. Permit Expiration

This permit will expire 5 years from the effective date. The permittee must reapply for permit coverage 180 days before the expiration of this permit unless the permit has been terminated consistent with § 122.64(b) or the CAFO will not discharge upon expiration of the permit. If this permit is not reissued or replaced before the expiration date, it will be administratively continued in accordance with the Administrative Procedures Act and remain in force and effect. Any permittee who is granted permit coverage before the expiration date will automatically remain covered by the continued permit until the earlier of any of the following:

1. Reissuance or replacement of this permit, at which time the permittee must comply with the NOI conditions of the new permit to maintain authorization to discharge.
2. Issuance of an individual permit for the permittee's discharges.
3. A formal decision by the permitting authority not to reissue this general permit, at which time the permittee must seek coverage under an individual permit.
4. The permitting authority grants the permittee's request for termination of permit coverage.

H. Change in Ownership

If a change in the ownership of a facility whose discharge is authorized under this permit occurs, coverage under the permit will automatically transfer if (1) the current permittee notifies the permitting authority at least 30 days prior to the proposed transfer date; (2) the notice includes a written agreement between the existing and new permittees containing a specific transfer date for permit responsibility, coverage, and liability; and (3) the permitting authority does not notify the existing permittee and the proposed new permittee of its intent to modify or revoke and reissue the permit. If the new CAFO owner or operator modifies any part of the NMP, the NMP shall be submitted to the permitting authority in accordance with Part III.A. of this permit and 40 CFR part 122.42(e)(6).

I. Termination of Permit Coverage

1. Coverage under this permit may be terminated in accordance with 40 CFR part 122.64 and if EPA determines in writing that one of the following three conditions are met:
   a. The facility has ceased all operations and all wastewater or manure storage structures have been properly closed in accordance with Natural Resource

Conservation Service (NRCS) Conservation Practice Standard No. 360, Closure of Waste Impoundments, as contained in the *Natural Resources Conservation Service Field Office Technical Guide* and all other remaining stockpiles of manure, litter, or process wastewater not contained in a wastewater or manure storage structure are properly disposed.

b. The facility is no longer a CAFO that discharges manure, litter, or process wastewater to waters of the United States.

c. In accordance with 40 CFR part 122.64, the entire discharge is permanently terminated by elimination of the flow or by connection to a publicly owned treatment works (POTW).

Part II. Effluent Limitations and Standards and Other Legal Requirements

A. Effluent Limitations and Standards

The following effluent limitations apply to facilities covered under this permit:

1. **Technology-based Effluent Limitations and Standards—Production Area**
The CAFO must implement the terms of an NMP, as specified below and in Part III.B of this permit.

   a. There may be no discharge of manure, litter, or process wastewater pollutants into waters of the United States from the production area except as provided below:

      Whenever precipitation causes an overflow of manure, litter, or process wastewater, pollutants in the overflow may be discharged into waters of the United States provided:

      i. The production area is properly designed, constructed, operated and maintained to contain all manure, litter, process wastewater and the runoff and direct precipitation from the 25-year, 24-hour storm event for the location of the CAFO.

      ii. The design storage volume is adequate to contain all manure, litter, and process wastewater accumulated during the storage period including, at a minimum, the following:

      - The volume of manure, litter, process wastewater, and other wastes accumulated during the storage period.
      - Normal precipitation less evaporation during the storage period.
      - Normal runoff during the storage period.
      - The direct precipitation from the 25-year, 24-hour storm.
      - The runoff from the 25-year, 24-hour storm event from the production area.

- Residual solids after liquid has been removed.
- Necessary freeboard to maintain structural integrity.
- A minimum treatment volume, in the case of treatment lagoon.

b. Installation of a depth marker in all open surface liquid impoundments. The depth marker must clearly indicate the minimum capacity necessary to contain the runoff and direct precipitation of the 25-year, 24-hour rainfall event. The marker shall be visible from the top of the levee.

c. Weekly visual inspections of all stormwater diversion devices, runoff diversion structures, and devices channeling contaminated stormwater to the wastewater and manure storage and containment structures are conducted.

d. Weekly inspections of the manure, litter, and process wastewater impoundments noting the level as indicated by the depth marker installed in accordance with Part II.A.1.b of this permit are conducted.

e. Daily visual inspections of all water lines, including drinking water and cooling water lines are conducted.

f. Any deficiencies that are identified in daily and weekly inspections are corrected in a timely manner.

g. Dead animals are properly disposed of within three (3) days unless otherwise provided for by the permitting authority. Mortalities must not be disposed of in any liquid manure or process wastewater system that is not specifically designed to treat animal mortalities. Animals shall be disposed of in a manner to prevent contamination of waters of the United States or creation of a public health hazard.

h. Complete, on-site records documenting implementation of all required additional measures for a period of 5 years, including the records specified for Operation and Maintenance in Part V.C, Table V-A of this permit are maintained.

i. The production area must be operated in accordance with the additional measures and records specific in Part II.A.2 of this permit.

2. Additional Measures—Applicable to the Production Area

In addition to meeting the requirements in Part III.B below, the permittee must implement the following additional measures:

a. Ensure adequate storage of manure, litter, and process wastewater, including procedures to ensure proper operation and maintenance of the storage facilities.

b. Mortality handling practices shall be in accordance with all applicable state and local regulatory requirements. Any such state/local requirements should be consistent with NRCS Practice Standard 316 as applicable.

c. Ensure that clean water is diverted, as appropriate, from the production area in accordance with Part III.A.3.c of this permit.

d. Prevent direct contact of confined animals with waters of the United States.

e. Ensure that chemicals and other contaminants handled on-site are not disposed of in any manure, litter, process wastewater, or storm water storage or treatment system unless specifically designed to treat such chemicals and other contaminants.

f. Identify specific records that will be maintained to document the implementation and management of Part II.A.2. a through e of this permit.

g. In cases where CAFO-generated manure, litter, or process wastewater is sold or given away the permittee must comply with the following conditions:

i. Maintain records showing the date and amount of manure, litter, and/or process wastewater that leaves the permitted operation.

ii. Record the name and address of the recipient.

iii. Provide the recipient(s) with representative information on the nutrient content of the manure, litter, and/or process wastewater.

iv. The records must be retained on-site, for a period of 5 years, and be submitted to the permitting authority on request.

3. Water Quality-based Effluent Limitations and Standards—Production Area

The permitting authority has established the following permit conditions to protect water quality standards.

a. Discharges to Water Quality Impaired Waters

i. If the CAFO discharges to an impaired water with an EPA approved or established TMDL, EPA will inform the facility if any additional limits or controls are necessary for the discharge to be consistent with the assumptions of any available wasteload allocation in the TMDL, or if coverage under an individual permit is necessary in accordance with Part I.F of this permit. Any additional limits or controls shall be included in the NMP.

ii. If the CAFO discharges to an impaired water without an EPA approved or established TMDL, EPA will inform the facility if any additional limits or controls are necessary to meet water quality standards, or if coverage under an individual permit is necessary in accordance with Part I.F of this permit. Any additional limits or controls shall be included in the NMP.

iii. If a CAFO's authorization for coverage under this permit relied on Part I.D.6 of this permit for a new discharge to an impaired water, the facility must implement and maintain any control measures or conditions on its site that enabled the CAFO to become eligible under Part I.D.6 of this permit, and shall include these control measures or conditions in its NMP.

iv. If at any time the facility becomes aware, or EPA determines, that a discharge to an impaired water has occurred and the requirements of Part II.A.3.a.i-iii of

this permit have not been addressed, the facility must take corrective action to fulfill the requirements of Part II.A.3.a.i-iii of this permit. Any changes to the NMP required to fulfill the requirements of Part II.A.3.a.i-iii of this permit shall be done in accordance with Part III.A.7 of this permit.

b. Tier 2 Antidegradation Requirements for New or Increased Dischargers

i. If the CAFO discharges directly to waters designated by a State or Tribe as Tier 2 or Tier 2.5 for antidegradation purposes under 40 CFR part 131.12(a) (see list of Tier 2 and 2.5 waters on EPA's website at *http://www.U.S. Environmental Protection Agency.gov/npdes/stormwater/msgp*), the permitting authority may notify the facility that additional analyses, control measures, or other permit conditions are necessary to comply with the applicable antidegradation requirements, or notify you that an individual permit application is necessary in accordance with Part I.F of this permit. Any such additional requirements shall be included in the NMP.

4. Technology-based Effluent Limitations and Standards—Land Application Areas under the Control of the CAFO Owner/Operator

Permittees that apply manure, litter, or process wastewater to land under the permitted CAFO's ownership or operational control must implement the terms of an NMP, as specified below and in Part III.B of this permit. The NMP must be developed in accordance with the requirements of this section and Part III.A of this permit.

a. Determination of application rates. Application rates for manure, litter, or process wastewater must minimize phosphorus and nitrogen transport from the field to surface waters in compliance with the technical standards for nutrient management established by the permitting authority, as follows:

i. Application rates must be determined in accordance with the result of the Iowa Phosphorus Index as specified in IAC Chapter 567—65.17(17).

ii. Realistic yield goals must be established in accordance with the procedures in IAC Chapter 567—65.17(6).

iii. The crop nutrient recommendations provided in Appendix A5, "Crop Nitrogen Usage Rate Factors for Various Crops," and Appendix A6, "Nutrient Removal for Iowa Crops," of Iowa DNR's Manure Management Plan Form or Iowa State University Extension publication PM-1688, "General Guide to Crop Nutrient and Limestone Recommendations in Iowa," must be used.

iv. Nitrogen credits for prior legume crops must be determined in accordance with values specified in footnote t of Iowa DNR's Manure Management Plan form.

v. Nitrogen mineralization rates must be consistent with the ranges identified in Iowa State University Extension publication PMR 1003, "Using Manure Nutrients for Crop Production."

vi. Nitrogen loss factors must be consistent with those provided in Appendix A7, "Nitrogen Application Losses," of Iowa DNR's Manure Management Plan Form.

vii. Timing and method of manure, litter, and process wastewater application must be addressed in accordance with the criteria and considerations in Iowa NRCS Conservation Practice Standard Code 590 (Nutrient Management).

viii. For fields where P-based management is required, in accordance with the outcome of the Iowa Phosphorus Index, multi-year phosphorus application is permitted on fields that do not have a high potential for phosphorus runoff to surface water. Such applications must be in accordance with the procedures and limitations specified in footnote bb of Iowa DNR's Manure Management Plan Form.

b. Manure and soil sampling. Manure must be analyzed at least once annually for nitrogen and phosphorus content in accordance with the manure testing requirements of Iowa NRCS Conservation Practice Standard Code 590 (Nutrient Management). Manure samples must be analyzed by a laboratory listed with the Manure Testing Laboratory Certification Program (MTLCP). Soil must be analyzed at least once every 4 years in accordance with soil testing requirements established in IAC Chapter 567—65.17(16). The results of the analyses must be used in determining application rates for manure, litter, and process wastewater.

c. Inspection of land application equipment for leaks. Equipment used for land application of manure, litter, or process wastewater must be inspected periodically for leaks.

d. Land application setback requirements. Manure, litter, or process wastewater must not be applied closer than 100 feet to any downgradient water of the United States, open tile line intake structures, sinkholes, agricultural well heads, or other conduits to waters of the United States. The permittee may elect to use a 35-foot vegetated buffer where applications of manure, litter, or process wastewater are prohibited as an alternative to the 100-foot setback to meet the requirement. As a compliance alternative, the permittee may demonstrate that a set-back or buffer is not necessary because implementation of alternative conservation practices or field-specific conditions will provide pollutant reductions equivalent or better than the reductions that would be achieved by the 100-foot setback.

e. Record Keeping requirements. Complete, on-site records including the site-specific NMP must be maintained to document implementation of all required land application practices. Such documentation must include the records specified for Soil and Manure/Wastewater Nutrient Analyses and Land Application in Part V.C, Table V-A of this permit.

5. Additional Measures—Applicable to the Land Application under the Control of the CAFO Owner/Operator

a. Additional BMPs to control discharges from land application areas.

i. Areas shall be identified that, due to topography, activities or other factors, have a high potential for significant soil erosion. Where these areas have the potential to contribute pollutants to waters of the United States, measures used to limit erosion and pollutant runoff shall be identified.

ii. Irrigation systems shall be managed so as to minimize (a) ponding or puddling of wastewater on land application fields, (b) contamination of ground and surface water and (c) the occurrence of nuisance conditions, such as odors and flies.

b. Prohibitions

i. There shall be no discharge of manure, litter, or process wastewater to waters of the United States from a CAFO as a result of the application of manure, litter or process wastewater to land areas under the control of the CAFO, except where it is an agricultural stormwater discharge. Where manure, litter, or process wastewater has been applied in accordance with the terms of the NMP as set forth in Part II.A. and III.B of this permit, a precipitation related discharge of manure, litter, or process wastewater from land areas under the control of the CAFO is considered to be an agricultural stormwater discharge.

ii. Nutrients and organic nutrient sources shall not be surface applied to frozen, snow covered ground, or saturated soil if a potential risk for runoff exists. A potential risk for runoff exists on slopes greater than 5% unless erosion is controlled to soil loss tolerance levels ("T") or less. Manure may be surface applied to frozen, snow covered or saturated ground if a potential risk for runoff exists only under one of the following conditions with the permission of the permitting authority:

- Where manure storage capacity is insufficient and failure to surface apply creates a risk of an uncontrolled release of manure.
- On an emergency basis.

6. Water Quality-based Effluent Limitations and Standards–Applicable to the Land Application under the Control of the CAFO Owner/Operator

There shall be no unauthorized dry weather discharges from land application sites.

7. Effluent Limitations–Other Discharges

a. Process wastewater discharges from outside the production area, including washdown of equipment that has been in contact with manure, raw materials, products or byproducts that occurs outside of the production area and runoff of pollutants from raw materials, products or byproducts (such as manure, feathers, litter, bedding and feed) from the CAFO that have been spilled or otherwise

deposited outside the production area and which are discharged to waters of the United States, shall be identified in the NMP. The NMP shall identify measures necessary to meet applicable water quality standards.

b. Discharges that do not meet the definition of process wastewater, including: (1) discharges associated with feed, fuel, chemical, or oil spills, equipment repair, and equipment cleaning, where the equipment has not been in contact with manure, raw materials, products or byproducts; and (2) domestic wastewater discharges to waters of the United States shall be identified in the NMP. The NMP shall identify measures necessary to meet applicable water quality standards.

c. Storm water discharges that are not addressed under the effluent limitations in Part II.A.1-6 of this permit, remain subject to applicable industrial or construction storm water discharge requirements.

In addition to meeting the above effluent limitations in Part II.A of this permit, the permittee must comply with the special conditions established in Part IV of this permit.

B. Other Legal Requirements

No condition of this permit shall release the permittee from any responsibility or requirements under other statutes or regulations, federal, state/Indian tribe or local.

Part III. Effluent Limitations and Standards of the Nutrient Management Plan

A. Procedural Requirements for Implementing the Terms of the Nutrient Management Plan

CAFO owners or operators seeking coverage under this general permit must submit a Nutrient Management Plan (NMP) with the NOI, as required by Part I.E.1. of this permit. The NMP shall specifically identify and describe practices that will be implemented to assure compliance with the effluent limitations and other conditions of this permit set forth in this part and Part II.A of this permit (Effluent Limitations and Standards). The NMP must be developed in accordance with the technical standards for nutrient management identified in Appendix B of this permit.

1. **Schedule.** The completed NMP must be submitted to the permitting authority with the NOI for CAFOs seeking coverage under this permit. The CAFO shall implement its NMP upon authorization under this permit, in accordance with the terms of the NMP set forth in Part III.B of this permit.

2. **NMP Review and Terms.**

   a. Upon receipt of the NMP, the permitting authority will review the NMP. The permitting authority may request additional information from the CAFO owner or

operator if additional information is necessary to complete the NMP, or to clarify, modify, or supplement previously submitted material, the Director may request such information from the CAFO owner or operator.

b. The permitting authority will use the NMP to identify site-specific permit terms to be incorporated into this permit. The permitting authority will identify site-specific permit terms with respect to protocols for the land application of manure, litter, and process wastewater. The permitting authority will also identify site-specific permit terms with respect to manure, litter, and process wastewater storage capacities and site-specific conservation practices on the basis of the CAFO's NMP to the extent that such terms are necessary to support the application rates expressed in the NMP. The permitting authority will also identify site-specific permit terms with respect to mortality management, clean water diversions, preventing direct contact of animals with waters of the United States, chemical handling, protocols for manure and soil testing, and record keeping as appropriate.

c. When the permitting authority determines that the NMP and notice of intent are complete, the permitting authority will make available to the public the NOI submitted by the CAFO, including the CAFO's NMP, and the terms of the NMP to be incorporated into the permit, as determined by the permitting authority. The permitting authority will notice the proposal to grant coverage under the permit and the availability of the aforementioned documentation for public review and comment. The notice will also provide the opportunity for a public hearing on the NOI and draft NMP in accordance with 40 CFR parts 124.11 and 12.

d. The period for the public to comment and request a hearing on the proposed terms of the NMP to be incorporated into the permit shall be thirty (30) days.

e. The permitting authority will respond to comments received during the comment period, as provided in 40 CFR part 124.17, and, if necessary, require the CAFO owner or operator to revise the NMP to be granted permit coverage.

f. When the permitting authority authorizes the CAFO owner or operator to discharge under the general permit, the terms of the NMP shall be incorporated as terms and conditions of the permit for the CAFO. The permitting authority will notify the CAFO owner or operator that coverage has been authorized and of the applicable terms and conditions of the permit. Those site-specific permit terms will be provided to the permittee in a written permit authorization notice which will be included as Part III.B of this permit.

g. Each CAFO covered by this permit must comply with the site-specific permit terms established by the permitting authority on the basis of the CAFO's site-specific NMP.

3. **NMP Content.** The site-specific NMP at a minimum must include practices and procedures necessary to implement the applicable effluent limitations and standards

in Part II.A of this permit. In addition, the NMP and each CAFO covered by this permit must, as applicable, do the following:

a. Ensure adequate storage of manure, litter, and process wastewater, including procedures to ensure proper operation and maintenance of the storage facilities. All wastewater and manure containment structures shall at a minimum be designed, constructed, operated, and maintained in accordance with the standards of the Natural Resources Conservation Service, Field Office Technical Guide. Storage capacity must be sufficient to meet the minimum requirements of Part II.A.1 of this permit and also must be sufficient to allow the CAFO to comply with the land application schedule specified in the NMP. To the extent that the NMP depends on off-site transport or other means of handling to ensure adequate storage capacity this must be described in the NMP.

   If the CAFO needs to maintain storage capacity that exceeds the minimum capacity requirements of Part II.A.1 of this permit to comply with the land application provisions of the NMP, the storage capacity shall become a term of this permit and the permitting authority will develop site-specific terms based on the submitted NMP.

b. Ensure proper management of mortalities (i.e., dead animals) to ensure that they are not disposed of in a liquid manure, storm water, or process wastewater storage or treatment system that is not specifically designed to treat animal mortalities. Mortalities shall be handled in such a way as to prevent the discharge of pollutants to waters of the United States.

c. Ensure that clean water is diverted, as appropriate, from the production area. Any clean water that is not diverted and comes into contact with raw materials, products, or by-products including manure, litter, process wastewater, feed, milk, eggs, or bedding is subject to the effluent limitations specified in Part II.A of this permit. Where clean water is not diverted, the CAFO owner or operator must document that it has been accounted for in meeting the requirement to ensure adequate storage capacity as a condition of this permit. Clean water includes, but is not limited to, rain falling on the roofs of facilities and runoff from adjacent land.

d. Prevent the direct contact of animals confined or stabled at the facility with waters of the United States.

e. Ensure that chemicals and other contaminants handled on-site are not disposed of in any manure, litter, process wastewater, or stormwater storage or treatment system unless specifically designed to treat such chemicals or contaminants. All wastes from dipping vats, pest and parasite control units, and other facilities used for the management of potentially hazardous or toxic chemicals shall be handled and disposed of in a manner sufficient to prevent pollutants from entering the manure, litter, or process wastewater retention structures or waters of the United States. Include references to any applicable chemical handling protocols and indicate that other protocols included in the NMP will be reviewed.

f. Identify appropriate site-specific conservation practices to be implemented, including as appropriate buffers or equivalent practices, to control runoff of pollutants to waters of the United States and specifically, to minimize the runoff of nitrogen and phosphorus. Each CAFO covered by this permit must implement the site-specific conservation practices determined by the permitting authority to be a term of this permit, as specified in the CAFO's permit authorization notice. Those practices may include residue management, conservation crop rotation, grassed waterways, strip cropping, vegetated buffers, riparian buffers, setbacks, terracing, and diversions.

g. Identify protocols for appropriate testing of manure, litter, process wastewater, and soil. Manure, wastewater and soil sampling must be conducted in accordance with the requirements of Part II.A.4.b. of this permit and the following protocols:

   i. Manure, litter, and process wastewater must be sampled annually in accordance with protocols established in Iowa NRCS Conservation Practice Standard Code 590 (Nutrient Management) and Iowa State University Extension publication 1558, "How to Sample Manure for Nutrient Analysis."

   ii. Manure, litter, and process wastewater must be analyzed, at a minimum, for constituents identified in Iowa NRCS Conservation Practice Standard Code 590 (Nutrient Management) (total nitrogen, phosphorus, and potassium, and percent moisture and/or percent solids) by a laboratory listed with the Manure Testing Laboratory Certification Program (MTLCP).

   iii. Soil must be sampled and analyzed at least once every four years in accordance with protocols established in IAC Chapter 567—65.17(16).

h. Establish protocols to land apply manure, litter, or process wastewater in accordance with site-specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure, litter, or process wastewater.

   The CAFO's site-specific NMP shall document the calculation of land application rates of manure, litter, or process wastewater. The technical standards identified in Appendix B of this permit shall be used for calculating these rates. The rate calculation shall address the form, source, amount, timing, and method of application on each field to achieve realistic production goals while minimizing nitrogen and phosphorus movement to surface water. The rate calculation shall be based on the results of a field specific assessment of the potential for nitrogen and phosphorus transport from the field to surface waters using the Iowa Phosphorus Index, as specified in IAC Chapter 567—65.17(17).

   Development of site-specific terms will be based on the permitting authority's review of the NMP submitted in accordance with the requirements of Parts I.E and III.A of this permit. To support the development of site-specific terms the submitted NMP must include at a minimum:

   - Names of fields available for land application.

- Field-specific rates of application properly developed as specified below, under Narrative Rate Approach, in the following chemical forms in this part and [nitrogen and phosphorus].
- The information specified for the narrative rate approach in the paragraph below.
- Any additional information necessary to assess the adequacy of the application rates included in the NMP.

Application rates should be expressed in NMPs consistent with the narrative rate approach described below:

Narrative Rate Approach. Expresses a narrative rate of application that results in the amount, in tons or gallons, of manure, litter, and process wastewater to be land applied. The narrative rate approach must include in the NMP submitted to the permitting authority the following information for each crop and field covered by the NMP, which will be used by the permitting authority to establish site-specific permit terms:

- The maximum amounts of nitrogen and phosphorus that will be derived from all sources of nutrients (pounds/acre for each crop and field).
- The outcome of the field-specific assessment of the potential for nitrogen and phosphorus transport from each field. The potential for nitrogen and phosphorus transport shall be determined using the Iowa Phosphorus Index as specified in IAC Chapter 567—65.17(17). The CAFO must specify any conservation practices used in calculating the risk rating.
- The crops to be planted in each field or any other uses of a field such as pasture or fallow fields, including alternative crops if applicable. Any alternative crops included in the NMP must be listed by field, in addition to the crops identified in the planned crop rotation for that field.
- The realistic annual yield goal for each crop or use identified for each field for each year, including any alternative crops identified.
- The nitrogen and phosphorus recommendations from Appendix A5, "Crop Nitrogen Usage Rate Factors for Various Crops," and Appendix A6, "Nutrient Removal for Iowa Crops," to Iowa DNR's Manure Management Plan Form for each crop or use identified for each field, including any alternative crops identified.
- The methodology (including formulas, sources of data, protocols for making determination, etc.) and actual data that will be used to account for: (1) the results of soil tests required by Parts II.A.4.b and III.A.3.g of this permit, (2) credits for all nitrogen in the field that will be plant-available, (3) the amount of nitrogen and phosphorus in the manure, litter, and process wastewater

to be applied, (4) consideration of multi-year phosphorus application (for any field where nutrients are applied at a rate based on the crop phosphorus requirement, the methodology must account for single-year nutrient applications that supply more than the crop's annual phosphorus requirement), (5) other additions of plant available nitrogen and phosphorus to the field (i.e., from sources other than manure, litter, or process wastewater or credits for residual nitrogen), (6) timing and method of land application, and (7) volatilization of nitrogen and mineralization of organic nitrogen.

- Any other factors necessary to determine the amounts of nitrogen and phosphorus to be applied in accordance with the Narrative Rate Approach

The NMPs must also include the following projections, which will not be used by the permitting authority in establishing site-specific permit terms:

- Planned crop rotations for each field for the period of permit coverage.
- Projected amount of manure, litter, or process wastewater to be applied.
- Projected credits for all nitrogen in the field that will be plant-available.
- Consideration of multi-year phosphorus application.
- Accounting for other additions of plant-available nitrogen and phosphorus to the field.
- The predicted form, source, and method of application of manure, litter, and process wastewater for each crop.

4. **Signature.** The NMP shall be signed by the owner/operator or other signatory authority in accordance with Part VII.E of this permit (Signatory Requirements).

5. **A current copy of the NMP** shall be kept on site at the permitted facility in accordance with Part VIII.C of this permit and provided to the permitting authority upon request.

6. **Recordkeeping Requirement.**
   a. All CAFOs using the narrative rate approach must calculate maximum amounts of manure, litter, and process wastewater to be land applied at least once each year using the methodology specified in the NMP pursuant to Part III.A.3.h of this permit before land applying manure, litter, and process wastewater. Such calculations must rely on the following data:
      i. A field-specific determination of soil levels of nitrogen and phosphorus. For nitrogen, the determination must include a concurrent determination of nitrogen that will be plant available. For phosphorus, the determination must include the results of the most recent soil test conducted as required in Parts II.A.4.b and III.A.3.g of this permit,

ii. The results of the most recent representative manure, litter, and process wastewater tests for nitrogen and phosphorus taken within 12 months of the date of land application, as required in Parts II.A.4.b and III.A.3.g of this permit, in order to determine the amount of nitrogen and phosphorus in the manure, litter, and process wastewater to be applied.

b. Identify and maintain all records necessary to document the development and implementation of the NMP and compliance with the permit.

7. Changes to the NMP

a. When a CAFO owner or operator covered by this permit makes changes to the CAFO's NMP previously submitted to the permitting authority, the CAFO owner or operator must provide the permitting authority with the most current version of the CAFO's NMP and identify changes from the previous version, except that annual calculations of application rates for manure, litter, and process wastewater as required in Part III.A.6.a of this permit are not required to be submitted to the permitting authority.

b. When changes to an NMP are submitted to the permitting authority, the permitting authority will review the revised NMP to ensure that it meets the requirements of Parts II.A and III.A.3. If the permitting authority determines that the changes to the NMP necessitate revision to the terms of the NMP incorporated into the permit issued to the CAFO, the permitting authority must determine whether such changes are substantial. Substantial changes to the terms of an NMP incorporated as terms and conditions of a permit include, but are not limited to the following:

i. Addition of new land application areas not previously included in the CAFO's NMP, except if the added land application area is covered by the terms of an NMP incorporated into an existing NPDES permit and the CAFO complies with such terms when applying manure, litter, and process wastewater to the added land.

ii. For NMPs using the Narrative Rate Approach, changes to the maximum amounts of nitrogen and phosphorus derived from all sources for each crop.

iii. Addition of any crop or other uses not included in the terms of the CAFO's NMP.

iv. Changes to site-specific components of the CAFO's NMP, where such changes are likely to increase the risk of nitrogen and phosphorus transport to waters of the United States.

c. If the permitting authority determines that the changes to the terms of the NMP are not substantial, the permitting authority will include the revised NMP in the permit record, revise the terms of the permit on the basis of the site-specific NMP,

and notify the CAFO and the public of any changes to the terms of the permit on the basis of revisions to the NMP.

d. If the permitting authority determines that the changes to the terms of the NMP are substantial, the permitting authority will notify the public, make the proposed changes and the information submitted by the CAFO owner or operator available for public review and comment, and respond to all significant comments received during the comment period. The public notice will be provided using the guidelines described in Part III.A.2.c of this permit. The permitting authority may require the permittee to further revise the NMP, if necessary. Once the permitting authority incorporates the revised terms of the NMP into the permit, the permitting authority will notify the permittee of the revised terms and conditions of the permit.

B. Site-Specific Terms of the Nutrient Management Plan

This permit specifically authorizes **DEF Feedlot** to discharge as of **September 1, 2009** when the facility is operating in compliance with the terms and conditions of this permit. The site-specific terms of the NMP set forth in this section are applicable to **DEF Feedlot**:

1. The permittee must ensure adequate storage of manure, litter, and process wastewater, including procedures to ensure proper operation and maintenance of the storage facilities by complying with section 2.3 of the nutrient management plan.

2. The permittee must ensure proper management of mortalities by following NRCS IA Standard 316, Animal Mortality Facility, October 2007 for proper management of dead animals. Dead animals will be disposed of utilizing Valley Rendering Services. When rendering services are used, dead animals will be picked up within 24 hours. Dead animals will be stored in a separate bermed area adjacent to the production area to control runoff. Adequate space must be available in the bermed area to hold normal animal mortality at the feedlot operation. Process wastewater that runs off this area must be collected and transported to the waste storage ponds. There are no additional operation and maintenance activities required with plan to be used to address normal animal mortality at the operation. Under no circumstances, will the manure treatment systems be used to manage any mortality.

3. The permittee must ensure that clean water is diverted, as described in section 2.2 of the nutrient management plan.

4. The permittee must ensure that chemicals and other contaminants handled on-site as described in section 3.4 of the nutrient management plan.

5. The permittee must implement the following conservation practices:

6. The permittee will maintain the specific records required by section 7 of the NMP.

7. The permittee will implement the following protocols to land apply manure, litter or process wastewater to ensure appropriate agricultural utilization of the nutrients in the manure, litter or process wastewater:

The methodology is expressed within Manure Management Planner (MMP) version 0.29. The permitting authority has determined that the methodology used by MMP encompasses all the factors of the methodology and the plan was developed in accordance with the State's technical standard. Additional site specific permit terms for expressing protocols for land application under the narrative rate approach include:

Field	Area	Conservation Practice	NRCS Iowa Conservation Practice Reference
Bob's Farm North – 8N	56.4 Acres	50' Stream Vegetated Buffer	Riparian Forest Buffer (Ac.) (391) (August 2007)
		Contour Farming	Contour Farming (Ac.) (330) (May 2005)
		Residue Management	Residue Management, Seasonal (Ac.) (344) (March 2007)
Bob's Farm South – 8S	79.6 Acres	50' Stream Vegetated Buffer	Riparian Forest Buffer (Ac.) (391) (August 2007)
		Contour Farming	Contour Farming (Ac.) (330) (May 2005)
		Residue Management	Residue Management, Seasonal (Ac.) (344) (March 2007)

Fields available for land application					Outcome of the assessment of the potential for nutrient transport							Alternative Crops			
Field	Subfield	Crop Year	Total Acres	Timing limitations for land application	P Loss risk	Manure Application Rate	Planned crops or other use	Realistic Annual Yield Goal	Total N and P recommend-ations for each crop on each field	Max lbs N/acre derived from all sources	Max lbs P_2O_5/acre derived from all sources	Crops	Yield Goal	N Rec	P Rec
														lbs/acre	
Bob's Farm South	8S	2010	79.6	Field slope 7%. Manure may only be surface applied to this field when the ground is frozen, snow covered or saturated if one of the following conditions exists: 1. Where manure storage capacity is insufficient and failure to surface apply creates a risk of an uncontrolled release of manure 2. On an emergency basis	Medium	Manure shall not be applied in excess of two times the crop phosphorus removed with crop harvest over the period of the crop rotation	Soy-bean	61 bu/ acre	Soybean Recommend-ations: 232 lbs N /acre 49 lbs P_20_5 /acre Corn Recommend-ations: 210 lbs N /acre 73 lbs P_20_5 /acre	Soybeans = 0 lbs Corn = 210 lbs	Soybeans = 0 lbs Corn = 190 lbs	Wheat	78 bu/ acre	88	41
		2011					Corn	195 bu/ acre				Corn	41 ton/ acre	205	51
		2012					Soy-bean	61 bu/ acre							
		2013					Corn	195 bu/ acre							
		2014					Soy-bean	61 bu/ acre							

Part IV. Special Conditions

A. Facility Closure

The following conditions shall apply to the closure of lagoons and other earthen or synthetic lined basins and other manure, litter, or process wastewater storage and handling structures:

1. Closure of Lagoons and Other Surface Impoundments
   a. No lagoon or other earthen or synthetic lined basin shall be permanently abandoned.
   b. Lagoons and other earthen or synthetic lined basins shall be maintained at all times until closed in compliance with this section.
   c. All lagoons and other earthen or synthetic lined basins must be properly closed if the permittee ceases operation. In addition, any lagoon or other earthen or synthetic lined basin that is not in use for a period of 12 consecutive months must be properly closed unless the facility is financially viable, intends to resume use of the structure at a later date, and either (1) maintains the structure as though it were actively in use, to prevent compromise of structural integrity; or (2) removes manure and wastewater to a depth of one foot or less and refills the structure with clean water to preserve the integrity of the synthetic or earthen liner. In either case, the permittee shall notify the permitting authority within thirty (30) days of basin closure detailing the actions taken, and shall conduct routine inspections, maintenance, and record keeping as though the structure were in use. Prior to restoration of use of the structure, the permittee shall notify the permitting authority in writing and provide the opportunity for inspection.
   d. All closure of lagoons and other earthen or synthetic lined basins must be consistent with NRCS Conservation Practice Standard Code 360 (Closure of Waste Impoundments). Consistent with this standard the permittee shall remove all waste materials to the maximum extent practicable and dispose of them in accordance with the permittee's nutrient management plan, unless otherwise authorized by the permitting authority.
   e. Unless otherwise authorized by the permitting authority completion of closure for lagoons and other earthen or synthetic lined basins shall occur as promptly as practicable after the permittee ceases to operate or, if the permittee has not ceased operations, 12 months from the date on which the use of the structure ceased, unless the lagoons or basins are being maintained for possible future use in accordance with the requirements above.
2. Closure Procedures for Other Manure, Litter, or Process Wastewater Storage and Handling Structure

   No other manure, litter, or process wastewater storage and handling structure shall be abandoned. Closure of all such structures shall occur as promptly as practicable

after the permittee has ceased to operate, or, if the permittee has not ceased to operate, within 12 months after the date on which the use of the structure ceased. To close a manure, litter, or process wastewater storage and handling structure, the permittee shall remove all manure, litter, or process wastewater and dispose of it in accordance with the permittee's NMP, or document its transfer from the permitted facility in accordance with Manure Transfer requirements specified in Table V-A in Part V.C of this permit unless otherwise authorized by the permitting authority.

B. Additional Special Conditions

1. Liner Requirement: The permittee shall document that no direct hydrologic connection exists between the contained wastewater and surface waters of the United States. Where the permittee cannot document that no direct hydrologic connection through ground water exists, the ponds, lagoons and basins of the containment facilities must have a liner which will prevent the potential contamination of surface waters.
   a. Documentation of no direct hydrologic connection. The permittee can document lack of hydrologic connection by either: (1) documenting that there will be no significant leakage from the retention structure; or (2) documenting that any leakage from the retention structure would not migrate to surface waters. For documentation of no significant leakage, in-situ materials must, at a minimum, meet the minimum criteria for hydraulic conductivity and thickness described in Part IV.B.1.b of this permit. Documentation that leakage will not migrate to a surface water must include maps showing ground water flow paths, or that the leakage enters a confined environment. This documentation must be certified in writing by a NRCS engineer or a Professional Engineer and must include information on the hydraulic conductivity and thickness of the natural materials underlying and forming the walls of the containment structure up to the wetted perimeter.
   b. Liner Construction. Liners constructed and maintained in accordance with NRCS design specifications shall be considered to prevent hydrologic connection which could result in the contamination of surface waters. Where no site-specific assessment has been done by a NRCS engineer or Professional Engineer, the liner shall be constructed to have hydraulic conductivities no greater than 1x10 (-7) cm/sec, with a thickness of 1.5 feet or greater or its equivalency in other materials.
   c. Liner Maintenance. The permittee must maintain the liner to inhibit infiltration of wastewaters. Liners shall be protected from animals by fences or other protective devices. No tree shall be allowed to grow such that the root zone would intrude or compromise the structure of the liner. Any mechanical or structural damage to the liner must be evaluated by a NRCS Engineer or Professional Engineer within thirty (30) days of the damage. Documentation of liner maintenance shall be kept with the Nutrient Management Plan (NMP). The permittee shall have a NRCS Engineer

or Professional Engineer review the documentation and do a site evaluation a minimum of once every five (5) years. If notified by the permitting authority that a direct hydrological connection to waters of the United States exists for the contamination of surface waters or drinking water, the permittee shall install a leak detection system or monitoring wells, or take other appropriate measures in accordance with that notice. Documentation of compliance with the notification must be kept with the NMP, as well as all sampling data. Data from the monitoring wells must be kept on site for three (3) years with the NMP. The first year's sampling shall be considered the baseline data and must be retained on site for the life of the facility.

2. Retention Structure Dewatering. A schedule must be developed for liquid waste removal from the retention structure(s). A date log indicating weekly inspection of wastewater level in the retention facility, including specific measurement of wastewater level must be kept. Retention facilities shall be equipped with either irrigation or evaporation or liquid removal systems capable of dewatering the retention facilities. Operators using pits, ponds, or lagoons for storage and treatment of storm water, manure and process generated wastewater, including flush water waste handling systems, shall maintain sufficient available storage capacity to contain the runoff and the direct precipitation from a 25-year, 24-hour rainfall event. The operator shall restore the storage capacity as soon as possible after any rainfall event or accumulation of wastes reduces such storage capacity, weather permitting.

3. Spills. Appropriate measures necessary to prevent spills and to cleanup spills of any toxic and other pollutants shall be taken. Handling procedures and storage for these materials must be specified in the NMP. Procedures for cleaning up spills shall be identified, and the necessary equipment to implement clean up shall be made available to facility personnel. All spills and clean-up activities must be documented. Documentation of spills and clean-up must be kept with the NMP.

4. Solids, sludges, manure or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner to prevent pollutants from being discharged to waters of the United States.

5. Manure, litter, and process wastewater handling, treatment, and management shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species, or contribute to the taking of endangered or threatened species of plant, fish or wildlife. The operator shall notify State and Federal wildlife agencies, the permitting authority, and the U.S. Environmental Protection Agency within 48 hours if any dead or injured threatened or endangered species or protected migratory birds are observed in or on receiving waters following a discharge or on the facility's land application areas at any time.

6. Manure, litter, and process wastewater handling, treatment, and management shall not create an environmental or public health hazard; shall not result in the contamination of drinking water; shall conform to State guidelines and/or regulations for the protection of surface water quality.

7. Employee Training. Employees responsible for permit compliance must be regularly trained or informed of any information pertinent to the proper operation and maintenance of the facility and waste disposal. Training shall include topics such as land application of wastes, proper operation and maintenance of the facility, good housekeeping and material management practices, necessary record-keeping requirements, and spill response and clean up. The permittee is responsible for determining the appropriate training frequency for different levels of personnel and the NMP shall identify periodic dates for such training.

Part V. Discharge Monitoring and Notification Requirements

A. Notification of Discharges Resulting from Manure, Litter, and Process Wastewater Storage, Handling, On-site Transport and Application

If, for any reason, there is a discharge of pollutants to waters of the United States, the permittee is required to make immediate oral notification within 24 hours to the permitting authority. The permittee is also required to notify the permitting authority in writing at the address in Part I.E.4 of this permit within 5 working days of the discharge from the facility. In addition, the permittee shall keep a copy of the notification submitted to the permitting authority together with the other records required by this permit. The discharge notification shall include the following information:

1. A description of the discharge and its cause, including a description of the flow path to the receiving waterbody and an estimate of the flow and volume discharged.

2. The period of noncompliance, including exact dates and times, the anticipated time it is expected to continue, and steps taken or planned to reduce, eliminate and prevent recurrence of the discharge.

B. Monitoring Requirements for All Discharges from Retention Structures

If any overflow or other discharge of pollutants occurs from a manure and/or wastewater storage or retention structure, whether or not authorized by this permit, the permittee shall take following actions:

1. All discharges shall be sampled and analyzed. Samples must, at a minimum, be analyzed for the following parameters: total nitrogen, ammonia nitrogen phosphorus, fecal coliform, 5-day biochemical oxygen demand (BOD5), total suspended solids, pH, and temperature. The discharge must be analyzed in accordance with approved U.S. Environmental Protection Agency methods for water analysis listed in 40 CFR part 136.

2. Record an estimate of the volume of the release and the date and time.

3. Samples shall consist of grab samples collected from the over-flow or discharges from the retention structure. A minimum of one sample shall be collected from the initial discharge (within 30 minutes). The sample shall be collected and analyzed in accordance with U.S. the U.S. Environmental Protection Agency approved methods for water analysis listed in 40 CFR part 136. Samples collected shall be representative of the monitored discharge. The discharge must be collected in accordance with approved U.S. Environmental Protection Agency methods for water analysis listed in 40 CFR part 136.

4. If conditions are not safe for sampling, the permittee must provide documentation of why samples could not be collected and analyzed. For example, the permittee may be unable to collect samples during dangerous weather conditions (such as local flooding, high winds, hurricane, tornadoes, electrical storms, and such). However, once dangerous conditions have passed, the permittee shall collect a sample from the retention structure (pond or lagoon) from which the discharge occurred.

C. General Inspection, Monitoring, and Record-Keeping Requirements

The permittee shall inspect, monitor, and record the results of such inspection and monitoring in accordance with Table V–A.

Table V-A. NPDES Large CAFO Permit Record-keeping Requirements

Parameter	Units	Frequency
Permit and Nutrient Management Plan ***(Note: Required by the NPDES CAFO Regulation—applicable to all CAFOs)***		
The CAFO must maintain on-site a copy of the current NPDES permit, including the permit authorization notice. **[SPECIFY MECHANISM TO IDENTIFY SITE-SPECIFIC TERMS]**	N/A	Maintain at all times
Permit and Nutrient Management Plan ***(Note: Required by the NPDES CAFO Regulation—applicable to all CAFOs)***		
The CAFO must maintain on-site a current-site specific NMP that reflects existing operational characteristics. The operation must also maintain on-site all necessary records to document that the NMP is being properly implemented with respect to manure and wastewater generation, storage and handling, and land application. In addition, records must be maintained that the development and implementation of the NMP is in accordance with the minimum practices defined in 40 CFR part 122.42(e).	N/A	Maintain at all times

Table V-A. NPDES Large CAFO Permit Record-keeping Requirements *(continued)*

Parameter	Units	Frequency
Soil and Manure/Wastewater Nutrient Analysis ***(Note: Required by the CAFO ELG—applicable to Large CAFOs)***		
Analysis of manure, litter, and process wastewater to determine nitrogen and phosphorus content.[a]	ppm Pounds/ton	At least annually after initial sampling
Analysis of soil in all fields where land application activities are conducted to determine phosphorus content.[a]	ppm	At least once every 5 years after initial sampling
Operation and Maintenance ***(Note: Required by the CAFO ELG—applicable to Large CAFOs)***		
Visual inspection of all water lines	N/A	Daily[b]
Documentation of depth of manure and process wastewater in all liquid impoundments	Feet	Weekly
Documentation of all corrective actions taken. Deficiencies not corrected within 30 days must be accompanied by an explanation of the factors preventing immediate correction.	N/A	As necessary
Documentation of animal mortality handling practices	N/A	As necessary
Design documentation for all manure, litter, and wastewater storage structures including the following information:		
• Volume for solids accumulation	Cubic yards/gallons	Once in the permit term unless revised
• Design treatment volume	Cubic yards/gallons	
• Total design storage volume[c]	Cubic yards/gallons	
• Days of storage capacity	Days	
Documentation of all overflows from all manure and wastewater storage structures including: ***(Note: Required by the NPDES Regulation—applicable to all CAFOs)***		
• Date and time of overflow	Month/day/year	Per event
• Estimated volume of overflow	Total gallons	Per event
• Analysis of overflow (as required by the Permitting Authority)	TBD	Per event
Land Application ***(Note: Required by the CAFO ELG—applicable to Large CAFOs)***		
For each application event where manure, litter, or process wastewater is applied, documentation of the following by field:		
• Date of application	Month/day/year	Daily
• Method of application	N/A	Daily
• Weather conditions at the time of application and for 24 hours prior to and following application	N/A	Daily
• Total amount of nitrogen and phosphorus applied[d]	Pounds/acre	Daily

Table V-A. NPDES Large CAFO Permit Record-keeping Requirements *(continued)*

Parameter	Units	Frequency
Documentation of the crop and expected yield for each field	Bushel/acre	Seasonally
Documentation of the actual crop planted and actual yield for each field	Bushel/acre	Seasonally
Documentation of test methods and sampling protocols used to sample and analyze manure, litter, and wastewater and soil.	N/A	Once in the permit term unless revised
Documentation of the basis for the application rates used for each field where manure, litter, or wastewater is applied.	N/A	Once in the permit term unless revised
Documentation showing the total nitrogen and phosphorus to be applied to each field including nutrients from the application of manure, litter, and wastewater and other sources	Pounds/acre	Once in the permit term unless revised
Documentation of manure application equipment inspection	N/A	Seasonally
Manure Transfer ***(Note: Required by the NPDES CAFO Regulation—applicable to Large CAFOs)***		
For all manure transfers the CAFO must maintain the following records:		
• Date of transfer	N/A	As necessary
• Name and address of recipient	N/A	As necessary
• Approximate amount of manure, litter, or wastewater transferred	Tons/gallons	As necessary

Notes:

a. For the specific analyses to be used, see the state nutrient management technical standard.

b. Visual inspections should take place daily during the course of normal operations. The completion of such inspection should be documented in a manner appropriate to the operation. Some operations might wish to maintain a daily log. Other operations might choose to make a weekly entry, when they update other weekly records that required daily inspections have been completed.

c. Total design volume includes normal precipitation less evaporation on the surface of the structure for the storage period, normal runoff from the production area for the storage period, 25-year, 24-hour precipitation on the surface of the structure, 25-year, 24-hour runoff from the production area, and residual solids.

d. Including quantity/volume of manure, litter, or process wastewater applied and the basis for the rate of phosphorus application.

Part VI. Annual Reporting Requirements

A. The permittee must submit an annual report to the permitting authority by the 31st of July of each year.

B. The annual report must include the following information:

1. The number and type of animals, whether in open confinement or housed under roof.
2. Estimated amount of total manure, litter, and process wastewater generated by the CAFO in the previous 12 months (tons/gallons).
3. Estimated amount of total manure, litter, and process wastewater transferred to other person by the CAFO in the previous 12 months (tons/gallons).
4. Total number of acres for land application covered by the NMP.
5. Total number of acres under control of the CAFO that were used for land application of manure, litter, and process wastewater in the previous 12 months.
6. Summary of all manure, litter, and process wastewater discharges from the production area that have occurred in the previous 12 months, including date, time, and approximate volume.
7. A statement indicating whether the current version of the CAFO's NMP was developed or approved by a certified nutrient management planner.
8. Actual crops planted and actual yields for each field for the preceding 12 months.
9. Results of all samples of manure, litter or process wastewater for nitrogen and phosphorus content for manure, litter and process wastewater that was land applied.
10. Results of calculations conducted in accordance with Part III.A.6.a of this permit.
11. Amount of manure, litter, and process wastewater applied to each field during the preceding 12 months.
12. For rates of application:
    i. The results of any soil testing for nitrogen and phosphorus conducted during the preceding 12 months.
    ii. The data used in calculations conducted in accordance with Part III.A.3.h of tis permit.
    iii. The amount of any supplemental fertilizer applied during the preceding 12 months.

Part VII. Standard Permit Conditions

A. General Conditions

1. In accordance with the provisions of 40 CFR part 122.41 *et. seq.*, this permit incorporates by reference all conditions and requirements applicable to NPDES Permits set forth in the Clean Water Act, as amended, (the Act) and all applicable regulations.

2. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation, and reissuance; for denial of a permit renewal application; and/or for requiring a permittee to apply for and obtain an individual NPDES permit.

3. The permittee shall comply with effluent standards and prohibitions established under section 307(a) of the Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

4. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

5. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state/tribal or local laws or regulations.

6. The permittee shall furnish to the permitting authority, within a reasonable time, any information that the Director might request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the permitting authority, on request, copies of records required to be kept by this permit.

7. Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Any false or materially misleading representation or concealment of information required to be reported by the provisions of the permit, the Act, or applicable regulations, which avoids or effectively defeats the regulatory purpose of the permit may subject the permittee to criminal enforcement pursuant to 18 U.S.C. 1001.

8. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established

pursuant to any applicable state/tribal law or regulation under authority preserved by section 510 of the Act.

9. The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

10. Bypass
    a. *Definitions*
        i. Bypass means the intentional diversion of waste streams from any portion of a treatment facility.
        ii. Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.
    b. *Bypass not exceeding limitations.* The permittee may allow any bypass to occur that does not cause effluent limitations to be exceeded but only if it also is for essential maintenance to assure efficient operation. Those bypasses are not subject to Parts VII.A.10.c. and 10.d. of this permit.
    c. *Notice*
        i. *Anticipated bypass.* If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass.
        ii. *Unanticipated bypass.* The permittee shall submit notice of unanticipated bypass as required in Part VII.D.5. of this permit (24-hour notice).
    d. *Prohibitions of bypass.*
        i. Bypass is prohibited, and the permitting authority may take enforcement action against a permittee for bypass, unless the following are true:
            - Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage.
            - There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. That condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventive maintenance.

- The permittee submitted notices as required under Part VII.A.10.c. of this permit.

ii. The permitting authority may approve an anticipated bypass, after considering its adverse effects, if the permitting authority determines that it will meet the three conditions listed above in Part VII.A.10.d.(i) of this permit.

11. Upset

a. *Definition. Upset* means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance caused by operational error, improperly designed treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. *Effect of an upset.* An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of Part VII.A.11.c. of this permit are met.

c. *Conditions necessary for a demonstration of upset.* A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence of the following:

i. An upset occurred and that the permittee can identify the cause(s) of the upset.

ii. The permitted facility was at the time being properly operated.

iii. The permittee submitted notice of the upset as required in Part VII.D.5 of this permit (24-hour notice).

iv. The permittee complied with any remedial measures required under Part VII.A.14 of this permit (duty to mitigate).

d. *Burden of proof.* In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

12. *Duty to reapply.* If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit.

13. *Need to halt or reduce activity not a defense.* It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity to maintain compliance with the conditions of this permit.

14. *Duty to mitigate.* The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit, which has a reasonable likelihood of adversely affecting human health or the environment.

15. *Inspection and entry.* The permittee shall allow the permitting authority, or an authorized representative (including an authorized contractor acting as a representative of the permitting authority), upon presentation of credentials and other documents as may be required by law, to do the following:
    a. Enter the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit
    b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit
    c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit
    d. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location.

B. Proper Operation and Maintenance

The permittee shall, at all times, properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

C. Monitoring and Records

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
2. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 5 years from the date of the sample, measurement, report, or application. That period may be extended by request of the permitting authority at any time.
3. Records of monitoring information shall include the following:
    a. The date, exact place, and time of sampling or measurements.
    b. The individual(s) who performed the sampling or measurements.
    c. The date(s) analyses were performed.
    d. The individual(s) who performed the analyses.

e. The analytical techniques or methods used.

f. The results of such analyses.

4. The permittee shall follow the following monitoring procedures:
   a. Any required monitoring must be conducted according to test procedures approved under 40 CFR part 136, unless other test procedures have been specified in this permit or approved by the permitting authority.
   b. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instruments at intervals frequent enough to ensure accuracy of measurements and shall maintain appropriate records of such activities.
   c. An adequate analytical quality control program, including the analyses of sufficient standards, spikes, and duplicate samples to ensure the accuracy of all required analytical results shall be maintained by the permittee or designated commercial laboratory.

5. Monitoring reports. Monitoring results shall be reported at the intervals specified elsewhere in this permit.
   a. Monitoring results must be reported on a Discharge Monitoring Report (DMR) or forms provided or specified by the permitting authority for reporting results of monitoring of sludge use or disposal practices.
   b. If the permittee monitors any pollutant more frequently than required by the permit using test procedures approved under 40 CFR part 136 or, in the case of sludge use or disposal, approved under 40 CFR part 136 unless otherwise specified in 40 CFR part 503, or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or sludge reporting form specified by the permitting authority.
   c. Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the permitting authority in the permit.

D. Reporting Requirements

1. The permittee shall give notice to the permitting authority as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when any of the following are true:
   a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR part 122.29(b).
   b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. The notification applies to pollutants

that are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR part 122.42(a)(1).

c. The alteration or addition results in a significant change in the permittee's manure use or disposal practices, and such alteration, addition, or change could justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an NMP.

2. The permittee shall give advance notice to the permitting authority of any planned physical alterations or additions or changes in activity that could result in noncompliance with requirements in this permit.

3. This permit is not transferable to any person except after notice to permitting authority. The permitting authority may require modification or revocation and reissuance of the permit to change the name or the permittee and incorporate such other requirements as might be necessary under the Act.

4. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each scheduled date.

5. The permittee shall report any noncompliance that could endanger human health or the environment. Any information must be provided orally to the permitting authority within 24 hours from the time that the permittee becomes aware of the circumstances. A written submission shall also be provided to the permitting authority within 5 days of the time the permittee becomes aware of the circumstances. The report shall contain the following information:

   a. A description of the noncompliance and its cause

   b. The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue

   c. Steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance

6. The following shall be included as information, which must be reported within 24 hours:

   a. Any unanticipated bypass that exceeds any effluent limitation in the permit

   b. Any upset that exceeds any effluent limitation in the permit

   c. Violation of a maximum daily discharge limitation for any of the pollutants listed by the permitting authority in the permit to be reported within 24 hours

   The permitting authority may waive the written report on a case-by-case basis for reports under the above if the oral report has been received within 24 hours.

7. The permittee shall report all instances of noncompliance not reported under above and of this section, at the time monitoring reports are submitted. The reports shall contain the information listed in Part VII.D.6 of this permit.

8. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the permitting authority, the permittee shall promptly submit such facts or information to the permitting authority.

E. Signatory requirements

All applications, reports, or information submitted to the permitting authority shall be signed and certified consistent with 40 CFR part 122.22:

1. All notices of intent shall be signed as follows:
    a. For a corporation: By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means either of the following:
        i. A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation.
        ii. The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions that govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
        iii. For a partnership or sole proprietorship: By a general partner for a partnership or the proprietor, respectively.

2. All reports required by the permit and other information requested by the U.S. Environmental Protection Agency shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if the following are true:
    a. The authorization is made in writing by a person described above.
    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or any individual or position having overall responsibility for environmental matters for the company. A duly authorized

representative may thus be either a named individual or an individual occupying a named position.

c. The written authorization is submitted to the U.S. Environmental Protection Agency.

F. Availability of Reports

Any information submitted pursuant to this permit may be claimed as confidential by the submitter. If no claim is made at the time of submission, information may be made available to the public without further notice.

G. Penalties for Violations of Permit Conditions

1. Criminal Penalties:

   a. Negligent violations: The Act provides that any person who negligently violates section 301, 302, 306, 307, 308, 318, or 405 of the Act or any condition or limitation implementing those provisions in a permit issued under section 402 is subject to a fine of not less than $2,750 nor more than $27,500 per day of violation, or by imprisonment for not more than one year, or both.

   b. Knowing violations: The Act provides that any person who knowingly violates sections 301, 302, 306, 307, 308, 318, or 405 of the Act or any permit conditions implementing those provisions is subject to a fine of not less than $5,500 nor more than $55,000 per day of violation, or by imprisonment for not more than 3 years, or both.

   c. Knowing endangerment: The Act provides that any person who knowingly violates sections 301, 302, 303, 306, 307, 308, 318, or 405 of the Act or permit conditions implementing those provisions and who knows at that time that he or she is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $275,000, or by imprisonment for not more than 15 years, or both.

   d. False statements: The Act provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $11,000, or by imprisonment for not more than 2 years, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $22,000 per day of violation, or by imprisonment of not more than 4 years, or by both. [See section 309(c)4 of the Clean Water Act.]

2. Civil penalties: The Act provides that any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a civil penalty not to exceed $27,500 per day for each violation. [See section 309(d).]

3. Administrative penalties: The Act provides that the Administrator may assess a Class I or Class II administrative penalty if the Administrator finds that a person has violated sections 301, 302, 306, 307, 308, 318, or 405 of the Act or a permit condition or limitation implementing these provisions, as follows [See section 309(g).]:

   a. Class I penalty: Not to exceed $11,000 per violation nor shall the maximum amount exceed $27,500.

   b. Class II penalty: Not to exceed $11,000 per day for each day during which the violation continues nor shall the maximum amount exceed $137,500.

Part VIII. Definitions

Animal feeding operation means a lot or facility (other than an aquatic animal production facility) where the following conditions are met: (i) animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and (ii) crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Application means the EPA standard national forms for seeking coverage under for an NPDES permit, including any additions, revisions or modifications to the forms; or forms approved by EPA for use in *approved states,* including any approved modifications or revisions [e.g. for NPDES general permits, a written NOI pursuant to 40 CFR part 122.28; for NPDES individual permits, Form 1 and 2B pursuant to 40 CFR part 122.1(d)].

Concentrated animal feeding operation (CAFO) means an AFO that is defined as a Large CAFO or Medium CAFO by 40 CFR parts 122.23 (4) and (6), or that is designated as a CAFO.

Fecal coliform means the bacterial count (Parameter 1 at 40 CFR part 136.3 in Table 1A), which also cites the approved methods of analysis.

Grab sample means a sample that is taken from a wastestream on a one-time basis without consideration of the flow rate of the wastestream and without consideration of time.

Land application means the application of manure, litter, or process wastewater onto or incorporated into the soil.

Land application area means land under the control of a CAFO owner or operator, whether it is owned, rented, or leased, to which manure, litter, or process wastewater from the production area is or could be applied.

Large CAFO means an AFO that stables or confines as many as or more than the numbers of animals specified in any of the following categories: (i) 700 mature dairy cattle, whether milked or dry; (ii)1,000 veal calves; (iii)1,000 cattle other than mature dairy cows or veal calves. Cattle includes but is not limited to heifers, steers, bulls and cow/calf pairs; (iv) 2,500 swine each weighing 55 pounds or more; (v)10,000 swine each weighing less than 55 pounds; (vi) 500 horses; (vii) 10,000 sheep or lambs; (viii) 55,000 turkeys; (ix) 30,000 laying hens or broilers, if the AFO uses a liquid manure handling system; (x)125,000 chickens (other than laying hens), if the AFO uses other than a liquid manure handling system; (xi) 82,000 laying hens, if the AFO uses other than a liquid manure handling system; (xii) 30,000 ducks (if the AFO uses other than a liquid manure handling system); or (xiii) 5,000 ducks (if the AFO uses a liquid manure handling system).

Liquid manure handling system means a system that collects and transports or moves waste material with the use of water, such as in washing pens and flushing confinement facilities. That includes the use of water impoundments for manure or wastewater treatment.

Manure is defined to include manure, litter, bedding, compost and raw materials or other materials commingled with manure or set aside for land application or other use.

Medium CAFO means any AFO that stables or confines as many or more than the numbers of animals specified in any of the following categories: (i) 200 to 699 mature dairy cattle, whether milked or dry cows; (ii) 300 to 999 veal calves; (iii) 300 to 999 cattle other than mature dairy cows or veal calves. Cattle includes but is not limited to heifers, steers, bulls and cow/calf pairs; (iv) 750 to 2,499 swine each weighing 55 pounds or more; (v) 3,000 to 9,999 swine each weighing less than 55 pounds; (vi) 150 to 499 horses, (vii) 3,000 to 9,999 sheep or lambs, (viii) 16,500 to 54,999 turkeys, (ix) 9,000 to 29,999 laying hens or broilers, if the AFO uses a liquid manure handling system; (x) 37,500 to 124,999 chickens (other than laying hens), if the AFO uses other than a liquid manure handling system; (xi) 25,000 to 81,999 laying hens, if the AFO uses other than a liquid manure handling system; (xii) 10,000 to 29,999 ducks (if the AFO uses other than a liquid manure handling system); or (xiii) 1,500 to 4,999 ducks (if the AFO uses a liquid manure handling system) *and* either one of the following conditions are met (a) pollutants are discharged into waters of the United States through a man-made ditch, flushing system, or other similar man-made device; or (b) pollutants are discharged directly into waters of the United States that originate outside and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.

Notice of Intent (NOI) is a form submitted by the owner/operator applying for coverage under a general permit. It requires the applicant to submit the information necessary for adequate program implementation, including, at a minimum, the legal name and address of the owner or operator, the facility name and address, type of facility or discharges, and the receiving stream(s). 40 CFR § 128.28(b)(2)(ii)

Process wastewater means water directly or indirectly used in the operation of the CAFO for any or all of the following: spillage or overflow from animal or poultry watering systems; washing, cleaning, or flushing pens, barns, manure pits, or other AFO facilities; direct contact swimming,

washing, or spray cooling of animals; or dust control. Process wastewater also includes any water that comes into contact with or is a constituent of raw materials, products, or by-products including manure, litter, feed, milk, eggs, or bedding.

Production area means that part of an AFO that includes the animal confinement area, the manure storage area, the raw materials storage area, and the waste containment areas. The animal containment area includes but is not limited to open lots, housed lots, feedlots, confinement houses, stall barns, free stall barns, milk rooms, milking centers, cowyards, barnyards, medication pens, walkers, animal walkways, and stables. The manure storage area includes but is not limited to lagoons, runoff ponds, storage sheds, stockpiles, under house or pit storages, liquid impoundments, static piles, and composting piles. The raw materials storage area includes but is not limited to feed silos, silage bunkers, and bedding materials. The waste containment area includes but is not limited to settling basins, and areas within berms and diversions that separate uncontaminated stormwater. Also included in the definition of production area is any egg washing or egg processing facility, and any area used in the storage, handling, treatment, or disposal of mortalities.

Small CAFO means an AFO that is designated as a CAFO and is not a Medium CAFO.

Setback means a specified distance from waters of the United States or potential conduits to waters of the United States where manure, litter, and process wastewater may not be land applied. Examples of conduits to surface waters include open tile line intake structures, sinkholes, and agricultural well heads.

The Act means Federal Water Pollution Control Act as amended, also known as the Clean Water Act as amended, found at 33 U.S.C. 1251 *et seq*.

Vegetated buffer means a narrow, 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 slowing water runoff, enhancing water infiltration, and minimizing the risk of any potential nutrients or pollutants from leaving the field and reaching waters of the United States.

Waters of the United States means (1) all waters that are used, were used in the past, or might be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide; (2) all interstate waters, including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, and streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters: (a) that are or could be used by interstate or foreign travelers for recreational or other purposes; from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or that are or could be used for industrial purposes by industries in interstate commerce; (4) all impoundments of waters otherwise defined as waters of the United States; (5) tributaries of waters identified in (1) through (4) of this definition; (6) the territorial sea; and (7) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in items (1) through (6) of this definition.

Appendix A.

(Insert Form 2B/Notice of Intent or Appropriate State Form)

Appendix B.

Sample Technical Standard for Nutrient Management

While this sample technical standard is adapted from Iowa state publications, it does not constitute Iowa's technical standard for nutrient management. This documentation has not been identified by the Iowa State Director as required by 40 C.F.R. 123.36 nor has EPA reviewed these documents for consistency with the requirements of 40 C.F.R. 412.4(c)(2). EPA is circulating this technical standard to demonstrate how the terms of the nutrient management plan depend on technical information that would be found in a technical standard. Some of the original documents have been modified to better illustrate the relationship between techincal standards and terms. Circulation of the sample technical standards herein does not constitute an endorsement of this technical documentation as an adequate technical standard for Iowa. This sample is intended for educational purposes only and does not create or remove any legal rights or requirements upon any member of the public, States or any other Federal agency.

Manure Management Plan Form

Iowa law requires certain confinement feeding operations to develop and obtain Department of Natural Resources (DNR) approval of a manure management plan (MMP), to apply manure in accordance with the plan, to submit annual updates of the manure management plan, to pay an annual compliance fee and to provide copies of the manure management plan to the counties where the operation is located and where manure is applied. Manure management plans submitted to the DNR must use the attached forms. Submit one copy of the MMP to the DNR, two if you are applying for a construction permit. Additionally, submit one copy to the county where the facility is located, one to each county where manure will be applied, and keep a copy within 30 miles of the operation. It is recommended that one copy be kept for your manure applicator.

These forms are not intended for use if manure is being sold. Plans involving the sale of manure should be developed in accordance with the requirements of DNR rules 567 Iowa Administrative Code 65.17(2). These rules are found in Appendix A.9 of these forms. Forms can be found on the DNR website at http://www.state.ia.us/epd/wastewtr/feedlot/manure.htm.

Who Needs to Submit a Plan and Annual Updates?

- Owners of confinement animal feeding operations constructed or expanded after May 31, 1985 (unless the operation is a small animal feeding operation [1]);
- If you are constructing a manure storage structure or a confinement building – you must submit an original manure management plan (unless the operation is a small animal feeding operation [1]);
- Owners of out-of-state confinement operations that apply manure in Iowa (unless the operation is a small animal feeding operation [1]).

Instructions for Use of These Forms

- Make additional copies of pages 2 and 3 as needed.
- A copy of the manure management plan and attachments listed on the following page must be provided to the county where the facility is located and each county where manure is applied. Submit a signed copy of the **Verification of County Receipt for MMP** to the DNR for each county involved. Use the form for non-permitted sites Verification of County Receipt (Form 542-8046) Verification of County Receipt (Form 542-8046) **OR** if a construction permit is required, use the Construction Application Package and use fee forms for construction permit sites (Form 542-1428).
- In addition to the required forms, information indicated on the following page must be submitted to DNR and maintained as part of the current manure management plan.

---

1. **Small animal feeding operation:** an animal feeding operation which has an animal unit capacity of 500 au or less.

SECTION A:

Attachments to be submitted to the county and maintained with the current MMP within thirty miles of the site (in addition to required forms): *These items are not required to be submitted to DNR.*

- A plat map which shows the location of the confinement feeding operation and of all fields being used for manure application;
- Aerial photos (available from the county Farm Services Agency office) or similar photos of all fields being used for manure application. For each field, mark the field boundaries, areas not available or unsuitable for manure application, and areas where specific restrictions on manure application apply;
- Information documenting the optimum yields calculated for the manure application fields (if required – see footnote "h");
- Operations using irrigation to apply manure must provide information indicating how they will comply with applicable restrictions and requirements, and any additional methods or practices that will be used to reduce potential odors.

SECTION B:

Attachments to be submitted to DNR (in addition to required forms):

With Annual Updates

- The **Annual Compliance Fee form** – Annual Compliance Fee (Form 542-8064) rev. 3/06 and a check for the amount due ($0.15 per animal unit);
- MMP Short Form 2 (Form 542-8162)

With an Original MMP (new construction or expansion) and with an Original P Index-Based MMP

- A plat map which shows the location of the confinement operation.
- Written manure application agreements for all fields identified in the plan that are not owned or rented for crop production purposes by the owner of the confinement feeding operation;
- Manure sampling results, if sample results were used to determine the manure's nutrient content for this plan;
- When the P index is required, the MMP must include the NRCS P index "detailed report" from the Iowa P index calculator (available at http://www.ia.nrcs.usda.gov/) with a P index for each field and a document (e.g. RUSLE2 profile erosion calculation record) indicating the inputs and results of RUSLE2 for each field in the plan. The "detailed report" should be submitted with this form once every 4 years as the update.
- **For permitted sites only:** The aerial photos of the manure application fields must be submitted for permitted sites.
- The Filing Fee form [for facilities filing an MMP **for construction, expansion or modification or** filing an **original (first-time)** MMP] and a check for the $250 filing fee and the indemnity fee if required:
  (No indemnity fee applies if the operation was constructed or expanded prior to May 31, 1995 and no construction permit was required.)
  - For **non-permitted sites**: Indemnity fee and MMP filing fee and form (Form 542-4021) rev 3/06.
  - For **permitted sites** - please follow instructions in the Construction Permit Application form (Form 542-4021) rev. 6/03).
  - Verification form of county receipt for non-permitted sites, OR if applying for a construction permit, follow the instructions on the application (Form 542-4021).

- DNR may request submittal of the attachments listed in Section A that are maintained with the current MMP.

Plan Updates & Recordkeeping

Prior to making changes in an operation's manure management practices, the operation must update the plan to show the proposed changes. Updates that occur after the submittal of the plan should be maintained on site and indicated with the next annual update to DNR and the counties.
Records of manure application must be maintained within thirty miles of the confinement site, and must be available for DNR inspection. For a list of record keeping requirements, see 65.17(13) of appendix A9. Records must be maintained for five years after the year of manure application or for the length of the crop rotation, whichever is greater.

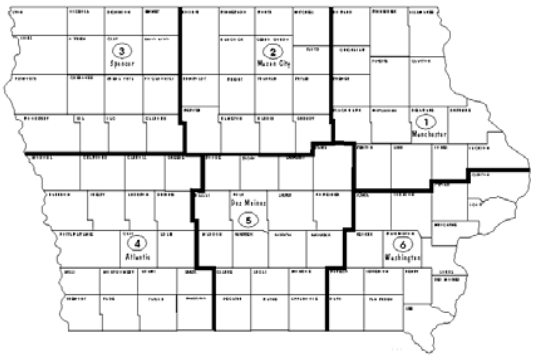
Assistance

Assistance in developing a manure management plan may be available from a number of sources, including private consultants, Iowa State University Extension, and USDA's Natural Resources Conservation Service. Some of these sources will prepare a complete plan for an operation, while others will only provide general assistance. Contact your county extension or NRCS office to determine the assistance they will provide, as well as to obtain a list of consultants who will prepare plans. If you have specific questions about the Manure Management Plan forms, contact your regional DNR field office. See attached map for contact information and to determine the appropriate office.

Mail Plan and Attachments

Please mail the plan, attachments and annual updates to the appropriate Iowa Department of Natural Resources field office (See map below). If submitting a construction permit application, follow instructions on the application form (Form 542-1428). Questions on permits? Please call 515-281-8941.

IOWA DEPARTMENT OF NATURAL RESOURCES
Environmental Services Division Field Office Locations



DNR Environmental Services Division

Field Office #1
909 West Main, Ste 4
Manchester, IA 52057
563-927-2640

Field Office #2
2300 15th St SW
Mason City, IA 50401
641-424-4073

Field Office #3
1900 N. Grand Ave.
Spencer, IA 51301
712-262-4177

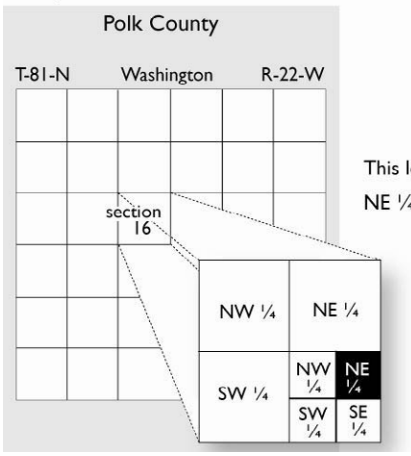
Field Office #4
1401 Sunnyside Lane
Atlantic, IA 50022
712-243-1934

Field Office #5
401 SW 7th, Ste I
Des Moines, IA 50309
515-725-0268

Field Office #6
1023 W. Madison
Washington, IA 52353
319-653-2135

Example of Legal Description for Facility

Please refer to the example on the right when describing the location of your operation on Page 1. This property is located in Washington Township, Polk County.



This location would be described as follows:
NE ¼ of the SE ¼ of section 16 T81N-R22W

Manure Management Plan Form
Animal Feeding Operation Information

Instructions: Complete this form for your animal feeding operation. Footnotes are provided on page 4.

The information within this form, and the attachments, describes my animal feeding operation, my manure storage and handling system, and my planned manure management system. I (we) will manage the manure, and the nutrients it contains, as described within this manure management plan (MMP) and any revisions of the plan, individual field information, and field summary sheet, and in accordance with current rules and regulations. Deviations permitted by Iowa law will be documented and maintained in my records.

Signed: _____ **Date:** _____
(Signature) (Print name)

Name of operation: _____ **Facility ID No.** __ __ __ __ __

Location of the operation*: _____
(911 Address)

_____
(Town) (State) (Zip Code)

_____ ¼ of the _____ ¼ of Sec _____ T_____ R____ _____ _____
(¼ ¼) (¼) (Section) (Tier & Range) (Township Name) (County)

Owner and Contacts of the animal feeding operation:

Owner _____ Phone _____

Address _____

Email address (optional) _____ Cell phone (optional) _____

Contact person (if different than owner) _____ Phone _____

Address _____

Email address (optional) _____ Cell phone (optional) _____

Contract Company (if applicable) _____ Phone _____

Address _____

This manure management plan is for: (check one)

___ existing operation, not expanding ___ existing operation, expanding ___ existing operation, new owner ___ new operation

Construction and Expansion Dates: _____ date of initial construction

_____ _____ _____ and date(s) of all expansion(s)

Table 1. Information about livestock production and manure management system

1	2	3	4	5	6	7	8
Animal Type/ Production phase [a]	Max. Number of Animals Confined (head)	Manure Storage Structure [b]	N[c]	P_2O_5 [c]	gal/space/day or ton/space/year [d]	Days/yr Facility Occupied	Annual Manure Produced [e] (gal or tons)
			lb/1000 gal or lb/ton				
						Total Gallons	
						Total Tons	

Estimate of Annual Animal Production [f]: _____ animals/year

Source of Nutrient Content Data (columns 4, 5): standard tables, analysis of manure samples, other**:** _____

* An example of a legal description is available on page 3 of the Introduction and Instructions.

Manure Management Plan Form

Determining Maximum Allowable Manure Application Rates

Instructions: Complete a worksheet for each unique combination of the following factors (crop rotation, optimum crop yield, manure nutrient concentration, remaining crop N need, method of application) that occurs at this operation. Footnotes are given on pages 4, 5 and 6.

Management Identification (Mgt ID)[g]: _____

(identify this application scenario by letter)

Method used to determine optimum yield [h]: _____ **Timing of Application:** _____

Method of Application [i]: _____ **Application Loss Factor [i]:** _____

If spray irrigation is used, identify method [j]: _____

Table 2. Manure Nutrient Concentration

Manure Nutrient Content (lbs/1000gal or lbs/ton)					
Manure Storage Structure(s) [k]					
Total N		**P_2O_5**			
% TN available 1st year[l]		**% 2nd year**		**% 3rd year**	
Available N 1st year[m]		**2nd year [n]**		**3rd year [o]**	

Table 3. Crop Usage Rates [p]

(lbs/bu or lbs/ton)	**N**	**P_2O_5**
Corn		0.375
Soybean	3.8	0.8
Alfalfa	50	12.5

* Use blank space above to add crop not listed.

Table 4. Calculations for rate based on nitrogen (always required).

1	**Applying Manure For** (crop to be grown)[q]					
2	**Optimum Crop Yield [h]**	bu or ton/acre				
3	**P_2O_5 removed with crop by harvest [r]**	lb/acre				
4	**Crop N utilization [s]**	lb/acre				
5a	**Legume N credit [t]**	lb/acre				
5b	**Commercial N planned [u]**	lb/acre				
5c	**Manure N carryover credit [v]**	lb/acre				
6	**Remaining crop N need [w]**	lb/acre				
7	**Manure rate to supply remaining N [x]**	gal/acre or ton/acre				
8	**P_2O_5 applied with N-based rate [y]**	lb/acre				

Table 5. Calculations for rate based on phosphorus (fill out only if P-based rates are planned)

9	**Commercial P_2O_5 planned [z]**	lb/acre				
10	**Manure rate to supply P removal [aa]**	gal/acre or ton/acre				
11	**Manure rate for P based plan [bb]**	gal/acre or ton/acre				
12	**Manure N applied with P-based plan [cc]**	lb/acre				

Table 6. Application rates that will be carried over to page 3.

13	**Planned Manure Application Rate [dd]**	gal/acre or ton/acre				

Manure Management Plan Form

Year by Year Manure Management Plan Summary

Instructions: Complete this form for each of the next four growing seasons, to demonstrate sufficient land base to apply manure over multiple crop years. If this page is identical for multiple years (e.g. every other year), submit only once for the identical years, and indicate which years the form represents. Footnotes are given on page 6.

Crop Year(s): _____

1	2	3	4	5	6	7	8	9	10	11
Field Designation[ee]	Field Location ___ ¼ of the ___1/4 Sec ___ T____ R____ Township Name _____ County Name _____	Mgt ID[ff]	Planned Crop	Acres receiving manure [gg]	Own, rent, or agreement (include length of agreement) [hh]	P Index Value [ii]	HEL (Y/N) [jj]	Planned Application: gal or tons/acre	Planned Application: gal or ton/field[k] [k]	Correct Soils Test for P [ll] (Yes or No)
Total acres available for manure application					**Total gallons that could be applied**					
					Total tons that could be applied					

Manure Management Plan Footnotes

[a] Complete Appendix B1 Worksheet if a manure storage structure receives manure from several animal production phases and the manure and nitrogen production values given in Appendices A1 and A2 do not adequately represent the operation (such as with a farrow-to-finish swine operation where half the pigs produced are sold as feeders and the remainder held for finishing).

[b] For example, indoor or outdoor formed storage, earthen basin, or anaerobic lagoon; to simplify calculations similar manure storage structures that contain manure with essentially the same nutrient concentrations may be grouped together (for example, the manure storage structures for a 3-building finishing unit with below-building pits could be identified as "3 below-building finishing pits").

[c] From standard tables (Appendix A4), your own samples, or other sources – identify source in space provided below Table 1 on page 1. If your own samples are used, DNR requires submittal of laboratory reports supporting manure concentrations. If your own samples are used, the results may need to be converted from parts per million (ppm) to pounds/1000 gallons. The formula for making this conversion is: N or P_2O_5 concentration (lb/1000 gal) = N or P_2O_5 concentration in parts per million (ppm) X 0.00834. For solid manure the conversion is: N or P_2O_5 concentration (lb/ton) = N or P_2O_5 concentration in parts per million (ppm) X 0.002. If measured volume or weight of manure is used in the plan, actual N and P_2O_5 concentrations must also be used.

[d] From Appendix A1; adjust values if operation has data justifying use of different volumes or weights (e.g., operation uses large volume of clean up water, and thus its manure production volume per animal space is higher than that given in table). If actual volumes or weights are used, DNR may require submittal of supporting data. If actual manure N and P_2O_5 concentrations are used in the plan, measured volume or weight must also be used.

[e] Annual manure produced (**liquid** manure) = maximum number of animals confined (column 2) multiplied by (x) gal/space/day (column 6) x days/ year building occupied (column 7). Annual manure produced (**solid** manure) = maximum number of animals confined (column 2) x tons/space/year (column 6).

[f] Estimated Annual Animal Production = Maximum number of animals confined (column 2 of Table 1) x production cycles per year. If operation has no production cycles (e.g. sows) state only total maximum number confined.

[g] Use the management ID to identify each unique combination of the following factors (crop rotation, optimum crop yields, manure nutrient concentration, remaining crop N need, method of application) that occur. The idea behind the management ID is to group fields with identical management on the same page 2, to avoid the redundancy of doing the exact same calculations for multiple fields.
For example, if 8 fields in the plan are in a corn/bean rotation with yields of 160 and 50 bu/acre and all will receive injected manure with the same nutrient concentration and availability, then page two would only need to be filled out once for the 8 fields and the management ID (e.g. "A") would represent all 8 fields. The same management ID could be used to describe these fields even if they were in different phases of the crop rotation (i.e. some are in corn and some in beans each year).

[h] Yields can be used from any of the following:

- USDA Iowa ag statistics county yield averages
- Multi-peril insurance proven yields
- USDA Farm Service Agency proven yields
- Individual farm proven yields
- Soil survey interpretation records

Documentation of the information used to determine optimum yields must kept with the plan (DNR may require submittal of yield documentation). Documentation may include copies of historical farm yield records, soil survey maps and average yields for the soils found, FSA yield data, etc... If Iowa Ag Statistics county average yields, Appendix A8, are used, documentation is not required to determine optimum yields for corn and soybean crops. The optimum yield for each crop may be set equal to either the average of the last 5-year county yields plus 10 percent or the average of the highest 4 out of the last 5-year county average. If crops other than corn or soybeans are grown, Iowa Ag Statistics yield data for those crops will need to be obtained and optimum yield levels calculated (both the yield data and the calculations should be kept with the plan). If proven yield methods are used to determine optimum yields, the Appendix B2 Worksheet should be used to calculate the optimum yields.

[i] Use list of application methods and application loss factors provided in Appendix A7. If methods other than those listed in Appendix A7 are used, identify the methods and the nitrogen loss factors for those methods.

[j] Use of spray irrigation for manure application: Iowa law includes a number of requirements and restrictions on applying manure through spray irrigation. If spray irrigation is being used, the plan should identify the actions the operation will take to ensure compliance with these requirements and restrictions. In addition, the plan should identify any additional methods or practices the operation will use to reduce potential odor, if any additional methods will be used.

[k] From Table 1 column 3.

[l] Recent research by Iowa State University indicates 100 percent of the nitrogen contained in liquid manure from confinement swine operations is available for plant use in the first year after application. Prior research indicates this may not be the case for liquid manure from other animal species or for solid (dry) manure from confinement operations. A manure management plan may be developed based on the assumption that less than 100 percent of the nitrogen remaining in the manure after deducting application losses will be available for plant use in the first crop year after manure application. However, for planning purposes all nitrogen not considered available in the first crop year must be accounted for in subsequent crop years, and must be considered in determining allowable nitrogen applications (from all sources) during those years. Suggested availability values are: liquid swine manure – 100% in 1st crop year; other liquid manure – 75%, 15%, and 10% in 1st, 2nd, & 3rd crop years respectively; solid manure – 60-75% in 1st crop year, remainder split between 2nd and 3rd years.

[m] 1st year available N = Total N x Application loss factor x Percentage of TN available in the first year (e.g. for 95% N available in first year multiply by 0.95), Appendix B3 can be used to make the calculation.

[n] 2nd year available N = Total N x Application loss factor x Percentage of TN available in the second year. Appendix B3 can be used to make the calculation.

[o] 3rd year available N = Total N x Application loss factor x Percentage of TN available in the third year. Appendix B3 can be used to make the calculation.

[p] Appendices A5 and A6 list crop nitrogen and phosphorus requirements for various crops. These values, or crop use requirements from other credible sources, may be used to determine the crop nitrogen needs and phosphorus removal rates for the crops included in the crop schedule for the fields. For non-legume crops such as corn or grasses, the crop N need value represents the amount of nitrogen required to produce the optimum yield for that crop, and is determined by multiplying the crop nitrogen requirement (in lb/bu or lb/ton of yield) times the optimum crop yield. For legume crops such as soybeans or alfalfa, the crop utilization value represents the amount of nitrogen these legumes will utilize from the soil in producing the optimum crop yield, provided nitrogen is available at these levels in the soil. Again, this amount is determined by multiplying the crop utilization rate (in lb/bu or lb/ton of yield) times the optimum crop yield.

[q] As a minimum, Table 4 should indicate the full crop rotation for the management ID (i.e. , for a corn, corn, soybean rotation, Table 4 should cover a minimum of three crop years).

[r] P_2O_5 removed with crop by harvest = P_2O_5 crop usage rate (Table 3) x Optimum crop yield (row 2)

[s] Crop N utilization = N crop usage rate (Table 3) x Optimum crop yield (row 2)

[t] Credit for nitrogen carryover from prior year legume crops should be determined as follows:

- last year's soybean crop: 1 lb nitrogen per bushel of yield, maximum of 50 lb nitrogen per acre credit
- legume forage crop:
  - ◊ last year's crop with 50 to 100% alfalfa or other legume in stand: 100 to 140 lb nitrogen per acre
  - ◊ last year's crop with 20 to 50% alfalfa or other legume in legume/grass mixture: 50 to 80 lb nitrogen per acre
  - ◊ two years ago crop with 50 to 100% alfalfa or other legume in stand: 30 lb nitrogen per acre
- last year's legume green manure crop: 100 lb nitrogen per acre

[u] Amount of N applied with commercial fertilizer (e.g. starter, with herbicide carrier, etc...).

[v] Manure N carryover credit represents the amount of nitrogen available for crop use due to manure applications made in prior crop years. The carryover N credit is determined by:

1. multiplying the amount of manure (in 1000 gal/acre or ton/acre) applied to the field in the previous crop by the 2nd Year Available N concentration for the applicable manure storage source and method of application;
2. multiplying the amount of manure (in 1000 gal/acre or ton/acre) applied to the field two crop years ago by the 3nd Year Available N concentration for the applicable manure storage source and method of application; adding the resulting N carryover credit values together.

[w] Remaining crop N need = Crop N utilization (row 4) minus (–) Legume N credit (row 5a) – Commercial N planned (row 5b) – Manure N carryover credit (row 5c)

[x] Manure rate to supply remaining N = Remaining crop N need (row 6) divided by (/) 1st year available N (Table 2) (x 1000 for liquid manure)

[y] P_2O_5 applied with N-based rate = Manure rate to supply remaining N need (row 7) x P_2O_5 concentration (Table 2) (Divide by 1000 for liquid manure)

[z] Amount of P_2O_5 applied with commercial fertilizers.

[aa] Manure rate to supply P removal = (P_2O_5 removed with crop by harvest (row 3) – Commercial P_2O_5 planned (row 9))/ Manure P_2O_5 content (Table 2) (x 1000 for liquid manure).

[bb] Manure rates for a P based plan can apply up to the amount of P_2O_5 removed with harvest by the next 4 anticipated crops in a single application if the application rate doesn't exceed the N-based rate (row 7) and no additional P is applied for the period covered by the application. For example, in a corn/soybean rotation if the "manure rate to supply P removal" (row 10) was 2,000 gal/acre for the corn crop and 1,500 for the bean crop, then 3,500 gal/acre could be applied in a single application if the nitrogen rate was not exceeded. Phosphorus in addition to crop removal may be applied if soil tests are very low or low in phosphorus and additional phosphorus is recommended by Pm-1688 "General Guide to Crop Nutrient and Limestone Recommendations in Iowa."

[cc] Manure N applied with P-based plan = Manure rate for P based plan (row 11) x 1st year available N (Table 2) (divided by 1000 for liquid manure)

[dd] Manure application rate that is planned. Use these values for page 3 of the form.

[ee] Field designation may be by Farm Services Agency (FSA) field number, landowner's name, or other suitable designation. A plat map showing the animal feeding operation and all application fields should be kept in the plan. In addition, aerial photos (e.g. FSA section photos) of the fields receiving manure should be in the plan with the boundaries of the individual application fields marked. Also marked on aerial photos should be areas of the fields that are unavailable or unsuitable for manure application, and areas where specific restrictions on manure application apply. DNR may require submittal of plat maps and aerial photos. Areas with specific restrictions on manure application include:

- within 200 feet of a designated area: A designated area means a known sinkhole, or a cistern, abandoned well, unplugged agricultural drainage well, agricultural drainage well surface tile inlet, drinking water well, lake, or a farm pond or a privately owned lake as defined in Iowa Code Section 462A.2. A designated area does not include a terrace tile inlet or surface tile inlet other than an agricultural drainage well surface tile inlet. Iowa law requires manure from an animal feeding operation be injected or incorporated within the same day of application if applied within 200 feet of a designated area. However, this restriction does not apply if a 50-foot buffer of permanent vegetation surrounds the designated area and no manure is applied within the 50-foot buffer.
- within 750 feet of neighboring residence, church, school, business, or public use area: Iowa law requires liquid manure from a confinement feeding operation be injected or incorporated within 24 hours of application if applied within 750 feet of a neighboring residence not owned by the owner of the confinement feeding operation, a church, school, business, or public use area. However, this restriction does not apply if a written waiver is obtained from the owner of the property benefiting by this distance requirement.
- areas where liquid manure is applied through spray irrigation systems: see footnote *"t"* for page 2.

[ff] Identify how the field will be managed using management IDs from page 2.

[gg] The number of acres of the field that will receive manure. Acres not available for manure application include areas where topography, soils, or other factors make manure application impossible; areas where manure will not be applied; areas where application is prohibited under a manure disposal agreement; and areas where Iowa law or DNR rules prohibit manure application. It may also include areas where Iowa law or DNR rules restrict manure application to methods different than those being used by the operation.

[hh] A copy of all written manure application agreements for all fields identified in the plan that are not owned or rented for crop production purposes by the owner of the animal feeding operation must be kept with the plan (agreements must be signed by the landowner). DNR requires submittal of manure application agreements. If manure is applied based on an agreement, also indicate in column 6 the length of the agreement (e.g. annual, 3-yr, 10-yr).

[ii] The MMP must be based on the P index in accordance with DNR rules as indicated in the table below. If the P index is required, submit a NRCS P index detailed report containing a P index for each field in the MMP. Additionally, when the P index is required, the manure management plan must include a document (e.g. NRCS RUSLE2 profile erosion calculation record) indicating the inputs and results of RUSLE2 for each field in the plan (These documents must be submitted to the DNR).

Implementation Date for P-index Based Plans	
Original MMP Submitted	**P-index Based MMP Update Due**
Prior to April 1, 2002	First update after August 25, 2008
Between April 1, 2002 and October 24, 2004	First update after August 25, 2006
On and after October 25, 2004	Upon submittal

[jj] Identify if the field receiving manure is classified as Highly Erodible Land (HEL). Conservation plans are not required in the MMP for HEL if the plan is using the P Index.

[kk] gallons or tons / field = Acres receiving manure (column 5) x gallons or tons/acre (column 9)

[ll] Check "yes" if soil sampling meets minimum requirements. Refer to Rule 65.17(16) in the Iowa Administrative Code for minimum soil sampling requirements. This rule can be found in Appendix A of the MMP. If correct sampling was not used, fields must be resampled within one year.

Appendix A to the

Manure Management Plan Form

Contents

Appendix A1: Manure Production Per Space of Capacity 2

Appendix A2: Annual Pounds of Nitrogen Per Space of Capacity 3

Appendix A3: Annual Pounds of Phosphorus (as P_2O_5) per Space of Capacity 4

Appendix A4: Nutrients in Animal Manure 5

Appendix A5: Crop Nitrogen Usage Rate Factors for Various Crops 6

Appendix A6: Nutrient Removal for Iowa Crops 7

Appendix A7: Nitrogen Application Losses 7

Appendix A8: Iowa Ag Statistics -- County Corn and Soybean Yield Averages, 2001 - 2005 8

Appendix A9: Chapter 567-- 65. 16 and 567-- 65.17 Rules for Animal Feeding Operations..... 11

Appendix A

Appendix A1: Manure Production Per Space of Capacity [1]

		Daily		Yearly
Swine	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Nursery, 25 lb.	1 head	0.2 gal	0.7 gal	0.34 tons
Grow-finish, 150 lb.				
Formed storage*				
Dry feed	1 head	1.2 gal		2.05 tons
Wet/dry feed	1 head	0.9 gal		2.05 tons
Earthen storage**	1 head	1.2 gal		2.05 tons
Lagoon***	1 head		4.1 gal	2.05 tons
Gestation, 400 lb.	1 head	3.0 gal	3.7 gal	2.77 tons
Sow & Litter, 450 lb.	1 crate	3.5 gal	7.5 gal	6.16 tons
Farrow-nursery	Per sow in breeding herd	2.2 gal	5.4 gal	6.09 tons
Farrow-finish	Per sow in breeding herd	9.4 gal	30 gal	12.25 tons

Dairy, Confined	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Cows, 1200 & up lb.	1 head	18.0 gal	40.1 gal	14 tons
Heifers, 900 lb.	1 head	8.8 gal	29.9 gal	6.5 tons
Calves, 500 lb.	1 head	4.9 gal	16.5 gal	1.5 tons
Veal calves, 250 lb.	1 head	2.5 gal	8.2 gal	1.1 tons
Dairy herd	Per productive cow in herd	18.5 gal	59.8 gal	20 tons

Beef, Confined	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Mature cows, 1000 lb.	1 head	7.2 gal	15.7 gal	12.23 tons
Finishing, 900 lb.	1 head	6.5 gal	13.1 gal	11.00 tons
Feeder calves, 500 lb.	1 head	3.6 gal	7.3 gal	6.11 tons

Poultry	Space	Dry Manure
Layer, cages	1000 head	10.5 tons
Broiler, litter	1000 head	9.00 tons
Turkeys, litter	1000 head	35.00 tons

* Formed manure storage structure
** Earthen manure storage basin
*** Anaerobic lagoon

[1] This table is from Table 5 of Chapter 567-65, Rules for Animal Feeding Operations.

Appendix A2: Annual Pounds of Nitrogen Per Space of Capacity [2]

Swine	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Nursery, 25 lb.	1 head	2	1	5
Grow-finish, 150 lb.				
Formed storage*				
Dry feeders	1 head	21		29
Wet/dry feeders	1 head	19		29
Earthen storage**	1 head	14		29
Lagoon***	1 head		6	29
Gestation, 400 lb.	1 head	27	5	39
Sow & Litter, 450 lb.	1 crate	32	11	86
Farrow-nursery	Per sow in breeding herd	22	8	85
Farrow-finish	Per sow in breeding herd	150	44	172

Dairy, Confined	Space	Liquid, Pit* or Basin**	Liquid Lagoon***	Solid Manure
Cows, 1200 & up lb.	1 head	164	59	140
Heifers, 900 lb.	1 head	81	44	65
Calves, 500 lb.	1 head	45	24	15
Veal calves, 250 lb.	1 head	22	12	10
Dairy herd	Per productive cow in herd	169	87	180

Beef, Confined	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid, Manure
Mature cows, 1000 lb.	1 head	105	23	147
Finishing, 900 lb.	1 head	95	19	132
Feeder calves, 500 lb.	1 head	53	11	73

Poultry	Space	Dry Manure
Layer, cages	1000 head	367
Broiler, litter	1000 head	585
Turkeys, litter	1000 head	1400

* Formed manure storage structure
** Earthen manure storage basin
*** Anaerobic lagoon

2 This table is from Table 3 of Chapter 567-65, Rules for Animal Feeding Operations. Source: PM 1811, Managing Manure Nutrients for Crop Production

Appendix A3: Annual Pounds of Phosphorus (as P_2O_5) per Space of Capacity[3]

Swine	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Nursery, 25 lb.	1 head	1	0.7	3
Grow-finish, 150 lb.				
Formed storage*				
Dry feeders	1 head	15		18
Wet/dry feeders	1 head	13		18
Earthen storage**	1 head	10		18
Lagoon***	1 head		5	18
Gestation, 400 lb.	1 head	27	4	25
Sow & Litter, 450 lb.	1 crate	26	8	55
Farrow-nursery	Per sow in breeding herd	18	6	55
Farrow-finish	Per sow in breeding herd	109	33	110

Dairy, Confined	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Cows, 1200 & up lb	1 head	78	44	42
Heifers, 900 lb.	1 head	38	33	20
Calves, 500 lb.	1 head	22	18	5
Veal calves, 250 lb.	1 head	10	9	3
Dairy herd-per productive	cow in herd	80	66	80

Beef, Confined	Space	Liquid, Pit* or Basin**	Liquid, Lagoon***	Solid Manure
Mature cows, 1000 lb.	1 head	66	17	73
Finishing, 900 lb.	1 head	59	14	66
Feeder calves, 500 lb.	1 head	33	8	37

Poultry	Space	Dry Manure
Layer, cages	1000 head	840
Broiler, litter	1000 head	585
Turkeys, litter	1000 head	1400

* Formed manure storage structure
** Earthen manure storage basin
*** Anaerobic lagoon

3. Source: Pm-1811 Managing Manure Nutrients for Crop Production

Appendix A4: Nutrients in Animal Manure

(modified from Table 2 of ISU Extension Pm-1811)

Management System	N	P_2O_5	K_2O	Management System	N	P_2O_5	K_2O
Liquid, Pit	lbs./1,000 gallon			**Solid Manure (Bedded)**	lbs./ton		
Swine				Swine—confined			
Nursery, 25 lbs.	35	20	20	Nursery, 25 lbs.	14	9	11
Grow-finish, 150 lbs (wet/dry)	58	40	45	Grow-finish, 150 lbs.	14	9	11
Grow-finish, 150 lbs. (dry feed)	50	42	30	Gestation, 400 lbs	14	9	11
Grow-finish, 150 lbs. (earthen)	32	22	20	Sow and litter, 450 lbs.	14	9	11
Gestation, 400 lbs.	25	25	25	Farrow-nursery	14	9	11
Sow and litter [1], 450 lbs.	25	20	15	Farrow-finish	14	9	11
Farrow-nursery [2]	27	23	22				
Farrow-finish[3]	44	32	24				
Dairy—confined				Dairy—confined			
Cows, 1,200 lbs. or more	25	12	11	Cows, 1,200 lbs. or more	12	6	12
Heifers, 900 lbs.	25	12	11	Heifers, 900 lbs.	12	6	12
Calves, 500 lbs.	25	12	11	Calves, 500 lbs.	12	6	12
Veal calves, 250 lbs.	25	12	11	Veal calves, 250 lbs.	12	6	12
Dairy herd[4]	25	12	11	Dairy herd	12	6	12
Beef—confined				Beef—confined			
Mature cows, 1,000 lbs.	40	25	35	Mature cows, 1,000 lbs.	12	6	12
Finishing, 900 lbs.	40	25	35	Finishing, 900 lbs.	12	6	12
Feeder calves, 500 lbs.	40	25	35	Feeder calves, 500 lbs.	12	6	12
Lagoon [5]				Poultry			
(all animals)	4	3	4	Layer, caged, 4 lbs. [6]	35	80	50
				Broiler, litter, 2 lbs.	65	65	45
				Turkeys, litter, 10 lbs.	40	40	25
Open Lot Runoff							
Earthen lots (liquids)				Open lot (solids, scraped)			
Beef, 400 sq. ft./hd.	3	1	6	Beef, 400 sq. ft./hd.	22	16	14
Dairy, 1,000 sq. ft./hd.	3	1	6	Dairy, 1,000 sq. ft./hd.	11	6	11
Swine, 50 sq. ft./hd.	3	1	6	Swine, 50 sq. ft./hd.	15	14	9
Concrete lots (liquids)							
Beef, 400 sq. ft./hd.	6	2	7				
Dairy, 1,000 sq. ft./hd.	6	2	7				
Swine, 50 sq. ft./hd.	15	5	10				

[1] Sow and litter figures are per farrowing crate.

[2] Farrow-nursery figures are per sow in the breeding herd and include one farrowing sow, five gestation sows, and nine nursery pig spaces.

[3] Farrow-finish figures are per sow in the breeding herd and include one farrowing sow, five gestation sows, nine nursery pigs, and 36 finishing pig spaces.

[4] Per productive cow in the herd; includes lactating cow, 330 days; dry cow, 35 days; heifer, 222 days; and calf, 165 days.

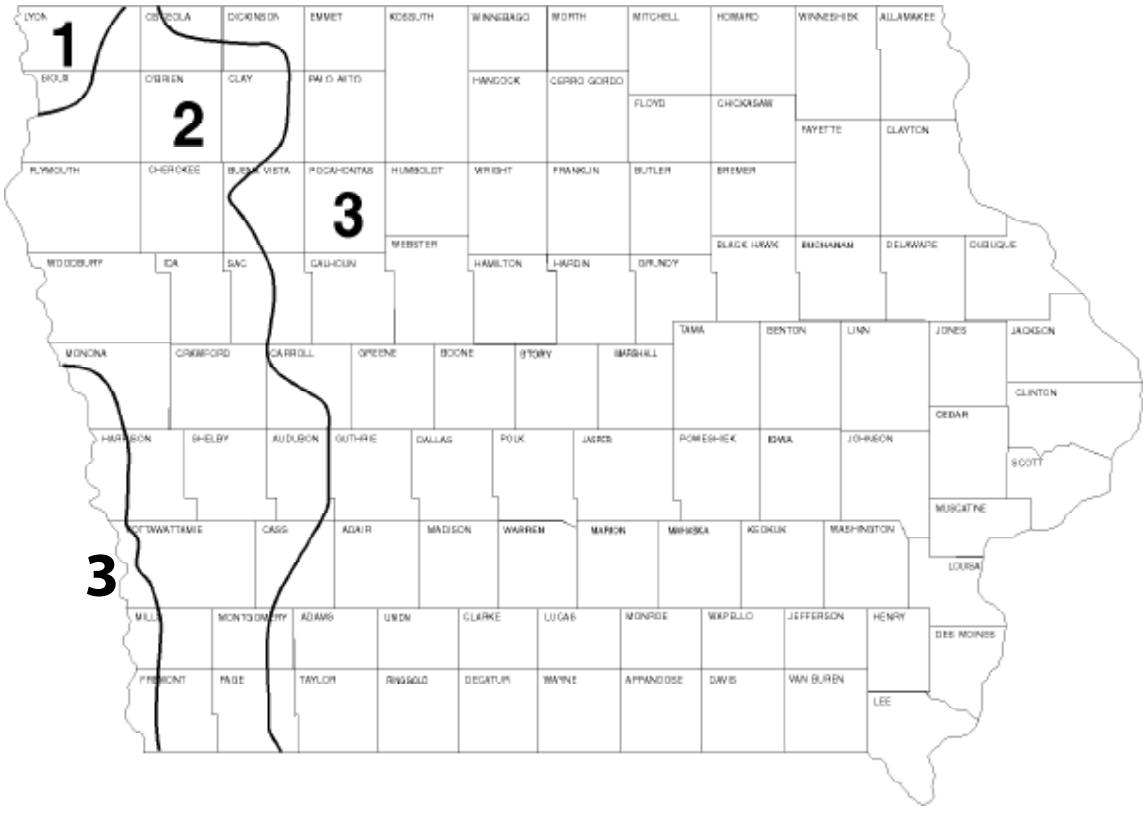
[5] Weights assumed: beef, 1,000 pounds; dairy, 1,200 pounds; swine, 150 pounds.

[6] Wet basis at 41 percent moisture.

Appendix A5: Crop Nitrogen Usage Rate Factors for Various Crops [3]

Corn	Zone 1	0.9 lbs/bu	Orchardgrass	38.0 lbs/ton
	Zone 2	1.1 lbs/bu	Tall fescue	38.0 lbs/ton
	Zone 3	1.2 lbs/bu	Switchgrass	21.0 lbs/ton
Corn silage		7.5 lbs/ton	Vetch	56.0 lbs/ton
Soybean		3.8 lbs/bu	Red clover	43.0 lbs/ton
Oats		0.75 lbs/bu	Perennial ryegrass	24.0 lbs/ton
Alfalfa		50.0 lbs/ton	Timothy	25.0 lbs/ton
Wheat		1.3 lbs/bu	Wheat straw	13.0 lbs/ton
Smooth bromegrass		40.0 lbs/ton	Oat straw	12.0 lbs/ton
Sorghum-sudan		40.0 lbs/ton		

The following map outlines the three zones for the corn nitrogen usage rates indicated in the Table 4. Zone 1 corresponds to the Moody soil association. Zone 2 corresponds to the Marshall, Monona-Ida-Hamburg, and Galva-Primghar-Sac soil associations. Zone 3 corresponds to the remaining soil associations.



[3] Appendix A5 and the accompanying map are from Table 4 in Appendix B of Chapter 567-65.

Appendix A6: Nutrient Removal for Iowa Crops[4]

			Pounds/Unit	
Crop	Units		P_2O_5	K_2O
Corn	bu.	-	0.375	0.3
Corn Silage	ton (65% H_2O)	-	3.5	8.0
Corn Silage	bu. grain equivalent	-	0.55	1.25
Soybean	bu.	3.8	0.8	1.5
Alfalfa	ton	50	12.5	40
Oat and Straw	bu.	0.75	0.4	1.0
Wheat	bu.	1.3	0.6	0.3
Smooth bromegrass	ton	40	9	47
Orchardgrass	ton	38	14	68
Tall fescue	ton	38	12	66
Switchgrass	ton	21	12	66
Sorghum-sudan	ton	40	12	38
Vetch	ton	56	12	47
Red clover	ton	43	12	35
Perennial ryegrass	ton	24	12	34
Timothy	ton	25	9	32
Wheat straw	ton	13	4	25
Oat straw	ton	12	5	33

Appendix A7: Nitrogen Application Losses

Application Method	Application Loss Factor [5]
Knifed in or soil injection of liquid manure	0.98
Surface apply liquid or solid (dry) manure with incorporation within 24 hours	0.95
Surface apply liquid or solid (dry) manure with incorporation after 24 hours	0.80
Surface apply liquid manure with no incorporation	0.75
Surface apply solid (dry) manure with no incorporation	0.70
Irrigate liquid manure with no incorporation	0.60

4. Appendix A6 is from PM 1688: General Guide for Crop Nutrient Recommendations in Iowa
5. Percent of applied nitrogen remaining after deducting application losses

Appendix A8: Iowa Ag Statistics
County Corn and Soybean Yield Averages, 2004 - 2008

	Corn			Soybeans		
County	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)
Adair	167.1	183.9	169.2	50.0	55.0	51.2
Adams	156.2	171.9	159.0	47.2	51.9	49.4
Allamakee	168.8	185.7	170.2	47.6	52.4	49.2
Appanoose	149.9	164.9	157.9	43.0	47.3	46.1
Audubon	173.5	190.8	176.7	52.1	57.3	52.8
Benton	174.5	191.9	175.6	52.3	57.5	52.8
Black Hawk	177.2	194.9	180.3	52.1	57.4	52.8
Boone	181.1	199.2	184.9	51.2	56.3	53.1
Bremer	180.6	198.7	185.5	51.8	57.0	53.7
Buchanan	172.7	189.9	175.1	49.6	54.6	50.7
Buena Vista	172.6	189.9	180.0	50.3	55.3	50.9
Butler	180.3	198.3	181.6	51.0	56.1	52.0
Calhoun	178.1	195.9	181.2	49.6	54.6	50.5
Carroll	176.3	193.9	179.7	50.6	55.6	51.0
Cass	172.6	189.8	176.3	50.6	55.6	51.9
Cedar	175.8	193.4	183.7	49.8	54.8	50.3
Cerro Gordo	172.1	189.3	173.6	48.2	53.0	49.2
Cherokee	175.9	193.5	183.8	55.1	60.6	55.4
Chickasaw	172.9	190.2	176.4	49.4	54.3	50.6
Clarke	142.1	156.4	150.4	41.5	45.6	45.3
Clay	172.9	190.2	176.3	48.9	53.8	49.3
Clayton	175.0	192.5	176.0	52.7	58.0	53.6
Clinton	165.5	182.0	177.7	48.5	53.3	50.0
Crawford	170.0	187.0	177.8	51.6	56.8	52.3
Dallas	174.8	192.3	177.5	52.2	57.4	53.6
Davis	151.2	166.4	160.3	44.5	48.9	46.6
Decatur	152.9	168.2	163.1	45.4	49.9	49.0
Delaware	174.6	192.1	178.5	52.1	57.3	53.6
Des Moines	177.6	195.4	183.4	50.6	55.7	51.6
Dickinson	170.4	187.4	173.3	47.2	52.0	48.2
Dubuque	177.7	195.5	182.7	52.7	58.0	54.9
Emmet	174.8	192.3	177.1	48.2	53.0	49.2
Fayette	173.7	191.1	175.5	50.8	55.9	52.4

updated 3/2009

Appendix A8: Iowa Ag Statistics
County Corn and Soybean Yield Averages, 2004 - 2008

	Corn			Soybeans		
Counties	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)
Floyd	173.5	190.9	175.7	49.0	53.9	50.2
Franklin	179.4	197.3	182.5	49.3	54.3	50.6
Fremont	158.7	174.6	161.9	48.0	52.8	49.8
Greene	176.3	193.9	180.6	49.9	54.9	50.9
Grundy	182.9	201.1	184.6	56.0	61.6	56.8
Guthrie	164.6	181.1	166.1	47.7	52.5	48.8
Hamilton	178.5	196.4	183.9	49.7	54.6	50.5
Hancock	176.9	194.5	178.3	50.0	55.0	51.6
Hardin	180.5	198.5	185.9	52.8	58.0	54.0
Harrison	162.4	178.7	167.5	44.4	48.8	45.6
Henry	172.5	189.8	177.4	50.7	55.7	51.5
Howard	168.7	185.6	170.7	47.1	51.8	48.8
Humboldt	181.8	200.0	184.3	50.5	55.6	51.3
Ida	170.6	187.6	181.9	49.8	54.7	50.6
Iowa	172.4	189.7	178.7	50.9	56.0	52.0
Jackson	159.7	175.7	168.6	49.2	54.1	50.0
Jasper	183.9	202.3	186.4	54.9	60.4	55.5
Jefferson	162.9	179.1	167.7	48.1	53.0	49.8
Johnson	162.7	179.0	169.4	47.7	52.4	48.2
Jones	168.1	184.9	173.0	49.9	54.9	50.9
Keokuk	164.7	181.2	172.2	49.3	54.3	50.2
Kossuth	178.5	196.4	180.4	50.2	55.2	52.0
Lee	160.8	176.9	168.7	47.2	51.9	48.5
Linn	169.9	186.8	174.3	48.8	53.7	49.4
Louisa	166.9	183.6	175.3	47.4	52.2	47.9
Lucas	140.7	154.7	147.3	42.1	46.3	45.6
Lyon	177.7	195.5	181.3	53.2	58.5	54.0
Madison	163.3	179.6	165.4	48.9	53.8	50.8
Mahaska	175.0	192.5	178.7	52.2	57.5	53.6
Marion	159.1	175.0	163.1	49.0	53.9	50.1
Marshall	185.4	204.0	186.8	55.7	61.3	57.0
Mills	162.3	178.5	166.0	48.5	53.4	50.4
Mitchell	176.1	193.7	177.5	49.6	54.5	51.0

Appendix A8: Iowa Ag Statistics
County Corn and Soybean Yield Averages, 2004 - 2008

	Corn			Soybeans		
Counties	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)	5-yr. avg. yield (bu./a)	5-yr. ave. yield + 10% (bu./a)	Avg. yield of 4 highest (bu./a)
Monona	151.3	166.4	161.8	44.8	49.3	45.4
Monroe	152.0	167.2	156.0	43.9	48.3	46.7
Montgomery	162.1	178.3	166.3	48.0	52.8	50.6
Muscatine	165.7	182.2	173.3	48.0	52.8	49.1
O Brien	179.2	197.1	182.5	54.2	59.6	55.6
Osceola	177.0	194.7	179.9	51.2	56.4	52.2
Page	153.9	169.3	159.2	47.6	52.3	50.2
Palo Alto	175.8	193.4	179.1	49.2	54.2	50.5
Plymouth	167.3	184.0	174.8	50.1	55.1	50.4
Pocahontas	178.1	195.9	181.0	49.8	54.8	50.8
Polk	172.4	189.6	177.0	49.4	54.3	50.8
Pottawattamie	174.6	192.0	177.6	50.5	55.5	52.9
Poweshiek	179.5	197.5	181.9	53.8	59.2	55.2
Ringgold	140.9	155.0	147.4	42.9	47.2	47.2
Sac	172.4	189.6	182.0	50.9	56.0	51.9
Scott	175.5	193.1	182.2	52.2	57.4	52.6
Shelby	175.5	193.0	177.5	51.3	56.4	52.1
Sioux	177.5	195.3	182.7	55.2	60.7	55.6
Story	180.1	198.1	185.1	52.0	57.2	53.5
Tama	178.9	196.8	180.4	53.9	59.3	55.1
Taylor	145.9	160.5	148.7	44.6	49.0	47.3
Union	154.7	170.1	156.3	47.0	51.7	49.4
Van Buren	153.8	169.2	161.3	46.5	51.1	48.0
Wapello	157.9	173.7	163.3	47.5	52.3	48.9
Warren	156.4	172.0	161.8	49.7	54.7	51.9
Washington	174.7	192.1	180.1	50.5	55.6	50.9
Wayne	142.4	156.6	152.3	44.6	49.0	48.2
Webster	181.1	199.2	184.6	49.3	54.2	49.9
Winnebago	181.1	199.2	182.9	49.9	54.9	51.9
Winneshiek	174.6	192.1	175.8	48.7	53.6	50.1
Woodbury	161.3	177.4	169.2	45.9	50.5	46.4
Worth	175.3	192.8	176.6	47.8	52.6	49.6
Wright	179.5	197.4	183.4	50.0	55.0	51.0

Appendix A9: Chapter 567-- 65. 16 and 567-- 65.17 Rules for Animal Feeding Operations

Please note: Manure management plans that include the phosphorus index will be phased in between the fall of 2004 and 2008, depending upon the date that the original MMP was submitted to the DNR. See 65.17(1)"d" below for the phase in schedule.

Disclaimer: Producers should consult Chapter 65 of the Iowa Administrative Code for more information and the actual wording of rules governing animal feeding operations. Consult Chapter 459 of the Iowa Code for actual wording of the laws governing animal feeding operations in Iowa.

567—65.16(455B) Manure management plan requirements.

65.16(1) In accordance with Iowa Code section 455B.203 as amended by 2002 Iowa Acts, chapter 1137, section 38, the following persons are required to submit manure management plans to the department, including an original manure management plan and an updated manure management plan, as required by this rule:
a. An applicant for a construction permit for a confinement feeding operation. However, a manure management plan shall not be required of an applicant for an egg washwater storage structure.
b. The owner of a confinement feeding operation, other than a small animal feeding operation, if one of the following applies:
(1) The confinement feeding operation was constructed or expanded after May 31, 1985, regardless of whether the confinement feeding operation structure was required to have a construction permit.
(2) The owner constructs a manure storage structure, regardless of whether the person is required to be issued a permit for the construction pursuant to Iowa Code section 455B.200A as amended by 2002 Iowa Acts, chapter 1137, sections 28 and 29, or whether the person has submitted a prior manure management plan.
c. A person who applies manure in Iowa that was produced in a confinement feeding operation, other than a small operation, located outside of Iowa.
d. A research college is exempt from this subrule and the manure management plan requirements of rule 65.17(459) for research activities and experiments performed under the authority of the research college and related to animal feeding operations.

65.16(2) Effective February 13, 2002, an owner of a proposed confinement feeding operation who is required to file a manure management plan pursuant to paragraph 65.16(1)*"b"* shall submit the confinement feeding operation's manure management plan to the department at least 30 days before the construction of an animal feeding operation structure begins, as that term is defined in subrules 65.8(1) and 65.8(2). After the manure management plan has been received by the department, the department will date-stamp the plan as received and provide written confirmation of receipt to the owner. In addition to the content requirements specified in rule 65.17(459), the owner shall include:
a. Documentation that the board of supervisors or auditor of the county where the confinement feeding operation is proposed to be located received a copy of the plan.
b. Information (e.g., maps, drawings, aerial photos) that clearly shows the intended location of the animal feeding operation structures and locations and animal weight capacities of any other confinement feeding operations within a distance of 2,500 feet in which the owner has an ownership interest or which the owner manages.

65.16(3) Scope of manure management plan; updated plans; annual compliance fee.
a. Each confinement feeding operation required to submit a manure management plan shall be covered by a separate manure management plan.

b. The owner of a confinement feeding operation who is required to submit a manure management plan under this rule shall submit an updated manure management plan on an annual basis to the department. The updated plan must reflect all amendments made during the period of time since the previous manure management plan submission. The owner of the animal feeding operation shall also submit the updated manure management plan on an annual basis to the board of supervisors of each county where the confinement feeding operation is located and to the board of supervisors of each county where manure from the confinement feeding operation is land-applied. If the owner of the animal feeding operation has not previously submitted a manure management plan to the board of supervisors of each county where the confinement feeding operation is located and each county where manure is land-applied, the owner must submit a complete manure management plan to each required county. The county auditor or other county official or employee designated by the county board of supervisors may accept the updated plan on behalf of the board. The updated plan shall include documentation that the county board of supervisors or other designated county official or employee received the manure management plan update. The department will stagger the dates by which the updated manure management plans are due and will notify each confinement feeding operation owner of the date on which the updated manure management plan is due. To satisfy the requirements of an updated manure management plan, an owner of a confinement feeding operation must submit one of the following:
(1) A complete manure management plan;
(2) A department-approved document stating that the manure management plan submitted in the prior year has not changed; or
(3) A department-approved document listing all the changes made since the previous manure management plan was submitted and approved.
c. An annual compliance fee of $0.15 per animal unit at the animal feeding operation shall accompany an annual manure management plan update submitted to the department for approval. The annual compliance fee is based on the animal unit capacity of the confinement feeding operation stated in the updated annual manure management plan submission. If the person submitting the manure management plan is a contract producer, as provided in Iowa Code chapter 202, the active contractor shall pay the annual compliance fee.

65.16(4) The department shall review and approve or disapprove all complete manure management plans within 60 days of the date they are received.

65.16(5) Manure shall not be removed from a manure storage structure, which is part of a confinement feeding operation required to submit a manure management plan, until the department has approved the plan. As an exception to this requirement, until July 1, 2002, the owner of a confinement feeding operation may remove and apply manure from a manure storage structure in accordance with a manure management plan submitted to the department prior to September 18, 2001, but which has not been approved within the required 60-day period. Manure shall be applied in compliance with rule 65.2(455B).

65.16(6) All persons required to submit a manure management plan to the department shall also pay to the department an indemnity fee as required in Iowa Code section 455J.3 except those operations constructed prior to May 31, 1995, which were not required to obtain a construction permit.

65.16(7) Any person submitting an original manure management plan must also pay to the department a manure management plan filing fee of $250. This fee shall be included with each original manure management plan being submitted. If the confinement feeding operation is required to obtain a construction permit and to submit an original manure management plan as part of the construction permit requirements, the applicant must pay the manure management plan filing fee together with the construction permit application fee, which total $500.

567—65.17(459) Manure management plan content requirements. All manure management plans are to be submitted on forms or electronically as prescribed by the department. The plans shall include all of the information specified in Iowa Code section 459.312 and as described below.

65.17(1) *General.*
a. A confinement feeding operation that is required to submit a manure management plan to the department shall not apply manure in excess of the nitrogen use levels necessary to obtain optimum crop yields. When a phosphorus index is required in a manure management plan as provided in 65.17(1)*"d,"* a confinement feeding operation shall not apply manure in excess of the rates determined in conjunction with the phosphorus index. Information to complete the required calculations may be obtained from the tables in this chapter, actual testing samples or from other credible sources including, but not limited to, Iowa State University, the United States Department of Agriculture (USDA), a licensed professional engineer, or an individual certified as a crop consultant under the American Registry of Certified Professionals in Agronomy, Crops, and Soils (ARCPACS) program, the Certified Crop Advisors (CCA) program, or the Registry of Environmental and Agricultural Professionals (REAP) program.
b. Manure management plans shall comply with the minimum manure control requirements of 65.2(455B) and the requirements for land application of manure in 65.3(455B).
c. Manure management plans shall include all of the following:
(1) The name of the owner and the name of the confinement feeding operation, including mailing address and telephone number.
(2) The name of the contact person for the confinement feeding operation, including mailing address and telephone number.
(3) The location of the confinement feeding operation identified by county, township, section, 1/4 section and, if available, the 911 address.
(4) The animal unit capacity of the confinement feeding operation and, if applicable, the animal weight capacity.
d. A person who submits a manure management plan shall include a phosphorus index as part of the manure management plan as follows:
(1) A person who submitted an original manure management plan prior to April 1, 2002, shall submit a phosphorus index with the first manure management plan update on and after August 25, 2008.
(2) A person who submitted an original manure management plan on or after April 1, 2002, but prior to October 25, 2004, shall submit a phosphorus index with the first manure management plan update on and after August 25, 2006.
(3) A person who submits an original manure management plan on and after October 25, 2004, shall include the phosphorus index as part of the original manure management plan and manure management plan updates.

65.17(2) *Manure management plans for sales of manure.* Selling manure means the transfer of ownership of the manure for monetary or other valuable consideration. Selling manure does not include a transaction where the consideration is the value of the manure, or where an easement, lease or other agreement granting the right to use the land only for manure application is executed.
a. Confinement feeding operations that will sell dry manure as a commercial fertilizer or soil conditioner regulated by the Iowa department of agriculture and land stewardship (IDALS) under Iowa Code chapter 200 or 200A shall submit a copy of their site-specific IDALS license or documentation that manure will be sold pursuant to Iowa Code chapter 200 or 200A, along with the departmentapproved manure management plan form for sales of dry manure. Operations completely covered by this paragraph are not required to meet other manure management plan requirements in this rule.
b. A confinement feeding operation not fully covered by paragraph *"a"* above and that has an established practice of selling manure, or a confinement feeding operation that contains an animal species for which selling manure is a common practice, shall submit a manure management plan that includes the following:
(1) Until a phosphorus index is required as part of the manure management plan, an estimate of the number of acres required for manure application shall be calculated by dividing the total nitrogen available to be applied from the confinement feeding operation by the crop usage rate. Crop usage rate may be estimated by using a corn crop usage rate factor and an estimate of the optimum crop yield for the property in the vicinity of the confinement feeding operation.
(2) When a phosphorus index is required as part of the manure management plan, an estimate of the number of acres required for manure application shall be calculated by one of the following methods:

1. Dividing the total phosphorus (as P2O5) available to be applied from the confinement feeding operation by the corn crop removal of phosphorus. The corn crop removal of phosphorus may be estimated by using the phosphorus removal rate in Table 4a at the end of this chapter and an estimate of the optimum crop yieldfor the property in the vicinity of the operation.
2. Totaling the quantity of manure that can be applied to each available field based on application rates determined in conjunction with the phosphorus index in accordance with 65.17(17), and ensuring that the total quantity that can be applied is equal to or exceeds the manure annually generated at the operation.
(3) The total nitrogen available to be applied from the confinement feeding operation.
(4) The total phosphorus (as P2O5) available to be applied from the confinement feeding operation if the phosphorus index is required in accordance with 65.17(1)*"d."*
(5) An estimate of the annual animal production and manure volume or weight produced.
(6) A manure sales form, if manure will be sold, shall include the following information:
1. A place for the name and address of the buyer of the manure.
2. A place for the quantity of manure purchased.
3. The planned crop schedule and optimum crop yields.
4. A place for the manure application methods and the timing of manure application.
5. A place for the location of the field including the number of acres where the manure will be applied.
6. A place for the manure application rate.
7. When a phosphorus index is required as part of a manure management plan in accordance with 65.17(1)*"d,"* a place for a phosphorus index of each field receiving manure, as defined in 65.17(17)*"a,"* including the factors used in the calculation. A copy of the NRCS phosphorus index detailed report shall satisfy the requirement to include the factors used in the calculation.
(7) Statements of intent if the manure will be sold. The number of acres indicated in the statements of intent shall be sufficient according to the manure management plan to apply the manure from the confinement feeding operation. The permit holder for an existing confinement feeding operation with a construction permit may submit past records of manure sales instead of statements of intent. The statements of intent shall include the following information:
1. The name and address of the person signing the statement.
2. A statement indicating the intent of the person to purchase the confinement feeding operation's manure.
3. The location of the farm where the manure can be applied including the total number of acres available for manure application.
4. The signature of the person who may purchase the confinement feeding operation's manure.
(8) The owner shall maintain in the owner's records a current manure management plan and copies of all of the manure sales forms; the sales forms must be completed and signed by each buyer of the manure and the applicant, and the copies must be maintained in the owner's records for three years after each sale. Effective August 25, 2006, the owner shall maintain in the owner's records copies of all of the manure sales forms for five years after each sale. An owner of a confinement feeding operation shall not be required to maintain current statements of intent as part of the manure management plan.

65.17(3) *Manure management plan for nonsales of manure.* Confinement feeding operations that will not sell all of their manure shall submit the following for that portion of the manure which will not be sold:
a. Calculations to determine the land area required for manure application.
b. The total nitrogen available to be applied from the confinement feeding operation.
c. The planned crop schedule and optimum crop yields.
d. Manure application methods and timing of the application.
e. The location of manure application.
f. An estimate of the annual animal production and manure volume or weight produced.
g. Methods, structures or practices that will be used to reduce soil loss and prevent surface water pollution.
h. Methods or practices that will be utilized to reduce odor if spray irrigation equipment is used to apply manure.
i. When a phosphorus index is required as part of the manure management plan in accordance with 65.17(1)*"d,"* the following are required:

for Farm Service Agency programs.
2. Proven yields for multiperil crop insurance. Yields established for the purpose of purchasing multiperil crop insurance shall be used as proven yield data.
3. Proven yields from other methods. The plan shall use the proven yield data and indicate the method used in determining the proven yield.
b. Crop schedule. Crop schedules shall include the name and total acres of the planned crop on a field-by-field or farm-by-farm basis where manure application will be made. A map may be used to indicate crop schedules by field or farm. The planned crop schedule shall name the crop(s) planned to be grown for the length of the crop rotation beginning with the crop planned or actually grown during the year this plan is submitted or the first year manure will be applied. The confinement feeding operation owner shall not be penalized for exceeding the nitrogen or phosphorus application rate for an unplanned crop, if crop schedules are altered because of weather, farm program changes, market factor changes, or other unforeseeable circumstances.

65.17(7) *Manure application methods and timing.*
a. The manure management plan shall identify the methods that will be used to land-apply the confinement feeding operation's manure. Methods to land-apply the manure may include, but are not limited to, surface-apply dry with no incorporation, surface-apply liquids with no incorporation, surface-apply liquid or dry with incorporation within 24 hours, surface-apply liquid or dry with incorporation after 24 hours, knifed in or soil injection of liquids, or irrigated liquids with no incorporation.
b. The manure management plan shall identify the approximate time of year that land application of manure is planned. The time of year may be identified by season or month.

65.17(8) *Location of manure application.*
a. The manure management plan shall identify each farm where the manure will be applied, the number of acres that will be available for the application of manure from the confinement feeding operation, and the basis under which the land is available.
b. A copy of each written agreement executed with the owner of the land where manure will be applied shall be maintained with the current manure management plan. The written agreement shall indicate the acres on which manure from the confinement feeding operation may be applied and the length of the agreement. A written agreement is not required if the land is owned or rented for crop production by the owner of the confinement feeding operation.
c. If a present location becomes unavailable for manure application, additional land for manure application shall be identified in the current manure management plan prior to the next manure application period.

65.17(9) *Estimate of annual animal production and manure volume or weight produced.* Volumes or weights of manure produced shall be estimated based on the numbers of animals, species, and type of manure storage used. The plan shall list the annually expected number of production animals by species. The volume of manure may be estimated based on the values in Table 5 at the end of this chapter and submitted as a part of the plan. If the plan does not use the table to determine the manure volume, other credible sources for standard table values or the actual manure volume from the confinement feeding operation may be used.

65.17(10) *Methods to reduce soil loss and potential surface water pollution.* The manure management plan shall include an identification of the methods, structures or practices that will be used to prevent or diminish soil loss and potential surface water pollution during the application of manure. Until a phosphorus index is required in accordance with 65.17(1)*"d,"* the current manure management plan shall maintain a summary or copy of the conservation plan for the cropland where manure from the animal feeding operation will be applied if the manure will be applied on highly erodible cropland. The conservation plan shall be the conservation plan approved by the local soil and water conservation district or its equivalent. The summary of the conservation plan shall identify the methods, structures or practices that are contained in the conservation plan. When a phosphorus index is required in accordance with 65.17(1)*"d,"* the manure management plan shall indicate for each field in the plan the crop rotation, tillage practices and supporting practices used to calculate sheet and rill erosion for the phosphorus index. A copy of the NRCS RUSLE2 profile erosion calculation record shall satisfy the requirement to indicate the crop rotation, tillage practices and supporting practices

to calculate sheet and rill erosion. The plan shall also identify the highly erodible cropland where manure will be applied. The manure management plan may include additional information such as whether the manure will be injected or incorporated or the type of manure storage structure.

65.17(11) *Spray irrigation.* Requirements contained in subrules 65.3(2) and 65.3(3) regarding the use of spray irrigation equipment to apply manure shall be followed. A plan which has identified spray irrigation equipment as the method of manure application shall identify any additional methods or practices to reduce potential odor, if any other methods or practices will be utilized.

65.17(12) *Current manure management plan.* The owner of a confinement feeding operation who is required to submit a manure management plan shall maintain a current manure management plan at the site of the confinement feeding operation or at a residence or office of the owner or operator of the operation within 30 miles of the site. The plan shall include completed manure sales forms for a confinement feeding operation from which manure is sold. If manure management practices change, a person required to submit a manure management plan shall make appropriate changes consistent with this rule. If values other than the standard table values are used for manure management plan calculations, the source of the values used shall be identified.

65.17(13) *Record keeping.* Records shall be maintained by the owner of a confinement feeding operation who is required to submit a manure management plan. This recorded information shall be maintained for three years following the year of application or for the length of the crop rotation, whichever is greater. Effective August 25, 2006, records shall be maintained for five years following the year of application or for the length of the crop rotation, whichever is greater. Records shall be maintained at the site of the confinement feeding operation or at a residence or office of the owner or operator of the facility within 30 miles of the site. Records to demonstrate compliance with the manure management plan shall include the following:
a. Factors used to calculate the manure application rate:
(1) Optimum yield for the planned crop.
(2) Types of nitrogen credits and amounts.
(3) Remaining crop nitrogen needed.
(4) Nitrogen content and first-year nitrogen availability of the manure.
(5) Phosphorus content of the manure if required in accordance with 65.17(3)*"i."* If an actual sample is used, documentation shall be provided.
b. If phosphorus-based application rates are used, the following shall be included:
(1) Crop rotation.
(2) Phosphorus removed by crop harvest of that crop rotation.
c. Maximum allowable manure application rate.
d. Actual manure application information:
(1) Methods of application when manure from the confinement feeding operation was applied.
(2) Date(s) when the manure from the confinement feeding operation was applied.
(3) Location of the field where the manure from the confinement feeding operation was applied, including the number of acres.
(4) The manure application rate.
e. Effective August 25, 2005, date(s) and application rate(s) of commercial nitrogen and phosphorus on fields that received manure. However, if the date and application rate information is for fields which are not owned for crop production or which are not rented or leased for crop production by the person required to keep records pursuant to this subrule, an enforcement action for noncompliance with a manure management plan or the requirements of this subrule shall not be pursued against the person required to keep records pursuant to this subrule or against any other person who relied on the date and application rate in records required to be kept pursuant to this subrule, unless that person knew or should have known that nitrogen or phosphorus would be applied in excess of maximum levels set forth in paragraph 65.17(1)*"a."* If manure is applied to fields not owned, rented or leased for crop production by the person required to keep records pursuant to this subrule, that person shall obtain from the person who owns, rents or leases those fields a statement specifying the planned commercial nitrogen and phosphorus fertilizer rates to be applied to each field receiving the manure.

f. When a phosphorus index is required in accordance with 65.17(1)*"d,"* a copy of the current soil test lab results for each field in the manure management plan.
g. For sales of manure under 65.17(2)*"b,"* record-keeping requirements of 65.17(2)*"b"*(8) shall be followed.

65.17(14) *Record inspection.* The department may inspect a confinement feeding operation at any time during normal working hours and may inspect the manure management plan and any records required to be maintained. As required in Iowa Code section 459.312(12), Iowa Code chapter 22 shall not apply to the records which shall be kept confidential by the department and its agents and employees. The contents of the records are not subject to disclosure except as follows:
a. Upon waiver by the owner of the confinement feeding operation.
b. In an action or administrative proceeding commenced under this chapter. Any hearing related to the action or proceeding shall be closed.
c. When required by subpoena or court order.

65.17(15) *Enforcement action.* An owner required to provide the department a manure management plan pursuant to this rule who fails to provide the department a plan or who is found in violation of the terms and conditions of the plan shall not be subject to an enforcement action other than assessment of a civil penalty pursuant to Iowa Code section 455B.191.

65.17(16) *Soil sampling requirements for fields where the phosphorus index must be used.* Soil samples shall be obtained from each field in the manure management plan at least once every four years. Each soil sample shall be analyzed for phosphorus and pH. The soil sampling protocol shall meet all of the following requirements:
a. Acceptable soil sampling strategies include, but are not limited to, grid sampling, management zone sampling, and soil type sampling. Procedural details can be taken from Iowa State University extension publication PM 287, "Take a Good Soil Sample to Help Make Good Decisions," NCR-13 Report 348, "Soil Sampling for Variable-Rate Fertilizer and Lime Application," or other credible soil sampling publications.
b. Each soil sample must be a composite of at least ten soil cores from the sampling area, with each core containing soil from the top six inches of the soil profile.
c. Each soil sample shall represent no more than ten acres. For fields less than or equal to 15 acres, only one soil sample is necessary.
d. Soil analysis must be performed by a lab enrolled in the IDALS soil testing certification program.
e. The soil phosphorus test method must be an appropriate method for use with the phosphorus index. If soil pH is greater than or equal to 7.4, soil phosphorus data from the Bray-1 extraction method is not acceptable for use with the phosphorus index.

65.17(17) *Use of the phosphorus index.* Manure application rates shall be determined in conjunction with the use of the Iowa Phosphorus Index as specified by the USDA Natural Resources Conservation Service (NRCS) Iowa Technical Note No. 25.
a. The phosphorus index shall be used on each individual field in the manure management plan. The fields must be contiguous and shall not be divided by a public thoroughfare or a water source as each is defined in this chapter. Factors to be considered when a field is defined may include, but are not limited to, cropping system, erosion rate, soil phosphorus concentration, nutrient application history, and the presence of site-specific soil conservation practices.
b. When sheet and rill erosion is calculated for the phosphorus index, the soil type used for the calculation shall be the most erosive soil map unit that is at least 10 percent of the total field area.
c. The average (arithmetic mean) soil phosphorus concentration of a field shall be used in the phosphorus index.
d. Soil phosphorus concentration data is considered valid for use in the phosphorus index if the data is four years old or less and meets the requirements of 65.17(16).
e. For an original manure management plan, previous soil sampling data that does not meet the requirements of 65.17(16) may be used in the phosphorus index if the data is four years old or less. In the case of fields for

which soil sampling data is used that does not meet the requirements of 65.17(16), the fields must be soil-sampled according to the requirements of 65.17(16) no more than one year after the manure management plan is approved.

f. The following are the manure application rate requirements for fields that are assigned the phosphorus index site vulnerability ratings below as determined by the NRCS Iowa Technical Note No. 25 to the NRCS 590 standard rounded to the nearest one-hundredth:

(1) Very Low (0-1).

1. Manure shall not be applied in excess of a nitrogen-based rate in accordance with 65.17(18).
2. If, pursuant to 65.17(19), manure is applied at phosphorus-based rates within soil sampling periods on fields in the Very Low risk category, each soil sample may represent up to 20 acres for the next required soil sampling.

(2) Low (>1-2).

1. Manure shall not be applied in excess of a nitrogen-based rate in accordance with 65.17(18).
2. If, pursuant to 65.17(19), manure is applied at phosphorus-based rates within soil sampling periods on fields in the Low risk category, each soil sample may represent up to 20 acres for the next required soil sampling.

(3) Medium (>2-5).

1. Manure may be applied at a nitrogen-based rate in accordance with 65.17(18) if current or planned soil conservation and phosphorus management practices predict the rating of the field to be not greater than 5 for the next determination of the phosphorus index as required by 65.17(17)*"h"*(3).
2. Manure shall not be applied in excess of two times the phosphorus removed with crop harvest over the period of the crop rotation.
3. If, pursuant to 65.17(19), manure is applied at phosphorus-based rates within soil sampling periods on fields in the Medium risk category, each soil sample may represent up to 20 acres for the next required soil sampling.

(4) High (>5-15). Manure shall not be applied on a field with a rating greater than 5 and less than or equal to 15 until practices are adopted which reduce the phosphorus index to at least the Medium risk category. However, prior to December 31, 2008, fields with a phosphorus index greater than 5 and less than or equal to 10 may receive manure at a phosphorus-based rate in accordance with 65.17(19) if practices will be adopted to reduce the phosphorus index to the Medium risk category.

(5) Very High (>15). Manure shall not be applied on a field with a rating greater than 15.

g. Additional commercial fertilizer may be applied as follows on fields receiving manure:

(1) Phosphorus fertilizer may be applied in addition to phosphorus provided by the manure up to amounts recommended by soil tests and Iowa State University extension publication PM 1688, "General Guide for Crop Nutrient Recommendations in Iowa."

(2) Nitrogen fertilizer may be applied in addition to nitrogen provided by the manure to meet the remaining nitrogen need of the crop as calculated in the current manure management plan. Additional nitrogen fertilizer may be applied up to the amounts indicated by soil test nitrogen results or crop nitrogen test results as necessary to obtain the optimum crop yield.

h. Updating the phosphorus index.

(1) When any inputs to the phosphorus index change, an operation shall recalculate the phosphorus index and adjust the application rates if necessary.

(2) If additional land becomes available for manure application, the phosphorus index shall be calculated to determine the manure application rate before manure is applied.

*(*3) An operation must submit a complete manure management plan using a new phosphorus index for each field in the manure management plan a minimum of once every four years.

65.17(18) *Requirements for application of a nitrogen-based manure rate to a field.*

a. Nitrogen-based application rates shall be based on the total nitrogen content of the manure unless the calculations are submitted to show that nitrogen crop usage rates based on plant-available nitrogen have not been exceeded for the crop schedule submitted.

b. The correction factor for nitrogen losses shall be determined for the method of application by the following

or from other credible sources for nitrogen volatilization correction factors.
Knifed in or soil injection of liquids 0.98
Surface-apply liquid or dry with incorporation within 24 hours 0.95
Surface-apply liquid or dry with incorporation after 24 hours 0.80
Surface-apply liquids with no incorporation 0.75
Surface-apply dry with no incorporation 0.70
Irrigated liquids with no incorporation 0.60
c. Nitrogen-based application rates shall be based on the optimum crop yields as determined in 65.17(6) and crop nitrogen usage rate factor values in Table 4 at the end of this chapter or other credible sources.
d. A nitrogen-based manure rate shall account for legume production in the year prior to growing corn or other grass crops and shall account for any planned commercial fertilizer application.

65.17(19) *Requirements for application of a phosphorus-based manure rate to a field.*
a. Phosphorus removal by harvest for each crop in the crop schedule shall be determined using the optimum crop yield as determined in 65.17(6) and phosphorus removal rates of the harvested crop from Table 4a at the end of this chapter or other credible sources. Phosphorus crop removal shall be determined by multiplying optimum crop yield by the phosphorus removal rate of the harvested crop.
b. Phosphorus removal by the crop schedule shall be determined by summing the phosphorus crop removal values determined in 65.17(19)*"a"* for each crop in the crop schedule.
c. The phosphorus applied over the duration of the crop schedule shall be less than or equal to the phosphorus removed with harvest during that crop schedule as calculated in 65.17(19)*"b"* unless additional phosphorus is recommended by soil tests and Iowa State University extension publication PM 1688, "General Guide for Crop Nutrient Recommendations in Iowa."
d. Additional requirements for phosphorus-based rates.
(1) No single manure application shall exceed the nitrogen-based rate of the planned crop receiving the particular manure application.
(2) No single manure application shall exceed the rate that applies to the expected amount of phosphorus removed with harvest by the next four anticipated crops in the crop schedule.
e. If the actual crop schedule differs from the planned crop schedule, then any surplus or deficit of phosphorus shall be accounted for in the subsequent manure application.
f. Phosphorus in manure should be considered 100 percent available unless soil phosphorus concentrations are below optimum levels for crop production. If soil phosphorus concentrations are below optimum levels for crop production phosphorus availability, values suggested in Iowa State University extension publication PM 1811, "Managing Manure Nutrients for Crop Production" or other credible sources shall be used.

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 management plan for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to:

- legume credits,
- animal manure and organic by-products,
- waste water,
- commercial fertilizer,
- crop rotation,
- soil nutrient availability,
- and irrigation water.

Land receiving nutrients shall be evaluated for environmentally sensitive areas such as, but not limited to:

- perennial water bodies,
- areas of concentrated flow,
- surface inlets,
- Karst topography,
- wellhead protection areas,
- flood plain,
- coarse textured soils.

Soil and Tissue Sampling and Laboratory Analyses (Testing)

At a minimum, obtain soil test analyses for phosphorus, potassium, and pH. All soil samples shall be collected according to Iowa State University (ISU) for sampling methods based on soil maps, management zones, or grid sampling. See ISU PM 287 “Take a Good Sample to Help Make Good Decisions.” The minimum frequency for soil testing shall be once during a four-year period for continuous row crop or once during the cycle of other crop rotations that consists of close grown crops such as grasses and legumes. The sampling frequency can be less frequent for organic matter, however no greater than every 12 years.

Use of the Late Spring Nitrate Test and Fall Corn Stalk Test is encouraged in determining rates of nitrogen and/or evaluating the nitrogen management program. See ISU publications PM-1714 “Nitrogen Fertilizer

Recommendations for Corn in Iowa" and PM 1584 "Corn Stalk Test to Determine Nitrogen".

All soil tests shall be analyzed by a soil test lab that is certified according to Iowa Department of Agriculture and Land Stewardship (IDALS) soil test lab certification standards. See ISU-Extension publication, PM-1310 (rev) "Interpretation of Soil Test Results. and PM-1688 "A General Guide for Crop Nutrient and Limestone Recommendations in Iowa."

Nutrient Application Rates

Nutrient application includes form, source, amount, timing and method of application on each field. Plant nutrients may be applied as broadcast, starter, surface band other than starter, or injected band applications. Nutrients shall be applied to achieve realistic production goals, while minimizing nitrogen and/or phosphorus movement to surface and/or ground waters.

All commercial nutrient applications shall be based on ISU recommendations for the soil type and crop to be grown. Use the most recent publications. See ISU-Extension Publications PM1714 "Nitrogen Fertilizer Recommendations for Corn in Iowa", PM-1688 "General Guide for Crop Nutrient Recommendations in Iowa", and PM 869 "Fertilizing Pasture". Unless specific nutrient content for animal manure has been obtained through sample analysis, the nutrient value of animal manures will be estimated using the Agricultural Waste Management Field Handbook (AWMFH), Chapter 4.

All nutrient applications shall be based on realistic yield potential for the field. Guidance for estimating realistic yield potentials is outlined in ISU-Extension Publication PM-1268 (rev) "Establishing Realistic Yields." Realistic yield potentials can be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soils, cropping systems, and soil and manure/organic by-products tests. For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Phosphorus and Potassium.

All nutrient values for phosphorus and potassium should be expressed in pounds of P_2O_5 and K_2O.

Phosphorus and potassium application for crop and forage production (including non-crop areas) shall be based on soil test results. Phosphorus and potassium additions shall not exceed crop removal rates when soil test levels are optimum or above unless specified under "Additional Criteria Applicable to Manure and Organic By-Products or Biosolids Applied as a Plant Nutrient Source".

Commercial Nitrogen:

The amount of nitrate-nitrogen that moves below the crop root zone is directly related to nitrogen application rate. Therefore, over-application in an attempt to produce unrealistic yields or offset anticipated losses shall be avoided.

No fall application of commercial nitrogen shall be made with the following exceptions:

- Anhydrous ammonia if: (1) mid-day soil temperatures, at 4"soil depth, is not greater than 50 ^{o}F and trending lower; (2) soil moisture conditions are conducive to proper application and sealing and (3) soil texture conditions favor the retention of applied nitrogen.

- Application of nitrogen associated with products that contain phosphorus and/or potassium.

- Nitrogen associated with the production of winter grains.

For more information consult Iowa State University website on nitrogen management. http://extension.agron.iastate.edu/soilfertility/nutrienttopics/nutrienttopics.html

Where the Late Spring Nitrate Test is not applicable, use the general recommendations for nitrogen found in Iowa State Publications ISU PM-1714 "Nitrogen Fertilizer Recommendations for Corn in Iowa", ISU PM-869 "Fertilizing Pasture", ISU PM-1584 "Cornstalk Testing to Evaluate Nitrogen Management".

All nutrient additions shall be adjusted for contributions from legumes, manure or other organic nutrient sources.

Legume contributions are shown in ISU Publication PM-1714 “Nitrogen Fertilizer Recommendations for Corn in Iowa”.

Soil pH shall be maintained at levels shown in ISU Publication PM-1688 “General Guide for Crop Nutrient Recommendations in Iowa”. All recommendations are based on Effective Calcium Carbonate Equivalents (ECCE).

For soil tests requiring less than 2000 pounds per acre ECCE, the lime requirement may be waived.

Application equipment for fertilizers and manure shall be calibrated at least annually to determine actual applied rates. After calibration, adjustments can be made in the application process to meet the planned or intended rates.

All specifications will be consistent with federal, state, and local regulations.

Nutrient Application Timing

Timing and method of nutrient application (particularly nitrogen) shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, risk assessment tools, (e.g., P-index) manure storage capacity and field accessibility.

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).
- Nutrients shall be applied considering the plant growth habits, irrigation practices, and other conditions so as to maximize availability to the plant and minimize the risk of runoff, leaching, and volatilization losses.
- Nutrient applications associated with irrigation systems shall be applied in a manner that prevents or minimizes resource impairment.

Nutrients and organic nutrient sources shall not be surface applied to frozen, snow covered ground, or saturated soil if a potential risk for runoff exists. A potentia l risk for runoff exis ts on slopes greater than 5% unless erosion is controlled to soil loss tolerance levels (“T”) or less. Manure may be surface applied to frozen, snow covered or saturated ground if a potential risk for runoff exists only under one of the following conditions.

  - Where manure storage capacity is insufficient and failure to surface apply creates a risk of an uncontrolled release of manure.
  - On an emergency basis.

Manure surface applied to frozen, snow covered, or saturated ground shall be based on a manure disposal plan. That plan shall include:

- Under what circumstances the manure may be applied to frozen, snow covered, or saturated ground. (Ex: storage capacity exceeded).
- Rates of application.
- Area of application.
- Other requirements such as runoff control as indicated through the use of the Iowa Phosphorus Index assessment tool

Conservation Management Unit (CMU) Risk Assessment

In areas with identified or designated nutrient related water quality impairment, a CMU (which is defined as a portion of a field, field, group of fields, or other land units of the same land use and having similar treatment needs and management plans) shall be assessed for the potential phosphorus transport risk from the area. See Agronomy Technical Note 25,

Iowa Phosphorus Index.
Any one of the following threshold factors will trigger CMU risk assessment:

- The CMU is located in a watershed directly draining into waters identified in the Iowa Department of Natural Resources (DNR) Iowa Integrated Report as impacted by phosphorus. http://wqm.igsb.uiowa.edu/wqa/303d.html
- Manure or organic by-products are applied
- Soil loss exceeds the tolerable level
- The average soil test phosphorus level in the very high range as shown in ISU Publication PM-1688 "General Guide for Crop Nutrient Recommendation in Iowa".

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, the Iowa Phosphorus Index will be used as the risk assessm ent tool to evaluate the potential for phosphorus transport from the CMU and to adjust the amount, placement, form and timing of application of phosphorus sources.

Manure shall be analyzed for nutrient content of total nitrogen, phosphorus and potassium, percent moisture, and or percent solids. This analysis shall be done at least annually for each different source of manure being generated at the animal feeding operation. Methods for sampling manure are discussed in ISU Publication PM-1558 "How to Sample Manure for Nutrient Analysis".

In planning for new animal feeding operations, acceptable "book values" for the nutrient content and volume of manure that are recognized by the NRCS may be used for the proposed animal feeding operation (NRCS Agricultural Waste Management Field Handbook, Chapter 4). In the alternative, nutrient content and volumes for proposed animal feeding operations may be based on historic nutrient content and volumes from existing animal feeding operations utilizing similar design and management as the proposed animal feeding operation.

For additional information on manure and other organic nutrient management refer to Standard and Specificati on Waste Utilization (633) and the Agricultural Waste Management Field Handbook.

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.

Manure and Organic By-Product Nutrient Application Rates

Planned application rates of nitrogen and phosphorus shall be determined based on the following guidance:

A. Nitrogen Application.

When determining allowable nutrient application rates from manure or other organic sources, nitrogen may be applied based on crop nitrogen needs for that crop year. This may allow application of more phosphorus and potassium than required by the crop. This practice may continue as long as the risk of phosphorus moving to surface waters based on the Iowa Phosphorus Index is very low, low or medium.

When the plan is being implemented on a phosphorus standard, manure or other organic by-products shall be applied at rates consistent with the phosphorus standard. In such situations, an additional nitrogen application from nonorganic sources may be required to supply the recommended amounts of nitrogen.

Manure or other organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in the harvested portion of the crop that is removed from the field in that growing season.

B. Phosphorus Application.

When manure or other organic by-products are used, the planned rates of phosphorus

application shall be determined with reference to the Iowa Phosphorus Index (Agronomy Technical Notice 25). The Iowa Phosphorus Index (Iowa PI) asse sses the potential for phosphorus movement from a field to surface water, and designates fields as very low risk, low risk, medium risk, high risk, and very high risk. Conservation practices and/or phosphorus management practices can be adopted that reduce the risk of phosphorus movement and may reduce the risk rating on the field. See Agronomy Technical Notice 25, Iowa Phosphorus Index.

- If a field is rated very low risk, low risk, or medium risk by the Iowa PI, the application of manure or organic by-products may be made based on the nitrogen needs of the crop as set forth in subpart A above.

- If a field is rated in the medium risk category, planned conservation and phosphorus management practices should not increase the rating of the field above the medium risk category.

- If a field is rated high risk or very high risk by the Iowa PI; Manure or organic by-products may be applied to meet the needs of the planned crop rotation for phosphorus removal **if conservation practices and/or phosphorus management practices are adopted to reduce the risk of phosphorus movement.**

Nitrogen application limits of Subpart A above should not be exceeded.

C. Sensitive Areas.

Manure and other organic nutrient sources shall not be applied to the following areas unless injected or incorporated within 24 hours:

- Within 200 feet of sinkholes, drainage wells, or other direct conduits to the groundwater.

- Within 200 feet of lakes, ponds, or other perennial water bodies.

- During the peak flood periods (April, May, June, July) on land that floods more than once every 10 years.

Heavy Metal Monitoring

When sewage sludge or biosolids are applied, the application of potential heavy metal pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be in accordance with the Iowa Administrative Code (IAC) IA567—67 and IAC567--121.

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.

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

CONSIDERATIONS

Considerations are items to be considered during the planning process, however, are not a required component of the nutrient management plan.

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.

Action should be taken to protect National Register listed and other eligible cultural resources.

Animal feeding operations requiring removal of manure more frequently than annually should consider taking samples more frequently (i.e. seasonally or after material changes to feed rations or other operational aspects of the animal feeding operation that may impact the nutrient content of the manure) .

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

For sites on which there are special environmental concerns, other sampling techniques may be appropriate. These include soil profile sampling for nitrogen, Pre-Sidedress Nitrogen Test (PSNT).

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

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.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients.

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

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 (NUE) 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, t ilth, diversity of soil organisms and protect or improve water and air quality (Consider installation of one or more NRCS FOTG, Section IV – Conservation Practice Standards).

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

Apply nutrient materials uniformly to the application area. 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,
- Use stalk-test to minimize risk of over applying nitrogen in excess of crop needs.
- Avoid winter nutrient application for spring seeded crops,
- Band applications of phosphorus near the seed row,
- Incorporate surface applied manures or organic by-products as soon as possible after application to minimize nutrient losses,
- Delay field application of animal manures or organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.
- On soils with high permeability (greater than 2 inches per hour through the 5 foot profile), apply nitrogen using split spring preplant/sidedress, at planting/sidedress or sidedress applications to provide distribution of nutrients at a time when plants will utilize the nutrients.
- Limit the application rate of liquid materials applied to not exceed the soil infiltration rate, to minimize ponding, to avoid runoff, and to minimize loss to subsurface tile drains.
- When applying manure to legume crops, limit the crop available nitrogen application to 125 pounds of nitrogen per acre.

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

In areas with an identified or designated nutrient management related air quality concern, any com ponent(s) of nutrient management (i.e., amount, source, placement, form, timing of application) identified by risk

assessment tools as a potential source of atmospheric pollutants should be adjusted, as necessary, to minimize the loss(es).

When tillage can be performed, surface applications of manure and fertilizer nitrogen formulations that are subject to volatilization on the soil surface (e.g., urea) should 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) should be managed to minimize volatilization losses.

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

Operators should 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) should be recorded and maintained in accordance with the operation and maintenance section of this standard.

Odors associated with the land application of manures and organic by-products can be offensive to the occupants of nearby homes. When possible, application of these materials upwind of occupied structures when residents are likely to be home (evenings, weekends and holidays) should be avoided.

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 should be reduced when applied under a crop canopy.

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

Nutrient applications associated with irrigation systems should be applied in accordance with the requirements of Irrigation Water Management (Code 449).

CAFO operations seeking permits under USEPA regulations (40 CFR Parts 122 and 412) should consult with their respective state permitting authority for additional criteria.

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 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 plan:

- aerial site photograph(s) or site map(s), and a soil survey map of the site,
- location of designated sensitive areas or resources and the associated, nutrient management restriction,
- current and/or planned plant production sequence or crop rotation,
- results of soil, water, manure and/or organic by-product sample analyses,
- results of plant tissue analyses, when used for nutrient management,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the crop rotation or sequence,
- listing and quantification of all nutrient sources,
- CMU specific recommended nutrient

application rates, timing, form, and method of application and incorporation, and

- guidance for implementation, operation, maintenance, and recordkeeping.

If increases in soil phosphorus levels are expected, the nutrient management 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 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 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 animal numbers and/or feed management will necessitate additional manure sampling and analyses to establish a revised average nutrient content.
- protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- calibration of application equipment to ensure uniform distribution of material at planned rates.
- documentation of 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.
- Maintaining records to document 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 applications,
    - weather conditions and general soil moisture (e.g. wet, damp, dry) at the time of application; lapsed time to manure incorporation, rainfall or irrigation event.
    - crops planted, planting and harvest dates, yields, and crop residues removed,
    - 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.

REFERENCES

These publications are available at County Extension Offices; Ex tension Distribution Center, Printing Building, Iowa State University, Ames, IA 50011; and several are available on the ISU Publications Home page at http://www.extension.iastate.edu/Pages/pubs/.

- ISU PM-1310 “Interpretation of Soil Test Results”
- ISU PM-287 “Take a Good Sample to Help Make Good Decisions”
- ISU PM-1714 “Nitrogen Fertilizer Recommendations for Corn in Iowa”
- ISU PM-2015 “Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn”
- ISU PM-1688 “General Guide for Crop Nutrient Recommendations in Iowa”
- ISU PM-869 “Fertilizing Pasture”
- ISUPM-1268(rev) “Establishing Realistic Yields”
- ISU PM-1584 “Cornstalk Testing to Evaluate Nitrogen Management”
- ISU PM-1436 “Nitrogen Fertilizer Management for Northeast Iowa”
- ISU PM-569 “Warm-Season Grasses for hay and Pasture”
  ISU PM-1558 “How to Sample Manure for Nutrient Analysis”
- ISU PM-1941 “Calibration and Uniformity of Solid Manure Spreaders”
- ISU PM-1948 “Calibrating Liquid Tank Manure Applicators”

The following publication is available on the NRCS web site at http://policy.nrcs.usda.gov/viewerFS.aspx?hid=21430

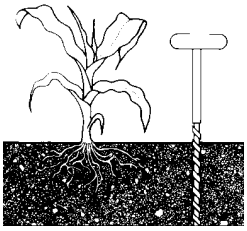
- Agricultural Waste Management Field Handbook

The following Standard on Manure Production and Characteristics is available from the American Society of Agricultural and Biological Engineers. http://asae.frymulti.com/standards.asp

- ASABE D384.2 MAR2005

The following publications are available at the Iowa Conservation Partners Home page at: http://www.ia.nrcs.usda.gov.

- Iowa Technical Note 25, Iowa Phosphorus Index
- Background and Basic Concepts of the Phosphorus Index
- Phosphorus Index Calculator (Excel Spreadsheet)
- Waste Utilization Standard (633)



Nitrogen Fertilizer Recommendations for Corn in Iowa

This pamphlet replaces all earlier guidelines for using the late-spring test for soil nitrate and all previous nitrogen fertilizer recommendations based on corn yield goals and credits for N supplied by legumes and animal manures. Recommendations concerning applications of animal manures are provided in Pm-1596a, *Managing manure nutrients for crop production*.

Nitrogen fertilization is essential for profitable corn production. It also is a major cost of production and can contribute to degradation of the environment. The economic and environmental costs of N fertilization are more important than in the past, and they are likely to become even more important in the future. These costs provide compelling reasons for intensifying efforts to improve N management practices.

The late-spring test for soil nitrate is a new technology that enables site-specific assessments of plant-available N just before the crop begins rapid uptake of N. Use of this test should help corn producers manage N to increase their profits while reducing environmental degradation. All producers are encouraged to use this test, but the way the test is used depends on whether or not the producer exercises the option for in-season fertilization (i.e., N applications after corn plants are 6 inches tall).

Producers who apply all their N before emergence of the crop (i.e., before planting, at planting, soon after planting) should apply N at rates indicated in Table 1 and use the late-spring test to evaluate their N management. Select rates within the ranges given by considering price for fertilizer, expected price for grain, supply of subsoil moisture, and feedback given by the end-of-season cornstalk test in previous years. If price and yield outlook are favorable, select the upper part of the range; if unfavorable, select the lower part of the range.

Table 1. Rates of N usually needed if all N is applied preplant or before crop emergence (option for in-season application of N not exercised).

Crop category	N rate (lb. N/acre)
Corn on recently manured soils	0-90
Corn after established alfalfa	0-30
2nd-year corn after alfalfa	0-60
Other corn after corn	150-200
Corn after soybean (no manure)	100-150

Additional information is provided on page 4.

Producers who use the option for in-season fertilization (i.e., split applications or all applied after corn plants are 6 inches tall) should apply N at rates indicated in Table 2 and then use the late-spring test to estimate additional amounts of N needed. Rates within the range given should be selected based on the extent to which the producer wants to rely on in-season fertilization, amounts of rainfall during the previous six months, and feedback given by the end-of-season cornstalk test in previous years.

Application of some N before crop emergence is desirable to avoid the possibility of early-season deficiencies and to reduce risks associated with weather conditions that prevent in-season fertilization. Application of all N before planting, however, reduces the ability to adjust N rates for the effects of spring weather on amounts of N supplied by the soil or the amounts lost during spring rainfall. Use of the late-spring test over a period of years provides information that can be used to optimize pre-emergence applications of N.

Table 2. Rates of N to apply before crop emergence if the option for in-season fertilization is exercised.

Category	N rate (lb. N/acre)
Corn on recently manured soils	0-30
Corn after established alfalfa	0-30
2nd-year corn after alfalfa	0-30
Other corn after corn	50-125
Corn after soybean (no manure)	0-75

The 30-lb. rates could be applied as a starter.

IOWA STATE UNIVERSITY
University Extension

Ames, Iowa

LEOPOLD CENTER

Pm-1714 | May 1997

Soil Sampling and Testing

Time of Soil Sampling

Soil samples should be collected when corn plants are 6 to 12 inches tall (measured from the ground surface to the center of the whorl).

Selecting Test Areas

Soil samples should be collected within several test areas that are 1 to 10 acres and seemingly uniform with respect to soil characteristics and management histories. Care should be taken to avoid unusual spots (e.g., sites of old barnyards, feedlots, or manure piles, field edges or ends where fertilizer applicators may have made skips or double applications, abnormal patches of growing weeds or plant residues, or small areas where corn plants suggest differences in N availability).

The optimal number of test areas per farm should be expected to vary with many factors. First-year users of the test should consider testing about five areas for the first 100 acres and two more areas for each additional 100 acres. Information gathered in the first year can be used to help select future sampling strategies that are appropriate for a particular farm.

Depth of Soil Sampling

Samples collected for the late-spring soil test must be representative of the surface foot of soil.

Number of Cores per Sample

Soil samples analyzed for this test should be derived from at least 16 to 24 cores. Care should be taken to ensure that the soil samples are collected in a manner that is not biased by the presence of corn rows or bands of fertilizer. At least 24 cores should be collected if anhydrous ammonia was applied for the present crop.

Sampling bias can be minimized by collecting soil samples in "sets of eight" cores that have various assigned positions relative to corn rows. By this method, the person doing the sampling moves in a random pattern within the test area to select approximate positions for collecting cores. Each time a core is collected, however, its exact position is selected relative to the two nearest corn rows. The first core is collected in a row. The second is collected one-eighth of the distance between any two rows after moving to another part of the test area. The third is collected one-quarter of the distance between any two corn rows after moving to another part of the test area. The process is continued until the eighth core is collected seven-eighths of the distance between any two corn rows.

The soil from all cores should be crushed and thoroughly mixed before a subsample is removed for analysis.

Handling and Shipping Soil Samples

Moist soil samples should be protected from temperatures above 75°F and should be refrigerated if they cannot be analyzed within two days. Mailing usually poses no problem if the samples are without refrigeration for no more than two days. Assume that soil testing laboratories will protect the samples as soon as they are received.

Soil samples expected to be without refrigeration for more than two days should be dried as soon as possible. Samples can be air-dried by spreading in a thin layer on paper — a fan will accelerate drying. Samples can be dried in an oven provided the temperature does not exceed 250° F.

Soils that are extremely wet or muddy should not be sampled. Incorrect results will be obtained if water "drips" from the samples.

Soil Analysis

The late-spring test is based on concentrations of nitrate-nitrogen (NO^-_3-N) in the soil sample. Most soil testing laboratories can perform this analysis. Nitrate concentrations also can be measured on the farm by using commercially available kits.

This pamphlet expresses nitrate concentrations in terms of ppm nitrate-N (parts of N per million parts of dry soil), which is the same as ppm N as nitrate. Concentrations expressed as ppm nitrate must be multiplied by 0.23 to be converted to ppm nitrate-N.

Users of the soil test should be alert to the possibility of incorrect results on individual samples. Errors can occur during collection, handling, and analysis of samples. The impact of such errors can be substantially reduced by observing trends in soil test results and using caution when making recommendations on results that deviate from these trends.

Soil Test-based N Recommendations

Manured Soils, First-year Corn After Alfalfa, and Second-year Corn After Alfalfa

Soils that have received recent applications of animal manures or have decaying sods with alfalfa roots seem to mineralize more plant-available N after the time of soil sampling than do other soils. These soils, therefore, are treated as a separate category when making N fertilizer recommendations. These recommendations are given in Table 3.

The first step for making recommendations from Table 3 is to decide whether the top half of the table or the lower half of the table best describes the current prices for grain and fertilizer.

Table 3. Nitrogen fertilizer recommendations for manured soils[a] and corn after alfalfa.

Grain and fertilizer prices	Soil test nitrate	Recommended N rate	
		Excess[b] Rainfall	Normal Rainfall
	ppm N	-------- lb. N/acre---------	
Unfavorable	0-10	90	90
(1 bu buys	11-15	0	60
7 lb. of N)	16-20	0	0[c]
	> 20	0	0
Favorable	0-10	90	90
(1 bu buys	11-15	60	60
15 lb. of N)	16-25	0	30
	> 25	0	0

[a] A field should be considered manured if animal manures were applied with a reasonable degree of uniformity since harvest of the previous crop or in 2 of the past 4 years.
[b] Rainfall should be considered excess if rainfall in May exceeded 5 inches.
[c] Addition of 30 lb. N/acre may have no detectable effects on profits, but producers could reasonably elect to apply this rate.

The second step is to decide whether the "excess rainfall" column or the "normal rainfall" column of the table best describes weather conditions before the soils were sampled.

The third step is to use the results of the soil test to select the appropriate N rate specified. Interpolation between specified N rates is appropriate when site conditions fall between those given.

Corn After Soybean and Corn After Corn

The first step in making a fertilizer recommendation for this crop category is to select a critical concentration for nitrate (i.e., the concentration that distinguishes between adequate and inadequate supplies of available N). A critical concentration of 25 ppm-N is appropriate in absence of additional information.

The second step is to adjust the critical concentration if excess rainfall occurred at the site shortly before the soils were sampled. Reducing the critical concentration by 3 to 5 ppm is advised if rainfall is more than 20 percent above normal amounts between April 1 and time of soil sampling.

The third step is to estimate fertilizer needs by subtracting the concentration of soil-test nitrate (ppm-N) from the chosen critical concentration (ppm-N). This value is then multiplied by 8. A factor of 8 is used because studies have shown that it usually takes about 8 lb. of N/acre before planting to increase soil-test nitrate-N by 1 ppm.

Examples: A soil test of 15 ppm and a critical concentration of 25 ppm results in a recommendation of 80 lb. of N per acre to be applied.

(25 ppm - 15 ppm) x 8 = 80 lb. N/acre needed

A soil test of 35 ppm and a critical concentration of 25 ppm indicates that the soil already has approximately 80 lb. of N more than needed.

(25 ppm - 35 ppm) x 8 = -80 lb. N/acre needed.

Additional Information

Yield Goals and Nitrogen Credits

Yield goals (or potentials) are no longer used when making N fertilizer recommendations because research has shown no relationship between optimal rates of N fertilization and yields at these optimal rates.

The use of legume and(or) manure credits has been eliminated. The effects of those sources of N are addressed by giving recommendations for separate categories.

Addressing Variability

The best rate of N fertilization for corn varies greatly with year and location. This variability is caused by complex interactions of soil factors, management practices, and weather. Time and method of N application are important because they influence amounts of N lost before it can be used by the corn.

Great variability in optimal rates of N fertilization is a problem because the best rates across a wide range of conditions usually are not best for most individual sites in a given year. This problem was unavoidable in the past, but advances in technology offer new opportunities for site-specific management of N.

Users of the soil test should expect much greater variability in amounts of N supplied by animal manures and legumes than would be expected from commonly used methods to calculate N credits. Research has shown that this variability should be considered a reason for using the soil test rather than evidence that the test is not reliable.

Reliability of the Soil Test

The soil test should be considered only a tool for estimating availability of N in soils. Like any tool, the usefulness of this test varies with the skill of the user. First-time users are encouraged to experiment with the test in small areas before using it to guide fertilization on all their fields.

Recommendations for using the soil test are intended to maximize profits for the producer when used across many sites and years. Because many factors that influence fertilizer needs at a specific site and year happen after the soils are tested, the soil test should not be expected to be a perfect predictor of fertilizer needs. Use of the soil test is recommended because it is more reliable than other methods of estimating N fertilizer needs. Moreover, it is likely that the reliability of the soil test can be improved as new knowledge is acquired.

Where Caution is Required

The soil test may underestimate amounts of plant-available N when (1) nitrification inhibitors or urease inhibitors are applied with fertilizers, (2) more than 150 lb. N/acre are applied as anhydrous ammonia, and (3) more than 150 lb. N/acre are applied as injected manure.

Use of the soil test on sandy soils may require deeper sampling if fertilizers are applied before crop emergence and unusually large amounts of rainfall occur between fertilization and sampling. There are relatively few sandy soils in Iowa.

End-of-season Cornstalk Testing

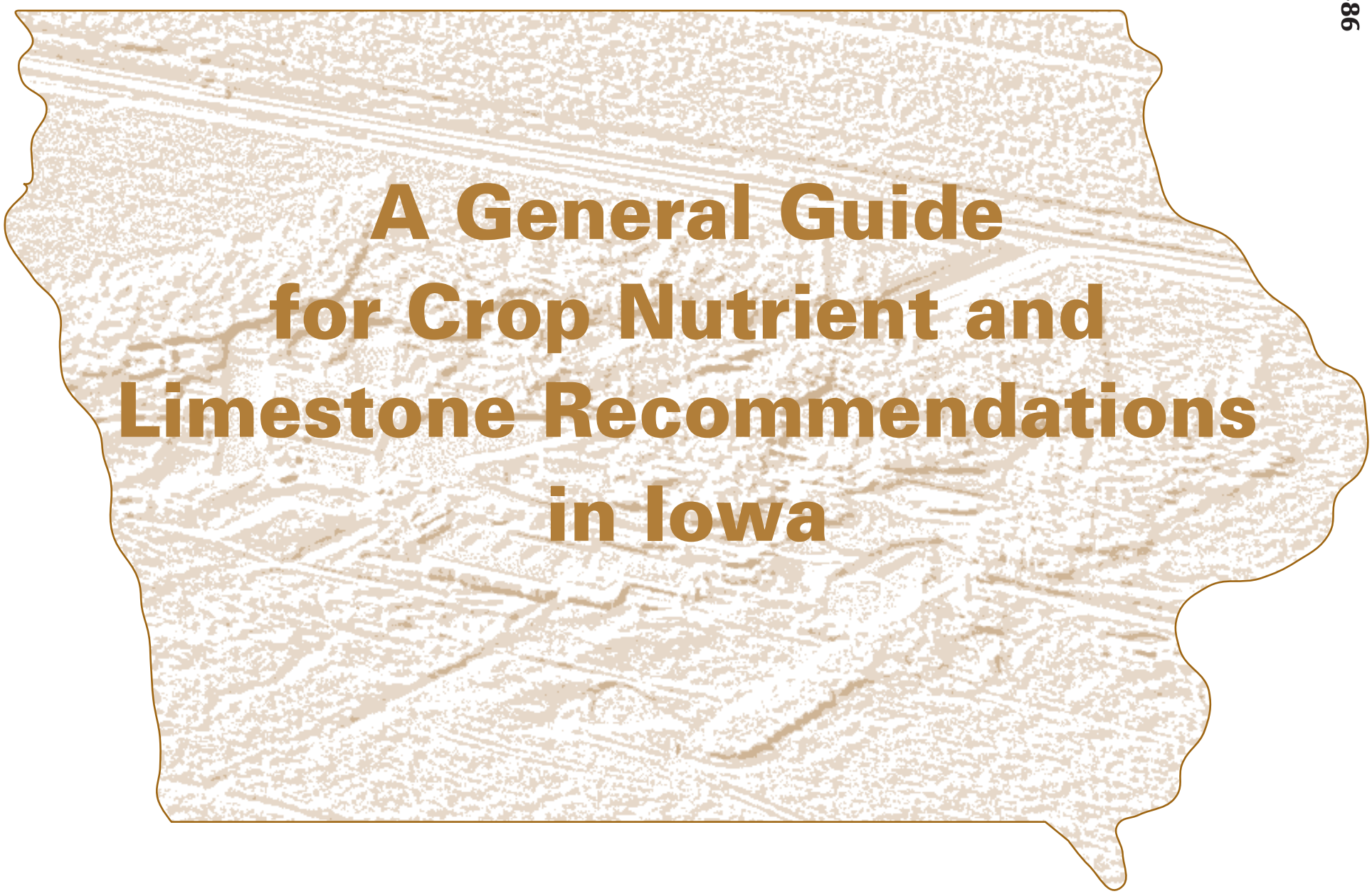
Users of the late-spring test are encouraged to use the end-of-season cornstalk test, which is described in ISU Extension factsheet, *Cornstalk Testing to Evaluate Nitrogen Management,* Pm-1584. The end-of-season test essentially asks if the corn crop had too little, too much, or optimal amounts of N. The resulting information can be used to evaluate the reliability of the soil test or any other system of making N recommendations. When used over a period of several years, information provided by the cornstalk test can be used to help select rates of N application that are most appropriate for the soil factors and management practices that make sites differ in N fertilizer requirements.

Prepared by A.M. Blackmer and R.D. Voss, professors; and A. P. Mallarino, assistant professor, ISU Department of Agronomy.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Stanley R. Johnson, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

File: Agronomy 8-5

CO-86



A General Guide for Crop Nutrient and Limestone Recommendations in Iowa

IOWA STATE UNIVERSITY
University Extension

PM 1688 Reviewed and Reprinted September 2008

Contents

Introduction 1

Soil Test Procedures 1

Soil Test Categories 1

Table 1. Interpretation of soil test values for phosphorus (P) determined by Bray P_1, Mehlich-3, or Olsen extractants and potassium (K) determined by ammonium acetate or Mehlich-3 extractants for surface soil samples (6- to 7-inch deep cores) 2

Phosphorus and Potassium Recommendations 2

Table 2. The nutrient content of harvested crops used to calculate nutrient removal and recommended amounts of P_2O_5 and K_2O for optimum soil test category 2

Method of Application 3

Table 3. Phosphorus and potassium recommendations for corn grain production 4

Table 4. Phosphorus and potassium recommendations for soybean production 4

Table 5. Phosphorus and potassium recommendations for oat grain and straw production 5

Table 6. Phosphorus and potassium recommendations for wheat production 5

Table 7. Phosphorus and potassium recommendations for sunflower production 6

Table 8. Phosphorus and potassium recommendations for corn silage or sorghum silage production 6

Table 9. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay and pastures 7

Table 10. Phosphorus and potassium recommendations for clover- and trefoil-grass hay and pastures 7

Table 11. Phosphorus and potassium recommendations for tall cool-season grasses, warm-season perennial grasses, and sorghum-sudan hay and pastures 8

Table 12. Phosphorus and potassium recommendations for bluegrass dominant pasture 8

Micronutrient Recommendations 9

Table 13. Zinc recommendations for corn and sorghum production 9

Limestone Recommendations 9

Table 14. Lime recommendations, based on SMP Buffer Test, are given in pounds of pure fine calcium carbonate ($CaCO_3$) to increase soil pH from its present level to pH 6.5 or 6.9 for the depth of soil to be neutralized 9

Soils 10

Table 15. Subsoil phosphorus and potassium levels that are to be used to determine phosphorus and potassium nutrient recommendations for the major soil series in each of the 12 major soil areas in Iowa. 10–17

Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters) and the 12 major soil areas (numbers). 18

General Guide for Crop Nutrient and Limestone Recommendations in Iowa

Introduction

Phosphorus (P), potassium (K), zinc (Zn), and lime recommendations based on soil testing are provided in this publication for the major agronomic crops grown in Iowa. Interpretation of soil test values and nutrient recommendations are based on soil samples taken to a 6- to 7-inch depth. Research results from long-term and short-term field experiments have been used to determine the interpretation of soil test values and the nutrient recommendations.

Nutrients applied to meet the recommended amounts may be from inorganic sources, from manure, or both. Nutrient contents of manures are most accurately determined by laboratory analyses.

Soil Test Procedures

The soil tests for which interpretations are given in this publication are the Bray P_1, Mehlich-3, and the Olsen tests for P, the ammonium acetate and Mehlich-3 tests for K, the DTPA test for Zn, a water-soil slurry for soil pH, and the SMP buffer method for lime requirement. The Bray P_1 test is not recommended for soils with soil pH 7.4 or higher (calcareous) because it often underestimates plant-available P in those soils and can return false low values. Soil test P interpretations in this publication apply when a colorimetric method is used to measure the P extracted by the Bray P_1, Mehlich-3, and Olsen P tests. These tests, and those for soil pH and buffer pH, are among the tests recommended for the North Central Region by the NCR-13 Regional Committee on Soil Testing and Plant Analysis. These and other tests are described in the North Central Regional Publication 221 (Revised 1998), *Recommended Chemical Soil Test Procedures for the North Central Region.* In addition, soil test P interpretations are provided when an ICP (inductively coupled plasma) analytical method is used to measure the P extracted by the Mehlich-3 P test (Mehlich-3 ICP). All laboratory procedures have some inherent variability and thus soil test results should be viewed as a potential range in values. The ranges in variation for routine soil test results produced within a laboratory are expected to be on the order of ±10% for soil test P and K, and ±0.1 pH unit.

Soil Test Categories

Soil test numerical values are reported as parts per million (ppm). Soil test values for P and K have been classified into interpretive categories designated very low (VL), low (L), optimum (Opt), high (H), and very high (VH). These categories represent a decreasing probability of an economic yield response to applied nutrients. The percentage of P and K applications expected on average to produce a yield response within each soil test category is 80% for very low, 65% for low, 25% for optimum, 5% for high, and <1% for very high. Based on input costs and expected yield increases, the optimum category is the most profitable category to maintain over time. The very high category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a profitable yield response. Recommended applications are structured so that over time soil tests will move to the optimum category.

Soil test categories for the numerical soil test values of P and K are given in Table 1. The interpretation of P and K soil test values into categories depends on the nutrient demand of the crop to be grown, the subsoil concentrations of P and K, and the soil test value. The interpretation of P soil test values for wheat and alfalfa is different than for the other agronomic crops indicating that these two crops require a higher soil P level in the surface soil for profitable production. The interpretation of P soil test values for all crops other than wheat and alfalfa, and K soil test values for all agronomic crops, differs according to subsoil P and K levels of the soil series.

Subsoil P and K levels are determined at the depth that provides the greatest range of soil test values for each nutrient. Subsoil P is determined by the Bray P_1 soil test for samples taken from the 30- to 42-inch depth. Subsoil K is determined by the ammonium acetate soil test for samples taken from the 12- to 24-inch depth. Subsoil P is designated low for subsoil test values of 8 ppm or less and high for values of 9 ppm or more. Subsoil K is designated low for subsoil test values of 50 ppm or less and high for values of 51 ppm or more. The effect of a high subsoil level of P or K is to require a lower concentration of that nutrient in the surface soil for optimum crop production.

Subsoil P and K levels for soil series with more than 5,000 acres and a corn suitability rating (CSR) greater than 30 are given in Table 15 for each of the major soil areas in Iowa that contain the principal soil associations shown in Figure 1. Subsoil levels do vary by soil series but not by soil mapping units within a soil series.

Table 1. Interpretation of soil test values for phosphorus (P) determined by Bray P_1, Mehlich-3, or Olsen extractants and potassium (K) determined by ammonium acetate or Mehlich-3 extractants for surface soil samples (6- to 7-inch deep cores).

	Wheat, alfalfa	All crops except wheat, alfalfa		All crops	
		Subsoil P		Subsoil K	
		Low	High	Low	High
	ppm				
Relative level	Bray P_1 or Mehlich-3 P			Ammonium Acetate or Mehlich-3 K	
Very low (VL)	0–15	0–8	0–5	0–90	0–70
Low (L)	16–20	9–15	6–10	91–130	71–110
Optimum (Opt)	21–25	16–20	11–15	131–170	111–150
High (H)	26–30	21–30	16–20	171–200	151–180
Very high (VH)	31+	31+	21+	201+	181+
	Olsen P				
Very low (VL)	0–10	0–5	0–3		
Low (L)	11–14	6–10	4–7		
Optimum (Opt)	15–17	11–14	8–11		
High (H)	18–20	15–20	12–15		
Very high (VH)	21+	21+	16+		
	Mehlich-3 ICP				
Very low (VL)	0–20	0–15	0–10		
Low (L)	21–30	16–25	11–20		
Optimum (Opt)	31–40	26–35	21–30		
High (H)	41–50	36–45	31–40		
Very high (VH)	51+	46+	41+		

Phosphorus and Potassium Recommendations

The recommended amounts of P_2O_5 and K_2O are based on research conducted in Iowa during many years. Applying the recommended rates for the very low and low soil test categories will result in profitable crop responses in that year and at the same time increase soil test values after crop harvest because of significant residual effects from the applied P and K.

The recommended P and K rates for the optimum soil test category are based on average nutrient removal in harvested crop parts (grain, silage, straw, and hay). The fertilization amounts shown in the tables for the optimum soil test category use default yield levels. These can be adjusted to a field-specific yield. The nutrient content per unit of yield for Iowa agronomic crops is given in Table 2.

Table 2. The nutrient content of harvested crops used to calculate nutrient removal and recommended amounts of P_2O_5 and K_2O for optimum soil test category.

		Pounds per unit of yield	
Crop	Unit of Yield	P_2O_5	K_2O
Corn	bu	0.375	0.30
Corn silage	bu grain equivalent	0.55	1.25
Corn silage	ton, 65% H_2O	3.50	8.0
Corn stover*	ton	5.9	25.0
Soybean	bu	0.80	1.5
Soybean stover*	ton	2.8	9.9
Oat and straw	bu	0.40	1.0
Oat straw	ton	5.0	33.0
Wheat	bu	0.60	0.30
Wheat straw	ton	4.0	25.0
Sunflower	100 lb	0.80	0.70
Alfalfa	ton	12.50	40.0
Red clover	ton	12.0	35.0
Trefoil	ton	12.0	35.0
Vetch	ton	12.0	47.0
Smooth bromegrass	ton	9.0	47.0
Orchardgrass	ton	14.0	68.0
Tall fescue	ton	12.0	66.0
Timothy	ton	9.0	32.0
Perennial ryegrass	ton	12.0	34.0
Sorghum-sudan	ton	12.0	38.0
Switchgrass	ton	12.0	66.0
Reed canarygrass	ton	9.0	47.0

*Nutrients in corn and soybean stover reflect content at plant maturity (dry matter based), and will therefore be more representative of stover harvested immediately after grain harvest. Corn stover is an average content of all aboveground plant components except grain. Soybean stover is nutrient content only of stems.

The recommendation tables provide suggested P and K applications intended for a single crop grown after soil sampling. Economic considerations suggest that a new soil test should be planned every two to four years for most crops. For P and K applications after the initial crop year and between soil testing years, and for multi-year applications planned for consecutive grain crops (for example, multi-year application for corn-soybean and corn-corn rotations), adjustment should be made to the recommended annual amounts. Available research data suggest that when recommended P and K amounts are applied to soils that test in the very low category, recommended amounts for the low category can be applied to subsequent crops until the next planned soil testing, but not for more than three years. When the recommended P and K amounts are applied to soils that test in the low category, recommended amounts for the optimum category can be applied to subsequent crops until the next planned soil testing, but not for more than three years. When soil tests are in the optimum category, the crop removal amount can be applied each year. For grain crops, an amount equivalent to the sum over two crop years can be applied in one application. Annual P and K applications are recommended for silage or forage crops to minimize excessive nutrient removal when large nutrient rates are applied at one time.

The optimum soil test category is the most profitable to maintain. Phosphorus and K application in the high category seldom produces a profitable yield increase, and no recommendation is made for annual (one crop-year) application. However, if the soil test is in the lower part of the high range, a multi-year application is planned for grain crops (for example, consecutive corn and soybean crops), and it will be two to four years until the next soil sampling, consider applying a partial crop removal rate during that period to ensure adequate nutrients for subsequent crops and to moderate soil test decline. The very high soil test category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a yield response. Therefore, no application is recommended for the very high category.

Method of Application

The recommended amounts for P and K are based on yield responses to applications in many tillage systems—from conventional-tillage to reduced-tillage and no-tillage systems. Research has shown that in most reduced-tillage systems equivalent crop responses are expected for broadcast, 2×2 band, and deep band P and K applications. The exceptions are for K in ridge-tillage corn and soybean where bands placed into the ridge provide higher yields than broadcast, and K in no-tillage corn where deep banding can produce greater yield response than broadcast or 2×2 band placement. However, on average the no-tillage corn yield increase from deep K banding is not large and may often not pay for the increased application costs.

Application of banded NP or NPK starter fertilizer for corn in the high soil test category may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. Placement of starter fertilizer with corn seed should be limited to 10 pounds or less of N + K_2O per acre to reduce the risk of decreased plant stand. If soils are sandy or dry, reduce the amount of N + K_2O by one-half. It is recommended that no fertilizer be placed in contact with soybean seed.

Table 3. Phosphorus and potassium recommendations for corn grain production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	100	75	55	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	130	90	45	0	0
Sandy Textured	110	70	45	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 150 bu corn grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. At the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. None is recommended for the very high soil test category. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 4. Phosphorus and potassium recommendations for soybean production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	80	60	40	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	120	90	75	0	0
Sandy Textured	100	85	75	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 50 bu soybean grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 5. Phosphorus and potassium recommendations for oat grain and straw production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	50	40	30	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	100	90	80	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 80 bu oat grain per acre and straw. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 6. Phosphorus and potassium recommendations for wheat production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–15	16–20	21–25	26–30	31+
Olsen P:					
All Subsoil P Levels	0–10	11–14	15–17	18–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–20	21–30	31–40	41–50	51+
			P_2O_5 to apply (lb/acre)		
	60	50	30	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	70	40	15	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 50 bu wheat grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 7. Phosphorus and potassium recommendations for sunflower production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	70	50	15	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	90	50	15	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 2,000 lb sunflower seed per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 8. Phosphorus and potassium recommendations for corn silage or sorghum silage production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	105	90	75	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	240	210	175	0	0
Sandy Textured	220	200	175	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on approximately 22 tons corn silage per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. At the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. None is recommended for the very high soil test category. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 9. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–15	16–20	21–25	26–30	31+
Olsen P:					
All Subsoil P Levels	0–10	11–14	15–17	18–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–20	21–30	31–40	41–50	51+
			P_2O_5 to apply (lb/acre)		
	110	80	60	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	280	240	200	0	0

*For soils that test in the high soil test P category, 30 lb P_2O_5 per acre is recommended at seeding time. The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on 5 ton per acre of harvested hay. Nutrient removal amounts can be adjusted higher or lower for other yield levels. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 10. Phosphorus and potassium recommendations for clover- and trefoil-grass hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	80	60	40	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	180	140	100	0	0

*The recommended amounts of P_2O_5 and K_2O in the optimum test category are based on 3 ton per acre of harvested hay. Nutrient removal amounts can be adjusted higher or lower for other yield levels. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 11. Phosphorus and potassium recommendations for tall cool-season grasses, warm-season perennial grasses, and sorghum-sudan hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
	P_2O_5 to apply (lb/acre)				
	90	60	30	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
	K_2O to apply (lb/acre)				
All Soil Textures	160	120	80	0	0

*The amounts of P_2O_5 and K_2O for the optimum category can be adjusted for approximate nutrient removal for the harvested yield. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 12. Phosphorus and potassium recommendations for bluegrass dominant pasture.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum**	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–8	9–15	16–20	21–30	31+
Olsen P:					
All Subsoil P Levels	0–5	6–10	11–14	15–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–15	16–25	26–35	36–45	46+
			P_2O_5 to apply (lb/acre)		
	40	30	0	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum**	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
All Subsoil K	0–90	91–130	131–170	171–200	201+
			K_2O to apply (lb/acre)		
All Soil Textures	40	30	0	0	0

Micronutrients Recommendations

Iowa State University recommends only zinc (Zn) for corn and sorghum based on soil testing. The Zn soil test has been calibrated on Iowa soils. Zinc recommendations for corn and sorghum are given in Table 13.

Soil test procedures for the other micronutrients have not been calibrated because of either lack of or inconsistency of occurrence of deficiencies with the exception of iron deficiency on soybean. Iron deficiency on soybean occurs on high pH (calcareous) soils in central and north central Iowa and can be predicted by soil occurrence as shown in soil survey reports. Development of soybean varieties tolerant to low iron availability in calcareous soils has been an acceptable solution to the problem.

Table 13. Zinc recommendations for corn and sorghum production.

	Zinc Soil Test (ppm)		
Soil Test Category:	**Low**	**Marginal**	**Adequate**
DTPA Extractable Zn:	0–0.4	0.5–0.8	0.9+
	Zn to apply broadcast (lb/acre)		
	10	5	0
	Zn to apply in band (lb/acre)*		
	2	1	0

*Recommendation for amount to apply in band is based on other states' information.

Limestone Recommendations

Limestone recommendations (Table 14) are given in pounds of pure fine calcium carbonate ($CaCO_3$). The recommended amounts listed in Table 14 are for different soil Buffer pH, intended soil pH, and depth of soil to be neutralized. Actual rates of limestone to apply are calculated from the recommended $CaCO_3$ rate (Table 14) and the effective calcium carbonate equivalent (ECCE) of the limestone product to be applied (ECCE is determined for all agricultural limestone sources in Iowa). Soil pH is used to determine whether or not to lime the soil. The SMP Buffer (also termed the Ohio Buffer) solution has been calibrated to determine the amount of lime required to increase soil pH to a specific pH.

Recommendations are given to increase soil pH to 6.5 or to 6.9. Soil pH 6.0 is considered to be sufficient for grass pastures and grass haylands. Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH (pH > 7.4) in the subsoil of the Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime is recommended to raise soil pH to 6.5.

The amount of limestone recommended is adjusted for the incorporation depth from tillage, which determines the volume of soil to be neutralized. The equivalent depth for no-till is considered to be 2 to 3 inches.

Table 14. Lime recommendations, based on SMP Buffer Test, are given in pounds of pure fine calcium carbonate ($CaCO_3$) to increase soil pH from its present level to pH 6.5 or 6.9 for the depth of soil to be neutralized.

	Depth of soil to be neutralized*							
Buffer	**2 inch**		**3 inch**		**6 inch**		**8 inch**	
pH	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**
	$CaCO_3$ to apply (lb/acre)							
7.0	0	400	0	600	0	1,100	0	1,500
6.9	0	600	0	1,000	0	1,900	0	2,500
6.8	200	900	300	1,400	600	2,700	800	3,600
6.7	400	1,200	700	1,800	1,300	3,500	1,700	4,700
6.6	700	1,500	1,100	2,200	2,100	4,400	2,800	5,900
6.5	900	1,700	1,400	2,600	2,800	5,200	3,700	6,900
6.4	1,200	2,000	1,800	3,000	3,500	6,000	4,700	8,000
6.3	1,400	2,300	2,100	3,400	4,200	6,800	5,600	9,100
6.2	1,700	2,600	2,500	3,900	5,000	7,700	6,700	10,300
6.1	1,900	2,800	2,900	4,300	5,700	8,500	7,600	11,400
6.0	2,200	3,100	3,200	4,700	6,400	9,300	8,600	12,400
5.9	2,400	3,400	3,600	5,100	7,100	10,100	9,500	13,500
5.8	2,600	3,700	4,000	5,500	7,900	11,000	10,600	14,700
5.7	2,900	3,900	4,300	5,900	8,600	11,800	11,500	15,900

*Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH subsoils in the Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime to soil pH 6.5. Soil pH 6.0 is sufficient for grass pastures and grass hayland.

Soils

Table 15. Subsoil phosphorus and potassium levels that are to be used to determine phosphorus and potassium nutrient recommendations for the major soil series in each of the 12 major soil areas in Iowa. Soil series of more than 5,000 acres and with a corn suitability rating of 30 or greater are listed. (Source: Iowa Soil Properties and Interpretations Database [ISPAID] 7.0, revised November 2002**)**

Abbreviations used in the subsections of this table are as indicated:
Str Sub: stratified subsoil
R: rock
S&G: sand and gravel

A. Major soil area 1 that includes the Downs, Fayette, and Fayette-Dubuque-Stonyland soil associations.

1. Loess-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Arenzville	19,679	H	L
Arenzville-Chaseburg Complex	54,144	H	L
Bertrand	7,871	H	L
Caneek	9,223	H	L
Chaseburg	47,346	H	L
Chelsea-Lamont-Fayette	6,090	L	L
Colo-Ely Complex	10,234	H	L
Dinsdale	24,260	L	L
Dockery	5,430	H	L
Dorchester	22,927	H	L
Downs	545,763	H	L
Downs Benches	6,276	H	L
Downs-Tama Complex	40,208	H	H
Eitzen	9,480	L	L
Exette	27,685	H	L
Fayette	1,174,150	H	L
Fayette Benches	5,967	H	L
Huntsville	6,140	H	L
Ion	6,560	L	L
Newvienna	19,125	H	L
Orion	14,940	H	L

—continued

A. Major soil area 1 that includes the Downs, Fayette, and Fayette-Dubuque-Stonyland soil associations, continued.

1. Loess-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Orwood	27,947	H	L
Ossian	6,250	H	L
Otter Overwash	6,180	H	H
Otter-Worthen Complex	24,968	H	L
Rozetta	14,800	H	L
Rozetta-Eleroy Complex	23,880	H	L
Sawmill	15,710	H	L
Tama	19,150	H	L
Worthen	11,167	H	L

2. Till-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Jacwin	5,878	L	L
Lamont	14,374	H	L

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	35,020	H	L
Ackmore-Colo Complex	48,635	H	L
Amana-Lawson-Perks	7,238	L	L
Ambraw	11,540	H	L
Atterberry	51,420	H	L
Atterberry Benches	9,754	H	L
Atterberry Sandy Subsoil	12,735	H	L
Bassett	7,722	H	L
Bolan	6,405	L	L
Bremer	30,630	H	H
Calco	7,094	H	L
Chelsea-Lamont-Fayette	15,046	L	L
Colo	207,339	H	L
Colo-Ely Complex	250,218	H	L

—continued

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Dickinson	13,545	L	L
Dinsdale	358,010	H	L
Downs	70,560	H	L
Downs Sandy Subsoil	16,560	H	L
Ely	20,551	L	L
Fayette	34,295	H	L
Fayette Sandy Subsoil	5,000	H	L
Franklin	20,145	H	L
Fruitfield	7,760	L	L
Garwin	77,013	L	L
Garwin Sandy Subsoil	5,450	L	L
Judson	26,501	H	H
Kennebec	10,597	H	H
Kenyon	9,274	L	L
Killduff	110,635	H	L
Klinger	6,940	L	H
Klinger-Maxfield Complex	8,040	L	L
Koszta	8,056	H	L
Lawler 32–40″ To S&G	8,362	L	L
Lawson	14,426	H	L
Liscomb	10,375	L	L
Maxfield	35,141	L	L
Mt. Carroll	5,610	H	L
Muscatine	225,802	H	L
Muscatine Benches	7,856	H	L
Nevin	38,641	H	H
Nodaway	55,726	H	L
Nodaway-Arenzville Complex	13,160	H	L
Port Byron	9,335	H	L
Raddle	5,445	H	L
Radford	5,690	H	L
Richwood	7,272	H	L
Rowley	10,555	H	L
Saude	5,425	L	L
Sawmill	34,745	H	L
Sawmill-Garwin Complex	35,937	L	L

—continued

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Shaffton	14,510	H	L
Shelby	11,590	H	L
Sparta	16,005	L	L
Tama	841,398	H	L
Tama Benches	18,759	H	L
Tama Sandy Subsoil	23,777	H	L
Tama-Dickinson Complex	8,895	L	L
Walford	24,465	H	L
Walford Benches	5,122	H	L
Waubeek	26,515	H	L
Waukee	5,225	H	L
Waukegan	22,137	H	L
Whittier	8,535	H	L
Wiota	24,783	H	H
Zook	16,691	H	L

C. Major soil area 3 that includes the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Amana	16,568	H	L
Ambraw	8,405	H	L
Bremer	5,205	H	H
Clinton	377,687	H	L
Clinton Benches	24,697	H	L
Coland	5,095	H	L
Colo	38,379	H	L
Colo-Ely Complex	52,688	H	L
Colo-Zook Complex	8,070	H	L
Coppock	8,984	H	L
Ely	16,760	H	H
Fayette	7,790	H	L
Gara	51,687	H	L
Givin	43,369	H	L
Hedrick	47,455	H	L

—continued

C. Major soil area 3 that includes the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Inton	11,675	H	H
Kalona	23,015	L	L
Keomah	16,095	H	L
Klum	5,588	L	L
Ladoga	281,324	H	L
Ladoga Benches	14,194	H	L
Lawson	6,175	H	L
Lindley	44,305	H	L
Mahaska	212,911	H	H
Nevin	5,200	H	H
Nira	75,880	H	L
Nodaway	39,128	H	L
Nodaway-Cantril Complex	15,373	L	L
Nodaway-Martinsburg Complex	13,318	H	L
Nodaway-Vesser Complex	9,725	H	L
Nodaway-Vesser-Ackmore	7,210	L	L
Olmitz	6,124	L	H
Otley	295,300	H	L
Otley Benches	5,568	H	L
Otley-Nira Complex	5,670	H	L
Radford	5,504	H	L
Shelby	20,229	L	L
Sparta	11,476	L	L
Sperry	11,162	H	H
Taintor	161,872	L	L
Titus	5,340	H	L
Tuskeego	8,858	H	L
Vesser	7,911	H	L
Zook	24,622	H	L

D. Major soil area 4 that includes the Adair-Seymour, Grundy-Haig, Adair-Grundy-Haig, and Lindley-Keswick-Weller soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	5,015	H	L
Adair	47,502	L	L
Amana	6,125	H	L
Appanoose	8,353	H	L
Arispe	135,013	L	L
Armstrong	6,735	L	L
Beckwith	7,321	H	L
Belinda	31,906	H	L
Caleb	14,047	L	L
Cantril	8,156	L	L
Cantril-Coppock-Nodaway	58,539	L	L
Chequest	16,665	H	L
Clarinda	29,645	L	L
Clearfield	6,535	H	L
Clearfield-Arispe Complex	9,252	L	L
Colo	24,877	H	L
Colo-Ely Complex	13,800	H	L
Coppock	16,582	H	L
Downs	6,951	H	L
Edina	108,035	L	L
Fayette	5,362	H	L
Gara	226,070	H	L
Gara-Armstrong Complex	7,650	L	L
Grundy	160,303	H	L
Haig	121,765	H	L
Humeston	24,668	H	L
Kennebec	6,170	H	H
Kennebec-Amana Complex	11,905	H	L
Kniffin	66,856	H	L
Ladoga	6,225	H	L
Ladoga Benches	5,210	H	L
Lamoni	31,091	L	L
Landes	6,439	L	L
Lawson	13,393	H	L
Lindley	26,328	H	L
Lineville	17,597	L	L

—continued

D. Major soil area 4 that includes the Adair-Seymour, Grundy-Haig, Adair-Grundy-Haig, and Lindley-Keswick-Weller soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Macksburg	8,385	H	H
Nira	19,600	H	L
Nodaway	36,717	H	L
Nodaway-Lawson-Ackmore	14,038	H	L
Nodaway-Lawson-Klum	12,710	L	L
Olmitz	20,020	L	H
Olmitz-Vesser-Colo	203,026	L	L
Pershing	218,817	H	L
Pershing Benches	29,905	H	L
Rathbun	8,328	H	L
Seymour	124,134	H	L
Sharpsburg	9,860	H	H
Shelby	116,359	L	L
Tuskeego	7,618	H	L
Vesser	35,935	H	L
Wabash	7,403	H	H
Weller	169,524	H	L
Zook	29,433	H	L
Zook-Ely Complex	11,475	H	L

E. Major soil area 5 that includes the Shelby-Sharpsburg-Macksburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	9,380	H	L
Adair Thin Solum	30,255	L	L
Adair-Shelby Complex	10,931	L	L
Bremer	6,206	H	H
Clarinda	7,505	L	L
Clearfield	42,780	H	L
Clinton	26,697	H	L
Colo	67,442	H	L
Colo Overwash	9,364	H	L
Colo-Ackmore Complex	9,340	H	L
Colo-Ely Complex	146,672	H	L
Colo-Judson-Nodaway	36,528	H	L

—continued

E. Major soil area 5 that includes the Shelby-Sharpsburg-Macksburg soil association, continued.

Soil Name	Acres in Series	Sub P	Sub K
Downs	14,100	H	L
Fayette	11,697	H	L
Gara	59,582	H	L
Humeston	5,400	H	L
Judson	14,752	H	H
Kennebec	8,808	H	H
Ladoga	160,886	H	L
Lamoni	30,780	L	L
Macksburg	87,651	H	H
Nevin	16,527	H	H
Nira	84,629	H	L
Nira-Sharpsburg Complex	25,248	H	L
Nodaway	55,004	H	L
Olmitz	12,275	L	H
Sharpsburg	639,674	H	H
Sharpsburg Benches	17,294	H	H
Shelby	234,586	L	L
Tama	19,626	H	L
Vesser	8,431	H	L
Wabash	38,287	H	H
Winterset	22,844	H	H
Zook	76,217	H	L
Zook-Colo-Ely	11,165	H	L

F. Major soil area 6 that includes the Marshall soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	31,048	H	L
Burchard	6,030	H	H
Calco	6,994	H	L
Colo	69,125	H	L
Colo-Judson Complex	473,474	H	L
Ely	7,226	H	H
Exira	234,720	L	H
Judson	118,471	H	H
Kennebec	62,245	H	H
Kennebec-Ackmore Complex	6,420	H	L
Marshall	926,427	H	H
Marshall Benches	44,816	H	H
Minden	6,673	H	H
Monona	50,630	L	L
Napier-Kennebec-Nodaway	53,090	L	L
Nevin	5,515	H	H
Nodaway	98,318	H	L
Shelby	34,400	L	L
Zook	55,426	H	L

G. Major soil area 7 that includes the Monona-Ida-Hamburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Calco	5,230	H	L
Castana	16,086	L	L
Ida	402,531	L	L
Kennebec	72,505	H	H
Kennebec-McPaul Complex	8,015	H	H
McPaul	9,490	H	H
McPaul-Kennebec Complex	16,000	H	H
Monona	688,686	H	H
Monona Benches	15,393	H	L
Napier	270,672	L	H
Nodaway	8,940	H	H
Rawles	8,470	H	H

H. Major soil area 8 that includes the Luton-Onawa-Salix soil association.

Soil Name	Acres in Series	Sub P	Sub K
Albaton	54,983	L	H
Blake	20,158	L	H
Blencoe	16,117	L	H
Blend	7,267	L	H
Carr	5,920	L	H
Cooper	9,748	L	H
Forney	13,916	L	H
Grable	9,845	L	H
Haynie	39,041	L	H
Keg	20,553	L	H
Lakeport	14,131	L	H
Lossing	5,767	L	H
Luton	114,634	L	H
Luton Thin Surface	17,575	L	H
McPaul	66,426	H	H
McPaul-Kennebec Complex	13,410	H	H
Modale	10,424	L	H
Moville	8,085	L	H
Napier-Castana Complex	8,900	L	L
Napier-Nodaway-Colo	5,177	L	L
Onawa	31,497	L	H
Owego	6,207	L	H
Percival	8,195	L	H
Salix	26,372	L	H
Tieville	5,858	L	H
Woodbury	16,169	L	H

I. Major soil area 9 that includes the Galva-Primghar-Sac soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	11,305	H	L
Afton	45,552	L	L
Allendorf	5,520	L	L
Bolan	6,302	L	L
Calco	28,242	H	L
Colo	97,943	H	L
Colo-Judson Complex	28,610	H	L
Davis	5,970	H	L
Ely	7,235	H	H
Everly	59,439	L	L
Galva	1,068,182	L	L
Galva Benches	67,332	L	L
Galva Str Sub	15,715	L	L
Ida	9,005	L	L
Judson	7,255	H	H
Kennebec	26,265	H	H
Letri Calcareous	5,445	L	L
Marcus	159,279	L	L
Nicollet	24,494	L	L
Ocheyedan	13,358	L	H
Primghar	366,779	L	L
Radford	59,045	H	L
Ransom	12,555	L	L
Sac	169,598	L	L
Spicer	7,195	L	L
Spillco	11,195	H	L
Spillville	7,960	L	L
Steinauer	5,561	L	L
Terril	9,280	L	L
Tripoli	17,241	L	L
Wadena 24–32″ To S&G	5,910	L	L
Wilmonton	23,815	L	L

J. Major soil area 10 that includes the Moody soil association.

Soil Name	Acres in Series	Sub P	Sub K
Crofton	5,700	L	L
Egan	17,620	L	L
Moody	153,555	L	L
Moody Loamy Subsoil	5,015	L	L
Trent	13,100	L	L

K. Major soil area 11 that includes the Clarion-Nicollet-Webster soil association.

Soil Name	Acres in Series	Sub P	Sub K
Biscay Deep	43,703	L	L
Blue Earth	16,208	L	L
Bode	56,321	L	L
Brownton	57,027	L	L
Calco	10,371	H	L
Canisteo	1,297,749	L	L
Clarion	1,629,066	L	L
Clarion Long Slopes	26,815	L	L
Clarion-Storden Complex	83,342	L	L
Coland	134,671	H	L
Coland-Spillville Complex	63,328	L	L
Collinwood	19,024	L	L
Colo	18,452	H	L
Crippin	40,208	L	L
Cylinder Deep	34,026	L	L
Cylinder Moderately Deep	14,270	L	L
Dickinson	8,072	L	L
Dickman	12,231	L	L
Estherville	9,746	L	L
Fieldon	11,369	L	L
Fostoria	8,731	L	L
Guckeen	11,452	L	L
Hanlon	8,280	L	L
Hanska	5,325	L	L
Harcot	20,750	L	L
Harps	255,122	L	L

—continued

K. Major soil area 11 that includes the Clarion-Nicollet-Webster soil association, continued.

Soil Name	Acres in Series	Sub P	Sub K
Havelock	13,735	L	L
Hayden	37,778	H	L
Kilkenny	13,704	H	L
Knoke	24,276	L	L
Kossuth	76,968	L	L
Le Sueur	14,598	H	L
Lester	104,111	H	L
Lester Long Slopes	5,050	H	L
Linder	8,683	L	L
Luther	8,684	H	L
Marna	23,015	L	L
Mayer 24–32″ To S&G	6,662	L	L
Mayer 32–40″ To S&G	5,620	L	L
Nicollet	1,067,487	L	L
Okoboji	318,210	L	L
Okoboji-Harps Complex	40,776	L	L
Ottosen	72,172	L	L
Palms	35,517	H	L
Ridgeport	16,714	H	H
Rolfe	5,355	L	H
Spicer	5,882	L	L
Spillville	66,514	H	L
Storden	109,067	L	L
Talcot 32–40″ To S&G	45,340	L	L
Terril	29,781	L	L
Truman Str Sub	7,020	H	L
Vinje	6,836	L	L
Wacousta	20,232	L	L
Wadena 24–32″ To S&G	77,175	L	L
Wadena 32–40″ To S&G	31,082	L	L
Waldorf	24,575	L	L
Webster	918,520	L	L
Webster-Nicollet Complex	77,907	L	L
Zenor	15,938	H	L

L. Major soil area 12 that includes the Kenyon-Floyd-Clyde and Cresco-Lourdes-Clyde soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ansgar	9,495	H	L
Aredale	37,724	L	L
Ashdale	6,255	H	L
Atkinson	6,978	L	L
Bassett	140,498	H	L
Bolan	26,491	L	L
Burkhardt-Saude Complex	6,857	L	L
Chelsea	12,351	L	L
Clyde	381,543	L	L
Clyde-Floyd Complex	318,086	L	L
Coggon	7,078	H	L
Coland	25,785	H	L
Cresco	47,728	L	L
Dickinson	84,505	L	L
Dickinson Loamy Subsoil	15,850	L	L
Dickinson-Ostrander Complex	5,039	L	L
Dinsdale	44,033	H	L
Donnan	24,633	L	L
Downs	9,558	H	L
Finchford	10,170	H	L
Flagler	42,799	L	L
Floyd	256,708	L	L
Franklin	23,132	H	L
Hayfield 24–32″ To S&G	23,484	H	L
Hayfield 24–40″ To S&G	9,739	H	L
Hoopeston	7,317	L	L
Jameston	6,484	L	L
Kenyon	591,170	L	L
Klinger	139,349	L	H
Lamont	7,542	H	L
Lawler 24–32″ To S&G	37,772	L	L
Lawler 32–40″ To S&G	50,196	L	L
Lourdes	19,330	L	L

—continued

L. Major soil area 12 that includes the Kenyon-Floyd-Clyde and Cresco-Lourdes-Clyde soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Marshan 24–32″ To S&G	27,264	L	L
Marshan 32–40″ To S&G	88,781	L	L
Maxfield	63,479	L	L
Olin	63,200	L	L
Oran	83,395	L	L
Ostrander	94,518	L	L
Palms	10,864	L	L
Protivin	34,767	L	L
Racine	43,776	L	L
Readlyn	200,316	L	L
Riceville	13,283	L	L
Rockton 20–30″ To R	38,953	L	L
Rockton 30–40″ To R	22,146	L	L
Rossfield	8,075	H	L
Sattre	6,566	H	L
Saude	133,715	L	L
Schley	61,513	L	L
Seaton	6,008	H	L
Sparta	70,253	L	L
Spillville	34,753	L	L
Spillville-Coland Complex	29,291	L	L
Tama	5,850	H	L
Terril	22,225	L	L
Tripoli	102,559	L	L
Turlin	5,218	L	L
Udolpho	5,105	H	L
Wapsie	52,150	H	L
Waubeek	9,387	H	L
Waukee	61,392	H	L
Winneshiek	25,549	H	L

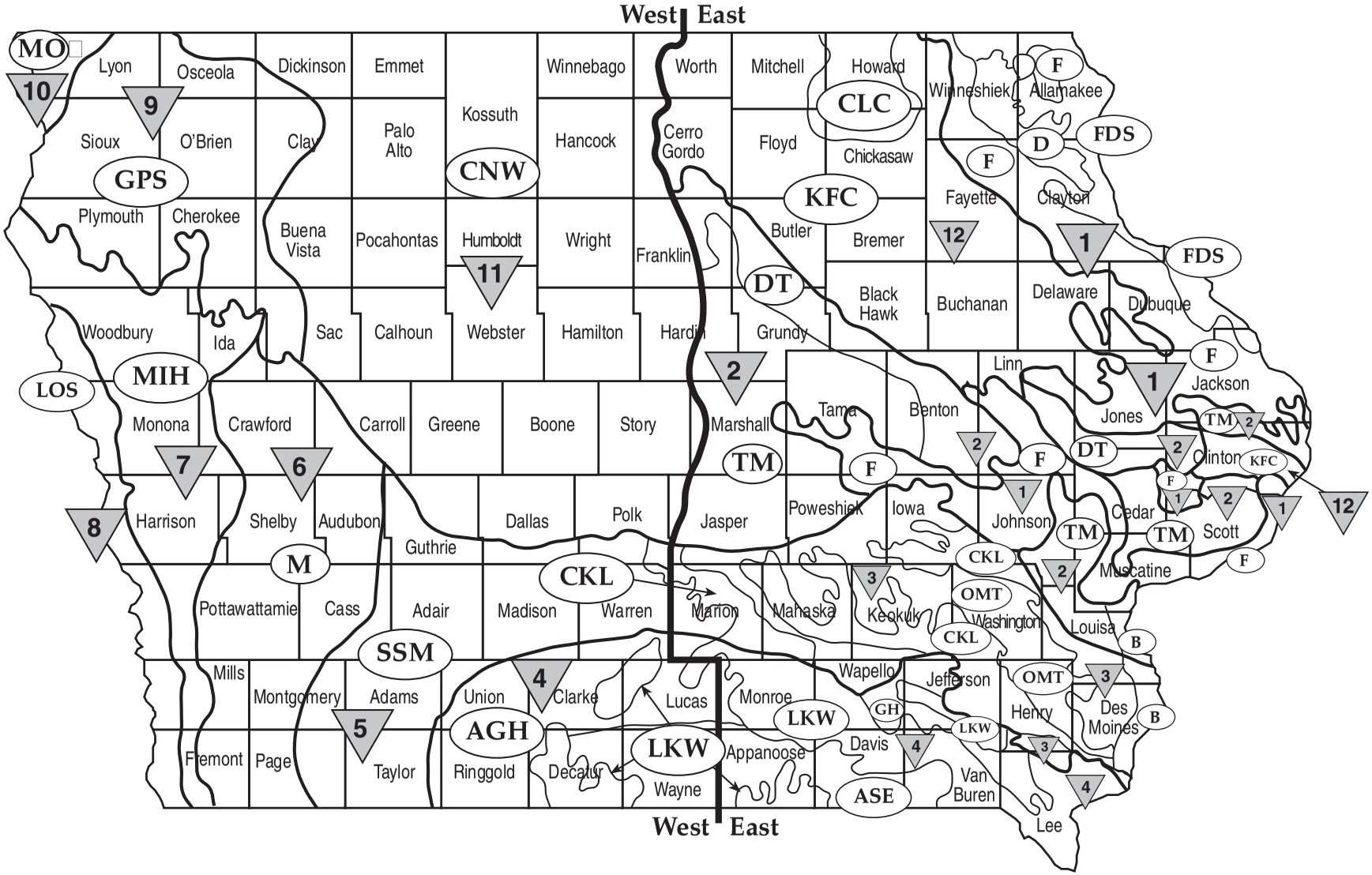


Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters) and the 12 major soil areas (numbers). B designates the Mississippi bottomland.

AGH:	Adair-Grundy-Haig	D:	Downs	GH:	Grundy-Haig	MIH:	Monona-Ida-Hamburg
ASE:	Adair-Seymour-Edina	DT:	Dinsdale-Tama	KFC:	Kenyon-Floyd-Clyde	Mo:	Moody
CKL:	Clinton-Keswick-Lindley	F:	Fayette	LKW:	Lindley-Keswick-Weller	OMT:	Otley-Mahaska-Taintor
CLC:	Cresco-Lourdes-Clyde	FDS:	Fayette-Dubuque-Stonyland	LOS:	Luton-Onawa-Salix	SSM:	Shelby-Sharpsburg-Macksburg
CNW:	Clarion-Nicollet-Webster	GPS:	Galva-Primghar-Sac	M:	Marshall	TM:	Tama-Muscatine

IOWA STATE UNIVERSITY
University Extension

File: Agronomy 8-2

Prepared by J. E. Sawyer, A. P. Mallarino, R. Killorn, and S. K. Barnhart, Department of Agronomy, Iowa State University.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jack M. Payne, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

Using Manure Nutrients for Crop Production

Nutrients in Animal Manure

Manure can supply nutrients required by crops and replenish nutrients removed from soil by crop harvest. Since manure contains multiple nutrients, applications should consider not only what is needed for the crop to be grown but also how the ratio of nutrients in manure could affect soil test levels. This ensures adequate nutrient supply and reduces potential for over- or under-application and subsequent buildup or depletion in the soil. Good manure nutrient management should consider short-term and long-term impacts on crop nutrient supply and soil resources.

Manure has characteristics that make nutrient management different and sometimes more complicated than fertilizer. These include a mix of organic and inorganic nutrient forms; variation in nutrient concentration and forms; variation in dry matter and resultant handling as a liquid or solid; and relatively low nutrient concentration requiring large application volumes. Since manure nutrient composition can vary significantly, sampling and laboratory analysis are always needed, while with fertilizer nutrient concentrations are provided at a guaranteed analysis.

The manure nutrient concentration varies considerably between animal species; dietary options; animal genetics; animal performance; production management and facility type; and collection, bedding, storage, handling, and agitation for land application. Use of average or "book" nutrient values can be helpful for designing a new facility and creating manure management plans but is not very helpful in determining specific manure nutrient supply or application rates due to wide variation in nutrient concentrations between production facilities. For example, a recent sampling across swine finishing facilities found a range in total N from 32 to 79 lb N/1,000 gal, P from 17 to 54 lb P_2O_5/1,000 gal, and K from 23 to 48 lb K_2O/1,000 gal. A similar or larger range can be found with other manure types. Nutrient analyses often vary greatly as storage facilities are emptied or manure is stockpiled, and also among multiple samples collected from loads during land application. Therefore, collecting multiple manure samples and maintaining a history of analysis results will improve use of manure nutrients.

For determining manure application rates and equating to crop fertilization requirements, it is most helpful if manure analyses give N, P_2O_5, and K_2O based on an as-received or wet basis in lb per ton or lb per 1,000 gal units. It is beyond the scope of this publication to give detailed manure sampling and laboratory analysis

PMR 1003 September 2008

recommendations. Those can be found in the extension materials listed on page 7. If manure analyses are provided from the laboratory in other units, they must be converted to these units. See the ISU Extension manure sampling publication for appropriate conversion factors. If manure average nutrient values or methods to estimate manure nutrient concentrations based on excretion are of interest or needed for planning purposes, those can be found in the Midwest Plan Service bulletins listed on page 7.

Manure Nutrient Availability for Crops

Nutrient management guidelines use the words "manure nutrient availability" when suggesting manure applications to supply nutrients needed by crops. However, the meaning of "availability" for manure nutrients often is not clear or its use not consistent. Available is defined as present or ready for immediate use, or present in such chemical or physical form as to be usable (as by a plant). The main reasoning for using the term "available" in describing manure nutrients is that some portions are in forms that cannot be used by plants immediately upon application to soil and have to be converted to a form that plants can take up. The term "available" is not typically applied to fertilizers because most include chemical forms that plants can take up or are quickly converted upon application to soil. According to this definition, most inorganic fertilizers contain basically 100 percent crop-available nutrients. For example, anhydrous ammonia dissolves in water and rapidly changes to ammonium, urea hydrolyzes to ammonium within a few days, and ammonium is further transformed to nitrate by soil microorganisms. Monoammonium phosphate (MAP) and diammonium phosphate (DAP) are highly soluble in water and dissolve to ammonium and orthophosphate. Potassium chloride (KCl, potash), dissolves in water to potassium (K^+) and chloride (Cl^-) ions. Both orthophosphate and K ions are taken up by plants. Because all K contained in manure is in the K^+ ionic form, manure K is readily crop available in all manure sources.

For manure N and P, there is usually a mix of organic and inorganic materials that varies among manure sources, production systems, bedding, storage, and handling. This variety in forms of N and P in manure contributes to greater uncertainty in manure nutrient management compared with fertilizers. The ratio of inorganic (mainly ammonium) and organic N varies considerably with the manure source. This was shown, for example, by on-farm research that included manure sampling and analysis from swine and poultry operations. The fraction of total N as ammonium N was almost 100 percent for swine manure from the liquid portion of anaerobic lagoons, 65 to 100 percent (average 84 percent) for liquid swine manure from under-building pits or storage tanks, and 10 to 40 percent (average 20 percent) for solid poultry manure. The large ammonium-N concentration and organic-N fraction that is easily mineralized after applica-

tion to soil explain why N in liquid swine manure is considered "highly" crop available and almost comparable to fertilizer N. Other manures have lower ammonium-N concentrations and greater (and tougher to degrade) organic materials due to bedding and feed materials. Considerable P in swine manure is orthophosphate and calcium phosphate compounds (derived both from feed and mineral supplements added to rations) that are soluble or dissolve quickly once applied to soil. The rest is organic P, which varies greatly in complexity and reaction in soil. Testing manure for ammonium-N or water-soluble N can be a way of estimating immediately available N. Unfortunately, a similarly useful test does not exist for P. Therefore, the availability estimate for manure N and P can be, and often is, less than 100 percent of total N and P.

Manure Nutrient Supply

There is a clear difference between crop availability of nutrients in fertilizer or manure and season-long supply of nutrients. Significant amounts of plant usable forms of nutrients in both fertilizer and manure might be lost and became unavailable to crops after application. For example, N can be lost through processes such as leaching, volatilization, or denitrification while P can be lost through erosion and surface runoff. Also, these nutrients can be converted for short or long periods of time into forms not usable by plants through processes such as immobilization to organic materials for N and retention by soil mineral constituents for P. Nutrient loss issues are not as pertinent for P and K as for N in Iowa soils as long as there is little soil erosion and surface runoff.

The immediate or long-term fate of plant usable nutrients in soil can be similar for manure and fertilizer. However, variation in manure nutrient concentration, application rate, and application distribution affect nutrient supply and contribute to increased uncertainty with manure management. Application rate and distribution uncertainties affect all applied nutrient sources but are more difficult to manage with manure than with fertilizer. With careful manure sampling, pre-application nutrient analysis, study of nutrient analysis history, and calibration of application equipment, reasonable manure nutrient application rates can be achieved. Due to material characteristics, and sampling and analysis variability, field distribution and application rate variability often is greater for dry manure sources.

These supply issues can be important for N, P, and K, although typically are of greater concern with N. There are several reasons, including manure usually is applied for corn production where N supply is critical, many Iowa soils have optimum or higher P and K test levels where need for and response to P and K is much less than with N, and crop deficiency symptoms and yield loss resulting from nutrient supply problems are more obvious for N.

Manure nutrient loss, application rate, and distribution uncertainties usually are not included in crop nutrient availability estimates. Instead, they are handled by suggested management practices. Not all published guidelines are consistent in this regard and, therefore, suggested crop nutrient availabilities do vary between states and regions. In this publication, use of "availability" refers to manure nutrients potentially available for plant uptake (with no losses) by the first crop after application or beyond, and percent nutrient availability values provided correlate to those for commonly used fertilizers. The guidelines in this publication assume supply issues are handled in the best way possible as is done with fertilizers. It is important to understand that for successful manure nutrient management, in many instances supply issues are as, or more, critical than estimates of nutrient availability.

Improving crop nutrient supply with manure can be achieved by understanding the issues related to manure nutrient analysis, application rate, application distribution, and the benefits and risks related to management practices such as application timing and placement that influence potential losses. Additionally, use of available tools to determine initial soil nutrient levels and adjust application rates can help provide for adequate season-long nutrient supply when either manure or fertilizer is used. These tools include commonly used pre-plant soil testing for P and K, estimates of N application rate need based on response trial data (such as

the *Corn Nitrogen Rate Calculator*), and tools to help determine need for additional N after planting corn such as the late-spring soil nitrate test and in-season crop sensing for N stress.

Manure Nutrient Application Recommendations

To determine manure application rates, the following information is required: needed crop nutrient fertilization rate for N, P, K, or other deficient nutrients; manure type; nutrient analysis; nutrient crop availability; and method of application. Nutrient recommendations for crops are provided in other Iowa State University Extension publications and are not repeated here (see list on page 7).

Once the needed nutrient application rate is determined, the manure rate to supply crop available nutrients is calculated based on the specific manure source being used.

An additional consideration is what portion of the needed fertilization will be supplied from manure—to meet the full crop nutrient requirement, or a partial requirement from manure and the remaining from fertilizer. This is an important consideration because manure contains multiple nutrients and a manure rate to supply the most deficient nutrient can over-supply other nutrients. Also, manure application to meet the least deficient or most environmentally restrictive nutrient application can result in under-supply of other nutrients.

In these cases, use of fertilizers in addition to manure application is necessary to appropriately meet all nutrient application requirements.

Manure Nutrient Availability Values

Many of the manure N, P, and K crop availability estimates listed in Table 1 are derived from research trials conducted in Iowa. However, when local research is lacking, applicable information was taken from research conducted in other states. For manure sources not listed in the table, values based on manure with similar characteristics can provide a reasonable estimate.

First-Year Availability Estimates

Table 1. First-year nutrient availability for different animal manure sources.

Manure Source	Nitrogen[1]	Phosphorus[2]	Potassium[2]
	- - - - - - - - - - - - - Percent of Total Nutrient Applied - - - - - - - - - - - - -		
Beef cattle (solid or liquid)	30–40	60–100	90–100
Dairy (solid or liquid)	30–40	60–100	90–100
Liquid swine (anaerobic pit)	90–100	90–100	90–100
Liquid swine (anaerobic lagoon)	90–100[3]	90–100[3]	90–100
Poultry (all species)	50–60	90–100	90–100

[1]The estimates for N availability do not account for potential volatile N losses during and after land application. Correction factors for volatile loss are given in Table 2. The ranges are provided to account for variation in the proportion of ammonium N (and for poultry manure also uric acid), bedding type and amount, and both sampling and analysis.

[2]The ranges in P and K availability are provided to account for variation in sampling and analysis, and for needed P and K supply with different soil test levels. A small portion of manure P may not be available immediately after application, but all P is potentially available over time. Use lower P and K availability values for soils testing in the Very Low and Low soil test interpretation categories, where large yield loss could occur if insufficient P or K is applied and a reasonable buildup is desirable. Use 100% when manure is applied to maintain soil-test P and K in the Optimum soil test category, when the probability of a yield response is small.

[3]Values apply for the liquid portion of swine manure in lagoons; the N and P availability will be less and difficult to estimate with settled solids.

Second- and Third-Year Availability Estimates

While manure N may become crop available over multiple years for some sources, there should not be an expectation that all of the manure N will eventually become crop available. This happens because some of the N is in difficult to degrade organic forms (recalcitrant) and will become part of the soil organic matter. For some manure sources, such as with bedded systems, not all of the manure N should be accounted for in manure plans over multiple years and the first-, second-, or third-year availability may not add up to 100 percent.

Animal manure that has considerable organic material can have some residual-N availability in the second or third year after application. The second-year N availability estimate for beef cattle and dairy manure is 10 percent, and 5 percent for the third year. Other manures that have similar organic N and bedding could have similar second- and third-year N availability. Manure sources that have low organic N will not have second-year crop available N. These include liquid systems like swine manure stored in under-building pits and above-ground tanks, and anaerobic lagoons. Poultry manure, since it has considerable organic material, has some but low second-year (0–10 percent) availability and no third-year N availability.

The P and K contained in animal manure are estimated at 100 percent crop available over a long term. Residual effects of P and K not used in the year of application will be reflected in soil tests and crop use, just like fertilizer P and K applied for one year or for multiple years.

Adjusting for Manure Nitrogen Volatilization

The estimates for manure N availability in Table 1 do not consider potential volatile N losses during or after application. Losses are from various volatile N compounds in manure, such as ammonia, and ammonia that is produced when urea, uric acid, or other compounds convert to ammonium. These are similar losses that can occur from some N fertilizers such as anhydrous ammonia, urea, and urea-ammonium nitrate (UAN) solutions. If manure is left on the soil surface, losses may occur until N is moved into the soil with rainfall or incorporated with tillage. Many factors affect the rate and amount of volatile loss, such as temperature, humidity, rainfall, soil moisture, soil pH, surface residue cover, and days to incorporation. Volatile losses at or after application often are difficult to predict accurately. However, losses can be significant, and, therefore, it is important to make an adjustment for volatile N losses from applied manure and for manure management planning purposes. Values given in Table 2 provide guidance on potential volatile losses. The correction factors in Table 2 do not account for N losses during storage and handling (time from excretion to sampling for analysis) and assume a reasonable time period from sampling to land application so that the manure analysis represents the manure being applied. To estimate manure N remaining in soil after application, multiply the applied manure N rate by the appropriate correction factor.

Table 2. Correction factors to account for N volatilization losses during and after land application of animal manure.[1]

Application Method	Incorporation	Volatilization Correction Factor[2]
Direct injection	—	0.98–1.00
Broadcast (liquid/solid)	Immediate incorporation	0.95–0.99
Broadcast (liquid)	No incorporation	0.75–0.90
Broadcast (solid)	No incorporation	0.70–0.85
Irrigation	No incorporation	0.60–0.75

[1]Adapted from Midwest Plan Service MWPS-18, Third Edition. Nitrogen losses during and within four days of application.

[2]Multiply the manure total N rate applied times the volatilization correction factor to determine the portion of total manure N remaining.

Considerations for Time of Application

The time of application influences nutrient availability and potential manure and nutrient loss from soil. Fall applications allow more time for organic N and P portions of manure to mineralize so they are available for plant uptake the next crop season. This is more important for N in manures with high organic matter content, such as bedded systems. Iowa research has shown that fall versus springtime P and K application usually is not an agronomic issue for fertilizers or manure. The increased time for organic N mineralization with fall application also allows for nitrification of ammonium and therefore more potential nitrate loss through leaching or denitrification with excessively wet spring conditions. This is a more important issue for manure with large ammonium-N concentration, such as liquid swine manure. Coarse-textured soils, with high permeability, are the most likely to have leaching losses. Fine- and moderately fine-textured soils, prone to excess wetness, are most likely to have denitrification losses. Manure applied in the spring has less time for organic N and P mineralization before crop uptake. Delayed mineralization can be an important issue for manure with high organic matter content, especially in cold springs. With manure that contains a large portion of N as ammonium, spring application allows for better timing of nitrification to nitrate and subsequent crop use, and less chance of N loss.

As a general rule, do not apply manure in the fall unless the soil temperature is 50° F and cooling at the four-inch soil depth. This will slow the mineralization and nitrification processes and is an especially important consideration for manure containing a large portion of N as ammonium.

Broadcasting manure onto frozen, snow-covered, water-saturated soils increases the potential for nutrient losses with rainfall or snowmelt runoff to surface water systems. If manure must be applied in these conditions, it should be applied on relatively flat land, slopes less than 5 percent, and well away from streams and waterways (see Iowa Department of Natural Resources rules on setback distances).

Example Calculation of Manure Application Rates

Note: *The N, P, and K fertilization requirements in these examples are determined from appropriate extension publications and Web-based tools listed at the right.*

Example 1

- Manure source: liquid swine manure, finishing under-building pit.
- Manure analysis: 40 lb N/1,000 gal, 25 lb P_2O_5/1,000 gal, 35 lb K_2O/1,000 gal.
- Intended crop: corn in a corn-soybean rotation.
- Soil tests: 19 ppm Bray P-1 (Optimum), 165 ppm Ammonium Acetate K (Optimum).
- Crop yield and P and K removal for determining nutrient rates needed to maintain the Optimum soil test category: 200 bu/acre corn yield; 75 lb P_2O_5/acre and 60 lb K_2O removal.
- Manure rate: based on corn N fertilization requirement at 125 lb N/acre.
- Manure application: injected late fall.
- Manure nutrient availability: 100 percent for N, P, and K.
- Manure N volatilization correction factor: 0.98.
- Manure rate: 125 lb N/acre ÷ (40 lb N/1,000 gal × 0.98) = 3,200 gal/acre.
- Manure available P and K nutrients applied: 3,200 gal/acre × (25 lb P_2O_5/1,000 gal × 1.00) = 80 lb P_2O_5/acre; and 3,200 gal/acre × (35 lb K_2O/1,000 gal × 1.00) = 112 lb K_2O/acre.
- Phosphorus and K applied with the manure are adequate for P (slightly more than expected corn removal) and will supply more than needed K. The extra P and K can be used by the next crop and should be accounted for. However, additional P and K will need to be applied for the following soybean crop.

Example 2

- Manure source: solid layer manure.
- Manure analysis: 72 lb N/ton, 69 lb P_2O_5/ton, 54 lb K_2O/ton.
- Intended crop: corn-soybean rotation.
- Soil tests: 18 ppm Bray P-1 (Optimum), 120 ppm Ammonium Acetate K (Low).
- Manure rate: based on P requirement for the crop rotation at 120 lb P_2O_5/acre.
- Manure application: late fall, incorporated after four days.
- Manure nutrient availability: 55 percent for N, 100 percent for P and K.
- Manure N volatilization correction factor: 0.80.
- Manure rate: 120 lb P_2O_5/acre ÷ (69 lb P_2O_5/ton × 1.00) = 1.7 ton/acre.
- Manure available N and K nutrients applied: 1.7 ton/acre × (72 lb N/ton × 0.60 × 0.80) = 60 lb N/acre; and 1.7 ton/acre × (54 lb K_2O/ton × 1.00) = 92 lb K_2O/acre.
- Corn N fertilization need and K needed for the corn and soybean crops with a Low soil test category: 130 lb N/acre and 172 lb K_2O/acre.
- Crop available N and K applied with manure is not adequate for N, need additional 70 lb fertilizer N/acre (130 lb N/acre – 60 lb N/acre); and applied K is not adequate for the corn and soybean crops, need additional 80 lb K_2O/acre (172 – 92 lb K_2O/acre) from fertilizer.

Additional Resources

PM 1688 *A General Guide for Crop Nutrient and Limestone Recommendations in Iowa*

PM 287 *Take a Good Sample to Help Make Good Decisions*

PM 2015 *Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn*

PM 1714 *Nitrogen Fertilizer Recommendations for Corn in Iowa*

PM 2026 *Sensing Nitrogen Stress in Corn*

PM 1584 *Cornstalk Testing to Evaluate Nitrogen Management*

PM 1588 *How to Sample Manure for Nutrient Analysis*

A3769 *Recommended Methods of Manure Analysis* (University of Wisconsin)

MWPS-18-S1 *Manure Characteristics: Section 1* (Midwest Plan Service)

MWPS-18 *Livestock Waste Facilities Handbook, Third Edition* (Midwest Plan Service)

Corn Nitrogen Rate Calculator, **http://extension.agron.iastate.edu/soilfertility/nrate.aspx**

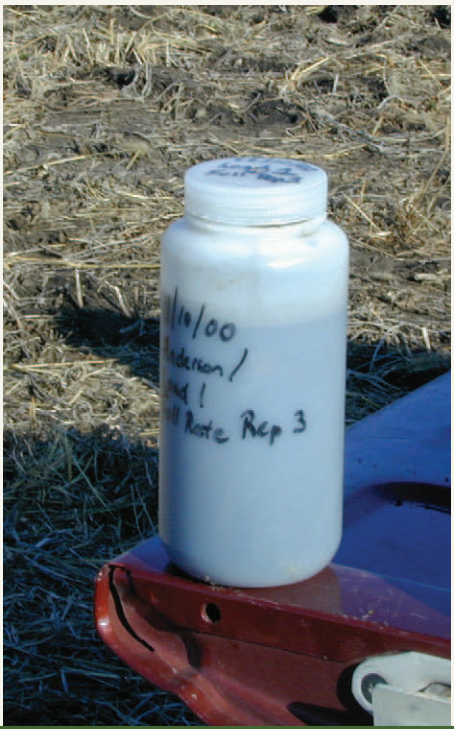
Using Manure Nutrients for Crop Production

Summary

- Carefully manage the nutrients in animal manure as you would manage fertilizer.
- Have representative manure samples analyzed to determine nutrient concentration. At a minimum, samples should be analyzed for moisture (dry matter) and total N, P, and K. For additional information on N composition, samples can be analyzed for ammonium. Maintain a manure analysis history for production facilities.
- Set the manure application rate according to crop fertilization requirements and for the crop availability of manure N, P, and K.
- Adjust manure rates for estimated N volatilization.
- For manure application rates, consider the crop N, P, and K fertilization requirements and field P-Index ratings, but do not exceed the crop N fertilization need.
- Consider the nutrient needs of crop rotations rather than just individual crops, which is especially important for P and K management.
- Allocate manure to fields based on soil tests and crops to be grown.
- Fall applications of manure should not be made until the soil temperature is 50° F and cooling, especially for manure sources that have a large portion of N as ammonium.
- Do not apply manure to snow-covered, frozen, or water-saturated sloping ground to reduce risk of nutrient loss and water quality impairment.

Prepared by John E. Sawyer and Antonio P. Mallarino, professors of agronomy and extension soil fertility specialists, Iowa State University.

Expert Reviewed This publication was peer-reviewed by three independent reviewers using a double-blind process.



How to Sample Manure for Nutrient Analysis

A field-by-field nutrient management program requires multiple components to maintain adequate fertility for crop growth and development. A well-designed soil sampling plan, including proper soil test interpretations along with manure sampling, manure nutrient analysis, equipment calibration, appropriate application rates and application methods are all necessary components of a nutrient management plan. Implementing these components allows manure to be recognized and used as a credible nutrient resource, potentially reducing input costs and the potential of environmental impacts.

Animal manure has long been used as a source of nutrients for crop growth. Standard nutrient values are guides to determine the amount of nutrients that animal manure will supply as a fertilizer source. Iowa State University Extension publication, *Managing Manure Nutrients for Crop Production* (PM 1811), recommends manure nutrient content and credits by type of animal, handling system and application methods.

While "book values" like those in PM-1811 are reasonable average values, an individual farm's manure analyses can vary from those averages by 50 percent or more. Species, age of animal, feed rations, water use, bedding type, management, and other factors make every farm's manure different. Two key factors affecting the nutrient content of manure are manure handling and type of storage structures used. Each handling system results in different types of nutrient losses—some unavoidable and others that can be controlled to a certain degree. Because every livestock production and manure management system is unique, the best way to assess manure nutrients is by sampling and analyzing the manure at a laboratory.

This publication describes how to sample solid, semi-solid, and liquid manure. Manure with greater than 20 percent solids (by weight) is classified as dry manure and is handled as a solid, usually with box-type spreaders. Manure with 10 to 20 percent solids is classified as semi-solid manure and can usually be handled as a liquid. Semi-solid manure usually requires the use of chopper pumps to provide thorough agitation before pumping. Manure with less than 10 percent solids is classified as liquid manure and is handled with pumps, pipes, tank wagons, and irrigation equipment.

A representative manure sample is needed to provide an accurate reflection of the nutrient content. Unfortunately, manure nutrient content is not uniform within storage structures, so obtaining a representative sample can be challenging. Mixing and sampling strategies should therefore insure that samples simulate as closely as possible the type of manure that will be applied.

When to Sample Manure

Sampling manure prior to application will ensure that you receive the analysis in time to adjust nutrient application rates based on the nutrient concentration of the manure. However, sampling manure prior to application may not completely reflect the nutrient concentration of the manure due to storage and handling losses if long periods of time pass before application begins or when liquid storage facilities are not adequately agitated while sampling. "Pre-sampling" such as dipping samples off the top of storage structure for nitrogen (N) and potassium (K) concentrations, can be done to estimate application rates. (See page 3 for more on pre-sampling). Producers must remember to go back and determine the actual nutrient rates applied by using manure samples collected during application and calculating volumes.

For best results, manure should be sampled at the time of application or as close as possible to application. Sampling during application will help to ensure that samples are well-mixed and representative of the manure being applied. Because manure nutrient analysis typically takes several days at a lab, sampling at the time of application will not provide immediate manure nutrient recommendations. The results can, however, be used for subsequent manure applications and to adjust commercial fertilizer application. This is why it is important to develop a manure sampling history and use those analyses in a nutrient management plan. A manure sampling history will also help you recognize if unplanned changes have occurred to your system if management and other factors have remained constant. A manure sampling history will give you confidence in using manure, and show you how consistent nutrient concentration is from year to year.

Take manure samples annually for three years for new facilities, followed with samples every three to five years, unless animal management practices, feed rations, or manure handling and storage methods change drastically from present methods. If you apply manure several times a

IOWA STATE UNIVERSITY
University Extension

PM 1558 Revised November 2003

year, take samples when you plan to apply the bulk of manure. For example, it may be appropriate to sample in the spring when manure that has accumulated all winter will be applied. If storages are emptied twice a year, it may be necessary to sample in both spring and fall since the different storage temperatures in summer versus winter will affect manure nutrient levels. *NOTE: Implementation of future federal regulations may require concentrated animal feeding operations (> 1,000 animal units) to sample annually. Please check state and federal requirements to determine sampling frequency.*

How to Sample Semi-Solid or Liquid Manure

In liquid and semi-solid systems, settled solids can contain over 90 percent of the phosphorus (P), so complete agitation is needed to accurately sample the entire storage if all the manure in the storage structure is going to be applied. If, however, solids will purposely be left on the bottom of the storage structure when the manure is pumped out, as is sometimes the case with lagoons, then complete agitation during sampling may generate artificially high nutrient values. In this case agitation of the solids or sludge on the bottom of a lagoon is not needed for nutrient analysis.

Liquid manure is best sampled during land application, for it is potentially more difficult and dangerous to sample from liquid storage facilities than dry manure systems. When sampling manure during application is not possible, or pre-application analysis is desired for determining rates, refer to the section on sampling from a storage facility. If sampling from a liquid storage facility, use caution to prevent accidents, such as falling into the manure storage facility or being overcome with hazardous gases produced by manure. Have two people present at all times. Never enter confined manure storage spaces without appropriate safety gear such as a self-contained breathing apparatus.

Ideally, liquid manure should be agitated so a representative sample can be obtained for laboratory analysis. When agitating a storage pit below a building, be sure to provide adequate ventilation for both animals and humans. When agitating outdoor unformed pits, monitor activities closely to prevent erosion of berms or destruction of pit liners.

Liquid Manure Sample Preparation

All liquid samples should be handled as follows:

- Prior to sampling label a plastic bottle with your name, date and sample identification number using a waterproof pen.
- If the sample cannot be mailed or transported to a laboratory within a few hours, it should be frozen. Place the container in a tightly sealed plastic bag and keep it cold or frozen until it arrives at the laboratory.
- Most manure analysis laboratories do have plastic bottles available for sample collection. Do not use glass containers, as expansion of the gases in the sample can cause the container to break.

Liquid Manure Sampling During Land Application

Liquid Manure Applied with Tank Wagons

- Since settling begins as soon as agitation stops, samples should be collected as soon as possible after the manure tank wagon is filled unless the tanker has an agitator.
- Immediately after filling the tank wagon, use a clean plastic pail to collect manure from the loading or unloading port or the opening near the bottom of the tank. Be sure the port or opening does not have a solids accumulation from prior loads.
- Use a ladle to stir the sample in the bucket to get the solids spinning in suspension. While the liquid is spinning remove a ladle full and carefully pour in the sample bottle. See Figure 1.
- Repeat this procedure and take another sample until the sample bottle is three-quarters full (Make sure the manure solids have not settled to the bottom of the bucket as each ladle is extracted; it is important to include the solids in the sample). Screw the lid on tightly.

Figure 1. Collecting a liquid manure sample.

Liquid Manure Applied by Irrigation Systems

- Place catch pans or buckets randomly in the field to collect liquid manure that is applied by an irrigation system. Inexpensive aluminum roasting pans or plastic buckets can be used as catch pans. Use several pans at different distances from the sprinkler head.
- Immediately after the manure has been applied, collect manure from catch pans or buckets and combine the manure in one bucket to make one composite sample.
- Use a ladle to stir the sample in the bucket. While the liquid is spinning remove a ladle full and carefully pour into a sample bottle. See Figure 1.
- Repeat this procedure and take another sample until the sample bottle is three-quarters full. Screw the lid on tightly.

Liquid Manure Sampling from Storage Facilities

For best sampling results, samples should be taken with a sampling probe or tube (see Figure 2). Probes can be constructed out of 1.5-inch diameter PVC pipe. Cut the PVC pipe a foot longer than the depth of the pit. Run a 1/4 -inch rod or string through the length of the pipe and attach a plug such as a rubber stopper or rubber ball (see Figure 3). The rod or the string must be longer than the pipe. If using a rod, bend the top over to prevent it from falling out of the pipe.

- Insert the pipe slowly into the pit or lagoon, with the stopper open, to the full depth of the pit.

Figure 2. Sampling earthen basin with sampling probe.

- Pull the string or rod to close the bottom of the pipe and extract the vertical profile sample inside the pipe (be careful not to tip the pipe and dump the sample).
- Release the sample carefully into a bucket.
- Repeat the process at least three times around the pit or lagoon creating a composite sample in the bucket.
- Use a ladle to stir the sample in the bucket to get the solids spinning in suspension. While the liquid is spinning,

take a ladle full and carefully pour into a sample bottle.
- Repeat again and take another sample until sample bottle is three-quarters full. Make sure the manure solids have not settled to the bottom of the bucket as each dipper is extracted; it is important to include the solids in the sample. Screw the lid on tightly.

Figure 3. Rubber stopper attached to a metal rod to serve as a stopper for PVC manure sampling tube.

Pre-Sampling Nitrogen and Potassium from Liquid Manure

If the procedures described above for sampling liquid manure are impractical due to lack of sampling equipment, or the inability to agitate the manure, manure samples can be dipped off the top of stored liquid manure to analyze for N and K concentrations. Research has shown that top-dipped liquid samples represent approximately 90 percent of the N concentration measured in mixed, field-collected samples. Multiply the results of the N concentration from top-dipped samples by 1.1 for a better estimate of the N concentration of the liquid storage facility. Dipping a sample from the surface of a liquid storage pit does NOT provide a good estimate of P concentration in the pit and is not recommended.

How to Sample Dry or Solid Manure

In solid manure handling systems, many of which include bedding, the proportions of fecal matter, urine, and bedding will vary from one location to another within sites, and often from season to season as well. It is necessary to take samples from various places in the manure pile, stack, or litter to obtain a representative sample for analysis. It may even be beneficial to sample several times per year based on the bedding content.

Manure sampling is best done in the field as manure is applied. This ensures that losses that occur during handling, storage, and application are taken into account and that manure is better mixed, reducing stratification found during sampling storage facilities. As with field sampling of liquid manure, results will not be available in time to adjust current application rates. However, sampling during application will still allow producers to adjust any planned future commercial fertilizer rates and manure application in subsequent years. The following method describes a procedure for collecting dry or solid manure samples from the field.

Dry Manure Sampling During Land Application

Collect manure samples according to the following field sampling procedure.
- Spread a sheet of plastic or tarp on the field. A 10-feet-by-10-feet sheet works well for sampling manure.
- Fill the spreader with a load of manure.
- Drive the tractor and manure spreader over the top of the plastic to spread manure over the sheet.
- Collect subsamples as described below (Steps 1-3, Composite Sample Collection).
- Samples should be collected to represent the first, middle and last part of the storage facility or loads applied and should be correlated as to which loads are applied on certain fields to track changes in nutrient concentrations throughout the storage facility.

Sampling from Dry or Solid Storage Facilities and Open Lots

Manure should be sampled at the time of application, but if time and management practices prevent this, manure samples can be collected from the storage facility. Sampling from storages is not generally recommended due to difficulty in collecting a representative sample. Although solid manure storages are generally not fully enclosed and gases are somewhat diluted, always exercise caution when sampling from storage facilities. If you have to enter a confined storage facility, follow the safety recommendations described previously in the section on sampling liquid manure storages.

Open Paved Lots

Manure that accumulates on paved feedlots and is scraped and hauled to the field is classified as scrape-and-haul feedlot manure. Manure is usually removed from the feedlot daily or several times a week.
- Collect manure by scraping a shovel across approximately 25 feet of the paved feedlot. This process should be repeated ten or more times, taking care to sample in a direction that slices through the large-scale variations of moisture, bedding, depth, age, etc. (See Figure 4). Avoid manure that is excessively wet (near waterers) or contains unusual amounts of feed and hay.
- Use the shovel to thoroughly mix manure by continuously scooping the outside of the pile to the center of the pile.
- Collect subsamples from this pile using the hand-in-bag method that is described below (Steps 1-3 Composite Sample Collection).
- This may need to be done several times to collect several composite samples for analysis.

Figure 4. Sampling a feed-lot for manure sample.

Barn Gutter

Manure that accumulates in a barn or housing facility, is temporarily stored in a gutter, and then removed by a barn cleaner is classified as barn gutter manure. Manure is usually removed from the barn once or twice daily.
- Shovel a vertical “slice” of manure from the gutter, making sure the shovel reaches to the bottom of the gutter.
- Remove manure from the gutter and pile it on the barn floor. Mix the manure with a shovel or pitchfork to ensure that bedding is mixed thoroughly with manure. When collecting samples from a gutter, be sure to include the liquid that accumulates in the gutter’s bottom. Discard foreign material and also take care not to add large amounts of barn lime.
- Repeat steps one and two from various locations along the gutter.
- Mix each pile thoroughly and collect subsamples from each pile using the hand-and-bag method that is described below (Steps 1-3, Composite Sample Collection).

Dry Stack and Manure with Litter

Manure that is stored outside in a solid waste storage facility, such as a stacking shed or horizontal concrete silo located above ground, is classified as a dry stack. These facilities are usually covered to prevent the addition of extra water. Dry

manure with litter should also be sampled in the following manner.

- Remove manure from 10 to 20 locations throughout the dry stack and place it in a pile using a pitchfork or shovel. Manure should be collected from the center of the stack as well as from near the outside walls, to get samples that represent all ages and moisture levels of manure in the stack. A bucket loader can cut a path into the center of the pile to provide access for sampling. Subsamples should be collected to the depth the litter will be removed for application.
- Thoroughly mix manure with the shovel by continuously scooping the outside of the pile to the center of the pile.
- Collect a composite manure sample as described below (Steps 1-3, Composite Sample Collection).

Composite Sample Collection for Dry or Solid Samples

1. Whether collecting from a plastic tarp in the field, a feedlot, a storage facility, or a barn, sample in a grid pattern so that all areas are represented. Combine 10 to 20 subsamples in a bucket or pile and mix thoroughly. More subsamples will produce more accurate results and are often required to produce a composite that best represents nutrient levels.
2. The final composite sample that will be submitted for nutrient analysis should be collected using the hand-in-bag method. To collect a composite sample from the mixed subsamples, place a one-gallon resealable freezer bag turned inside out over one hand. With the covered hand, grab a representative handful of manure and turn the freezer bag right side out over the sample with the free hand. Be careful not to get manure in the sealable tracks.
3. Squeeze excess air out of the bag, seal, and place it in another plastic bag to prevent leaks. Label the bag with your name, date, and sample identification number with a waterproof pen and freeze it immediately to prevent nutrient losses and minimize odors. For manure with a high degree of variability, multiple samples may need to be analyzed. Manure samples should be mailed or delivered to the laboratory as soon as possible after sampling.

Manure samples should be sent to a lab for chemical analysis as quickly as possible to avoid nutrient losses. For a list of commercial laboratories, please call your ISU Extension office or visit the Web at: http://extension.agron.iastate.edu/immag/sp.html.

Table 1. Conversion Factors

To switch from	Multiply by	To get
mg/l	1.0	ppm
ppm	0.0001	percent
ppm	0.00834	lb/1,000 gal
ppm	0.002	lb/ton
ppm	0.2265	lb/acre-inch
lb/1,000 gal	0.012	percent
lb/ton	0.05	percent
percent	83.4	lb/1,000 gal
percent	20.0	lb/ton
percent	2265	lb/acre-inch
P (elemental)	2.29	P_2O_5
K (elemental)	1.2	K_2O

Additional Information and Resources

Basic manure analyses determined by laboratories include total nitrogen, total phosphorus, and total potassium. Results from commercial laboratories are presented either as a percent of the sample weight, as pounds per ton, as pounds per 1,000 gallons of manure, or in parts per million (ppm). Table 1 shows factors used to convert between measurements. Usually, nutrients are expressed as N, P_2O_5, or K_2O on a wet or "as received" basis, but some labs may instead report data on an elemental (P instead of P_2O_5, K instead of K_2O) or dry (without water) basis; so, be sure to confirm the units. In any case, manure values from commercial laboratories express nutrients as the total amount of nutrient in the manure sample. Some primary nutrients, such as N and P, may not be completely available for plant growth the first year manure is applied. A portion of some nutrients present in manure are in an organic form and unavailable for immediate plant uptake. Organic forms require transformation to an inorganic form to be available for plant uptake. This transformation is dependent on temperature, moisture, chemical environment, and time. Availability of nutrients can be limited by field losses, which are affected by the type of manure and by manure application methods. These losses are not accounted for in laboratory results. Refer to the ISU Extension publication *Managing Manure Nutrients for Crop Production* (PM 1811) for nutrient availability estimates and losses due to types of manure application methods.

PM 1518k *Manure Storage Poses Invisible Risks*
PM 1941 *Calibration and Uniformity of Solid Manure Spreaders* (12/03)
PM 1948 *Calibrating Liquid Manure Applicators* (02/04)
PM 1811 *Managing Manure Nutrients for Crop Production*

Additional resources may be found on the Iowa Manure Management Action Group (IMMAG) Web page at: http://extension.agron.iastate.edu/immag/default.htm

Prepared by Angela Rieck-Hinz, extension program specialist, Dept. of Agronomy; Jeffery Lorimor, associate professor, and Tom L. Richard, associate professor, Dept. of Agricultural and Biosystems Engineering and Kris Kohl, ISU field specialist- Agricultural Engineering.

Photos submitted by John Sawyer, Kris Kohl, Joel DeJong, Jeff Lorimor and Charles Wittman

Reviewed by: John Sawyer, ISU; Chris Murray, Iowa Natural Resources Conservation Service and Marty Schwager, Iowa Pork Producers Association.

File: Agronomy 7-4

Appendix C. Historic Properties Requirements

Coverage under this permit is available only if your CAFO discharges and discharge- related activities meet one of the eligibility criteria below:

Criterion A. Your CAFO discharges do not have the potential to have an effect on historic properties and you are not constructing or installing new control measures on your site that cause subsurface disturbance.

Criterion B. Your discharge-related activities (i.e., construction and/or installation of control measures that involve subsurface disturbance) will not affect historic properties.

Criterion C. Your CAFO discharges and discharge-related activities have the potential to have an effect on historic properties; you have consulted with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer (THPO), or other tribal representative regarding measures to mitigate or prevent any adverse effects on historic properties; and, you have either (1) obtained and are in compliance with a written agreement that outlines all such measures, or (2) been unable to reach agreement on such measures.

Criterion D. You have contacted the SHPO, THPO, or other tribal representative and EPA in writing informing them that you have the potential to have an effect on historic properties and you did not receive a response from the SHPO, THPO, or tribal representative within 30 days of receiving your letter.

If you have been unable to reach agreement with a SHPO, THPO, or other tribal representative regarding appropriate measures to mitigate or prevent adverse effects, the permitting authority may notify you of additional measures you must implement to be eligible for coverage under this permit.

CAFO operators must determine whether their permit-related activities have potential to affect a property that is either listed or eligible for listing on the National Register of Historic Places. CAFO operators must contact the SHPO, THPO, and/or any Indian tribe that attaches religious and cultural significance to historic properties that may be affected. In instances where a Tribe does not have a THPO, CAFO operators should contact the appropriate Tribal government office.

Appendix D. Notice of Termination

(Insert Notice of Termination (NOT) Form or Appropriate State Form)