Manure Management Plan

A Step-by-Step Guide for Minnesota Feedlot Operators

Revised February 2010

Name of farming operation _____

MPCA registration number _____

Minnesota Pollution Control Agency

University of Minnesota Extension Service

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Comments Welcome, More Information Available

Written by Jim Courneya, Minnesota Pollution Control Agency, with special thanks to the University of Minnesota Extension Service and Kevin Blanchet who developed many of the forms used in developing this Manure Management Plan.

The MPCA welcomes your comments or suggestions for improving future editions of this handbook. Please send them to feedlot staff at your regional office.

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More information about MPCA feedlot programs and regulations, as well as an electronic version of this handbook and forms which can be printed out on a home computer, are available on the Web:

- http://www.pca.state.mn.us/hot/feedlot-management.html

- http://www.pca.state.mn.us/hot/feedlot-publications.html

Introduction to Developing a Manure Management Plan

Manure should not be considered a waste product requiring disposal. Rather, it should be stored, handled and applied with the same care given to expensive commercial fertilizers. Applied properly, manure can yield considerable savings in fertilizer costs. If over-applied, nutrients will be wasted and water resources can be negatively impacted.

Minnesota Pollution Control Agency (MPCA) feedlot regulations require many farms to develop and follow a **manure management plan** (sometimes called a **nutrient management plan***)*. A manure management plan can help all feedlots comply with application requirements near waters, and is required when applying for a permit for construction or expansion. Most feedlots with 300 animal units or more are required to have a completed manure management plan by Jan. 1, 2006.

Can't get to a workshop? This guide provides "home schooling"

There are numerous consultants available to write manure management plans for producers and computer programs are available from the University of Minnesota and MPCA. In addition, the University offers workshops designed to allow producers to write at least a portion of a manure management plan in a classroom setting.

This guide was developed using the forms and procedures taught in University of Minnesota workshops and is designed to allow those unable to attend a workshop to develop and follow a Manure Management Plan at home by answering these four main questions:

Step 1. How much manure is produced on the farm?
Step 2. How many nutrients are contained in the manure?
Step 3. How many nutrients are needed for a growing crop and how much should be applied?
Step 4. How should manure be managed in sensitive areas and high phosphorous soils?

Some sections need to be updated annually, such as the ***Field Nutrient Management Plan***. For more information on manure management plan components, a checklist is available at: http://www.pca.state.mn.us/hot/feedlot-management.html

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Step 1. How much manure is produced on the farm?
(Completing the ***Master Worksheet - Manure Storage, Handling and Testing***)

Begin by filling out the ***Master Worksheet - Manure Storage, Handling and Testing*** worksheet. This will become the main worksheet for the plan.

Notice that the vertical columns on this worksheet are labeled "Manure Source #1" and "Manure Source #2." When calculating manure and nutrient production on the farm, each barn or open lot should be treated as a separate manure source, unless feeding and management for each lot is essentially the same. If more than two barns or lots are in use, an additional copy of this worksheet is included at the end of the booklet. This may also be photocopied along with any of the other forms or tables in this booklet.

Master Worksheet – Manure Storage, Handling and Testing

Producer name/operator **Date**

	Manure Source #1	Manure Source #2	*Example Dairy Barn*
I. Livestock Information			
Animal (#1) type			*Dairy cows*
Animal (#1) number, size			*50 @ 1400 lbs.*
Animal (#2) type			*Dairy heifers*
Animal (#2) number, size			*7 @ 800 lbs.*
II. Manure Storage			
Storage type			*Above ground tank*
Storage capacity (tons, gals.)			*5000,000 gallons*
Storage (days, months)			*7 months*
III. Application Methods			
Commercial hauler			*No*
Spreader type[1]			*Slurry tanker*

I. Livestock Information

Indicate the animal type, number and size. Size is defined as the average weight of the animal during the time it is in the building. For example, the size of a hog that increases from 40 pounds to 300 pounds while in the building would be the initial weight plus the final weight divided by two (300+40 = 340/2) or **170 pounds**. The far right column shows examples of how to enter the information.

II. Manure Storage

a. Storage type - Indicate the type of storage for each building or lot. Some common examples include: above ground tank, under-floor pit, earthen basin, poured concrete pit, manure pack or stockpile.

b. Storage capacity - Indicate the storage capacity in tons (for dry manure) or gallons (for liquid).

1. Capacity in gallons for rectangular liquid basins can be determined by multiplying **Length** (in feet) x **Width** (in feet) x **Depth** (in feet) x **7.48 gal/ft^3** (gallons per cubic foot).

2. Capacity in gallons for round or cylinder shaped tanks or basins can be determined by multiplying the **Diameter** (in feet) x **Diameter** (in feet) x **Height** or **Depth** (in feet) x **0.785** x **7.48 gal/ft^3**.

c. Storage time - Indicate the average length of time manure is stored in each location prior to field application.

Completing the* "Master Worksheet – Manure Storage, Handling and Testing"** ***form continued on page 6

Master Worksheet – Manure Storage, Handling and Testing

Producer name/operator _____ **Date** _____

	Manure Source #1	Manure Source #2	*Example* ***Dairy Barn***
I. Livestock Information			
Animal (#1) type			*Dairy cows*
Animal (#1) number, size			*50 @ 1400 lbs.*
Animal (#2) type			*Dairy heifers*
Animal (#2) number, size			*7 @ 800 lbs.*
II. Manure Storage			
Storage type			*Above ground tank*
Storage capacity (tons, gal)			*5000,000 gallons*
Storage (days, months)			*7 months*
III. Application Methods			
Commercial hauler			*No*
Spreader type[1]			*Slurry tanker*
Spreader calibrated (date)			*Yes, 11/03/2001*
When applied[2]			*Fall and spring*
Application method[3]			*Knife inject*
Incorporation timing[4]			*Immediate*
IV. Manure Analysis			
Sampling frequency			*Annually*
Sampling methods			*Spreader during filling*
Date analyzed			*11/03/2001*
N (lbs./ton or 1000 gal)			*24 lbs./1000 gal*
P_2O_5 (lbs. per ton, 1000 gal)			*18 lbs./1000 gal*
K_2O (lbs./ton or 1000 gal)			*29 lbs./1000 gal*
V. Annual Manure/Nutrients Generated			
Manure volume or tons per year			*450,000 gallons*
Manure volume/tons based on records			*Yes*
Annual amount N (lbs.)[5]			*24 x 450=10,800 lbs.*
Annual amount P_2O_5 (lbs.)[5]			*18 x 450 = 8,100 lbs.*
Annual amount K_2O (lbs.)[5]			*29 x 450 = 13,050 lbs.*

1. "Spreader types" are: Slurry tanker, Solids spreader, Towed hose, Center pivot, Other sprinkler
2. "When applied" choices: Daily, Every other day, Weekly, Every 2 weeks, Monthly, Fall, Winter, Spring, Summer
3. "Application method" choices: Surface broadcast, Sweep inject, Knife inject
4. "Incorporation time" choices: Immediate, less than 12 hours, 12-96 hours, greater than 96 hours
5. Annual nitrogen from manure (in lbs) to be land applied after accounting for storage losses.

An additional copy of this worksheet is located on page 28.

III. Application Method

a. Commercial Hauler - Indicate whether or not you hire a commercial hauler or applicator.

b. Spreader Type - Refer to footnote #1 at the bottom of the worksheet to indicate the type of spreader used.

c. Spreader Calibrated - Enter the date the spreader was last calibrated. Spreaders should be calibrated to accurately determine the application rate. Refer to the Minnesota Extension bulletin "**Calibrating Manure Spreaders"** found at http://www.manure.umn.edu/applied/calibration_of_manure_spreaders/index.html or contact your NRCS office for assistance in calibrating your spreader.

d. When Applied – Refer to footnote #2 at the bottom of the worksheet and indicate the time period or interval that best describes your practices.

e. Application Method – Refer to footnote #3 at the bottom of the worksheet and enter your application method.

f. Incorporation Timing – Refer to footnote #4 at the bottom of the worksheet. For any type of injection, enter "immediate" on this line.

Step 2.
How many nutrients are contained in the manure?

The second step in creating a good manure management plan is determining the nutrient content of each source of manure, as well as the total amount of nutrients produced on the farm. Continue with the ***Master Worksheet – Manure Storage, Handling and Testing.***

IV. Manure Analysis

a. Sampling frequency
b. Sampling methods
c. Date Analyzed

Ideally, manure from each source should be sampled and analyzed each year for three consecutive years to develop an average nutrient analysis for each source. After the initial three years of sampling, each source should be sampled at least once every four years or whenever feeding or management changes significantly. This allows you to maintain a "rolling" average analysis and helps to fine tune manure nutrient application. If you have manure nutrient sample results, they should be entered here. Sampling **must** be done for manure sources from 100 animal units or more**.**

If you do not have manure sample results, refer to **Table A3** ***Estimated nutrient content of liquid and solid manure*** on page 26 until an actual manure test result is available**.** Find the **animal type** for each manure source on your farm and fill in the N, P_2O_5 and K_2O on the worksheet. Be sure to use the numbers under the appropriate heading "Liquid" or "Solid."

V. Animal Manure/Nutrients Generated

Determine the annual amount of manure produced and the annual amount of nutrients produced from each manure source. There are two methods of finding the amount of manure produced on the farm:

1. Past farm records of the annual amount of manure that was hauled from each manure source. **Or**,
2. Animal manure excretion estimates using the *Manure and Nutrient Generation Worksheet* on page 9.

If you have records for the amount of manure in thousand gallon units or tons, multiply this number by the manure analysis in pounds of nutrient per 1000 gallons or tons from Section IV. See example.

Example – In the far right column of the worksheet on Page 5, 450,000 gallons are produced annually and the analysis for nitrogen was 24 lbs. per thousand gallons (from Section IV) so:
450 (thousand gallons) x 24 (pounds N per 1000 gal.)=10,800 lbs. of N produced annually
Repeat this procedure for P_2O_5 (phosphate) and K_2O (potash)

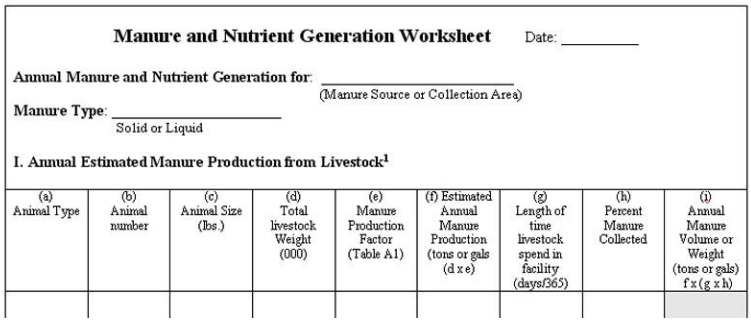
NOTE: If you do not have records or do not know the amount of manure produced on the farm, you must fill out the *Manure and Nutrient Generation Worksheet* that follows before you can complete Section V.

Instructions for completing the *Manure and Nutrient Generation Worksheet*

(Complete if you do not have records or know the amount of manure produced on the farm. Enter results in Section V of Master Worksheet.)

Instructions for Top Half

The top half of this worksheet is devoted to determining the amount of manure produced annually. **Use a new worksheet for each manure source**. The bottom half of this worksheet will determine the quantity of nutrient produced annually after storage losses.



Manure and Nutrient Generation Worksheet Date: _____

Annual Manure and Nutrient Generation for: _____
(Manure Source or Collection Area)

Manure Type: _____
Solid or Liquid

I. Annual Estimated Manure Production from Livestock[1]

(a) Animal Type	(b) Animal number	(c) Animal Size (lbs.)	(d) Total livestock Weight (000)	(e) Manure Production Factor (Table A1)	(f) Estimated Annual Manure Production (tons or gals (d x e)	(g) Length of time livestock spend in facility (days/365)	(h) Percent Manure Collected	(i) Annual Manure Volume or Weight (tons or gals) f x (g x h)

At the top of the page, indicate the source or collection area such as "barn pit # 1", "earthen basin", or "north lot" etc. Indicate whether manure is liquid or solid. Then proceed to the top of table titled: **"I. Annual Estimated Manure Production from Livestock."**

(a) Enter the animal type. This should be the same as the animal type you entered
   a. in Section I of the Master Worksheet.

(b) Enter the number of animals. Again, this should be the same number entered on the master worksheet.

(c) Enter the average weight of the animals over the entire time they are housed in this barn or lot. For example: The average weight of "growing and finishing" swine during the entire time they are on the farm might be 165 lbs. This number should be the same as the number entered in Section I of the Master worksheet.

(d) Multiply (b) x (c) or (animal number x animal size) then divide the result by 1,000. Enter this final result in column (d)**.**

(e) Find **Table A1** on page 26 of this booklet. Find the "Animal Type" and look under the first two columns "Manure Production" to find the correct "Manure Production Factor". For example: Grow-Finish swine with liquid manure shows a Manure Production Factor of 2166. Find the correct factor for your animal type and manure type and enter it in column (e) of the worksheet.

(f) Multiply (d) x (e) or (Total livestock weight x Manure Production Factor) and enter the result in column (f).

(g) Determine the number of days the animals are in the lot or barn and divide that number by 365. For example: if the animals are in the facility for 180 days, then 180 / 365 = 0.493. Enter your result in column (g).

(h) Enter the percent of manure (expressed as a decimal) produced by these animals that is collected. In total confinement housing, this number will generally be 1.0. For example, 75% would be expressed as 0.75.

(i) Multiply (g) x (h) and then multiply the result x (f)**.** Enter the result in column (i).

Manure and Nutrient Generation Worksheet

Date: _____

Annual Manure and Nutrient Generation for: _____
Manure Source or Collection Area

Manure Type: _____
Solid or Liquid

I. Annual Estimated Manure Production from Livestock[1]

(a) Animal Type	(b) Animal Number	(c) Animal Size (lbs.)	(d) Total livestock Weight (000) (b x c)/1,000	(e) Manure Production Factor (Table A1)	(f) Estimated Annual Manure Production (tons or gals) (d x e)	(g) Length of time livestock spend in facility (days/365)	(h) Percent Manure Collected (%)	(i) Annual Manure Volume or Weight (tons or gals) f x g x h

Total Estimated Manure Volume or Weight Produced Per Year

1. Annual estimated manure production does not include dilution from bedding or water

II. Annual Estimated Nutrients Excreted by Livestock

(a) Animal Type	(b) Total livestock Weight (000)	Nutrient Production Factors (Table A1)			(f) Nitrogen Availability After Storage (1 - % N loss) (Table A2)	(g) Length of time livestock spend in facility (days/365)	Annual Excreted Nutrients After Storage Losses		
		(c) N	(d) P_2O_5	(e) K_2O			(h) N (lbs) b x c x f x g	(i) P_2O_5 (lbs) b x d x g	(j) K_2O (lbs) b x e x g

	N (lbs)	P_2O_5 (lbs)	K_2O (lbs)
Total Estimated Nutrients Excreted Per Year after Storage Losses			

Manure and Nutrient Generation Worksheet

Date: _____

Annual Manure and Nutrient Generation for: _____
Manure Source or Collection Area

Manure Type: _____
Solid or Liquid

I. Annual Estimated Manure Production from Livestock[1]

(a) Animal Type	(b) Animal Number	(c) Animal Size (lbs.)	(d) Total livestock Weight (000) (b x c)/1,000	(e) Manure Production Factor (Table A1)	(f) Estimated Annual Manure Production (tons or gals) (d x e)	(g) Length of time livestock spend in facility (days/365)	(h) Percent Manure Collected (%)	(i) Annual Manure Volume or Weight (tons or gals) f x g x h

Total Estimated Manure Volume or Weight Produced Per Year

1. Annual estimated manure production does not include dilution from bedding or water

II. Annual Estimated Nutrients Excreted by Livestock

(a) Animal Type	(b) Total livestock Weight (000)	Nutrient Production Factors (Table A1)			(f) Nitrogen Availability From Storage (1 - % N loss) (Table A2)	(g) Length of time livestock spend in facility (days/365)	Annual Excreted Nutrients After Storage Losses		
		(c) N	(d) P_2O_5	(e) K_2O			(h) N (lbs) b x c x f x g	(i) P_2O_5 (lbs) b x d x g	(j) K_2O (lbs) b x e x g

	N (lbs)	P_2O_5 (lbs)	K_2O (lbs)
Total Estimated Nutrients Excreted Per Year after Storage Losses			

Completing the *Manure and Nutrient Generation Worksheet* (Bottom Half)

The bottom half of this form is used to determine the **estimated quantity of nutrients** produced. You cannot simply multiply the estimated amount of manure produced by the analysis of N, P and K because there will be storage losses for N. Storage losses are already accounted for when you sample and test manure before application. If samples have not been tested, you must do the calculations on this page before entering the final numbers on the Master Worksheet. Refer to the bottom half of the worksheet titled ***"II. Annual Estimated Nutrients Excreted by Livestock"***

(a) Enter the animal type exactly as you did in the top half of this worksheet.

(b) Enter the total livestock weight in thousands of pounds. For example, if the total weight is 70,000 pounds, enter "70." The total livestock weight is found by multiplying the "animal number" (b) by "animal size" (c) from the top half of this worksheet.

(c) , (d) and **(e).** Turn to **Table A1** (page 26) and look at the last three columns under the heading "Excreted Nutrients in Manure per 1,000 lbs. of Animal Weight." Find the Nutrient Production Factor for each nutrient (N, P_2O_5 and K_2O) that corresponds to the correct animal type. For example: the factors for a dairy milk cow would be 263, 135 and 146 for N, P_2O_5 and K_2O, respectively. Enter the correct numbers for each animal type on the worksheet.

(f) Return to the tables on page 26 and find **Table A2,** "Nitrogen losses from animal manure as affected by method of storage." Find the manure storage and handling method employed on your farm for each manure source. Be sure to distinguish between "liquid" and "solid." The number on the far right of this table represents the percentage of Nitrogen that is lost during storage. For example, in a "**Daily scrape and Haul**" management system, 25 percent of the nitrogen will be lost before it is applied. If you subtract 25 percent from 1, the remainder will be 0.75. Subtract the storage loss of your storage and handling method from "1" and enter it in column (f) of the worksheet.

(g) If animals are kept in a barn, lot or facility for less than a full year, divide the number of days they are in the facility by 365 and enter this factor in column (g). If animals are in the facility the entire year, enter a "1" in column (g).

(h) Multiply (b) x (c) x (f) (g)= lbs. N.
In our example we had 70 (thousand pounds) x 263 (N production factor for dairy cows) x 0.75 (remaining N in storage system after storage loss) x (g) [time in facility factor] = 13,807 lbs. of N produced by our dairy cows. Do the calculations using your numbers.

(i) And **(j)** For P_2O_5 and K_2O, multiply (b) x (d) x (g) = lbs. of P_2O_5. or (b) x (e) (g) for K_2O **Do Not multiply by the storage loss %.** Storage loss is only used when calculating Nitrogen.

Once you have calculated the "Annual Excreted Nutrients" for each type of animal, add up the numbers and fill them in at the bottom of the worksheet. Now return to the ***Master Worksheet – Manure Storage, Handling and Testing*** and also enter these numbers in the final spaces in Section V, "Annual amounts of N, P_2O_5 and K_2O."

Step 3.
How many nutrients are needed for a growing crop?
(Completing the ***Field Nutrient Management Plan***)

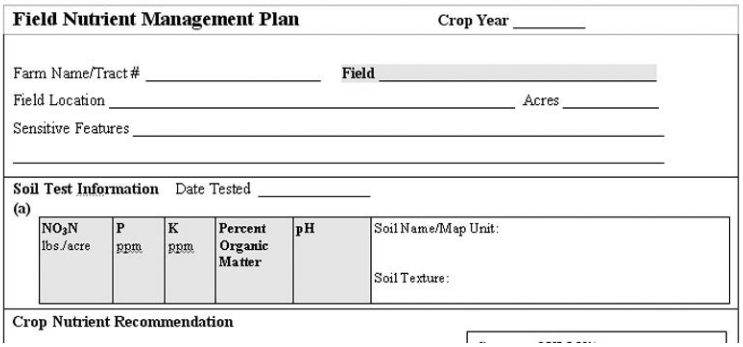
The next step is to start planning manure applications to specific field and crop situations. Before you start the planning process, you will need to gather basic field information such as field size and location, sensitive features, past soil testing, and crop information.

You will need to gather aerial photos and/or field maps for all fields that could receive manure from your livestock operation. On these maps or photos, each field should be identified and outlined. Show any sensitive features (ditches, tiles, lakes, streams, wetlands etc.), for each field and the planned setbacks from those features. Refer to the MPCA publication "Applying Manure in Sensitive Areas" for complete information on how to identify sensitive areas. This publication is available on the Web at: http://www.pca.state.mn.us/publications/feedlots-manureapplication.pdf

The next step is completing a ***Field Nutrient Management Plan*** for **each** field that may receive manure. Two copies of this form are provided on the following pages. Before filling out the form(s), make numerous copies so you will have one for **each** field as well as extras for yearly plan updates.

At the top of the form, fill in the individual field information. Be sure to include any sensitive features.

(a) Fill in the most recent soil test information for this specific field. In order to get the most benefit from manure nutrients, it is vital to perform regular soil testing. If you do not know the Soil Name/Map Unit, you can obtain this from your local SWCD.



Field Nutrient Management Plan Crop Year _____

Farm Name/Tract # _____ **Field** _____

Field Location _____ Acres _____

Sensitive Features _____

_____

Soil Test Information Date Tested _____

(a)

NO_3N lbs./acre	P ppm	K ppm	Percent Organic Matter	pH	Soil Name/Map Unit: Soil Texture:

Crop Nutrient Recommendation

(b) Determine **Crop Nutrient Recommendation** for each field by using the soil test and crop information that was previously gathered. For most crops besides corn, refer to the University of Minnesota publication "Fertilizer Recommendations for Agronomic Crops in Minnesota" which you may have received with this manure management planning booklet. It can also be found, along with corn recommendation publications, at: http://www.extension.umn.edu/Corn/genfertility.html. Fruit and vegetable publication can be found at http://www.extension.umn.edu/Vege&Fruit/. Information is also available at http://www.extension.umn.edu/distribution/cropsystems/DC3553.html.

Completing the* "Field Nutrient Management Plan" *continued on page 15

Field Nutrient Management Plan

Crop Year _____

Farm Name/Tract # _____ **Field** _____

Field Location _____ Acres _____

Sensitive Features _____

_____

Soil Test Information Date Tested _____

(a)

NO_3N lbs/acre	**P** ppm	**K** ppm	**Percent Organic Matter**	**pH**	Soil Name/Map Unit: Soil Texture:

Crop Nutrient Recommendation

Planned Crop _____ Yield Goal _____

Previous Crop _____ Quality/Yield _____

Source of UMN Nitrogen Recommendation
- ❍ UMN Nitrogen Tables
- ❍ Western MN Soil Nitrate Test

Pounds Per Acre			
	N	**P_2O_5**	**K_2O**
(b)	--------	---------	--------

UM Broadcast Nutrient Recommendation
First-year legume nitrogen credits are already accounted for on line (b)

Other Nitrogen Credits

(c) _____ Second-Year Legume Nitrogen Credit **Crop/Quality** _____

(d) _____ Second-Year Manure Nitrogen Credit

(e) _____ Nitrogen Credit Based on Early-Spring Soil Nitrate Test

(**f**) _____ _____ _____ **Net Nutrients Needed**

(g) _____ _____ _____

Planned Manure Applications

Manure Source	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**h**) _____ _____ _____ **Supplemental Nutrient Needs**

(i) _____ _____ _____

Planned Fertilizer Application

Fertilizer form	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**j**) _____ _____ _____ **Total Nutrients to be Applied in Planning Year**

Sensitive Area Management (See page 19)

Field Nutrient Management Plan

Crop Year _____

Farm Name/Tract # _____ **Field** _____

Field Location _____ Acres _____

Sensitive Features _____

_____

Soil Test Information Date Tested _____

(a)

NO_3N lbs/acre	**P** ppm	**K** ppm	**Percent Organic Matter**	**pH**	Soil Name/Map Unit: Soil Texture:

Crop Nutrient Recommendation

Planned Crop _____ Yield Goal _____

Previous Crop _____ Quantity/Yield _____

Source of UMN Nitrogen Recommendation
- ❍ UMN Nitrogen Tables
- ❍ Western MN Soil Nitrate Test

	Pounds Per Acre		
	N	**P_2O_5**	**K_2O**
(b)	--------	---------	--------

UM Broadcast Nutrient Recommendation
First-year legume nitrogen credits are already accounted for on line (b)

Other Nitrogen Credits

(c) _____ Second-Year Legume Nitrogen Credit **Crop/Quality** _____

(d) _____ Second-Year Manure Nitrogen Credit

(e) _____ Nitrogen Credit Based on Early-Spring Soil Nitrate Test

(**f**) _____ _____ _____ **Net Nutrients Needed**

(g) _____ _____ _____

Planned Manure Applications

Manure Source	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**h**) _____ _____ _____ **Supplemental Nutrient Needs**

(i) _____ _____ _____

Planned Fertilizer Application

Fertilizer form	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**j**) _____ _____ _____ **Total Nutrients to be Applied in Planning Year**

Sensitive Area Management (see page 19)

(c) If forage legumes were in the rotation of this field in the last 2 years, refer to Table 19 and the discussion on the top of page 12 of the University of Minnesota fertilizer recommendations booklet for second year legume nitrogen credits when growing corn. For other crops to be grown this year, refer to the text in the discussion sections of the publication.

(d) If manure was applied last year on this field, enter the second-year available nutrients as determined on the Manure Nutrient Credit Worksheet.

(e) If you performed an early spring soil nitrate test, enter the result here. If you enter a result here, do not enter a second year legume credit (c) or a second year manure credit (d) since this test will be measuring these nitrogen sources.

(f) Subtract the nitrogen credits identified in (c), (d) and (e) from the U of Minnesota recommendations listed in (b) and record the **Net Nutrient Needs** for this field.

(g) In order to determine the amount of nutrients that will be available from your planned manure application, you will now take a break from this form and fill out the **Manure Nutrient Credit Worksheet.** Once completed, the results from the worksheet (d-1, d-2, and d-3) will be entered here and you will resume filling out the Field Management Plan on page 18.

Completing the ***Manure Nutrient Credit Worksheet*** *(see p. 17)*

I. Manure Nutrient Credit

If your manure applicator is calibrated to apply a specific amount in tons or thousand gallons, enter the rate here. For instance, if your applicator applies 3,500 gallons per acre, enter "3.5," and then move on to Section III.

Manure Nutrient Credit Worksheet Date _____ Crop Year _____

Producer/Operator _____

I. Manure Nutrient Credits for: _____
Manure Source or Collection Area

Calibrated Application Rate ___ Yes ___ No *(If NO, then complete section III below before continuing)*

Rate Amount _____ (tons or 1,000 gals.) Manure Application Method _____

If you do not have a set calibrated application rate, complete Section II next.

II. Manure Rate Determination

(a) Choose the Nutrient for which your application rates will be determined. In most cases, you will determine your rate of application based on the nitrogen content of the manure and the nitrogen needs of the crop to be planted. In the case of high or very high phosphorus soil tests, refer to the *High Phosphorus Soils* worksheet on page 23 of this booklet.

(b) Fill in the nutrient content for the nutrient you chose to base your application rates on. This number can be found in section IV of the **Master Worksheet.**

III. Manure Rate Determination

(a) Nutrient for which to base application rate (N, P^2O^5 or K^2O)

(b) Nutrient content of manure for the nutrient listed above _____ (lbs./ton or 1,000 gal.)

(c) Crop nutrient need for the listed nutrient _____ (lbs./acre) (d) Crop _____

Application Method	(e) Percent First-Year Nutrient Availability (Table A4)	(f) First-Year Nutrients Available (lbs./ton or 1,000 gal) (b x e)	(g) Manure Application Rate (tons or 1,000 gals/acre) (c / f)
Broadcast no incorporation			
Broadcast (incorporated 12-96 hours)			
Broadcast (incorporated <12 hours)			
Sweep injected			
Knife injected			

Return to the above Sections I and II to complete the nutrient credit calculations for crops.

(c) Fill in the crop nutrient need for the listed nutrient. This can be found in your partially completed Field Nutrient Management Plan.

(d) Fill in the crop.

(e) Turn to **Table A4** (page 27) which begins with the words "Nitrogen availability and loss……." Find the type of animal you raise and follow the **Year 1** line across the table. These numbers are the percentage of nitrogen available for crop use based on different manure application methods. Copy these numbers for your animal type into column (e) of this form. Remember that the numbers in the table are expressed as a percentage so you need to put a decimal point in front of them when copying into column (e). For example if the number in Table A4 is 25, write it in column (e) as 0.25. ***Note:*** *The percentages listed in Table A4 are used for* ***nitrogen only****. If you base your manure application rate on Phosphorus, always use 0.80 as the first year available percentage and would therefore enter 0.80 behind all application methods in column (e).*

(f) Multiply the nitrogen content in your manure (b) by each of the decimal percentages in column (e) and enter them in column (f).

(g) Divide the crop nutrient needs (c) by the results recorded in column (f) and record the results in column (g). Column (g) represents the amount of manure in "tons" or "1000 gallons" you would need to apply to fully meet the crop nutrient needs in the first year.

III. First- and Second-Year Nutrient Availability to Crops

(a) Fill in the nutrient analysis of your manure from section IV of the *Master Worksheet***.**
(b) Enter the manure application rate in tons or thousand gallons. This can be an application rate chosen after completing section II of this worksheet or a calibrated rate at which you normally apply manure.
(c) Multiply (a) x (b) under each of the nutrients. This is the total pounds of each nutrient you will apply before calculating first year availability.

First and Second Year Availability – Multiply the first-year availability percentage (expressed as a decimal) x the Total Nutrients Applied (c). Notice that the percentage availability for P_2O_5 and K_2O are set at 0.80 and 0.90 respectively, regardless of application method or animal type. For nitrogen, refer to **Table A4** (page 27) to find the appropriate first and second year availability percentage for your application method. The calculated pounds per acre first-year and second-year available nutrients are used when planning manure applications to individual field and crop situations. Complete this worksheet and transfer the results (d-1, d-2, and d-3) to line (g) of the Field Nutrient Management Plan.

Manure Nutrient Credit Worksheet

Date _____ Crop Year _____

Producer/Operator _____

I. Manure Nutrient Credits for: _____

Manure Source or Collection Area

Calibrated Application Rate ___ Yes ___ No *(If NO, then complete section III below before continuing)*

Rate Amount _____ (tons or 1,000 gal) Manure Application Method _____

II. Manure Rate Determination

(a) Nutrient for which to base application rate (N, P_2O_5 or K_2O)

(b) Nutrient content of manure for the nutrient listed above _____ (lbs./ton or 1,000 gal)

(c) Crop nutrient need for the listed nutrient _____ (lb/acre) (d) Crop _____

Application Method	(e) Percent First-Year Nutrient Availability (Table A4)	(f) First-Year Nutrients Available (lb/ton or 1,000 gal) (b x e)	(g) Manure Application Rate (tons or 1,000 gal/acre) (c / f)
Broadcast no incorporation			
Broadcast (incorporated 12-96 hours)			
Broadcast (incorporated <12 hours)			
Sweep injected			
Knife injected			

III. First- and Second-Year Manure Nutrient Availability to Crops

	N	P_2O_5	K_2O
Manure Analysis (lbs./ton or 1,000 gals.)	(a)	(a)	(a)
Application Rate (tons or 1,000 gal/acre)	(b)	(b)	(b)
Total Nutrients Applied (lbs./acre)	(a x b) = (c)	(a x b) = (c)	(a x b) = (c)

Nutrient Availability to Crops	N (lbs./acre)	P_2O_5 (lbs./acre)	K_2O (lbs./acre)
First-Year Availability	(% N available from Table A4) x (c) = (d-1)	(0.80) x (c)= (d-2)	(0.90) x (c)= (d-3)
Second-Year Availability	(% N available from Table A4) x (c) =		

Field Nutrient Management Plan (continued from page 15)

Returning to Step 3, Completing the Field Nutrient Management Plan (pages 13, 14)

(h) (*Supplementary nutrient needs*) Subtract the nutrients from Planned Manure Applications (g) from the Net Nutrients Needed (f) and fill in the result here. If the nutrients from manure are higher than the Net Nutrients Needed, then you may be over applying at your planned application rate and you may need to reduce the manure application rate. If this field has a high phosphorus soil test, you should plan a long-term strategy of how often manure can be applied so that soil test levels do not continue to increase. Refer to Part 14 on page 23.

(i) Record any planned fertilizer applications such as starter fertilizers or supplemental broadcast fertilizer needed to complete the crop needs. Enter the fertilizer type under "fertilizer form" and fill in the timing, method, rate/acre and actual pounds of each nutrient.

(j) Add the Nutrients from Planned Manure Applications (g) and Planned Fertilizer Applications (i) and enter the result here. These are the total nutrients to be applied to this field in the planning year.

At the bottom of the page, record any sensitive area management and complete the form on p. 24.

Remember, you must fill out one of these ***Field Nutrient Management Plan*** forms for **each** field on the farm. This form is a vital part of your overall Manure Management Plan that should be updated each year to help you manage manure nutrient application on your farm.

An additional copy of the Field Nutrient Management Plan form is provided on page 29. Use this copy to make photocopies.

Step 4.
How Will I Manage Manure in Sensitive Areas and High Phosphorus Soils?

If you apply manure in sensitive areas, you are required to include sensitive area management in your overall manure management plan before it will be considered complete.

Instructions:
Step 1. **Fields** – In the middle of the top row of Sensitive Area Management Table on page 20, list the field name or identification number (for all fields to receive manure). If more than nine fields are used, photocopy this form and complete for remaining fields. Make sure that the field acreage and location information for these same field names is listed in the manure management plan.

Step 2. **Sensitive Areas** – For each field listed on Sensitive Area Management Table, check all of the sensitive features that are in the field or adjacent to the field. For surface waters, check the box if the water type is within 300 feet of areas receiving manure. For floodplains, only check if manure is to be applied within a floodplain that is more than 300 feet from the water. A "public well management area" can be identified by asking city water managers (check if the fields are within about a mile of a community water supply well).

Whenever one or more fields has a sensitive feature, look at the right hand column to find out which part of the following pages (***"Sensitive Areas parts 1-14"***) needs to be completed. For example if a field has an open tile intake, then complete part 4 in sensitive areas (identify the setback option to be used for each field with an open tile intake). If no tile intakes are found in any field, then part 4 of Sensitive Areas does not need to be completed.

Step 3. **Soil Test Phosphorus** – For each field listed on Sensitive Area Management Table, check either a, b, c, or d, based on the field average soil phosphorus test levels.
Only one of the four boxes should be checked. If b, c, or d are checked for any of the fields, then follow the instructions in the right hand column (e.g. complete the corresponding Parts 13 and/or 14).

Step 4. **Timing of application** – For each field in Sensitive Area Management Table, check one of the five seasons that corresponds to the time manure will be applied onto that field. Follow the instructions in the right hand column of the Table. For example, if manure is to be applied to frozen or snow-covered soils, then complete Sensitive Areas Parts 11 and 12.

Step 5. **Soil Conservation** – All CAFOs and NPDES permitted feedlots must include a description of soil conservation practices. For all fields receiving manure from your CAFO facility, complete part 12 of Sensitive Areas. Part 12 is also required when manure will likely be applied onto frozen or snow-covered soils.

Sensitive Area Management Table

Field name/tract # Show same field name/tract # on maps or aerial photos of fields	**Example field A**	1	2	3	4	5	6	7	8	9	10	**What is needed to complete the manure management plan when one or more fields are checked in the row?**
Sensitive areas (check each feature that is within 300 ft of field)												Sensitive areas parts 1-14 are found on the following pages.
a. Lake or Stream												Complete Sensitive Areas part 1
b. Intermittent stream												Complete Sensitive Areas part 2
c. Drainage ditch without protective berms	X											Complete Sensitive Areas part 2
d. Wetlands over 10 acre (public waters wetland)												Complete Sensitive Areas part 3
e. Open tile intakes	X											Complete Sensitive Areas part 4
f. Wetlands under 10 acres												Complete Sensitive Areas part 5
g. Sinkhole, well, mine or quarry												Complete Sensitive Areas parts 6 and 7
h. Floodplain												Complete Sensitive Areas part 8
i. Public well mgmt. area												Complete Sensitive Areas part 9
k. Shallow soil over fractured rock												Complete Sensitive Areas part 10
l. Other conduits to water												Complete Sensitive Areas part 2, if CAFO
Soil test Phos. (ppm) check one (a-d)												Note: Use field average P
a. Under 22 ppm Bray P1 or 17 Olsen												No state restrictions on P applications
b. 22-75 Bray P1 or 17-60 Olsen	X											If field is within 300 ft of sensitive areas a,b,c,or d, above, then complete Sensitive Areas part 13
c. 76-150 Bray P1 or 61-120 Olsen												If field is within 300 ft of the sensitive areas a, b, c, d **or e** above, then complete Sensitive Areas part 14
d. Over 150 Bray P1 or 120 Olsen												Complete Sensitive Areas part 14
Timing of application (check one)												
June, July or August												Describe cover crop: _____
September to mid/late-October												If CAFO, no application to coarse-textured soils until soil temps drop below 50º F
Late Oct. to soil freeze	X											No added requirements
Frozen or snow-covered soils												Complete Sensitive Areas parts 11 and 12
Spring application to unfrozen soils												No added requirements
Soil Conservation												
Is feedlot a CAFO or NPDES permitted site?	N											Complete Sensitive Areas part 12 if the feedlot is a CAFO

Sensitive Areas Parts 1-14

Part 1. Lake or perennial stream

Option A

- inject or incorporate within 24 hours and prior to rainfall (within 300 feet), and
- 25 foot setback with no manure applied
- avoid long term soil P build-up

Option B – 100 ft wide non-manured grassed buffer
Option C – 100 ft non-manured setback with at least one rod (16.5') as grassed buffer
Option D – other (describe)
_____

Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___

Part 2. Intermittent stream or drainage ditch without protective berm

Option A

- inject or incorporate within 24 hours and prior to rainfall (within 300 feet), and
- 25 foot setback with no manure applied
- Avoid long term soil P build-up

Option B – 50 ft wide non-manured grassed buffer
Option C – 100 ft non-manured setback with at least one rod (16.5') as grassed buffer
Option D – other (describe) _____
_____

All fields…… Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___

Part 3. Public waters wetland (i.e. >10 acres)

Option A

- inject or incorporate within 24 hours and prior to rainfall (within 300 feet), and
- 25 ft setback with no manure applied
- avoid long term soil P build up

Option B – 50 ft wide non-manured grassed buffer
Option C – 100 ft non-manured setback with at least one rod (16.5') as grassed buffer
Option D – other (describe) _____
_____

All Fields……. Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___

Part 4. Tile intakes

Option A

- inject or incorporate within 24 hours and prior to rainfall (within 300 ft of intake)
- 25 foot setback with no manure applied
- avoid long term soil P build-up

Option B

- inject or incorporate within 24 hours and prior to rainfall (within 300 ft of intake), and
- Use a riser pipe that allows at least 75% solids settling in ponded area surrounding the intake*

Option C – 35 foot non-manured grassed buffer
Option D – 100 foot non-manured setback with at least one rod (16.5') as grassed buffer
Option E – other (describe) _____
_____
* Note: needed if NPDES permitted facility

All fields…… Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___

Part 5. Wetlands under 10 acres

No specific state-wide requirements. Check which practices will be followed to meet any permit conditions and/or to voluntarily protect water quality:

□ Setback of _____ ft
□ Grassed buffer _____ ft wide
□ No long term soil P build-up
□ Incorporate manure within _____ ft
□ Soil conservation practices
□ Other _____
□ Other _____

Part 6. Sinkhole

Option A

- inject or incorporate within 24 hours and prior to rainfall (upslope and within 300 ft), and
- 50 ft setback with no manure applied (100 ft setback for CAFOs)

Option B – Diversion berm to prevent runoff into the sinkhole

Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___
Field _____ Option ___

Part 7. Wells, Mines, Quarries

50 ft setback – minimum required
(100 ft if CAFO applying near agricultural wellhead)

Field _____ setback _____
Field _____ setback _____
Field _____ setback _____
Field _____ setback _____
Field _____ setback _____
Field _____ setback _____

Part 8. Floodplains extending beyond 300 feet of waters

No minimum state-wide requirements.
Check which practices will be followed:

□ Avoid manure application during peak flooding periods
□ Incorporate or inject manure when there is a risk of flooding
□ Avoid winter-time manure applications
□ Other _____

Part 9. Public Well Management Areas

i.e. Those vulnerable to contamination

No state requirements specifically for these areas.
Check which practices will be followed:

□ Follow practices recommended in city wellhead protection plans
□ Maintain a setback of _____ ft
□ Soil nitrate test will be used to refine nitrogen rate management decisions
□ Apply no earlier than late October, or when soil temperatures are less than 50ºF
□ Use crops that mine nitrogen out of the soil (e.g. alfalfa, legume grasses, etc.)
□ Other _____

Part 10. Shallow soil over fractured bedrock

(i.e. < 3 feet above limestone)

No specific state requirements
Check which practices will be followed:

□ Use composted manure or other processes which kill bacteria
□ Till manure into soil
□ Maximize separation between fractured bedrock and manure
□ Other _____

Part 11. Winter Application Sites

Fields used for winter application

Field	Slope	Distance to nearest water

Check which practices will be followed for **winter application fields.**

Required for all sites:

□ I will not apply manure to frozen or snow-covered soils within 300 feet of lakes, streams, intermittent streams, public waters wetlands, drainage ditches without berms, and open tile intakes.

Management Options Check which will be followed (all are Required for CAFOs)

□ Avoid spreading during snowmelt that creates runoff or when rainfall over ¼ inch is expected within 24 hrs
□ Spread liquid Manure to slopes less than 2 percent and solid Manure to slopes less than 6 percent.
□ Spread manure where tillage is on the contour (if slopes >2%)
□ Apply liquids at rates that prevent runoff during the application process
□ Find alternative fields or management where MPCA determines that water will be polluted

Part 12. Conservation Practices

Check which conservation practices will be used:

□ grassed waterways
fields: _____
□ field edge buffers
fields: _____
□ contour stripcropping
fields: _____
□ chisel or disk tillage w/residue
fields: _____
□ contour buffer strip
fields: _____
□ no-till
fields: _____
□ sediment control basin
fields: _____
□ terrace
fields: _____
□ cover crop
fields: _____
□ rotations that include crops other than row crops
fields: _____
□ meets tolerable soil erosion losses "T" defined by NRCS
□ Other _____

Part 13. High phosphorus soils

Over 21 ppm Bray P1 (weak Bray);
Over 16 ppm Olsen; or
Over 30 ppm Mehlich III

If applying manure to high phosphorus soils that are within 300 feet of lakes, streams, intermittent streams, public waters wetlands (i.e. over 10 acres), and drainage ditches without protective berms, check the box and insert the planned frequency of application.

☐ I will maintain or reduce my soil P levels when applying manure within 300 feet of waters by applying manure no more than _____ times during a six-year period. Additionally, I will test my soils and further reduce manure rates and/or frequency of application if soil test levels are found to continue to increase.

To determine the number of times that manure should be applied during a six year period to prevent long-term soil P build-up follow the three steps below.

Step 1. Determine average P removal during the crop rotation (multiply expected yields by the crops' P_2O_5 removal rates as listed in Table A5 on page 27).
Example: Corn/soybean rotation with 160 bushel corn and 45 bushel beans -
Corn – [160 * 0.34] = 54 lbs P_2O_5 removed per year
Soybeans [45 * 0.82] = 37 lbs P_2O_5 removed per year
Average – 45 lbs P_2O_5 removed per year

Step 2. Determine the amount of P_2O_5 that is typically applied in manure applications (multiply rate of application times manure P_2O_5 content times 0.80).
Example: 4000 gals/ac * 28 lbs P_2O_5 /1000 gals * 0.8 = 90 lbs P_2O_5 applied

Step 3. Divide result of step 2 by result of step 1.
Example: 90/45 = 2 (i.e. manure can be applied on average once every 2 years or three times in a 6-year rotation without expecting soil P build-up).

Part 14. Extremely high phosphorus soils

Proximity to waters*	Bray P1 (ppm)	Olsen (ppm)	Mehlich III (ppm)
Within 300 ft of waters or open tile intakes	>75	>60	>90
All other land away from waters and intakes	>150	>120	>180

Below, circle the option(s) that will be used for soils exceeding the thresholds in the above table for extremely high P soils. Check appropriate boxes and fill in other needed information.

Option A. Discontinue manure applications to the following fields.
Field _____
Field _____
Field _____
Field _____

Option B. I will follow all NRCS 590 standards for extremely high P soils as stated in the three conditions below:

☐ I will Maintain or reduce soil P levels by applying manure no more than _____ times during a six-year period to all manured fields with extremely high P (use same procedure as described for high P soils near waters).

☐ I will not apply manure to fields with sheet and rill erosion exceeding 4 tons/acre, unless a 100 foot grassed buffer is along all receiving waters and erosion is less than 6 tons/acre (list fields that will not receive manure due to these conditions):
Field _____
Field _____
Field _____
Field _____

☐ I will not apply manure within 300 feet of waters if soil P exceeds 150 ppm Bray P1 (or 120 Olsen), except if a 100 foot grass buffer exists along the water and erosion is less than 2 tons/acre (list fields that will not receive manure due to these conditions):
Field _____
Field _____
Field _____

Option C
☐ I have used the University of Minnesota soil phosphorus index and will only apply manure to those fields which show a low or very low rating. The phosphorus index can be found at the following web site: www.mnpi.umn.edu. Attach P index results for fields where manure applications are planned.

☐ Additionally, I will maintain or reduce my soil P levels by only re-applying manure after the manure P is removed by crops planted after the manure application (see attached table of crop P removal).

Definitions of Sensitive Features

Tile intakes – a direct conduit (e.g. piping) from the ground surface to waters of the state and any other mechanism used to drain surface runoff ponding from fields that does not result in effective treatment or removal of pollutants (i.e. including blind inlets or rock inlets). This also includes side inlets through berms along drainage ditches.

Drainage ditch – edge of field drainage ditches (typically shown on U.S. Geological Survey quadrangle maps), excluding ditches that have berms sufficiently high to prevent runoff into the ditch.

Lakes, River or Stream – Lakes can be generally considered as bodies of waters over 25 acres. Rivers or streams flow continuously.

Intermittent streams – Streams which do not flow all year. They can flow continuously for long or short periods of time, and when a storm or major snowmelt occurs. They are denoted by dashed lines on U.S. Geological Survey Topographic maps.

Wetlands over 10 acres (public waters wetlands) – DNR protected wetlands, which are typically over 10 acres in rural areas.

Wetlands under 10 acres (non-farmed wetlands) – Wetlands under 10 acres, excluding wetlands that are used for agricultural purposes.

Floodplains – Land that regularly floods during the spring or during large storms.

Public well management area – Drinking water supply management areas delineated in accordance with Minnesota Health Department rules, where the aquifer/well is considered vulnerable. The well owner/manager should know whether the land is in such an area.

Shallow bedrock – Areas with bedrock less than 36 inches below the soil surface as identified in the soil survey, field checks, or NRCS evaluations.

Sinkhole – A surface depression caused by a collapse of soil or overlying formation above a fractured or cavernous bedrock.

Well, Mine or Quarry – Active wells, inactive unsealed wells, or any human excavations to remove stone, gravel, sand, iron, or other minerals.

Other conduits to waters – This category can include road ditches, especially those which are mapped as intermittent streams, or other pipes or channels that lead directly to waters of the state.

Final Steps, Additional Forms

Aerial Photographs

As discussed on page 12, your Manure Management Plan is not complete until you secure aerial photos of each field you will have access to for manure spreading. On the photos, outline each field and also outline any sensitive areas or areas of special concern where you might need to use special management practices such as setbacks or immediate incorporation.

It is suggested that you staple these photos to the back page of this booklet.

Soil and Manure Test Results

It is also a good idea to gather copies of all soil test results and manure nutrient analysis results and keep them with this booklet for quick reference.

A Living Document

Remember that this Manure Management Plan is a living and working document. That is, once completed, it needs to be updated each year with new cropping information or any changes in management or test results. If it is not followed, you will not benefit from the maximum value of the manure nutrients produced on your farm.

Extra Forms

Additional copies of the Master Worksheet and Field Nutrient Management Plan are located on the following pages. Use these copies to make any additional photocopies you may need to develop or update your plan.

Additional information on sensitive area management, including additional forms, is available on the MPA Web site:

http://www.pca.state.mn.us/hot/feedlots.html#forms
http://www.pca.state.mn.us/publications/feedlots-manureapplication.pdf

Check the Checklist

Remember to download and use the Manure Management Plan Requirements and Checklist available on the MPCA Web site to make sure you have completed all the necessary components of the plan.
http://www.pca.state.mn.us/hot/feedlot-management.html

Nutrient/Manure Management Information Tables

Table A1. Annual manure production and nutrient excretion from livestock.

Animal Type	Manure production per 1,000 lbs. Animal Weight		Excreted Nutrient in Manure per 1,000 lbs. of Animal Weight		
	Solid (tons/year)	Liquid (gals/year)	N	P_2O_5	K_2O
BEEF					
calf	19.5	4591	162	73	130
finishing	9.0	2141	131	39	83
cow	16.8	3982	128	66	106
DAIRY					
calf	14.6	3358	146	24	122
heifer	11.0	2536	112	39	112
lactating	20.3	4876	263	135	146
dry	9.3	2241	110	40	88
veal	4.8	1153	44	29	73
SWINE					
nursery	13.9	3358	292	146	146
finishing	9.0	2166	219	73	97
gestating	4.1	998	61	37	49
lactating	8.5	2025	165	107	127
boar	3.8	900	49	37	37
POULTRY					
broiler	17.3	4198	383	256	183
layer	9.1	2068	316	97	146
turkey (female)	8.6	2044	285	186	124
turkey (male)	6.8	1606	203	135	88
duck	20.1	4836	392	310	237
HORSE					
pleasure	9.9	2394	66	22	22
SHEEP					
feeder	7.5	1825	146	73	146

Adapted from *Manure Characteristics*, MWPS-18 Section 1, MidWest Plan Service, 2004

Calibrating Your Manure Spreader

1. Determine manure weight (solid manure) or manure volume (liquid manure) per spreader load.

(Use measured manure weight or 90% of the manufacturer's listed volume for liquid.)

2. Calculate rate based on loads applied per field

OR

Calculate rate based on acres covered per load.

Table A2. Nitrogen losses by storage/handling method

Storage, handling method	Manure type	% N loss
Daily scrape, haul	Solid (tons)	25
Manure pack	Solid (tons)	30
Open lot	Solid (tons)	50
Litter	Solid (tons)	35
Above ground tank	Liquid (gals)	20
Below ground covered pit	Liquid (gals)	20
Below ground open pit	Liquid (gals)	25
Under-floor dry	Solid (tons)	25
Under-floor liquid	Liquid (gals)	20
Earthen storage	Liquid (gals)	30
Lagoon	Liquid (gals)	75

Table A3. Estimated nutrient content of liquid and solid manure.

Animal type	Liquid Manure lbs./1,000 gals			Solid Manure lbs./ton		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Beef - Feeder cattle	29	18	26	14	9	14
Cow	20	16	24	11	7	9
Dairy - Heifer	32	14	28	13	12	19
Cow	25	15	27	11	7	9
Swine – Sow, litter	15	12	11	14	6	4
Nursery	25	19	22	13	8	4
Grow, finish	53	39	29	16	9	5
Gestation	25	25	24	9	7	5
Poultry - Layers	57	52	33	34	51	26
Broilers	63	40	29	46	53	36
Turkey	53	40	29	44	63	34
Horse				14	4	14
Sheep				18	11	26

Sources: Manure Management in Minnesota, WW-03553 (2007), University of Minnesota Extension Service; Manure Characteristics, MWPS-18 Sec. 1, MidWest Plan Service, 2004; Livestock Waste Facilities Handbook, MWPS-18, MidWest Plan Service, 1985

Table A4. Nitrogen availability and loss as affected by method of manure application and animal type

Year Available	Broadcast Incorporation Timing[2]			Injection	
	> 96 hrs	12 - 96 hrs	< 12 hrs	Sweep	Knife
Beef	Percent of Total Nitrogen Available Per Year				
Year 1	25	45	60	60	50
Year 2	25	25	25	25	25
Lost	*40*	*20*	*5*	*5*	*10*
Dairy					
Year 1	20	40	55	55	50
Year 2	25	25	25	25	25
Lost	*40*	*20*	*10*	*5*	*10*
Swine					
Year 1	35	55	75	80	70
Year 2	15	15	15	15	15
Lost	*50*	*30*	*10*	*5*	*15*
Poultry					
Year 1	45	55	70	NA	NA
Year 2	25	25	25	NA	NA
Lost	*30*	*20*	*5*		

Adapted from: Manure Planning Record Keeping Guide, BU-6957, University of Minnesota Extension Service, 2001

1. Third year available N is not listed but can be computed by adding years 1 and 2 and lost percentages and subtracting this sum from 100.
2. Timing categories: length of time between application and incorporation.

Conversion Factors

1 acre = 43,560 ft^2
1 cubic ft = 7.48 gallons
1 gal of water = 8.33 lbs

Soil Testing Conversions

Plow layer (6-7 in.) = ppm x 2 = lb/acre
Top 12 in. = ppm x 4 = lbs./acre
Top 24 in. = ppm x 8 = lbs./acre
P_2O_5 x 0.44 = P
P x 2.29 = P_2O_5
K_2O x 0.83 = K
K x 1.20 = K_2O

Fertilizer Conversions

1 gal of UAN (28%) = 10.66 lbs
1 gal (10-34-0) = 11.65 lbs
1 gal (7-21-7) = 11.0 lbs
1 gal (9-18-9) = 11.11 lbs

Table A5. Nutrient removal in harvested portion of the crop – Source (http://plants.usda.gov/plants/index.html)

Crop	Yield Units	Crop Nutrient Removal (lbs. per unit)		
		N	P_2O_5	K_2O
Alfalfa	Tons (air dry)	50.4	10.8	46.2
Alsike clover	Tons (air dry)	40.8	10.5	54.0
Barley (grain)	Bushels		0.41	0.28
Barley (grain and straw)	Bushels		0.55	1.67
Birdsfoot trefoil	Tons (air dry)	45.3	9.3	41.1
Canola	Cwt.		1.3	1.1
Corn (grain)	Bushels		0.34	0.19
Corn silage	Tons (as fed)		3.8	7.4
Edible beans	Pounds		0.01	0.03
Grass hay or pasture	Tons (air dry)	27.1	8.9	31.3
Grass/legume	Tons (air dry)	43.5	11.2	41.3
Oats (grain)	Bushels		0.25	0.16
Oats (grain and straw)	Bushels		0.32	1.31
Peas	Pounds		0.01	0.01
Potatoes	Cwt.		0.14	0.56
Red Clover	Tons (air dry)	45.1	10.8	41.1
Rye (grain)	Bushels		0.44	0.31
Rye grain, straw	Bushels		0.59	1.25
Soybeans	Bushels	3.5	0.82	1.0
Sugar beets	Tons		2.2	7.3
Sunflowers	Pounds		0.01	0.01
Sweet corn	Tons		11.0	13.9
Wheat (grain)	Bushels		0.53	0.3
Wheat (grain and straw)	Bushels		0.64	1.5

Common Fertilizer Analysis

Fertilizer	Analysis
Nitrogen (N)	
Anhydrous ammonia	82-0-0
Ammonium nitrate	34-0-0
Urea	46-0-0
UAN solution (Urea Ammonium Nitrate)	28 to 32-0-0
Aqua ammonia	20-0-0
Ammonium sulfate	21-0-0-24(S)
Phosphorous (P)	
Triple superphosphate	0-44 to 46-0
Diammonium phosphate	18-46-0
Monoammonium phosphate (MAP)	11-48-0
Ammonium polyphosphate liquid	10-34-0
Ammonium polyphosphate Dry	15-62-0
Potassium (K)	
Potassium chloride (Muriate of potash)	0-0-60
Potassium sulfate	0-0-50-18(S)
Potassium-magnesium sulfate (Sulf-fo-mag)	0-022-22S-11(Mg)
Potassium nitrate	13-0-44

More information from the Extension Service is available online:
http://www.manure.umn.edu/applied/application.html

Master Worksheet – Manure Storage, Handling and Testing

Producer name/operator _____ **Date** _____

	Manure Source #1	Manure Source #2	*Example* ***Dairy Barn***
I. Livestock Information			
Animal (#1) type			*Dairy cows*
Animal (#1) number, size			*50 @ 1400 lbs.*
Animal (#2) type			*Dairy heifers*
Animal (#2) number, size			*7 @ 800 lbs.*
II. Manure Storage			
Storage type			*Above ground tank*
Storage capacity (tons, gal)			*5000,000 gallons*
Storage (days, months)			*7 months*
III. Application Methods			
Commercial hauler			*No*
Spreader type[1]			*Slurry tanker*
Spreader calibrated (date)			*Yes, 11/03/2001*
When applied[2]			*Fall and spring*
Application method[3]			*Knife inject*
Incorporation timing[4]			*Immediate*
IV. Manure Analysis			
Sampling frequency			*Annually*
Sampling methods			*Spreader during filling*
Date analyzed			*11/03/2001*
N (lbs per ton or 1000 gal)			*24 lbs./1000 gal*
P_2O_5 (lbs per ton, 1000 gal)			*18 lbs./1000 gal*
K_2O (lbs per ton or 1000 gal)			*29 lbs./1000 gal*
V. Annual Manure/Nutrients Generated			
Manure volume or tons per year			*450,000 gallons*
Manure volume/tons based on records			*Yes*
Annual amount N (lbs)[5]			*24 x 450 = 10,800 lbs*
Annual amount P_2O_5 (lbs)[5]			*18 x 450 = 8,100 lbs*
Annual amount K_2O (lbs)[5]			*29 x 450 = 13,050 lbs*

1. "Spreader types" are: Slurry tanker, Solids spreader, Towed hose, Center pivot, Other sprinkler
2. "When applied" choices: Daily, Every other day, Weekly, Every 2 weeks, Monthly, Fall, Winter, Spring, Summer
3. "Application method" choices: Surface broadcast, Sweep inject, Knife inject
4. "Incorporation time" choices: Immediate, less than 12 hours, 12-96 hours, greater than 96 hours
5. Annual nitrogen of manure in lbs to be land applied after accounting for storage losses.

Field Nutrient Management Plan

Crop Year _____

Farm Name/Tract # _____ **Field** _____

Field Location _____ Acres _____

Sensitive Features _____

_____

Soil Test Information Date Tested _____

(a)

NO_3N lbs/acre	**P** ppm	**K** ppm	**Percent Organic Matter**	**pH**	Soil Name/Map Unit: Soil Texture:

Crop Nutrient Recommendation

Planned Crop _____ Yield Goal _____

Previous Crop _____ Quality/Yield _____

Source of UMN Nitrogen Recommendation
- ❍ UMN Nitrogen Tables
- ❍ Western MN Soil Nitrate Test

	Pounds Per Acre		
	N	**P_2O_5**	**K_2O**
(b)	--------	---------	--------

UM Broadcast Nutrient Recommendation
First-year legume nitrogen credits are already accounted for on line (b)

Other Nitrogen Credits

(c) _____ Second-Year Legume Nitrogen Credit **Crop/Quality** _____

(d) _____ Second-Year Manure Nitrogen Credit

(e) _____ Nitrogen Credit Based on Earl-Spring Soil Nitrate Test

(**f**) _____ _____ _____ **Net Nutrients Needed**

(g) _____ _____ _____

Planned Manure Applications

Manure Source	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**h**) _____ _____ _____ **Supplemental Nutrient Needs**

(i) _____ _____ _____

Planned Fertilizer Application

Fertilizer form	Timing	Method	Rate/acre	N	P_2O_5	K_2O

(**j**) _____ _____ _____ **Total Nutrients to be Applied in Planning Year**

Sensitive Area Management (see page 19)

Aerial Photos

Attach aerial photos here