ID-211

Cooperative Extension Service

Kentucky Nutrient Management Planning Guidelines (KyNMP)

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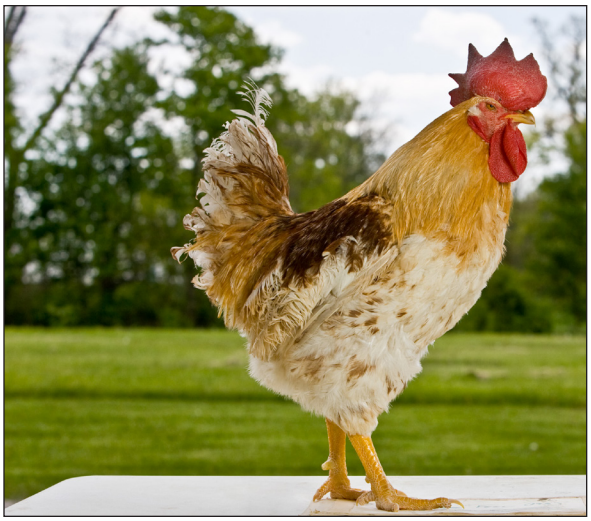
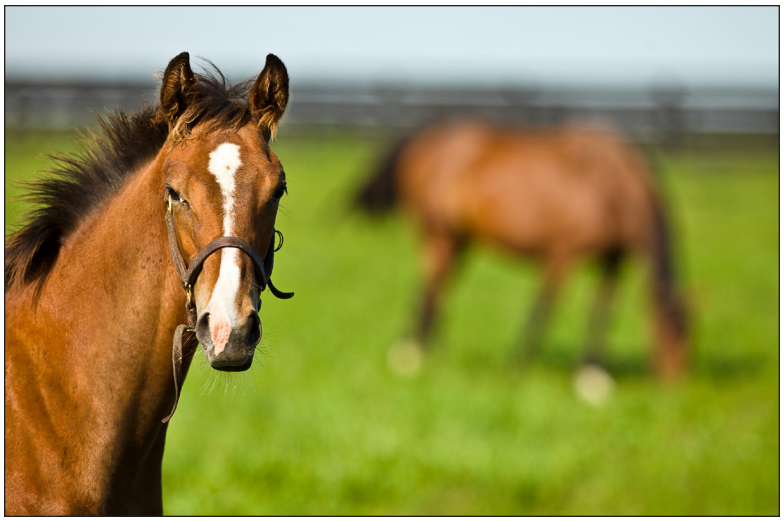
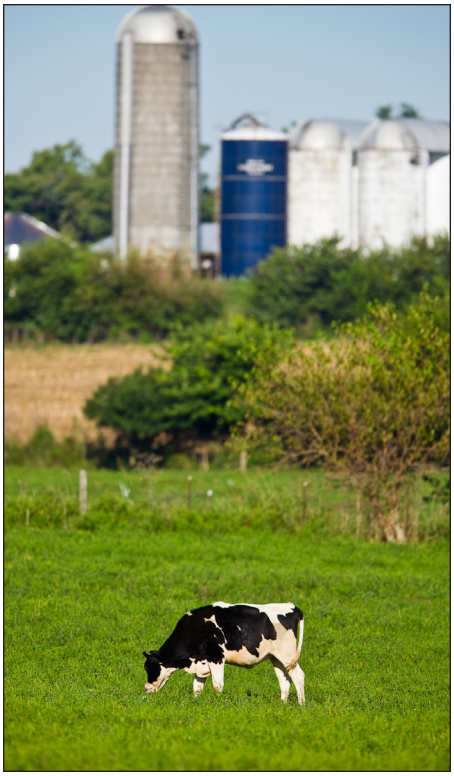
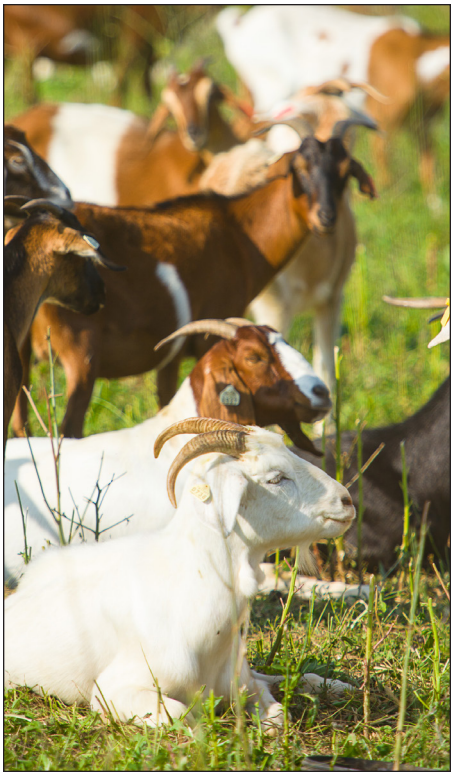
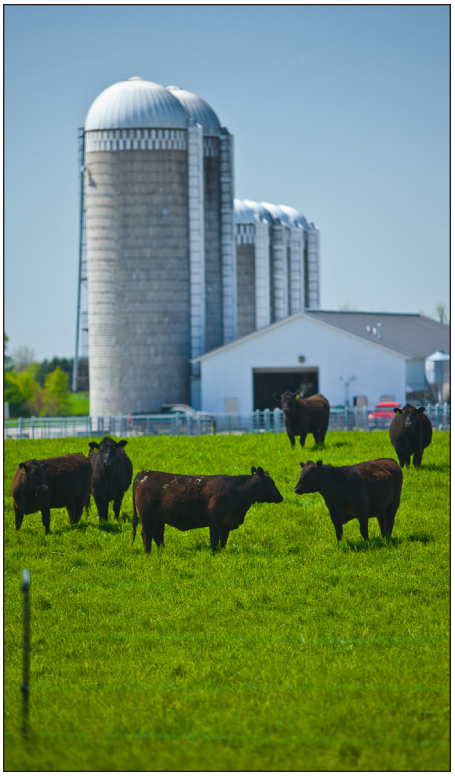

Contents

Nutrients are constantly cycling through farms. Nutrients come onto a farm in the form of feed, commercial fertilizers, manure, or compost, and they leave the farm with harvested crops, sold livestock, and off-site disposal of manure and other waste. Sometimes nutrients are even lost to the air, soil, or water. Nutrient management allows farmers to use nutrients (specifically nitrogen, phosphorus, and potassium) wisely for optimal economic benefit with minimal impact on the environment.

Approximately 80 percent of nutrients fed to an animal passes through the gut and into its manure. If managed correctly, the nutrients and organic matter in this manure can be recycled to produce crops and save producers money. If managed incorrectly, manure can contribute to nonpoint source pollution that threatens water quality. One practice that reduces the impact of agriculture on natural resources is nutrient management planning, which involves monitoring and recording all aspects of soil fertility, manure sampling, and crop production so that air, soil, and water resources are not compromised.

Compliance and Regulation History

All farms with 10 or more acres that land apply animal manures, commercial fertilizers, or other soil amendments as plant available nutrients are required to develop and implement a nutrient management plan (NMP) as part of their Kentucky Agriculture Water Quality Plan (KAWQP). In some cases, farms with fewer than 10 acres may also need a nutrient management plan if they are seeking cost share. The KAWQP, through Livestock BMP #11 and Crops BMP #14 (Nutrient Management), provides guidance for developing and implementing NMPs. The purpose of developing a nutrient management plan is to keep Kentucky agriculture sustainable by addressing potential pollution impacts before they occur.

The Kentucky Agriculture Water Quality Act (KAWQA) was passed in 1994 to address nonpoint source pollution from forestry and agricultural operations greater than or equal to 10 acres in size. This act relies on voluntary compliance by forestry and agricultural operations to implement best management practices (BMPs) that control, trap, and prevent pollution from reaching surface and groundwater resources. The Agriculture Water Quality Act required full implementation of BMPs, including nutrient management planning, by 2001; but even today, many producers are not aware that they need a nutrient management plan. In 1999, the United States Department of Agriculture and the U.S. Environmental Protection Agency initiated a unified strategy to encourage all animal feeding operations (AFOs) to develop and implement an NMP within 10 years, meaning that all AFOs should have had an NMP by 2009; however, NMPs are still not widely developed or implemented. In 2011, the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) modified their policy to require all producers requesting funding or technical assistance for any practice pertaining to manure management to have a comprehensive nutrient management plan (CNMP).

What is a Nutrient Management Plan?

A nutrient management plan (NMP) is a record of planned and actual nutrient application rates and dates on a field-by-field basis and includes a list of established BMPs. There are two types of documents used for nutrient management planning: an NMP and a comprehensive nutrient management plan (CNMP). Generally, a CNMP is written by a professional other than the producer, is more thorough and detailed, and accounts for all aspects of nutrients on the farm. An NMP is often written by the producer and is a more basic, hands-on document. At this time, the difference between an NMP and a CNMP is a technical difference between the federal and state agencies requesting and developing the documents; however, the concept behind each document is the same.

This document is a guide for developing basic NMPs that can be used to comply with the KAWQA. **All nutrient management plans can be simplified into the 4-R concept: right source, right place, right amount, and right time.** The ultimate goal of nutrient management planning is to develop a strategy for utilizing manure and inorganic fertilizer sources on the farm without polluting the environment. As new information becomes available for the farming operation, the plan should be adjusted to incorporate this information using an adaptive management approach.

The basic steps for developing a nutrient management plan:

1. Determine the total volume and amount of nutrients generated.
2. Determine soil fertility.
3. Determine application rates (right rate) based on existing soil fertility, crop requirements, application timing (right time), application method (right place), and fertilizer type (e.g. commercial fertilizer versus slow release fertilizer or additives to slow release) (right source).
4. Create a cropping plan for utilizing generated manure, based on storage capacity, on a field-by-field basis for a total of five years.
5. Implement the plan and keep records.

Phosphorus Threshold

This document utilizes a phosphorus threshold to determine manure and fertilizer applications. A phosphorus threshold is a maximum soil test phosphorus value that a soil can have and still receive phosphorus additions without a threat to the surrounding environment. The following soil test phosphorus values will determine application rates in your nutrient management plan (KyNMP):

Phosphorus Threshold (STP = Soil Test Phosphorus in lb/acre)

- < 400 STP—Nutrient applications can be made based on crop nitrogen requirements.
- 401-600 STP—Phosphorus applications at rates not to exceed the estimated removal of phosphorus in the harvested plant biomass.
- 601-800 STP—Phosphorus applications at rates not to exceed 1/2 of the estimated removal of phosphorus in the harvested plant biomass.
- >800 STP—Phosphorus applications are no longer allowed (manure may not be land applied in accordance with this guidance).

As soil test phosphorus levels increase above 400 lb/acre, planned phosphorus application rates (from any nutrient source) should be based on estimated phosphorus removal in harvested plant biomass and realistic yield average (5 to 10 year average). Plan developers are strongly encouraged to adopt manure application rates based on the phosphorus removal rate for receiving crops. Operations with soil test phosphorus levels above 600 should implement a phosphorus drawdown strategy.

Checklist of Information Needed Before Developing a Plan

Before beginning to develop an NMP, gather the following information and materials:

- A description of the farming operation, including farm layout map or sketch indicating fields that are planned for nutrient application
- Inventory of all nutrient sources (including animal manures produced or applied on the farm, inorganic fertilizers, and organic by-products)
- Soil test results, manure analysis results, and organic by-product analysis results
- A description of how normal mortalities will be managed in addition to a realistic plan for a catastrophic failure
- Necessary worksheets for the operation and their accompanying tables (provided at the back of this document)
- Calculator

Developing a Nutrient Management Plan

The rest of this document will explain how to manually develop an NMP step-by-step using five worksheets in the back of this document (basic calculations are involved). However, there is also a Nutrient Management Calculator (in Microsoft Excel Workbook format) available for download at http://www.bae.uky.edu/awqpt/calculators.htm that automatically performs the calculations once information is entered. The worksheets used in this document are also available for download on this website if multiple sheets are needed.

The five worksheets and tables used to develop an NMP:

The type of operation will determine which of these worksheets will be used. These worksheets and their accompanying tables are located in the back of this document.

To determine which worksheet(s) to use, select the scenario below that best describes the operation developing the NMP:

Inorganic fertilizer only: Crop producers using inorganic fertilizers should develop an NMP using a realistic yield average (5 to 10 year average), documented using Worksheet 3, and following fertilizer recommendations outlined in the current version of the University of Kentucky's AGR-1, *Lime and Fertilizer Recommendations.*

Manure not generated on the farm, but applied to fields: Crop producers utilizing manure not generated on the farm should collect and analyze manure using guidelines in the current version of the University of Kentucky's ID-148, *Sampling Animal Manure,* follow the Phosphorus Threshold criteria, and use Worksheet(s) 2 (Solids and/or Liquids) and Worksheet 3 to develop and implement an NMP.

Manure generated on the farm, but all exported: Livestock operations that generate manure but export all of it should use Worksheet(s) 1 (Solids and/or Liquids) to develop an inventory of the nutrients produced and the volume of manure generated. Other points that should be covered in the plan include:

- A description of the operation (i.e. number and size of animal production buildings, herd size or number and size of flocks per year, number of cleanings per year, capacity of manure storage structures, and other pertinent production area information)
- How manure will be handled and stored to prevent a discharge
- How normal mortalities will be managed in addition to a realistic plan for a catastrophic failure
- A list of names and contact information for those who will be receiving the exported manure
- A description of the recording system that will be used to document the names and addresses of entities receiving exported manure along with the date and volume exported

Manure generated and applied on the farm: Livestock producers that generate and apply manure to the same operation should use Worksheets 1-3 (Solids and/or Liquids) and follow the guidelines in the "Record Keeping" section of this document to develop and implement an NMP.

About the Worksheets

Worksheet 1

Solids Worksheet 1 and Liquids Worksheet 1 calculate how many pounds of nutrients per ton of waste or how many pounds of nutrients per thousand gallons of waste are generated on a particular operation, respectively. Depending on the operation, only one or both of these worksheets may be used. Determine if the manure is handled as a solid, liquid, or both and choose the corresponding worksheet(s) for how manure is handled.

Worksheet 2

Worksheet 2 determines application rates based on existing soil fertility, crop requirements, fertilizer credits, and application timing and method; essentially, it is a nutrient budget that is completed on a field-by-field basis.

Manure application rates should be based on soil test results, realistic crop yield averages (5 to 10 year average), and crop removal rates or an approach that considers the University of Kentucky's AGR-1, *Lime and Fertilizer Recommendations.* Application rates must also consider fertilizer credits from starter fertilizers or other nutrient sources. Application timing and application method will also affect manure nutrient availability and must be considered when calculating manure application rates.

Worksheet 2 should be completed for each field/cropping sequence, by year and by season, for no less than three years and no more than five years to document how generated nutrients will be utilized. Multiple copies of Worksheet 2 will likely have to be completed in order to utilize all of the tons or gallons of waste available.

Worksheet 3

Worksheet 3 is the final NMP that producers should follow and implement. The plan should record where manure is to be applied and how much was actually applied and when. Worksheet 3 should also be used to record future soil test phosphorus results as a way of monitoring soil fertility as a result of manure applications. Any deviation from planned manure application rates or management changes should be documented on Worksheet 3.

Completing Solids Worksheet 1

Remove Solids Worksheet 1 (pages 36-37) and Table 1.1 (page 33) from the back of the document and complete Steps 1-5 below. Examples for how to fill in the worksheet follow each step.

Step 1. Nutrients Generated (As Excreted)

a. Record the animal type, number of animals, percent waste handled as solid, average weight per animal, and the confinement period. Table 1.1 can be used to see options for animal type.

Note: Confinement period should be adjusted for animals that are only in confinement for a portion of the day. For example, if animals spend 16 hours on pasture and 8 hours in confinement, then confinement period would be one-third of a day or 122 days per year.

Note: If additional manure is being generated from other animal production groups, use additional lines in Step 1 and repeat the process to calculate nutrients produced.

Step 1. Nutrients Generated (As Excreted)

	Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Solid [a]	x	Average Weight (lb)	÷	1000	x	Confinement Period [b] (days/year)
1.)	Poultry Litter Broiler	300,000	x	100%	x	3.0	÷	1000	x	48
2.)			x		x		÷	1000	x	
3.)			x		x		÷	1000	x	

b. Calculate the animal unit days by first multiplying the number of animals by percent of waste handled as a solid (as a decimal, 0.5 equals 50% and 1.00 equals 100%) and then multiply that number by the average weight. The product of these numbers should be divided by 1,000 to get the value in animal units. This value is then multiplied by the number of confinement days to calculate animal unit days.

Step 1. Nutrients Generated (As Excreted)

	Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Solid [a]	x	Average Weight (lb)	÷	1000	x	Confinement Period [b] (days/year)	=	Animal Unit Days
1.)	Poultry Litter Broiler	300,000	x	100%	x	3.0	÷	1000	x	48	=	43,200
2.)			x		x		÷	1000	x		=	
3.)			x		x		÷	1000	x		=	

c. Using the values in Table 1.1, record the portion of N, P_2O_5, and K_2O as excreted per 1,000 lb live weight per day for the specific animal type in the column labeled "Table 1.1 Values." Multiply these values by the animal unit days to determine the pounds of N, P_2O_5, and K_2O produced. Record the sum of N, P_2O_5, and K_2O produced for Step 1 Total.

Step 1. Nutrients Generated (As Excreted)

Animal Unit Days			Table 1.1 Values		N	P_2O_5	K_2O
		N	0.96	=	41,472		
		P_2O_5	0.64	=	+	27,648	
43,200	x	K_2O	0.65	=		+	28,080
		N		=			+
		P_2O_5		=	+		
	x	K_2O		=		+	
		N		=			+
		P_2O_5		=			
	x	K_2O		=	=	=	=
			Step 1 Total	=	41,472	27,648	28,080
						(lb)	

Step 2. Manure Generated (As Excreted)

Transfer the number of animal unit days from Step 1. Using values from the "Volume of Manure Per Animal Unit" column in Table 1.1, record the manure volume per animal unit (cu. ft.). Calculate the total manure volume for all animal units by multiplying animal unit days by manure volume per animal unit. Add all volumes of manure generated and record for Step 2 Total.

Step 2. Manure Generated (As Excreted)

	Animal Unit Days (from Step 1)	x	Manure/A.U. (See Table 1.1)	=	Volume of Manure				
1.)	43,200	x	1.4	=	60,480	cubic feet			
2.)		x		=		cubic feet			
3.)		x		=		cubic feet	**Step 2 Total** (1 + 2 + 3)	=	**60,480** **cu.ft.**

Step 3. Total Tons

Transfer the volume of manure for each animal type. Find and record the Table 1.1 "Bedding Value" for each animal type. Divide the volume of manure by the bedding value; this will convert manure from cubic feet to tons, and will be used for calculations on Worksheet 2. Sum the total tons for each animal type and record for Step 3 Total.

Step 3. Total Tons

	Step 2 Vol. of Manure	÷	See Table 1.1 Bedding Value	=	Total Tons			
1.)	60,480	÷	74	=	817			
2.)		÷		=				
3.)		÷		=		**Step 3 Total** (1 + 2 + 3)	=	**817** **tons**

Step 4. Weighted Nutrient Values Before Nutrient Losses

Calculate the weighted nutrient value before nutrient losses by dividing the as-excreted nutrient concentrations (Step 1 Totals) by the number of tons generated (Step 3 Total). Record these values for the Step 4 Total. These values will be used on Worksheet 2 to estimate the concentration of nutrients in manure.

Step 4. Weighted Nutrient Values Before Nutrient Losses

	Step 1	÷	Step 3 Total	=			N	P_2O_5	K_2O
N	41,472	÷	817	=					
P_2O_5	27,648	÷	817	=					
K_2O	28,080	÷	817	=	Step 4 Total	=	50.7	33.8	34.4
								(lb/ton)	

Completing Liquids Worksheet 1

Remove Liquids Worksheet 1 (pages 38-40) and Table 1.1 (page 33) from the back of the document and complete Steps 1-7 below. Examples for how to fill in the worksheet follow each step.

Step 1. Nutrients Generated (As Excreted)

a. Record the animal type, number of animals, percent waste handled as a liquid, average weight per animal, and the confinement period. Table 1.1 can be used to see options for animal type.

Note: Confinement period should be adjusted for animals that are only in confinement for a portion of the day. For example, if animals spend 16 hours on pasture and 8 hours in confinement, then confinement period would be one-third of a day or 122 days per year.

Note: If additional manure is being generated from other animal production groups, use additional lines in Step 1 and repeat the process to calculate nutrients produced.

Step 1. Nutrients Generated (As Excreted)

	Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Liquid [a]	x	Average Weight (lb)	÷	1,000	x	Confinement Period [b] (days/year)
1.)	Dairy Cows	50	x	50%	x	1,400	÷	1,000	x	180
2.)	Dairy Heifers	20	x	50%	x	1,000	÷	1,000	x	180
3.)			x		x		÷	1,000	x	

b. Calculate the animal unit days by first multiplying the number of animals by percent of waste handled as a liquid (as a decimal, 0.5 equals 50% and 1.00 equals 100%) and then multiply that number by the average weight. The product of these numbers should be divided by 1,000 to get the value in animal units. This value is then multiplied by the number of confinement days to calculate animal unit days.

Step 1. Nutrients Generated (As Excreted)

	Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Liquid [a]	x	Average Weight (lb)	÷	1,000	x	Confinement Period [b] (days/year)	=	Animal Unit Days
1.)	Dairy Cows	50	x	50%	x	1,400	÷	1,000	x	180	=	6,300
2.)	Dairy Heifers	20	x	50%	x	1,000	÷	1,000	x	180	=	1,800
3.)			x		x		÷	1,000	x		=	

c. Using the values in Table 1.1, record the portion of N, P_2O_5, and K_2O as excreted per 1,000 lb live weight per day for the specific animal type in the column labeled "Table 1.1 Values." Multiply these values by the animal unit days to determine the pounds of N, P_2O_5, and K_2O produced. Record the sum of nutrients produced for Step 1 Total.

Step 1. Nutrients Generated (As Excreted)

Animal Unit Days			Table 1.1 Values		N	P_2O_5	K_2O
		N	0.45	=	2,835		
		P_2O_5	0.21	=	+	1,323	
6,300	x	K_2O	0.35	=		+	2,205
		N	0.27	=	486		+
		P_2O_5	0.11	=	+	198	
1,800	x	K_2O	0.14	=		+	252
		N		=			+
		P_2O_5		=			
	x	K_2O		=	=	=	
							=
			Step 1 Total	=	**3,321**	**1,521**	**2,457**
						(lb)	

Step 2. Manure Generated (As Excreted)

Transfer the number of animal unit days from Step 1. Using values from the "Volume of Manure Per Animal Unit" column in Table 1.1, record the manure volume per animal unit (cu. ft.). Calculate the total manure volume for all animal units by multiplying animal unit days by manure volume per animal unit by 7.5 to convert to gallons. Add all volumes of manure generated and record for Step 2 Total.

Step 2. Manure Generated (As Excreted)

	Animal Unit Days (from Step 1)	x	Manure/A.U. (See Table 1.1)	x	Conversion	=	Volume of Manure		
1.)	6,300	x	1.4	x	7.5	=	66,150	gallons	
2.)	1,800	x	0.9	x	7.5	=	12,150	gallons	
3.)		x		x	7.5	=		gallons	**Step 2 Total** (1 + 2 + 3) = **78,300** **gallons**

Step 3. Water Added by Wastage or Cleaning

To record the volume of water added by wastage or cleaning in gallons per day per animal, record the gallons used per day using values from the "Wastewater" column in Table 1.1 for each animal type and the number of animals and the number of days in confinement from Step 1. Calculate the volume of water by multiplying gallons per head per day by the number of head by the number of days in confinement. Sum these values and record for Step 3 Total.

Step 3. Water Added by Wastage or Cleaning

	Gallons/Day (See Table 1.1)	x	Number of Animals	x	Confinement Period (from Step 1)	=	Volume of Water		
1.)	5	x	50	x	180	=	45,000	gallons	
2.)	5	x	20	x	180	=	18,000	gallons	
3.)		x		x		=		gallons	**Step 3 Total** (1 + 2 + 3) = **63,000** **gallons**

Step 4. Water Added by Feedlot Runoff

The gallons of water added by feedlot runoff are calculated by determining the area that drains into liquid manure storages. Record the width (feet) and length (feet) of paved surfaces such as concrete, roofs without gutters, or other hard surface areas and unpaved surfaces such as gravel, dirt, or soil cement that contribute water to the liquid manure pond/lagoon. Record the frequency that the pond/lagoon is pumped for land application; this is the number of days before the storage pond/lagoon is pumped for land application divided by 365. For example, if the pond is pumped twice a year, it would be approximately 180 days before pump divided by 365, which equals .5 (180 ÷ 365 = .5). Calculate runoff (in gallons) by multiplying the width and the length of the paved/unpaved surfaces by the frequency of pump by the conversion factor (18.75 and/or 11.25). Sum these values and record for Step 4 Total.

Step 4. Water Added by Feedlot Runoff

	Width (feet)	x	Length (feet)	x	Frequency of Pump [c]	x	Conversion	=	Feedlot Runoff				
Paved Surface [d]	15	x	60	x	0.5 (days before pump ÷ 365)	x	18.75	=	8,438	gallons			
Unpaved Surface [e]		x		x	(days before pump ÷ 365)	x	11.25	=		gallons	**Step 4 Total** Paved + Unpaved	=	**8,438** **gallons**

Step 5. Water Added from Rainfall minus Evaporation on Storage Pond

Calculate the water added from rainfall minus evaporation on a storage structure by multiplying the length by the width of the liquid storage structure by the frequency of pump from Step 4 by the conversion factor (11.25) and record for Step 5 Total.

Step 5. Water Added from Rainfall minus Evaporation on Storage Pond

	Width (feet)	x	Length (feet)	x	Frequency of Pump [c]	x	Conversion	=	Net Rainfall on Storage Pond		
Lagoon/Pond Surface Area	224	x	464	x	0.5 (days before pump ÷ 365)	x	11.25	=		**Step 5 Total**	= **584,640** **gallons**

Step 6. Total Volume of Manure Produced

Record the total volume of manure produced in gallons by adding values from Steps 2, 3, 4, and 5 and record for Step 6 Total.

Step 6. Total Volume of Manure Produced

Step 2	+	Step 3	+	Step 4	+	Step 5	=			
78,300	+	63,000	+	8,438	+	584,640	=	**Step 6 Total**	=	**734,378** **gallons**

Step 7. Weighted Nutrient Values Before Nutrient Losses

Calculate the weighted nutrient value before nutrient losses by dividing the as-excreted nutrient concentrations (Step 1 Totals) by the number of gallons generated (Step 6 Total) and multiply by the conversion factor (1,000). Record the values for Step 7 Total. These values will be used on Worksheet 2 to estimate the concentration of nutrients in manure.

Step 7. Weighted Nutrient Values Before Nutrient Losses

	Step 1	÷	Step 6 Total	x	Conversion	=					
N	3,321	÷	734,378	x	1,000	=					
P_2O_5	1,521	÷	734,378	x	1,000	=					
K_2O	2,457	÷	734,378	x	1,000	=	**Step 7 Total**	=	**N**	**P_2O_5**	**K_2O**
									4.5	**2.1**	**3.3**
									(lb/1,000 gallons)		

Completing Solids Worksheet 2

Remove Solids Worksheet 2 (pages 41-44) and Tables 2.1, 2.2, 2.3, and 2.4 (pages 34-35) from the back of the document and complete Steps 1-15 below. Examples for how to fill in the worksheet follow each step.

Step 1. Crop or Crop Sequence/Rotation

Record the field number, acreage, and the soil test phosphorus value for the field where manure applications will be made.

Note: The Phosphorus Threshold may create manure application limitations that will determine whether a nitrogen- or phosphorus-based manure application rate will be utilized. Actual manure application rates should match and not exceed the recommended rate.

Tract	Field No.	Acres	Soil Test P Value (Mehlich 3)
	1	200	200

Record the crop or cropping sequence for this field. Table 2.1 can be used to see crop or crop sequence options.

Step 1. Crop or Crop Sequence/Rotation	Corn Grain (Bushel)

See Table 2.1 Options

Step 2. Realistic Yield

Record a realistic yield average on a per acre basis (5 to 10 year average).

Step 2. Realistic Yield (Average from 5-10 Years on a per acre basis)	200

Step 3. Plant Nutrients Needed or Allowed

Determine the nutrient values needed for the planned cropping sequence using Table 2.1 based on per unit yield. Multiply values in Table 2.1 by the realistic yield average (5 to 10 year average) recorded in Step 2 to determine the total nutrients required per acre. Record these values.

Step 3. Plant Nutrients Needed or Allowed (lb/ac)	N	P_2O_5	K_2O
	180	80	70

N	0.9 (Table 2.1 Value for N)	x	200 (Step 2)	=	180
P	0.4 (Table 2.1 Value for P)	x	200 (Step 2)	=	80
K	0.35 (Table 2.1 Value for K)	x	200 (Step 2)	=	70

Step 4. Adjusted P_2O_5 Application Rate According to Threshold

Record the value for Step 3 P_2O_5. Record the application rate adjustment from Table 2.2 based on the soil test phosphorus. Multiply these values and record for Step 4.

						P_2O_5	
Step 4.	**Adjusted P_2O_5 Application Rate According to Threshold**					0	
P	80 (Step 3 P_2O_5)	x	0 (Table 2.2 Value)	=	0		

Step 5. Fertilizer Credits

Record the nutrient credits from starter fertilizers or other nutrient sources applied to the field in pounds per acre.

		N	P_2O_5	K_2O
Step 5.	**Fertilizer Credits** (lb/ac)	0	0	0

Step 6. Plant Nutrients Needed Minus Credits

Calculate the plant nutrients needed minus credits by subtracting all fertilizer credits from plant nutrients required (Step 3 minus Steps 5; if your manure applications are limited by the Phosphorus Threshold, subtract Step 5 from Step 4).

						N	P_2O_5	K_2O
Step 6.	**Plant Nutrients Needed Minus Credits** (lb/ac)					180	80	70
N	180 (Step 3 for N)	–	0 (Step 5 for N)	=	180			
	If Step 4 > 0:							
P	(Step 4 for P)	–	(Step 5 for P)	=				
	If Step 4 = 0:							
	80 (Step 3 for P)	–	0 (Step 5 for P)	=	80			
K	70 (Step 3 for K)	–	0 (Step 5 for K)	=	70			

Step 7. Nutrients in Manure

Record the concentration of nutrients in manure from Solids Worksheet 1 Step 4 or the lab results from a manure sample.

		N	P_2O_5	K_2O
Step 7.	**Nutrients in Manure** (lb/ton)	50.7	33.8	34.4

Step 4 Values from Solids Worksheet 1 **or** use Lab Results

Step 8. Percent Nutrients Retained in System

Record the percent nutrients retained in the manure, based on storage and handling, using Table 2.3 values. If an actual manure sample analysis is used, record zero for this step.

Note: Manure samples should follow guidelines in the "Manure Sampling" section of this document and the University of Kentucky's ID-148, *Sampling Animal Manure*.

		N	P_2O_5	K_2O
Step 8.	**Percent Nutrients Retained in System**	70%	95%	95%
	Enter Table 2.3 values **or** Enter zero if lab analysis is used	(Manure with bedding in roofed storage)		

Step 9. Net Retained Nutrients in Manure

Determine nutrients retained in manure by multiplying Step 7 by values in Step 8. If an actual manure sample analysis is used, record zero for this step.

		N	P_2O_5	K_2O
Step 9.	**Net Retained Nutrients in Manure** (lb/ton)	35.5	32.1	32.6

Enter zero if lab analysis is used

N	50.7 Step 7 for N	x	0.7 Step 8 for N	=	35.5	
P	33.8 Step 7 for P	x	0.95 Step 8 for P	=	32.1	
K	34.4 Step 7 for K	x	0.95 Step 8 for K	=	32.6	

Step 10. Percent of Available Nutrients

Determine the percent of available nitrogen in manure based on time of year and application method from value in Table 2.4.

		N	P_2O_5	K_2O
Step 10.	**Percent of Available Nutrients**	45%	80%	100%
	Enter Table 2.4 Value for N	(Spring: Incorporated 7 days or more)		

Step 11. Net Available Nutrients

Determine net available nutrients by multiplying Step 9 by Step 10. If using an actual manure analysis, multiply Step 7 by Step 10.

Step 11. Net Available Nutrients (lb/ton)	N	P_2O_5	K_2O
	16.0	25.7	32.6

If Lab Results are used in Step 7:

N	_____ Step 7 for N	x	_____ Step 10 for N	=	_____	
P	_____ Step 7 for P	x	_____ Step 10 for P	=	_____	
K	_____ Step 7 for K	x	_____ Step 10 for K	=	_____	

If Solid Worksheet 1 Values are used in Step 7:

N	35.5 Step 9 for N	x	0.45 Step 10 for N	=	16	
P	32.1 Step 9 for P	x	0.8 Step 10 for P	=	25.7	
K	32.6 Step 9 for K	x	1 Step 10 for K	=	32.6	

Step 12. Application Rate

Calculate the application rate for each nutrient by dividing the amount of plant nutrients needed by the net nutrients available in the manure (Step 6 divided by Step 11). Assess the different application rates for each nutrient and choose one application rate accordingly. It may be helpful to experiment with different application rates in Steps 13 and 14.

Note: As soil test phosphorus levels increase above 400 lb per acre, planned phosphorus application rates (from any nutrient source) should be based on estimated phosphorus removal in harvested plant biomass and realistic yield average (5 to 10 year average) at levels prescribed in Table 2.2. In other words, if the soil test phosphorus is greater than 400 lb/acre, the application rate cannot exceed the calculated application rate for phosphorus (Step 6 divided by Step 11).

Note: There are limits to one-time manure application rates. Solids should not exceed 10 tons per acre. Multiple applications may need to be made to adhere to application limits.

Step 12. Application Rate (tons/ac)	N	P_2O_5	K_2O
	11	3	2

N	180 Step 6 for N	÷	16 Step 11 for N	=	11
P	80 Step 6 for P	÷	25.7 Step 11 for P	=	3
K	70 Step 6 for K	÷	32.6 Step 11 for K	=	2

Step 13. Net Application Amount for All Nutrients

Using the selected manure application rate determined in Step 12, calculate the pounds per acre of all nutrients applied by multiplying Step 11 by the chosen application rate.

Note: In this example, 4 lb/acre was chosen as the application rate to come closer to meeting the plant's need for nitrogen without drastically exceeding the plant's need for phosphorus and potassium.

						N	P_2O_5	K_2O
Step 13. Net Application Amount for All Nutrients (lb/ac)						64	103	130
N	16 Step 11 for N	x	4 Application Rate	=	64			
P	25.7 Step 11 for P	x	4 Application Rate	=	103			
K	32.6 Step 11 for K	x	4 Application Rate	=	130			

Step 14. Nutrient Needs (negative) or Surpluses (positive)

Determine nutrient needs or surpluses by subtracting Step 6 from Step 13.

Note: In this example, nitrogen fertilizer will need to be applied to the field.

						N	P_2O_5	K_2O
Step 14. Nutrient Needs (negative) or Surpluses (positive) (lb/ac)						-116	23	60
N	64 Step 13 for N	–	180 Step 6 for N	=	-116			
P	103 Step 13 for P	–	80 Step 6 for P	=	23			
K	130 Step 13 for K	–	70 Step 6 for K	=	60			

Step 15. Balance

a. At the bottom of Solids Worksheet 2, record the total volume of manure from Step 3 of Solids Worksheet 1 (or the balance if this is a subsequent Worksheet 2).
b. Determine the planned manure application rate to the field by multiplying the application rate (Step 12) by the number of acres.
c. Subtract this number from the total volume of manure available to determine if any manure will be left over. If the balance is a negative number or to deplete the entire supply, take number of tons of manure available and divide by total field acreage to determine a uniform manure application rate for the entire field.

Note: If a significant balance remains, repeat Worksheet 2 for additional fields until the manure supply is depleted.

Step 15. Balance

Tons Available	**817** Step 3 from Solids Worksheet 1 or Balance from Previous Worksheet 2	-	**Tons Applied in Field**	**800** Application Rate x Field Acres **or** to deplete supply in one field: Tons Available ÷ Num. of Acres = Uniform App. Rate (Be sure not to exceed 10 tons/acre)	=	**Balance**	**17**

Completing Liquids Worksheet 2

Remove Liquids Worksheet 2 (pages 45-48) and Tables 2.1, 2.2, 2.3, and 2.4 (pages 34-35) from the back of the document and complete Steps 1-15 below. Examples for how to fill in the worksheet follow each step.

Step 1. Crop or Crop Sequence/Rotation

a. Record the field number, acreage, and the soil test phosphorus value for the field where manure applications will be made.

Note: The Phosphorus Threshold may create manure application limitations that will determine whether a nitrogen- or phosphorus-based manure application rate will be utilized. Actual manure application rates should match and not exceed the recommended rate.

Tract	Field No.	Acres	Soil Test P Value (Mehlich 3)
	1	28	401

b. Record the crop or cropping sequence for this field. Table 2.1 can be used to see crop or crop sequence options.

Step 1. Crop or Crop Sequence/Rotation	Corn silage (ton)
See Table 2.1 Options	

Step 2. Realistic Yield

Record a realistic yield average on a per acre basis (5 to 10 year average).

Step 2. Realistic Yield (Average from 5-10 Years on a per acre basis)	20

Step 3. Plant Nutrients Needed or Allowed

Determine the nutrient values needed for the planned cropping sequence using Table 2.1 based on per unit yield. Multiply values in Table 2.1 by the realistic yield average (5 to 10 year average) recorded in Step 2 to determine the total nutrients required per acre. Record these values.

					N	P_2O_5	K_2O
Step 3.	**Plant Nutrients Needed or Allowed** (lb/ac)				194	72	160
N	9.7 (Table 2.1 Value for N)	x	20 (Step 2)	=	194		
P	3.6 (Table 2.1 Value for P)	x	20 (Step 2)	=	72		
K	8 (Table 2.1 Value for K)	x	20 (Step 2)	=	160		

Step 4. Adjusted P_2O_5 Application Rate According to Threshold

Record the value for Step 3 P_2O_5. Record the application rate adjustment from Table 2.2 based on the soil test phosphorus. Multiply these values and record for Step 4.

			P_2O_5	
Step 4. Adjusted P_2O_5 Application Rate According to Threshold			72	

P 72 (Step 3 P_2O_5) x 1 (Table 2.2 Value) = 72

Step 5. Fertilizer Credits

Record the nutrient credits from starter fertilizers or other nutrient sources applied to the field in pounds per acre.

	N	P_2O_5	K_2O
Step 5. Fertilizer Credits (lb/ac)	0	0	0

Step 6. Plant Nutrients Needed Minus Credits

Calculate the plant nutrients needed minus credits by subtracting all fertilizer credits from plant nutrients required (Step 3 minus Steps 5). If your manure applications are limited by the Phosphorus Threshold, subtract Step 5 from Step 4.

	N	P_2O_5	K_2O
Step 6. Plant Nutrients Needed Minus Credits (lb/ac)	194	72	160

N 194 (Step 3 for N) – 0 (Step 5 for N) = 194

If Step 4 > 0:

P 72 (Step 4 for P) – 0 (Step 5 for P) = 72

If Step 4 = 0:

____ (Step 3 for P) – ____ (Step 5 for P) = ____

K 160 (Step 3 for K) – 0 (Step 5 for K) = 160

Step 7. Nutrients in Manure

Record the concentration of nutrients in manure from Liquids Worksheet 1 Step 7 or the lab results from a manure sample.

	N	P_2O_5	K_2O
Step 7. Nutrients in Manure (lb/1,000 gallons)	4.5	2.1	3.3

Step 4 Values from Liquids Worksheet 1 **or** use Lab Results

Step 8. Percent Nutrients Retained in System

Record the percent nutrients retained in the manure, based on storage and handling, using Table 2.3 values. If an actual manure sample analysis is used, record zero for this step.

Note: Manure samples should follow guidelines in the "Manure Sampling" section of this document and the University of Kentucky's ID-148, *Sampling Animal Manure*.

	N	P_2O_5	K_2O
Step 8. Percent Nutrients Retained in System	35%	50%	65%
Enter Table 2.3 values **or** Enter zero if lab analysis is used	(Anaerobic lagoon or stored in waste storage pond diluted >50%)		

Step 9. Net Retained Nutrients in Manure

Determine nutrients retained in manure by multiplying Step 7 by values in Step 8. If an actual manure sample analysis is used, record zero for this step.

	N	P_2O_5	K_2O
Step 9. Net Retained Nutrients in Manure (lb/1,000 gallons)	1.6	1.1	2.2

Enter zero if lab analysis is used

N	4.5 (Step 7 for N)	x	0.35 (Step 8 for N)	=	1.6
P	2.1 (Step 7 for P)	x	0.5 (Step 8 for P)	=	1.1
K	3.3 (Step 7 for K)	x	0.65 (Step 8 for K)	=	2.2

Step 10. Percent of Available Nutrients

Determine the percent of available nitrogen in manure based on time of year and application method from value in Table 2.4.

	N	P_2O_5	K_2O
Step 10. Percent of Available Nutrients	45%	80%	100%
Enter Table 2.4 Value for N	(Incorporation: 7 days or more)		

Step 11. Net Available Nutrients

Determine net available nutrients by multiplying Step 9 by Step 10. If using an actual manure analysis, multiply Step 7 by Step 10.

Step 11. Net Available Nutrients (lb/1,000 gallons)	N	P_2O_5	K_2O
	0.7	0.9	2.2

If Lab Results are used in Step 7:

N	_____ Step 7 for N	x	_____ Step 10 for N	=	_____	
P	_____ Step 7 for P	x	_____ Step 10 for P	=	_____	
K	_____ Step 7 for K	x	_____ Step 10 for K	=	_____	

If Liquid Worksheet 1 Values are used in Step 7:

N	1.6 Step 9 for N	x	0.45 Step 10 for N	=	0.7	
P	1.1 Step 9 for P	x	0.8 Step 10 for P	=	0.9	
K	2.2 Step 9 for K	x	1 Step 10 for K	=	2.2	

Step 12. Application Rate

Calculate the application rate for each nutrient by dividing the amount of plant nutrients needed by the net nutrients available in the manure (Step 6 divided by Step 11). Assess the different application rates for each nutrient and choose one application rate accordingly. It may be helpful to experiment with different application rates in Steps 13 and 14.

Note: As soil test phosphorus levels increase above 400 lb/acre, planned phosphorus application rates (from any nutrient source) should be based on estimated phosphorus removal in harvested plant biomass and realistic yield average (5 to 10 year average) at levels prescribed in Table 2.2. In other words, if the soil test phosphorus is greater than 400 lb/acre, the application rate cannot exceed the calculated application rate for phosphorus (Step 6 divided by Step 11).

Note: There are limits to one-time manure application rates. Liquids should not exceed approximately 13,500 gallons/acre or ½ in/acre. Multiple applications may need to be made to adhere to application limits.

Step 12. Application Rate (1,000 gallons/ac)	N	P_2O_5	K_2O
	277	80	73

N	194 Step 6 for N	÷	0.7 Step 11 for N	=	277
P	72 Step 6 for P	÷	0.9 Step 11 for P	=	80
K	160 Step 6 for K	÷	2.2 Step 11 for K	=	73

Step 13. Net Application Amount for All Nutrients

Calculate the net application amount for all nutrients by multiplying Step 11 for each nutrient by the chosen application rate.

Note: In this example, 13,000 gallons per acre was chosen as the application rate because one time application rates should not exceed 13,500 gallons/acre or ½ in/acre for liquids. In addition, because the soil test phosphorus is greater than 400 lb/acre, the application rate must be equal to or less than the application rate calculated for phosphorus in Step 12.

						N	P_2O_5	K_2O
Step 13. Net Application Amount for All Nutrients (lb/ac)						9	12	29
N	0.7 Step 11 for N	x	13 Application Rate	=	9			
P	0.9 Step 11 for P	x	13 Application Rate	=	12			
K	2.2 Step 11 for K	x	13 Application Rate	=	29			

Step 14. Nutrient Needs (negative) or Surpluses (positive)

Determine nutrient needs or surpluses by subtracting Step 6 from Step 13.

						N	P_2O_5	K_2O
Step 14. Nutrient Needs (negative) or Surpluses (positive) (lb/ac)						-165	-60	-131
N	9 Step 13 for N	–	194 Step 6 for N	=	-165			
P	12 Step 13 for P	–	72 Step 6 for P	=	-60			
K	29 Step 13 for K	–	160 Step 6 for K	=	-131			

Step 15. Balance

a. At the bottom of Liquids Worksheet 2, record the total volume of manure from Step 6 of Liquids Worksheet 1 (or the balance if this is a subsequent Worksheet 2).
b. Determine the planned manure application rate to the field by multiplying the application rate (Step 12) by the number of acres by 1,000.
c. Subtract this number from the total volume of manure available to determine if any manure will be left over. If the balance is a negative number or to deplete the entire supply, take the gallons of manure available and divide by total field acreage to determine a uniform manure application rate for the entire field.

Note: If a significant balance remains, repeat Worksheet 2 for additional fields until the manure supply is depleted.

Step 15. Balance							
Tons Available	**734,378** Step 6 from Liquids Worksheet 1 or Balance from Previous Worksheet 2	-	**Tons Applied in Field**	**364,000** Application Rate x Field Acres x 1,000 **or** to deplete supply in one field: Gallons Available ÷ Num. of Acres = Uniform App. Rate (Be sure not to exceed 13,000 gallons/acre)	=	**Balance**	**370,378**

Completing Worksheet 3

The information recorded from all completed copies of Worksheet 2 should be used to develop the manure application plan that will be recorded in Worksheet 3 (page 49) (See Examples below). This is the actual NMP that producers should follow and implement. The plan should represent where manure is to be applied, as well as a record of how much was actually applied and when. Worksheet 3 should also be used to record future soil test phosphorus results as a way of monitoring soil fertility as a result of manure applications. Any deviation from planned manure application rates or management changes should be documented on Worksheet 3.

Example Solids Worksheet 3

EXAMPLE SOLIDS WORKSHEET 3 - APPLICATION RATES AND LAND REQUIREMENTS [1]

Tract No.

Field No.	Acres	Soil Test Phosphorus (STP)	Crop Rotation / Sequence	Planned Application Date or Timing	Planned Application Rate[2] (tons/ac)	Solid or Commercial Fertilizer (S or C)	Actual Application Date	Actual Application Rate[2] (tons/ac)	Weather at Time of Application[3] (Cloudy, Raining, Sunny)	
									24 Hours Before	24 Hours After
1	200	200	Corn Grain (Bushel)	Spring 2014	4	S	Spring 2014	Spring 2014	Sunny	Sunny

1. Where land application is occurring under long term lease or agreement with adjacent landowner, fields must be included in the above table.
2. Fields that have a "High" soil test phosphorus (>400) should implement Best Management Practices (BMPs) to reduce the risk of nutrient movement to sensitive waterbodies. BMPs may include, but not be limited to: installing conservation buffers, reducing P2O5 application rate, incorporating manure, adding chemical treatments to litter that tie up soluble P and keep it from moving over the landscape, and/or adjusting application timing.
3. It illegal to make land applications when the ground is frozen. It is recommended that land applications are not made within 48 hours of forecasted precipitation.

Modified January 14, 2014

Example Liquids Worksheet 3

EXAMPLE LIQUIDS WORKSHEET 3 - APPLICATION RATES AND LAND REQUIREMENTS [1]

Tract No.

Field No.	Acres	Soil Test Phosphorus (STP)	Crop Rotation / Sequence	Planned Application Date or Timing	Planned Application Rate[2] (1,000 gal/ac)	Liquid or Commercial Fertilizer (L or C)	Actual Application Date	Actual Application Rate[2] (1,000 gal/ac)	Weather at Time of Application[3] (Cloudy, Raining, Sunny)	
									24 Hours Before	24 Hours After
1	28	401	Corn Silage (ton)	Spring 2014	13	L	Spring 2014	Spring 2014	Sunny	Sunny

1. Where land application is occurring under long term lease or agreement with adjacent landowner, fields must be included in the above table.
2. Fields that have a "High" soil test phosphorus (>400) should implement Best Management Practices (BMPs) to reduce the risk of nutrient movement to sensitive waterbodies. BMPs may include, but not be limited to: installing conservation buffers, reducing P2O5 application rate, incorporating manure, adding chemical treatments to litter that tie up soluble P and keep it from moving over the landscape, and/or adjusting application timing.
3. It illegal to make land applications when the ground is frozen. It is recommended that land applications are not made within 48 hours of forecasted precipitation.

Modified January 14, 2014

Record Keeping

After completing the necessary Worksheet(s), follow these guidelines for record keeping if manure is generated and applied on the same operation:

- Document the as-applied manure application rates (Worksheet 3). When the actual rates used differ from or exceed the recommended and planned rates, indicate the reasons for the differences.
- Document changes to the plan on Worksheet 3 if modified because of weather, cropping sequence, etc. Record any changes such as field location, date, or cropping sequence.
- Maintain records for the following:
  - Soil test results and corresponding recommendations for nutrient application;
  - Quantities, analyses, and sources of nutrients applied;
  - Dates and method(s) of nutrient applications; and
  - Crops planted, planting and harvest dates, yields, and residues removed.
- Document manure application setback distances from environmentally sensitive areas and the appropriate best management practices (BMPs) implemented to protect natural resources.
- Records should be maintained for five years or for a period longer than five years if required by other federal or state permit requirements, local ordinances, or program or contract requirements.

Additional Important Information

The following information is critical to properly developing and implementing an NMP.

Soil Testing

Soil testing should be used to monitor the buildup of phosphorus in the soil. Soil samples should be collected in accordance with the University of Kentucky Cooperative Extension Service guidance. A current soil test is one that is less than one year old. Producers with high soil test phosphorus levels (>400) should consider implementing a drawdown strategy and possibly consider changing animal diets to replace dicalcium phosphate with phytase.

Manure Storage

- Store dry manure under roof until removal for use. (Livestock BMP #10 Manure Storage Structure (Stack Pad)).
- Liquid manure storages should provide enough capacity to store manures for a minimum of 180 days. Adequate freeboard must be maintained to avoid a discharge or breach.
- Storage of manure, inorganic fertilizers, and biosolids should be conducted in a manner consistent with the KAWQP to prevent pollution of ground and surface waters.
- Divert surface water away from stored manure (Livestock BMP #18 Stormwater Diversion).
- New storage areas must not be within 150 feet of waterways, streams, sinkholes, or 300 feet of water wells.
- Eliminate discharges from manure storage areas.
- Implement conservation buffers or filter strips downslope of manure storage areas that trap, control, and prevent runoff to environmentally sensitive areas. Periodically harvest vegetation to remove nutrients and prevent a buildup of soil fertility.

Transporting Manures

- Prevent manure spillage on roadways.
- Cover manure so it does not blow out or spill during transport.
- Avoid travelling through high population areas as much as possible.
- For manure transferred off-site, and not under your control, document the name of the recipient, date, and the amount of manure transported.

Manure Sampling

All manure sampling should follow the recommended procedures for collecting and preparing manure samples in the current version of the University of Kentucky's ID-148, *Sampling Animal Manure.*

Liquids

Special considerations should be made for liquid manures. Ideally, manure samples should be collected prior to land application, but it is often difficult to collect a sample representative of actual applied nutrients. In this case, producers should collect a sample during the application process for nutrient analysis. This information can then be used as a basis for calculating manure nutrient concentrations for future applications.

New Animal Feeding Operations

When preparing nutrient management plans on new animal feeding operations, Worksheet 1 (pages 36-40) and Table 2.1 (page 34) should be used to estimate manure nutrient content until a manure analysis can be obtained. Once historical laboratory manure analysis data is established (at least three samples with consistent nitrogen, phosphorus, and potassium levels), annual analysis is not required unless operational changes occur with manure storage facilities, storage intervals, feed rations and other situations.

Nutrient Application

Timing

The most important factor in determining when manure should be applied is **when the crop can best use the nutrients.** This means considering cropping system limitations, weather and climatic conditions, as well as field accessibility. Table 2.4 shows how nitrogen can best be utilized based on application timing and method. For annual crops such as corn, this usually means spreading manure just before seeding. For perennial crops, such as pasture or hay, timing of application is much more flexible. Most Kentucky farms have some fields that manure can be applied to during any season. Below are seasonal guidelines for application:

Spring

Spring is the best time to spread manure for a summer crop such as corn or other row crops. Manure spread in early spring will lose less nitrogen and have the most nutrients available at the time of vegetative growth. Spring is not the best time for applying manures to cool-season forages, especially after early April. Nitrogen losses from the manure will be greater at this time, and weed competition could be increased.

Summer

Manure spread in the summer will have the greatest risk of nitrogen loss through ammonia volatilization. However, if storage facilities need to be emptied, there are options for use. Fields with older stands of alfalfa, which are going to be re-established in a row crop sequence are good choices. Warm-season grass fields used for hay are one of the best options for manure application in summer. Sudangrass responds well to manure applied following harvest in July or August. Manure can be applied on bermudagrass fields any time after a harvest during the summer. Bermudagrass is a heavy user of nutrients, and if it is removed as hay, nutrient accumulation in the soil is reduced.

Fall

Kentucky has large acreages of cool-season pasture and hay fields that could benefit from fall applications of manure. But nutrients removed on pastures are low compared to row crops. Soil test phosphorus should be closely monitored so as to not exceed the phosphorus threshold. Wheat fields and crop fields with cover crops are also good choices. Ideally, manure should not be applied in fall on crop fields that do not have a cover crop that could utilize available nutrients.

Winter

Opportunities for manure application in winter are limited. Adequate manure storage capacity should be developed to hold manure until spring when manure can be properly utilized. The best options are on cool-season forages and small grains in February and March. Manure should not be applied on frozen or snow-covered fields where subsequent rains could wash the manure off the field before it has a chance to move into the soil. Manure should not be applied in winter on crop fields that do not have a cover crop to utilize nitrogen.

Although nutrients should generally not be applied in areas that are frozen, snow covered, or that have saturated soils, the following exceptions apply ONLY if BMPs such as filter strips, crop residue management, vegetative cover management, and other strategies are implemented properly to reduce the risk of pollution:

- Solid waste (animal manure with bedding) applications may be land applied on frozen soils in fields/areas unless heavy precipitation is forecast in the next 24 hours. When solid wastes are applied on frozen soils without a cover crop, an application setback of at least 100 feet from streams, sinkholes and other sensitive areas is recommended. When solid wastes are applied on frozen soils with a cover crop, an application setback of at least 35 feet from streams, sinkholes and other sensitive areas is recommended. Additional federal, state and local guidelines may apply to application setbacks.
- Liquid (animal manure) waste applications should not be applied on frozen soils. Liquid applications may be land applied in fields/areas within 30 days of the beginning of crop growth when soil conditions are favorable unless heavy precipitation is forecasted before the liquid can be absorbed into the soil profile. Careful planning also needs to be exercised when making liquid manure applications to fields drained by tiles and open ditches.

Guidelines and Setbacks for Nutrient Application

- Apply the right nutrients using the right amount, at the right time, using the right source, and in the right place (4Rs) for the crop based on soil test recommendations or crop nutrient removal values as applicable.
- Apply to a vegetative crop or just before a crop goes vegetative (within three weeks of spring planting).
- When applying manure in fall or winter apply only to a cover crop.
- Apply nutrients where the crop can reach them.
- Although no-tillage is a preferred practice in Kentucky, consider incorporation versus surface application of manure to reduce odors, bind nutrients to soil particles, and reduce the chance for surface runoff.
- Calibrate equipment to achieve planned application rates.
- Be considerate of neighbors when spreading manure.
- Avoid applications near streams, floodplains, or sinkholes.
- Consider implementing site-specific best management practices (BMPs) to protect water quality such as vegetative or forest buffers, cover crops, no-till, contouring, and terracing.
- Avoid applying liquid manure on tile drained or open-ditch fields when fields are saturated or when heavy precipitation (> 0.5 inch in a 24-hour period) is forecast in the next 48 hours.
- Avoid applying to fields without a growing crop or cover crop.
- Avoid applying liquid manures through irrigation past the soil's intake/infiltration rate (no ponding within 24 hours of application).
- Do not exceed 10 tons per acre for one time application of solids.
- Do not exceed ½ inch or 13,500 gallons per acre for one time application of liquids. Use multiple applications of 6,500 gallons or less when possible.
- Do not apply in a state or national park or forest or nature preserve.
- Do not apply in a wellhead protection area.
- Avoid applying manures when field conditions are saturated to avoid rutting, soil compaction, and lessen the chance for liquids to infiltrate into the soil.
- Contact the Kentucky Division of Water immediately in the case of an accidental spill (1-800-928-2380). Every effort should be made to contain the manure on site and protect environmentally sensitive areas.
- Use Table A below to determine manure application setback distances based on the appropriately implemented BMPs.

Table A. Manure Application Setback Distances

	Liquid Manure Operations			Dry Manure Operations	
		Land Application Distance[a]		Barn and/or Manure Storage Structure (Facilities)	Land Application Distance[a]
Setback Feature	**Barn or Lagoon**	**Injection/ Incorporation**	**Other Method**		
Lake, river, stream (a defined channel with flow three months or more of the year), spring, or karst feature (e.g. sinkhole, depression, etc.)	150 feet	35[c] or 75 feet	50[c] or 100 feet	150 feet	35[c] or 75 feet
Water well[b]	300 feet	75[c] or 150 feet	75[c] or 150 feet	300 feet	50[c] or 100 feet

[a] Measured from the edge of the barn, lagoon, or land application area to the nearest edge of the setback feature.
[b] Existing at the time the first animal feeding operation permit is issued.
[c] Utilizing one or more of the following BMPs: Vegetative or forest buffer, cover crops, no-till, contouring, or terracing.

Kentucky No Discharge Operating Permit Holders

Producers obtaining a Kentucky No Discharge Operating Permit (KNDOP) must utilize setbacks and siting criteria in Table B below as described by the Kentucky Division of Water:

The following siting criteria applies to all land application areas and to all new barns and lagoons.

Table B. Setbacks and Siting Criteria

Setback Feature[1]	Barn or Lagoon	Land Application Area	
		Injection	Other Method
Dwelling not owned by applicant, church, school, schoolyard, business, park or other structure to which the general public has access[2]	1,500 feet	500 feet	1,000 feet
Incorporated city limit[2, 3]	3,000 feet	1,000 feet	2,000 feet
Lake, river, blue-line stream or karst feature	150 feet	75 feet	150 feet
Water well not owned by applicant[2]	300 feet	150 feet	150 feet
Downstream[4] water listed as Outstanding State Resource Water, Outstanding National Resource Water or Exceptional Water[5]	1 mile	750 feet	1,500 feet
Downstream[4] public water supply surface water intake	5 miles	1 mile	1 mile
Roadways, primary (state and federal)[2]	150 feet	75 feet	150 feet
Roadways, secondary (county)[2]	150 feet	75 feet	150 feet

[1] Measured from the edge of the barn, lagoon, or land application area to the nearest edge of the setback feature.
[2] Existing at the time the first animal feeding operation permit is issued.
[3] For existing operations, land application setbacks do not apply to city limits.
[4] Measured along gradient.
[5] Designated Outstanding State Resource Waters (OSRWs) are listed in 401 KAR 10:026, Section 5. Outstanding National Resource Waters (ONRWs) and Exceptional Waters (EWs) are listed in 10:030, Section 1.

Water quality BMPs can be used to reduce setback distances while still protecting water quality. Producers should consider implementing crop production BMPs from the Crops Section of the Kentucky Agriculture Water Quality Plan. Other management techniques to protect water quality may include filter strips, stream buffers, grassed waterways, grade stabilization structures, terraces, diversions, and other stormwater management techniques.

Crop Producers

In certain cropping situations involving soybeans, alfalfa and other legumes, nitrogen application may not be recommended according to the University of Kentucky's AGR-1, *Lime and Fertilizer Recommendations.* In these situations, manure or other organic by-products (containing nitrogen) may be applied at rates not to exceed the estimated removal of phosphorus in harvested plant biomass (crop removal rates can be obtained using Table 2.1). Producers may want to consider forages such as orchard grass and/or timothy as alternatives to alfalfa; these forages will enable more frequent manure applications.

New Facilities

New facilities should be built using setback distances in Tables A and B above.

A new barn or lagoon may not be located in:

- A state or national park or forest or nature preserve.
- A wellhead protection area approved by the Kentucky Energy and Environment Cabinet, pursuant to 401 KAR 4:220.
- A 100-year floodplain, unless permitted pursuant to 401 KAR 4:060.
- A jurisdictional wetland as determined by the Natural Resources Conservation Service (NRCS).
- A sinkhole or other enclosed depression where subsidence is evident.

Insufficient Acreage

Producers who do not have enough acreage to utilize the volume of manure generated may want to consider re-evaluating the operation to reduce manure production or consider exporting manure.

Producers who have permission to utilize additional fields, which are not owned or controlled by the operation requiring a nutrient management plan, must develop a land control certification. A sample form of the land control certification is included on the last page of this document, but alternative documentation is acceptable if farm name, farm number, tracts, fields, and dates are included. This certification will be used to verify that the operation requiring a nutrient management plan has permission to access and utilize fields, not owned or controlled by the operation, for the purpose of manure applications. The nutrient management plan should include those fields and should complete and include them in Worksheets 2 and 3. The landowner granting permission should receive a final copy of the KyNMP and verify, on the control certification document, fields controlled by the operation and that control of them is granted for the duration of the plan.

Leachate

Milk-house wastewater and silage leachate can cause major environmental impacts and appropriate measures should be taken to keep these pollutants from entering the Waters of the Commonwealth. Milk-house wastewater should be managed by following KAWQP Livestock BMP #16 (Milking Center Wastewater Treatment). If possible, both products should be discharged into a lagoon or wastewater storage structure.

Additional Resources

University of Kentucky Publications

- AGR-1, *Lime and Fertilizer Recommendations*
- AGR-16, *Taking Soil Test Samples*
- ID-148, *Sampling Animal Manure*

Online Tools

- Kentucky Agriculture Water Quality Act Planning Tool **http://www.bae.uky.edu/awqpt/**
- Nutrient Management Calculator **http://www.bae.uky.edu/awqpt/calculators.htm**

References

This document was adapted from the following documents:

- IP-71, *Nutrient Management in Kentucky.* 2001
- ENRI-136, *Nutrient Management Planning Guidelines for Producers.* 2002
- KY NRCS, *Nutrient Management Practice Code 590.* 2001

Additional information was acquired from the following resources:

- Coffey, Richard. Personal communication, June 2013.
- Hahn, Russel H. and Landeck, Dolores C. ASAE Standards 1999. American Society of Agricultural Engineers: Madison, WI.
- Midwest Plan Service, Livestock Waste Facilities Handbook MWPS-18. Ames, Iowa: Midwest Plan Service. 1985
- Murrell, T. Scott. 2008. "Measuring Nutrient Removal, Calculating Nutrient Budgets." Soil Science Society of America: Madison, WI. Eds. Logsdon, S., Clay, D., Moore, D., and Tsegaye. T. In Soil Science Step-by-Step Field Analysis, pp. 159-182.
- Natural Resources Conservation Service. Agricultural Waste Management Field Handbook. 2008. Retrieved at **http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/?&cid=stelprdb1045935**.
- Natural Resources Conservation Service. Nutrient Management Practice Code 590. 2001. Retrieved at **http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046177.pdf**.

Tables, Worksheets, and Land Control Certification

Table 1.1. Manure and Nutrients as Excreted Per 1,000 lb Live Weight/Day

Animal Type	Volume of Manure Per Animal Unit (cu. ft.)	Dry Matter Manure (lb)	Wastewater (gal/day)	Total Nitrogen (lb)	Total P as P_2O_5 (lb)	Total K as K_2O (lb)	Bedding
Beef (all cattle and calves)[1]	1	8.5	0	0.34	0.21	0.25	33
Dairy cows[1]	1.4	12	5	0.45	0.21	0.35	33
Dairy heifers[5]	0.9	8.5	5	0.27	0.11	0.14	33
Swine lactating sows w/litters[6]	0.96	11	2	0.52	0.41	0.35	33
Swine gestating sows, boars, gilts[6]	0.5	5.5	2	0.26	0.2	0.17	33
Swine wean to finish pigs[6]	1.15	7.3	2	0.52	0.41	0.35	33
Swine grow to finish pigs[5]	1.1	6.5	2	0.54	0.21	0.29	33
Poultry caged layer[5]	0.93	15	0	1.1	0.76	0.47	74
Poultry caged layer pullet[5]	0.73	11.4	0	0.62	0.55	0.31	74
Poultry litter broiler[2]	1.4	22	0	0.96	0.64	0.65	74
Poultry litter/slats breeder layer[5]	0.93	16	0	0.84	0.69	0.36	74
Poultry litter breeder pullet[5]	0.73	11.4	0	0.62	0.55	0.31	74
Poultry turkeys (toms)[3]	0.57	8.8	0	0.53	0.37	0.3	74
Poultry turkeys (hens)[4]	0.77	12.5	0	0.72	0.46	0.37	74
Horses[5]	0.82	7.6	0	0.25	0.11	0.14	32
Sheep and lambs[5]	0.63	10	0	0.45	0.16	0.36	33
Goats[5]	0.65	13	0	0.45	0.25	0.37	33

[1] Adapted from 1999 ASAE Standards
[2] Adapted from NRCS Agricultural Waste Management Field Handbook, March 2008. Based on 2.6 lb average weight and 48 days on feed
[3] Adapted from NRCS Agricultural Waste Management Field Handbook, March 2008. Based on 17.0 lb average weight and 133 days on feed
[4] Adapted from NRCS Agricultural Waste Management Field Handbook, March 2008. Based on 7.6 lb average weight and 105 days on feed
[5] Adapted from NRCS Agricultural Waste Management Field Handbook, March 2008.
[6] From Dr. Richard Coffey, Extension Swine Specialist and Director of the University of Kentucky Research and Education Center at Princeton

Table 2.1. Crop Nutrient Removal Values

Crop	Unit	Yield (lb)		
		Total N	P_2O_5	K_2O
Alfalfa hay	ton	51	14	55
Barley grain	bushel	0.99	0.41	0.32
Barley straw	ton*	13	5.1	39
Bermudagrass—hay	ton	37.6	8.7	33.6
Big bluestem, indiangrass, little bluestem—hay	ton	22	12	58
Bluegrass	ton*	30	12	46
Bromegrass	ton*	32	10	46
Corn grain	bushel	0.9	0.4	0.35
Corn silage	ton	9.7	3.6	8
Corn stover	ton*	16	5.8	40
Eastern gamagrass—hay	ton	35	16.1	31.2
Fescue	ton*	37	12	54
Flax grain	bushel*	2.5	0.7	0.6
Flax straw	bushel*	0.7	0.16	2.2
Forage for pastureland		10.5	3.6	15.9
Millet	bushel*	1.4	0.4	0.4
Oat grain	bushel*	0.77	0.28	0.19
Oat silage	ton*	9	11	45
Oat straw	ton*	12	6.3	37
Orchardgrass	ton*	36	13	54
Other cool season grass/ legume hay	ton	35	12	53
Red clover	ton*	45	12	42
Rye grain	bushel*	1.4	0.46	0.31
Rye straw	ton*	12	3	22
Ryegrass	ton*	43	12	43
Sorghum grain	bushel	0.95	0.41	0.3
Sorghum stover	ton*	28	8.3	42
Sorghum-sudan	ton*	30	9.5	34
Soybean grain	bushel*	3.8	0.84	1.3
Soybean hay	ton*	45	11	25
Switchgrass	ton*	22	12	58
Timothy	ton*	25	11	42
Tobacco	pound	0.07	0.01	0.08
Vetch	ton*	57	15	49
Wheat grain	bushel*	1.5	0.6	0.34
Wheat silage	ton	44	4	20
Wheat straw	ton*	14	3.3	24

* Value from Murrell, 2008.

Table 2.2. Phosphorus Threshold

STP	Application Rate Adjustment	Interpretation
< 400	0	Manure applications can be made based on crop nitrogen requirements
401-600	1	Phosphorus applications at rates not to exceed the estimated removal of phosphorus in the harvested plant biomass
601-800	0.5	Phosphorus applications at rates not to exceed 1/2 of the estimated removal of phosphorus in the harvested plant biomass
>800	-	Phosphorus applications are no longer allowed

Table 2.3. Percent of Original Nutrient Content of Manure Retained By Various Management Systems*

	Beef			Dairy			Poultry			Swine		
Management System	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
Open lot—cool humid region	70	80	70	85	95	95	-	-	-	70	80	70
Liquids and solids in a covered essentially watertight structure	85	95	95	85	95	95	-	-	-	85	95	95
Liquids and solids in a uncovered essentially watertight structure	75	90	90	75	90	90	-	-	-	75	90	90
Liquids and solids (diluted less than 50%)—waste storage pond	80	95	95	80	95	95	-	-	-	80	95	95
Manure with bedding in roofed storage	80	95	95	80	95	95	70	95	95	-	-	-
Manure with bedding in unroofed storage leachate lost	75	85	85	75	85	85	-	-	-	-	-	-
Manure stored in pits beneath slatted floor	85	95	95	85	95	95	90	95	85	85	95	95
Anaerobic lagoon or stored in waste storage pond diluted >50%	35	50	65	35	50	65	30	50	60	30	50	60

* Adapted from 1992 NRCS Agricultural Waste Management Field Handbook

Table 2.4. Percent of Nutrients from Manure Available to a Crop During the Year of Application in Comparison with Fertilizer Nutrients*

		Availability Coefficient	
Nutrient and Application Type		**Poultry or Liquid**	**Other Manures**
Nitrogen (N) Corn, Tobacco, Annual Grasses or Sorghum	**Spring Applied**		
	Incorporation: same day	75	60
	Incorporation: 2 days or less	65	50
	Incorporation: 3-4 days	55	45
	Incorporation: 5-6 days	50	40
	Incorporation: 7 days or more	45	35
	Fall Applied		
	Without cover crop	15	20
	With cover crop	50	40
	Small Grains (pre-plant)	50	40
	Pasture (Fall or early Spring)	80	60
Phosphate (P_2O_5)		80	80
Potash (K_2O)		100	100

*Note: Information from Table 2.3 or from a laboratory analysis will be used as a basis for Table 2.4. Table 2.4 Source: AGR-146 "Using Animal Manures as Nutrient Sources" 8/2000 University of Kentucky.

WORKSHEET 1—SOLIDS. Estimating Nutrients Generated per Confinement Period

Step 1. Nutrients Generated (As Excreted)

	Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Solid [a]	x	Average Weight (lb)	÷	1000	x	Confinement Period [b] (days/year)	=	Animal Unit Days		Table 1.1 Values	=	N	P_2O_5	K_2O
													N		=			
													P_2O_5		=	+		
1.			x		x		÷	1000	x		=		x K_2O		=		+	
													N		=			+
													P_2O_5		=	+		
2.			x		x		÷	1000	x		=		x K_2O		=		+	
													N		=			+
													P_2O_5		=	+		
3.			x		x		÷	1000	x		=		x K_2O		=	=		
																	=	
														Step 1 Total	=			
																	(lb)	

Step 2. Manure Generated (As Excreted)

	Animal Unit Days (from Step 1)	x	Manure/A.U. (See Table 1.1)	=	Volume of Manure				
1.		x		=		cubic feet			
2.		x		=		cubic feet			
3.		x		=		cubic feet	**Step 2 Total**	=	**cu.ft.**
							1 + 2 + 3		

continued

WORKSHEET 1—SOLIDS. *(continued)*

Step 3. Total Tons

	Step 2 Vol. of Manure	÷	See Table 1.1 Bedding Value	=	Total Tons
1.		÷		=	
2.		÷		=	
3.		÷		=	

Step 3 Total = _____ **tons**

1 + 2 + 3

Step 4. Weighted Nutrient Values Before Nutrient Losses

	Step 1	÷	Step 3 Total	=
N		÷		=
P_2O_5		÷		=
K_2O		÷		=

	N	P_2O_5	K_2O
Step 4 Total =			
		(lb/ton)	

[a.] The percent of the manure that is handled as a solid.

[b.] Confinement period should be adjusted for animals that are only in confinement for a portion of the day. For example, if animals spend 16 hours on pasture and 8 hours in confinement, then the confinement period would be 1/3 of a day or 122 days/year.

Modified January 14, 2014

WORKSHEET 1—LIQUIDS. Estimating Nutrients Generated per Confinement Period

Step 1. Nutrients Generated (As Excreted)

Animal Type (See Table 1.1)	Number of Animals	x	Percent Waste as Liquid [a]	x	Average Weight (lb)	÷	1,000	x	Confinement Period [b] (days/ year)	=	Animal Unit Days		Table 1.1 Values	=	N	P_2O_5	K_2O
												N		=			
												P_2O_5		=			
1.		x		x		÷	1,000	x		=		x K_2O		=			
												N		=			
												P_2O_5		=			
2.		x		x		÷	1,000	x		=		x K_2O		=			
												N		=			
												P_2O_5		=			
3.		x		x		÷	1,000	x		=		x K_2O		=			
														Step 1 Total	=			

Step 2. Manure Generated (As Excreted)

Animal Unit Days (from Step 1)	x	Manure/A.U. (See Table 1.1)	x	Conversion	=	Volume of Manure				
1.	x		x	7.5	=		gallons			
2.	x		x	7.5	=		gallons			
3.	x		x	7.5	=		gallons	**Step 2 Total**	=	**gallons**
								1 + 2 + 3		

continued

WORKSHEET 1—LIQUIDS. *(continued)*

Step 3. Water Added by Wastage or Cleaning

	Gallons/Day (See Table 1.1)	x	Number of Animals	x	Confinement Period (from Step 1)	=	Volume of Water	
1.	_____	x	_____	x	_____	=	_____	gallons
2.	_____	x	_____	x	_____	=	_____	gallons
3.	_____	x	_____	x	_____	=	_____	gallons

Step 3 Total = _____ **gallons**

1 + 2 + 3

Step 4. Water Added by Feedlot Runoff

	Width (feet)	x	Length (feet)	x	Days Before Pump [c]	x	Conversion	=	Feedlot Runoff	
Paved Surface [d]	_____	x	_____	x	_____ (days before pump ÷ 365)	x	18.75	=	_____	gallons
Unpaved Surface [e]	_____	x	_____	x	_____ (days before pump ÷ 365)	x	11.25	=	_____	gallons

Step 4 Total = _____ **gallons**

Paved + Unpaved

Step 5. Water Added from Rainfall minus Evaporation on Storage Pond

	Width (feet)	x	Length (feet)	x	Frequency of Pump [c]	x	Conversion	=	Net Rainfall on Storage Pond
Lagoon/Pond Surface Area	_____	x	_____	x	_____ (days before pump ÷ 365)	x	11.25	=	

Step 5 Total = _____ **gallons**

continued

WORKSHEET 1—LIQUIDS. *(continued)*

Step 6. Total Volume of Manure Produced

Step 2	+	Step 3	+	Step 4	+	Step 5	=
_____	+	_____	+	_____	+	_____	=

Step 6 Total = _____ **gallons**

Step 7. Weighted Nutrient Values Before Nutrient Losses

	Step 1	÷	Step 6 Total	x	Conversion	=
N	_____	÷	_____	x	1,000	=
P_2O_5	_____	÷	_____	x	1,000	=
K_2O	_____	÷	_____	x	1,000	=

Step 7 Total =

N	P_2O_5	K_2O

(lb/1,000 gallons)

a. The percent of the manure that is handled as a liquid.
b. Confinement period should be adjusted for animals that are only in confinement for a portion of the day. For example, if animals spend 16 hours on pasture and 8 hours in confinement, then the confinement period would be 1/3 of a day or 122 days/year.
c. The number of days before the storage pond/lagoon is pumped for land application divided by 365. For example, if the pond is pumped twice a year, it would be .5 (180 ÷ 365 = .5).
d. Impervious surface areas such as concrete, asphalt, and roofs without gutters that contribute water to storage pond/lagoon.
e. Pervious surface areas such as gravel, dirt, or soil cement that contribute water to storage pond/lagoon.

WORKSHEET 2—SOLIDS. Nutrient Balance

Tract	Field No.	Acres	Soil Test P Value (Mehlich 3)

	N	P_2O_5	K_2O
Step 1. Crop or Crop Sequence/Rotation			
See Table 2.1 Options			
Step 2. Realistic Yield (Average from 5-10 Years on a per acre basis)			
Step 3. Plant Nutrients Needed or Allowed (lb/ac)			
N _____ (Table 2.1 Value for N) x _____ (Step 2) = _____			
P _____ (Table 2.1 Value for P) x _____ (Step 2) = _____			
K _____ (Table 2.1 Value for K) x _____ (Step 2) = _____			
		P_2O_5	
Step 4. Adjusted P_2O_5 Application Rate According to Threshold			
P _____ (Step 3 P_2O_5) x _____ (Table 2.2 Value) = _____			
	N	**P_2O_5**	**K_2O**
Step 5. Fertilizer Credits (lb/ac)			

continued

WORKSHEET 2—SOLIDS. *(continued)*

	N	P_2O_5	K_2O
Step 6. Plant Nutrients Needed Minus Credits (lb/ac)			
N ____ (Step 3 for N) – ____ (Step 5 for N) = ____			
If Step 4 > 0:			
P ____ (Step 4 for P) – ____ (Step 5 for P) = ____			
If Step 4 = 0:			
____ (Step 3 for P) – ____ (Step 5 for P) = ____			
K ____ (Step 3 for K) – ____ (Step 5 for K) = ____			
	N	**P_2O_5**	**K_2O**
Step 7. Nutrients in Manure (lb/ton)			
Step 4 Values from Solids Worksheet 1 **or** use Lab Results			
	N	**P_2O_5**	**K_2O**
Step 8. Percent Nutrients Retained in System			
Enter Table 2.3 values **or** Enter zero if lab analysis is used			
	N	**P_2O_5**	**K_2O**
Step 9. Net Retained Nutrients in Manure (lb/ton)			
Enter zero if lab analysis is used			
N ____ (Step 7 for N) x ____ (Step 8 for N) = ____			
P ____ (Step 7 for P) x ____ (Step 8 for P) = ____			
K ____ (Step 7 for K) x ____ (Step 8 for K) = ____			
	N	**P_2O_5**	**K_2O**

continued

WORKSHEET 2—SOLIDS. *(continued)*

Step 10. Percent of Available Nutrients		80%	100%
Enter Table 2.4 Value for N			
	N	**P_2O_5**	**K_2O**
Step 11. Net Available Nutrients (lb/ton)			

If Lab Results are used in Step 7:

N _____ (Step 7 for N) x _____ (Step 10 for N) = _____

P _____ (Step 7 for P) x _____ (Step 10 for P) = _____

K _____ (Step 7 for K) x _____ (Step 10 for K) = _____

If Solid Worksheet 1 Values are used in Step 7:

N _____ (Step 9 for N) x _____ (Step 10 for N) = _____

P _____ (Step 9 for P) x _____ (Step 10 for P) = _____

K _____ (Step 9 for K) x _____ (Step 10 for K) = _____

	N	**P_2O_5**	**K_2O**
Step 12. Application Rate (tons/ac)			

N _____ (Step 6 for N) ÷ _____ (Step 11 for N) = _____

P _____ (Step 6 for P) ÷ _____ (Step 11 for P) = _____

K _____ (Step 6 for K) ÷ _____ (Step 11 for K) = _____

continued

WORKSHEET 2—SOLIDS. *(continued)*

	N	P_2O_5	K_2O
Step 13. Net Application Amount for All Nutrients (lb/ac)			

N _____ (Step 11 for N) x _____ (Application Rate) = _____

P _____ (Step 11 for P) x _____ (Application Rate) = _____

K _____ (Step 11 for K) x _____ (Application Rate) = _____

	N	P_2O_5	K_2O
Step 14. Nutrient Needs (negative) or Surpluses (positive) (lb/ac)			

N _____ (Step 13 for N) – _____ (Step 6 for N) = _____

P _____ (Step 13 for P) – _____ (Step 6 for P) = _____

K _____ (Step 13 for K) – _____ (Step 6 for K) = _____

Step 15. Balance

Tons Available _____ – **Tons Applied in Field** _____ **= Balance** _____

Step 3 from Solids Worksheet 1 or Balance from Previous Worksheet 2

Application Rate x Field Acres **or** to deplete supply in one field: Tons Available ÷ Num. of Acres = Uniform App. Rate (Be sure not to exceed 10 tons/acre)

Modified January 14, 2014

WORKSHEET 2—LIQUIDS. Nutrient Balance

Tract	Field No.	Acres	Soil Test P Value (Mehlich 3)

Step 1. Crop or Crop Sequence/Rotation	
See Table 2.1 Options	

Step 2. Realistic Yield (Average from 5-10 Years on a per acre basis)	

	N	**P_2O_5**	**K_2O**
Step 3. Plant Nutrients Needed or Allowed (lb/ac)			

N _____ (Table 2.1 Value for N) x _____ (Step 2) = _____

P _____ (Table 2.1 Value for P) x _____ (Step 2) = _____

K _____ (Table 2.1 Value for K) x _____ (Step 2) = _____

		P_2O_5	
Step 4. Adjusted P_2O_5 Application Rate According to Threshold			

P _____ (Step 3 P_2O_5) x _____ (Table 2.2 Value) = _____

	N	**P_2O_5**	**K_2O**
Step 5. Fertilizer Credits (lb/ac)			

continued

WORKSHEET 2—LIQUIDS. *(continued)*

	N	P_2O_5	K_2O
Step 6. Plant Nutrients Needed Minus Credits (lb/ac)			

N _____ (Step 3 for N) – _____ (Step 5 for N) = _____

If Step 4 > 0:

P _____ (Step 4 for P) – _____ (Step 5 for P) = _____

If Step 4 = 0:

_____ (Step 3 for P) – _____ (Step 5 for P) = _____

K _____ (Step 3 for K) – _____ (Step 5 for K) = _____

	N	P_2O_5	K_2O
Step 7. Nutrients in Manure (lb/1,000 gallons)			

Step 4 Values from Liquids Worksheet 1 **or** use Lab Results

	N	P_2O_5	K_2O
Step 8. Percent Nutrients Retained in System			

Enter Table 2.3 values **or** Enter zero if lab analysis is used

	N	P_2O_5	K_2O
Step 9. Net Retained Nutrients in Manure (lb/1,000 gallons)			

Enter zero if lab analysis is used

N _____ (Step 7 for N) x _____ (Step 8 for N) = _____

P _____ (Step 7 for P) x _____ (Step 8 for P) = _____

K _____ (Step 7 for K) x _____ (Step 8 for K) = _____

continued

WORKSHEET 2—LIQUIDS. *(continued)*

	N	P_2O_5	K_2O
Step 10. Percent of Available Nutrients		80%	100%
Enter Table 2.4 Value for N			

	N	P_2O_5	K_2O
Step 11. Net Available Nutrients (lb/1,000 gallons)			

If Lab Results are used in Step 7:

N _____ (Step 7 for N) x _____ (Step 10 for N) = _____

P _____ (Step 7 for P) x _____ (Step 10 for P) = _____

K _____ (Step 7 for K) x _____ (Step 10 for K) = _____

If Liquid Worksheet 1 Values are used in Step 7:

N _____ (Step 9 for N) x _____ (Step 10 for N) = _____

P _____ (Step 9 for P) x _____ (Step 10 for P) = _____

K _____ (Step 9 for K) x _____ (Step 10 for K) = _____

	N	P_2O_5	K_2O
Step 12. Application Rate (1,000 gallons/ac)			

N _____ (Step 6 for N) ÷ _____ (Step 11 for N) = _____

P _____ (Step 6 for P) ÷ _____ (Step 11 for P) = _____

K _____ (Step 6 for K) ÷ _____ (Step 11 for K) = _____

continued

WORKSHEET 2—LIQUIDS. *(continued)*

	N	P_2O_5	K_2O
Step 13. Net Application Amount for All Nutrients (lb/ac)			

N _____ (Step 11 for N) x _____ (Application Rate) = _____

P _____ (Step 11 for P) x _____ (Application Rate) = _____

K _____ (Step 11 for K) x _____ (Application Rate) = _____

	N	P_2O_5	K_2O
Step 14. Nutrient Needs (negative) or Surpluses (positive) (lb/ac)			

N _____ (Step 13 for N) – _____ (Step 6 for N) = _____

P _____ (Step 13 for P) – _____ (Step 6 for P) = _____

K _____ (Step 13 for K) – _____ (Step 6 for K) = _____

Step 15. Balance

Tons Available _____ (Step 6 from Liquids Worksheet 1 or Balance from Previous Worksheet 2) **–** **Tons Applied in Field** _____ (Application Rate x Field Acres x 1,000 **or** to deplete supply in one field: Gallons Available ÷ Num. of Acres = Uniform App. Rate (Be sure not to exceed 13,000 gallons/acre)) **= Balance** _____

Modified January 14, 2014

WORKSHEET 3. Application Rates and Land Requirements [1]

Tract No.

Field No.	Acres	Soil Test Phosphorus (STP)	Crop Rotation / Sequence	Planned Application Date or Timing	Planned Application Rate[2] (tons/ac or 1,000 gal/ac)	Solid, Liquid, or Commercial Fertilizer (S, L, or C)	Actual Application Date	Actual Application Rate[2] (tons/ac or 1,000 gal/ac)	Weather at Time of Application[3] (Cloudy, Raining, Sunny)	
									24 Hours Before	24 Hours After

1. Where land application is occurring under long term lease or agreement with adjacent landowner, fields must be included in the above table.
2. Fields that have a "High" soil test phosphorus (>400) should implement Best Management Practices (BMPs) to reduce the risk of nutrient movement to sensitive waterbodies. BMPs may include, but not be limited to: installing conservation buffers, reducing P2O5 application rate, incorporating manure, adding chemical treatments to litter that tie up soluble P and keep it from moving over the landscape, and/or adjusting application timing.
3. It illegal to make land applications when the ground is frozen. It is recommended that land applications are not made within 48 hours of forecasted precipitation.

Modified January 14, 2014

Land Control Certification

Farm Name: _____

Farm Number: _____

Tract: _____

Field(s): _____

_____

_____

_____

_____

_____

For the above described land unit(s) that I own, I hereby certify that my Tenant,

_____,

will have control of this land for the purpose of satisfying the requirements of a Kentucky Nutrient Management Plan.

The proposed KyNMP plan will be in effect from

_____ to _____ .

Landowner Name:

_____

_____

Landowner Signature

_____

Date

Cooperative Extension Service

Agriculture and Natural Resources
Family and Consumer Sciences
4-H Youth Development
Community and Economic Development

MARTIN-GATTON COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT

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