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Land Application of Broiler and Turkey Litter for Farming Operations Without a DEQ Permit

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Introduction

Poultry litter (poultry manure and a bedding material such as sawdust, pine bark, or peanut hulls) is a good source of nutrients and organic matter for growing crops. Land application of poultry litter on farms has been the mainstay of effective and safe usage for years. Unfortunately, improper management of litter applications may cause nutrient enrichment and/or contamination of surface and ground water resources. The key to proper management is an understanding of the nutrients available in the litter, the nutrient requirements of the crops to be produced, and the potential for the litter and/or nutrients to reach surface or ground waters.

The Virginia General Assembly passed the Poultry Waste Management Act in 1999 to help assure environmentally-responsible handling of poultry litter. The act requires poultry growers with confined poultry feeding operations that have an annual production of 20,000 or more chickens or 11,000 or more turkeys to obtain a Virginia Pollution Abatement (VPA) permit. This permit governs the management of poultry waste and establishes requirements for proper nutrient management, waste storage, and tracking and accounting of poultry waste. The Poultry Waste Management Act also places regulatory requirements on "Poultry Waste Brokers," defined as "anyone, other than the poultry grower, who possesses more than 10 tons of poultry waste in any 365-day period and who transfers some or all of the waste to other persons."

Poultry growers covered by a VPA permit must, under the terms of the permit, have a nutrient management plan (NMP) that is approved by the Virginia Department of Conservation and Recreation. The NMP manages the amount, placement, timing, and application of manure, fertilizer, biosolids (treated sewage sludge), and other materials containing plant nutrients. It provides the operator with environmentally-sound guidance for managing all nutrient sources on a site-specific basis, taking into account the crops to be grown and the crop yield potential.

Nutrient Management Plans are not limited to VPA permit holders. Anyone with a farming operation in Virginia can receive free assistance in developing a nutrient management plan. For more information, contact your local Virginia Cooperative Extension Agent or your Department of Conservation and Recreation regional watershed office. The phone number for the local Extension Office can be found in the government pages of your phone book. Contact information for the DCR office serving your location can be found in the Appendix at the end of this publication.

This publication is intended to provide guidance on land-applying poultry litter in an environmentally-sound manner. The guidelines discussed herein are based upon the recommendations of the Virginia Departments of Environmental Quality and Conservation and Recreation. This material is not a substitute for an approved nutrient management plan (NMP), which is required for operations with a VPA permit.

Note: Several steps are required to calculate the appropriate poultry litter application rate for a given field and crop. The minimum data required for these calculations includes a soil test report from Virginia Tech where both the soil series (as listed on a NRCS

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soil survey map) and all of the crops to be grown on the field for a two-year period were listed when the sample was submitted to the lab. If this information was submitted, the lab report will include recommendations for nutrient applications to the field for all of the crops to be grown. With this data, and the worksheets provided in this publication, you can calculate the litter application rate(s) for your field. If you do not have a soil test report with data for the two-year rotation, you may wish to submit a new sample to the laboratory. Alternatively, contact your local Virginia Cooperative Extension Agent or your Department of Conservation and Recreation regional watershed office for assistance in making these calculations.

Developing a Plan for Land-Application of Nutrients from Poultry Litter

A properly designed land application plan includes a soil fertility program that uses litter to supply as much of the required plant nutrients as possible without oversupplying any nutrient. Nitrogen in poultry litter is readily converted to water soluble forms and nitrogen not taken up by growing plants can leach into ground water or runoff into surface water supplies. Therefore, the amount of nitrogen in a litter application should not exceed the nitrogen requirement of the crop being produced immediately following the application. Phosphorus is less soluble in water and less likely than nitrogen to move into ground or surface water. Therefore, the application rate for P_2O_5 (phosphate) can be based on crop P uptake for a two-year crop rotation. However, research has shown that repeated over-application of phosphorus can result in phosphorus losses to surface waters, so, even though P is less mobile than N, repeated over-application of P can result in water pollution and must be avoided. Unfortunately, the relative supply of nutrients in poultry litter seldom matches crop needs. As a result, one calculates the litter application rate for both the crop N and P requirements and applies at the lower application rate. Commercial fertilizer is generally added in addition to litter to provide the nutrient that is lacking.

The DEQ Poultry Litter Storage and Utilization Fact Sheet provides guidance for poultry litter management on non-poultry farms (www.deq.state.va.us/regulations/xwaterregs.html). These DEQ guidelines suggest that for fields with a soil test of very high (VH) in phosphorus, poultry litter should be applied based on crop removal of phosphorus for a two-year rotation, as long as nitrogen is not over-applied to the crop following litter applications. It is further suggested that following litter application to very high testing soils, no additional phosphorus should be applied to these fields from any source, during the two-year rotation. For all other situations (i.e. soils testing low, medium or high in phosphorus), the DEQ guidelines recommend that litter may be applied to supply nutrients based on soil test recommendations. The procedures and steps outlined in this publication for calculating the rate of poultry litter application on non-poultry farms are consistent with the DEQ guidelines outlined in the Poultry Litter Storage and Utilization Fact Sheet.

Use the following steps to develop a land application plan:

1. Determine the amount of nutrients in the litter.
2. Estimate the availability of the nutrients in the litter.
3. Collect soil samples to determine the existing nutrient levels in the soil.
4. Estimate expected crop yield and corresponding crop nutrient requirements.
5. Determine the litter application rate needed to match nutrient availability in the litter and the soil with the crop requirements.
6. Determine fertilizer applications needed to provide nutrients not provided by litter.

Nutrients in Poultry Litter

The nutrient content of poultry litter depends on many factors including poultry production practices and litter storage methods. Significant nutrient losses occur during storage; data from North Carolina indicates that stockpiled broiler litter typically contains less than half as much nitrogen as litter at the time of removal from the production house. Therefore, the litter nutrient content should be tested as close to the time of land application as possible.

Poultry growers holding a VPA permit are required to test the nutrient content of their litter at least once every three years. The VPA permit also requires growers to provide copies of the most recent litter analysis to anyone receiving 10 or more tons of litter within a year. If you receive litter from someone else, request a copy of their most recent litter analysis. Laboratory analyses of the litter should include total nitrogen, ammonium nitrogen (NH_4-N), phosphorus (P_2O_5), potassium (K_2O), and moisture content (% moisture).

If a laboratory analysis of the litter is not available, the values presented in Table 1 may be used to estimate

nutrient content of litter. However, the actual nutrient value of the litter you apply can vary significantly from the average values presented. Variations greater than ten-fold have been reported between minimum and maximum litter nutrient values.

Table 1. Average Values for Manure Tested in Virginia. Based upon samples received January 1989 – November 1992[1].

Manure Type[2]	Total N	NH_4	P_2O_5	K_2O
Dry Broiler litter	63	12	62	29
Dry Turkey litter	62	15	64	24
Layer or Breeder	36	9	65	24
Liquid Poultry	51	33	41	31

[1.] Reproduced from Virginia Nutrient Management Standards and Criteria, Department of Conservation and Recreation, Commonwealth of Virginia, November 1995.

[2.] Values in lbs of nutrient per ton except for liquid poultry, which is in lbs of nutrients per 1000 gal manure.

Table 2. Average Values for Post-Phytase Poultry Manure Tested in Virginia. Based on samples analyzed from Jan. 2000 – February 2001. (Unpublished Data).

Manure Type[1]	Total N	NH_4	P_2O_5	K_2O	Moisture (%)
Poultry Without Litter	46	7.5	29	20	61
Poultry With Litter	69	13	52	44	29

[1]Except for moisture content, values are in lbs of nutrient per ton.

Availability of the nutrients in the litter

PHOSPHORUS and POTASSIUM: The phosphorus and potassium in litter can be substituted for commercial fertilizer on a pound-for-pound basis. Use the value shown on the litter sample analysis (or from Table 1 if an analysis is not available) to estimate the phosphorus and potassium available in litter.

NITROGEN: The total nitrogen content of litter should not be substituted on a pound-for-pound basis for that in commercial fertilizer because some of the nitrogen in litter is in an organic form that is not readily available to plants and some is lost to the atmosphere as ammonia gas. Therefore, you must calculate the percentage of the manure nitrogen that is plant available.

Nitrogen (N) occurs in different forms in manure—both mineral and organic N. The mineral portion (approximately 20 percent of the total) is mainly present as urea, and in litter analyses is referred to as ammonium-N (NH_4-N). Up to 75 percent of the mineral portion of the N is lost to the atmosphere as ammonia gas within seven days after spreading if the manure is not soil-incorporated. The actual portion of mineral N lost is determined by the time that elapses between spreading and soil incorporation. The decision to incorporate manure will depend on factors such as cropping system, cost of incorporation, cost of nitrogen, erosion hazard created by the tillage, and availability of equipment.

The organic N fraction gradually becomes available for crop uptake as the litter decomposes. The amount of N available in the first year from the organic fraction depends upon when the litter is applied (as a preplant application or as a winter topdress on winter annuals). When determining how much nitrogen is needed, the nitrogen available from previous litter applications (called "residual" nitrogen) is also considered.

Worksheet 1 helps you calculate the available nitrogen content of the litter and nitrogen credits from previous legume crops and manure applications. The greatest accuracy in determining nutrient content will be obtained from litter sample test reports. Otherwise, use the values in Table 1. However, be aware that you have the potential to significantly over- or under-apply nutrients if you use these data.

Unfortunately, there are a lot of data to be considered and a lot of calculations required to determine proper litter application rates. Two sets of example calculations are included in the Appendix of this paper to help you to understand the necessary calculations. If you are having difficulty with the Worksheets, contact you local Extension Agent or DCR representative for assistance.

Determining Soil Nutrient Levels and Expected Crop Yield

Soil sampling determines the level of nutrients present in the soil. Soil samples from fields where litter is to be applied should be collected and analyzed at least once every three years for pH, phosphorus, potassium, calcium, and magnesium. Contact your local Virginia Cooperative Extension office for soil sampling materials and instructions on proper sampling methods.

When you submit a soil sample to the Virginia Tech Soil Laboratory, the submission form asks you to indicate the crops to be grown on the field over the rotation of interest and the soil series from which the sample was collected. If you submit samples every three years, list all crops to be grown in the three-year rotation. The soil series data comes from soil surveys conducted by the Natural Resources Conservation Service (NRCS). If you do not know the soil series in your field(s), your local NRCS office can help you determine them. Based upon this information, the report you receive from the Virginia Tech Soils Laboratory will provide you with recommendations for the amount of N, P, and K you should apply to each crop grown in the rotation. You need this data to complete Worksheet 2.

The soil test report also provides you with the Productivity Group for the **first** crop listed on the submission form. Unfortunately, the Productivity Group is a function of the crop grown, and the soil test report does not provide the Productivity Group for additional crops listed. The Productivity Group is needed for each crop to estimate the yield potential, and the yield potential is needed to estimate the crop phosphorus uptake and removal. If more than one crop is grown during the rotation, contact your local Virginia Cooperative Extension agent or DCR to determine the correct Productivity Group for each of the crops to be grown on the field.

Determining Crop Nutrient Requirements

Table 3 provides typical nutrient removal rates for various crops per unit of crop yield.

Table 4 provides estimates of yield for various non-irrigated crops as a function of soil productivity group. The soil productivity group is specified on the soil test from the Virginia Tech Soils Laboratory, if the form submitted with the soil sample indicated the soil series and crops to be grown. Remember, however, that the soil productivity group is different for different crops, so make sure the Soil Productivity Group you are using is for the crop of interest. If your crop(s) is not listed in Table 4, consult your local Virginia Cooperative Extension office or your regional DCR office for the yield estimates.

Land Application Conditions and Setbacks

In addition to determining the appropriate litter application rates, there are other considerations concerning when and where litter can be safely applied:

1. Do not spread litter when the field is frozen, covered with snow or ice, or saturated with water. These conditions encourage runoff, which can carry nutrients to surface water.

2. Application of litter on slopes greater than 15% should be avoided. However if litter is applied to pasture or hay fields with slopes greater than 15%, at least three inches of forage height should be maintained to reduce runoff potential.

3. To ensure nutrient utilization, apply litter within 30 days of crop planting or follow the schedule presented in Table 5. Additional commercial fertilizer (especially nitrogen) should be applied as a split application from the poultry litter, either topdressed or sidedressed.

4. Do not spread litter within the following buffer areas:

   - 100 feet from wells or springs
   - 50 feet from surface water (25 feet if incorporated)
   - 10 feet from agricultural drainage ditches
   - 200 feet from neighboring occupied dwellings unless the occupant waives or reduces the setback in writing
   - 50 feet from sinkholes
   - 50 feet from limestone outcroppings
   - 25 feet from other rock outcroppings

Spreading Poultry Litter

A nutrient management plan is only as good as its application. To spread poultry litter at the desired rate, it is necessary to calibrate your spreading equipment. This should be done at least annually and more frequently if the consistency of the litter is obviously different from the last batch used for calibration.

Table 3. Typical Crop Nutrient Removal per Unit Yield[1]

Crop (unit yield)	N	P_2O_5	K_2O
	---------- (lbs of nutrient/unit yield) ----------		
Alfalfa (ton)	45	10	45
Barley Grain (bu)	1.25	0.375	0.25
Barley Silage (ton)	12.5	5	10
Corn Grain (bu)	1.1	0.35	0.27
Corn Silage (ton)	7.65	4.7	8.3
Cotton seed & lint (lbs)	0.04	0.013	0.01
Grain Sorghum (bu)	1	0.41	0.25
Hay (ton)[2]	53.3	18	52
Hay/Pasture (ton)[2]	60	19	52
Rye Silage (ton)	16.6	6.67	21.8
Soybeans (bu)	3.75	0.88	1.42
Wheat (bu)	1.25	0.56	0.61

[1] Reproduced from DEQ Poultry litter storage and utilization fact sheet.

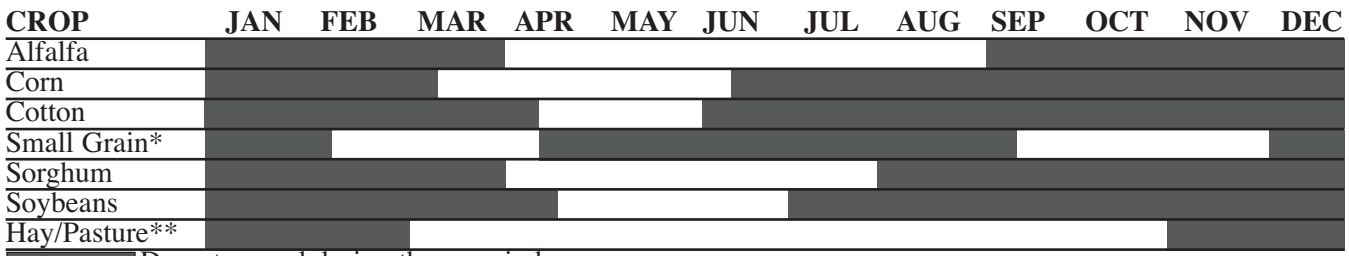
[2] Use hay rate if two or more cuttings occur. Use hay/pasture rate if only one cutting occurs and animals are then pastured.

Table 4. Estimated yields in bushels (bu) or tons (T) per acre (A) for various non-irrigated crops for identified soil productivity groups based on VALUES.

	Soil Productivity Group								
	I		II		III		IV		V
Crop	A	B	A	B	A	B	A	B	
Corn									
Grain (bu/A)	160	150	140	130	120	110	100	85	65
Silage (T/A)	21	20	19	18	17	16	15	13	10
Grain Sorghum (bu/A)	140	130	120	110	100	90	90	80	
Soybeans (bu/A)									
Early season	50	45	40		35		25		20
Late season[1]	40	34	34	30	25		18		15
Wheat (bu/A)									
Standard	64		56		48		40		24
Intensive	80		70		60		50		30
Barley (bu/A)									
Standard	100		70		60		50		30
Intensive	115		88		75		63		38
Oats (bu/A)	80		80		80		60		60
Tallgrass Hay (T/A)	>4.0		3.5-4.0	3.0-3.5	<3.0		NA		NA
Bermudagrass Hay (T/A)	>6.0		4.0-6.0		<4.0		NA		NA
Alfalfa Hay (T/A)	>6.0		4.0-6.0		<4.0		NA		NA

[1]Late season beans would be planted on or after 6/21 of that year.

Table 5: Poultry Litter Spreading Schedule. DEQ Poultry Litter Storage and Utilization Fact Sheet (www.deq.state.va.us/regulations/xwaterregs.html).



* Apply no more than 40 lbs of plant available nitrogen per acre in the fall. ** Except for Alfalfa and other warm season grasses.

Record Keeping

To assure that the proper amount of nutrients is added to fields in future years, it is important to keep accurate records of litter and fertilizer applications. You should keep the litter nutrient analysis data, soil sample results, and copies of the worksheets used to determine litter and fertilizer application rates and spreader calibration. The following form will assist you in record keeping.

Nutrient Management Field Record Sheet

Field Name: _____ Field Number: _____ Tract Name: _____

Tract Number: _____ Acres: _____

Crop Name: _____ Planting Date: _____ Harvest Date: _____

Yield (Yield/A): _____

Manure/Biosolids Source[1], Application Rate, and Time of Year From Job Sheet: _____

Manure/Biosolids Application						Fertilizer/Lime	
Date	Incorporation[2] Time	Acres Applied	Number of loads	Amount/ load	Actual Rate/ acre	Date	Type/Rate/A

Crop Name: _____ Planting Date: _____ Harvest Date: _____

Yield (Yield/A): _____

Manure/Biosolids Source[1], Application Rate, and Time of Year From Job Sheet: _____

Manure/Biosolids Application						Fertilizer/Lime	
Date	Incorporation[2] Time	Acres Applied	Number of loads	Amount/ load	Actual Rate/ acre	Date	Type/Rate/A

Verification of Rate/Acre {(Amount/load x Number of loads)/acres applied = rate/acre} and adjustment notes:

_____

[1]Manure source: biosolids, calf barn, bedded pack, upper pit, horse barn, etc.

[2]Incorporation: Immediate, greater than two days (>2 days), >4 days, or >7 days.

References

Poultry Litter Storage and Utilization Fact Sheet. Virginia Department of Environmental Quality. Richmond, Virginia.

Virginia Nutrient Management Standards and Criteria. Nov. 1995.
Department of Conservation and Recreation
Division of Soil and Water Conservation
203 Governor Street, Suite 206 Richmond, VA 23219-2094

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Appendix

Contact Information

If you have questions regarding litter application, contact your local Virginia Cooperative Extension Agent (listed in the phone book under County Government) or your local Department of Conservation and Recreation representative, as shown below:

DCR's regional offices

Abingdon (Tennessee-Big Sandy Watersheds Office): 252 W. Main Street, Suite 3, Abingdon, Va. 24210; phone: (276) 676-5528, fax: (276) 676-5527

Chase City (Roanoke Office): Bobby Long
11632 Hwy 15 S, Clarksville, VA 23927
phone: (434) 374-3648; fax: (434) 374-3648

Dublin (New River Watershed Office): P. O. Box 1506, Dublin, Va. 24084; phone: (540) 643-2590, fax: (540) 643-2597

Fredericksburg (Rappahannock Watershed Office): 2601 Princess Anne St., Suite 101, Fredericksburg, Va. 22401; phone (540) 899-4463; fax: (540) 899-4389

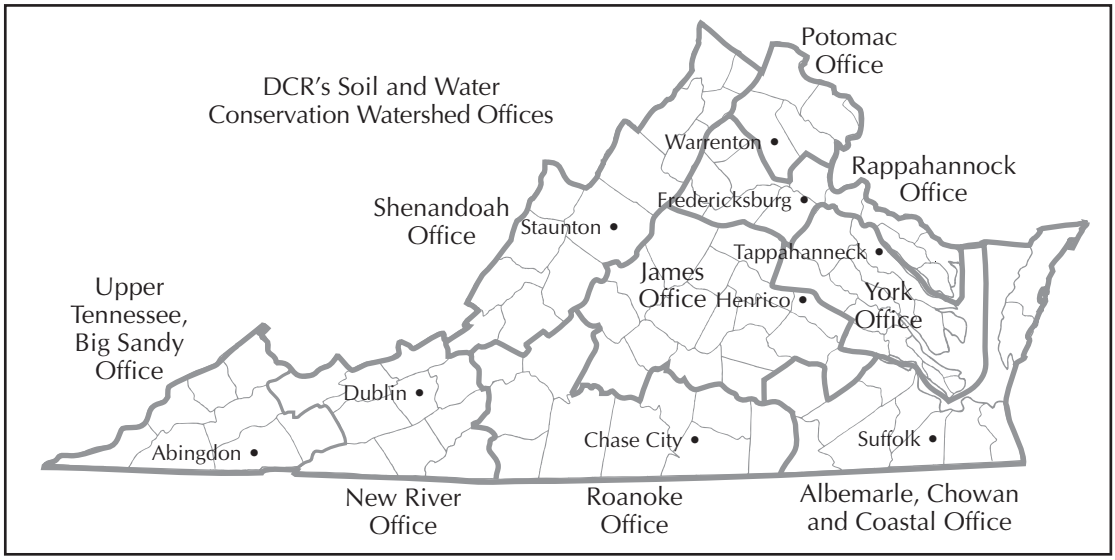
Henrico (James River Watershed Office): 3800 Stillman Pkwy., Suite 102, Richmond, Va. 23233; phone (804) 527-4484, fax (804) 527-4483

Staunton (Shenandoah Watershed Office): 44 Sanger Lane, Suite 102, Staunton, Va. 24401; phone: (540) 332-9991, fax: (540) 332-8956

Suffolk (Chowan-Albemarle Coastal Watersheds Office): 1548 Holland Road, Suffolk, Va. 23434; phone: (757) 925-2468, fax: (757) 925-2388

Tappahannock (York Watershed Office): P. O. Box 1425, Tappahannock, Va. 22560; phone: (804) 443-6752, fax: (804) 443-4534

Warrenton (Potomac Watershed Office): 98 Alexandria Pike, Suite 33, Warrenton, Va. 20186-2849; phone: (540) 347-6420, fax: (540) 347-6423



Worksheet 1: Calculating Available N in Litter

1. The portion of available inorganic N (NH_4-N) depends on when (and if) the litter is incorporated after it is broadcast. Select the appropriate multiplier from below, corresponding to your method of application, and record it here: _____

Method of Application	Multiplier
Broadcast with immediate incorporation:	0.90
Incorporated after 2 days:	0.80
Incorporated after 4 days:	0.65
Incorporated after 7 days or no incorporation:	0.50

2. Amount of NH_4-N in litter (From litter analysis or from Table 1): _____lbs/ton

3. Amount of NH_4-N available to plants (line 1 x line 2): _____ x _____ = _____lbs/ton

4. Amount of organic N in litter (Total N – NH_4-N = Organic N: use values from litter analysis, or Table 1): _____ - _____ = _____lbs/ton

5. The amount of organic N mineralized the first year. This depends on the timing of litter applications. Select the multiplier from below that corresponds to your time/method of application and record it here: _____

Time of Application	Multiplier
Spring or early fall (Pre-plant applications for summer annuals, or early fall applications for small grains)	0.6
Winter topdress on winter annuals	0.3

6. Organic N available in first year (line 5 x line 4): _____ x _____ = _____lbs/ton

7. Total N available in litter (line 3 + line 6): _____ + _____ = _____lbs/ton

8. Residual N from legume crops produced the previous year (select from table below): _____lbs/acre

Crop	% Stand	Description	Residual N (lb/A)
Alfalfa	50-75	Good (>4 t/A)	90
	25-49	Fair (3-4 t/A)	70
	<25	Poor (<3 t/A)	50
Red Clover	>50	Good (>3 t/A)	80
	25-49	Fair (2-3 t/A)	60
	<25	Poor (<2 t/A)	40
Hairy Vetch	80-100	Good	100
	50-79	Fair	75
	<50	Poor	50
Peanuts			45
Soybeans 0.5 lb N/bu yield, if previous yield is unknown, use			20

9. Calculate the residual N from previous manure/litter applications. *Note – if you applied litter or manure in the field one time or less in the last five years, skip the following data table and enter a "0" in line 9c. If you applied litter/manure two or more times in the past five years, complete the following table.*

1 Year	2 Type of Manure applied	3* Application Rate tons/acre or 1000 gal/acre	4 Total N in Manure (from records or Table 1) lbs N/ton or lbs N/1000 gal	5 NH_4-N in Manure (from records or Table 1) lbs NH_4/ton or lbs N/1000 gal	6 Organic N (Column 4 – Column 5)	7 Organic N applied (Column 3 x Column 6)
1 year ago						
2 years ago						
3 years ago						
4 years ago						
5 years ago						

*If the application rate is gallons per acre, divide by 1000 to report in 1000's of gal/acre. For example, 8,000 gal/acre should be recorded as 8 in column 3.

9a. Find the average Organic N applied by summing the values in Column 7 in the table above and dividing by the number of entries. Ignore 0's. In other words, if you applied manure three years out of five, sum the three values and divide by 3. Enter the average here:_____ .

9b. Select the appropriate Residual factor from the table below: _____

9c. Residual N from previous litter/manure applications: (line 9a x line 9b):
_____ x _____ = _____lbs/acre

Residual Nitrogen from Previous Litter/Manure Applications

Historical Frequency of Manure Application on Field	Residual Factor
Once or less in past five years	0
Two or three times in past five years	0.1
Four or five times in past five years	0.2

10. Total N Credit from Previous years (line 8 + line 9c): _____ + _____ = _____lbs/acre

11. N Values to be carried forward to Worksheet 2:

11a. Total Available Nitrogen in litter (from line 7): _____lbs/ton

11b. Total Nitrogen Credit from previous years (from line 10) _____lbs/acre

Example using Worksheet 1: Calculating available N in litter

A non-poultry producer will be purchasing broiler litter from a broker. The following chemical analysis was received with the litter: TKN = 65 lbs/ton; NH_4-N = 12 lbs/ton; P_2O_5 = 50 lbs/ton; K_2O = 45 lbs/ton. The producer intends to surface apply the litter in the spring to hay land and no-till crop land. There are no legume credits and the producer had not used animal manure in the past five years.

1. The portion of available inorganic N (NH_4-N) depends on when (and if) the litter is incorporated after it is broadcast. Select the appropriate multiplier from below, corresponding to your method of application, and record it here: __0.5 (no incorporation)__

Method of Application	Multiplier
Broadcast with immediate incorporation:	0.90
Incorporated after two days:	0.80
Incorporated after four days:	0.65
Incorporated after seven days or no incorporation:	0.5

2. Amount of NH_4-N in litter (From litter analysis or from Table 1): __12__ lbs/ton

3. Amount of NH_4-N available to plants (line 1 x line 2): __0.5__ x __12__ = __6__ lbs/ton

4. Amount of organic N in litter (Total N – NH_4-N = Organic N): use values from **litter analysis** (preferred), or Table 1: __65__ - __12__ = __53__ lbs/ton

5. The amount of organic N mineralized the first year. This depends on the timing of litter applications. Select the multiplier from below that corresponds to your time/method of application and record it here: __0.6__

Time of Application	Multiplier
Spring or early fall (Pre-plant applications for summer annuals, or early fall applications for small grains)	0.6
Winter topdress on winter annuals	0.3

6. Organic N available in first year (line 5 x line 4): __0.6__ x __53__ = __32__ lbs/ton

7. Total N available in litter (line 3 + line 6): __6__ + __32__ = __38__ lbs/ton

8. N credit from previous legume crops (select from table below): __0__ lbs/acre

Crop	% Stand	Description	Residual N (lb/A)
Alfalfa	50-75	Good (>4 t/A)	90
	25-49	Fair (3-4 t/A)	70
	<25	Poor (<3 t/A)	50
Red Clover	>50	Good (>3 t/A)	80
	25-49	Fair (2-3 t/A)	60
	<25	Poor (<2 t/A)	40
Hairy Vetch	80-100	Good	100
	50-79	Fair	75
	<50	Poor	50
Peanuts			45
Soybeans 0.5 lb N/bu yield, if previous yield is unknown, use			20

9. Calculate the residual N from previous manure/litter applications. *Note: if you applied litter or manure in the field one time or less in the last five years, skip the following data table and enter a "0" in line 9c. If you applied litter/manure two or more times in the past five years, complete the following table.*

1 Year	2 Type of Manure applied	3* Application Rate tons/acre or 1000 gal/acre	4 Total N in Manure (from records or Table 1) lbs N/ton or lbs N/1000 gal	5 NH_4-N in Manure (from records or Table 1) lbs lbs NH_4/ton or lbs N/1000 gal	6 Organic N (Column 4 – Column 5)	7 Organic N applied (Column 3 x Column 6)
1 year ago						
2 years ago						
3 years ago						
4 years ago						
5 years ago						

*If the application rate is gallons per acre, divide by 1000 to report in 1000's of gal/acre. For example, 8,000 gal/acre should be recorded as 8 in column 3.

9a. Find the average Organic N applied by summing the values in Column 7 in the table above and dividing by the number of entries. Ignore 0's. In other words, if you applied manure three years out of five, sum the three values and divide by 3. Enter the average here:_____.

9b. Select the appropriate Residual factor from the table below: _____

9c. Residual N from previous litter/manure applications: (line 9a x line 9b):

_____ x _____ = __0__lbs/acre

Residual Nitrogen from Previous Litter/Manure Applications

Historical Frequency of Manure Application on Field	**Residual Factor**
Once or less in past five years	0
Two or three times in past five years	0.1
Four or five times in past five years	0.2

10. Total N Credit from Previous years (line 8 + line 9c): __0__ + __0__ = __0__lbs/acre

11. N Values to be carried forward to Worksheet 2:

11a. Total Available Nitrogen in litter (from line 7): __38__lbs/ton

11b. Total Nitrogen Credit from previous years (from line 10) __0__lbs/acre

Determining Litter Application Rate

Complete Worksheet 2 for each field that will receive a litter application. To complete this worksheet, you need a soil test for the crops to be grown in the two-year rotation.

Worksheet 2. Determining Litter Application Rates

Note: complete one worksheet for each field with a unique set of crops/rotations and/or soil types.

Field Identifier (for your records): _____

1. List the crops that will be produced in a two-year rotation. Then complete the table **using data from your soil test report from the Virginia Tech Soil Testing Laboratory.**

	First Crop	Second Crop	Third Crop	Fourth Crop
Crop Name				
Productivity Group (from VCE or DCR)				
Estimated Yield (From Table 4):				

Recommended Nutrient Application Rate from Soil Test:

	First	Second	Third	Fourth	Total*
1a. Nitrogen (lbs N/acre)	_____	_____	_____	_____	XXX
1b. Phosphate (lbs P_2O_5/acre)	_____	_____	_____	_____	_____
1c. Potash (lbs K_2O/acre)	_____	_____	_____	_____	_____

* Total is the sum of the recommended application rates for each crop. It is acceptable to apply P_2O_5 and K_2O to meet the needs of a two-year rotation; however, nitrogen application should not exceed the uptake of the crop to which it is applied—therefore, the nitrogen requirement is not totaled.

2. List the amount of nutrients available in the litter:
   - 2a. Total available Nitrogen (from line 11a, Worksheet 1): _____lbs/ton litter
   - 2b. Nitrogen credit from previous years (from line 11b, Worksheet 1): _____lbs/acre
   - 2c. Phosphorus (from Manure Analysis Sheet or Table 1): _____lbs P_2O_5/ton litter
   - 2d. Potash (from Manure Analysis Sheet or Table 1): _____lbs K_2O/ton litter

3. Determine the amount of crop P removal for each crop in the two-year rotation:

First Crop:

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

Second Crop:

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

Third Crop:

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

Fourth Crop:

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

4. It is environmentally acceptable to apply litter to meet phosphorus needs of up to a two-year crop rotation. Decide if you want to calculate litter application rates based on a single crop, a one-year rotation, or a two-year rotation. Based on this decision, sum the values for the phosphorus needs of the crops you want included in the phosphorus calculation as follows:

   4a. Using the values you calculated for crop P removal in the previous step (3), sum the P removal rates for the crops you are considering: _____lbs P_2O_5/acre.

   4b. Determine the soil-test-based P_2O_5 application rate by summing the P_2O_5 application rates on line 1b for the crops you are considering: _____lbs P_2O_5/acre.

5. If your soil tested VH in phosphorus, skip to 5b; otherwise, complete 5a.

   5a. If your soil did not test VH in phosphorus, then the larger of the values found in 4a. and 4b. represents the lbs P_2O_5/acre that may be land applied for the number of crops you have considered. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the larger of the values (4a or 4b) here: _____lbs P_2O_5/acre.

   5b. For a soil that tests VH in phosphorus, the application rate should not exceed crop uptake for the two-year rotation. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the value from 4a here: _____lbs P_2O_5/acre.

6. Determine the phosphorus-based litter application rate (line 5a or 5b divided by line 2c):

   _____ ÷ _____ = _____tons litter/acre

7. Determine the nitrogen-based litter application rate ((line 1a – line 2b) divided by line 2a) for each crop in the rotation:

   Crop 1: (_____ - _____) ÷ _____ = _____tons litter/acre
   Crop 2: (_____ - _____) ÷ _____ = _____tons litter/acre
   Crop 3: (_____ - _____) ÷ _____ = _____tons litter/acre
   Crop 4: (_____ - _____) ÷ _____ = _____tons litter/acre
   Total Nitrogen Based litter rate for the two-year rotation (sum application for crops 1 through 4): _____ tons litter/acre

8. The total amount of litter that can be applied in a two-year period is the smaller of the amounts listed on line 6 (phosphorus basis) and line 7 (nitrogen basis). Enter the smaller of line 6 and line 7 (total): _____ tons litter/acre.

9 . Line 8 represents the amount of litter that can be spread during the 2-year rotation, however, the amount applied to any one crop can not exceed the Nitrogen needs of that crop. So at this point, a management decision must

be made regarding which crops will receive litter. Look at the total amount of litter you can apply in the two-year rotation (line 8) and then look at the amount of litter that can be applied to each individual crop based on Nitrogen requirements (line 7). Decide which crop or crops will receive litter and how much; remember the total should not exceed line 8. Two examples of management decisions are given in the example worksheets included in the Appendix. Enter the decision here:

9a. Plan to spread _____tons litter/acre to the _____ crop in year _____
9b. Plan to spread _____tons litter/acre to the _____ crop in year _____
9c. Plan to spread _____tons litter/acre to the _____ crop in year _____
9d. Plan to spread _____tons litter/acre to the _____ crop in year _____
9e. Total litter to be spread (sum 9a through 9d): _____tons litter/acre
Note: you may wish to only apply litter one year in the rotation.

10. After deciding which crops will receive litter and how much, you need to determine the phosphorus, nitrogen and potash that will be applied in the litter. This information will be used in step 11 to determine if commercial fertilizer is also needed.

10a. Phoshorus applied (line 9e x line 2c): _____x_____= lbs P_2O_5/acre
10b. Nitrogen applied to _____ crop: (line 9a x line 2a): _____ x _____lbs N/acre
10c. Nitrogen applied to _____ crop: (line 9b x line 2a): _____ x _____lbs N/acre
10d. Nitrogen applied to _____ crop: (line 9c x line 2a): _____ x _____lbs N/acre
10e. Nitrogen applied to _____ crop: (line 9d x line 2a): _____ x _____lbs N/acre
10f. Potash applied (line 9e x line 2d): _____lbs K_2O/acre

11. Determine the amount of commercial fertilizer needed by subtracting the amount of nutrients required based on soil testing from the pounds of nutrients applied per acre as litter. You can calculate the needed phosphorus and potash based upon the total litter to be applied during the rotation, but the Nitrogen application must be considered on a crop by crop basis, since Nitrogen should only be applied to meet the requirements of an individual crop. The examples in the Appendix should clarify this. *Note: If your soil tested VH in phosphorus, the rate of phosphorus application should be based on crop removal, not soil test recommendation. Therefore, if you are basing your litter application rate (line 8 on phosphorus, then enter 0 for line 11a):*

11a. Phosphorus needed from fertilizer (line 1b – line 10a): _____ - _____ = _____lbs/acre
11b. Nitrogen needed from fertilizer for crop _____ (line la – line 2b – line 10b) =
_____ - _____ - _____ = _____lbs/acre
11c. Nitrogen needed from fertilizer for crop _____(line 1a – line 2b – line 10c) =
_____ - _____ - _____ = _____lbs/acre
11d. Nitrogen needed from fertilizer for crop _____(line 1a – line 2b – line 10d) =
_____ - _____ - _____ = _____lbs/acre
11e. Nitrogen needed from fertilizer for crop _____(line 1a – line 2b – line 10e) =
_____ - _____ - _____ = _____lbs/acre
11f. Potash needed from fertilizer (line 1c – line 10f): _____ - _____ = _____lbs/acre

Determining Litter Application Rate – Field Number 1

Complete Worksheet 2 for each field that will receive a litter application. To complete this worksheet, you need a soil test for the crops to be grown in the two-year rotation.

Example using Worksheet 2: Determining Litter Application Rates

Example – Field No. 1

Field No. 1 is in tall grass hay and is located in Rockbridge County. The soil is in the Frederick series. A recent soil test reveals that the soil has a medium (M) soil test rating for phosphorus (P) and a medium (M) soil test rating for potassium (K). The intended rotation for the field includes tall grass hay for year 1 and no-till corn silage followed by rye grown for silage in year 2. Based on the soil test report, the Frederick soil has a soil productivity group of "II" for tall grass hay. A call to the local Extension office revealed that the Frederick Soil has a soil productivity group of "IIb" for corn and "I" for small grain, respectively. The producer intends to make at most one application of litter per growing season and would prefer applying the litter prior to planting corn during the second year.

Note: complete one worksheet for each field with a unique set of crops/rotations and/or soil types.

Field Identifier (for your records): __Field No. 1__

1. List the crops that will be produced in a two-year rotation. Then complete the table using data from your soil test report from the Virginia Tech Soil Testing Laboratory.

	First Crop	Second Crop	Third Crop	Fourth Crop
Crop Name	Tall Grass Hay	Corn Silage	Rye Silage	_____
Productivity Group (from VCE or DCR)	_____	_____	_____	_____
Estimated Yield (From Table 4):	3.5 t/acre	18 t/acre	5 /acre	_____

Recommended Nutrient Application Rate from Soil Test:

	First	Second	Third	Fourth	Total
1a. Nitrogen (lbs N/acre)	90 lbs/acre	140 lbs/acre	100 lbs/acre	_____	XXX
1b. Phosphate (lbs P2O5/acre)*	80 lbs/acre	60 lbs/acre	60 lbs/acre	_____	200 lbs/acre
1c. Potash (lbs K_2O/acre)	170 lbs/acre	140 lbs/acre	60 lbs/acre	_____	370 lbs/acre

* Total is the sum of the recommended application rates for each crop. It is acceptable to apply P_2O_5 and K_2O to meet the needs of a two-year rotation; however, nitrogen application should not exceed the uptake of the crop to which it is applied—therefore, the nitrogen requirement is not totaled.

2. List the amount nutrients available in the litter:

   2a. Total available Nitrogen (from line 11a, Worksheet 1): __38__lbs/ton litter
   2b. Nitrogen credit from previous years (from line 11b, Worksheet 1): __0__lbs/acre
   2c. Phosphorus (from Manure Analysis Sheet or Table 1): __50__lbs P_2O_5/ton litter
   2d. Potash (from Manure Analysis Sheet or Table 1): __45__lbs K_2O/ton litter

3. Determine the amount of crop P removal for each crop in the two-year rotation:

   First Crop: *Year 1 -Tall Grass Hay*
   - Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) __3.5__ (bu or tons/acre)

- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): 3.5 t/acre x 18 lb P_2O_5/ton = 63 lbs P_2O_5/acre

Second Crop: *Year 2 –No-till Corn Silage*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) 18 (bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5: 18 t/acre x 4.7 P_2O_5/ton = 85 lbs P_2O_5/acre

Third Crop: *Year 2 – Rye Silage*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) 5 (bu or tons/acre)
- Estimated P removal (Estimated Yield from above x Crop Nutrient removal from Table 3, page 5): 5 t/acre x 6.67 lb P_2O_5/ton = 33 lbs P_2O_5/acre

4. It is environmentally acceptable to apply litter to meet phosphorus needs of up to a two-year crop rotation. Decide if you want to calculate litter application rates based on a single crop, a one-year rotation, or a two-year rotation. Based on this decision, sum the values for the phosphorus needs of the crops you want included in the phosphorus calculation as follows:

   4a. Using the values you calculated for crop P removal in the previous step (line 3), sum the P removal rates for the crops you are considering: 181 lbs P_2O_5/acre.

   4b. Determine the soil-test-based P_2O_5 application rate by summing the P_2O_5 application rates on line 1b. for the crops you are considering. 200 lbs P_2O_5/acre.

5. If your soil tested VH in phosphorus, skip to 5b; otherwise, complete 5a.
   Note: Since this soil tested M for phosphorus, complete 5a.

   5a. If your soil did not test VH in phosphorus, then the larger of the values found in 4a and 4b represents the lbs P_2O_5/acre that may be land applied for the number of crops you have considered. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the larger of the values (4a or 4b) here: 200 lbs

   5b. For a soil that tests VH in phosphorus, the application rate should not exceed crop uptake for the two-year rotation. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the value from 4a here: _____ lbs P_2O_5/acre.

6. Determine the phosphorus-based litter application rate (line 5a or 5b divided by line 2c):
   200lbs P_2O_5/acre ÷ 50 lbs P_2O_5/ton = 4 tons litter/acre

7. Determine the nitrogen-based litter application rate ((line 1a – line 2b) divided by line 2a) for each crop in the rotation:

   Crop 1: Tall Grass Hay: (90 lbs/acre - 0 lbs/acre) ÷ 38 lbs N/ton = 2.4 tons litter/acre
   Crop 2: Corn Silage : (140 lbs/acre - 0 lbs/acre) ÷ 38 lbs N/ton = 3.7 tons litter/acre
   Crop 3: Rye Silage : (100 lbs.acre - 0 lbs/acre) ÷ 38 lbs N/ton = 2.6 tons litter/acre
   Crop 4: NONE : (_____ - _____) ÷ _____ = _____ tons litter/acre
   Total Nitrogen Based litter rate for the two-year rotation (sum application for crops 1 through 4): 8.7 tons litter/acre

8. The total amount of litter that can be applied in a two-year period is the smaller of the amounts listed on line 6 (phosphorus basis) and line 7 (nitrogen basis).

   Enter the smaller of line 6 and line 7 (total): 4 tons/acre

9. Line 8 represents the amount of litter that can be spread during the 2-year rotation, however, the amount of litter applied to any one crop can not exceed the Nitrogen needs of that crop. So at this point, a management decision must be made regarding which crops will receive litter. Look at the total amount of litter you can apply in the two-year rotation (line 8) and then look at the amount of litter that can be applied to each individual crop based on Nitrogen requirements (line 7). Decide which crops will receive litter and how much. Enter the decision here:

   9a. Plan to spread __0__ tons litter/acre to the tall grass hay crop in year one;
   9b. Plan to spread __3.7__ tons litter/acre to the corn silage crop in year two;
   9c. Plan to spread __0__ tons litter/acre to the rye silage crop in year two;
   9d. Plan to spread _____ tons litter/acre to the _____ crop in year _____;
   9e. Total litter to be spread (sum from9a through 9d): __3.7__ tons litter/acre
   Note: you may wish to apply litter to only one crop in the rotation.

10. After deciding which crops will receive litter and how much, you need to determine the phosphorus, nitrogen and potash that will be applied in the litter. This information will be used in step 11 to determine if commercial fertilizer is also needed. *Note: in this example, the producer decides to apply litter once during the two-year rotation and it will be applied at a rate to meet the nitrogen needs of the corn.*

    10a. Phoshorus applied: (line 9e x line 2c): 3.7 tons/acre x 50 lbs P_2O_5/ton = __185__ lbs P_2O_5/acre
    10b. Nitrogen applied to Tall grass hay crop: (line 9a x line 2a): __0__ x 38 lbs N/ton = 0 lbs N/acre
    10c. Nitrogen applied to Corn Silage crop (line 9b x line 2a): 3.7 tons litter/acre x 38 lbs N/ton = 140 lbs N/acre
    10d. Nitrogen applied to Rye Silage crop (line 9c x line 2a): 0 tons litter/acre x 38 lbs N/ton = 0 lbs N/acre
    10e. Nitrogen applied to Rye Silage crop (line 9d x line 2a): 0 tons litter/acre x 38 lbs N/ton = 0 lbs N/acre
    10f. Potash applied: (line 9e x line 2d): 3.7 tons litter/acre x 45 lbs K_2O/ton = 167 lbs K_2O/acre

11. Determine the amount of commercial fertilizer needed by subtracting the amount of nutrients required based on soil testing from the pounds of nutrients applied per acre as litter. You can calculate the needed phosphorus and potash based upon the total litter to be applied during the rotation, but the Nitrogen application must be considered on a crop by crop basis, since Nitrogen should only be applied to meet the requirements of an individual crop. *Note: If your soil tested VH in phosphorus, the rate of phosphorus application should be based on crop removal, not soil test recommendation.* Therefore, if you are basing your litter application rate (line 8) on phosphorus, then enter 0 for line 10a:

    11a. Phosphorus needed from fertilizer (line 1b – line 10a): __200__ - __185__ = __15__ lbs /acre P_2O_5
    11b. Nitrogen needed from fertilizer:
    Crop 1: Tall Grass Hay: (line la –line 2b – line 10b) = __90__ - __0__ - __0__ = __90__ lbs/acre
    Crop 2: Corn Silage: (line 1a –line 2b – line 10c) = __140__ - __140__ - __0__ = __0__ lbs/acre
    Crop 3: Rye Silage: (line 1a –line 2b – line 10d) = __100__ - __0__ - __0__ = __100__ lbs/acre
    Crop 4: NONE: (line 1a –line 2b – line 10e) = _____ - _____ - _____ = _____ lbs/acre
    11c. Potash needed from fertilizer (line 1c – line 10f): __370__ - __185__ = __185__ lbs/acre K_2O
    Note: Nitrogen as commercial fertilizer should be applied according to the rates calculated in 11b for the tall grass hay and the rye silage. Phosphorus and potash should be applied as commercial fertilizer in the rates determined in 11a and 11c. (15 lbs P_2O_5 /acre and 185 lbs K_2O/acre). This could be applied when the nitrogen fertilizer for the hay crop is applied.

Example No. 2 using Worksheet 2: Determining Litter Application Rates

Field No. 2

Field No. 2 is in continuous tall grass hay and is located in Rockbridge County. The soil is in the Frederick series. A recent soil test reveals that the soil has a medium (M) soil test rating for phosphorus (P) and a medium (M) soil test rating for potassium (K).

Determining Litter Application Rate – Field Number 2 – Tall Grass Hay

Complete Worksheet 2 for each field that will receive a litter application. To complete this worksheet, you need a soil test for the crops to be grown in the two-year rotation.

Note: complete one worksheet for each field with a unique set of crops/rotations and/or soil types.

Field Identifier (for your records): Field No. 2 – Tall Grass Hay

1. List the crops that will be produced in a two-year rotation. Then complete the table **using data from your soil test report from the Virginia Tech Soil Testing Laboratory.**

	First Crop	Second Crop	Third Crop	Fourth Crop
Crop Name:	Tall Grass Hay	Tall Grass Hay	_____	_____
Productivity Group (from VCE or DCR)	_____	_____	_____	_____
Estimated Yield (From Table 4):	3.5 t/acre	3.5 t/acre	_____	_____

Recommended Nutrient Application Rate from Soil Test:

	First	Second	Third	Fourth	Total
1a. Nitrogen (lbs N/acre)	90 lbs/acre	90 lbs/acre	_____	_____	XXX
1b. Phosphate (lbs P_2O_5/acre)	80 lbs/acre	80 lbs/acre	_____	_____	160 lbs P_2O_5/acre
1c. Potash (lbs K2O/acre)	170 lbs/acre	170 lbs/acre	_____	_____	340 lbs K_2O/acre

2. List the amount of nutrients available in the litter:
   - 2a. Total available Nitrogen (from line 11a, Worksheet 1): 38 lbs/ton litter
   - 2b. Nitrogen credit from previous years (from line 11b., Worksheet 1): 0 lbs/acre
   - 2c. Phosphorus (from Manure Analysis Sheet or Table 1): 50 lbs P_2O_5/ton litter
   - 2d. Potash (from Manure Analysis Sheet or Table 1): 45 lbs K_2O/ton litter

3. Determine the amount of crop P removal for each crop in the two-year rotation:

First Crop: *Year 1 -Tall Grass Hay*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) 3.5 (bu or *tons/acre*)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): 3.5 t/acre x 18 lb P_2O_5/ton = 63 lbs P_2O_5/acre

Second Crop: *Year 2 –Tall Grass Hay*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) 3.5 (bu or *tons/acre*)
- Estimated P removal (Estimated Yield from above x Crop Nutrient Removal from Table 3, page 5): 3.5 t/acre x 18 lb P_2O_5/ton = 63 lbs P_2O_5/acre

Third Crop: *Year 2 – NA*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or *tons/acre*)
- Estimated P removal (Estimated Yield from above x Crop Nutrient removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

Fourth Crop: *Year 2 – NA*

- Estimated yield potential for the crop (from Table 4, page 5, based on soil productivity group, OR use average of highest three yields from the last five years of yield data) _____(bu or *tons/acre*)
- Estimated P removal (Estimated Yield from above x Crop Nutrient removal from Table 3, page 5): _____ x _____ = _____lbs P_2O_5/acre

4. It is environmentally acceptable to apply litter to meet phosphorus needs of up to a two-year crop rotation. Decide if you want to calculate litter application rates based on a single crop, a one-year rotation, or a two-year rotation. Based on this decision, sum the values for the phosphorus needs of the crops you want included in the phosphorus calculation as follows:

   4a. Using the values you calculated for crop P-removal in line 3, sum the P removal rates for the crops you are considering: 126 lbs P_2O_5/acre.
   4b. Determine the soil-test-based P_2O_5 application rate by summing the P_2O_5 application rates on line 1b for the crops you are considering. 160 lbs P_2O_5/acre.

5. If your soil tested VH in phosphorus, skip to 5b; otherwise, complete 5a.
   Note: Since this soil tested M for phosphorus, complete 5a.

   5a. If your soil did not test VH in phosphorus, then the larger of the values found in 4a and 4b represents the lbs P_2O_5/acre that may be land applied for the number of crops you have considered. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the larger of the values (4a or 4b) here: 160 lbs
   5b. For a soil that tests VH in phosphorus, the application rate should not exceed crop uptake for the two-year rotation. Once this phosphorus is applied, no additional phosphorus from any source should be applied until the rotation period ends and a new crop rotation period begins. Enter the value from 4a here: _____lbs P_2O_5/acre.

6. Determine the phosphorus-based litter application rate (line 5a or 5b divided by line 2c):
   160 lbs P_2O_5/acre ÷ 50 lbs P_2O_5/ton = 3.2 tons litter/acre

7. Determine the nitrogen-based litter application rate ((line 1a – line 2b) divided by line 2a) for each crop in the rotation:

   Crop 1: Tall Grass Hay: (90 lbs/acre - 0 lbs/acre) ÷ 38 lbs N/ton = 2.4 tons litter/acre
   Crop 2: Tall Grass Hay: (90 lbs/acre - 0 lbs/acre) ÷ 38 lbs N/ton = 2.4 tons litter/acre
   Crop 3: NONE: (_____ - _____) ÷ _____ = _____tons litter/acre
   Crop 4: NONE: (_____ - _____) ÷ _____ = _____tons litter/acre

   Total Nitrogen Based litter rate for the two-year rotation (sum application for crops 1 through 4): 4.8 tons litter/acre

8. The total amount of litter that can be applied in a two-year period is the smaller of the amounts listed on line 6 (phosphorus basis) and line 7 (nitrogen basis).

   Enter the smaller of line 6 and line 7(total): 3.2 tons/acre

9. Line 8 represents the amount of litter that can be spread during the 2-year rotation, however, the amount of litter applied to any one crop can not exceed the Nitrogen needs of that crop. So at this point, a management decision must be made regarding which crops will receive litter. Look at the total amount of litter you can apply in

the two-year rotation (line 8) and then look at the amount of litter that can be applied to each individual crop based on Nitrogen requirements (line 7). Decide which crops will receive litter and how much. *Note: In this case, phosphorus defines the application rate and a total of 3.2 tons litter/acre may be applied during the two year rotation. However, the application in any one year is limited to 2.4 tons/acre—the nitrogen requirement of each hay crop. So the producer could apply the 3.2 tons litter/acre in two applications of 1.6 tons each to the tall grass hay each year. Potential problems with this scenario include the cost of litter application each year and extra trips across the field both years to supply the additional nitrogen needed for the tall grass hay. A second scenario would be to apply litter on a nitrogen basis to the tall grass hay during the first year of the rotation. A slightly lower total amount of litter would be applied (2.4 tons/acre), but this would be near the maximum suggested, it would provide all of the nitrogen needed to produce the tall grass hay during the first year of the rotation, and only one application of litter would be made during the two-year rotation.* Enter the decision here:

_____

9a. Plan to spread __2.4__ tons litter/acre to the tall grass hay crop in year __one__;
9b. Plan to spread __0__ tons litter/acre to the tall grass hay crop in year __two__;
9c. Plan to spread __NA__ tons litter/acre to the _____ crop in year _____;
9d. Plan to spread _____ tons litter/acre to the _____ crop in year _____;
9e. Total litter to be spread (sum from 9a through 9d): __2.4__ tons litter/acre.
Note: you may wish to apply litter to only one crop in the rotation.

10. After deciding which crops will receive litter and how much, you need to determine the phosphorus, nitrogen and potash that will be applied in the litter. This information will be used in step 11 to determine if commercial fertilizer is also needed. *Note: in this example, the producer decides to apply litter once during the two-year rotation and it will be applied at a rate to meet the nitrogen needs of the tall grass hay in year one of the rotation.*

10a. Phoshorus applied: (line 9e x line 2c): 2.4 tons/acre x 50 lbs P_2O_5/ton = __120__ lbs P_2O_5/acre
10b. Nitrogen applied to Tall grass hay crop: (line 9a x line 2a): __2.4__ x 38 lbs N/ton = __91__ lbs N/acre
10c. Nitrogen applied to Tall grass hay crop (line 9b x line 2a): __0__ tons litter/acre x 38 lbs N/ton = 0 lbs N/acre
10d. Nitrogen applied to _____ crop (line 9c x line 2a): _____ x _____ = _____ lbs N/acre
10e. Nitrogen applied to _____ crop (line 9d x line 2a): _____ x _____ = _____ lbs N/acre
10f. Potash applied: (line 9e x line 2d): 2.4 tons litter/acre x 45 lbs K_2O/ton = 108 lbs K_2O/acre

11. Determine the amount of commercial fertilizer needed by subtracting the amount of nutrients required based on soil testing from the pounds of nutrients applied per acre as litter. You can calculate the needed phosphorus and potash based upon the total litter to be applied during the rotation, but the Nitrogen application must be considered on a crop by crop basis, since Nitrogen should only be applied to meet the requirements of an individual crop. *Note: If your soil tested VH in phosphorus, the rate of phosphorus application should be based on crop removal, not soil test recommendation. Therefore, if you are basing your litter application rate (line 8) on phosphorus, then enter 0 for line 10a.*

11a. Phosphorus needed from fertilizer (line 1b – line 10a): __160__ - __120__ = __40__ lbs /acre P_2O_5
11b. Nitrogen needed from fertilizer:
Crop 1: Tall Grass Hay: (line la –line 2b – line 10b) = __90__ - __91__ - __0__ = __0__ lbs/acre
Crop 2: Tall Grass Hay: (line 1a –line 2b – line 10c) = __90__ - __0__ - __0__ = __90__ lbs/acre
Crop 3: __NONE__: (line 1a –line 2b – line 10d) = _____ - _____ - _____ = _____ lbs/acre
Crop 4: __NONE__: (line 1a –line 2b – line 10e) = _____ - _____ - _____ = _____ lbs/acre
11c. Potash needed from fertilizer (line 1c – line 10f): __340__ - __108__ = __232__ lbs/acre K_2O
Note: Nitrogen as commercial fertilizer should be applied according to the rates calculated in 11b for the second year tall grass hay. Phosphorus and potash should be applied as commercial fertilizer in the rates determined in 11a and 11c. (40 lbs P_2O_5/acre and 232 lbs K_2O /acre). This could be applied when the nitrogen fertilizer for the hay crop is applied.