Quick Reference Guide

Introduction

This document is intended to serve as a "quick reference" for small scale livestock owners. Various charts and tables are included that provide data and information that may be helpful in determining manure generation, manure storage needs, manure nutrients for land application, and measures for successful composting. At the end of the Quick Guide there are templates that can be copied and used to record specific farm information.

Charts and Tables

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Manure Generation and Storage

Use the charts and tables below to estimate the amount of space you will need for manure and bedding storage. Several different charts on manure generation and storage are provided. Each presents ways to measure manure in different ways. The "Animal Manure and Bedding Generation" calculator is included in the Resource Tool Kit. The calculator is an easy to use tool for figuring manure and bedding generation on your farm.

Estimation of Monthly Manure Generation		
Animal	**Weight Lbs.**	**Storage Cubic feet (ft^2)per month**
Beef	1,000	28.5
Beef	500	14.4
Horse	1,000	24.3
Pony	700	16.8
Sheep	100	1.8
Goats	50	.9
Llama	330	6.93
Swine	65	2.1
Swine	150	4.8
Gestating Sow	275	4.5
Sow & litter	375	10.8
Poultry, layers	4	0.11
Source: USDA Natural Resources Conservation Service, Lynden Field Office, Lynden, WA.		

Estimation of Bedding Generation	
Bedding	**Cubic feet/pound**
Hay	0.24
Straw	0.35
Sawdust	0.08
Wood shavings	0.11
Source: USDA Natural Resources Conservation Service, Lynden Field Office, Lynden, WA.	

Daily Manure and Waste Production from a Typical 1,000 lb. Horse			
			Total generation
Manure daily	31 lbs. feces	2.4 gallons urine	51 lbs. manure ($0.8 ft^3$)
Stall Waste Daily	15-20 lbs. bedding ($1.6 ft^3$)	51 lbs. manure ($0.8 ft^3$)	60-70 lbs. stall waste/day ($2.4 ft^3$)
Source: "Agricultural Management Practices for Commercial Equine Operations," Rutgers University.			

Estimated Area Needed for Six Months Storage (Ft^2)	
Animal	**Area Needed Per Animal for 6 Months Storage**
Horse	72 square feet
Cattle	72 square feet
Sheep	6 square feet
Pig	12 square feet
Goat	6 square feet
Llama	12 square feet
The actual space needed will vary according to the amount of bedding used, animal weight, and height of the manure pile. Source: "Pollution Control for Horse Stables and Backyard Livestock", US Environmental Protection Agency, and "Managing Mud and Manure," Small Acreage Factsheet. Tualatin Soil and Water Conservation District.	

Square Feet vs. Cubic Feet

1 square foot (Ft^2): A block 12 inches by 12 inches has a square foot area of 1 square foot.

1 cubic foot (Ft^3): The volume of a cube with sides of 1 foot in length (1 foot x 1 foot x 1 foot).

The formula for square feet: Length × Width

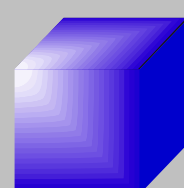
The formula for cubic feet: Volume = Length × Width × Height

Area = Length x Width Therefore— Area = Volume / Height

To convert cubic foot to square foot, divide by the height (in feet).

The height is usually given in inches, so convert the inches to feet before dividing.

Examples:



Average daily generation of a 1,000 lb. horse:

Manure (feces & urine) = 51 lbs. + Bedding = 8-15 pounds

= 2.4 cubic feet stall waste each day

Average monthly generation of a 1,000 lb. horse:

- 2 cubic yards per month of manure and bedding.
- 12 cubic yards of storage space will be needed for six months of storage for one horse.

One cubic yard = 27 cubic feet, so 324 cubic feet or an area roughly 9' long x 9' wide x 4' deep will be needed for six months storage.

Sources: "Horse Stable Manure Management," Eileen Wheeler and Jennifer Smith Zajaczkowski, PennState College of Agricultural Sciences Cooperative Extension, 2001. Connecticut Horse Environmental Awareness Program. "Manure Storage: Containing the HEAP."

Estimated Area Needed for Six Months Storage (ft^3)		
Animal	**Average Weight (lbs.)**	**Volume of Manure Produced in six months (Ft^3)**
Beef	900	150
Beef	500	80
Horse	1200	175
Poultry	7	1
Sheep	90	10
Pig (growing)	65	13
Pig (gestating sow)	275	27
Llama/Alpaca	130	16
If the animal is smaller or larger than weight listed, manure generation amounts can be adjusted. For example, a calf weighing 450 pounds will produce ½ of 150 ft^3 or 75 ft^3 of manure in six months. Source: "Strategies for Livestock Manure Management," King County Department of Natural Resources and Parks and Washington State University Cooperative Extension. 2002.		

Basic Calculations for Manure Generation[i]

a. Manure storage required:
Number of animals x volume of manure produced in six months in ft^3 = manure storage needs in ft^3

b. Soiled bedding storage requirement:
(Pounds bedding/month)[1] x volume (ft^3) of bedding[2] / lb. of bedding = ft^3 of bedding generated per month

ft^3 bedding / x 6 months x 0.5 compaction = soiled bedding storage needs (ft^3)

c. Manure Storage needs (ft^3) + soiled bedding storage needs (ft^3) = Total Storage Capacity Needed

Sample Calculations for a 5-llama operation using wood shaving bedding over a six-month period:

a. 8 llamas x 16 ft^3 = 128 ft^3
b. (20 lbs. wood shavings / month) x 0.11 (ft^3) = 2.2 ft^2 bedding / month generated.
2.2 ft^3 bedding / month x 6 months x 0.5 compaction = 7 ft^3
c. Manure storage needs
(a) 128 ft^3 + (b) 7 ft^3 = 135 ft^3 storage needed

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[1] Based on actual bedding use.
[2] See chart on page one for bedding volumes.

Equation for Manure Storage

The manure storage facility should be sized according to the number of animals and the number of days the manure will need to be stored. To estimate the base size of the storage pad use the following equation:

- Number of animal units (a.u. = the average total weight of your animals divided by 1000 lbs., or 1 horse per a.u.) X number of days storage = cubic feet of manure
- Number of a.u. X cubic feet of bedding/day X number of days = cubic feet of bedding
- Cubic feet of manure + cubic feet of bedding = Total Volume
- Square feet of area required = total volume divided by desired storage height.

Example

3 horses with a total weight of 3200lbs. Assume that the manure is removed 4 times a year and the manure pad (with sides) is 4 feet high.

- 3.2 a.u. X 90 days = 288 cubic feet of manure
- 3.2 a.u. X 2 cubic feet of bedding/day X 90 days = 576 cubic feet of bedding
- 288 + 576 = 864 total volume
- 864 /4 = 216 square feet required

A space 15' X 15' would be adequate for your needs.

Other dimensions are also possible, such as 10' X 22' or 12' X 18'.

Source: "Equine Facts: Guidelines for Horsekeeping in Maine," Bulletin #1011, The University of Maine Cooperative Extension.

Average Amount of Storage Required for Horse Manure				
No. of Horses	**Manure**		**Manure with bedding**	
	250 days (Yards^3)	**1 year (Yards^3)**	**250 days (Yards^3)**	**1 year (Yards^3)**
1	7	10	12-14	17-20
5	35	50	60-70	85-100
15	105	150	180-210	255-300
25	175	250	300-350	425-500
40	280	400	480-560	680-800

Assumes 0.75 ft^3 of manure/day, plus 0.5-0.75 ft^3 bedding/day. (A cube 3 ft. x 3ft. is 27 ft^3, which is equal to 1 yard^3.)

Source: "Horse Manure Management: a Guide for Bay Area Horse Keepers," Marc Buchanan, PhD., Cherry Hill 1999.

Comparison of Manure Utilization Options		
	Advantages	**Disadvantages**
Land Application	▪ Raw manure is rich in specific nutrients, phosphate and potash. ▪ Manure adds water-holding capacity to soils, particularly beneficial for sandy soils. ▪ Enhances soil aeration and drainage in soils, particularly beneficial in clay soils. ▪ May be a lower investment of time and money compared to other management options.	▪ Can be difficult to spread. ▪ Has a higher potential to impact water quality than compost. ▪ Repeated applications can build nutrients up to detrimental levels if not monitored. ▪ Fresh manure containing large amounts of nitrogen and salts can damage crops if applied improperly. ▪ Heavy applications can lead to excessive soil salinity. ▪ May cause nitrogen immobilization in plants. ▪ More likely to contain weed seeds and has a potential for higher pathogen levels. ▪ Odor may be an issue.
Composting	▪ Composted manure can be more easily land applied. ▪ Offers more utilization options, both on-farm and off-farm. ▪ Manure volume is significantly reduced, requiring fewer trips to be made to fields for land application or for handling. ▪ Potential odor problems are reduced. ▪ Eliminates fly breeding ground and kills larvae. ▪ Less likely to contain pathogens, worm eggs, and weed seeds. ▪ Valuable soil amendment: organic matter and plant nutrients. ▪ Significantly reduces the risk of water contamination from run-off compared to land application of raw manure. ▪ Avoids the problem of nitrogen immobilization. ▪ Safer soil amendment than raw manure or synthetic fertilizers: low in soluble salts so it will not burn plants. ▪ Less likely to cause nutrient imbalances. ▪ Stabilizes ammonia nitrogen and other nutrients into a slow release form. ▪ Can be applied directly to growing vegetable crops. ▪ Adds water-holding capacity to soils and helps make all soil types loamier. ▪ Enhances soil aeration and drainage in soil. ▪ Adds beneficial microbes to soil, stimulating biological activity in soil and which helps to suppress plant diseases.	▪ Higher investment of time. ▪ Potentially higher monetary costs for compost structures (if used) and additional equipment (if necessary). ▪ Requires sufficient space for composting (maybe integrated with manure storage).

Comparison of Manure Utilization Options, cont.		
	Advantages	**Disadvantages**
Give away or sell raw manure	▪ Beneficial if insufficient land is available for land application. ▪ Avoids time and expenses associated with composting manure. ▪ Often the easiest and quickest way to manage manure. ▪ Manure, particularly aged manure, is often sought after by gardeners, soil producers, and others.	▪ Requires some marketing. ▪ Requires manure handling either through loading or bagging. ▪ May require off-site delivery of manure. ▪ Requires sufficient storage during times when manure is not removed.
Give away or sell composted manure	▪ Often easier to give away or sell than raw manure. ▪ Depending on market and quality of compost, may be able to sell to cover costs or make profit.	▪ Requires some marketing. ▪ Requires handling either through loading or bagging.

Minimum Distances between Manure Storage/Composting Areas and Other Activities (Set-back)	
Sensitive Area	**Minimum Separation distance (feet)**
Property line	50
Residence or place of business	200
Private well or other potable water source	100
Wetlands or surface water (streams, ponds)	100
Subsurface drainage pipe	25
Water table (seasonal high)	25
Bedrock	3
Source: "Agricultural Management Practices for Commercial Equine Operations," Rutgers.	

[i] Adapted from: "Strategies for Livestock Manure Management," King County Department of Natural Resources and Parks and Washington State University Cooperative Extension, 2002.

Manure Nutrients

Charts and Tables

Introduction

Calculating appropriate manure land application rates is a mathematical exercise that considers the nutrients in your soil, the nutrients supplied by your manure, and the nutrient requirements of the crops you are growing. The tables in this section will be helpful in calculating the about of nutrients that are typically found in manure. This information can be used to calculate nutrient benefits for land application and other uses of manure. A list of nutrient management calculators is also provided. Consult crop fertilizer or production guide to determine the nutrient needs of forage or crops you are growing.

Average Weight of Typical Plant Nutrients Found In Livestock Manure Produced Daily and Yearly

Animal	**Animal Weight** (Pounds)	**Total Nitrogen**		**Phosphate** (See note 2)		**Potash** (See Note 3)	
		Lb/day	Lb/yr	Lb/day	Lb/yr	Lb/day	Lb/yr
Dairy Cow	1400	0.57	210	0.232	85	0.458	167
Dairy Heifer	1000	0.41	150	0.166	61	0.325	119
Beef Stocker	500	0.17	62	0.127	45	0.145	53
Beef Feeder	1000	0.34	124	0.250	91	0.289	105
Beef Cow	-	0.36	131	0.273	100	0.313	114
Horse	1000	0.27	99	0.105	39	0.205	75
Nursery Pig	35	0.016	5.7	0.0118	4.3	0.012	4.6
Growing Pig	65	0.029	5.7	0.0223	8.2	0.024	8.6
Finishing Pig	150	0.068	25	0.050	19	0.054	19
	200	0.090	33	0.068	25	0.071	27
Gestating Sow	275	0.062	23	0.048	18	0.048	18
Sow and Litter	375	0.230	84	0.173	64	0.181	66
Boar	350	0.078	28	0.059	22	0.061	23
Sheep Feeder	100	0.045	16	0.015	5.5	0.039	14
Laying Hen	4	0.0029	1.05	0.0025	0.93	0.0014	0.54
Broiler	2	0.0024	0.85	0.00123	0.43	0.0009	0.31

Notes:
1. Manure fertilizer elements are not completely available to plants.
2. To determine actual phosphorous (P) weight multiply phosphate value by 0.437 ($P = 0.437\ P_2O_5$).
3. To determine actual potassium weight multiply potash value by 0.826 ($K = 0.826\ K_2O$).

Source: Washington State University Agricultural Extension Service.

Approximate Amount of Manure Needed to Supply 50, 100, or 150 lbs. of N/acre to a Crop			
Manure	**50 lb. N**	**100 lb. N**	**150 lb. N**
Chicken litter	1.5	3	4.5
Laying hens	3	6	9
Rabbit	10	20	30
Beef cow	25	50	75
Horse (no sawdust bedding)[1]	60	120	180
Separated dairy solids	100	200	300

[1] Horse manure with sawdust bedding may reduce the amount of N that plants can use.

Source: "Manure on Your Farm: Asset or Liability? Craig Cogger, Washington State University. LPES Small Farms Fact Sheets, Midwest Plan Service.

Horse Manure Land Application Example

Step 1. The soil test says each acre of your mostly grass pasture needs:

Pounds/Acre

N	P_2O_5	K_2O
60	35	80

Step 2. You have one 1,000 pound horse.

Its manure will have:

Pounds/Year

N	P_2O_5	K_2O
32	40	72

Step 3. Look at the N and P_2O_5 numbers from the soil test.

- The manure from the horse will have about ½ of the N needed for 1 acre of pasture.
- However, the manure will have slightly more pounds of P_2O_5 than 1 acre of pasture needs.
- Therefore, you will need at least 1 acre of pasture to spread the manure and use the nutrients. That is just enough.
- You can use the same process for any number of horses or any other crops.

Source: "A Horse Owners Guide to Good Stewardship," Randall James, Ohio State University Extension.

Nutrient Management Calculators

Organic Fertilizer Calculator for Small Farms, Oregon State University Extension Service
A tool for comparing the cost, nutrient value, and nitrogen availability of organic materials. Also see, "Reducing the Risk of Groundwater Contamination from Live Stock Manure Management."

Land Application of Manure, Clemson University
Information on land application and worksheet for determining the nutrient needs of crops.

Illinois Manure Management Plan, University of Illinois
Information and various spreadsheets for determining manure spreader calibration, volume calculations, and nutrient management plans, etc.

Nutrient management Plan Tools, University of Maryland.
Includes calculator for manure quantity estimation and other resources.

NuMan Reporter Software, University of Maryland.
Calculator used to summarize the number of acres, total amounts of commercial fertilizer applied, and total amounts of organic material applied on a crop.

Manure Application Rate Calculator, (MARC) 2005. Manitoba Agriculture, Food and Rural Initiatives.
Helps producers determine sustainable manure application rates.

Michigan Agriculture Environmental Assurance Program. Web site has a wealth of resources including, Calculating the Estimated Annual Phosphorous Generated by Livestock, in "Manure Management: Getting Started."

Field Calibration Table
Manures for Organic Crop Production, Appropriate Technology for Rural Areas.

Nitrogen = N
Phosphorous = P
Potassium = K
Sulfur = S
Phosphate = P_2O_5
Potash = K_2O

Composting

Charts and Tables

Introduction

Composting requires specific carbon-to-nitrogen ratios, moisture content, oxygen levels, and other conditions to be successful. Composting on the farm is relatively easy, as manure and typical bedding sources make excellent compost materials. Planning and monitoring are required, however. The charts below provide information that will be helpful in successful composting.

Optimum Conditions for Successful Composting		
Factor	**Range**	**Ideal**
Carbon to Nitrogen (C:N) ratio	20:1-40:1	25:1-30:1
Moisture content	40-65%	50-60%
Oxygen concentration	Greater than 5%	Much greater than 5%
Particle size (diameter in inches)	0.12-0.5 (1/8"-1/2")	Varies
pH	5.5-9.0	6.5-8.5
Temperature (F)	110-150	130-145
Bulk density (pounds per cubic yard)	Less than 1100 (35-40 pounds per cubic foot)	--
Conditions are those recommended for rapid composting, variations outside of these ranges can also result in successful composting. Adapted from "On-Farm Composting Handbook," Natural Resource, Agriculture, and Engineering Service, 1992.		

Typical Weight of Manure and Moisture Content		
	Weight (lb./cubic yard)	**Moisture** (percent)
Chicken with litter	900	30
Laying hen	1,400	60
Sheep	1,400	72
Rabbit	1,400	75
Beef cow	1,400	77
Dairy cow, dry stack	1,400	65
Horse	1,400	63
Source: "Manure on Your Farm: Asset or Liability? Craig Cogger, Washington State University. LPES Small Farms Fact Sheets, Midwest Plan Service.		

Typical Characteristics of Selected Raw Materials for Composting				
Material	**%N** (dry weight)	**C:N ratio** (weight to weight)	**Moisture content %** (wet weight)	**Bulk Density** (pounds per cubic yard)
Apple-processing sludge	2.8	7/1	59	1,411
Corn cobs	0.4-0.8	56-123/1	9-18	557
Fruit wastes	0.9-2.6	20-24/1	62-88	-
Vegetable wastes	2.5-4	11-13/1	-	-
Mixed slaughterhouse waste	7-10	2-4/1	-	-
Manures				
- Boiler litter	1.6-3.9	12-15/1	22-46	756-1,026
- Cattle	1.5-4.2	11-30/1	67-87	1,323-1,674
- Horse	1.4-2.3	22-50/1	59-79	1,215-1,620
- Laying Hens	4-10	3-10/1	62-75	1,377-1,620
- Sheep	1.3-3.9	13-20/1	60-75	-
- Swine	1.9-4.3	9-19/1	65-91	-
- Turkey litter	2.6	16/1	26	783
Food waste	1.9-2.9	14-16/1	69	-
Corn silage	1.2-1.4	38-43/1	65-68	-
Hay	0.7-3.6	15-32/1	8-10	-
Straw	0.3-1.1	48-150/1	4-27	58-378
Sawdust	0.06-0.8	200-750/1	19-65	350-450
Wood chips	0.04-0.23	212-1,313/1	-	445-620
Grass clippings	2.0-6.0	9-25/1	82	300-800
Leaves	0.5-1.3	40-80/1	38	100-500
Adapted from "On-Farm Composting Handbook," Natural Resource, Agriculture, and Engineering Service, 1992.				

Average Carbon-to Nitrogen Estimations of Selected Materials		
Material	**Carbon (C)**	**Nitrogen (N)**
Compost, finished	15	1
Cow manure	18	1
Sheep manure	17	1
Poultry manure	15	1
Horse manure	25	1
Straw, wheat	130	1
Straw, oat	48	1
Corn stalks	40	1
Sawdust, rotted	208	1
Sawdust, raw	510	1
Hay, legume	17	1
Hay, grass	30	1
Grass clippings	13	1
Vegetable wastes	11	1
Oak leaves	50	1
Pine needles	85	1

- Successful composting requires a blend of high carbon materials with low carbon/high nitrogen materials. Proportions can be adjusted based on the approximate C:N ratio of the dominant feedstocks in this table. For example, equal quantities of dried sheep manure (C:N=17) and oat straw (C:N=48) will produce a compost pile with a C:N of about 32-33—a good C:N ratio for composting.
- Proportioning of feedstock materials should be based on weight rather than volume, if possible. High moisture materials may require drier, high carbon sources. Wood chips and other woody materials break down extremely slowly and may not provide sufficient carbon for the composting process, even though they are carbon amendment sources.
- Manure sources are typically mixed with bedding. This needs to be taken into consideration before adding additional materials.

Source: Organic Farm Document Series, NCAT's ATTRA Project.

Typical Times for Selected Manure Composting Methods		
Method	**Range**	**Curing time**
Passive pile	6 months to 2 years	0-1 month
Windrow	2-8 months	1-2 months
Passively aerated pile or windrow	10-12 weeks	1-2 months

Each method requires some turning with a pitchfork or bucket loader—the more often the compost is turned, the more rapidly it will decompose.

Adapted from "On-Farm Composting Handbook," Natural Resource, Agriculture, and Engineering Service, 1992.

Common On-Farm Materials That Can Be Used For Composting

Crop & garden residues	Sawdust and shavings
Fish processing wastes	Slaughterhouse & meat packing wastes
Food processing wastes	Spoiled hay & silage
Fruit & vegetable wastes	Straw
Grass clippings	Wood ash
Leaves	Wood chips
Livestock manures	

Sizing of Shed Composter for One Horse[a]

	Required volume (ft^3)[b] at daily manure production of:			Required area (ft^2)[c] at daily manure production of:	
	50 lbs per day	**83 lbs per day**		**50 lbs per day**	**83 lbs per day**
Month 1-3	133-200[c]	221-332		34-51	56-85
Month 4-6	67-100	111-166		17-25	28-42
Month 7-9	67-100	111-166		17-25	28-42
Month 1-9	267-400	443-664		68-101	112-169

[a] Additional space for access and maneuvering of front loader or other equipment will need to be factored in.
[b] Assumed bulk density of 31.3 lb/ft^3, volume reduction of 50% assumed after first 3 months.
[C] Assumed pile height of 4 ft.
[D] The lower numbers of the ranges are the calculated volumes and areas under the above listed assumptions. The upper numbers of the ranges include 50% additional space for varying manure production and possible expansion of the facility.

Source:"Best Management Practices for Horse Manure Composting on Small Farms," Uta Krogmann, Ph.D., Michael L. Westondorf, Ph.D, and Barbara F. Rogers. Rutgers Bulletin.

Compost Troubleshooting		
Problem	**Possible Causes**	**Solution**
Strong smell. Smells like "rotten eggs" or has putrid odor.	• Pile may be too wet. • Oxygen is lacking and process has gone anaerobic. • C:N ratio (<20) is low, excess N is being released as ammonia.	• Turn pile and increase turning frequency until problem subsides. • Increase carbon sources, such as bedding. • Cover to protect from rain.
Too wet	• Insufficient carbon sources. • Bedding or manure is too wet. • Rain water or other water source is entering compost.	• Add sawdust, straw, shredded paper or other dry amendments. • Turn more often. • Cover pile.
Too dry	• Compost amendments are too dry. Cannot squeeze water from materials.	• Water lightly. Expose pile to rain, if possible. Add wet ingredients (such as urine-soaked bedding). • Turn after watering.
Not heating up	• C:N ratio is too high (>60), microorganisms not active. • Pile lacks oxygen. • Pile is too dry (cannot squeeze water from ingredients). • Weather is too cold for compost process.	• Add additional nitrogen—manure or vegetable scraps. • Turn pile. • Add water throughout pile and turn. • When weather warms, turn pile. Add additional materials to pile.
Pile heated up, but only for a short time.	• Materials may be too dense and not allowing sufficient air flow. • Pile is too dry. • If the pile has been active for more than a month, the compost process may be complete.	• Turn piles to ensure distribution of materials. Add nitrogen source if necessary. • Water pile. • Turn pile again, water if necessary and continue monitoring temperature. Look for uniformity in material, there should be little or no recognition of original compost ingredients.
Decomposition process is slow. Temperature is too high.	• C:N ratio is too low (<20) causing high temperature which kills microorganisms that make compost work. • Pile lacks oxygen.	• Add carbon sources, such as bedding and turn pile. • Turn pile.

Compost Troubleshooting, cont.		
Problem	**Possible Causes**	**Solution**
Pile is very hot >160°F). Mixture has turned gray (ash-like) and may smoke.	• Insufficient turning. • Ingredients are too dry.	• Turn and spread it out to let it cool down. • Add water and turn pile.
Fly infestation	• Manure is exposed to open air.	• Keep compost covered. Cover freshly added manure with bedding. • Turn more often to ensure proper aeration and to increase composting activity. • Remove stored manure every 3 days to disrupt fly-breeding cycle.
Viable weed seeds, pest larva, & pathogens in compost	• Temperatures in pile did not reach 130°F or did not stay at this level for sufficient time.	• Turn pile more frequently and make sure carbon-to-nitrogen ratio is adequate to raise temperatures to 131°F for at least 2 weeks.
Pile has gone through two or more heating cycles, but compost still contains recognizable bedding material.	• Contains wood shavings or wood chips. These materials are slow to degrade.	• Monitor pile moisture, add water if necessary. Give pile additional time to degrade. Use as mulch instead of compost.
Sod base under pile is growing into pile.	• This is a natural occurrence.	• Trim around base of pile. • Spread pile to cover more of sod to smother it.

Farm Plan

Number and Type of Animals				
Animal type	Number	A.U.	Period of Confinement	Estimated Manure Production
Total Number Animals:				
Total Animal Units:				
Total Estimated Manure Production:				

1 A.U. = 1 Animal Unit = 1000 pounds equivalent

Special Environmental Factors

List sensitive areas, including wells, wetlands, streams, sand/gravel aquifer, soil type, etc. Refer to the Manure Management Handbook, “The Path to Best Management Practices for Manure,” for guidelines.

Farm Sketch

Below or on a separate piece of paper sketch your farmstead area. Refer to the Manure Management Handbook, “The Path to Best Management Practices for Manure,” for guidelines. Photo documentation is an excellent tool to use in manure management.

Manure storage type: (Use photo documentation, if possible)

Volume and length of planned storage:

Manure utilization description:

Other records (as applicable):

1. Grazing rotation.
2. Land application records and nutrient management plan.
    a. Soil test results.
    b. Manure test results.
    c. Crop nutrient needs.
    d. Calculations of how much manure to apply.
    e. Dates of manure application(s).
    f. Rate (amount of manure) applied.
    g. Incorporation date(s).
    h. Weather and field conditions during application.
3. Compost monitoring and application records
    a. See Compost Monitoring Chart Template.

Estimating Monthly Storage Needs[1]

Use the Charts in the Manure Generation and Storage section of the Quick Reference Guide to estimate the manure and bedding generated on your farm.

Estimated Manure Generation per Month			
Animal	**Number**	**Waste/month (cubic feet)**	**Storage Needed per Month**

Total storage needed per month = ________

Bedding Generation per month			
Bedding Type	**Lbs./Month**	**Cubic Feet/Month**	**Total**

Total Bedding = _________________
X 0.50 compaction (50%) = ____________

_____________Total Manure Generated
_____________Total Bedding Generated
Cubic Feet/Month of Total Storage Needed

[1] Adapted from USDA Natural Resources Conservation Service, Lynden Field Office, Lynden, WA.

Compost Monitoring Record								
Pile #	**Date**	**Time**	**Moisture rating**	**Odor rating**	**Temperature**			**General Observations**
#: Date started: Feedstocks: Estimated C/N Ratio:								
#: Date started: Feedstocks: Estimated C/N Ratio:								
#: Date started: Feedstocks: Estimated C/N Ratio:								
#: Date started: Feedstocks: Estimated C/N Ratio:								
#: Date started: Feedstocks: Estimated C/N Ratio:								

<u>Moisture rating</u>: Squeeze material, if moist like damp sponge and a few water drops are produced, moisture is good; if not, it needs water. If too soggy, add dry materials, such as bedding.
<u>Temperature</u>: Temperature readings should be taken near the middle of the pile (windrow) and near the bottom. Windrow temperatures should also be taken several feet from each end of the windrow.
<u>Odor rating</u>: Scale of 1-5: 1) little or no odor to 5) odor is offensive.
<u>General observations</u>: Was material turned? Is leachate a problem? Other problems?

Manure Management at a Glance

<u>January, February, March</u>
- Avoid applying manure on fields.
- Cover manure storage and compost piles.
- Collect manure from barns/stalls, paddocks, and fields (where necessary) and put into manure storage. Monitor storage for drainage.
- Use proper pasture rotation and use of paddock in wet weather.

<u>April and May</u>
- Remove manure from storage for utilization.
- Test soil and determine crop needs for land application of manure. Apply manure on cropland per nutrient needs of crops and soil. Till or incorporate manure into soil within 72 hours of application.
- Turn existing compost piles. Begin new piles.
- Prepare manure for off-farm utilization: post signs, bag as necessary, etc.
- Collect manure from barns/stalls, paddocks, and fields (where necessary) and put into manure storage, compost piles, or manure spreader for land application.
- Use proper pasture rotation and use of paddock in wet weather.

<u>June, July, August</u>
- Apply manure only as appropriate to fields after hay is removed and crops are harvested.
- Continue compost production.
- Continue off-farm utilization.
- Collect manure from barns/stalls, paddocks, and fields (where necessary) and put into manure storage, compost piles, or manure spreader for land application.
- Use proper pasture rotation.

<u>September and October</u>
- Apply manure to cropland prior to planting winter crops or as a dressing on winter cover crops (such as rye grass). Do not apply manure on annual crops where growth has slowed or stopped, due to potential nutrient loss into water.
- Continue monitoring and turning compost.
- Continue off-farm utilization.
- Prepare manure storage area for winter usage.
- Collect manure from barns/stalls, paddocks, and fields (where necessary) and put into manure storage, compost piles, or manure spreader for land application.
- Use proper pasture rotation.

<u>November and December</u>
- Begin stockpiling manure.
- Turn compost piles for winter storage. Cover securely.
- Collect manure from barns/stalls, paddocks, and fields (where necessary) and put into manure storage.
- Use proper pasture rotation and use of paddock in wet weather.

Glossary

Aeration: The process of adding oxygen into a compost pile or windrow through turning or through the use of perforated pipes that allow in air.

Aerobic: Process or organism requiring oxygen.

Ammonium Nitrogen: an inorganic form of nitrogen in manure. This type of nitrogen is important because it is immediately available for crop uptake.

Anaerobic: A process that occurs without air or oxygen.

Bulk density: Weight or mass per unit of volume of material. For example, the weight of a pile of wood shavings divided by the volume of the pile is the bulk density.

Bulking agent: Ingredients in compost mixtures added to improve the structure and porosity of the mixture. Bulking agents are usually dry, such as straw.

Carbon-to-nitrogen ratio (C:N ratio): The ratio of the weight of organic carbon (C) to that of the total nitrogen (N) in an organic material.

Composting: A controlled process where organic material is managed in a systematic way to yield a consistent end product.

Leachate: Liquid that results when water comes in contact with a solid, for example, manure or compost. The water extracts material, either dissolved or suspended, from the solid.

Mesophilic Composting: When temperatures in the composting process are between 50°F and 90°F, typically occurring during the beginning and end of the compost process.

Moisture content: The percentage of a material or substance comprised of water. The moisture content is equal to the weight of the water portion divided by the total weight (water plus dry matter portion) of the material.

Organic Nitrogen: Organic nitrogen contained in manure is not immediately available for crop uptake. It must be decomposed (mineralized) to inorganic nitrogen in order to be made available to plants.

pH: A measure of the concentration of hydrogen ions in a solution. It is expressed as a negative exponent, so a material having a pH of 8 has ten times fewer hydrogen ions than something with a pH of 7. The lower the pH value, the more hydrogen ions present, and the more acidic the material. The higher the pH value, the more basic it is. A pH of 7 is considered neutral.

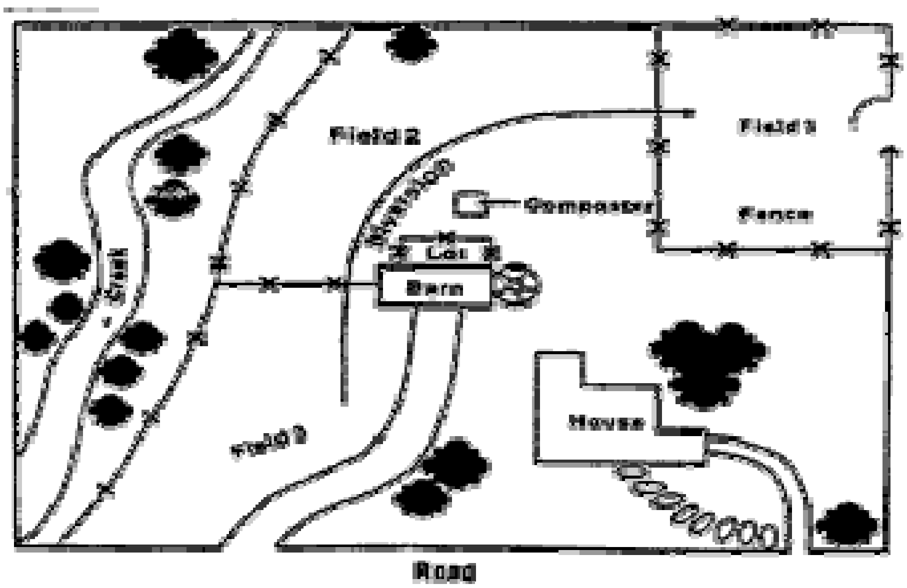
Porosity: A measure of the pore space of a pile of material, such as in a compost pile. Porosity equals the volume of the pores divided by the total volume.

Setback: A prescribed distance separating the area of a particular activity, such as manure storage, and a given boundary, such as a water body.

Thermophilic Composting: When compost temperatures reach between 130°F and 160° microbial pathogens such as coliforms and salmonella are typically destroyed, as are most weed seeds. A sustained Thermophilic condition for 15 days is required to produce high quality compost from manure and ensure that pathogens that may be present in the manure are destroyed.

Total Nitrogen (N): A measure of the entire N content of the manure. It includes the ammonium N, the organic N, and any nitrate N that may be present.

Sample Farm Maps



This map indicates fencing that prevents livestock from entering the creek. Note also the brush along the creek for filtering and protection of the waterway. The diversion (drainage system) is set up on higher ground to help prevent runoff from draining though the sacrifice (exercise) lot and the compost area. A diversion set-up below the lot will help direct runoff from the lot and away from the waterway.

Source: “Equine Facts: Guidelines for Horsekeeping in Maine,” Bulletin #1011, University of Maine Cooperative Extension.

Farm Plan Showing Manure Management Considerations for Minimizing Nuisances

The sample farm map on the next page presents an example of how to set up manure storage in order to minimize nuisances such as odor, as well as measures to protect water ways.

Source: “Horse Stable Manure Management,” Eileen Wheeler and Jennifer Smith Zajaczkowski, PennState College of Agricultural Sciences Cooperative Extension, 2001.

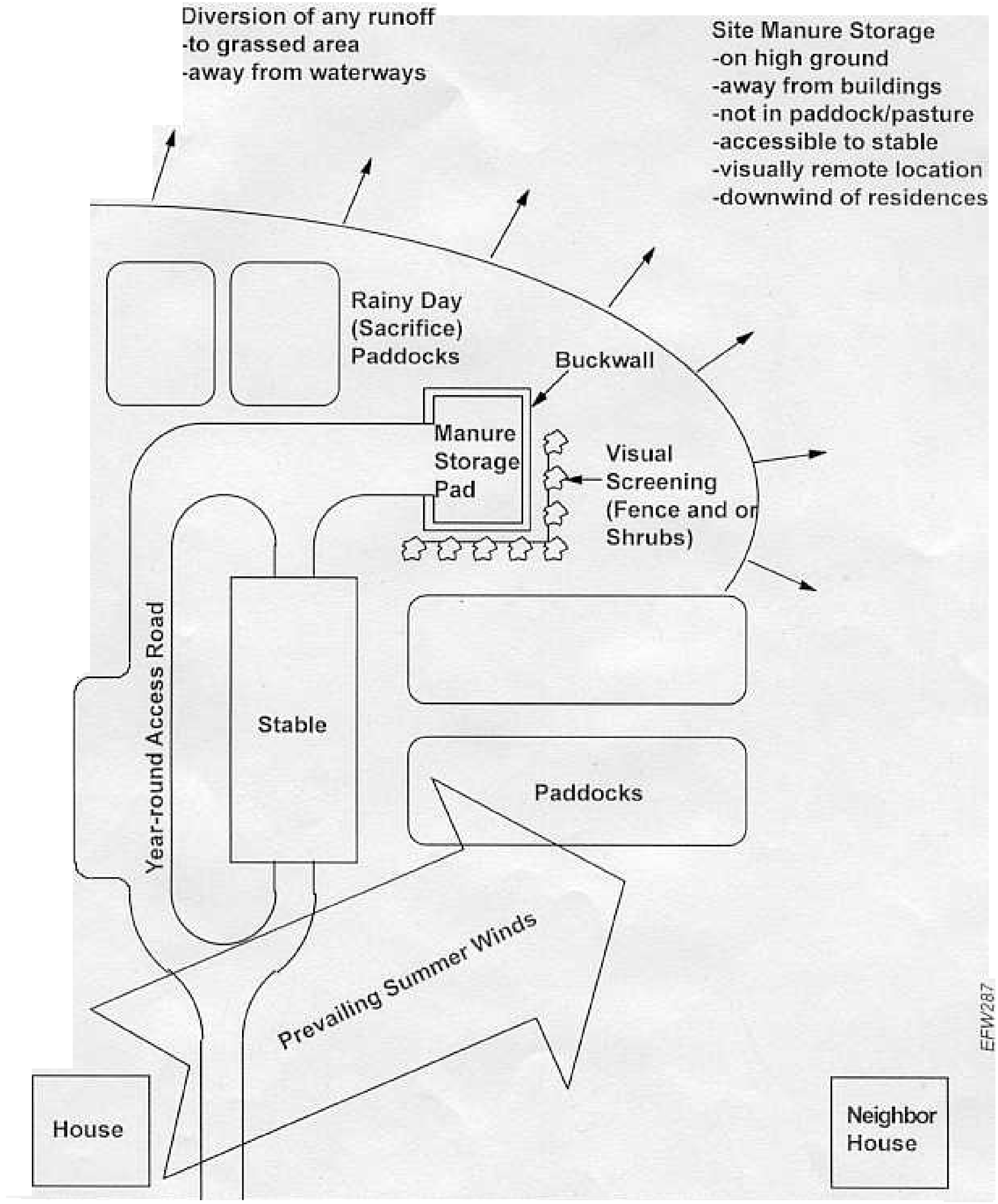


Figure 2. Farm plan showing manure management considerations for minimizing nuisances.