NEW JERSEY
FARM-A-SYST
A FARMSTEAD WATER QUALITY ASSESSMENT SYSTEM

#7 Fact Sheet: Reducing the Risk of Groundwater Contamination by Improving Livestock Waste Storage

Storage of livestock wastes involves simply accumulating wastes in some type of structure until the wastes can be land applied. From an environmental standpoint, this waste storage can be either positive or negative.

Manure storage can provide environmental benefits by allowing wastes to be stored until they can be safely spread, incorporated in the soil and used by a growing crop. The environmental safety of collecting large amounts of manure in one place for an extended period depends on three things:

1) the design and construction of the storage facility
2) the proper land application of the manure once it leaves the storage jacility
3) the physical and chemical characteristics of the soil and subsurface geologic materials within the storage area; and the soil and subsurface geologic materials of the area to which any runoff might flow

Waste storage is an important management option available to livestock producers. Stored manure can be applied to the soil at those times of the year when crops are not actively growing and the soils are open. This allows manure to be injected or incorporated by tillage immediately following application. Handling manure in this way ensures the farmer of the maximum fertilizer value from the waste materials, while reducing risks of groundwater and surface water contamination from the over-application of nutrients.

> Stored manure can easily be sampled and tested to determine how much nitrogen, phosphorus and potassium it contains. (When sampling manure, be sure to obtain as representative a sample as possible.) This information, combined with a knowledge of the amount of manure applied per acre, enables a farmer to determine whether additional commercial fertilizer is needed to meet realistic crop production goals.

Waste storage also reduces the need for land application during winter months when soil is frozen. This saves wear and tear on farm equipment, conserves nutrients contained in the manure and minimizes manure nutrient leaching and runoff. Storage is also valuable during extended periods of bad weather and when crops are actively growing, making application impractical.

1. Long-term storage

Livestock wastes can be stored either in solid, semi-solid or liquid states.

For glossary, see page 2 of Worksheet #7.

- Solid facilities use walls and slabs for stacking of heavily bedded manure.
- Semi-solid facilities use pumps to move manure into containment areas and may separate solids from liquids.
- Liquid facilities hold manure in tanks, pits or bermed areas.

Liquid and semi-solid storage systems are self-contained. Groundwater contamination can occur if the facility is not structurally sound, allowing waste materials to seep into the soil. A threat to surface water exists if pits are not emptied frequently enough, allowing wastes to flow over the top of the structure. Liquid storage systems require the use of pumps and pipes for moving wastes from the barn to the storage structure. These must be carefully installed and maintained to ensure that they do not leak.

Each time they are emptied, carefully check **steel and concrete structures** for cracks or the loss of watertight seals. If any breaks are apparent, repair them immediately. Likewise, check the walls of **earthen waste storage pits** to be certain that liner materials have not been eroded away by pit agitation.

After a period of years, freezing and thawing, as well as wetting and drying, may cause the sidewalls of earthen pits to crack and erode, allowing wastes to seep into the underlying soil or subsurface geologic material. Earthworm channels can also allow wastewater to move through the liner. Groundwater contamination will result if the subsurface materials do not have sufficient ability to break down contaminants contained in the leachate. Evidence suggests that the design life for earthen pits is probably 10 years.

While seepage from inground waste storage facilities is not always easy to recognize, there are some tell-tale signs:

- A properly designed structure has the capacity to handle wastes from a specific number of animals for a known number of days. If a pit designed for 180 days of storage and receiving designated waste amounts has not needed pumping for a year, the pit is almost certainly leaking.

- Evaporation from liquid storage pits is minimal, particularly with manure from dairy cattle, which forms a crust when it is stored. If additional liquids have to be added before the pits can be agitated and pumped, they may be leaking. (Monitoring wells installed around the pit upslope and downslope would be required to confirm the seepage.)

What Can Happen if a Soil Liner is Damaged?

A damaged soil liner in a liquid manure pit resulted in groundwater contamination that ultimately polluted a nearby spring. When the pit liner was damaged, it exposed the fractured limestone bedrock and allowed liquid manure to move to the spring source. The contaminated spring water was dark in color and smelled like cattle manure. Investigators determined that both groundwater and surface water were contaminated.

Some facilities for storage of solid or semi-solid manure are designed to allow seepage from the waste stack. In these instances, structure design must include treatment for the wastes that seep out. If conditions allow, structures such as picket dams can be used to hold back solids, and grass filter strips help remove remaining pollutants in runoff water. These systems should not be considered on sites with coarse-textured soils, creviced bedrock or shallow water tables. Care must be taken to ensure that the system is not overloaded.

Both systems require maintenance. With grass filter strips, it is important to ensure that the highly concentrated wastes do not "burn" vegetation in the filter strip. (A thick, healthy stand of vegetation allows runoff to seep into the soil and uses the nutrients in the water.)

The best way to handle seepage is to channel it into a watertight holding pond or storage tank. In those areas where sufficient soil is unavailable for the construction of filter strips, or where the construction of a holding pond is not feasible, another option is to build a roof over the structure to eliminate additional water being added to the manure stack. Roofed storage systems require adequate bedding to absorb and retain the liquid portion of the waste.

2. Short-term storage

Short-term storage (usually 30-90 days) is an important option available to farmers. It allows them to hold livestock wastes during periods of bad weather when daily spreading may not be feasible, when crops are growing and land is not available for applying manure, or when there is a shortage of crop acres to handle daily hauling and spreading of manure without the threat of runoff.

Short-term storage, which is restricted primarily to solid manure, has the disadvantage of requiring that the manure be handled twice. Designs are available, though, for **structures for short-term storage** that facilitate handling and provide effective protection for surface water and groundwater.

Short-term storage systems may be applicable for those farmers who often find themselves having to **stack manure in fields,** particularly during periods of bad weather. This is not a recommended practice. No matter how it is done, it poses a contamination threat to surface water and groundwater. If manure is frequently stacked in fields, it might be appropriate to consider constructing a short-term storage facility.

Likewise, many farmers will scrape manure into **piles in the livestock yard** rather than haul it during bad weather or busy work periods. This practice is not recommended either, because of possible herd health problems and water problems. The severity of those problems depends on characteristics of the livestock yard area where the manure is piled and the area to which runoff flows.

Many farmers have **open housing** for young stock, such as pole sheds, where wastes are allowed to accumulate for extended periods of time. Roofs on these structures keep rain and snow off the manure. These structures are relatively safe for water quality if they are protected from surface water runoff, and if adequate bedding is provided to absorb liquids in the wastes. To minimize water quality impacts, provide adequate bedding to reduce seepage and clean these sheds as frequently as possible.

3. Waste storage location

The location of livestock waste storage in relation to any well is an important factor in protecting the farm water supply. For temporary manure stacks and earthen storage facilities, the recommended minimum separation distance is 250 feet. For liquid-tight manure storage structures, the recommended minimum separation distance is 100 feet.

Minimum separation distances regulate new well installation or the distance from existing wells to new waste storage facility construction. Existing wells are required by law only to meet separation requirements in effect at the time of well construction. Make every effort, however, to exceed "old regulations,"and strive to meet current regulations whenever possible.

Observing these separation distances when siting a new facility is a good way to help protect your drinking water. Locating manure storage facilities downslope from of the well is also important for protection of your water supply. (For more information about separation distances, and how the condition of your well might affect the potential for contamination, see

Worksheet and Fact Sheet #1, *Drinking Water Well Condition*.)
While observing these well separation minimum distances may be helping to protect your own well, poorly designed or poorly maintained livestock waste storage facilities could still contaminate the groundwater that supplies other local drinking water wells. Protecting the groundwater resource as a whole can help protect your neighbors' wells, as well as possible drinking water supplies for future generations.

Depth to seasonal high water table or fractured bedrock, along with soil type at the waste storage location, is another important factor. These are among the site vulnerability characteristics in Worksheet #11, *Site Evaulation.*

Depth to water table is sometimes available in the county soil survey, but this varies from county to county. Your county Extension agent or the Natural Resources Conservation Service may also be able to help you gather this information.

4. Abandoned pits

Abandoned waste storage pits, especially earthen ones, can pose significant water quality problems. Any abandoned structure should be completely emptied. In the case of earthen waste storage facilities, liner materials (to a depth of about two feet) should be removed and spread over croplands. The remaining hole should be filled and leveled. Manure packs from pole sheds no longer in use should also be removed and the wastes land applied. If manure is stacked in fields, it should be removed as soon as conditions permit.

CONTACTS AND REFERENCES

Who to call about...

General Contacts

See introductory sheet.

Waste storage needs, designing appropriate structures

Your county office of Rutgers Cooperative Extension or your Soil Conservation District office.

Cost-sharing funds

Financial assistance for animal waste management practices, including waste storage, may be available as part of a priority watershed plan, through the Agricultural Conservation Program administered by the Consolidated Farm Services Administration; and other federal and state programs. Contact your Soil Conservation District for more information.

What to read about...

Publications are available from sources listed at the end of the reference section. (Refer to number in parentheses after each publication.)

Health effects of livestock waste in groundwater

Nitrate, Groundwater and Livestock Health. University of Wisconsin-Extension. G3217. (1)

The Nitrate Problem in Dairy Cattle. Rutgers Cooperative Extension Fact Sheet 118. (3)

Handling, management and storage of livestock waste

Outside Liquid Manure Storages. 1979. 8 pages. Midwest Plan Service. AED-23. (2) Discusses earth storage basins and non-earth above-ground storages.

Farm Animal Waste Management Systems. Rutgers Cooperative Extension Fact Sheet 255. (3)

Planning and design of livestock waste storage facilities

Livestock Waste Facilities Handbook. 1985. 112 pages. Midwest Plan Service. (2) Focuses on planning and design of livestock waste facilities and equipment, and information about land application techniques and animal waste utilization. Includes worksheet to help determine manure application rates.

Circular Concrete Manure Tanks. 1983. 4 pages. Midwest Plan Service. TR-9. (2)

Liquid Manure Tanks: Rectangular, Below Grade. Midwest Plan Service. MWPS-74303. (2)

Land application of livestock waste

Livestock Waste Facilities Handbook. 1985. 112 pages. Midwest Plan Service. (2) Includes information about land application techniques and animal waste utilization, as well as a worksheet to help determine manure application rates.

Publications available from...

1. Agricultural Bulletin, Room 245, 30 N. Murray Street, Madison, Wisconsin, 53715, (608) 262-3346. There may be charges for publications, postage and sales tax.

2. The Midwest Plan Service Secretary, Agricultural Engineering Department, 460 Henry Mall, University of Wisconsin, Madison, Wisconsin 53706, (608) 262-3310.

3. Your county office of Rutgers Cooperative Extension (found in the blue pages of your phone book) or the Publications-Distribution Center, Cook College-Rutgers University, PO Box 231, New Brunswick, NJ 08903, (732) 932-9762.

The New Jersey Farmstead Assessment System is a cooperative project of the USDA Natural Resources Conservation Service, Rutgers Cooperative Extension, and New Jersey Department of Environmental Protection.

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Materials adapted for New Jersey use from the Wisconsin-Minnesota Farm-A-Syst Program by Susan Lance, Program Associate in Water Quality, Rutgers Cooperative Extension; Fred Kelly, Resource Conservationist, USDA Natural Resources Conservation Service; Theodore B. Shelton, Extension Specialist in Water Resources Management.

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#7 Worksheet: Assessing the Risk of Groundwater Contamination from Livestock Waste Storage

Why should I be concerned?

Storing livestock waste allows farmers to spread manure when conditions are right for nutrient use by crops. Accumulating manure in a concentrated area, however, can be risky to the environment and to human and animal health.

Facilities for manure stored in liquid form on the farmstead sometimes leak or burst, releasing large volumes of pollutants. Manure in earthen pits can form a semi-impervious seal of organic matter that does limit leaching potential, but seasonal filling and emptying can cause the seal to break down. Short-term solid manure storage and abandoned storage areas can also be sources of groundwater contamination by nitrates. Manure can contribute nutrients and disease-causing organisms to both surface water and groundwater.

Nitrate levels in drinking water above federal and state drinking water standards of 10 milligrams per liter (mg/l; equivalent to parts per million for water measure) nitrate-nitrogen can pose health problems for infants under 6 months of age, including the condition known as methemoglobinemia (blue baby syndrome). Nitrate can also affect adults, but the evidence is much less certain.

Young livestock are also susceptible to health problems from high nitrate-nitrogen levels. Levels of 20-40 mg/l in the water supply may prove harmful, especially in combination with high levels (1,000 ppm) of nitrate-nitrogen from feed sources.

Fecal bacteria in livestock waste can contaminate groundwater, causing such infectious diseases as dysentery, typhoid and hepatitis. Organic materials that lend an undesirable taste and odor to drinking water are not known to be dangerous to health, but their presence does suggest that other contaminants are flowing into groundwater.

The goal of Farm•A•Syst is to help you protect the groundwater that supplies your drinking water.

How will this worksheet help me protect my drinking water?

- It will take you step by step through your livestock waste storage practices.
- It will rank your activities according to how they might affect the groundwater that provides your drinking water supplies.
- It will provide you with easy-to-understand rankings that will help you analyze the "risk level" of your livestock waste storage practices.
- It will help you determine which of your practices are reasonably safe and effective, and which practices might require modification to better protect your drinking water.

How do I complete the worksheet?

Follow the directions at the top of the chart on the next page. It should take you about 15-30 minutes to complete this worksheet and figure out your ranking.

Information derived from Farm•A•Syst worksheets is intended only to provide general information and recommendations to farmers regarding their own farmstead practices. It is not the intent of this educational program to keep records of individual results.

Glossary

Livestock Waste Storage

These terms may help you make more accurate assessments when completing Worksheet #7. They may also help clarify some of the terms used in Fact Sheet #7.

Concrete stave storage: A type of liquid-tight animal waste storage structure. Located on a concrete pad, it consists of concrete panels bound together with cable or bolts and sealed between panels.

Earthen basin or pit: Clay-lined manure storage facility constructed according to specific engineering standards. Not simply an excavation.

Engineering standards: Design and construction standards available at USDA Natural Resources Conservation Service (NRCS). These standards may come from NRCS technical guides, state regulations or land grant university engineering handbooks.

Filter strip: A gently sloping grass plot used to filter runoff from the livestock yard and some types of solid manure storage systems. Influent waste is distributed uniformly across the high end of the strip and allowed to flow down the slope. Nutrients and suspended material remaining in the runoff water are filtered through the grass, absorbed by the soil and ultimately taken up by plants. Filter strips must be designed and sized to match the characteristics of the livestock yard or storage system.

Glass-lined steel storage: A type of liquid-tight, above-ground animal waste storage structure. Located on a concrete pad, it consists of steel panels bolted together and coated inside and outside with glass to provide corrosion protection.

Poured concrete storage: A type of liquid-tight animal waste storage structure. Located on a concrete pad, it consists of poured concrete reinforced with steel.

Water table depth: Depth to the upper surface of groundwater. This depth is sometimes indicated in the county soil survey, but this varies from county to county. This information may be available from your well construction report or from hydrogeological reports and groundwater flow maps of your area. Your county Rutgers Cooperative Extension agent or NRCS specialist may also be able to help you gather this information.

There are two types of water table: (1) the water table typically noted in a well log as an indication of usable water supply; and (2) the seasonal high water table. The seasonal high water table is most important in regard to construction of livestock manure storage facilities, because it may present facility construction problems.

Worksheet #7

Livestock Waste Storage: Assessing Drinking Water Contamination Risk

1. Use a pencil. You may want to make changes.
2. For each category listed on the left that is appropriate to your farmstead, read across to the right and circle the statement that **best** describes conditions on your farmstead. (Skip and leave blank any categories that don't apply to your farmstead.) For categories separated by "OR," choose only one category.
3. Then look above the description you circled to find your "rank number" (4, 3, 2 or 1) and enter that number in the blank under "your rank."
4. Directions on overall scoring appear at the end of the worksheet.
5. Allow about 15-30 minutes to complete the worksheet and figure out your risk ranking for livestock waste storage practices.

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LONG-TERM STORAGE (180 days or more)					
Steel, glass-lined (liquid-tight design, above ground)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Leaking tank on medium-textured soils (silt loam, loam).	Leaking tank on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	____
OR					**OR**
Concrete stave (liquid-tight design)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	____
OR					**OR**
Poured concrete (liquid-tight design)	Designed and installed according to accepted standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	____
OR					**OR**
Earthen waste storage pit (below ground)	____	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Not designed to engineering standards. Constructed in medium- or fine-textured dense materials (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet. Earthen lining eroding.	Not designed to engineering standards. Constructed in coarse-textured materials (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet. More than 10 years old. Earthen lining perforated.	____

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
SHORT-TERM STORAGE (usually 30-90 days; in some cases, up to 180 days)					
Stacked in field (on soil base)	———	———	Stacked on high ground. Medium- or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table is deeper than 20 feet.	Stacked on high ground. Coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet.	____
Stacked in yard	Covered concrete yard with curbs, gutters and settling basin.	Concrete yard with curbs and gutters. Grass filter strips installed and maintained.	Earthen yard with medium- or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet.	Earthen yard with coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet.	____
Water-tight structure designed to accepted engineering standards and specifications	Designed and installed according to engineering standards. All liquids retained.	Designed and installed according to engineering standards on medium- and fine-textured soils (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet.	Designed and installed according to engineering standards on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	Designed and installed according to engineering standards. Not properly maintained. Water treatment and diversion and terrace structures allowed to deteriorate.	____
Stacked in open housing	Building has concrete floor, protected from surface water runoff. Adequate bedding provided.	Building has earthen or concrete floor on medium- or fine- textured soils (silt loam, loam, clay loams, silty clay), protected from surface water runoff. Water table deeper than 20 feet.	Building has earthen or concrete floor on medium- or fine-textured soils (silt loam, loam, clay loams, silty clay), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	Building has earthen floor on coarse-textured soils (sands, sandy loam), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	____

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LOCATION					
Location of livestock waste storage in relation to drinking water well	Manure stack or earthen waste storage pit more than 250 feet downslope from well. Manure storage structure (liquid tight) more than 100 feet downslope from well.	Manure stack or earthen waste storage pit more than 250 feet upslope from well. Manure storage structure (liquid tight) more than 100 feet upslope from well.	Manure stack or earthen waste storage pit less than 250 feet downslope from well. Manure storage structure (liquid tight) less than 100 feet downslope from well.	Manure stack or earthen waste storage pit less than 250 feet upslope from well. Manure storage structure (liquid tight) less than 100 feet upslope from well.	____

TOTAL [ ]

Use this total to calculate risk ranking on back page of worksheet.

What do I do with these rankings?

Step 1: Begin by determining your overall livestock waste risk ranking. Total the rankings for the categories you completed and divide by the number of categories you ranked:

_____ divided by _____ equals [ ]*

total of rankings / # of categories ranked / risk ranking

*Carry your answer out to one decimal place.

3.6–4=low risk, 2.6–3.5=low to moderate risk, 1.6–2.5=moderate to high risk, 1–1.5=high risk

This ranking gives you an idea of how your livestock waste practices **as a whole** might be affecting your drinking water. This ranking should serve only as a **very general guide, not a precise diagnosis.** Because it represents an **averaging** of many individual rankings, it can mask any **individual** rankings (such as 1's or 2's) that should be of concern. (See Step 2.)

Enter your boxed livestock waste risk ranking on page 1 of Worksheet #12. Later you will compare this risk ranking with other farmstead management rankings. Worksheet #11 will help you identify your farmstead's site conditions (soil type, soil depth and bedrock characteristics), and Worksheet #12 will show you how these site conditions affect your risk rankings.

Step 2: Look over your rankings for individual activities:

- **Low-risk** practices (4's): ideal; should be your goal despite cost and effort
- **Low-to-moderate-risk** practices (3's): provide reasonable groundwater protection
- **Moderate-to-high-risk** practices (2's): inadequate protection in many circumstances
- **High-risk** practices (1's): inadequate; pose a high risk of polluting groundwater

Regardless of your overall risk ranking, any individual rankings of "1" require immediate attention. Some concerns you can take care of right away; others could be major—or costly—projects, requiring planning and prioritizing before you take action.

Find any activities that you identified as 1's and list them under "High-Risk Activities" on pages 6-7 of Worksheet #12.

Step 3: Read Fact Sheet #7, *Improving Livestock Waste Storage*, and consider how you might modify your farmstead practices to better protect your drinking water.

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

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