B-6030

TEX★A★Syst

Rural Well Water Assessment

Texas A&M AgriLife Extension

Reducing the Risk of Ground Water Contamination by Improving Livestock Manure Storage and Treatment Facilities

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1. Are you aware of manure sampling and testing procedures?
2. Do you store livestock waste for longer than 90 days on your property?
3. Do you store livestock waste for short periods (30 to 90 days) on your property?
4. Do you store livestock waste closer than 150 feet from any water wells?
5. Do you use lagoons or detention ponds to store livestock waste?
6. Are there any abandoned livestock waste storage facilities on your property?

If these questions create doubt about the safety of your management practices, this publication will provide helpful information.

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Livestock Manure Storage

Improperly managed manure can contaminate both surface and ground water with nutrients and disease-causing organisms. Storing livestock manure allows producers to spread it when crops can best use the nutrients. However, accumulating manure in a concentrated area can be risky to the environment and to human and animal health unless done properly.

Federal and state drinking water standards state that nitrate levels in drinking water should not exceed 10 milligrams per liter (equivalent to parts per million for water measure). Nitrate nitrogen levels higher than this can pose health problems for infants under 6 months of age, including the condition known as methemoglobinemia (blue baby syndrome). Nitrate also can affect adults, but the evidence is much less certain.

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

Facilities for manure stored in liquid form may sometimes leak or burst, releasing large volumes of pollutants. Manure stored in earthen pits can form a semi-impervious seal of organic matter and bacterial cells on the bottom and sides. The seal limits leaching, but seasonal filling and emptying can cause the seal to break down. Short-term solid manure storage areas and abandoned storage areas also can be sources of ground water contamination by nitrates.

Livestock wastes (manure and wastewater) should be stored in an environmentally sound manner until they can be applied to land. Regulations of the Texas Natural Resource Conservation Commission (TNRCC) apply to the location of and minimum standards for seepage control from lagoons and detention ponds. Dry manure can be stored in stockpiles, and liquid manure can be stored in lagoons and detention ponds. The environmental safety of collecting large amounts of manure in one place for an extended period depends on the following items:

1. location of the storage site with respect to physical and chemical characteristics of the soil;
2. subsurface geologic materials and their structure;
3. design and construction of the storage site or facility, including control of seepage; and
4. proper land application of the manure once it leaves the storage site or facility, at a rate compatible with nutrient uptake by crops based on current soil test.

Manure stored in solid or liquid form can be applied most efficiently to the soil at those times of the year when crops are not actively growing. This allows solid manure to be tilled in immediately after application, or liquid manure slurry to be injected into the soil. Liquid manure also can be stored in lagoons where bio-degradation occurs and then applied to land by irrigation. Handling manure in this way ensures that fertilizer nutrients from the waste materials will be used by crops, while reducing risks of ground water and surface water contamination. Once manure is applied and incorporated, a forage crop will be planted to use the nutrients.

Stored manure can be easily sampled and tested to determine its nitrogen, phosphorus and potassium levels. When sampling manure, be sure to obtain as representative a sample as possible. This usually involves taking a number of subsamples (10 or more) and mixing them into one or more samples to be analyzed. With manure tests and a knowledge of the amount of manure applied per acre, a farmer can determine whether additional commercial fertilizer is needed to meet crop production goals.

Waste storage also reduces the need to apply it to land during winter months when many forage crops are dormant. It conserves nutrients contained in the manure and minimizes manure nutrient leaching and runoff. Storage is also valuable during extended periods of bad weather which make application impractical. Texas Natural Resource Conservation Commission rules prohibit irrigation with wastewater when the ground is frozen or saturated.

A glossary at the end of this publication will clarify terminology. The following topics are covered:

1) Long-term storage

2) Short-term storage

3) Waste storage location

4) Lining materials for lagoons, detention ponds or stroage pits

5) Other management factors

6) Abandoned pits

7) Evaluation table

Long-term Storage

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

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

Liquid and semi-solid storage systems are self-contained. Ground water contamination can occur if the facility is not structurally sound and waste materials are allowed to leak out into the soil. Surface water can be threatened if pits are not emptied frequently enough to prevent wastes from flowing over the top of the structure.

Liquid storage systems require the use of pipes and/or pumps for moving wastes from the barn to the storage structure. These must be carefully installed and maintained to check for leakage. After emptying, carefully check steel and concrete structures for cracks or the loss of watertight seals, and repair them immediately. Likewise, check the bottom and sides of earthen waste storage pits and lagoons to be certain the liner materials have not been eroded away by agitation and pumping. Fine-textured soil materials become “self-sealed” to a limited degree through bacterial clogging of soil pores. However, this seal can be destroyed through mechanical cleaning processes.

After a period of years, weathering, wave action, or wetting and drying cycles may cause the side walls of earthen pits to crack and erode. This allows waste to seep into the underlying soil or subsurface geologic material. Ground water contamination will result if the subsurface materials do not prevent leaching of contaminants.

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

- ★ A properly designed structure has the capacity to handle wastes from a specific number of animals for a known number of days. For example, if a pit or pond designed for 180 days of storage and receiving designated waste amounts has not needed pumping for a year or more, the structure is probably leaking.
- ★ Evaporation from a liquid manure storage pit is minimal if a crust forms. 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 could be used to confirm the seepage.)

Some facilities for storing semi-solid manure are designed to allow seepage from the waste stack. In these instances, structural design must include collection and treatment of the waste seepage. These systems should not be used on sites with coarse-textured soils, creviced bedrock or shallow water tables. The best way to handle seepage is to channel it into a watertight holding pond or storage tank.

In areas where the construction of a holding pond is not feasible, another option is to build a covered semi-solid manure storage 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.

Short-term Storage

Short-term storage (usually 30 to 90 days) is an important option available to producers. It allows them to hold livestock wastes during periods of bad weather when daily spreading may not be feasible.

Short-term storage, which is restricted primarily to solid or semi-solid manure, has the disadvantage of requiring that the manure be handled more than once. Some designs for short-term storage structures facilitate handling and provide effective protection for surface and ground water.

Short-term storage systems may be used by producers who stack manure in fields, particularly during periods of bad weather or between cropping cycles. However, this is not a recommended practice. No matter how it is done, it may pose a contamination threat to surface and ground water. If manure is stacked in fields, a runoff detention pond must be constructed at the storage site.

Many farmers have open housing for young livestock, 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. To minimize water contamination, provide adequate bedding to reduce seepage, and clean these sheds frequently.

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 minimum separation distance is 150 feet in Texas.

Minimum separation distances regulate new well installation as well as the distance from existing wells to new waste storage facilities. 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 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 sites or facilities downslope from the well is also important for protecting your water supply. For more information about separation distances, and how the condition of your well might affect the potential for contamination, see TEX*A*Syst publication B-6024, *Improving Well Head Management and Conditions*.

While observing the well separation distances may protect your own well, poorly designed or poorly maintained livestock waste storage facilities could still contaminate the ground water. Protecting ground water resources can help protect your neighbors' wells and drinking water supplies, as well as your own.

Depth to water table or fractured bedrock, along with soil type, is an important factor. These are among the site vulnerability characteristics described in B-6023, TEX*A*Syst *Introduction*.

The depth to water table is sometimes found in the narrative section of the county soil survey, but this varies from county to county. Your county Extension agent or Natural Resources Conservation Service office may also be able to help you gather this information.

Lining Materials for Lagoons, Detention Ponds or Storage Pits

The Texas Natural Resource Conservation Commission is responsible for implementing regulations that govern confined, concentrated livestock and poultry feeding operations. To protect ground water from seepage from lagoons or holding ponds, TNRCC regulations require that wastewater retention facilities be constructed of compacted or in-situ soil materials at least 12 inches thick and with low permeability. The soil material must meet or exceed the following criteria:

- liquid limit of 30 percent or more;
- plasticity index of 15 or more; and
- fraction passing a number 200 mesh sieve of 30 percent or more.

Many lagoons also are required to have clay liners that are nearly impermeable (permeability coefficient of $1X\ 10^{-7}$ cm/sec).

Other Management Factors

If animal waste storage causes any significant water contamination, the Texas Natural Resource Conservation Commission (TNRCC) can impose a fine and require corrective measures. Contact your county Extension agent or local Natural Resources Conservation Service office for information about local ordinances, state regulations and other available assistance.

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 should be removed to a depth of about 2 feet and then spread over disposal areas. The remaining hole should be filled and leveled. Manure packs from pole barns or sheds no longer in use also should be removed, and the wastes applied to disposal areas.

Evaluation Table

The following table can help agricultural producers and rural homeowners determine the risk that drinking water on a given property may become contaminated as a result of the management practices being used. For each category listed on the left that is appropriate, read across to the right and circle the statement that best describes conditions on your land. Allow 15 to 30 minutes to complete the table, and skip any categories that do not apply. Note any high risk ratings and take appropriate actions to remedy them. Strive for all low or low-moderate risk ratings.

Livestock Manure Storage: Assessing Drinking Water Contamination Risk				
	Low Risk	**Low-Moderate Risk**	**Moderate-High Risk**	**High Risk**
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). Water table deeper than 20 feet.	Leaking tank on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.
Concrete (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.
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.
Earthen waste storage pit (below ground)		Designed and installed according to accepted engineering standards and specifications. Properly maintained and lined.	Not designed to engineering standards. Constructed in medium- or fine-textured dense materials (silt loams, 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.
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 deeper than 20 feet.	Stacked on high ground. Coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet.

Livestock Manure Storage: Assessing Drinking Water Contamination Risk				
	Low Risk	**Low-Moderate Risk**	**Moderate-High Risk**	**High Risk**
Short-Term Storage (usually 30-90 days; in some cases, up to 180 days) (continued)				
Stacked in yard*	Covered concrete yard with curbs, gutters and settling basin.	Concrete yard with curbs and gutters.	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 in clay soils according to engineering standards. All liquids retained.	Designed and installed to engineering standards on medium- or fine-textured soils (silt loam, loam, clay loams, silty clay). With clay liners. 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, 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 floor on coarse-textured soils (sands, sandy loam), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	________
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.

*See Glossary.

Glossary

Concrete stave storage: A type of liquid-tight animal manure 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 or wastewater storage facility constructed according to specific engineering standards.

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

Filter strip: A grassy area used to filter and settle solids from livestock yard runoff and some types of solid manure storage systems. Waste is distributed uniformly across the high end of the strip and flows downslope. Nutrients and suspended material in the runoff water are partially filtered out by the grass, absorbed by the soil and 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 manure 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 manure storage structure. Located on a concrete pad, it consists of poured concrete reinforced with steel.

Water table depth: Depth to the upper surface of ground water. 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 ground water flow maps of your area. Your county Extension agent or NRCS representative may also be able to help you gather this information.

There are two types of water tables: (1) the water table typically noted in a well log as an indication of useable 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.

Contacts and References

For additional information contact your local county Extension agent, or:

- ★ Texas Natural Resource Conservation Commission at (512) 239-1000,
- ★ Texas Agricultural Extension Service Agricultural Engineering unit (409) 845-7451,
- ★ Texas Agricultural Extension Service Water Quality unit (409) 845-0887,
- ★ Texas State Soil and Water Conservation Board, (817) 773-2250.

Internet address: TEX*A*Syst bulletins and links to other water quality sites are contained in a homepage located on the World Wide Web at: http://waterhome.tamu.edu.

TEX*A*Syst is a series of publications to help rural residents assess the risk of ground water pollution, and to describe Best Management Practices (BMPs) that can help protect ground water. The TEX*A*Syst documents were developed from the national Farm*A*Syst ground water protection program. The TEX*A*Syst system is designed to help the user learn more about the environment, existing environmental policies and regulations, and recommended management practices. Thus, the user can voluntarily reduce the pollution risks associated with water wells.

TEX*A* Syst materials were edited by Anna Schuster Kantor, and reviewed by M.C. Dozier and the personnel of the USDA-Natural Resources Conservation Service, U.S. Environmental Protection Agency, Texas Department of Agriculture, Texas Natural Resource Conservation Commission, Texas Water Development Board, Texas State Soil and Water Conservation Board, Texas Water Resources Institute, and Texas Farm Bureau. Editorial and formatting assistance were provided by the Department of Agricultural Communications, The Texas A&M University System.

The TEX*A*Syst program is sponsored by the U.S. Environmental Protection Agency under Section 319(h) of the Clean Water Act. Funds for this program are administered by the Texas State Soil and Water Conservation Board's Agricultural/Silvicultural Nonpoint Source Management Program.

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