

# Lagoon Monitoring and Condition Parameters

## AEMS

*Agriculture Environmental  
Management Systems*

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### Introduction

Lagoons combine storage and treatment functions and thus are more sensitive to management inputs than are solid or slurry facilities. The establishment and maintenance of desirable microbiological populations in lagoons requires more specific procedures in the way lagoons are loaded and monitored.

### Startup and loading procedures

Lagoon startup is a very important factor in developing a mature lagoon that has an acceptable odor level and will perform in the expected manner over the long term. Lagoons are designed with a "treatment volume" that provides an environment for development and maintenance of a bacterial population that degrades and stabilizes manure. The size of the treatment volume is based on a volatile solids (VS) loading rate, which depends primarily upon temperature. Volatile solids are the "non-mineral" or organic solids in manure that are subject to bacterial degradation. At warmer temperatures, bacteria are more active and VS loading rates are higher. The converse is true for cooler temperatures. For the bacteria to develop and function properly, the actual VS loading rate should be as designed. The proper VS loading rate is achieved only if the lagoon contains a volume of water equal to the treatment volume at startup. A lagoon with only one-tenth of the treatment volume filled at startup will experience an "overload" by a factor of 10 (VS loading rate is ten times greater than designed). Therefore, it is very important to plan a procedure to have sufficient water in a lagoon at startup. The treatment volume should be used as a target. Achieving this goal may require identifying a water source (pond, lake) and implementing the needed pumping procedures to transfer the desired volume of water to the lagoon. Since bacteria are more active at warmer temperatures, consideration should be given to starting a lagoon in the spring or early summer. In this way, bacteria will have a warm season to establish themselves before activity slows during the winter. Spring startup of lagoons often requires special planning of construction schedules and animal procurement.

Problems associated with insufficient volume at startup include excessive odor and high rates of sludge buildup. A lagoon that is started with insufficient volume may take years to recover and may never attain an operating state equal to a lagoon that is started properly.

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In addition to startup, long-term loading procedures are critical to lagoon performance. A somewhat common and unfortunate practice in the livestock industry is to expand animal numbers without expanding lagoon size. This results in a proportionate increase in VS loading, and the associated problems can be expected to develop. Volatile solids loading should not be increased beyond the design loading. Alternatives to reduce VS loading (or expand animal numbers) include solids separation, construction of additional lagoon volume, or pretreatment of manure. Lagoons should also receive manure in a consistent manner (no "slug" loading). This is usually accomplished in modern production systems utilizing hydraulic transport of the manure to the lagoon.

### Salt and nutrient levels, testing

Bacterial activity is somewhat sensitive to salt levels in the lagoon. Salts are a natural byproduct of the biological degradation of manure. The removal of some salts as the lagoon is pumped and the addition of fresh water via rainfall, runoff, and wash water combine to generally keep salt levels within an acceptable range. However, some conditions can occur that may lead to elevated salt levels. These include extended periods of dry weather, high rates of evaporation, little or no dilution with lot runoff and wash water, and perhaps overloading of the lagoon. Elevated salt levels inhibit bacterial activity, and lagoon performance is characterized by increased odors or "sour" smells and increased sludge buildup rates. A simple field test called "electrical conductivity" (EC) is effective in monitoring salt levels. A University of Missouri study found that EC values in the range of 8,000 to 12,000 umho/cm were associated with greatest bacterial activity. If salt levels rise too high in a lagoon, the most effective remediation is to pump the lagoon and add water from a freshwater source (pond or lake). The availability of such a freshwater source is an enhancement to long-term lagoon operation, and consideration should be given to such a source when planning a lagoon.

While overall salt levels are the primary concern in lagoon health, occasionally other more specific compounds may affect lagoon performance. These might include copper, arsenic, (dietary inputs), certain medications, and perhaps excessive use of harsh cleaning agents. If reduced lagoon performance is suspected due to factors such as these, specific testing may be required to isolate the source.

### Overall Monitoring Activities

Certain activities are advisable and necessary in maintaining a manure storage structure and ensuring that it is performing as

expected. Some of these activities may be required by regulation, but all are evidence of good management and stewardship regardless of regulatory requirements.

### Monitoring during pumping activities

Experience has shown that unplanned discharges and spills sometimes occur with pumping activities. Sources of such unplanned discharges include burst or ruptured piping, leaking joints, operation of loading pumps past the full point of hauling equipment, and other factors. Hence, pumping activities should be closely monitored, especially in the “start-up” phase, to ensure that no spills or discharges occur. Continuous pumping systems such as drag-hose or irrigation systems can be equipped with automatic shut-off devices (which usually sense pressure) to minimize risk of discharge in the event of pipe failure.

### Periodic inspections and checklists

A manure storage facility should be inspected periodically to ensure that any potential problems are detected before environmental impacts occur. The frequency of inspections may vary, but a regular inspection schedule should be developed and followed for each system. Inspection frequency might depend on such factors as system size, system complexity, mechanical devices (recycle pumps, float switches in reception pits), flow rate of recycle system, proximity to a sensitive water source, and type of storage facility. Checklists offer a means of ensuring that all items are inspected and noting when they were inspected. They also are evidence of environmental stewardship and may be useful in the event of litigation.

### Liners

Liners in earthen manure storage impoundments are designed and constructed to provide an adequate barrier between the potential contaminants in the impoundment and groundwater. Hence, liner integrity is extremely important in maintaining an environmentally sound manure storage facility. To the extent possible, liners should be regularly inspected for signs of damage, erosion, or other compromising factors. Wave action can cause liner erosion at the level of the liquid in the impoundment. If this condition is severe, consideration might be given to the use of riprap or similar mitigation methods to preserve liner integrity.

The area around the pipes that discharge into the impoundment is also subject to erosion, especially if the pipes discharge directly onto the liner surface. A better configuration is to install inlet pipes such that they discharge into at least 4 ft of liquid, which may require a supporting structure for the end of the pipe. Concrete or rock chutes should be used with inlet pipes that discharge onto the liner surface. Agitation is also an activity that can damage liners. Care should be taken to operate agitators a sufficient distance above the liner so that liquid velocities are reduced enough to ensure that erosion does not occur. Heavy or unusual rainfall events can also erode liners, and special attention should be given to liner inspection after such storm events.

### Logbooks and recordkeeping

Certain data and recordkeeping involving manure storage structures can aid in overall maintenance and management, and is also evidence of responsible operation and good recordkeeping. In addition to the periodic inspections, manure levels in a storage structure should be monitored and recorded. This data can illustrate the effects of excessive

rainfall and lot runoff, and help in planning pump down or other land application activities. Manure levels should be observed and recorded frequently enough to provide a “feel” for the rate of accumulation, and pumping activities should be scheduled accordingly. When a lagoon is pumped or other manure storage structure is emptied, the date of the activity should be recorded along with the volume or date of manure removed, locations where the manure is spread, and the nutrient content (lab analysis) of the manure. This information is required by the Utah Department of Environmental Quality – Division of Water Quality (UDEQ-DWQ) for interim or year-end reports from those operations with Utah Pollution Discharge Elimination System (UPDES) permits.

### Pump down or manure-level markers

Pump down or manure-level markers, or indicators, are a simple but important component of a manure storage facility. Such a marker enables the operator to ascertain quickly and easily the degree of fill of the manure storage facility, the point at which pumping or emptying should begin, and the point at which it should end. The presence of a durable, easily read marker gives UDEQ-DWQ personnel confidence that a manure storage facility is being managed properly.

Experience has shown that pump down markers must be made of durable materials and properly installed to afford the long life needed. The operator or inspector should be able to ascertain the following information when observing a pump down marker:

- When pumping operations should begin and end
- Level at which overflow will occur
- Fraction of total storage that is currently filled

A common practice is to install steel fence posts at the upper and lower pump down levels for earthen impoundments. While this approach provides basic information on beginning and ending pump down, experience has shown that more knowledge is needed. Also, fence posts installed in this manner are subject to damage and displacement. A good pump down marker will indicate the level, or elevation, of manure throughout the possible range (from lower pump down level to overflow, or spillway) in the storage facility. Experience has shown that a 6 inch by 6 inch treated wood pole properly imbedded makes a good pump down marker. Notches or other indicators can be carved into the pole to show pertinent elevations. Painted numbers or colors on the pole are not durable enough to maintain readability over a number of years. Figure 1 shows a type of pump down marker that provides the information needed.

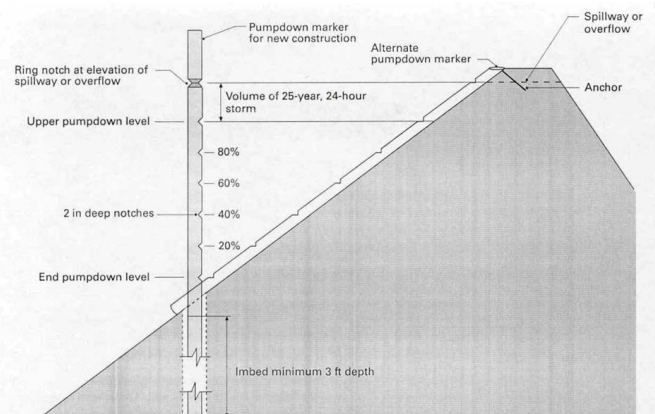


Figure 1.

## Weather stations

A simple weather station that indicates or records rainfall can be a useful tool in maintaining and managing a manure storage structure. Rainfall has a significant impact on open storage structures and structures serving open lots, so knowledge of rainfall amounts can be very useful. A weather station can aid in the documentation of such events without resorting to “off-site” data from stations that may not be descriptive of conditions at the storage facility. Recorded rainfall data is also evidence of good stewardship.

## Aesthetics and Appearance

Aesthetics and appearance may not be critical factors in protecting the environment or complying with environmental regulations. However, these characteristics are major factors in the perceptions formed by the public, tour groups, UDEQ-DWQ personnel, and others who may not be intimately associated or familiar with the livestock industry. Therefore, aesthetics and appearance should be given major priority for the overall benefit and viability of animal agriculture.

## General cleanliness and sanitation

The general cleanliness and sanitation characteristics of a livestock enterprise are often perceived as a measure of the concern of that enterprise for environmental stewardship and environmental compliance. A clean, well-landscaped production area will project a positive image for the operation, while the presence of debris, litter, and poorly maintained buildings will project a negative image. Typical items of concern for livestock production enterprises include leftover construction debris or refuse; old, unused vehicles; worn-out equipment; rusted equipment from the buildings (farrowing crates, pen dividers, feeders); torn and worn-out ventilation curtains; and loose roofing panels, etc.

All livestock production operations experience animal death loss. A specific plan for managing animal mortalities should be

developed and implemented. The visual and olfactory perceptions generated by the presence of dead animals in or around the production facility are highly offensive and likely will be attributed to the industry as a whole by the public. Additionally, poorly managed mortalities represent a very real health and disease risk to the enterprise.

## Mowing

Few activities undertaken by the producer are as effective as frequent mowing in conveying a positive image of livestock production. Producers who maintain “front yard quality” around the production and manure storage facilities provide a powerful first impression of pride and responsibility. Conversely, the presence of tall grass, weeds, shrubs, and trees in undesirable locations creates an impression of laxity and disrespect for environmental responsibility. UDEQ-DWQ personnel inspect UPDES permitted livestock production and manure storage facilities on an annual basis. If tall grass, weeds, brush, and trees hamper the inspector, a positive report is an unlikely outcome. Routine inspections for seepage, rodent burrowing, erosion, or other damage are much more effective if the areas have been mowed at regular intervals.

## Control of surface water

As confined production units become larger, control of surface water in the production area is a primary concern. Wider, longer buildings, placed relatively close together, create high rates of discharge from roof and paved areas. Special considerations and landscaping are needed to manage this water in a manner that does not create erosion and unwanted ditches and washed-out culverts or waterways. A surface water management plan should be developed based on a design storm event, expected runoff rates, soil types and erosive velocities, and properly designed and vegetated channels for carrying surface water away from the production area. Some states may require that surface water from production areas be contained and/or checked for contaminant levels before discharge to a watercourse.

## References:

Livestock and Poultry Environmental Stewardship curriculum, lesson authored by Charles Fulhage and John Hoehne, University of Missouri, courtesy of Midwest Plan Service, Iowa State University, Ames, Iowa 50011-3080.

Agricultural Waste Management Field Handbook. Natural Resources Conservation Service, USDA.

Livestock Waste Facilities Handbook, MWPS-18. Midwest Plan Service, Ames, Iowa.

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