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Lagoon Startup and Maintenance

For Optimal Livestock Waste Treatment

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What Is the Importance of Lagoon Maintenance?

Livestock waste treatment lagoons require proper startup and ongoing maintenance to achieve effective wastewater treatment and avoid excessive sludge accumulation and odor production. As agricultural producers, we are responsible for the perceptions formed by the public who are not closely associated with the livestock industry. Proper maintenance protects the environment, complies with regulations, and demonstrates an ethic of civic responsibility.

Proper Design

As with any project, proper planning and design eliminates most frustrations and problems. Local authorities with lagoon design expertise should be consulted when planning the type and location of a lagoon. A site investigation should examine the suitability of the soil, identify localized hazards such as tile drains, and determine the feasibility and type of lagoon construction needed. After the site investigation is complete, final planning and construction of the lagoon can continue. In Utah a lagoon construction permit is not required if the design is prepared or certified by the USDA Natural Resource Conservation Service (NRCS) and the construction is inspected by NRCS.

The key design aspects of waste management lagoons are: total volume of anticipated waste, sludge storage volume, minimum design volume, precipitation and runoff volume (also called dilution volume), and freeboard (Figure 1).

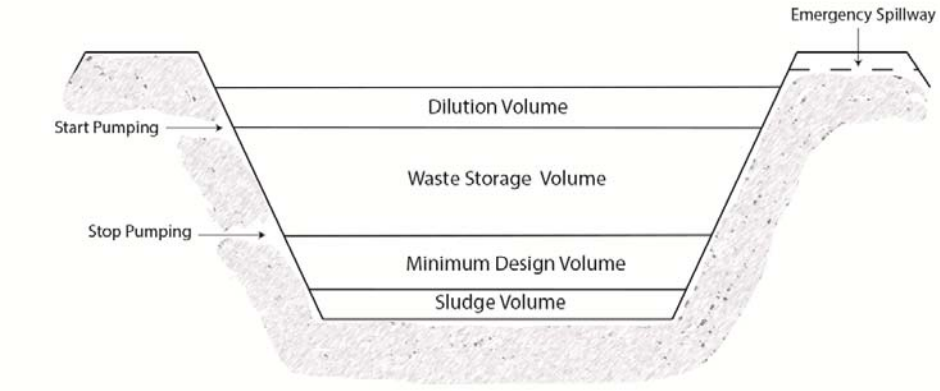

Figure 1. Cross-section of an anaerobic lagoon.

The minimum design volume is the volume of liquid left in the lagoon after the treated effluent is discharged. An adequate design volume will retain sufficient water to maintain a healthy bacterial population for wastewater treatment and minimize odor.

In a two-stage lagoon (Figure 2), the first cell holds the sludge and the minimum design volume. The second cell receives overflow from the first cell, stores effluent for further treatment, stores runoff and precipitation (dilution volume), and maintains the freeboard to guard against accidental discharges. A two-stage lagoon is easier to manage and provides higher quality effluent for reuse, stall flushing, or land application (Mukhtar, 1999).

The type, shape, and size of the lagoon itself is contingent on the area available, the type of waste to be treated, the soil characteristics (determined by site investigation), and the location of the lagoon in relation to groundwater sources (Jones, 1999).

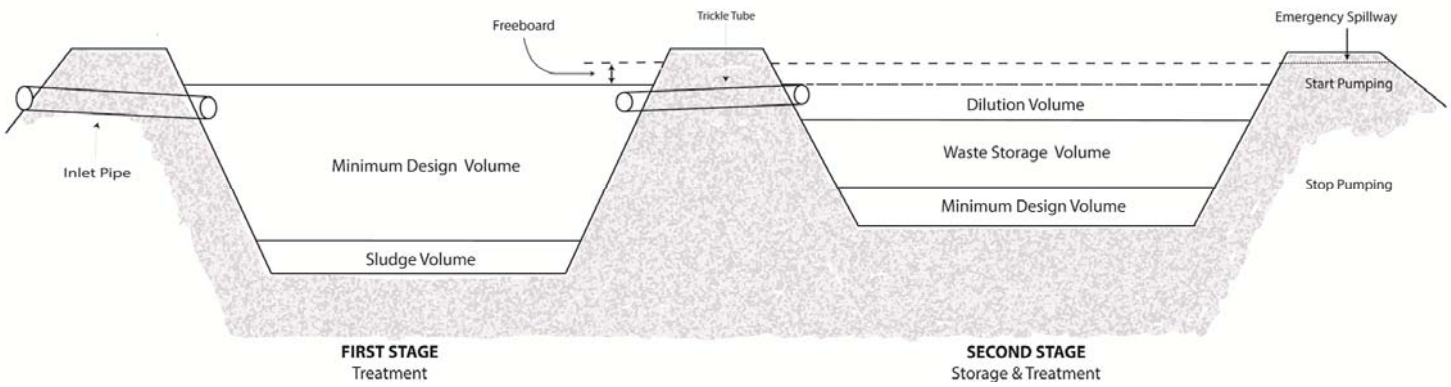

Figure 2. Cross-section of a two-stage lagoon.

Startup Procedures

Startup

Well-managed startup and loading procedures are second only to design when establishing a mature lagoon with minimal odors and long-term performance. When starting a lagoon the focus is on developing and growing the bacterial population that will treat (digest) the waste and establish the overall efficiency of the lagoon. At startup the lagoon should be filled with one half of the minimum design volume of fresh water before adding any waste; the fresh water can come from diverted surface water, roof drainage or ground water. Manure should be added to a new lagoon in the spring providing the bacteria with warm summer temperatures for optimal growth and activity so populations will be established before cold winter temperatures slow activity. Slowly adding water and manure up to the minimum design volume provides time for bacterial populations to develop sufficiently. When there is an insufficient volume of water at startup, severe odor and high sludge buildup rates can occur. These problems can take years to correct and the lagoon may never perform as well as one that was started properly (LPES – Lesson 24, 2001).

Loading

While in use, try to minimize large additions of waste, or "shock loading." It takes time for bacterial populations to increase and maintain the balance between acidifying and methane-producing bacteria. When anticipating an increase in herd size, the increased volume of waste to be treated should be considered. Alternatives to avoid lagoon overload during expansion, or from unexpected additions, include construction of temporary waste holding ponds, additional designed lagoon volume (add more treatment cells), pretreatment of manure, and solids separation.

Maintenance Procedures

Inspections and Checklists

During the design and planning period, producers should work with local authorities to develop routine inspection times and inspection checklists. Lagoon freeboard space should be monitored to prevent overtopping of the lagoon. Regular inspections allow for the timely detection of performance problems and early treatment. Inspection frequency will vary for each farm, but depends on system size, complexity, use of mechanical devices such as pumps and pipes, float switches, flow rate, and proximity to sensitive areas such as houses or water sources. A checklist of items to be inspected and a record of their condition at the time of the inspection is essential. Not only are these records needed to document compliance with a nutrient management plan (NMP), but they are helpful in the overall management of the lagoon, the isolation of problems, planning of future waste treatment systems, and as evidence of environmental stewardship in the event of litigation (LPES, 2001 – Chapter 24).

Cleanliness and Safety

Lagoons can pose a hazard to animals and humans so they should be properly marked and fenced to prevent accidents. To maintain efficient wastewater treatment and a pleasing aesthetic appearance, lagoon surfaces should be kept free of debris. Aerobic lagoons should be kept free of scum; however, anaerobic lagoons should form a scum layer. If the scum layer becomes greater than 12 inches in depth, it should be broken up and removed (ASABE, 2011).

Mowing and Removal of Weeds

Not only does mowing of weeds and tall grass provide a positive first impression, it also aids in the efficiency of the lagoon. Tall weeds around the edge of the lagoon hide seepage, erosion, and rodent damage that can result in structural damage to the lagoon. Larger rodents should be removed and repairs made immediately. Regular mowing of the tall grass and weeds discourages the establishment of rodent populations and exposes debris.

Any debris and aquatic plants and weeds should be removed from the water. Tall weeds near the lagoon's edge create dead spots in the water that affect the hydraulic action and overall treatment of wastewater. Their long roots can also damage liners and seals.

Liners

The need for a liner is determined during the site inspection prior to construction. If soils are high in clay content, liners may not be necessary; whereas more permeable soils will require a liner to prevent groundwater contamination. Like all other components of the lagoon, the liner must be inspected regularly to maintain an environmentally sound wastewater treatment facility. The area near the inflow pipe is the most prone to degradation if wastewater enters directly onto the liner. Problems associated with pipe inflow can be prevented by designing the inlet to discharge onto at least 4 feet of water or by designing a chute to funnel the effluent to the lagoon. Lagoons using an aeration system or having frequent agitation will erode their liners faster than other lagoon systems.

Nutrient Testing

Nutrient levels of the lagoon should be tested regularly to keep bacteria at optimal performance. Salt, in particular, is a natural by-product of the biological degradation of manure and can negatively affect bacterial activity if levels are too high. Elevated salt levels can be caused by several conditions including extended periods of dry weather, high rates of evaporation, insufficient dilution, or lagoon overloading. Increased odors and sludge buildup rates are the result of elevated salt concentrations. Lagoons with high salt levels can be treated by drawing down the lagoon liquids and adding freshwater. Salts are the primary concern of lagoon management, but other compounds can also affect performance. These compounds include: copper, arsenic, antibacterial medications, and excessively harsh cleaning agents. If lagoon performance is lacking, specific testing should be done to isolate the cause and allow for proper treatment.

Records

Lagoon records are very important for proper lagoon management. Records should be kept for several factors involved in lagoon maintenance. Lagoon levels should be observed and recorded frequently enough to provide a "feel" for the rate of accumulation. These rates can then be used to plan pumping days and land application. Lagoon levels, and the dates of pumping or other application activities, should be recorded along with the volume of liquid removed, the location where it was applied, and the nutrient analysis of the effluent. This information is required by the Utah Department of Environmental Quality – Division of Water Quality for reports from operations with a lagoon permit (UPDES permit). Evidence of proper maintenance is also needed in case of a discharge during a large storm event for operations with other coverage such as the Utah Permit-by-Rule, or the Utah Agricultural Certificate of Environmental Stewardship. All records should be maintained for at least 5 years.

Lagoon Markers

Lagoon level markers are an integral part of a lagoon monitoring system as they provide a visual confirmation of the need for pumping or, when combined with the loading records, increased dilution. A good marker will show the level to start and stop pumping. A treated wood post with notches to show the different elevations and the upper and lower pump down levels can be used for a marker. The marker can be either vertical or laid along the bank of the lagoon. While pumping, activity should be monitored continually to prevent spills or drawing the lagoon down past the minimum design volume.

Sludge Levels

Even well maintained lagoons will have sludge buildup and need to be dredged or pumped down at some point. Sludge buildup rates are dependent upon the solids content and degradability of the waste being added to the lagoon. As the sludge level increases, the treatment volume decreases reducing the effectiveness of the lagoon. Sludge levels can be determined either by calculations of the predicted accumulation rate or by direct measurements and estimation of the volume. Sludge cannot be measured or sampled from the edge of the lagoon: it must be measured from a boat. For safety reasons, at least three people should be present: two in

the boat, and one on the lagoon bank. A long, light-weight, rigid pole is slowly lowered into the lagoon until the liquid seems to become thicker and denser. The depth on the pole is recorded. The pole is then pushed further into the sludge until the bottom of the lagoon is reached. The depth on the pole is recorded. The difference between the two markings is the depth of the sludge. Since the sludge layer can vary in thickness, several readings should be taken to estimate the sludge volume.

Sludge Removal

Sludge removal can be accomplished by:

1) agitating the lagoon and irrigating/land applying;
2) dewatering the lagoon, agitating the sludge, and land applying the sludge;
3) dewatering the lagoon, dredging, and land applying the sludge; or
4) hiring a customer applicator.

To agitate the lagoon, the lagoon liquid and sludge are mixed with an agitator or a chopper-agitator impeller pump. Ideally the agitator should be able to mix, or create a "swirl" of the entire lagoon. More than one agitator may be required for large lagoons. The liquid can then be applied through large-bore irrigation equipment. Dewatering of the lagoon can be accomplished through pumps and irrigation equipment. The remaining sludge is then agitated and pumped into a liquid sludge applicator, or dredged, and applied to cropland. When using agitators, care should be taken to prevent erosion of earthen liners. Yearly agitating and pumping of the lagoon can remove many of the solids and help maintain the lagoon for many years.

Further Help

Proper maintenance of a lagoon will help keep the lagoon functioning effectively for many years. It also protects the environment, complies with regulations, and demonstrates an ethic of civic responsibility. If you need more help with lagoon problems or performance in Utah, several resources are available. You can contact: Rhonda Miller, Agricultural Waste Management Specialist for Utah State University Extension, your local NRCS office, or the resources listed below.

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