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Lagoon Pumping and Irrigating Equipment

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Lagoons are an important part of many Missouri livestock waste management systems. In addition to providing relatively low-cost storage for wastes, lagoons biologically degrade and liquefy manure for pumping and distribution onto pasture or crop land.

Lagoons definitely should not be considered final disposal impoundments for animal wastes. Pumping and distributing wastes onto the land is necessary for:

- Preventing lagoon overflow and the resulting pollution potential. Although overflow may seem infrequent or of little consequence, the discharge of lagoon effluent from the owner's property may result in a violation of state or federal pollution laws.
- Using fertilizer nutrients in the lagoon effluent. Significant amounts of fertilizer nutrients are present in lagoon effluent. These plant nutrients can supplement or reduce requirements for commercial fertilizer.
- Reducing the levels of salts and minerals that accumulate in the lagoon. In the bacterial breakdown of manure, salts and minerals are released as products of the biological activity. These salts and minerals can become concentrated, especially during periods of high evaporation and little rainfall, if they are not periodically removed from the lagoon.

Equipment requirements

Although the equipment required for pumping and distributing lagoon effluent may be similar to conventional irrigation equipment, the smaller volume of water handled in lagoons generally allows the use of smaller and less costly systems. Table 1 gives average annual pump-down volumes for lagoons receiving wastes from livestock.

Note
T he pump-down volumes for lagoons are less than the volumes of water normally handled in conventional irrigation systems. Thus, the lesser volume of lagoon water requires smaller and less sophisticated irrigating equipment.

Table 1
Average annual pump-down volume for lagoons.

Animal type	Lagoon pump-down volume
Beef, total confinement per 100 head	5 acre-inches per year
Beef, open dirt lot per 100 head	19 acre-inches per year
Poultry, total confinement per 10,000 layers	3.6 acre-inches per year
Swine, total confinement per 1,000 finishing hogs	16 acre-inches per year

Dairy, per 100 Cows	28 acre-inches per year

System types

The types of systems suitable for distributing lagoon effluent fall into two major categories

- Gated pipe or surface irrigation systems
- Sprinkler irrigation systems

Gated pipe systems
These systems consist of a pump or gravity flow arrangement from the lagoon to a distribution pipe that has holes at intervals along its length. Lagoon effluent is discharged through the holes at a rate compatible with the land slope and soil infiltration capability. The gated distribution pipe usually is laid as level as possible across the upper end of a sloped soil-plant filter or waste receiving area. Gated pipe or surface irrigation systems are suitable for land slopes from 0.2 to 5.0 percent. Flatter slopes result in ponding of effluent at the discharge point of the gated pipe, while steeper slopes cause effluent runoff with little opportunity for infiltration into the soil.

The advantages of gated pipe systems are relatively low cost, low operating pressures, and even distribution of effluent if the holes in the pipe are properly located and sized. The disadvantages of gated pipe systems are high labor and management to ensure the proper operation of the systems. Gated pipe systems do not perform well on uneven or steeply sloped land. Traditionally, gated pipe has been used to irrigate row crops. However, properly designed and managed gated pipe systems have been used successfully to distribute lagoon effluent onto grassed areas.

Simple, low-cost gated pipe systems can be made by drilling holes at 30- to 40-inch intervals in plastic pipe. Such distribution systems would be limited to small lagoons because flow rates would be 50 gallons per minute or less with 2-inch plastic pipe.

Commercially manufactured aluminum gated pipes, 4 to 8 inches in diameter, will provide greater flow rates at increased cost. The gates on commercially manufactured pipe usually are adjustable to provide even flow at the desired rate through each individual gate. Gated pipe systems usually are hand carried from one point to another on the soil-plant filter area to ensure full coverage. Pressure in gated pipe systems usually does not exceed 20 to 30 pounds per square inch.

Sprinkler systems

Sprinkler systems are more suited to the rolling terrain found in many areas of Missouri. With sprinklers, the water application rate is near the infiltration capability of the soil. Hence, potential for runoff is reduced even on steeper slopes. Sprinkler systems generally include a pump at the lagoon, aluminum or buried plastic pipe to carry effluent to the soil-plant filter, and some type of sprinkler or sprinklers to distribute the effluent. In addition to their suitability for rolling or steeply sloped land, some sprinkler systems can be designed with considerably less labor than gated pipe systems. Sprinkler systems usually operate in the range of 40 to 120 pounds per square inch pressure.

Hand-carry sprinkler systems
The simplest and least costly sprinkler systems are the hand carry or hand move types that require labor input for setting up and moving the system. Such systems are usually 4-inch or 6-inch pipe with one or

more sprinklers which tee off the main line at the appropriate intervals. Nozzle sizes for these systems usually are in the 1/2- to 1-inch range and typically cover 1/2 to 2 acres per sprinkler depending upon nozzle size and system operating pressure. Although some labor input is required, these systems are applicable because of their relatively low cost.

Stationary big gun
This system includes a pump and main line similar to the hand carry system, but with a single large-volume gun sprinkler replacing hand move sprinklers. Advantages of the big gun system include larger flow rates and a larger wetted area so less labor is required in moving the sprinkler. Some big guns are wheel-mounted to facilitate moving the unit. Stationary big guns typically have nozzle sizes ranging from 1 to 2 inches and operate best at pressures of 80 to 120 pounds per square inch. Coverage areas from 2.5 to 6.0 acres can be obtained with proper selection of nozzle size and operating pressure. Although stationary big guns cost more than smaller hand-carry systems, the reduced labor and higher flow rates may offset the higher cost.

The sprinkler systems already described require labor for movement from one set or location to another to ensure that the soil does not become saturated.

Traveling gun
This self-propelled unit covers larger areas than stationary sprinklers of the same size. Traveling guns consist of a conventional gun sprinkler mounted on wheels. A water-driven winch on the traveling gun pulls the unit across the ground by a cable anchored at the end of the field. This winch also may be driven (on some models) by a small gasoline engine. Such an arrangement prevents the possibility of solids plugging the water turbine. However, plugging problems are minimal when pumping effluent from properly sized lagoons.

In the typical water-driven traveling gun, water is directed to the traveling gun through a flexible hose pulled behind the unit. The distance a traveling gun can move between sets is dictated by the length of the flexible hose. Hose lengths from 330 to 660 feet are common and allow travel distances of 660 to 1,320 feet (twice the length of the hose). Effluent usually is carried by aluminum pipe from the lagoon to the point of connection with the flexible hose.

Traveling guns require pressure ranging from 75 to 120 pounds per square inch. Flow rates are from 100 to 800 gallons per minute. Typical coverages are 4 acres per set for small traveling guns to 13 acres per set for large traveling guns.

Large traveling guns, traditionally used for crop irrigation, are too costly to be used only for lagoon pumping. However, these units have been used successfully in dual-purpose applications for crop irrigation and lagoon pumping. Several manufacturers of irrigation equipment have small traveling gun systems that may be competitive in cost with the hand move or stationary big gun sprinklers. These units are adaptable to the rolling terrain often encountered near lagoons and are easily transported.

Center pivot irrigation systems
Obviously, these systems must be used primarily for crop irrigation. However, limited experience indicates that lagoon effluent can be distributed successfully through center pivot systems. In some cases, the irrigation reservoir also serves as the lagoon receiving livestock wastes. In such cases, take care to ensure that the reservoir does not overflow, or that the overflow does not violate pollution laws and regulations.

If a lagoon and irrigation reservoir are located close together, a properly designed pump intake system

may allow simultaneous withdrawal of liquid from both the irrigation reservoir and the lagoon. If the irrigation reservoir and lagoon are some distance apart, a pump at the lagoon probably will be required to inject the lagoon effluent into the pipe downstream from the pump serving the center pivot system. Another alternative is to pump or drain the lagoon effluent into the irrigation reservoir provided there is sufficient volume available. Regardless of the scheme selected, the use of center pivot systems for distributing lagoon effluent requires careful planning.

Pumps

Most conventional irrigation pumps will handle lagoon effluent with little difficulty. Power-take-off pumps are used most often for pumping lagoon effluent. Pumps with integral power units are usually too costly unless they have another application.

The pump intake should be floated 1 to 2 feet below the surface of the lagoon. This keeps the intake free of floating debris and above the sludge layer at the bottom of the lagoon. Properly designed lagoons operate with a sludge layer (usually 6 to 18 inches thick) but do not require agitation prior to pumping.

Pumping management

Lagoons should never be allowed to overflow and should be in the pumped down condition going into the fall and winter months. This ensures that maximum volume is available for waste and runoff accumulation during the winter and early spring. Lagoons should not be pumped dry because adequate levels of bacteria must remain in the lagoon to degrade incoming wastes after the lagoon is pumped down. Consult the designer of the lagoon or MU Extension for information on pumping your particular lagoon.

System design

The proper design and equipment selection for irrigation systems requires detailed knowledge of terrain elevations, pipe friction losses, suction head and performance specifications. Consult your local MU Extension specialist, a qualified consulting engineer or other qualified individuals for assistance in system design.

System flow rate, which depends on the time available for pumping, is the criteria usually used to size systems. Table 2 gives the pumping time required for different flow rates for the average annual pump down volumes in Table 1.

Table 2
Pumping time required to distribute the annual average pump-down volume

Animal type	System flow rate, gallons per minute	Average annual pumping time, hours	Pipe size (aluminum), inches
Beef, total confinement, per 100 head	100 300 500	22.5 7.5 4.5	3 to 4 5 6
Beef, open dirt lot, per 100 head	100	85.5	3 to 4

	300 500	28.5 17.1	5 6
Poultry, total confinement, per 10,000 layers	100 300 500	16.2 5.4 3.2	3- to 4 5 6
Swine, total confinement, per 1,000 finishing hogs	100 300 500	72.0 24.0 14.4	3 to 4 5 6
Dairy, per 100 cows	100 300 500	126.0 42.0 25.2	3- to 4 5 6

Equipment procurement

The costs of equipment procurement should fit into the economic framework of the livestock production facility. There are several ways to get equipment:

- Purchase a used system. In areas where crop irrigation is fairly common, used systems or system components may be available at prices considerably less than new equipment costs.
- Hire a custom operator. Although not a widespread practice, custom lagoon pumping may be available in your area. If so, it may be a more feasible alternative than owning your own system.
- Multiple ownership. Sharing the cost of a system among two or more producers may be a feasible method of reducing individual investment. With planning, lagoon pumping usually can be accomplished on a schedule flexible enough to accommodate two or more producers with a single system.
- Multiple use. If a system can be used for both crop irrigation and waste disposal, initial equipment costs may be easier to justify.

Purchase a small system with components large enough for expansion. If crop irrigation is anticipated in the future, consider purchasing a system with major components suitable for crop irrigation.

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Related MU Extension publications

- NRAES57, Fertilizer and Manure Application Equipment
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=NRAES57
- NRAES89, Liquid Manure Application Systems Design Manual
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=NRAES89
- WQ213, Calibrating Manure Spreaders
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=WQ213

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