

Hog Manure and Domestic Wastewater Management Objectives

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The objective of this publication is to identify the differences and similarities between managing municipal wastewater and managing the manure from grow-finish pig systems.

There are two defining differences between domestic wastewater treatment and animal manure systems:

1. Domestic wastewater systems discharge large volumes of treated water directly to surface waters of the state, whereas it is illegal to discharge manure from storage facilities or in runoff from agricultural fields into surface waters of the state.
2. Manure is a valued fertilizer on many hog operations, whereas human excreta are a component of a waste stream that is a net cost for homeowners, towns and municipalities.

Volume of human wastewater versus grow-finish manure

Domestic wastewater systems handle high-volume waste streams with relatively low concentrations of nutrients and other components of the waste (Figure 1). Every toilet, shower, washing machine and dishwasher contributes significant amounts of water to the waste stream. Plus, many sewage treatment plants handle water from industry and any stormwater that enters the system. The variability of industrial contributions and storm water makes per capita wastewater generation quite variable. As an example of the volumes involved, the city of Columbia, Missouri (population 92,000) handles 16 million gallons of wastewater each day, or about 175 gallons per person per day. The Metropolitan St. Louis Sewer District (population 1,400,000) handles 360 million gallons of wastewater each day, or about 255 gallons per person per day.

In contrast, manure production on hog finishing operations is predominantly feces and urine generated by the animals. Added water in the buildings is limited to cleaning activities and wasted drinking water. Total manure and wastewater production averages about

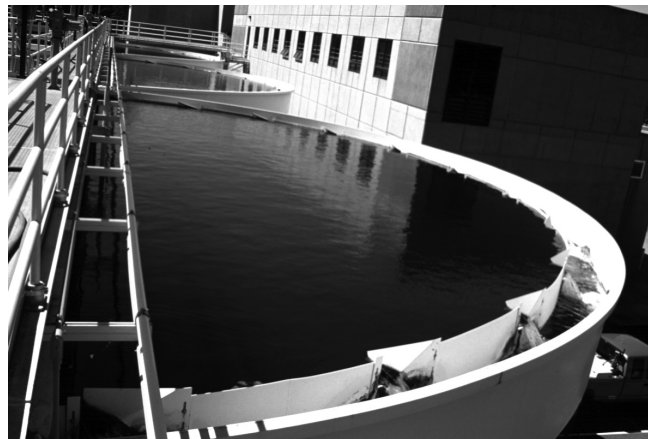


Figure 1. Settling basins at a wastewater treatment facility.

1.4 gallons per animal per day for grow-finish operations. Volumes are higher on operations that have open manure storages in regions where annual rainfall exceeds annual evaporation. On these operations, manure and wastewater production still typically runs less than 3 gallons per animal per day.

Cross-species comparisons are typically based on a standard live-weight basis. Daily wastewater production for 1,000 lb of humans (assuming 150 lb per person average weight and 175 gallons per person per day) is 1,170 gallons/day compared with 9.3 gallons/day for 1,000 lb of grow-finish pigs (average weight 150 lb per pig), a ratio of 125:1.

To put the differences in volume in perspective, all the grow-finish pigs in Missouri generate less manure volume than the City of Columbia. It would take 5.3 million to 11.4 million grow-finish pigs to produce the same volume of manure and wastewater as the volume of wastewater the city of Columbia treats in a day. Pig inventory in Missouri has hovered near 3 million head in the years 2000 to 2003.

Fate of human wastewater versus grow-finish manure

The high volume of wastewater forces most domestic systems to discharge treated wastewater directly to streams and other surface waters of the state. It is infeasible to construct sufficient storage and have sufficient land base to apply all domestic wastewater to the land as a nutrient or a source of irrigation water. Domestic wastewater is processed to reduce the potential impact of discharging wastewater directly into receiving streams and surface waters. The treatment process includes steps to reduce solids in the water, reduce nutrient concentration and sometimes other treatment processes to minimize the impact on receiving waters. The solids removed from domestic wastewater before discharge typically are land applied as a fertilizer (biosolids) to agricultural land. The regulatory permit for wastewater treatment plants stipulates the quality of the water that is released by the plant into surface waters and the management practices used to land apply biosolids.

The limited added water in swine manure systems makes it feasible to contain the manure in storage structures and then land apply the manure as a fertilizer source. Permits on almost all animal feeding operations make routine discharge of manure to waters of the state illegal; the permits are called “no-discharge” permits. All manure must be land applied in a manner that prevents overflow of manure storages and runoff during manure application. The rates of manure applied to fields also are dictated by the productivity of crops. Failure to comply with these standards typically results in a notice of violation and fines from regulatory agencies.

Fate of solids

In both systems, most of the solids and nutrients are land applied to agricultural fields (Figure 2). In domestic wastewater systems, the solids are removed from the wastewater that is discharged into surface water. The solids are then digested to reduce the volume of solids and to reduce human pathogens. This material, called biosolids, is typically land applied to agricultural fields.

In animal manure systems like anaerobic lagoons, solids are also digested before land application. In other liquid systems such as pit slurry manure, there is little digestion of the solids in the manure storage. Instead manure solids are digested by the microorganisms in the soil. Some composting takes place in manure collected in high-rise and other bedding-type manure management systems.

Biochemical oxygen demand

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen required to degrade organic



Figure 2. Injecting manure as a fertilizer for crop production.

matter in water. One major objective of domestic wastewater treatment is to reduce BOD in wastewater before discharging it into surface waters. Releasing wastewater with high BOD can lead to low oxygen (anoxic) conditions in the receiving waters as organisms in the water break down the excess organic matter. Anoxic conditions can lead to fish kills and other negative effects on receiving waters.

The Columbia Missouri water treatment plant typically receives waste with a BOD of 300 parts per million (ppm). Waste treatment in the plant reduces BOD to 60 ppm. Columbia then further “polishes” the water through artificial wetlands so that water released to the Missouri River has less than 10 ppm BOD. This last step is not typical of most waste treatment facilities.

The ultimate fate of animal manure is land application so the BOD of the manure is not a relevant indicator of environmental impact and typically is not measured. The BOD of hog manure is typically at least 100 times higher than untreated domestic wastewater. This is expected because the manure has not been diluted by high volumes of wastewater typical in domestic waste streams. Anaerobic lagoons reduce the BOD of manure, but other manure handling systems do not attempt to reduce BOD of the manure in storage. The organic matter in manure enhances biological activity and soil structure in soils receiving manure.

Pathogens

Treatment of human waste is designed to reduce pathogens to meet permit requirements and water quality standards. Missouri water quality standards limit fecal coliform levels, an indicator for pathogens, to 200 colonies per 100 milliliters in wastewater released to recreational waters. Land-applied biosolids are also processed to reduce pathogen levels.

Manure has no regulatory requirement for treatment and no specific pathogen limits before land application. Treatment for pathogens in manure includes digestion in some manure storage systems, exposure to sun, and degradation in the soil.

The value of manure

Fertilizer value is dictated in part by its nutrient concentration. Materials with a higher nutrient concentration cost less to transport and reduce the time to deliver recommended rates of nutrients to a field. Most commercial fertilizer sources exceed 30 percent composition of fertilizer nutrients. Examples include anhydrous ammonia (82%), ammonium nitrate (34%), diammonium phosphate (64%) and potassium chloride (63%). Manure sources have much lower nutrient concentrations than most commercial fertilizer sources; manure sources typically contain less than 5 percent fertilizer nutrients and in some cases the percentage is much lower. Recent increases in fertilizer prices have increased the value of manure.

Animal manure has been recognized through history as a valuable fertilizer source and it is no different in many modern manure management systems. In a slurry operation, manure is a key component of the operation's financial success. The MU Extension publication G9334 *Optimizing Fertilizer Value of Manure from Slurry Hog Finishing Operations* provides detailed information on the fertilizer value of slurry manure. A 2004 research paper found that manure value on slurry operations had the potential to be 16 percent of the net income of the operation.

Financial success of operations that use anaerobic lagoons is less dependent on extracting manure value from their manure. However, injected lagoon effluent

provides nitrogen in a form that is highly available to plants and more predictable than other manure types. A high percentage of the phosphorus and significant amounts of nitrogen and potassium accumulate in the bottom of lagoons. University of Missouri research is focused on determining strategies to cover the cost of removing solids from the bottom of lagoons with the fertilizer value of the material. This sludge material can have high concentrations of fertilizer nutrients, making it a potentially valuable fertilizer source.

Conclusions

Direct comparison of human wastewater production and animal manure production is misleading and typically unproductive.

Human waste systems are characterized by high volumes of diluted material that is treated to minimize the impact of the direct release of wastewater into surface waters of the state.

In contrast, it is illegal to discharge animal manure into waters of the state; instead manure is land applied as a fertilizer for crop production.

Hog manure typically has little added wastewater, resulting in a product that has substantially higher concentrations of nutrients and organic matter than human wastewater. These higher concentrations make it feasible to use the manure as a fertilizer source for crop production.

For further information

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From University of Missouri Extension Publications 1-800-292-0969

G9334 *Optimizing Fertilizer Value of Manure from Slurry Hog Finishing Operations*

G9182 *Managing Manure Phosphorus to Protect Water Quality*

G9220 *Strategies to Minimize Phosphorus Loss From Your Farm*

G9218 *Managing Nitrogen to Protect Water Quality*

G9219 *Setback Distances for Land Application of Manure*

G9183 *Phosphorus Best Management Practices for Biosolids and Other Organic Residuals*

WQ426 *Best Management Practices for Biosolids Land Application*

WQ421 *State and EPA Regulations for Domestic Wastewater Sludge and Biosolids*