Wastewater Management Issues of Small Communities in Jourdan River Watershed

Rainey, B.; Gude, V.; Truax, D.; Martin, J.

Wastewater treatment and nutrient removal alternatives for large size communities are very well-established and are feasible in many cases. When it comes to the small rural and especially for low-income disadvantaged communities, this is not the case, particularly with regard to nutrient removal. The alternatives for small communities are often viewed as cost-prohibitive and unreliable. While this is partly true, careful selection and implementation of appropriate technologies can result in high performance, energy and cost efficient and environmental-friendly solutions. Assessment of water and wastewater is very crucial to safeguard public health and the environment. However, water quality data on fresh and marine waters in the Mississippi coastal region, especially in Jourdan watershed are still sparse and uncoordinated. Therefore, monitoring these parameters is important for safety assessment of the environment and human public health and the water bodies. We have identified a few small and decentralized communities in the Jourdan River watershed area to assess the current wastewater treatment and management practices and their impacts on the receiving water bodies. This presentation will discuss the preliminary evaluation and understanding on the local water quality issues of the watershed.

Introduction

While wastewater treatment and nutrient removal at the municipal level is well established, some areas in Mississippi contain communities with homes that are too widespread to feasibly utilize municipal systems. Instead, these homes use on-site wastewater treatment systems, which are not as effective. Alternatives to these systems are often cost prohibitive or cannot be used because of space restraints. Without these alternatives as viable options for rural communities, the less effective systems are being used far beyond their useful life leading to failure and the discharge of insufficiently treated wastewater into rivers and groundwater. This report will focus on the effect these failing units are having on the Jourdan River watershed located near the Gulf Coast in Hancock County, where more than half of the on-site units are failing.

The Jourdan River Watershed

The Jourdan River starts just north of Hancock County, runs south through the county, and discharges into Bay St. Louis. This watershed has been identified as a priority watershed with impaired waters because its waters do not meet one or more water quality standards and are considered too polluted for their intended uses. Figure 1 shows the designated priority watersheds in southern Mississippi, including the Jourdan River watershed.

Due to the recent increase in urban growth and development in the area, there is a potential for groundwater contamination during heavy rainfall from the fertilizers and other chemicals applied to lawns. Agricultural runoff also contributes to the water quality issues in the watershed, but the main contributing factor is point source contamination from failing on-site septic systems. In Hancock County, more than half of these on-site units are failing, as shown by Table 1.

Reasons for the high number of failing units may include insufficient funding to repair or replace them once they have reached the end of their design life and a lack of knowledge on proper operation and maintenance procedures. A major contributor, though, to the failure of these units is their installation where the soil is unsuitable. Approximately two-thirds of all land area in the U.S. is estimated to be unsuitable for the installation of septic systems. Relative soil suitability in Hancock County is only 8%. Another reason

Table 1: On-Site Treatment Units within the Gulf Region (MDEQ, 2007)

Map	County	"No. of On-Site Treatment Units"	"Estimated Failing Units"	"Percentage of Units Failing"	"Estimated Flow from Failing Units (MGD)"
1	George	6597	990	15%	0.196
2	Hancock	12020	7212	60%	1.428
3	Harrison	24019	9608	40%	1.902
4	Jackson	22664	11332	50%	2.244
5	Pearl River	15953	6381	40%	1.263
6	Stone	3899	1560	40%	0.309
	Totals	85152	37083		7.342

on-site systems are failing correlates to their length of use. A properly maintained conventional septic system can be expected to perform for 20-30 years. If the owner does not have the funding to replace the unit once it reaches the end of its useful life, treatment levels will decline and failure will soon follow. Improper maintenance will lead to the failure of a unit. Issues associated with this include inadequate filtration of the effluent through the soil before it reaches the groundwater table and clogging of the drain field. These failing units are discharging inadequately treated sewage and wastewater into the watershed's groundwater and streams. This has led to water quality issues, health issues, and, during the warmer months, as increased risk of hypoxia in the Gulf. The water quality issues in the Jourdan River watershed are already substantial enough for the basin to be designated a priority watershed, and the primary concerns for the Jourdan River have been identified as faulty septic systems. In the warmer months, the Dead Zone in the Gulf of Mexico can be attributed in part to these failing systems as well. The high levels of nitrate and other nutrients in the improperly treated effluent being transported to the Gulf feed the algal blooms that thrive in warm temperatures. This causes a lack of oxygen in the waters, killing the organisms that regularly live there.

Comparing the Conventional Septic System to Current Alternatives

In order to improve the water quality, the failing units that are impairing it need to be replaced, ideally with alternative systems that provide a higher level of treatment; however, common alternatives are considered cost prohibitive, and they require more routine maintenance than the conventional septic system. On-site treatment systems are used to treat wastewater on the property in areas where it is not feasible or possible to get the wastewater to a centralized treatment plant. They are most often used in small rural communities where the homes and properties are too spread out for a centralized treatment facility to be economically feasible. They are also common in small industrial facilities and businesses (Davis & Cornwell, 2008).

Conventional Septic Systems

The most common type of on-site treatment system is the conventional septic system. The three main components in a convention septic system are the septic tank, the distribution device, and the absorption field. First, a pipe carries the wastewater from its place of discharge to the septic tank either by means of gravity or with the use of a pump. In the septic tank, grease and solids are separated from the raw sewage and partially decomposed through biological decomposition. Grease floats to the top and for a scum layer, and heavy solids that are not digested settle to the bottom as sludge. The size of the tank depends on the wastewater flow, but it needs to be large enough to retain the wastewater and allow for partial decomposition for at least 24 hours. After primary treatment in the septic tank, the distribution device equally distributes the effluent throughout the absorption field. This is a series of subsurface trenches that hold perforated pipes settled between layers of drainrock. The size of the absorption field depends wastewater flow

and the permeability of the soil in the field area. In the absorption field, the septic tank effluent seeps through the soil which allows for further bacterial treatment and filtration. During operation, bacteria produce a layer of slime at the bottom of the trench called the clogging mat. This layer slows the movement of water to the surrounding soil which maintains aerobic conditions essential for proper treatment of the effluent. Typically, the following levels of treatment can be expected from a properly functioning conventional system with a drainfield:
BOD5 = 10 mg/L
TSS = 10 mg/L
Fecal coliforms – usually less than 200 per 100 mL

When properly operated and maintained, conventional septic systems can function effectively for 20 to 30 years. The most common cause of failure in conventional systems in improper maintenance. Based on the size of the septic tank and the volume of sewage, the scum and sludge need to be pumped from the tank every 2 or 3 years. Because the rate of decomposition in the tank is slow, the levels of scum at the top and sludge at the bottom can build up and lead to an increase in distribution of solids to the absorption field. If too many solids reach the field, it could become clogged and lead to an early failure. Other causes for failure include hydraulic overloading or the introduction of substances that are toxic to the soil bacteria (Davis & Cornwell, 2008).

The advantages of this type of system include low installation cost as compared to other types of units, the return of nutrients from the wastewater to the soil, and that they allow for water reuse in a certain capacity. Disadvantages, however include possible odor problems, negative public perception, the introduction of pathogens into the groundwater through malfunctioning systems, and that they don't allow for nitrogen removal without the use of additional treatment. The costs associated with these systems are relatively low with only $1,500 to $4,000 for the system itself and the installation, and $250 to $550 per year for the operation and maintenance of the system (EPA, Septic Tank - Soil Absorption Systems, 1999).

Current Alternatives

While the conventional septic system is the most common, there are alternative types of on-site treatment systems. Another commonly used system is the aerobic treatment system. With this alternative, oxygen is incorporated into the wastewater inside the treatment tank in order to increase the rate at which the solids are broken down.

Aerobic systems

Another commonly used system is the aerobic treatment system. With this alternative, oxygen is incorporated into the wastewater inside the treatment tank in order to increase the rate at which the solids are broken down, providing a higher level of treatment. Aerobic systems mirror many of the steps and activities performed by municipal sewage plants. These systems are a good alternative for homeowners on lots with a high groundwater table or close to a body of water that might be polluted through the use of a conventional septic system with a drainfield. Aerobic systems employing a chlorinator and spray heads are a good option for landowners who don't want to clear trees to create a drainfield. From the aerobic treatment tank, the effluent is passed through a chlorinator to the final treatment tank. At this point, the resulting treated effluent is clean enough to be discharged via sprinklers directly over the absorption field. One of the disadvantages of using an aerobic system over a conventional system is the requirement for more routine maintenance (Pipeline, 2005).

Sand Filter Systems

Intermittent and recirculating sand filter systems are types of aerobic treatment systems. They provide secondary treatment and are often used along with a conventional septic system to pretreat the tank effluent before it is sent to the absorption field if the unsaturated depth or permeability of the soil is unsuitable for proper treatment. "Sand filters remove contaminants in wastewater through physical, chemical, and biological processes. Although the physical and chemical processes play in important role in the removal of many particles, the biological processes play the most important role in sand filters." Sand filters consist of a primary treatment system and the filter. The primary treatment system is most often a septic tank, but could be any other sedimentation system. The filter consists of a granular material, most often sand, over an underdrain system. The wastewater is dosed onto the surface of the granular material and allowed to percolate through to the bottom of the filter. The dose should be such that the mate-

rial is not saturated, and the wastewater is able to flow in a thin layer around the grain particles. This allows sufficient contact between the wastewater and the air.
At the end of the intermittent cycle, the wastewater is passed on to a drainfield for further treatment through filtration. At the end of the recirculating cycle, a portion of the wastewater is sent back through the sand filter system (Davis & Cornwell, 2008).

Intermittent Sand Filter System
Typically, the following levels of treatment can be expected from a properly functioning intermittent sand filter system:
BOD5 = 95% removal
TSS = 85% removal
Nitrification of 80%+ of the applied ammonia

The costs associated with this type of unit are substantially higher than those associated with the conventional system with the total capital cost at roughly $10,000, and the annual operation and maintenance costs totaling $155 per year, plus the cost for power. The major disadvantage associated with this type of unit is that it doesn't allow for nitrogen removal. In order for this to be achieved, a recirculating filter should be used (EPA, Intermittent Sand Filters, 1999).

Recirculating Sand Filter System
Typically, the following levels of treatment can be expected from a properly functioning recirculating sand filter system:
BOD5 = 95% removal
TSS = 95% removal
Almost complete nitrification is achieved
Denitrification has been shown to occur
Frequently used where nitrogen removal is necessary

The costs associated with this type of unit are higher still than those of the intermittent sand filter system. The total capital cost associated with recirculating sand filter systems can exceed $25,000, and the yearly costs associated with the operation and maintenance of the unit can reach upwards of $350 per year, plus the cost of power to run the system (EPA, Recirculating Sand Filters, 1999). Table 2 compares the different types of on-site systems discussed.

The conventional septic system is the most commonly used system because of the lower capital and operating costs. If other, more cost-effective, wastewater treatment and nutrient removal technologies are introduced, there is a higher chance these systems will actually be utilized, and the water quality in the watershed area can be improved.

Conclusion
There are several challenges associated with replacing the failing conventional on-site septic systems in the Jourdan River watershed. The first of which is to identify these units. Most records of specific, privately owned and operated on-site septic systems are not made available to the public. Assistance from the MDEQ, MSDH, USGS, and other organizations in possession of this information is required. Another challenge is to find or develop alternatives that offer the higher level of treatment necessary to improve the water quality in the watershed area without the high cost associated with the current alternatives. Once the data is analyzed, and the treatment parameters are defined for new alternative systems, research and development on these systems can be continued.

Table 2: Comparing the Conventional Septic System to Current Alternatives

System	Cost		Treatment Levels			
	Installation	Annual	BOD5	TSS	Nitrification	Denitrification
Conventional	$1,500 - $4,000	$250 - $550	10 mg/L	10 mg/L	-	-
"Intermittent Sand Filter"	$10,000	$155 + Power	95% Removal	85% Removal	80% +	-
"Recirculating Sand Filter"	$25,000 +	$350 + Power	95% Removal	95% Removal	Near Complete	Up to 50%

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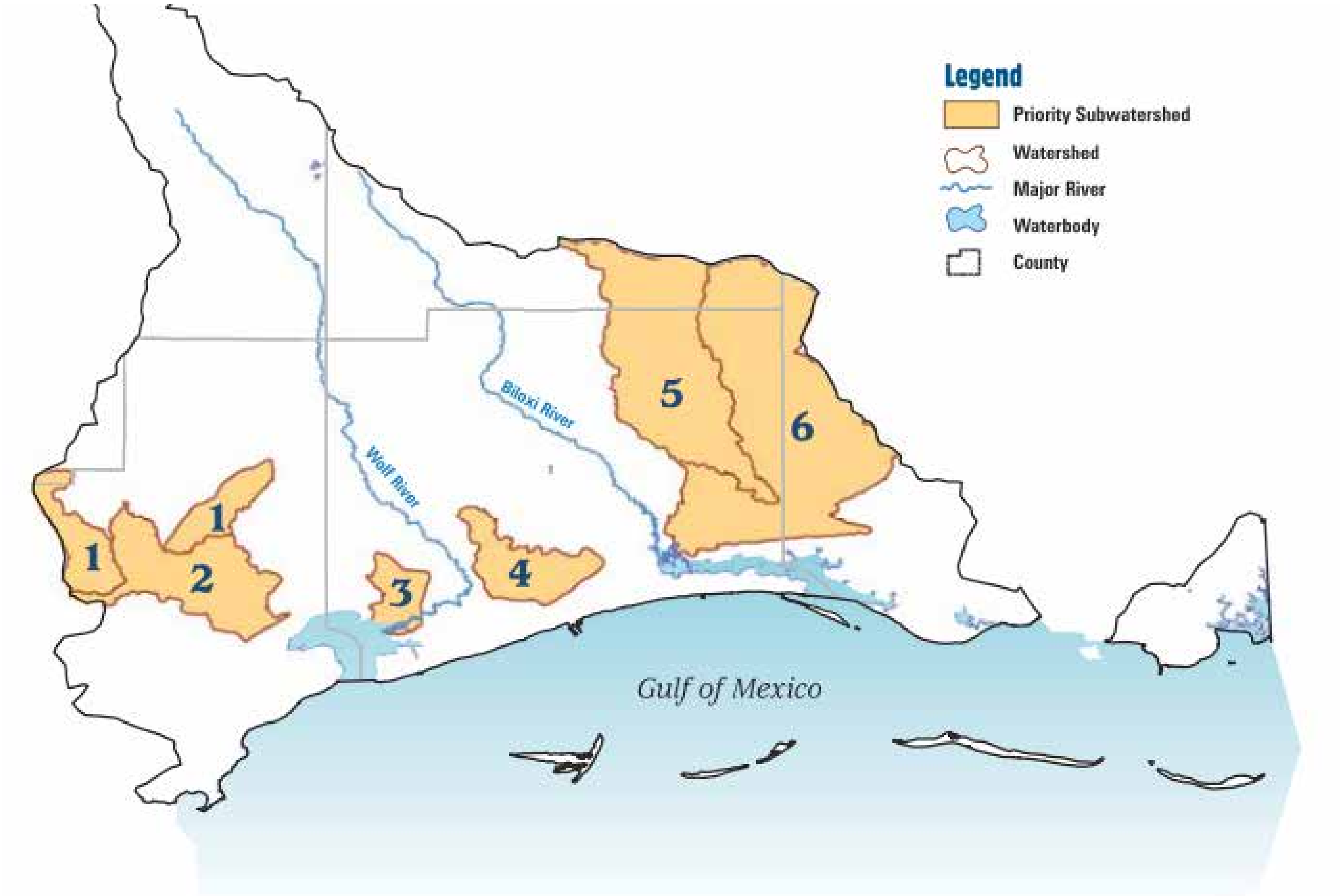

Figure 1: Priority Watersheds in Southern Mississippi (MDEQ, Citizen's Guide to Water Quality in the Coastal Streams Baisn, 2008).