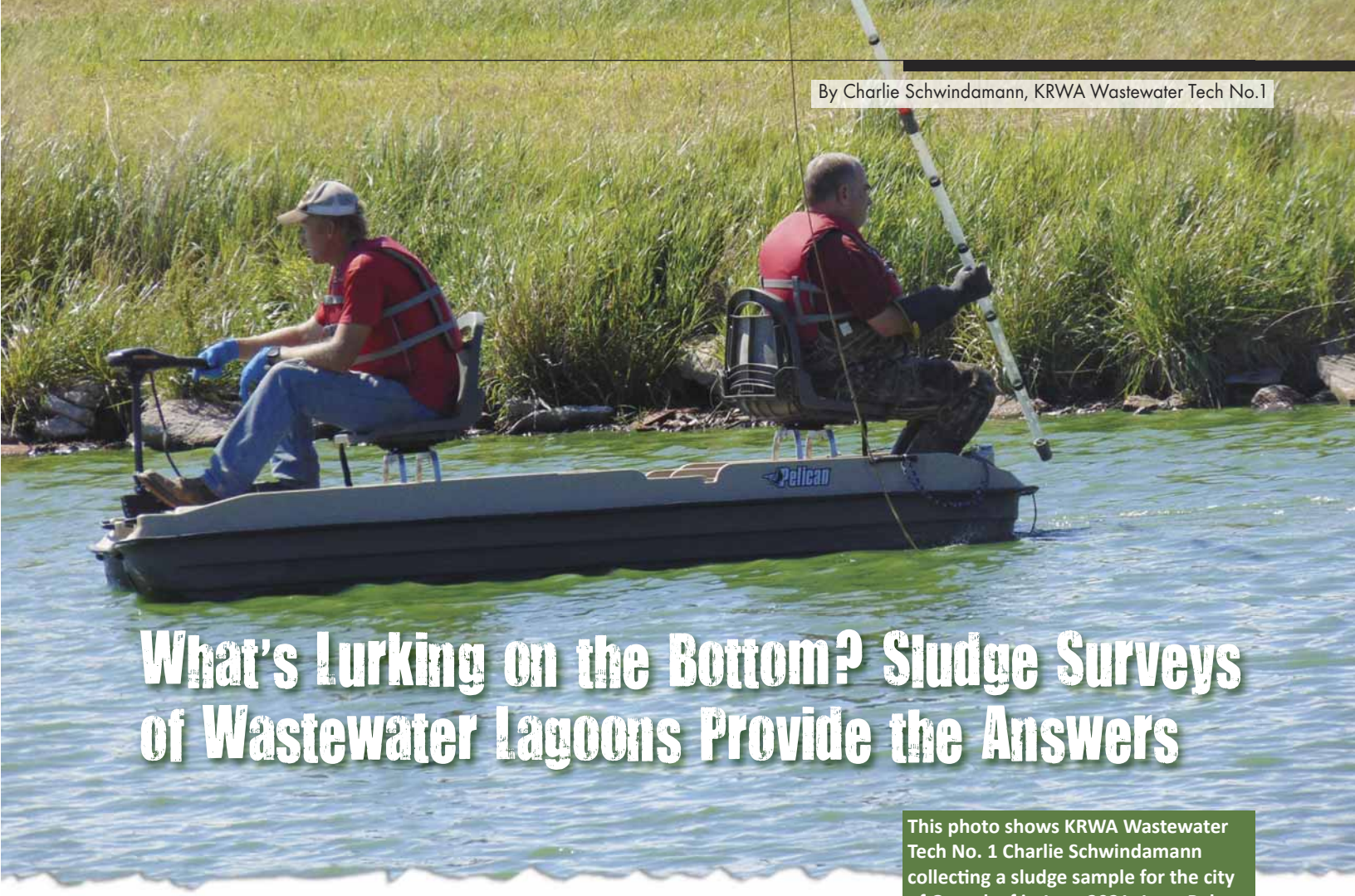
By Charlie Schwindamann, KRWA Wastewater Tech No.1



What's Lurking on the Bottom? Sludge Surveys of Wastewater Lagoons Provide the Answers

This photo shows KRWA Wastewater Tech No. 1 Charlie Schwindamann collecting a sludge sample for the city of Greenleaf in June 2021. Jerry Baker, Greenleaf Superintendent, helps by operating the trolling motor.

Lagoon design standards include consideration for sludge accumulation, and lagoon management should include periodic measurement of the sludge layer's depth. When its accumulation becomes excessive, sludge must be removed.

In the past three years, KRWA wastewater techs have been very busy with sludge surveys of wastewater stabilization ponds, commonly referred to as lagoons. KRWA has assisted more than 80 wastewater systems since 2021 in the performance of sludge surveys or profiles to determine the amount of sludge accumulation in these systems

A sludge profile is usually performed by use of a core-type sampler. The common terminology is a "sludge judge". KRWA provides all the needed equipment to complete the sludge profile, with the exception of someone from the utility to operate the boat while the KRWA staff member utilizes the sludge judge to get depth measurements of the sludge. The equipment includes a boat, trolling motor, batteries, sludge judge, life jackets, and tape recorder to record the measurements as they are taken.

Grid patterns of the cells are used to obtain a representative average of the sludge accumulations. Years ago, I saw some previous sludge profile reports by another organization that only displayed five measurements per cell regardless of the size of the cell. These reports showed a total of five measurement – one in the center and the other four in the corners of the lagoon. KRWA takes many more samples depending on the size of the lagoons. Wind greatly affects the effort for sludge profiles as the wind pushes the boat off course and maintaining a good grid pattern can be more difficult. This is why it's important to consider weather conditions before scheduling the sludge profile.

Cell No. 1

24"	16"	12"	12"	14"	12"	12"	12"		10"	14"	16"	18"	18"	18"	12"	18"
10"	8"	10"	8"	8"	8"	10"	16"		20"	20"	24"	30"	24"	12"	12"	14"
14"	8"	8"		8"	8"	8"	10"		10"	10"	12"	12"		14"	14"	24"
10"	10"	8"		10"	10"	10"	10"		10"	10'	10"	8"		10"	10"	12"
10"	10"	10"	10"	10"	10"	8"	10"	8"	8"	8"	8"	8"	8"	8"	10"	10"

Cell No. 3

8"	8"	6"	6"	8"	8"	10"	10"		
8"	8"	8"	8"	8"	8"	8"	8"	8"	10"

Cell No. 2

Cell No. 1 Operating Depth: 5 Feet — Average Sludge Depth: 13.74 Inches
Cell No. 2 Operating Depth: 5 Feet — Average Sludge Depth: 9.42 Inches
Cell No. 3 Operating Depth: 9.5 Feet — Average Sludge Depth: 8.83 Inches

This graphic shows a typical report of a recent sludge profile by KRWA. The report shows the depth of the sludge and the approximate location in the cells.

Depending on the size of the lagoon cells, it will usually take several hours per system to complete a sludge profile. We try to schedule several systems at a time, such as two systems per day depending on location to reduce travel costs.

After completing the sludge profile, a report is prepared and submitted to the wastewater system and appropriate agencies. This normally is accomplished within a week of collecting the measurements. The report includes the sludge amount, depth of the cells, and the percent of loss of capacity due to sludge accumulation. As an example, here is an excerpt from a recent report: "We took 57 measurements in Cell No. 1, the southwest cell. The average sludge depth in this cell was 15.47 inches. This cell was being operated at a total depth of 4.5 feet. The loss of capacity due to sludge accumulation is 28.65 percent."

These sludge profiles are mainly due to recommendations by the Kansas Department of Health and Environment (KDHE) staff during inspections of wastewater systems. KDHE recommends completing a sludge profile at least every ten years. This frequency helps establish a baseline for operators to evaluate the amount of sludge accumulation in the systems. It can also help project the timeline for when sludge will need to be removed. KDHE recommends consideration of sludge removal when the sludge accumulation exceeds 16 inches in each of the first two cells. The 16 inches equates to a loss of capacity of 26.66 percent due to sludge accumulation per cell.

This photo shows a non-discharging lagoon with excess wastewater. Permit limits are to two feet of free-board, which is the vertical distance from the top of the dike to the water level. The maximum operating depth of a lagoon is usually six feet.

Excess sludge affects all lagoon systems, either discharging or non-discharging in varying ways. In discharging lagoon systems, excess sludge accumulation can affect the discharge permit limits as it reduces the detention time needed to treat the wastewater to meet permit limits.

Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) are the most common issues.

The BOD limit is 30 mg/l for most systems. Excess BOD in receiving streams uses up the oxygen and causes fish kills and other issues for receiving streams. Measurements of excessive TSS is typically algae but it can also include solids discharged such as dirt due to dike erosion. Any TSS can settle to the bottom of the receiving stream and bury fish eggs, affecting

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invertebrate habitat, which causes problems with the food chain for the stream.

There are fewer effects on the environment by non-discharging lagoons. But it is no less important for wastewater systems, operators and managers to be aware of the need for sludge removal of these systems. An issue with excessive sludge in a non-discharging lagoon generally is the constant odor complaint especially when sludge accumulation reaches 16 inches or more. Discharging systems usually won't have constant odor complaints as they will likely be failing permit limits long before constant odor issues happen.

Operators of non-discharging lagoon systems raise the operating level of the cells to reduce odors and gain more time before sludge removal is a major issue. Operators need to be aware that the system's permit usually only allows for six feet of operating depth as any time the cells are within two feet of the free-board, which is the vertical distance from the top of the dike to the water level, they are required to report to KDHE for consideration of discharge. The results in discharge samples are required to be taken. These samples are usually BOD, TSS and E. *coli*.

Removal costs are high

Sludge removal projects can be very expensive. That is why KRWA often recommends creating a reserve fund for when sludge removal is needed. This reserve fund should be established as soon as the lagoon is completed. But for the sake of conversation, use a budget estimate price of $0.10 per gallon removed. An estimated cost for sludge removal is approximately $32,585 per foot of sludge per acre.

I saw a bid for a sludge removal project at least three years ago when the high bid was $0.11 per gallon, and the low bid was $0.03 per gallon for sludge removal. The $0.10 is for budgeting purposes. Actual bid prices will vary depending on the availability of land for sludge application and the location of the land. Hauling sludge increases the cost significantly. The location of the contractor to the project and the availability impact the cost. The cost may be cheaper if sludge removal can wait for six months or more.

KRWA is ready, willing and able to provide this service to any wastewater utility. KRWA does not charge for the service. Anyone interested can email me at charlie@krwa.net and KRWA will work on getting the project scheduled.

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Charlie Schwindamann has been Wastewater Tech at KRWA since September 1999. Charlie holds Class II Water and Class I Wastewater Operator certification. He has also served as a member of the Marysville, Kansas city council.