By Charlie Schwindamann, Wastewater Tech

Calculating Performance of Lift Stations is Important for Good Wastewater System Operation and Planning

Over the past several months, I have been contacted by various wastewater utilities wanting to know the capacity of their wastewater lift stations. The questions resulted due to the above-normal precipitation that many parts of Kansas received in 2010. Also, most of these lift stations are more than twenty years old; in many cases, the records and pumping information have been misplaced. Utility operators and managers need to know how many gallons per minute are being pumped to the treatment facility so as not to exceed the capacity of the plant as well as determining how much extra inflow and infiltration occurs during rainfall events.

Wastewater weir with flow sensing equipment installed

The first thing the system needs to do, if it hasn't been done already, is to log the hours the lift station pumps run each day. It is important that the run-time for each pump be logged. Some systems have had to add hour meters while others are quite fortunate because they have flow monitoring equipment that totalizes flow through the lift station, along with hour meters to log pump run-time. The flow measurement data is vital information for future upgrades on any portion of the treatment facility or collection system. Additional information that is very important to log is the amount of rainfall per day. I suggest that operators just install an inexpensive rain gauge near the lift station and record daily rainfall events with the pumping data.

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This information will also assist operators in determining the need to perform maintenance and repairs such as replacing impellers or pigging a force main. An increase in the hours that a lift station pump operates may take place gradually over several years, or, perhaps the increase will be sudden. Sometimes hour meters will show a sudden stoppage of one pump and a corresponding increase in run-time of the second pump. This could be due to pump failure or an electrical problem. However, if the hour meter shows no run-time on one pump but no obvious change or increase in run-time is noticed on the second pump, this indicates a failure of the an hour meter and the meter needs to be replaced. This is just one example of the importance of keeping the records.

Pump station calculations should be done at least annually or whenever changes are made to the lift station or pumps. Changing a float, motor, or even a pump can change the amount of wastewater pumped. Once the size of the lift

station and capacity of the wetwell from "pump on" to "pump off" are known, then the only variables may be the time the pumps run during the time there is flow into the wetwell.

Calculating capacity, flow rates

The following discussion will explain how to calculate the pump hours for a lift station. Assuming we have a wetwell that is 4 feet in diameter. To calculate the capacity, we use the formula (0.785 x Dia^2 x Depth) x 7.5 gallons per cubic foot or 0.785 x 4 ft. x 4 ft. x 1 ft. x 7.5 gal/ft.^{3} = 94.2 gallons per foot of depth. The next step is to determine the distance between "pump-on" and "pump-off". In our example, this distance is 51 inches. We need to change 51 inches to feet by dividing by 12 inches per foot, or 4.25 feet of depth in the wetwell. As a reminder when performing math calculations, it is important to keep the units consistent to ensure accurate information. Continuing with our example, pump operating cycles are on for three minutes, then off for ten minutes before coming on again. Next, since the volume in the wetwell within the pumping range is 4.25 feet; in our previous calculation we determined the volume of one foot in the wetwell was 94.2 gallons. Multiplying these (4.25 feet x 94.2 gal. per foot) gives us a pumping range wetwell capacity of 400.35 gallons.

There is one other component that needs to be considered when determining pump rates. This is the amount of wastewater entering the wetwell during the three-minute pump cycle. Since the wetwell's capacity is 400.35 gallons and since there are ten minutes between pump operating cycles, the rate of flow into the wetwell in gallons per minute (gpm) can be calculated. Divide 400.35 gallons by ten minutes; the flow rate is 40.035 gpm. Since the pumping cycle of three minutes and an inflow rate of 40.035 gpm, multiplying three minutes by 40.035 gpm indicates that 120.105 gallons of wastewater is being pumped. To determine actual pump rate in this example, add the wetwell capacity of 400.35 gallons to the additional inflow of 120.105 gallons. This gives a grand total of 520.455 gallons being pumped in three minutes. The actual pumping rate then is the wetwell capacity of (520.455 gallons) divided by the pump cycle of (three minutes) resulting in 173.48 gallons per minute.

Operators will need to make this calculation for each lift station and for each pump in the lift station. Once pump rates have been determined, operators can determine the gallons per day by using records of pump times. For example, if a pump ran 2.5 hours in a day, to calculate total gallons in the day, simply change the hours to minutes (2.5 hrs x 60 min/hr =150 minutes). The amount pumped then for the day is 150 min. x 173.48 gal./min. for a total of 26,772 gallons. With the pump rate determined and with the information obtained with an hour meter, an operator can calculate how many gallons per month each pump is discharging. This is why keeping daily records of the times the lift station pumps operate is so vital as it can assist with troubleshooting problems in the system, such as, determining if there are problems with excess inflow & infiltration or if there are capacity issues at the plant.

Flow chart recorder at the opposite end from the weir

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The Kansas Rural Water Association has provided assistance to wastewater utilities since 1993, thanks to funding through the USDA Rural Development and National Rural Water Association contract. There is a high demand for assistance by systems. As you may have read in the July issue of this magazine, the Kansas Department of Health and Environment (KDHE) has provided supplemental funding so that additional staff can provide help to wastewater systems across Kansas. Anyone with questions or having problems with facilities is encouraged to contact KRWA at 785-336-3760 or email directly to me at charlie@krwa.net or to Jeff Lamfers at jeff@krwa.net. Also, go to the KRWA Web site at www.krwa.net and then under "Technical Assistance" and then "Downloads" for sample lift station pump hour log sheets and pump station calculation sheets.

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