Operations & Maintenance Considerations when Designing a Low-Pressure Sewer Collection System

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Low-pressure sewer collection systems are an economical alternative to providing centralized wastewater collection to areas where the groundwater table is high and to converting areas which are serviced by septic tanks with drain fields to centralized sewer service. The typical low-pressure sewer system consists of smaller-diameter force mains that can be aligned easily and constructed along easements and right-of-ways with service laterals that provide connection to a pressurized pumping unit. Usually located within private property, however within deeded easements, the pressurized pumping unit can be thought of as a mini-lift station to service the account holder.

It is fairly simple to convert a service area which employs decentralized wastewater treatment in the form of septic tanks with a drain field for effluent disposal to a centralized low-pressure transmission collection operation. This conversion process usually involves the abandonment of the gravity drain field and the installation of a pump which will dispose of the effluent by pumping into the low-pressure transmission force main.

The conversion also includes a control panel, floats, and alarms to operate the pump inside the pressurized unit. As a basis for system design, the interested reader may get additional guidance and specifications from the Florida Department of Environmental Protection publication titled "Design and Specifications Guidelines for Low Pressure Sewer Systems," 1981, prepared by a technical advisory committee.

A low-pressure collection system has several advantages and disadvantages when compared to the traditional gravity collection system. For example, in gravity systems grades are extremely important, while in low-pressure systems they are not as critical as long as air relief facilities are provided.

In installations with a high groundwater table, which will require extensive dewatering in order to attain gravity sewer grades, the costs can be excessive to install a centralized gravity collection system; however, in these cases, a low-pressure collection system that is not dependent on grades to attain system design flows likely will not require dewatering with a 30- to 36-inch pipe cover all along the topography of a fairly flat terrain. Since all wastewater generated is pumped, manholes to changes in direction and alignment are not required for low-pressure collection systems.

Utilities also save in operational costs of wastewater treatment facilities. Solid loadings and BOD loading on the plant are significantly less, making it easier for operators to meet permitted effluent disposal requirements.

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The low-pressure tank provides anaerobic treatment which decomposes most of the solids locally on site; this operation reduces the loading on the centralized wastewater facility and also provides savings in sludge wasting, dewatering, and handling/hauling operations. System infiltration should also be minimal. Since the system is usually designed to remain pressurized, there is less chance of infiltration.

The electricity cost to operate the on-site pumping unit is the responsibility of the homeowner or business owner. Most utilities are responsible for repairs to the pressurized pumping units, but most of them also have adopted policies that pass on repair costs to residential and commercial customers at a base cost without markup. All these factors usually save money in processing wastewater at the treatment plant.

Figure 1. Electrical Control Panel With Generator Receptacle

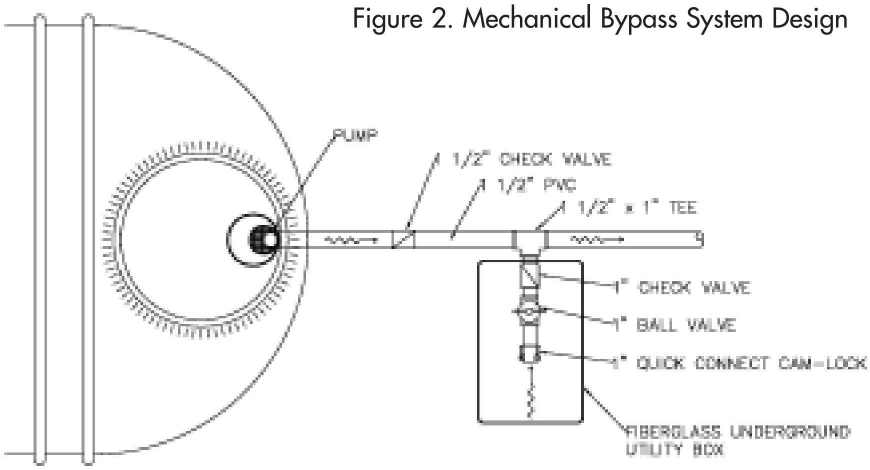

Figure 2. Mechanical Bypass System Design

So given these advantages, the question becomes: Why are utility field technicians and operational personnel so opposed to this type of collection system?

The answer is that most of the pressurized pumping units have been designed and constructed without full consideration of long-term operation and maintenance (O&M) issues. This article will report on field construction testing and system modeling construction done by the Sun ‘N Lake of Sebring Improvement District to address some of the more common maintenance challenges. We are of the opinion that these challenges will likely apply to all utilities charged with the O&M of this type of collection system, so we share the following findings:

<u>Challenge 1:</u>

When workers are called out to work on a failed pumping unit, there is no way to determine whether the float or pump has failed. We found that by updating our engineering specification, we could add a local/auto/off switch to the control panel to allow for this level of field troubleshooting. The panel cost increased by $35 to provide this switch. It also allows for immediate drawdown operations when the float is unresponsive in calling the pump on.

<u>Challenge 2:</u>

During a massive power outage such as a hurricane, how do we avoid or minimize sewer spills? One advantage of the pressurized unit is on-site storage within the tank of approximately 400 gallons. This provides the typical residential customer with on site storage for approximately two days, depending on the tank level prior to the outage.

Nevertheless, during a prolonged power outages, eventually the tank does need to be pumped down. We found that specifying a generator receptacle with interlock breaker mechanisms would allow utility personnel to pump down by providing auxiliary power using a portable small 2,500-watt generator.

Including a weatherproof generator receptacle with interlocking breakers into our engineering specification increased the control panel cost by an additional $120. Figure 1 shows our modified panel.

<u>Challenge 3:</u>

The system pump usually lasts seven to 10 years, but any pump can fail on any day and at any time of the day. If a field technician is called out because of a failure at 9 p.m., it is dark and the entire tank is backed up full of wastewater. It can be a difficult job to re-establish immediate service. How do we re-establish service economically and quickly, even if it means providing a temporary fix before re-establishing permanent service at a more appropriate time, with added resources and daylight?

This was probably our most important challenge in addressing typical field problems with system O&M. We designed a mechanical bypass system that allows our utility technicians to offer customers immediate relief by pumping down the tank in a 15-minute period. When the tank is pumped down, this provides the utility customer with approximately two days of storage.

Consequently, at odd hours when it is dark and there are obvious safety concerns, we are capable of performing bypass pumping operations by connecting a small portable pump weighing 25 pounds, then lowering the pump suction hose into the tank by removing the hatch cover. The discharge hose for the bypass pump attaches using cam-locks fasteners to a tee fitting service which was cut into the service lateral. A diagram of our bypass system design is provided under Figure 2, and Figure

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Figure 3. Recent Field Construction Test Model

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3 provides the actual field installation.

When examining Figure 2, it is worth emphasizing the importance of the check valve. Since any curious customer could possibly open the bypass valve accidentally, we thought that the addition of a check valve would prevent a possible sewage spill or bodily harm. We also emphasize the importance of adding a warning label to avoid unauthorized operation.

Finally, before moving into production mode, we are researching purchasing an inground box with a simple lock mechanism to again minimize the chances of unauthorized operation. To build this type of a mechanical bypass system, we spent $40 in parts per unit to retrofit the older pressurized pumping units. After further research, we have plans to adopt this basic mechanical bypass system on all new pumping units constructed within our service area. We believe the $40 cost is appropriate also for new installations.

There is no question that a gravity system requires less customer service maintenance and has fewer call-outs generated by customer complaints; however, initial infrastructure costs can also be much higher for gravity systems, especially if dewatering is required to set grades. The purpose of this article is to address the O&M design issues needed in order to make the low-pressure sewer collection alternative more ergonomically feasible to repair for field utility technicians.

In summary, Challenge 3 was our most important and economically researched solution. For a fixed investment of a $40 fee in materials, our utility staff will be able to retrofit pumping units to provide customers with immediate relief should their pump system fail at odd hours when immediate repairs are impossible. Obviously, this type of setup could also be used during prolonged power failures caused by hurricanes.

Additional field equipment research is needed to develop a telemetry-based pump controller or a system data logger that provides information either in real time or data logging to be downloaded on a monthly basis, similar to the existing communications platform used in automated meter reading. Conventional relay logic panels cost approximately $400 in the open market, so the challenge is developing a SCADA-based pump controller that could communicate with adjacent lift stations or wells to send system operational data back to the central SCADA system. This concept of communicating with adjacent remote terminal units is documented by Data Flow Systems and is known as digipeating.

If a real-time SCADA system is not economical at this time, one possible solution could be developing a communication technology similar to automated meter reading, enabling a utility representative to drive the streets and acquire operational data and diagnostics on system performance. In the current day and age, most utilities have also adopted automatic meter reading as a field standard. Consequently, when the utility representative drives the streets collecting water meter consumption data, data could be collected at the same time for all pumping unit installations.

Having this type of information could allow utilities staff to plan and detect systems that are bound to fail or simply to schedule preventative maintenance based on pump run hours—or even to detect system inflows through the pumping unit. We are of the opinion that customer repair costs could be lowered significantly through some level of preventative maintenance, which would minimize equipment and pump failures. These are the challenges and our findings; we are certainly interested in hearing other suggestions or alternatives.