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Liquid-Only Sewers: Past, Present, and Future

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Liquid-only sewers: What are they and where did they come from? That's the normal reaction of many knowledgeable engineers and utility operators in the wastewater industry. The confusion regarding the name is understandable. Variations on this technology have included small-bore sewers, effluent-drainage sewers, septic tank effluent pump systems, septic tank effluent pumping (STEP) systems, low-pressure sewers, and effluent sewers.

The variety of different names can be tracked throughout the evolution of the technology, and while these wastewater collection systems have changed throughout history, the principles they're based on have not. All liquid-only sewer systems are built on a simple concept:

> If an amply sized interceptor tank is provided between the source and the discharge, solids will settle to the bottom and scum will float, creating a clear zone in the middle of the interceptor tank.

Liquid-only sewers are designed to only convey wastewater from the clear zone. Figure 1 shows a typical liquid-only sewer clear zone.

Primary Wastewater Treatment

Simply put, a liquid-only sewer provides primary treatment of wastewater before it's conveyed offsite for final treatment and disposal. Benefits of providing primary wastewater treatment at the source include more-efficient wastewater conveyance, a reduction in biosolids volume, and reductions in final treatment costs. Since there are no solids in the collection mains, they essentially behave like water mains, a characteristic that can be leveraged to convey wastewater flows at greater distances, without the need for lift stations.

A liquid-only sewer can be as simple as elevating a pump on a cinder block, or placing a pump on a shelf within a septic tank so that it's only pumping from the clear zone. To this day, there are systems in service that use this concept; however, while simple in concept, these basic systems have a history of high maintenance costs. A modern-day liquid-only sewer looks far different than the historical versions. Current liquid-only sewers can include meander tanks, filtering, turbine pumps, hanging pump assemblies, click-tight electrical connections, and remote monitoring. A typical example of a modern liquid-only sewer tank and pump unit is shown in Figure 2.

The liquid-only sewer unit shown in Figure 2 is typically located at each property, where flow is intercepted, partially treated, and then pumped through small-diameter pressure mains for final treatment. Typically, a modern-day liquid-only sewer will reduce total suspended solids (TSS) and biochemical oxygen demand (BOD_5) by more than 65 percent (Bitton, 2005) and will digest over two-thirds of gross solids, grease, and oils (Tchobanoglous, 1998) before the flow enters the wastewater collection system. Most importantly, it does it for free. Indirect cost savings for capital costs, electricity, and sludge management are generated at the wastewater treatment plant.

A History of Liquid-Only Sewers

So where did this concept originate? The earliest documented liquid-only sewer appears to have been a small-bore sewer system in Zambia, Africa, in 1961 (Otis, 1985). The African Housing Board of Southern Rhodesia (now Zimbabwe) connected groups of what were then known as "aquaprivies" via small-diameter, gravity-flow pipes to move partially treated wastewater away from homes, with discharge to waste-stabilization ponds. There were similar systems constructed in Nigeria dating back to 1964.

Around the same time, common effluent drainage systems or effluent drainage sewers were being constructed in Australia. The first system was installed in Pinnaroo in 1962, and there was a larger system constructed in Barmera in 1964 (Otis, 1985).

The first liquid-only sewers in the United States were built in Florida back in the early 1970s (Subcommittee on Water Resources, 1981). Florida played a big part in the evolution of liquid-only sewers; however, these systems were referred to as STEP systems. These systems were the first examples of pressurized liquid-only sewers and were often referred to as low-pressure sewers. In the mid- to late 1970s, there were also small-bore sewer systems, similar to those in Australia, constructed in Mt. Andrews, Ala., and Westboro, Wis. (Otis, 1985).

The July/August 1978 issue of *EPA Journal*, a publication of the U.S. Environmental Protection Agency (EPA), published the article, "Treatment for Small Communities," which featured the pressure sewer systems constructed in Glide,

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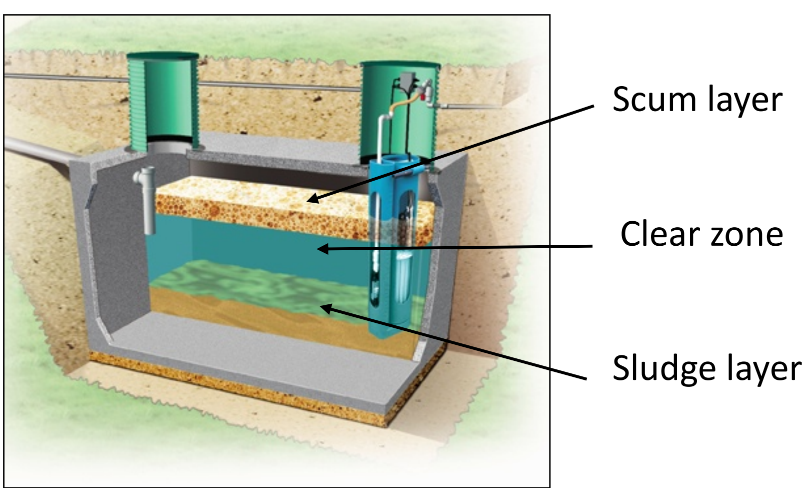

Figure 1. Typical liquid-only sewer configuration.

Figure 2. Modern liquid-only sewer tank and pump unit.

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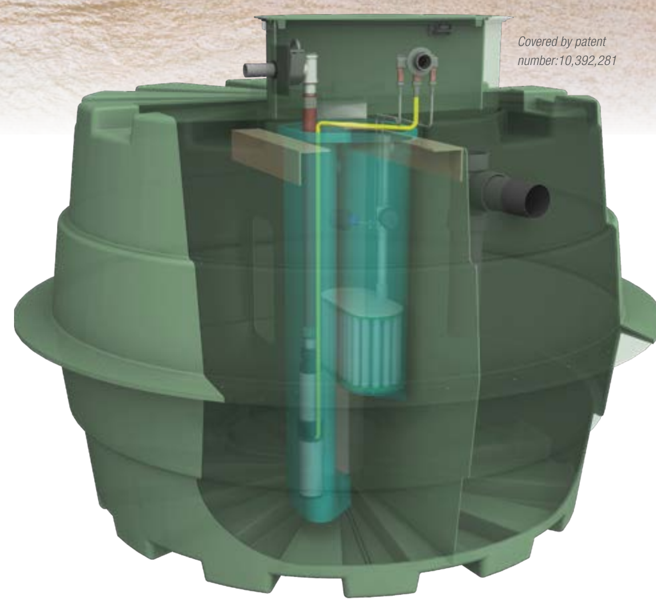

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Ore.; Port Charlotte, Fla,; and Port St. Lucie, Fla. (Dearth, 1978). The article stated that these systems had a capital cost of one-eighth to one-half that of a gravity sewer. While these systems were not specifically described in the article as liquid-only sewers, they were, in fact, the first pressurized liquid-only sewer systems in the U.S. The Port Charlotte and Port St. Lucie systems were developed, constructed, owned, and operated by General Development Corporation (GDC).

In July 1981, Arthur Harper, vice president of community operations for GDC, testified before the U.S. House of Representatives that, "The prototype low-pressure sewer system developed by Mr. (Harold) Schmidt now reflects over 10 years of successful operations," He went on to say, "The concept was initially greeted with skepticism, but the skyrocketing costs of orthodox gravity systems and the accumulating data testifying to the successful operations of these systems have won increasing acceptance by federal and state regulators." (Subcommittee on Water Resources, 1981)

In other testimony given by Harper, he talked about the significant energy savings being generated, stating that 100 homes on GDC's low-pressure sewer saved the equivalent of 25 barrels of oil a year when compared to gravity systems. He elaborated by equating the 25 barrels of oil to $675 a year and half the energy used by their gravity system. Interestingly, Harper was using the direct savings in the collection system and the indirect savings at the wastewater treatment plant to compute this number.

Harper also described GDC's experience with regard to capital costs, stating that one section of GDC's communities that would require a $3.5 million gravity sewer system could be served by a $1.3 million dollar low-pressure system.

In June 1981, General Development Utilities (GDU), owned by GDC, joined with the Florida Department of Environmental Protection (FDEP) to develop a Florida manual of design and technical guidelines for low-pressure collection and treatment systems (Kreissl, 1981). This document opened the door for the use of low-pressure sewers in Florida as an accepted method of wastewater treatment. Unfortunately, this 1981 document—still referenced by Florida code—has never been updated to reflect currently available technology.

The most interesting parts of the House testimony (Subcommittee on Water Resources, 1981) were the statements, made by Harold Schmidt (of GDU), regarding the difficulty in introducing new and emerging technology to the wastewater industry. First, he talked about the innate conservatism in the sewage collection and treatment field. Next, he stated that there had been a "natural tendency of suppliers, as well as design engineers, to hold to known technologies." Finally, he talked about federal funding policies that had been directed heavily toward the construction of new "conventional systems."

Schmidt then went on to predict the following: "Now that this system, and others like it, have been accepted as a design technology in Florida, the taxpayers of that state will be reaping in the indirect windfall." Interestingly, to this day, the original GDC low-pressure sewer systems are still in service, utilizing the GDU design guidelines from 1981.

Figure 3. Typical modern-day liquid-only sewer system.

An Affordable Technology

In 1981, Hall Ball, P.E., and Terry Bounds, P.E., founded Orenco Systems Inc. Ball and Bounds, having been involved in the design, construction, operation, and maintenance of the Glide, Ore., system, saw a need for affordable wastewater collection and treatment to service small communities. They also saw an opportunity to build on the concepts of STEP and small-bore sewers to bring the first engineered liquid-only sewer product to market.

Ball and Bounds introduced a completely new approach to these systems. First, they used multistage turbine pumps in their liquid-only sewer packages. These pumps were known for reliability and long life cycles in water well applications, but had never been used in wastewater applications. The low-head centrifugal pumps that were being used in Florida were low cost, but also had short life cycles and required a great deal of maintenance. Multistage turbine pumps provided higher operating heads, as well as much better reliability.

Secondly, Ball and Bounds introduced filtration into these systems. Filters are necessary to protect the pumps and are especially important for turbine pumps, since they can only handle solids smaller than ⅛ inch. The GDU low-head centrifugal pumps were protected by approximately 50 square inches of ¼-inch mesh, which would often get clogged due to the size and amount of solids. Orenco introduced several variations of screening, eventually offering the Biotube® filter, with more than 5 square feet of ⅛-inch filter area per filter.

Finally, Ball and Bounds introduced pump vaults within the liquid-only sewer tank. These pump vaults housed the pump, filter, and control floats in a vault that could be dropped into concrete, fiberglass, and high-density polyethylene (HDPE) tanks. This simplified needed maintenance and protected critical components in the system. The concepts introduced by Ball and Bounds have become the standard for all liquid-only sewer systems manufactured today.

Moving Forward

Looking ahead, liquid-only sewers appear to have a bright future. Specifically, they have proven to be ideally suited to areas that are seeing public health compromised by failing septic systems, which includes small and rural communities that need affordable and sustainable wastewater systems. Small systems simply do not have enough users to create sufficient economies of scale to make

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these kinds of projects affordable without a significant infusion of federal and state dollars (Martin, n.d.). Liquid-only sewers provide low initial capital costs for making public sewers available, while providing consistent long-term operation and maintenance costs that are closely aligned with revenues.

Liquid-only sewers also offer a sustainable, robust, and adaptive solution for communities impacted by climate change. For example, in Florida and other coastal states in the U.S., sea level rise is impacting existing septic systems in many communities, rendering them a public health risk (Elmir, 2018). In these areas, gravity sewers are proving too expensive and logistically too challenging to provide cost-effective solutions within the timelines required.

Today, the technology and quality of liquid-only sewers continue to advance (a typical, modern-day liquid-only sewer is shown in Figure 3). It's a proven, sustainable, resilient wastewater collection technology that has evolved significantly since the 1970s, and continues to do so.

The initial skepticism from some engineers and operators described by Schmidt in 1981 has not gone away entirely, despite more than 40 years of successful operational history. As more and more communities continue to embrace this technology, they will benefit from sustainable operational costs, reasonable user rates, and resilient infrastructure. Professionals in the industry are understanding these benefits and learning where they can best apply them.

As liquid-only sewers look forward to 50 years of history in the U.S., they're finally ready to become recognized as a mainstream solution for wastewater collection.

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