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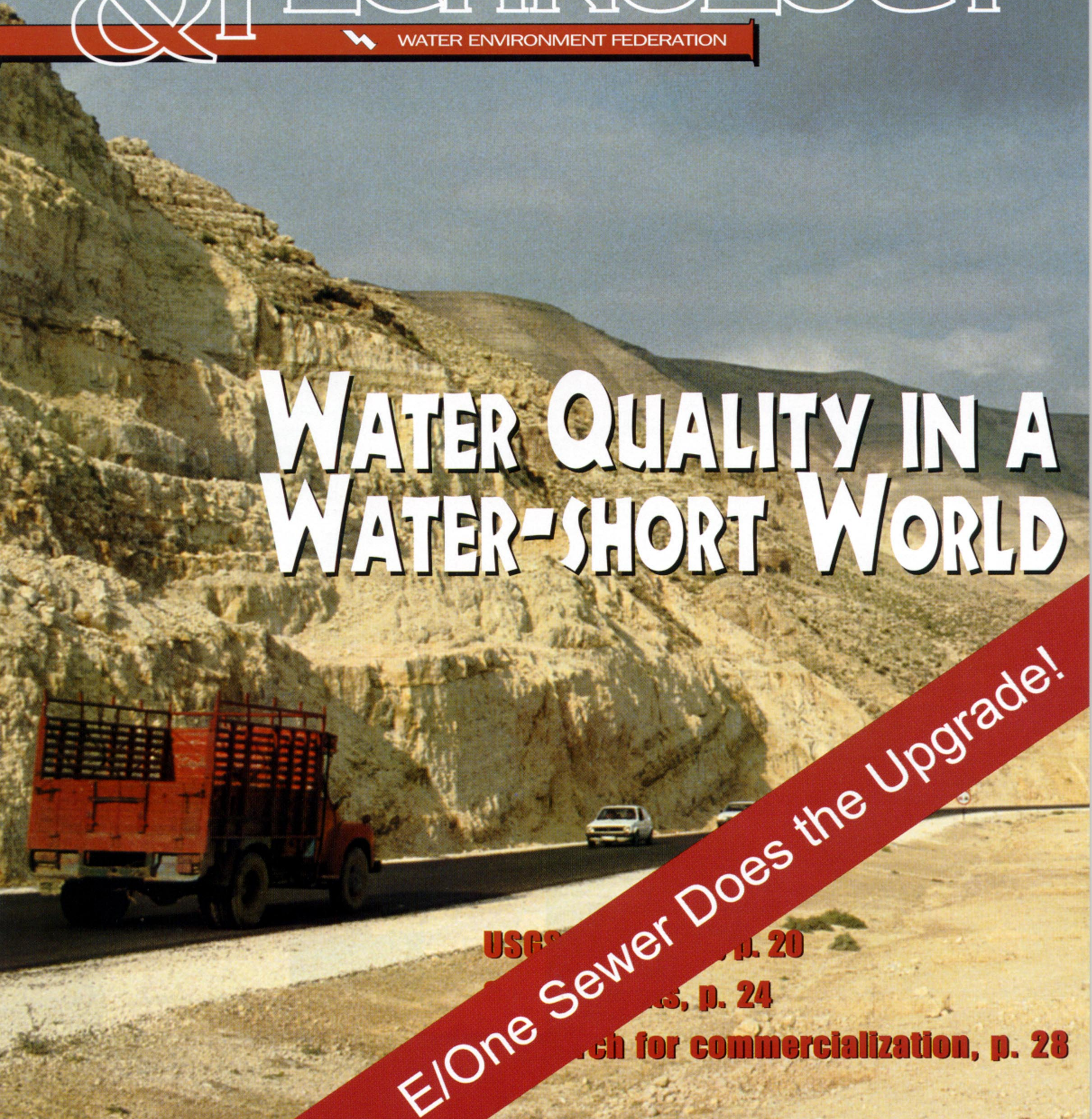

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E/One Sewer Does the Upgrade!

Red Light Weather

Infiltration backs up pumps at Lake Tapawingo, Mo.

Michael P. Kalis

For more than 10 years, significant wet weather events backed up grinder pump units at Lake Tapawingo, Mo., residences, triggering visual alarms. The red lights could commonly be seen glowing on more than half the 370 homes surrounding the recreational lake. Residents of this small Kansas City suburb (population 850) jokingly referred to their community as a "red-light district," but the humor of the situation became serious as the city tried to determine how stormwater got into its low pressure sewer system.

The city's first sewer system was constructed in the 1930's and consisted primarily of 150- and 200-mm-diameter (6- and 8-in.-diameter) clay or concrete gravity sewer lines. In most cases, houses were connected to the mains by 100-mm (4-in.) service lines. However, in some cases, houses were built directly over the sewer main, and the house plumbing was connected to the main beneath the house. This practice was commonly used to save money but the consequences of no access for maintenance were not understood.

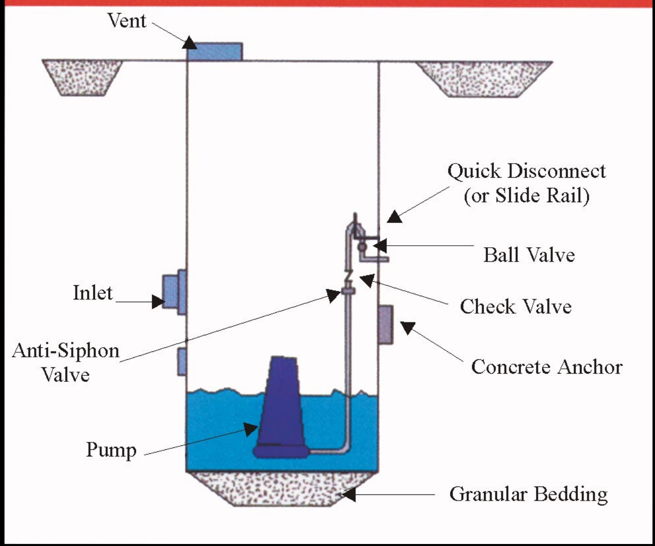
Because the 1930s system had deteriorated with leaky sewer lines and pump stations at the end of their useful life, the city installed in 1983 a low pressure sewer system comprising individual centrifugal-type grinder pump units at each house (see figure, right). The units pumped flow from the houses into a series of force mains ranging in diameter from 32 to 100 mm (1.25 to 4 in.). The force mains discharged to gravity sewers that conveyed for to the Little Blue valley Sewer District meter structure. The district, a large regional sewer authority that serves portions of the astern Kansas City metropolitan area, bills customers for sewer service based on flow rate and total volume. The meter structure, a partial flume with electronic equipment that measures flow depth, converts flow data into flow rate.

The grinder pump units were installed using either the original 100-mm (4-in.) service line from the house or new pipe and fittings for those houses constructed over the original sewer mains. In the latter case, the sewer main was cut off upstream of the house and a cleanout was installed. Downstream of the house, the sewer main was cut off and directed into the grinder pump unit. Thus, the existing sewer main continued to function as a service line.

The system operated efficiently with no apparent problems in dry weather, but under wet weather conditions, rain and snow melt entered the sanitary sewer system in large quantities. In the short term, the water was measured at three of four times the dry weather flow. Over the long term, annual flow increased by more than 33% during a wet year. Lake Tapawingo's system experienced problems after long, slow-soaking rains, indicating infiltration appeared to be entering the system through original, but deteriorated, service lines and sewer mains.

In dry weather conditions, the 370 grinder pump units in this low pressure system operate intermittently, and the maximum number of pumps operating simultaneously would be between 20 and 25. Infiltration causes more of the pump units to try to operate at the same time. As flow and pressure losses increase in the force main, the resulting higher line pressures reduce the pumping rate of each pressure-sensitive centrifugal pump unit. Where the rate of infiltration exceeds the pumping rate, red lights signal a high-

Typical Grinder Pump



Alarms attached to homes at Lake Tapawingo would glow when grinder pump units backed up.

ARCHER ENGINEERS

water condition.

The problems resulting from this wet weather mode of operation included

• basement flooding (residents typically limited use of their facilities until the weather event passed);

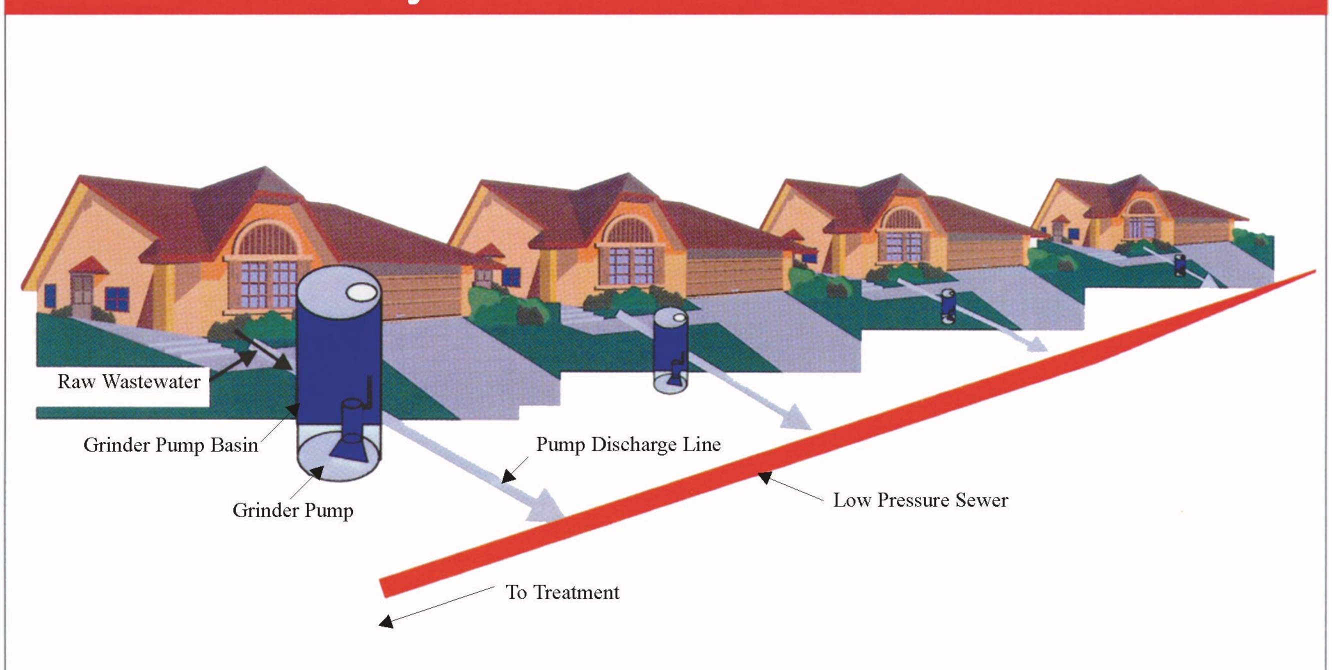
• sanitary flow and infiltration leaking into groundwater and ultimately into the lake;

• higher payments to the Little Blue Valley Sewer District, which charges on a volumetric basis; and

• additional wear and tear on the pumps, higher maintenance and repair costs, and pump failures.

In 1994, the city hired an engineering firm to help characterize and solve these problems. A task force including city and consulting firm representatives gathered information, much of which had been documented by the city's utility superin-

Low Pressure Sewer System



tendent who had kept detailed records of the problems over several years.

Using these historical data, the task force inspected each residence and grinder pump during a significant storm event. In 1994 and 1995, team members mobilized when the weather dictated, working nights and weekends to inspect all 370 grinder pump units.

Once the wet weather inspections were complete, the next series of inspections were conducted during dry weather. In the summer of 1995, the team smoke-tested sewers to locate entry points for extraneous flow. Finally, several "dig-ups" verified how the original sewers were incorporated into the low pressure system, which enabled the task force to make assumptions as to how representative problems were and prepare a better estimate of the project scope and cost.

As expected, the majority of the infiltration occurred through the old gravity sewers and service lines and, in some cases, at sump pump and foundation- and area-drain connections.

With the problem defined, the task force prepared construction documents. The rehabilitation work would be performed under two contracts.

One contract involved eliminating extraneous flow sources, including repairing and replacing old sewers and service lines, making plumbing modifications in basements, crawl spaces, and even under basement floor slabs. The construction plans included a schedule for each residence, outlining what work was required. Onsite inspection by a project representative during excavation and a unit price construction contract were used so the work plan could be adjusted as additional information was uncovered.

The second contract dealt with removing and replacing the grinder pumps, mot of which were on the verge of failure. A one-time capitalized replacement program was less costly to sewer rate payers than replacing the units as they failed. For example, replacing 370 pumps over 10 years at $2000 per pump would require a revenue stream (obtained through sewer rates) of $74,000 per year. By issuing bonds, the annual cost over 20 years would be $52,000 per year.

The task force could not accurately predict how much infiltration would be reduced by rehabilitating sewers and service lines and recognized that some infiltration could continue to stress the system beyond its dry weather design. Therefore, the team determined that the centrifugal grinder pumps should be replaced with positive displacement pumps, which are less sensitive to varying discharge pressure. If some infiltration continued to enter the system, these pumps would better handle the resulting higher discharge pressures.

The contract also replaced float-switch level controls, which are prone to grease accumulation and require high maintenance, with pressure diaphragm switches, which require minimal maintenance.

The project was financed for $1.7 million through the Missouri state revolving fund loan program. Because state funds were involved in financing the project, competitive procurement of equipment was required. However, there was only one established manufacturer in the Midwest of positive displacement pumps – Environment One Corporation. The city and its consultant worked closely with the Missouri Department of Natural Resources to obtain approval to procure pumps from this manufacturer under the state's "sole source procurement" provisions. The price of the equipment was negotiated in advance, and the manufacturer had to establish fairness by providing records of other sales.

Construction began in December 1995, 3 months after the project was put out for bids. The work was completed in about 7 months. Because the project was completed under budget, the city was able to install some valves and cleanout stations and build odor control and maintenance facilities.

More than 2 years of operating history have shown that the system is even more successful than expected. Red light incidences and maintenance calls have been negligible, and infiltration has been eliminated. With all new pumping equipment and actual flows and pressures approximating those of the original low pressure system design, the city has turned the "lights out" on sewer problems at Lake Tapawingo.

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