CITY OF PHOENIX COLLECTION SYSTEM REHABILITATION PROGRAM

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The City of Phoenix's wastewater collection system includes approximately 4,200 miles of sewer dating back to the early 1900s. The pipelines range in size from 8 to 90 inches in diameter with over 74,000 manholes. Approximately 95% of the system is comprised of small-diameter vitrified clay, less than 12 inches in diameter. The remaining 5% consists of large-diameter clay and concrete pipelines. Most of the pipelines are owned solely by the City of Phoenix with the exception of the large-diameter regional interceptors that convey wastewater from adjacent cities to the 91st Avenue Wastewater Treatment Plant. These interceptors are jointly owned by the Sub-Regional Operating Group (SROG), which is comprised of the Cities of Phoenix, Tempe, Mesa, Scottsdale, and Glendale.

Phoenix's Aging Infrastructure

The theoretical design life for a sewer is 50 years and much of the City's infrastructure is rapidly reaching the end of its useful life. Only 3.5% of the system is currently greater than 50 years old. However, an additional 43% of the system will exceed the theoretical pipe-life over the next 20 years. These pipelines may need to be rehabilitated or replaced in the near future to ensure satisfactory operation of the collection system.

The smaller-diameter clay pipelines are experiencing a variety of failures as a result of improper installation, corrosion of mortar joints, tree roots, and damage resulting from the installation of new service laterals and other adjacent utilities. These type of defects can increase the need for maintenance and, if not addressed, can lead to pipeline plugging, overflow, and collapse. Historically, most work on the smaller-diameter pipelines was provided in reaction to a problem. However, proactively maintaining the operation of the smaller-diameter pipelines is crucial since any interruption in service directly impacts the customer.

The larger-diameter pipelines are constructed of clay, unlined concrete, and polyvinyl chloride (PVC) lined concrete. Many of the larger pipelines are key interceptors with a high consequence of failure. These sewers convey large volumes of wastewater and are subject to flat slopes, long detention times, turbulence, and warm temperatures. These conditions enhance the conversion of hydrogen sulfide into sulfuric acid, which in high concentrations can rapidly corrode unlined concrete pipe. To prevent corrosion, all concrete sewers constructed after 1980 were manufactured with PVC liners.

Pipeline Collapse and Emergency Repair

In January 2001 a section of 54-inch-diameter concrete pipeline unexpectedly collapsed. The City of Phoenix immediately assembled an emergency response team of experts to investigate, stabilize, and temporarily repair the collapsed area. Subsequent investigation of the 25-foot deep sewer revealed that the pipeline had severely corroded and a 15-foot-long hole had developed at the springline of the pipe.

When the pipeline collapsed, large quantities of pipe, earth, rock, and asphalt fell into the pipeline. This restriction caused the pipeline to surcharge and erosion of the surrounding soil began to occur at a rapid rate. The increasing size of the "sink-hole" threatened the integrity of adjacent roads, railroad tracks, utilities, and structures. Working during wastewater low-flow periods, between 3:00 am and 11:00 am, the emergency response team stabilized the hole by diverting a portion of the flow to the 23rd Avenue WWTP and applying shotcrete to the exposed slopes.

Alternative methods for repairing the pipeline were evaluated based on the limited availability of temporary pumps to bypass the substantial amount of flow. A temporarily pipeline fix was provided by inserting a smaller-diameter fabricated-steel pipe into the existing concrete pipe and sealing the connections with sandbags, shotcrete, and oakum. The emergency repair process was completed in five days without a single spill outside of the immediate area of the break.

54-inch Diameter Sewer Collapse

Inspection and Repair Programs

Historically, sewer repair has been provided on a reactive basis in response to a system failure. To maintain the operation of the collection system, the City of Phoenix has been proactively assessing, repairing, and replacing pipelines for the past ten years. The City currently has four separate programs to provide a complete understanding of all the sewer pipelines within their system. Each program is designed to provide field investigation, condition evaluation, and recommendations for capital improvements to maintain uninterrupted operation of the collection system.

The City of Phoenix initiated its first condition assessment programs in 1992 with the Unlined Concrete Sewer Condition

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Assessment. The purpose of this program was to investigate the structural condition of unlined concrete pipelines, prioritize those sections of sewer requiring structural rehabilitation, and recommend preferred rehabilitation techniques. The project included identification of all unlined concrete sewers within the City's wastewater collection system, manhole condition assessment, inspection of 92,000 feet of unlined sewer, pipeline condition assessment, and prioritization for sewer rehabilitation over a five year period.

The second phase of the Unlined Concrete Sewer Assessment Program was completed in January 1999 and included 181,000 linear feet of sewer. The results of this program included development of a 10-year Capital Improvement Plan (CIP) to budget repair of the City's aging sewer infrastructure. This CIP included 32,000 linear feet of pipeline in need of immediate repair having a total estimated cost of $41 million, with an additional $75 million recommended for completion by the end of 2010.

150-mgd Bypass Operation During Pipeline Rehabilitation

Since 1998, the small-diameter program has utilized the City's Geographical Information System (GIS) to systematically rehabilitate pipes using Cured-in-Place Pipe (CIPP) technology. This approach allows the City to identify the optimum schedule for rehabilitation by comparing maintenance costs with sewer rehabilitation costs. The City can schedule the rehabilitation prior to serious maintenance issues, work with customers to minimize inconvenience, and reduce the likelihood of future disruption to sewer service in local neighborhoods.

In 1999, the City initiated the Large-Diameter Concrete Assessment program, which included all large-diameter clay pipelines. Providing services similar to the Unlined Concrete Sewer Assessment program, this project is in the final stages of investigating and repairing the large-diameter clay pipelines.

The third phase of the Unlined Concrete Sewer Assessment is currently underway and the City recently initiated an investigation of the large-diameter Lined Concrete Sewers.

Conclusion

"Out of site" is not always "out of mind". If ignored, aging infrastructure can seriously impact the community and the utility owner. Proactive investigation is the best way to ensure uninterrupted service and prevent negative impacts to public health and safety. The existing collection system is a valuable asset and systematic repair and replacement programs will extend the useful life of these assets. Of special concern is the high potential for failure of the unlined concrete pipe within the highly corrosive sewer environment. Within the City of Phoenix, an exponential rate of corrosion appears to have developed over the past ten years. This accelerated corrosion rate has mandated an extensive program to rehabilitate or replace most of the unlined concrete sewers.