United States
Environmental Protection
Agency

Water Engineering Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA/600/S2-85/131 Jan. 1986

EPA

Project Summary

Demonstration of Service Lateral Testing and Rehabilitation Techniques

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New equipment and techniques were used to repair service lateral piping in two sanitary sewer basins in Salem, Oregon. The object was to reduce infiltration and inflow (I/I) significantly. The project included identifying, testing, inspecting, and repairing the faulty piping.

The importance of repairing service laterals was well demonstrated. If these are faulty, particularly near the sewer main, repairing mains and manholes will do little to reduce peak I/I's. No single repair method was best for all service lateral installations.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Studies were conducted from 1981 through mid-1984 to determine how municipal sanitary sewers in Salem, Oregon, could be repaired to reduce infiltration and inflow (I/I). For many years, Salem's sewer system has collected large amounts of I/I during wet weather. These wet weather flows intermittently exceed the hydraulic capacities of the sewage collection and treatment systems, causing raw sewage bypasses into storm drainage systems, receiving streams, and occasionally onto city streets. Previous city efforts to correct these situations generally have not resulted in large demonstrable I/I reductions.

In late 1981, the city decided to repair the sewers in two small sewer basins and to measure the results carefully. Flows from the basins were monitored during the wet weather months before, during, and after repair work was done. Two sewer basins with large volumes of I/I were selected—the Skyline and the Missouri basins. Both drain to manholes where flows can be readily measured. The Skyline basin was chosen because most sewers there are constructed of rubber-ring-jointed concrete pipe similar to much Salem piping built since 1960. The Missouri basin was chosen because sewers there are built of concrete-mortar-jointed pipe similar to most sewer piping installed in Salem from 1940 to 1960.

For both basins, the project included identifying, testing, inspecting, and repairing faulty service lateral piping. These efforts required the use of new equipment and the development of new techniques.

Annual precipitation in Salem averages 40 in., 70 percent of which falls between November 1 and April 1. The topography of both sewer basins is low to moderately sloping. Red clay-loam soils of low permeability predominate. Winter rains result in groundwater levels near the ground surface. Since the percolation of precipitation into the deep soil strata is slow, most mid-winter precipitation runs off.

Both sewer repair projects were undertaken as cooperative ventures of the City of Salem, Westech Engineering, Inc., and Gelco Grouting Service. The City of Salem crews performed mainline TV inspections, smoke stesting, mainline grouting work, and manhole repair work. Westech Engineering, Inc., organized and guided both

projects, collected data, and prepared the reports. Gelco crews tested, inspected, and repaired service lateral piping.

The Skyline Basin Sewer Repairs

The Skyline basin is a 67-unit subdivision served by 2,584 ft of rubber-ring-jointed concrete pipe installed between 1964 and 1966, and 745 ft of PVC pipe constructed in the late 1970's. Almost all concrete sewer pipe had been previously tested and chemically grouted by city grouting crews; yet peak I/I flows measured 560,000 gpd during a storm in January 1982 at 3:00 a.m., when very little domestic sewage was contributed. When the sewers were eventually repaired, they still contributed 411,000 gpd.

Various investigations of pipe conditions were made. During the fall of 1981, flow monitoring and recording equipment was installed in the downstream manhole, and it has been maintained there during the wet weather months ever since. All sewer mains were TV-inspected, and each main joint was air tested. Only 15 faulty main joints were discovered. The sewers were smoke tested, but only one service lateral leak was found. Flows were measured at each manhole at night between 12:01 and 6:00 a.m. during storm periods to determine the amount of I/I contributed by each section of sewer main. I/I contributed by leaking manholes was also measured. The I/I entering mains and manholes was found to be small. Most service laterals were constructed of 4-in., rubber-ring-jointed, concrete pipe.

Property owner permission was obtained to install service lateral cleanouts adjacent to each house where leaking service laterals had been identified. Excavations were made by hand, and ABS plastic service cleanouts were installed. Next, plugs were inserted through the cleanouts, and a mainline packer normally used for mainline grouting work was centered over each service tee so that each service lateral could be air-tested. Of the 31 tested, 28 failed. Hydrostatic water tests were performed on each lateral at the same time. In all but one case, the hydrostatic test and the air test results were identical.

Next, the 28 faulty service laterals were TV-inspected by rodding a 1.5-in.-diameter TV camera down the service piping from the recently installed cleanouts. These inspections revealed service piping that was generally in good structural condition. Few visible leaks or broken pipes were discovered. These inspections raised suspicions that many service laterals were leaking at their connections to the sewer main. Thus the downstream 3-or 4-ft section of each faulty service lateral was isolated and air tested. Nineteen leaked. Because those faults were immediately adjacent to the main, they were considered to be major I/I contributors.

Repairs were subsequently made to the Skyline sewer system. Leaking manholes and joints in sewer mains were sealed by chemical grouting. Faulty service laterals were repaired with a variety of techniques, most of which involved chemical grouting. A new innovation, developed by Westech/Gelco and nicknamed "the snake," was used to repair most faulty service laterals. This equipment consisted of a flexible rubber cylinder that had a pneumatically operated apparatus to propel the unit through service lateral piping. The equipment was used to systematically isolate 7-ft sections of service lateral pipe, to perform air tests on the isolated piping, and to seal leaks using chemical grouting.

After the initial repairs were completed, peak I/I volumes of 150,000 gpd were measured—a 63-percent reduction from the original 411,000 gpd. In two sections of sewer main, only mains and manholes were repaired, not service laterals. This step was taken to see how repairing adjacent sewers affected the I/I collected by these two sewer sections. Although overall flows were greatly reduced, the I/I collected by these two sewers increased by 208 percent in one section and decreased by 43 percent in the other. Eventually, most of the remaining faults were repaired. Peak I/I flows from the repaired basin were reduced by approximately 92 percent.

Because initially the mains and manholes were relatively watertight in the Skyline basin, more than 90 percent of the peak I/I flow was attributed to the service laterals. TV inspections of sewer mains during high groundwater conditions revealed most faulty service laterals. The most significant service lateral faults were those immediately adjacent to the main, where sheared tees or leaking joints probably resulted from inadequate compaction of bedding materials beneath the service tee and service piping. During high groundwater conditions, some of these faults contributed more than 50 gpm I/I.

The cost of repairs to the Skyline sewer basin totaled about $70,000, not including the cost of flow monitoring, investigations for scientific purposes, report writing, and other similar tasks. Numerous difficulties were encountered in testing, inspecting, and repairing service lateral piping, but most of these have since been overcome.

The Missouri Basin Sewer Repairs

In the Missouri basin, 220 homes are served by 13,345 ft of concrete-mortar-jointed sewer mains installed in 1955 and 1956. Although investigations into the condition of the Missouri basin sewers began in the fall of 1981, repairs to this sewer system did not begin until 1983. The results of the work done in the Skyline basin had come to the attention of the U.S. Environmental Protection Agency (EPA) officials, who were interested in further developing and evaluating techniques and equipment for locating, testing, inspecting, and repairing faulty service laterals. EPA entered into a cooperative agreement with the City of Salem, offering financial aid for sewer repair work in the Missouri basin. A variety of techniques and equipment for service lateral work were to be used and evaluated as part of the Missouri basin repair program.

The investigations of the Missouri sewers paralleled the Skyline investigations. Beginning in the fall of 1981, flow monitoring and recording equipment was installed in a manhole at the downstream end of the sewer basin, where it has since been maintained during the wet weather months. Smoke tests were conducted and revealed seven leaking service laterals and several apparent interconnections with storm drainage piping. All sewer mains were inspected, revealing 33 leaking service laterals, 129 visibly leaking main joints, 26 holes in main pipes, 101 broken pipes, and 46 root intrusions. Night-time wet weather flow measurements were made to determine the amount of I/I entering each section of sewer pipe.

Major system repairs began in October 1983 and were completed by May 1984. City crews chemically grouted sewer mains, repaired faulty manholes, dug up and replaced broken pipes, and made other repairs where excavation and backfill were required. Gelco Grouting Service crews tested, inspected, and repaired service lateral pipes. Night-time flow measurements had revealed that some sections of sewer pipe contributed very little I/I. Consequently, little or no repair work was performed on those sewers. Of

the 68 sections of sewer main, 47 were chemically grouted.

Likewise, service laterals were tested and repaired in selected areas only. Eighty-six service laterals were tested, and most were repaired. Every service lateral connection at the main failed an air test and was sealed. Numerous dead tees and abandoned service laterals were sealed off.

Where service lateral work was to be done, permission from property owners was obtained to install cleanouts and to make repairs to private service laterals. Work on private service lateral pipes was done at city expense because of the experimental nature of the project. Access to service laterals was gained in one of these ways:

1. By installing a cleanout, usually adjacent to the house.
2. By excavating and sectioning the service lateral pipe, usually near the property line.
3. By using the Cues Lateral Sealing System* from within the sewer main.

Service lateral inspections was made using a 1.5-in.-diameter TV camera rodded through the pipe. Most service laterals were air-tested using a double-ball air test unit developed for the project. Service lateral repair methods included chemical grouting using the Cues Lateral Sealing System or the Westech/Gelco snake, installation of polyethylene liners, installation of Insituform liners, and replacement. Many service lateral pipes in the Missouri basin were in very poor condition and could not be repaired by chemical grouting.

Sewer repairs in the Missouri basin reduced peak I/I flows from 1.6 million gpd to approximately 386,000 gpd at a cost of about $375,000.

Findings and Conclusions

The Skyline and Missouri projects revealed a great deal about effective repair of sewer systems. Some lessons and conclusions are listed as follows:

1. Sewer repairs should be done by sewer basin to reduce I/I. During wet weather, stormwater and groundwater gravitate into and collect in the backfilled sewer trenches. The granular bedding materials and pipe zone materials usually allow this water to move freely along the sewer trenches outside the sewer pipe. Even a few sewer faults can allow large amounts of this trench water to enter the sewers. This trench water can and often does flow into service lateral faults several feet from the main. Because the water moves easily along the old sewer trenches, repairing only the obvious leaks usually causes the level of the trench water to rise somewhat, thereby causing it to migrate into other sewer system faults.
2. The importance of repairing service laterals was well demonstrated. If these are faulty, particularly near the sewer main, repairing mains and manholes alone will do little to reduce peak I/I.
3. Sewer repair needs to be a comprehensive program. Flows from the basin selected for repair need to be measured during wet weather before, during, and after repairs are made so that the effectiveness of the repair program can be determined. The repair of all faults initially identified is not usually sufficient to greatly reduce I/I flows. Usually a few major undetected faults are discovered after initial repairs are made. When these faults are prepared, I/I flows are dramatically reduced.
4. Rubber-ring-jointed piping systems are usually easier and less expensive to repair than older mortar joint systems where more extensive repairs are necessary. Because of the granular backfills, some newer sewer systems contribute more I/I per foot of sewer main than do the older, more delapidated sewer systems.
5. Repairing sewer systems and effectively reducing I/I is challenging, difficult, and demanding. To do it successfully requires both know-how and persistence.
6. Quality control is extremely important in repairing sewers. Many repair difficulties encountered in these two basins were caused by repair efforts (particularly chemical grouting work) that did not adequately seal the pipe and manhole faults.
7. Relatively little experience has been gained in testing, inspecting, and repairing service laterals. The following observations have been made about service lateral work.

   a. *Locating faulty service laterals.* Smoke testing identified less than 10 percent of the faulty service laterals. TV inspection of sewer mains located most leaking service laterals when the work was performed during periods of high groundwater. Approximately 40 to 50 percent of the service laterals in the Skyline system leaked. Locating leaking service laterals by TV inspection of mains in newer rubber-ring-jointed piping systems appears to be reasonably efficient. In older, mortar-jointed sewer systems such as the Missouri system, nearly all service laterals leak. Thus the most feasible approach to such a system is to systematically air test all service laterals or to replace or repair all of them without preliminary testing.

   b. *Access for testing, inspecting, and repairing.* Service lateral cleanouts have several advantages. The most important is that access for testing, inspection, and repairs is available as needed over an extended period. Excavation and sectioning of service lateral piping usually affords the best access for testing, inspection, and repairs, but the excavation usually cannot be left open for an extended period. Consequently all testing and repair must be completed with a few days—often a difficult accomplishment. Access from within the sewer main using the Cues equipment requires no excavation and no contact with or consent from property owners. However, only the few downstream feet of service lateral pipe can be entered, tested, or repaired.

   c. *Inspection and testing methods.* The small-diameter TV camera equipment provides a reasonably good visual inspection of service lateral pipes. Visual inspection is usually necessary to determine how repairs should be made. Several methods were used for leak testing service piping. The hydrostatic test is somewhat

*Mention of trade names or commercial products does not constitute endorsement or recommendation for use

slow. Air testing from the main to the service lateral cleanout is better, but it does not locate the service leaks. The double-ball air test unit provides rapid and accurate testing if a cleanout or excavation for access is available. This method locates pipe leaks but cannot test the connection to the main. The Cues Lateral Sealing System tests the connection to the main but cannot test farther than 6 or 8 ft upstream.

d. *Repair methods.* No single repair method was best for all service lateral installations. Each faulty service pipe installation had to be inspected, and pipe conditions, configurations, depths, and surface conditions were considered before a repair method was selected. In many cases, replacing service piping was least expensive and most desirable. Where the existing pipe was relatively straight, polyethylene liners were competitive in price with other repair methods and caused little disruption of surface facilities. The Westech/Gelco snake was best used where service piping was structurally sound with only a few leaking joints. Grouting these joints is usually less expensive than other repairs. The Cues Lateral Sealing System is especially applicable where sewer mains are deep or inaccessible and where the service lateral piping is structurally sound. Insituform liners may in time become an excellent method for service lateral repairs, but technical problems must be resolved before this method can be widely used.

The full report was submitted in fulfillment of Cooperative Agreement No. CS-811117 by the City of Salem, OR, under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Demonstration of Service Lateral Testing and Rehabilitation Techniques," (Order No. PB 86-135 647/AS; Cost: $16.95, subject to change) will be available only from:
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