CRITERIA FOR AN EFFECTIVE SERVICE LATERAL RENEWAL PROJECT UTILIZING TRENCHLESS TECHNOLOGY

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ABSTRACT

Service lateral pipes are similar in many respects to the mainline pipe. Similar in that both are typically constructed of the same materials, they are generally old, structurally damaged and a major source of infiltration. In 1992, 17 states reported 34 major water born disease outbreaks affecting 17,000 people. A draft report for the Environmental Protection Agency obtained by U.S. News found that more than a million Americans become ill each year from sanitary-sewer overflows. A 1999 report from the American Society of Civil Engineers indicates that the nation's 500,000 plus miles of sewer lines are 33 years old on the average. However, many cities today are maintaining and operating a wastewater collection system with sections that are nearly 100 years old or more. As much as 70 percent of the system's infiltration can originate from faulty house service laterals. Vast amounts of data are being compiled and more and more of the SSO's (sanitary sewer overflows) are being contributed to faulty service lateral pipes in wastewater collection systems. The US Environmental Protection Agency in conjunction with the Water Environment Federation (WEF) has been aggressively initiating Capacity Management, Operation and Maintenance (CMOM) implementation workshops. CMOM is part of the SSO's rule that will affect ALL wastewater collection systems and ALL wastewater collection system owners will be required to comply. Laterals offer new challenges for the maintenance and operation of a collection system. The significance of maintaining service lateral pipes is increased when the responsible agency initiates a program for CMOM compliance. The condition of old lateral pipes today exist for many reasons though a major factor is a direct result of typical installations without any engineering, specifications or inspection.

A service lateral is a small diameter pipe, with multiple bends where transition in pipe diameters is common. Entry into a lateral pipe is another factor where easy access simply does not exist. Access is usually gained through an existing clean-out or remote access from the mainline up into the lateral pipe. In either case, accessing lateral pipes is generally poor and very limited making rehabilitation very difficult.

INTRODUCTION

Due to the high cost of traditional excavation repairs, cities and towns throughout our nation are making pipe rehabilitation a high priority issue. Finding the most cost-effective and the longest-lasting method of repair is crucial while affordably maintaining the complex web of underground utility service systems. It is understood that dysfunctional pipes are hazardous to our environment and society in general. Defective pipe sections allow groundwater infiltration and subsidence of trench backfill and root intrusion, causing sewer backups, collapsed sewers as well as the roadways above. The result is taxpayers spending millions of dollars each year on sewer back ups, street repairs and EPA imposed fines.

However, in the final analysis the primary concern is finding an acceptable method of repair that has a long lasting design life, is a permanent repair, and has been proven.

What is the Goal of a Lateral Renewal Program?

- Eliminate tree root intrusion
- Stop subsidence of trench backfill
- Restore structural integrity of the lateral pipe
- Stop infiltration of ground water into the system
- Reduce monetary expenses by minimizing social cost
- Seal the system by creating a VNLC (verifiable non-leaky connection) between the main and lateral pipe
- Eliminate and control basement back up caused by faulty laterals and connections
- Eliminate and control (SSO's) sanitary sewer overflows caused by faulty laterals and connections

The Renewal Of Lateral Pipe Segments Is Unlike The Renewal Of Mainline Pipe Segments.

Mainline Pipe Segments

- Typically do not have changes in diameter
- Good access is available at each end via upstream and downstream manholes
- Typically do not have bends or fittings but are primarily constructed in a straight line
- Typically range in sizes of 200mm (8 in.) and larger offering simplified methods of pipe renewal
- Installations were constructed under an engineered program with on-site inspection

Lateral Pipe Segments

- Typically have multiple bends with multiple fittings
- Are small in diameter ranging from 75 mm (3 in.) to 150mm (6 in.)
- Oftentimes are constructed by local plumbing contractors with little or no inspection
- Do not have access points other than the mainline connection and possibly a clean-out
- Commonly change in diameter with transitions found at the foundation or property line
- Usually have defective connections due to "break-in" installations, which oftentimes protrude severely

Lateral Renewal - What Works, What Does Not And Why?

There are many types of delivery systems used today for lateral renewals. Some systems are proprietary and some are generic. Specifying Engineers and Public Utilities associated with the public bidding process must recognize that a proprietary process contains techniques, materials, methods and trade secrets, which provide advancements that, can significantly enhance the end product. These advancements are "non-generic" and are protected under patent laws. Most proprietary systems offer true advancements for a superior end product. However, that is not the case for all systems. Education of Trenchless Lateral Renewal Techniques will set uniform standards, which require methods that are effective and long lasting for rehabilitating subterranean pipes. In order for this to be achieved, the specifications must require systems that maintain the highest quality end product throughout the installation process and are ***proven through field-tested procedures.***

Cured-in-place pipe in general remains a relatively consistent and uniform product when tested in a laboratory or controlled environment. However, the installation process and materials used are the most important factors in determining the quality of the end product for an effective pipe renewal process. Methods of installation, or "delivery systems" are critical, especially when considering the difficulties encountered with lateral renewals as previously outlined.

The following information is a brief description of the current CIPP (cured-in-place pipe) methods being utilized in the art of renewing lateral pipes:

The most common practices currently in use and previously used in the past decade consist of creating an access point upstream of the mainline pipe. An excavation is performed creating an entry pit whereby the lining is introduced into the lateral pipe segment. This method allows for the lining to be inserted upstream and downstream. The lining tube may be introduced into the pipe by one of the following methods:

A Pushing Action Using Connecting Rods
The concept is to push the liner until the forward end is aligned with the point of termination such as the mainline junction. This method is limited to shorter lengths and is expressly relevant to the friction of the host pipe's interior. Pushing rods are also limited by defects, bends and fittings in the lateral pipe.

A Pull-In Process Using a Cable and Winch
This method is also limited to length due to the friction that is inherent in the host pipe as well as bends and fittings. Though more force can be achieved with this method, it should be noted that excessive force could stretch and damage the lining. Stretching causes damage to the liner as the lining tube elongates with the stretch, the walls become thinner, significantly reducing the structural integrity of the finished product. In addition, the diameter is reduced and the length of the tube increases. Once the liner is aligned with the mainline junction, shrinkage will occur as the lining tube is inflated, drawing each end of the lining tube towards the other. Further case studies have shown that such winching methods can cause extensive damage to the mainline pipe. In instances where tremendous force was exerted, as much as one foot of the main pipe has been cut away when utilizing a cable and winch method.

An Inversion Process Using a Water Column or Compressed Air

Inversion installation systems are the most widely accepted for introducing the lining tube into a lateral pipe. Installation of the lining tube is not restricted by friction of the host pipe since the tube is unrolled over itself as it projects forward. This delivery system is suitable for lateral pipes with multiple bends or fittings. Although the lining is not pushed or winched into the pipeline, the lining tube can still be damaged during the inversion process. Fittings are the root of all evil when designing a lateral renewal project. There are many different configurations of fittings. The older vitrified clay tile fittings were typically constructed with a sweeping bend. Newer VCP and PVC fittings are commonly mitered sections of pipe that have been fused together to form various degrees of blunt angles within the interior of the fitting. These newer fittings and ninety-degree bends provide installation complications that can result in a defective cured-in-place pipe. ***Excessive pressures may be exerted on the lining tube during efforts to invert the tube through these fittings that can significantly affect the end product as previously outlined.***

PRESSURE DURING INVERSION

A lining tube is pressurized through its interior face with the forward end turned over the remaining tail and is commonly referred to as the "cuff". The cuff is fastened onto the open end of a launching device such as a lateral inversion tank or a scaffold with a down tube. The internal pressure causes the portion of the lining tube with the least resistance to unroll or invert, hence the term "inversion". As internal pressure is increased, either the turned over forward end will invert or the tube will fail by rupturing. The failure or the rupturing of the lining tube is usually not a major concern. With this example, the primary concern is for the loss of resin due to high inversion pressures. The pressure used to invert the tube also squeezes the portion of lining tube that lays flat within the launching device during the inversion process. The lay flat portion lies within the inflated portion that is currently in contact with the host pipe or may be within the launching device. The squeezing affect presses the liquid resin forcing the resin to seek the path of least resistance. The liquid resin exits the lining tube through the forward end thus weakening the structural properties of the soon to be cured-in-place pipe. Laboratory testing must be performed on the end product of an "in-field" installation. However, as previously mentioned, lateral pipes do not offer good access making the retrieval of a sample impractical or in most cases, impossible. The above information discusses the need to use high pressures to negotiate fittings and the affects that high pressures produce for an end product. See the section "In-Field Testing and Inspection Procedures" to verify a high quality end product.

METHODS

Other methods currently in use for nearly a decade also utilize an inversion delivery system whereby the inversion begins within the mainline pipe. These methods are addressing and correcting the lateral pipe and the connection at the mainline. The lining tube configuration and installation may consist of one of the following:

Pull-In And Inflate With A Rim Type Seal To The Mainline

This method is similar to the pull-in process using a cable and winch. However, three significant differences exist. One, is the location of the winch providing the pulling force. The second is that the lining tube exhibits a twisting action during a change in direction as it moves from the mainline into the lateral pipe. A twisted cured liner is obviously a failure. Unfortunately, it is not possible to inspect and verify the condition of the liner using this method. Therefore, the installer and inspector will receive this information once the liner is depressurized and inspected with an

internal video camera. Either the liner will be smooth and open or twisted and partially to completely closed conforming to the shape of a bowtie. The third difference is that attention is focused on making a seal or VNLC (verifiable non-leaky connection) at the mainline.

Inversion Up Into the Lateral with a Rim Type Seal to the Mainline
The positive and negative affects of inverting a cured-in-place pipe as described above apply to this method of installation as well. However, two differences do exist. First, the liner is remotely installed utilizing an inversion technique from the mainline. Secondly, attention is focused on making a seal at the mainline.

Adhesion Required Rim Type Seals
Methods utilizing a rim or collar shaped connection depend solely on adhesion for the seal. The rim or collar must adhere to the mainline interior. Most all cured-in-place pipes consist of an interior film coating. The liner tube is typically constructed of needle-punched felt and the coating is typically extruded or spread onto the felt. These rim type connections are usually affixed to the coating on the inner side of the mainline liner. Various resins such as polyester and epoxies are used to affix these rims. Various compounds for coatings are used such as vinyl, urethane or polyethylene. It is difficult to verify the effectiveness of adhesion between the rim and the film coating. In fact, there is no known resin capable of effectively creating a seal with polyethylene. For this reason alone, polyethylene coatings should be banned as an approved coating for cured-in-place pipe.

The objective is to seal the collection system. Considering that the manholes, mainlines and laterals have been renewed, the results should be a significantly sealed system. By significantly sealing the system, the ground water table rises above the previous level where infiltration existed. As the water table rises, additional hydrostatic force is exerted and the main to lateral seal based on adhesion only must not fail. If the coating applied to the felt or the resin adhering the rim to the coating delaminates, then the seal is broken and the collection system leaks.

Self-Supporting Full Circle Seal
Methods utilizing a full circle seal at the connection depend on adhesion and pipe stiffness as the full circle seal is accomplished with a cylindrical shaped sleeve. The area of adhesion between the mainline coating and the cylindrical sleeve is typically ***no less than 400 mm (16 in.)*** in length or 125 mm (5 in.) ***either side of the lateral opening***.

The objective is to seal the collection system while restoring and providing structural integrity to the defect area. Considering that the manholes, mainlines and laterals have been renewed, the results should be a significantly sealed system. The sealed collection system leads to the ground water table rising above the previous level where infiltration existed. As the water table rises, additional hydrostatic force is exerted and the main to lateral seal based on adhesion and the pipe design for the mainline sleeve portion must not fail. The cylindrical sleeve is pressed tight against the coating applied to the felt and the wall thickness of the sleeve and is designed for the pipe diameter and known conditions. Resin migration during installation and adhesion from the resin create a VNLC, while the cylindrical shaped sleeve provides a structural seal.

MATERIALS

For twenty-plus years, polyester resin has been the most widely accepted resin for the cured in-place processes. Recently the EPA has focused heavily on industries utilizing this type of resin because of the contaminants, namely styrene that is contained in the raw materials. Some of the industries that have come under fire are companies who manufacture recreation vehicles, boats, campers and pipe manufacturers. Because of the severity, the EPA has now issued standards for industries that utilize styrenated materials and are requiring them to reduce the use of and/or emissions of this material due to the extreme contaminants associated with it. The cured-in-place pipe industry is currently not affected by these EPA regulations. However, homeowners are of major concern during renewal of lateral pipes. Many plumbing fixtures have what is commonly called a "dry trap". A dry trap allows not only sewer gas to enter the home but also any volatile organic chemicals that may be being used during pipe renewal projects. A newly developed polyester resin is now available that provides a better end product while eliminating the emissions of severe contaminants associated with standard lining practices. A better end product is produced primarily because the resin contains no solvents or styrene. Styrenated resins are made up of nearly forty-percent styrene. During the curing process, solvents are depleted when using traditional polyester resins for cured-in-place applications. Materials that are depleted result in a reduction of the remaining solid materials thus creating shrinkage in the cured-in-place pipe that can create a significant annular space between the liner and the host pipe.

Various types of materials are used for the substrate in creating a lining tube for lateral renewal methods. The total ounces of fabric per square yard and the thickness of the coating on the fabric are unlike what is typically used for mainline renewal methods. It is essential that the materials used are compatible with the method used for renewing a lateral pipe. The lining tube must be capable of inverting through pipe diameters from 75 mm (3 in.) to 150 mm (6 in.) while negotiating fittings and transitions of pipe diameter.

In-Field Testing Procedures

Verification of a proper installation can be accomplished by requiring video documentation before, during and after the installation procedure. However, this can only be achieved when an inversion technique is used. The lateral must be video inspected and documented prior to inserting the liner. This provides adequate verification that the pipe has been properly prepared for renewal. During the entire inversion process, the lining tube must be video inspected and documented for the following reasons:

- Ensuring the liner fully conforms to the host pipe
- Ensuring that the resin is not pressed out of the lining tube at its forward end.
- Ensuring the liner is not placed over any foreign object such as broken tile.
- Post-Lining Video Documentation is essential; it is the only documentation for the renewed pipe.

Further requirements to ensure the highest quality end product lies in the low pressure installations. The lining tube should not exceed 34.5 kPa (5 psi) during inversion in a straight pipe segment and pressures should not exceed 68.4 kPa (10 psi) during inversion through pipeline segments with ninety-degree fittings as stipulated in the section covering **"Pressure During Inversion."**

Air testing is a critical step in order to verify the integrity of the seal at the connection. Air testing is typically performed by inserting a plug at the clean-out and either side of the lateral connection and introducing 27.6 kPa (4 psi) for a period specified by the diameter and length of pipe. If each lateral pipe has been renewed, the mainline plugs may be placed at the upstream and downstream manholes allowing the entire reach to be tested simultaneously. These test methods verifies a non-leaking connection has been made at the lateral to main interface, typically referred to as a VNLC (verifiable non-leaky connection).

Who Has A Current Lateral Renewal Program In-Place?

- Nashville, Metro, Tennessee
- Dupage County Public Works, IL
- Glenview, IL
- South Palos Sanitary District, IL
- Village Of Highland Park, IL
- Broward County, FL
- Boston Water And Sewer Commission, MA
- City Of Portland, OR
- Woodland, CA

DUPAGE COUNTY PUBLIC WORKS

Dupage County started their lateral renewal program several years ago at Brookhaven subdivision in Darien, Illinois. The first attempt of their program began by utilizing a pipe bursting process. Difficulties encountered included the inability to negotiate bends in the lateral pipe. To compensate for this inability, the contractor excavated at the main/lateral connection, the foundation and at every bend throughout the pipe segment. Oftentimes, the lateral pipe is not accessible at the foundation due to porches, driveways, patios, garages and building additions, which further complicates the rehabilitation process. In addition to the challenges already outlined, the potable water lines were being damaged in the process due to the fact that they were typically found in the same trench as the sanitary lateral. As a direct result of the extremely high social costs and multiple excavations on a so-called “trenchless project” the county terminated the contract after one year of disasters and constant public complaints. Mr. Jim Fucilla, assistant to the Director of Public Works stated the subdivision (Brookhaven) “looked like a battlefield”. At the time this particular phase was cancelled, the project far exceeded the engineer’s estimate and was never completed.

Their second attempt for a lateral renewal program relied on a directional boring technique. The second program was also riddled with complications, failures and infuriated residents. One problem with the procedure was inaccurate boring. This occurred due to multiple bends and large rocks that caused the boring head to veer off course. Further complications in the program resulted in damaged storm sewers and potable water lines. After repeated failures and multiple excavations the residents were outraged. The seriousness of the public outcry escalated when the Illinois Department of Public Health mandated separation of sanitary sewer laterals and potable water lines. The mandate only applied when an excavation was necessary and the potable water line and sewer lateral were exposed on private property. Due to the many complications and multiple failures, the contract was once again terminated.

Their third attempt for renewing laterals, basically was to excavate and replace knowing in advance the amount of disruption that would follow. However, prior to the specifications being let for bidding, Performance Pipelining, Inc. discussed an alternative method with the county. After researching and evaluating other comparable lateral projects of Performance Pipelining, Inc., the county agreed to allow the alternative for a cured in-place lateral renewal system utilizing both, the T-Liner™ and the Performance Liner® lateral lining processes.

The engineer's estimate to finish the remainder of the project was approximately $630,000.00 for the renewal of the remaining fifty service lines to be replaced from the mainline to the building foundation including the transition from six-inch clay tile to four-inch cast iron pipe. Performance Pipelining, was the successful low bidder at $486,000.00. Performance Pipelining, completed this project while battling some very adverse weather conditions with temperatures as low as zero degrees. The project was completed successfully and under budget.

Nashville Metropolitan Sewer District
Nashville Metro is letting approximately one contract per month for the renewal of mainline sewers, manholes and lateral pipes. Nashville has a unique approach whereby a majority of the system is being renewed, sealed and verified through an air-testing program. Nashville's program consists of renewing the upstream and downstream manholes, the mainline, and every service lateral within a given line segment. A clean-out is installed at the property line and the lateral is renewed up to the clean-out. Once the installations have been completed, the entire system is tested. The manholes are vacuum tested and the mainline and lateral pipes are subjected to a 4 PSI air test. Nashville will not accept chemical grout as a permanent repair for sealing the collection system.

Boston Water and Sewer Commission
The commission set forth a project located at the Boston Naval Ship Yard. This project consisted of renewing mainline sewers, manholes, and service laterals utilizing trenchless techniques. What makes this project unique is that the lining had to be scheduled between incoming tides. The entire collection system surcharged daily as the tide came in. A dissertation by Ms. Irene McSweeney of the Boston Water and Sewer Commission was presented at the NASTT No Dig 2000 that provided detailed information relevant to this project. As of June 2002, with all current information available, an exclusive project where trenchless techniques was utilized and one hundred percent of the existing infiltration was successfully removed.

CONCLUSION
In conclusion, a majority of all wastewater infrastructure failure is a result of faulty service lateral pipes, which in turn augments sanitary sewer overflows. As previously noted, CMOM is the US Environmental Protection Agencies solution to enforce and police the upgrade, repair or renewal of our Nations Wastewater Collection Systems. In order for a collection system to be in compliance, a successful pipe renewal program will be required which will in turn require lateral renewal projects that address both the service lateral pipe and the connection between the main/lateral pipe. Today, proven technology is available for the renewal of service lateral pipes providing a solution for collection system owners in their search for CMOM compliance.

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