The North American Society (NASTT) and the
International Society for Trenchless Technology (ISTT)
International No-Dig Show 2009

Toronto, Ontario Canada
March 29 – April 3, 2009

Paper D-4-04

# SERVICE CONNECTIONS UPGRADE ON A STRUCTURALLY REHABILITATED WATER MAIN

Kamran Sarrami[1] and Ben Côté[2]

[1] Sr. Engineer, City of Toronto, Toronto Water, ON, Canada
[2] Vice-president, Sanexen Environmental Services Inc., Montreal, QC, Canada

**ABSTRACT**: In the summer of 2008, 19.3 km (12 miles) of water mains were structurally rehabilitated in the City of Toronto. The scope of the project included the upgrade of substandard service connections (i.e. constructed of non-copper material (lead) or water service less than 19 mm (3/4 inch) in diameter and not meeting the minimum acceptable flow) in addition to cleaning and lining of water mains. This paper will present why the City opted to upgrade thousands of service connections while structurally rehabilitating the water mains. The paper will describe the methods used and how new services were tapped into the lined main.

## 1. INTRODUCTION

The City of Toronto is the largest city in Canada with a population of over two million people. Toronto is one of the major economic and cultural center of Canada. As other North-American metropolis cities, Toronto has deteriorating infrastructures and buried assets that are in desperate need of attention.

The City of Toronto maintains and manages five hundred bridges, 5,600 kilometers (3,500 miles) of roads, 4,600 km (3,000 miles) of water mains and 10,000 km (6,200 miles) of storm, sanitary and combined sewers. Some of Toronto's water mains reach a venerable 120 years old and are in desperate need of rehabilitation to retain expected quality of service. As in many old installations, the water services are of smaller diameter and were often made of non-copper material such as lead.

In July 2007, City of Toronto Council approved a new Lead Water Service Replacement Program to accelerate the replacement of approximately 65,000 lead water services over the next nine years within public road allowances, which extend from the watermain to the property line. The replacement of the privately owned section of the water service connection beyond the property line extending into the home, is the responsibility of the homeowner.

It is the object of this paper to present how the City of Toronto has incorporated the upgrade of the service connections in their trenchless rehabilitation of water mains program. The paper will explain how a 19.3 km water main rehabilitation project was carried out, the methods used and the economic benefits of combining the upgrade of services with the trenchless rehabilitation of the water mains.

## 2. THE CONTRACT SCOPE OF WORK

The City issued two Tenders on February 21, 2008 and March 18, 2008 for the rehabilitation of 19.3 km (12 miles) of water mains. The diameters of the water mains are mostly 150 mm (6 inch) with some 200 mm (8 inch). The Tenders included the upgrade of approximately 1900 services. Most services were made of materials other than copper (mostly lead). The Tenders called for trenchless method and for a structural lining CIPP system as per ASTM F1216 appendix X.1 design.

The scope of work included the installation of a temporary by-pass system, disconnection of sub-standard services, structural lining of the main pipe, tapping new services into the lined pipe and restoration of the site. All of the work had to be performed at the same time as the property owners were on temporary by-pass.

In order to achieve all the above, the lining technology used had to allow for tapping of new services into lined pipe while assuring water tightness of the new tap. This was the case with the lining technology used in this project.

The contracts were awarded in April 2008 to Fer-Pal construction Ltd. of Toronto. The Aqua-Pipe structural lining system developed by Sanexen Environmental Services Inc. (Quebec, Canada) was used to structurally rehabilitate the water mains.

## 3. MOTIVATION FOR UPGRADING SERVICES COMBINED WITH REHAB OF WATERMAIN

Lead pipes are becoming an issue in Toronto as well as other North –American cities that were developed in the post WWI demographic boom. Under the non-regulated testing program that was initiated by Toronto Water above MOE requirements (these are tests completed at the request of a resident), Toronto Water has collected and analyzed 8,113 water samples, from June 2007 to October 5, 2008. Water service connections with a lead test result above the Ministry of Environment (MOE) maximum of 10 parts per billion (ppb) will be replaced on a priority basis. The property owners that have a lead exceedance are advised by Toronto Water in writing for replacement of their service in a priority sequence. All other results (less than 10 ppb) will be replaced through the Lead Pipe Replacement Program over the next nine years.

Most homes in the proposed area for rehabilitation in the two contracts were built before mid-1950s and are more likely to have 12mm (½ inch) diameter lead pipe service line which is inadequate to supply sufficient amount of water. Homes built between the mid-1950s and 1989 may have lead from some fixtures or from solder used to connect pipes. Homes built after 1989 are unlikely to have any lead pipes, services lines, or solder or joints. The current Plumbing Code in Ontario prohibits the use of lead-based solder.

By combining the upgrade of the services with the lining of the water mains and replacement of valves and fire hydrants, it allows to completely renew the water distribution system in an area thus minimizing service interruptions and the impact on the communities. This means less risk of future breaks and emergency intervention for the Toronto water.

## 4. REHABILITATION OF THE WATER MAIN

The structural rehabilitation of the water mains was performed using Sanexen's Aqua-Pipe technology. Toronto Water started employing the Aqua-Pipe technology in 2004 and has rehabilitated over 50 km (31 miles) of water mains using this technology. In order to make sure

that Aqua-Pipe would perform in accordance with manufacture's specifications, Toronto Water carried out an independent study of the liner through the University of Waterloo's Center for the advancement of Trenchless Technologies (CATT). The results were satisfactory and a paper was published/presented at 2006 No-Dig Conference ("Third Party Evaluation of the Aqua-Pipe Watermain Rehabilitation Product", Dr. Mark Knight, and Kamran Sarrami, P. Eng.).

The structural rehabilitation of water mains involves a number of steps that are executed in sequence as they would be in any other water main lining project. These steps include the installation of a temporary drinking water by-pass system; the excavation of access pits in pre-determined places; cleaning the water main; lining and restoration.

In a normal structural lining project, the specialized contractor will, after the line has been cleaned, locate and insert plugs in services in order to prevent the migration of resin up the service lines. Then, the lining and curing of the liner can proceed normally. The final lining step, after the line has been pressure tested, would be the opening of the services from within the lined pipe using robotic cutters.

However, in this project, since the services are to be upgraded, some changes were made to the typical execution sequence.

Prior to lining the pipe, all the services were milled flush with the inside wall of the pipe. The milling was performed without excavation by using a remote controlled robot equipped with a milling head. The result is a smooth surface on which the structural liner will adhere. Milling of the service is necessary to increase the contact surface of the structural liner to the wall of the pipe. The liner thus covers the old milled service and reduces the risk of any leaks though the old main stop in the future dramatically.

The final step of the lining sequence is the hydrostatic test of the lined pipe. Lined sections of pipe are tested under hydrostatic pressure equivalent to 120% of the lines normal operating pressure. Rehabilitated water mains that have been structurally lined are not recommended to be tested as a new pipe. The reason is that composite liners will have a tendency to expand under pressure thus creating excessive stress on the host pipe.

Once the old pipe has been lined, and tested, upgrading of the services may begin.

## 5. INSTALLATION OF NEW SERVICES

In order to upgrade the sub-standard services, the services have to be located. Finding the service may involve several steps.

First, the outside curb stop has to be located. Sometimes it may be visible, but most times it will have to be located using different technologies such as acoustic correlation or metal detection. Next, an in-house inspection was performed to find out service material, size, location, water meter, availability of garden tap and etc.

The in-house inspection, although putting an extra burden on the planning of the contract execution, actually led to savings for the City since it prevented any unnecessary digs (i.e. where services are already copper or upgraded but are not recorded in the City's data base).

Finally, pre-lining CCTV inspection confirms the location, size and material of the services.

Once the sub-standard service is located, a small excavation is required in order to disconnect the old service at the water main. Upon disconnection, a new service is tapped in the host pipe. In this project the pipe material was cast iron.

The new services are taped directly in the lined pipe following the liner manufacturer's procedures. The new service is installed using an appropriate size service saddle. The saddle is attached to the main and the corporation stop is threaded into the clamp. In the case of Aqua-Pipe, the taping procedure involves the use of a taping machine either manual or electric, fitted with a taping bit of the appropriate size service. This bit is used for taping through the wall of the cast pipe. Once the wall of the host pipe has been drilled, the bit must be replaced with a shell cutter of the appropriate size for the service. The shell cutter must be new or undamaged. The shell cutter is used to cut open the service through the liner.

Once the service is tapped in the lined pipe, the new copper service pipe is connected to the new corporation stop and the line is replaced from the water main to the service box.

## 6. ECONOMICS

The City of Toronto opted to upgrade the services connections as part of a trenchless rehabilitation of water mains contracts. This implies that extra costs were incurred for the upgrade of the services.

It is a well know fact that trenchless rehabilitation of water mains allows asset managers to make important savings as opposed to open cut replacement. However, when upgrading services in the same contract, these savings might not be as obvious. This section details the cost analysis that was made after the contract was executed, in order to demonstrate the cost savings in such circumstances.

The project included 19.3Km of watermain lining, replacement of fire hydrants, replacement of valves and replacement of sub-standard services. The project was awarded in two contracts based on geography. The re-lining and service replacement costs were $9.4 million CDN and $6.7 million CDN, respectively. The average cost of lining was approximately $450/m including temporary restoration, fire hydrant and valve replacements comparing to $900/m open-cut. However, as for indirect costs that are not considered in the above figures, the City was able to upgrade water distribution system much faster (i.e. surveys, designs, duration of work, employing the same alignment and etc.) with less impact and disruption to communities and businesses.

As for the replacement cost of water services, there are no significant advantages between replacing the services in conjunction with lining verses open-cut since all services in a street are upgraded and the main is not in commission. The average cost of replacing the services was approximately $3,500/service.

Although the in-house inspection added an extra step on the planning of the contract execution, it actually led to some savings for the City in terms of efficiency, identifying all standard and non-standard services and money since it prevented 353 unnecessary digs (i.e. where services are already copper or upgraded but are not recorded in the City's data base) and capturing 238 lead services that were not identified to be replaced.

## 7. CONCLUSION

Upgrading sub-standard service connections at the same time as rehabilitation a water main proved to be advantageous. The lead replacement and cost savings are a great motivation to performing the upgrades. Furthermore, the City will have a new distribution system with less risk of having future breaks at the water services as well as at the main. Finally, the impact on the

clients is reduced to one single intervention as opposed to performing multiples construction activities in consecutive years.

However, combining upgrades with re-lining of the water mains can become a planning nightmare if communication and coordination between all parties (contractor, sub-contractor, property owners, other City department and etc.) involved is not carefully reviewed and thought out. Also, upgrading will have an impact on the length of the project schedule. Finally, digging at every service leads to many cut repairs to front lawns, sidewalks, curbs and asphalt.

Table 1. Advantages and disadvantages of combing service upgrade to lining contracts

| Advantages | Disadvantages |
|---|---|
| • New water distribution system (eliminating possibility of watermain breaks and leaky services)<br>• Less impact on communities (one service disruption)<br>• Eliminate lead services<br>• Tap directly in lined pipe | • Requires more planning (longer time required to complete the project, coordination with other projects)<br>• More contact with property owners (requires excellent public relation and communication protocols)<br>• More cut repairs |