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TRENCHLESS RENEWAL OF WATER MAINS BENEFICIAL TO BOTH THE EXISTING WATER MAIN AND THE ASPHALT PAVEMENT

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ABSTRACT

How many times have we witnessed a newly installed street pavement be prematurely excavated to repair an unforeseen water main break? Why do road crews wait over a year before installing the final asphalt layer on the roadway after a new water main installation? Should trenchless technologies be preferred over open cut replacement to increase life expectancy of the new pavement? Is public perception and political responsibility important to the utility manager? These issues and questions are often used in the decision process to choose the best method to either replace or renew a deteriorated water main while at the same time considering the life cycle of the roadway.

Like many North American cities, the city of Dollard des Ormeaux has completed and put in place an Asset Management Program for its water, sewer and roads infrastructures. This Program allows the Engineering Department to target the water mains that need to be renewed and the streets that need repaving. For the latter case, the ensuing inspection of the water and sewer infrastructures under these streets has led to the structural renewal of the water mains under them.

Today, many water utilities work closely with city road departments to efficiently schedule their construction work and to achieve the best design possible for both the water main and the new pavement. For the past ten years, the City of Dollard des Ormeaux has been using structural cured in place liners to renew their water mains and has constantly saved money therefore optimizing each dollar spent on infrastructure renewal. This paper will present, with the help of examples, the decision criteria used by the City of Dollard des Ormeaux to choose and prioritize the renewal of their water mains and also discuss how sidewalk and street paving considerations often impact their water main renewal priorities.

1. INTRODUCTION

The City of Dollard-des-Ormeaux is a west island suburb located on the island of Montreal, Quebec, Canada. The city, founded in 1960, and with a population of approximately 50,000 residents, owns and manages approximately 122 miles each of water, sanitary and storm mains as well as approximately 115 miles of road infrastructure. The majority of the water mains that have been installed were made of unlined cast and ductile iron pipes ranging in diameters from 4 to 24 inches. In the mid nineties, like many other cities in North America, the city's water system was slowly deteriorating. An analysis of the city's database revealed that 91 % of the water main breaks in the last

10 years occurred on water mains installed between 1959 and 1972. As a result, city managers had to deal with many water main breaks and leaks along with red water and water flow complaints.

2. METHODOLOGY

Until 2004, work on the water distribution network was carried out to resolve the system's hot spots. For example, from 1996 to 1999, water mains with chronic red water problems were rehabilitated using non structural epoxy lining.

As of the year 2000, the city started lining its water mains with structural cured in place pipe (CIPP). At the time, water mains were prioritized to be rehabilitated by using the break history criteria. Since 1996, the City has rehabilitated or renewed over 31% or 39 miles of its water mains of which 23 miles were rehabilitated with structural CIPP, 11 miles with non structural cement mortar and epoxy linings and 5 miles were replaced (Figure 1).

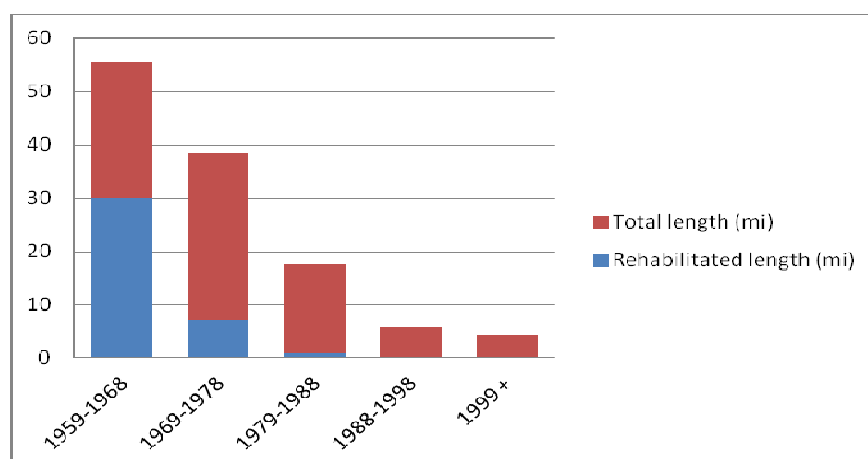


Figure 1: Total length installed versus total rehabilitated length

In 2004, the City started its integrated asset management program allowing it to put together a master plan which indicated the short and long term work priorities for the city's water mains, sanitary and storm sewer mains as well as its road infrastructure. This plan was created based on the *Quebec Ministry of Municipal Affairs, Regions and Land Occupancy's* guide for elaborating a master plan for the renewal of water and sewer mains (Figure 2).

The weighted average of several criteria was used to establish the order of its interventions. For example, for each segment of water main the following information was gathered and weighted to establish the priority of interventions: the number of water main breaks (last 5 years); water quality (colored water); static and dynamic water pressures; condition assessment results (internal and external corrosion); resident complaints and street classification (boulevard, collector or local street). A similar exercise was used to establish the priorities for sanitary and storm sewers and for establishing street reconstruction priorities. Based on the priorities, the subsurface utilities are either rehabilitated or replaced. It should be noted that only after the subsurface utilities have been renewed or show no signs of significant degradation does the city proceed with road reconstruction, if warranted.

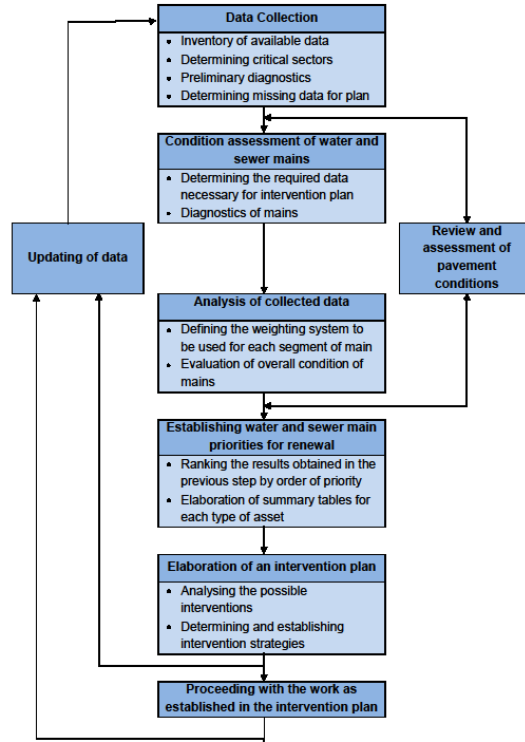


Figure 2 : Methodology used to create intervention plan

3. REPLACEMENT OR REHABILITATION OF WATER MAINS

The choice to structurally rehabilitate, replace or cathodically protect a water main is determined by the condition of the pipe and the pavement. If the water main assessment indicates that the main is at an advanced stage of deterioration, it is the city's policy to recommend rehabilitation using a structural cured-in-place pipe (CIPP) over the conventional open cut method. CIPP provides many advantages to the city including: short construction time; reduced construction costs; minimal excavations; minimal pavement settlement at pit locations; reduced disruptions to residents and traffic.

Furthermore, structural rehabilitation of water mains produces 84% less green house gases (GHG) than the conventional open cut method. Figure 3 shows, for a specific CIPP manufacturer, the quantity of GHG emissions for the renewal of small diameter pipes (6-12 in.) for both CIPP and the conventional open cut method. A rigorous quantification protocol was used to calculate emissions from the following GHG Sources: material production, on-site operations and transportation.

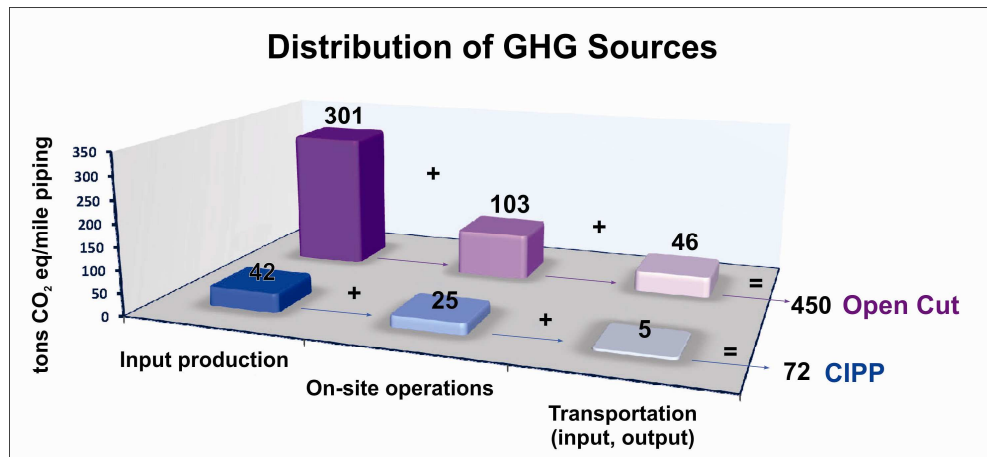


Figure 3: Distribution of GHG Sources

The GHG emission reductions for a water main rehabilitated using CIPP would be even greater if the indirect reductions associated with traffic detours were quantified.

The recommendation to proceed with a pipe replacement is only considered if the size of the water main needs to be increased to improve its hydraulic properties, other utilities also need to be replaced or the main needs to be relocated.

Due to our geographic location, climate constraints also influence the choice of the rehabilitation method. In winter, climatic conditions in Quebec are particularly harsh and depending on the region, the ground freezes to a depth varying from 4 to 10 ft for a period of more than four months. Combined with the temperature fluctuations and humidity levels, this has a considerable impact on pavement performance. Therefore, for the period from November 15th to March 15th, only local repairs are carried out due to high construction costs attributed to winter conditions. From mid-March to mid-May, the annual spring thaw period also limits the amount of construction work that can be carried out. During this period, the road composition is weakened by water accumulation; therefore to protect the road network, provincial legislation limits vehicle loading to take into account the weaker load bearing capacity of the roads. Consequently, most of the planned construction work is carried out in the five month window from mid-May to late October.



Figure 4: Paving after CIPP rehabilitation

Also, studies have shown that utility cuts on road pavements can reduce the life span of the pavement between 30 and 50 %. In order to minimize pavement settlement and cracking, cities typically wait one full year before applying the final asphalt coat. So using the low dig or trenchless technologies to renew the subsurface utilities allows for much less disruption to the road infrastructure and provides the city with the option of paving the streets during the same year. Figure 4 shows a road repair subsequent to a CIPP access pit excavation. The access pit was backfilled with non shrink concrete and as a result this method produced almost no settlement. Consequently, the asphalt repair remains in good condition for years thus prolonging the life of the street pavement.

4. RESULTS AFTER A 10 YEAR REHABILITATION PROGRAM

After 10 years of water main renewal with structural CIPP liners, the City of Dollard-des-Ormeaux has reduced its annual break rate by 65%. In 2000, the city experienced 65 breaks per 100 miles of pipe while in 2010, this figure decreased to 22 breaks per 100 miles. In addition, the city has not experienced any breaks on rehabilitated water mains. This has also had a significant impact in resolving colored water and reduced pressure problems. Figure 5 shows the annual water main breaks registered for the entire water distribution network since the year 2000.

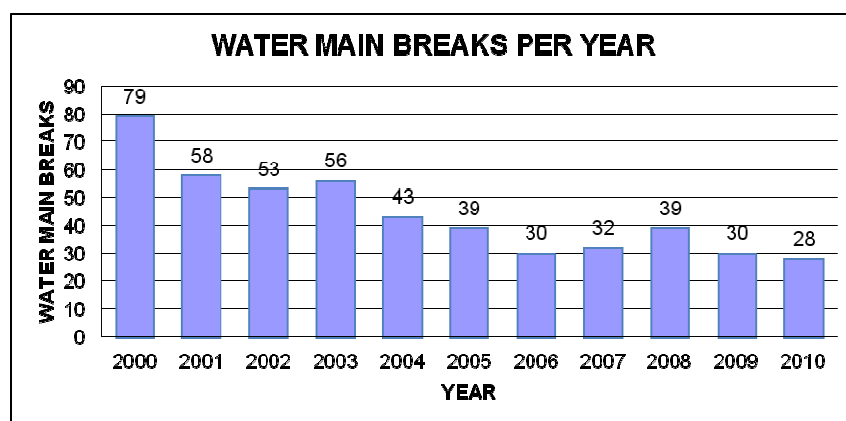


Figure 5: Water main breaks per year for entire network

In 2011, the City agreed to participate in a pilot project with the *Center for Expertise and Research for Infrastructures in Urban Areas* (CERIU) to monitor the performance of the first mains, in the Province of Quebec, that had been renewed using trenchless technologies. A condition assessment was carried out on a water main that had been structurally rehabilitated in 2001. This assessment was carried out using the Investigator™ technology, by Wachs Water Systems, which operates in a pressurized water main and provides high quality CCTV visuals, precise acoustic leak detection and advanced tracking/mapping capabilities. The results of the water main condition assessment at this test site revealed that the liner is still in excellent condition, shows no signs of failure and no leaks were detected on the water main nor on the service connections (Figure 6). More random verifications will be done to continue monitoring the performance of rehabilitated water mains.



Figure 6: Pipe condition (rehabilitated in 2001)

5. CONCLUSION

For the past ten years, the Municipal Council of the City of Dollard-des-Ormeaux adopted a proactive approach regarding the annual investment for the renewal of its underground utilities. The City has been using structural cured in place liners to renew its water mains and has constantly saved money therefore optimizing each dollar spent on infrastructure renewal. On average, the City saves 40% in direct costs by using CIPP compared to the full replacement of the main. Furthermore, using cured in place pipe (CIPP) to renew its water and sewer mains not only improves the stability and quality of the networks but also promotes sustainable development by the reduction of green house gases produced during construction by more than 84% in comparison to using the traditional open cut replacement option. Finally, by rehabilitating the mains by using the CIPP method, this shortens the work time, considerably reduces the risks of damaging other underground utilities, no street closures are required and the citizens are not inconvenienced as much as they would be if the traditional open cut method were used.

6. REFERENCES

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