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Halifax Water

# Northwest Arm Trunk Sewer (NATS) Rehabilitation

CANADIAN CONSULTING ENGINEERING AWARDS

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The CIPP installation lengths averaged over 400m and this is well beyond the typical CIPP installation lengths of 100m to 200m.

Of note, one installation length was 680m and set a new Canadian record for the longest single installation of CIPP

Halifax Water required the renewal of an inaccessible 100 year old, large diameter, 4,000 m long trunk sewer that was exfiltrating into the Northwest Arm inlet, a major recreational and natural environment asset in Halifax, Nova Scotia serving a population of over 360,000. Halifax water's primary goals for this project was to remove debris, restore the structural integrity, eliminate exfiltration, establish a corrosion barrier and extend the life of the sewer up to 75 years, all while minimizing the social, environmental and cost implications associated with construction.

The original construction of the NATS involved a combination of trenching and hand tunnelling using poured concrete pipe or clay tile block. The sections of the sewer that were constructed using the clay tile block had significant gaps between the blocks that allowed the exfiltration of sewage into the Northwest Arm inlet when the combined sewer surcharged during rain events. This resulted in contamination of the water and an unpleasant sewage smell along the coastof the Arm that was noticeable to the local residents.

CIPP rehabilitation of the NATS offered Halifax Water a solution which addressed all the primary goals of the project and also necessitated the removal of debris from the sewer, gaining back its original intended flow capacity.

Robinson Consultants Inc. (RCI) provided the planning and engineering for an innovative and record breaking solution extending the service life of the sewer and eliminating contamination of the coastline. The project was executed in a cost effective manner while significantly reducing social and environmental impacts.

The Northwest Arm Trunk Sewer (NATS) was one of the most challenging Cured-In-Place-Pipe (CIPP) rehabilitation projects ever completed in North America. Several Canadian CIPP installation records were broken in the completion of this project (including longest single continuous installation length at 682 m). The engineering scope for this project included CCTV inspection, condition assessment, feasibility study, constructability, detailed design, tendering, contract administration and site inspection for the rehabilitation of over 4,000 m of a combined trunk sewer ranging from 1200 mm diameter round pipe to 1200 mm x 1500 mm arch pipe, located in some of the most difficult to access residential terrain in Halifax.

The ambitious goals of this project presented several significant challenges including extremely limited access, accelerated completion schedule and complex engineering design of a CIPP in an arch shaped pipe.

Located on the coast of the Northwest Arm inlet, the NATS alignment meanders along the shoreline anywhere from 0-10 meters from the water's edge and is land locked by a CN rail track with bridge access only. The NATS presented numerous accessibility challenges including being located mainly on built up multimillion dollar historic residential water front properties, steep shoreline slopes, 100 year old load restricted CN bridges and a hydro corridor.

This project was Canadian Water Wastewater Fund (CWWF) financed with an aggressive schedule which required this project to be completed by March 31, 2018. Typically a project of this magnitude and complexity would be planned and constructed over 24 months; however, The RCI project team was able to successfully complete all planning and engineering requirements in 7 months to meet the project schedule, with the project as a whole being completed in only 16 months from the start of planning to the completion of construction.

## Professional Engineering enhancement in the Eyes of the Public.

Engagement with key stakeholders was a vital component of the success of this project. Due to the location of the sewer crossing multi-million dollar historic ocean front residences, it was critical that property owners where engaged throughout the project. Public Consultation began in the planning stage, providing the residents with a clear understanding of the issues and concerns with the NATS condition and the benefits to the community that would be achieved through rehabilitation of the sewer.

The typical alternate construction methodology of open cut pipe replacement was also discussed in detail with the public. Given the alternative of replacing this sewer through a naturally beautiful shore line, the CIPP allowed a considerably smaller construction footprint providing significant reductions in social, environmental and economic impacts.

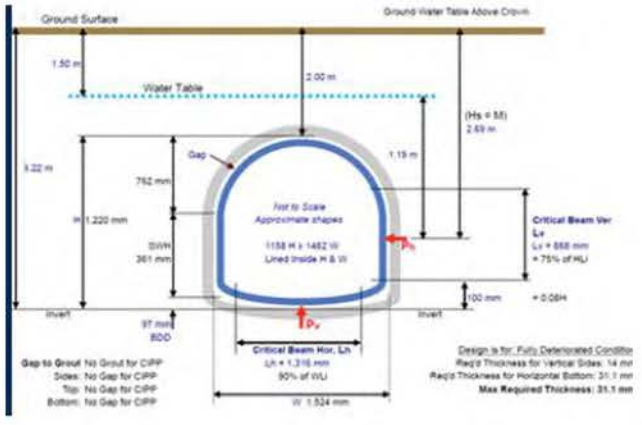
The off-street location within the ocean view backyards of multi-million dollar homes and the steep terrain surrounding the sewer presented significant accessibility challenges which resulted in approximately 3000 m of the total 4000 m being installed from just four access points. This required numerous CIPP installation lengths being completed in excess of 400 m versus the typical installation, which ranges from 100 m – 150 m in length. Furthermore, the limited access required an innovative on-site fabrication approach to reduce the weight of material trucks required to enter the site over the load restricted bridges.

The existing condition also resulted in heavy debris removal of over 750 m3 from just 5 access locations, pulling debris over lengths in excess of 500m in some cases.

## Engineering Excellence in Design of CIPP

While CIPP was a constructible solution to address access and schedule challenges associated with the project, the design of the CIPP liner required a unique approach. CIPP design standards (ASTM F1216) are founded on the basis of a circular sewer and are not applicable for non-circular sewers. The use of CIPP on the non-circular portions of the NATS totaled approximately 2000 m, requiring a design method to be developed. As a result, a highly technical and a unique design approach utilizing a first principles methodology to develop a specialized non-circular CIPP design calculation for the arch shaped portions of the sewer was established. The design approach assessed the pipe cross-section in three distinct components, the arch top, the vertical sides and the dished bottom.

The design parameters for each of these individual components were established, along with design equations to identify the CIPP thickness required to meet the expected loads. The design methodology expanded the l imitations of the CIPP technology and involved a team of RCI's industry recognized technical experts as part of the design team.



## Economic and Socioeconomic Benefits

While the replacement of the NATS was socially unimaginable, it is estimated that overall cost savings through the use of CIPP was between 50% and 60% versus replacement. It was further estimated the total construction period was reduced by as much as 6-8 months

CIPP is a structurally sound pipe within the existing pipe, providing considerable economic and socioeconomic benefits eliminating the need for significant excavation. In the case of the NATS, while some minor excavation of existing MH`s was required, no linear length of sewer pipe required excavation. This significantly reduced the cost and social disruption associated with excavating through the yards of the homes along the Northwest Arm shoreline, allowing residents and the public to continue to use the recreational shoreline during construction. To further ensure the successful completion of the project, a risk workshop was undertaken at the inception of the project.

As a result rehabilitation technologies were reviewed to identify all risks associated with the NATS rehabilitation using CIPP and Slip lining.

The top risk identified was the impact of major rain events which could exceed the capacity of the by-pass system established to complete the work. This risk was substantially mitigated through the retrofitting and upgrading of the primary sewerage pump station feeding the NATS, allowing the station to divert flow to another trunk sewer system and treatment facility.

RCI's sub consultants CBCL Limited completed the design, tendering and contract administration prior to the sewer rehabilitation work, which not only provided significant benefits to the rehabilitation project but also reduced the CSO frequency due to rain events as this diversion was made to be a permanent alteration to the sewer collection system.

## Environmental Benefits

CIPP has a significantly reduced construction footprint relative to traditional concrete required to complete the work. The installation of a new pipe would have required the excavation of a 4000 m long by 4 m wide by approximately 8 m deep trench or approximately 80,000 m3 of earth and rock. This disruption would have damaged the natural environment along the coast causing negative effects to aquatic and terrestrial habitats. The smaller construction footprint also reduced the risk of sediment and other contaminants from spilling into the Northwest Arm inlet. This approach further provided benefits in the reduction of greenhouse gas emissions produced during construction. It is estimated that the greenhouse gas emissions where reduced by 70% versus open cut replacement.