Coxwell Sanitary Trunk Sewer Emergency Repair: By-pass Sewer Tunnel Construction Update

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<td>To:</td>
<td>Public Works and Infrastructure Committee</td>
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<td>From:</td>
<td>General Manager, Toronto Water</td>
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SUMMARY

This report provides an update on the progress made in the construction of a permanent by-pass tunnel around the damaged section of the Coxwell Sanitary Trunk Sewer. The report provides information on challenges experienced during construction that have delayed completion of the project. It also provides an update on the emergency measures that have been implemented to mitigate impacts in the event of a partial or complete failure of the sewer prior to completion of the permanent by-pass.

RECOMMENDATIONS

The General Manager, Toronto Water recommends that:

1. The Public Works and Infrastructure Committee receive this report for information.

Financial Impact
There are no financial implications resulting from receipt of this report.

DECISION HISTORY

City Council at its meeting of January 27 and 28, 2009, authorized the General Manager, Toronto Water, to retain the various professional and engineering consultants and to procure the various goods and/or services to undertake the engineering design and the construction of physical works to support the implementation of emergency works necessary to address the damaged section of the Coxwell Sanitary Trunk Sewer (CSTS). The General Manager was also authorized, subject to certain conditions, to negotiate, and execute on behalf of the City

At the May 20, 2009, Public Works and Infrastructure Committee the General Manager, Toronto Water, presented an information report providing an update on the progress made in contingency planning, activities and various options being considered in advancing the work required to address the damaged section of the CSTS. A copy of the report can be found at: http://www.toronto.ca/legdocs/mmis/2009/pw/bgrd/backgroundfile-21457.pdf

At the October 6, 2009, Public Works and Infrastructure Committee the General Manager, Toronto Water, presented a follow up information report on the progress made on the various activities being undertaken to address the damaged section of the CSTS and the selection of a by-pass tunnel as the permanent solution. A copy of the report can be found at: http://www.toronto.ca/legdocs/mmis/2009/pw/bgrd/backgroundfile-23800.pdf

At the May 18, 2010, Public Works and Infrastructure Committee the General Manager, Toronto Water, presented a report on the progress made on the various activities being undertaken to address the damaged section of the CSTS, and the Contract award for the by-pass sewer tunnel. A copy of the report can be found at: http://www.toronto.ca/legdocs/mmis/2010/pw/bgrd/backgroundfile-29782.pdf

**ISSUE BACKGROUND**

During an inspection of the CSTS, significant damage was found to about 60 metres of pipe located beneath Barbara Crescent, north of the intersection of Coxwell Avenue and O’Connor Drive. While the initial inspection, as well as subsequent additional inspections, of the sewer shows that it is working as it should, with no backups or flow restrictions, the severity of the observed distress is such that the potential for blockage cannot be ruled out should there be further deterioration or a collapse of the sewer.

As reported to Public Works and Infrastructure Committee on October 6, 2009 staff explored and evaluated a number of temporary and permanent by-pass options while continuing to monitor the status of the CSTS. Given the associated site constraints, high flow conditions, construction timelines and costs, it was concluded that temporary measures or internal repairs were not feasible and that a permanent by-pass tunnel around the damaged section of the CSTS, extending from about the confluence of the Don River and Taylor-Massey Creek to the intersection of Coxwell Avenue and O’Connor Drive, should be designed and constructed as expeditiously as possible.

A design-build approach was selected to reduce the delivery schedule by overlapping the design and construction phases of the by-pass. The consulting engineering firm Hatch Mott MacDonald (HMM) was retained, through a competitive process, to act as an agent on behalf of the City, to prepare a preliminary design for the by-pass, and to administer the design-build contract.
In parallel, work also proceeded, on an emergency basis, on the implementation of monitoring programs to detect changes in the condition of the CSTS, and on measures to control the discharge of sewage and help mitigate environmental impacts in the event the CSTS were to collapse.

**COMMENTS**

The following presents an update on the construction of the permanent by-pass tunnel (the By-pass) and other related activities outlined in the report dated May 3, 2010 by the General Manager, Toronto Water, to the Public Works and Infrastructure Committee.

McNally Construction Inc. (McNally) was awarded a design-build contract on February 26, 2010, in the amount of $31,229,500.00 (net of GST/HST). McNally began detailed design immediately and construction started on April 9, 2010.

The By-pass consists of three basic components (see Attachment 1):

i) **Entry Shaft:** 10 metres deep located in Taylor Creek Park and represents the site where the tunnel boring machine (TBM) was launched and where a permanent diversion connection will be made to the existing CSTS (i.e. the upstream connection point); **[COMPLETED]**

ii) **Tunnel:** 510 metres, segmented concrete lined 2.7 metre diameter tunnel which bypasses the damaged section of the CSTS; **[COMPLETED]** and

iii) **Exit Shaft:** 42 metres deep located at the northwest corner of the intersection of Coxwell Avenue and O’Connor Drive and represents the site from which the TBM was retrieved and where the permanent connection will be made to the existing CSTS (i.e. downstream connection point) **[PARTIALLY COMPLETED].**

A key element of construction at the Entry Shaft was successfully completed during the early morning hours October 6, 2011. This involved careful removal of the top half of the concrete walled CSTS within the Entry Shaft, and installing a temporary flume (steel pipe) connection within the existing CSTS using innovative techniques under live flow conditions. This procedure will be repeated at the Exit Shaft, under slightly more challenging conditions. Once completed, both Shafts will be prepared for the installation of permanent flumes, which will then permit the rerouting of flows to the new by-pass tunnel from the Entry Shaft to the Exit Shaft. Several photographs illustrating the completed work to date is contained within Attachment 2 of this report.

The schedule, contained in McNally’s design-build proposal, indicated that construction of the By-pass was to be completed by January 2011. While the noted Tunnel component of the by-pass and virtually all the work that can be completed at the Entry Shaft was completed in 2011, construction has been hampered at the Exit Shaft. The entire project has been delayed due to unforeseen construction difficulties and ground conditions at the Exit Shaft location. Extra time and precautions are being taken during construction at this location due to its close proximity to the damaged section of the CSTS.
Construction Delays

The Exit Shaft was constructed directly over top of the existing CSTS and is 42 metres in depth. Unforeseen construction difficulties and ground conditions have significantly delayed this portion of the construction project.

Unforeseen Construction Difficulties

There have been a number of unanticipated delays to the project schedule caused by site conditions, mechanical issues, and safety concerns which included:

- An abandoned, buried, sewage pumping station at the Exit Shaft was deeper than assumed, as there were no as-built drawings on record. A complex shoring system was constructed to permit its demolition and removal. This pushed construction of the Exit Shaft into the winter season impacting the original schedule.

- The specialized excavator used to construct the concrete slurry walls of the Exit Shaft experienced numerous mechanical breakdowns.

- Since the Exit Shaft was not ready in time to receive the TBM, the schedule had to be reworked to extract the TBM and mitigate risk of damage to or loss of this expensive piece of equipment, in advance of completing the construction of the Exit Shaft.

- To reduce the risk of collapse of the CSTS, the Exit Shaft walls extended close to but did not connect with the CSTS, leaving a gap between the two structures. An initial attempt at jet grouting to seal this gap was attempted, but unfortunately a solid seal was not possible because of unanticipated timbers left in place when the original sewer was constructed. A second round of jet grouting was needed to successfully seal the gap around the sewer above the spring line (i.e. centreline of the sewer).

- A defect in one of the newly constructed concrete wall panels of the Exit Shaft was discovered immediately above the CSTS, which allowed the passage of water and sand into the shaft once the defect was exposed by excavation. Work had to be stopped on two occasions, for safety reasons, and additional time was required to develop solutions to rectify this problem.

- Once the excavation of the Exit Shaft proceeded and exposed the CSTS below the spring line it became apparent that a solid seal had not been achieved on the underside of the sewer with the earlier jet grouting.

- Excavation within the Exit Shaft took longer than expected because of the dense soil and soilcrete left by the jet grouting process for ground control purposes at the base of the Exit Shaft.

- The Exit Shaft is located in close proximity to the damaged section of the CSTS and excavation techniques had to be limited to medium-to-light duty to minimize the risk of damage to the existing sewer.
Ground Conditions
The ground conditions at the bottom of the Exit Shaft and where the existing CSTS is placed consists of fine-grained sand/silty-sand in a pressurized aquifer. Excavation in this layer without any ground control measures could result in an uncontrolled flow of these sands, which could trigger ground subsidence above.

Unfortunately, a solid and complete seal between the CSTS and the Exit Shaft concrete walls to prevent ground intrusion into the Exit Shaft has not been possible yet due to the challenging ground conditions and remnant formwork material from the original construction of the sewer. Given the risk this represents to workers, infrastructure and structures on the surface from potential ground subsidence, every precaution has been taken while excavating near the existing CSTS within the Exit Shaft.

As of the writing of this report, all efforts are being made to create a solid seal between the CSTS and the Exit Shaft as past efforts have not been able to fully seal the underside of the CSTS. Access to this area with grouting equipment is limited due to space limitations within the Exit Shaft. Based on a review of a number of ground control options by the various engineering consultants and geotechnical engineering specialists, dewatering of the aquifer within the Exit Shaft has been initiated. Grouting will then be reattempted to create the necessary seal. Other options for ground control are available, but they were discounted at this time due to the length of time required to implement. Subject to successfully depressurizing the aquifer at the Exit Shaft through dewatering, and grouting to creating a solid seal in the area between the CSTS and Exit Shaft, completion of a functional By-Pass is expected by July 2012.

Once the By-pass is operational, the intent is to enter the damaged section of the CSTS, complete a thorough inspection, make working conditions safe, probe for and grout any voids in the soil surrounding the sewer, and finally fill the entire length of the by-passed sewer completely with concrete. This would stabilize the sewer and surrounding ground. This additional work is anticipated for the fall of 2012.

Restoring and landscaping the Entry and Exit Shaft sites will follow the plans which have been developed for both sites in conjunction with staff from Parks, Forestry and Recreation and a group of local residents. The landscaping is expected to be completed in the fall of 2012 and/or spring of 2013, as seasonal planting conditions permit.

Update on Additional Activities and Costing

The following provides an update on additional activities and costing as identified in the May 2010 staff report:

Easements
The proposed alignment is located within property owned by the Toronto and Region Conservation Authority (TRCA), Hydro One Networks Inc., and two private property owners. Staff carried out the negotiations to secure these necessary easements.
**Emergency Contingency Measures**

All the emergency modifications to the Don Sanitary Trunk Sewer system to mitigate the impacts in the event of a partial or full collapse of the CSTS have been implemented. An Emergency Response Plan was developed by Toronto Water in consultation with the City’s Office of Emergency Management and the Ontario Ministry of the Environment, to address various scenarios. Staff responsible for the implementation of the Plan have been trained and briefed on roles and responsibilities, have participated in mock training exercises; and have been mobilized on site during key events such as the installation of the temporary flume in the Entry Shaft.

The design of emergency treatment works within the Keating Channel consisting of: disinfection equipment, spill containment booms to capture floatables, a submerged curtain wall to contain settled sludge, dredging to remove settled sludge, and skimmers to remove floating debris, has been completed. Provisions have been made for the implementation and operation of these works, should they be necessary.

**Monitoring Program**

A comprehensive monitoring program was implemented when the damage to the CSTS was discovered consisting of flow level, ground subsidence, and sewer condition monitoring, to track any changes associated with the damaged CSTS, and to help provide early warning should conditions deteriorate. The flow level monitoring program has shown conditions to be stable with no deterioration in system hydraulics.

The data obtained from the ground monitoring has not indicated any large scale movement, however, slight, gradual settlement at the surface above the damaged section of the CSTS has been observed since the monitoring program began. Periodic re-inspection of the damaged section of the CSTS indicates that the condition of the CSTS is stable, despite two seismic events (earthquakes) that have occurred during the course of construction of the permanent By-pass.

Settlement and vibration monitoring has been carried out adjacent to the By-pass construction sites since this work began. These records demonstrate that both settlement and vibration levels have been well within acceptable limits and that construction of the By-pass is not the source of the observed settlement mentioned above.

**Communications with Local Residents, Regulatory Agencies and City Divisions**

Regular contact has been maintained with local residents, Councillors and other impacted City Divisions to inform them of the situation and ongoing activities. The City’s Office of Emergency Management – Emergency Management Working Group Meetings continues to include the CSTS as an agenda item.

Also, ongoing dialogue is being maintained with the Ontario Ministry of the Environment and the Toronto and Region Conservation Authority.

**Procurement of Services**

Purchase Orders, including amendments, to a total amount of approximately $38,725,000 (net of GST/HST) have been issued to obtain professional engineering, legal, and construction
services to perform necessary emergency work required as a direct result of the damaged CSTS. Federal Infrastructure Stimulus Funding of $9,659,072 has been provided to support the construction of the By-pass. The following summarizes the procurement of goods and services supporting the construction of the By-pass and the implementation of emergency contingency measures to date (net of GST/HST):


b) Screening analysis of available options - $156,912.27 (MMM Group Ltd.).

c) Property condition assessments and settlement monitoring in area of damaged Coxwell STS - $400,000 (MMM Group Ltd. using Golder Associates as the geotechnical sub-consultant); amended for an additional $300,000 in 2010 to extend the assignment during construction; and amended for an additional $200,000 in 2012 to account for the delays in completing construction.

d) Geotechnical investigation and assessment of permanent relief sewer constructability - $315,760.55 (MMM Group Ltd. using Golder Associates as the geotechnical sub-consultant).

e) Preliminary design of potential temporary sewage by-pass pumping system - $127,331.64 (R.V. Anderson Associates Ltd.).

f) Inspection of other priority/critical trunk sewers in the City’s system and screening of unsolicited repair offers - $290,000 (Andrews Infrastructure); amended for an additional $270,163.18 for additional inspections of the CSTS during construction.

g) Review of alternative by-pass/treatment options - $497,700 (CH2M Hill Canada Limited); amended for an additional $40,000 for pilot testing of trash nets; and amended for an additional $46,668.82 for refinement of conceptual designs.

h) External legal services - $262,000 (Borden Ladner Gervais LLP).

i) Flow level monitoring upstream and downstream of damaged section of CSTS - $205,000 (Clarifica Inc.).

j) Expenditures for emergency measures associated within the Keating Channel - $1,085,000.

k) Construction of Massey Creek Sanitary Trunk Sewer Emergency Overflow - $240,165.22 (Utility Force Inc.).

l) Supply of a 70 foot span of galvanized portable panel bridge - $97,038.88 (Acrow Bridges).
m) Competitively-bid consultant assignment for preliminary design of the CSTS Bypass Tunnel and contract administration services during detailed design and construction of the Bypass Tunnel - $1,324,568.00 (Hatch Mott MacDonald).

n) Design-Build of the permanent By-pass Sewer Tunnel around the damaged section of the CSTS - $31,229,500.00 (McNally Construction Inc.).

o) Subsurface location of CSTS - $10,185.73 (TSH/TBE Subsurface Utility Engineers).

p) Owner Controlled Insurance Program, implemented by the City to reduce the perceived risks of the By-pass construction, through our broker - $1,056,436.56 in premiums paid up to April 30, 2012 (Marsh Canada Limited).

q) Abandonment of the damaged CSTS can likely be accommodated within the contingency allowance in the Design-Build assignment issued to McNally (see item (n) above).

r) Services for easement negotiation & registration related to Bypass Sewer Tunnel - $22,016.80 (Facilities & Real Estate Division).

s) Miscellaneous costs including permits, payments to property owners for construction access, archeological review, etc… - $390,000.

CONTACT

Senior Engineer                             Director
Design and Construction – Major Works      Water Infrastructure Management
Facilities                                 Toronto Water
Technical Services                         Tel.: (416) 397-4631
Tel:    416-392-8253                        Fax: (416) 338-2828
Fax:    416-338-2828                      E-mail: mdandre@toronto.ca
E-mail: bbuchan3@toronto.ca

SIGNATURE

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Lou Di Gironimo
General Manager, Toronto Water

ATTACHMENTS

Attachment 1: Schematic Diagram of Coxwell Sanitary Trunk Sewer Permanent By-pass Tunnel
Attachment 2: Photographs of Coxwell Sanitary Trunk Sewer By-pass Tunnel Construction Project
Attachment 1
Schematic Diagram of Coxwell Sanitary Trunk Sewer Permanent By-pass Tunnel
Attachment 2
Photographs of Coxwell Sanitary Trunk Sewer By-pass Tunnel Construction Project

Photo 1 – Inside view of segmented concrete 2.7 metre diameter tunnel

Photo 2 – Removing top half of existing Coxwell Sanitary Trunk Sewer at Entry Shaft
Photo 3 – Workers preparing for temporary flume installation during live flow conditions

Photo 4 – Installing temporary flume connection at Entry Shaft