# Using SUE to reduce Delays and Disruptions on City of Toronto's Yonge Street Project

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## ABSTRACT

As more and more municipalities look towards replacing aging infrastructure along key transportation corridors, one common goal is minimizing the interruption to traffic and business along those critical routes.  This paper reviews the City of Toronto's use of Subsurface Utility Engineering (SUE) services to manage this important issue for their Yonge Street Redevelopment Project.

The City of Toronto is currently in the process of developing strategies for proactively replacing aging infrastructure throughout the City.  One such project is the replacement of the existing watermains along Yonge Street from Eglinton Ave to Lawrence Ave.   The existing watermains are being replaced with two 300 mm watermains.  In addition to the watermains, there are plans for sewer chamber rehabilitation, sewer lining, boulevard reconstruction and road resurfacing within the project area.  In order to minimize disruption along this critical corridor the City looked at methods of gathering utility information that could be used to help minimize or eliminate potential delays during construction. The City decided to complete a Subsurface Utility Engineering (SUE) investigation, in accordance with the CI/ASCE 38-02: Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data.

One critical aspect for the City was to compile an inventory of all the existing storm and sanitary chambers to determine if any rehabilitation would be required. To facilitate the collection of this data TSH/TBE used an innovative new technology – zoom camera – to take a photo inventory of each manhole from above, eliminating the need for confined space entry.  The zoom camera allowed TSH/TBE to photograph all areas of the chamber, as well as take video and photos up each of the sewers to look for obstructions.

The authors will analyze how the scope of the investigation was developed to ensure the efficient gathering of the data.  They will also discuss the techniques used for the investigation, and comment on the benefits and limitations of each technique based on the site specific conditions.  The paper will outline the key and interesting findings of the investigation – including the identification of abandoned sewers and sewers that had been compromised by directional drilling.  It will comment on how the information from the SUE investigation helped to identify issues that would have caused delays during construction.

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## INTRODUCTION

This paper focuses on the investigation methodologies and techniques used to gather utility information in support of the design of 2 – 300mm watermains on Yonge Street in the City of Toronto. The installation of the watermains and rehabilitation of the sewer manholes will require a shut down of sections of the road which will have major vehicular and pedestrian traffic flow issues. The goal for the City of Toronto was to minimize the impacts on traffic by reducing delays during construction.

The project area extended from Eglinton Ave to Lawrence Ave. This is one of the busiest and most congested roadways in Toronto and in the Country. Peak vehicular traffic counts on this section of roadway are typically 5,400 vph, and peak pedestrian traffic counts are typically 4,900 pph.

The City of Toronto has a database of Utility information which is collected and managed by the City. The Digital Map Owners Group (DMOG) is made up of the major Utilities Owners including the City of Toronto, who administers the map. The DMOG mapping was used as a baseline for the investigation, and the data collected was compared to it.

The SUE investigation was completed in 2007/2008. Investigation was completed in accordance with the CI/ASCE 38-02: “Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data”. . Information was collected up to Quality Level B. Key techniques used included electromagnetic cable locating and zoom cameras. The SUE investigation revealed some significant discrepancies between the information that was shown on the DMOG map and the actual site conditions. The availability of this information during the design stage of the project allowed the City to effectively deal with any issues prior to construction. In some instances the accurate information allowed the designers to alter the design, and avoid utility relocations that were originally anticipated.

## BACKGROUND INFORMATION ON ASCE 38-02

The American Society of Civil Engineers (ASCE), published CI/ASCE 38-02: Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data in January of 2003. The standard is the backbone for the practice of SUE, an engineering discipline dedicated to accurately mapping and coordinating subsurface utility data. Information concerning existing underground utilities is vital during the design stage of construction projects as it provides the designers and engineers with an accurate, reliable map of the underground infrastructure. SUE allows them to determine how the existing infrastructure will be affected by the project, so they can make adjustments and plan ahead to minimize impacts.

The ASCE Standard outlines the processes that should be utilized when collecting utility data for design purposes. Early on, during the planning stages, the engineer responsible for the SUE investigation should advise the owner of potential impacts the project could have on existing subsurface utilities and recommend a scope for the utility investigation. The earlier the process is started the greater the benefits that can be experienced.

Quality Level Descriptions from ASCE Standard 38-02

Quality Level D – Information derived from existing records or oral recollections

Quality Level C – Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to quality level D information.

Quality Level B – Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities. Quality level B data should be reproducible by surface geophysics at any point of their depiction. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents.

Quality Level A – Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously exposed surveyed utilities) and subsequent measurement of surface utilities, usually at a specific point. Minimally intrusive excavation equipment is typically used to minimize the potential for utility damage. A precise horizontal and vertical location, as well as other utility attributes, is shown on plan documents. Accuracy is typically set to 15-mm vertical and to applicable horizontal survey and mapping accuracy as defined or expected by the project owner.

**Figure 1 - Excerpt from ASCE 38-02**

## SUE INVESTIGATION METHODOLOGY

The SUE investigation was completed by TSH/TBE Subsurface Utility Engineers JV. All field investigations including utility designating and the zoom camera investigation were completed by TSH/TBE crews.

The following provides a summary of the basic step by step procedures used to complete the field investigation:

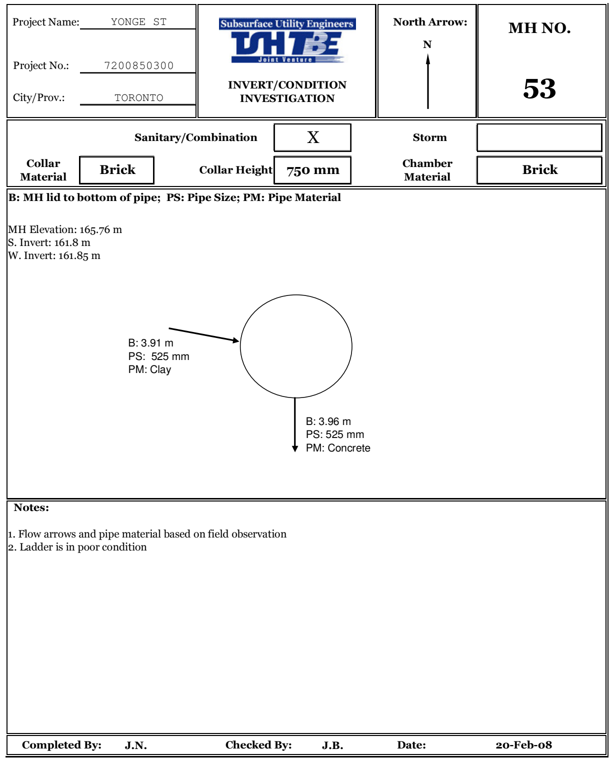
Step #1: Review of the existing DMOG mapping. In addition to this review TSH/TBE contacted Utility owners to determine if there was any information not shown on the drawing.

Step #2: Collect QL-B information using multi-frequency electromagnetic cable locate instruments, ground penetrating radar and other geophysical methods. The designating efforts focused on the utility plant located in the key areas. Utilities were painted in the field and collected using Total Station Equipment.

Step #3: Investigate key sewer chambers. Investigation included the collection of size, type (Concrete, PVC, CSP, etc), and invert elevation for all pipes entering each chamber. Manhole elevations were collected using total station equipment.

Step #4: Complete a condition survey for key maintenance holes using the Zoom-Camera technology. Condition survey information included:

- photographs of each maintenance hole structure to confirm structural condition;
- depth of adjustment units; and
- type of structure (i.e., brick, poured concrete, precast).



Project Name: YONGE ST
Project No.: 7200850300
City/Prov.: TORONTO

Subsurface Utility Engineers
TSH TBE
Joint Venture
INVERT/CONDITION INVESTIGATION

North Arrow:
N

MH NO.
53

Sanitary/Combination: X
Storm:

Collar Material: Brick
Collar Height: 750 mm
Chamber Material: Brick

B: MH lid to bottom of pipe; PS: Pipe Size; PM: Pipe Material

MH Elevation: 165.76 m
S. Invert: 161.8 m
W. Invert: 161.85 m

B: 3.91 m
PS: 525 mm
PM: Clay

B: 3.96 m
PS: 525 mm
PM: Concrete

Notes:

1. Flow arrows and pipe material based on field observation
2. Ladder is in poor condition

Completed By: J.N. Checked By: J.B. Date: 20-Feb-08

**Figure 2 - Sample MH Data Sheet**

Step #5: Using AutoCAD the utility information was imported into a distinct layer on the City's base drawing. A final composite utility drawing was created which provides an accurate depiction of the location of utilities as per the appropriate quality level.

## SUE INVESTIGATION TECHNIQUES

There were two basic investigative techniques used in the field to complete the investigation. The underground utilities were identified using single and multi-frequency electromagnetic cable locate equipment. The manholes were investigated using a zoom camera. Both techniques proved effective in efficiently gathering information that was vital to the project.

## SINGLE AND MULTI-FREQUENCY ELECTROMAGNETIC CABLE LOCATE EQUIPMENT

Single and multi-frequency electromagnetic cable locate equipment is used extensively for mapping underground utilities. The basic principle behind the use of this equipment is that when current is passed through a conductor it will create an electromagnetic field that can then be detected and measured. With cable locate equipment there are two components: a transmitter and a receiver. The transmitter emits a signal onto the conductor via either directly connecting to the conductor or by inducing signal onto the conductor. The receiver is then used to measure the magnetic field created and determine the horizontal location of the utility that is creating the field.

**Figure 3 - Field Technician using Cable Locate Equipment**

For the Yonge Street project, due to the congestion of utilities within the investigation area, a number of different instruments and techniques were used. The equipment used was a Metrotech 810 (single frequency) and a Subsite 950 (multi-frequency). The measurements from the instruments were used to determine where to place paint on the ground. The paint was then surveyed and used to create the drawing.

## ZOOM CAMERA

A zoom camera was used to complete the condition assessment for each of the critical manholes. The purpose of the condition assessment was to determine in advance which manholes would require rehabilitation, and what type of rehabilitation would be required. By using the zoom camera the field crews were able to take accurate photos of the manholes, without having to actually enter the manholes.

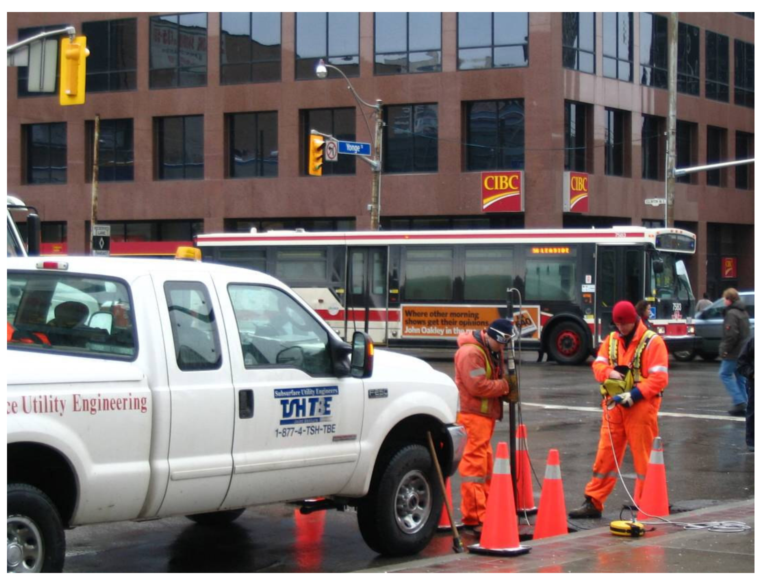



**Figure 4 - Field Technicians operating Zoom Camera**

**Figure 5 - Zoom Camera photo from inside Sewer Chamber**

The zoom camera was mounted to a rod that could be lowered and positioned in order to take photos of manholes and pipes. The camera is capable of taking video and still shots. The camera has a powerful zoom lense (216:1 for the camera used in this investigation), allowing it to take photos up the sewer lines, while physically remaining in the manhole. It uses High Intensity Discharge Lamps to provide a bright narrow beam of illumination, allowing it to focus effectively on objects several hundred feet away.

When operating the camera, one technician was responsible for holding and manipulating the camera on the pole while the second technician was responsible for viewing the image from the camera and taking still photos or video footage as required.

For the Yonge Street investigation the use of zoom cameras provided the City with an opportunity to collect data more safely and more quickly than traditional techniques. This minimized impacts to traffic during the investigation. It also provided additional data that may not have been identified. One such example is the location where the camera identified conduits that had been directionally drilled through a sewer. Identifying this upfront allowed the City the opportunity to rectify the issue prior to construction, so that there would be no delays to their contractor.


**Figure 6 - Zoom Camera photo showing conduits directionally drilled through Storm Sewer**

**CONCLUSIONS**

The City of Toronto identified early on in the process that the proposed construction of the new watermains and the sewer rehabilitation work along Yonge Street would have a major impact on traffic along the roadway. The City understood from past experience the profound impacts that not having accurate utility information could have on the cost of projects, but more importantly the duration of projects. To minimize the duration of construction and the effects to traffic the City effectively completed a SUE investigation during the design phase of the project. The SUE investigation effectively identified issues that could be addressed during design in order to eliminate delays during construction.

The tools and techniques used for the field investigation allowed for the efficient collection of data in the field. The electromagnetic cable locate equipment effectively identified conductive utilities within the project area.

The zoom camera technology, drastically reduced the time required to collect data in the field and thus reduced the impact to the traffic flow during the field investigation. It provided an efficient method of determining and documenting the condition of the manholes and incoming pipes without the need for confined space entry.

For this project there were no test holes installed as part of the investigation. The decision to not do test holes was based on the fact that due to the nature of the pipe being installed the City has an opportunity in the field to bend the pipe around any vertical obstructions. In addition it was decided to minimize the impacts on the local business owners and traffic. In general on projects, the collection of the Quality Level A data can provide vital information that can be used by designers.

## RECOMMENDATIONS

The identification of key aspects of a project that could affect project duration is vital to minimizing the traffic related impacts on a project. On roads with high vehicular and pedestrian traffic, eliminating delays and minimizing the time for construction can result in major project savings and societal savings.

The ASCE Standard 38-02 outlines a framework for completing utility investigations. The effective use of these techniques can help to gather the necessary utility related information that can be used by designers to identify and rectify some of those impacts. It should be used on projects where utility related conflicts could cause delays during construction and thus negatively impact traffic flows.

The use of zoom camera technology is an effective tool for gathering manhole condition assessment information. The camera reduces the time needed in the field to collect the data, and thus the traffic impacts during collection. The data collected allows the designer to effectively determine if rehabilitation is required, and what techniques would be most effective. This helps to reduce the time in the field during construction and improves the overall process.

The project identified that the earlier in the process that the data is collected, the more useful and more beneficial the data becomes. High quality data provided at the 30% design stage of projects, will allow utility designers to effectively make the necessary design decisions early in the design process.

## REFERENCES


1. American Society of Civil Engineers. (2003) Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data, Standard #38-02, Reston, Virginia.