CSA S250-11 and CI/ASCE 38-02 – How to effectively utilize these Utility Standards for the 3 R's Reduce Reuse Recycle during Infrastructure projects.

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ABSTRACT:

Published in September 2011, the CSA S250 – Mapping Underground Utility Infrastructure will play a key role in the creation of more accurate and reliable as-built utility drawings and maps in Canada. CI/ASCE 38-02 – Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data, which was published in 2003, has already been used extensively on infrastructure projects across Canada and the US. Together these two standards form a solid foundation to both map and records utility infrastructures.

The location of existing utilities can play a key role in the design and implementation of infrastructure projects. These impacts need to be managed properly to avoid significant cost and schedule over runs. CI/ASCE 38-02 forms the basis for engineers to create accurate drawings of existing conditions for the project. The data provided upfront is a critical, however equally important is the generation of accurate, reliable maps and drawings of new utility infrastructure placed in the ground. Creation of these new records is the primary focus of the CSA S250 Standard. The paper will review the key highlights of the new CSA S250 standard including – standard symbology, Accuracy Levels, and data record keeping - and how it will improve our future knowledge of underground infrastructure. It will highlight the government and private agencies such as the Ontario Ministry of Transportation, City of Toronto, and Fortis Gas, currently using or looking to implement the use of the

standard, and identify how the knowledge learned from that exercise can assist the principles of Reduce Reuse Recycle. .

Accurate reliable drawings of our underground utility infrastructure produced in accordance with these industry standards is a benefit to all stakeholders – Project Owners, Designers, Utilities, Regulators and Contractors. Further promotion for the use of these standards is the key, if we wish to raise the bar and move forward as an industry.

INTRODUCTION

This paper outlines SUE investigations and applications in for the Reduce Reuse recycle principal in infrastructure projects. These investigations are typically done as part of the design phase of projects so valuable information pertaining underground utilities were provided to design team and utility issues are managed effectively.

The primary scope of work on these projects was to establish the accurate base drawing of existing utilities. On typical projects in the past a number of common issues tended to be present regarding the underground Utilities:

- Utility records are not reliable or accurate enough for the project designers/engineers.
- Design drawings didn’t accurately depict utility locations.
- Utility relocations ended up being a time consuming and costly part of the overall project.

A solution that have been proven successful on a number of major projects throughout the country is the use of Subsurface Utility Engineering (SUE) principals, in accordance with the CI/ASCE 38-02: “Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data” as well as CSA Standard S250 – “Mapping of Underground Utility Infrastructure.”

What are the benefits of following CI/ASCE 38-02 and CSA S250?

- It provides designers/engineers with valuable information during design stage of the project. (Reduce)
- It is a defined systematic, repeatable process with established and proven standards. (Reuse)
- It helps to clearly defines potential conflicts/ relocations upfront when they can be managed more effectively.(Recycle)
- It helps reduce number of relocations by clearly highlighting the exact location of conflicts and the relationship to the proposed project works(Reduce)

- It helps reduce re-design costs by eliminating the need to redesign elements of the projects once it is determined that utilities are not where they were originally thought.(Reuse)

- It helps contractors reduce bid prices, by eliminating some of their risks.(Reduce)

- It helps reduce project delays, by reducing the probability that unexpected utilities will be encountered in the field.

- It helps improve project safety by providing that accurate reliable record that can be used as a valuable tool not only during the design but during construction (it is important to note that a SUE drawing does not replace the need for contractors to call before they dig)

- It reduces clients overall risk.

- It improves records for future projects.

- Better records improve operations and maintenance operations.

BACKGROUND INFORMATION ON ASCE 38-02 and CSA S250 Standards

There are two key standards presently used in Canada for utility mapping. ASCE 38-02 sets out guidelines for how to qualify the accuracy of mapping existing infrastructure and relay that information to a drawing. ASCE goes into the SUE process and roles and responsibilities of the SUE professional and the owner. It's more prescriptive.

CSA S250 set's out requirements for classifying the accuracy of newly installed or exposed infrastructure. The CSA S250 accuracy levels provide a finer level of detail to define the positional location of the infrastructure which translates into a better defined reliability in the accuracy of the record. Both standards help to complement each other.

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.

> Quality Level Descriptions from ASCE Standard 38-02
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> Quality Level D – Information derived from existing records or oral recollections
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> 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

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 Utility Investigation should advise the owner of potential impacts the project could have on existing subsurface utilities and recommend a scope for the investigation. The earlier the process is started the greater the benefits that can be experience.

More recently, in September 2011, the Canadian Standard Association published CSA S250 – "*Mapping of Underground Utility Infrastructure.*" This standard specifies the mapping requirements for new infrastructure being installed in the ground. It provides consistency for key items such as line color, utility description and accuracy. Accurate records will improve safety of public, environment and reduce costs.

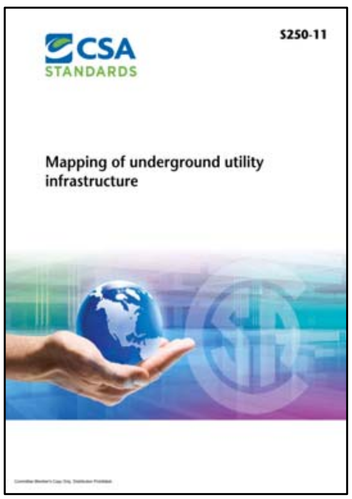


Figure 2 – CSA S250

Colour	Colour name	Colour co-ordinates	Used to designate
	RED	RGB (205,0,50) CMYK (0,81,61,20) HTML #CD0032	Electric features, power lines, cables, conduit, and lighting cables
	YELLOW	RGB (235,210,90) CMYK (0,0,80,0) HTML #FFFF33	Gas, oil, steam, petroleum, and gaseous materials
	ORANGE	RGB (255,102,0) CMYK (0,60,100,0) HTML #FF6600	Communication, alarm, signal lines, and cable television
	BLUE	RGB (0,0,255) CMYK (100,100,0,0) HTML #0000FF	Potable water
	GREEN	RGB (50,150,50) CMYK (40,0,40,42) HTML #329632	Sewer, sanitary, storm, and combined
	PINK	RGB (255,204,204) CMYK (0,20,20,0) HTML #FFCCCC	Temporary survey markings
	PURPLE	RGB (153,51,204) CMYK (20,60,0,20) HTML #9933CC	Reclaimed and untreated water, irrigation, and slurry lines

Figure 3 – Excerpt from CSA S250 Color Code

Accuracy level	Description	Reference
1	Accurate to within +/- 25mm in the x, y, and z coordinates, and referenced to an accepted geodetic datum with a 95% confidence level.	Absolute
2	Accurate to within +/- 100mm in the x, y, and z coordinates, and referenced to an accepted geodetic datum with a 95% confidence level.	Absolute
3	Accurate to within +/- 300mm in the x, y, and z coordinates, and referenced to an acceptable geodetic datum or topographical and cadastral features with a 95% confidence level.	Absolute or relative
4	Accurate to within +/- 1000mm in the x, y, and z coordinates, and referenced to an acceptable geodetic datum or topographical and cadastral features with a 95% confidence level.	Absolute or relative
0	No information available related to spatial accuracy.	

Figure 4 – Excerpt from CSA S250 Mapping Record

UTILITY INVESTIGATION METHODOLOGY AS PER ASCE 38-02

The following provides a summary of the basic step by step procedures followed by SUE consultants when following the ASCE 38-02 Standards.

Step #1:

The first step in the investigations, is to collect **Quality Level D** information by collecting all available utility records. Key sources include municipal records, as-built and utility company record drawings. Records are collected through a formal request process which outlined the general project scope, the project limits for which records information was required, and timeframes for when information is needed.

Step #2:

The second step in the investigation is to review the topographic survey data available and upgrade any information to **Quality Level C** by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D information. This process is mostly utilized for the sewer systems where crews could be sent to collect invert data at required maintenance holes, then that information used to determine alignments based on records available. Due to the linear nature of most gravity sewer systems, this is quite affective. In situations where there are complex systems or bends in the system, additional steps need to be followed.

Step # 3:

As the overall project design progresses to the stage where it can be determined which areas were most critical, the third basic step of collecting **Quality Level B** information is completed. For this step information is obtained through the application of appropriate surface geophysical methods to determine the existence and horizontal position of subsurface utilities. Electromagnetic cable locate, equipment, sondes, ground penetrating radar (GPR) and other geophysical methods are used. The designating efforts focused on the utilities located within the key impact areas of the project.

Figure 5 – Geophysical Designating

Step # 4:

The fourth step is to collect **Quality Level A** information and determine the precise horizontal and vertical location of utilities obtained by the actual exposure and subsequent measurement of subsurface utilities, at key critical locations as identified via a review of the project design in consultation with all parties involved. A non-destructive air or hydro based vacuum excavation methods are used to vacuum excavates the test holes. Holes are then surveyed to provide precise x,y,z information. The test holes are backfilled and reinstated as per permit requirements.

Figure 6 – Test Holes on a Downtown Ottawa Project

Step # 5:

Based on all information obtained, the corresponding composite utility design drawing is completed and over laid on client's base drawings. All utility information and utility design are assigned a Quality Level and respectively color, specific line types and utility description in accordance with the Standards mentioned above. In addition to the drawing a full report is provided outlining the steps of the invsetigaiton and results obtained. Both the report and drawing are signed and sealed by the Professional Engineer responsible for the project.

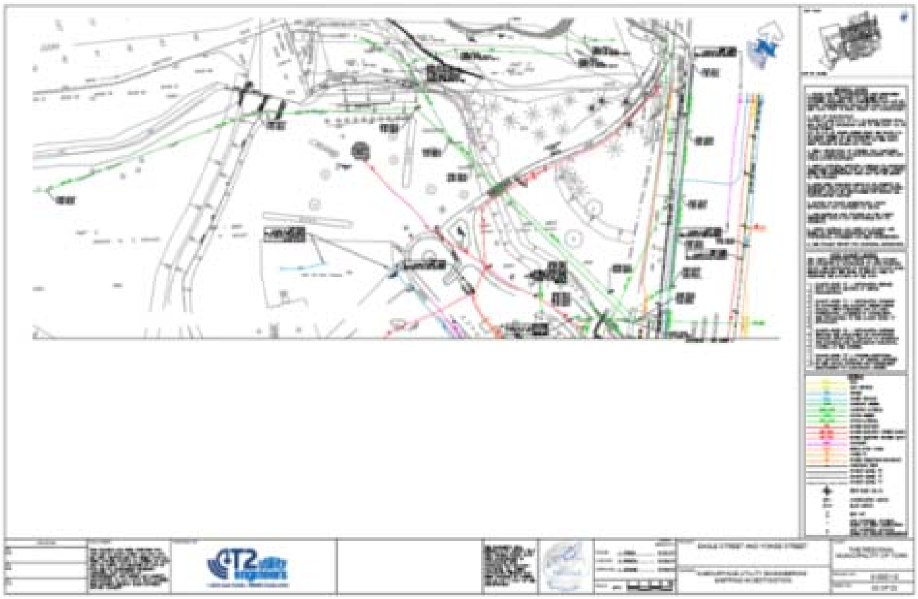


Figure 7– Utility Drawing (sample)

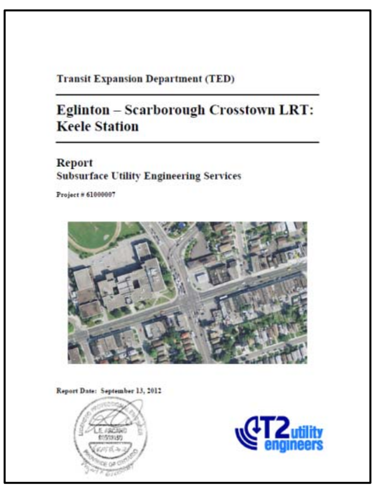
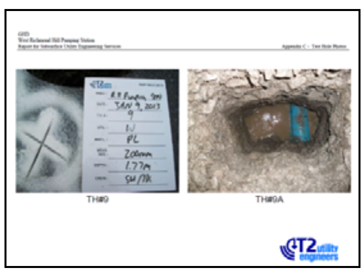


Figure 8– SUE Report



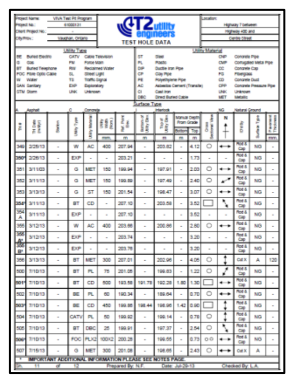


Figure 9– Typical Test Hole Data

SUE COST SAVINGS

Performing a utility investigation in accordance with ASCE 38-02 leads to more accurate depiction of underground utilities which in-turn will-lead to several benefits to all project proponents, particularly coordination of utility relocations. Several studies have been completed which placed a dollar amount on the savings associated with doing a SUE mapping investigation and calculated a return on investment which was essentially Return = Savings / Cost of doing the investigation. Calculating a similar number for these projects was beyond the scope of this paper, however based on the positive results encountered and the results found by the Stevenson, Purdue and University of Toronto Studies, we can estimate that it would be between $3 and $5 dollars for every dollar spent. Collectively that would represent millions of dollars in savings to Canadian tax payers.

Results from recent projects has shown that cost savings are typically realized from:

- Re-use of existing infrastructure, rather than relocating it.
- Reduction of contractor claims, and
- Reduction in utility relocation costs
- Recycling of past SUE investigation data for future projects through maintenance of permanent utility records.

IMPLIMENTATION OF CSA S250

Several major companies and government agencies have started to review and implement the guidelines in the CSA 250 Standard as part of their record keeping practices.

Fortis Gas BC has undertaken a comprehensive review of their mapping and as-built practices and highlighted gap analysis of their current practices. The have identified high medium and low priority items and steps needed to ensure compliance.

Ontario Ministry of Transportation, Region of York, and City of Toronto are currently looking to prescribe Utility companies to adhere to the CSA S250 standard as part of their requirement for as-built records for their municipal consent processes.

As the CSA S250 gains more popularity across the country its use will continue to expand.

Conclusions

Both the CI/ASCE 38-02 and the CSA S250 Standards are key documents to the success of future infrastructure projects for the Reduce Reuse Recycle principals. The CI/ASCE 38-02 should be followed when creating composite utility drawings of all existing utilities impacted by a new project. The CSA S250 Standard should be followed to create standardized accurate reliable as-builts and records of newly installed infrastructure.

We are installing thousands of meters of new utilities every year to meet demand of our ever growing country. Knowing where this infrastructure is located has important ramifications for safety and asset management. Adherence to both these standards will help to ensure that accurate reliable drawings of our underground utility infrastructure are produced. The benefits are numerous, but all result in an overall reduction in risk associated with the unknown. They are a benefit to all stakeholders – Project Owners, Designers, Utilities, Regulators and Contractors.

Acknowledgments

The authors appreciate the time and dedication of all the volunteers who helped to write and publish both the CI/ASCE 38-02 and the CSA S250, as well as those professionals dedicated to raising the bar on utility information.

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