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Empowering safe construction and sound design – here's what you need to know about Subsurface Utility Engineering (SUE)

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2018 brought with it a demanding construction season, and contractors across the province expect to grind out even more work this year, according to the Ontario Construction Secretariat's 2019 Contractor Survey. More than 30 per cent of non-residential contractors forecast a busier 2019 compared to last year, combined with population gains, reduced trade uncertainty and infrastructure spending.

More and more, medium-large scale construction projects are implementing the practice of Subsurface Utility Engineering (SUE) at the design phase to reduce risk and save on long term costs. Subsurface Utility Engineering (SUE) is an engineering practice that makes it possible to more accurately establish the location of buried utilities within a project area. This provides a foundation for decision-making around construction design, allowing a designer to make important decisions related to utility coordination, utility accommodation and utility relocation at the outset.

How does SUE reduce risk and prevent damage to underground infrastructure?

There are a number of ways that Subsurface Utility Engineering cuts project risk, minimizes damage to underground infrastructure and eliminates surprises at later stages of a project, and these significant gains have been affirmed by several studies. For example, the Ontario Sewer and Watermain Contractors Association, in collaboration with the University of Toronto, commissioned a study that determined for each dollar spent on Subsurface Utility Engineering (SUE) for construction projects, $3.41 was saved.

A Subsurface Utility Engineering program provides a mechanism to accurately map both the horizontal and vertical position of buried underground assets, providing the information necessary to avoid utility strikes. When Subsurface Utility Engineering is applied prior to construction, the need for field verification diminishes as both the horizontal and vertical component of a buried utility is provided to the contractor or engineer by the SUE provider. In addition to avoiding utility strikes, this enables informed decision making so that unexpected utility coordination and relocation activities can be avoided at later stages of the project.

Furthermore, where utility records exist for a project area, they may be outdated or contain inconsistencies, and there's always a risk of additional utilities existing in the area that do not appear on the records. Carrying out the four quality levels of a Subsurface Utility Engineering program provides a mechanism to fill in data gaps in utility records so there are no surprises. Once a SUE investigation is complete, a utility conflict matrix is created that highlights any data inconsistencies and calls for further investigation where required.

What exactly comprises a SUE program?

SUE is based on the CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, which provides a framework for evaluating the integrity of data based on four Quality Levels:

Quality Level D (QL-D): Information derived from existing records or oral recollections.

Quality Level C (QL-C): Information obtained by surveying and plotting visible above-ground utility features and using professional judgment to correlate this information with the results of QL-D.

Quality Level B (QL-B): The application of surface geophysical methods to determine the existence and horizontal position of subsurface utilities within a project's limits. Non-destructive technologies including Ground Penetrating Radar (GPR) and Electromagnetic (EM) tools are leveraged at this stage to accurately detect conductive and non-conductive underground assets.

Quality Level A (QL-A): Also known as daylighting, QL-A provides the precise horizontal and vertical location of utilities along with type, size, condition and material, obtained by exposing the utility, usually through vacuum excavation.

Do I need to apply all four Quality Levels?

Where a topographic survey exists that was recently completed by an engineer or Ontario Land Surveyor (OLS), QL-C can typically be considered complete as surface utility data is captured during the topographic survey. Topographic surveys and base plans should always be supplied to the SUE service provider at the project kick off meeting. The service provider will then correlate the topographic survey with information collected at the QL-D stage, to develop a starting point for the field investigation. Insights gleaned from combining these two datasets will allow the investigation to be targeted and precise.

What is most important is that Quality Levels be carried out in their prescribed order – QL-D, QL-C, QL-B, QL-A. This is the most effective strategy for minimizing risk and avoiding rework. QL-D and QL-C should be applied to the entire project area including areas not expected to be affected by future construction, (e.g., temporary staging areas) whereas QL-B can be targeted to the impacted area. QL-A investigations are required when depth data or precise horizontal location must be obtained to achieve project goals. QL-A should also be considered when the results of a QL-B investigation appear to be conflicting with existing utility records in key project areas.

How do I customize a SUE program for my specific requirements?

The SUE scope of work can vary greatly from project to project, and there are some key considerations for defining the scope of work. Ask these questions at the outset, and you'll be able to tailor a SUE program to your project-specific requirements.

1. What are the potential project risks associated with utility location information? Will utilities be involved directly or indirectly with the project?
2. What level of utility information should be obtained to adequately manage risks such as project cost overruns, construction and design delays, stakeholder impact, etc.?
3. At a project level, is there evidence to suggest the presence of buried objects or subsurface infrastructure?
4. Do the existing records contain inconsistencies? Is there evidence of additional utilities or buried structures not on record?
5. If utilities are not in the exact location as shown on the records, what risk might this pose to the project?
6. Will the project involve excavation and if so, what is the depth?
7. Is information on the vertical position (depth) of subsurface utilities or buried structures required to minimize risk or will information on the horizontal position suffice?
8. Is the project high risk for utility conflicts with existing or future utilities? e.g., new bridge construction or bridge widenings where footings are placed; projects involving daylighted utilities that will clearly conflict and require rework; excavation projects, particularly tunnel/grade separations where there is a conflict.

What should I think about in terms of schedule?

There are several factors that can affect the SUE schedule which should be considered in relation to your project's overall timeline. Examples of these factors include:

- Requesting data acquisition activities that reside outside the scope of SUE which may result in project delays. For example, chamber investigations may require traffic control, night work, special permits and on-duty police scheduling and fees.
- Other activities occurring on the project site, for example, topographical surveying, geotechnical or environmental assessments. Be sure to assess subcontractor project schedules for potential site access conflicts.
- The location of the SUE investigation. If the investigation occurs within a rail or congested vehicle corridor, traffic control and closures may be required. If, however, the investigation is related to a boulevard or private construction land, there will be far fewer time constraints.
- The time required to review QL-B data, and schedule test pits. Determining the necessity, quantity and location of test pits usually occurs after reviewing the completed QL-B investigation and subsequent CAD utility drawing.

What technology should be applied?

The CI/ASCE 38-02 Standard stipulates that “appropriate geophysical methods” be leveraged to carry out the Quality Level B aspect of a SUE program. As this is a generic statement, there is room for interpretation. The geophysical method that is primarily leveraged to carry out the Quality Level B aspect of a SUE program is Electromagnetic (EM) Induction – otherwise known as pipe and cable locating. This technique is extremely effective at locating utilities comprised of electrically conductive material or those that contain an intact tracer wire.

When data collected at the QL-D and QL-C stages of a SUE program reveals a likeliness that non-conductive utilities reside on the project site, such as concrete or plastic pipes, buried trunk sewers, etc., other methods can be leveraged to supplement the SUE scope of work such as Ground Penetrating Radar (GPR) which is highly effective at locating non-conductive buried assets.

What deliverables should I expect?

SUE deliverable formats can vary greatly based on project specifications. Municipalities, for example, each have their own CAD standards, and CAD drawings are submitted through the municipality's quality checker: a software tool that scans the submitted drawings to ensure they comply with the requirements of these standards.

Considerations for deliverables will include: whether data is to be reflected on separate layers or a single layer, labelling conventions, CAD software format (MicroStation or AutoCAD), digital submissions vs. hard copy, colour conventions, etc. The SUE report format may also vary based on whether the Project Manager desires photographs of test pits, test pit sketches, field sketches of utility locations, etc. When it comes to SUE deliverables, there's a lot of room for customization to meet the unique needs of the project. Having said that, deliverables should always be overseen and stamped by a Professional Engineer.

What should I look for in a SUE service provider?

The right certifications. SUE service providers must have a Certificate of Authorization from the Association of Professional Engineers of Ontario (PEO). As SUE involves geophysical activities, it is recommended, but not mandatory, that the service provider also have a Certificate of Authorization from the Association of Professional Geoscientists of Ontario (APGO). A Professional Engineer is required to approve, sign and seal SUE deliverables and a Professional Geoscientist oversees geophysical activities that comprise the SUE scope of work, for example, the application of Ground Penetrating Radar (GPR) and subsequent analysis of GPR data.

Relevant experience. SUE service providers should have experience locating all utility types required within the impacted area and also have verifiable experience completing projects of similar size and scope. Expertise in a range of technologies is required – Electromagnetic Induction, Ground Penetrating Radar (GPR), sonding, surveying, Global Positioning Systems (GPS), Geographic Information Systems (GIS), etc. Certifications to look out for include Damage Prevention Technician (DPT) certification, and relevant safety certifications including First Aid, WHMIS, Confined Space Entry (CSE), Confined Space Rescue, and Working at Heights, to name a few.

Advanced experience with Ground Penetrating Radar and related technologies. Where non-conductive utilities and features are believed to be within the project area, such as plastic, fiber optic, cable TV lines, water and concrete sewer lines, foundations, ducts and chambers, expertise in the application of Ground Penetrating Radar is key. GPR data can yield a cross section of subsurface utilities and can also be depicted three dimensionally, providing data on the actual depth of utilities.

The ability to innovate when challenges arise. As SUE projects vary greatly in size and scope, unique and unexpected challenges can arise. Many variables can affect the ability to collect data such as broken tracer wires, soil conductivity, or the presence of water that makes it difficult to achieve a signal. It's important to partner with a service provider that has experienced these challenges before and can innovate to overcome them.