Subsurface Utility Engineering

A White Paper

ASCE/UESI/CI 38-22

Practical guidance for defining, sequencing, applying and documenting Subsurface Utility Engineering investigations.

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1.0 Description

Subsurface Utility Engineering (SUE) is an engineering practice used to investigate, document and communicate information about existing subsurface utilities in support of planning, design and construction decisions. A well-planned SUE program helps a project team understand what utilities may be present, where they are located, how reliable the available information is, and where additional investigation is warranted.

SUE is based on ASCE/UESI/CI 38-22, Standard Guideline for Investigating and Documenting Existing Utilities. The standard replaces CI/ASCE 38-02 and retains the four familiar Utility Quality Levels — D, C, B and A — while expanding requirements and guidance related to investigation, utility attributes, depth information, documentation, geophysical methods and professional judgment.

The Quality Levels should not be treated simply as four labels applied to an entire project. Different utility features or segments within the same project may be supported by different levels of information. In practical application, however, the investigation commonly progresses from existing information to visible surface evidence, then to geophysical investigation, and finally to direct exposure where the project requires greater positional certainty.

The purpose of this white paper is to provide practical guidance on defining and applying a SUE scope of work. It is intended to help owners, designers and project teams determine the appropriate extent of investigation for the decisions that must be made.

Several related data-acquisition activities may support a utility investigation but do not, by themselves, define a SUE Quality Level. These can include chamber and invert investigations, Closed Circuit Television (CCTV) sewer inspection, sonde locating, pole camera inspection and confined space entry. These activities are discussed later in this document.

Utility investigations combine available information, field observations and targeted investigation to support project decisions.

2.0 Considerations for Determining the SUE Scope of Work

The appropriate SUE scope can vary substantially from project to project. The objective is not to obtain the highest level of utility information everywhere; it is to obtain sufficient, reliable information in the locations where utility uncertainty can affect project decisions.

The following questions should be considered at the outset:

1. What work is proposed, and where can existing utilities affect the design, staging, construction methodology or project schedule?
2. What utility information is required to support the decisions that must be made at the current design stage?
3. What are the project limits, and what smaller investigation or impact limits can reasonably be defined within them?
4. What utility types are known or suspected to be present based on records, prior investigations and local knowledge?
5. Are the available records complete, current and internally consistent, or are there discrepancies, gaps or indications of utilities not shown on record?
6. What visible utility features are present, and do they support or conflict with the available record information?

7. Where is QL-B investigation required to establish horizontal utility information with sufficient confidence for design?
8. What utilities or portions of the site may not be detectable by a single geophysical method, and what combination of methods may be appropriate?
9. Does the design require depth information? If so, what level of reliability is required for the particular decision?
10. Where would precise horizontal and vertical information materially affect a design decision, such as determining whether proposed work can pass above or below an existing utility?
11. Are grade changes, structures, foundations, excavations or other proposed works close enough to existing utilities that direct exposure should be considered?
12. What would be the project consequence if a utility is found to be materially different from the available information — for example, requiring redesign, owner coordination, relocation engineering, service continuity planning or schedule changes?

3.0 Approach

Professional Practice in Ontario

Where the scope constitutes professional engineering services offered or provided to the public in Ontario, the entity providing those services must operate under a Certificate of Authorization from Professional Engineers Ontario (PEO). Professional engineering work must be carried out under the responsibility of appropriately licensed professionals and engineering documents must be reviewed, authenticated and sealed where required by the Professional Engineers Act and its regulations.

Where work constitutes the practice of professional geoscience in Ontario, applicable requirements of Professional Geoscientists Ontario (PGO) also apply. Corporations and other entities that offer or provide professional geoscience services to the public are generally required to hold a PGO Certificate of Authorization. Geophysical activities that fall within professional geoscience should be undertaken under appropriate professional responsibility.

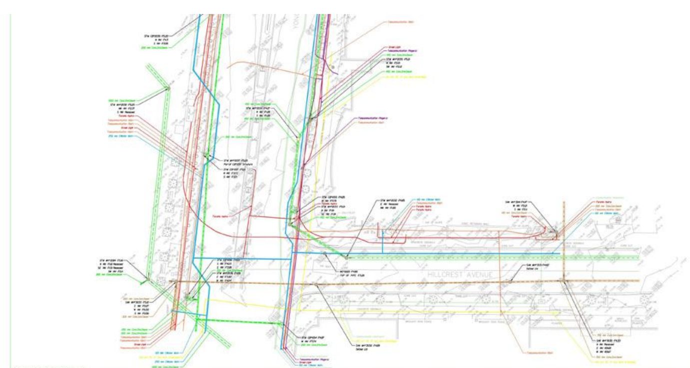
In addition to professional authorization, the SUE consultant should have demonstrated experience with the utility types, investigation methods, project environments and deliverable requirements relevant to the assignment.

Utility Management Standards and Practices

ASCE/UESI/CI 38-22 — Standard Guideline for Investigating and Documenting Existing Utilities

ASCE 38-22 provides a standardized framework for investigating and documenting existing utilities. It functions both prescriptively, by identifying minimum actions associated with Utility Quality Level documentation, and as a performance standard, by recognizing the professional judgment required to determine the appropriate timing, sequencing, location and scope of an investigation.

The standard retains the four Utility Quality Levels while placing greater emphasis on the utility feature or segment being documented, the evidence supporting the assigned Quality Level, utility attributes, depth information, investigation limitations and clear communication of the results.



Example of a composite utility drawing integrating information collected through the SUE process.

Quality Level	Primary Basis	Practical Role
QL-D	Existing records, documentation and relevant recollections	Establishes what utilities are known or suspected to exist and provides the starting inventory for the investigation.
QL-C	Visible surface utility features and field observations correlated with available information	Adds physical evidence such as maintenance holes, hydrants, valves, pedestals, poles and other appurtenances that help interpret buried systems.
QL-B	Appropriate surface geophysical investigation, interpreted in the context of QL-D and QL-C information	Establishes the existence and horizontal position of detectable utilities within the defined investigation limits.
QL-A	Direct exposure and measurement of the utility, or qualifying prior exposure information where applicable	Provides precise horizontal and vertical position and observable utility attributes at specific locations where that certainty is required.

A single project can contain utility segments at different Quality Levels. The Quality Level assigned to a feature or segment should reflect the investigation and supporting information applicable to that feature or segment, rather than being treated as a blanket designation for the entire project.

CSA S250 — Mapping of Underground Utility Infrastructure

CSA S250 provides requirements and guidance for the mapping, recording, storage and exchange of underground utility infrastructure information. The current edition should be considered where project requirements include utility mapping, records management, as-built information, data exchange or long-term infrastructure record improvement. Its application should be determined in relation to the specific project deliverables rather than assumed to require QL-A investigation across an entire SUE project.

Other Applicable References

Depending on the assignment, additional standards and guidance may apply, including current ASTM guidance for selecting and applying surface geophysical methods, applicable survey standards, client CAD or digital delivery standards, and owner-specific utility mapping requirements.

4.0 Application of SUE Quality Levels

A SUE investigation develops utility information progressively. The practical sequence is important because the field investigator cannot reliably determine whether the expected utility population has been investigated without first understanding what may be present and what surface evidence exists.

> **Practical principle: QL-D tells the investigator what may be present. QL-C adds visible evidence of how those systems relate to the site. QL-B uses that information to guide the geophysical investigation. QL-A is then applied where direct exposure and measurement are warranted by the project decision.**

Quality Levels D, C and B — An Integrated Investigation

QL-D records research should establish the known and suspected utility population within the relevant project or investigation limits. The objective is not simply to collect drawings; it is to understand which utility owners and systems may be present, how many separate facilities may exist, where record information conflicts, and where information is incomplete.

QL-C follows by observing and, where required, surveying visible surface features that provide evidence of buried systems. Maintenance holes, valve boxes, hydrants, pedestals, poles, transformers, chambers and other features can confirm, refine or challenge the record picture.

This combined QL-D and QL-C information provides the field investigator with the context needed to conduct a thorough QL-B investigation. Detecting one line does not establish that all utilities of that type have been found. For example, an urban corridor may contain several generations of telecommunications infrastructure — older copper, DSL-era facilities, fibre and abandoned plant — on one or both sides of the road and sometimes only a short distance apart. Records and visible features help establish how many separate facilities should reasonably be investigated.

Accordingly, QL-B should generally be undertaken with the benefit of available QL-D and QL-C information. A geophysical sweep conducted without that context may locate detectable utilities, but it provides a weaker basis for determining whether the expected utility systems have been completely investigated.

Defining the Level of Effort

The progression of the Quality Levels does not mean that every project requires the same investigation intensity or that every utility requires QL-A. The extent of each activity should be proportionate to the project need.

A dense urban reconstruction corridor may warrant extensive records research, field correlation and broad QL-B coverage because multiple utilities, generations of infrastructure and design alternatives must be considered. A rural gravel road may have a much smaller utility population and require a narrower effort once QL-D and QL-C have established what is likely to be present.

Similarly, the investigation should be relevant to the proposed work. A shallow construction activity may not require detailed information on a deep trunk sewer that cannot reasonably affect the work. A building project may require detailed utility information around the site and proposed servicing routes without requiring kilometres of approaching corridor data.

As the investigation progresses, additional evidence generally increases the quality, confidence and positional certainty of the information available to the project. Where the project elects not to obtain information that could materially affect a design or construction decision, the resulting uncertainty remains with the project.

Quality Level A — Applying Precision Where It Matters

QL-A should be applied where direct exposure and precise horizontal and vertical measurement are required to support a specific project decision. It is not necessary simply because a utility exists; it becomes important when uncertainty in the utility position can change the design, project sequence or utility coordination requirements.

Depth information can be obtained or inferred from several sources, including records, geophysical observations and direct measurement. Those sources do not provide the same degree of positional certainty. Where the design must know, for example, whether proposed infrastructure can pass above or below an existing gas main, QL-A may be warranted to directly expose and measure the utility.

This distinction can be significant. If the verified position shows that the proposed design cannot clear the gas main, the project may need to engage the utility owner's engineering group, evaluate relocation, obtain approvals, coordinate staging and service continuity, and revise the project schedule. In that circumstance, obtaining precise information early can be far more valuable than carrying the uncertainty into later design.

QL-A direct exposure provides precise horizontal and vertical measurement where the project decision requires that level of certainty.

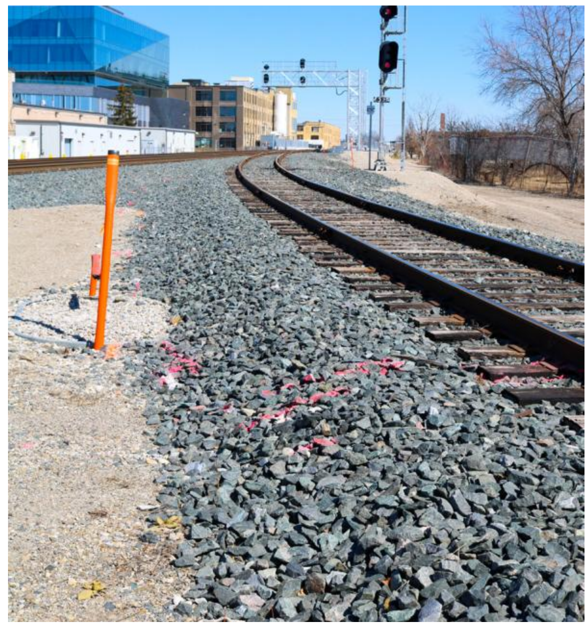
Consider QL-A where one or more of the following apply:

- Precise horizontal and vertical position is required to confirm a design clearance or crossing.
- QL-B information conflicts with records, visible features or other project information in a location important to design.
- A utility is sufficiently close to proposed foundations, structures, excavation, grading or other work that positional uncertainty can change the design decision.
- A potential utility relocation could have substantial cost, schedule, owner-coordination or service-continuity implications.
- A utility could not be confidently resolved through QL-D, QL-C and QL-B investigation.
- The project requires direct confirmation of utility size, material, configuration or other observable attributes at a specific location.

5.0 SUE Timing

The timing of a SUE program should be coordinated with the overall design process. Utility information has the greatest value when it is available early enough to influence design, but the sequence of investigation should also allow each stage to inform the next.

- Records acquisition can require lead time, particularly where multiple utility owners or historical sources are involved. This should be considered in the project schedule.
- Topographic survey, geotechnical, environmental and other field programs should be coordinated where practical so that useful information can be shared and site access conflicts minimized.
- QL-B and QL-A fieldwork can be affected by traffic conditions, rail corridors, permits, access restrictions, seasonal conditions and other site-specific constraints.



Site conditions such as rail corridors can materially affect access, scheduling and investigation methodology.

- The need and location of QL-A test holes are often best determined after QL-B results have been reviewed against records, visible features and the developing design. Time should be allowed for this review and for subsequent utility-owner coordination or permitting where required.
- Related activities such as chamber entry, CCTV inspection or specialized investigations may require additional access planning and should be scheduled according to their value to the design decision.

6.0 SUE Scope

Each SUE assignment should begin with a clear understanding of the project objectives, proposed design activity, investigation limits, available information and expected deliverables. A project kick-off meeting is recommended for assignments of sufficient size or complexity.

Topics should include, as applicable:

- Project description, current design stage and proposed work.
- Project limits and the specific investigation or impact limits within them.
- Known existing and proposed utilities and any available utility-owner information.
- Available records, surveys, prior SUE information and other relevant project data.
- Required Utility Quality Levels and the project decisions those levels are intended to support.
- Expected treatment of utilities or areas that cannot be resolved to the intended Quality Level.
- Proposed investigation methods, including the potential need for multiple geophysical techniques.
- Potential QL-A locations or the process for selecting them after QL-B review.
- Survey control, coordinate system, datum and client digital-delivery requirements.
- Expected drawings, reports, test-hole information, photographs, metadata and other deliverables.
- Site access, traffic control, permits, third-party coordination and schedule constraints.
- Roles, professional responsibilities, quality-management requirements and review procedures.

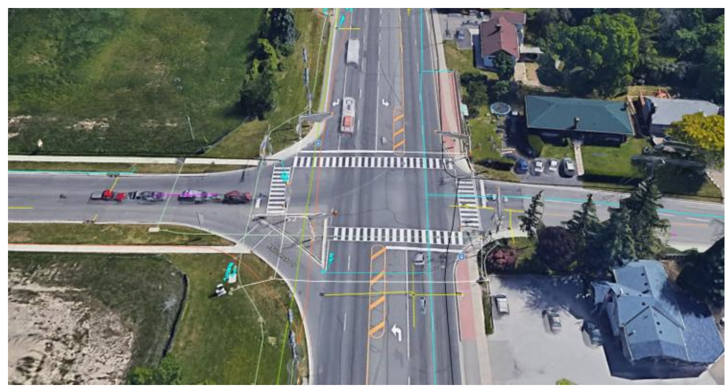
Existing topographic surveys can be valuable inputs to the QL-C process, particularly where visible utility features were surveyed. However, the existence of a topographic survey should not automatically be taken to mean that all requirements of QL-C have been satisfied. The SUE consultant should review the survey, confirm its scope and currency, and complete any additional field observation, correlation or survey necessary for the utility investigation.

7.0 Deliverables

SUE deliverables should communicate not only where utility information is depicted, but also the basis, Quality Level, limitations and relevant attributes associated with that information. The required format should be defined in the procurement or project requirements and coordinated with applicable client CAD, MicroStation, GIS or digital-delivery standards.

Utility Drawing / Digital Utility Model

Collected and interpreted utility information is compiled into the project drawing or digital model in accordance with the client's standards. Utility features or segments should be depicted at the appropriate Quality Level and should preserve clear traceability to the information supporting the interpretation.



Utility information can be compiled into project drawings and digital deliverables in accordance with client requirements.

Depending on project requirements, the deliverable may include:

- Utility type, owner and status where known.
- Utility Quality Level assigned to the applicable feature or segment.
- Survey datum, coordinate system and project control information.
- Relevant utility attributes available from the investigation.
- QL-A test-hole locations and measured information.
- Limits of investigation and areas where the requested investigation could not be completed.
- Known unresolved discrepancies, non-detectable utilities, inaccessible areas or other

limitations important to the use of the information.
- Dates and/or source information necessary to understand when and how the utility information was obtained.

SUE Report

Where a report is required, it should provide sufficient context for the project team to understand the investigation, findings, limitations and recommended next steps. The required content may vary with the project, but commonly includes:

- Cover page and project identification.
- Project overview and investigation objectives.
- Reference to ASCE/UESI/CI 38-22 and other applicable project standards.
- Description of available records and other source information reviewed.
- Field investigation and survey methodology.
- Geophysical methods used and relevant limitations.
- Discussion of findings, discrepancies and unresolved utility information.
- Description of investigation limits and areas not investigated or not fully resolved.
- QL-A test-hole information, where applicable.
- Drawings, field documentation, photographs and supporting data as required.
- Conclusions and recommendations for additional investigation where unresolved information could materially affect the project.
- Professional authentication in accordance with applicable Ontario requirements.

QL-A Test-Hole Documentation

QL-A documentation should identify the exposed utility and record the measured information required by the project. Depending on the scope, this may include test-hole identification, location, XYZ coordinates, ground elevation, depth to top and/or bottom, utility size, material, configuration, observable condition, excavation dimensions, photographs and notes regarding the exposure.

8.0 SUE-Related Data Acquisition Activities

The following activities may support a utility investigation when additional information is required. They should be scoped according to the project need and should not automatically be assumed to establish a Utility Quality Level on their own. Their results should be integrated with the broader utility investigation where relevant.

Invert and Chamber Investigations

Chamber investigations can provide information such as sewer type, invert elevation, pipe material and diameter, chamber size, offsets and configuration. Some chambers can be investigated from the surface, while others may require additional access methods. The value of the information should be considered in relation to the design need and the access effort required.

Closed Circuit Television (CCTV) Sewer Inspection

CCTV inspection can investigate sewer mains, maintenance holes, chambers and lateral connections. Video inspection can provide information on pipe condition and configuration, while associated sonde or other locating techniques can assist with surface positioning of otherwise non-toneable sewer infrastructure.

CCTV and related inspection methods can supplement a utility investigation where additional sewer or chamber information is required.

Pole Camera Investigation

Pole cameras can be used from the surface to inspect maintenance holes, chambers, pipe connections and other underground features. They can assist in understanding chamber configuration, pipe direction and visible utility conditions where direct entry is not required.

Sonde Locating

A transmitting sonde can be inserted or pushed through suitable non-toneable pipes and tracked from the surface using compatible electromagnetic locating equipment. Pipe configuration, depth, access, debris and other site conditions can affect the method's effectiveness.

Confined Space Entry

Where required to obtain information that cannot reasonably be collected from the surface, confined space entry may be undertaken by appropriately trained and equipped personnel in accordance with applicable requirements. The need for entry should be established by the information required from the chamber or structure.

9.0 SUE Technology

ASCE/UESI/CI 38-22 recognizes the use of appropriate geophysical methods as part of utility investigation and includes expanded guidance on geophysical techniques. No single technology can reliably detect every utility in every environment. Method selection should therefore be based on the expected utility types, construction materials, available records, surface features, soil and surface conditions, utility congestion, access and the information required by the project.

Electromagnetic locating remains highly effective for conductive utilities and facilities with an intact tracer wire or other conductive path. It may be less effective or ineffective for non-conductive utilities, broken tracer wires, poor grounding conditions, congested corridors and other site-specific circumstances.

Ground Penetrating Radar (GPR) can be an important complementary method because it does not depend on an electrically conductive path. Its effectiveness is influenced by soil properties, moisture, surface conditions, depth, target size, utility material, clutter and the contrast between the target and surrounding materials.

GPR and other field methods can complement electromagnetic locating where utility characteristics and site conditions warrant additional investigation.

Other geophysical techniques may be appropriate for particular conditions and targets. The selection and interpretation of methods should be undertaken by qualified personnel using the available QL-D and QL-C information to guide the investigation.

Related non-geophysical techniques — such as CCTV, sonde locating, chamber inspection and direct exposure — can provide additional information where geophysical methods alone cannot resolve the project question.

The objective is not to apply every available technology on every project. The objective is to select a combination of methods and an investigation extent that provides sufficient information for the decisions the project needs to make, while clearly documenting the limitations and unresolved areas that remain.

10.0 Closing Guidance

A successful SUE program is not defined by applying the highest Quality Level everywhere. It is defined by collecting and integrating the information necessary to understand the existing utility environment and support the project decisions that matter.

In practical terms, the investigation should begin with records, proceed to visible surface evidence, use that information to guide the geophysical field investigation, and apply direct exposure where greater positional certainty is warranted. The limits and level of effort should remain proportionate to the project, the design stage and the potential consequence of unresolved utility information.

QL-D establishes what may be present.

QL-C adds observable field evidence.

QL-B investigates horizontal position using appropriate geophysical methods informed by that evidence.

QL-A provides direct exposure and precise measurement where the project decision requires that level of certainty.

Primary Standards and Regulatory References

- American Society of Civil Engineers (ASCE). ASCE/UESI/CI 38-22, Standard Guideline for Investigating and Documenting Existing Utilities.
- CSA Group. CSA S250, Mapping of Underground Utility Infrastructure (current edition applicable to the project).
- Professional Engineers Ontario (PEO). Certificate of Authorization and professional practice requirements.
- Professional Geoscientists Ontario (PGO). Certificate of Authorization and professional geoscience practice requirements.

Note: This white paper is practical guidance and is not a substitute for the full text of the applicable standards, legislation, regulations, client specifications or professional practice requirements.