# Subsurface Utility Engineering

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Subsurface Utility Engineering (SUE) is the practice of locating and mapping of underground utilities, surveying the information obtained and producing a drawing that is representational of what utilities exist underground. Utilities that are buried underground can be the most critical element during the design and construction process. If these utilities are bypassed when the design and construction planning are underway, cost estimates and schedules will often have to be adjusted well after the conceptual phases of project management have come and gone. Because utilities are frequently added, relocated or removed it has proven very difficult for these owners to have an accurate record of them. The benefit of having SUE information includes giving the excavator additional resources to keep the project successful, minimize cost by preventing damage to the utility and maintaining a good relationship with the public by minimizing utility service disruptions. Projects which might benefit from SUE are ones that include utility maintenance, new utility installation, demolition of existing structures or construction of new structures, new roadway pavement, pavement improvements and traffic control device installation.

SUE can be used by a client, such as an engineering firm when the information sought may provide key details required to make correct and effective decisions during the design phase of the project and not at the point when the contractor has already mobilized and begun work. The unseen information can help avoid utility conflicts, reduce change orders in the field and help the contractor maintain the critical path and stay within project budget.

Subsurface utility engineering as defined by the ASCE is a branch of engineering practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies and utility design. SUE incorporates traditional engineering practices such as utility records research, relocation cost estimates, utility relocation design and plotting utilities from records.

Two terms must draw distinction when discussing elements of SUE deliverables. Designation is the science of searching for a utility via subsurface geophysical means to gain information as to the alignment and depth of the utility. Location is the actual exposing of the utility for survey so that precise geophysical coordinates and elevations are acquired based on a known survey datum. These distinctions are clearly defined in the different quality levels of utility identification that are delivered to the client.

Four Quality Level attributes are attached to plotted utilities indicating how the utility data is developed. Utilities identified as Quality Level D are plotted based on available utility records, verbal testimony and indications made from field visits. Utilities identified as Quality Level C have been identified based on surface appurtenances, such as valves, manholes, vent pipes and then the Level D information is correlated with these surveyed surface features. Quality Levels C and D are still considered incomplete when the utility needs to be "located". Quality Level B includes the act of "designating" utilities based on geophysical instrumentation. Finally, "locating" a utility by Quality Level A SUE involves non-destructive excavation by means of air-vacuum or water. This excavation creates a small test hole in which each utility can be identified in size, material, depth or cover and location. Quality Level A SUE is the most accurate and also the most expensive method.

So the engineer or even the contractor with his conceptual estimate and schedule may begin to determine if there is enough money to mitigate the risk of unknown underground utilities. Thus, a decision must be made as to which utilities should be designated and which ones should be located.

Level B SUE designation incorporates the science of transmitting a signal to a utility using conduction (metal to metal) or induction and receiving a return signal from that utility. However, it is not just a matter of designating a utility by means of signal transmission. Correct designating takes into account the physical characteristics of the utility system which impact the accuracy and knowing which field conditions can be overcome and which ones can cause impedance. Successful designating also takes into account the metallic continuity of various types of utilities, that is, knowing what to hook on to and what not to hook on to.

Factors which affect designating are types of soil, moisture content of the soil, proximity of other utilities, depth of target utility and presence of other metallic objects, such as rails, guy wire anchors and even chained link fences.

The electromagnetic spectrum encompasses a wide range of frequencies (30 kHz to 300,000 MHz). SUE uses a small window in this spectrum to locate utilities but can span a range from as low as 8 kHz to as much as 500 kHz.

However, the higher the frequency the higher the risk in finding the utility that is being sought. The higher frequencies (considered radio frequencies) should be confined to situations where lower frequencies do not work and where there is a low chance for energizing nearby conductors that will distort the signal and misinform the 'locator'.

Lower ranges of frequency, the audio frequencies, are the most successful frequencies in designating. Characteristics of this frequency include the following: resistance to energizing stubs, dead-ends and poorly grounded utility laterals. This range is useful in identifying utilities that are in congested areas because of the ability to limit the effects of in-ground induction.

For conductive designation, some utilities are installed in the ground with tracer wires that provide the most direct circuit. The transmitter's signal can not follow any other path other than the feeder cable itself, which is adjacent to the utility. This minimizes conductance from other sources and is extremely helpful when the locator needs to record a depth. Other utility material factors that effect designation are conductivity of material, size of material, continuity, grounding, splices, joints or transitions and insulation.

Inductive conduction is made transmitting a signal without metal to metal contact with the utility by placing the transmitter directly on the ground or by using inductive clamps. An inductive signal can travel along a metallic conductor. The transmitter must be directed properly over the utility to induce a signal onto the buried utility. What the locator is trying to accomplish in either method is a complete circuit between the transmitter (source), the utility (the medium) and the grounding device (closed door) by introducing a current through the earth (another medium). The earth and the utility have enough capacitance to transfer the energy through the complete circuit. Frequency selection is important in order that only the capacitance being targeted is from the utility being designated. Designating requires field experience and resource utilization.

Quality Level A Utility Location is the most accurate means of mapping a utility but it requires the utilization of the other three levels in order to pick the right test hole location. It can be used in all kinds of soil, and can even be used under concrete. If Levels B, C and D are used correctly, one will have a utility to map once the earth or pavement is temporarily removed and the utility is exposed.