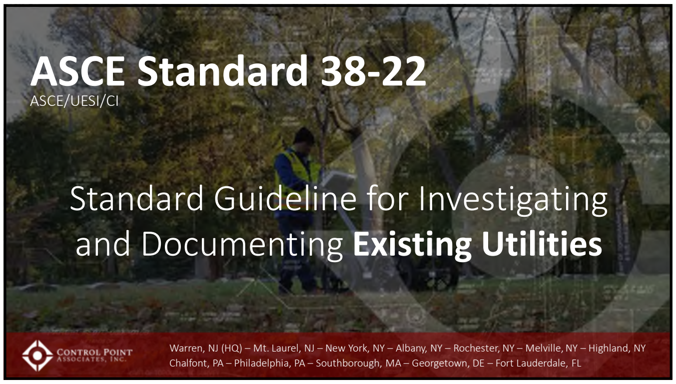
ASCE Standard 38-22
ASCE/UESI/CI
Standard Guideline for Investigating and Documenting **Existing Utilities**
CONTROL POINT ASSOCIATES, INC.
Warren, NJ (HQ) – Mt. Laurel, NJ – New York, NY – Albany, NY – Rochester, NY – Melville, NY – Highland, NY
Chalfont, PA – Philadelphia, PA – Southborough, MA – Georgetown, DE – Fort Lauderdale, FL

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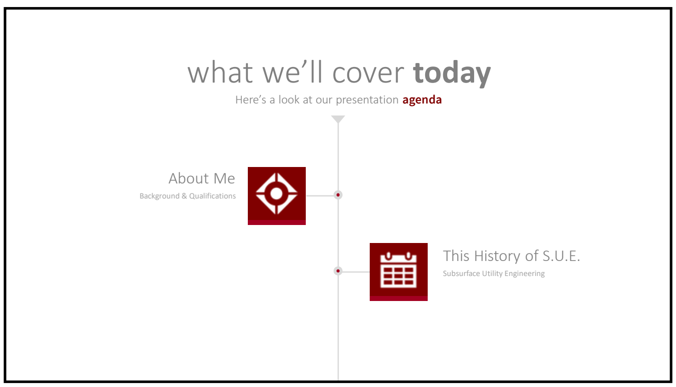
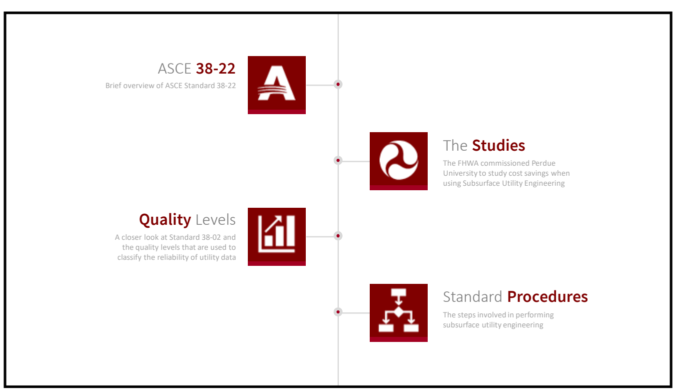

what we'll cover **today**
Here's a look at our presentation **agenda**
About Me
Background & Qualifications
This History of S.U.E.
Subsurface Utility Engineering

2


ASCE **38-22**
Brief overview of ASCE Standard 38-22
The **Studies**
The FHWA commissioned Perdue University to study cost savings when using Subsurface Utility Engineering
Quality Levels
A closer look at Standard 38-02 and the quality levels that are used to classify the reliability of utility data
Standard **Procedures**
The steps involved in performing subsurface utility engineering

3

Equipment & Technology

There is a wide variety of equipment and technologies available to collect different quality levels of utility data

Final Thoughts & Questions

Where is the industry headed and what to expect in the future

Final **Exam**

(just kidding)

4

Today's **Agenda**

- What is ASCE/UESI/CI 38-22?
- What are the benefits?
- Quality Levels Explained
- Equipment & Technologies
- Call 811 is not QL-B
- Question & Answer

- 1 Continuing Education credit hour
- Must complete 50 question final examination to qualify.
- Just kidding…

5

THE HISTORY OF
SUBSURFACE UTILITY ENGINEERING

6

Michael Faraday

Electromagnetic Theory; **1831**

Electromagnetic technology was discovered by famed British scientist Michael Faraday in 1831, laying the foundation for electromagnetic theory. Shortly after its discovery, electromagnetic tools were first used to detect underground utilities and faults in 1910. The technologies continued to improve over the next few decades, and the demand for utility locating skyrocketed as more and more utilities were buried under growing cities and municipal centers.

7

Christian Hülsmeyer

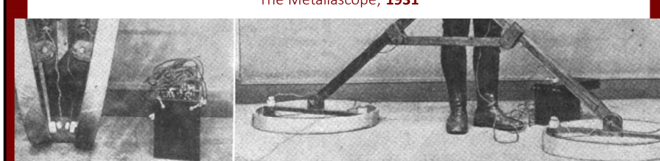
The First Radar Device; **1904**

The foundation for radar systems in general was laid by Christian Hülsmeyer when he obtained the worldwide first patent in radar technology on April 30, 1904. Six years later in 1910 Gotthelf Leimbach and Heinrich Löwy applied for a patent to use radar equipment to locate buried objects. This system used surface antennas together with a continuous-wave radar. In 1926, a pulse radar system was introduced and filed for a patent by Dr. Hülsenbeck which improved the depth resolution and is still widely used today.

8

1931 Dr. Gerhard R. Fisher

The Metallascope; **1931**



In 1931 Dr. Gerhard R. Fisher founded Fisher Research Labs in his garage in Palo Alto, Calif. He and four employees produced the "Metallascope," a rugged, easy-to-use metal detector. By today's standard of lightweight handheld detectors, it was an ungainly device with two large, flat wooden boxes containing simple copper coils, five vacuum tubes and a few assorted components. The Metallascope soon captivated the imagination of the country, and within a short time, the world.

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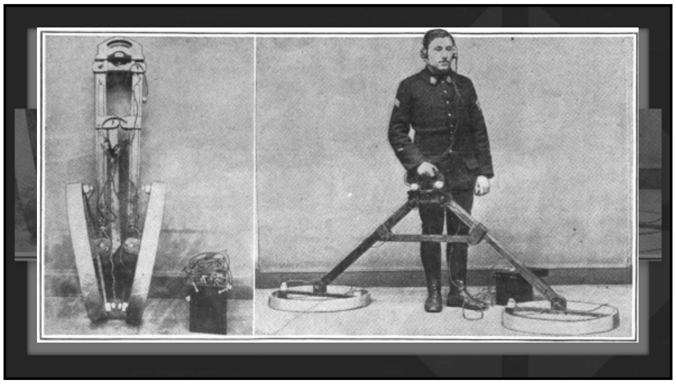


10

Federal Highway Administration

Adopts and Promotes use of SUE; **1987**

The Federal Highway Administration (FHWA) has been promoting the use of Subsurface Utility Engineering since 1987 as a means to reduce costs associated with underground utility conflicts on Federal Highway Construction Projects. The FHWA is credited with much of the industries current day presence.

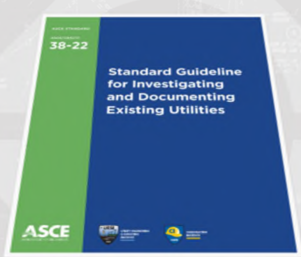
11

WHAT IS ASCE/UESI/CI 38-22?

SUBSURFACE UTILITY ENGINEERING

Standard 38-22 provides guidelines for how utility data is **collected and depicted** on drawings.

4 “Quality Levels” are used to classify the reliability or **accuracy of utility information** that exists on drawings.



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WHY IS ACCURATE UTILITY DATA IMPORTANT?

13

*Nearly **20 Million Miles** of underground pipelines, cables and sewers have been constructed since World War II with an average lifespan of 20-50 years.*

14

*World War II ended **78 Years Ago***

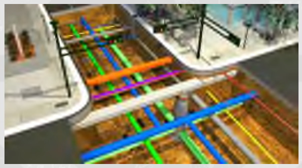
15

THE **DEMAND** FOR ACCURATE **DATA**

Many design and construction projects are taking place in areas where **underground utilities already exist**, such as in cities, process plants, airports, highways, and so forth.

These existing utilities **create risks** for the project owner, designer, contractor, and the general public.

Although there are many reasons for these risks, one of the fundamental reasons is that accurate data on the location, and even sometimes on the existence of these out-of-sight utilities, is rare.



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POOR UTILITY RECORDS

Existing records of underground site conditions are usually incorrect, incomplete, or otherwise inadequate because:

- They were **not accurate in the first place**: design drawings are not as-built, or installations were field run, and no record was ever made of actual locations;
- On old sites, there have usually been **several utility owners**, architects/engineers, and contractors installing facilities and burying objects for decades in the area. Seldom are the records placed in a single file, and often they are lost. There is almost never a composite;
- **References are frequently lost**: records show that an object is a certain distance from a building that is no longer there, or an object is a certain distance from the edge of a two-lane road that is now four lanes or is part of a parking lot;
- **Changes & updates occur** without proper utility record updates. Utility lines, pipes, and tanks are removed from the ground, but aren't removed from the drawings.

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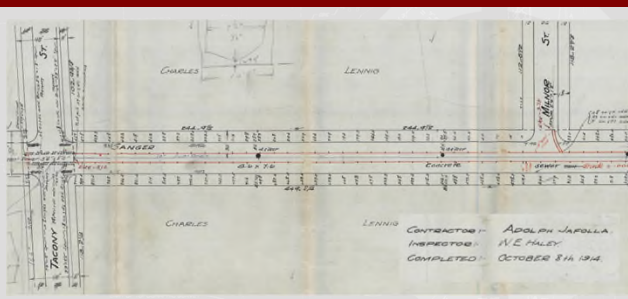
OUTDATED UTILITY RECORDS



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PURDUE UNIVERSITY STUDY

The Federal Highway Administration (FHWA) commissioned Purdue University in 1996 to study the effectiveness of subsurface utility engineering (SUE) as a means of **reducing costs and delays** on highway projects.

The concepts and practice of SUE have been developed and refined over many years, but basically were systematically put into professional practice in the 1980s.

PURDUE UNIVERSITY

U.S. Department of Transportation Federal Highway Administration

19

PURDUE UNIVERSITY STUDY

A total of **seventy-one (71) projects** from Virginia, North Carolina, Texas, and Ohio were studied. The combined construction costs of these projects totaled over one billion dollars.

These projects involved a mix of Interstate, Arterial, and Collector Roads in urban, suburban, and rural settings. DOT project managers, utility owners, constructors, and designers were interviewed. Two broad categories of savings emerged: **quantifiable** savings and **qualitative** savings.

20

PURDUE UNIVERSITY STUDY

The results are in:

A total of **$4.62 in savings** for every $1.00 spent on SUE was quantified.

Only **three projects** returned less in savings than expenditures.

Reduced project costs related to the risks associated with existing subsurface utilities and should be used in a systemic manner.

21

PENN STATE UNIVERSITY STUDY

A more recent study conducted in 2007 by the Pennsylvania Transportation Institute at PSU studied **10 PennDOT projects.**

The study concluded that there was an average **cost savings of $22.21** for every $1.00 spent on Subsurface Utility Engineering.

Improvements in standard processes, procedures, and technologies have helped to **increase ROI over time.**

22

ADDITIONAL **BENEFITS** OF SUE

- ✓ Increased Project **Safety**
- ✓ Reduction in unforeseen utility conflicts and relocations;
- ✓ **Reduction in project delays** due to utility relocates;
- ✓ Reduction in claims and change orders;
- ✓ Reduction in delays due to utility cuts;
- ✓ Reduction in project contingency fees;
- ✓ Lower project bids;
- ✓ Reduction in costs caused by conflict redesign;
- ✓ Reduction in the cost of project design;
- ✓ Reduction in travel delays during construction to the motoring public;
- ✓ Improvement in contractor productivity and quality;
- ✓ Reduction in utility companies' cost to repair damaged facilities;
- ✓ Minimization of utility customers' loss of service;
- ✓ Minimization of damage to existing pavements;
- ✓ Minimization of traffic disruption, increasing DOT public credibility;
- ✓ Improvement in working relationships between DOT and utilities;
- ✓ **Increased efficiency of surveying activities** by elimination of duplicate surveys;
- ✓ Facilitation of electronic mapping accuracy;
- ✓ Minimization of the chance of environmental damage;
- ✓ Inducement of savings in risk management and insurance;
- ✓ Introduction of the concept of a comprehensive SUE process;
- ✓ Reduction in Right-of-Way acquisition costs.

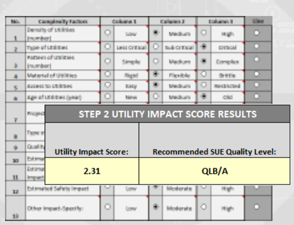
23

WIDELY UTILIZED BY **STATE DOT's**

PennDOT – Acceptable utility data quality level is determined using the SUE Utility Impact Rating Form

DelDOT – Statewide SUE open-end contracts with multiple firms.

MDDOT SHA – SUE is utilized on Every Highway Project regardless of size or presence/absence of utilities.



24

KNOWLEDGE IS **POWER**

Not knowing the location of underground utilities is **dangerous.**

Safety Issues | Project Delays | Utility Damages | Bad Publicity

25

CURRENT REQUIREMENTS

Currently, there is not much oversight or regulations in place for companies providing Subsurface Utility Engineering services.

As the process of providing SUE services advances in technology and techniques, stricter regulations will become more prevalent.

26

THE SUE **ASSOCIATION**

- The Subsurface Utility Engineering (SUE) Association was organized in 2018 to promote **knowledge, best practices, and the exchange of information** in the profession.
- Legislative representation in Congress and before state and local government and regulatory bodies;
- Developing **certification program** for SUE companies
- SUE-specific continuing educational programs, and information-packed conferences, seminars and workshops;

Subsurface Utility Engineering Association

27

STRICTER REQUIREMENTS

The State of Colorado signed into law on May 25, 2018 **Senate Bill 18-167** requiring the use of Subsurface Utility Engineering when a:

- Project involves a construction contract with a **public entity**;
- Project involves primarily horizontal construction and does not involve primarily the construction of buildings;
- Project has anticipated excavation footprint that exceeds 2 feet in depth and that is a contiguous 1000 square feet (excluding fencing and signing projects) OR involves utility directional boring; and
- Project requires the **design services of a licensed PE.**

28

SUE SERVICES **VS. OTHERS**

STATEWIDE **CALL 811**	PRIVATE UTILITY **LOCATING**	SUBSURFACE UTILITY **ENGINEERING**
Risk-based system designed to prevent utility damages during excavation.	Focused on preventing damage to any **detectable utility** within the project.	Entirely focused on providing the **highest level** of utility data possible.
Utility Companies only responsible to mark utilities they own or maintain.	Will mark out all utilities regardless of ownership, both private and public.	Projects are treated as investigations and **not limited** to only field work.
Call 811 markings typically account for approximately **60% of all underground utilities** on any given project.	Most companies are unable to survey markings **within tolerance** in accordance with ASCE 38-22.	Utilities **are surveyed** within appropriate tolerances under the supervision of licensed professional.
Not in the business of providing **useful utility data** for engineering decisions.	Rarely provide useful utility data except for utility type and painted location.	Provide **documentation of investigation** in addition to a standard field sketch (utility report).

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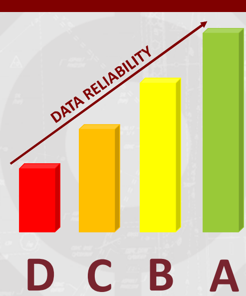
UTILITY DATA QUALITY LEVELS

The **reliability of utility data** depicted on a drawing is classified using one of four possible quality levels. Quality Level D data is the least reliable, whereas Quality Level A data is the most reliable.



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TEST YOUR KNOWLEDGE

RAPID FIRE

Subsurface Utility Engineering provides standardization for the **collection and depiction** of utility data and was published by whom?

- ✓ American Society of Civil Engineers (ASCE)

True or False, Utility Data Quality Levels are the **classification of how reliable** the data is?

- ✓ True!

What are the **four quality levels** used to classify utility data?

- ✓ Quality Level A, B, C, & D

31

Quality Level D & C Utility Data

32

QUALITY LEVEL D UTILITY DATA

QL-D is the **most basic level** of information for utility information data. It comes solely from existing utility records or verbal recollections, both commonly regarded as **unreliable sources.**

Quality Level D data will provide an overall "feel" for the congestion of utilities, however, is often highly limited in terms of comprehensiveness and accuracy.

QL-D is useful primarily for project planning and route selection activities and should **never be classified as reliable** for engineering or construction activities.

33

WHERE DOES **QL-D DATA** COME FROM?

Utility Records – Procurement of utility records from public & private sources.

Interviews – Records can be obtained in the form of oral recollections from knowledgeable key personnel.

State Call 811 System – Many state Call 811 systems help facilitate utility record requests or offer design tickets. Call 811 Paint markings can be considered a utility record as well.

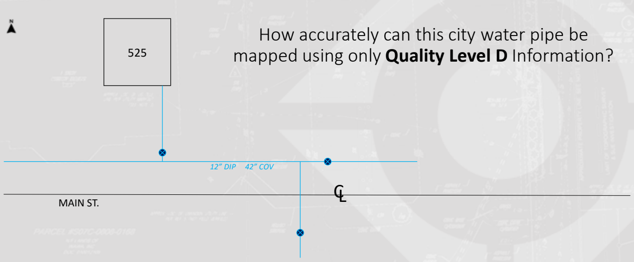
34

NOT ALL UTILITY MAPS **ARE EQUAL**

35

THE PROBLEM WITH QL-D DATA

How accurately can this city water pipe be mapped using only **Quality Level D** Information?



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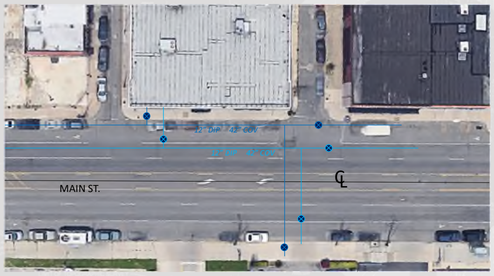
THE PROBLEM WITH QL-D DATA



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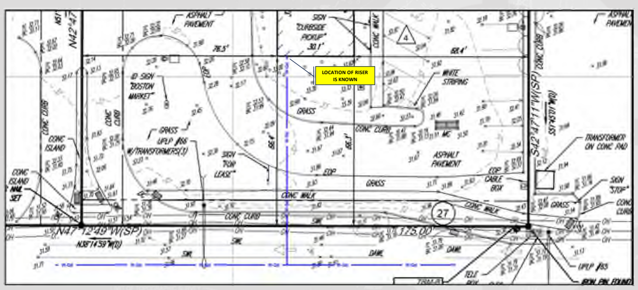
EXAMPLE **QL-D** UTILITY DATA



38

*How can we **increase the reliability** of utility data obtained from records?*

39

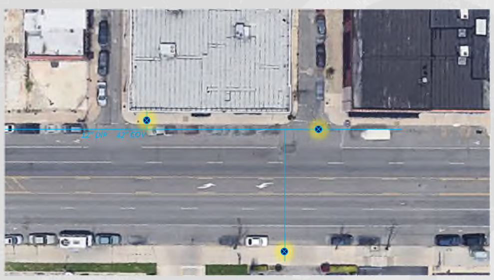
QUALITY LEVEL C UTILITY DATA

QL-C data involves **surveying visible utility facilities** (e.g., manholes, valve boxes, etc.) and correlating this information with existing utility records (QL-D information).

When using this information, it is not unusual to find that many underground utilities have been either omitted or erroneously plotted. Its usefulness, therefore, is primarily on rural projects where underground utilities are not prevalent or are not too expensive to repair or relocate.

40

BETTER CONFIDENCE WITH QL-C DATA



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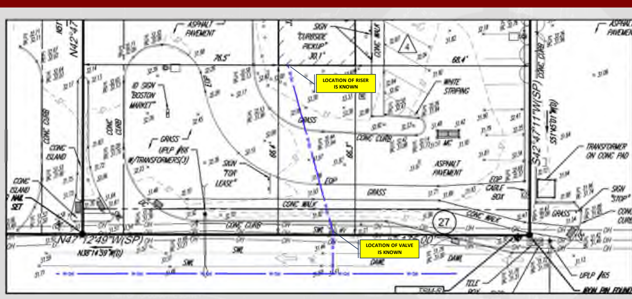
EXAMPLE **QL-C** UTILITY DATA



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43

How can we ***increase the reliability*** *of utility data to make better engineering decisions?*

44

Quality Level B Utility Data

45

QUALITY LEVEL B UTILITY DATA

Achieving Quality Level B utility data is obtained through the **field verification** of underground utilities.

Utility locations known to exist through utility record research are verified, and **previously unknown utilities** are designated and identified.

46

FIELD VERIFICATION OF UTILITIES

Field Verification is performed with both human observations and the use of various **geophysical sensing instruments.**

- Electromagnetic Equipment
- Ground Penetrating Radar
- Robotic Video Inspection
- 3D Structure Scanning
- Acoustic/Illumination Testing

47

WHY IS **FIELD VERIFICATION** IMPORTANT?

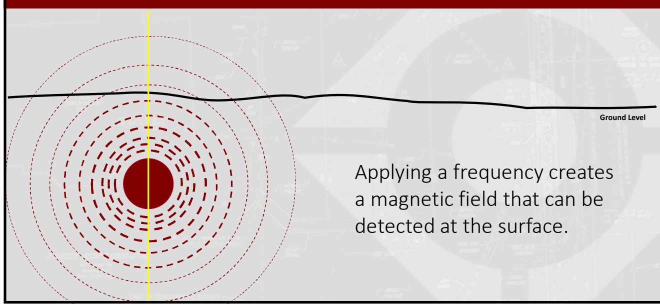
48

ELECTROMAGNETIC UTILITY **DETECTION**

- **Primary method** for field verification.
- Transmitting device applies a controlled frequency to **conductor.**
- Frequency creates **magnetic field** around the conductor.
- Magnetic field can be detected on the surface using a **receiver device**.

49

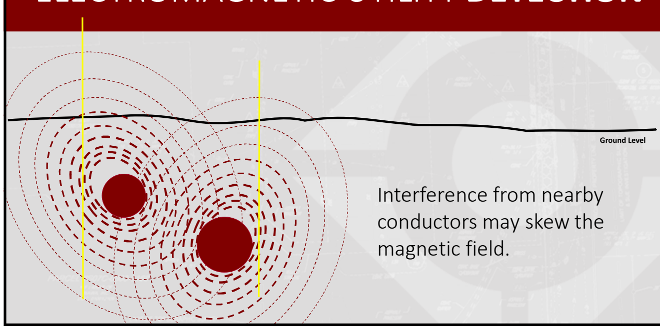
ELECTROMAGNETIC UTILITY **DETECTION**



Applying a frequency creates a magnetic field that can be detected at the surface.

50

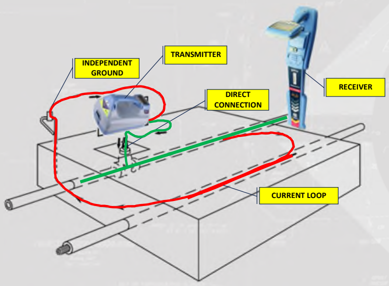
ELECTROMAGNETIC UTILITY **DETECTION**



Interference from nearby conductors may skew the magnetic field.

51

DIRECT CONNECTION METHOD



- Connection directly to pipe or cable using leads
- Low Frequencies vs. High Frequencies
- Works similar to A/C current
- Transmitter must be grounded independently from utility system

52

INDIRECT CONNECTION METHODS

Inductive Coupler

Used when direct access to the conductor is not possible or safe.

Can be extended on EH rated extension pole for accessing wires in manholes without confined space entry

Conductor must be grounded on both ends of the connection point

53

INDIRECT CONNECTION METHODS

Broadcast Induction

A.K.A. "Drop the box"

Used when direct access to the conductor is not possible or safe.

Signal is broadcast in a wide area. All conductive utilities within range will transmit the broadcast signal.

Not ideal in congested environments.

54

THE **“SPLIT-BOX”** LOCATOR

Uses broadcast induction to detect buried metallic objects such as utilities, tanks, manholes, and foundations (reinforcement).

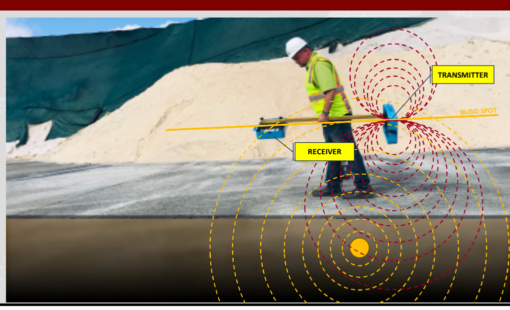
Used to confirm electromagnetic findings and discover previously unmarked targets.

Great for “clearing” an area prior to excavation or soil borings.

55

56

HOW DOES THE **SPLIT-BOX** WORK?



57

ROBOTIC CAMERA INSPECTION

Inspect pipe interior for defects, failures, obstructions, and **hidden tie-ins.**

Camera head can be **pin-pointed** using electromagnetic detection equipment.

Camera wires can be traced out similarly to **tracer wire** for pipe location.

Capable of traversing pipes as small as 6 inches in diameter.

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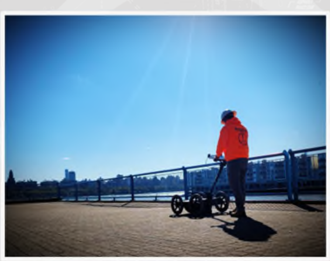
EXAMPLE PIPE INSPECTION

59

GROUND PENETRATING **RADAR**

- GPR uses high-frequency radio waves to emit electromagnetic energy into the ground at a **programmed velocity.**
- Radio waves return to the antenna at **different velocities** based on the conductivity of the object the signal was reflected from.
- Has the **capacity to detect** metallic and non-metallic targets underground.



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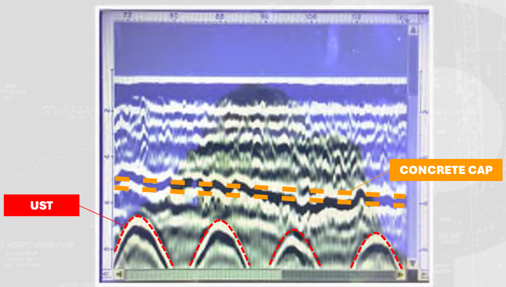
HOW DOES **GPR WORK?**

61

INTERPRETING GPR DATA **IN REAL-TIME**



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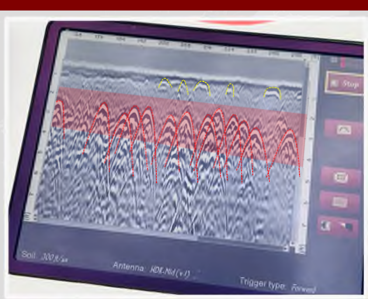
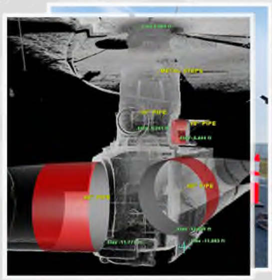
INTERPRETING GPR DATA **IN REAL-TIME**



63

3D MANHOLE SCANNING

- Most common application is to obtain pipe size and inverts within structures where **pipes are recessed** or not accessible from the surface.
- Much **safer and cost-effective** alternative to performing confined space entry.
- Not effective in structures where debris or abundance of water is present.



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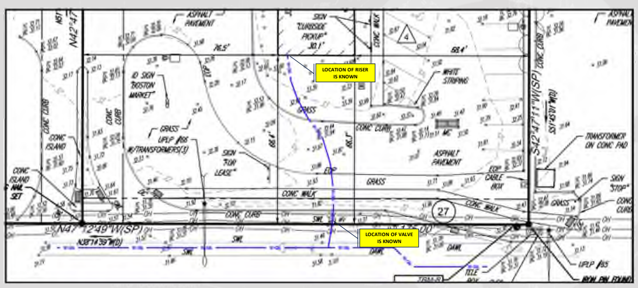
EXAMPLE **QL-B** UTILITY DATA



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APWA® UNIFORM **COLOR CODE**

RED	ELECTRIC
YELLOW	PRESSURIZED GAS
ORANGE	COMMUNICATIONS
BLUE	POTABLE WATER
PURPLE	NON-POTABLE WATER
GREEN	STORM/SANITARY SEWER
PINK	TEMP SURVEY MARKINGS
WHITE	PROPOSED EXCAVATION

66

CALL 811 IS **NOT QUALITY LEVEL B**

- Call811 is a **risk-based system** used to prevent damage to underground utilities during excavation.
- Typically, only **one instrument** is utilized by Call811 Locators that is best suited for the utility they are marking.
- Member companies will only mark the portion of the underground utility **they are financially liable** for, leaving undiscovered and unmarked utilities present.
- Often, there is no follow up or QAQC performed under the responsible charge of a registered **professional engineer or surveyor.**
- Old standards (38-02) did not differentiate **who** would provide the utility markout, new standards do.

One-Call markings are markings placed by others. The Professional has no control or supervision over these marks or knowledge of their integrity. These marks can be recognized only as a source of second-party information. Survey of these marks leads only to QLD, or QLC information if visible Utility Features are identified, processed, and surveyed in accordance with Section 2.3. **One-Call marks can never lead to QLB information** without an independent Geophysical Search under the responsible charge of the Professional.

67

ERRORS AVOIDED BY USING QL-B

USCG Auxiliary Flotilla 22

Sandy Hook, New Jersey

Crews installing new thermal wells at a military complex hired an SUE firm to markout the utilities prior to excavating. The SUE firm discovered a buried object about the size of a fuel oil tank in the proposed location of the wells that was not documented on any current or historic drawings.

It was later discovered by the military that the grounds had been utilized to dispose of unused and unexploded ordinances leftover from WWII, and the discovered object was likely a cache of surplus explosives.

68

RAPID FIRE TEST YOUR **KNOWLEDGE**

Obtaining Quality Level B data for utility lines on a drawing guarantees that all utility lines will be discovered, true or false?

- ✓ False! Not all underground utilities are detectable with geophysical instruments.

True or False, utility markings observed from Call 811 sources should always be classified as Quality Level B data?

- ✓ False!

For a utility segment to be considered quality level B, it should be verified in the field using what type of instruments?

- ✓ Geophysical Detection Equipment

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Quality Level A Utility Data

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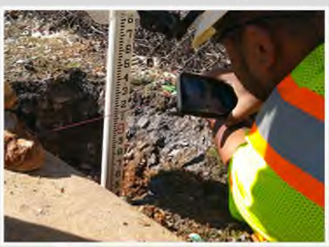
QUALITY LEVEL A UTILITY DATA



QL-A utility data is the **highest level** of accuracy presently available because it requires physically exposing and measuring the utility size and elevation.

Quality Level A data includes information for the precise plan and profile mapping of underground utilities through the **nondestructive exposure** of underground utilities (locating), and provides the type, size, condition, material and other characteristics of underground features.

Obtaining Quality Level A utility data is referred to as **Utility Locating**

71

PRECISE MEASUREMENTS

- Rarely is Quality Level A data required on every utility line throughout the entire project.
- Used when **precise utility data** is required to resolve conflicts.
  - Horizontal Location & Vertical Elevation
  - Nominal Size & Condition of Utility
  - Utility Composition/Outer Material
  - Surface, Sub-base & Soil Conditions

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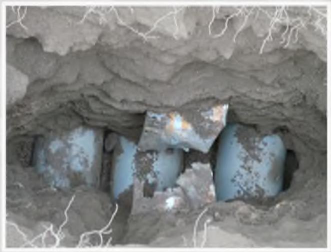
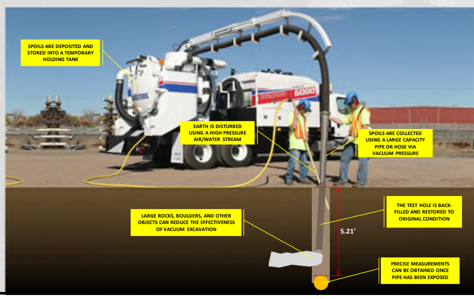
ACHIEVING QUALITY LEVEL A DATA

- Most commonly obtained by performing **test holes** over known utility locations using air or hydro excavation.
- Access to physically measure and inspect exposed utility **required** to achieve Quality Level A data.
- Can **invert measurements** obtained in manhole or storm inlet structures be considered a Quality Level A data point?
  - ✓ **YES!**



73

HOW ARE **UTILITIES EXCAVATED** WITH AIR?



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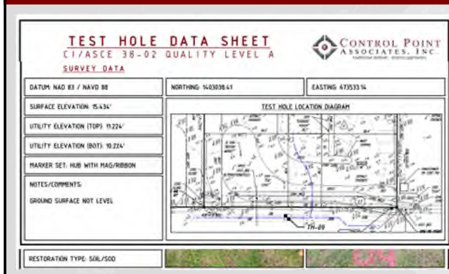
EXAMPLE TEST HOLE **DATA SHEETS**



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RAPID FIRE TEST YOUR **KNOWLEDGE**

Can Quality Level A utility data only be obtained using air vacuum excavation?

- ✓ NO! Any physical measurement on a subsurface utility can be a Quality Level A data point.

True or False, Quality Level A data is more reliable than Level A data because it provides physical measurements and locations over detected locations?

- ✓ True!

What data points can be documented while obtaining Quality Level A utility data?

- ✓ Precise horizontal & Vertical (elevation) Location, Nominal Size & Material Composition, Utility, Soil, & Surface Conditions

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QA/QC

- Field sketches are drafted depicting all utilities designated using geophysical methods.
- Field sketches are used during drafting to ensure accuracy in depiction.
- Surveyed locations are checked against photographs, field sketches, and utility records to ensure accuracy.

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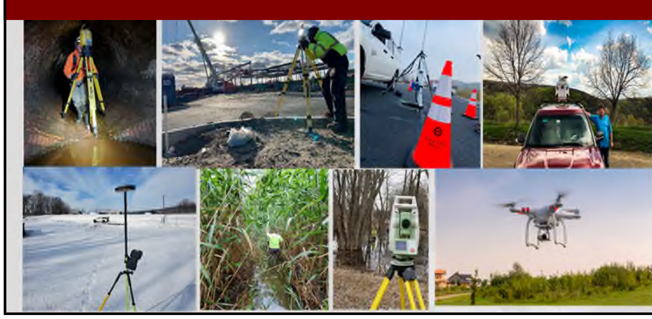
SUPPLEMENTAL SERVICES



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QUESTIONS?

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