Subsurface Utility Engineering:
Updating Scopes of Work for the 21st Century

Presented by:
Bob Clemens, VP
Cardno TBE

Kentucky Transportation Cabinet
Partnering Conference Presentation
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Designating Locating 1989
The process of using surface geophysical methods to interpret the presence of a subsurface utility and to mark its approximate horizontal position (its designation) on the ground surface. (Note: Utility owners and contractors often call this process “locating.”)
The process of exposing and recording the precise vertical and horizontal location of a utility, through the use of vacuum excavation. It is non-destructive and typically more time and cost efficient than other conventional digging methods.
Subsurface Utility Engineering

Designating
Locating

1989

Quality Levels
Gravity Systems (Sanitary & Storm)
Overhead Utilities
Subsurface Utility Engineering

1990s

Quality Levels
Gravity Systems (Sanitary & Storm)
Overhead Utilities

QL D – Records Research
QL C – Surveyed Surface Features
QL B – Designating
QL A – Locating

1990s
Subsurface Utility Engineering
A Professional Service

QL D – Records Research
QL C – Surveyed Surface Features
QL B – Designating
QL A - Locating

Utility Coordination
Utility Relocation Design
Construction Observation

Late 90’s – Early 2000’s
Subsurface Utility Engineering:

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.
Four “Quality Levels” defined
Quality Levels

D, C, B, A
Research of records such as:
- As-Built Records
- Utility System Drawings
- Oral Recollections
Records Research:
Information comes solely from existing utility records, individual recollections and design tickets.
Field Research:

- Involves surveying visible aboveground utility facilities, i.e. manholes, valve boxes, etc.
- Correlates survey data with existing utility records plans reconciled to Quality Level D
**Designating:** Using surface geophysical techniques to determine the existence and approximate horizontal position of underground utilities
Subsurface Utility Engineering vs. “One Call / Call Before You Dig”

Utility location according to One-Call System

7' difference

Actual location of utility found with designation (surveyed)
Subsurface Utility Engineering vs. “One Call / Call Before You Dig”
Locating: Verification of precise horizontal and vertical location of subsurface utilities by non-destructive exposure; typically vacuum excavation.
Subsurface Utility Engineering

A Professional Service

QL D – Records Research
QL C – Surveyed Surface Features
QL B – Designating
QL A - Locating

Utility Coordination
Utility Relocation Design
Construction Observation

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Collection & Depiction

QL D – Records Research
QL C – Surveyed Features
QL B – Designating
QL A – Locating

Utility Coordination
Utility Relocation Design
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Late 90’s – Early 2000’s
Subsurface Utility Engineering

A Professional Service

Collection & Depiction

QL D – Records Research
QL C – Surveyed Features
QL B – Designating
QL A - Locating

Utility Coordination
Utility Relocation Design
Construction Observation

Gravity Systems (Rims & Inverts, CCTV, Sondes, Designating & Locating)

Overhead (Poles, Lines, Pole Counts, Inventories)
Manhole Detailing
Profiles Development

2000’s
Subsurface Utility Engineering

A Professional Service

Collection & Depiction
- QL D – Records Research
- QL C – Surveyed Features
- QL B – Designating
- QL A - Locating

Utility Coordination
- Conflict Analysis
- Conflict Resolution

Utility Relocation Design
Construction Observation

Gravity Systems (Rims & Inverts, CCTV, Sondes, Designating & Locating)
Overhead (Poles, Lines, Pole Counts, Inventories)
Manhole Detailing
Profiles Development

“Non-QL Mapping”
GIS Database Population
Corridor Planning
Authoring Utility Policies
3D Imaging
Briefly...

“Non-QL Mapping” Field Sketches

GIS Database Population

Corridor Planning

Authoring Utility Policies
• Conflict Matrix

• Design solutions
• Utilizes 38-02 data
• Identifies all potential conflicts
• Recommends where to use QL-A
<table>
<thead>
<tr>
<th>Conflict Number</th>
<th>Station and Offset (BL)</th>
<th>Utility</th>
<th>Identified Conflict</th>
<th>Test hole Needed</th>
<th>Test Hole Number</th>
<th>Utility Impact with Cost (&quot;As-designed&quot;)</th>
<th>Recommended Resolution</th>
<th>*Benefit of Resolution</th>
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*Benefit of Resolution
### Conflict Matrix

<table>
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<tr>
<th>Conflict</th>
<th>Station and Offset</th>
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<th>Recommended Resolution</th>
<th>*Benefit of Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>100+06, 21'L 14th St Constr. BL</td>
<td>AGL-BFO</td>
<td>Proposed storm structure and existing BFO</td>
<td>No</td>
<td>Relocate 1150LF of BFO-DUCT ($91,000)</td>
<td>Relocate proposed storm drainage into street. Use DI's that drain toward roadway.</td>
<td>Save Cost to Relocate BFO-DUCT ($91,000)</td>
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<tr>
<td>C2</td>
<td>100+09, 21'L 14th St Constr. BL</td>
<td>AGL-BFO</td>
<td>Proposed storm structure and existing BFO</td>
<td>No</td>
<td>See C1</td>
<td></td>
<td></td>
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<tr>
<td>C3</td>
<td>100+36, 24'R 14th St Constr. BL</td>
<td>UNK@Tee</td>
<td>Proposed 18&quot; storm and unknown utility</td>
<td>TH 1</td>
<td>Relocate unknown type and function utility</td>
<td>TH to identify utility and conflict</td>
<td>Eliminate possible delay during construction</td>
</tr>
<tr>
<td>C4</td>
<td>100+06, 25'R 14th St Constr. BL</td>
<td>8&quot;W</td>
<td>Proposed 18&quot; storm and existing 8&quot;W</td>
<td>TH 2</td>
<td>Relocate 8&quot;W ($7,500)</td>
<td>TH on 8&quot;W, adjust depth of proposed storm drainage</td>
<td>Save Cost to Relocate 8&quot;W ($6,000)</td>
</tr>
<tr>
<td>C5</td>
<td>100+01, 25R 14th St Constr. BL</td>
<td>8&quot;W</td>
<td>Proposed 18&quot; storm and existing 8&quot;W</td>
<td>TH 3</td>
<td>Relocate 8&quot;W ($7,500)</td>
<td>TH on 8&quot;W, adjust depth of proposed storm drainage</td>
<td>Save Cost to Relocate 8&quot;W ($6,000)</td>
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<tr>
<td>C6</td>
<td>100+82, 28'R 14th St Constr. BL</td>
<td>4&quot;G</td>
<td>Proposed storm structure and existing 4&quot;G</td>
<td>TH 4</td>
<td>Relocate 20 LF of 4&quot;G ($6,000)</td>
<td>TH on 4&quot;G, adjust depth of proposed storm structure</td>
<td>Save Cost to Relocate 4&quot;G ($4,500)</td>
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<tr>
<td>C7</td>
<td>101+22 27'R 14th St Constr. BL</td>
<td>4&quot;G</td>
<td>Proposed 18&quot; storm and existing 4&quot;x2&quot; gas tee</td>
<td>TH 5</td>
<td>Relocate 2&quot;G &amp; 4&quot;G Tee ($12,500)</td>
<td>TH on G lines, adjust depth of proposed storm structure</td>
<td>Save Cost to Relocate G lines ($11,000)</td>
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<tr>
<td>C8</td>
<td>101+01 28'L 14th St Constr. BL</td>
<td>16&quot;G</td>
<td>Proposed 18&quot; storm and existing 16&quot;G</td>
<td>TH 6</td>
<td>Relocate 16&quot;G ($10,000)</td>
<td>TH on 16&quot;G, adjust depth of proposed storm structure</td>
<td>Save Cost to Relocate 16&quot;G ($8,500)</td>
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<tr>
<td>C9</td>
<td>101+25 41'L 14th St Constr. BL</td>
<td>BT-DUCT 2&quot;G</td>
<td>Proposed storm structure and two BT-ducks</td>
<td>TH 7</td>
<td>Relocate BT-DUCT &amp; 2&quot;G ($11,000)</td>
<td>TH on BT-DUCT &amp; 2&quot;G, adjust depth of proposed storm structure</td>
<td>Save Cost to Relocate BT-DUCT &amp; 2&quot;G ($10,500)</td>
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<tr>
<td>C10</td>
<td>101+37, 41'L 14th St Constr. BL</td>
<td>8&quot;W</td>
<td>Proposed 18&quot; storm and existing 8&quot;W</td>
<td>TH 8</td>
<td>Relocate 8&quot;W ($5,000)</td>
<td>TH on 8&quot;W, adjust depth of proposed storm drainage</td>
<td>Save Cost to Relocate 8&quot;W ($3,500)</td>
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<tr>
<td>C11</td>
<td>101+57, 27'L 14th St Constr. BL</td>
<td>16&quot;G</td>
<td>Proposed 18&quot; storm and existing 16&quot;G</td>
<td>TH 9</td>
<td>Relocate 16&quot;G ($10,000)</td>
<td>TH on 16&quot;G, adjust depth of proposed storm drainage</td>
<td>Save Cost to Relocate 16&quot;G ($8,500)</td>
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<td>C12</td>
<td>101+68, 22'L 14th St Constr. BL</td>
<td>AGL-BFO</td>
<td>Proposed storm structure and existing BFO</td>
<td>No</td>
<td>See C1</td>
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<tr>
<td>C13</td>
<td>102+20, 25'R 14th St Constr. BL</td>
<td>AGL-BFO</td>
<td>Proposed storm structure and existing BFO</td>
<td>No</td>
<td>See C1</td>
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<td>C14</td>
<td>102+36, 24'L 14th St Constr. BL</td>
<td>AGL-BFO</td>
<td>Proposed storm structure and existing BFO</td>
<td>No</td>
<td>See C1</td>
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</table>

*Please include all benefits incurred including time, costs, and safety improvements.

**Utility Owner:**
- AC - Asbestos Concrete
- BE - Buried Electric
- BFO - Buried Fiber Optic
- BT - Buried Telephone
- G - Gas
- L - Left
- MES - Milled End Section
- OE - Overhead Electric
- OT - Overhead Telephone
- R - Right
- WC - Water Main
- TH - Test Hole, verify vert. and horiz.
- UNK - Unknown
- AGL - Atlanta Gas Light
- BE - Georgia Power
- KP - Kenton Cove Concrete Pipe
- L3 - Level 3 Communications
- MFN - Metromedia Fiber Network
- SAN - Fulton County Public Works
- W - Water
- W City of Atlanta
- UNK - Unknown Owner
Purpose:

- Resolves utility conflicts
- Organizational tool
- Damage prevention
Conflict Resolution

- Modify Roadway Design
- Modify Drainage Design
- Identify Utility Conflicts
- Additional SUE
- Utility Coordination
Conflict Resolution Task
Summary

- Utility Coordination
- Modify Project Design
- Prepare Conflict matrix
  - Introduced after 2005
  - Used whenever QL-B SUE is provided
  - After QL-B and prior to FFPR (ideally before PFPR)
- Introduce Design Alternatives
- Identify Req’d. Utility Relocations
- Utility Relocation Plans complete
  - (Prior to FFPR)
- Final Utility plans to PM
- Three months prior to FFPR

*Iterative Process (pending design progression)*
Alternative Design Strategies:

- Conflict structure
- Adjust drainage pipes/structures
- Pre-cast versus casting on-site
- Basic design modification
- Utility prioritization
When Utilities Have to Move

- Lessen impact
- Joint trenches
- Utility Installation by Highway Contractor
Geophysical Imaging Technologies include:
- 14-channel 3D Ground Penetrating Radar system
- Multi-Sensor Electromagnetic Induction (EMI) system

High-Accuracy Positioning Systems include:
- 10-cm differentially-corrected GPS (DGPS)
- Fully-automated Robotic surveying system
14-Channel 3D Radar system

Multi-Sensor Electromagnetic Induction
3D Underground Imaging Compliments Conventional Subsurface Utility Engineering:

- Finds utilities conventional SUE (including single-channel GPR) might not
- Provides vertical information without test holes
- Achieves 100% geophysical investigation coverage
- Identifies non-utility subsurface features that may impact a project
- Can discern stacked and multi-conduit utilities
Case Study: Subsurface Mapping for Power Plant Expansion, NC
Case Study: Subsurface Mapping for Power Plant Expansion, NC

SUE + 3D-UI

- Buried Linear Features (possible utilities)
- Locations of possible trenches
- Buried Railroad Tracks
- Areas that have been Excavated and Backfilled
- Areas of Buried Rebar and Reinforced Concrete
Engineering Design **Standard of Care**

- Design Survey
- Geotechnical Investigation
- Subsurface Utility Engineering

Routinely used on public and private works projects
THANK YOU!

Contact:
Robert L (Bob) Clemens
Cardno TBE
317.491.5716 (cell)
Bob.Clemens@CardnoTBE.com