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

Presented by:
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Cardno TBE

Kentucky Transportation Cabinet
Partnering Conference Presentation
August 11th, 2009

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Subsurface Utility Engineering

Designating

Locating

1989

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Designating

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.”)

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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.

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Subsurface Utility Engineering

Designating

Locating

1989

Subsurface Utility Engineering

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Designating

Locating

1989

Quality Levels

Gravity Systems
(Sanitary & Storm)

Overhead Utilities

Subsurface Utility Engineering

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A Professional Service

QL D – Records Research

QL C – Surveyed Surface Features

QL B – Designating

QL A - Locating

1990s

~~Quality Levels~~

~~Gravity Systems (Sanitary & Storm)~~

~~Overhead Utilities~~

Subsurface Utility Engineering

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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.

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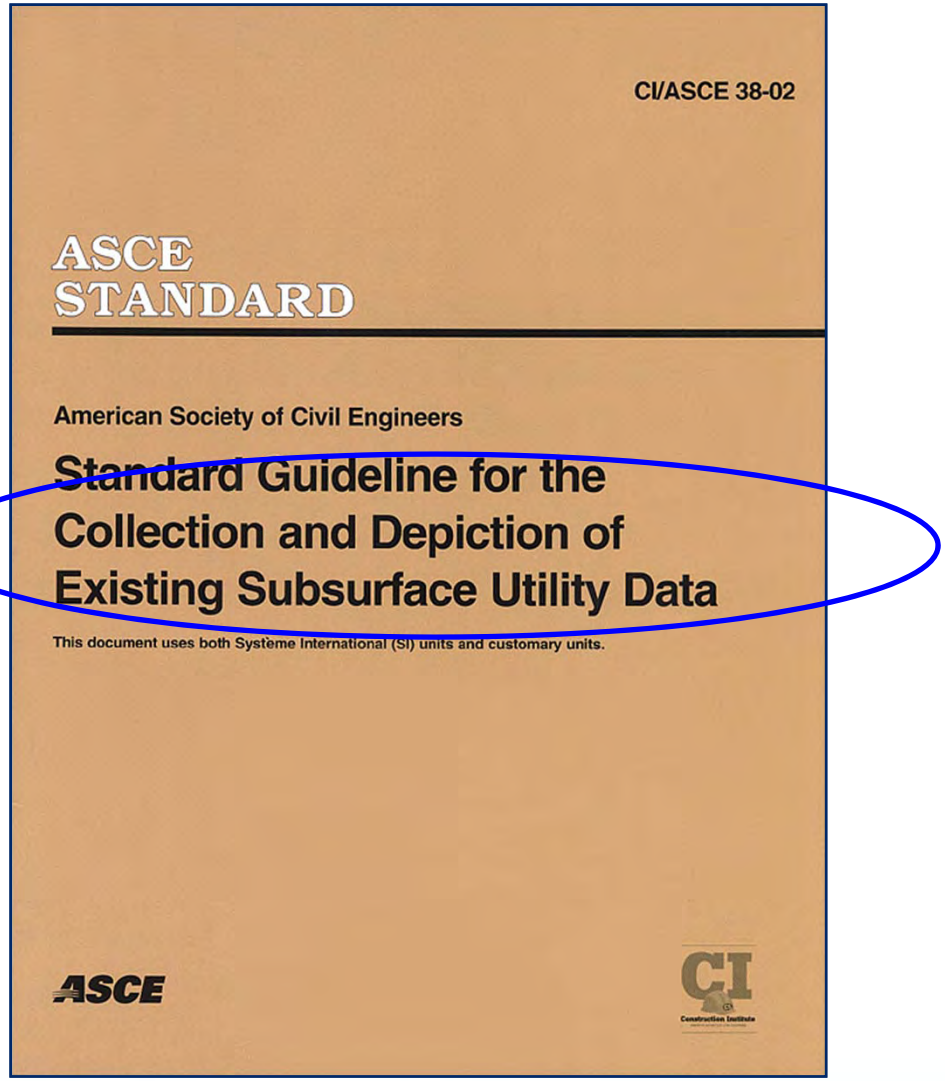
CI/ASCE 38-02



Four
"Quality Levels"
defined

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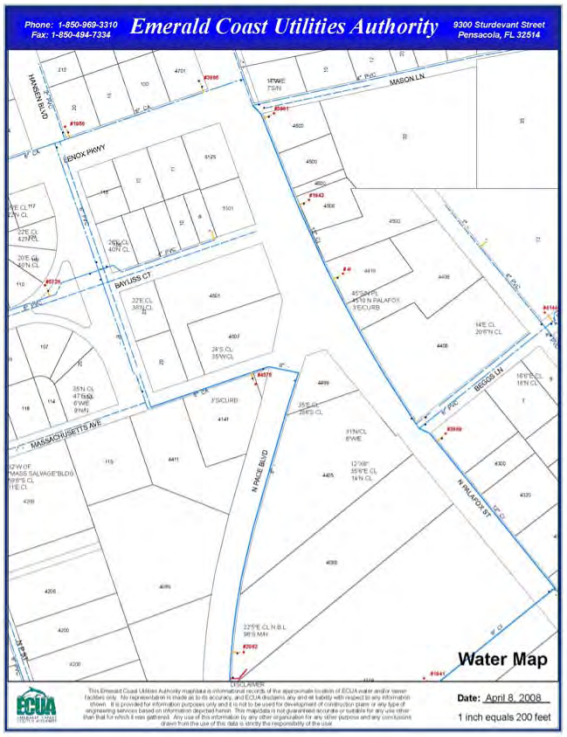
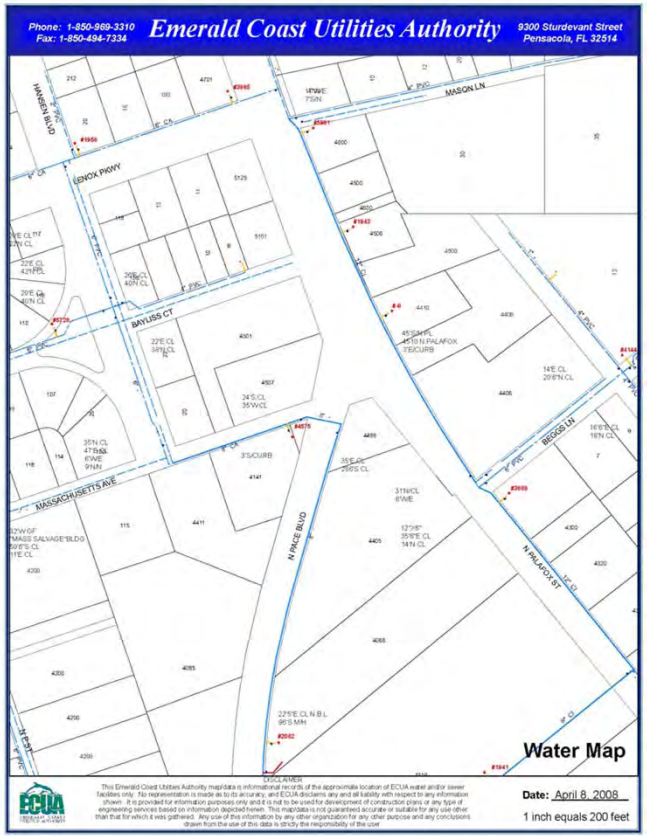
Quality Levels



D, C, B, A

ASCE Standard Quality Level D

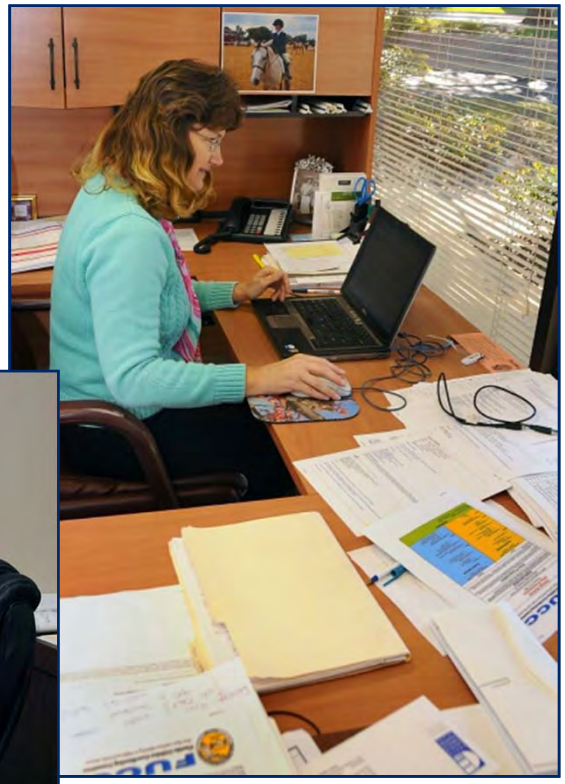
- **Research of records such as:**
  - As-Built Records
  - Utility System Drawings
  - Oral Recollections



ASCE Quality Level D

Records Research:

Information comes solely from existing utility records, individual recollections and design tickets



ASCE Quality Level C

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*

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ASCE Quality Level B

Designating: Using surface geophysical techniques to determine the existence and approximate horizontal position of underground utilities

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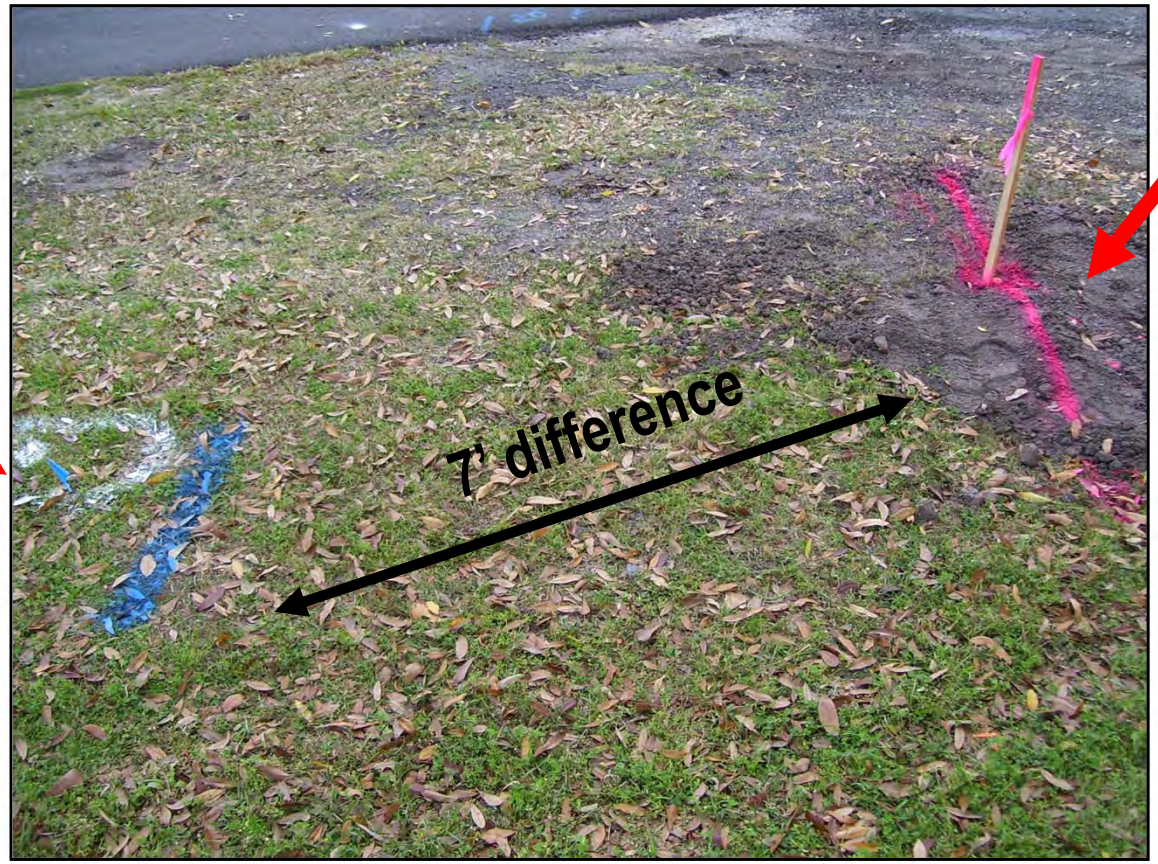
Subsurface Utility Engineering vs. "One Call / Call Before You Dig"

Utility location according to One-Call System



Actual location of utility found with designation (surveyed)

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Subsurface Utility Engineering vs. "One Call / Call Before You Dig"

ONE-CALL MARK
INDICATING GAS LINE

ASCE QUALITY LEVEL B MARK
INDICATING GAS LINE

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ASCE Quality Level A

Locating: Verification of precise horizontal and vertical location of subsurface utilities by non-destructive exposure; typically vacuum excavation.

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Late 90's – Early 2000's

Subsurface Utility Engineering

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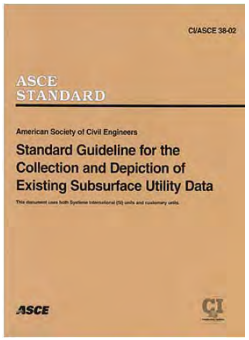

Collection & Depiction

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

- Utility Coordination
- Utility Relocation Design
- Construction Observation

Late 90's – Early 2000's

Subsurface Utility Engineering

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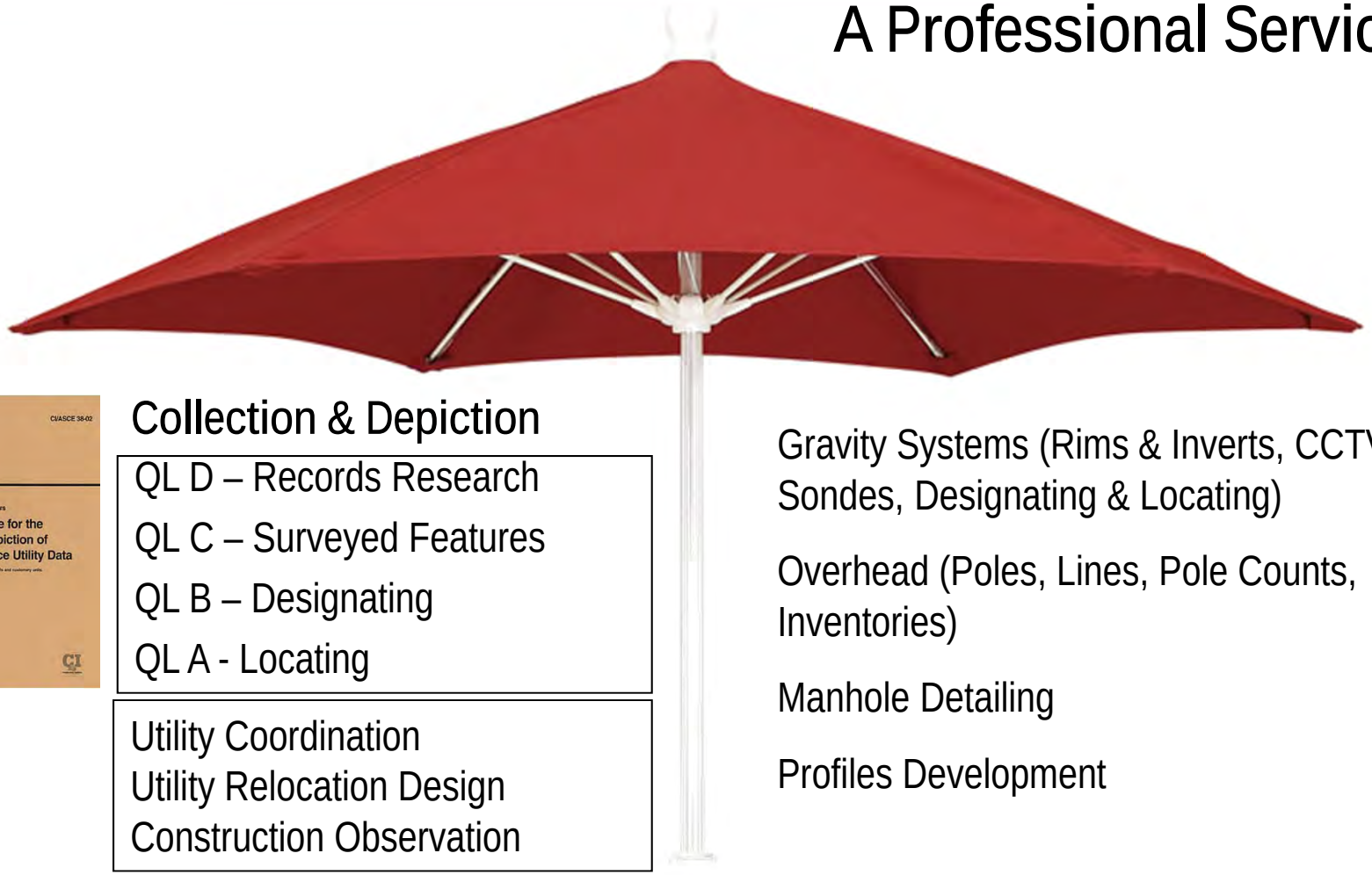
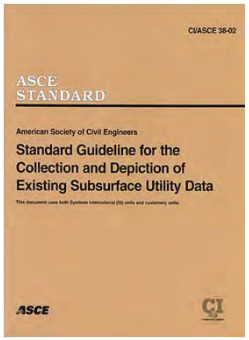
A Professional Service





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

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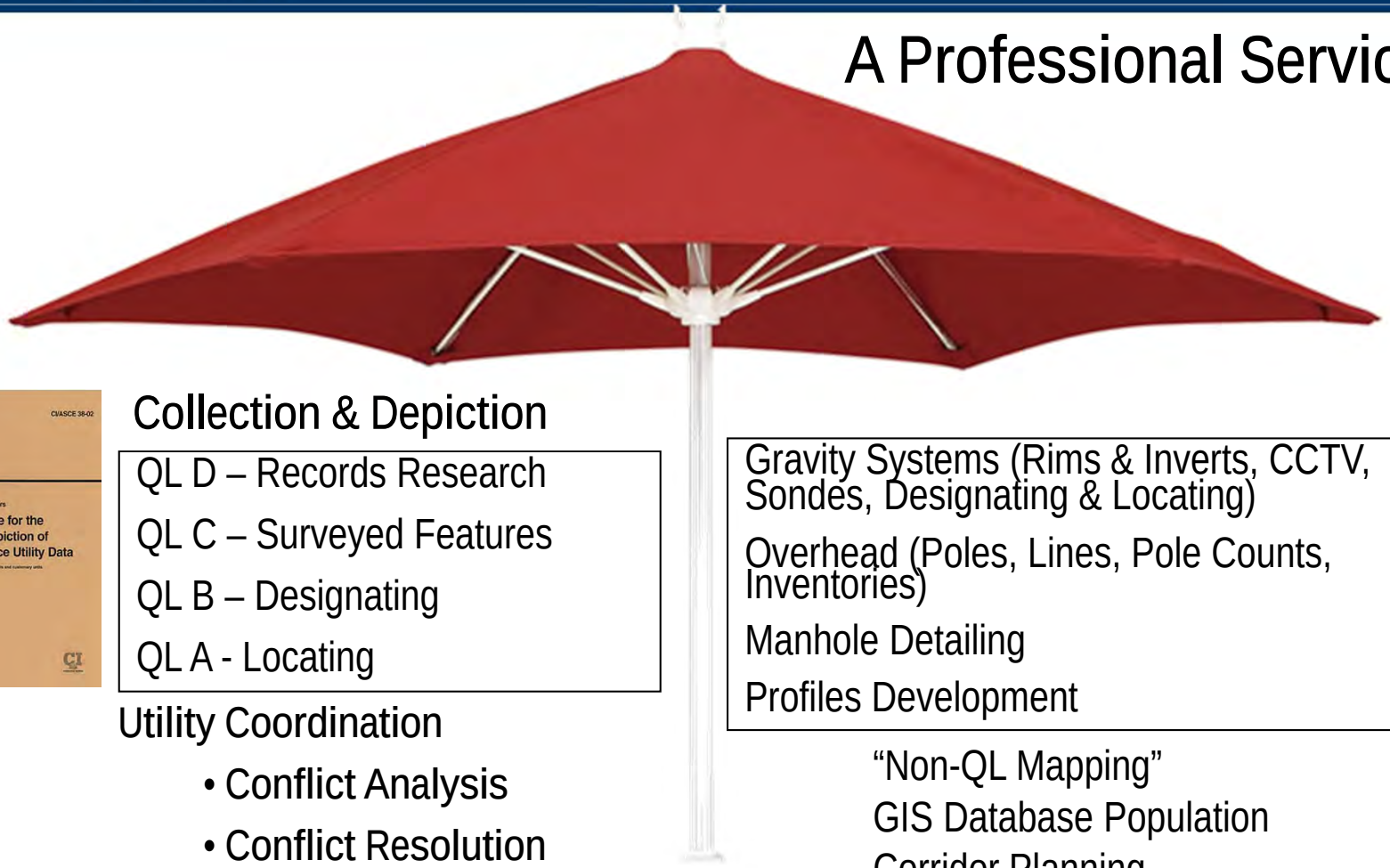
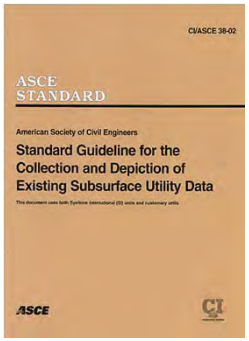
Subsurface Utility Engineering

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

Today

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

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Briefly…

"Non-QL Mapping" Field Sketches

GIS Database Population

Corridor Planning

Authoring Utility Policies

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Conflict Analysis & Conflict Resolution

- Conflict Matrix
- Design solutions

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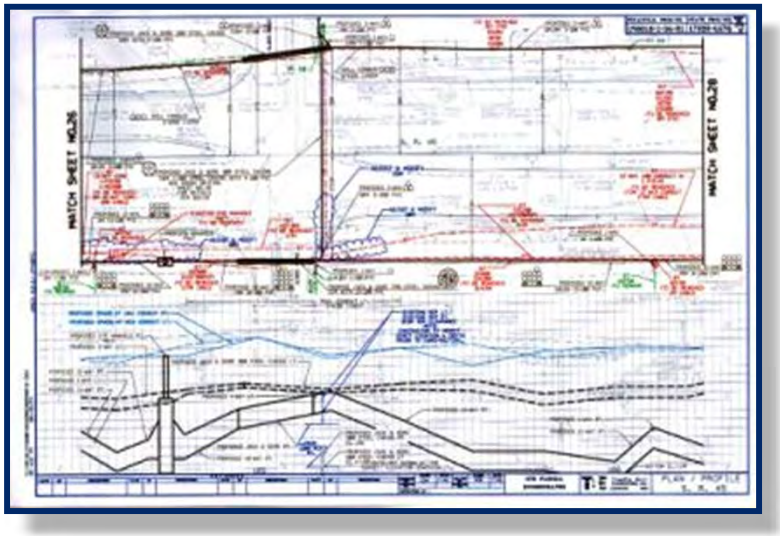
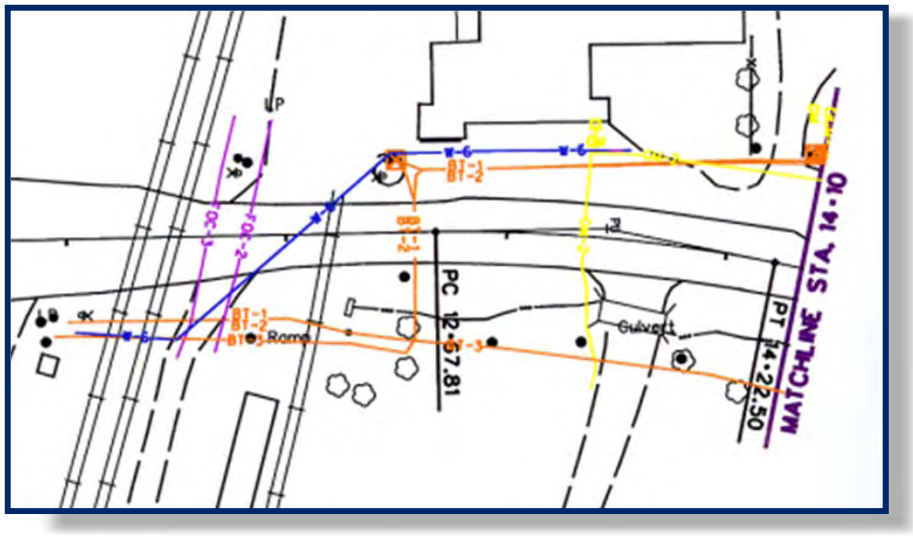
Conflict Matrix

- Utilizes 38-02 data
- Identifies all potential conflicts
- Recommends where to use QL-A





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Conflict Matrix

Conflict Number	Station and Offset (BL)	Utility	Identified Conflict	Test hole Needed	Test Hole Number	Utility Impact with Cost ("As-designed")	Recommended Resolution	*Benefit of Resolution

Conflict Matrix

Conflic	Station and Offset	Utility	Identified Conflict	Testhole Needed	Utility Impact with Cost ("As-designed")	Recommended Resolution	*Benefit of Resolution
C1	100+05, 21'L 14th St Constr. BL	AGL-BFO	Proposed storm structure and existing BFO	No	Relocate 1150LF of BFO-DUCT ($91,000)	Relocate proposed storm drainage into street. Use DI's that drain toward roadway.	Save Cost to Relocate BFO-DUCT ($91,000)
C2	100+66, 21'L 14th St Constr. BL	AGL-BFO	Proposed storm structure and existing BFO	No	See C1		
C3	100+38, 24'R 14th St Constr. BL	UNK@Tee	Proposed 18" storm and unknown utility tee	TH 1	Relocate unknown type and function utility	TH to identify utility and conflict	Eliminate possible delay during construction
C4	100+56, 25'R 14th St Constr. BL	8"W	Proposed 18" storm and existing 8"W	TH 2	Relocate 8"W ($7,500)	TH on 8"W, adjust depth of proposed storm drainage	Save Cost to Relocate 8"W ($6,000)
C5	100+61, 25R 14th St Constr. BL	8"W	Proposed 18" storm and existing 8"W	TH 3	Relocate 8"W ($7,500)	TH on 8"W, adjust depth of proposed storm drainage	Save Cost to Relocate 8"W ($6,000)
C6	100+82, 28R 14th St Constr. BL	4"G	Proposed storm structure and existing 4"G	TH 4	Relocate 20 LF of 4"G ($6,000)	TH on 4"G, adjust depth of proposed storm structure	Save Cost to Relocate 4"G ($4,500)
C7	101+22 27'R 14th St Constr. BL	4"G	Proposed 18" storm and existing 4"x2" gas tee	TH 5	Relocate 2"G & 4"G Tee ($12,500)	TH on G lines, adjust depth of proposed storm structure	Save Cost to Relocate G lines ($11,000)
C8	101+01 28'L 14th St Constr. BL	16"G	Proposed 18" storm and existing 16"G	TH 6	Relocate 16"G ($10,000)	TH on 16"G, adjust depth of proposed storm structure	Save Cost to Relocate 16"G ($8,500)
C9	101+25 41'L 14th St Constr. BL	BT-DUCT 2"G	Proposed storm structure and two BT-ducts	TH 7	Relocate BT-DUCT & 2"G ($11,000)	TH on BT-DUCT & 2"G, adjust depth of proposed storm structure	Save Cost to Relocate BT-DUCT & 2"G ($10,500)
C10	101+37, 41'L 14th St Constr. BL	6"W	Proposed 18" storm and existing 6"W	TH 8	Relocate 6"W ($5,000)	TH on 6"W, adjust depth of proposed storm drainage	Save Cost to Relocate 6"W ($3,500)
C11	101+57, 27'L 14th St Constr. BL	16"G	Proposed 18" storm and existing 16"G	TH 9	Relocate 16"G ($10,000)	TH on 16"G, adjust depth of proposed storm structure	Save Cost to Relocate 16"G ($8,500)
C12	101+58, 22'L 14th St Constr. BL	AGL-BFO	Proposed storm structure and existing BFO	No	See C1		
C13	101+90, 22'L 14th St Constr. BL	AGL-BFO	Proposed storm structure and existing BFO	No	See C1		
C14	102+20, 27'R 14th St Constr. BL	4"G	Proposed storm structure and existing 4"G	No	Relocate 4"G ($4,500)	Relocate 4"G	Elimnate conflict with proposed DI
C15	102+36, 24'L 14th St Constr. BL	AGL-BFO	Proposed storm structure and existing BFO	No	See C1		

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

Key:

AC - Asbestos Concrete
BE - Buried Electric
BFO - Buried Fiber Optic
BT - Buried Telephone
G - Gas
L - Left
MES - Mitered End Section
OE - Overhead Electric
OT - Overhead Telephone
R - Right
RCP - Reinforce Concrete Pipe
W - Water
WM - Water Main
TH - Test Hole, verify vert. and horiz
UNK - Unknown Type
SAN - Sanitary Sewer

Utility Owner:

AGL Atlanta Gas Light
BE Georgia Power
BT Bell South
L3 Level 3 Communications
MFN Metromedia Fiber Network
SAN Fulton County Public Works
W City of Atlanta
UNK Unknown Owner

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Conflict Matrix

Purpose:

- Resolves utility conflicts
- Organizational tool
- Damage prevention

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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)

Conflict Analysis

Alternative Design Strategies:

- Conflict structure
- Adjust drainage pipes/structures
- Pre-cast versus casting on-site
- Basic design modification
- Utility prioritization

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Conflict Analysis

When Utilities Have to Move

- Lessen impact
- Joint trenches
- Utility Installation by Highway Contractor

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3D Underground Imaging

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

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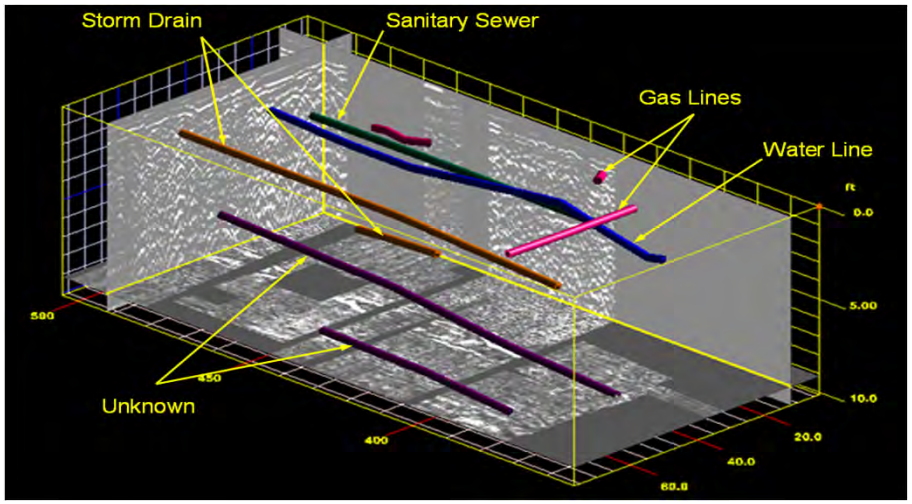
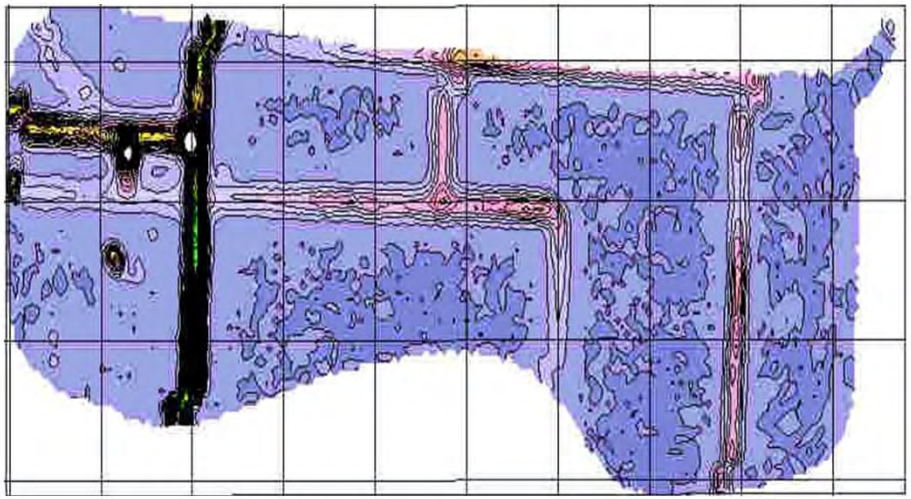
3D Underground Imaging



14-Channel
3D Radar system



Multi-Sensor
Electromagnetic
Induction

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3D Underground Imaging

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

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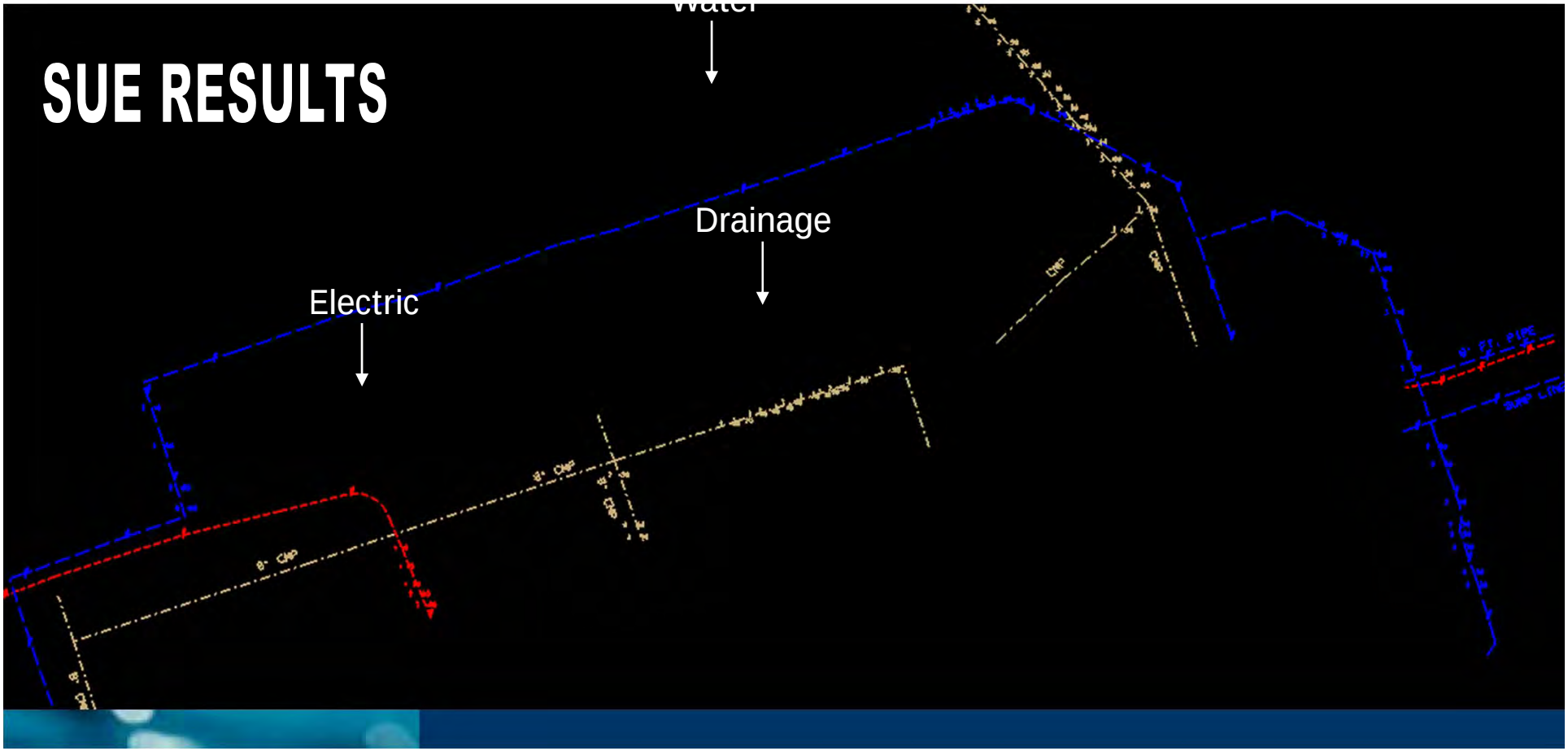
Case Study: Subsurface Mapping for Power Plant Expansion, NC



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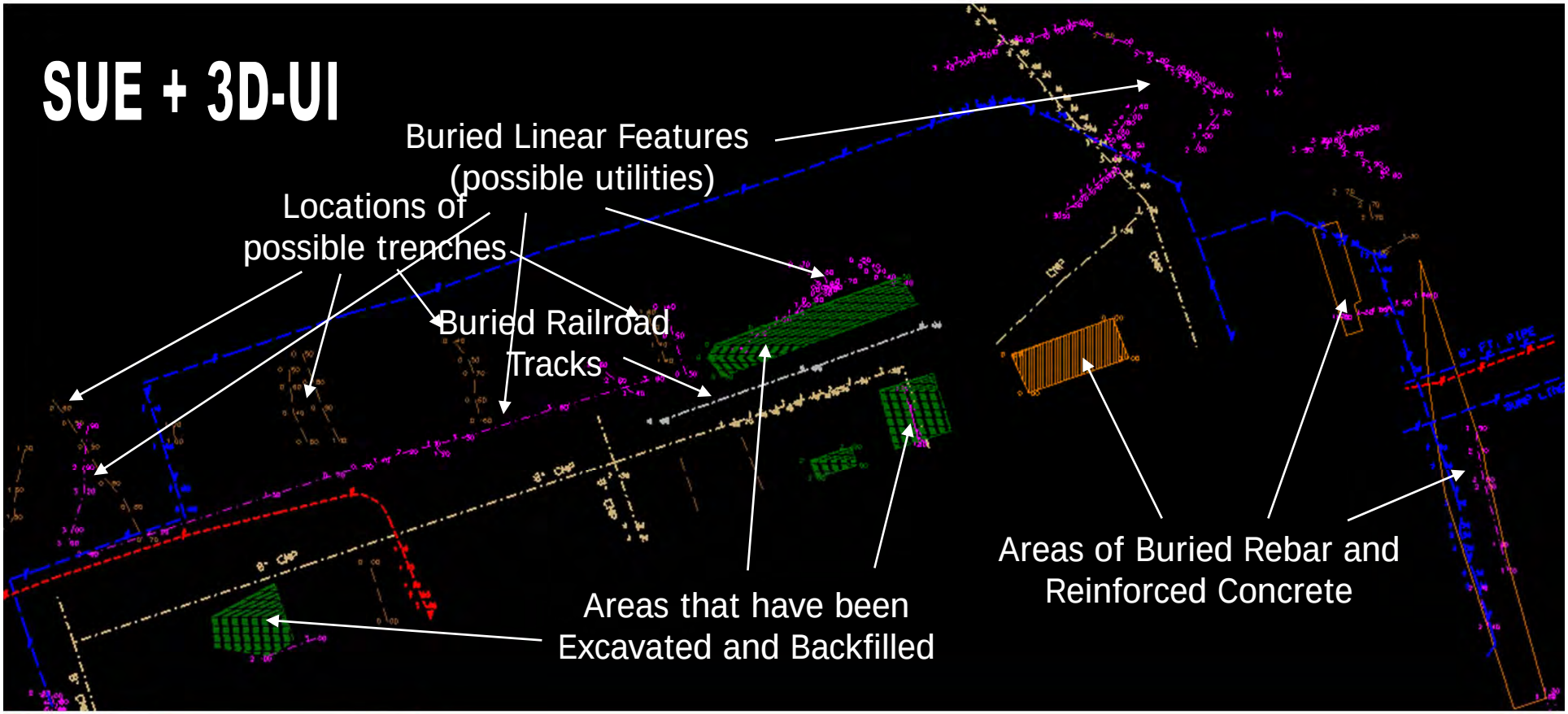

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Tomorrow

Engineering Design Standard of Care

- Design Survey
- Geotechnical Investigation
- Subsurface Utility Engineering

Routinely used on public and private works projects

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THANK YOU!

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