MITIGATING UTILITY-RELATED IMPACTS ON PROJECTS
What was the biggest headache on your last project?

Many engineering and construction project managers will say:

UTILITIES
UTILITY RELATED ISSUES

Utilities marked for construction and not mapped ahead of time

Incorrect utility locations on records and plans

Unknown utilities in the project area

Coordination and negotiation with utility owners

"North End, Springfield MA" by Rusty Clark is licensed under CC BY 2.0
INCORRECT UTILITY LOCATIONS

Depth Slice Location

Offset From Utility Records ~ 10 Feet

Records Position of Fuel Line

GPR Mapped Position of Fuel Line
UNKNOWN UTILITIES NOT IN RECORDS
UNKNOWN UTILITIES:
Example From Pipeline Project

Less than one mile of pipeline alignment

In a critical urban area

Found (not on records):
93 unknowns
9 traffic signal networks
5 storm drains
4 electric lines
4 gas lines
3 water lines
2 sanitary sewer lines
UTILITY IMPACTS ON DESIGN

Proposed structures that conflict with existing utilities

Unknown critical relocations

Design change orders during construction to deal with unanticipated utility conflicts
UTILITY IMPACTS ON CONSTRUCTION

- Construction change orders
- Injuries and damages due to utility strikes
- Cost and schedule overruns due to unanticipated utility issues
- Coordination with utility owners
What are some of the impacts utilities pose during design and construction?

Conflicts with proposed structures
Expensive relocation costs
Unknown/mis-mapped utilities increase risk to safety, schedule, & budget
HOW CAN UTILITY RISK BE ADDRESSSED?

Subsurface Utility Engineering

- **Quality Level D (QL D)**
  - Review of Existing Records & Information

- **Quality Level C (QL C)**
  - Surveying & Plotting Above Ground (Surficial) Features and connecting points

- **Quality Level B (QL B)**
  - Surface Geophysical Methods to Map Utilities

- **Quality Level A (QL A)**
  - Non-Destructive Excavation to Expose & Survey Utility
HOW CAN UTILITY RISK BE ADDRESSED?

- Investigate Drawings
- Call 811 Records
- Utility Mapping
- Vacuum Excavate
- Slot Trench Entire Site

Lower Cost & Risk with Utility Impact Mitigation

HIGH RISK

LOW RISK

HIGH COST

LOW COST
UTILITY MAPPING TECHNOLOGIES

Advanced EMI
3D GPR
2D GPR
RFEMI Locators
3D RFEMI Locators

RTS & GPS Systems
Vacuum Excavation

PLUS
Many types of EMI
Multiple frequency GPR
Inertial mapping inside pipes
THE CASE FOR MULTIPLE SENSORS

EMI FEATURES

GPR FEATURES

FINAL MAP
POP QUIZ #2

What are some technologies & methods for mapping utilities?

Existing records
Surface features
Electromagnetic/Radio Frequency Locators
Ground Penetrating Radar
Vacuum Excavation
WHAT ELSE CAN BE SEEN?
# Utility Conflict Matrix

## Benefits

- Systematic management of utility conflicts
- Improved organization, tracking, and accountability
- Cost estimate analysis spreadsheet
- No IT support needed for single project matrix (Excel sheet)

<table>
<thead>
<tr>
<th>Utility Owner and/or Contact Name</th>
<th>Conflict ID</th>
<th>Drawing or Sheet No.</th>
<th>Utility Type</th>
<th>Size and/or Material</th>
<th>Utility Conflict Description</th>
<th>Start Station</th>
<th>End Station</th>
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<th>End Offset</th>
<th>Utility Investigation Level Needed</th>
<th>Test Hole</th>
<th>Recommended Action or Resolution</th>
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</table>
PROJECT PLAN VIEW

Conflict?

18” Proposed Drainage

30” Water

COURTESY OF SHRP2
How deep is the water pipe?

30” Water
How deep is the water pipe?

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>C16</td>
<td>17</td>
<td>W</td>
<td>3</td>
<td>30”</td>
<td>36+50</td>
<td>47.0</td>
<td>31</td>
<td>6.15'</td>
<td>22</td>
<td>NG</td>
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</table>
### ROSWELL ROAD PLAN VIEW

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</thead>
<tbody>
<tr>
<td>AWS</td>
<td>C16</td>
<td>1</td>
<td>WM</td>
<td>30&quot; ductile iron pipe</td>
<td>Proposed 18&quot; drainage pipe would cross WM.</td>
<td>36+50</td>
<td></td>
<td>47' LT</td>
<td></td>
<td>QLA</td>
<td>17</td>
<td>Review possibility of adjusting drainage pipe up to avoid conflict.</td>
<td>U</td>
<td>n/a</td>
<td>Utility conflict identified.</td>
<td></td>
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</tbody>
</table>

### Test Hole Form

<table>
<thead>
<tr>
<th>Utility Type</th>
<th>Utility Material</th>
<th>Offset Measured From</th>
<th>Identified By</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Electrical</td>
<td>1 Steel</td>
<td>30 Edge of Pavement</td>
<td>20 Sleeve</td>
</tr>
<tr>
<td>BT Buried Telephone</td>
<td>3 PVC (Polyvinyl Chloride)</td>
<td>32 Right-of-Way</td>
<td>21 Hub/Latch</td>
</tr>
<tr>
<td>FCC Fiber Optic Cable</td>
<td>4 RPC (Ringed Plastic Clay)</td>
<td>33 Centerline</td>
<td>22 Nail/Disk</td>
</tr>
<tr>
<td>Water</td>
<td>5 PE (Polyethylene Pipe)</td>
<td>34 Back of Curb</td>
<td>23 &quot;X&quot; in Concrete</td>
</tr>
<tr>
<td>SAN Sanitary Sewer</td>
<td>6 AC (Galvanized Steel)</td>
<td>35 Survey Hub</td>
<td>24 Sot Iron Rod and Cap 6/8&quot;</td>
</tr>
<tr>
<td>STM Storm Sewer</td>
<td>7 CI (Cast Iron)</td>
<td>36 &quot;X&quot; in Concrete</td>
<td>25</td>
</tr>
<tr>
<td>CATV Cable TV</td>
<td>8 DBC (Direct Buried Cable)</td>
<td>37 Swing Ties</td>
<td>26</td>
</tr>
<tr>
<td>NW Force Main</td>
<td>9 Concrete Pipe</td>
<td>38 Ref. Point in Driveway</td>
<td></td>
</tr>
<tr>
<td>RW Reclaimed Water</td>
<td>10 Corrugated Metal Pipe</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>SL Street Light</td>
<td>11 Duct</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>TS Traffic Signal</td>
<td>12 Fiber Optic</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>FL Fuel Line</td>
<td>13 Unknown</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>EXP Exploratory</td>
<td>14 Corrugated Plastic</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>UNK Unknown</td>
<td>15 Concrete Duct</td>
<td>44</td>
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### Utility Conflict Table

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**COURTESY OF SHRP2**
# Utility Conflict Management Summary

**Goal:** Minimize Unnecessary Utility Relocations

- Gather available info & perform preliminary field investigation
- Identify potential utility conflicts
- Prepare utility conflict matrix
- Evaluate alternatives (both utility and project)
- Conduct utility impact analysis
- Coordinate with stakeholders

Iterative process (pending design progression)

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**Goal:** Minimize Unnecessary Utility Relocations

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Note: refer to subsheet for utility conflict cost analysis.
How can Utility Conflict Matrices help during utility coordination?

- Provides management tool to deal with conflicts
- Organizes relevant information on conflicts & alternatives
- Allows tracking of conflict resolution progress
EXAMPLE: DRAINAGE CHANNEL & ELECTRICAL DUCT SYSTEM

Rapid City, South Dakota

Impact discovered during preliminary project scoping inspection

Typical concrete lined drainage ditch would have impacted electrical cabinet and cables

Recommendation: Redesign sloped ditch to vertical wall

Additional benefit: Elimination of some right of way acquisition
RECOMMENDED REDESIGN

ORIGIN DESIGN

Profile View

Grading cut section

Electric cabinet and cables

Vertical wall

COURTESY OF SHRP2
SUBSURFACE GEOPHYSICAL SURVEY
WASTEWATER TREATMENT PLANT
VESTAL, BROOME COUNTY, NEW YORK

INVESTIGATION AREA

LOCATION MAP

DRAWING INDEX

REFER TO SHEET GNI FOR NOTES, CONDITIONS AND UNDERSTANDING
CASE STUDY: MISSOURI RIVER WWTP

Existing utility data was unreliable and incomplete

Potential for design conflicts, construction delays and cost overruns

GOALS OF SUBSURFACE GEOPHYSICAL INVESTIGATION

Survey of proposed design areas to reduce design conflicts with unknown or poorly mapped utilities

Reduce project costs and timeline by improved targeting of pot-holing program

Verify utilities in critical priority areas throughout the Project Site
2D MAP OF EMI DATA OVER SEVERAL TARGETS
INVESTIGATION AND CONFIRMATION OF TARGETS

Original Test Hole Location #8

Adjusted Test Hole Location #8

Confirmed Gas Line

Confirmed Water Main

Based upon the UIT geophysical investigation, the location of the test hole was adjusted. Resulting in the verification of two previously unknown utilities.
3D UTILITY MODELS

Answers questions on utilities across disciplines; communication tool

Visualization of utility routes through project areas

Clash detection of proposed structures

Comprehensive elevation data in 3D

Unlimited profile views across complex utility crossings
CLASH DETECTIONS

Can “automatically” create preliminary Utility Conflict Matrix

Designers can check proposed bridge, wall, drainage, and other civil structures for conflicts

Utility Engineers can run proposed utility relocations against existing utilities & design structures

Construction Teams can run tolerance checks to find areas requiring test holes
MODEL USE BY CONSTRUCTION

Construction Sequence Planning

Constructability checks

Easy utility reacquisition for staking or potholing before construction

Visualization in field for on the spot decisions
MACHINE GUIDANCE

2D maps available in machine cab to inform operator about utility proximity
POP QUIZ #4

What are some benefits to a 3D utility model?

- Can house all utility information on a project
- Clash detections
- Utility visualizations in field
- Unlimited arbitrary profiles possible
- Input into MCG systems
What’s the Result of All This?

...In Terms of Dollars...
## Savings & Efficiency

### With Good Utility Management

### Test Hole Savings

<table>
<thead>
<tr>
<th>Project</th>
<th>Data</th>
<th>Savings Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOHO</td>
<td>250/68 Test Holes</td>
<td>3.7</td>
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</tbody>
</table>

### Mapping Efficiency

<table>
<thead>
<tr>
<th>Project</th>
<th>Data</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>TOHO</td>
<td>1 miss/68 test holes</td>
<td>98.5%</td>
</tr>
</tbody>
</table>
Where do savings come from on Enhanced Utility Management?

- Redesign/realignment of proposed structures to avoid relocating existing utilities during design phase
- Number of test holes reduced
- Fewer *dry holes* during intrusive investigations
- Utility-related change orders reduced from encountering unknown utilities during construction
High quality mapping is the foundation of utility impact mitigation.

Utility Conflict Matrix offers good way to manage conflicts.

3D Models offer an advanced method to manage utilities.

Utility Impact Mitigation Lets You:
- Design more efficiently
- Construct more safely
- Save money & reduce schedule delays