Committee on Right of Way, Utilities and Outdoor Advertising Control

2019 Annual Meeting

Chattanooga, Tennessee
April 28–May 2, 2019
Utility Locating Technologies R01B

Feasibility of Mapping & Marking Underground Utilities by DOTs

Heather Howe
Heather.C.Howe@odot.state.or.us

Committee on Right of Way, Utilities, and Outdoor Advertising Control Annual Meeting, 2019
Oregon DOT
Establishing a SUE Program

- Backing of ODOT’s Chief Engineer
- Recruited multi-skilled team of staff
- Created an initial set of documents
- Outreach to key stakeholders
- Went hunting for projects
Overall Project Scope

OR 8: Hocken to Short

- Signal replacement
- Roadway geometry adjustment
- Create a left turn lane
- Improvements to sidewalks and curb ramps, illumination, drainage and water quality treatment elements
R01B: Why OR 8?

OR 8: Hocken to Short

- Located in the Portland-Metro area
- Project scope was a good fit
- Good mix of existing features to test MCGPR and TDEMI
- Reasonable sized project, appropriate for our first SUE project
R01B: Why OR 8?

OR 8: Hocken to Short

Intersection at SW Cedar Hills Blvd

Intersection at SW Hocken Ave

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R01B: Trying Something New
OR 8: Hocken to Short
R01B Project
OR 8: Hocken to Short

- Field work – 300 man hours, approx.
  - MCGPR – IDS Stream EM system
  - TDEMI – A Geonics EM-61 MK2A

- Data analysis – 800 man hours, approx.

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R01B Project Challenges
OR 8: Hocken to Short

• Overcoming internal processes needed to execute a contract
• Maintaining the delivery schedule
Lessons Learned

Increased knowledge and awareness of SUE methods and applications

- Availability of tools
- Benefits SUE can provide
- Risk mitigation
- Acknowledgement of uncertainty

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Lessons Learned

MCGPR and TDEMI are complex and complicated

• Field work is safer and quicker
• Equipment is easy to use
• Data processing requires more time and skill
Lessons Learned

SUE requires new contract language and dedicated procurement processes

- Start early
- Distinguish SUE from utility coordination
- Meet procurement team face-to-face
- Conduct outreach
- Know your end game

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Lessons Learned

At the onset of project development – Always be thinking SUE

- Timing is key
- Evaluate the project’s complexity early
- Engage the utility coordinator
- Determine needs – 2D or 3D
Lessons Learned

Never forget, cost is king

- Project leaders want to know “what’s my bottom line”
- Track every project to build a cost history
- Every job is different
Lessons Learned

Need for prequalified contractor list to expedite procurement process

- RFP process is long
- Establish standard contract language
- Make it easy for project leaders to use
Oregon DOT’s Next Steps

✔ Update our procurement and contracting documents
✔ Develop new tools and refine our existing ones
✔ Expand stakeholder outreach and education efforts
✔ Look for projects
Alternative Uses of the Right of Way/Fiber Optics on the Interstate – Utah DOT Experience

Chattanooga, Tennessee
May 1, 2019
UDOT’s Fiber Optic Network
Coordinating with Telecomms

- Yearly planning meetings
  - Single point of contact
  - Telecomm wish-list
- Know what facilities are in the ROW in order to direct questions to the right people
  - Permits Office
  - ROW Office
- Communication is the key!
Reducing Broadband Deployment Time

- DOT involvement makes access to the ROW easier
  - Cooperation between other state and federal agencies
    - Forest Service
    - BLM
    - School Trust Lands
    - State and National Parks
  - Telecomm wish-list
- Do not allow exclusive access!
Underserved Area Incentives

- Help communities understand how to attract fiber providers
  - Allow them to use DOT standards for construction
  - Attend City/County planning meetings to help with coordination
- Build it and they will come
  - Big & Little Cottonwood Canyons
  - Fiber in the canyons boosts economic development
Big & Little Cottonwood Canyons
Big & Little Cottonwood Canyons

4 major ski resorts
500 inches of annual snowfall
Year-round recreation
Peak Traffic Days are Snow Days
Avalanches
Stakeholders
Project Summary

- Project Estimate: $5 Million
  - 35 poles
  - 24.5 miles of fiber optics
  - 7200 volt electrical system
  - 12 new cameras
  - 8 Road Weather Information Systems (RWIS)
  - 15 chain-up signs
  - Improved communications for all users
  - Avalanche Operations Center
References

- State Code/Rules for Longitudinal Telecommunications Access
  - http://le.utah.gov/code/TITLE72/htm/72_07_010800.htm
Fiber Highway

Lynne Yocom
Utah Department of Transportation Fiber Optics
lyocom@Utah.gov
801 514 4565
Utility Locating Technologies (R01B)
2019 – ‘Final’ Update

Phil Sirles (SME)
Sr. Geophysicist
Olson Engineering
& Collier Geophysics
**Todays Outline**

SHRP2 & R01B Summary
R01B Implementation Plan
Geophysical Methods:
- MCGPR
- TDEMI
State / DOT Project Presentations:
- Oregon DOT
- Montana DOT
- Ohio DOT
- *Caltrans

Lessons Learned / Summary
SHRP2 Implementation:
INNOVATE.IMPLEMENT.IMPROVE.

State Project!!
Advancing technologies to help agencies detect subsurface utilities.

Utility Investigation Technologies (R01B)
Three Products – “The Utility Bundle”

- **Utility Locating Technologies** (R01B)
  - 3D Utility Location Data Repository (R01A*)
  - Identifying and Managing Utility Conflicts (R15B*)

*R01A and R15B SME: Cesar Quiroga, TTI

**Round 6:** Proof of Concept ($150K each agency)
**Round 7:** Lead Adopter ($100K each agency)
MCGPR and TDEMI for 3D Utility Location
## 2015 SHRP2 R01B Goals – From Research

<table>
<thead>
<tr>
<th>Goal</th>
<th>Outcomes</th>
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</table>
| 1. Educate industry and agencies about benefits and limitations of subsurface utility engineering (SUE) investigation technologies, when it may be advantageous to incorporate multi-channel utility designation into business practices, and 2. How to implement these systems. | • Increased understanding of reliability of 3D data and quality levels.  
• Determination of depth and 3D data, which allows Quality Level B data to be identified earlier in the design process.  
• Multi-channel utility designation is accepted as another tool for facilitating subsurface utility investigations.  
• Implementation integrated with other SHRP2 utility products and coordinated with American Society of Civil Engineers’ committees’ standards for utilities. |
| 3. Establish standard processes to incorporate SUE across agency departments. | • Scope the work needed for subsurface utility detection and provide data that can be used for measuring the performance of the outcomes. |
| 4. Develop ability of agencies to incorporate SUE in total cost of facility ownership to improve return on investment. | • SUE integrated into agency asset management plans.  
• Proactively collected data on utility location as it is installed (using database developed under R01A). |
Two Geophysical Technologies selected for SHRP2 IAP to SUPPLEMENT the standard tool box for SUE Investigations!

Advanced Hardware*

- Multi-Channel Ground Penetrating Radar (MCGPR)
- Time-Domain Electromagnetic Induction (TDEMI)

Advanced Software*

- Software for processing, interpretation and visualization of MCGPR in 3D (X,Y,Z), and TDEMI data in 2D (X,Y)

* Commercially Available and Proven Technologies
Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data

QL-D
QL-C
QL-B
QL-A
2D Utility Mapping

- Utility location services: X, Y
- Test holes at specified locations: Z (X, Y if surveyed)
- American Society of Civil Engineers ASCE 38-02

**Standard Guideline:**
- Quality Level D: Review of existing records: X, Y
- Quality Level C: Survey of visible appurtenances: X, Y
- Quality Level B: Geophysical methods for underground utilities: X, Y
- Quality Level A: Exposed utilities at specified locations: X, Y, Z
  - Test holes
  - Valves
  - Manholes
  - Vaults
  - Building basement walls
Traditional Geophysical Technology Toolbox for 2D SUE

Many types of systems:
- Radio-Frequency (RF)
- Radio Frequency Identification (RFID)
- Electromagnetic Induction (EMI)
- Ground Penetrating Radar (GPR)
- Magnetometers (MAG)
- Acoustic sensors
- Inertial mapping inside pipes
- Use of sondes inside pipes
Implementation Assistance Program (IAP) States Awarded Grants:

- Virginia
- Ohio
- Arkansas
- Oregon*
- California
- Montana*
- MDT
- Ohio Department of Transportation
- Caltrans
- VDOT
- ARDOT
- Oregon Department of Transportation
Implementation Plan:

1) Training ➔ on-site: classroom and field / instrument demonstrations
2) Planning ➔ Site / Project Selection
3) Implementation ➔ Active DOT design project for deployment of technologies (part of SUE process)
4) Reporting ➔ DOT Reports (project) and AASHTO SHRP2 Report-outs
For Both Methods:

- Basic Theory
- Benefits & Limitations
- Complications
- Variations (*of the method*)
- Applications (*beyond utilities*)
- Why it works for utility mapping
- When it won’t work for utility mapping
- Requirements for effective use
- Final Products – What are the deliverables?
Training and Demonstrations
Advanced* GPR Systems

*Advanced is Multi-Channel / Multi-Frequency
MCGPR – “Multi-Channel” GPR
MCGPR – “Multi-Channel” GPR
MCGPR Towed Systems
IDS Stream-EM System

3D Radar DXG System
Monostatic, Bistatic vs. Multichannel/Multistatic GPR

- **Monostatic** GPR uses the same antenna for transmission and reception
- **Bistatic** GPR use separated antenna for transmission and reception
- **Multichannel/Multistatic** GPR uses multiple receivers and transmitters for illumination and tomographic solutions!
MCGPR - From 2D Detection to 3D imaging

From detection to mapping...
MCGPR Basic Concepts – Building a 3D Data Set

Volumetric Imaging with 3D MCGPR allows for depth (Z) calculation, and horizontal control / resolution!
MCGPR Basic Concepts – Building a 3D Data Set

Build the 3D Grid

Horizontal slices

In-line profile

Cross profiles
• Towed by a vehicle (speed ~10mph).
• Data collection in longitudinal direction (without the need of moving the array in the transversal directions) but detection of utilities and connections.
• High detection capability
• Avoid blocking the road traffic
• Exploit advanced processing features
The IDS **GRED HD** software comes with a 3D graphic interface, and advanced software features making it a complete tool for post processing GPR data.

**GRED** is able to display:
- Tomography (time slices),
- Radar scans parallel to the acquisition direction,
- Virtual Radar scans orthogonal to the acquisition direction
MCGPR: IDS Gred Output (.avi file)
MCGPR: 3D Radar DXG

3D Radar

The Ground is No Limit
# MCGPR: 3D Radar DX Series

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Applications</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| DX      | • IED / UXO / Landmine  
          • Railway – ballast  
          • Airport runway  
          • Road  
          • Bridge deck | ➢ **Air-coupled**  
                           ➢ High speed data collection  
                           ➢ Largest arrays |
| DXG     | • Utility mapping  
          • Bridge deck  
          • Road  
          • Archaeology | ➢ **Ground-coupled**  
                           ➢ High vertical and lateral resolution  
                           ➢ Better penetration than DX |
3D Radar - Theory Of Operation

Step-frequency waveform

- Frequency: 3.0 GHz
- Frequency step: 30 MHz
- Dwell Time
- Scan Time (Integration Time)
- N frequencies
3D-Radar Examiner

- Designed to handle huge datasets
  - No data reduction
  - Post processing performed on full dataset

Drastically reduced processing time
- Data available for analysis almost immediately after the survey

Intuitive GUI
- Easy extraction of meaningful data

High positioning accuracy
- State-of-the-art GPS outliers filtering

Easy to use annotation function
- Annotations exported with subsurface images

Import/Export of geo-referenced maps and images
- AutoCAD, Google Earth, Video

Fully documented SW development kit
- Integration of specific algorithms
Making ‘sense’ of it all!

2D SUE + 3D MCGPR = Best Possible Solution (!?!)

Data courtesy Utility Mapping Services, Inc.
TDEMI: Utility / Metal Object Detector
When Does TDEMI Work Well for Utilities?

- When the target utility is metal
  
  \textit{(ferrous \& non-ferrous)}

- When utility is within the top 5-10 feet

- Tracer wire is on a shallow utility

- In \textit{any} geologic setting
Range of Conductivity in Various Earth Materials

WHY DOES TDEMI WORK? → Material Contrasts!
TDEMI Multisensor Array: Geonics EM61-MK2

Specifications

MEASURED QUANTITIES
Four time gates of secondary response in mV

EM SOURCE
Air-cored coil, 1 x 0.5 m size

CURRENT WAVEFORM
Unipolar rectangular current with 25% duty cycle

EM SENSORS
1. Main: Air-cored coil, 1 x 0.5 m in size, coincident with EM source
2. Focusing: Air-cored coil, 1 x 0.5 m in size, 30 cm above main coil

DYNAMIC RANGE
18 bits

OUTPUT MONITORS
Color active matrix TFT-LCD 240 x 360 pixels, and audio tone

DATA STORAGE
512 MB internal disk, SD and CF slots, user accessible

DATA OUTPUT
RS232 - serial, Bluetooth

POWER SOURCE
12 V rechargeable battery for 4 h continuous operation

OPERATING TEMPERATURE
-30°C to +60°C

OPERATING WEIGHTS & DIMENSIONS
41 kg trailer mode;
100 x 50 x 5 cm (bottom),
100 x 50 x 2 cm (top)
TDEMI Data

- TDEMI is a 2D (X,Y) digital geophysical mapping technology with high-precision RTK GPS
- Does not discriminate below-ground and above-ground metallic objects (*including vehicles*); requires good culture mapping
- Interpretation / Integration with 2D SUE is key!

Data courtesy Cardno
TDEMI Data

- Easy to overly on GPR data, Google Earth Imagery, and export to GIS, and Acad packages.
- No depth estimates to anomalies
DOT Project Examples

- Montana – Gabe Priebe
- Oregon – Heather Howe
• Ohio – Wendi Snyder
• Caltrans – Bill Owen
Cleveland-Massillon Road (CR-17)

- Asphalt overlay on reinforced concrete
- Unknown site conditions
- Data deemed useless except in small areas w/o rebar
- Few MCGPR anomalies interpreted
• TDEMI Results
  – Along Massillon Road useless
  – TDEMI
  – Along Gardner Blvd match with
    4” Water Line is OK
Video of 3D Radar DXG System
- Purchased DXG system
- Trained on Examiner Software
- Acquired at greater than 10 mph
- Greater than 1 road mile of data with 3 passes, all in 20 minutes
DOT Caltrans TDEMI

• Caltrans – Preliminary S. Main / SR395

Field Work April 17, 2019
<1 week to process preliminary TDEMI results. Need to integrate Phase 1 2D SUE data
## 2015 SHRP2 Goals – How did we do?

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Goal – Educate DOT’s
Goal – Implement on Projects

MCGPR

Figure 4: MCGPR profile showing apparent utility buried beneath Curver Avenue, just west of National Avenue. This alignment was among many revealed with MCGPR, but not identified in the Phase 1 SUE.
Goal – Implement on Projects
<table>
<thead>
<tr>
<th>Strengths</th>
<th>MCGPR</th>
<th>TDEMl</th>
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<tbody>
<tr>
<td></td>
<td>• Maps in 3D: X, Y, and Z; with survey-grade GPS integrated for positional accuracy</td>
<td>• Detects both ferrous and non-ferrous metallic utilities</td>
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<tr>
<td></td>
<td>• Detects metallic, PVC, cement, and tile utilities</td>
<td>• Detects other buried, non-utility related, metallic objects (e.g., UST, debris/trash, etc.)</td>
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<tr>
<td></td>
<td>• Detects other non-utility subsurface features such as: shallow voids, depth to ground water, and geologic variations (e.g., layering and/or boulders)</td>
<td>• Processing and interpretation generally straightforward using various commercially available software (i.e., less experience required compared to MCGPR)</td>
</tr>
<tr>
<td></td>
<td>• Utilities distinguishable as close as 1-foot apart, depending on size and burial depth</td>
<td>• TDEMI systems can be configured for the site size/width</td>
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<td></td>
<td>• High precision depth-to-target information, based on site-specific calibration for depth</td>
<td>• Towed multisensor arrays can be dis-assembled for small or hand-towed systems that are 2 or 3 feet wide to work along ROW (non-roadway) areas</td>
</tr>
<tr>
<td></td>
<td>• Other larger utilities can be imaged and their geometry estimated (e.g., duct banks and vaults)</td>
<td>• RTK GPS data can stream into single or multisensor arrays for positional accuracy of data</td>
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<td></td>
<td>• Often find edges of trenches where utilities exist, even if the utility is not detected</td>
<td>• Data are unaffected by site soil conditions</td>
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<td>• Data can be acquired in areas where surface features such as cars, fences, powerlines, and other infrastructure are present</td>
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<td></td>
<td>• Not necessary to conduct surveys at night</td>
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<td></td>
<td>• Multiple manufactures of sophisticated MCGPR hardware (both towed arrays and hand-pushed smaller MCGPR arrays)</td>
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<tr>
<td>Weaknesses</td>
<td>• Requires extensive analysis by experienced staff</td>
<td>• Maps metallic utilities in 2D: X, Y</td>
</tr>
<tr>
<td></td>
<td>• More involved visualization techniques (3D data manipulation)</td>
<td>• For towed-array (multisensor) configurations, field operations must be conducted at night to avoid nearby traffic (vehicles) negatively impacting data quality</td>
</tr>
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<td></td>
<td>• Most software for processing and interpretation of data, and visualization of results is proprietary (i.e., dedicated for manufactures instruments)</td>
<td>• Cannot detect nonmetallic targets</td>
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<tr>
<td></td>
<td>• Survey surfaces must be generally flat and not encumbered by obstacles and/or vegetation</td>
<td>• Depth of investigation limited (approximately 6 to 8-feet for TDEMI systems used in R01B)</td>
</tr>
<tr>
<td></td>
<td>• Knowledge of soil clay content required prior to use (generally &lt;50% clay fraction, or dry clay conditions)</td>
<td>• Independent metallic utilities generally not distinguishable closer than 5ft apart, depending on burial depth and size of targets</td>
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<tr>
<td></td>
<td>• Depth of investigation is governed by soil type and water content</td>
<td>• Target depth information not available</td>
</tr>
<tr>
<td></td>
<td>• Road salts can impact data quality</td>
<td>• Powerlines, parked or moving cars, dumpsters, fences, or other metallic objects within 15ft of survey area can result in poor quality data</td>
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<td>• Requirement that road base does not include mineralized materials such as iron slag</td>
<td>• Dense roadway rebar is problematic for target detection</td>
</tr>
<tr>
<td></td>
<td>• Best with unsaturated subsurface conditions</td>
<td>• Limited number of TDEMI manufacturers for multisensor (towed) arrays</td>
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<tr>
<td></td>
<td>• Data affected if surface is covered with ice</td>
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</tbody>
</table>
Lessons Learned

• Coordination and Planning are Key Elements
  – Multiple Departments in the DOT
  – Contractor(s) for advanced geophysical technologies
  – SUE providers not all qualified

• Work at night for TDEMI *(vehicles cause interference with data)*

• Consequences if 2D SUE and advanced methods are not reconciled and integrated carefully

• MCGPR affected by concrete with rebar and/or very clayey soils

• Good depth (Z) estimates from MCGPR and geometry in 3D

• Traffic controls are critical

• 1 ‘shift’ of data collection yield weeks of analysis & reporting

• MCGPR hardware is much better and software is getting easier to work with process *(i.e., learn!)*
• **VDOT** – Pleased MCGPR worked in ‘clayey’ soils (*no USCS*)
• **MTD** – Pleased Yellow Stone pipeline was detected
• **OR-DOT** – Pleased with ties between SUE and MCGPR/TDEMI and developed / matured their SUE statewide program

3. Establish standard processes to incorporate SUE across agency departments.

- Scope the work needed for subsurface utility detection and provide data that can be used for measuring the performance of the outcomes.

• **ARDOT** – Learned the contractors may not be as prepared as planned, and contracting can take a long time
• **MCGPR** is reliable as another SUE QL B tool, and will aid states to optimize QL A verification plans using depth (Z) and 3D utility models (*with good site conditions*)
• **TDEMI** does not provide depth information, but useful for sites with high clay content or saturated soils and metal utilities.
Advancing technologies to help agencies detect subsurface utilities.

Utility Investigation Technologies (R01B)

1. Too early for any state project to provide performance metrics or insights to ‘return-on-investment’ for costs of Advanced Utility Locating Technologies and benefits to project.

2. AASHTO and FHWA will continue to help IAP states evaluate the effectiveness of this R01B effort.

4. Develop ability of agencies to incorporate SUE in total cost of facility ownership to improve return on investment.
   - SUE integrated into agency asset management plans.
   - Proactively collected data on utility location as it is installed (using database developed under R01A).
THANK YOU – QUESTIONS?

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**GoSHRP2 website**  
www.fhwa.dot.gov/goSHRP2  
– Product details  
– Information about SHRP2 implementation phases

**SHRP2 Utility Bundle website**  
http://shrp2.transportation.org/Pages/UtilityRelatedProducts.aspx  
Implementation Information for AASHTO members
Why is Utility data Important to MDT?

MDT’s Experience with R01B Technologies
Why is Utility data Important to MDT?

• Affect the delivery of approximately $300M in projects annually

• Certification to FHWA

• Statute and MDT Policy requirements - 75%+ reimbursement

60-4-403. Relocation -- costs. (1) Except as provided in subsections (2) and (3), 75% of all costs of relocation, dismantling, and removal must be paid by the department as a cost of federal-aid systems construction.
committee on right of way, utilities, and outdoor advertising control annual meeting, 2019

locating technologies (r01b), feasibility of mapping & marking underground utilities by dot's

drawing parallels from mdt's processes

why is utility data important to mdt?

30% 60% 90%

typical design project – 100 to 200 activities!

affect the delivery of approximately $300m in projects annually
Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs

Drawing parallels from MDT's Processes
**Available Data Sources - Yesterday**

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Scope</th>
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<tbody>
<tr>
<td><em>Subsurface Utility Engineering (SUE):</em></td>
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<tr>
<td><strong>Phase I SUE</strong> – Qualified consultant using</td>
<td>90% Design</td>
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<td>non-invasive techniques to obtain data</td>
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<td><strong>Phase II SUE</strong> – Vacuum Excavation</td>
<td>60% Design</td>
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<td>30% Design</td>
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<td>Design Utility Conflicts Review</td>
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<td>Preliminary Utility Conflicts Review</td>
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<td>Research</td>
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<td>Ut. Co. As-builts</td>
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<td>One-call</td>
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<td>Surveyed features</td>
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<td>*Phase I SUE</td>
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<td>*Phase II SUE</td>
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<td>*Additional Phase II SUE</td>
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<td>*Phase II SUE</td>
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<td>Ut. Co. CADD records</td>
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<tr>
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<td>*Phase II SUE</td>
<td></td>
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<tr>
<td>*Additional Phase II SUE</td>
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</tbody>
</table>

- **30% Design**
- **60% Design**
- **90% Design**
- **Construction**
- **Relocation**
- **Utility Plans**
- **Research**
- **Ut. Co. As-builts**
- **One-call**
- **Surveyed features**
- ***Phase I SUE**
- ***Phase II SUE**
- **Ut. Co. CADD records**
- ***Additional Phase II SUE**
Available Data Sources - Tomorrow

- **30% Design**
  - Design Utility Conflicts Review
  - Preliminary Utility Conflicts Review
  - MCGPR
  - TDEMI
  - SPAR300
  - ULDR
  - LiDAR
  - Research
  - Ut. Co. As-builts
  - One-call
  - Surveyed features
  - Phase I SUE

- **60% Design**
  - Utility Plans
  - MCGPR
  - TDEMI
  - SPAR300
  - ULDR
  - LiDAR
  - Research
  - Ut. Co. As-builts
  - One-call
  - Surveyed features
  - Phase I SUE
  - Phase II SUE
  - Ut. Co. CADD records

- **90% Design**
  - Utility Agreements
  - Relocation
  - Construction
  - MCGPR
  - TDEMI
  - SPAR300
  - ULDR
  - LiDAR
  - Research
  - Ut. Co. As-builts
  - One-call
  - Surveyed features
  - Phase I SUE
  - Phase II SUE
  - Ut. Co. CADD records
  - Additional Phase II SUE
Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs
Drawing parallels from MDT’s Processes

**Available Data Sources**

- **30% Design**
- **60% Design**
- **90% Design Relocation**
- **Construction**

**Utility Agreements**

**GOAL – Minimize Data Rediscovery**

**Preliminary Utility Conflicts Review**

- MCGPR
- TDEMI
- SPAR300

**ULDR**

- LiDAR
- Research
- Ut. Co. As-builds
- One-call
- Surveyed features
- Phase I SUE

**ULDR**

- LiDAR
- Research
- Ut. Co. As-builds
- One-call
- Surveyed features
- Phase I SUE
- Phase II SUE
- Ut. Co. CADD records

**Additional Phase II SUE**

- MCGPR
- TDEMI
- SPAR300

**LiDAR**

- Research
- Ut. Co. As-builds
- One-call
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- Phase I SUE
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Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs
Drawing parallels from MDT's Processes

Available Data Sources

30% Design
60% Design
90% Design
Relocation
Construction

GOAL – Minimize Data Rediscovery

Utility Agreements

MCGPR
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Preliminary Utility
Conflicts Review

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The Permitting Life-Cycle for Highway and Non-Highway Projects

Approved Utility Permits

Utility Permitting Coordination (Non-Hwy Project)

Utility Coordination (Hwy)

Construction

Relocation or Installation

Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs
The Permitting Life-Cycle for Highway and Non-Highway Projects

Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs
The Permitting Life-Cycle for Highway and Non-Highway Projects

1. Utility Permitting Coordination (Non-Hwy Project)
2. Utility Coordination (Hwy Construction)
3. Construction
4. Relocation or Installation
5. Approved Utility Permits
6. RETAIN AS-BUILT SURVEY IN ULDR (Condition of Permit Approval)
Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTS
Drawing parallels from MDT's Processes

Available Data Sources

30% Design

60% Design

90% Design Relocation

Construction

Custer Avenue

Design Conflicts Review

GOAL – Minimize Data Rediscovery

Preliminary Utility Conflicts Review

MCGPR
TDEMI
SPAR300

MCGPR
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Locating Technologies (R01B), Feasibility of Mapping & Marking Underground Utilities By DOTs

Custer Avenue

- 1.6 Mile Reconstruction Project with major utility and right-of-way constraints
- $6M in potential impacts to Yellowstone Pipeline if not avoided
- “OT” Phase: Alignment/Grade, Typical Section, Intersection control not yet determined
- Data from R01B technologies and other SUE methods used to aid in determination
Custer Avenue

**MCGPR**
- IDS GeoRadar Stream C 600 megahertz
- 34 antennas in two polarizations
- Survey-grade RTK GPS
- 3D

**TDEMI**
- Multiple-coil Geonics EM61 Mk2
- Three-coil machine-towed array
- Survey-grade RTK GPS
- 2D only
Custer Avenue

RESULTS

- 78 New Point Features
- 64 Linear anomalies not associated with Phase I
  - 18% of detected Phase I linear features
- Captured known metallic pipes such as Yellowstone Pipeline
- Signal loops and comm lines, paved over lids and valves

TDEMI
- Multiple-coil Geonics EM61 Mk2
- Three-coil machine-towed array
- Survey-grade RTK GPS
- 2D only

MCGPR
- IDS GeoRadar Stream C 600 megahertz MCGPR
- 34 antennas in two polarizations
- Survey-grade RTK GPS
- 3D
Custer Avenue

RESULTS

- 2 New Point Features
- 68 Linear Anomalies not associated with Phase I
  - 19% of detected Phase I linear features
- Captured several pipes and cables not otherwise detected
- Pavement and distress cracks

MCGPR
- IDS GeoRadar Stream C 600 megahertz
- 34 antennas in two polarizations
- Survey-grade RTK GPS
- 3D

TDEM
- Multiple-coil Geonics EM61 Mk2
- Three-coil machine-towed array
- Survey-grade RTK GPS
- 2D only
## RESULTS

<table>
<thead>
<tr>
<th>Test Holes</th>
<th>Spar Elevation &amp; Offsets</th>
<th>MGPR Elevation &amp; Offsets</th>
<th>TDEM</th>
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<td></td>
<td>Top</td>
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<td>Vertical</td>
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<tr>
<td>#</td>
<td>Feature</td>
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<td>1</td>
<td>duct bkn cap</td>
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*Test hole accessible to trailers
**Nearby metallic object
TH 3 elevation computed w/ tone
N/A = not surveyed
Figure 4: MCGPR profile showing apparent utility bored beneath Custer Avenue, just west of National Avenue. This alignment was among many revealed with MCGPR, but not identified in the Phase 1 SUE.
Custer Avenue MCGPR
3D Model of Utilities - Custer Avenue Helena, MT