



SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

SHRP2 R01A and R15B

Implementation Assistance Program

Utility Bundle (R01A, R01B, R15B)

Meeting at Caltrans

March 10, 2016

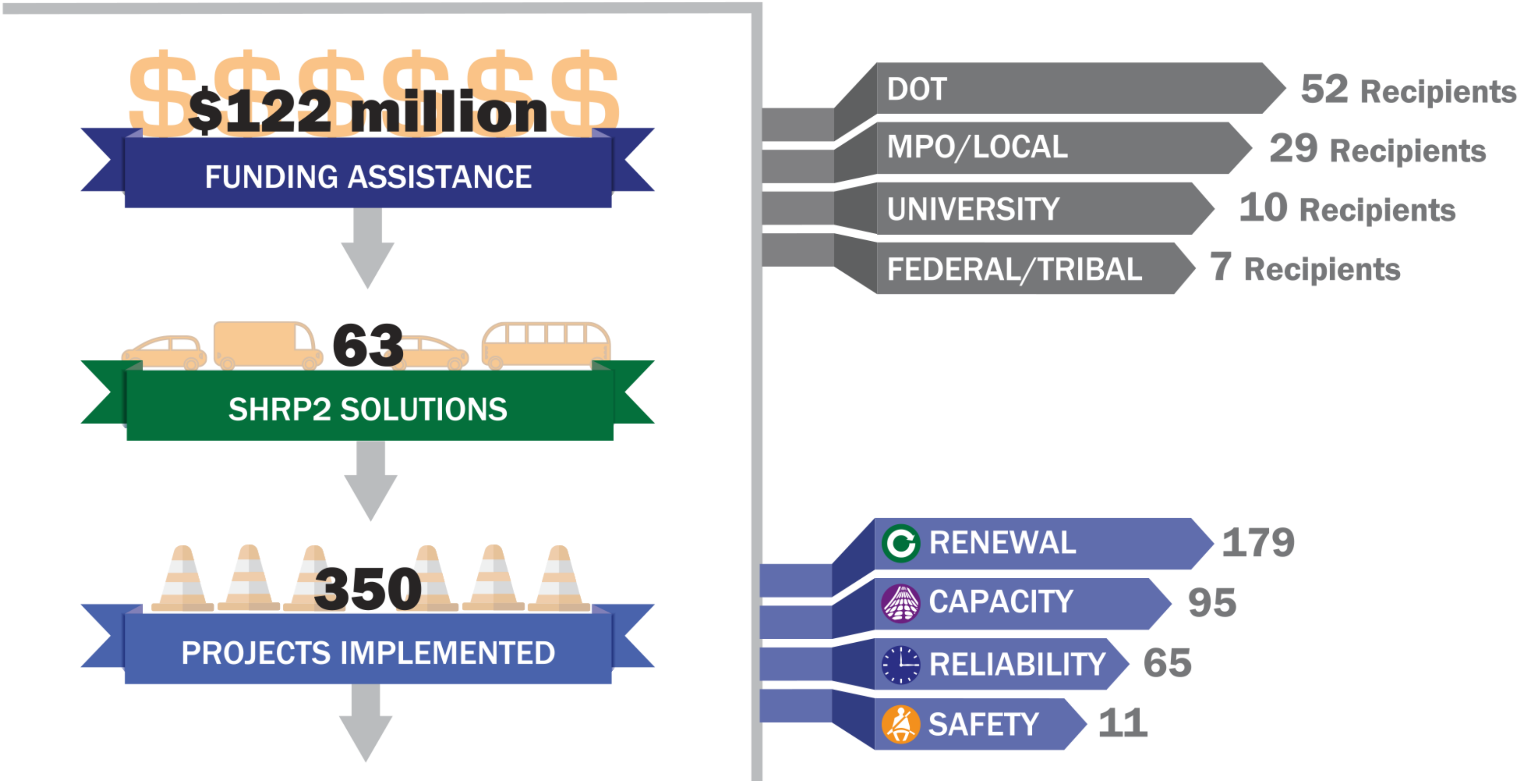
U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Agenda

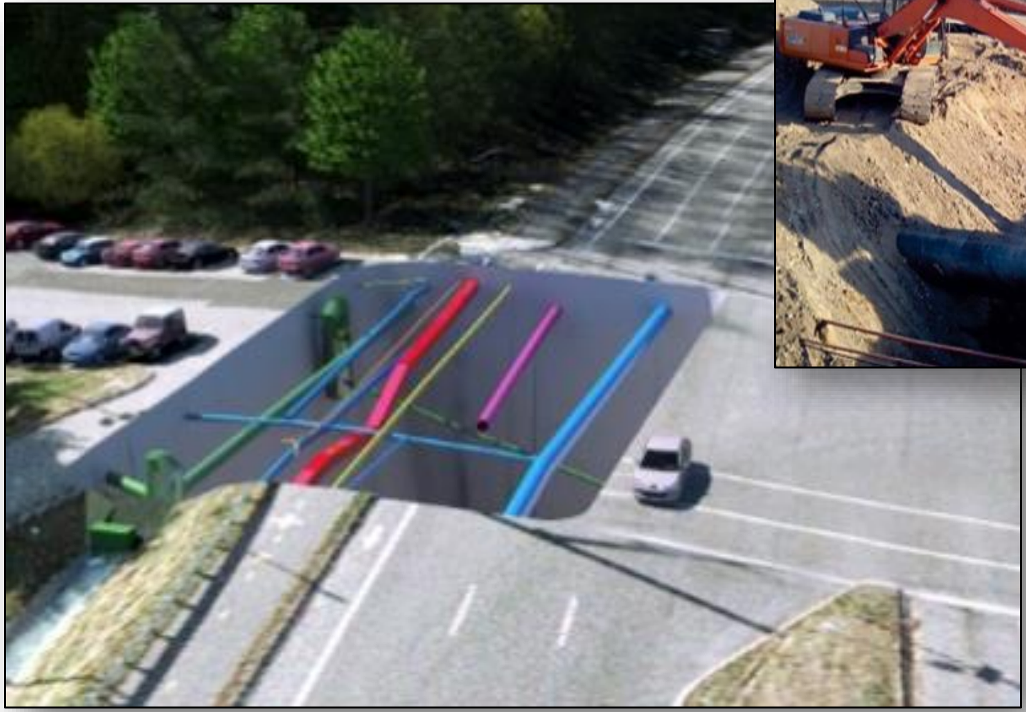
Time	Item	Presenter
9:00	Introductions	All
9:05	Purpose of Visit and Background on SHRP2 Projects	Quiroga
9:30	Outline of Bentley Map Database for Utilities and R01A Status	Kepley
10:30	Utility Conflict Matrix Data Model and R15B Status	Turner
11:15	R01B Status	Owens
11:30	Lunch	
12:30	Review Proposed Pilot Projects	Caltrans
1:30	Sandbox – Caltrans IT Infrastructure and File Systems – Sample Project with Bentley Map – Sample Project with Oracle Database	Caltrans/Quiroga
4:45	Next Steps	
5:00	End	

SHRP2 Implementation: Moving Us Forward



Utility Bundle (R01A/R01B/R15B)

Challenge: Locating and Managing Utilities



SHRP2 SOLUTIONS
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3D Utility Location Data Repository (R01A)

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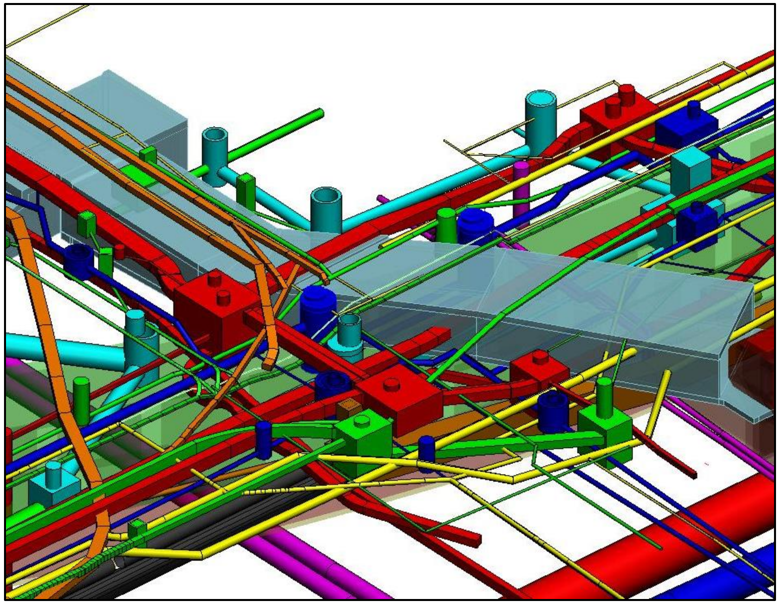
3D Utility Location Data Repository (R01A)

Challenge

- A critical factor that contributes to utility inefficiencies is the lack of adequate information about the location and attributes of utility facilities that might be affected by a transportation project. This challenge is more significant as transportation agencies migrate to 3D design and construction workflows.

Solution

- R01A's 3D storage/retrieval data model as well as parallel initiatives (e.g., FHWA 3D utility research, ASCE data standards, some state DOTs) provide the framework to help agencies develop 3D repositories of utility location and attribute data.



2D Utility Mapping

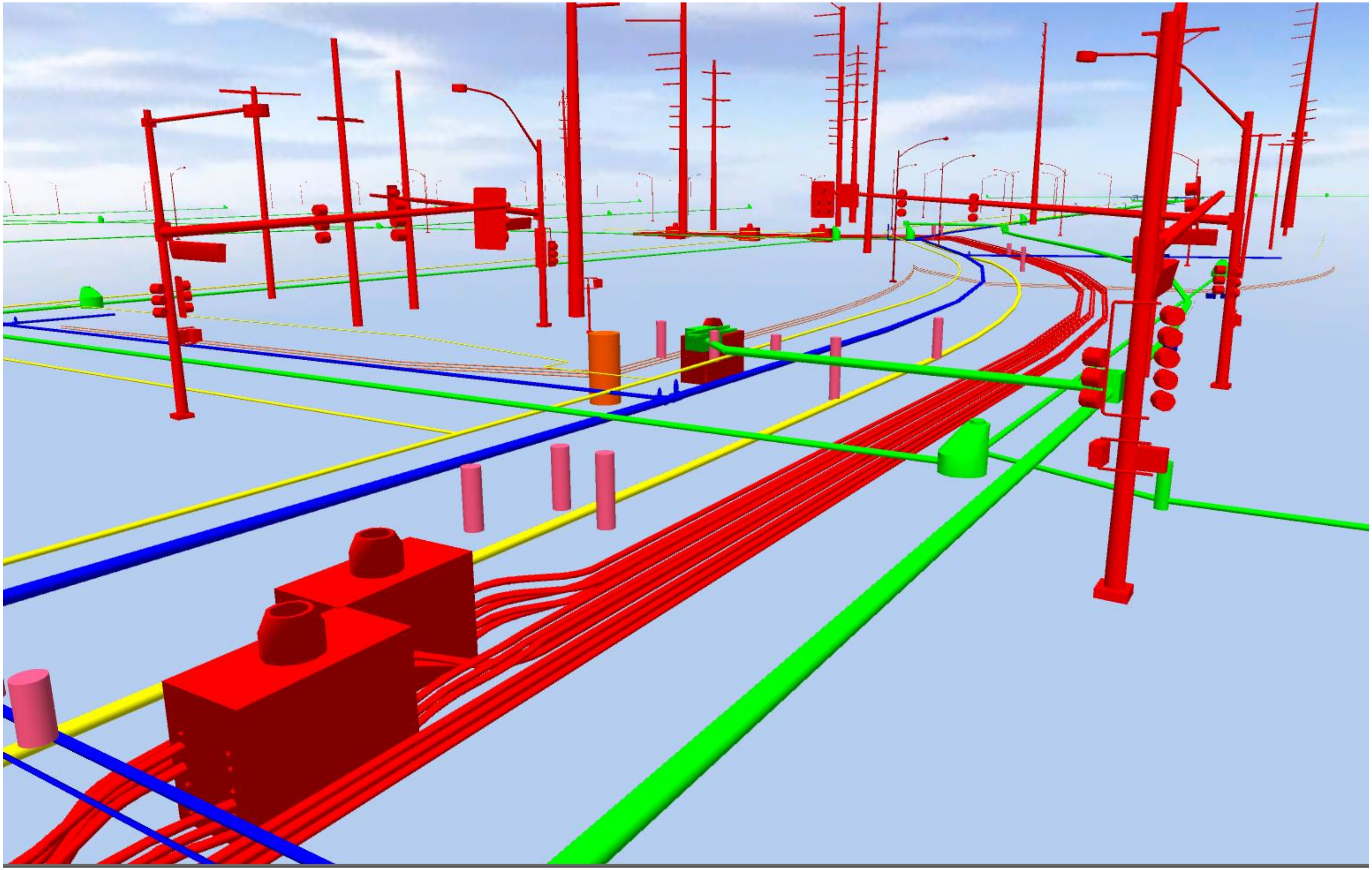
- Utility location services: X, Y
- Test holes at specified locations: Z (X, Y if surveyed)
- American Society of Civil Engineers ASCE) /CI 38-02 Standard Guideline:
  - Quality Level D: Review of existing records: X, Y
  - Quality Level C: Survey of visible appurtenances: X, Y
  - Quality Level B: Geophysical 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

GPR and EMI Arrays

GPR array

EMI array

3D Model of Existing Facilities



R01A 3D Utility Data Model

Field (Property)
LABEL
DESCRIPTION
COMMENTS
UTILITYOWNER
GASNETWORKTYPE
GASNODETYPE
QUALITYLEVEL (ASCE 38)
OPERATIONALSTATUS
INVESTIGATIONLEVEL
CONFLICTID
RESOLUTION
RESOLUTIONSTATUS
DATEINSTALLED
DATECHANGED
SOURCEFILE
SITEID

General Properties

Utility-specific Properties

Data Relationships, Quality, & Conflict Resolution Properties common to all features

Field (Property) *[cont.]*
OBJECTID
UTILITYNODETYPE
FITTINGTYPE
VOLUMETYPE
NODESHAPETYPE
LENGTH
WIDTH
HEIGHT
ELEVATION
ELEVATIONACCURACY
BOTTOMDIAMETER
TOPDIAMETER

Civil Design-specific Properties

Recent FHWA Research Project

- Research Contract DTFH61-12-C-00025, *Feasibility of Mapping and Marking Underground Utilities by State Highway Agencies*
  - Feasibility of having SHAs as the central repository of utility data within the state highway right-of-way
  - Potential benefits of having accurate utility data available during project development and delivery
  - Barriers for collecting and managing utility location data, as well as strategies to overcome those barriers
  - Cost to manage 3D utility location data and mark utilities with RFID technology

Case Studies

- California: Data model, 3D modeling, 3D utility inventory
- Connecticut: Guidelines for use of 3D in projects
- Florida: Radar tomography for 3D utility mapping
- Iowa: 3D for design and grading and paving AMG
- North Carolina: data collection costs, 3D visualization
- Texas: 3D for design and construction, utility conflict
- Virginia: RFID for utility monitoring and inventory
- Washington State: 3D for design and visualization
- Wisconsin: 3D utility data collection

Texas– TxDOT

3D utility model and utility conflict resolution:

- Review all previous utility information, including Quality Level B data.
- Collect additional Quality Level B and Quality Level A data.
  - New utility installations on the ground after bidding.
- Strengthen utility permitting process.
  - PE signature and seal required.
  - Field inspection and surveying required.
- Build 3D utility model and integrate into main 3D model.
- Conduct "hard" and "soft" clash detections.
- Use UCM approach from SHRP2 R15B.

Washington State – WSDOT

Process to develop 3D utility model:

- Calculate spot utility elevations from data gathered at points such as vaults, valves, basements, and records
- Use subject matter experts to estimate depths between spot locations
- Develop 3D utility model
- Collect QLA data at critical locations
- Update 3D utility model as needed

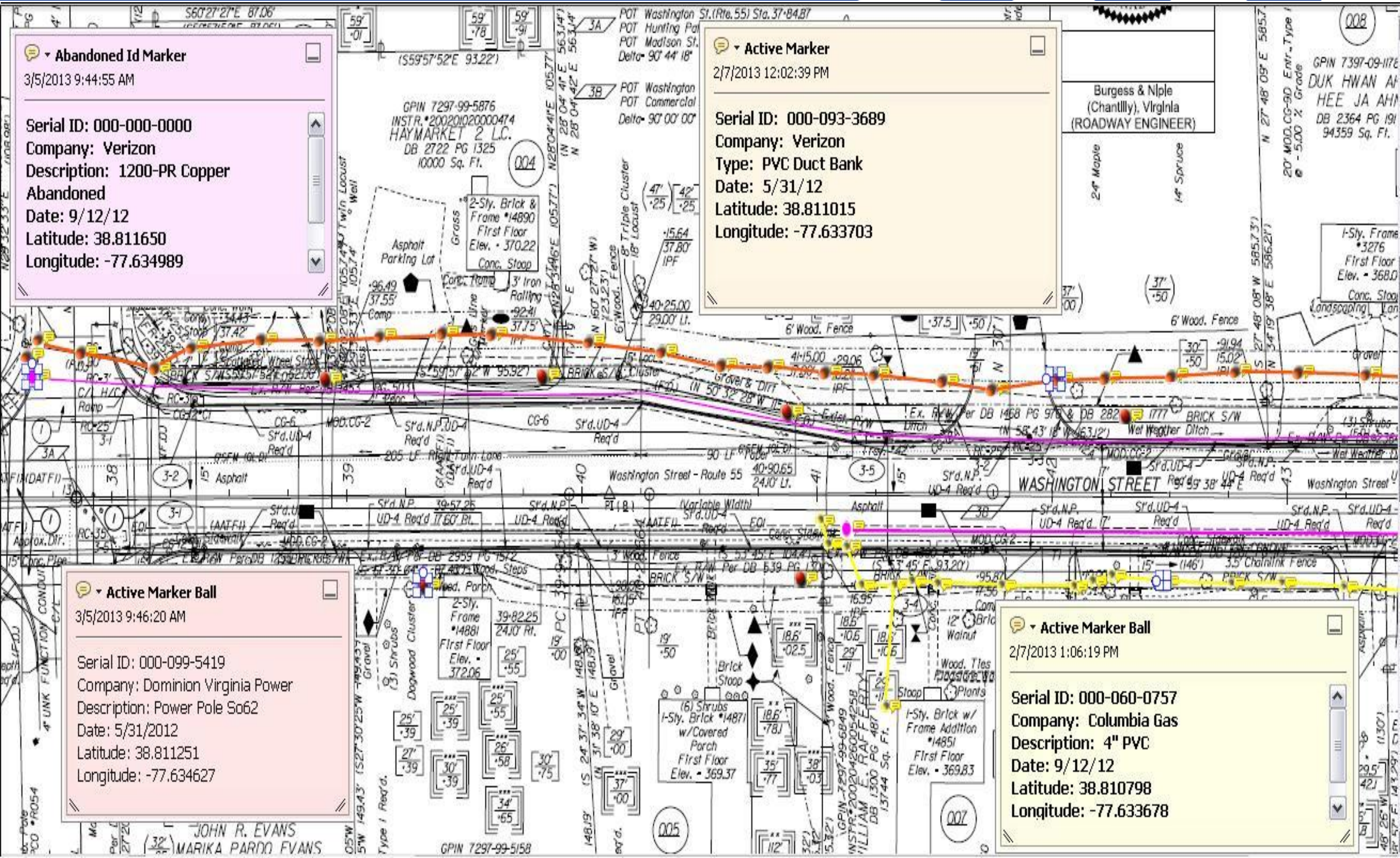
Virginia – VDOT

Radio frequency identification (RFID) marker implementation:

- Mainly at VDOT's Northern Virginia District
  - 40% of construction projects at VDOT
- Some at Fredericksburg District
- Purpose:
  - Damage prevention
  - Evolved to support utility asset inventory and management
- Motivation:
  - Changes to utility installations after initial Quality Level B investigation
  - Changes to VDOT's own underground installations

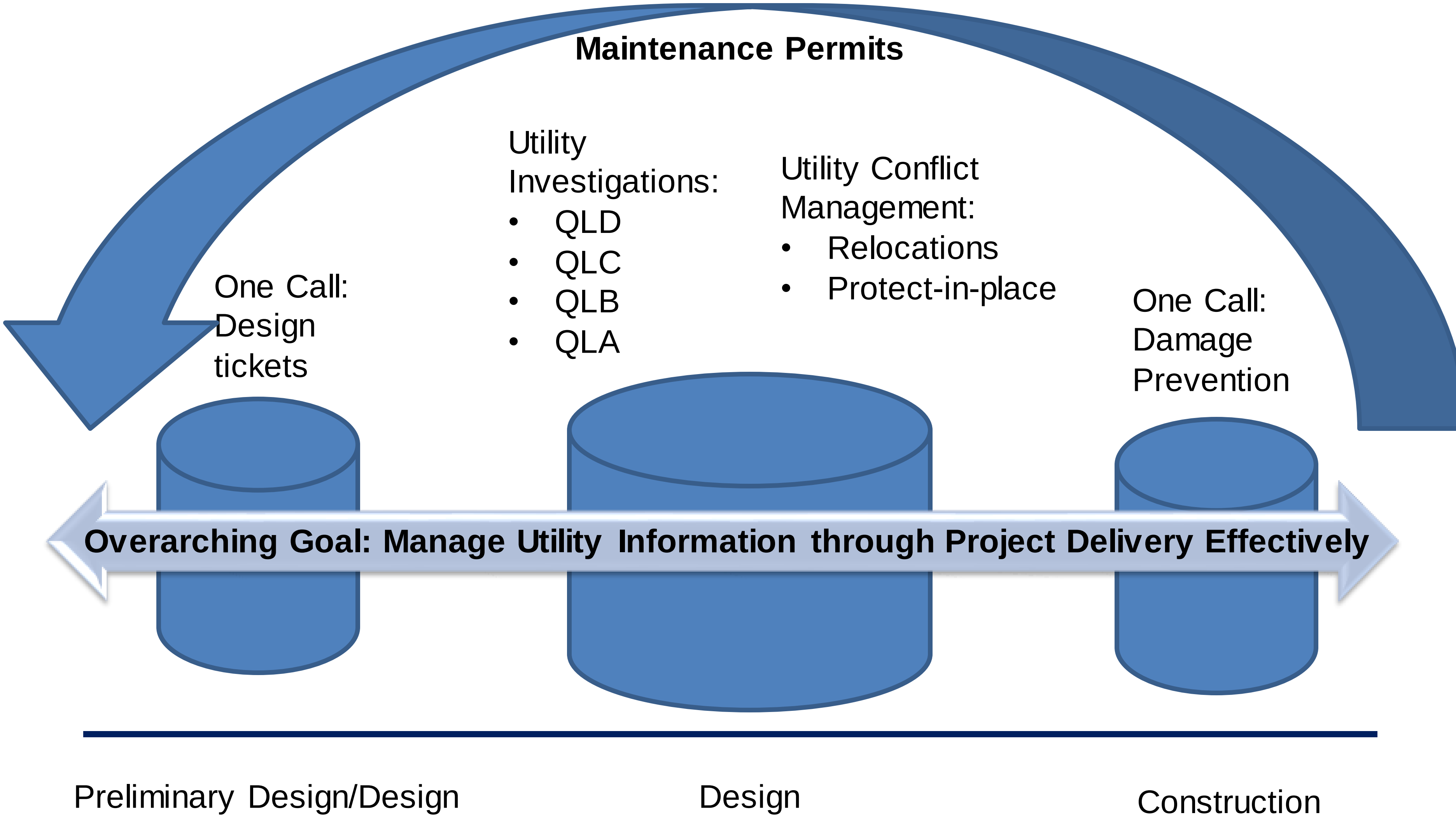
Virginia – VDOT

Virginia – VDOT



Virginia – VDOT

Effective Utility Data Management



American Society of Civil Engineers (ASCE) Standards

- ASCE 38
  - Industry standard for collection and depiction of utility data
  - Focus on process to collect data about existing installations
  - Focus on underground facilities
  - Current version: ASCE/CI 38-02
  - Update expected later in 2016
- ASCE Utility “As-Built” Data Standard
  - Currently under development
  - Expected release later in 2016
  - Focus on new or exposed utility installations
  - Covers both underground and aboveground facilities
  - Focus on positional accuracy and attribute data

Positional Accuracy Requirements

Level	Positional Accuracy[1]	Applies to	Comment
1	±15 mm (±0.05 feet) Vertical	Z data	Coincides with requirements in ASCE 38 quality level A (QLA)
	±50 mm (±0.2 feet) Horizontal	X and Y data	
2	±50 mm (±0.2 feet)	X, Y, and Z data	
3	±150 mm (±0.5 feet)	X, Y, and Z data	
4	±300 mm (±1 foot)	X, Y, and Z data	
5	±1000 mm (±3+ feet)	X, Y, and Z data	
6	±1000 mm (±3+ feet)	X and Y data	Positional accuracy of the Z data is unreliable or not available
9	Indeterminate		Positional accuracy of the X, Y, and Z data is indeterminate.

[1] At the 95% confidence level, using the root-mean-square error (RMSE) in accordance with FGDC-STD-007.3-1998.

- Level 1 is designed specifically to match up with QLA as defined in ASCE 38.
- Level 2 is substantially identical to Level 1, but removes the close tolerance on vertical methods and thus can be generally achieved without the need for survey bench leveling.
- Level 3 is generally possible using GPS equipment and RTK methods.
- Level 4 is provided as an additional breakpoint between levels 3 and 5.
- Level 5 is generally achievable by post-processed mapping grade GPS equipment.

Feature Classes and Attributes

GIS Feature Class	Geometry	id	utilityType	deviceType	material	matterConveyed	conveyancePurpos	conveyanceMethod	diameter	length	width	height	owner	instDate	isCathProt	isEncassed	descrip	providerDef	X	Y	Z
Communications																					
CommDuct	LineString	x	x		x		x		x	x	x	x	x	x			x	x			
CommLine	LineString	x	x		x		x		x	x			x	x		x	x	x			
CommDevice	Point	x	x	x			x							x			x	x	x	x	x
Electric																					
ElecDuct	LineString	x	x		x		x		x	x	x	x	x	x			x	x			
ElecLine	LineString	x	x		x		x		x	x			x	x		x	x	x			
ElecDevice	Point	x	x	x			x							x			x	x	x	x	x
Gas																					
GasLine	LineString	x	x		x	x	x		x	x			x	x	x	x	x	x			
GasDevice	Point	x	x	x		x	x							x			x	x	x	x	x
Fuel																					
FuelLine	LineString	x	x		x	x	x		x	x			x	x	x	x	x	x			
FuelDevice	Point	x	x	x		x	x							x			x	x	x	x	x
SanitarySewer																					
SanitaryLine	LineString	x	x		x		x	x	x	x			x	x	x	x	x	x			
SanitaryDevice	Point	x	x	x			x	x						x			x	x	x	x	x

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Utility Locating Technologies (R01B)

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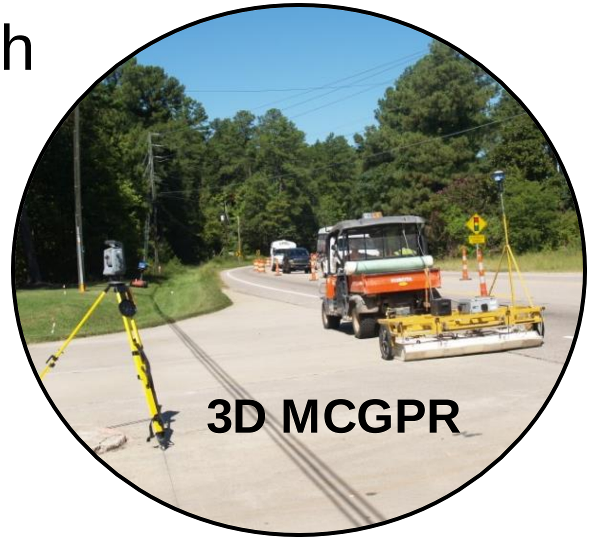
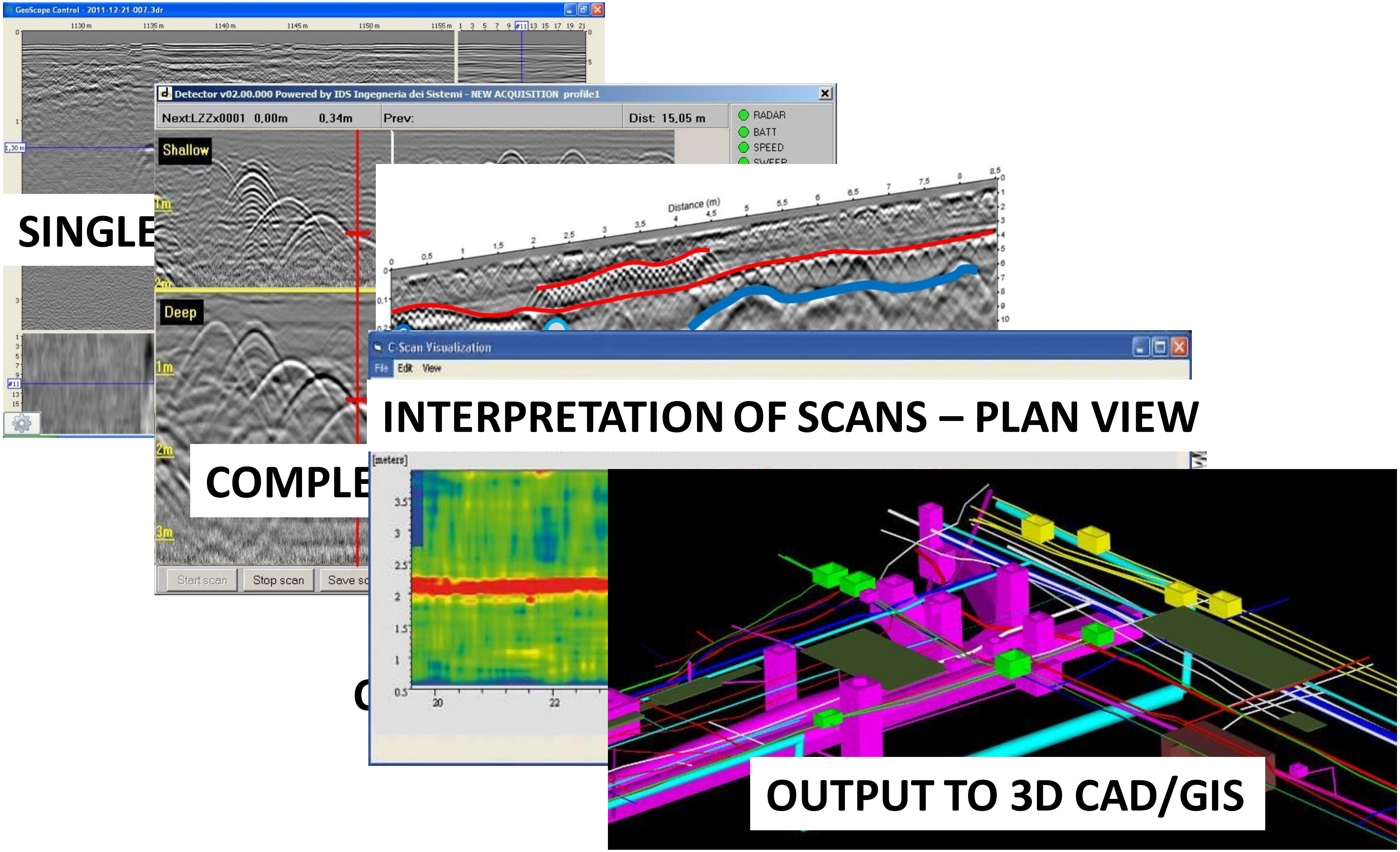
Definitions for MCGPR

Multi-Channel GPR

- “Multi”-channel hardware is a minimum of 4 antennas
- Multiple / variable frequency antennas
- Frequencies between 200 to 800 MHz
- Hardware to receive concurrent position control
- Scans every 6-square inches with 6-inch positional accuracy
- Compatible software to field unit output



Software for MCGPR

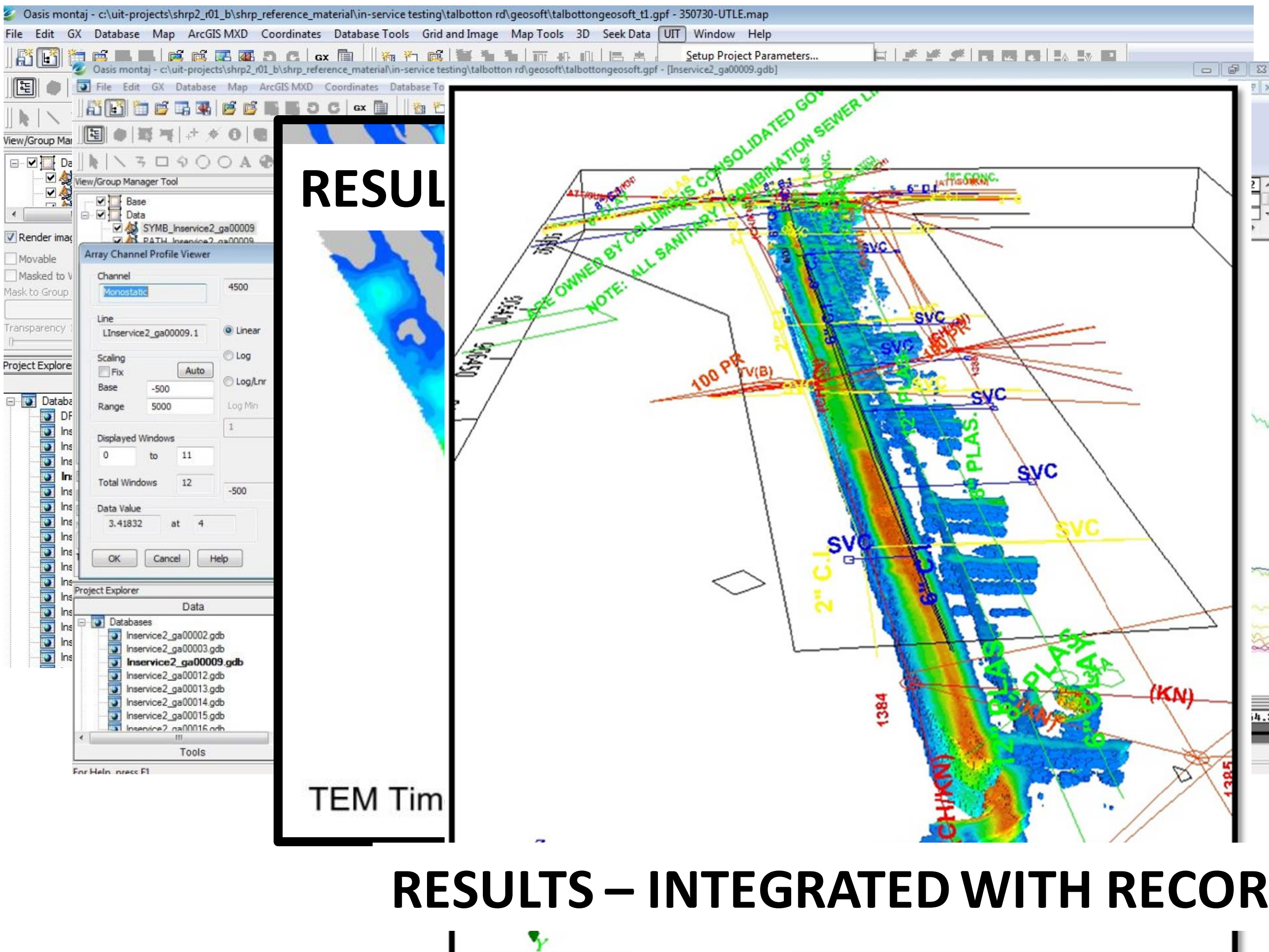


Definitions for TDEMI

Time-Domain Electromagnetic Induction

- A multi-coil system with synchronized sensors
- Instrumentation must receive concurrent position control (i.e, GPS or RTS)
- System adjustable / variable time gates for sampling
- Less than 12-inch positional accuracy
- Software compatible with specific unit

Software for TDEMI



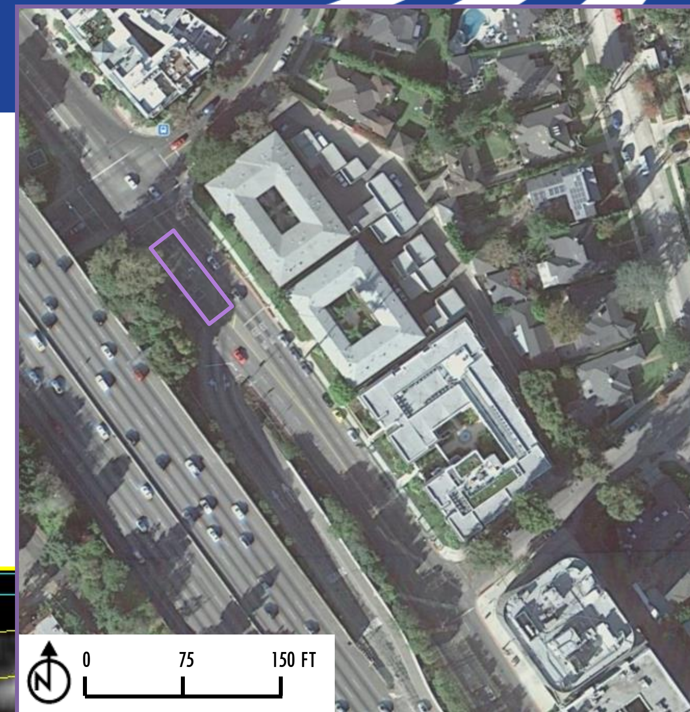
RESULTS – INTEGRATED WITH RECORDS

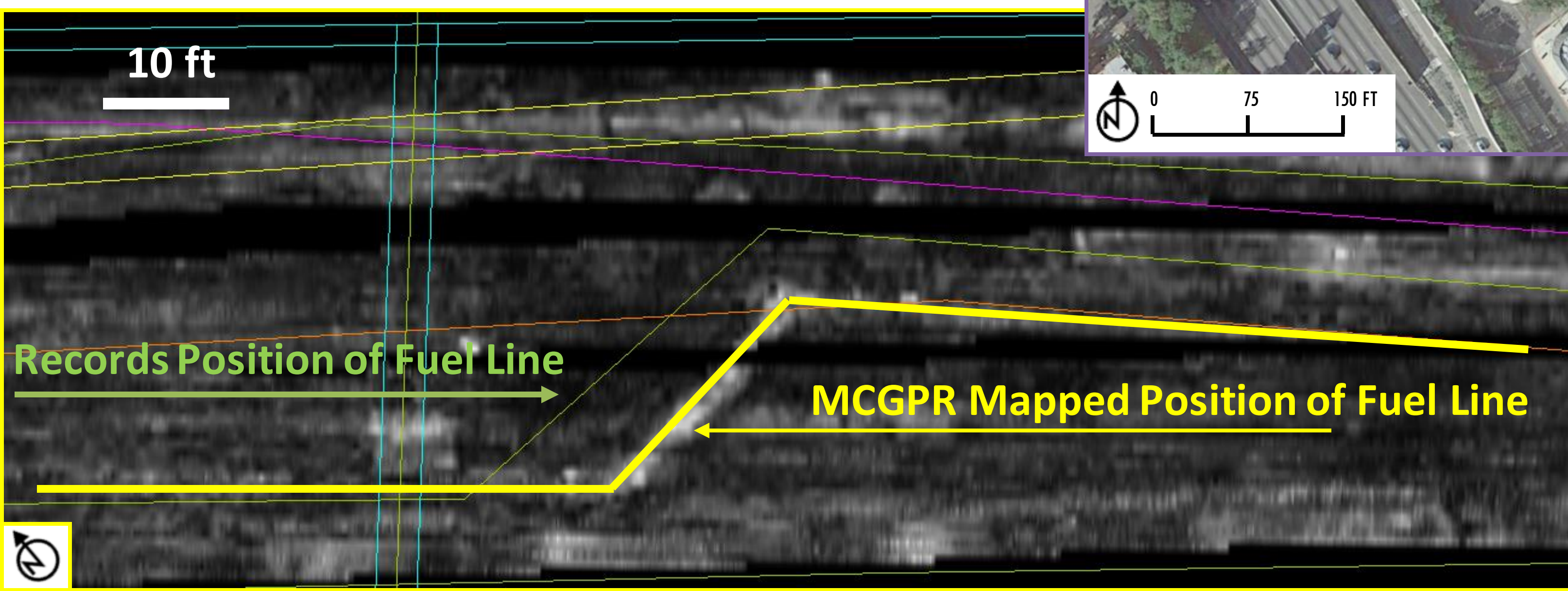
Example CalTrans Project

Correctly mapped a high-impact utility that was mis-located on records

An example of utility detection in the "*unlocatable*" 20% based on traditional SUE methods.

Fuel pipeline detected with 3D GPR.





Note: Image above is displayed as a *DEPTH SLICE at* 7 ft

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Identifying and Managing Utility Conflicts (R15B)

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Identifying and Managing Utility Conflicts (R15B)

Challenge

- Two critical factors that contribute to utility inefficiencies are: (a) the lack of adequate information about the location and attributes of utility facilities that might be affected by a transportation project, and (b) how to manage conflicts between those facilities and transportation project features and phases.

Solution

- R15B resulted in three products that use a utility conflict management (UCM)-based engineering approach, which are designed to help agencies and utility companies manage utility conflicts effectively during all phases of project delivery.

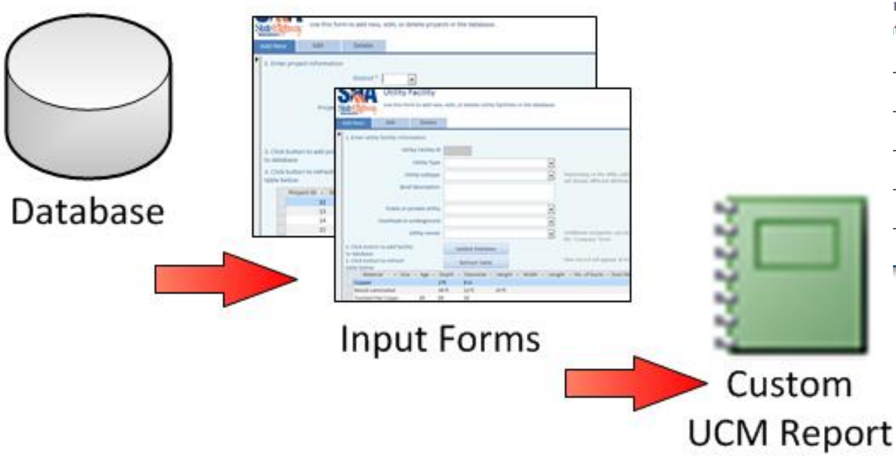
Identifying and Managing Utility Conflicts (R15B)

SHRP2 R15B Products

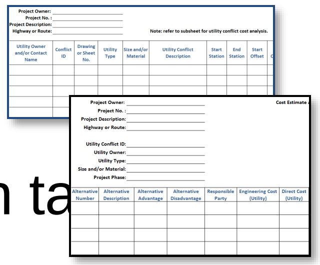
- Product 1: Compact, standalone utility conflict matrix
- Product 2: Utility conflict data model and database
- Product 3: One-day UCM training course

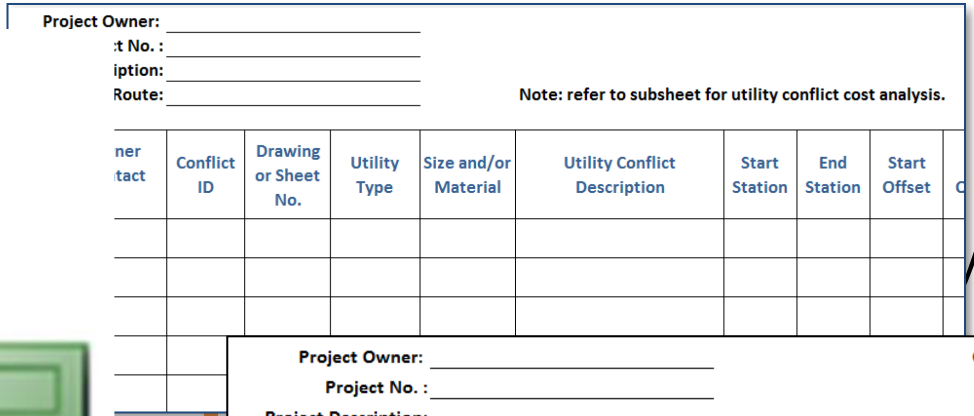
Products 1 and 2

Product 1: Compact



- UCM cost estimate analysis
- Process embedded in ta
  structure

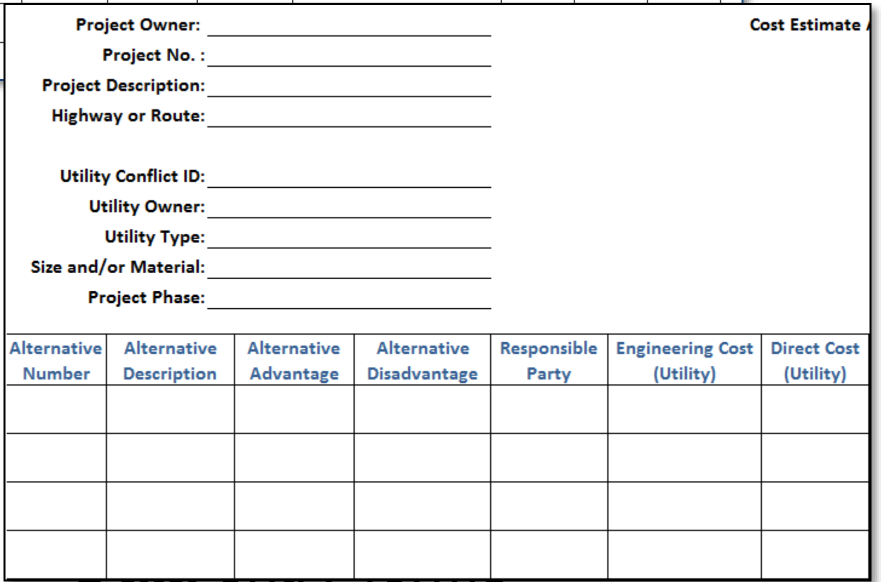




Project Owner:
t No. :
iption:
Route:

Note: refer to subsheet for utility conflict cost analysis.

ner tact	Conflict ID	Drawing or Sheet No.	Utility Type	Size and/or Material	Utility Conflict Description	Start Station	End Station	Start Offset



Project Owner:
Project No. :
Project Description:
Highway or Route:

Cost Estimate

Utility Conflict ID:
Utility Owner:
Utility Type:
Size and/or Material:
Project Phase:

Alternative Number	Alternative Description	Alternative Advantage	Alternative Disadvantage	Responsible Party	Engineering Cost (Utility)	Direct Cost (Utility)

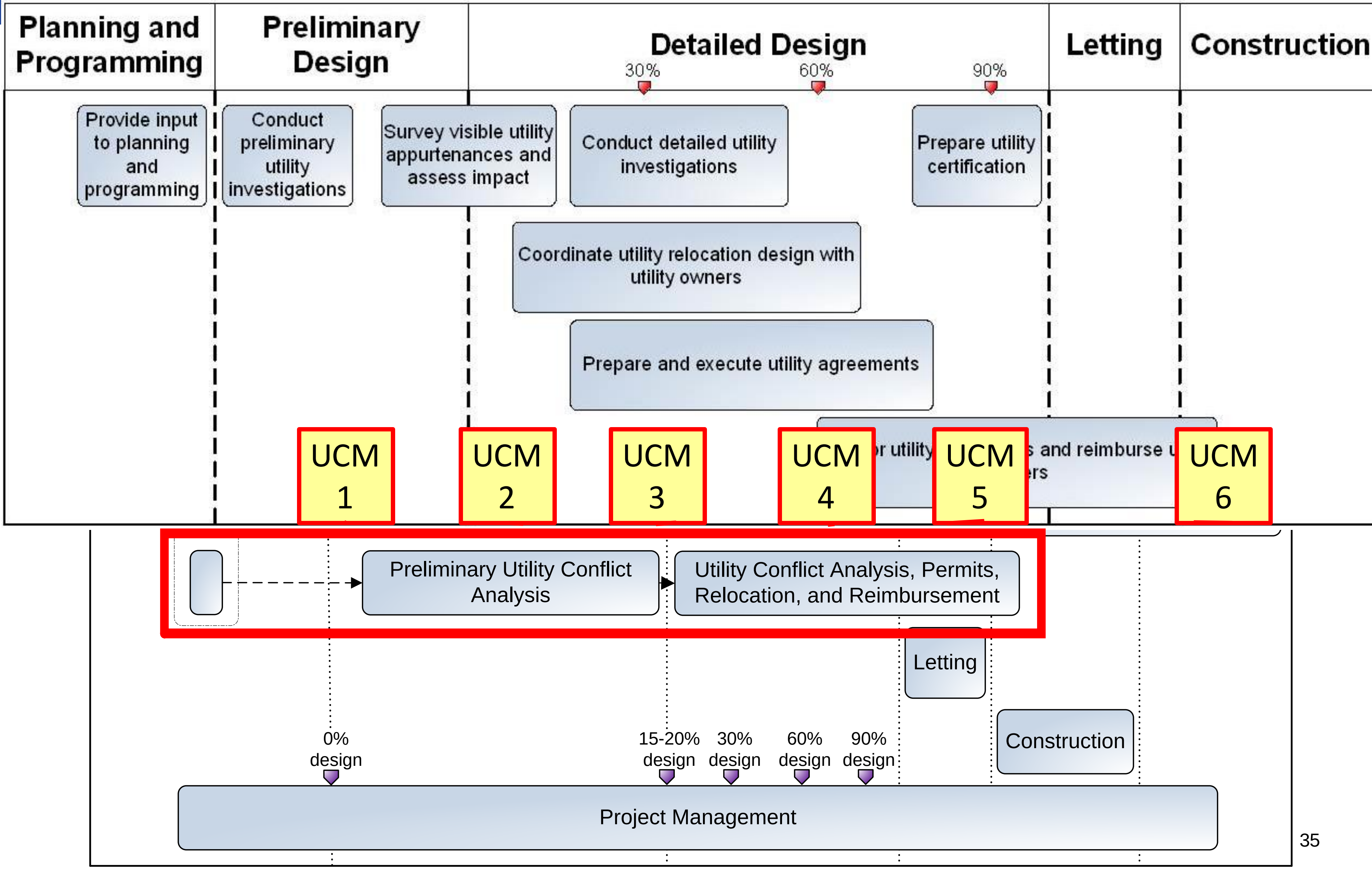
Product 3: One-Day UCM Training Course

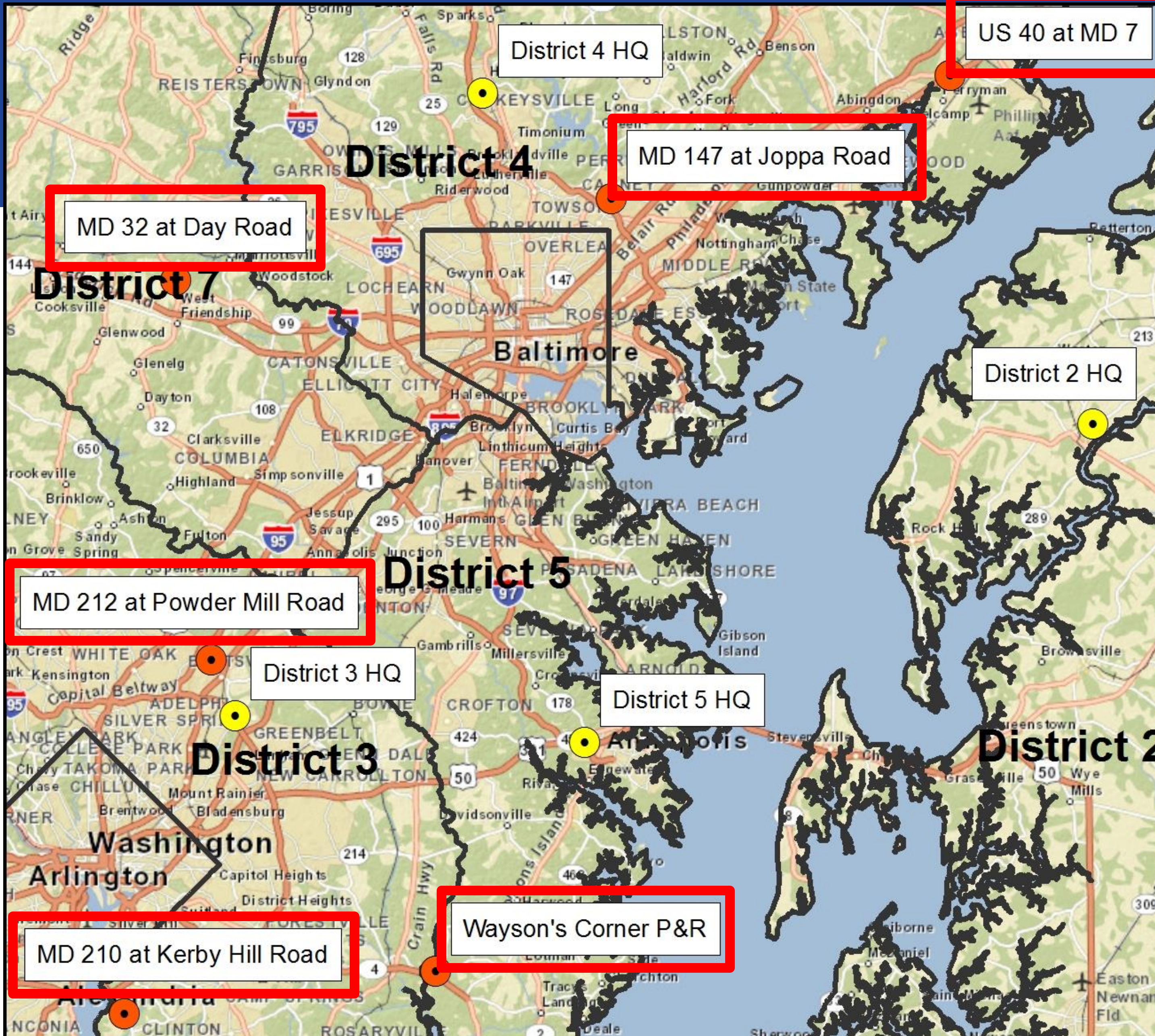
- Lesson plan (6 lessons)
- Training course binder:
  - PowerPoint files
  - Presenter notes
  - Participant handouts
  - Sample project plans
  - UCM templates
  - Companion CD:
    - All training materials + Products 1 and 2

Benefits, Limitations, and Challenges

Product	Benefits	Limitations/Challenges
<u>Product 1</u> Compact, standalone UCM table	• Systematic management of utility conflicts • Improved tracking and accountability • Cost estimate analysis spreadsheet • No IT support needed	• Scalability • Variety of UCM structures in use
<u>Product 2</u> Utility conflict data model and database	• Efficient management of utility conflicts • Automated tracking and accountability • Wide range of queries and reports • More effective use of staff and other resources	• IT support depending on implementation level/path • Higher initial investment • Need to develop user interface
<u>Product 3</u> One-day UCM training course	• Comprehensive training for Product 1 • Full benefit by including interactive utility conflict resolution module • Paradigm shift for managing utility conflicts • Promotes collaboration and coordination among internal and external stakeholders	• Introduction to Product 2 • Willingness to invest in full one-day training course • Need to include project managers, designers, utility coordinators, and other stakeholders

Using the UCM for Project Delivery




US 40 at MD 7
District 4 HQ
District 4
MD 147 at Joppa Road
MD 32 at Day Road
District 7
Baltimore
District 2 HQ
District 5
MD 212 at Powder Mill Road
District 3 HQ
District 5 HQ
District 3
District 2
Washington
Arlington
Annapolis
Wayson's Corner P&R
MD 210 at Kerby Hill Road

UCM Training Course

MD 32 Road Widening: Lessons Learned

- Avoided $500,000 gas line relocation, resolved utility conflicts by changing drainage design.
- 4-6 months' time savings.
- Changed construction sequencing, which avoided other conflicts.
- UCM challenged designers to think outside the box.
  - Made designers aware of utility issues on the project.
  - Helped utility coordinators understand design process better.

Overall Lessons Learned

- UCM is useful for documenting utility conflicts and for discussing and resolving utility conflicts.
- UCM raises awareness about utility impacts.
- UCM helps to avoid utility relocations.
- Tangible economic and time benefits.
- UCM facilitates coordination with utilities and contributes to better working relationships.
- UCM process facilitates agency's internal teamwork.
- Front-end investment with expectation of benefits later during the PDP.
- Limit UCM updates to major milestones.

For Additional Information

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