


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Deployment of Emerging SHRP2 Technologies at the California Department of Transportation

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FHWA NDE Technologies for Evaluating Asphalt Pavement-Virtual User-Group Peer Exchange
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Caltrans
U.S. Department of Transportation
Federal Highway Administration
American Association of State Highway and Transportation Officials
AASHTO
TRANSPORTATION RESEARCH BOARD
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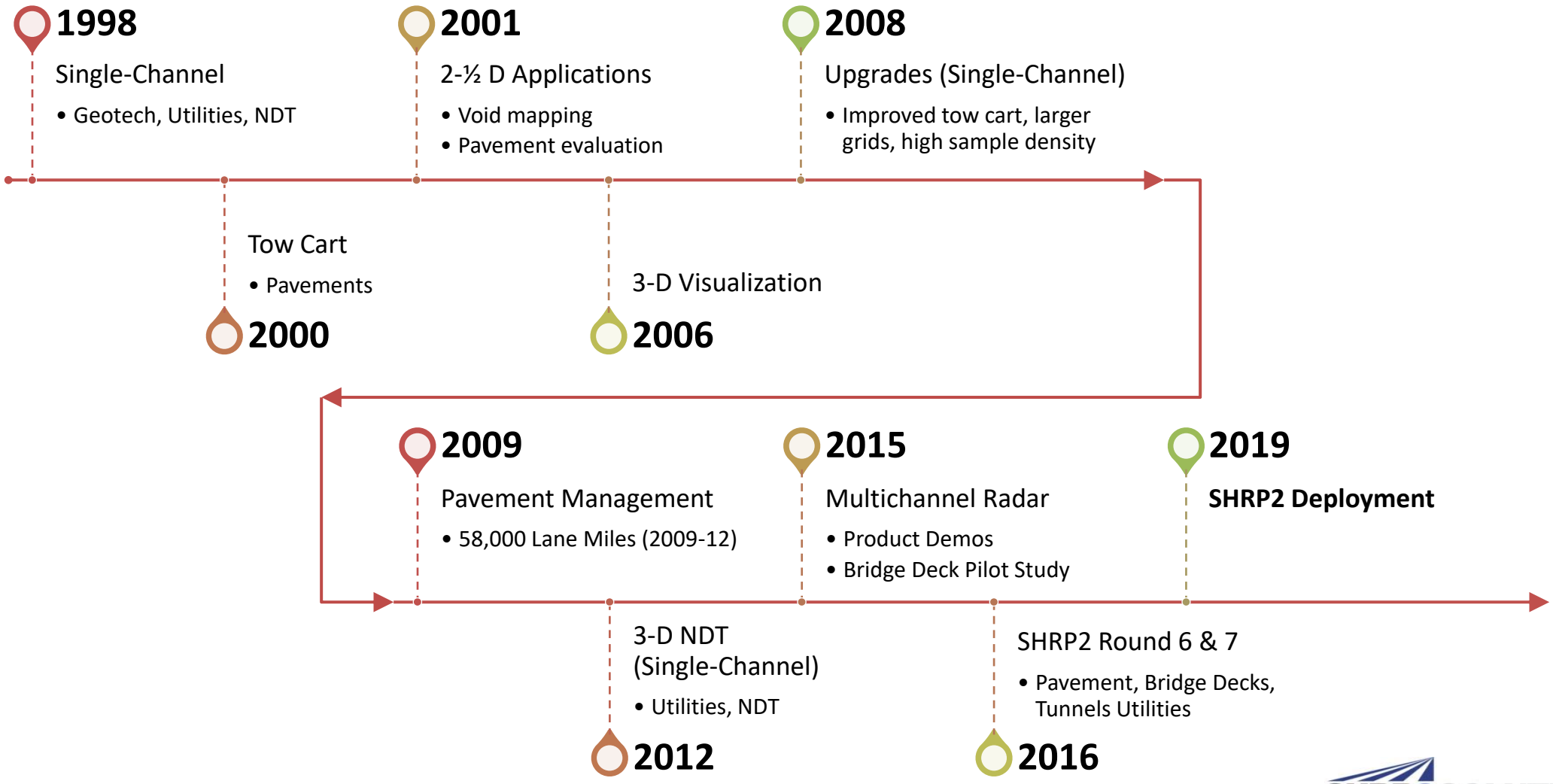
Introduction

- History of GPR at Caltrans
- Caltrans SHRP2 Implementation
- Post-SHRP2 Deployment
- Continuing Improvements

History of Caltrans GPR Development



Multichannel GPR (3D Radar)

Hardware

GeoScope™ Controller Unit

- Step-frequency continuous waveform radar
- Real-time 3D Display
- GPS/Total Station interface
- Max 1.4-in sample spacing @ 50 MPH

DX series & DXG series ultra-wideband antenna arrays

- 200 MHz - 3.0 GHz
- 8 - 41 channels (0.6 – 3.1m scan width)
- Air-coupled and ground-coupled models

Software

Examiner™

- Fast and intuitive
- Annotate features, utilities, map layers and more
- Export findings ready for drawing production and information/reports
- Dramatically improves office processing times, comparable to single-channel processing

More info at **http://3d-radar.com/**

SHRP2 Implementation Assistance Program

Caltrans Focus Area - Renewal

- USER INCENTIVE
  - ✓ **Nondestructive Testing for Concrete Bridge Decks (R06A)**
  - ✓ **Nondestructive Testing for Tunnel Linings (R06G)**
- PROOF OF CONCEPT
  - ✓ **Advanced Methods to Identify Pavement Delamination (R06D)**
- LEAD ADOPTER
  - ✓ **Utility Investigation Technologies (R01B)**

Technology Overlap

- Several technologies deployed under SHRP2
  - ✓ **Multichannel GPR**
  - ✓ **Time-domain EM**
  - ✓ **Thermal IR**
- No single grant provided full funding
- Leverage multiple grants for technology acquisition

Caltrans SHRP2 Goals

- **SHRP2**
  - ✓ Validate GPR technology for diverse applications
  - ✓ Bring high-speed GPR technology to Caltrans for utilities, pavements, bridge decks, tunnels

- **Post SHRP2:**
  - ✓ Deploy Thermal IR for bridge decks
  - ✓ Improve testing methodology and reporting
  - ✓ Training and technology transfer
  - ✓ Develop appropriate roles, responsibilities and business practices for collaboration

GPR Van, Air-Launched Assembly

- Limited to shallow investigation (2-5 ft)
- Bridge Decks, Asphalt Pavements
- Acquisition speed up to posted speed limit
- No lane closure required

GPR Van, Ground-Coupled Assembly

- Better for deeper investigation (5-10 ft)
- Better for concrete pavement & utilities
- Acquisition at 15 MPH max (current)
- Lane closure may be needed
- Faster acquisition hardware in development
- New antenna model in development for even deeper investigation

Types of Outputs From GPR Results

Analysis Outputs

- Total pavement thickness
- Intra-layer (Overlay) thickness
- Overlay delamination
- Void distribution
- Rebar location/depth
- Concrete thickness/condition
- Subsurface utility location

QC Outputs

- Gridding accuracy
- Intra-layer accuracy
- Georeferencing accuracy
- Depth/thickness correlation

Current Deployed Applications

Pavement Design & Inspection

- Concrete Over Asphalt Overlay (COA)
- Void detection in concrete pavements
- Construction QC for concrete pavements

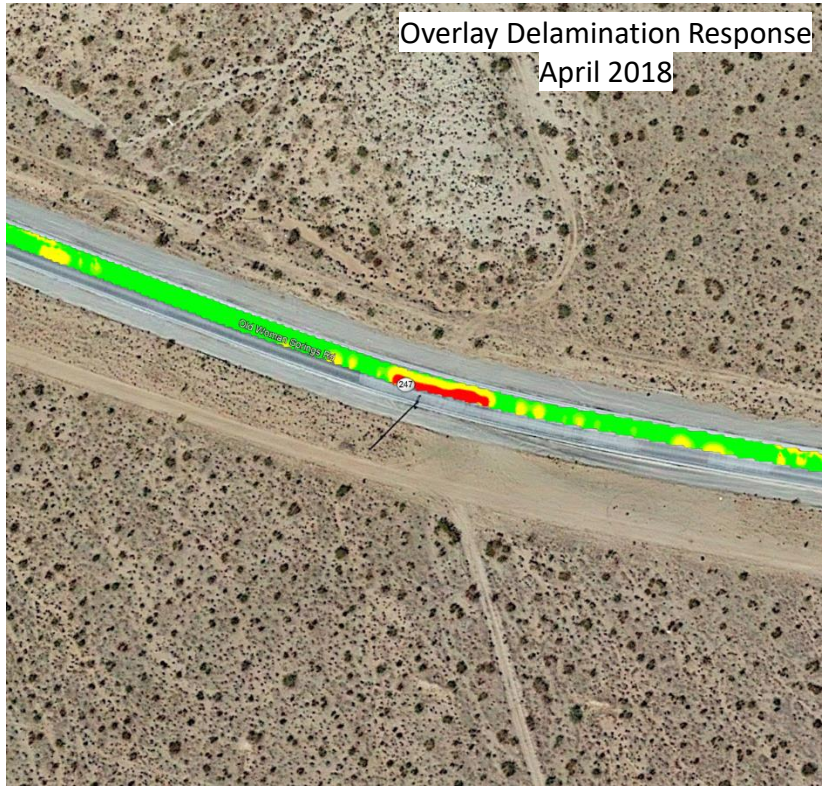
Subsurface Utility Engineering

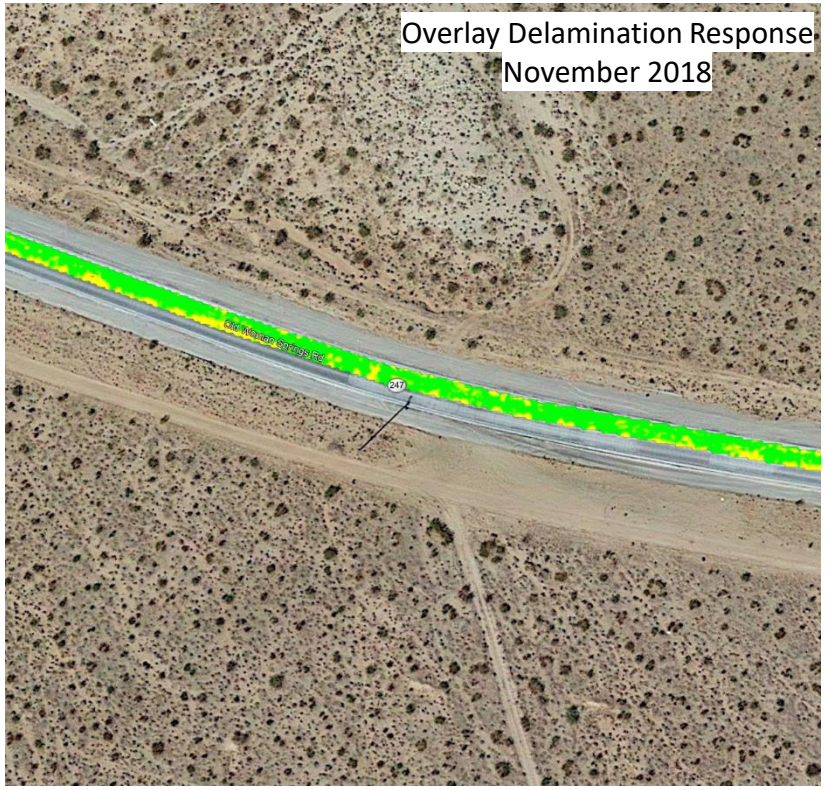
Bridge Deck Design & Forensics

- Overlay thickness and delamination
- Depth to top of deck mat for:
  - ✓ Mill and overlay
  - ✓ Sawcut clearance for signal coil installation
  - ✓ Construction QC

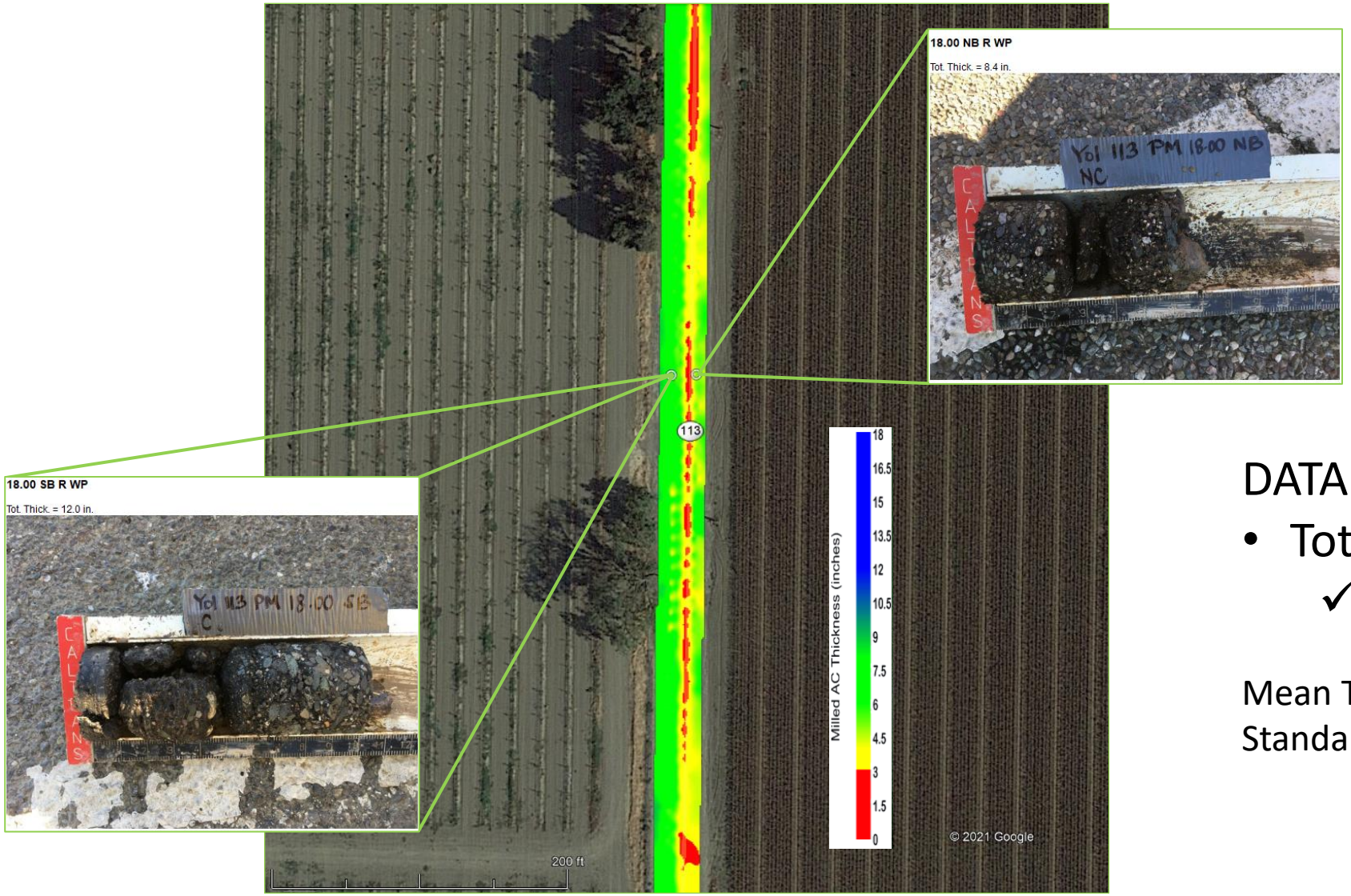
San Bernardino County, SR 247 (Concrete Overlay)
Seasonal Variation in GPR Response

For evaluation of HMA delamination and stripping, seasonal variation in pavement moisture content creates scheduling constraints dependent upon regional climate.





Yolo County, SR 113 (Concrete Overlay)

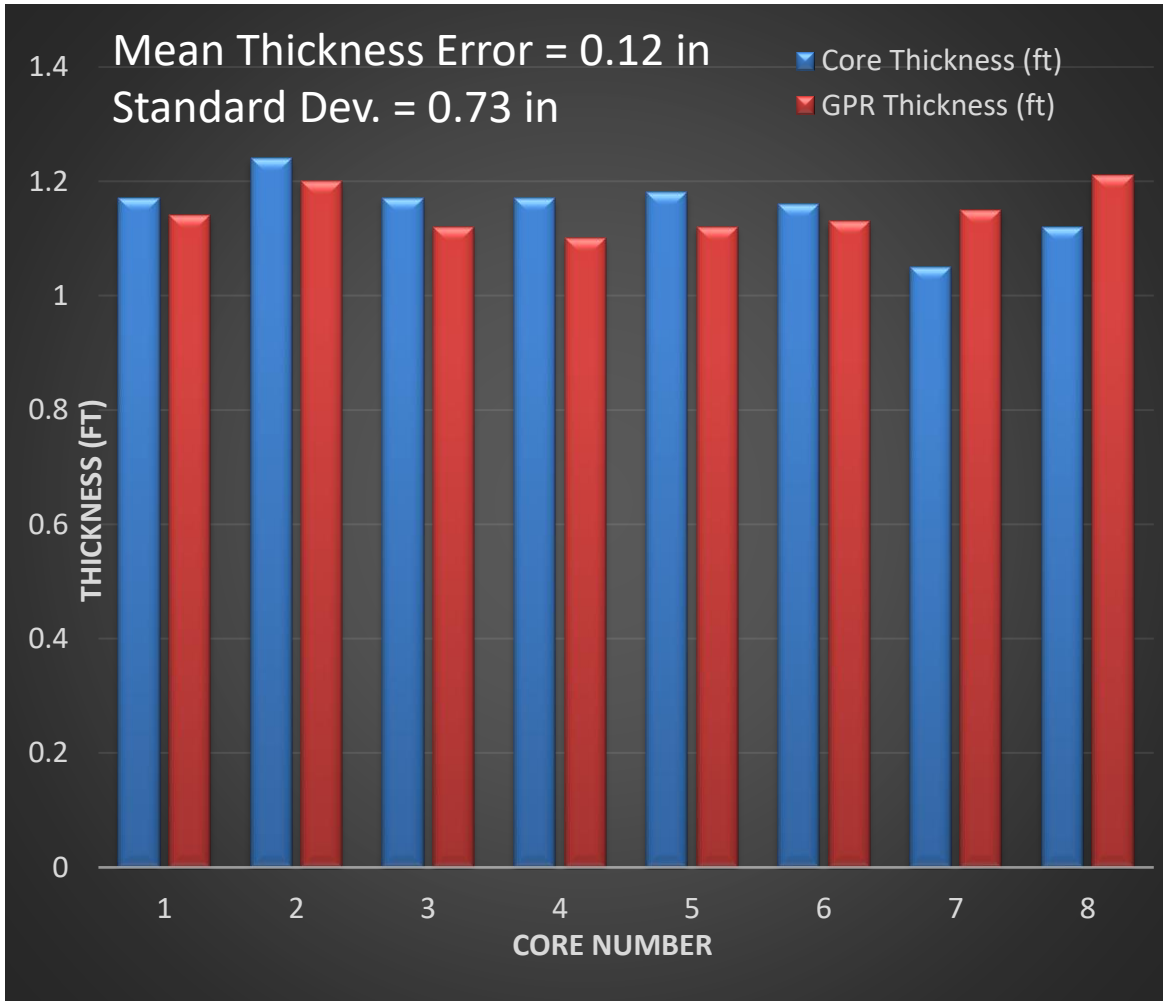


DATA OUTPUT

- Total pavement thickness
  - ✓ (6” mill specified)

Mean Thickness Error = 1.10 in
Standard Dev. = 1.61 in

Kern County, SR 99 (Continuous-Reinforced Concrete)

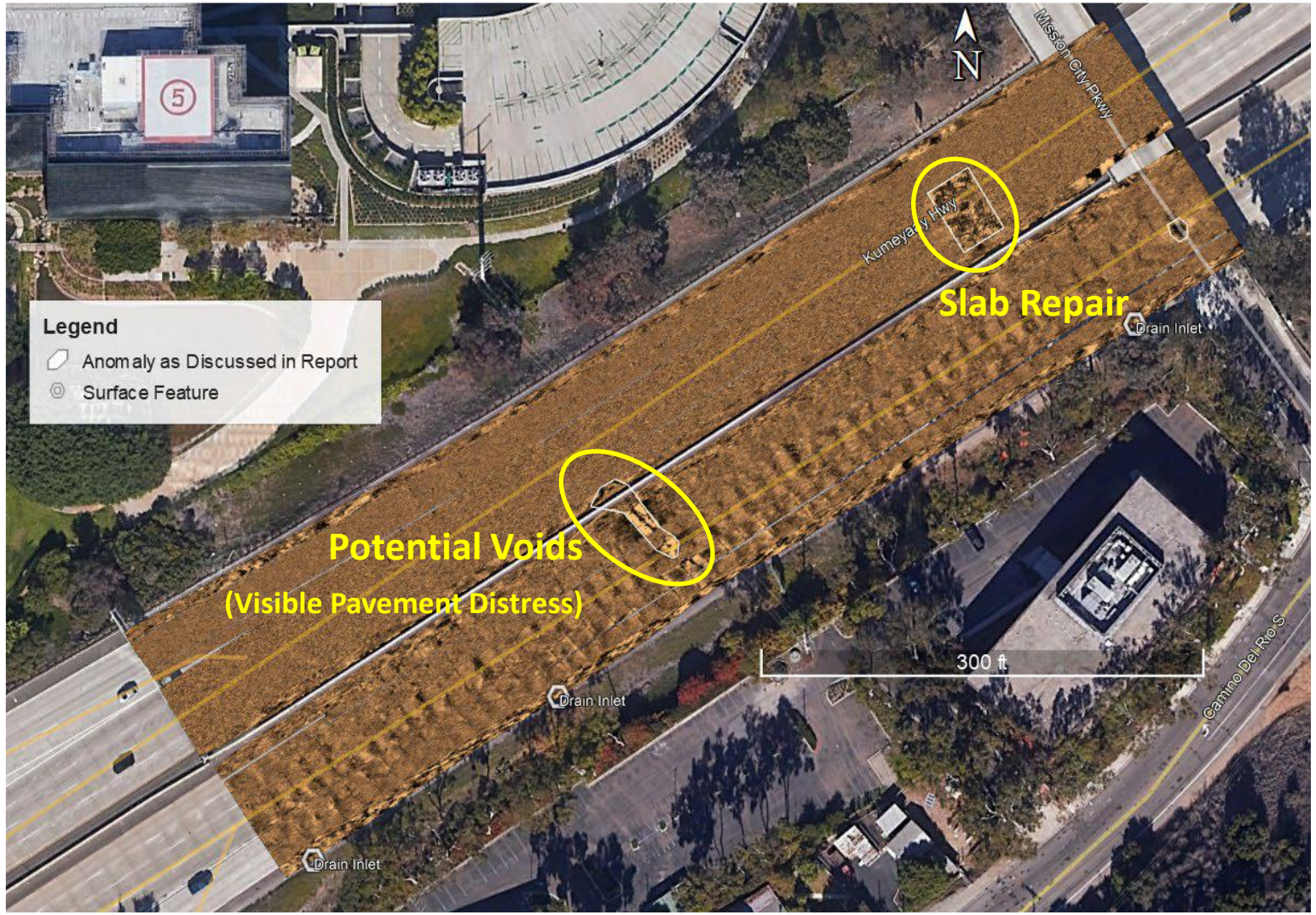


San Diego County, SR 8 (PCC Pavement)

- GPR acquired to assist investigation of pavement subsidence
- Multiple geophysical methods deployed
- Area of potential voids followed up by coring

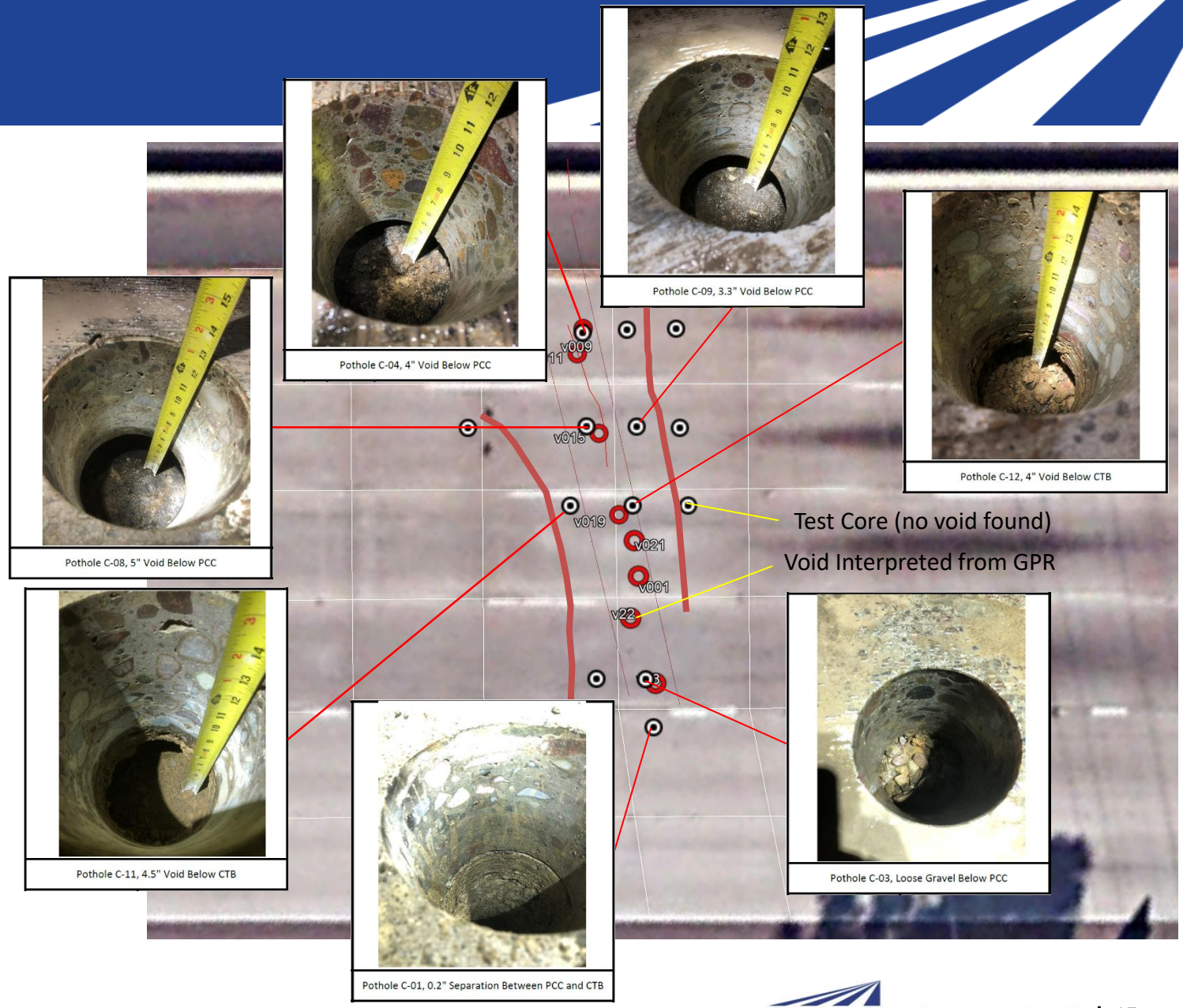
DATA OUTPUT

- Void Detection/Distribution



SR 8, Test Core Confirmation

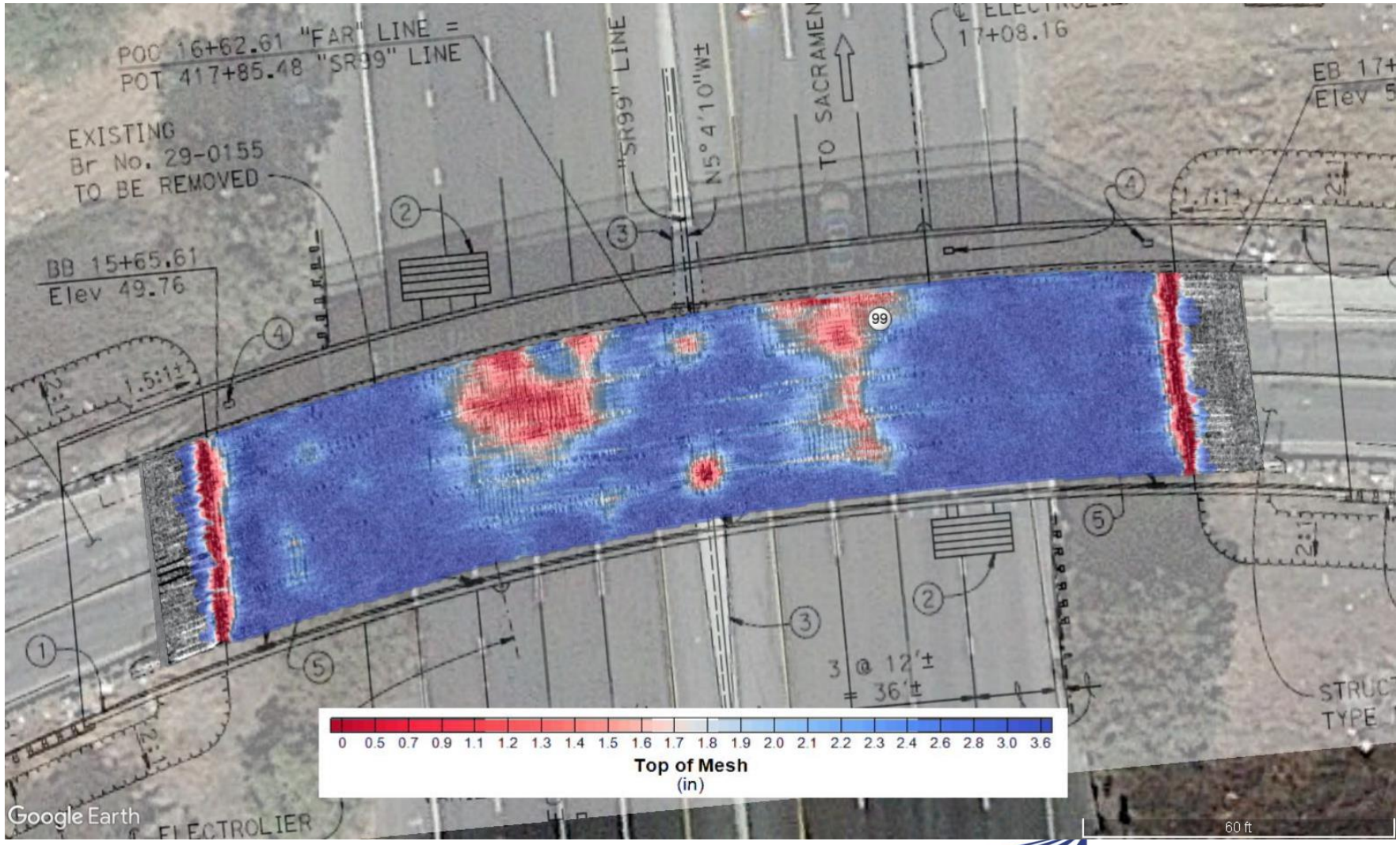
- Cores show excellent agreement with GPR data
- Provided vital information for estimating grout quantities needed for pressure-injection stabilization of slabs



Bridge Decks (Forensics)

DATA OUTPUT

- Depth to top of mat
  (contract spec = 1.75 in)
- “Heat Map” contour plot of depth to top of mat
  - ✓ Overlaid on 1.75-in slice view



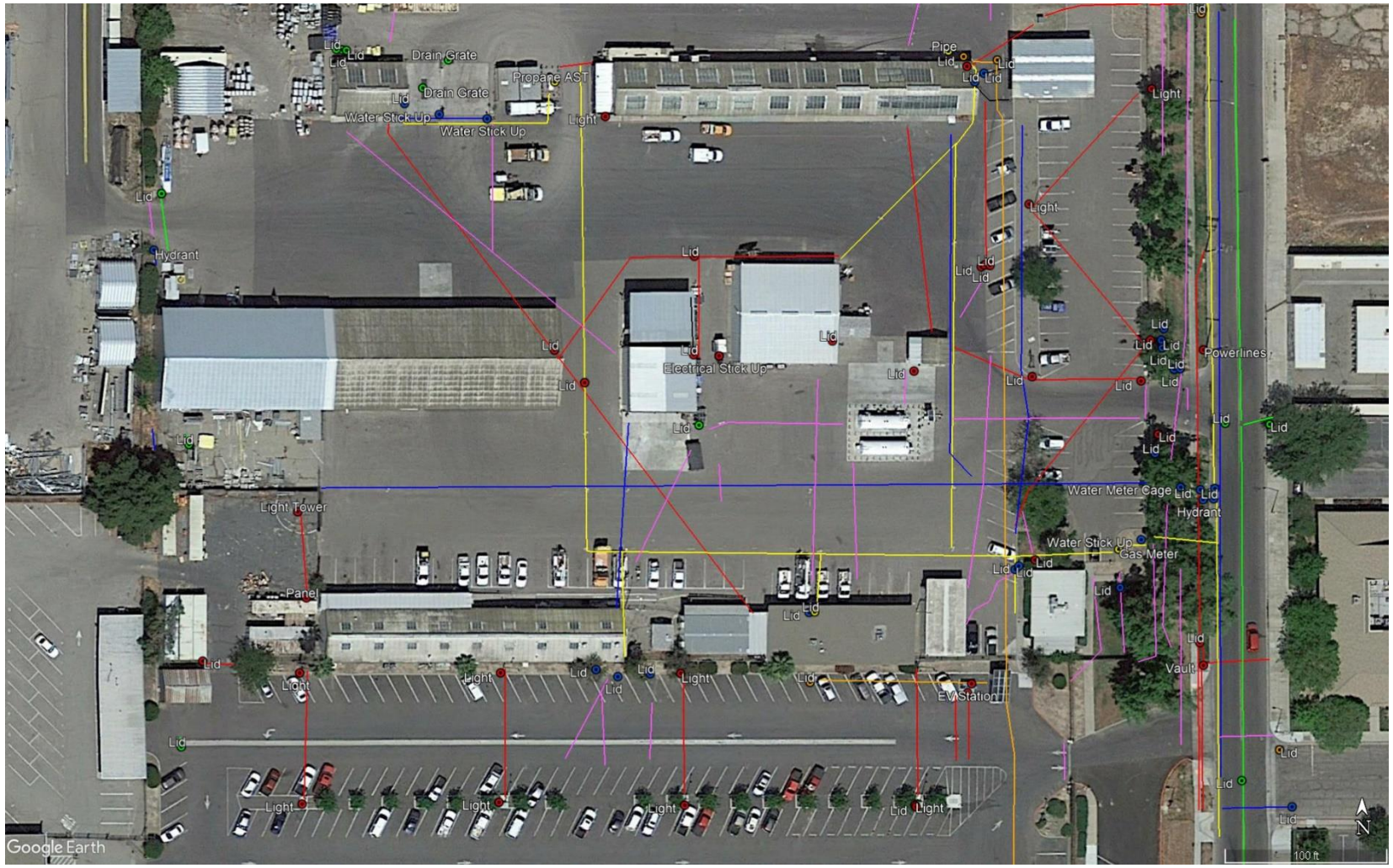
GPR Survey Consultant Support

- Mix of in-house and consultant support work
- Consultant support for large-scale projects and peak demand
- Recent example
  - Riverside County, SR 10 (Concrete Overlay)
    - Two GPR consultants used
    - >115 lane miles total

Background image courtesy ARA

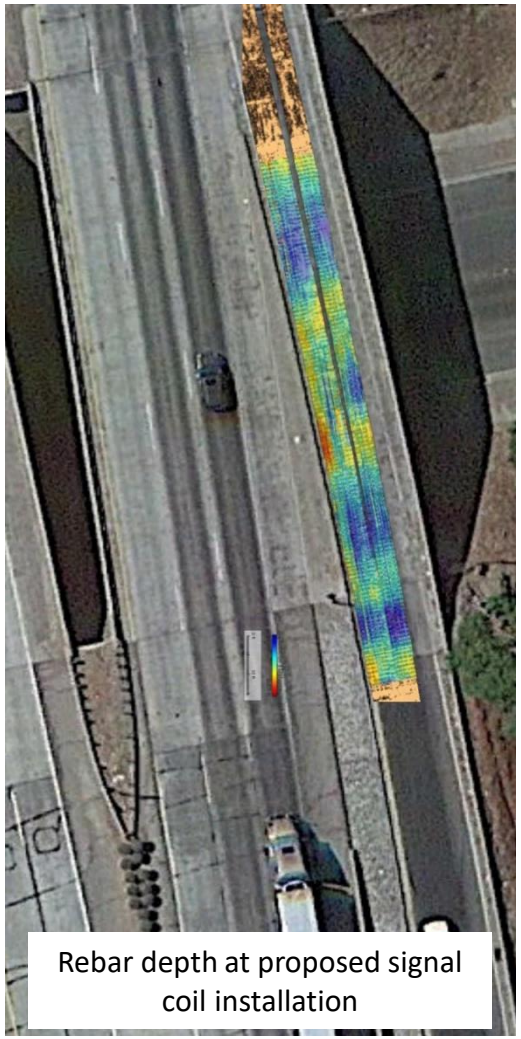
Subsurface Utility Engineering

- Highway Realignment
- Maintenance Station Construction
  - ✓ Redevelopment
  - ✓ New Construction
- *MCGPR not a primary tool for SUE*
  - ✓ TDEM, FDEM, Pipe & Cable locators better
  - ✓ Single-channel & MCGPR complementary use



Findings

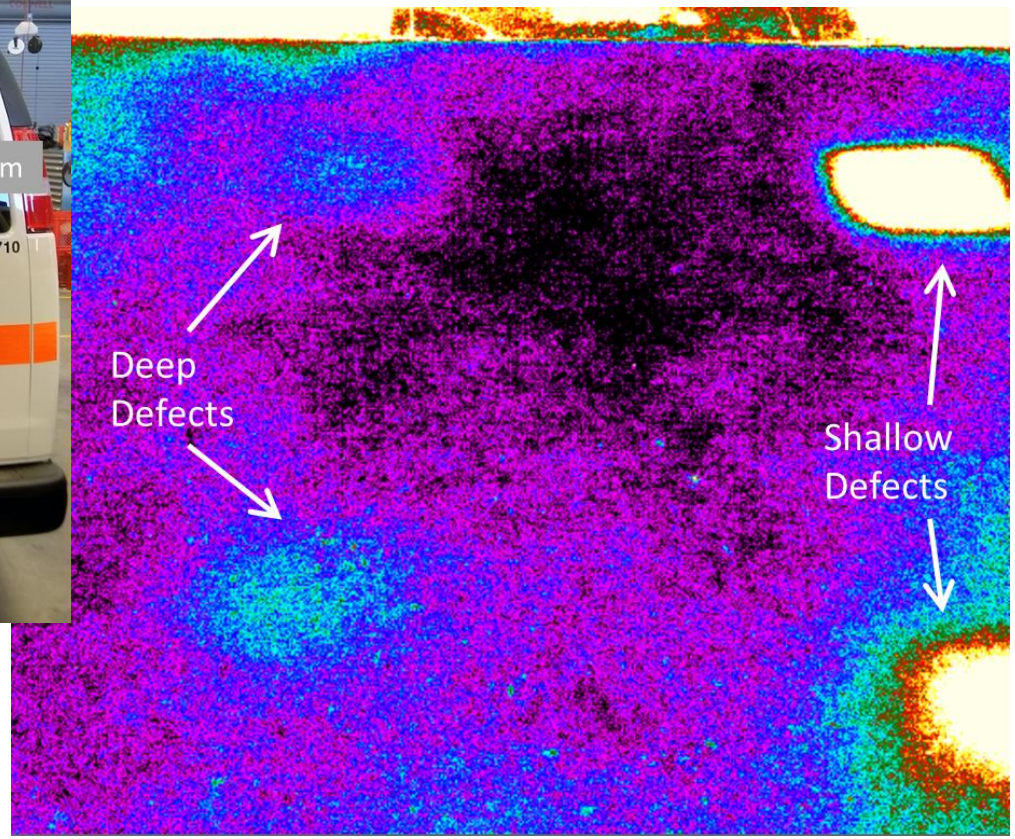
- Multichannel GPR arrays make large area survey acquisition cost-effective
- Ultra-fast I/O = 3D GPR acquisition at near-highway speeds
- Improved post-processing software renders faster interpretation and reduces processing cost
- Outputs provide valuable data for project design
- Better information can reduce construction claims and reduce delay payouts.



Rebar depth at proposed signal coil installation

Going Forward

- **Process Improvement**
  - ✓ QA/QC
  - ✓ Automation of data processing & analysis
- **Integration with visual/thermal imaging systems**
  - ✓ Full synthesis with existing systems
  - ✓ “One-Pass” acquisition



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  - ✓ Geophysics and Geology Branch