



## How Much is Enough (or Too Much)



Mobile Mapping for Transportation Corridor Projects

Bradley E. Adams, P.E.

Woolpert

June 15, 2012

### Agenda

- + Background
- + History
- + Sample Data
- + Signature Projects
- + Other Uses
- + Conclusion
  - + Complete, Comprehensive, Collection
  - + Accurate
  - + Safe



## About Woolpert



Indianapolis, Indiana

- + Established in 1911
- + Over 650 Professional Nationally
- + Top 100 A/E Design Firm (ENR)
- + Award Winning, Full Service Design Firm
- + Technology Focused
  - + Known nationally and internationally as leveraging technology and information for our clients
- + 90% Repeat Client Performance
- + Diverse Client Base



## Services



- + Surveying
- + Aerial Photography
- + Terrestrial LiDAR
- + Mobile Laser Scanning
- + Architecture
- + Civil Engineering
- + Landscape Architecture
- + Lighting Design
- + Program Management
- + Structural Engineering
- + Traffic/Roadway Design
- + MEP Engineering
- + Land Planning

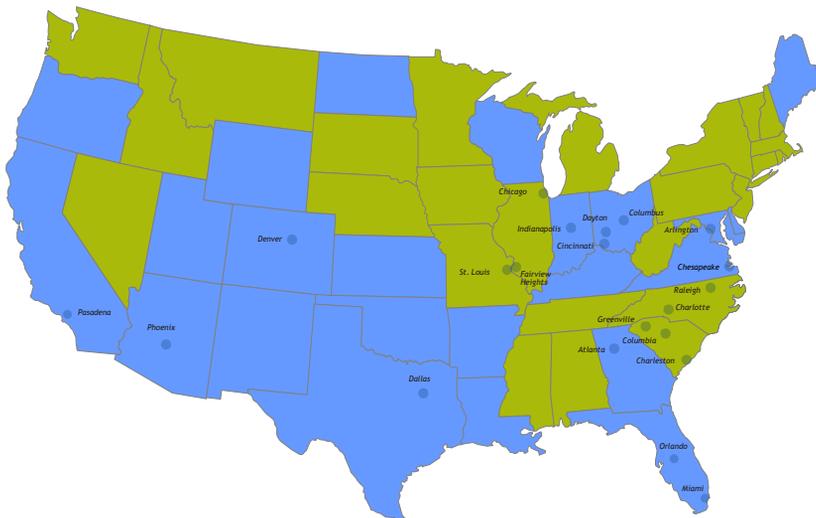


## Bradley E. Adams, P.E.

- + Started Career at TxDOT
- + Design Engineer for 15 Years
  - + Super Conducting Super Collider
  - + DFW East Airfield Expansion
  - + Dallas Area Rapid Transit System
  - + IH 635 Corridor Reconstruction
- + Worked with Dozens DOTs
- + Implementing and Managing LiDAR Projects since 2001



## Projects with DOTs





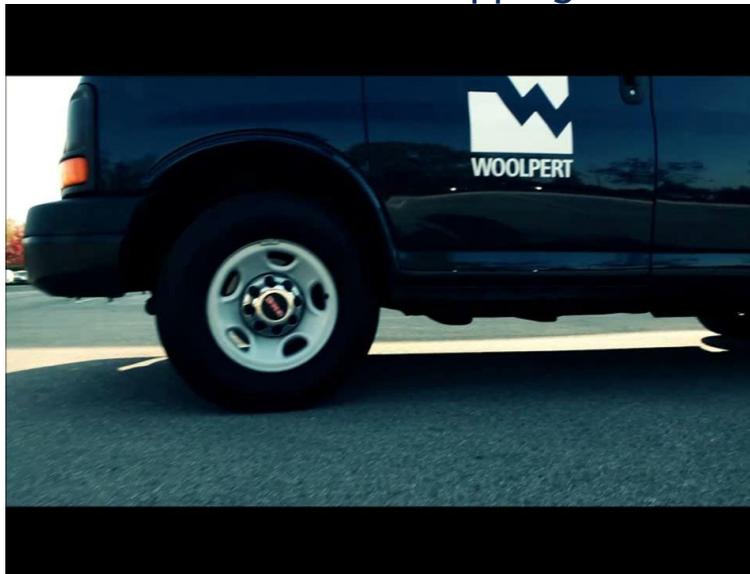
## Terrestrial LiDAR



THE PARK



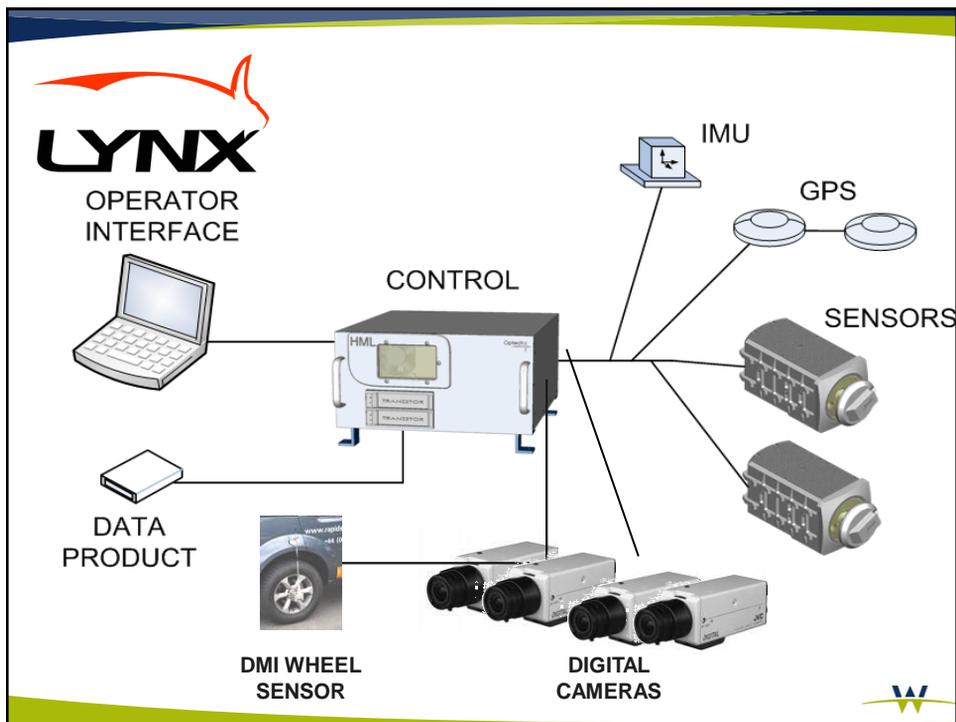
## Introduction to Mobile Mapping



## Mobile Mapping System



- + 1 million points per second
- + 200 meter range
- + Sub cm relative accuracy @ 2 cm absolute (controlled)
- + 4 integrated cameras (5mp)
- + Real-Time pt cloud viewing
- + Ability to adjust density by distance



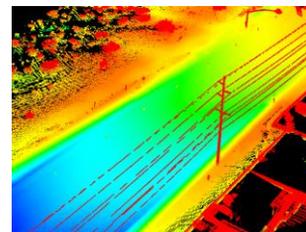
## System Configuration



## Laser Scanning Accuracies

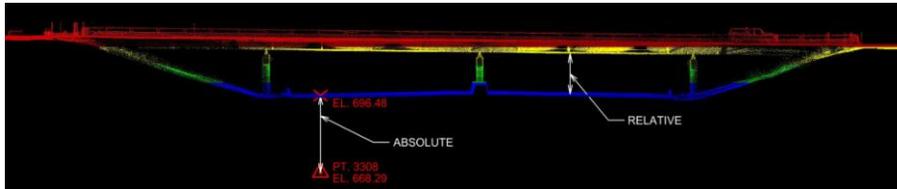
Two ranges of accuracies depending on needs

- + **Planning/Mapping Level Accuracy**
  - + No ground control ( $\cong 0.2'$ ) with **Good** satellite visibility
  - + No ground control ( $\cong 1.0'$ ) with **Poor** satellite visibility
  
- + **Design Level Accuracy**
  - + Done with benefit of ground control
    - +  $\cong 0.06'$  using Mobile Mapping System ( $1\sigma$ )



## Absolute and Relative Accuracy

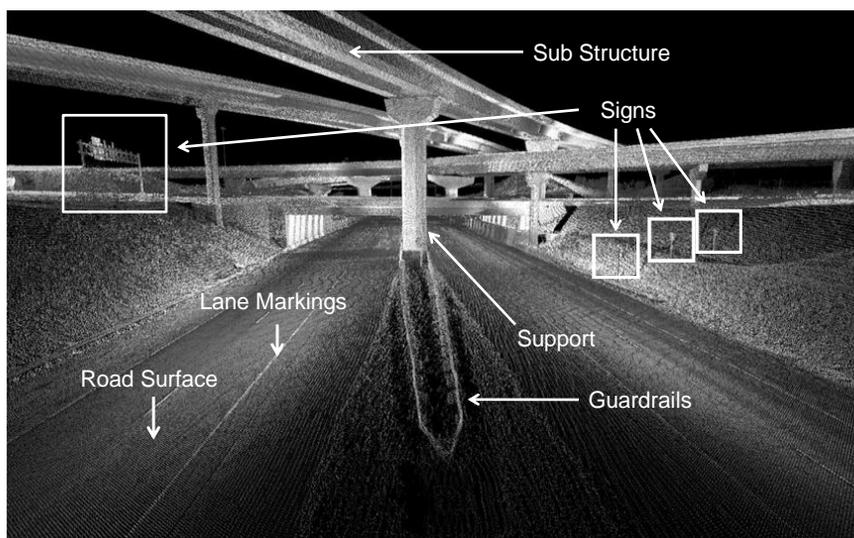
- + **Absolute** accuracy refers to how accurate the survey is with respect to a known benchmark.



- + **Relative** accuracy refers to how accurate one LiDAR point within the survey is to another point within the same survey.



## Comprehensive Collection



## National Projects

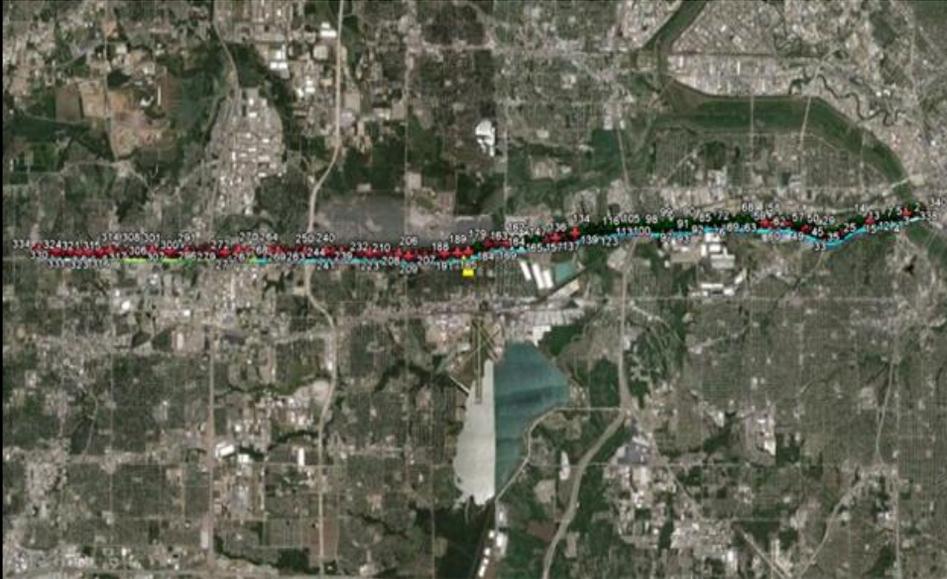


## Overview of Scanning IH30

- + Managed Lanes Project for Freeway Capacity Improvements
- + First Large Scale Mobile LiDAR Project for TxDOT
- + Obtain Continuous Dataset of an Existing Facility
- + Utilize the Same Dataset for Multiple Design Teams



## Overview of Scanning IH30



## Overview of Scanning IH30



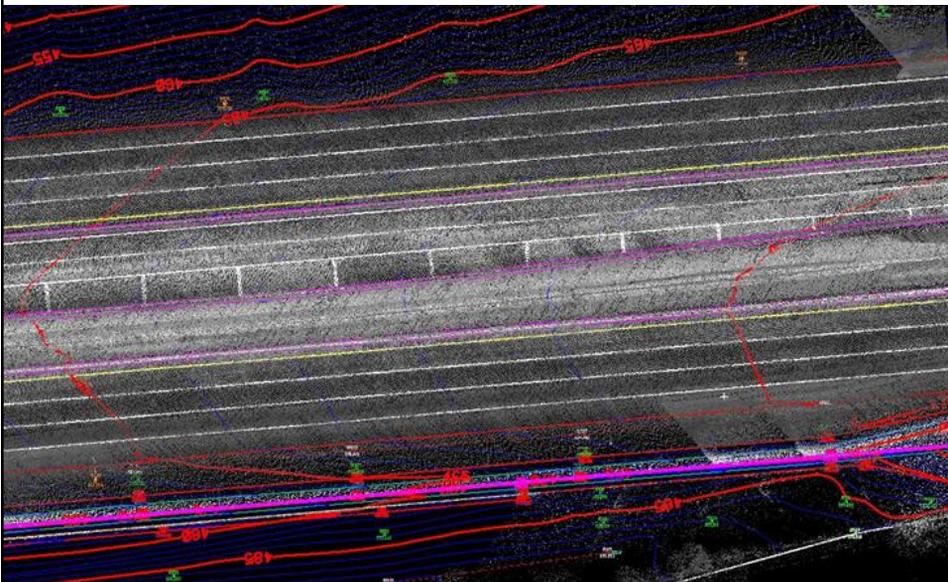
## Overview of Scanning IH30



Collect EP to EP



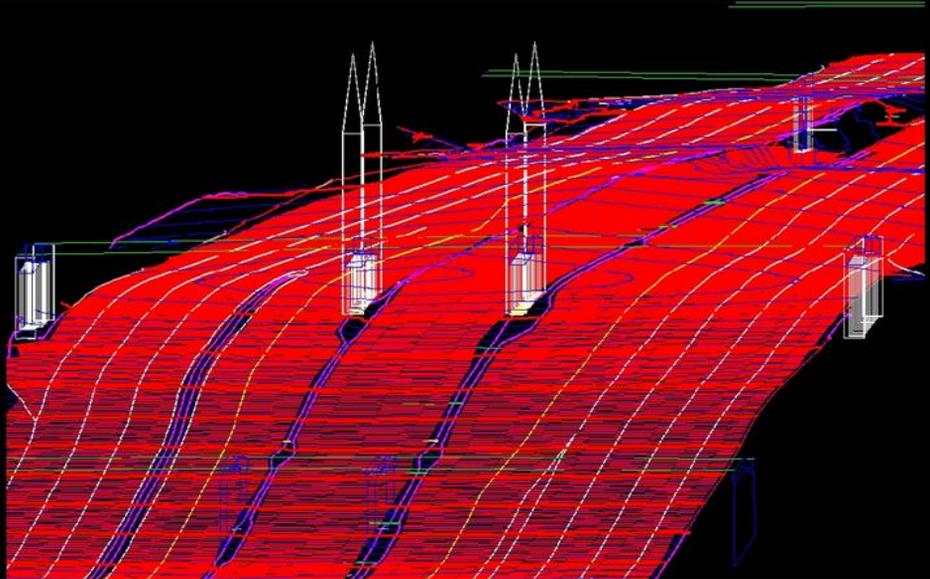
## Overview of Scanning IH30



Update Existing Surface



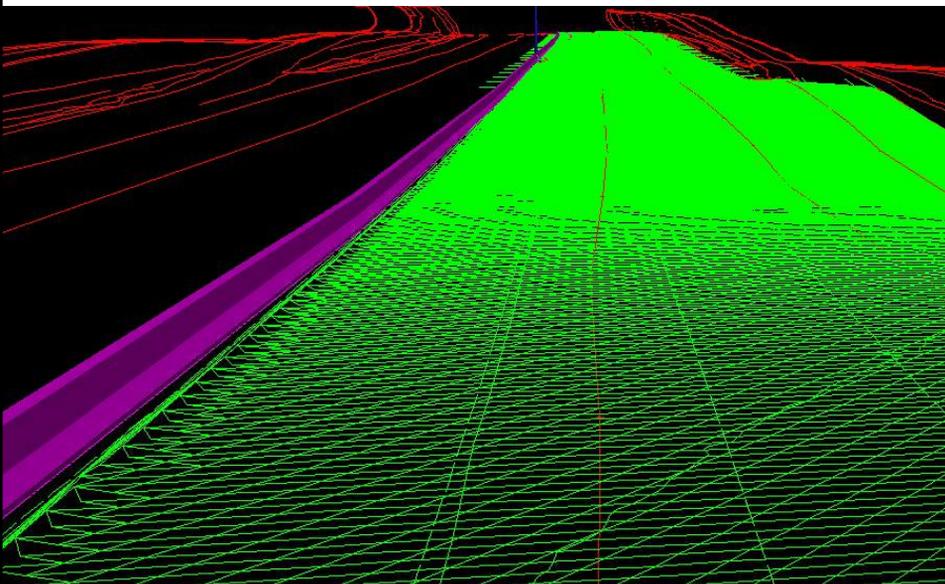
## Overview of Scanning IH30



Update Existing Surface



## IH 30 Cross Section of LiDAR



## Overview of Scanning IH30



Orthophotography Surface vs. LiDAR Surface

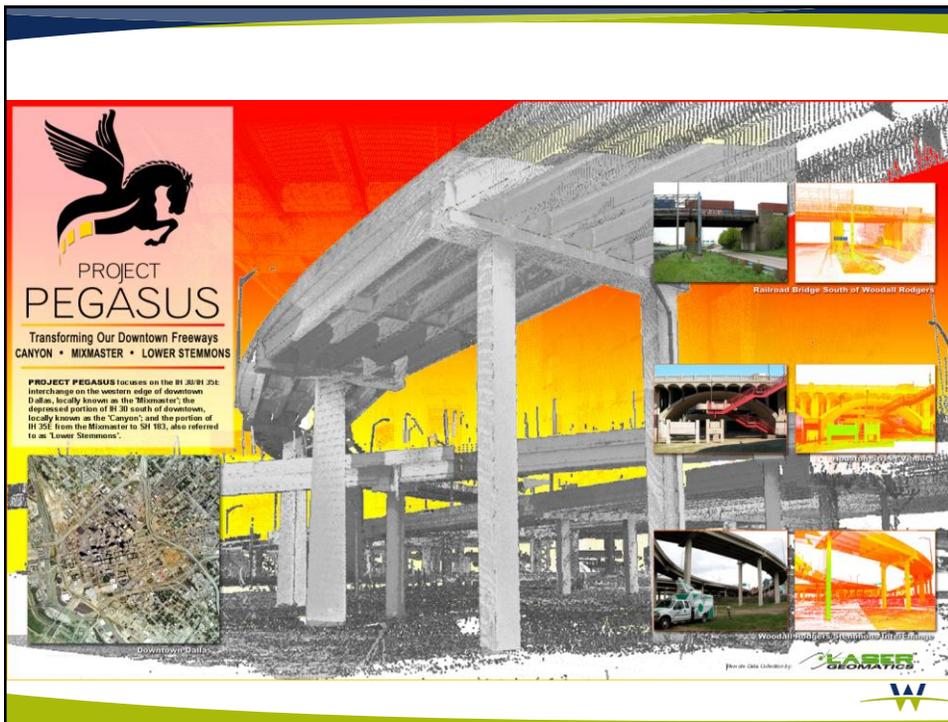


## TxDOT GPS Verification Vehicle

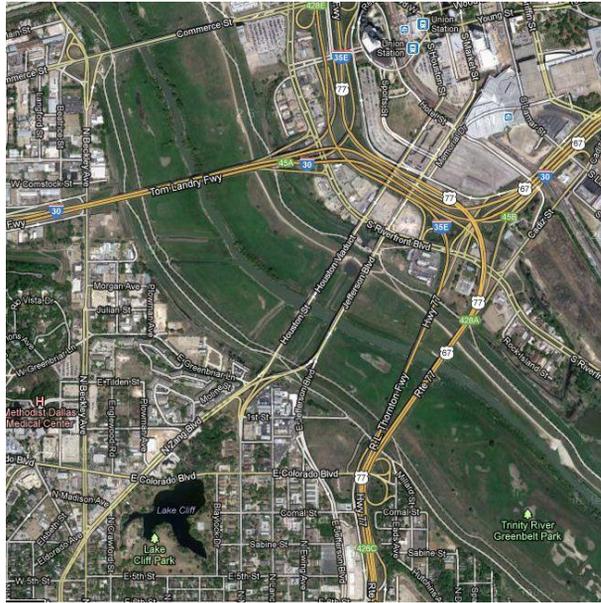


## Scanning Accuracy On IH 30

- + Control points were set at 1000 feet apart
- + All control were collected by GPS
- + A site calibration was used for geometrically controlling the project
- + Level runs were completed on 20% to verify geoid elevations
- + Mobile Mapper accuracy were from .06' @ 1σ
- + Verification of Data was accomplished using TxDOT mobile GPS system
- + Accuracies are dependent on the GPS Control and/or surveying methods



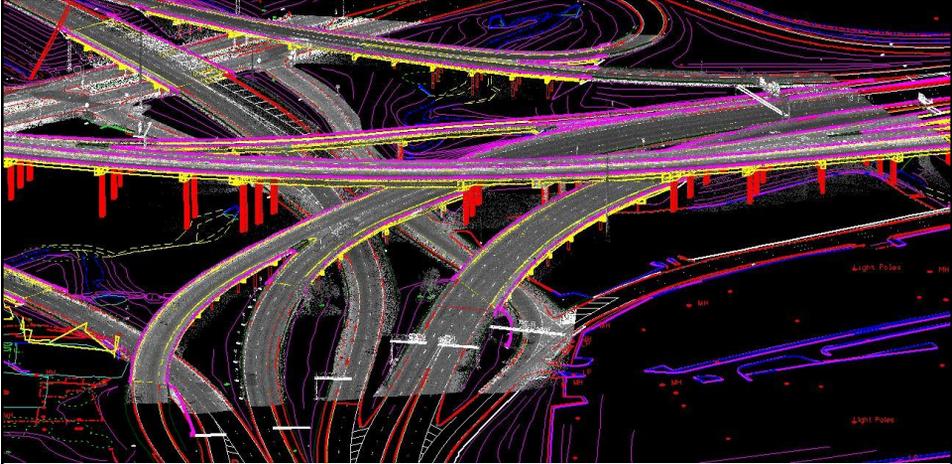
## Project Pegasus Overview



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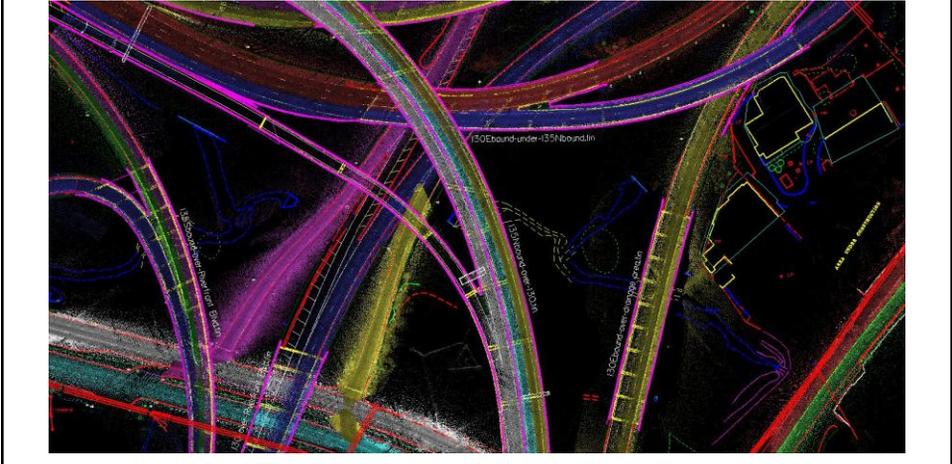
## Project Pegasus Overview



This image shows a detailed aerial view of a complex highway interchange. The roads are overlaid with various colors: purple for main roadways, red for shoulders or specific lanes, and yellow for other features. Several vertical red lines are scattered across the interchange, likely representing light poles. Labels such as "Light Pole" are visible on the right side of the image. The overall scene is a dense network of elevated and ground-level roadways.



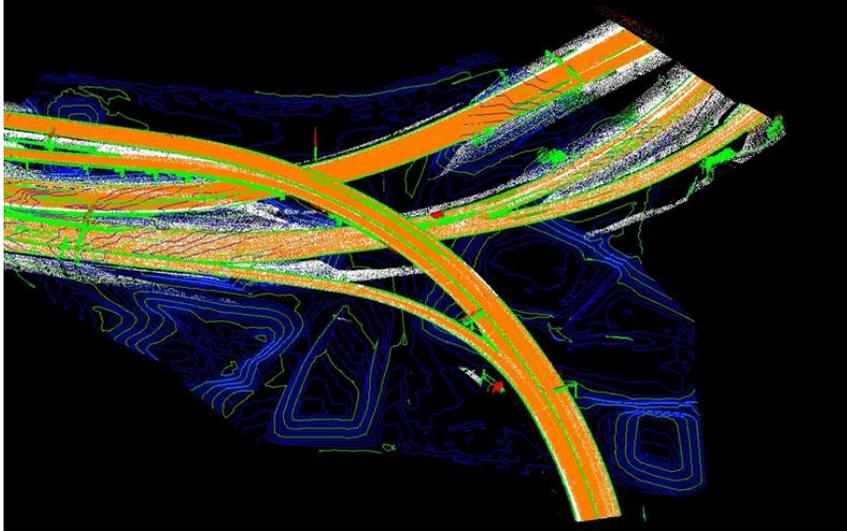
## Project Pegasus Overview



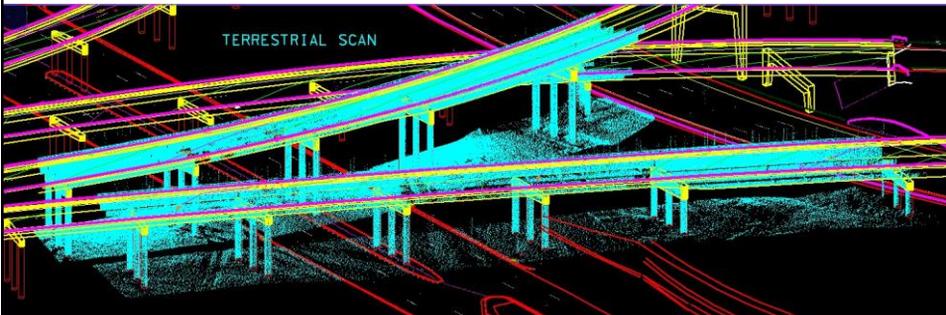
This image provides another aerial view of a highway interchange, similar to the one above. It features several labels for specific road segments: "130Ebound-under+35Nbound.in", "130Ebound-over+35Nbound.in", and "130Ebound-over+35Nbound.out". The roads are color-coded, with purple and red being prominent. The interchange shows a complex arrangement of overpasses and underpasses connecting different directions of travel.



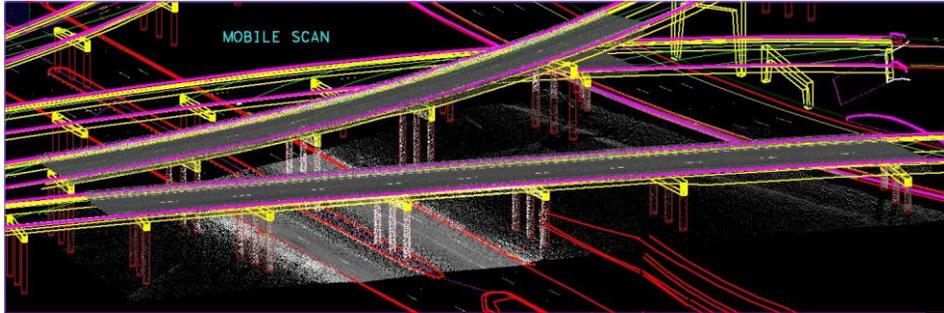
## Project Pegasus Combined Data Sources



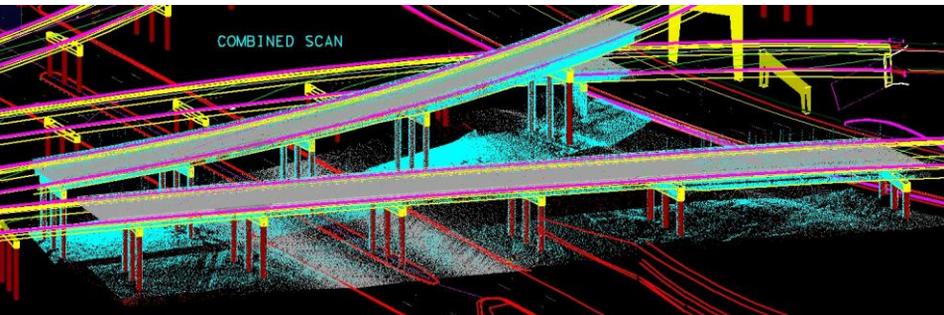
## Project Pegasus Combined Data Sources



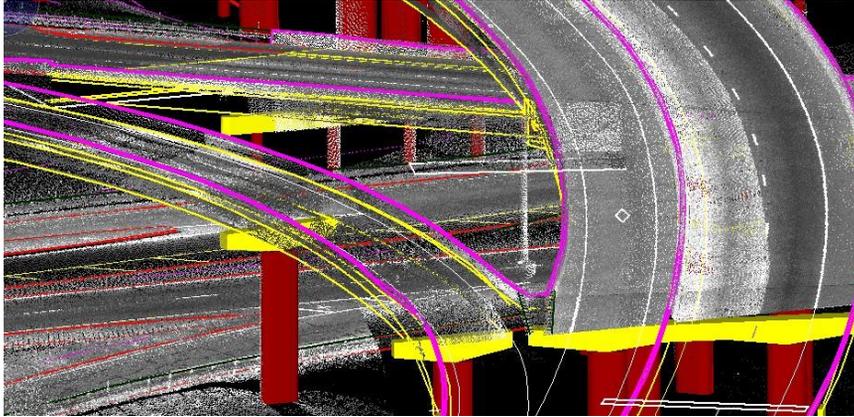
## Project Pegasus Combined Data Sources



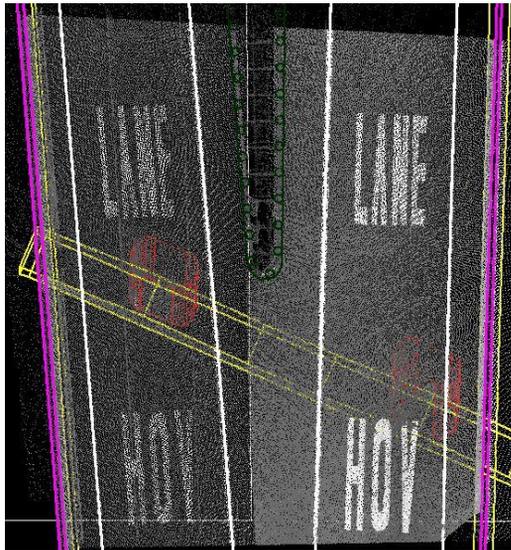
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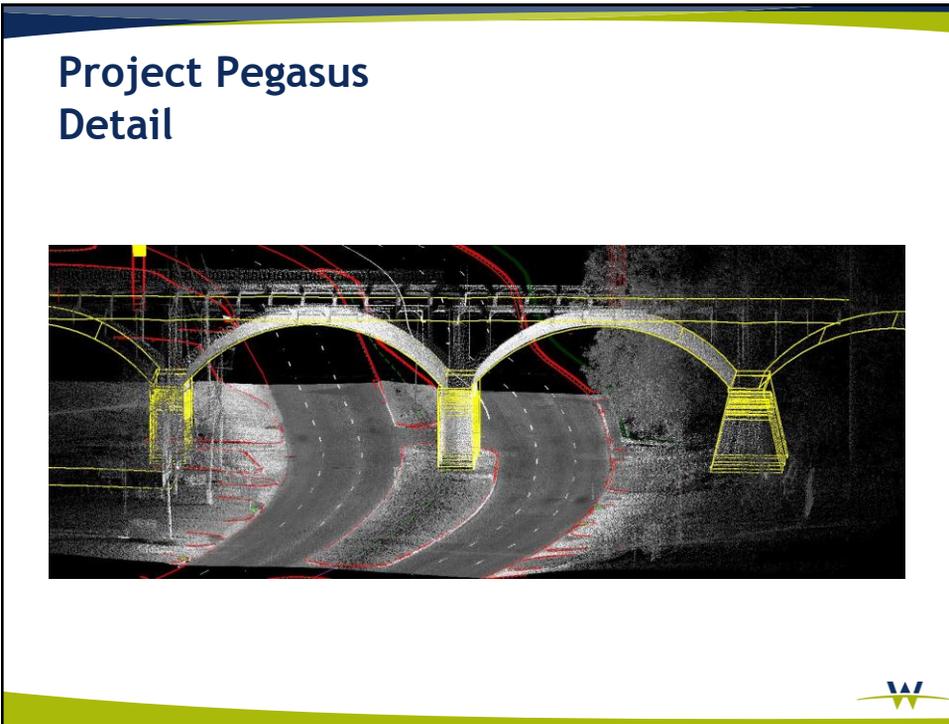
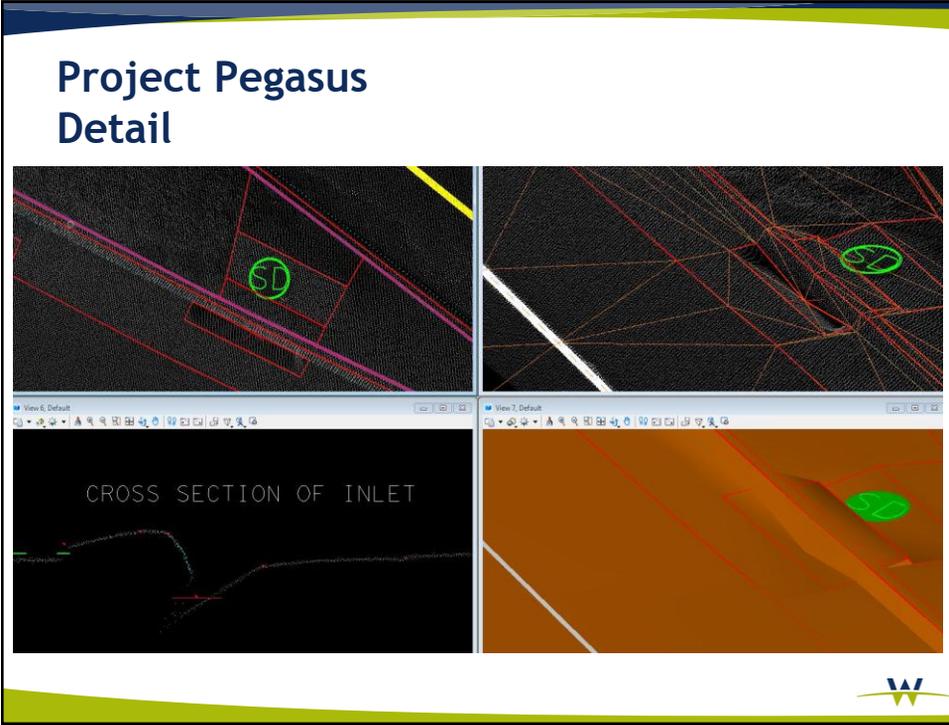


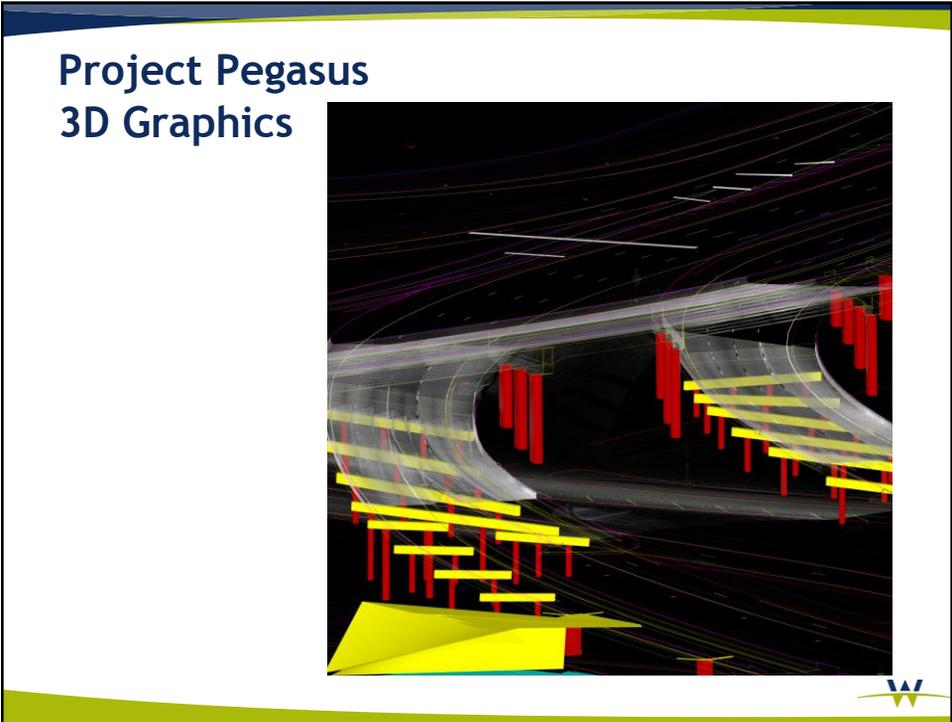
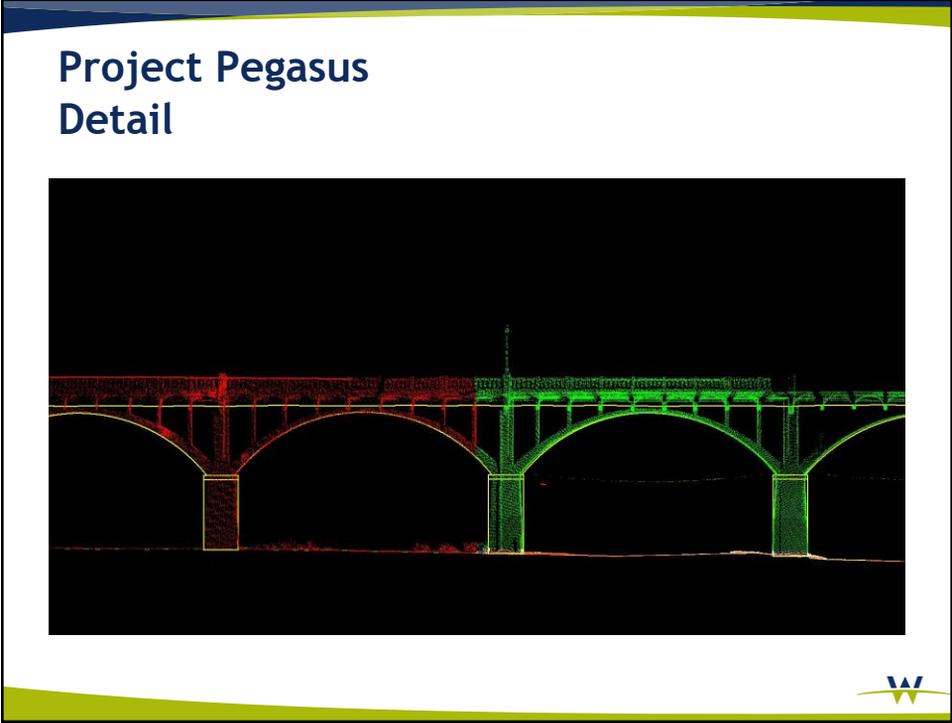
## Project Pegasus Detail



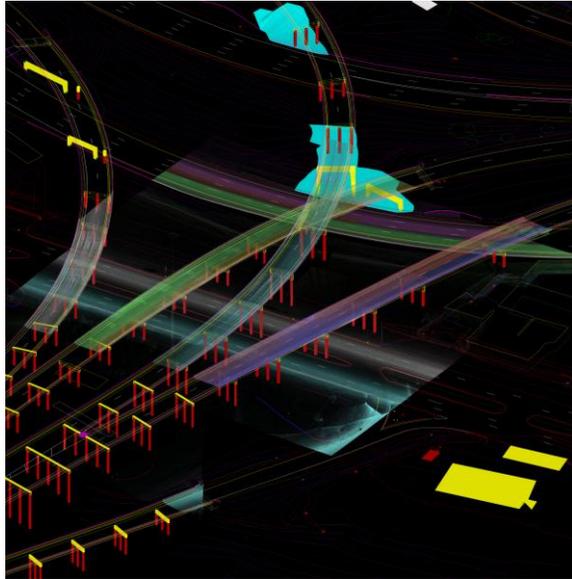
## Project Pegasus Detail



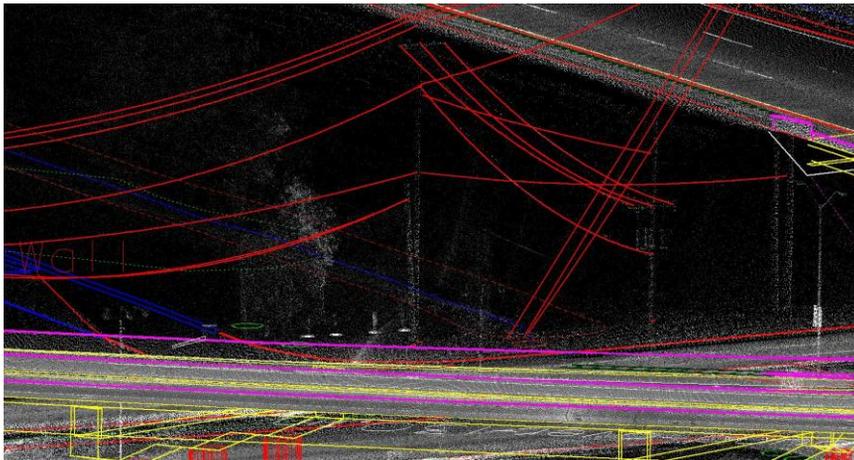




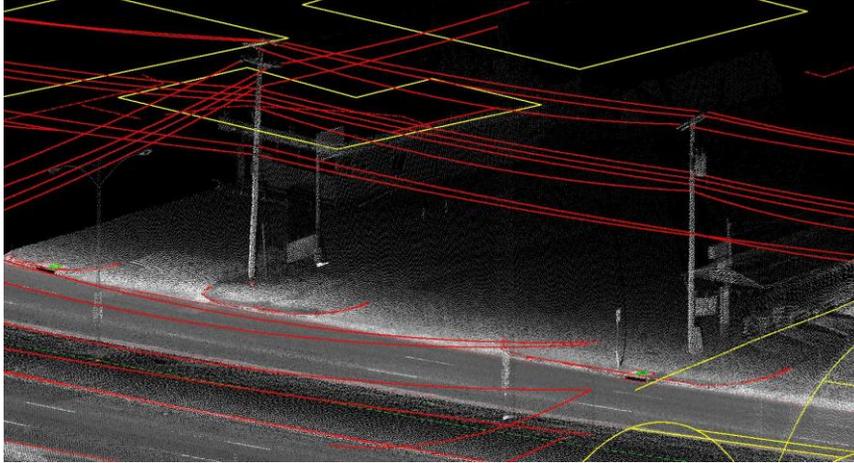
## Project Pegasus 3D Graphics



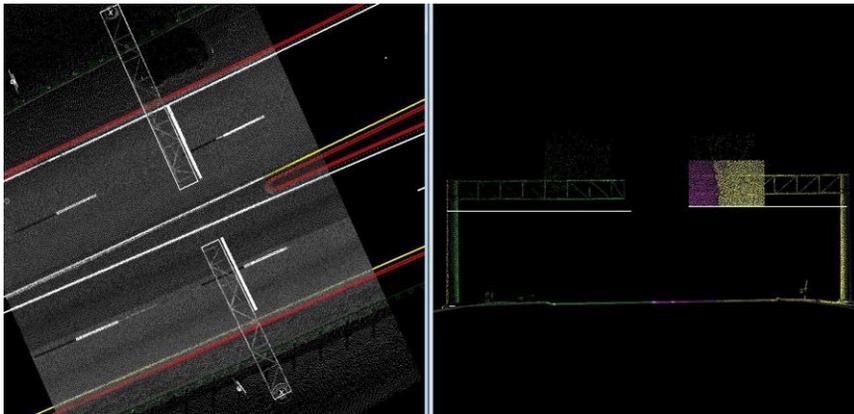
## Project Pegasus 3D Graphics



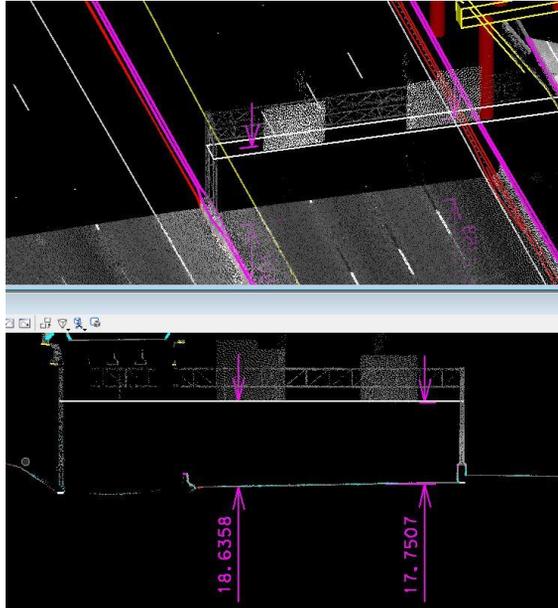
## Project Pegasus 3D Graphics



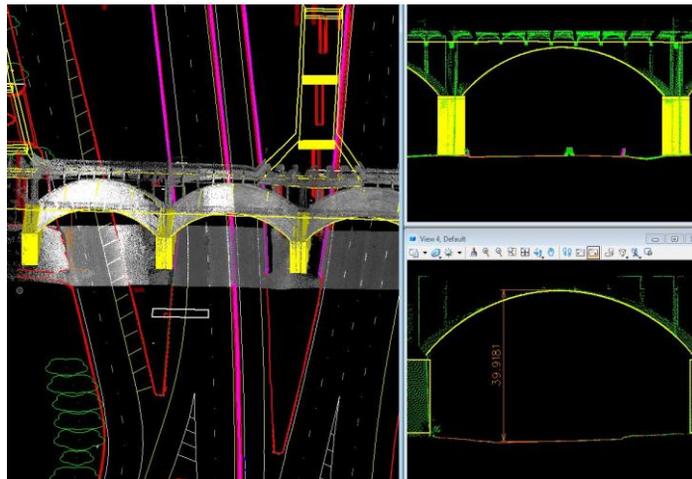
## Project Pegasus Clearance



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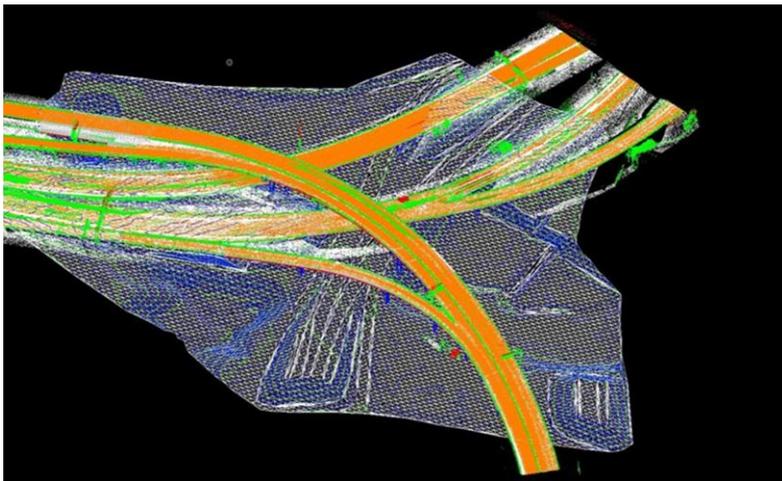
## Project Pegasus Clearance



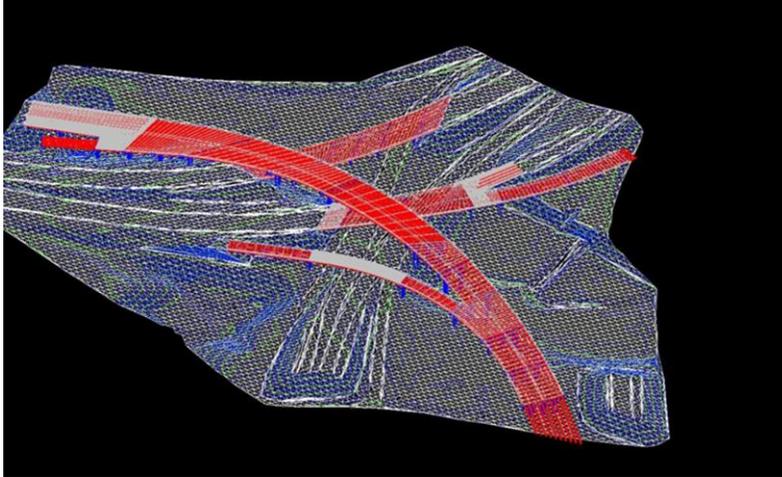
## Project Pegasus Survey Deliverables



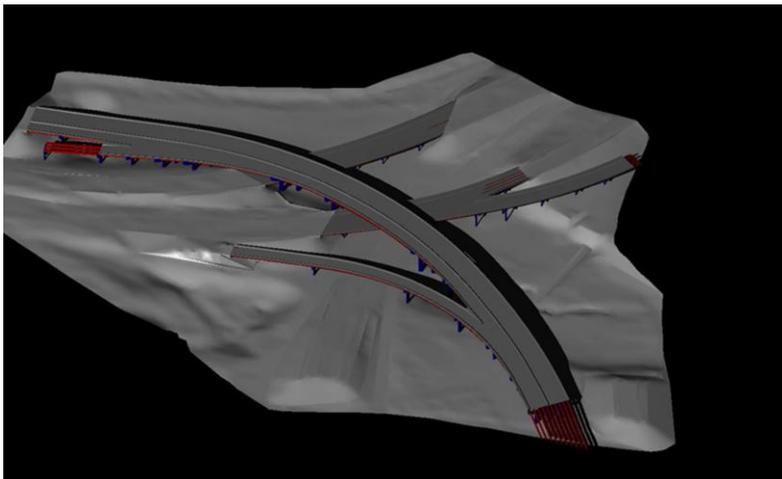
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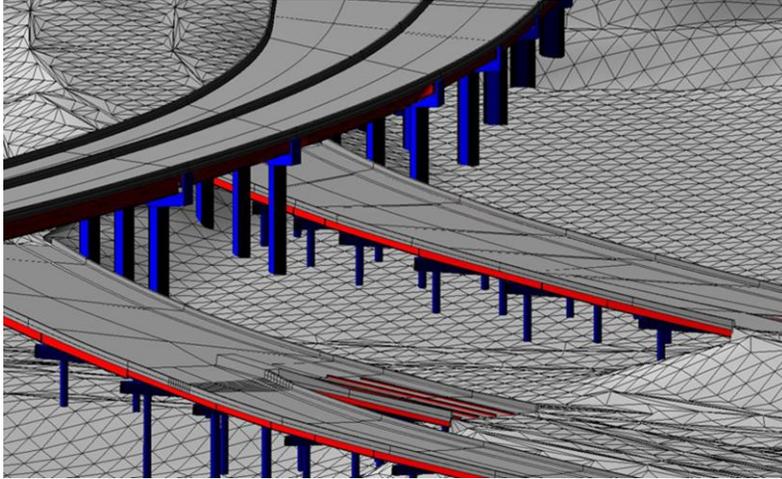
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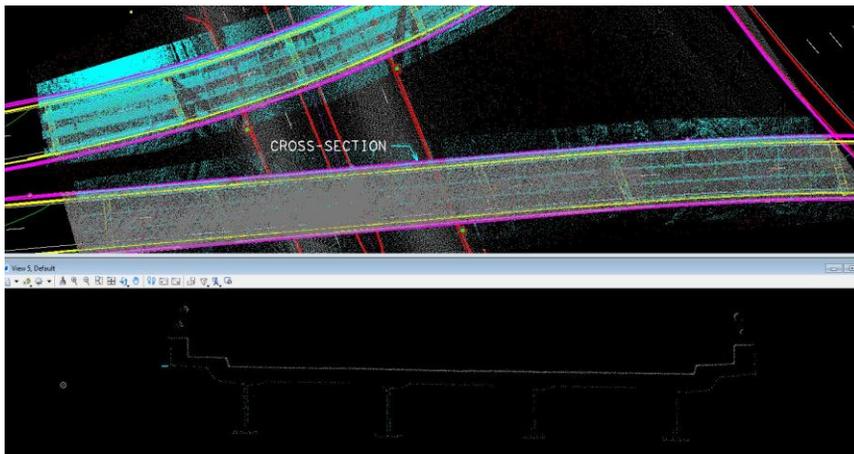
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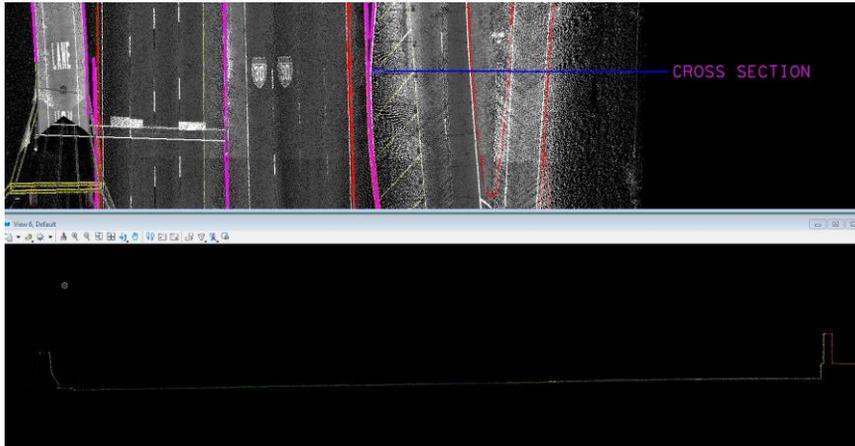
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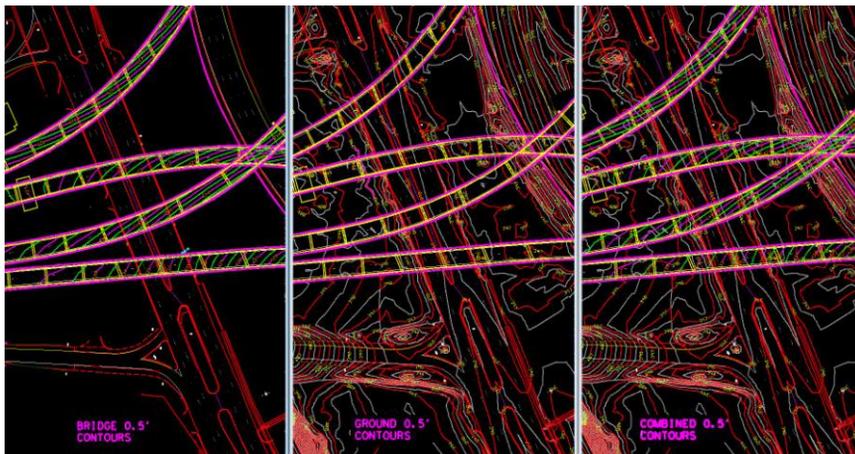
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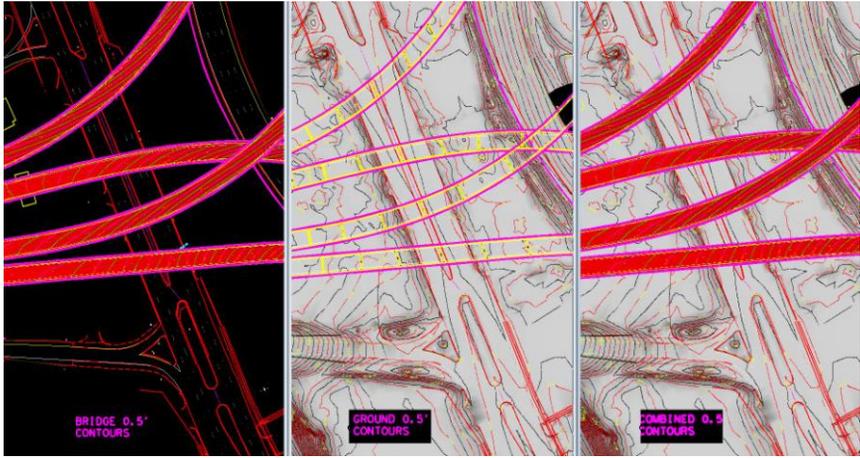
# Project Pegasus Survey Deliverables



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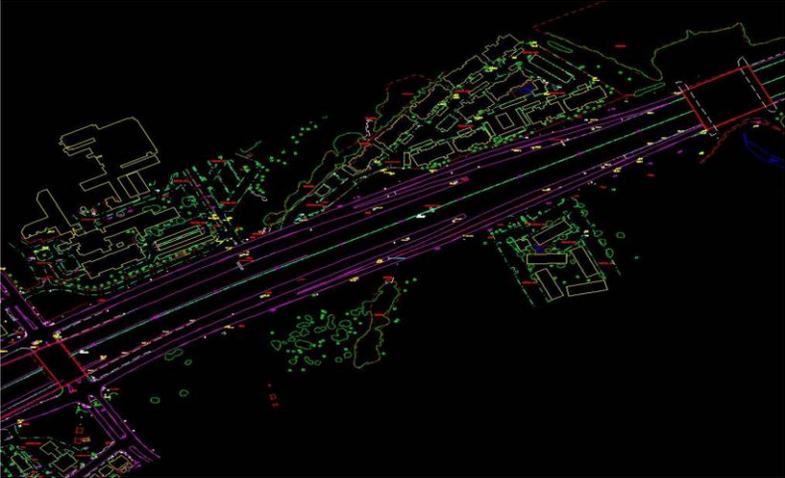


## Project Pegasus Survey Deliverables



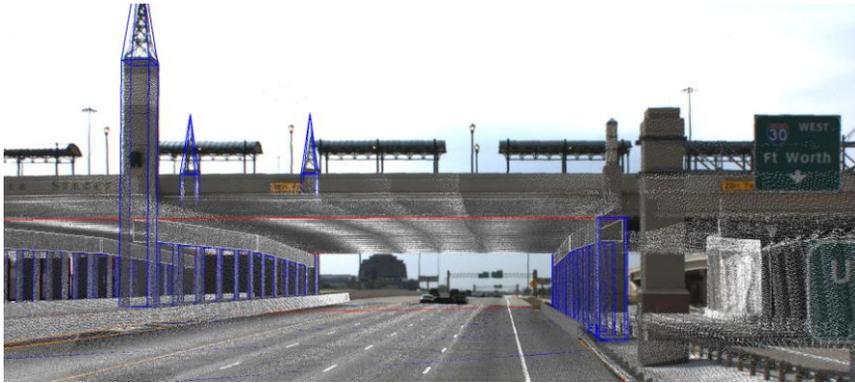
The image displays three panels of survey data. The left panel, labeled 'BRIDGE 0.5' CONTOURS', shows a dark background with red and pink contour lines. The middle panel, labeled 'GROUND 0.5' CONTOURS', shows a light gray background with red and pink contour lines. The right panel, labeled 'COMBINED 0.5' CONTOURS', shows a light gray background with red and pink contour lines, combining the bridge and ground data. A logo with a stylized 'W' is located in the bottom right corner of the slide.

## Project Pegasus Survey Deliverables



The image shows an aerial view of a complex highway interchange. The roads are highlighted in purple and green, with various colored overlays (red, yellow, blue) indicating specific survey data or construction zones. A logo with a stylized 'W' is located in the bottom right corner of the slide.

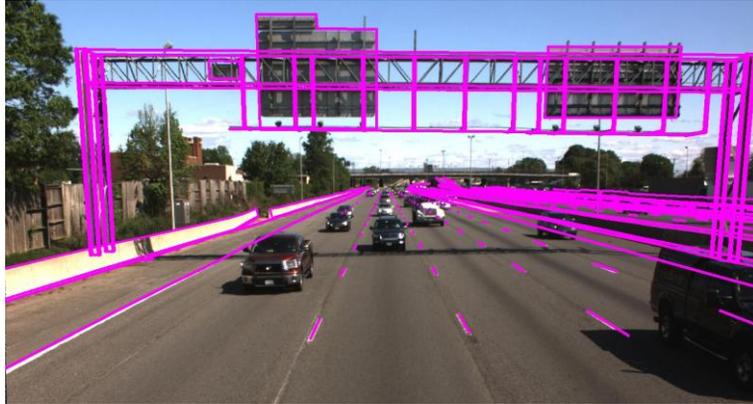
## Other Mobile LiDAR Advantages Road Asset Information



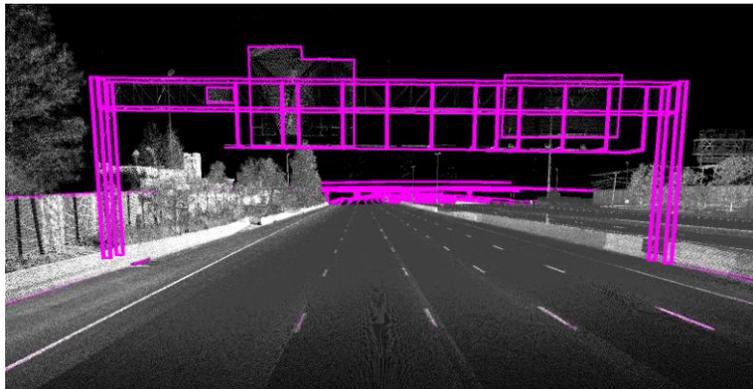
## Other Mobile LiDAR Advantages Road Asset Information



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## Other Mobile LiDAR Advantages Road Asset Information



## Other Mobile LiDAR Advantages Road Crossfalls

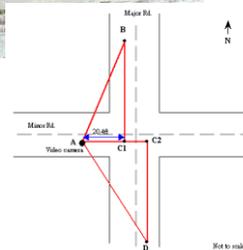
- + **Slope calculations** - To facilitate drainage
- + Computed from pavement scan pts – surface model
- + Crossfalls measured b/w pavement markings or EOP, to then...
- + Auto-calc **radius of curvature**,
- + Then able to compute **superelevations!**



## Other Mobile LiDAR Advantages Line-of-Sight - “View shed” Analysis

### Horizontal & vertical line-of-sight analysis

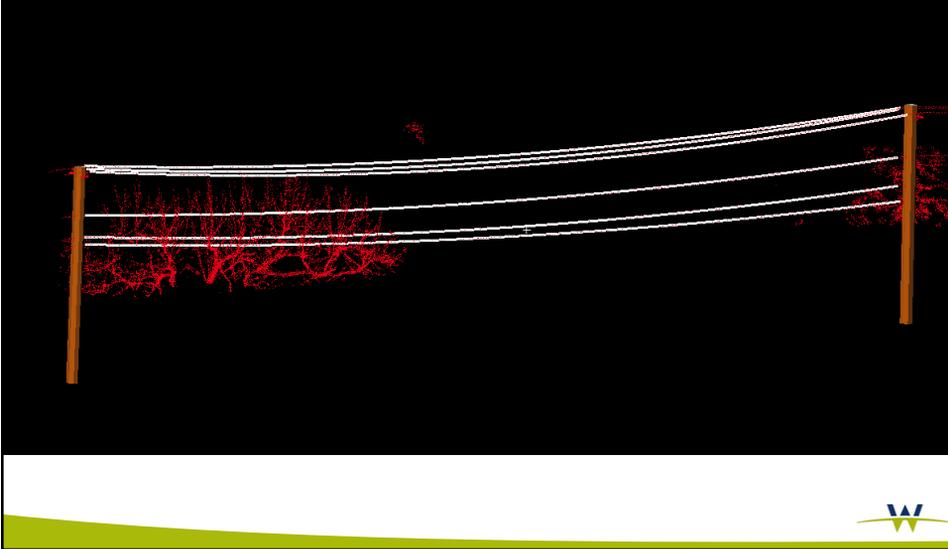
- + Apply sight standards from 3D surface model
- + Obstructions/blockage
- + Vegetation, buildings, utility poles, signage, etc.
- + Directional LOS– visibility in all directions from stationary location
- + Vector LOS – a defined vector along a route



## Other Mobile LiDAR Advantages

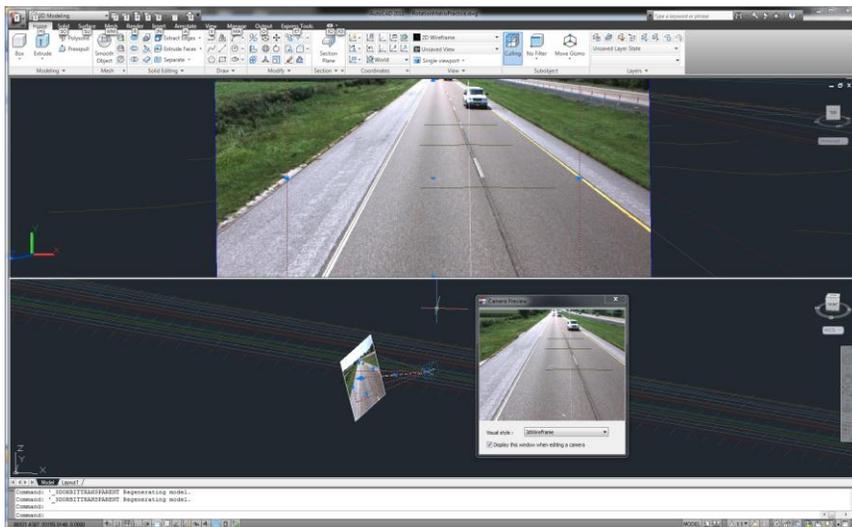
### Power line Exclusion

- Vegetation Management -Utility Mapping

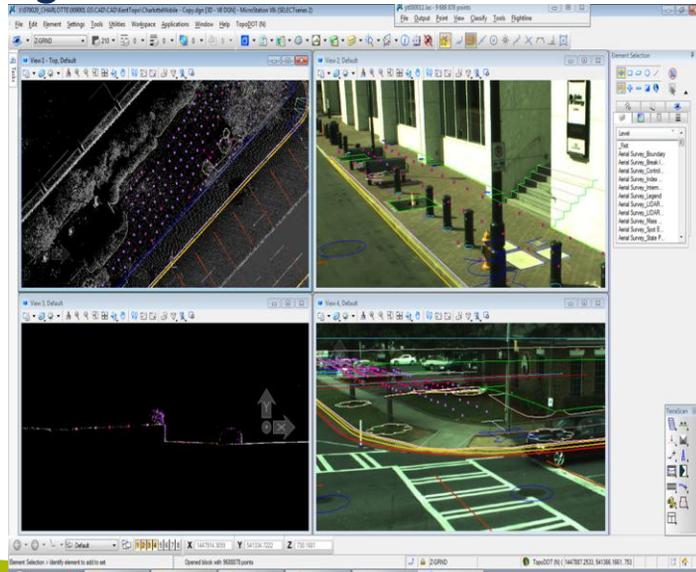


## Other Mobile LiDAR Advantages

### MicroStation -AutoCAD



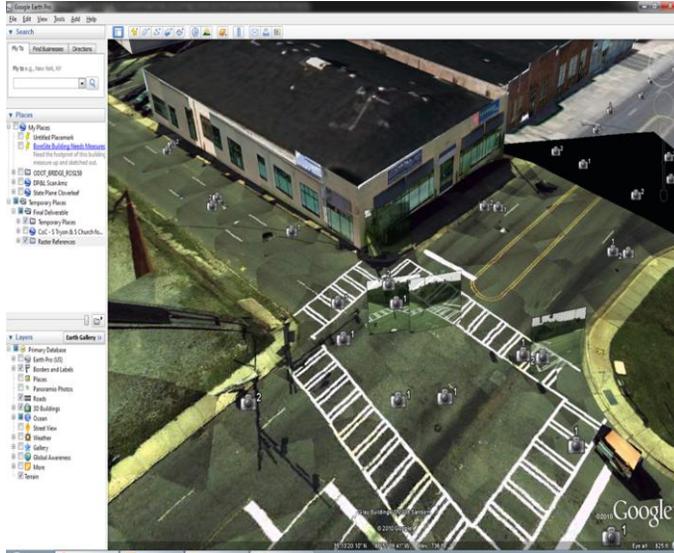
# Other Mobile LiDAR Advantages Google Earth



# Other Mobile LiDAR Advantages Google Earth

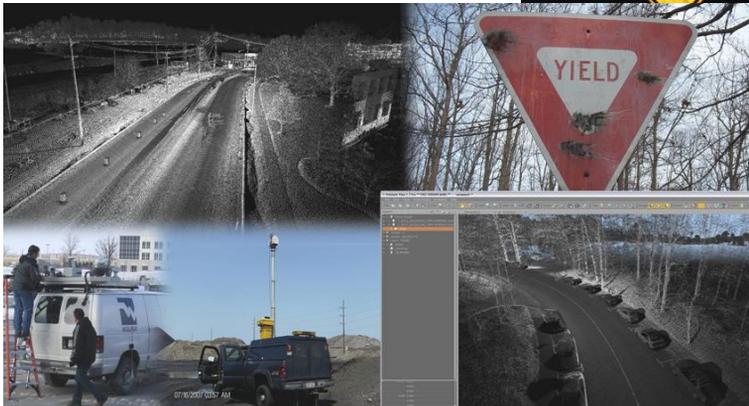


## Other Mobile LiDAR Advantages Google Earth



## Other Mobile LiDAR Advantages Sign Inventories

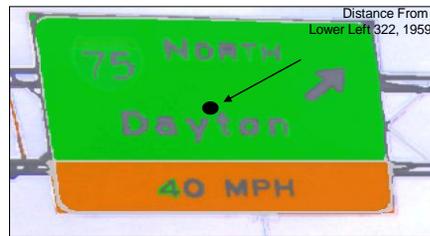
- + Increase the safety of the motoring public
- + Document Value of Assets



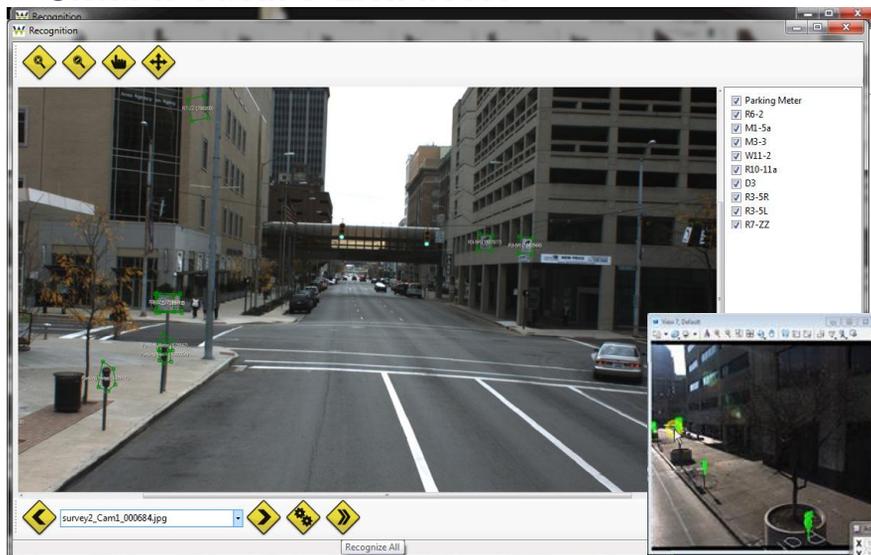
## Other Mobile LiDAR Advantages Sign Inventories

Innovative Extraction Process:

- + Identify Sign Candidates from Imagery Using Pattern Recognition Image Processing (PRIP) Software - Automatic
- + Paint sign candidates green in Image, paint everything else black
- + Locate relative position of sign face (center of sign) with respect to bottom left hand corner of sign
- + Precise location and further attributes inside LiDAR dataset
- + Import into GIS/CAD

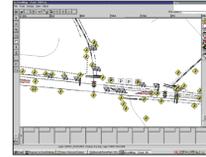


## Other Mobile LiDAR Advantages “SmartFeature Extractor”



## Taking it to the Streets... and Beyond!

- + Obstructions to viewing signs (trees, etc.)
- + Sidewalks
- + ADA ramps
- + Pavement analysis
- + Guardrails
- + Curb/gutter
- + Trees
- + Hydrants
- + Utility features
- + Parking meters
- + Pavement Assessment Collect
- + Traffic signals
- + Utility poles/lines
- + Surface model (DEM)
- + Building corners
- + Images of houses (appraisals)
- + Data for future CIP projects for planning and design
- + Risk Management
- + And So On; and So On



**One Collect, Many Uses**



## Conclusion

- + Complete; Comprehensive Collection
  - + Increases Engineers Understanding of Project Site
  - + Creates Confidence in Alternatives
  - + Reduces Changes Orders from Unknowns
  - + Office "Site Investigations"
- + Accurate
  - + Relative- 0.03 feet
  - + Absolute- 0.06 to 0.10 feet
- + Safe
  - + Eliminates Lanes Closures
  - + Keeps Surveyors out of Harms Way



# Questions?

