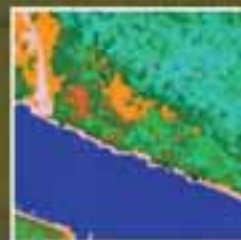




GIS/LiDAR Applications for Railroad/Utility Corridor Development and Third-Party Right-of- Way Mapping



GEOSPATIAL SOLUTIONS

July 15, 2010

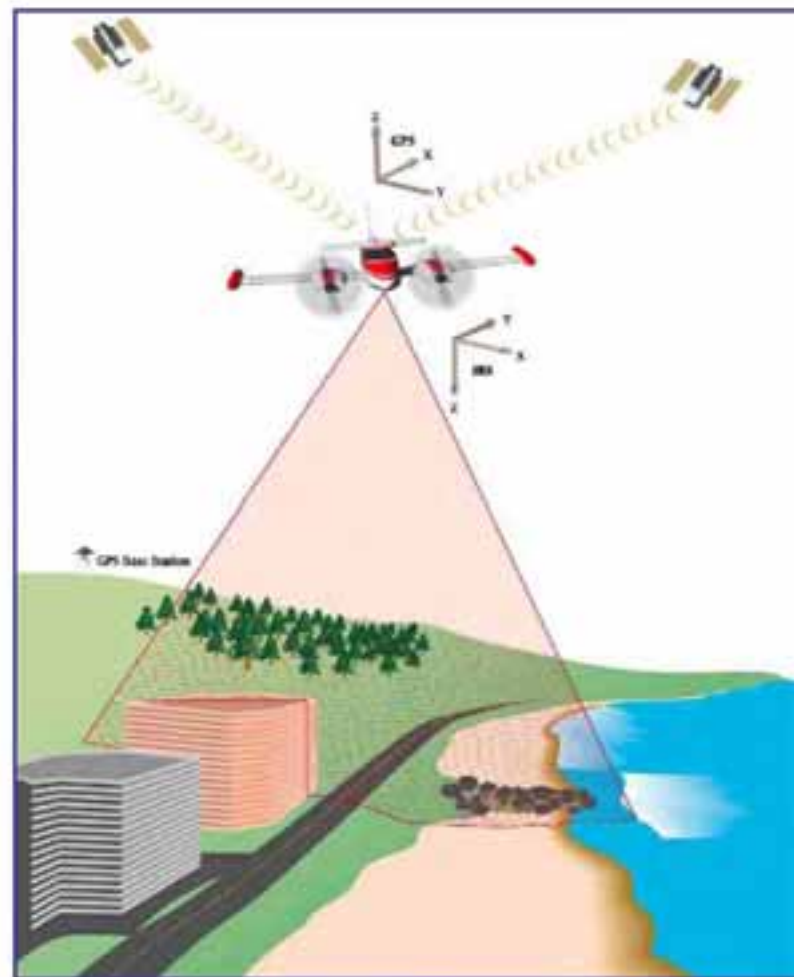
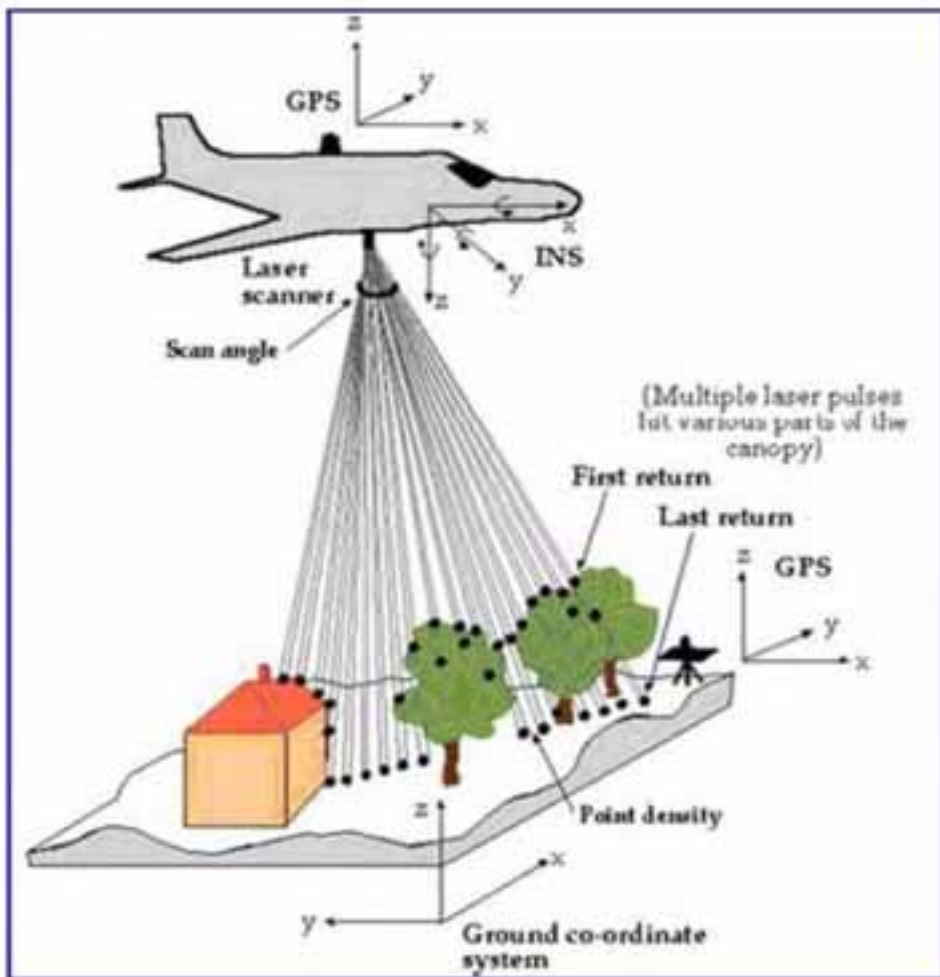
Introduction/Purpose

- Light Detection and Ranging (LiDAR) and GIS are decisive and key technologies for corridor planning and third party ROW mapping.
- LiDAR provides high density and high precision X,Y,Z ground coordinates, which can produce highly accurate terrain models/contours for design purposes.

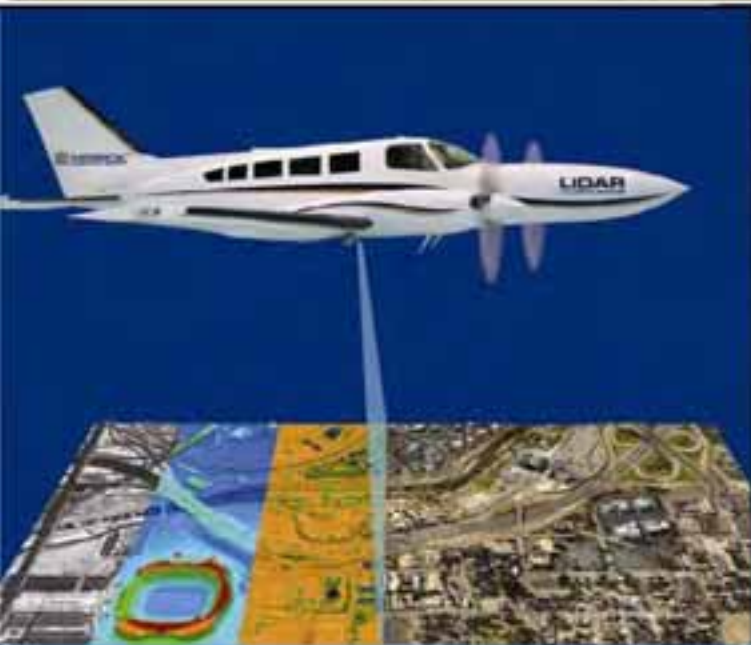
Introduction/Purpose

- By properly organizing ROW data layers in a GIS, the data can be instantly accessed, viewed, analyzed and printed out as needed.
- When data is stored in a centralized GIS, it can be accessed by multiple disciplines.

LIDAR



Methods of LiDAR Collection



Benefits of the different LiDAR Platforms for Corridor Mapping

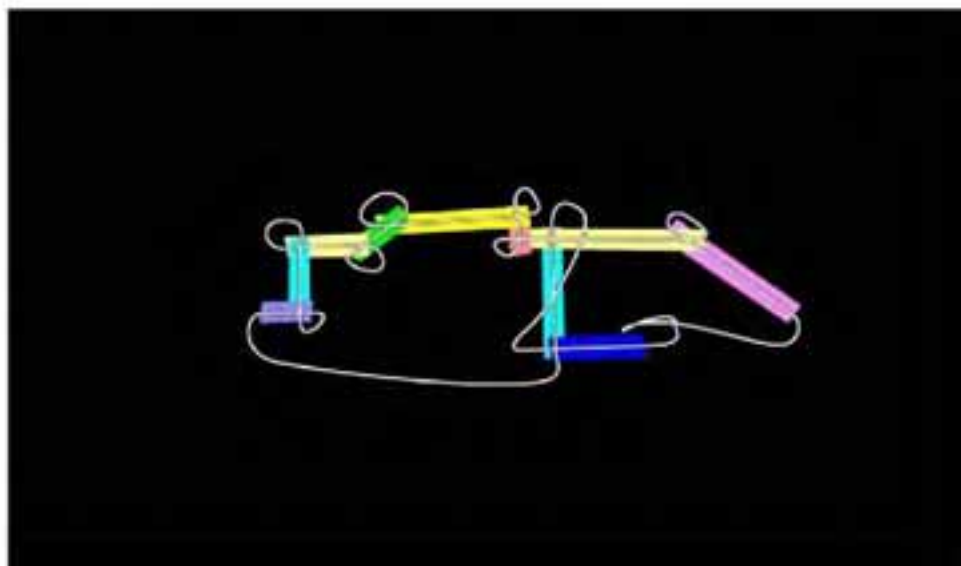
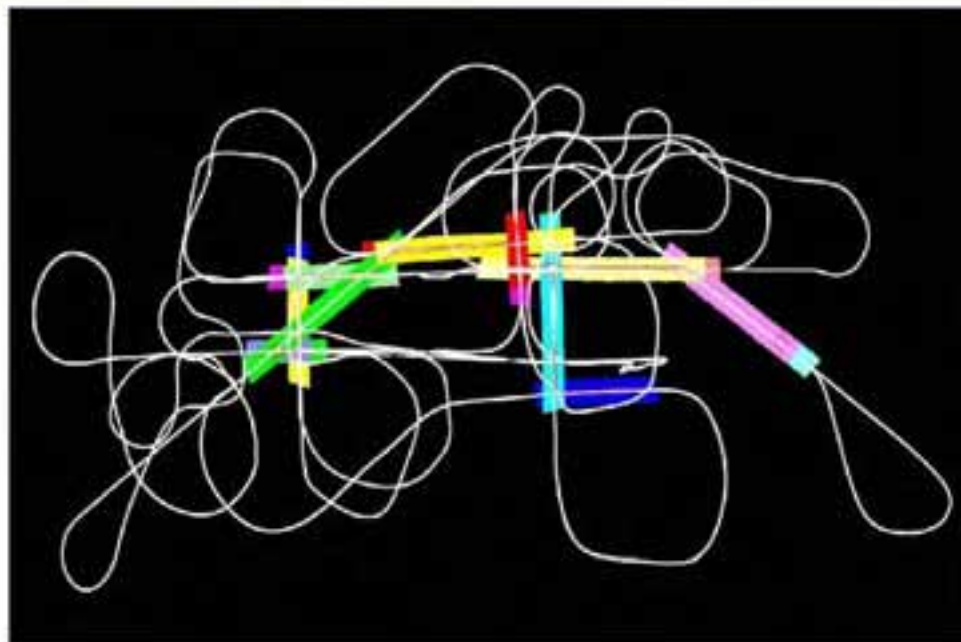
- **Fixed Wing:**
 - For large, continuous areas with low GSD (Ground Sample Distance).
 - Ideal for ROW footprint mapping.
- **Helicopter:**
 - For mapping winding, existing corridors such as rail, road or utility.
 - For areas requiring high GSD for tighter contour generation.
 - Ideal for high precision mapping required for additional corridor track, highway lane widening, utility corridor construction and light corridor feature extraction.
- **Ground-Base/Stationary**
 - For extremely high GSD with survey-grade accuracy.
 - Ideal for viewshed analysis and extreme feature extraction.

Helicopter Corridor Flight Efficiencies

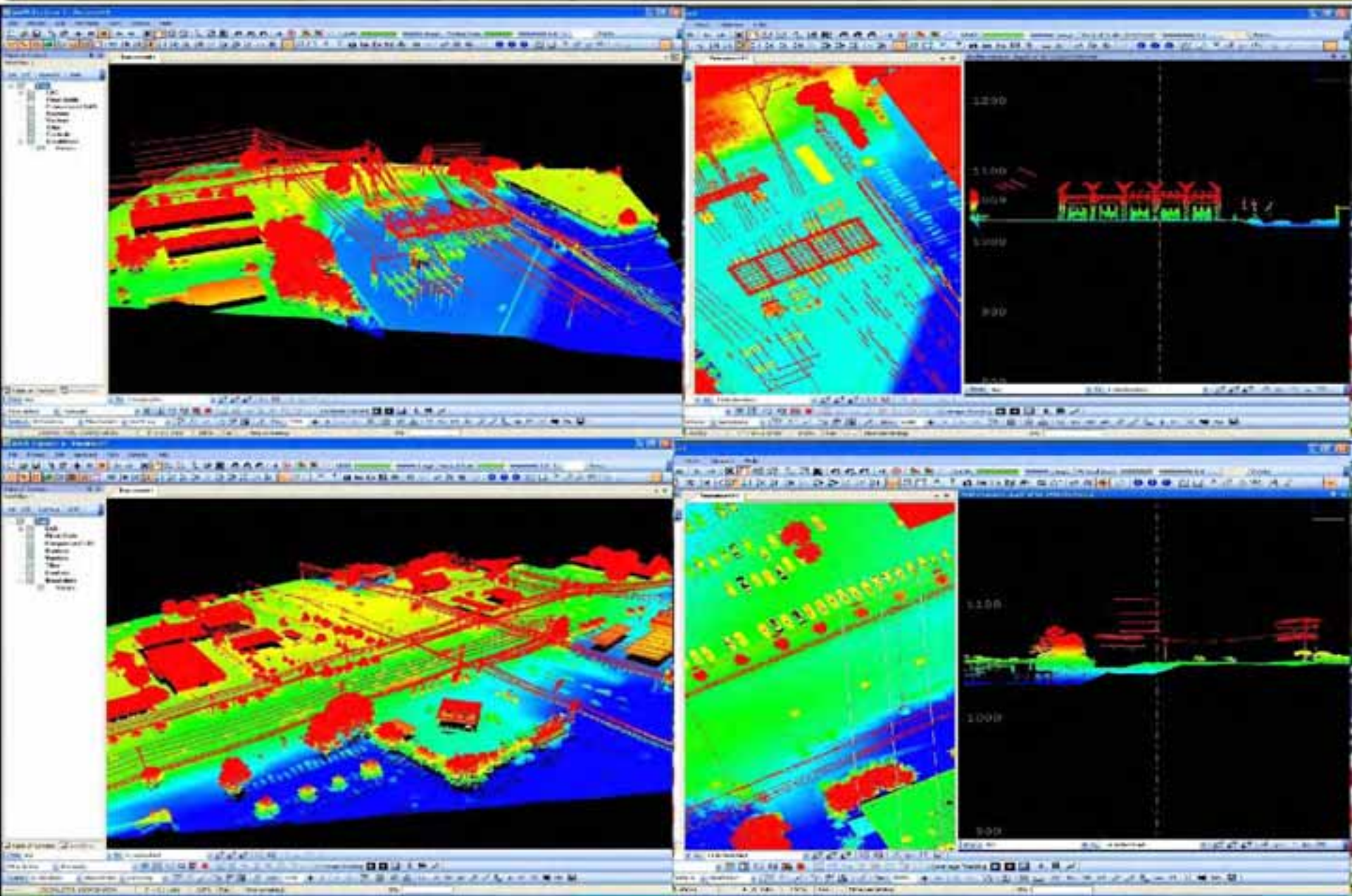
– Less Turns / Smaller Turns

24 mile corridor with 0.5m GSD Requirement

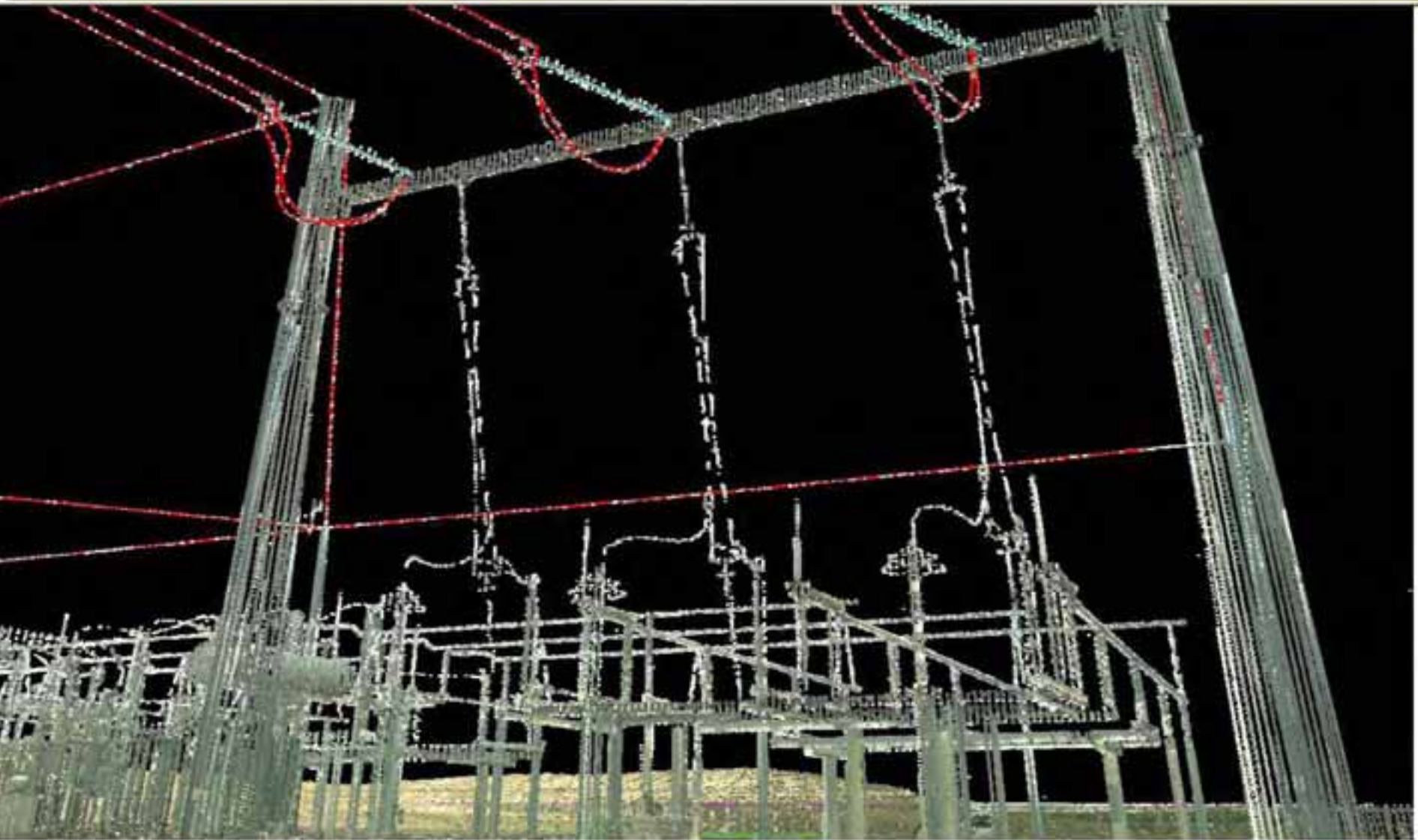
- The 24 mile long corridor must be flown twice for data density – 0.5 m GSD
- Turn radiiuses = 4-7 miles
- Length of turn track = 9-20 miles
- Turn times = 4 – 8 minutes per turn
- Flight time breakdown:
 - Over target = 0.5 hrs / 15%
 - Flight line turns = 1.8 hrs / 59%
 - Taxiing, takeoff, ascending, descending, landing = 0.8 hrs / 26%
- **Total = 3.1 hrs**
- Estimated flight time for helicopter = 20 minutes
- This equates to a 9X savings in flight time
- Flight time breakdown:
 - Over target = 0.2 hrs / 61%
 - Flight line turns = 0.1 hrs / 30%
 - Takeoff and landing = 0.03 hrs / 9%
- **Total = 0.34 hrs**



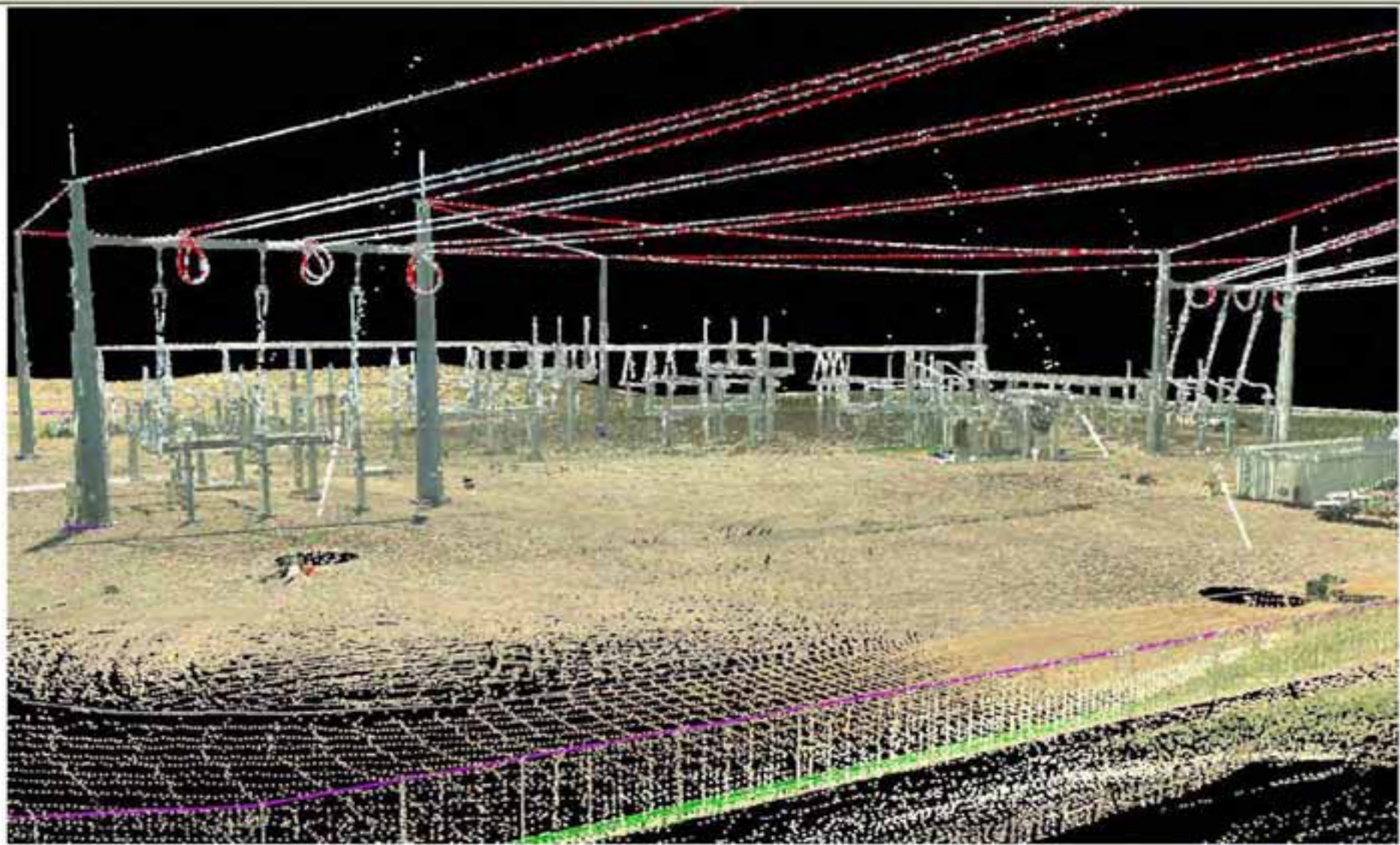
Utility LiDAR



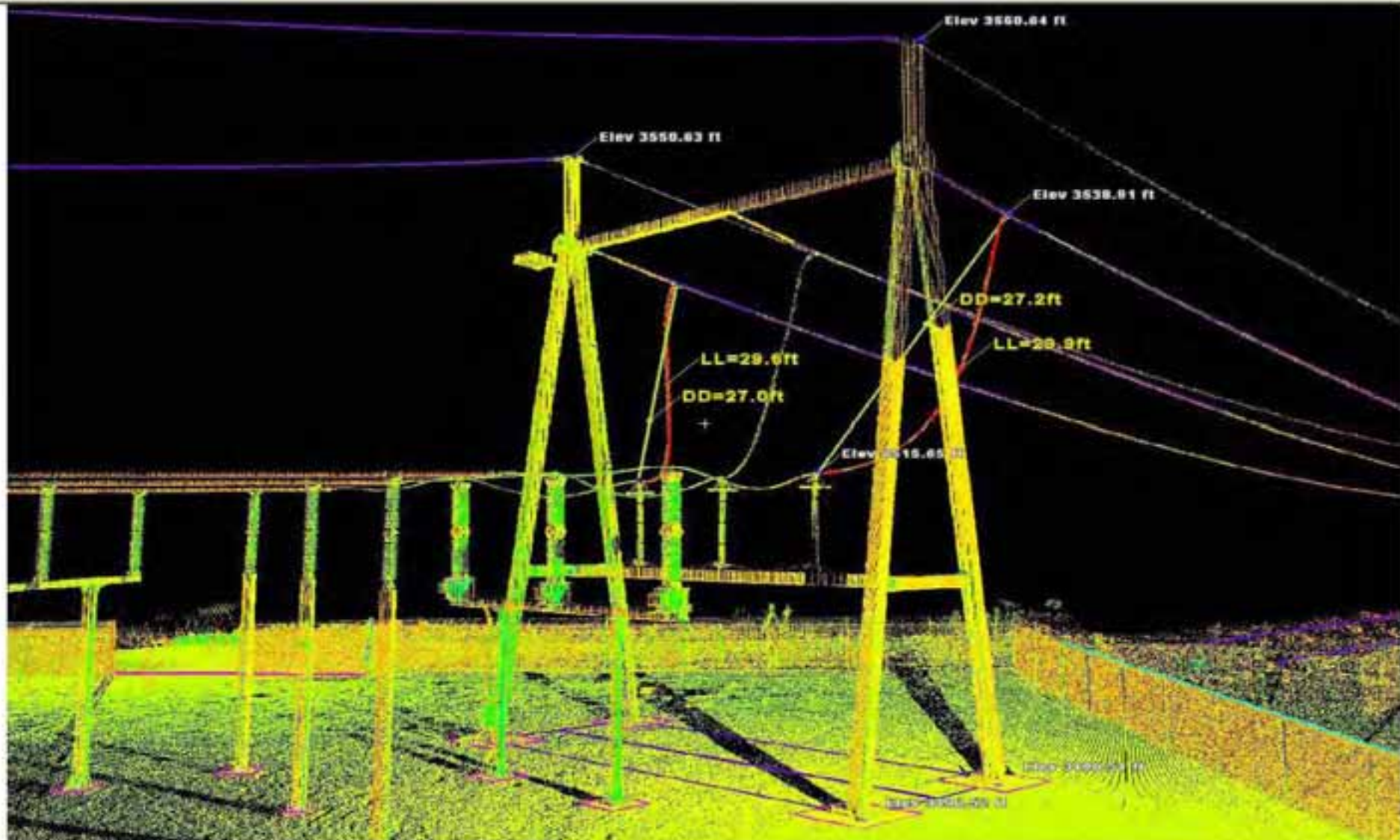
Utility LiDAR



Utility LiDAR



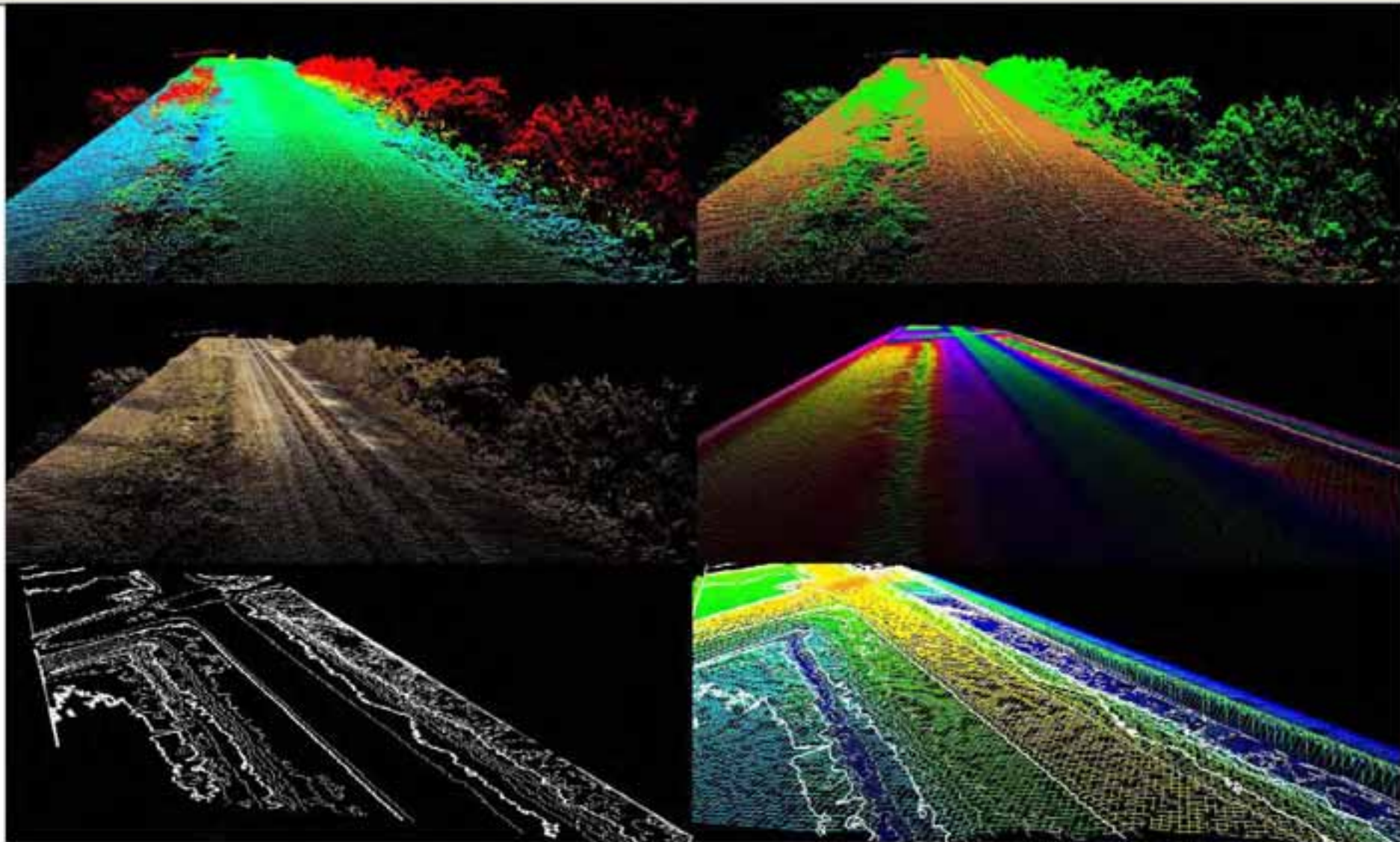
Utility LiDAR



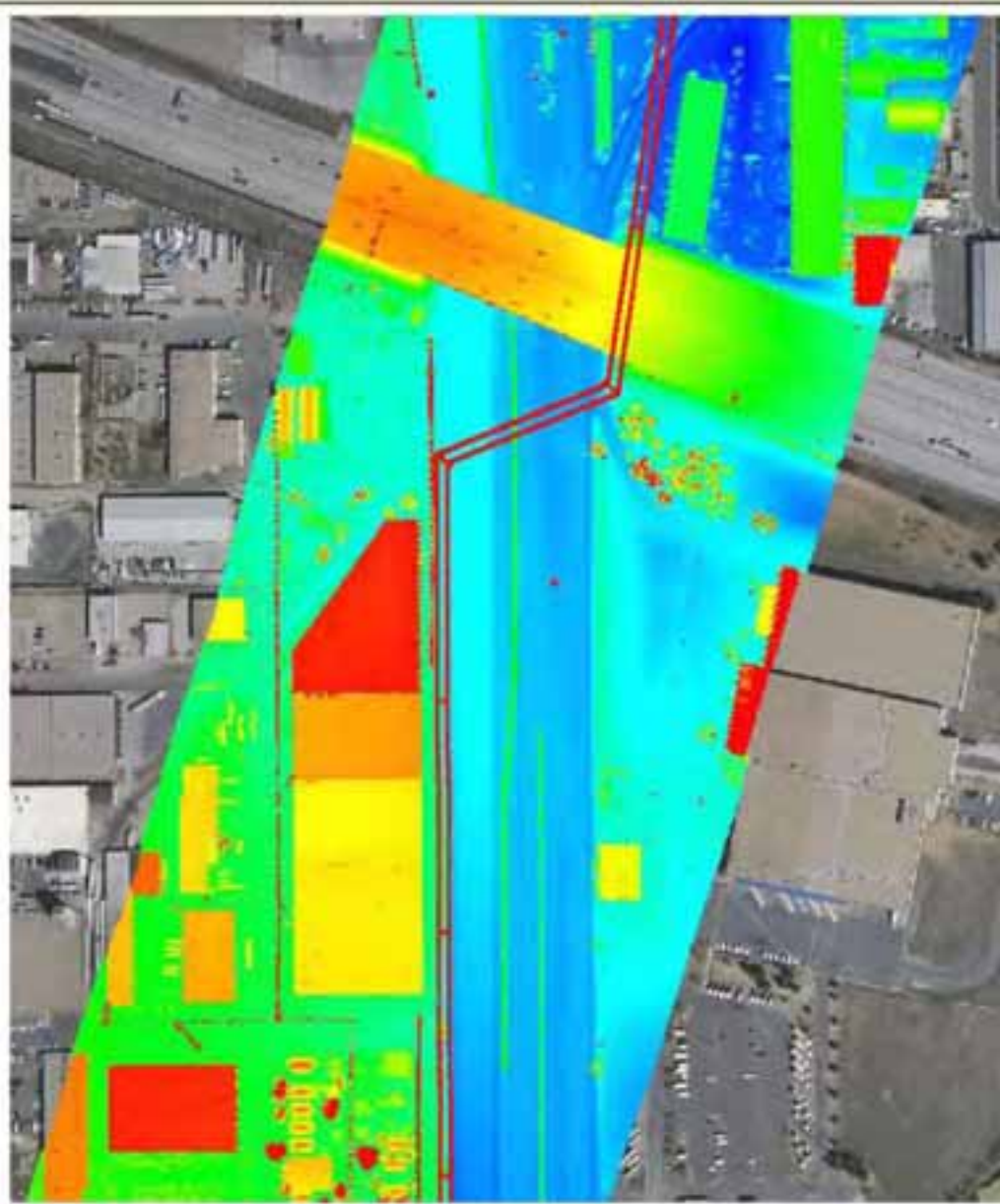
Utility LiDAR



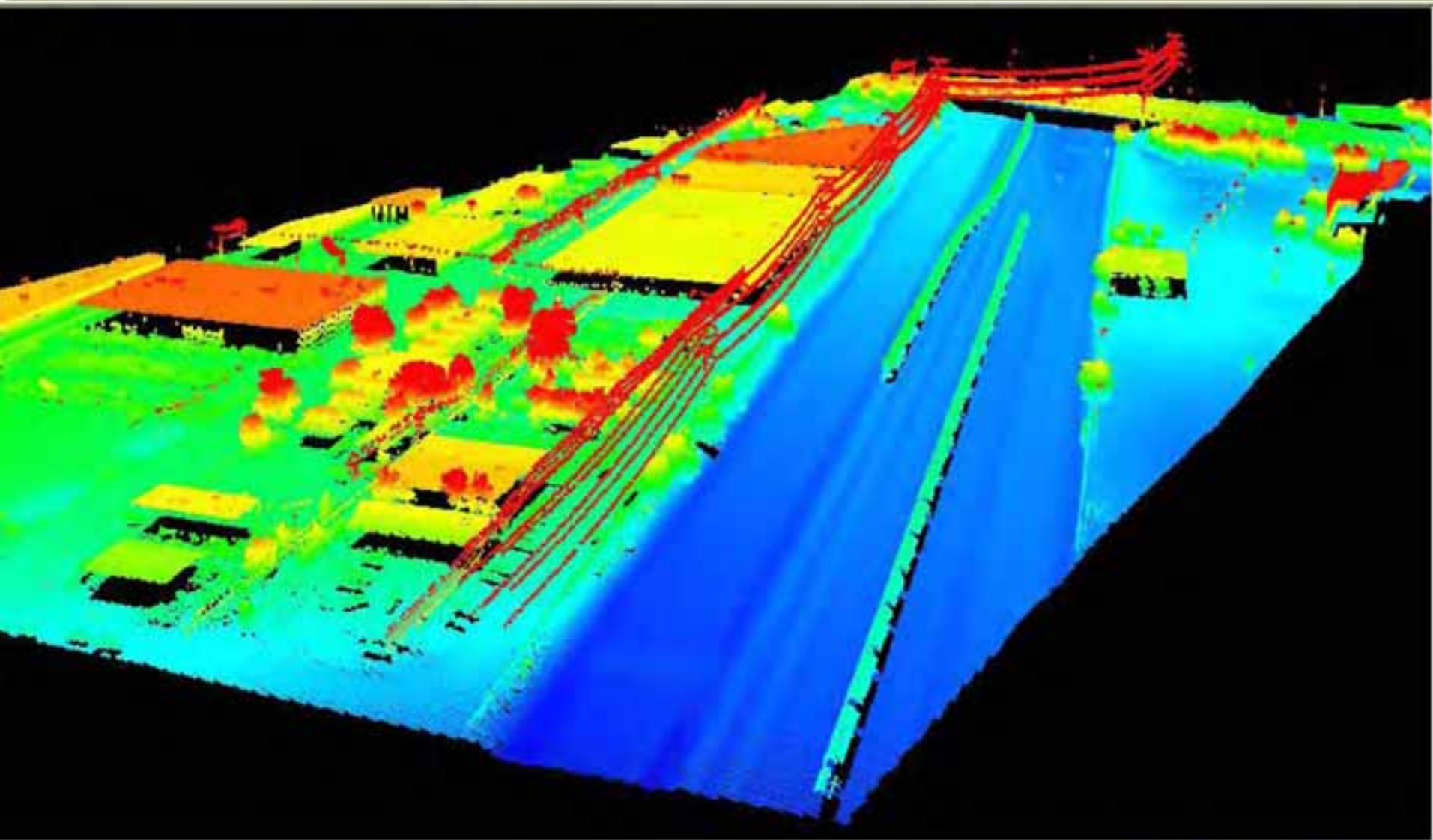
Railroad Corridor LiDAR



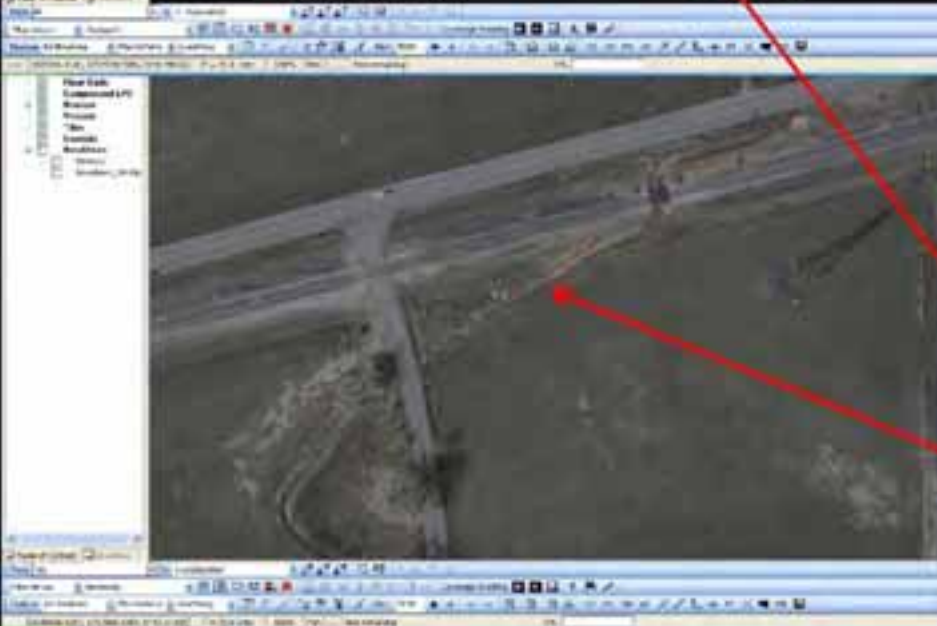
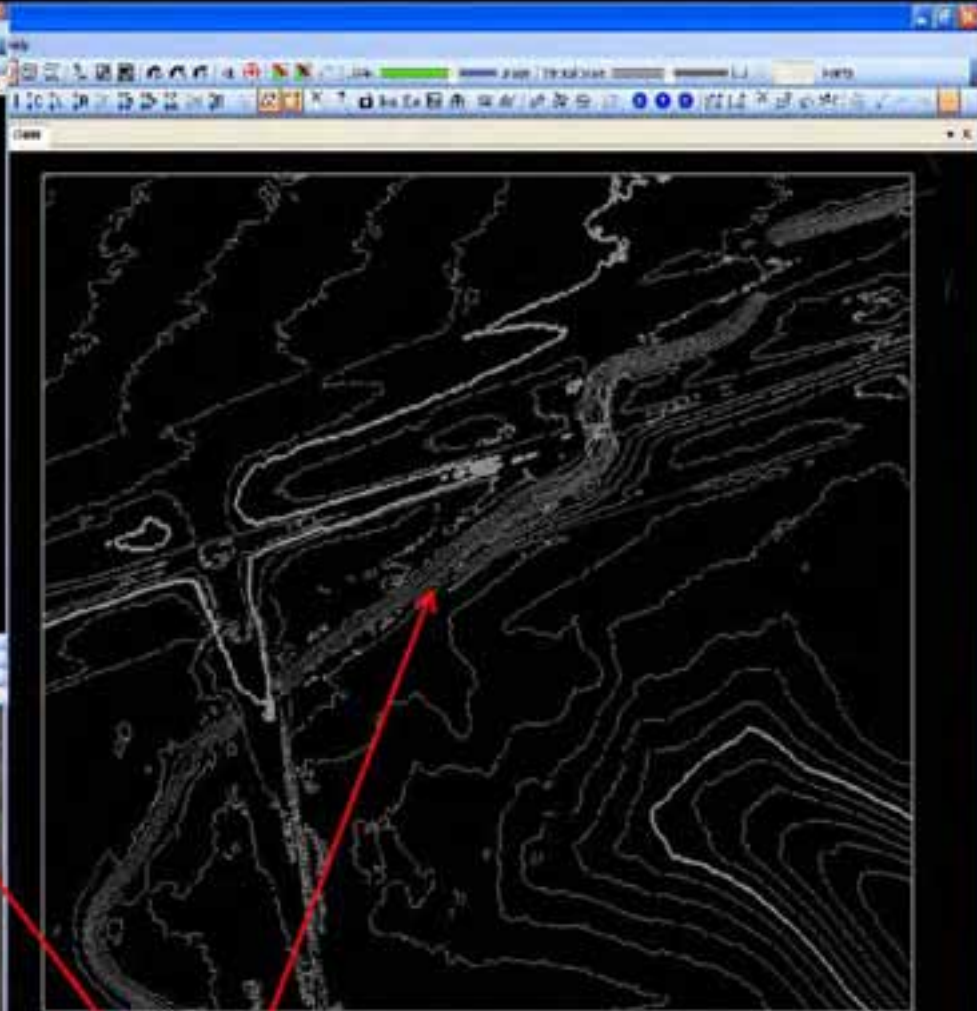
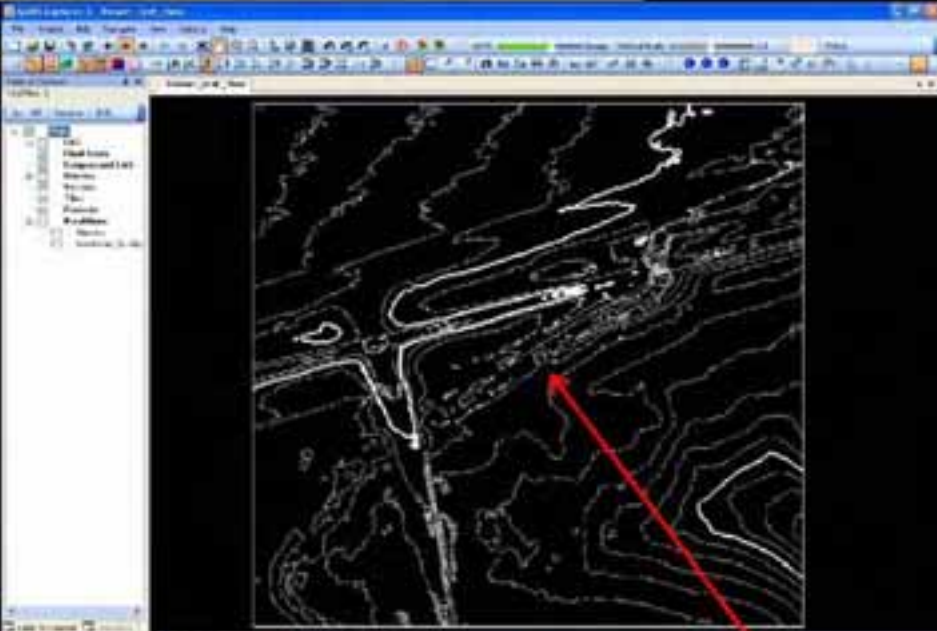
Railroad Corridor LiDAR



Railroad Corridor LiDAR

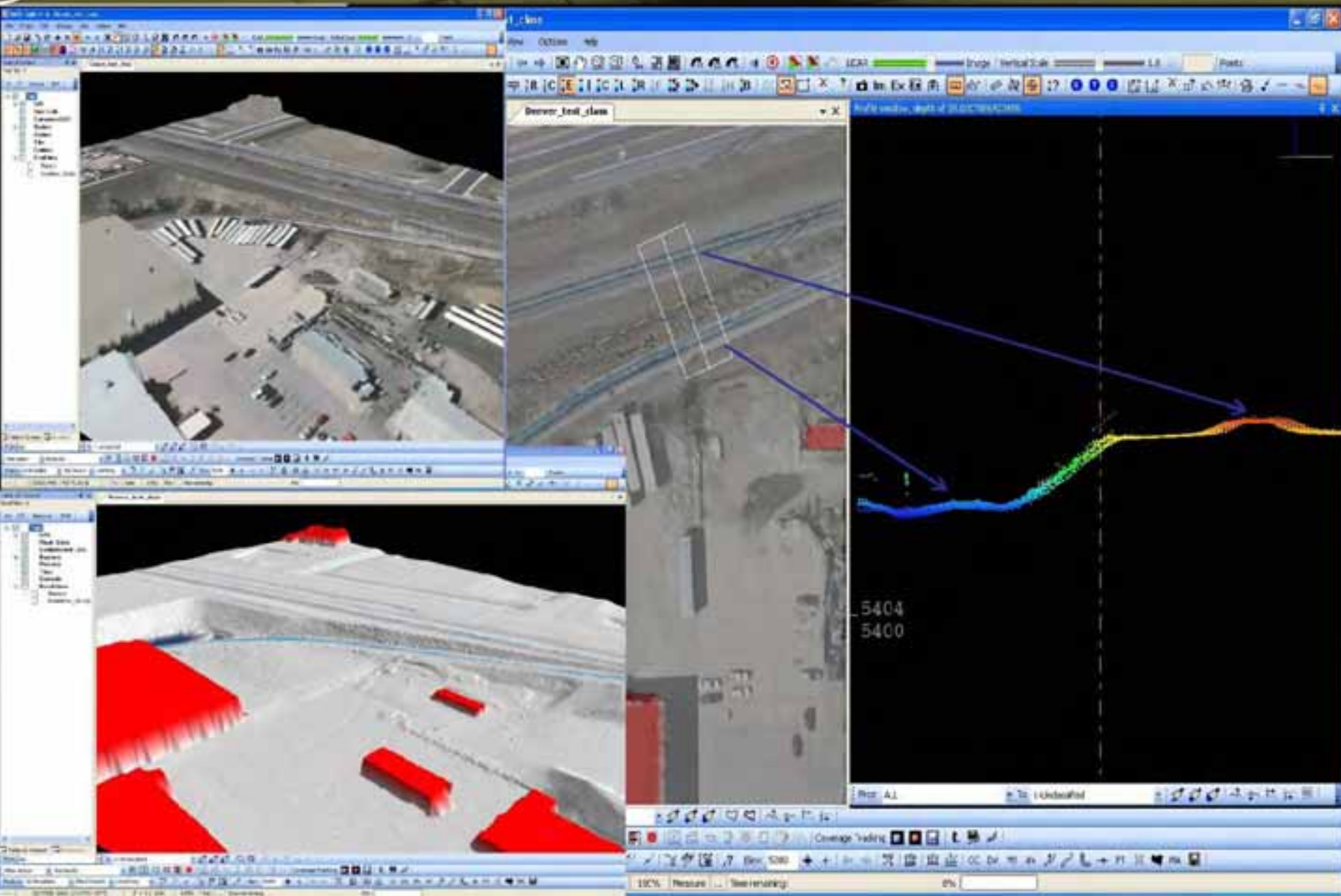


Railroad Corridor LiDAR - Breaklines

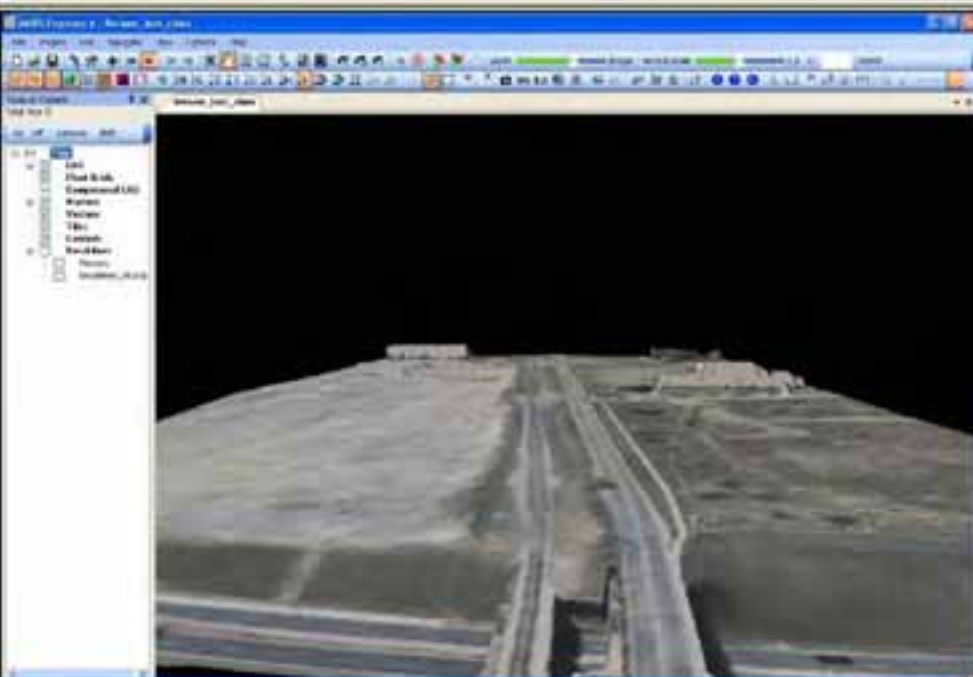


stream

Railroad Corridor LiDAR – Grade Analysis



Railroad Corridor LiDAR – Bridge Analysis



MARS Explorer

LIDAR Point selected:

Flight line: C:\86\Datasets\Rail Data and Images\LAS_1.2_Classified\1\0.las(107)

X: 3104186.247

Y: 1712404.019

Z: 5459.309

Timestamp: 329976.444321048 (Adjusted GPS Time)

UTC time: Sat 21:26:16.4443

Local machine time: Sat 15:26:16.4443

Intensity: 109

Classification: 10

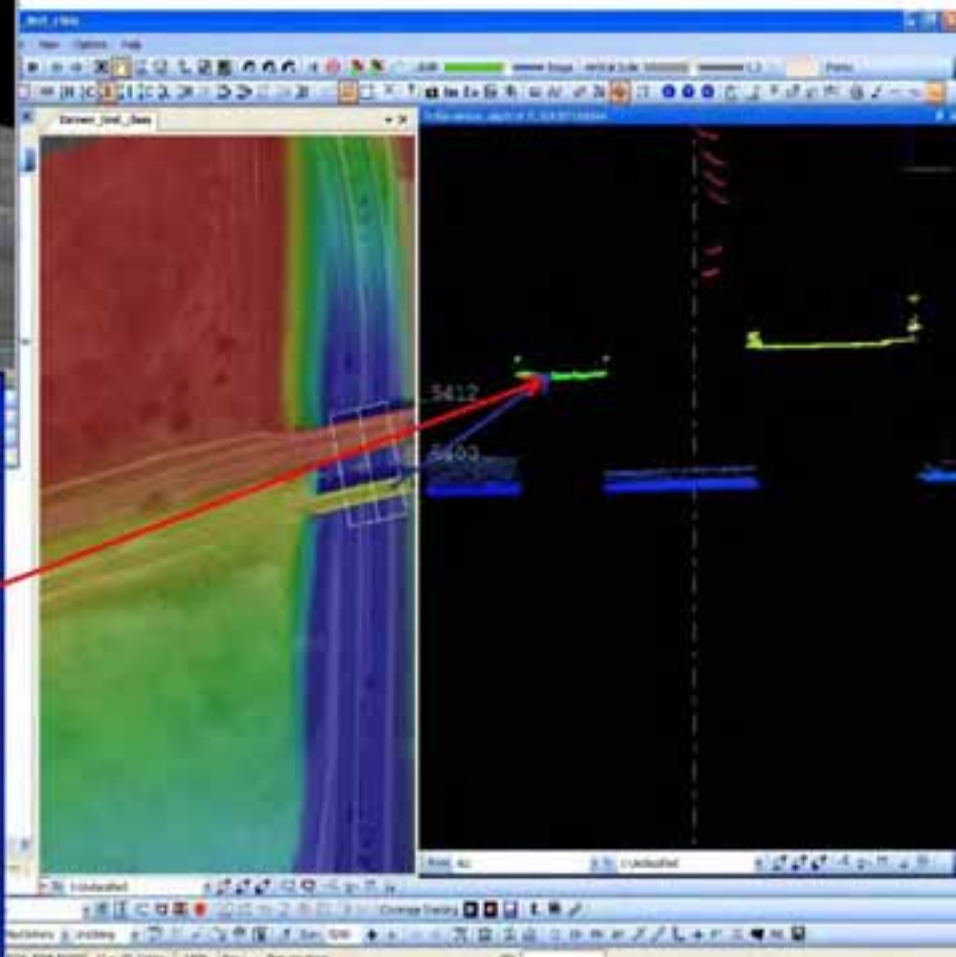
Return: Single return

File Position: 171263832

User Bits (AGC): 0

Scan Angle Rank: 1

OK

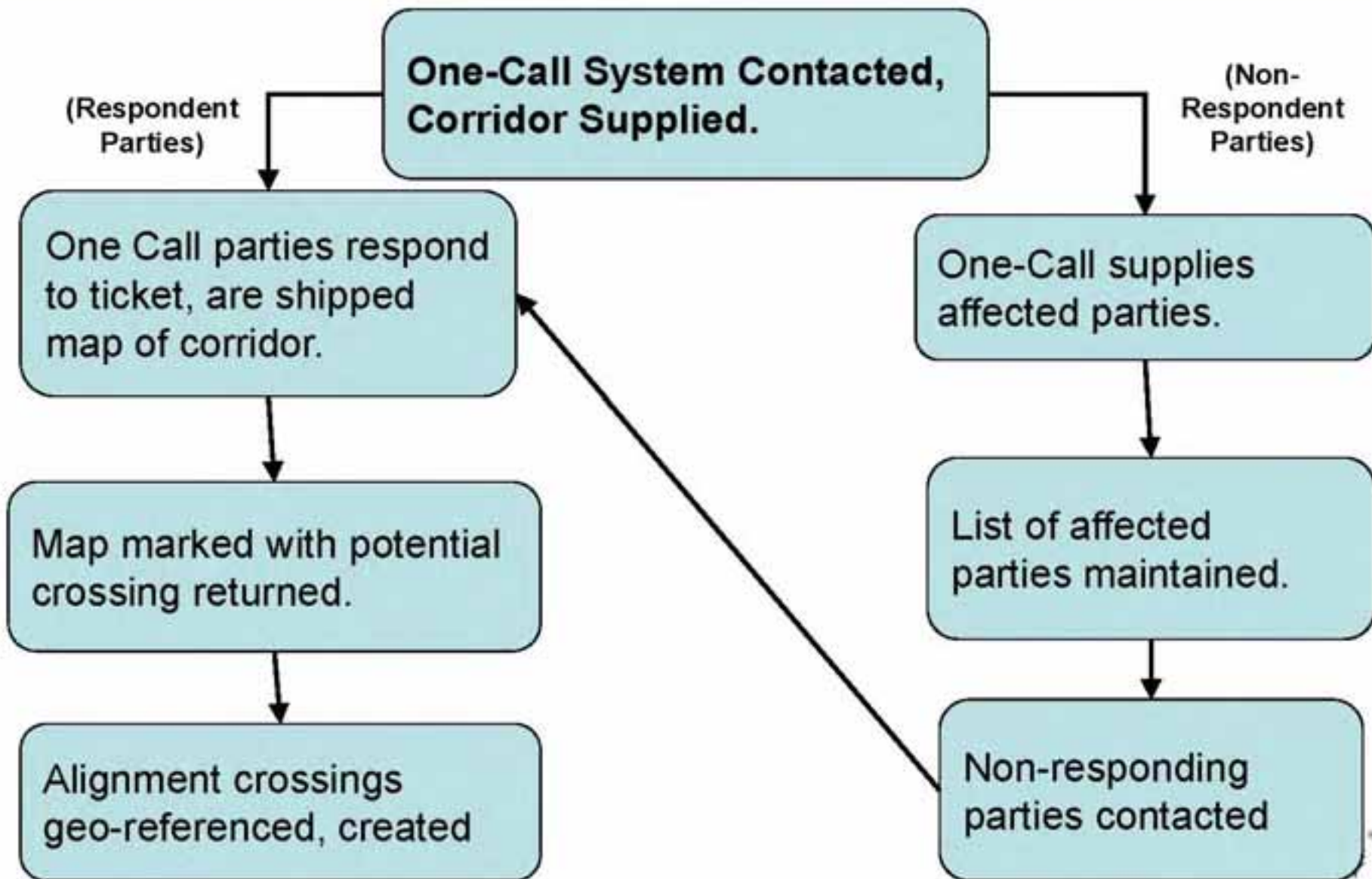


Corridor Third Party Right-of-Way Mapping

Inputting Features and Attribute Information – 2 Step Process

- STEP 1 – Coordinating with state utility one-call systems. Data from respondents is imported into GIS.
- STEP 2 - Boundaries of proposed route are handed over to land-men who research title information and government records. Information is then imported into GIS.

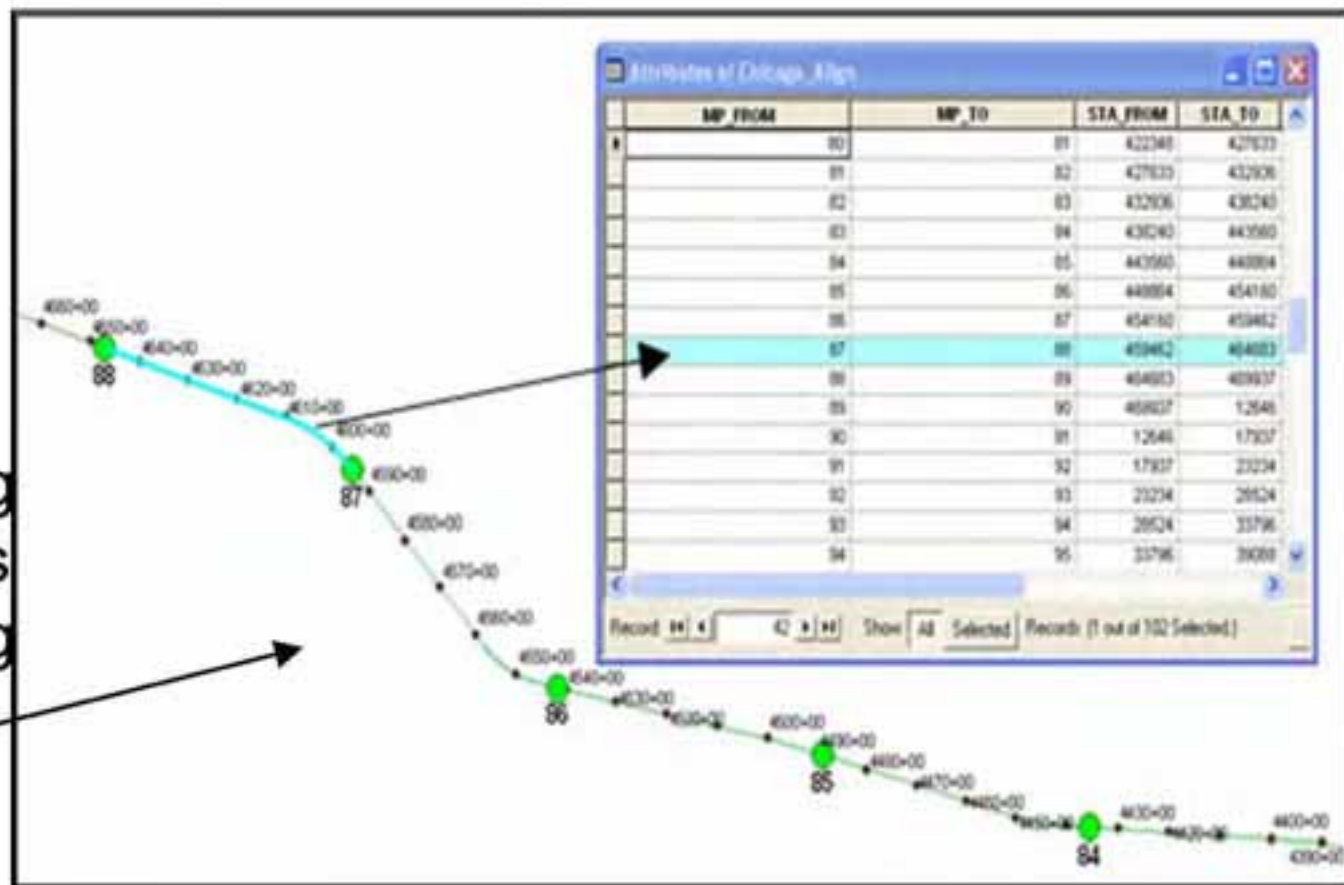
Inputting Features and Attribute Information



Integrating Distance Dynamics

Customized GIS routine makes the line dynamic to calculate milepost and/or stationing for any given point on the line.

Note that each segment has its starting and ending milepost as well as starting and ending stationing.



Inputting Features and Attribute Information

Inputting the Data into GIS

The screenshot displays a GIS application window with a map of an area including Galesburg and Quames. A proposed pipeline corridor is shown as a series of green dots connected by a line, with stationing labels such as 2760+00, 2770+00, 2780+00, 2790+00, 2800+00, 2810+00, 2820+00, 2830+00, 2840+00, 2850+00, 2860+00, 2870+00, 2880+00, 2890+00, 2900+00, 2910+00, 2920+00, 2930+00, 2940+00, 2950+00, 2960+00, 2970+00, 2980+00, 2990+00, 3000+00, 3010+00, 3020+00, 3030+00, 3040+00, 3050+00, 3060+00, 3070+00, 3080+00, 3090+00, 3100+00, 3110+00, 3120+00, 3130+00, 3140+00, 3150+00, 3160+00, 3170+00, 3180+00, 3190+00, 3200+00, 3210+00, 3220+00, 3230+00, 3240+00, 3250+00, 3260+00, 3270+00, 3280+00, 3290+00, 3300+00, 3310+00, 3320+00, 3330+00, 3340+00, 3350+00, 3360+00, 3370+00, 3380+00, 3390+00, 3400+00, 3410+00, 3420+00, 3430+00, 3440+00, 3450+00, 3460+00, 3470+00, 3480+00, 3490+00, 3500+00, 3510+00, 3520+00, 3530+00, 3540+00, 3550+00, 3560+00, 3570+00, 3580+00, 3590+00, 3600+00, 3610+00, 3620+00, 3630+00, 3640+00, 3650+00, 3660+00, 3670+00, 3680+00, 3690+00, 3700+00, 3710+00, 3720+00, 3730+00, 3740+00, 3750+00, 3760+00, 3770+00, 3780+00, 3790+00, 3800+00, 3810+00, 3820+00, 3830+00, 3840+00, 3850+00, 3860+00, 3870+00, 3880+00, 3890+00, 3900+00, 3910+00, 3920+00, 3930+00, 3940+00, 3950+00, 3960+00, 3970+00, 3980+00, 3990+00, 4000+00. The map also shows a Facility ROW (Right-of-Way) as a red dashed line and a Crossing Point as a red dot. A 'Proposed pipeline corridor' is labeled at the bottom. A 'Crossing Point Attributes' dialog box is open, showing the following data:

Field	Value
Point ID	0088_01
MilePost Number	31.64
Station Distance	27245

Other elements in the interface include a 'Layers' panel on the left with layers like 'no_pipeline_ut', 'sta_pipeline_no', 'pipeline_utilities', 'Cities', 'sta_pipeline_align', 'no_pipeline_align', and 'pipeline_align'. A 'Merrick customized ROW mapping toolbar' is visible at the top, and an 'Interactive Placement tool icon' is also present. The map shows contour lines, roads, and buildings, with labels for 'Galesburg', 'Quames', and 'Water Tank'.

Inputting Features and Attribute Information

Inputting the Data into GIS (cont.)

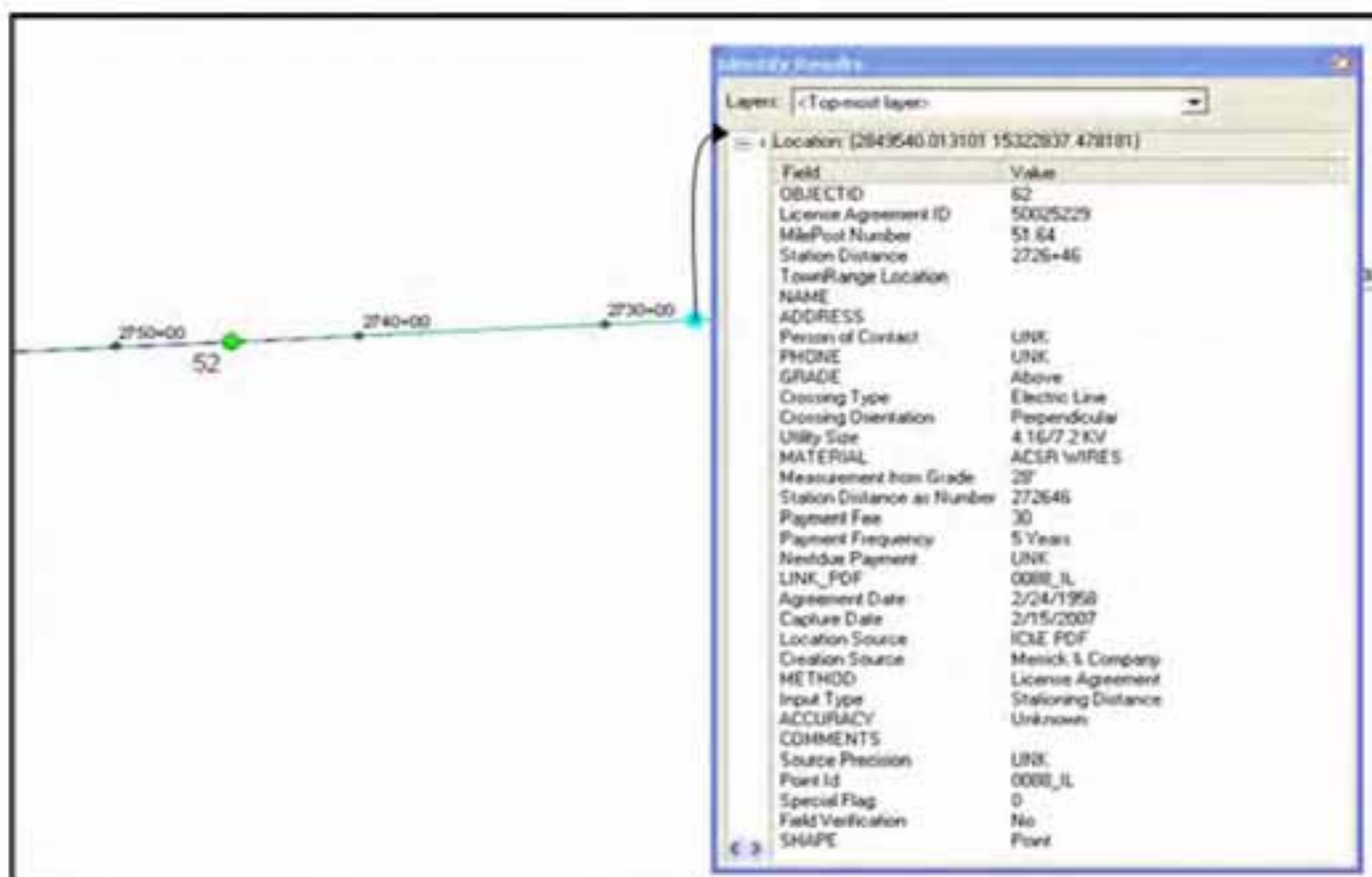
Customized tool for inputting ROW crossing feature data

The image displays four screenshots of a 'Crossing Point Attributes' form, arranged in a 2x2 grid. Each screenshot shows a different tab of the form, which is used for inputting data for a crossing point. The form is titled 'Crossing Point Attributes' and has a blue header bar. The top section contains fields for 'Point ID' (0000_A), 'MilePost Number' (01.44), and 'Station Distance' (070546). The tabs are: 'Crossing & Utility Info', 'License Agreement Info', 'Data Collection Info', and 'Comments'. The 'Crossing & Utility Info' tab includes fields for 'Crossing Type' (Electric Line), 'Crossing Orientation' (Perpendicular), 'Grade' (Atgrade), 'Distance Above Station Grade' (00), 'Utility Type' (A 12/12), 'Material' (PCCP pipes), and 'Trough/Storage Location'. The 'License Agreement Info' tab includes fields for 'License Agreement ID' (162020), 'Agreement Date' (12/24/1999), 'License Holder Name' (EDISON CO), 'Address' (CHICAGO, IL 60606), 'Contact Person' (JRM), 'Phone' (JRM), 'Fax' (8), 'Payment Frequency' (5 Year), and 'Next Payment Due'. The 'Data Collection Info' tab includes fields for 'Method to Location' (License Agreement), 'Inpd Type' (Stationing/Concrete), 'Source Person' (JRM), 'Location Source' (SCANNED PDF), 'Source Document Link' (0000_A), 'Capture Date' (6/6/2007), 'Creation Source' (PENN & COMPANY), 'Accuracy' (Unknown), and 'Field Verified' (No). The 'Comments' tab contains a text area with the text: 'E-UNIT SHOWS THAT LINE MAY GO BELOW GROUND WHILE STILL ABOVE ROW SURFACE'. An arrow points from the text 'Customized tool for inputting ROW crossing feature data' to the first screenshot.

Inputting Features and Attribute Information

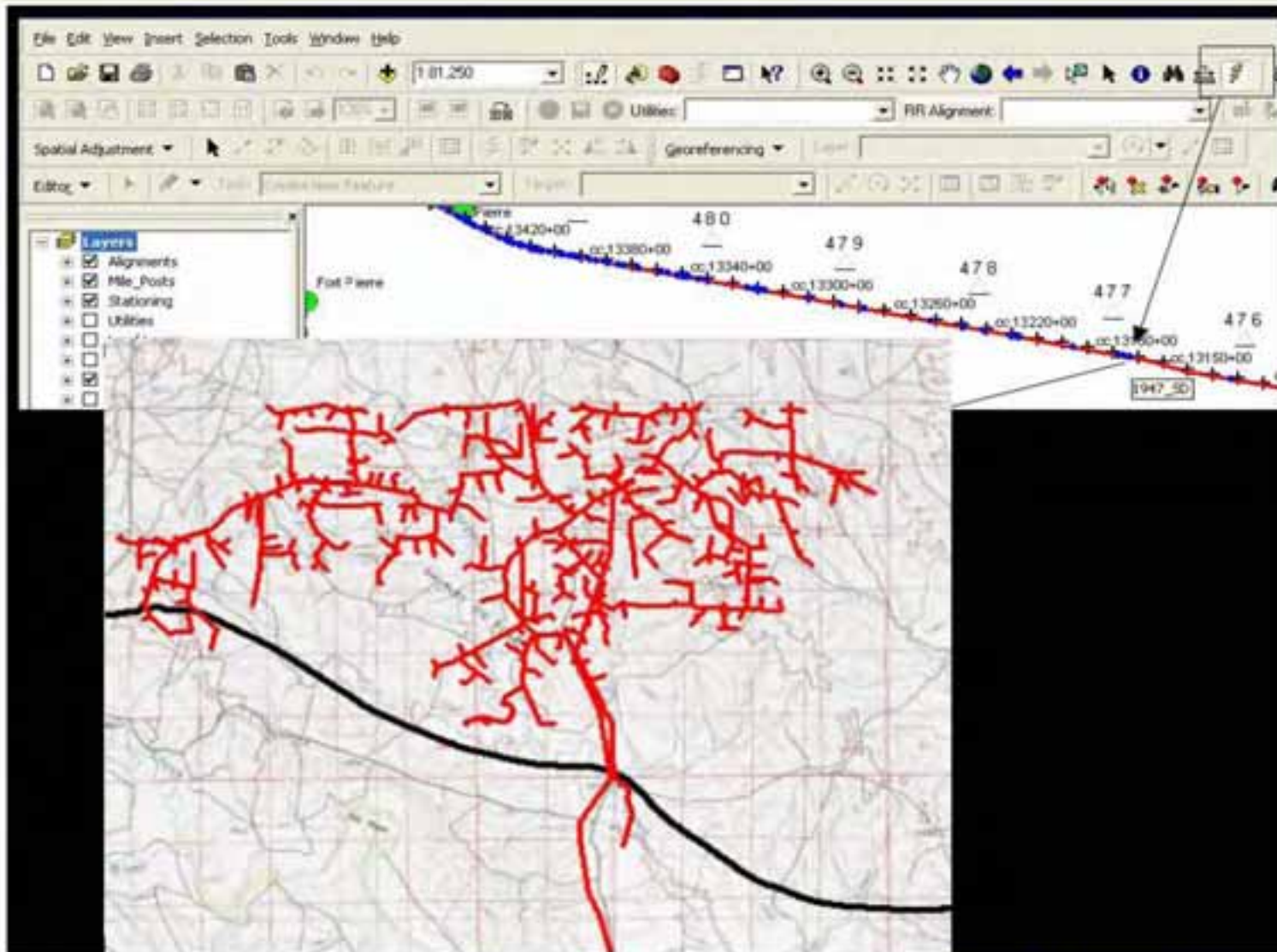
Inputting the Data into GIS (cont.)

Detailed attribute window of inputted ROW crossing feature.



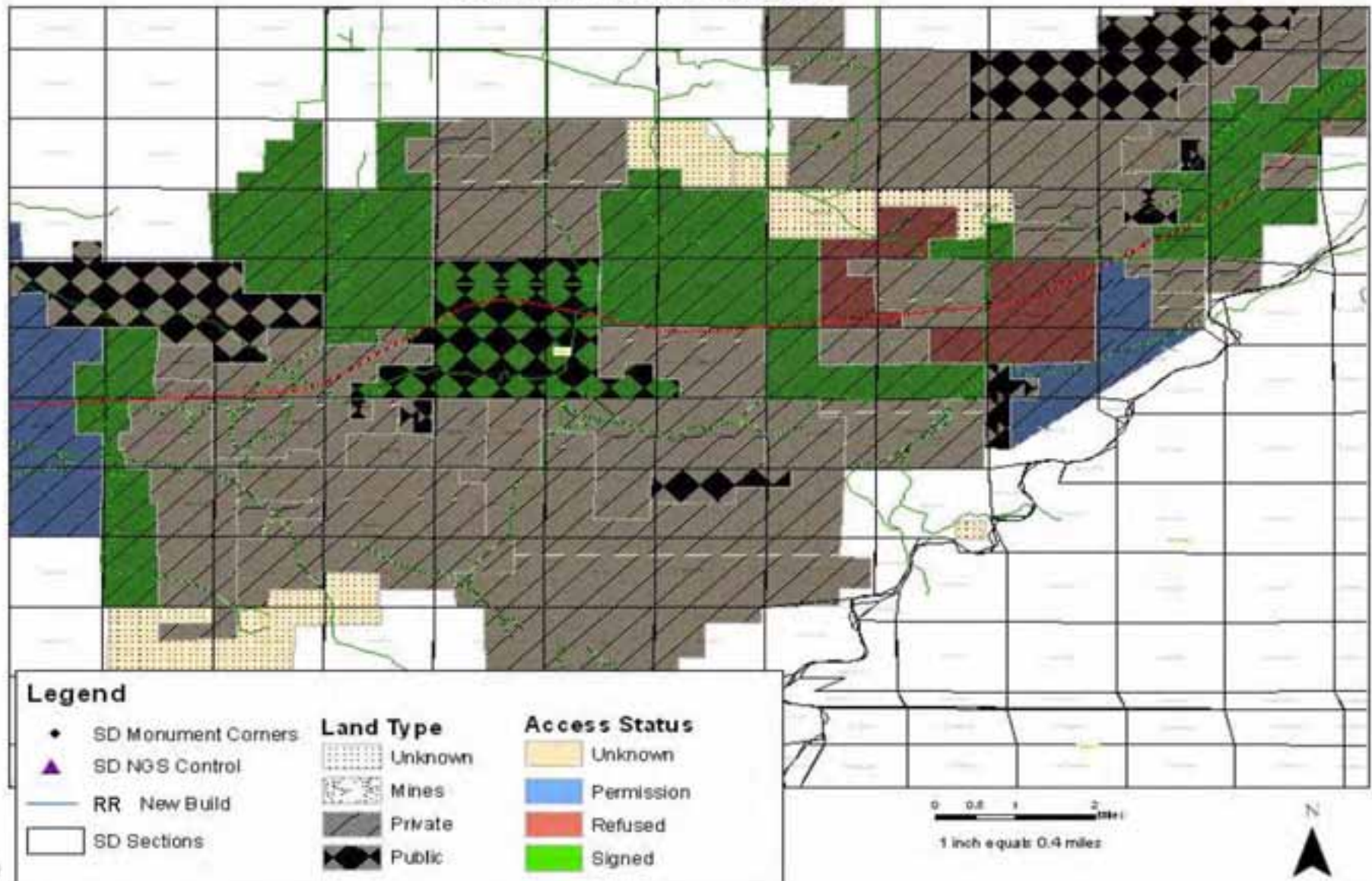
Hyperlinking

Hyperlinking with the feature on the GIS interface allows the actual scanned document to be viewed.



Land Acquisition Data

Corridor Land Access



Land Acquisition Data

Corridor Land Access



Identify Results

Layers: Parcels Mstr

Parcels Mstr
+ SDCS013

Location: (-102.830783 43.775068)

Field	Value
Tract_No	SDCS013
Primary_Ow	
Primary_1	
Primary_2	
Secondary_	
Secondary1	
Secondar_1	
RDW_Requr	1
Land_Owner	0
Signed_Agr	0
Land_Type	Private
BRIDGEACTI	
BRIDGEAC_1	
BRIDGE_STA	<null>
BRIDGE_FIN	<null>
Linked_to_TractNo	SDCS013
Date_Tract_Available	7/1/2007
Date_Req_For_Const	9/18/2007
Final_Offer_Date	4/1/2007
Tract_State	South Dakota
Tract_County	Custer
AccessStatus	Signed
ShapeAcres	<null>
Fence_1	Type 4 Barbed
Fence_2	<null>
Fence_3	<null>
Land_Man_Sent	10/17/2006

Legend

- SD Monument Corners
- ▲ SD NGS Control
- RR New Build
- SD Sections

Land Type

- Unknown
- Mines
- Private
- Public

Access Status

- Unknown
- Permission
- Refused
- Signed



1 inch equals 0.4 miles



Review

1. Determine/Map Alignment with LiDAR.
2. Make Alignment Dynamic.
3. Coordinate With State-One-Call Systems to Determine ROW Crossings.
4. Input Data From One-Call Respondents.
5. Coordinate with Land Acquisition, Input Land Acquisition Data.

Conclusion

- GIS/LiDAR are important tools for effective and efficient ROW Corridor planning and third party ROW crossings when planning any corridor route.
- Methods and tools described provide a high precision topographic layout and convenient centralized data depot for all information pertaining to third party property and impacting feature ROW crossings that a user can utilize for a variety of consulting purposes.

Questions?