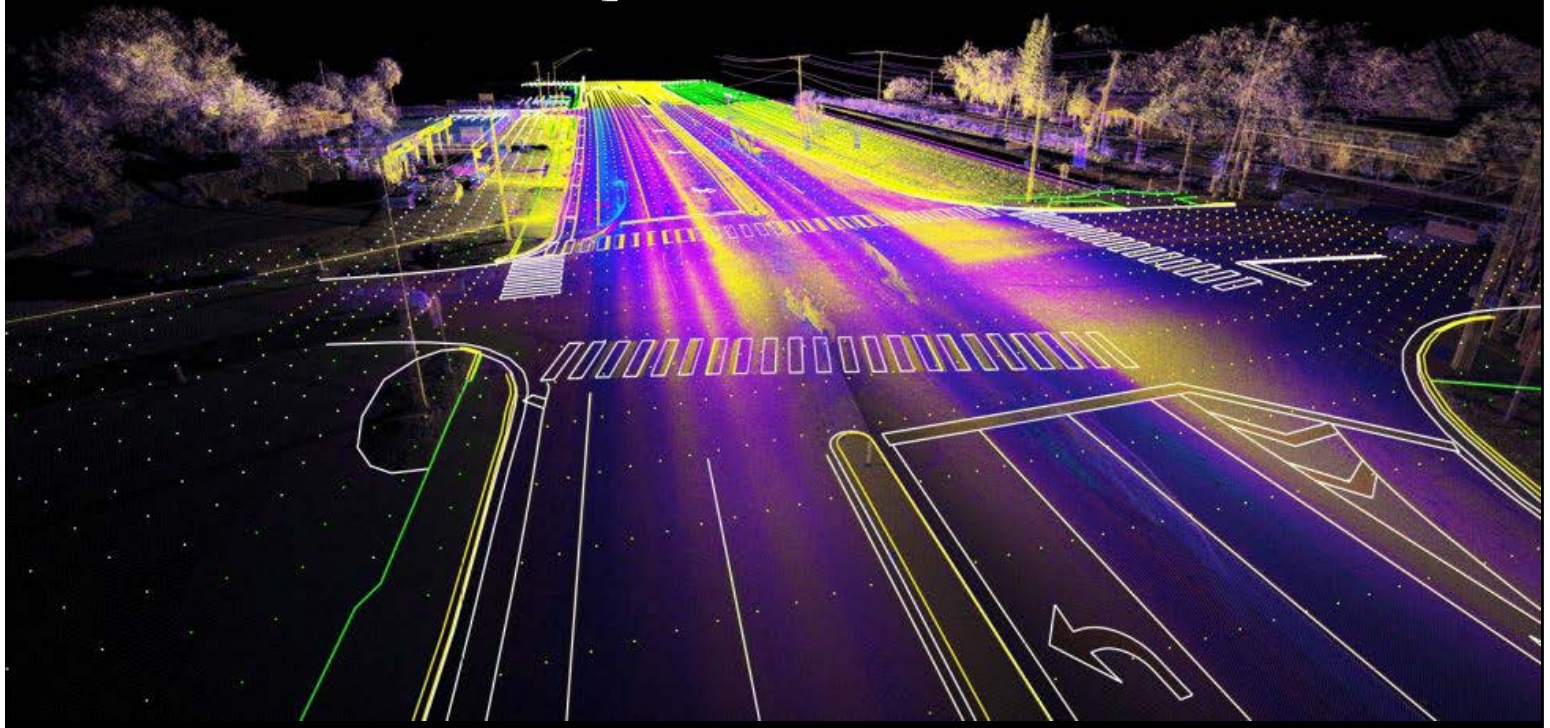
Managing Safety Assets at the Speed of LiDAR

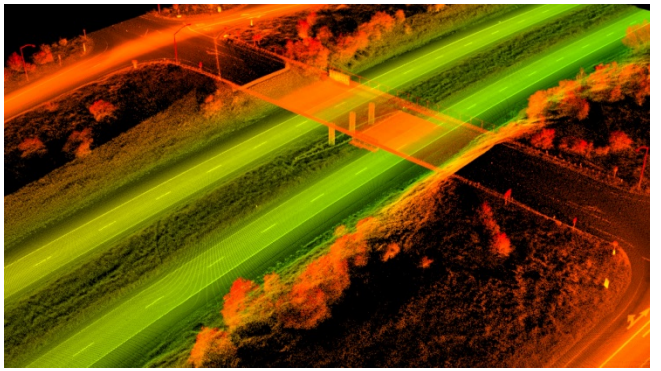


Paul DiGiacobbe, PE, DBIA – MASER Consulting

Ryan Putt, PE – HNTB Corporation

Kevin Poad, PE – HNTB Corporation

Introduction



Using LiDAR to Manage Safety Assets

SPEED – the acquisition phase is being performed at driving speeds

SAFETY – the information acquired is being done without putting workers in harms way

RELIABILITY – the spatial information is proving to be very reliable and reusable for a wide variety of applications

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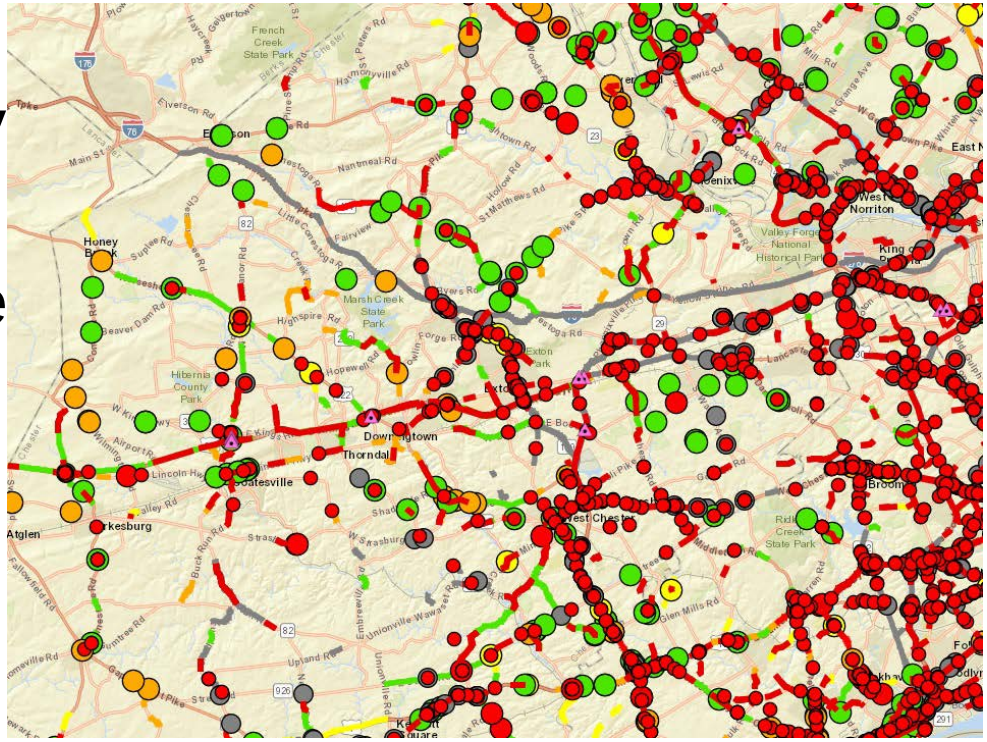
Low Cost Safety Improvements

- PennDOT District 6-0 identified locations based on crash clusters
- Hundreds of locations across the district's five counties
- Address safety solutions
  - Striping / Lege
  - Signage
  - Guide Rail
  - Delineation



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Low Cost Safety Improvements

- Pre-LiDAR Survey Plan Production
  - Base Mapping
    - Pennsylvania Spatial Data Access (PASDA)
    - Google Street View
    - Field View
  - Identifying Curve Speed Advisories
    - Ball Bank
  - Proposed Plans
    - Base map revisions
    - Proposed safety improvements

LiDAR efforts at PennDOT District 6

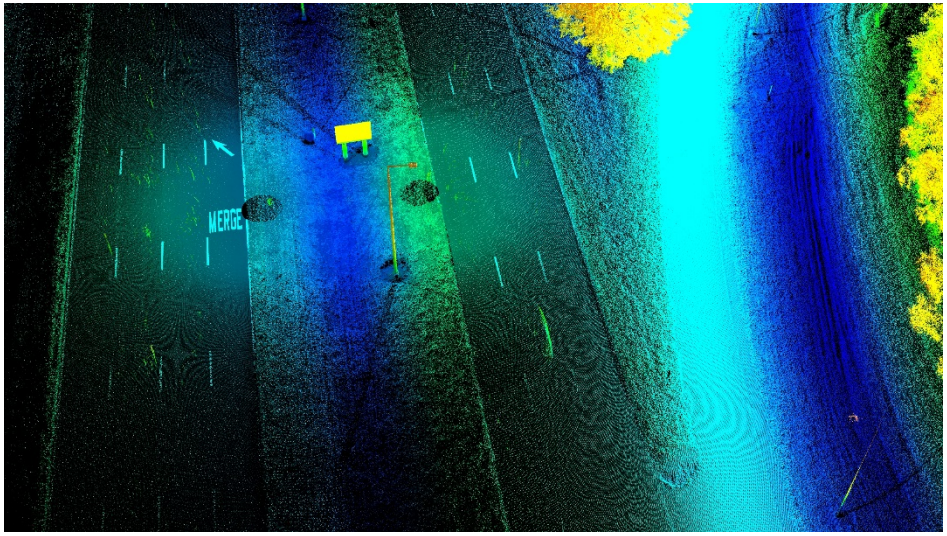
Low Cost Safety Improvements

Case Study #1

Roundabout Design Survey

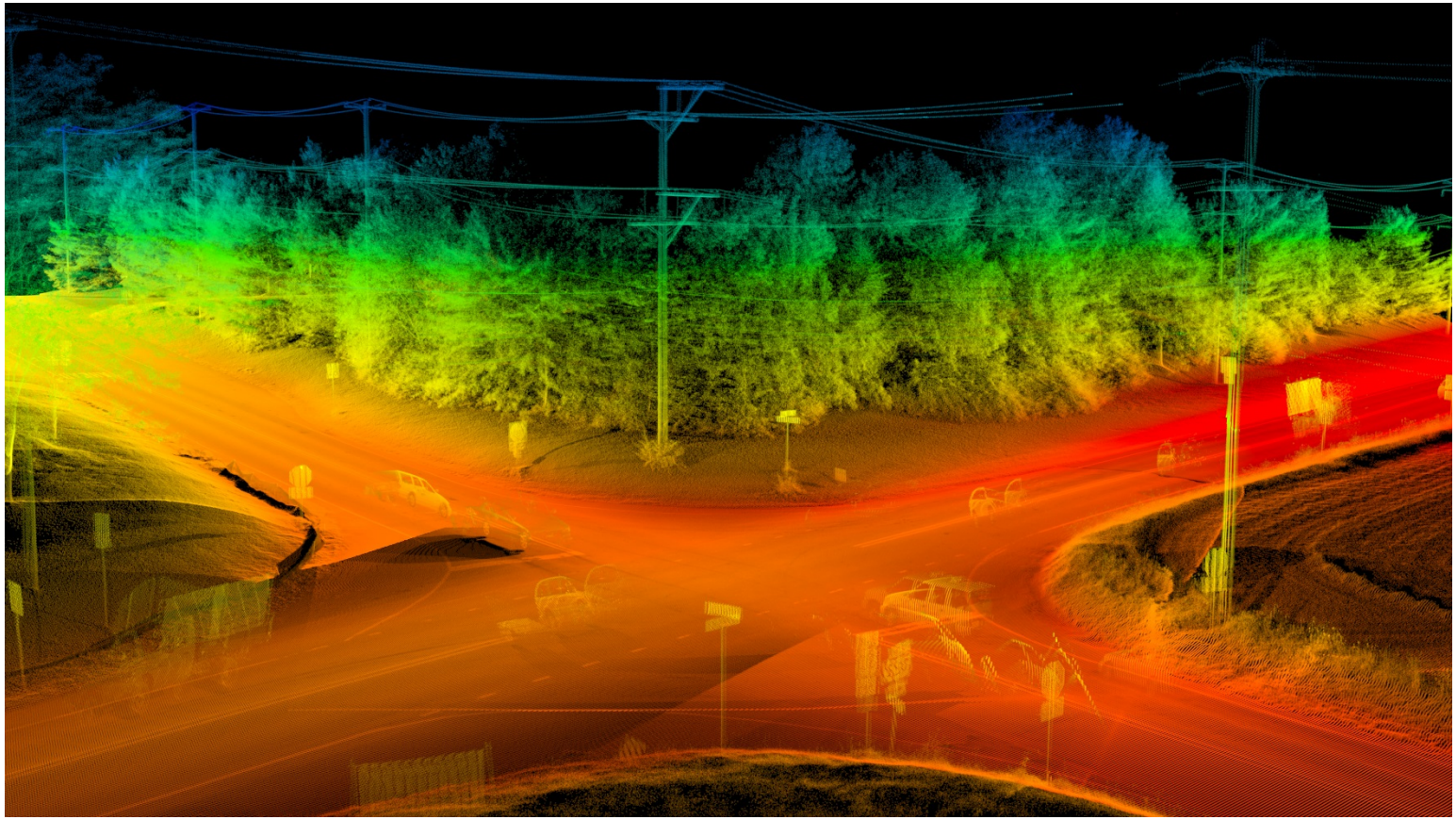
Case Study #2

Realignment Study



Base Mapping for Roundabout Design

- Data collected for asset inventory
- Post-controlled to produce an engineering base
- Currently being used to develop a roundabout design



LiDAR – Realignment Study

Step 1 – Aerial image draped on surface

LiDAR – Realignment Study

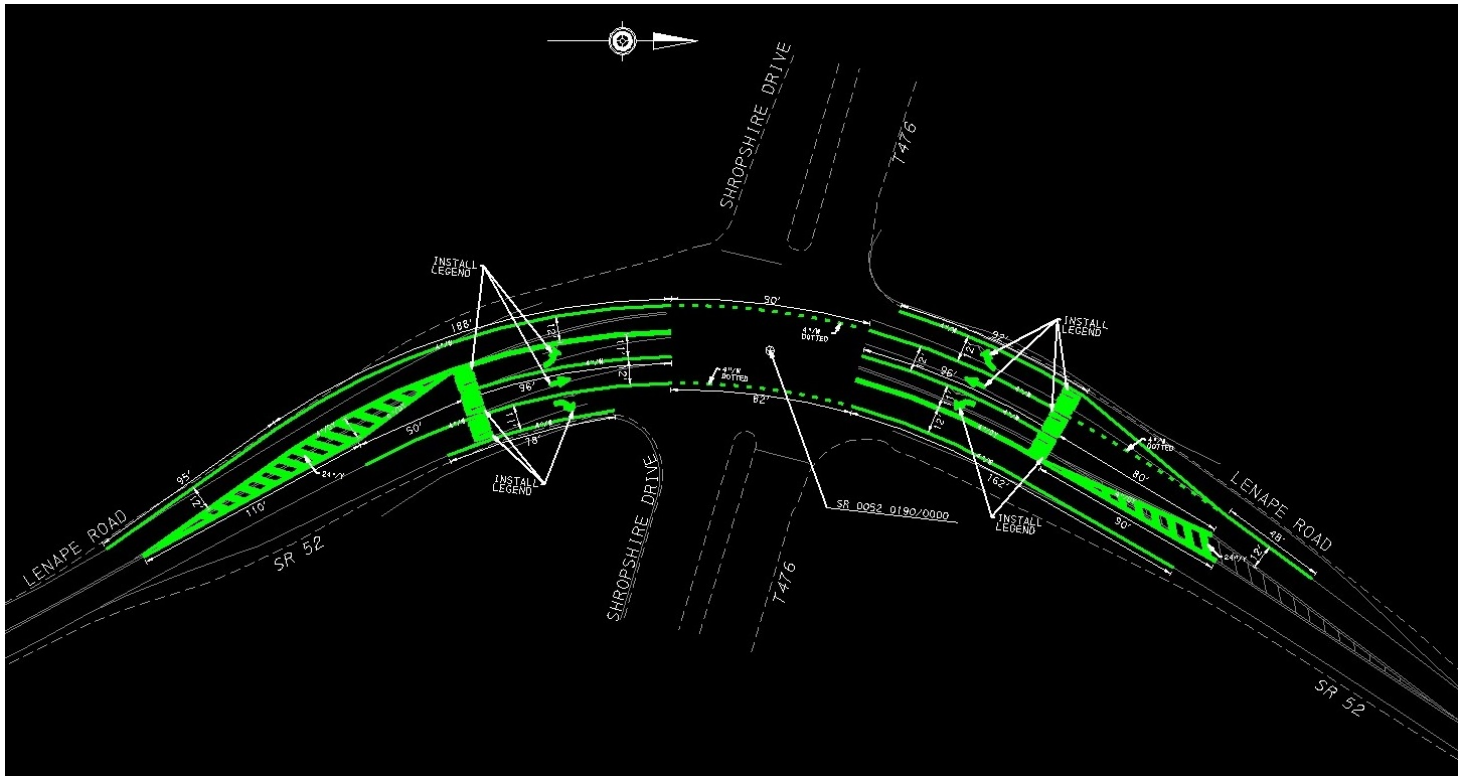
Step 2 – Extracted roadway geometry features

LiDAR – Realignment Study

Step 3 – Proposed realignment

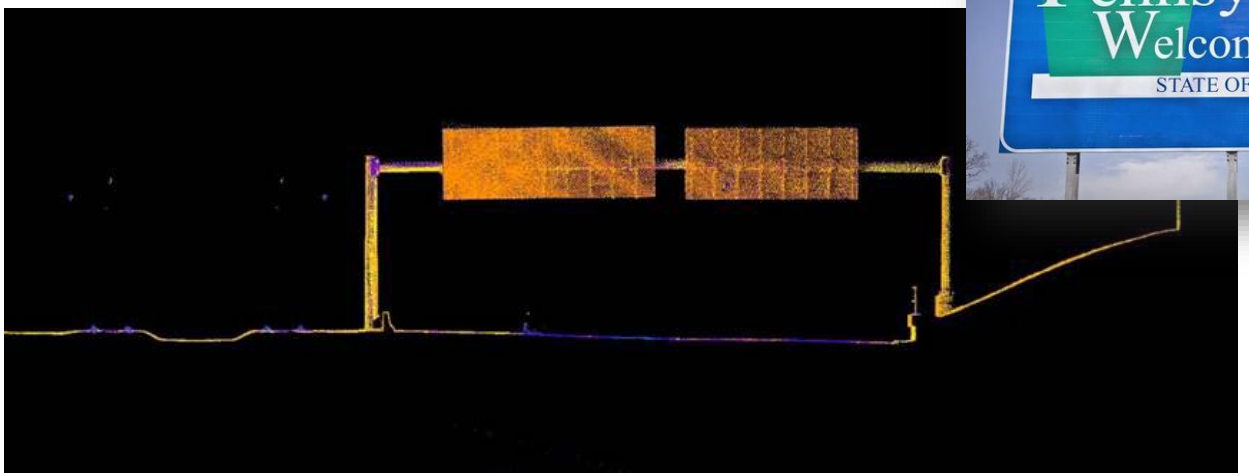
LiDAR – Realignment Study

Step 4 – Plan production



LiDAR – Asset Management

- High speed geospatial data acquisition
- Processed safely in the office
- Pavement markings, signs, guide rail, etc. can be collected and attributed efficiently
- Information collected can be displayed in either MicroStation or ESRI



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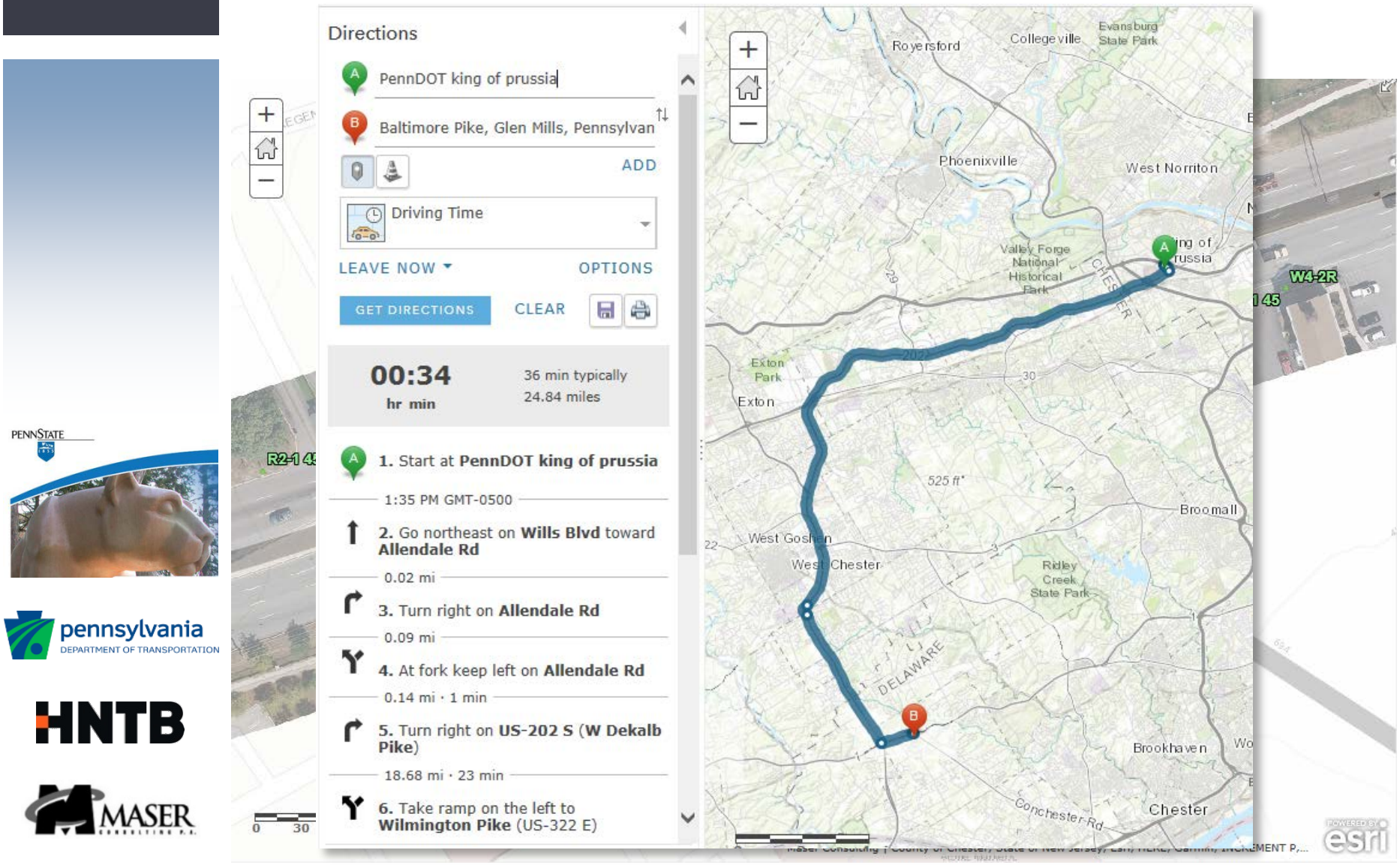
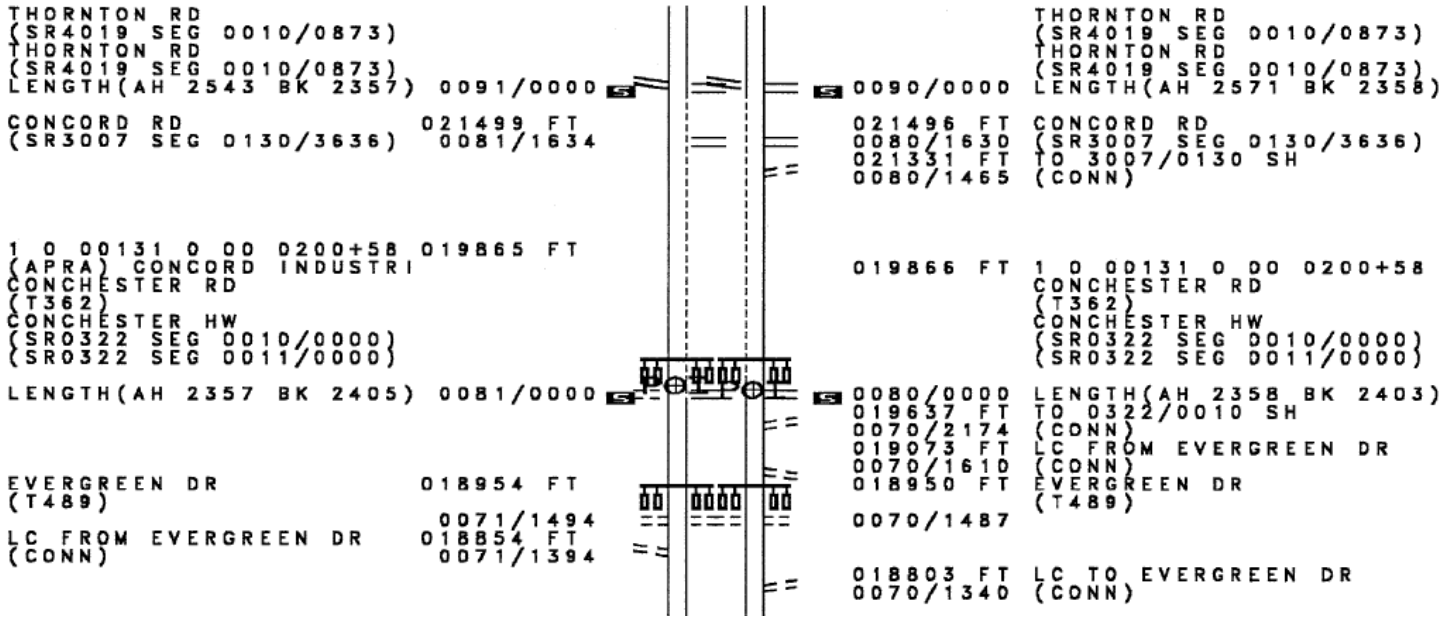
LiDAR – Asset Management



LiDAR – Asset Management

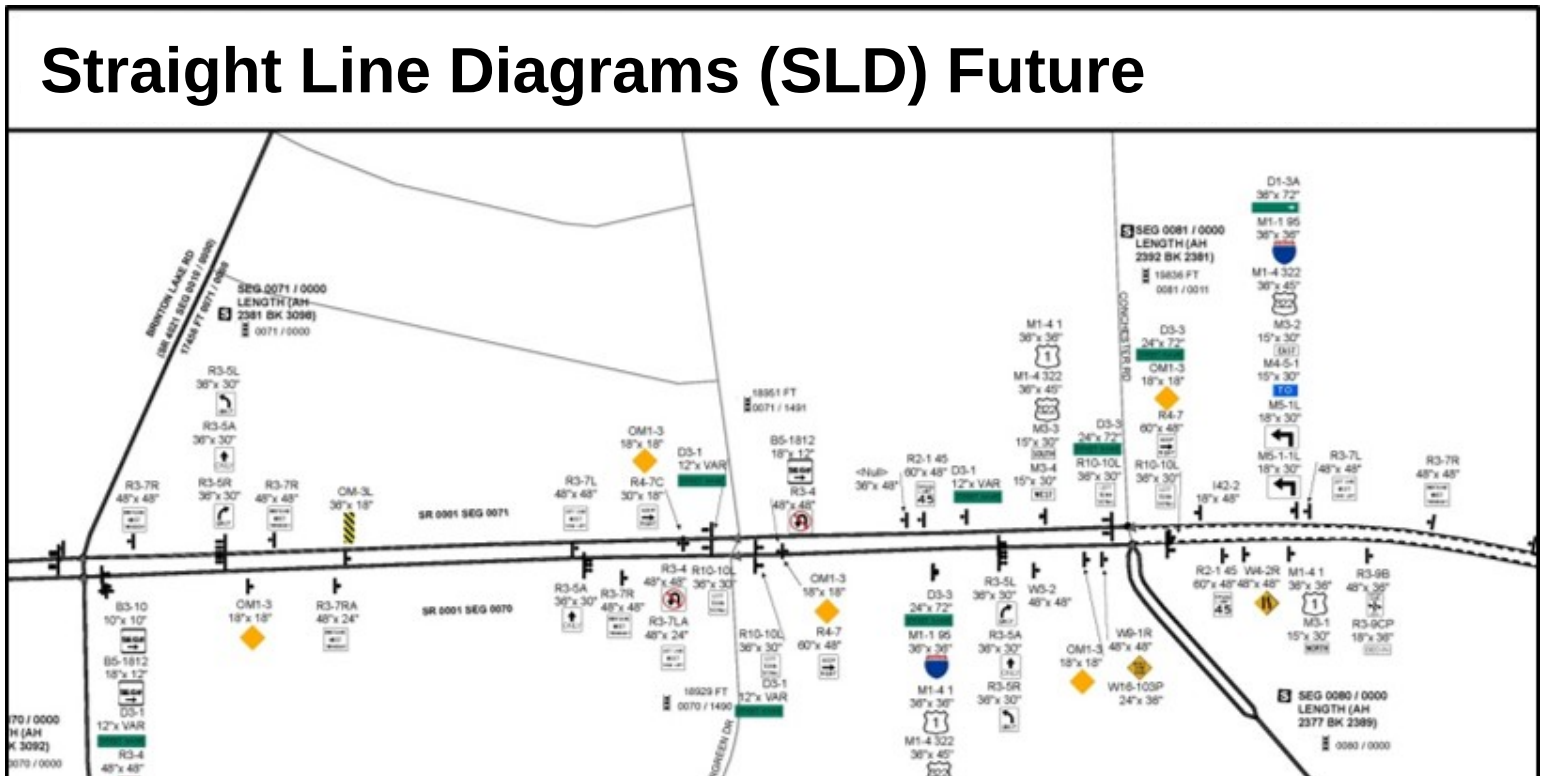
Straight Line Diagrams (SLD) Historic



- Paper Diagrams
- Not to Scale
- Complex Annotation
- Infrequent Updates

LiDAR – Asset Management

Straight Line Diagrams (SLD) Future

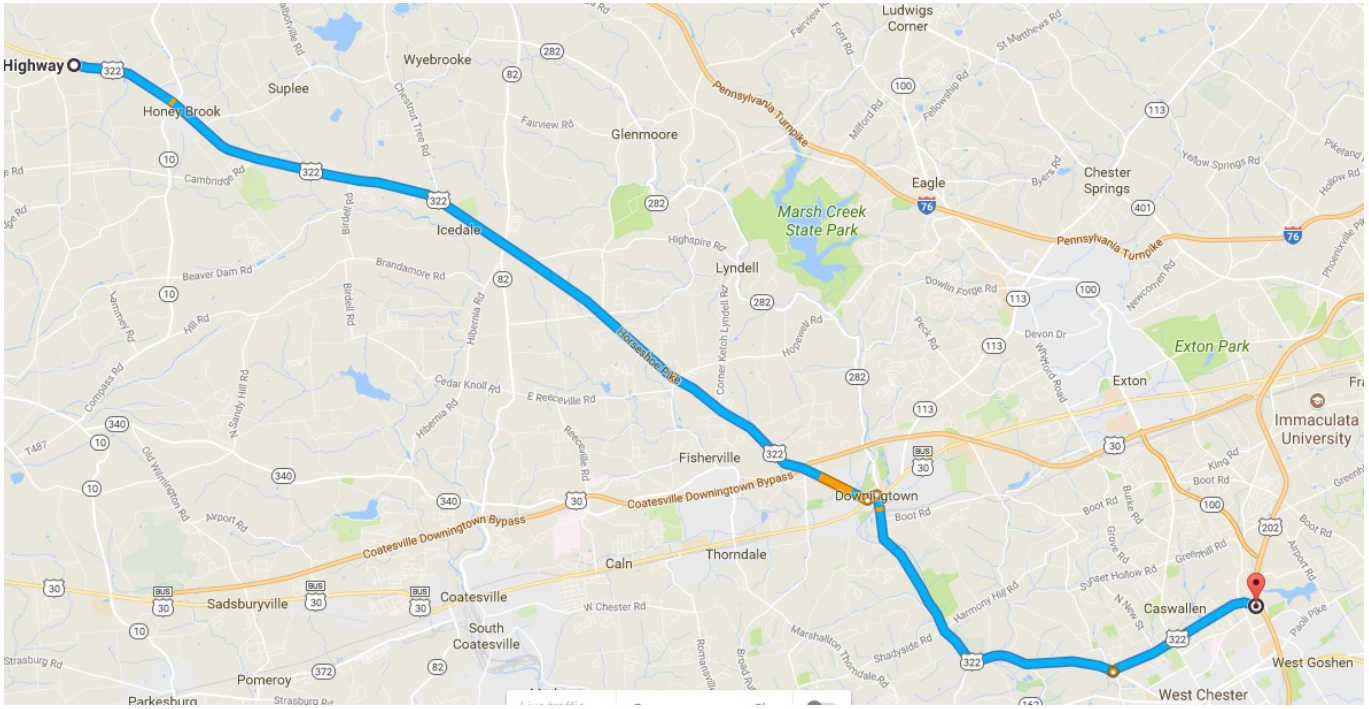


- Dynamic Map
- To Scale
- Automatic Updates
- Direct Access – Office and Field

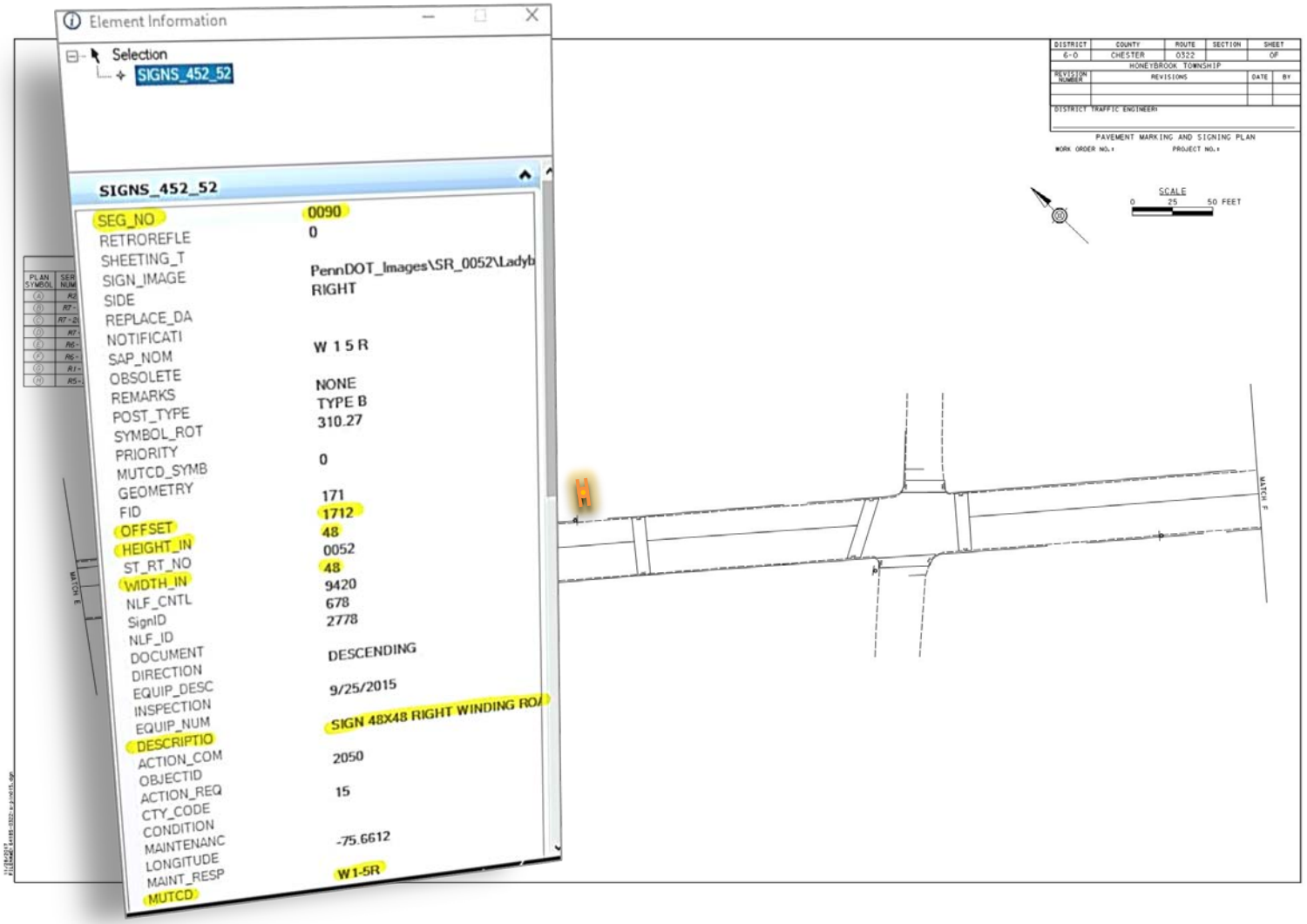
Low Cost Safety Improvements

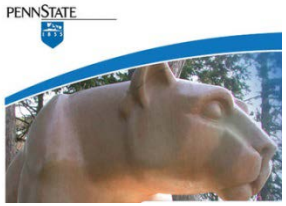
SR 0322 – District 6-0, Chester County

- 23 miles long
- Final product over 100 plan sheets



Low Cost Safety Improvements





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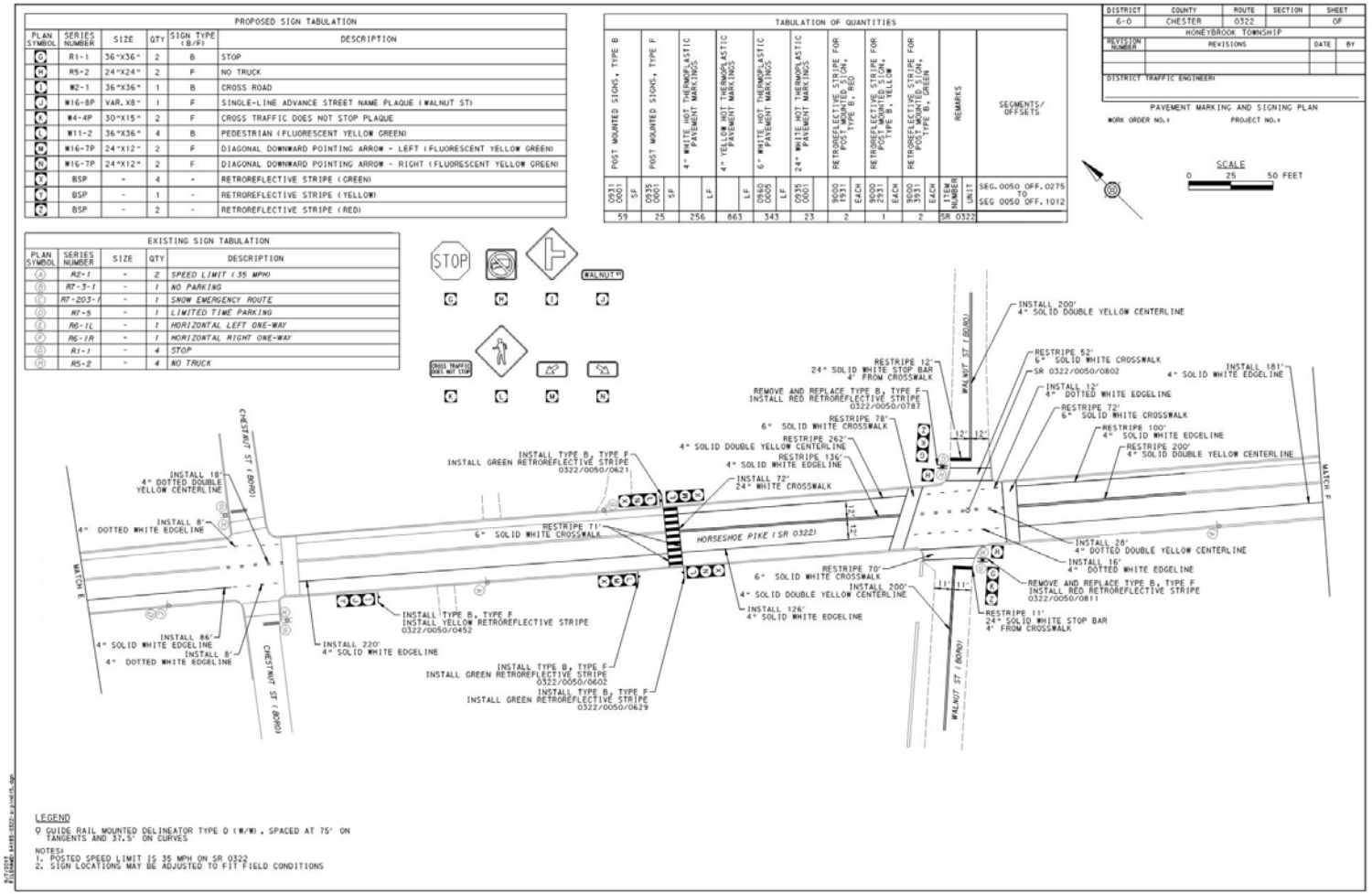
Low Cost Safety Improvements



PROPOSED SIGN TABULATION

PLAN SYMBOL	SERIES NUMBER	SIZE	QTY	SIGN TYPE (B/F)	DESCRIPTION
	R1-1	36"X36"	2	B	STOP
	R5-2	24"X24"	2	F	NO TRUCK
	W2-1	36"X36"	1	B	CROSS ROAD
	W16-8P	VAR. X8"	1	F	SINGLE-LINE ADVANCE STREET NAME PLAQUE (WALNUT ST)
	W4-4P	30"X15"	2	F	CROSS TRAFFIC DOES NOT STOP PLAQUE
	W11-2	36"X36"	4	B	PEDESTRIAN (FLUORESCENT YELLOW GREEN)
	W16-7P	24"X12"	2	F	DIAGONAL DOWNWARD POINTING ARROW - LEFT (FLUORESCENT YELLOW GREEN)
	W16-7P	24"X12"	2	F	DIAGONAL DOWNWARD POINTING ARROW - RIGHT (FLUORESCENT YELLOW GREEN)
	BSP	-	4	-	RETROREFLECTIVE STRIPE (GREEN)
	BSP	-	1	-	RETROREFLECTIVE STRIPE (YELLOW)
	BSP	-	2	-	RETROREFLECTIVE STRIPE (RED)

EXISTING SIGN TABULATION

PLAN SYMBOL	SERIES NUMBER	SIZE	QTY	DESCRIPTION
	R2-1	-	2	SPEED LIMIT (35 MPH)
	R7-1-1	-	1	NO PARKING
	R7-203-I	-	1	SNOW EMERGENCY ROUTE
	R7-5	-	1	LIMITED TIME PARKING
	R6-1L	-	1	HORIZONTAL LEFT ONE-WAY
	R6-1R	-	1	HORIZONTAL RIGHT ONE-WAY
	R1-1	-	4	STOP
	R5-2	-	4	NO TRUCK

TABULATION OF QUANTITIES

POST MOUNTED SIGNS, TYPE B		POST MOUNTED SIGNS, TYPE F		4" WHITE HOT THERMOPLASTIC PAVEMENT MARKINGS		4" YELLOW HOT THERMOPLASTIC PAVEMENT MARKINGS		6" WHITE HOT THERMOPLASTIC PAVEMENT MARKINGS		24" WHITE HOT THERMOPLASTIC PAVEMENT MARKINGS		RETROREFLECTIVE STRIPE FOR POST MOUNTED SIGN, TYPE B, RED		RETROREFLECTIVE STRIPE FOR POST MOUNTED SIGN, TYPE B, YELLOW		RETROREFLECTIVE STRIPE FOR POST MOUNTED SIGN, TYPE B, GREEN		REMARKS	SEGMENTS/ OFFSETS
0931 0001	SF	0935 0001	SF		LF		LF	0850 0850	LF	0855 0003		9000 1931	EACH	9000 2931	EACH	9000 3931	EACH	ITEM NUMBER	UNIT
59		25		256		863		343		23		2		1		2		SR 0322	SEG. 0050 OFF. 0275 TO SEG 0050 OFF. 1012

DISTRICT	COUNTY	ROUTE	SECTION	SHEET
6-0	CHESTER	0322		OF

HONEYBROOK TOWNSHIP

REVISION NUMBER	REVISIONS	DATE	BY

DISTRICT TRAFFIC ENGINEER

PAVEMENT MARKING AND SIGNING PLAN

WORK ORDER NO.: PROJECT NO.:

SCALE 0 25 50 FEET

LEGEND

GUIDE RAIL MOUNTED DELINEATOR TYPE D (W/W), SPACED AT 75' ON TANGENTS AND 37.5' ON CURVES

NOTES:
1. POSTED SPEED LIMIT IS 35 MPH ON SR 0322
2. SIGN LOCATIONS MAY BE ADJUSTED TO FIT FIELD CONDITIONS

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LiDAR – Developing CAD files

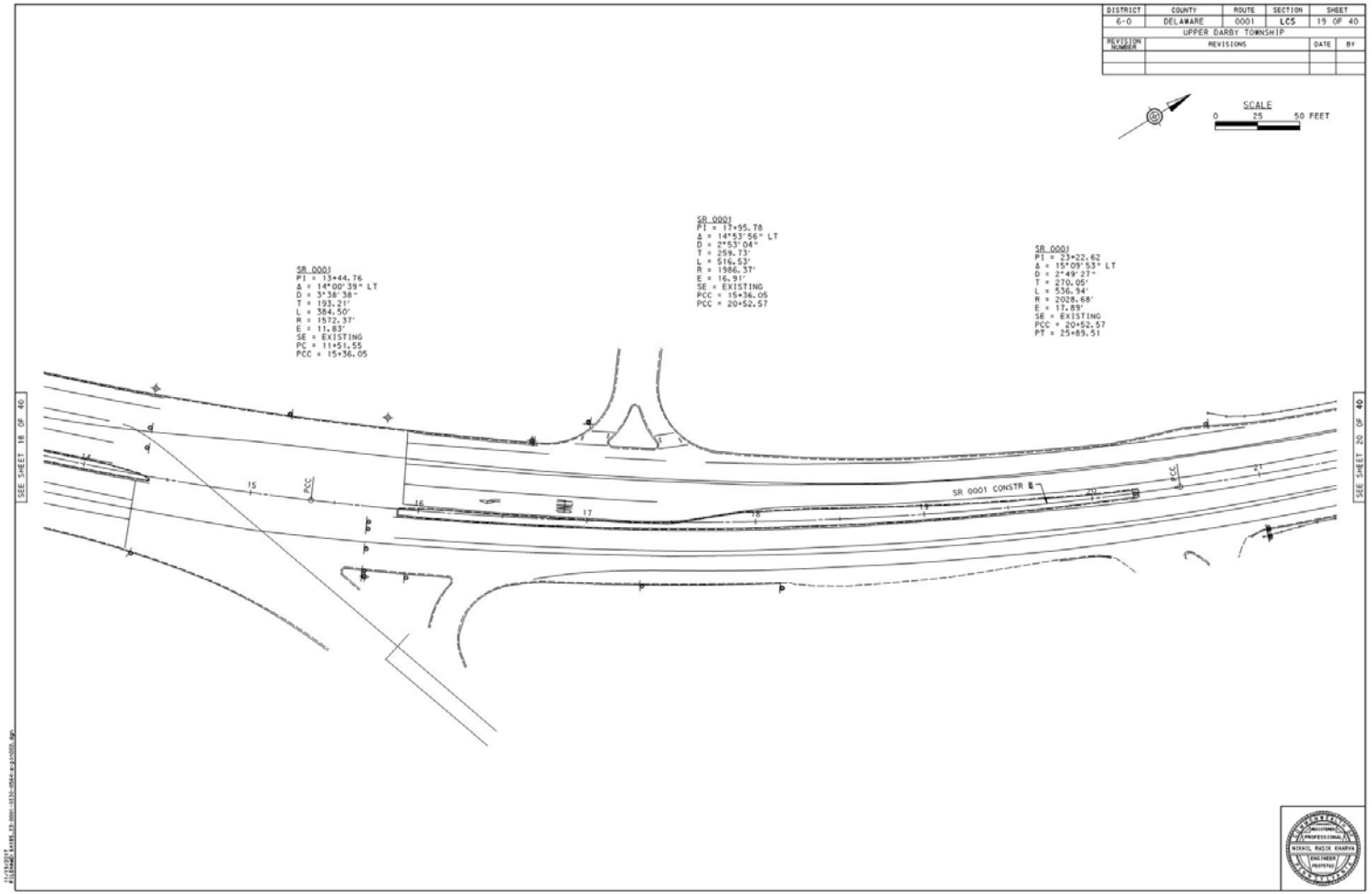
US 1 Township Line Road

- Emergency Location
- Frequency of Traffic Incidents
- Public spotlight

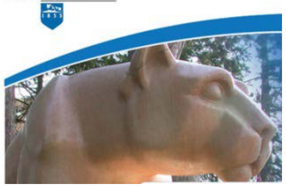
BEFORE

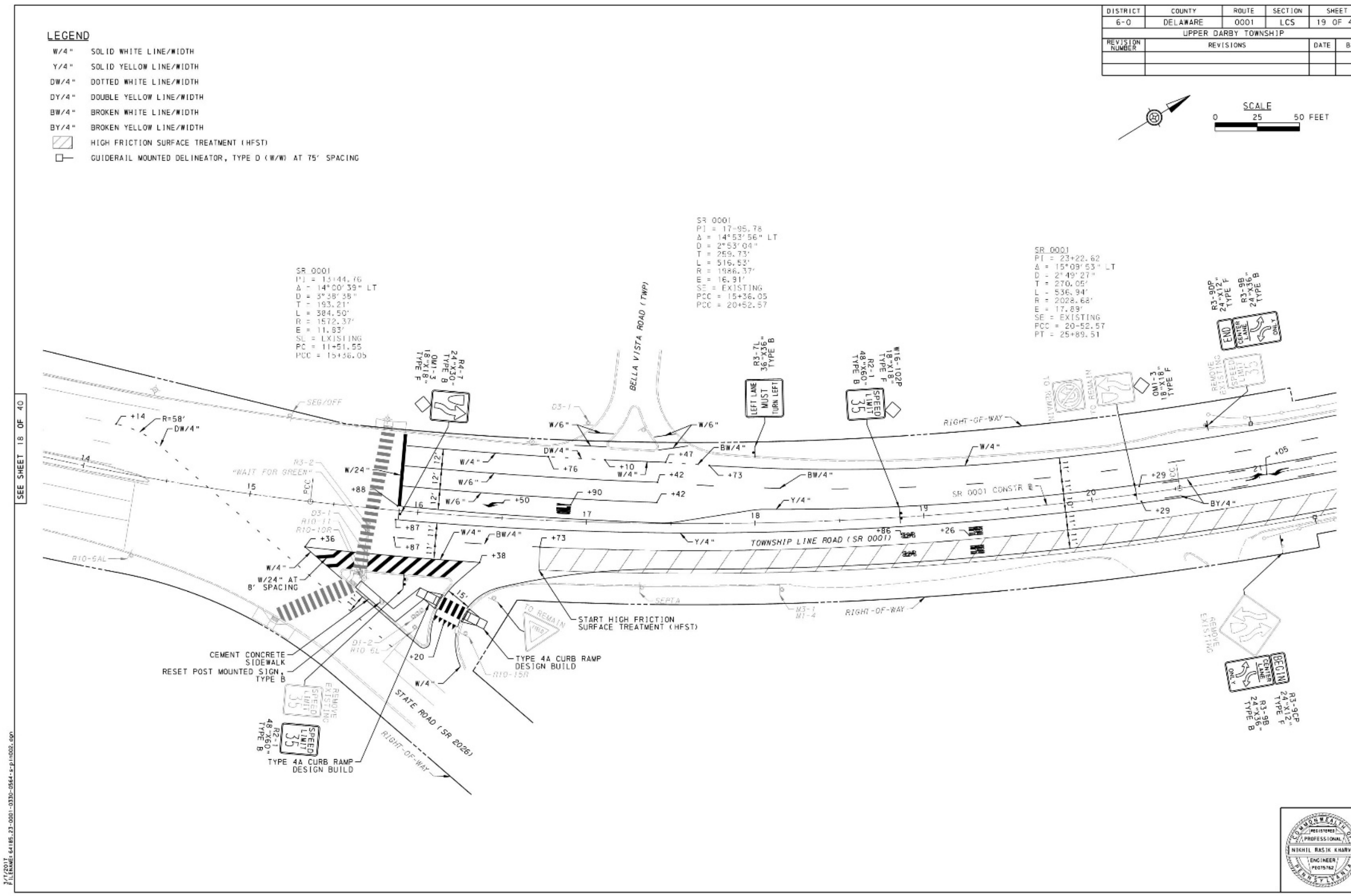
AFTER

LiDAR – Developing CAD files



LiDAR – Developing CAD files



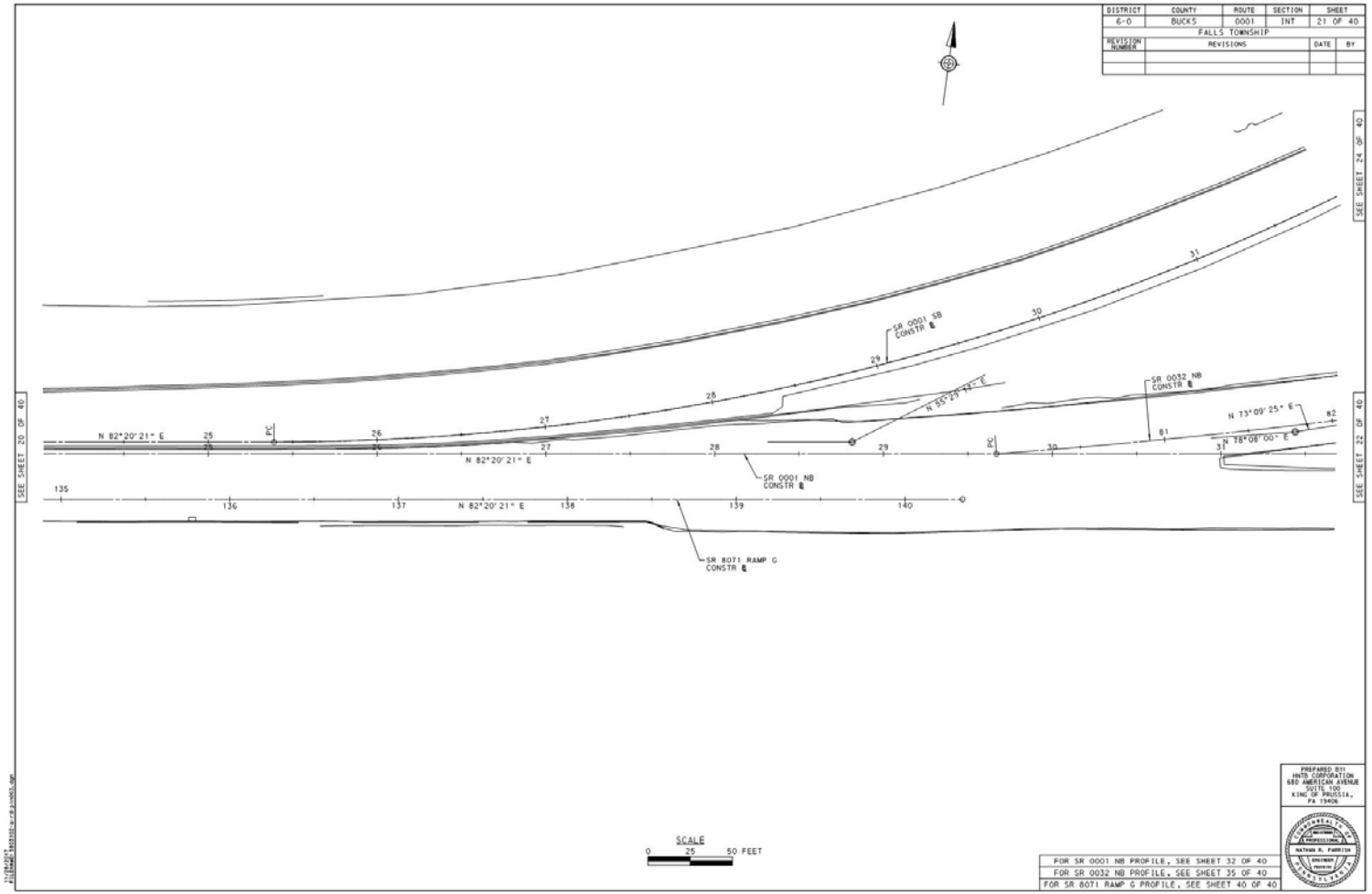


LiDAR – Developing CAD files

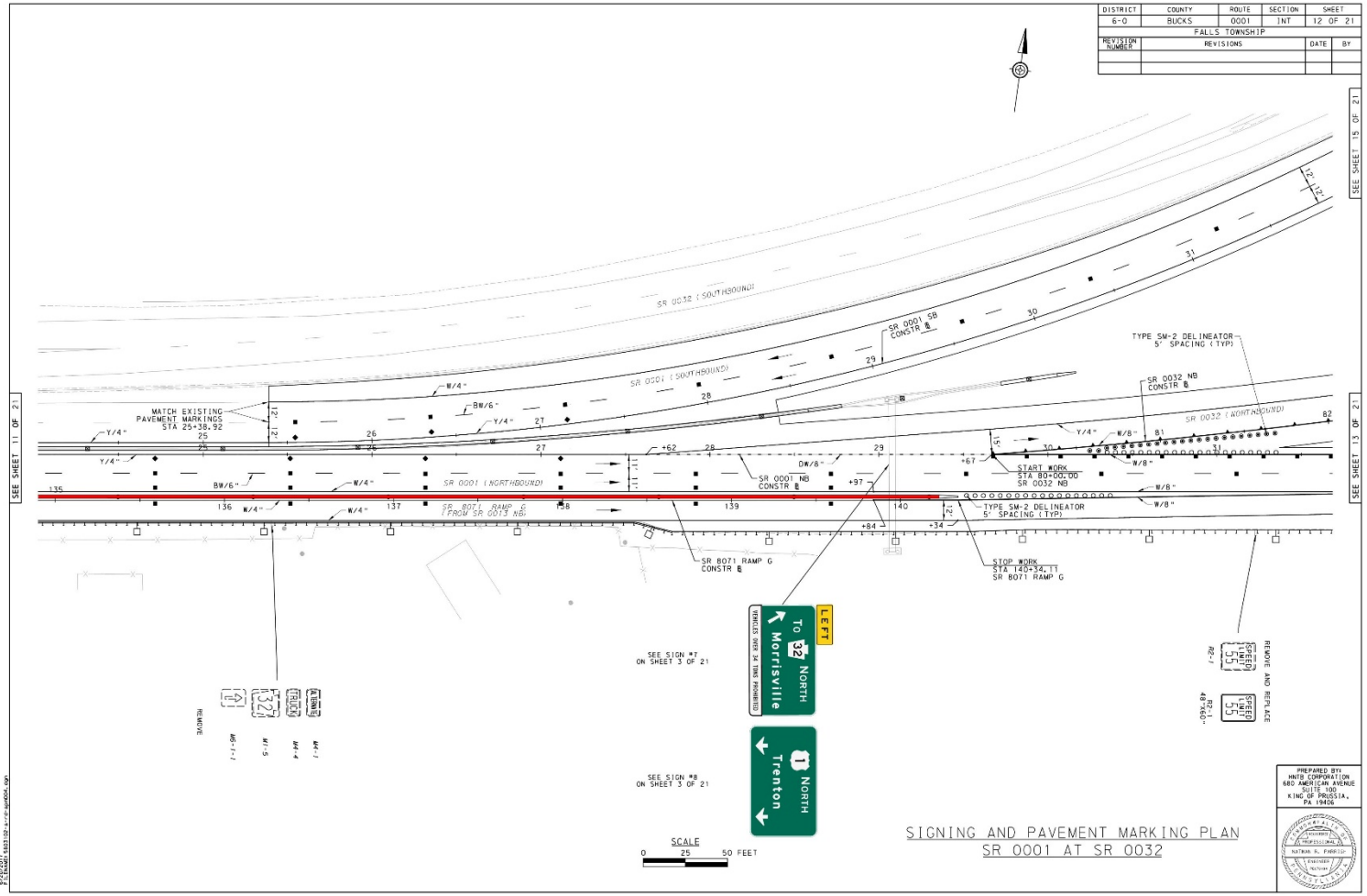
SR 0001 & SR 0032 Limited Access Interchange

- District 6-0, Bucks County
- Emergency Location
- Dangerous weave

LiDAR – Developing CAD files



LiDAR – Developing CAD files



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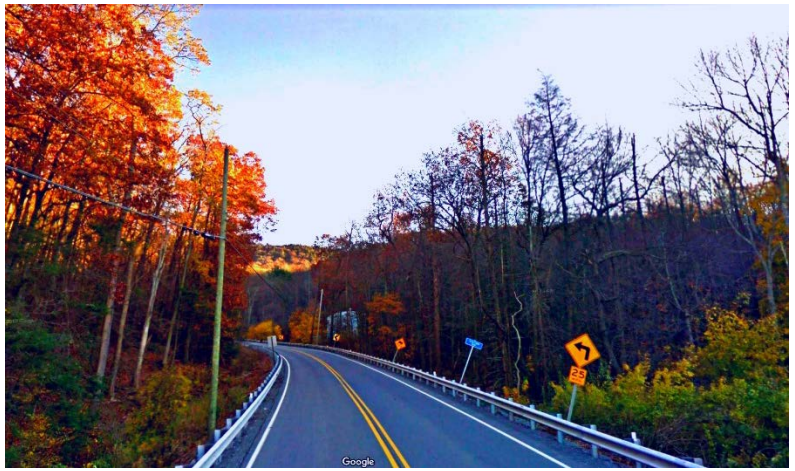
Using Mobile LiDAR to Optimize the Analysis of Safety Assets

Advisory Speed for Horizontal Curves

How current technology is being used to improve upon prevailing methods



The Statistics

- Large number of fatal crashes classified as roadway departures
- Many of these occur at horizontal curves
- In general, crash statistics show increases across-the-board in 2015 and 2016 for the first time in nearly a decade

The Statistics

Speeding

Speeding-Related Fatalities	
2016	10,111 (27%)
2015	9,723 (27%)
2014	9,283 (28%)

Source: FARS

General Statistics

Fatality Rate per 100 Million VMT	
2016	1.18
2015	1.15
2014	1.08

Source: FARS/FHWA

Fatality Rate per 100,000 Population	
2016	11.59
2015	11.06
2014	10.28

Source: FARS/Census

Injury Rate per 100 Million VMT	
2016	N/A†
2015	79
2014	77

Source: GES/FHWA

Injury Rate per 100,000 Population	
2016	N/A†
2015	761
2014	734

Source: GES/Census

Rural Versus Urban Fatalities*		
	Rural	Urban
2016	18,590 (51%)	17,656 (49%)
2015	17,572 (51%)	16,830 (49%)
2014	16,791 (51%)	15,917 (49%)

Source: FARS *Percent based on known land use.

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NHTSA
U.S. Department of Transportation
National Highway Traffic Safety Administration

Prevailing Methods

- Accelerometer Method
- Ball-Bank Indicator Method
- AASHTO Geometric Design Method
- Comp
- GPS Method
- Direct Method

$$V^2=15(0.01e+f)R$$

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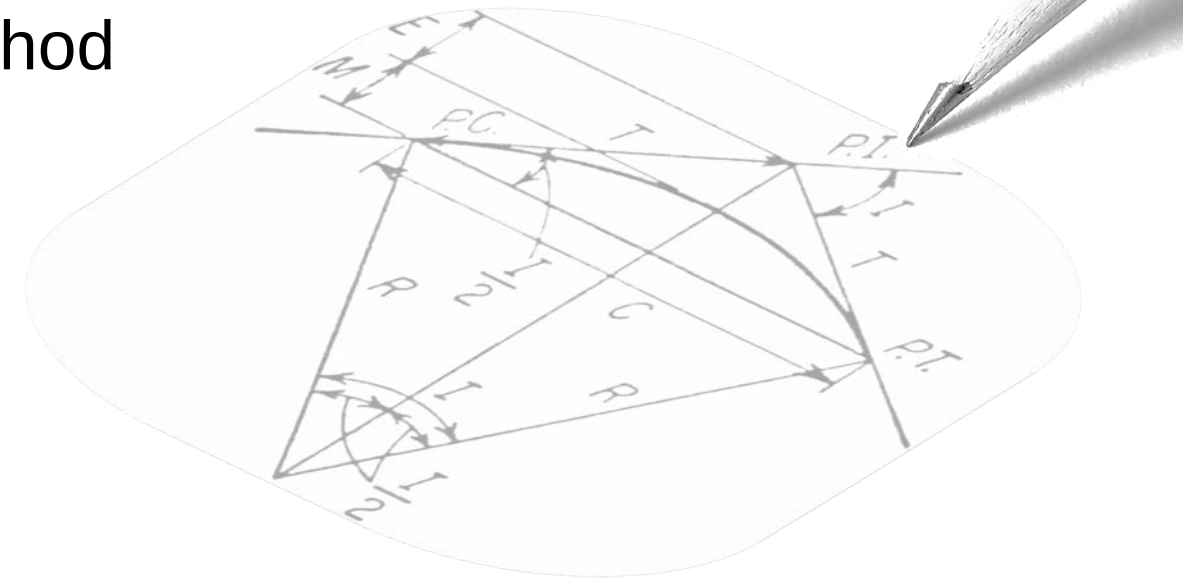

Drawbacks of Prevailing Methods

- Time-consuming
- Difficult to replicate and verify findings
- Subjective and Inconsistent Results
- Equipment installation, calibration, training
- Personnel Safety during field testing

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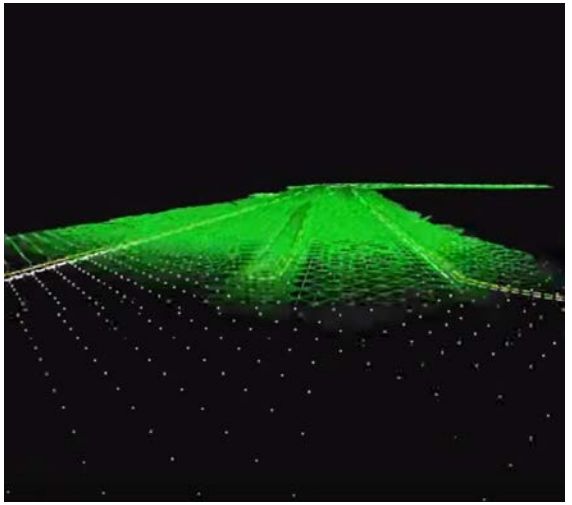
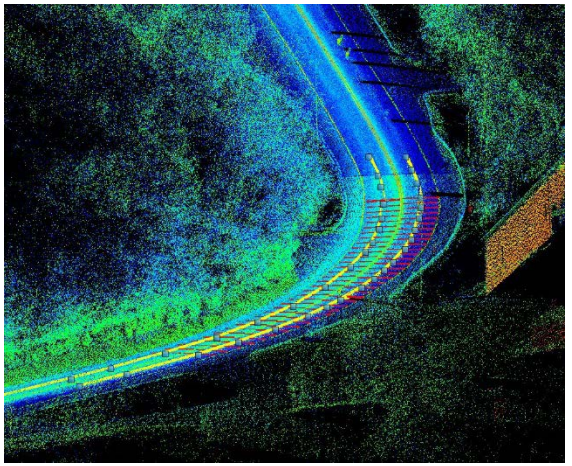
A New Method…

…using LiDAR

- Precise, real-world data at your finger tips
- Curve can be evaluated from the office using TopoDOT, a MicroStation add-on
- Calculations can be checked, verified and replicated
- Consistent results





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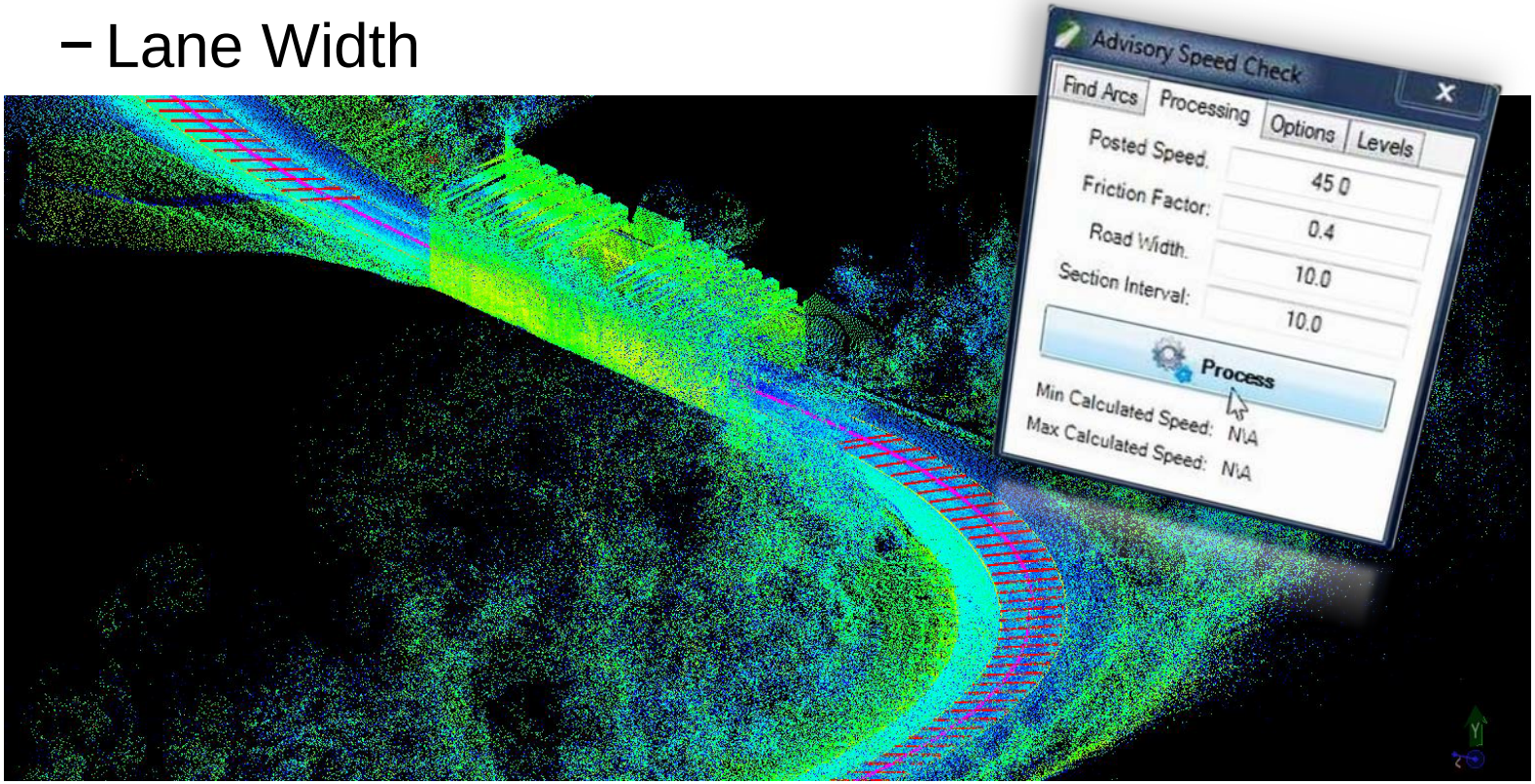
How it Works

$$V^2=15(0.01e+f)R$$

- **Required Inputs using TopoDOT:**
  - Posted Speed
  - Friction Factor, f (Table 3-7, AASHTO Green Book 2011)
  - Lane Width



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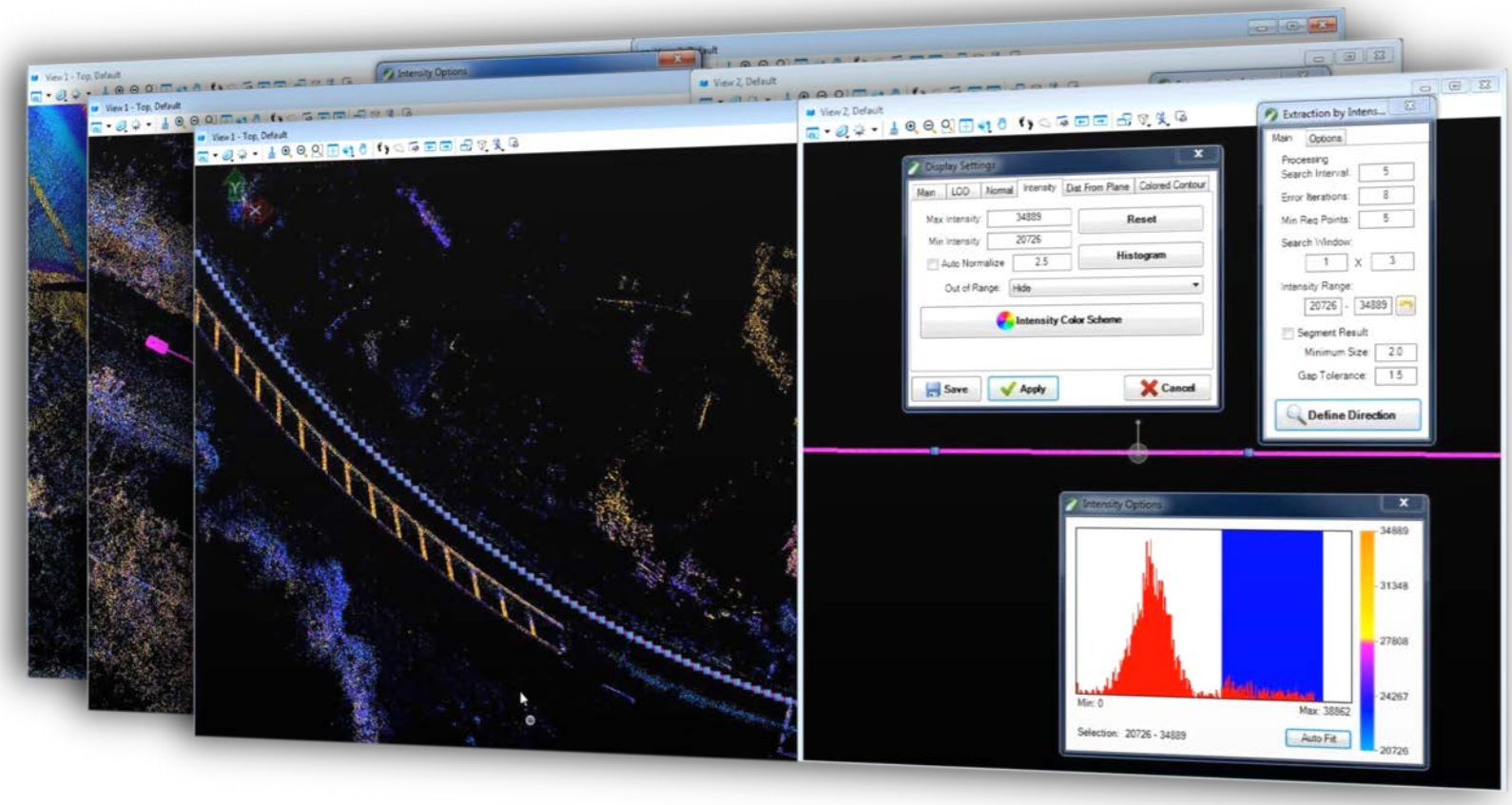
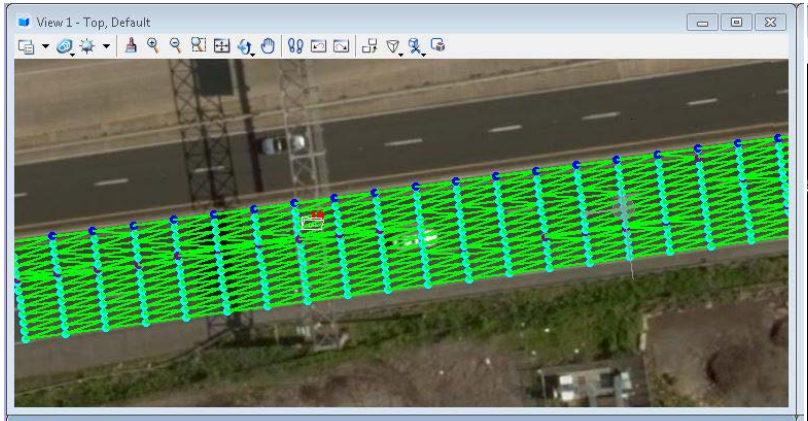
How it Works (cont'd)

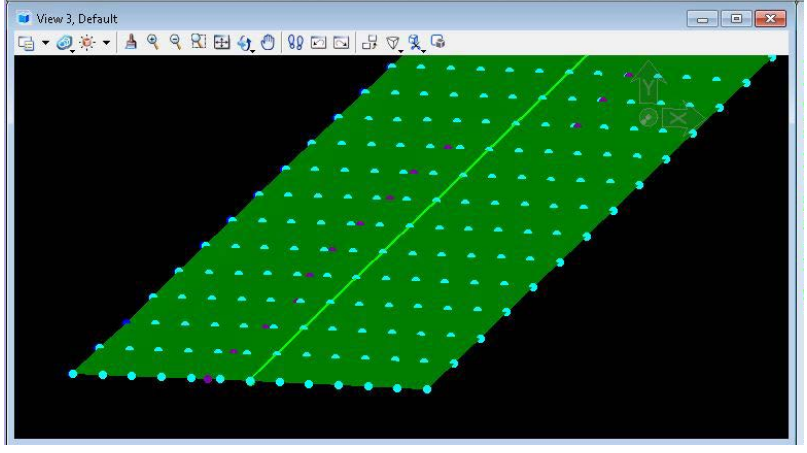
- Establish lane centerline
  - Striping can easily be extracted by intensity
  - Offset to center of lane

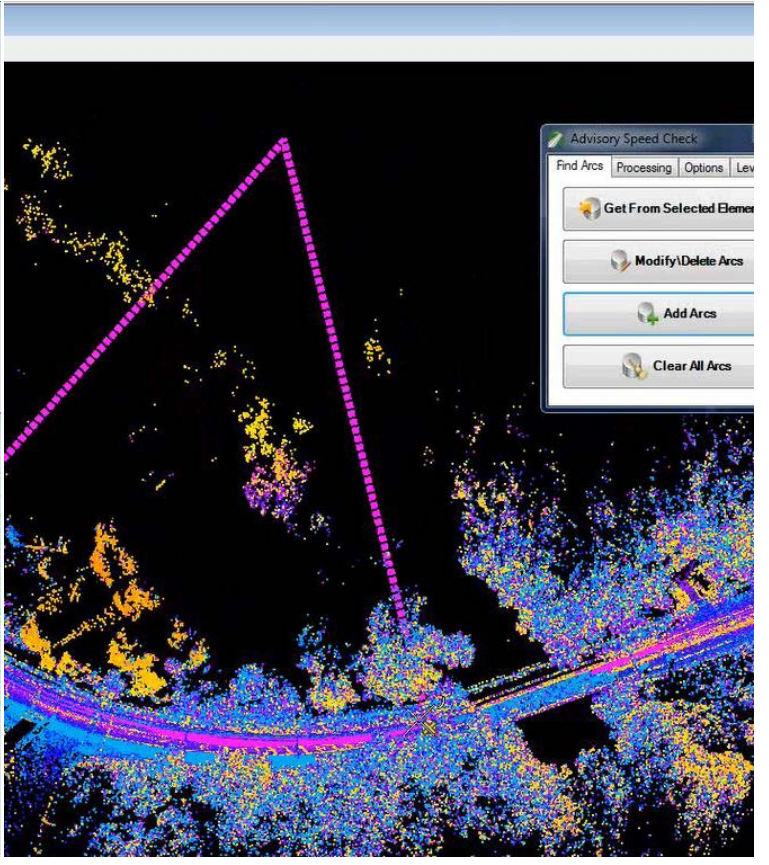


How it Works (cont'd)

- Drape centerline onto point cloud surface
- Generate best fit arcs







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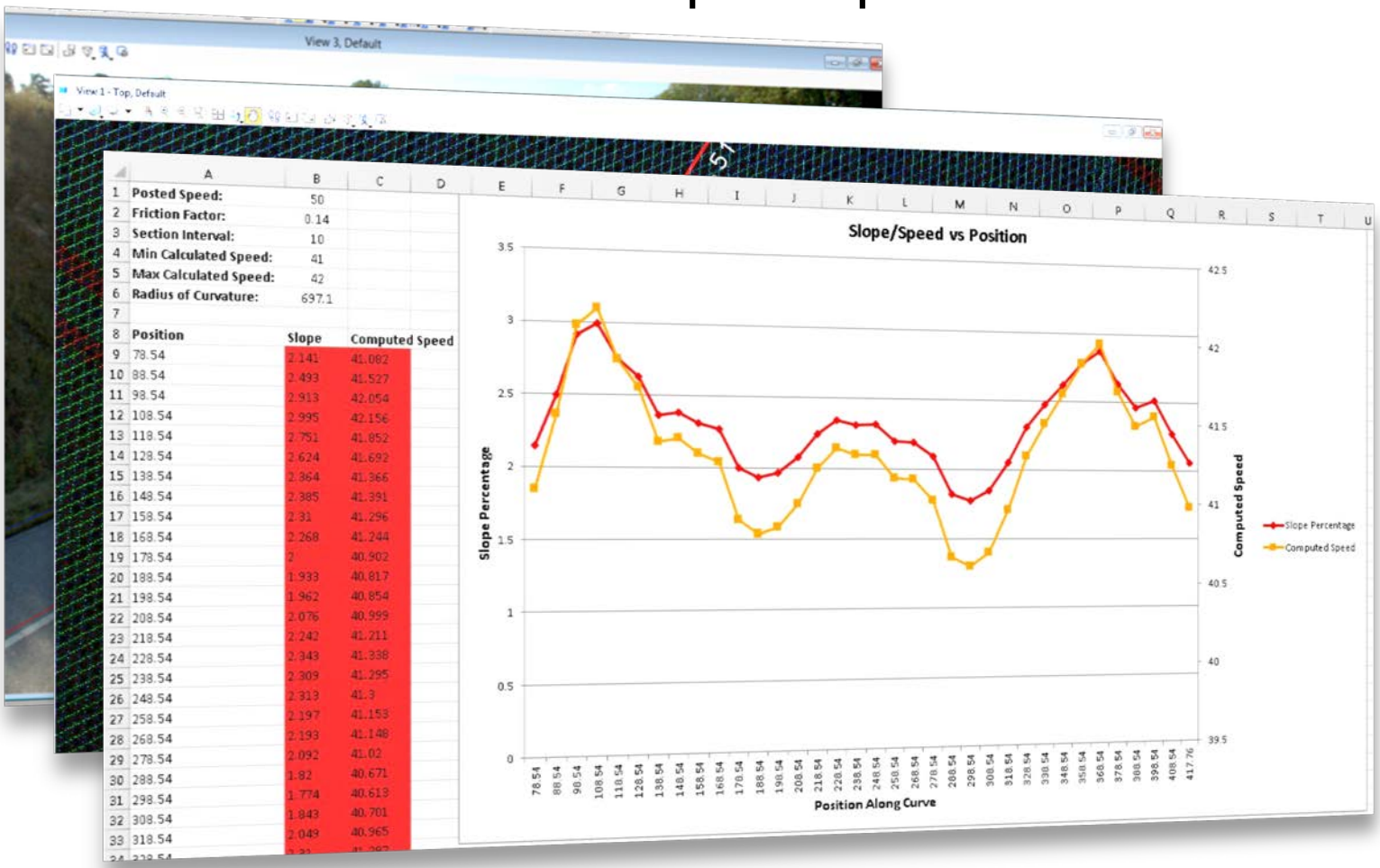
How it Works (cont'd)

- Process data and compile reports



	A	B	C	D
1	Posted Speed:	50		
2	Friction Factor:	0.14		
3	Section Interval:	10		
4	Min Calculated Speed:	41		
5	Max Calculated Speed:	42		
6	Radius of Curvature:	697.1		
7				
8	Position	Slope	Computed Speed	
9	78.54	2.141	41.082	
10	88.54	2.493	41.527	
11	98.54	2.913	42.054	
12	108.54	2.995	42.156	
13	118.54	2.751	41.852	
14	128.54	2.624	41.692	
15	138.54	2.364	41.366	
16	148.54	2.385	41.391	
17	158.54	2.31	41.296	
18	168.54	2.268	41.244	
19	178.54	2	40.902	
20	188.54	1.933	40.817	
21	198.54	1.962	40.854	
22	208.54	2.076	40.999	
23	218.54	2.242	41.211	
24	228.54	2.343	41.338	
25	238.54	2.309	41.295	
26	248.54	2.313	41.3	
27	258.54	2.197	41.153	
28	268.54	2.193	41.148	
29	278.54	2.092	41.02	
30	288.54	1.82	40.671	
31	298.54	1.774	40.613	
32	308.54	1.843	40.701	
33	318.54	2.049	40.965	

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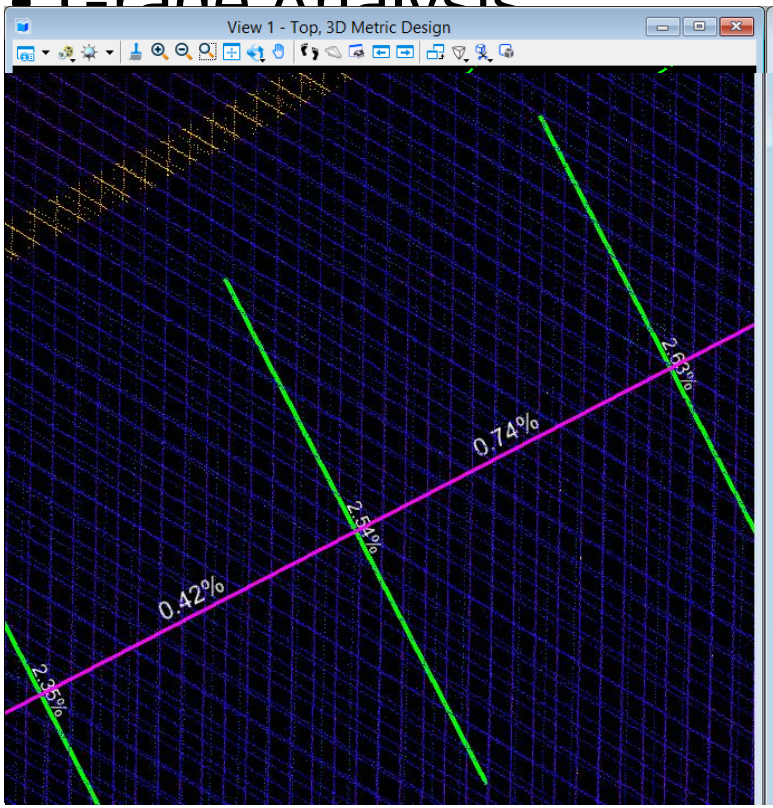
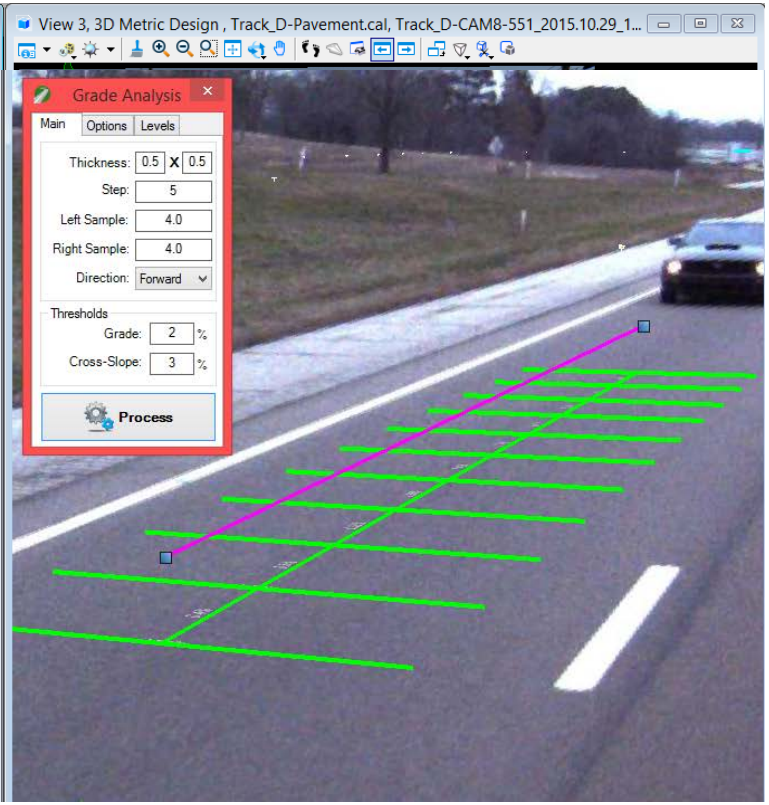
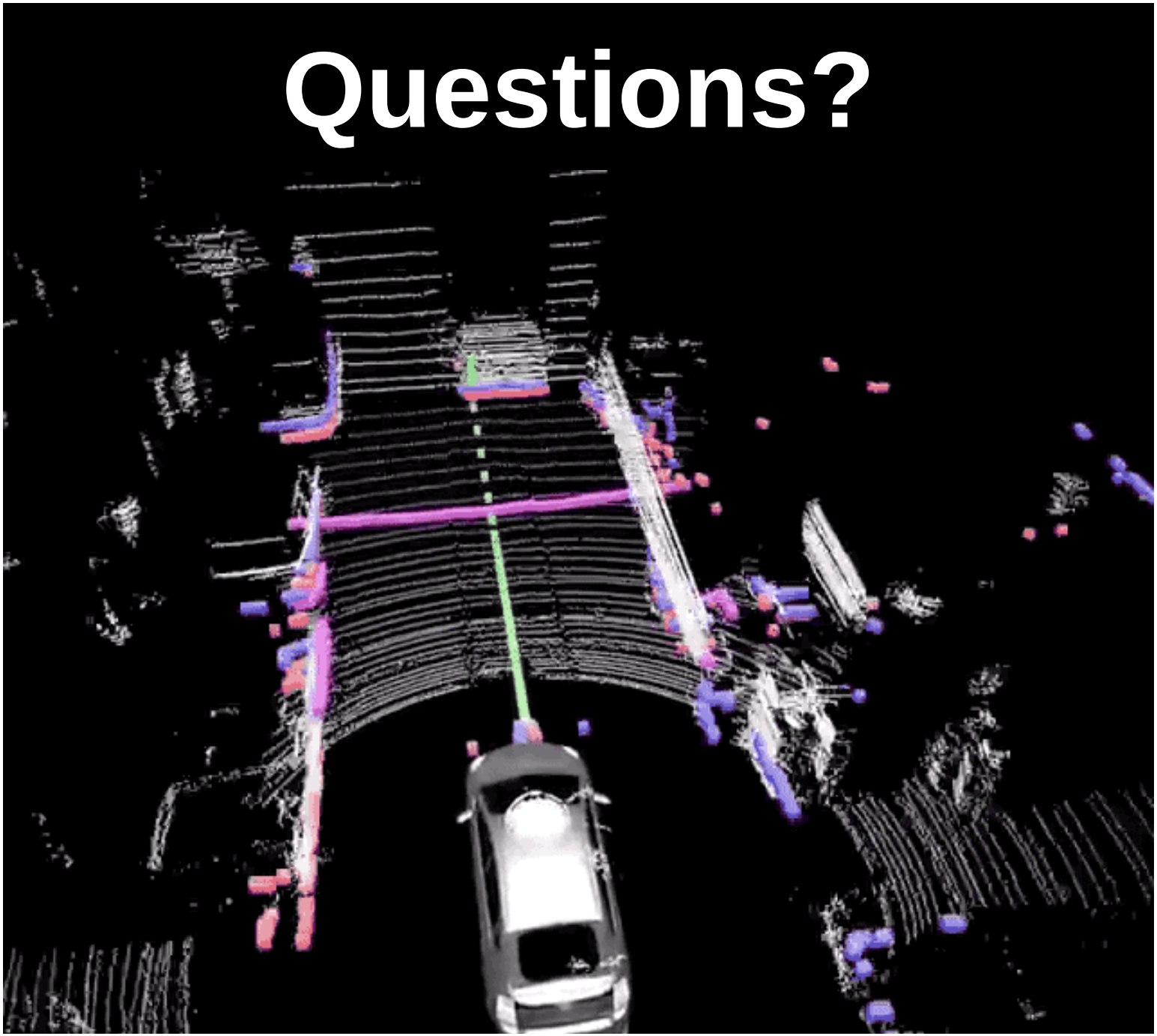
The Future of LiDAR

- Guide rail asset management
- Pavement Condition
- Grade Analysis





Questions?



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