MoDOT's use of LiDAR and Models

AGCMO/MODOT ANNUAL CO-OP MEETING
DECEMBER 5, 2018

STEPHEN ATKINSON
KEVIN VOLLET

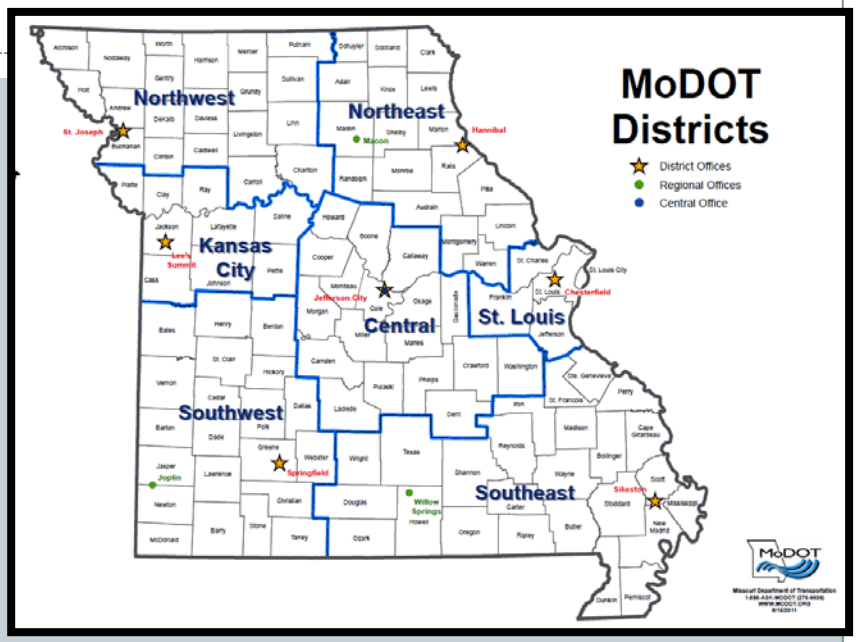
LiDAR & Models – *Presentation Outline*

- Steve
  - Background about why and how we use LiDAR
  - LiDAR Quality Assurance
  - Describe LiDAR types and deliverables that MoDOT uses
- Kevin
  - How MoDOT Designers use LiDAR surfaces to create models
  - How models are used to produce plans
  - How electronic design data is produced.

CADD Services Unit Responsibilities

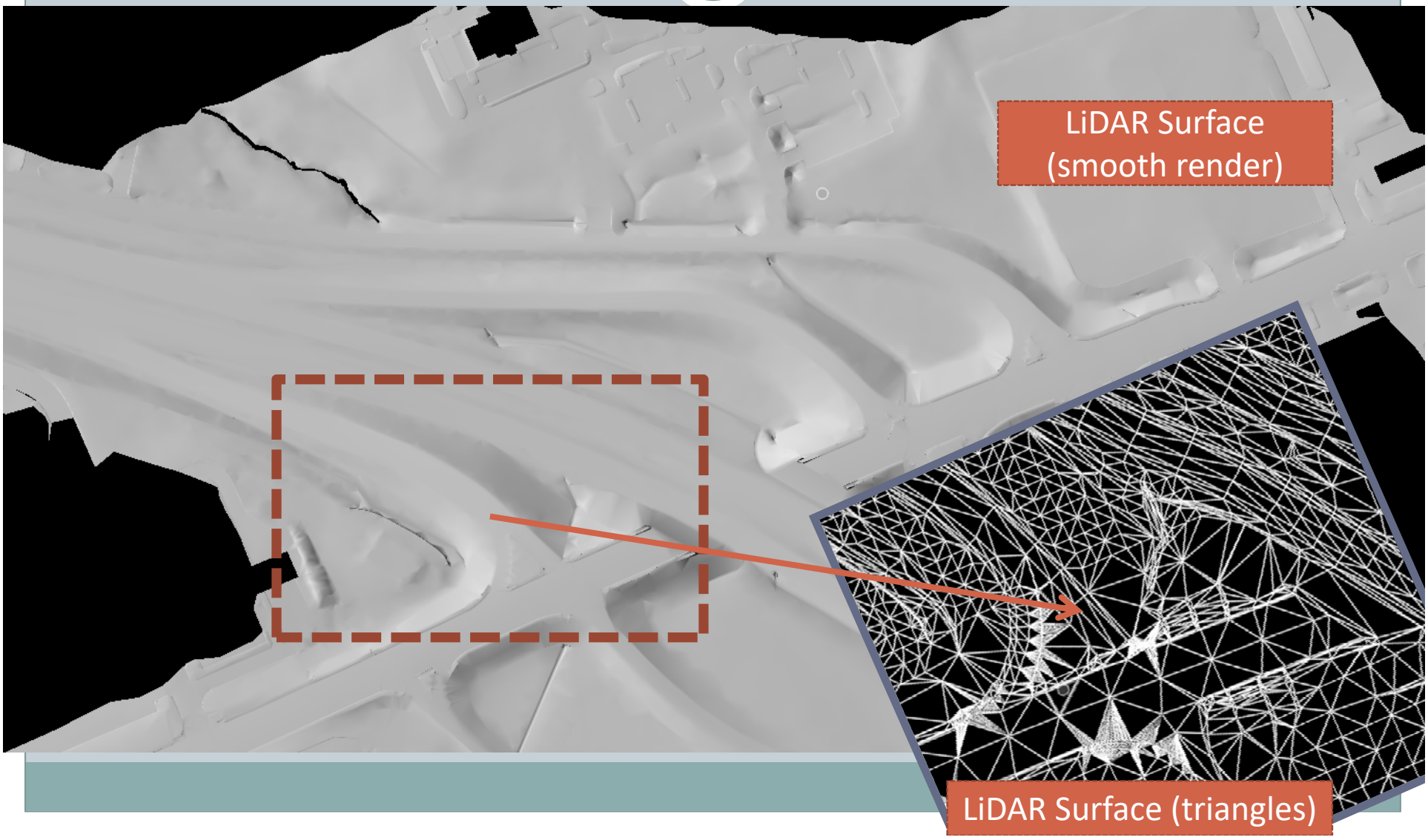
- Design software support
- Surveying support (equipment, software, policy)
- Statewide LiDAR Program
- Real Time Network.

LiDAR & Models – *District Survey*

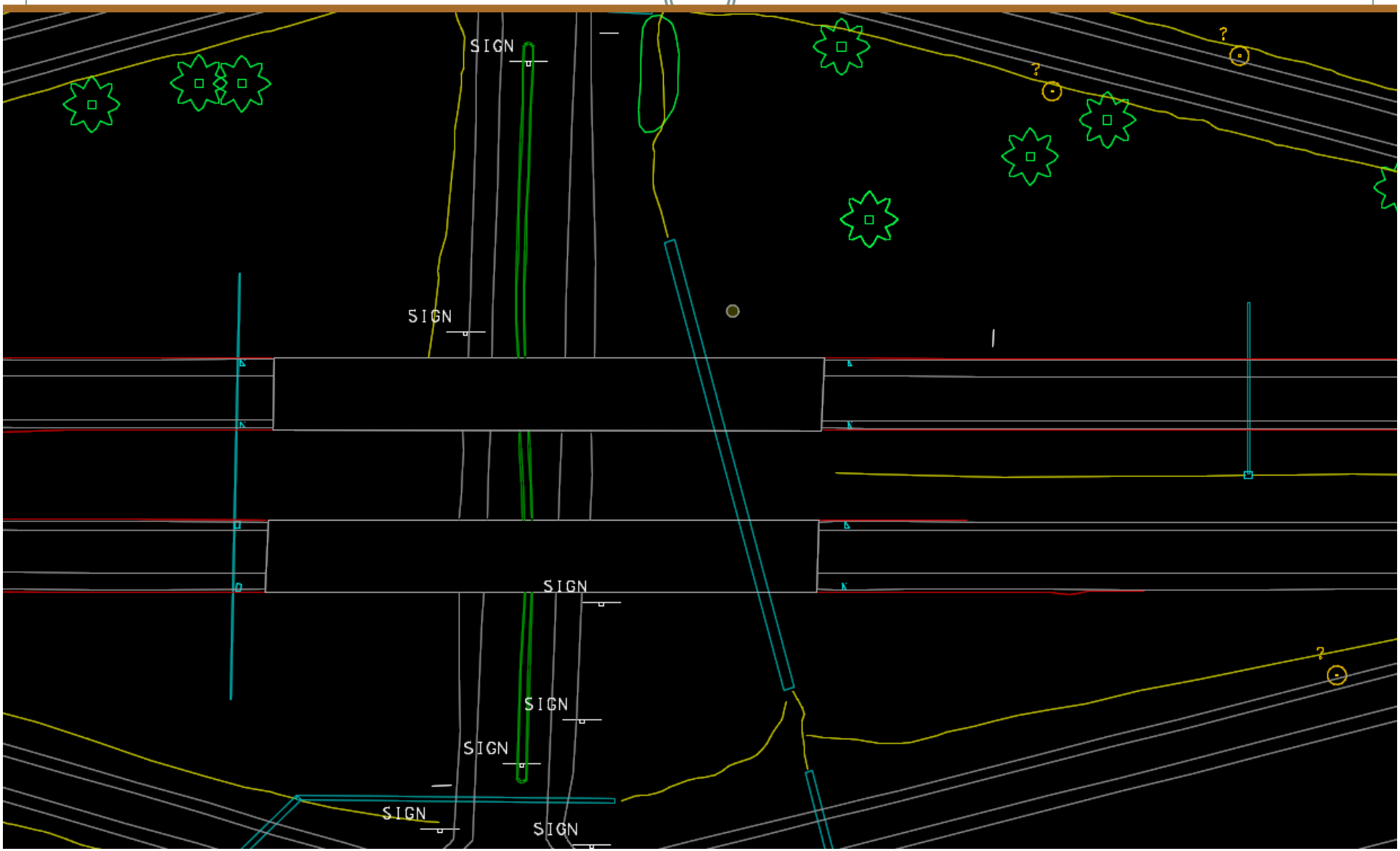


- District Design Survey is responsible for all survey products required for project design
- Survey crews in each district
- District Design Engineer can request LiDAR for projects
  - Project LiDAR deliverables obtained via consultant contract
  - Existing ground surface, Mapping, Initial project control.

Survey Deliverables – *Existing Ground Surface*



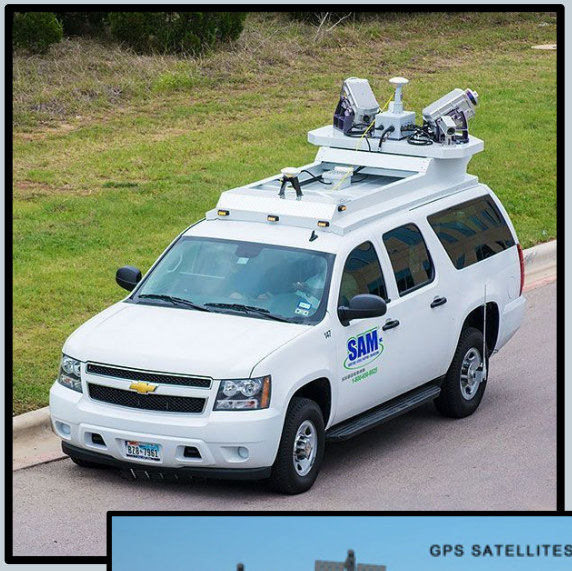
Survey Deliverables – *Mapping*

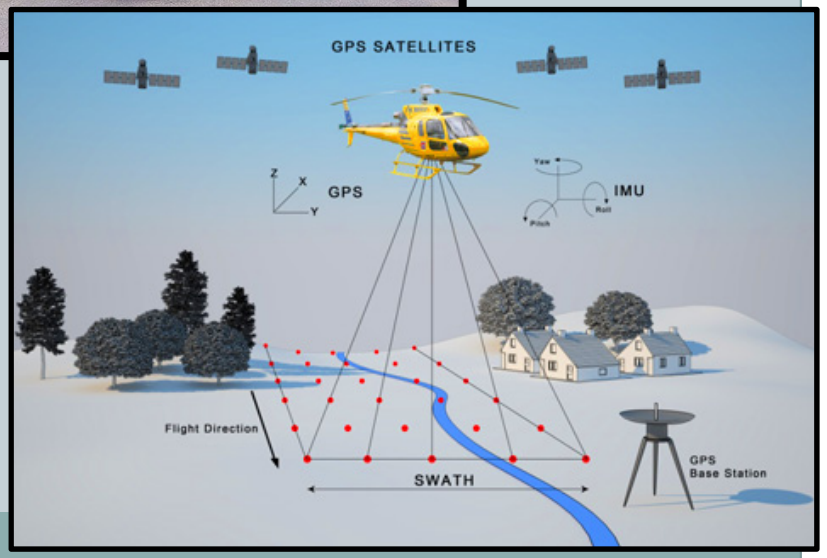


Survey Deliverables – *Aerial Photos*

LiDAR– *Types*

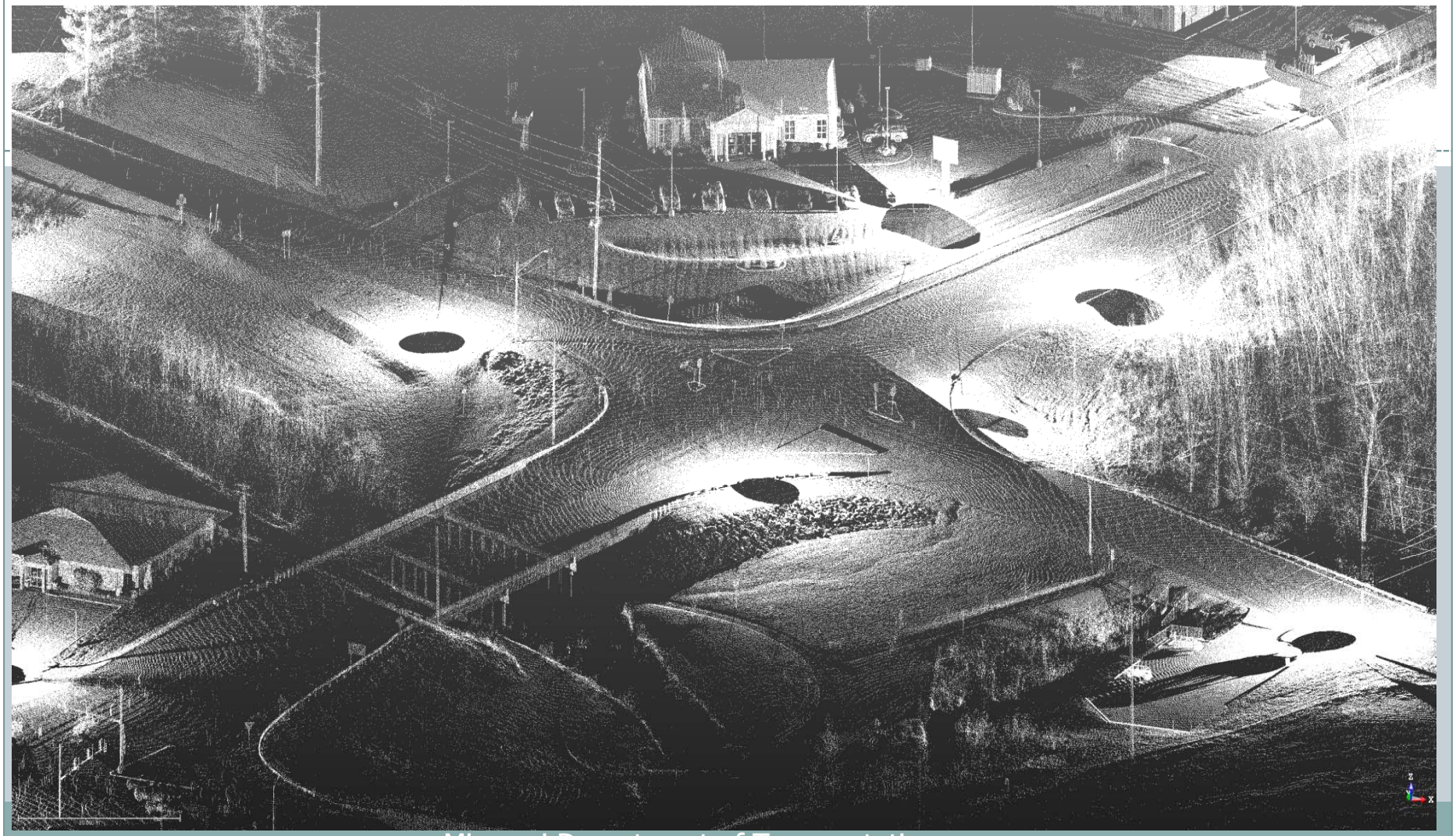
- Terrestrial Static
- Mobile
- Aerial.





Terrestrial Laser Scanning Example

Safety Application

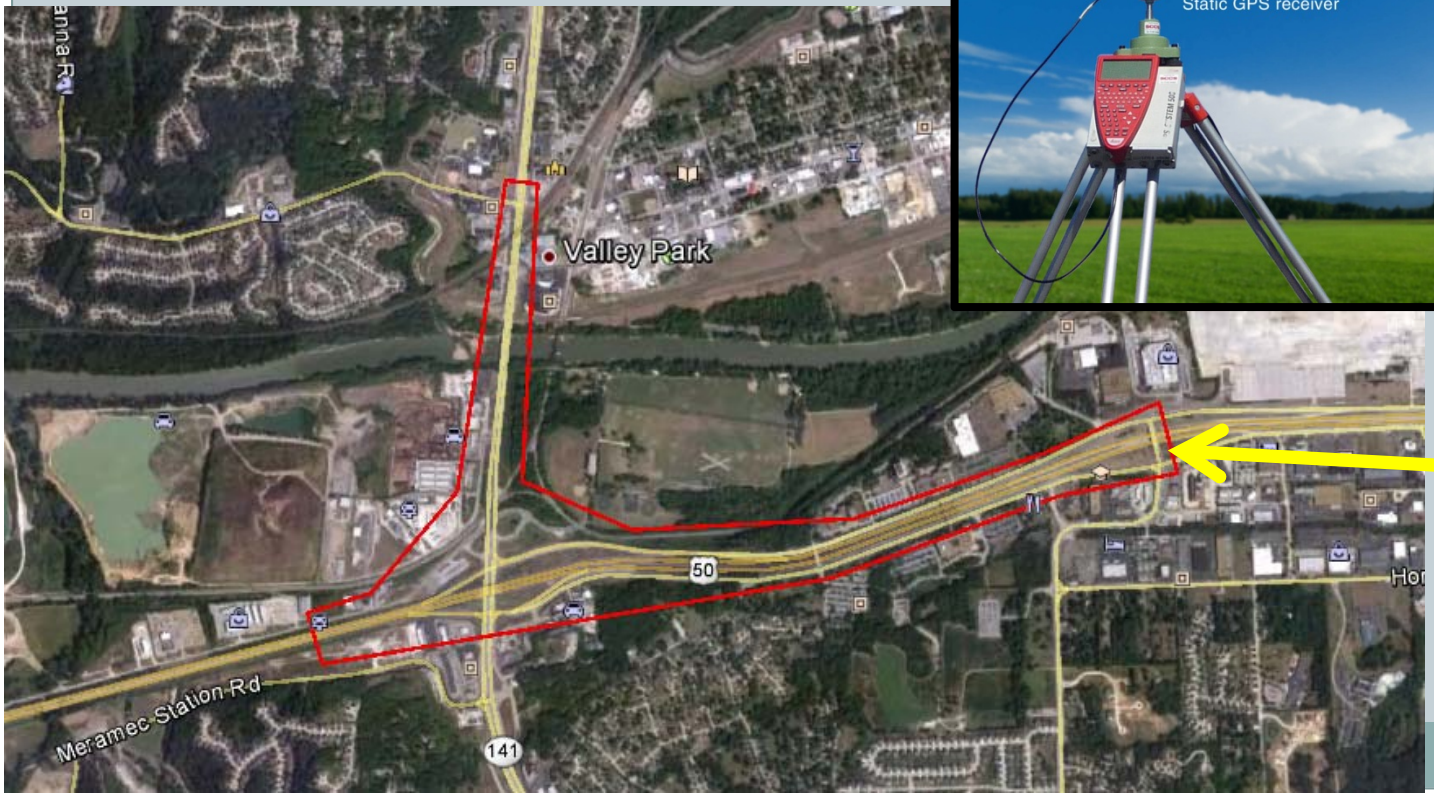


Terrestrial Laser Scanning Example

Historic Preservation Application

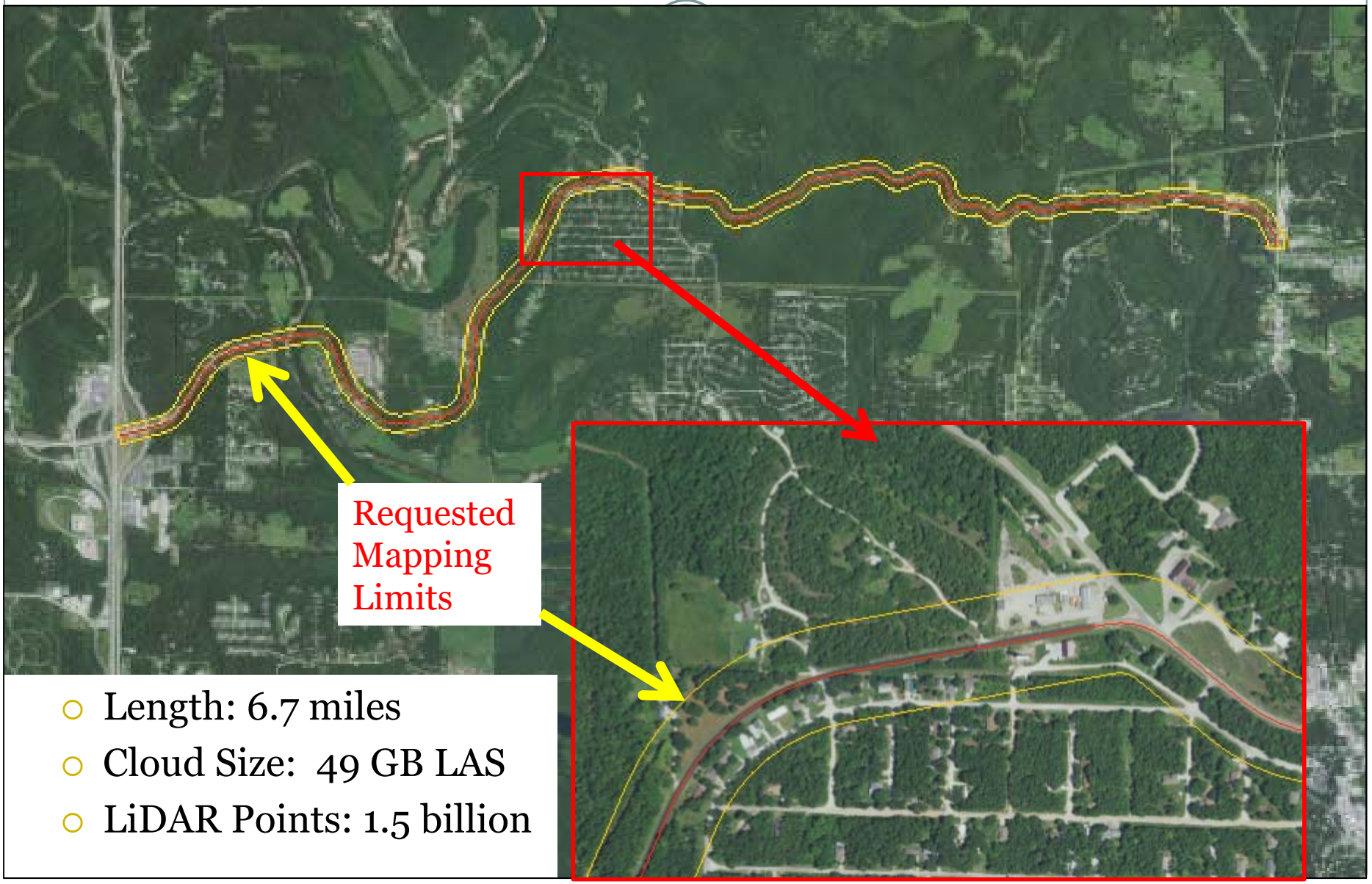
Airborne LiDAR

- Density: 5 points/SF
- Accuracy: 0.3 feet Horiz. & Vert.



Requested Mapping Limits

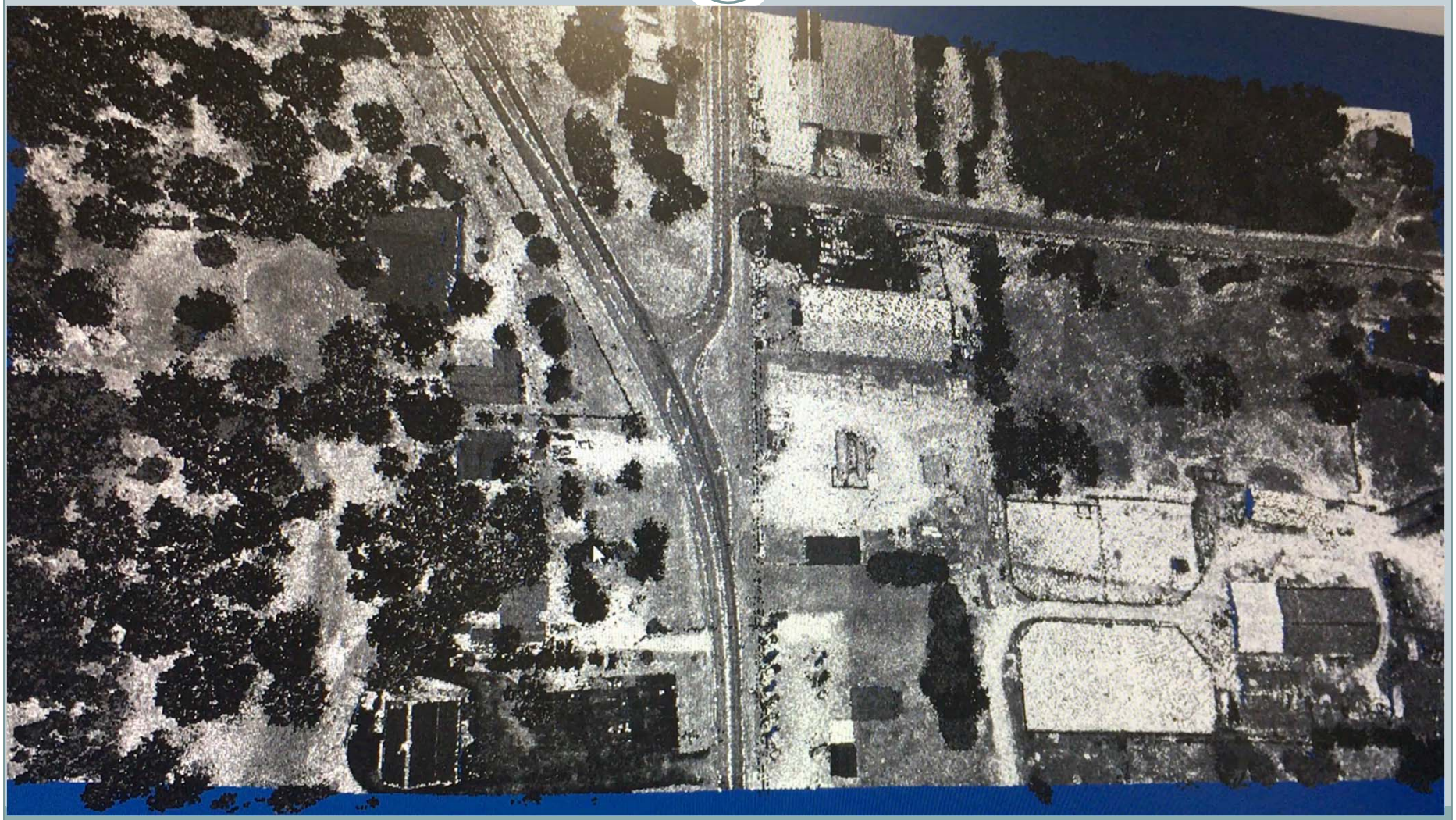
LiDAR– *Aerial LiDAR Example*



- Length: 6.7 miles
- Cloud Size: 49 GB LAS
- LiDAR Points: 1.5 billion

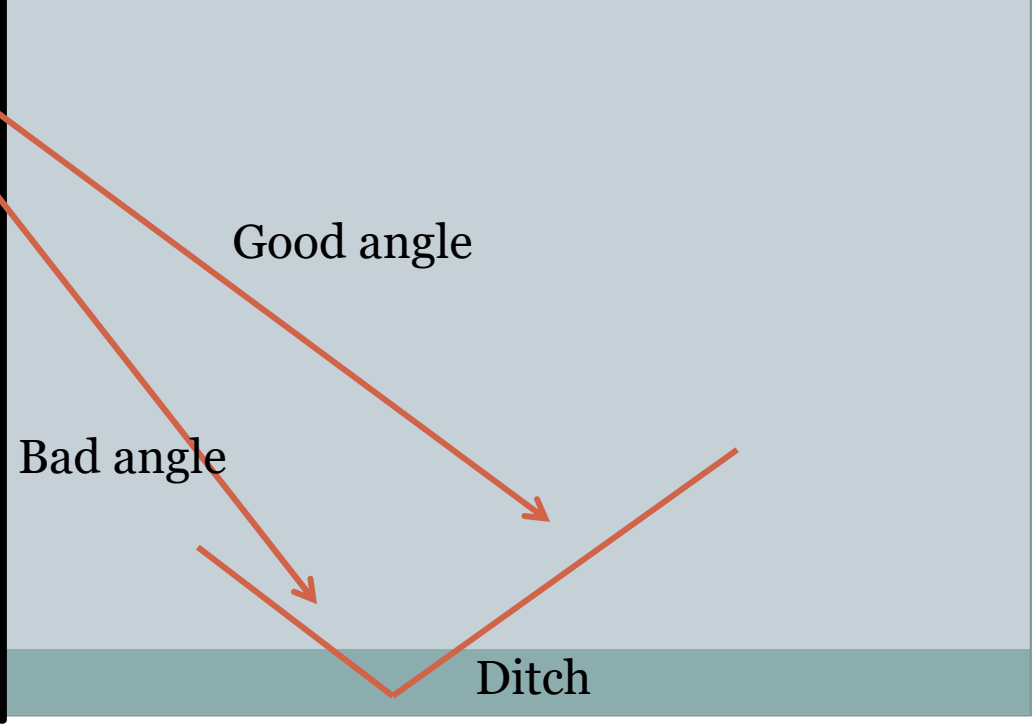
LiDAR– *Aerial Point Cloud Example*

LiDAR– *Aerial Point Cloud Example*

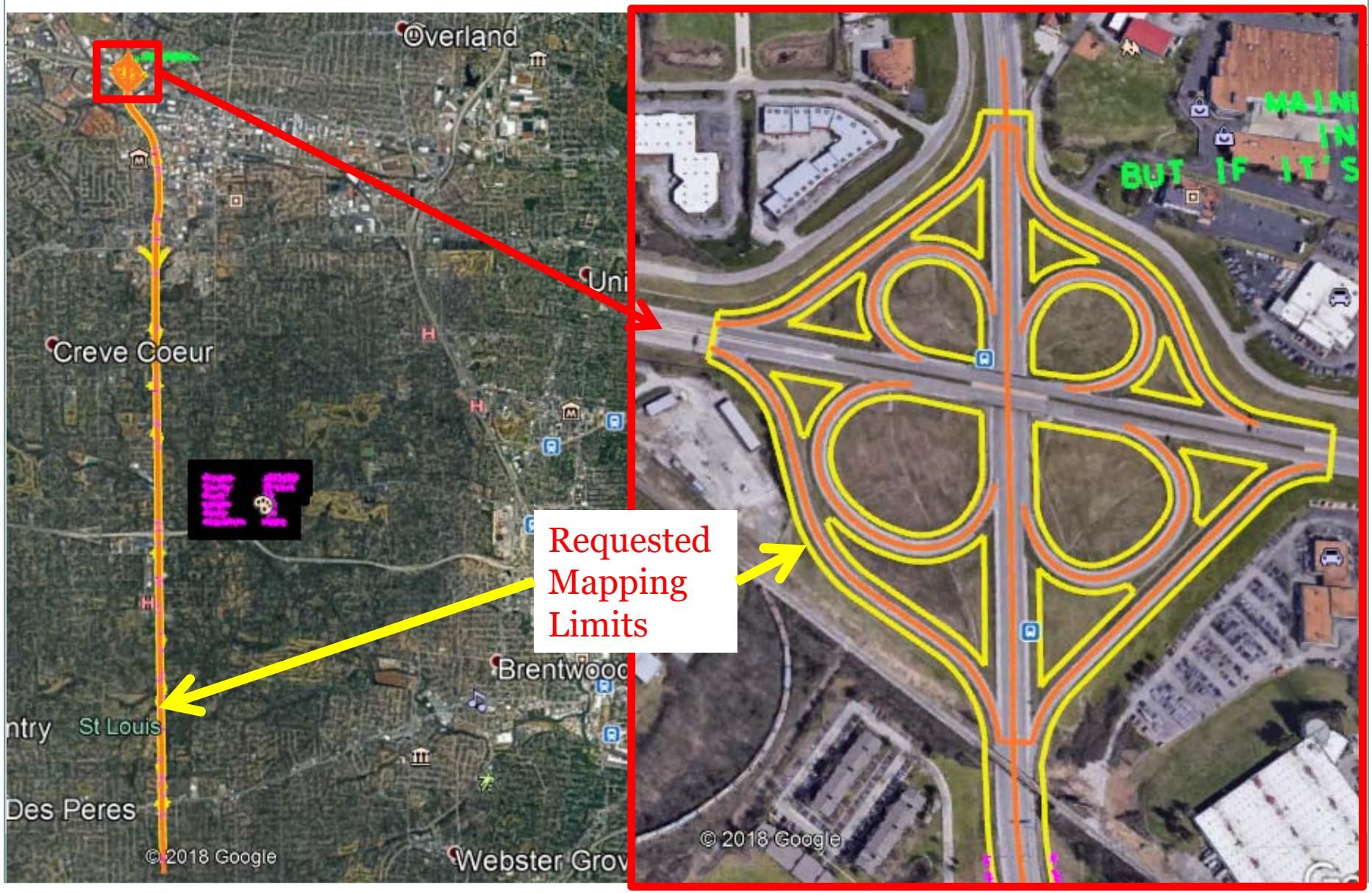


LiDAR– *Mobile*

- Density: 20 points/SF
- Accuracy: 0.1 to 0.2 feet Horiz. & Vert.
- Precision between adjacent around 5mm



LiDAR– *Mobile LiDAR Example*



LiDAR– *Mobile Cloud Example*

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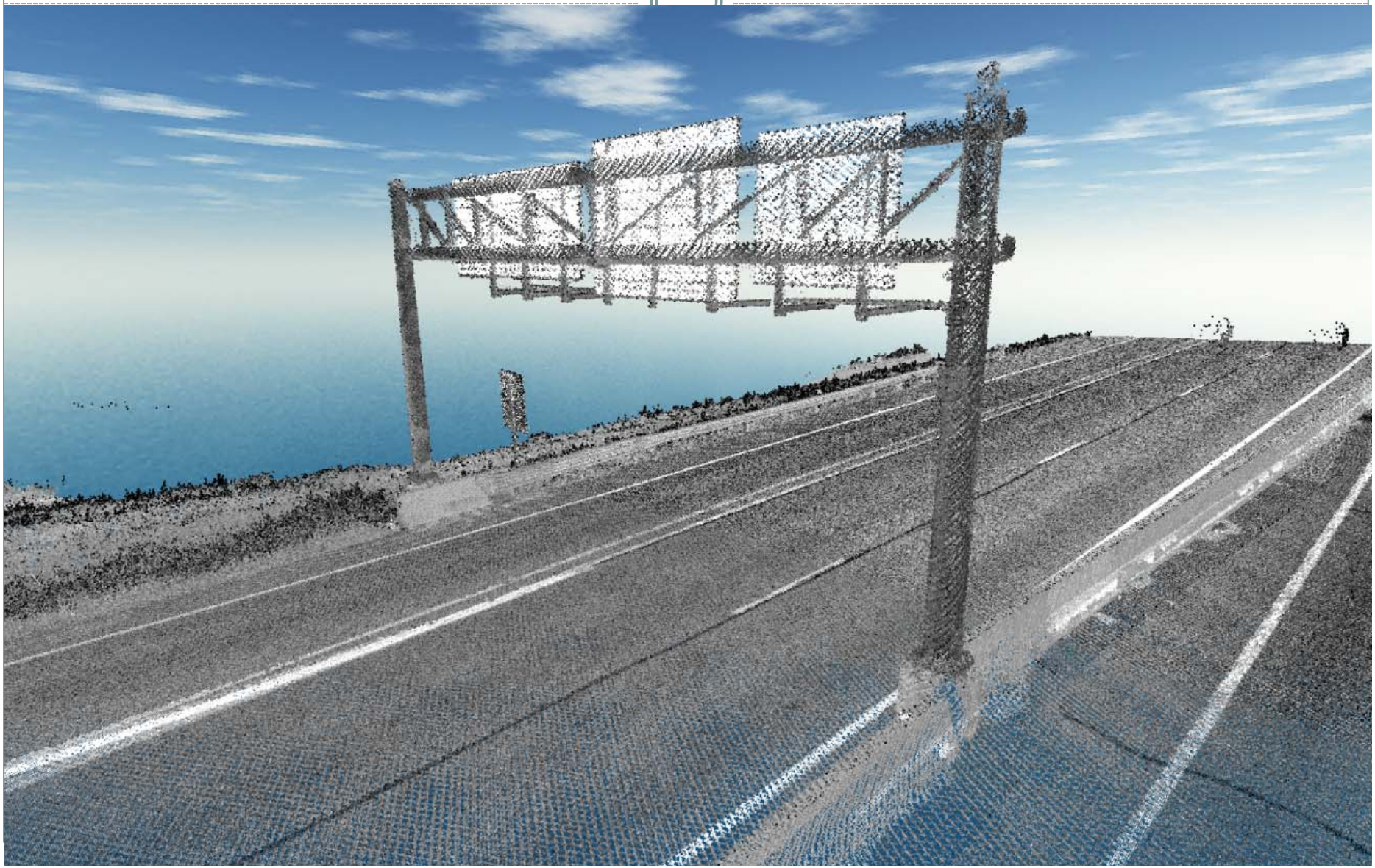
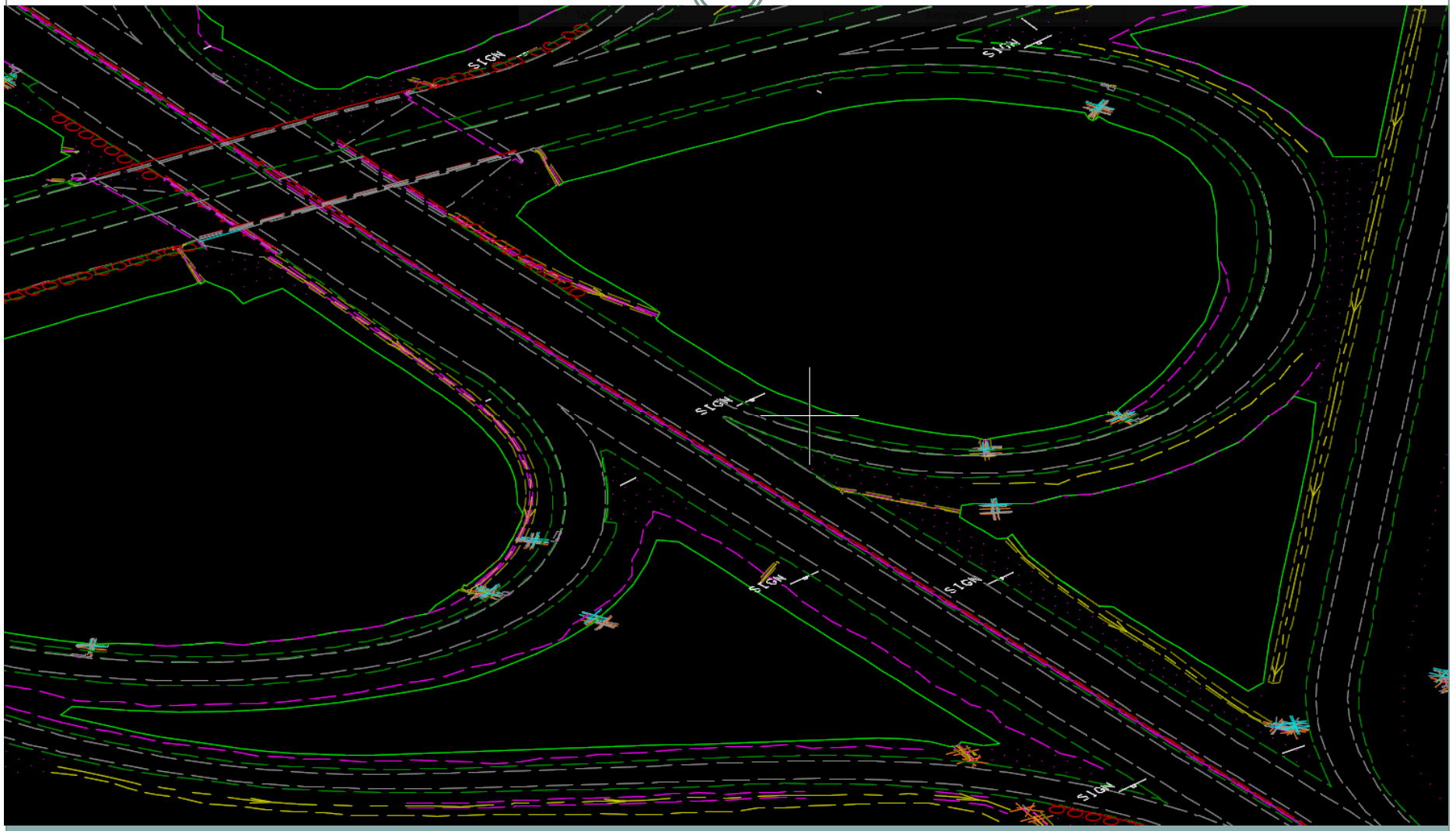


LiDAR– *Point Cloud Processing*

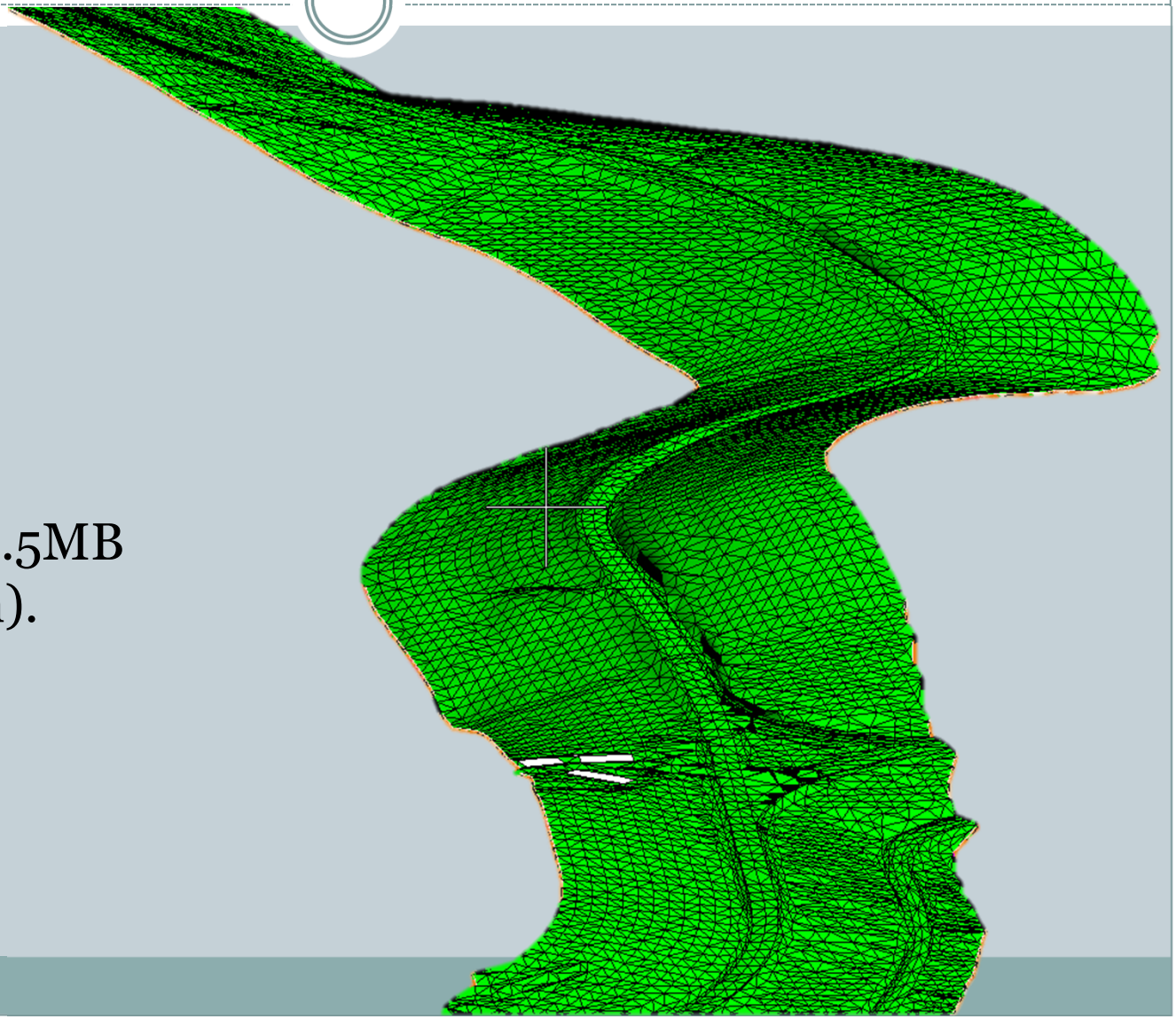
- Calibration
  - Make all the points have real world coordinates
- Classification
  - **Ground**, Noise, high vegetation, low vegetation, buildings, etc
- Compilation
  - Digitize existing point features
    - Manholes, Fence, buildings
  - Digitize existing linear features and breaklines
    - EOP, EOS, Curb, Flow lines.

LiDAR– *Compilation*

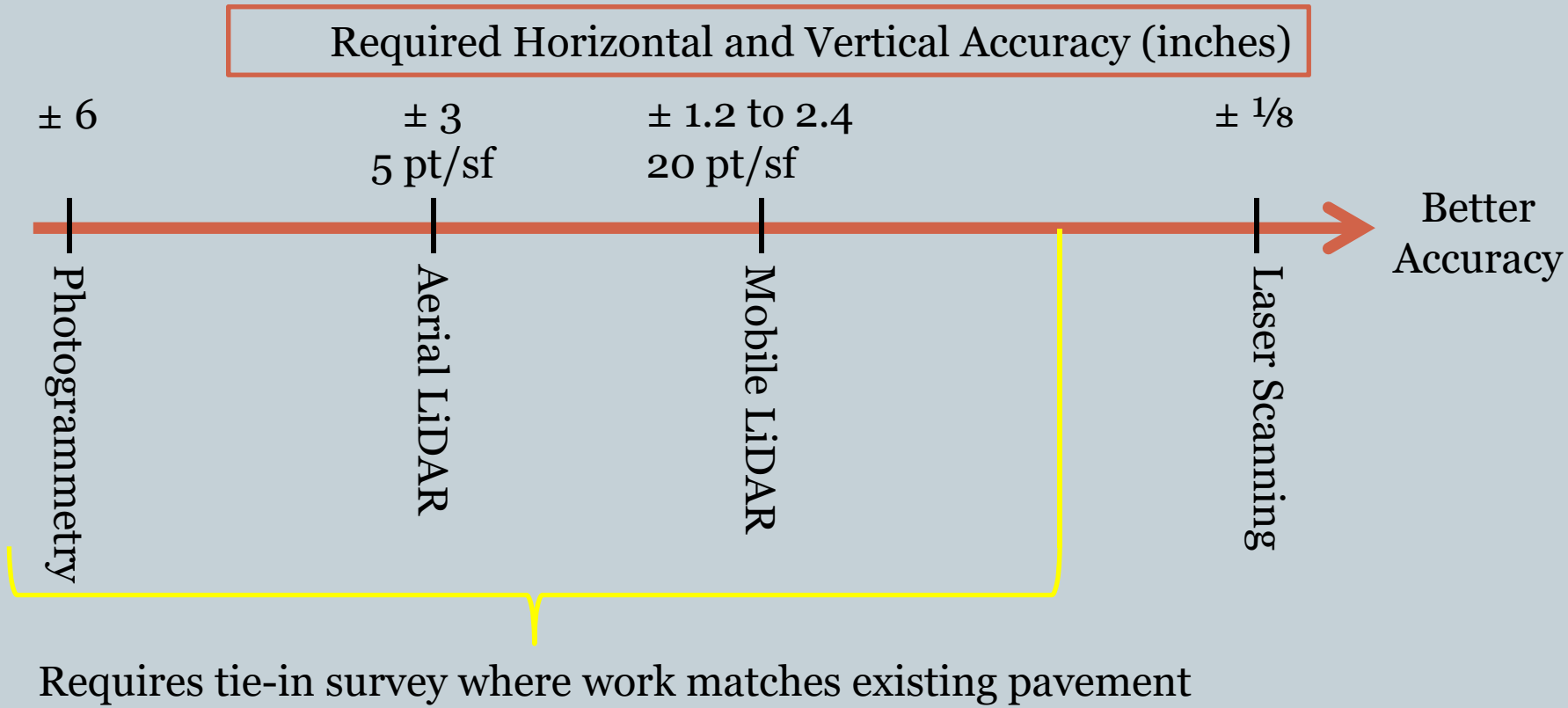


Surface Creation From LiDAR

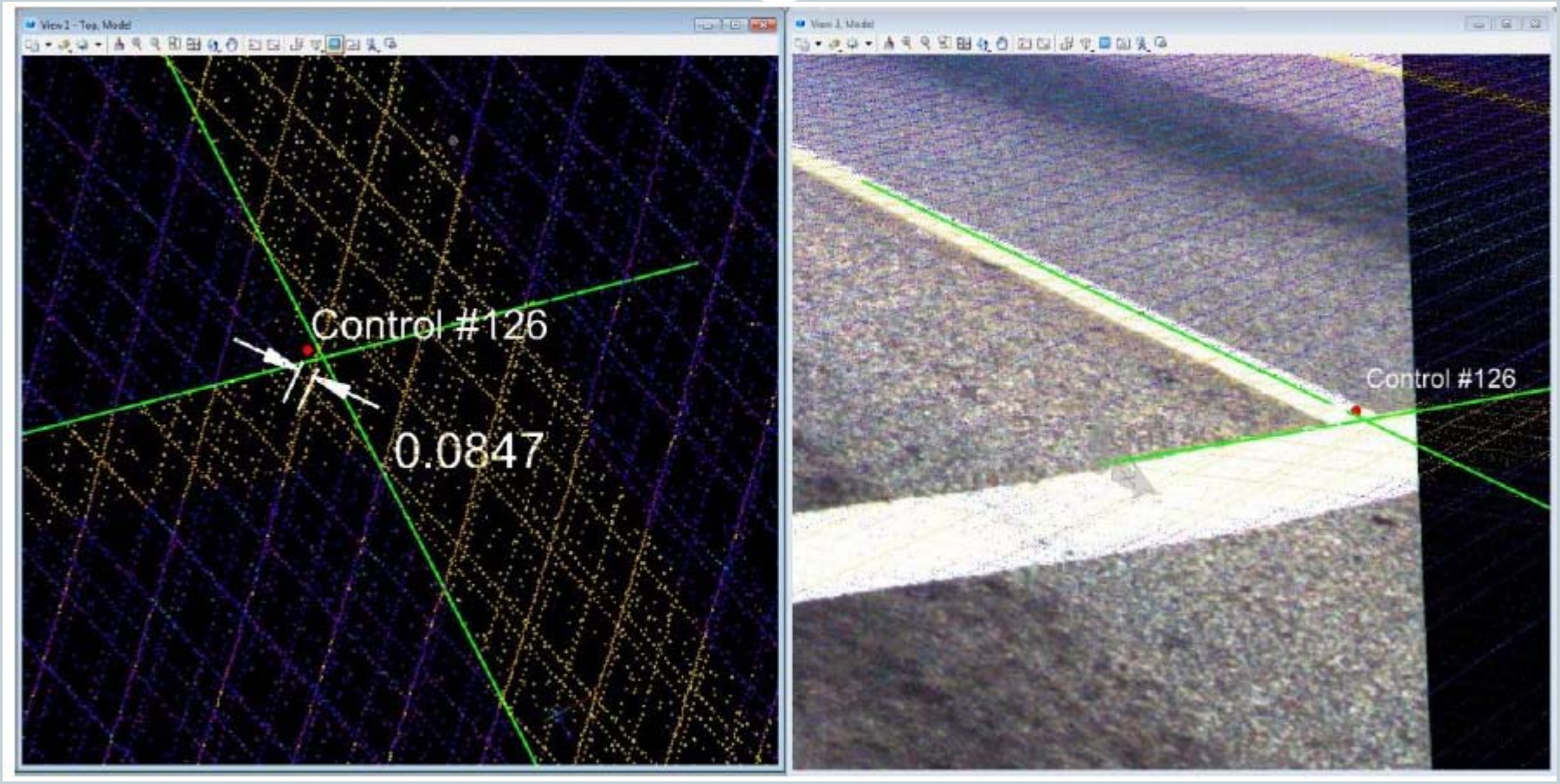
- Taney County
- 6.7 miles
- Cloud size: 49GB
- Surface file size: 6.5MB (GEOPAK Terrain).



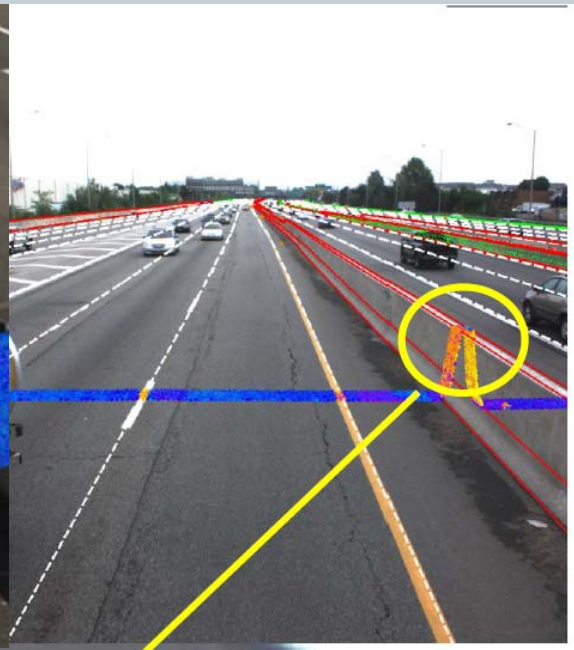
LiDAR Surface Accuracy Comparison

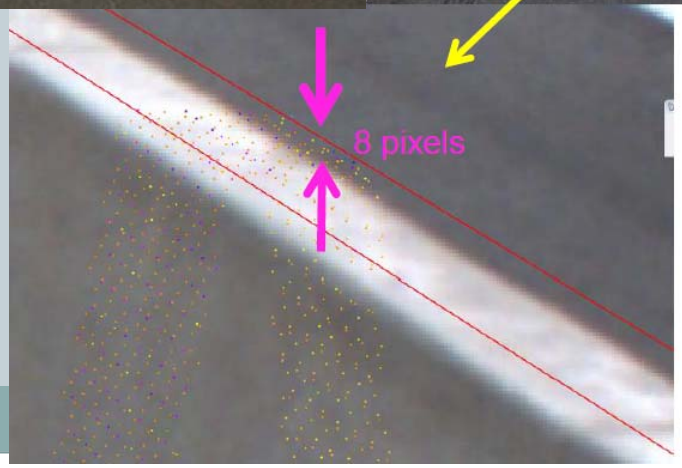


LiDAR– *QA Point Checks*

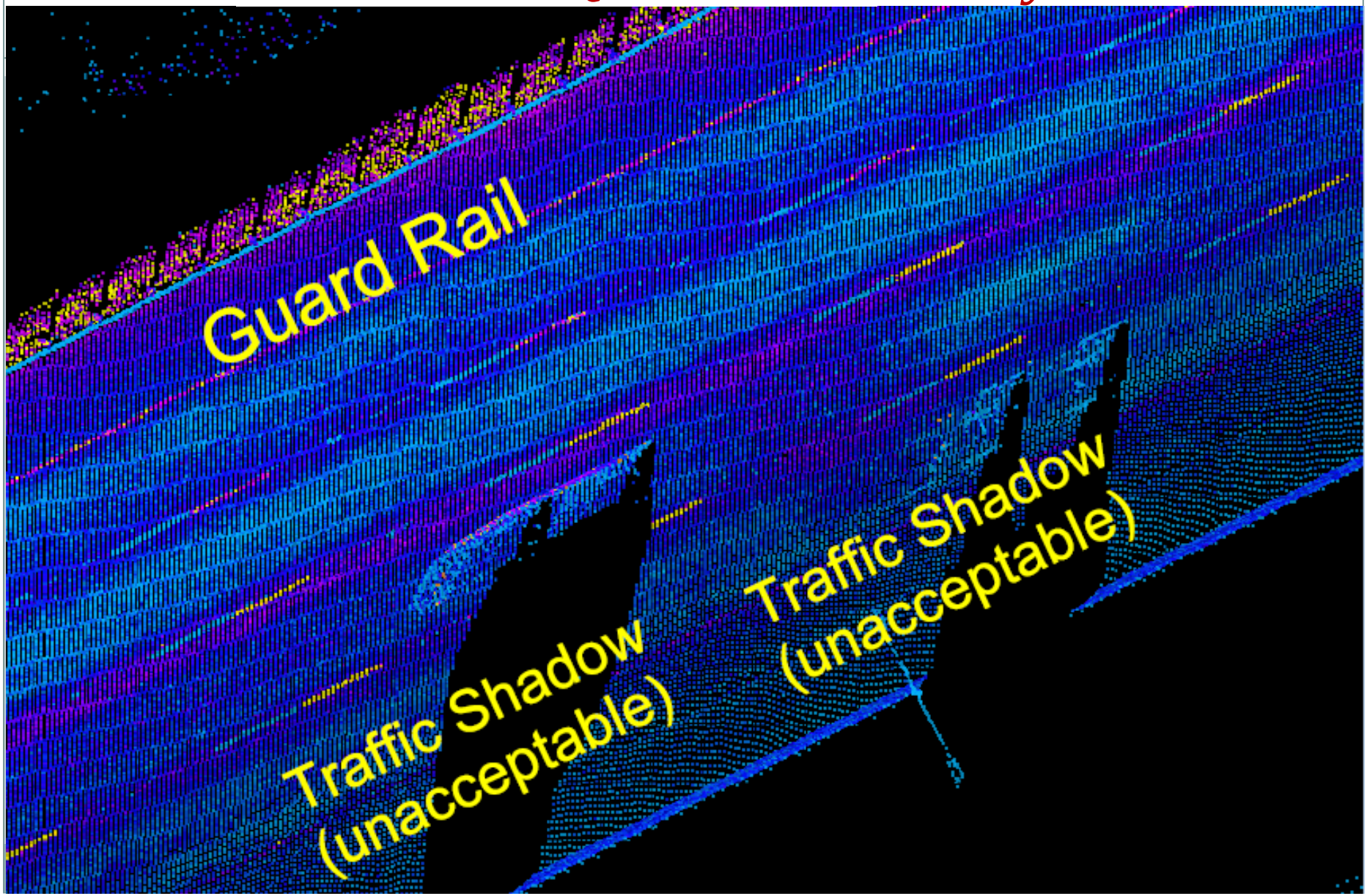


LiDAR– *QA Alignment Checks*

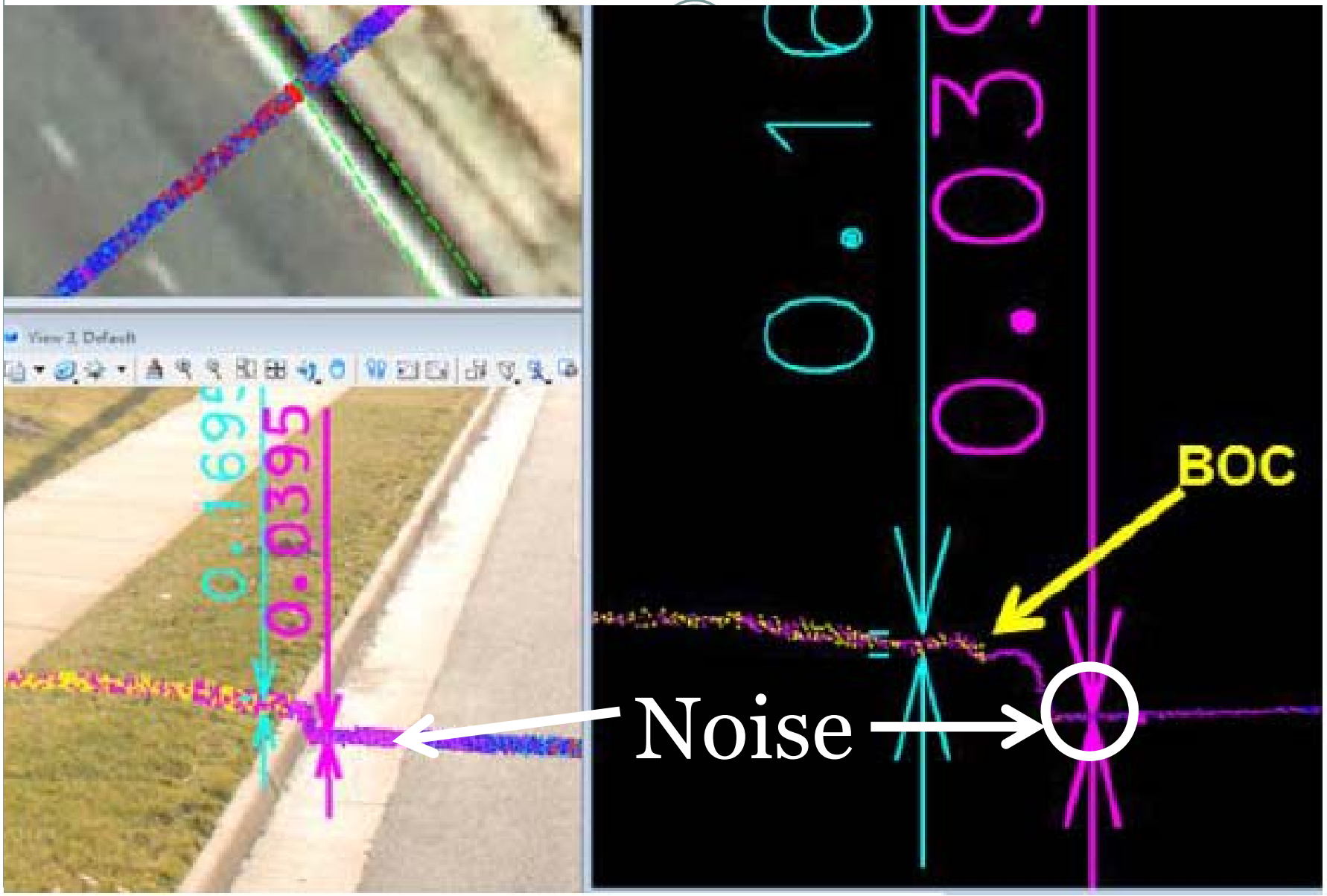




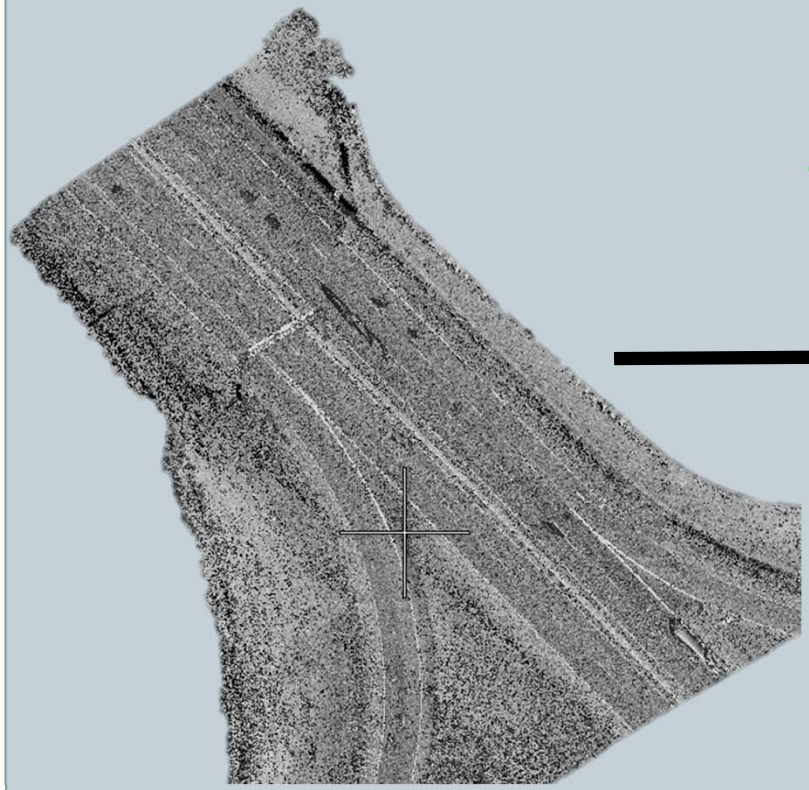
LiDAR– *QA Point Density*



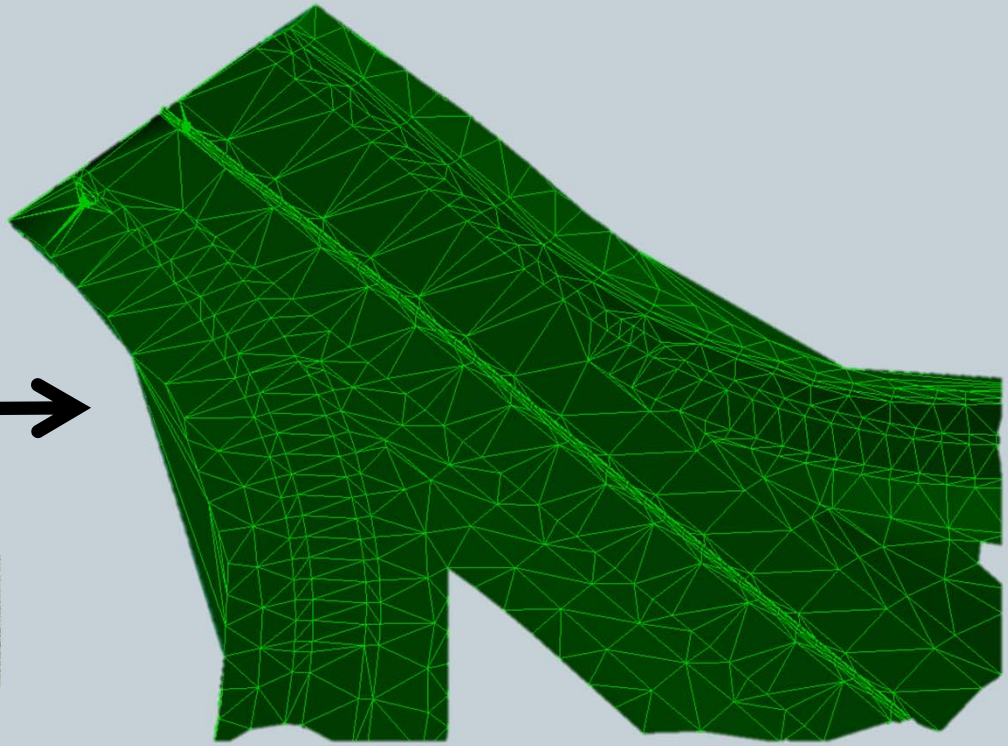
LiDAR– *Random Noise*



LiDAR– *QA Compare Point Cloud to Surface*



Point Cloud (St. Louis)
80GB

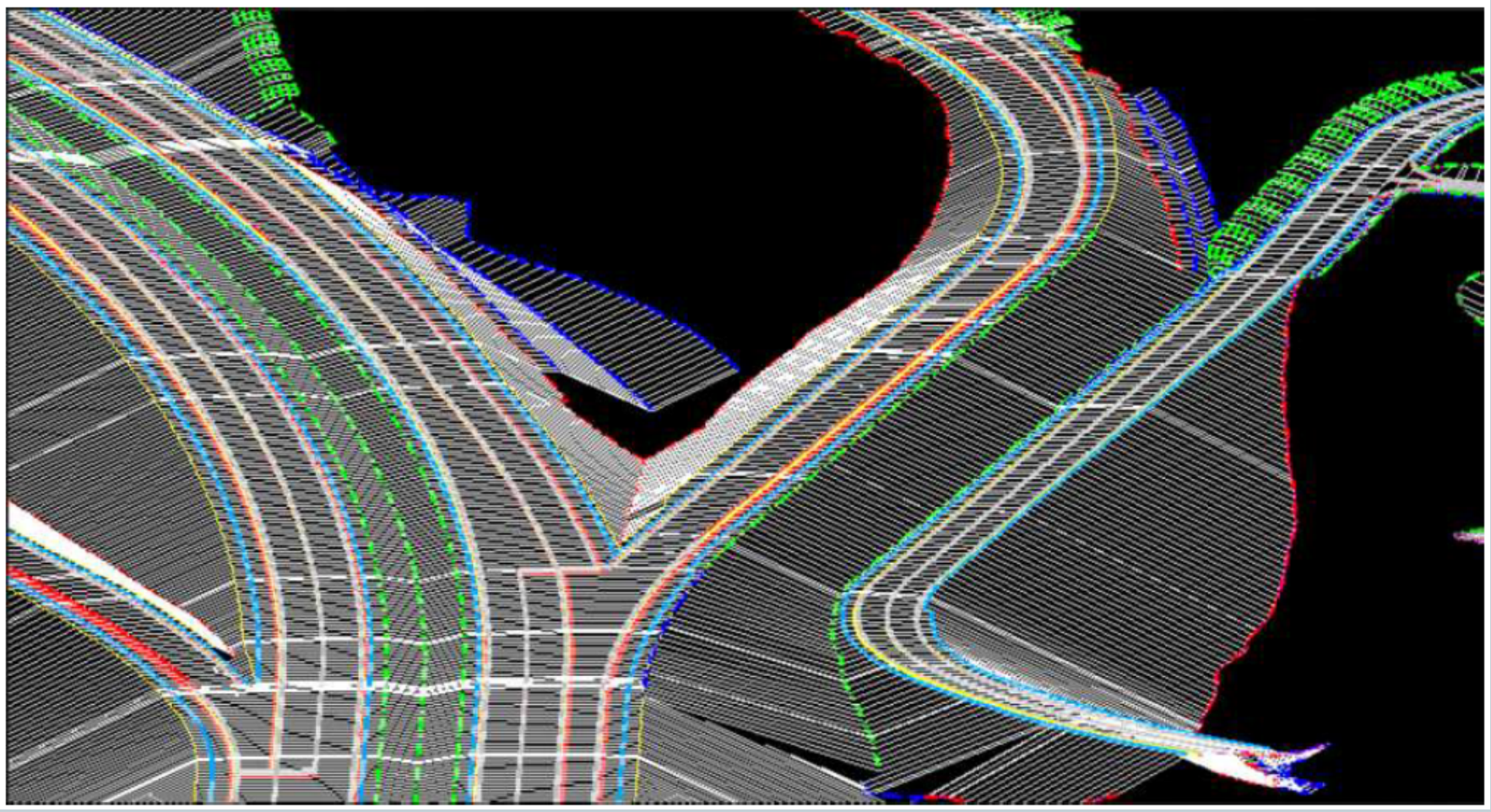


Surface (GEOPAK Terrain)
9.5MB

LiDAR– *Transfer to District Survey and Design*

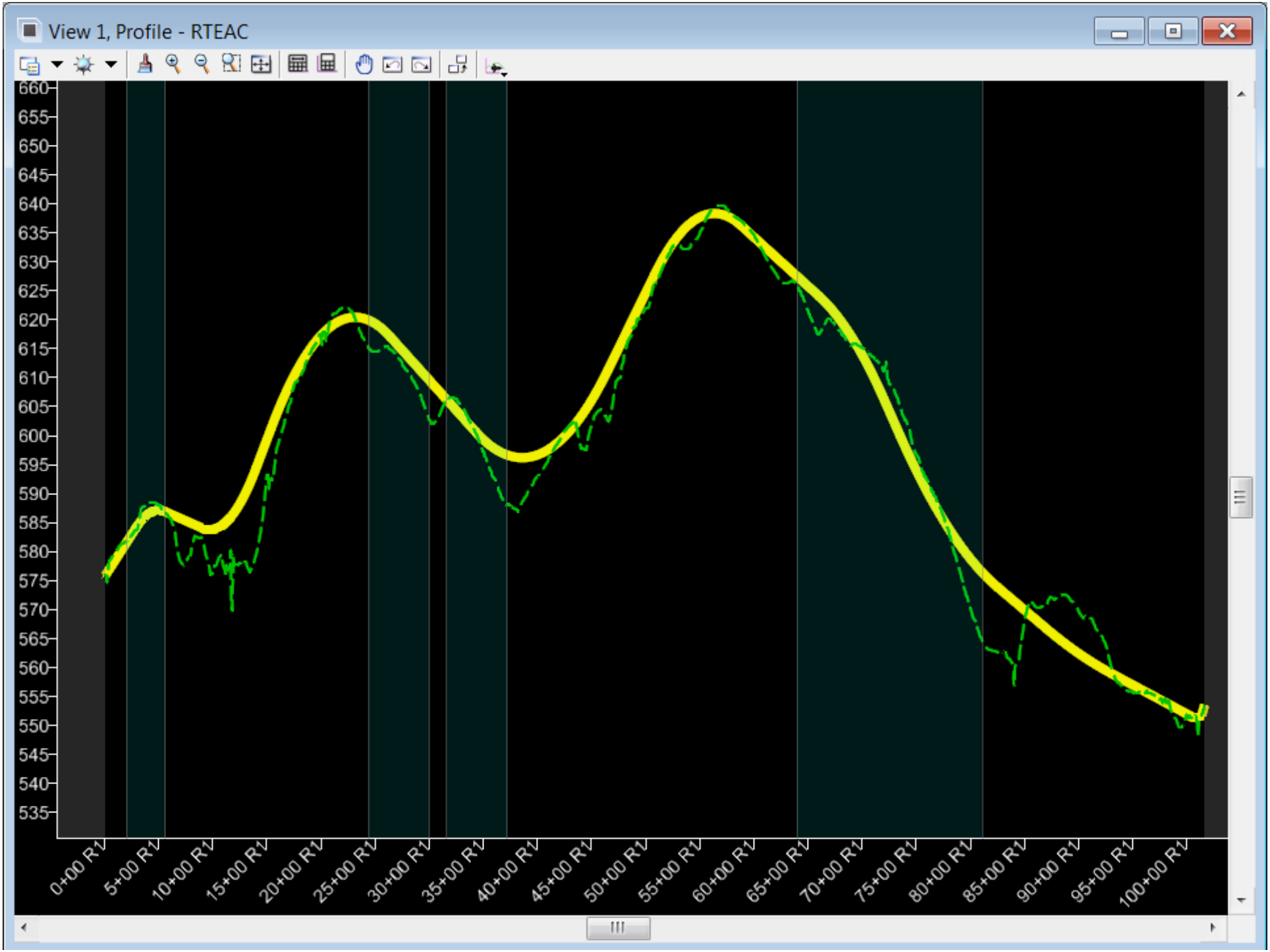
- CADD Services transfers LiDAR District Survey:
- District Survey:
  - performs their own QA
  - adds their survey information and other work such as boundary surveys
- District Survey then transfers the survey data to the Design Team.

Corridor Models



How MoDOT uses LiDAR surfaces to create *Corridor Models?*

- On the Design side, a LiDAR Surface is one of the first pieces of information used in the creation of the *Corridor Model*.
- You need three pieces of information to create a *Corridor model*:
  1. Alignment
  2. Profile
     - Existing, Proposed, etc.
       - Only one profile can be active per *Corridor Model*.
  3. Surface
     - You can have multiple surfaces.
       - Only one active surface per *Corridor Model*.


View 1, Profile - RTEAC
660
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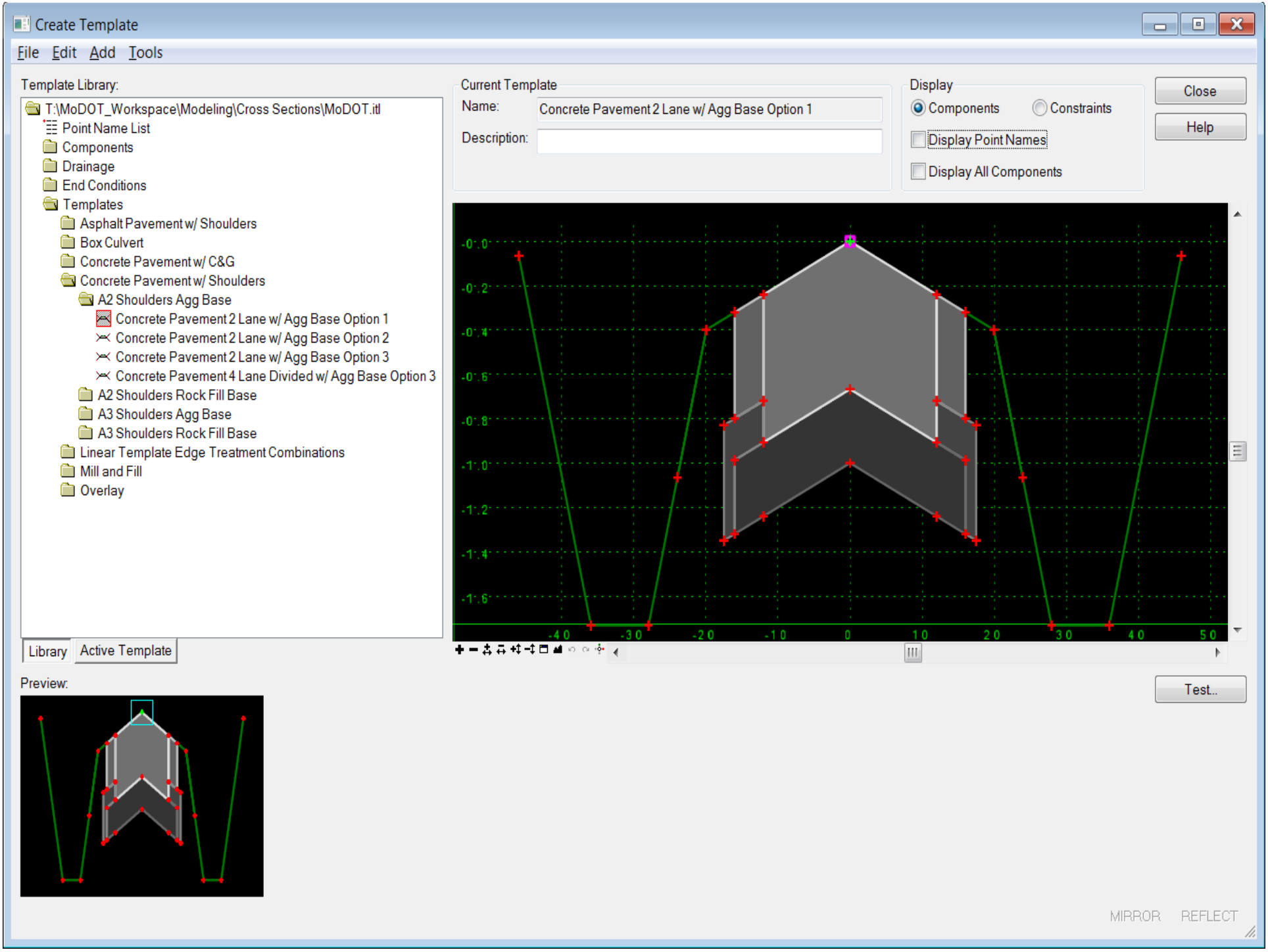
535
0+00 R1
5+00 R1
10+00 R1
15+00 R1
20+00 R1
25+00 R1
30+00 R1
35+00 R1
40+00 R1
45+00 R1
50+00 R1
55+00 R1
60+00 R1
65+00 R1
70+00 R1
75+00 R1
80+00 R1
85+00 R1
90+00 R1
95+00 R1
100+00 R1

How MoDOT uses LiDAR surfaces to create Corridor Models?

- *Corridor Models*
  - There can be multiple *Corridors Models* in a single MicroStation file.
  - Template(s) – tell the Corridor Model what to draw.
    - Components – the main parts of a roadway
      - Pavement, Shoulder, Barrier, Walls, etc.
    - End Conditions – tie Components to a surface (typically ground)
      - Fill & Ditch Slopes.


Create Template
File Edit Add Tools
Template Library:
T:\MoDOT_Workspace\Modeling\Cross Sections\MoDOT.itl
Point Name List
Components
Drainage
End Conditions
Templates
Asphalt Pavement w/ Shoulders
Box Culvert
Concrete Pavement w/ C&G
Concrete Pavement w/ Shoulders
A2 Shoulders Agg Base
Concrete Pavement 2 Lane w/ Agg Base Option 1
Concrete Pavement 2 Lane w/ Agg Base Option 2
Concrete Pavement 2 Lane w/ Agg Base Option 3
Concrete Pavement 4 Lane Divided w/ Agg Base Option 3
A2 Shoulders Rock Fill Base
A3 Shoulders Agg Base
A3 Shoulders Rock Fill Base
Linear Template Edge Treatment Combinations
Mill and Fill
Overlay
Library
Active Template
Current Template
Name:
Concrete Pavement 2 Lane w/ Agg Base Option 1
Description:
Display
Components
Constraints
Display Point Names
Display All Components
Close
Help
-0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-40
-30
-20
-10
0
10
20
30
40
50
Preview:
Test...
MIRROR
REFLECT

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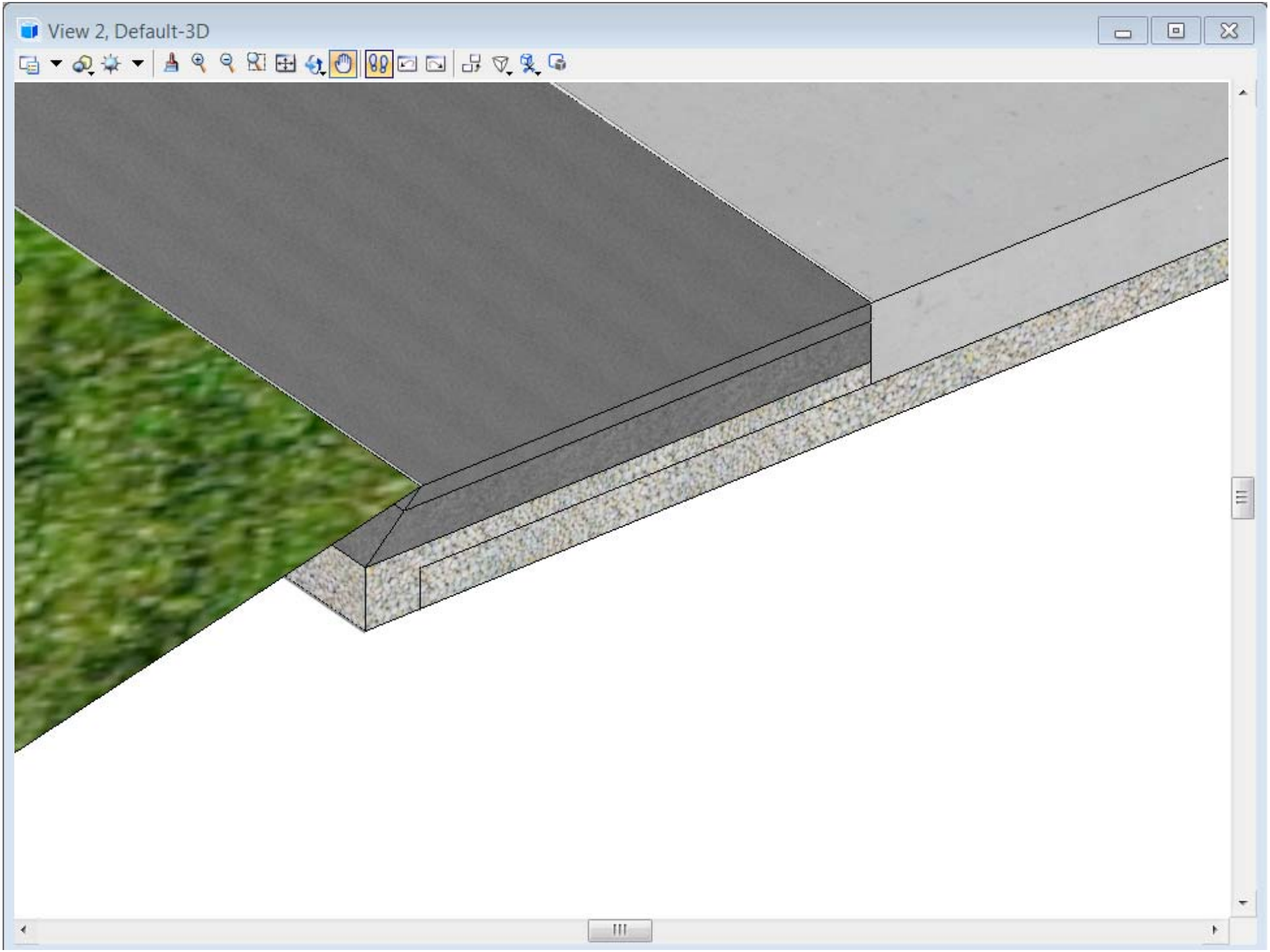
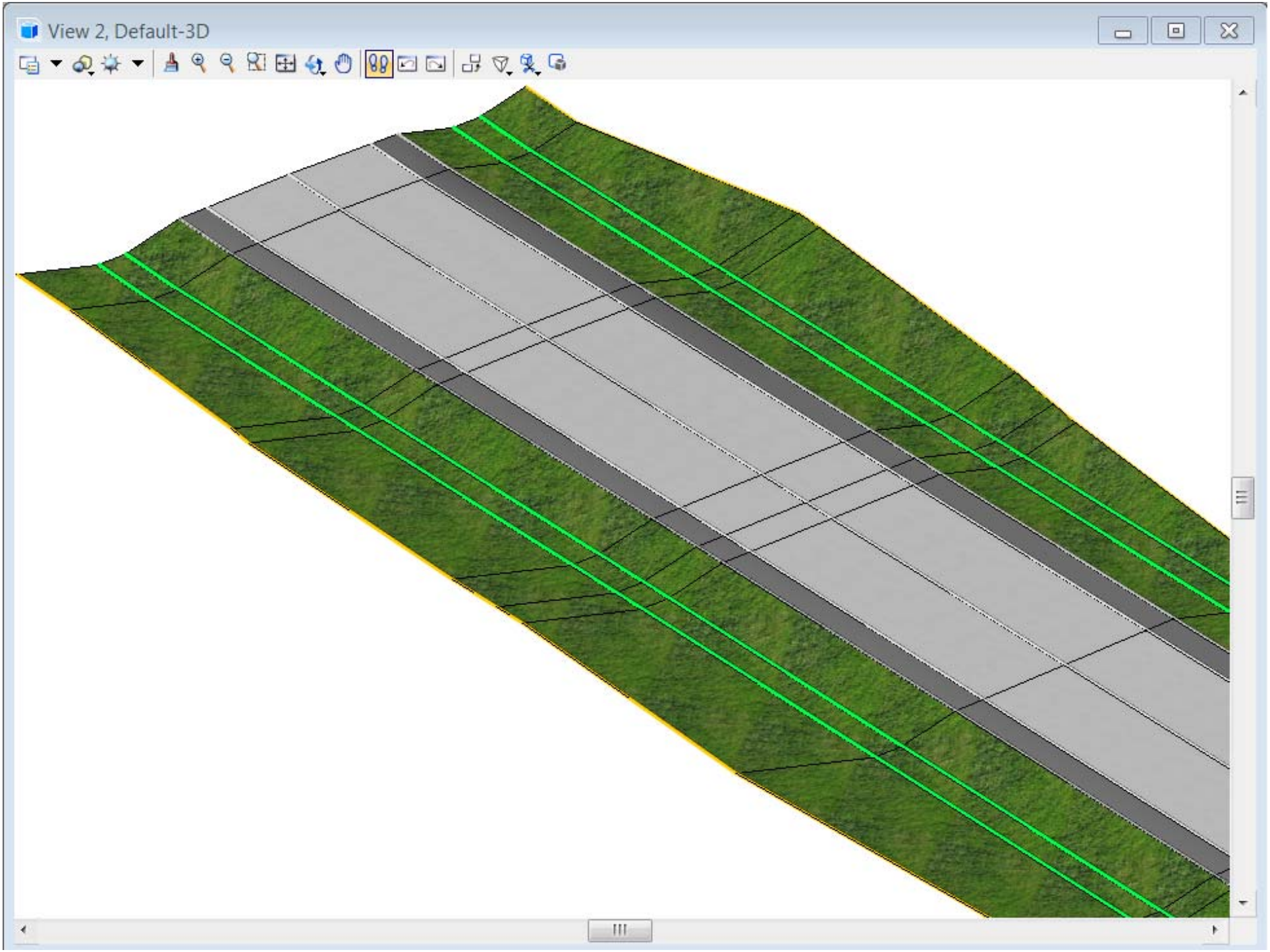

View 2, Default-3D


View 2, Default-3D

How *Corridor Models* are used to Produce Plans

- From the *Corridor Model* the User can create:
  - Cross Sections
    - The “Create Cross-Section” tool basically takes slices of the *Corridor Model*
  - Plan Sheets
    - The *Corridor Model* can create plan view elements
      - Edges of pavement
      - Slope limits
      - Ditch lines
      - etc.
  - Proposed Surfaces
    - This can be generated several ways.

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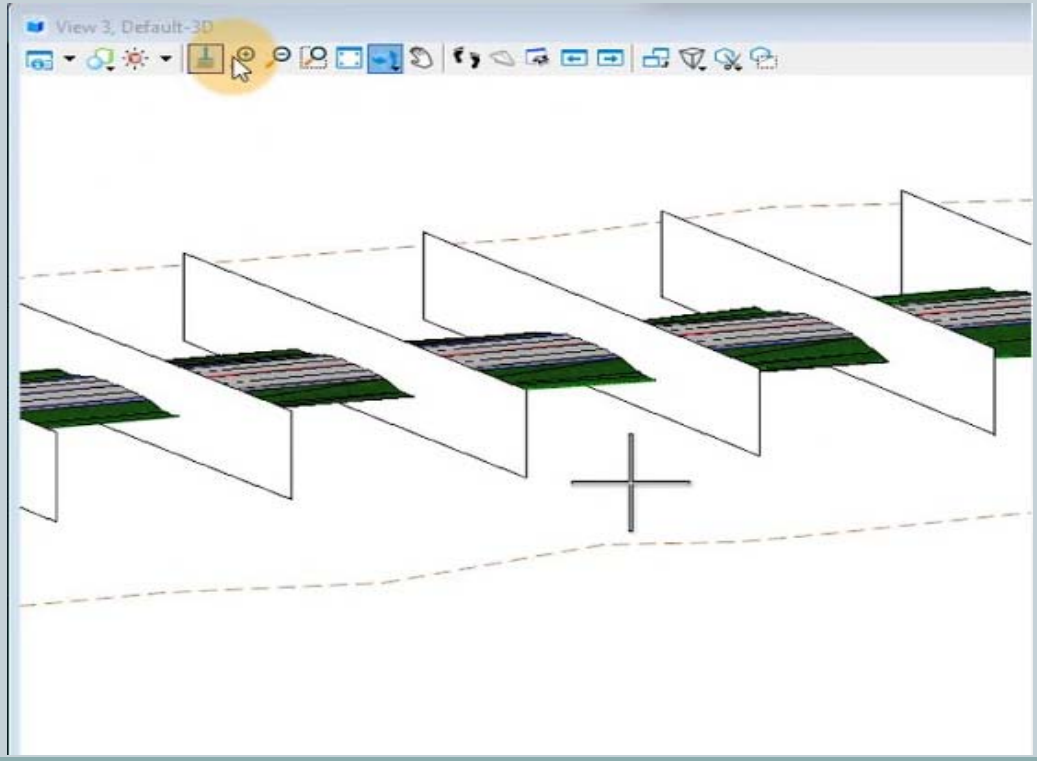

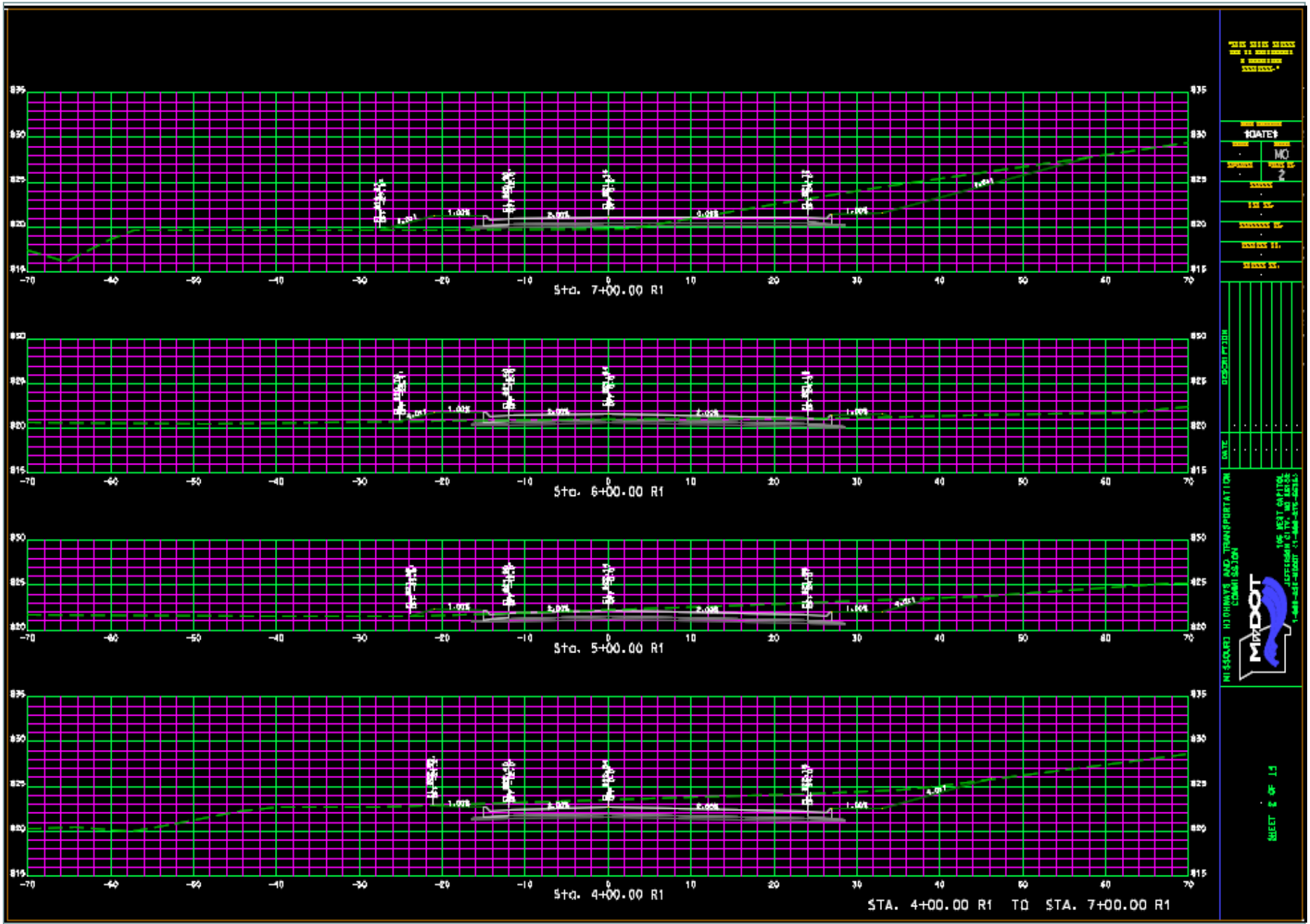
Sta. 7+00.00 R1
Sta. 6+00.00 R1
Sta. 5+00.00 R1
Sta. 4+00.00 R1
STA. 4+00.00 R1 TO STA. 7+00.00 R1
MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
MoDOT
DESCRIPTION
DATE
SHEET 2 OF 13

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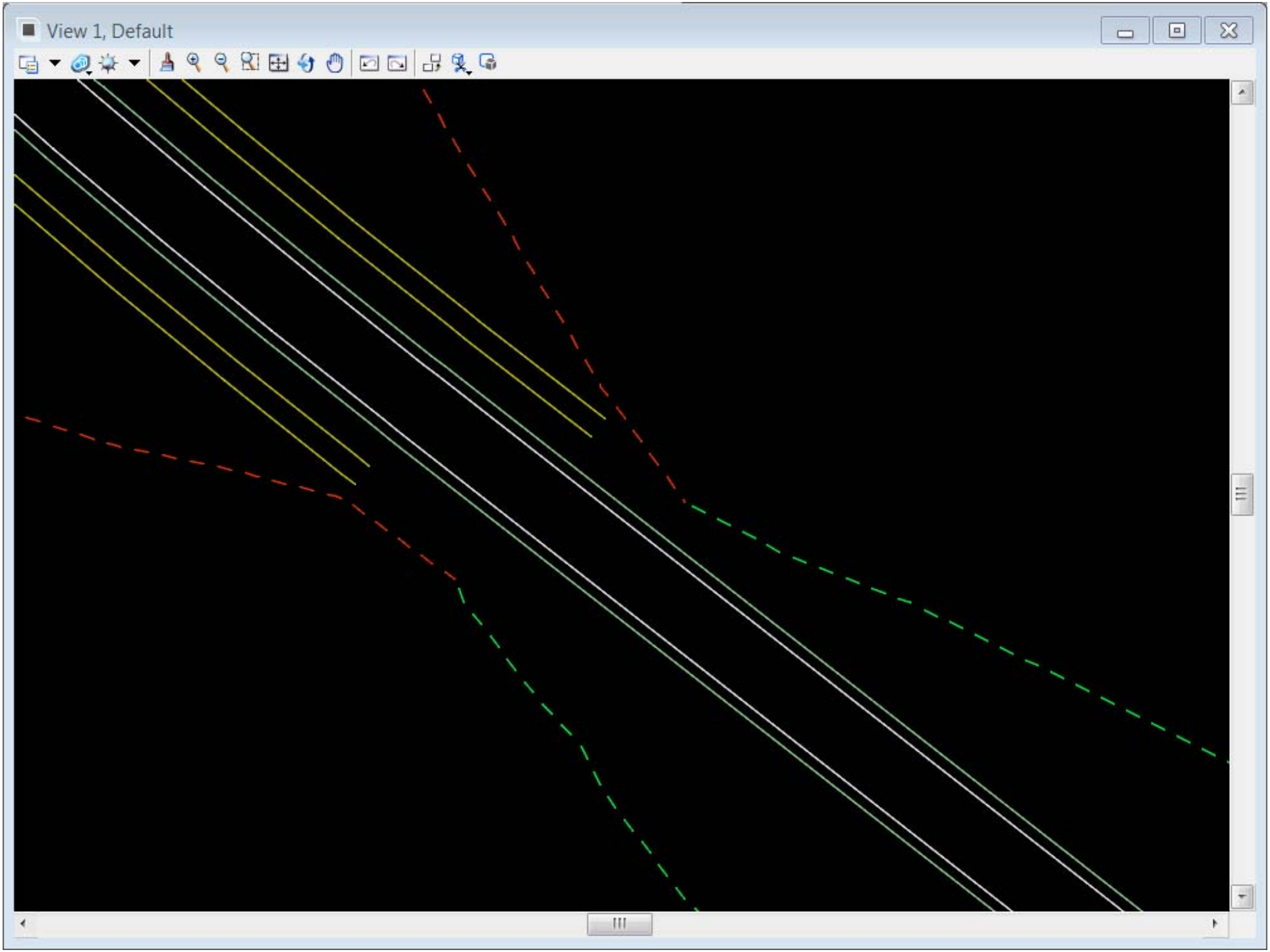
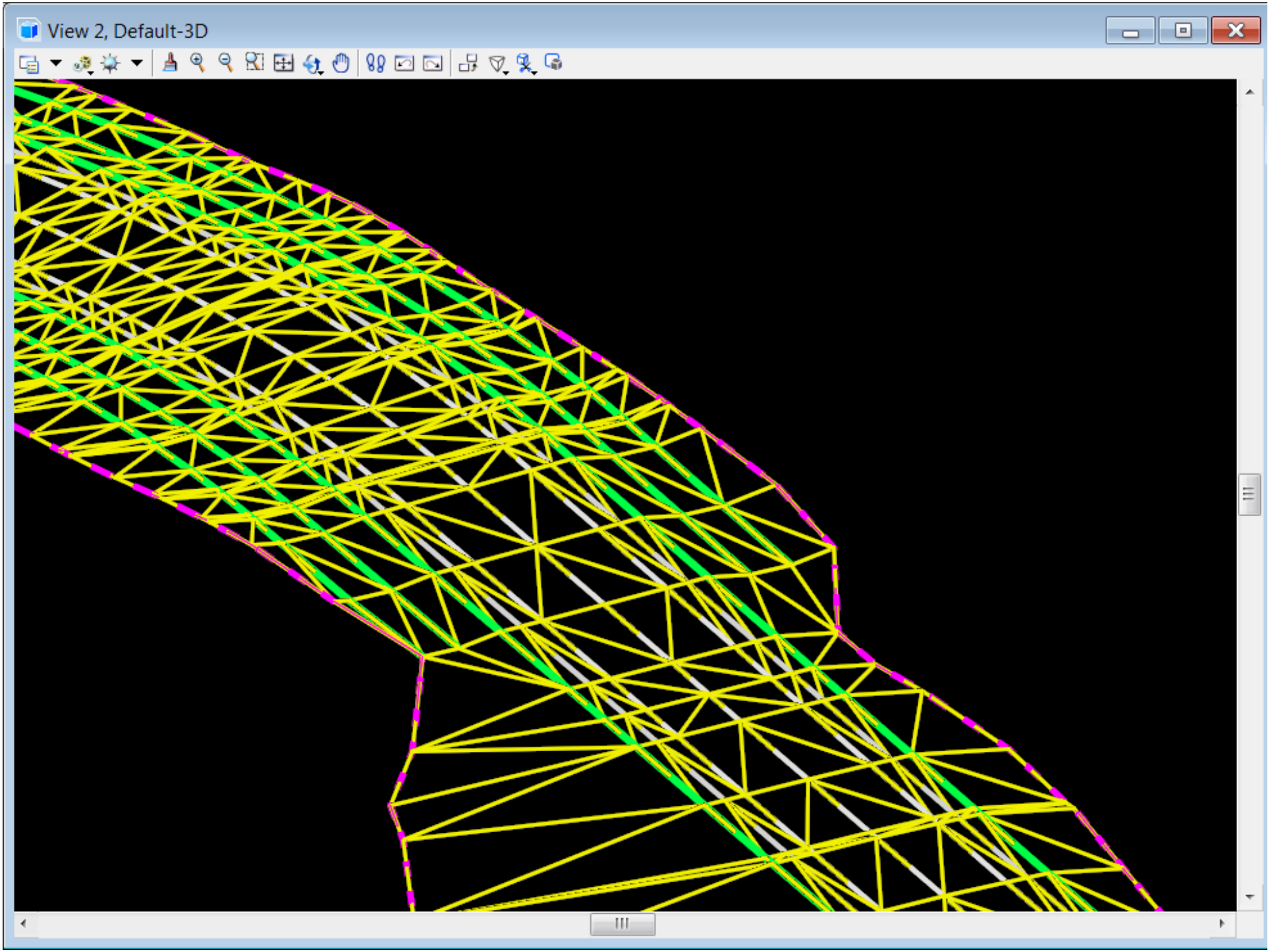

View 1, Default

How Electronic Design Data is Produced

- From the *Corridor Model* the User can create:
  - Proposed Surfaces – Terrain Model
    - Can be created many different ways
      - Create from elements
      - Create from Corridor Alternate Surfaces
      - Create Terrain Model from Graphic Filter


View 2, Default-3D

What Electronic Design Data is Provided to Construction?

- Engineering Policy Guide (EPG) 237.14
  - Updated in early 2018
    - MoDOT and Consultant Electronic Design Data Requirements
    - Required is all Electronic Design Data used to generate the design to be delivered.
      - Files include but are not limited to:
        - Project Data Summary Report (.xlsx)

Project Data Summary Sheet

Missouri Department of Transportation

Submitted Date:

Project Information		
County:		
Project Number:		
Project Location:		
Project Description:		
Project Manager:		
Designer:		

All Design and Survey File Information (.dgn and landXML) - (insert lines for additional files)	Type (geometry, terrain, corridor, superelevation, etc.)	Description
Civil Geometry File Name (.dgn):		
Civil Geometry File Name (xml):		
Corridors File Name (.dgn):		
Terrain Proposed File Name (.dgn):		
Terrain Proposed File Name (.xml):		
Drainage File Name (.dgn):		
Land Boundary File Name (.dgn):		
Pattern Lines File Name (.dgn):		
Plan File Name (.dgn):		
Plan Profile File Name (.dgn):		
Superelevation File Name (.dgn):		
Survey File Name (.dgn):		
Terrain Existing File Name (.dgn):		
Terrain Existing File Name (.xml):		
Cross Section File Name (.dgn):		
Survey Report name (.pdf):		
Corrdinate File Name (.csv, .rec, etc.)		
Any other referenced file (.dgn):		

What Electronic Design Data is Provided?

- Engineering Policy Guide (EPG) 237.14
  - MoDOT and Consultant Electronic Design Data Requirements
    - Required Electronic Design Data includes all files used to generate the design.
      - Files include but are not limited to:
        - Project Data Summary Report (.xlsx)
        - Survey Data
          - Survey file (.dgn)
            - Existing surface(s) export (.xml)
          - Survey Report (.pdf)

Survey Report
(Project Metadata)

Project Information

Route | County | Job Number | District | Date of Survey

Mapping Data Acquisition

- [ ] Conventional
- [ ] Photogrammetry
- [ ] Aerial LiDAR
- [ ] Mobile LiDAR
- [ ] Terrestrial (Static) LiDAR
- [ ] UAV
- [ ] Other (explain)

Explanation

Project Control Metadata

Horizontal Control Reference Source | Adjustment Date | Epoch Date | Horizontal Datum | Coordinate System | State | Zone

Grid Factor | Method of Projection Calculation | Projection Factor | Vertical Control Reference | Vertical Datum | Geoid Model

Geodetic Control Reference Information

Designation | CORS_ID | PID | Type of Control | Adjustment Date | Epoch Date

Latitude (N) | Longitude (W) | Northing (m) | Easting (m) | Ellip. Ht (m) | Geoid Ht (m) | Ortho. Ht (m) | Grid Factor

Designation | CORS_ID | PID | Type of Control | Adjustment Date | Epoch Date

Latitude (N) | Longitude (W) | Northing (m) | Easting (m) | Ellip. Ht (m) | Geoid Ht (m) | Ortho. Ht (m) | Grid Factor

Professional Land Surveyor

Professional Land Surveyor | Title | License Number | State | Phone Number

MoDOT District or Company Name | Address | City | Zip Code

Signature | Date

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- Engineering Policy Guide (EPG) 237.14
  - MoDOT and Consultant Electronic Design Data Requirements
    - Required Electronic Design Data includes all files used to generate the design.
      - Files include but are not limited to:
        - Project Data Summary Report (.xlsx)
        - Survey Data
          - Survey file (.dgn)
            - Existing surface(s) export (.xml)
          - Survey Report (.pdf)
          - Survey Coordinate file(.csv)

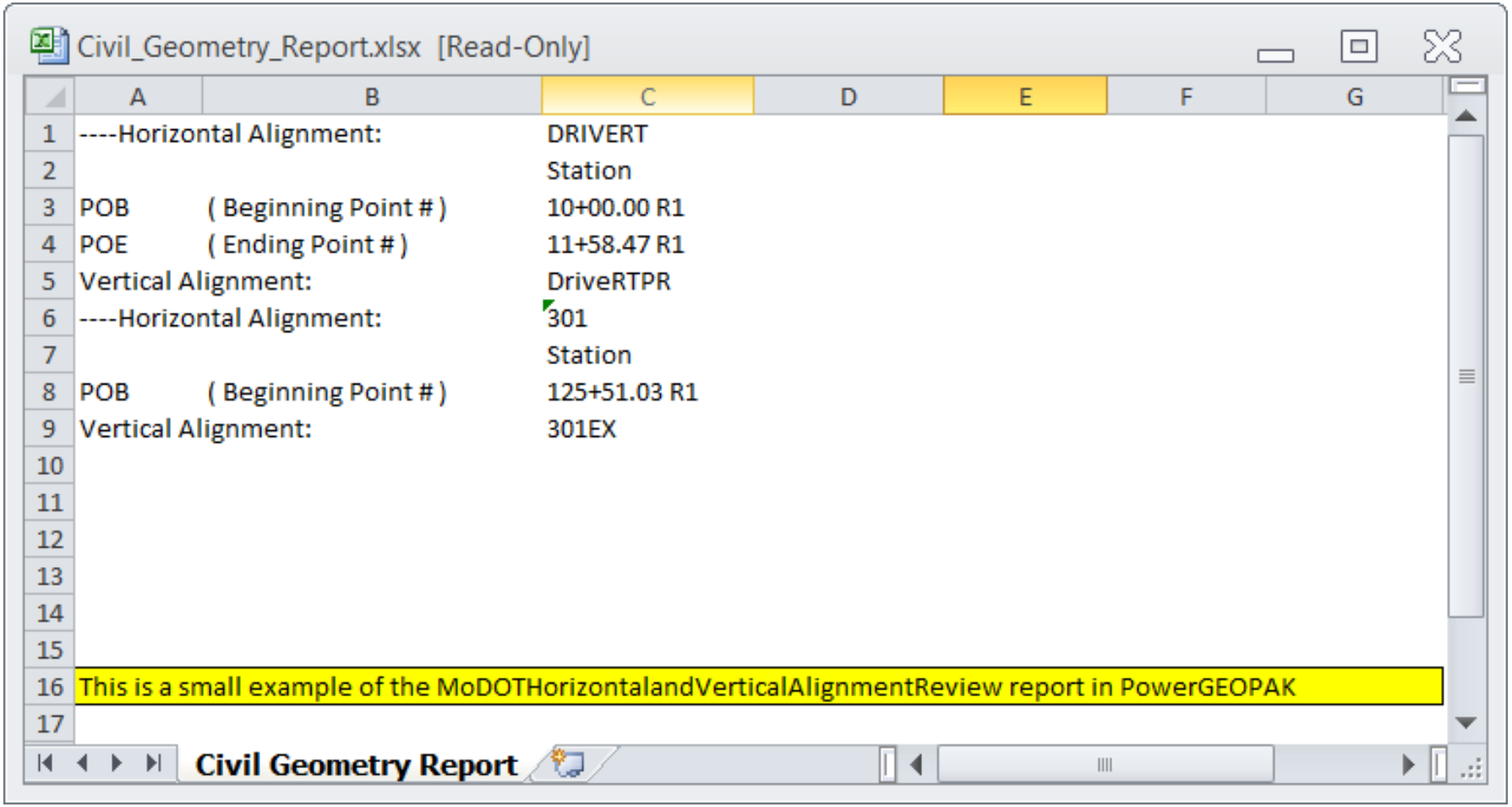
Survey Coordinate file(.csv)

```
CP100,836044.652,349091.900,466.140,74/5/8"RBR 24"LONG W/ALUM CAP
CP101,833477.134,347885.353,469.380,74/5/8"RBR 24"LONG W/ALUM CAP
CP102,833932.628,345059.344,445.430,74/5/8"RBR 24"LONG W/ALUM CAP
CP103,836775.389,347932.856,464.890,74/5/8"RBR 24"LONG W/ALUM CAP
CP104,835167.291,348331.647,435.410,74/5/8"RBR 24"LONG W/ALUM CAP
CP105,834114.840,347854.571,449.840,74/5/8"RBR 24"LONG W/ALUM CAP
CP106,835434.242,347912.179,461.270,74/5/8"RBR 24"LONG W/ALUM CAP
CP107,834397.662,346295.493,410.710,74/5/8"RBR 24"LONG W/ALUM CAP
BM1,835499.64480,348692.67490,453.830,75/SQ TOP W CONC OH SIGNBASE
BM2,834976.6,348141.7,428.000,75/SQ CONC "YEILD" SGN BASE
BM3,834377.100,346282.900,409.040,75/CNTR N EDGE DI
BM4,833994.700,344958.700,448.050,75/NW BLT W LEG SIGN
BM5,833630.900,347819.500,465.210,75/SPK N SIDE 24" POSTOAK
BM6,834787.100,347863.300,447.360,75/SQR TOP W END S CONC WHLGRD
BM7,835121.200,347898.700,456.290,75/SQR TOP E END N CONC WHLGRD
BM8,835821.600,347928.500,426.350,75/SPIKE S ROOT 24" W OAK
BM9,836974.800,347947.100,462.550,75/SQ NW COR CON SIGN BASE
```

What Electronic Design Data is Provided?

- 237.14 Electronic Design Data Delivery - MoDOT and Consultant Electronic Design Data Requirements
  - Required Electronic Design Data includes all files used to generate the design.
    - Files include but are not limited to:
      - Civil geometry file (.dgn)
        - Alignment(s) & Profile(s), export (.xml)
        - Civil geometry report (.xlsx)

Civil geometry report (.xlsx)



What Electronic Design Data is Provided?

- 237.14 Electronic Design Data Delivery - MoDOT and Consultant Electronic Design Data Requirements
  - Required Electronic Design Data includes all files used to generate the design.
    - Files include but are not limited to:
      - Civil geometry file (.dgn)
        - Alignment(s) & Profile(s), export (.xml)
        - Civil geometry report (.xlsx)
      - Corridor file(s) plus reference(.dgn)
      - Proposed Terrain(.dgn), export(.xml)
      - Plan sheets plus references (.dgn)
      - Signed Adobe Acrobat plan sheets (.pdf)

Update from CADD Services

Any Questions?