





# How To Create a GIS Rock Slope Inventory Without Ever Leaving Your Office



**Brian S. Bruckno, Ph.D., P.G.**



**Yonathan Admassu, Ph.D.**



**William Swanger**

# How To Create a GIS Rock Slope Inventory Without Ever Leaving Your Office (Almost)



**Brian S. Bruckno, Ph.D., P.G.**



**Yonathan Admassu, Ph.D.**



**William Swanger**

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)

# The Law

- **Map-21**
- **F.A.S.T. Act**
  
- **Encourage, but do not *require*, geotechnical asset inventory.**

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)

# The Law

- **Map-21**
- **F.A.S.T. Act**
- **Encourage, but do not *require*, geotechnical asset inventory.**
- **Some states have moved forward with a rock slope inventory – but...**

The Law

Basemaps

DEM

Surface  
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DB and  
Rating (?)

# The Law

- **Rock slope inventories from scratch are –**
  - **Expensive**
  - **Time-Consuming**
  - **Divert technical experts**
  - **Have a perceived poor return on investment**

The Law

Basemaps

DEM

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DB and  
Rating (?)

# The Law

- **So, can we compile a rough rock slope inventory using existing data and analysis methods?**
- **Existing Basemaps? Free DEMs? Built-in tools in ArcGIS?**

# Basemaps

The Law

Basemaps

DEM

Surface  
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DB and  
Rating (?)

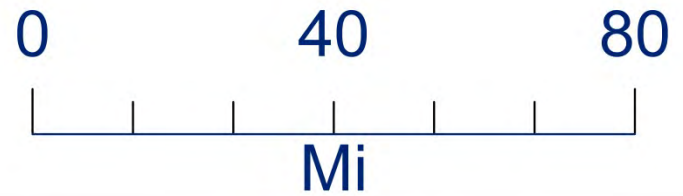
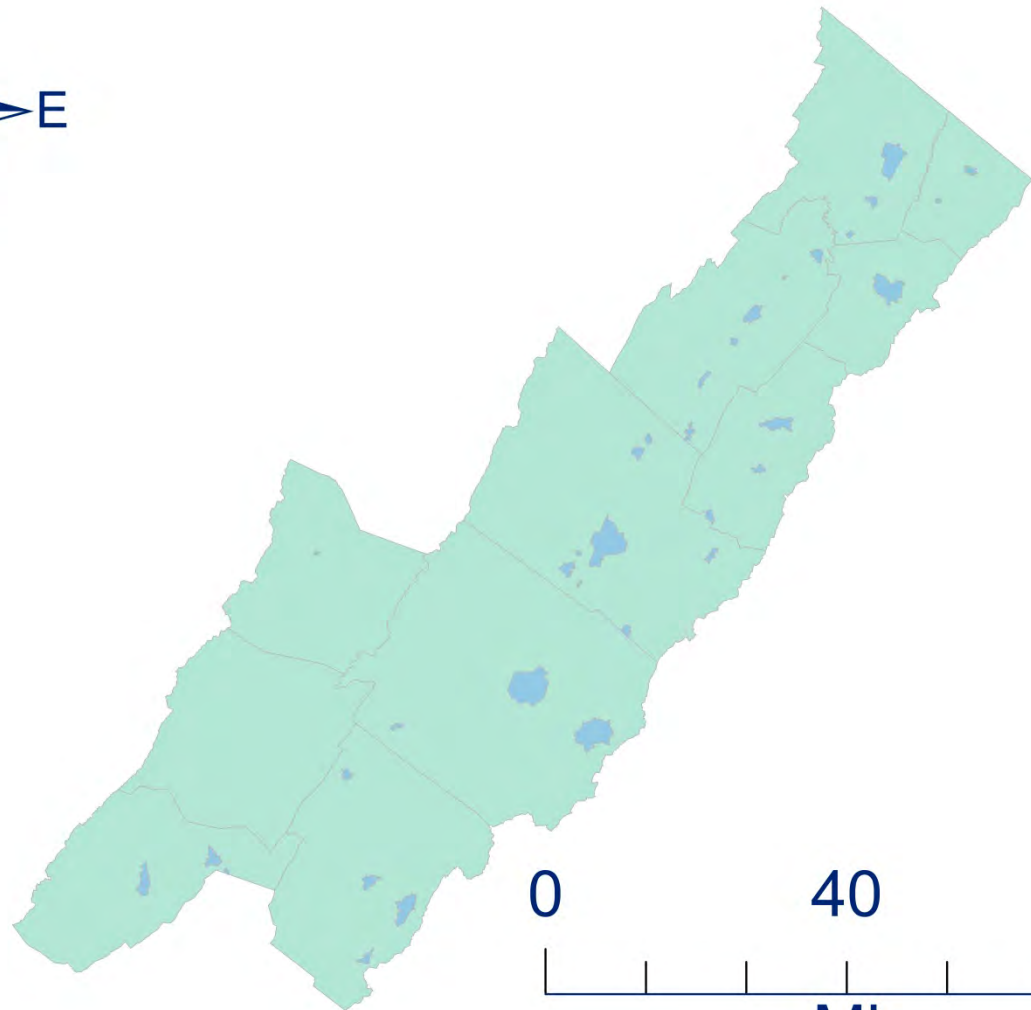
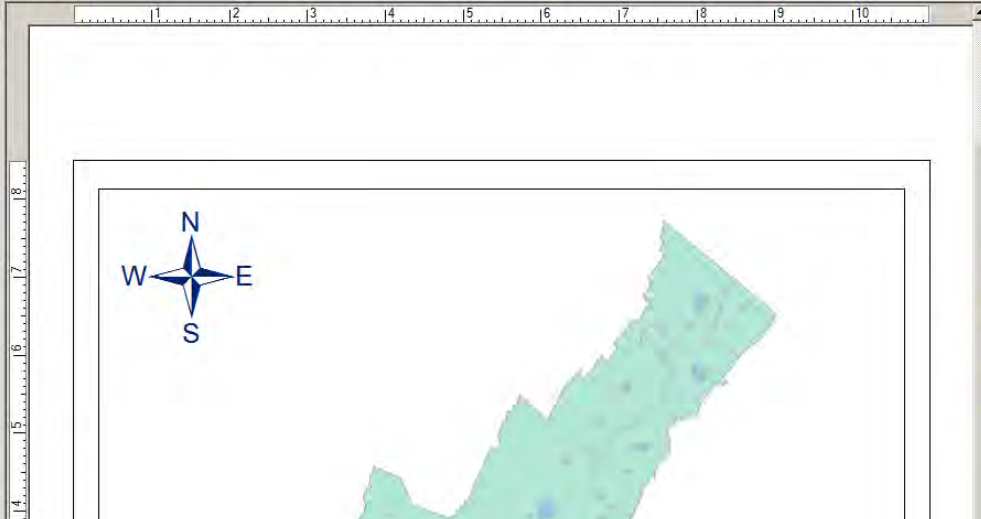




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    - Mosaic\_DEM\_in\_District
    - Slope\_in\_District
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    - AOISubsidenceNovember2014\_LOWEST\_RESIDUAL\_ON\_STRUCT



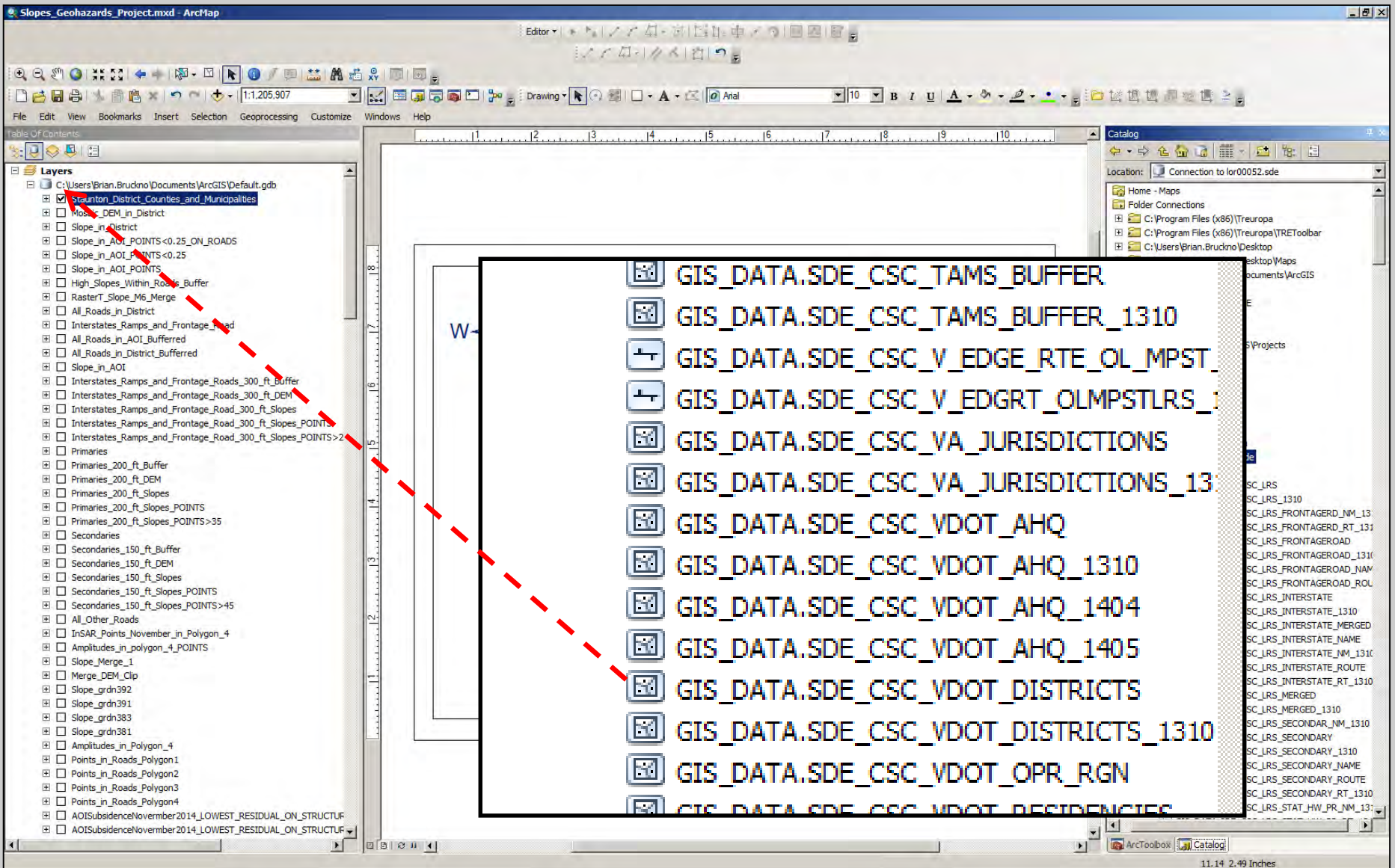
Add Database Server

- Database Connections
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    - GIS\_DATA.CSC
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      - GIS\_DATA.SDE\_CSC\_LRS\_FRONTAGERD N

Catalog

Location: Connection to lor00052.sde

- Home - Maps
- Folder Connections
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  - C:\Program Files (x86)\Treuropa\TREToolbar
  - C:\Users\Brian.Bruckno\Desktop
  - C:\Users\Brian.Bruckno\Desktop\Maps
  - C:\Users\Brian.Bruckno\Documents\ArcGIS
  - E:\
  - E:\RITA14\GIS RITA HOME
  - E:\RITA14\TIFFS\N16\_79
  - F:\
  - \\dotgiswebst\Public.GIS\Projects
- Toolboxes
  - My Toolboxes
  - System Toolboxes
- Database Servers
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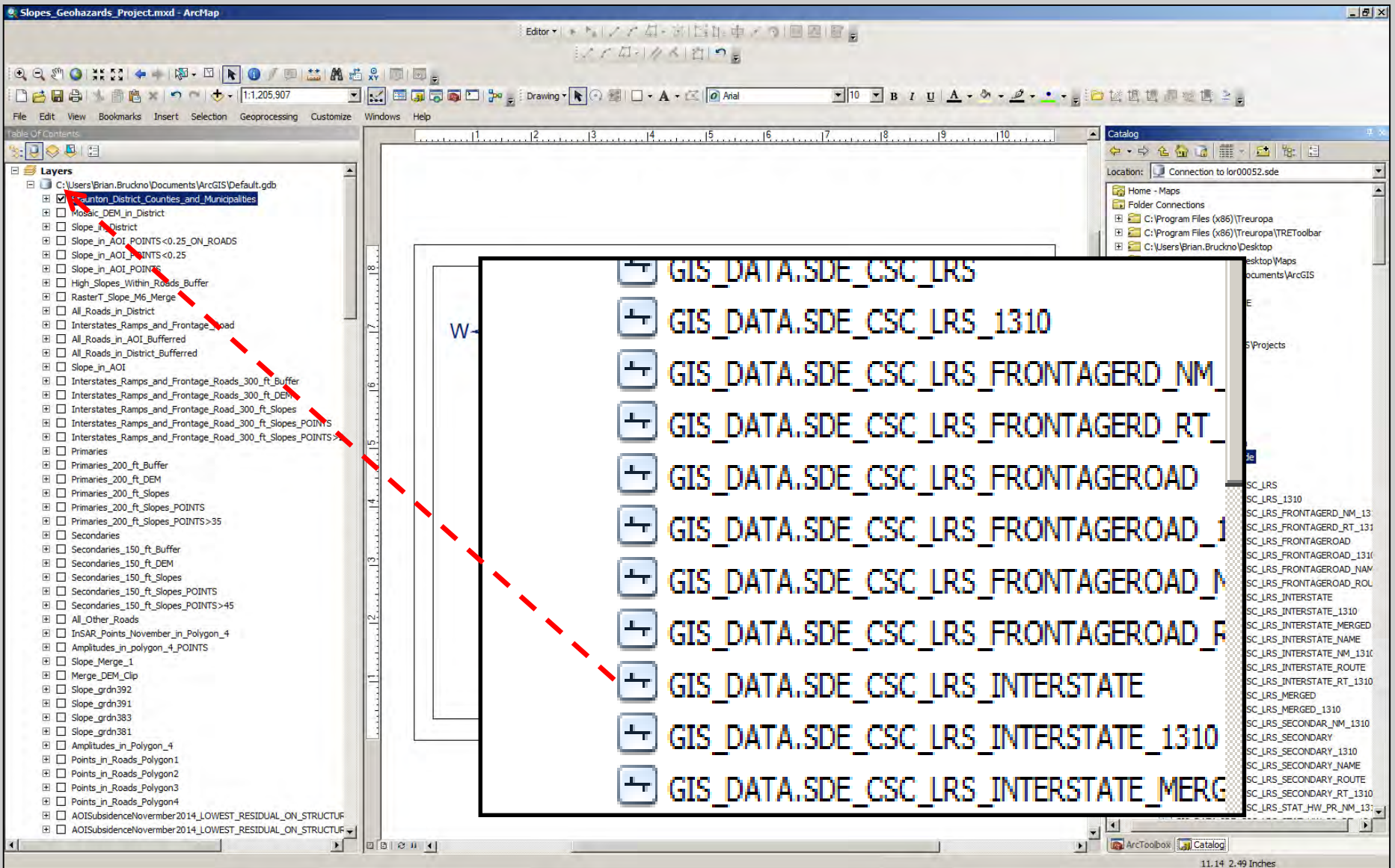
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- Documents\ArcGIS
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  - SC\_LRS\_SECONDARY\_ROUTE
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ArcToolbox Catalog





- GIS\_DATA.SDE\_CSC\_LRS
- GIS\_DATA.SDE\_CSC\_LRS\_1310
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# Basemaps

The Law

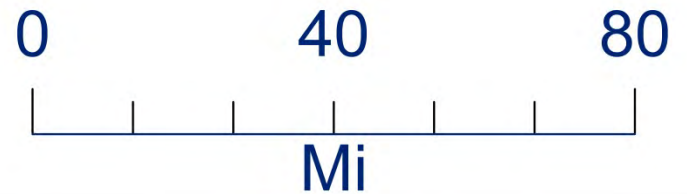
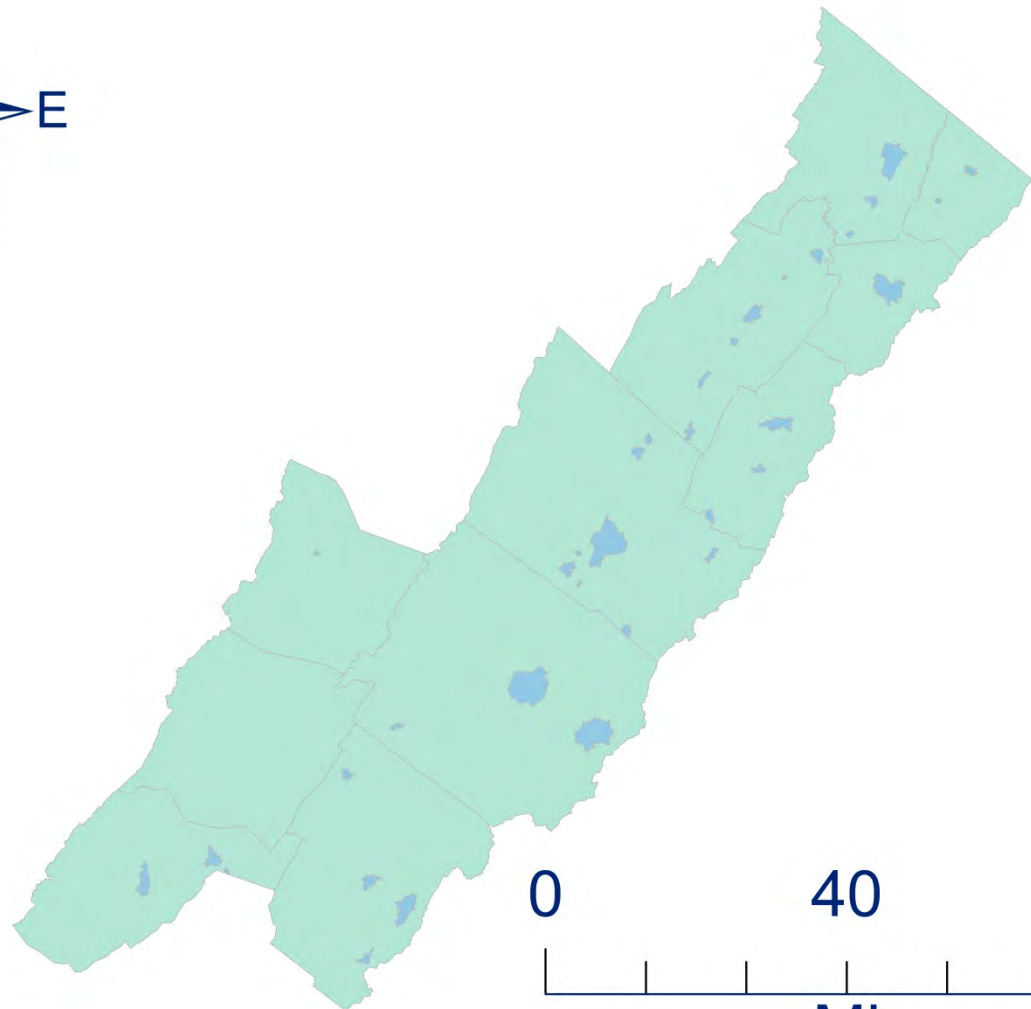
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)





The Law

Basemaps

DEM

Surface  
Analysis

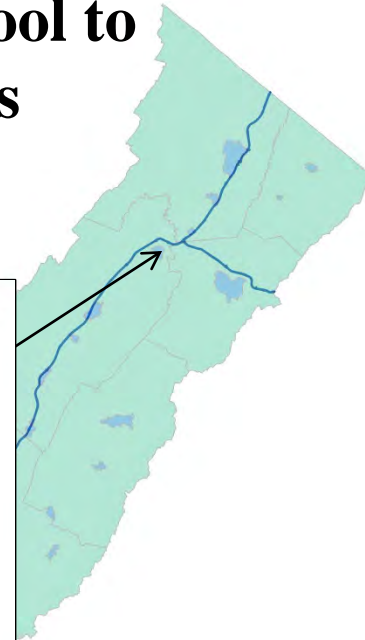
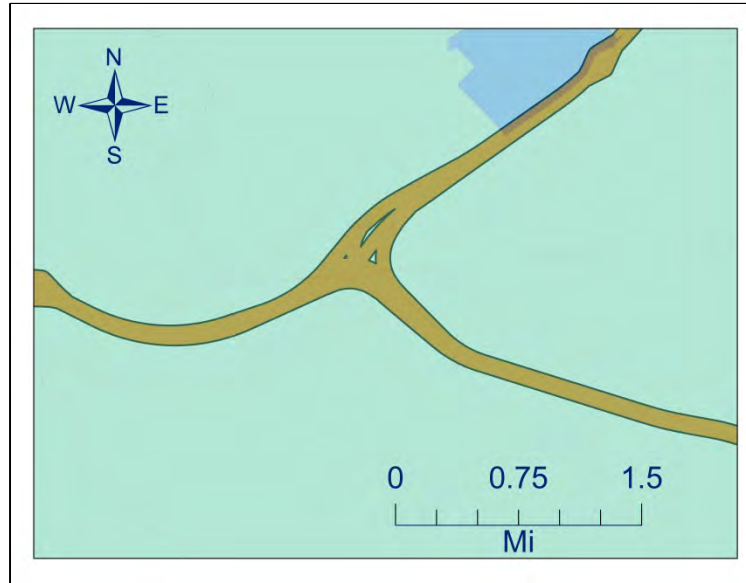
Logical  
Analysis

DB and  
Rating (?)

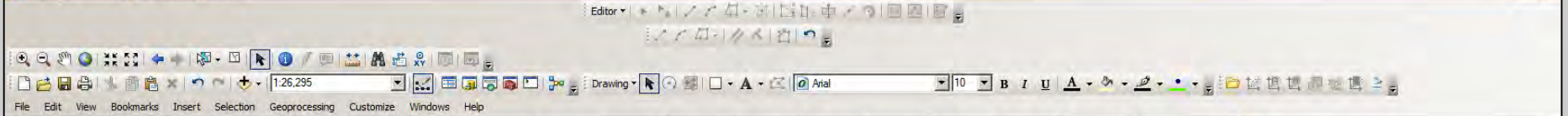
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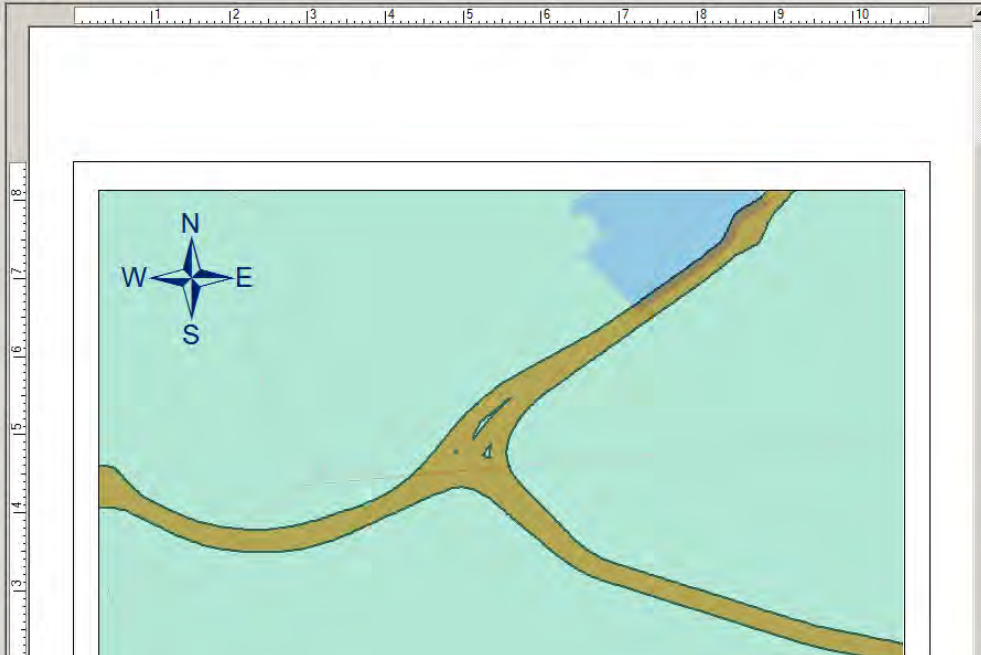
**Use the Proximity tool to  
Buffer the roads**



Tool: ArcToolbox→Analysis Tools→Proximity→Buffer



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<input type="checkbox"/>	InSAR_Points_November_in
<input type="checkbox"/>	Amplitudes_in_polygon_4_P



- ArcToolbox
  - 3D Analyst Tools
  - Analysis Tools
    - Extract
      - Clip
      - Select
      - Split
      - Table Select
    - Overlay
      - Erase
      - Identity
      - Intersect
      - Spatial Join
      - Symmetrical Difference
      - Union
      - Update
    - Proximity
      - Buffer
      - Create Thiessen Polygons
      - Generate Near Table
      - Multiple Ring Buffer
      - Near
      - Point Distance
      - Polygon Neighbors
    - Statistics
    - Cartography Tools
      - Annotation
      - Cartographic Refinement
      - Data Driven Pages
      - Generalization
      - Graphic Conflicts
      - Grids and Graticules
      - Masking Tools
      - Representation Management
    - Conversion Tools
      - Excel
      - From GPS
      - From KML
      - From Raster
        - Raster to ASCII
        - Raster to Float
        - Raster to Point
        - Raster to Polygon
        - Raster to Polyline
        - Raster To Video
      - From WFS
      - JSON
      - Metadata
      - To CAD
      - To Collada
      - To Coverage
      - To dBASE
      - To dBASE
      - To Database
        - Tracked Database

Raster To Polyline

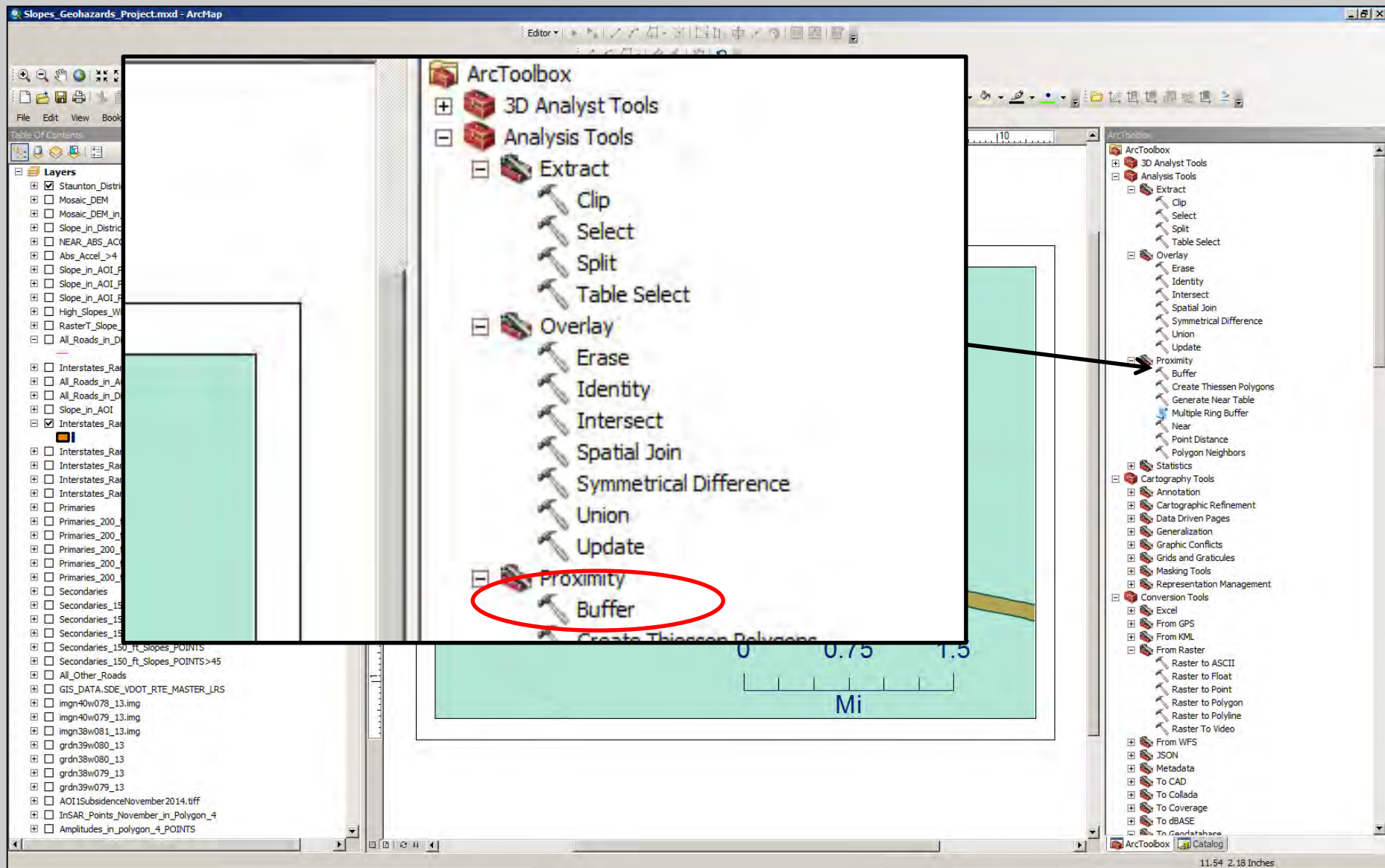
Raster To Video

- From WFS
- JSON
- Metadata
- To CAD
- To Collada
- To Coverage
- To dBASE
- To Database

ArcToolbox | Catalog

11.54 2.18 Inches





Tool: ArcToolbox→Analysis Tools→Proximity→Buffer



# Basemaps

The Law

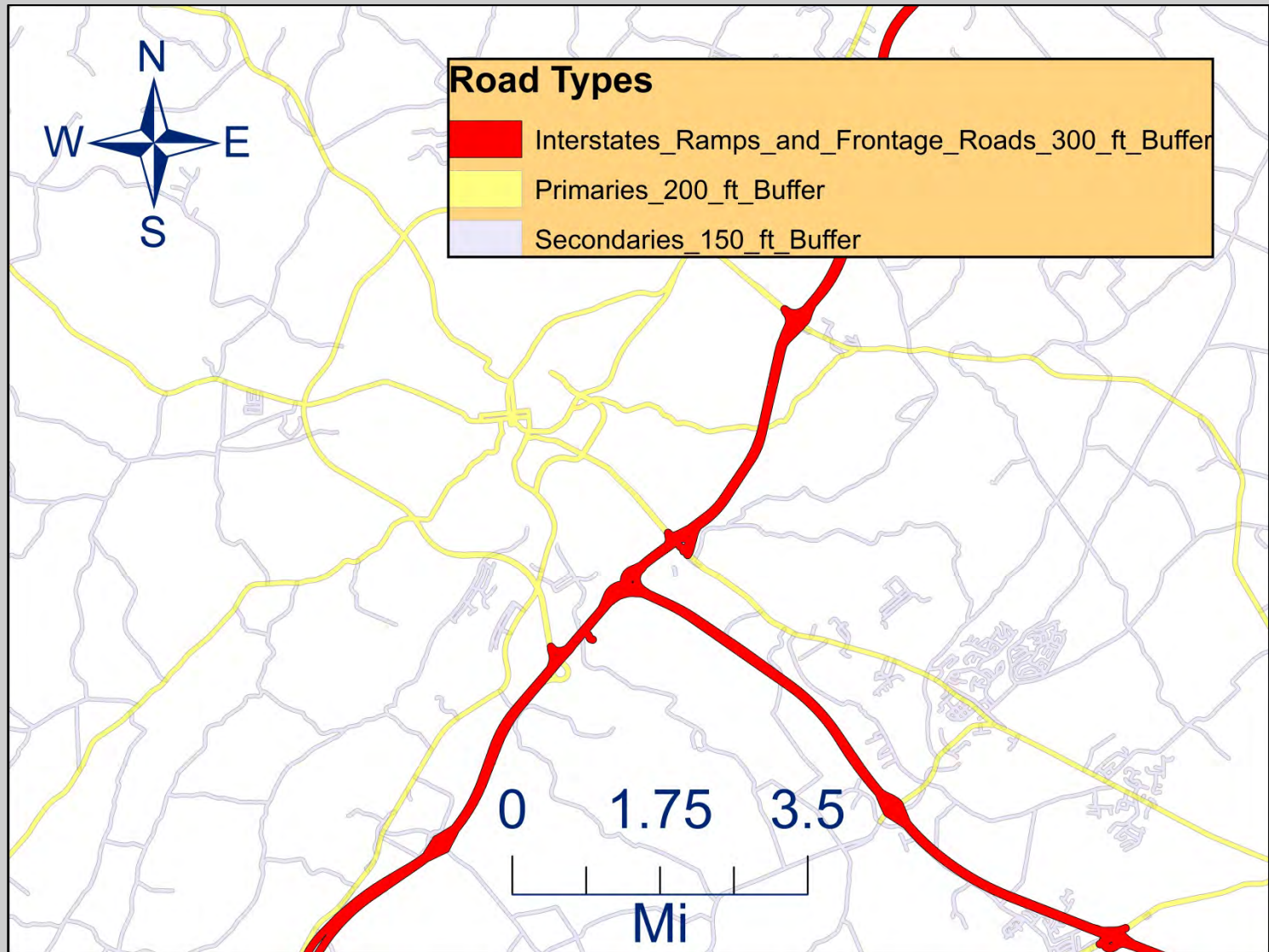
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DB and Rating (?)

# DEM: <http://viewer.nationalmap.gov>

The screenshot shows the National Map Viewer interface. The top navigation bar includes '3DEP View (V1.0)', 'How to', 'Start Over', 'Custom Views', and 'Share Link'. The main content area is divided into 'Datasets' and 'Products' tabs. Under 'Products', there are 'Available Products' and 'Elevation Products (3DEP)' sections. A table lists three DEM products with their respective metadata and actions.

Preview	Product	Actions	Cart
<input type="checkbox"/> <a href="#">Im</a>	USGS NED n45w122 1/3 arc-second 20140718 1 x 1 degree ArcGrid <b>Published Date:</b> 2014-07-18 <b>Metadata Updated:</b> 2014-07-22 <b>Format:</b> ArcGrid (490.89 MB), <b>Extent:</b> 1 x 1 degree	<a href="#">Footprint</a> <a href="#">Thumbnail</a> <a href="#">Zoom To</a> <a href="#">Info/Metadata</a> <a href="#">Download</a>	<a href="#">+</a> <a href="#">-</a>
<input type="checkbox"/> <a href="#">Im</a>	USGS NED 1/3 arc-second n40w078 1 x 1 degree ArcGrid 2015 <b>Published Date:</b> 2015-07-21 <b>Metadata Updated:</b> 2015-08-11 <b>Format:</b> ArcGrid (367.14 MB), <b>Extent:</b> 1 x 1 degree	<a href="#">Footprint</a> <a href="#">Thumbnail</a> <a href="#">Zoom To</a> <a href="#">Info/Metadata</a> <a href="#">Download</a>	<a href="#">+</a> <a href="#">-</a>
<input type="checkbox"/> <a href="#">Im</a>	USGS NED n40w104 1/3 arc-second 2013 1 x 1 degree ArcGrid <b>Published Date:</b> 2013-01-01 <b>Metadata Updated:</b> 2014-07-22 <b>Format:</b> ArcGrid (316.06 MB), <b>Extent:</b> 1 x 1 degree	<a href="#">Footprint</a> <a href="#">Thumbnail</a> <a href="#">Zoom To</a> <a href="#">Info/Metadata</a> <a href="#">Download</a>	<a href="#">+</a> <a href="#">-</a>

The map on the right shows the United States with state boundaries and major cities labeled. The interface includes a search bar, map controls (zoom, pan, home), and a legend. A download dialog box is visible at the bottom, asking to open or save 'USGS\_NED\_13\_n39w079\_ArcGrid.zip (368 MB) from rockyftp.cr.usgs.gov?'. The footer contains 'DIA Privacy Policies and Notices'.

# DEM

The Law

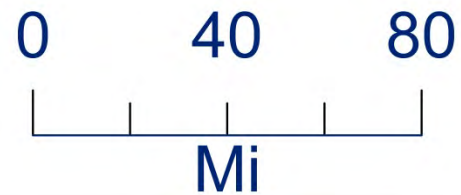
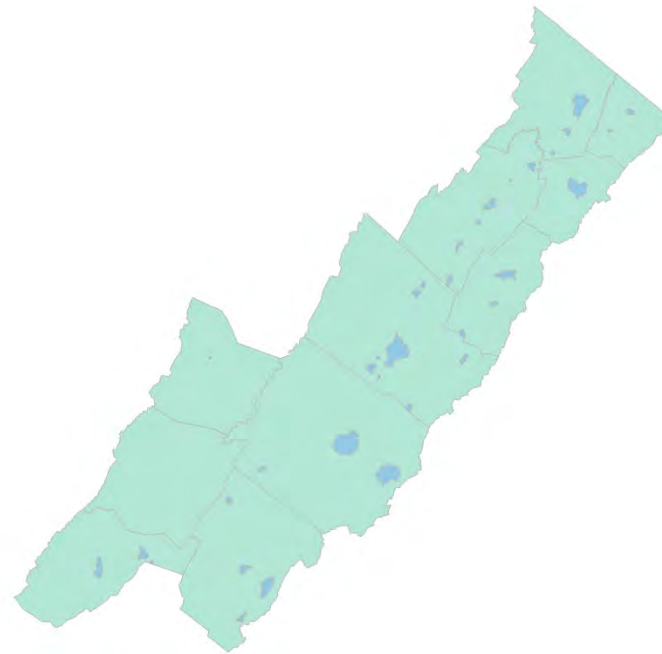
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**DEM**

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Analysis

Logical  
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DB and  
Rating (?)



# DEM

The Law

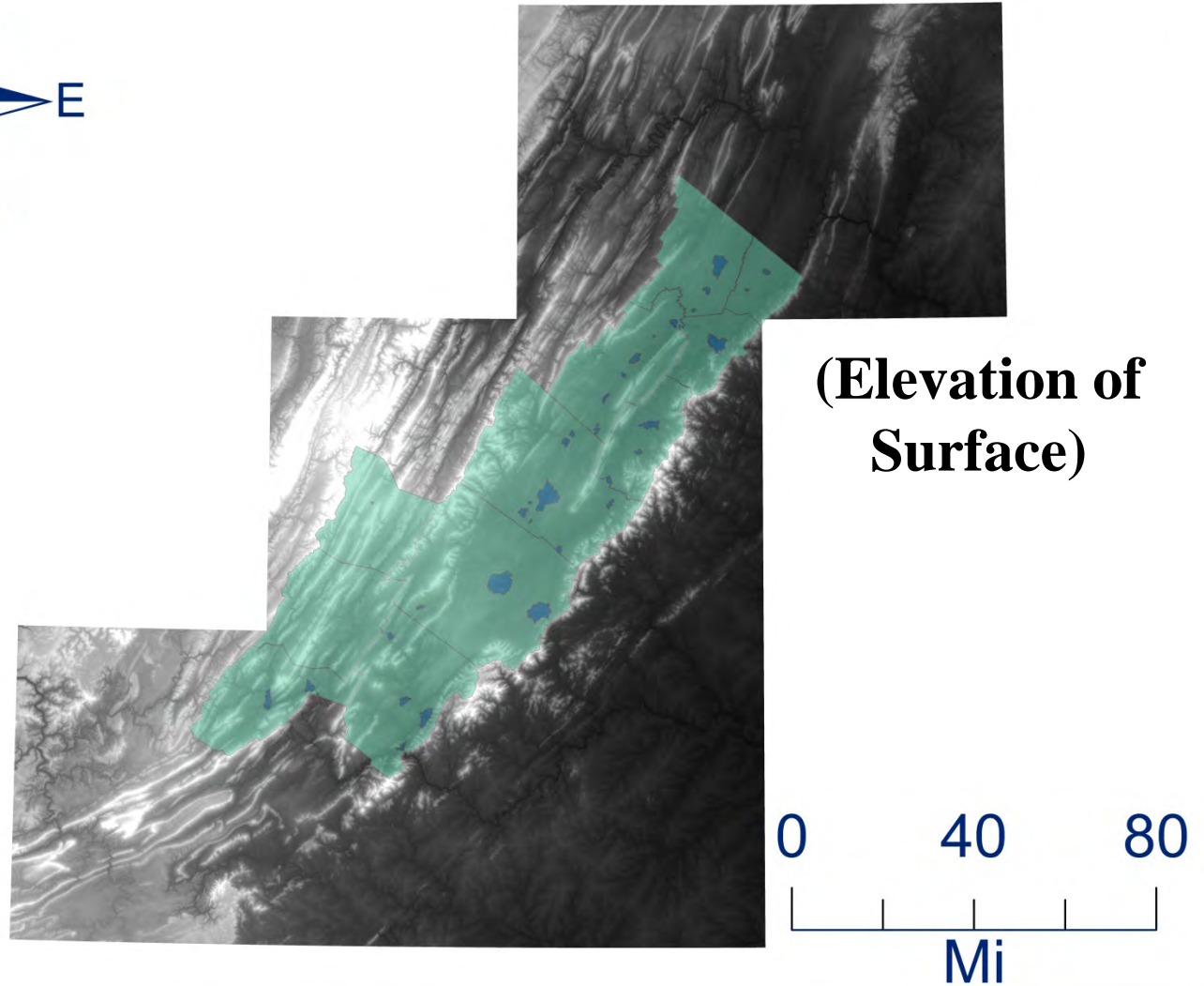
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Analysis

DB and  
Rating (?)





# DEM

The Law

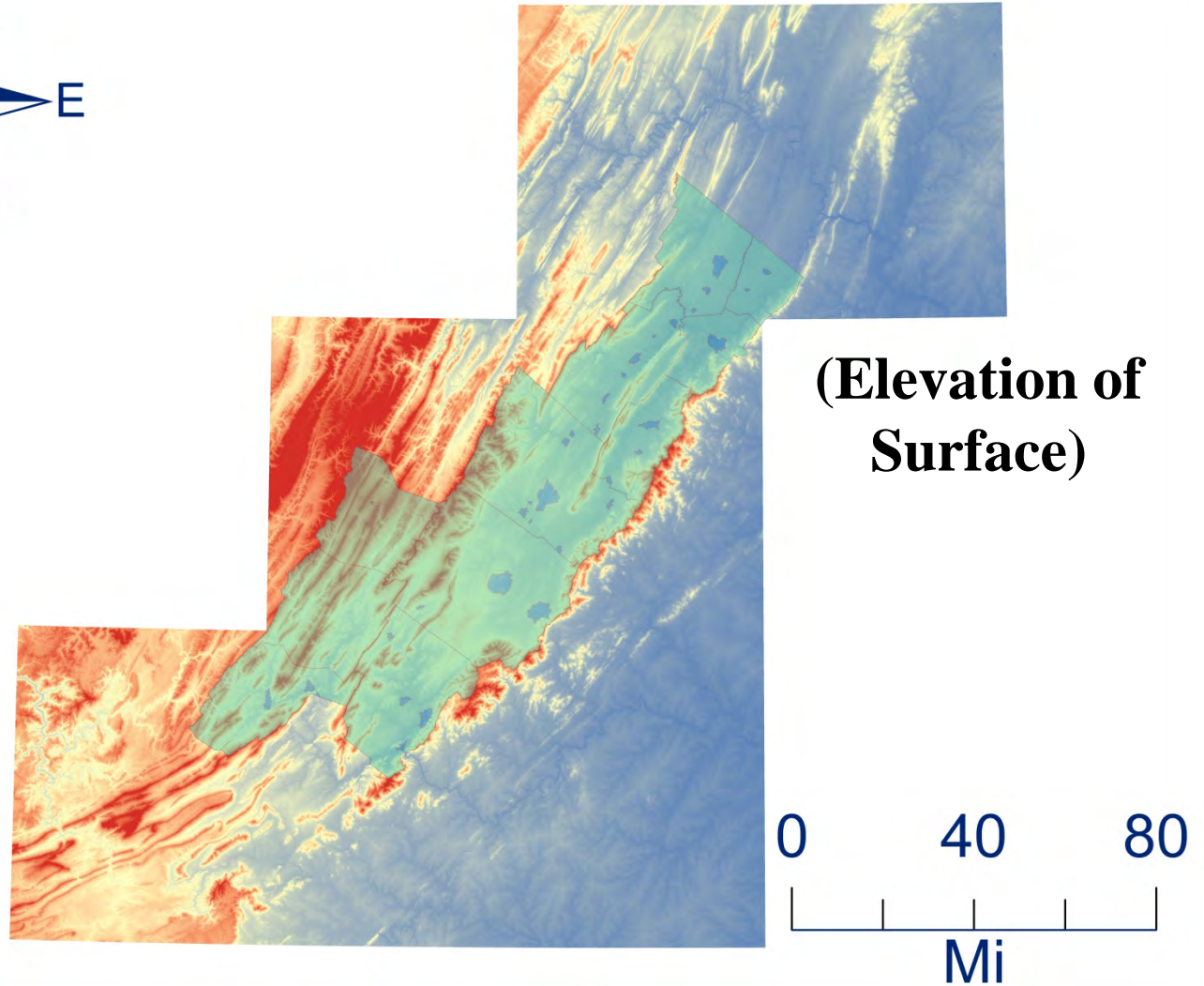
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)





# DEM

The Law

Basemaps

**DEM**

Surface  
Analysis

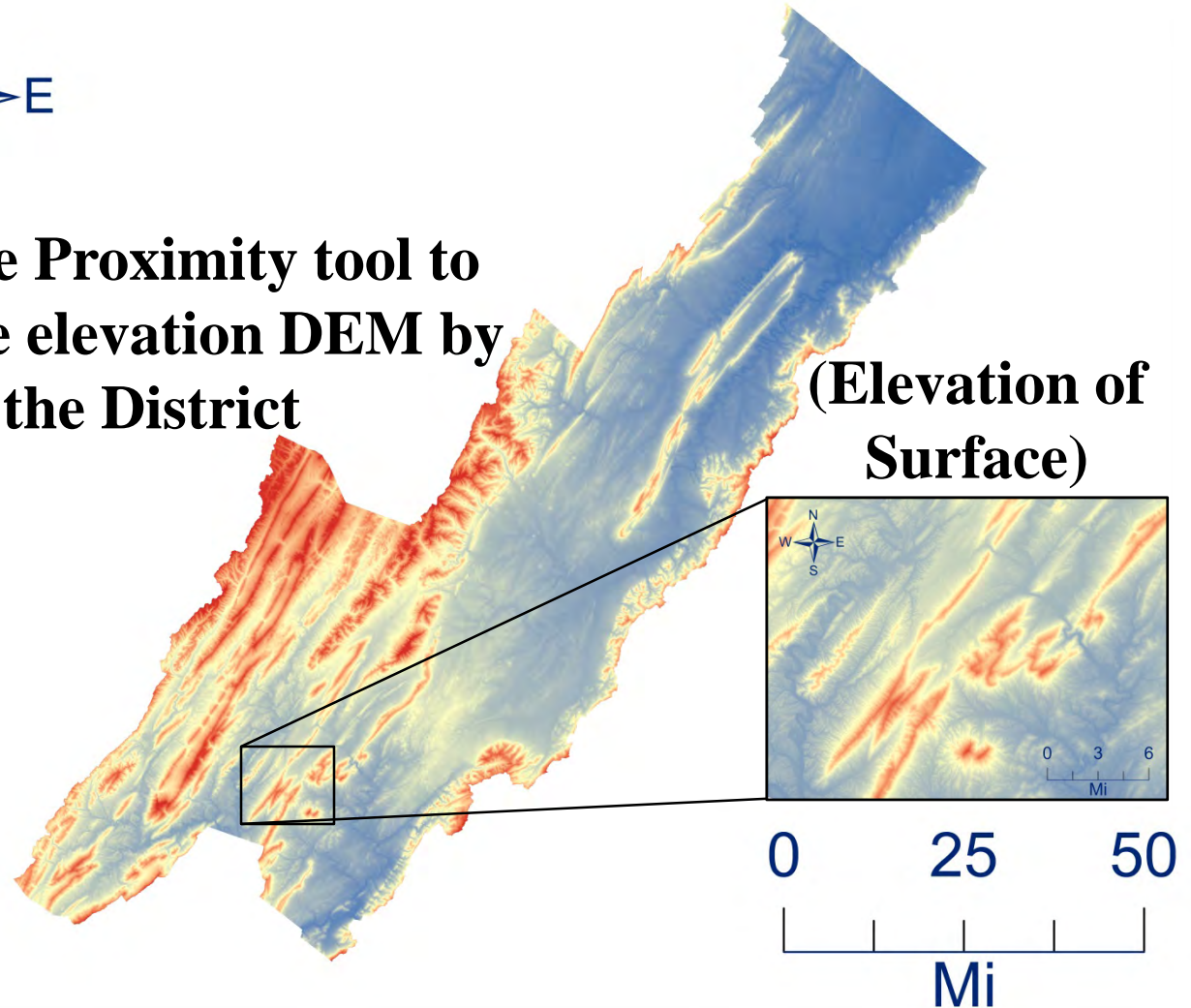
Logical  
Analysis

DB and  
Rating (?)



**Use the Proximity tool to  
Clip the elevation DEM by  
the District**

**(Elevation of  
Surface)**



Tool: ArcToolbox→Analysis Tools→Extract→Clip

# DEM

The Law

Basemaps

**DEM**

Surface  
Analysis

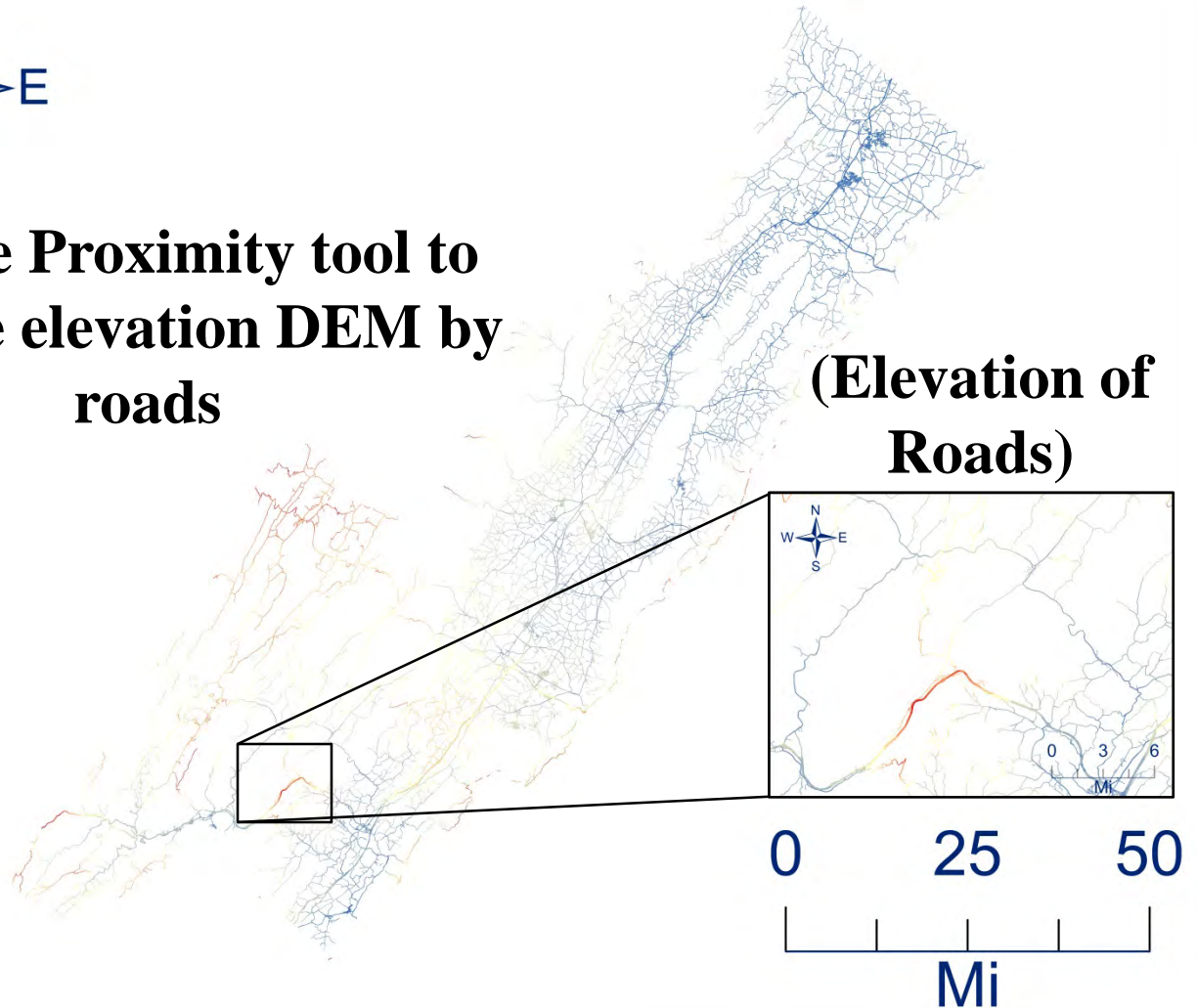
Logical  
Analysis

DB and  
Rating (?)



**Use the Proximity tool to  
Clip the elevation DEM by  
roads**

**(Elevation of  
Roads)**



Tool: ArcToolbox → Analysis Tools → Extract → Clip

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

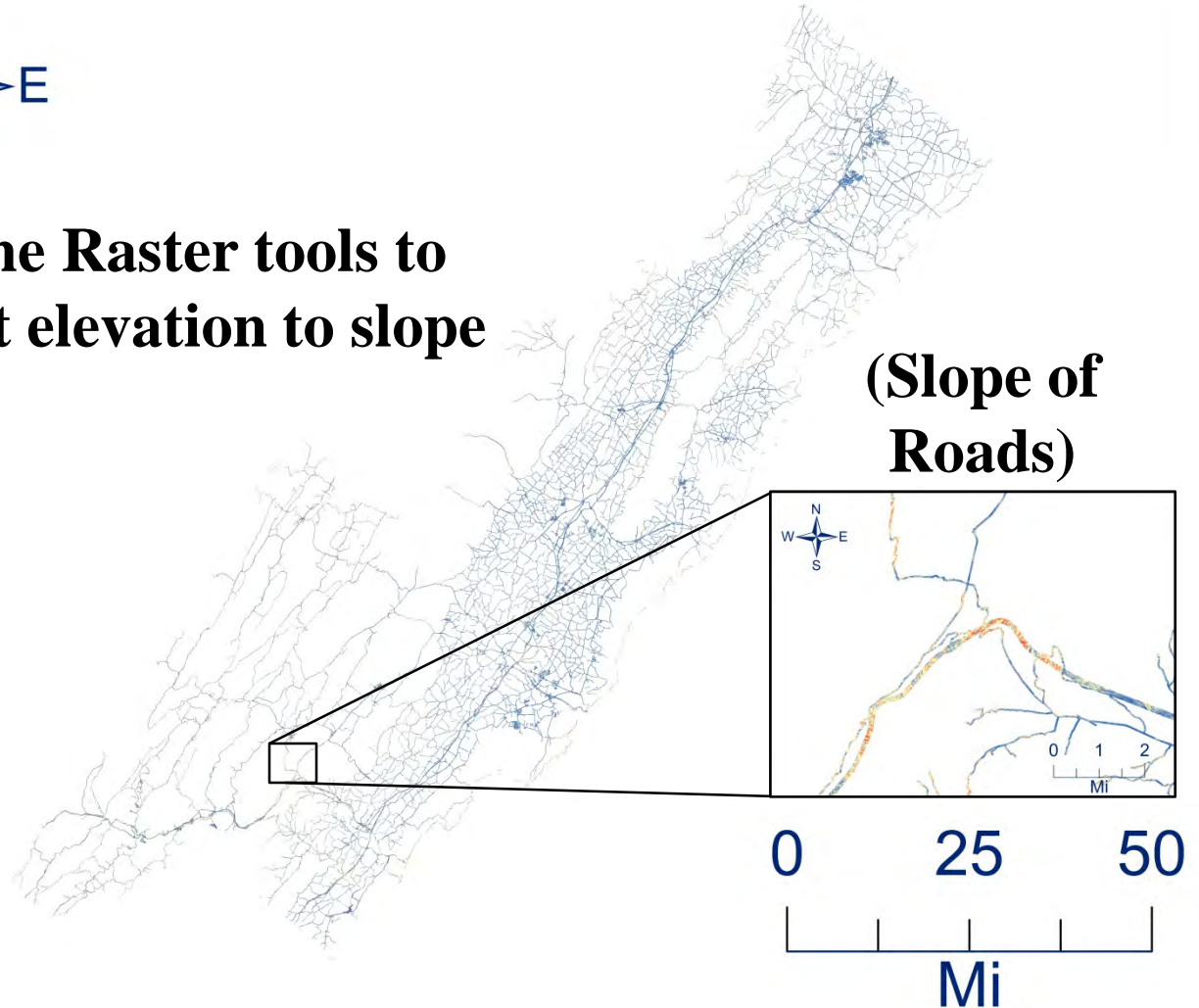
DB and  
Rating (?)

# Surface Analysis



**Use the Raster tools to  
convert elevation to slope**

**(Slope of  
Roads)**



Tool: ArcToolbox→Spatial Analyst Tools→Surface→Slope



The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

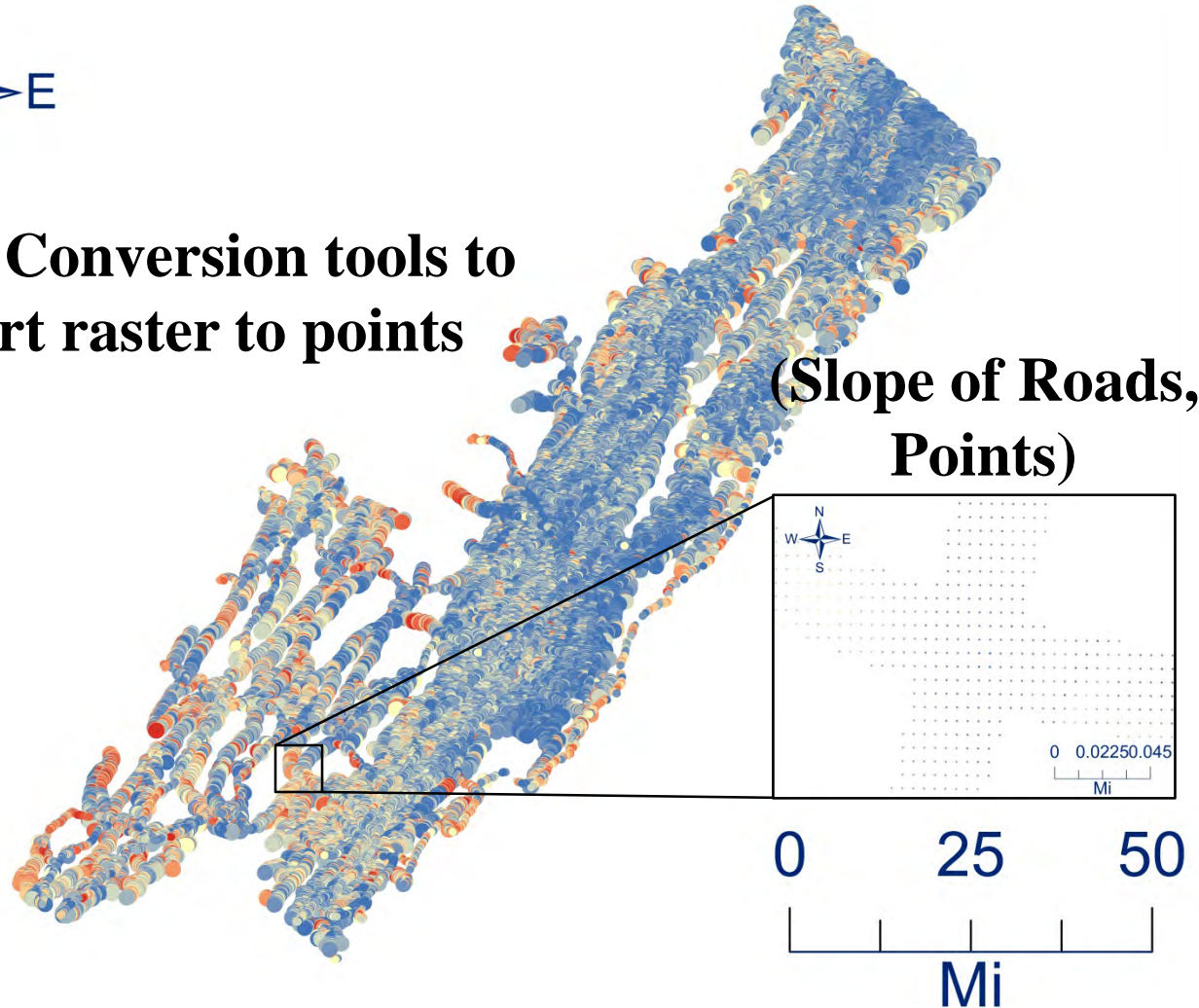
DB and  
Rating (?)

# Surface Analysis



Use the Conversion tools to  
convert raster to points

(Slope of Roads,  
Points)



Tool: ArcToolbox→Conversion Tools→From Raster→Raster to Point

Slopes\_Geohazards\_Project

File Edit View Bookmarks

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Layers

- Staunton\_District\_Count
- Mosaic\_DEM
  - Value
  - High : 1482.56
  - Low : -16.1973
- Mosaic\_DEM\_in\_District
- Slope\_in\_District
- NEAR\_ABS\_ACCEL\_and\_Abs\_Accel\_>4
- Slope\_in\_AOI\_POINTS<0
- Slope\_in\_AOI\_POINTS<0
- Slope\_in\_AOI\_POINTS
- High\_Slopes\_Within\_Roads
- RasterT\_Slope\_M6\_Merg
- All\_Roads\_in\_District
- Interstates\_Ramps\_and
- All\_Roads\_in\_AOI\_Buffer
- All\_Roads\_in\_District\_Buffer
- Slope\_in\_AOI
- Interstates\_Ramps\_and
- Interstates\_Ramps\_and
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- Primaries
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- Primaries\_200\_ft\_DEM
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- Primaries\_200\_ft\_Slopes
- Primaries\_200\_ft\_Slopes
- Secondaries
- Secondaries\_150\_ft\_Buffer
- Secondaries\_150\_ft\_DEM
- Secondaries\_150\_ft\_Slopes
- Secondaries\_150\_ft\_Slopes
- Secondaries\_150\_ft\_Slopes
- All\_Other\_Roads
- GIS\_DATA.SDE.VDOT\_Roads
- imgn40w078\_13.img
- imgn40w079\_13.img
- imgn38w081\_13.img
- grdn39w080\_13
- grdn38w080\_13
- grdn38w079\_13
- grdn39w079\_13

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- Remove
- Open Attribute Table**
- Joins and Relates
- Zoom To Layer
- Zoom To Make Visible
- Visible Scale Range
- Use Symbol Levels
- Selection
- Label Features
- Edit Features
- Convert Labels to Annotation...
- Convert Features to Graphics...
- Convert Symbology to Representation...
- Data
- Save As Layer File...
- Create Layer Package...
- Properties...

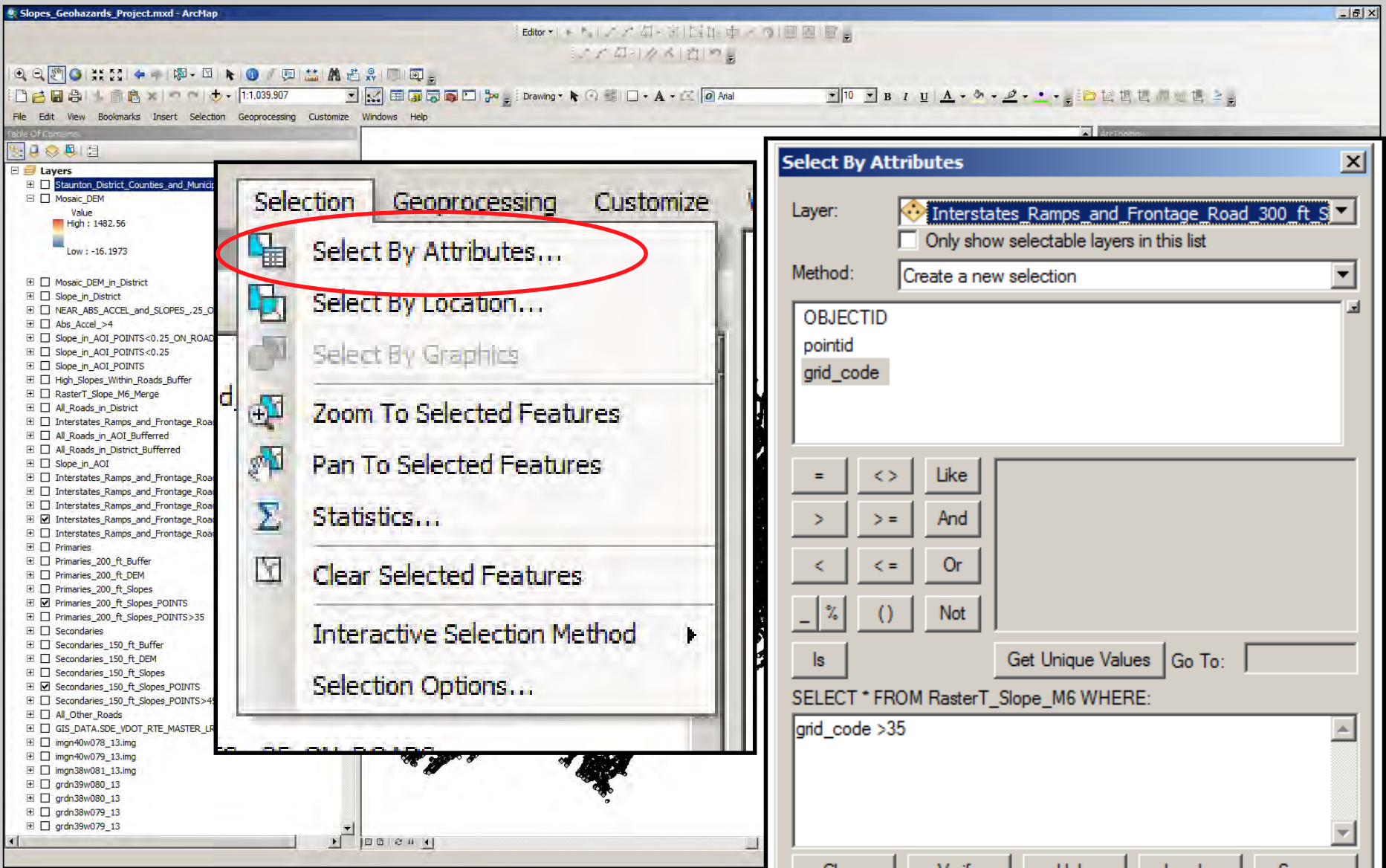
Table

Primaries\_200\_ft\_Slopes\_POINTS

OBJECTID *	Shape *	pointid	grid_code
1	Point	1	4.433265
2	Point	2	3.090978
3	Point	3	2.845834
4	Point	4	6.03685
5	Point	5	6.221472
6	Point	6	5.084016
7	Point	7	4.680163
8	Point	8	5.53858
9	Point	9	6.134885
10	Point	10	6.899548
11	Point	11	7.125647

- Extract by Attributes
- Extract by Crde
- Extract by Mask
- Extract by Points
- Extract by Polygon
- Extract by Rectangle
- Extract Multi Values to Points
- Extract Values to Points
- Sample
- Generalization
- Groundwater
- Hydrology
- Interpolation
- Local
- Map Algebra
- Math
- Multivariate
- Neighborhood
- Overlay
- Raster Creation
- Reclass
- Solar Radiation
- Surface
- Zonal
- Spatial Statistics Tools
- SplitLayerByAttributes
- Split Layer By Attributes
- Tracking Analyst Tools
- ArcToolbox
- Catalog

78°41'51.321"W 38°49'51.037"N



Selection Geoprocessing Customize

Select By Attributes...

Select By Location...

Select By Graphics

Zoom To Selected Features

Pan To Selected Features

Statistics...

Clear Selected Features

Interactive Selection Method

Selection Options...

Select By Attributes

Layer: Interstates Ramps and Frontage Road 300 ft S

Only show selectable layers in this list

Method: Create a new selection

OBJECTID  
pointid  
grid\_code

= <> Like

> >= And

< <= Or

\_ % ( ) Not

Is Get Unique Values Go To:

SELECT \* FROM RasterT\_Slope\_M6 WHERE:

grid\_code >35

Clear Verify Help Load... Save...

OK Apply Close



# Logical Analysis

The Law

Basemaps

DEM

Surface  
Analysis

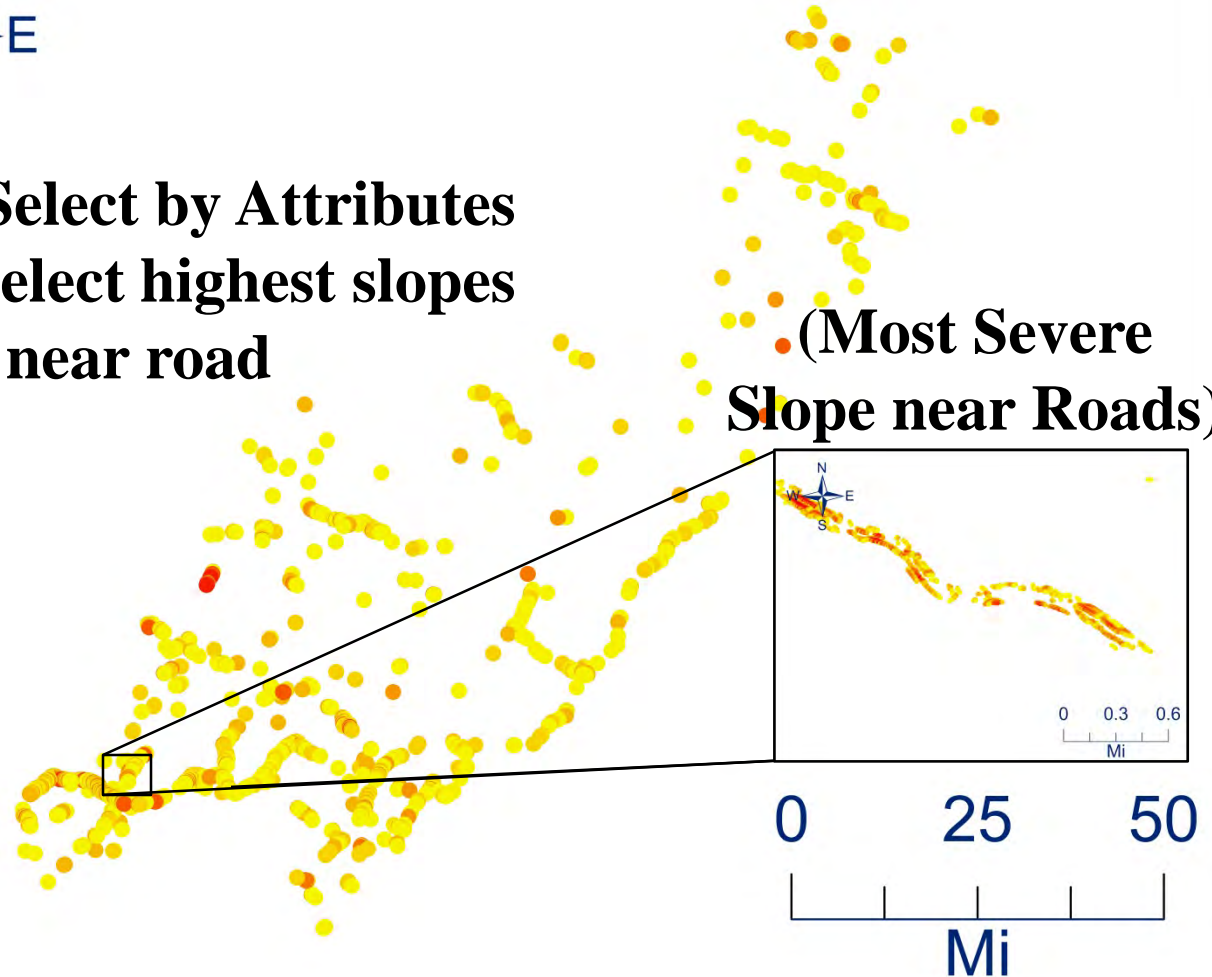
Logical  
Analysis

DB and  
Rating (?)



Use the **Select by Attributes**  
tools to select highest slopes  
near road

(Most Severe  
Slope near Roads)



Tool: Select by Attributes, Boolean selection for slopes

# Logical Analysis

The Law

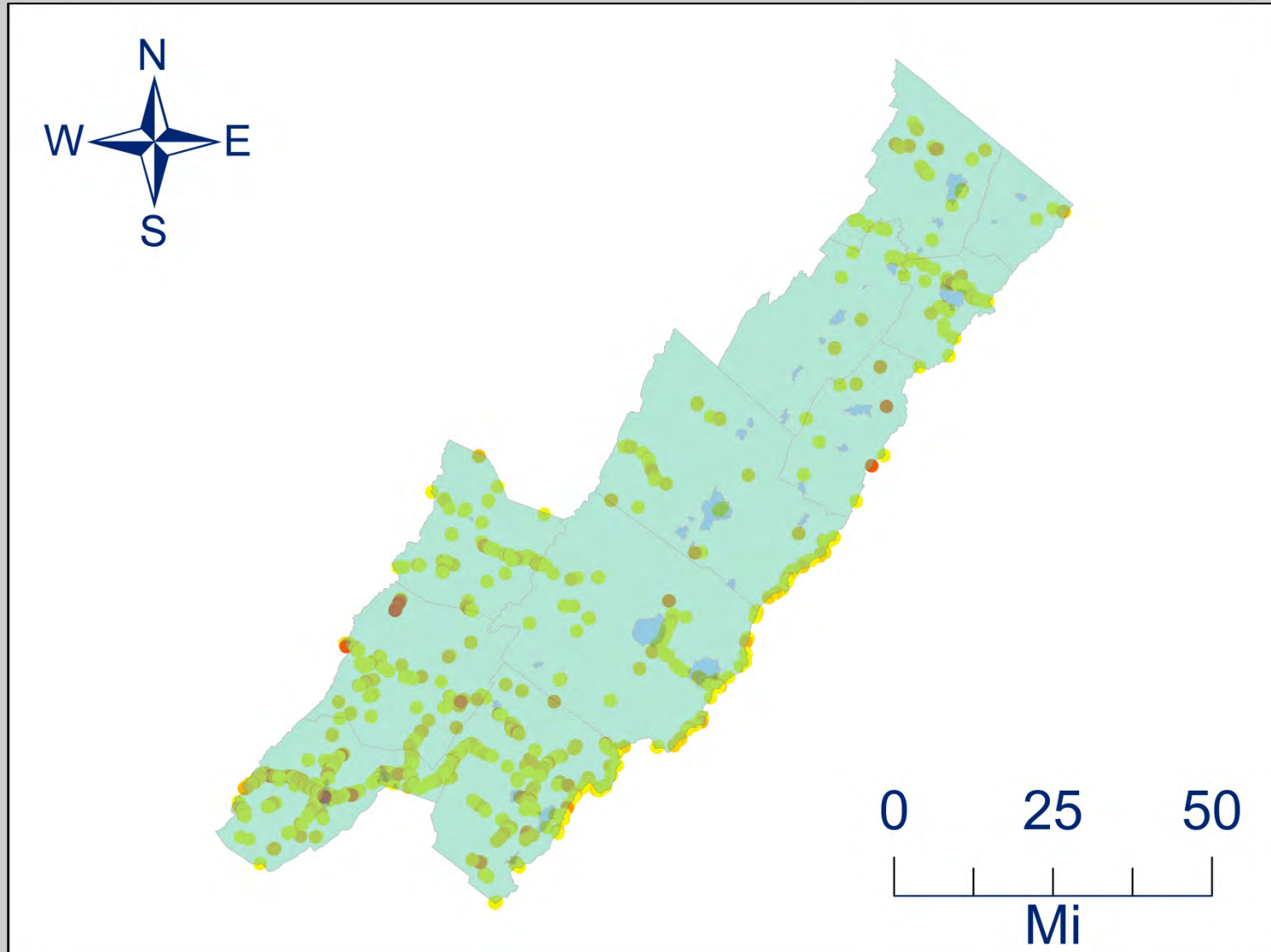
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



Tool: Select by Attributes, Boolean selection for slopes

# Logical Analysis

The Law

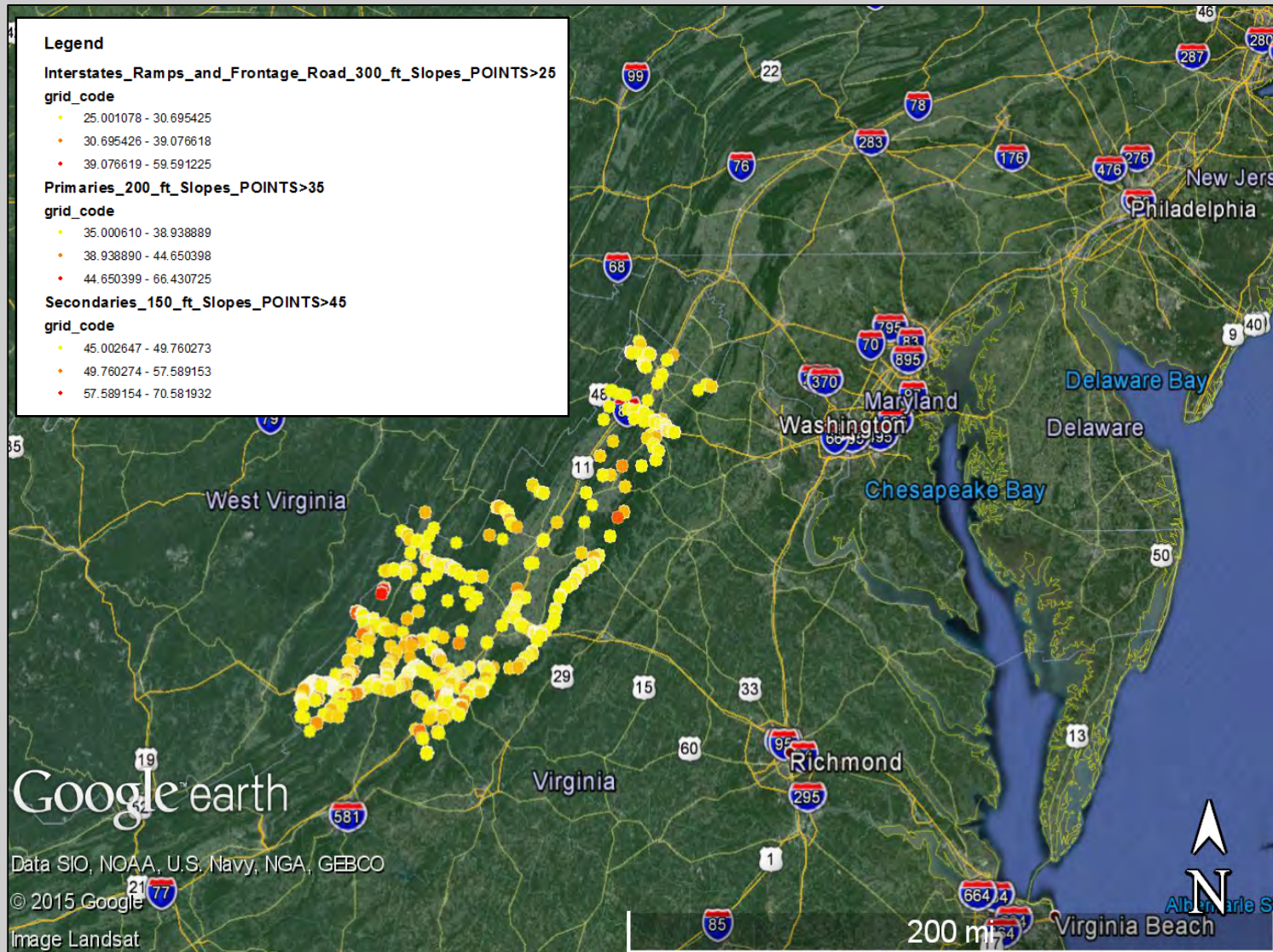
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



Tool: ArcToolbox→Conversion Tools→To KML→Layer to KML



# Logical Analysis

The Law

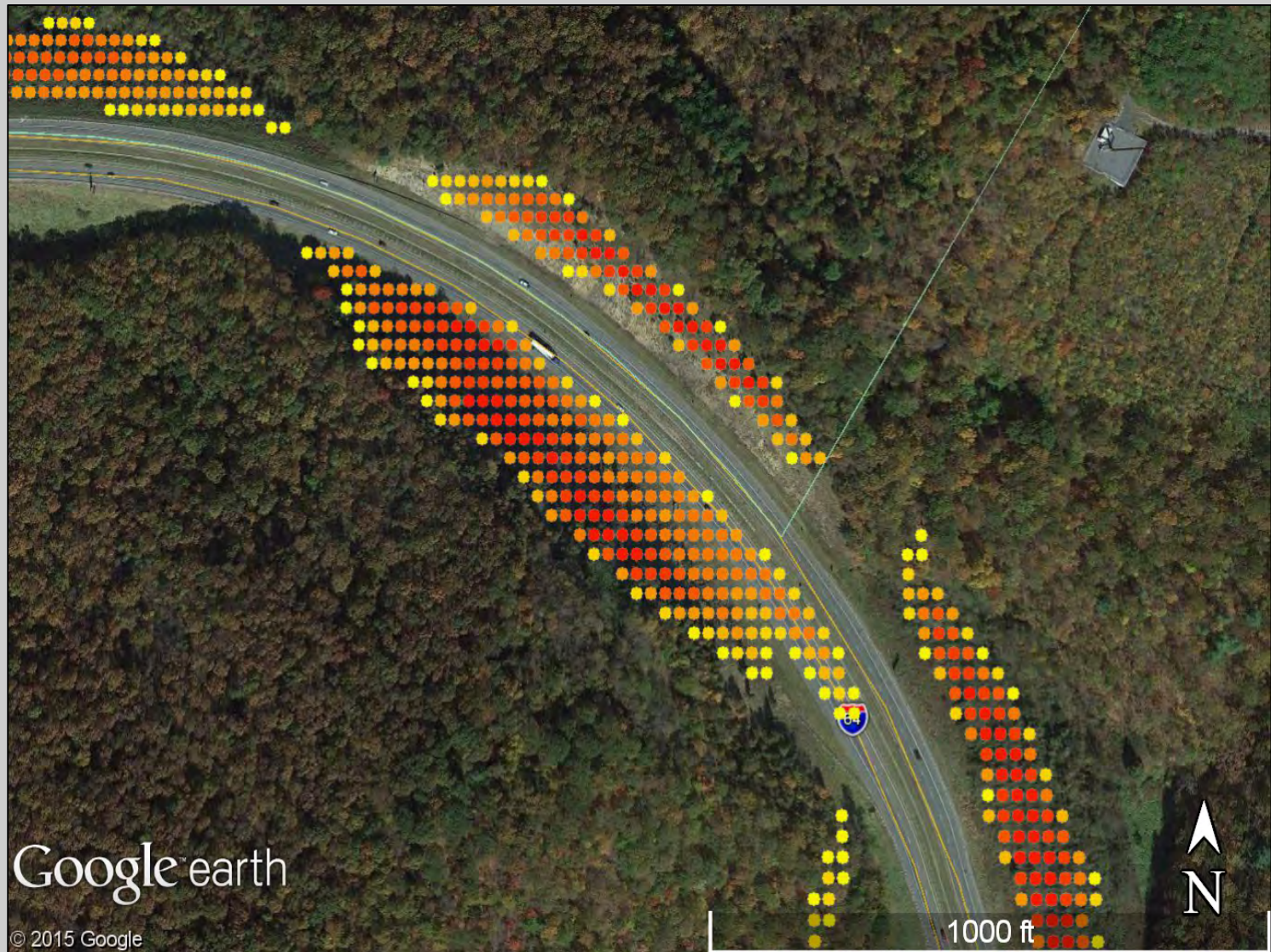
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



Tool: ArcToolbox→Conversion Tools→To KML→Layer to KML



# Logical Analysis

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



Tool: ArcToolbox→Conversion Tools→To KML→Layer to KML



# Logical Analysis

The Law

Basemaps

DEM

Surface  
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Logical  
Analysis

DB and  
Rating (?)



Tool: ArcToolbox→Conversion Tools→To KML→Layer to KML



# Logical Analysis

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



Tool: ArcToolbox→Conversion Tools→To KML→Layer to KML

# Logical Analysis

The Law

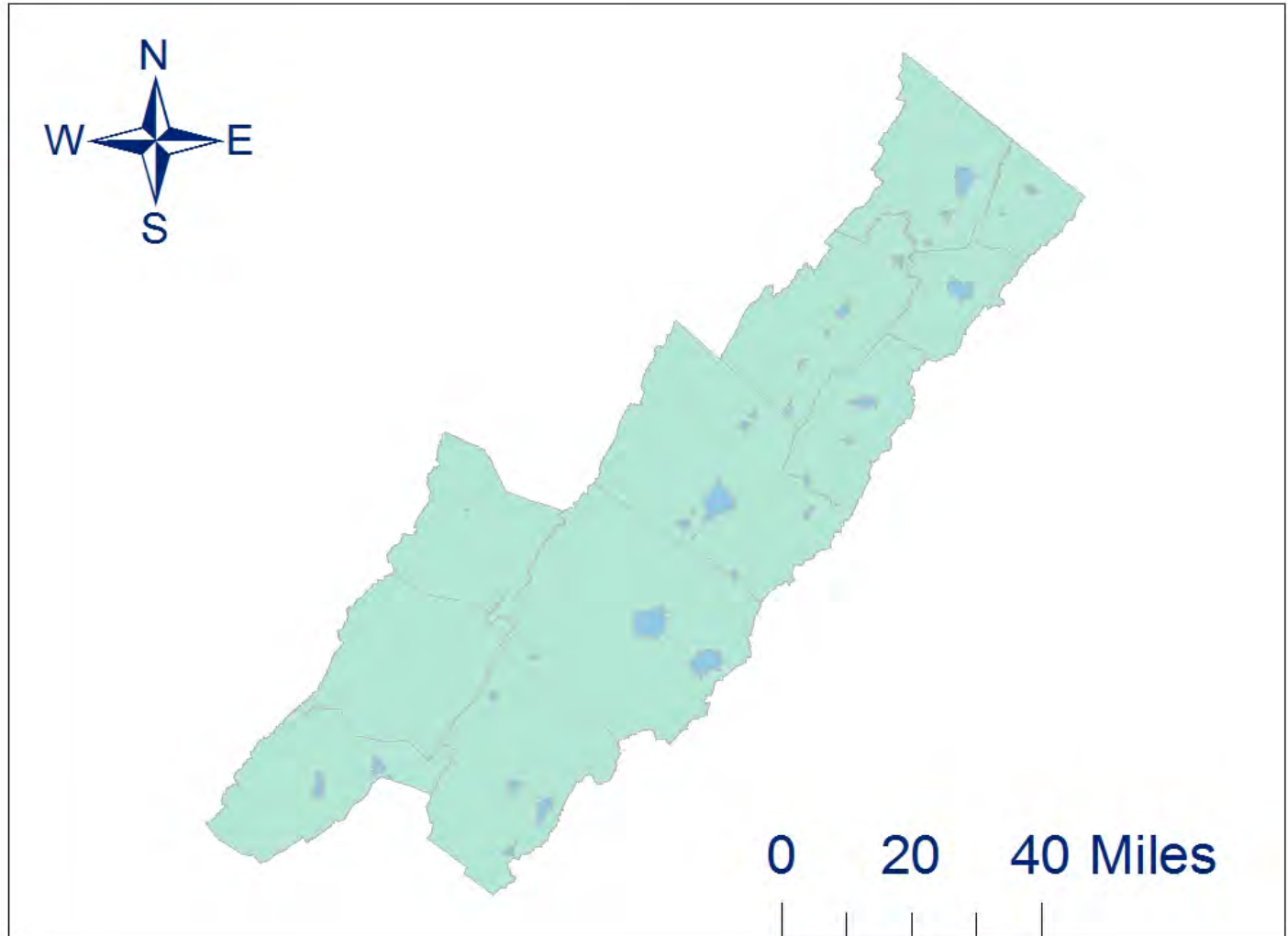
Basemaps

DEM

Surface  
Analysis

**Logical  
Analysis**

DB and  
Rating (?)



# Logical Analysis

The Law

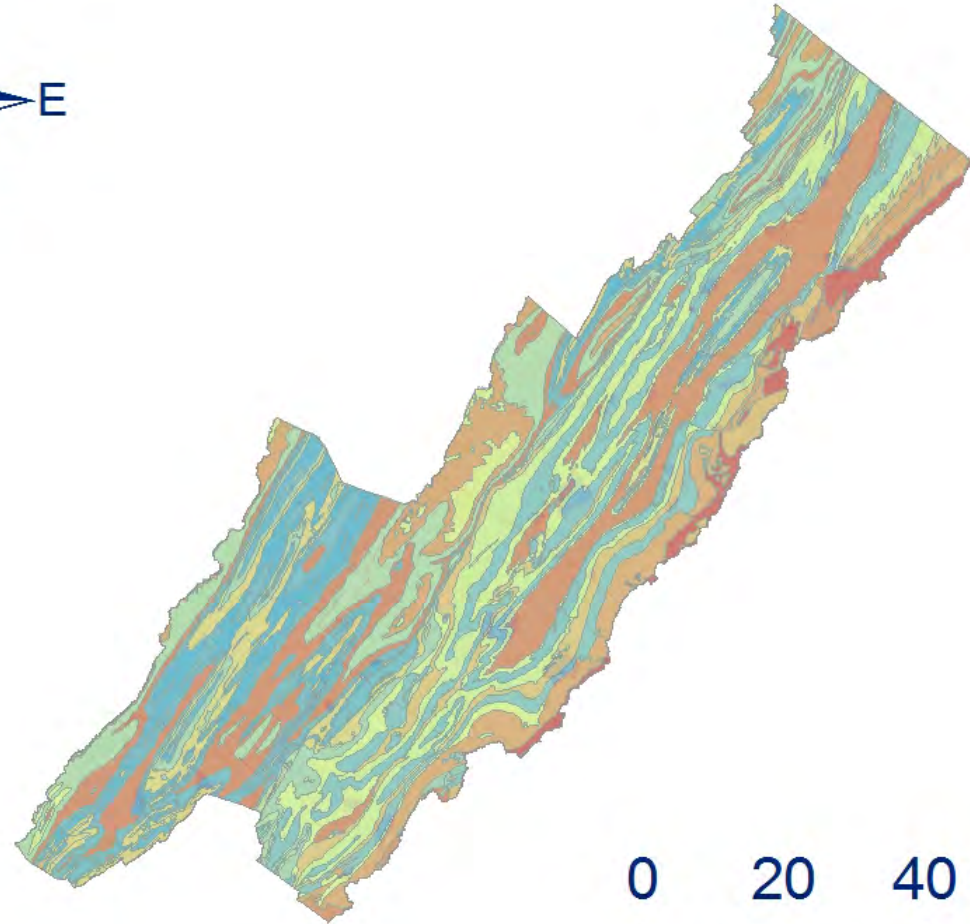
Basemaps

DEM

Surface  
Analysis

**Logical  
Analysis**

DB and  
Rating (?)



0 20 40 Miles



# Logical Analysis

The Law

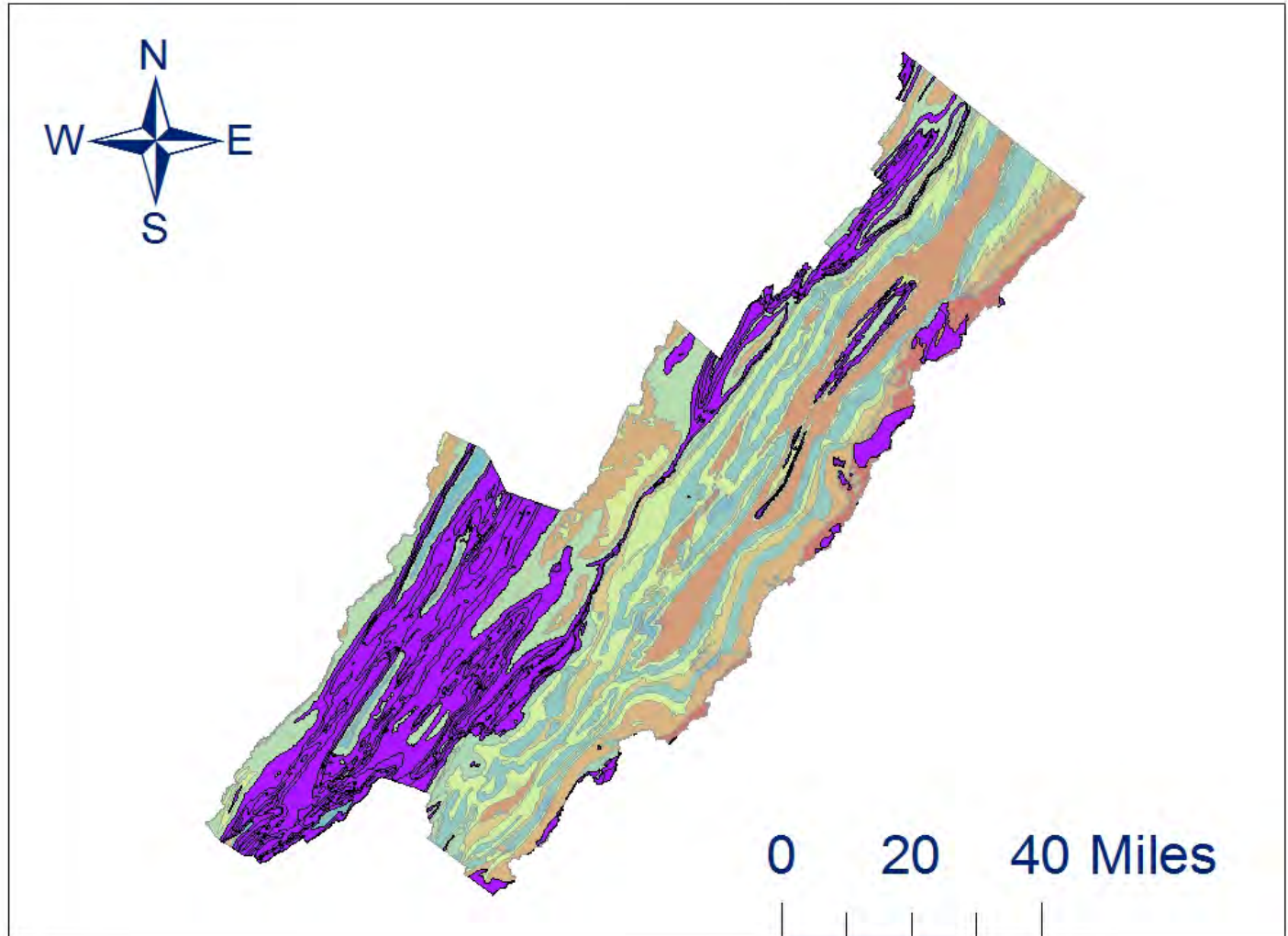
Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)



# Logical Analysis

The Law

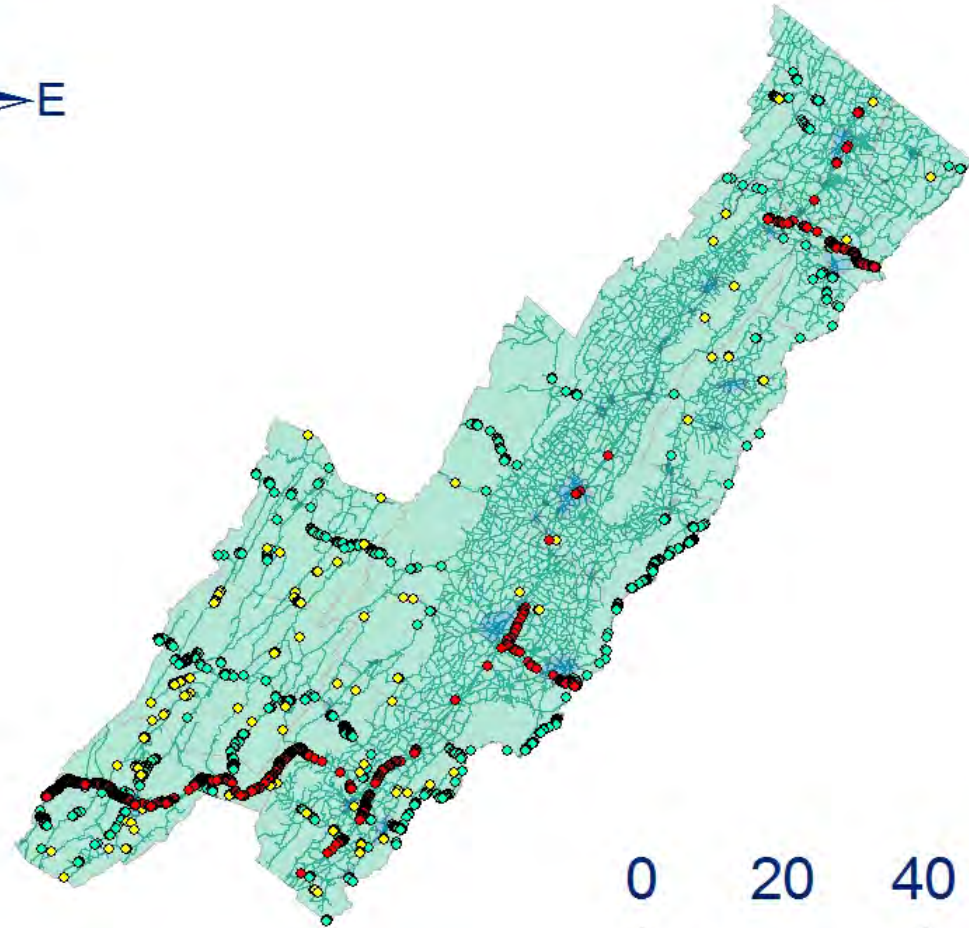
Basemaps

DEM

Surface  
Analysis

**Logical  
Analysis**

DB and  
Rating (?)



0 20 40 Miles

# Logical Analysis

The Law

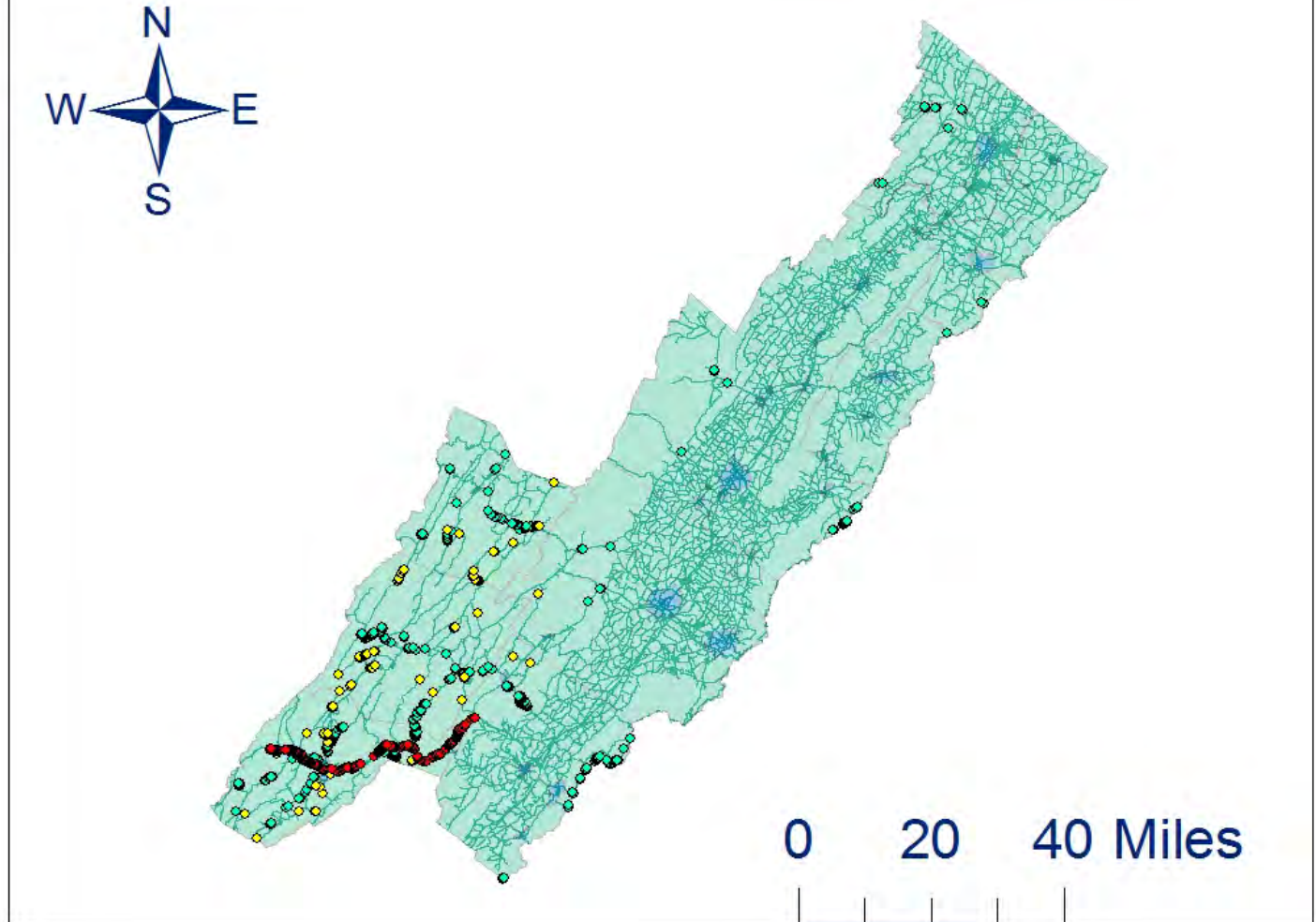
Basemaps

DEM

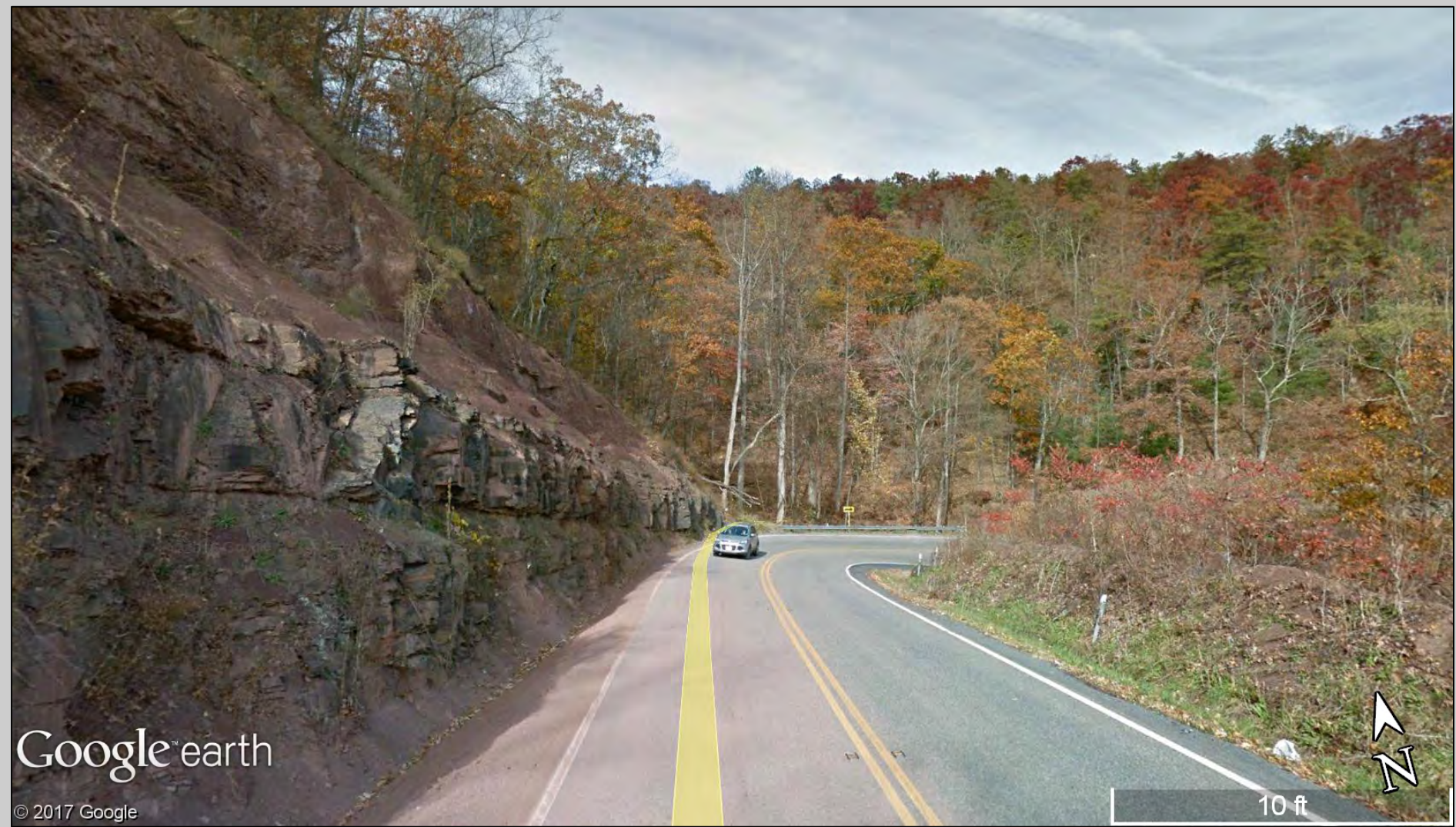
Surface  
Analysis

**Logical  
Analysis**

DB and  
Rating (?)





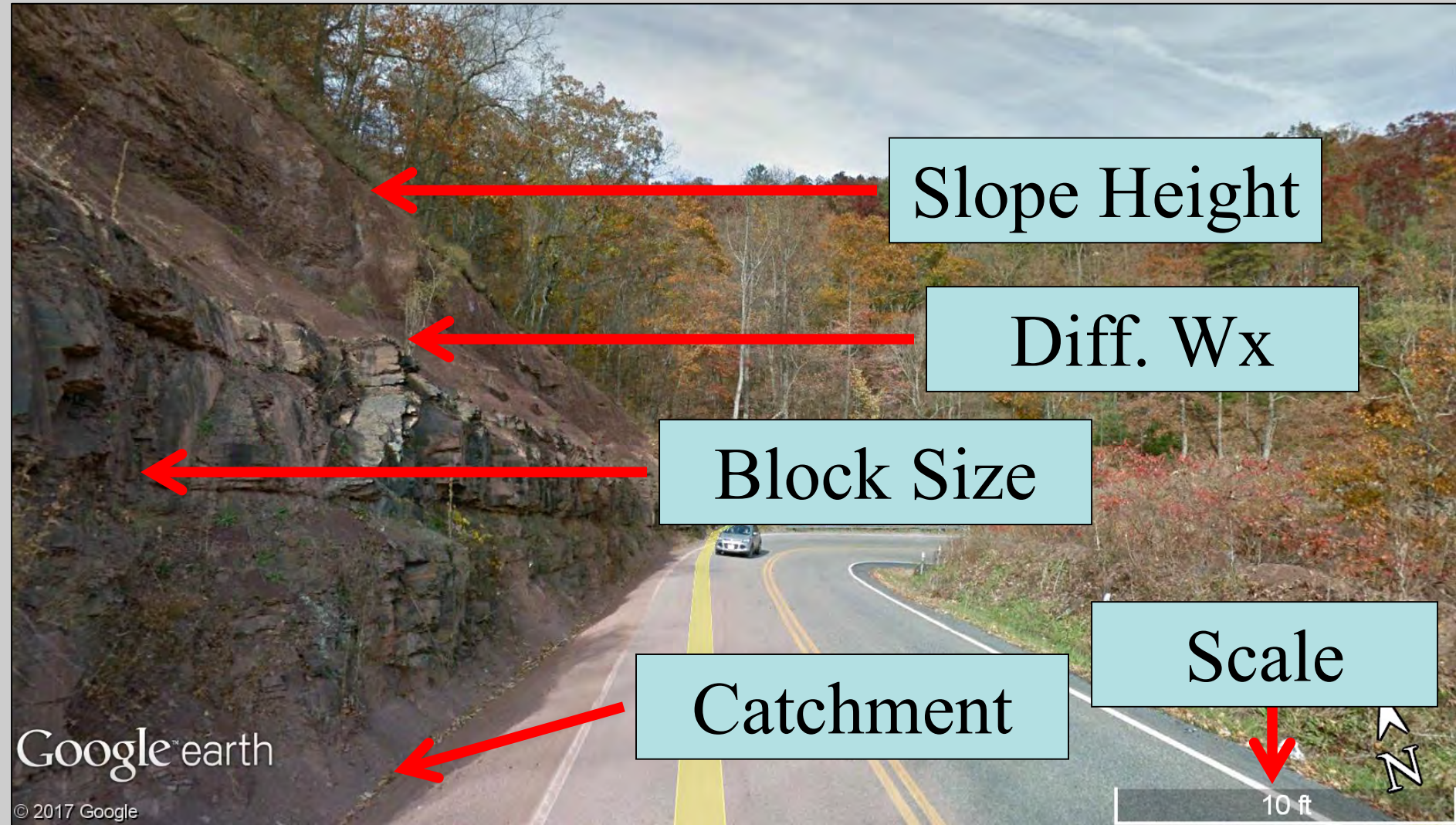


Google™ earth

© 2017 Google

10 ft





Slope Height

Diff.  $W_x$

Block Size

Catchment

Scale

10 ft



Google earth

© 2017 Google

Table

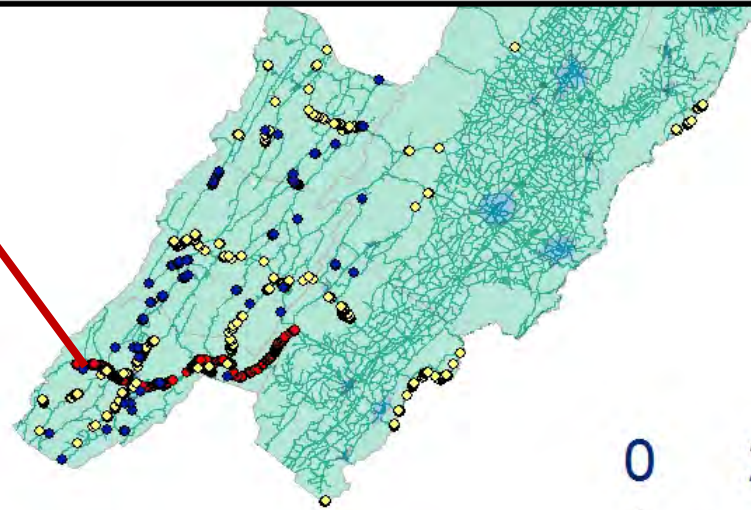


SDE\_VDMME\_GEOLOGY\_Clip4\_Inte2

OBJECTID *	FORMATION	FORMATION_NAME	FORMATION_PERIOD	POINT_X	POINT_Y
1	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-80.176065	37.617269
2	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-80.209398	37.672454
3	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-80.018472	37.680139
4	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-80.01838	37.680139
5	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-80.018565	37.680231
6	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015972	37.680509
7	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.01588	37.680602
8	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015787	37.680602
9	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015787	37.680694
10	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015694	37.680694
11	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015602	37.680787
12	Ous	Juniata Formation, Reedsville Shale, Trenton Limestone, Eggleston Formation	Ordovician	-80.015509	37.680787
13	Dmn	Millboro Shale and Needmore Formation	Devonian	-80.06162	37.681065
14	Dmn	Millboro Shale and Needmore Formation	Devonian	-80.061528	37.681065
15	Dmn	Millboro Shale and Needmore Formation	Devonian	-80.061435	37.681157
16	Skrt	Keefer Sandstone, Rose Hill and Tuscarora Formations	Silurian	-79.996898	37.721991
17	Db	Braker Formation	Devonian	-80.003194	37.736343

0 out of 571 Selected

SDE\_VDMME\_GEOLOGY\_Clip4\_Inte2



0 20 40 Miles



# sis

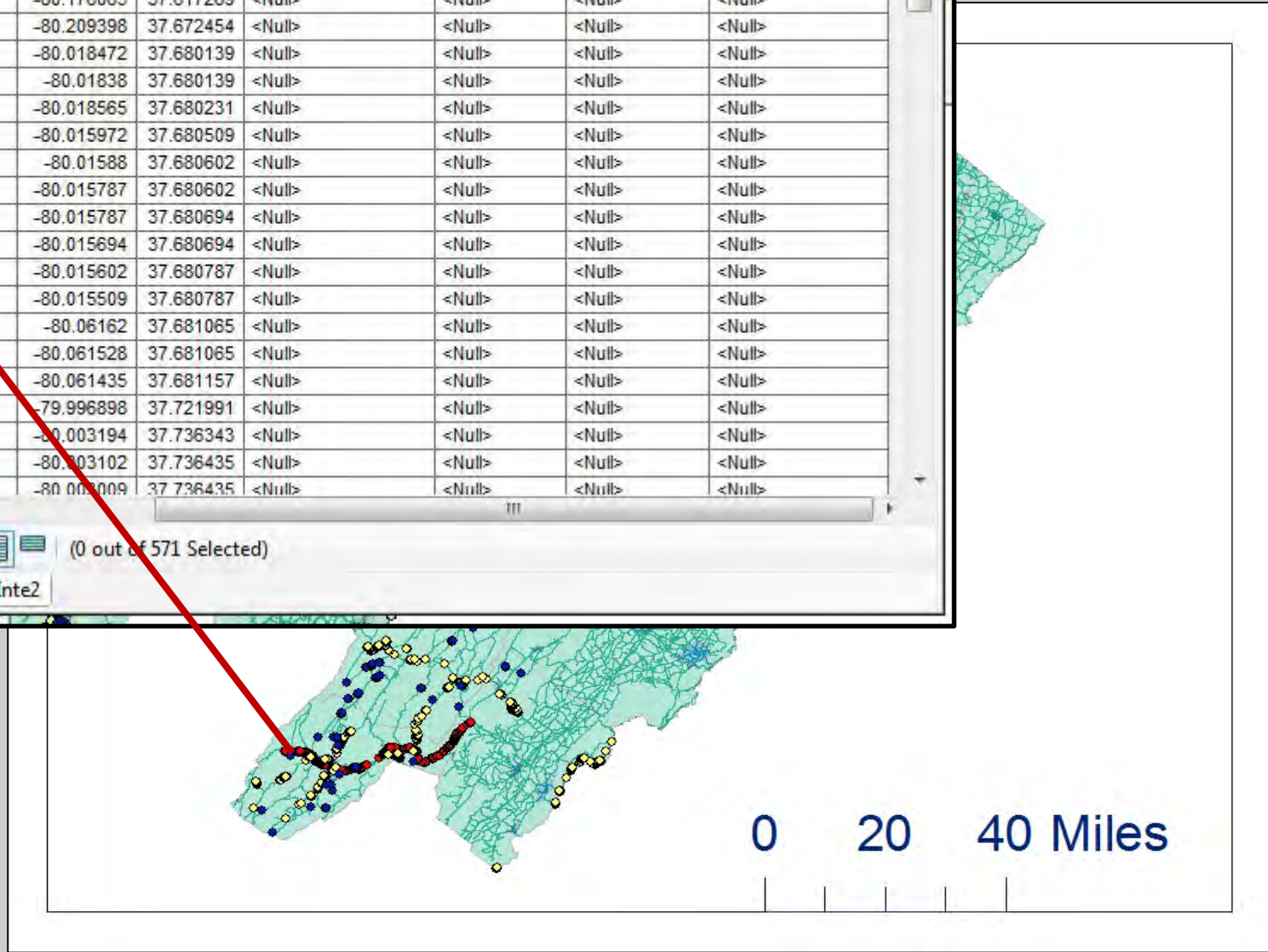
Table

SDE\_VDMME\_GEOLOGY\_Clip4\_Inte2

FORMATION_PERIOD	POINT_X	POINT_Y	Block_Shape	Catchment	Block_Size	And_et_Cetera
Silurian	-80.176065	37.617269	<Null>	<Null>	<Null>	<Null>
Silurian	-80.209398	37.672454	<Null>	<Null>	<Null>	<Null>
Silurian	-80.018472	37.680139	<Null>	<Null>	<Null>	<Null>
Silurian	-80.01838	37.680139	<Null>	<Null>	<Null>	<Null>
Silurian	-80.018565	37.680231	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015972	37.680509	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.01588	37.680602	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015787	37.680602	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015787	37.680694	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015694	37.680694	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015602	37.680787	<Null>	<Null>	<Null>	<Null>
Ordovician	-80.015509	37.680787	<Null>	<Null>	<Null>	<Null>
Devonian	-80.06162	37.681065	<Null>	<Null>	<Null>	<Null>
Devonian	-80.061528	37.681065	<Null>	<Null>	<Null>	<Null>
Devonian	-80.061435	37.681157	<Null>	<Null>	<Null>	<Null>
Silurian	-79.996898	37.721991	<Null>	<Null>	<Null>	<Null>
Devonian	-80.003194	37.736343	<Null>	<Null>	<Null>	<Null>
Devonian	-80.003102	37.736435	<Null>	<Null>	<Null>	<Null>
Devonian	-80.003009	37.736435	<Null>	<Null>	<Null>	<Null>

(0 out of 571 Selected)

SDE\_VDMME\_GEOLOGY\_Clip4\_Inte2



# Process Steps

The Law

Basemaps

DEM

Surface  
Analysis

Logical  
Analysis

DB and  
Rating (?)

- **Use pre-existing data from Agency (DOT, ACE, Geological Survey)**
- **Use National Map DEM Data (3M or 1M)**
- **Use built-in ArcGIS Tools**
- **Export to Device for Ground Truthing**
- **Complete First-Pass Rating for Database**





04.07.2016