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Using Aerial LiDAR to Assess Stream Restoration Project Sites

EcoStream 2018 Conference – Asheville, NC

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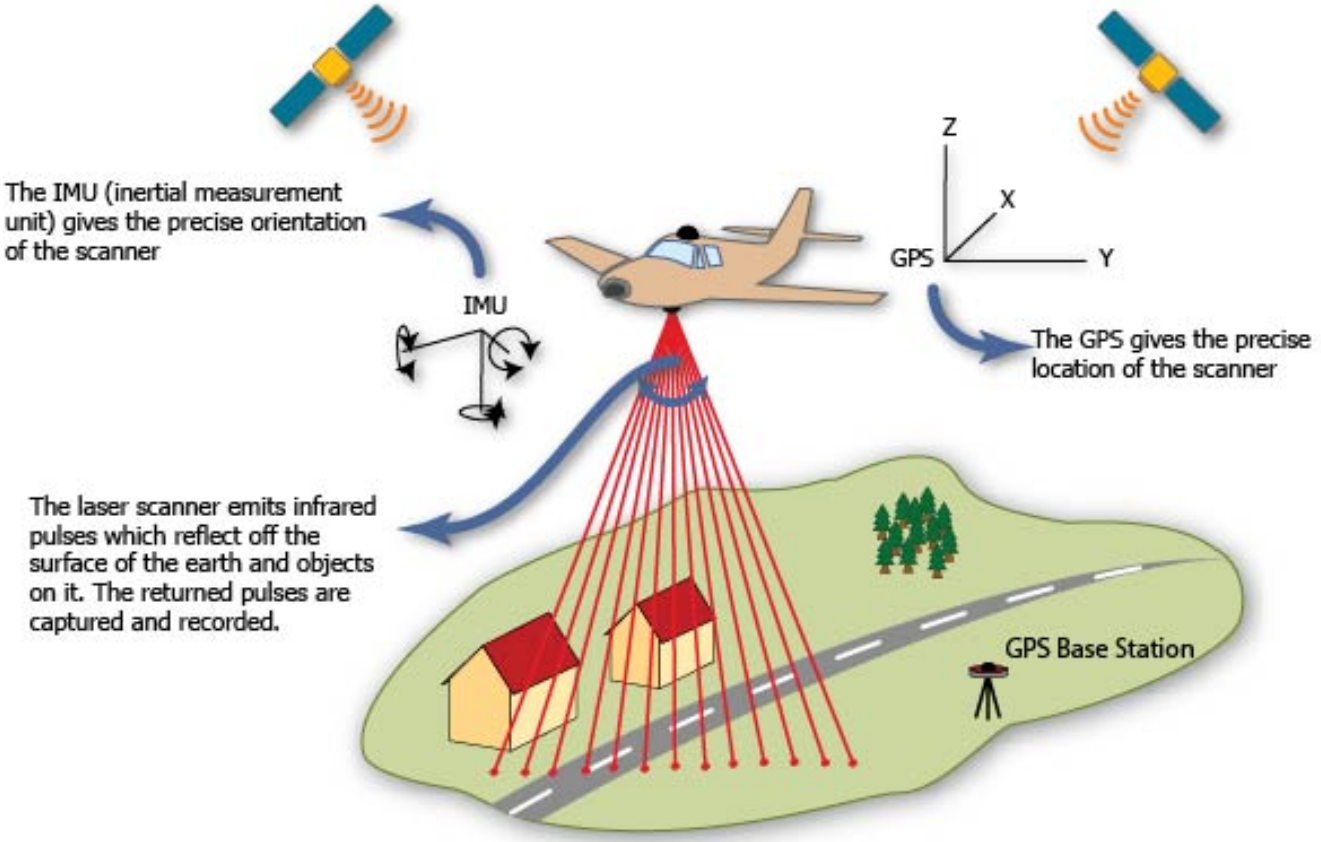
August 16, 2018

Overview

- What is LiDAR?
- Where can I find publically available LiDAR?
- How can I process LiDAR?
- How can I use LiDAR to assess stream restoration project sites?

What is LiDAR?

- **Light Detection and Ranging = LiDAR**
- **Aerial LiDAR Scanning (ALS)**



Uses of LiDAR

- Highly detailed maps of topography
- Identify anthropogenic disturbances in watershed
- Identify landslides that could impact restoration
- Identify areas of erosion within watershed
- Identify areas that may need special consideration during fieldwork
- Create surfaces for design purposes

Where to Find Public Available LiDAR

- **A google search is going to be your best friend for finding data**
- **USGS – The National Map (https://viewer.nationalmap.gov/basic/)**
- **Open Topography (https://opentopography.org/)**
- **GIS Data Clearinghouses**
  - Often hosted by a university, state or county agency

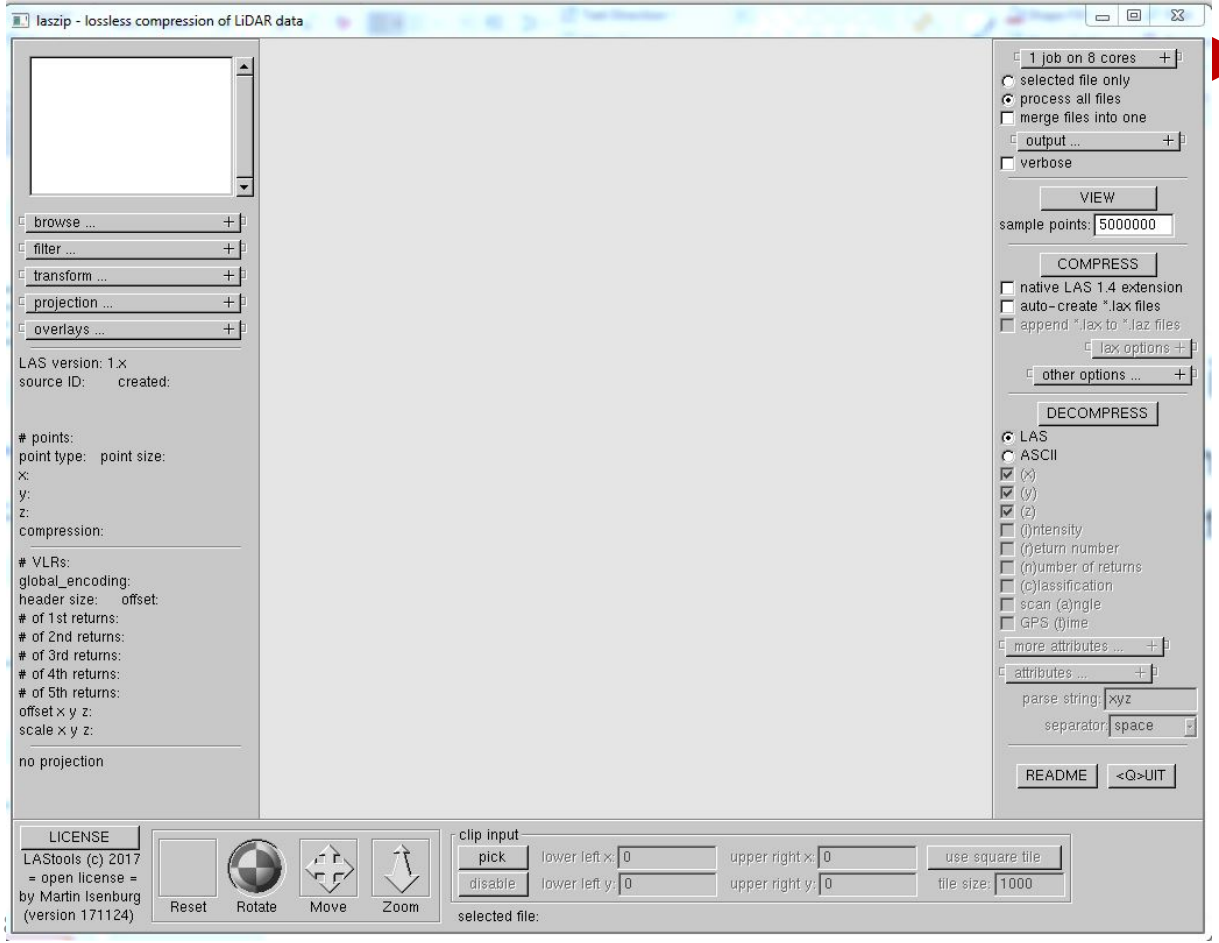
Public Available LiDAR

- **LiDAR is not available everywhere**
- **Some states have statewide LiDAR**
- **Some states only have LiDAR for specific areas**
- **LiDAR data can vary in resolution**
  - Sub-meter resolution to 5 meter resolution

Types of LiDAR Data

- **Comprehensive Digital Elevation Model (DEM)**
  - Includes all returns
- **Bare Earth DEM**
  - All returns removed except for ground returns
  - When it comes to DEMs this is what you want
- **LAS files**
  - Point cloud that includes all data points
  - Can be filtered
  - This is the ultimate dataset if you can process it

How to Process LAS files



LAS files are often compressed into LAZ files

- Free software is needed to extract the LAS data
- LASzip or LAStools can be used to extract data (https://rapidlasso.com/laszip/)

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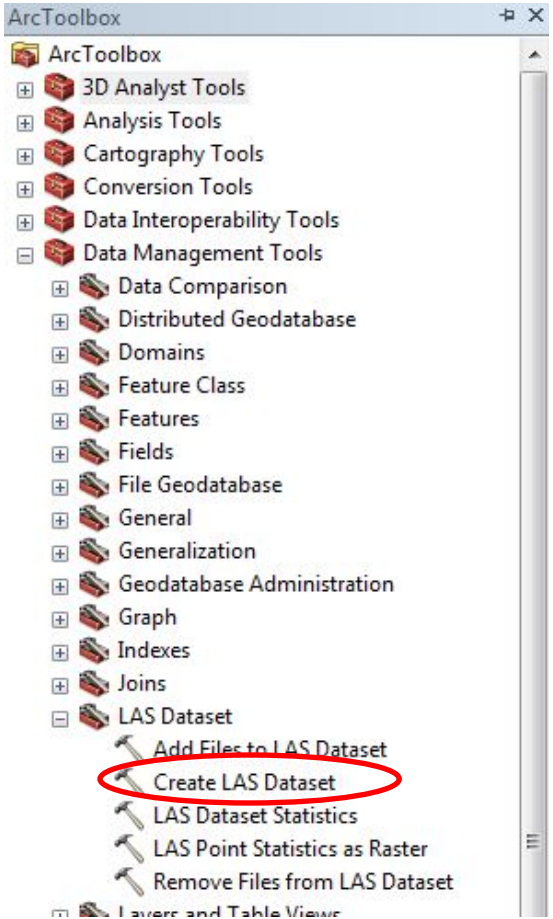
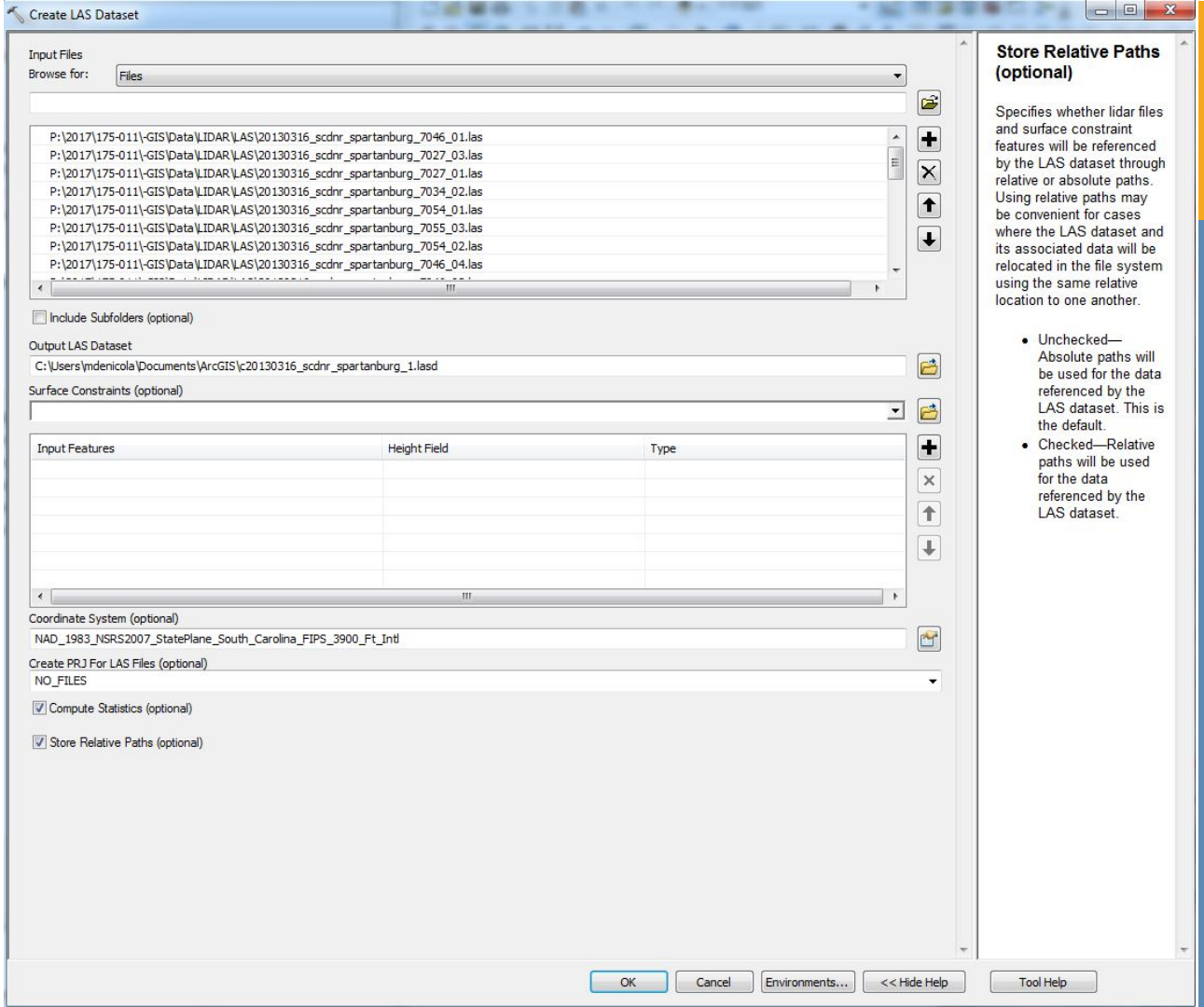
How to Process LAS files



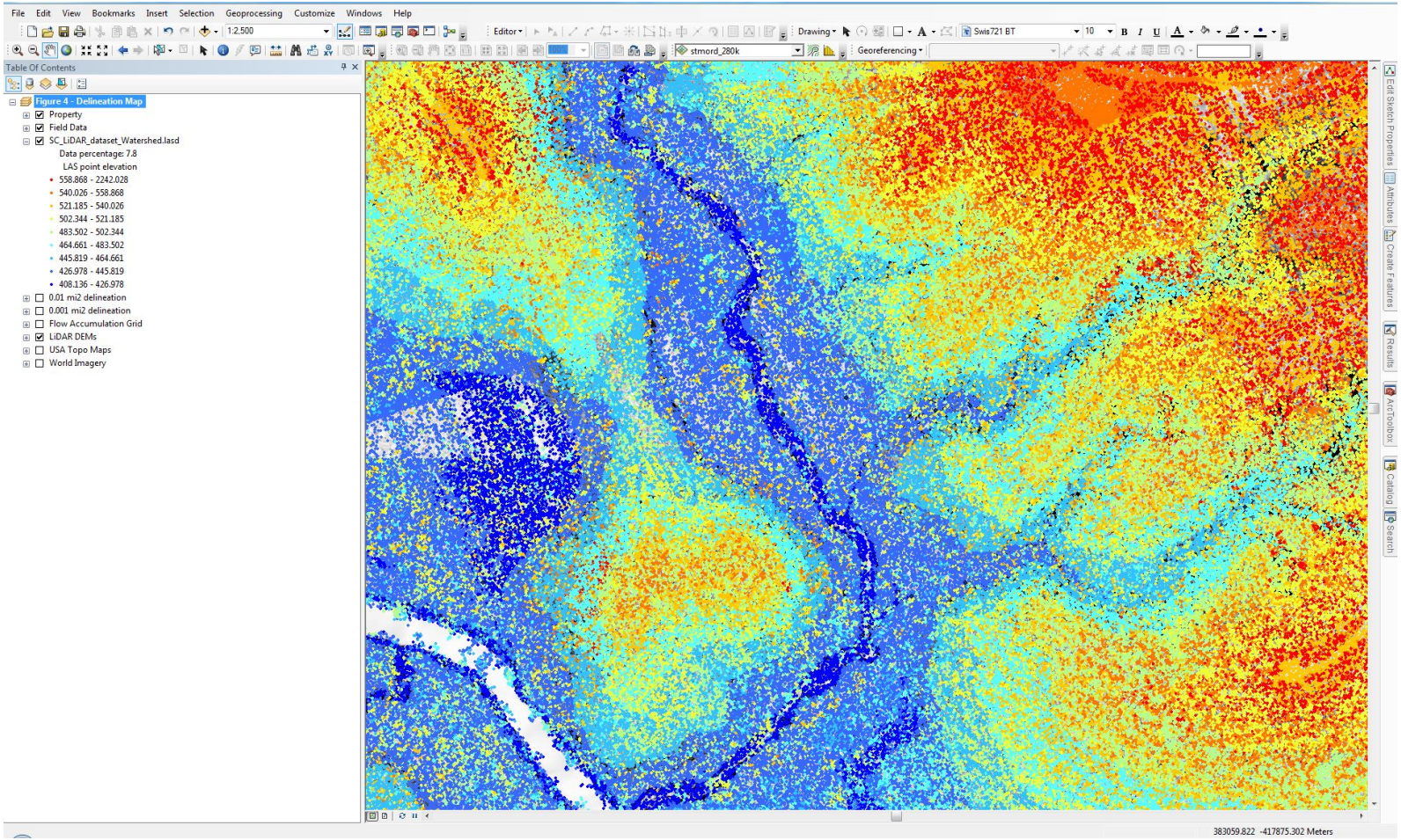
- **ArcMap is used to process the data**
  - Open Source GIS programs and AutoCAD can also be used but with potentially different results
- **ArcToolbox > Data Management Tools > LAS Dataset > Create LAS Dataset**

LAS Dataset

- **Choose LAS files**
- **Use appropriate coordinate system**
  - Found in metadata
- **Best practice to compute statistics and store relative paths**



Unfiltered LAS Dataset



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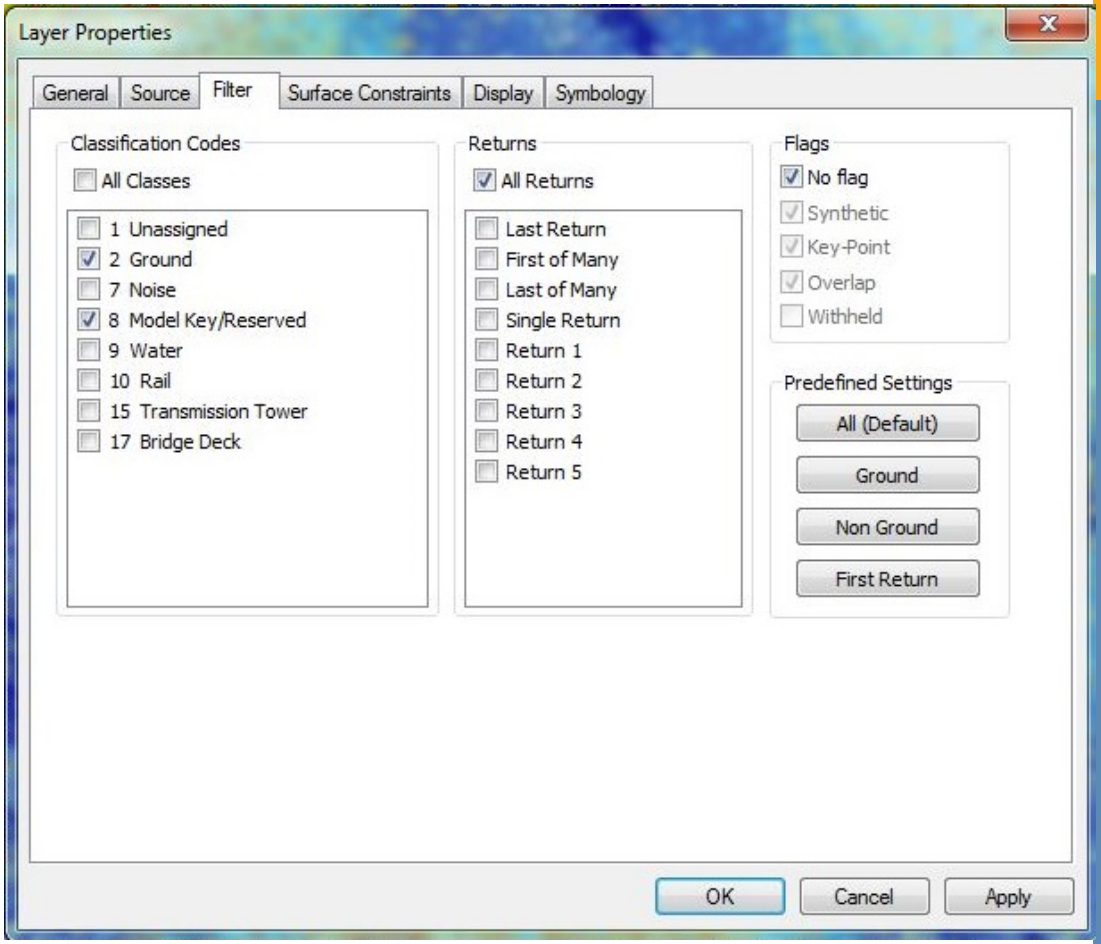
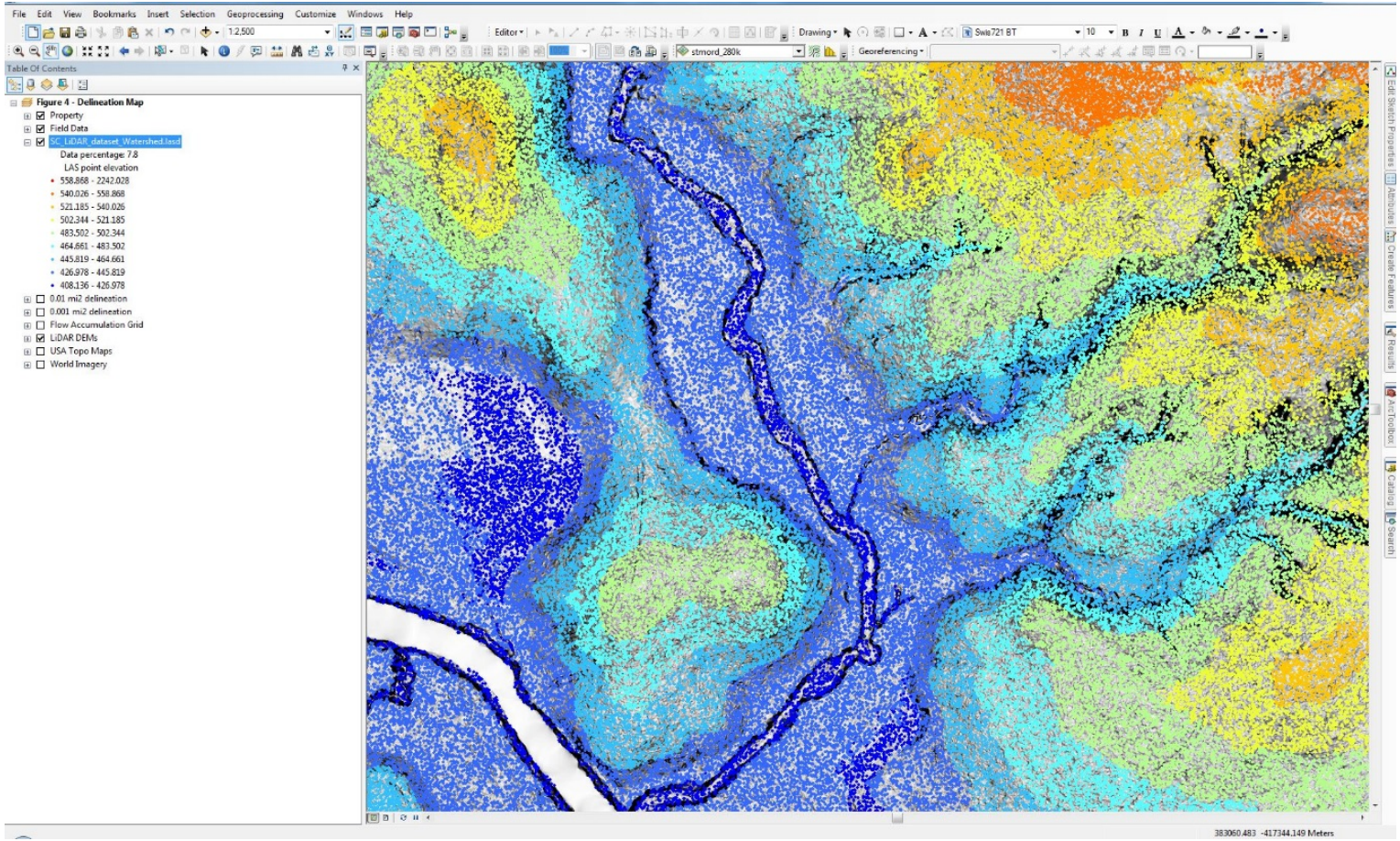
Filter LAS Dataset

- **Filter LAS dataset within layer properties**
  - Choose ground classifications
  - Choose Model Key/Reserved if available
    - This classification is typically surveyed ground control points



Filtered “Bare Earth” LAS Dataset



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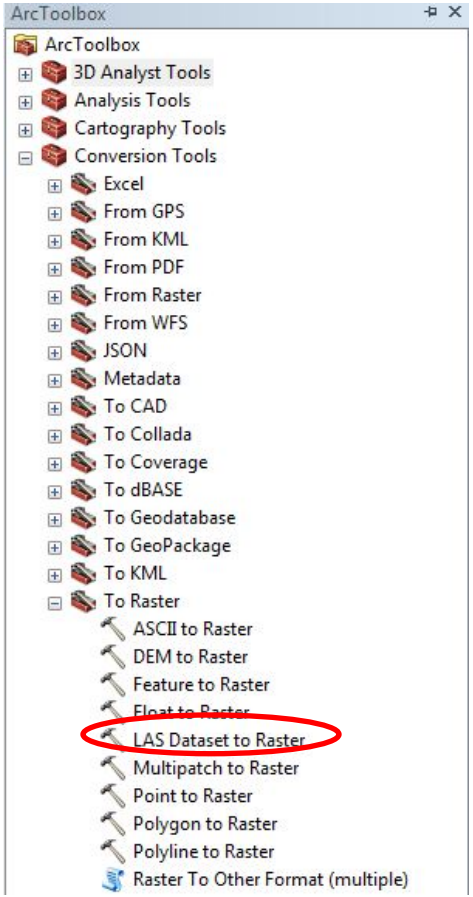
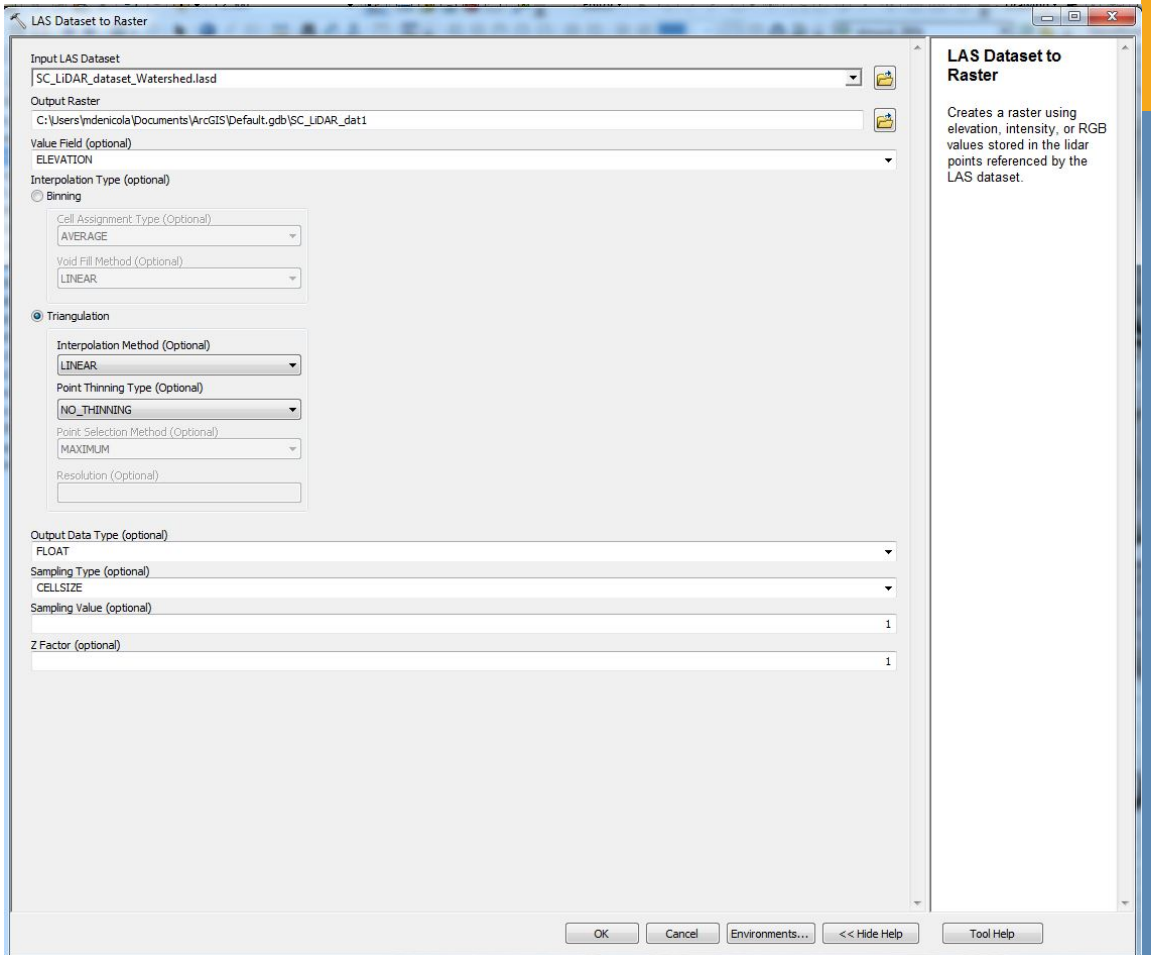
Convert Filtered LAS Dataset to Raster

- **ArcMap > ArcToolbox > Conversion Tools > To Raster > LAS Dataset to Raster**



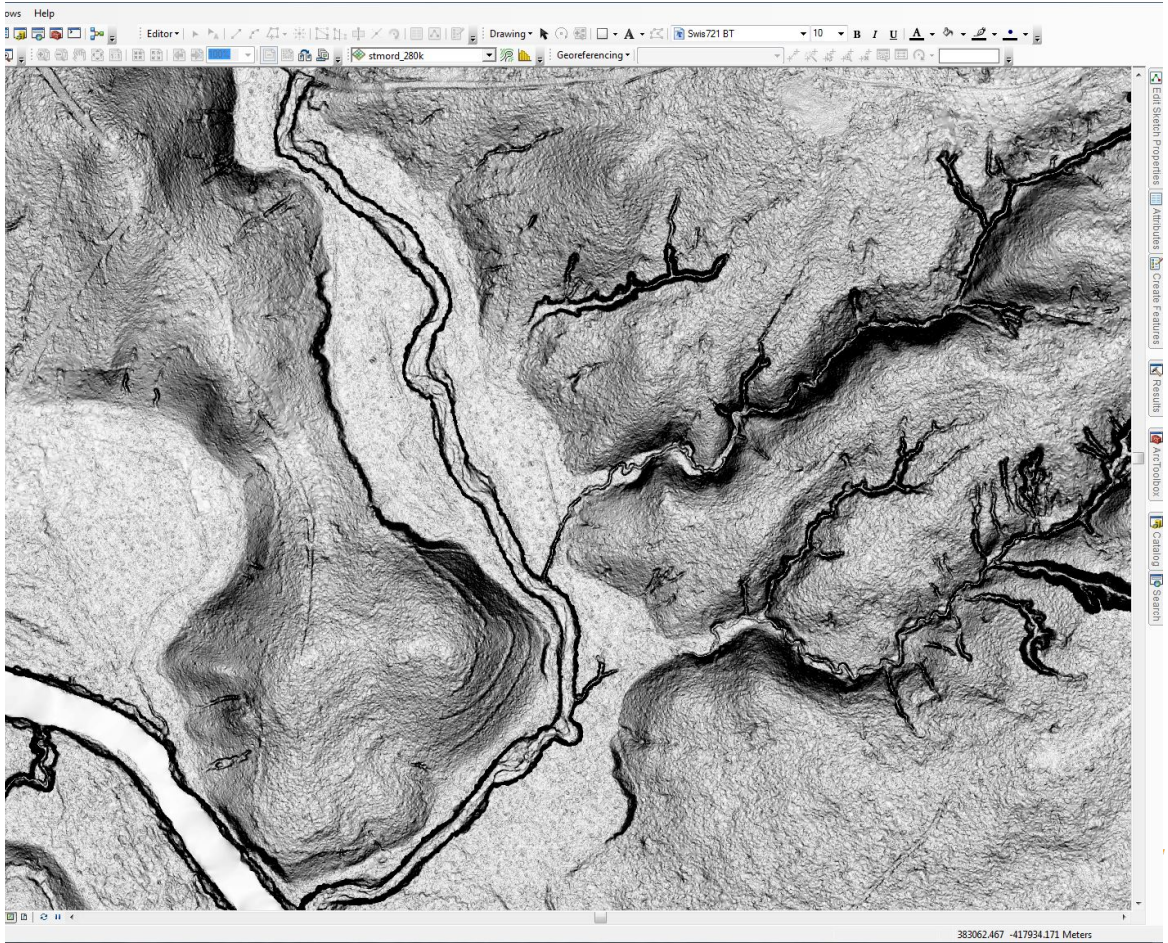
Convert Filtered LAS Dataset to Raster

- **Input filtered LAS Dataset**
- **Use Triangulation Interpolation Method**
  - Linear Interpolation Method is quickest
  - Nearest Neighbor Interpolation Method is more accurate
  - No Thinning of points
- **Output Datatype is Float**
- **Sampling Type is Cell Size**
- **Sampling Value and Z Factor should be 1**
- **This process can take a while**
- **Output raster may be very large**



Bare Earth DEM

- Create a slope map of the DEM
- Allows for close examination of dataset



Bare Earth DEM

West Virginia LiDAR

- Created from Bare Earth DEM

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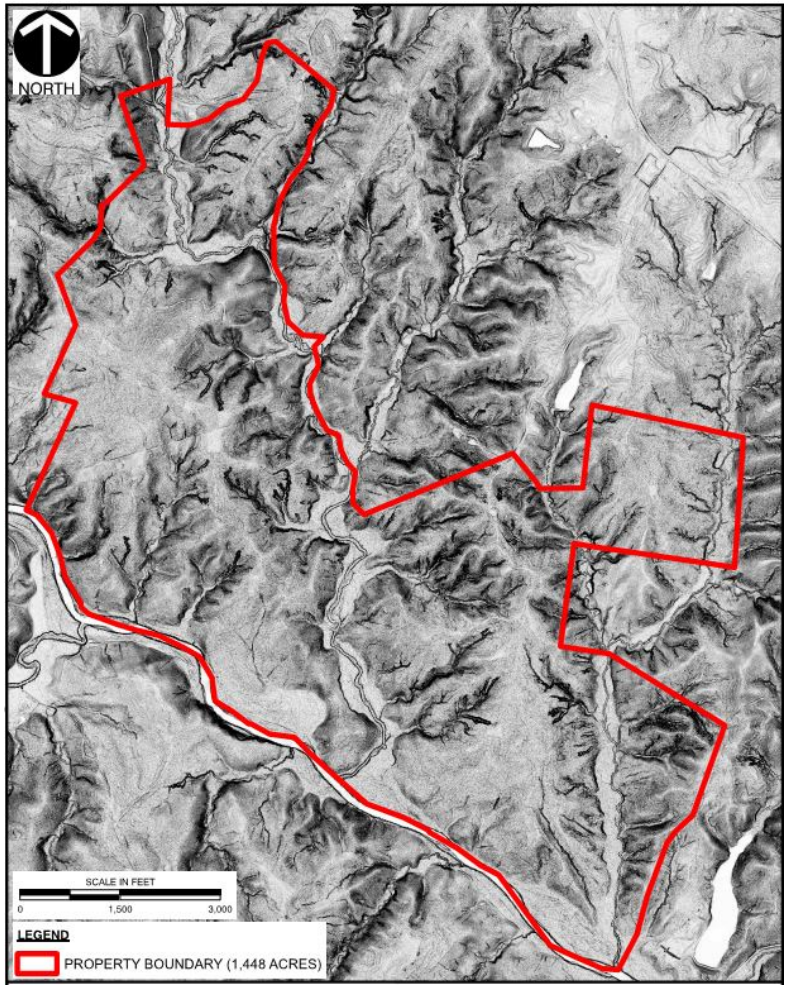
Bare Earth DEM

South Carolina LiDAR

- Created from filtered LAS Dataset



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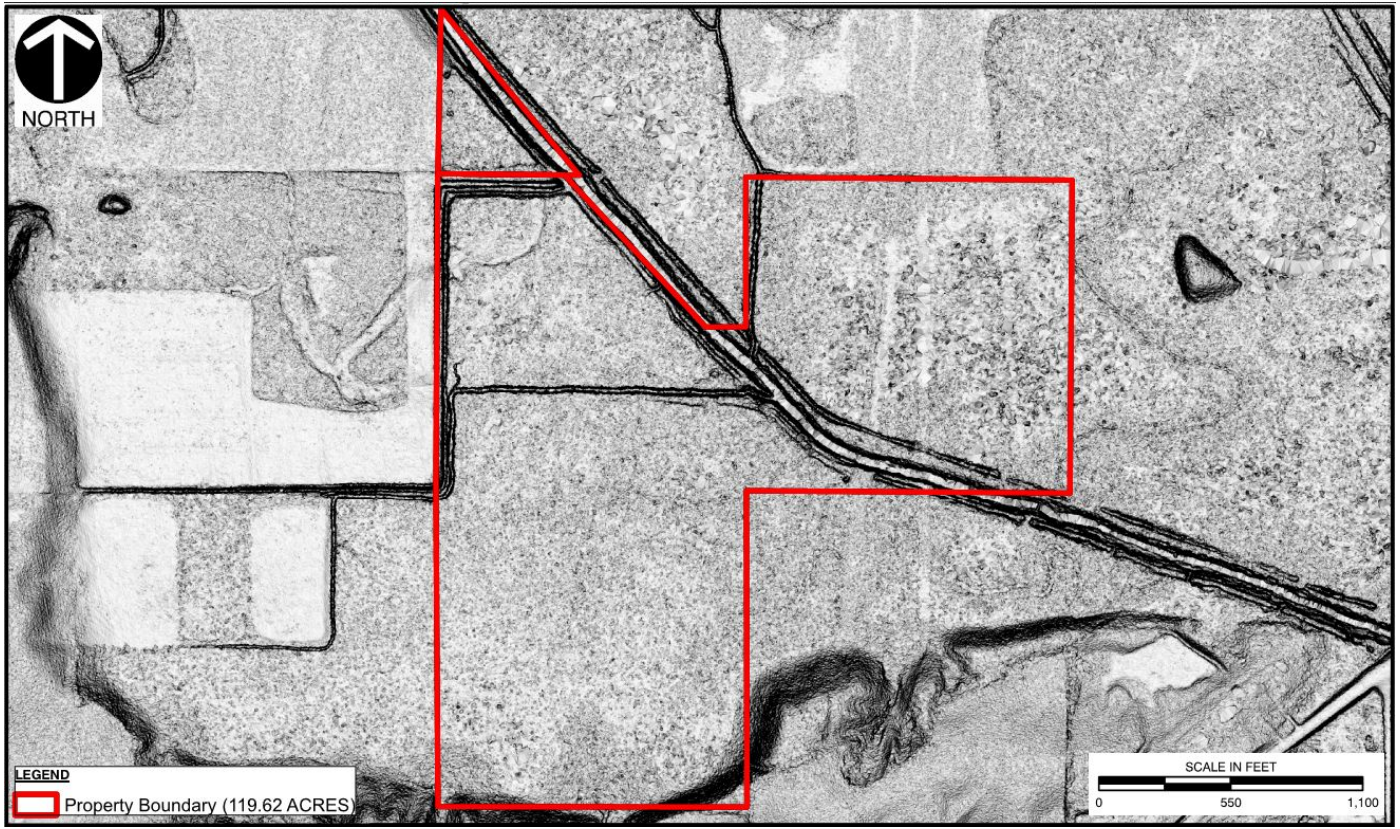
Bare Earth DEM



Indiana LiDAR

- Created from filtered LAS Dataset

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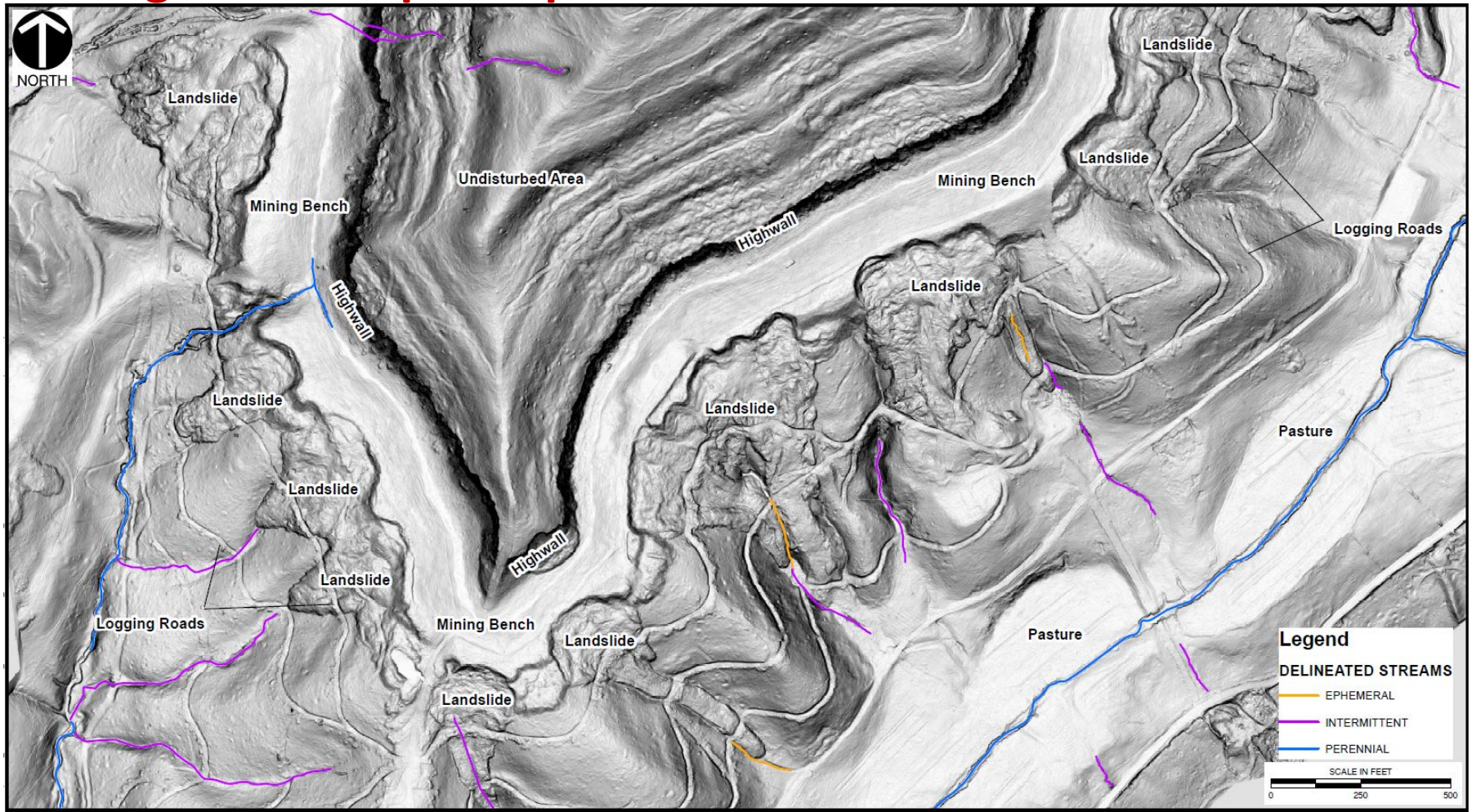
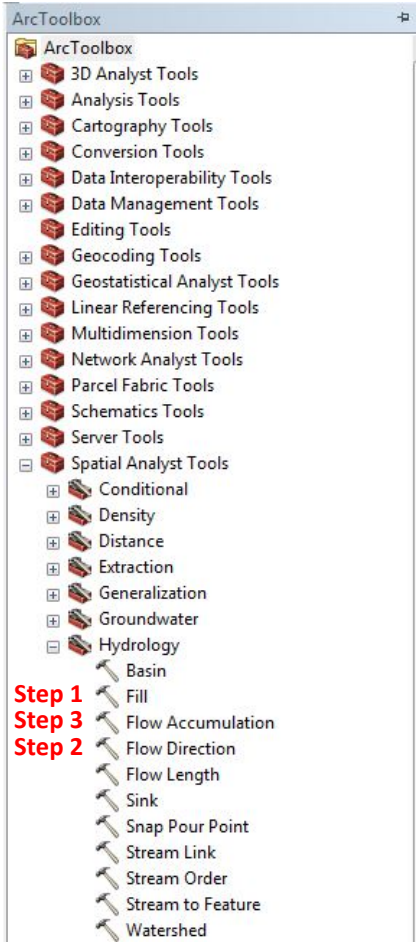
Using LiDAR Slope Map



Using DEM to Create Flow Accumulation Grid

- **ArcToolbox > Spatial Analyst > Hydrology**
  - Bare Earth DEM is used to create a Fill raster
  - Fill raster is used to create a Flow Direction raster
  - Flow Direction raster is used to create a Flow Accumulation Raster

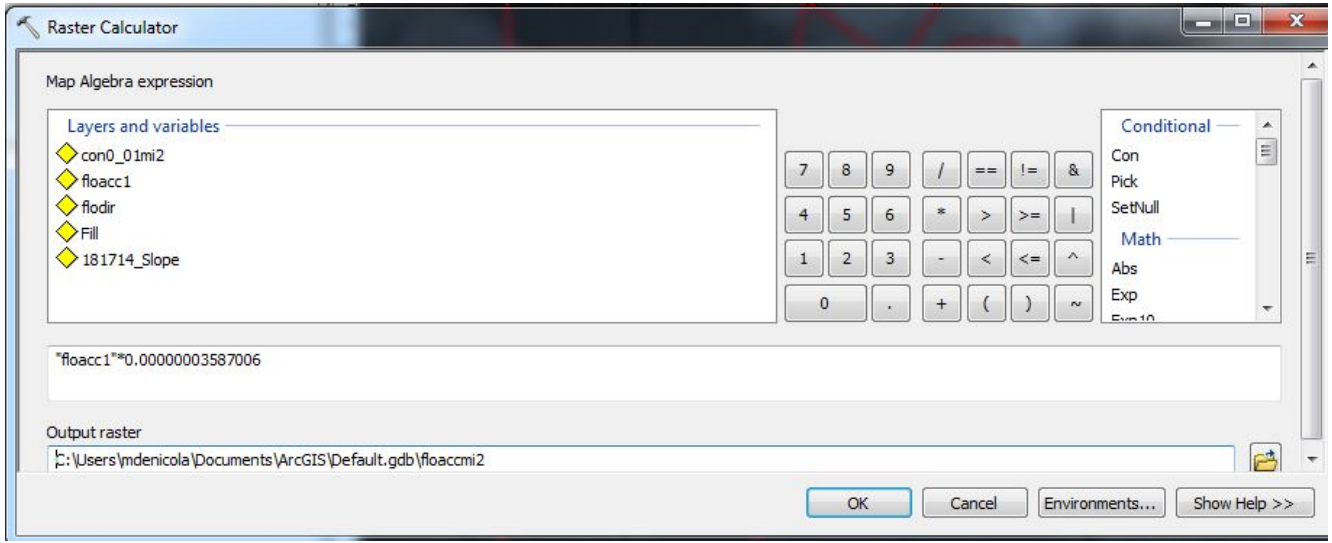


Understanding a Flow Accumulation Grid

- **Flow accumulation raster represents the number of cells that flow to a particular cell**
- **The processing gets more complicated from here**
  - You need to have a basic understanding of map algebra
- **I convert my flow accumulation grid from number of cells to square miles to better understand drainage area**
  - You could also make an excel “calculator” to convert number of cells to square miles

Understanding a Flow Accumulation Grid

- **Basic steps to convert flow accumulation grid from number of cells to square miles**
  - Cell Size (ex. 1 ft^2)
  - Area of a cell converted to mi^2 – multiply flow accumulation by this number
    - 1 ft^2 is equal to 0.00000003587006 mi^2
  - ArcToolbox > Spatial Analyst > Map Algebra > Raster Calculator



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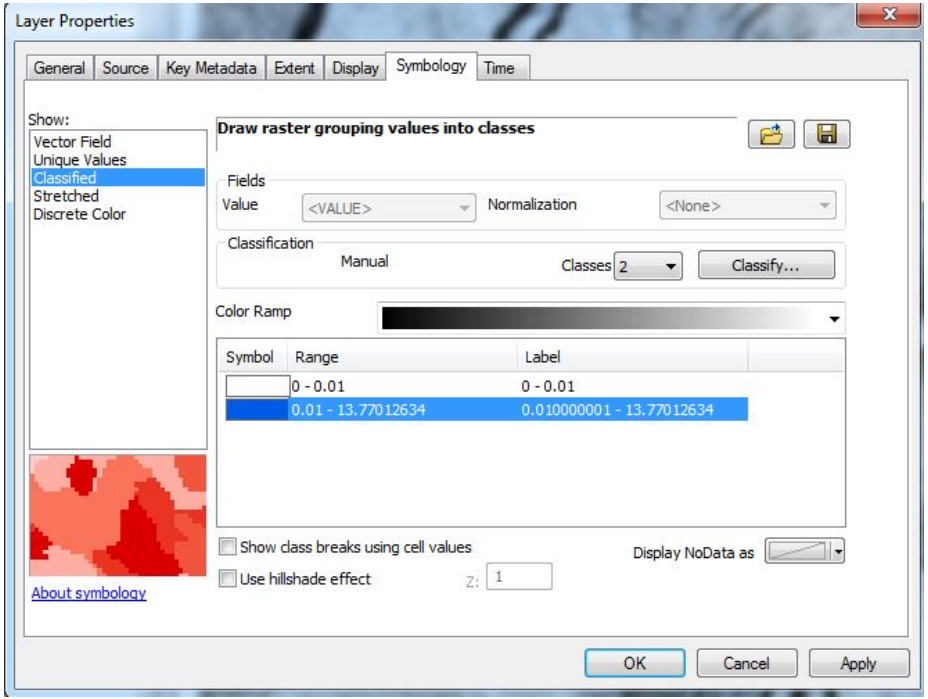
Understanding Flow Accumulation Grid

- **Change symbology of flow accumulation grid to fine tune the drainage area thresholds**



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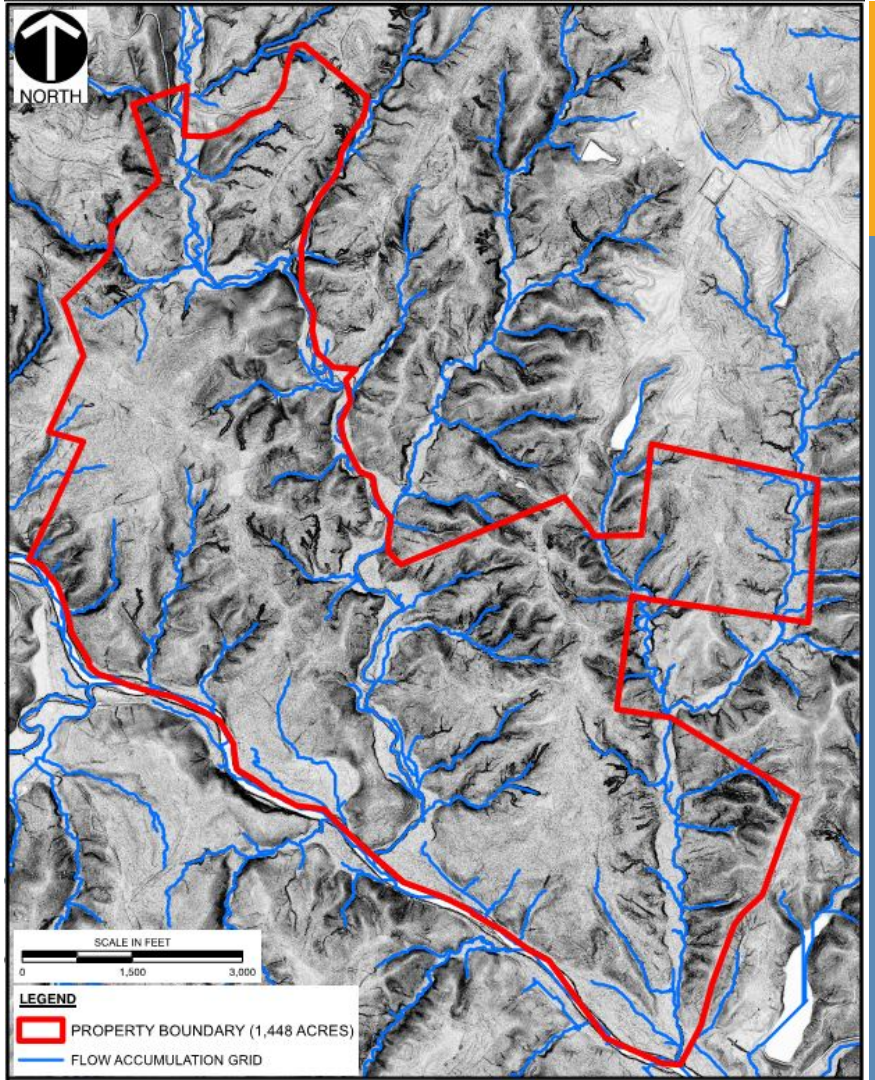
Flow Accumulation Grid

- **Ideal for smaller tributaries**
- **Not ideal for large rivers**
  - HUGE raster needed to calculate drainage area
  - Use in combination with USGS StreamStats for large rivers
- **Great for planning design parameters based on drainage area**
- **Excellent resource for planning delineations and estimated linear footage of stream on a project site**



Conclusions

- **Public available LiDAR is usually found as bare earth DEMs or LAS files**
  - Bare Earth DEMs can be used with little to no processing
  - LAS files require careful processing
- **Bare Earth DEMs can be used to:**
  - Identify various landforms or surficial geology
  - Areas of erosion
  - Anthropogenic disturbances
  - Create flow accumulation grids
  - Use for design purposes
  - Etc. – the possibilities go on and on

Questions?

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