Working with Topographic LiDAR in Maryland

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Today's Schedule

- Quick Introduction to LiDAR
- Accessing Maryland LiDAR
- Formatting of training documents
- Hands-on portion
  - Module 1 – LAZ to LAS; LAS Datasets; DSM and DEM
  - Module 2 – Image Analysis Window
  - Module 3 – Map Algebra and Hypothetical Scenario
  - Module 4 – Contours and ArcPy Script Tools

What is LiDAR?

Light Detection and Ranging

Light in the form of a pulsed laser measures variable distances from an object back to the sensor.

Ranges (distances), combined with position and orientation data, result in a dense cloud of points – “point cloud”

Source: NOAA

Light Detection and Ranging

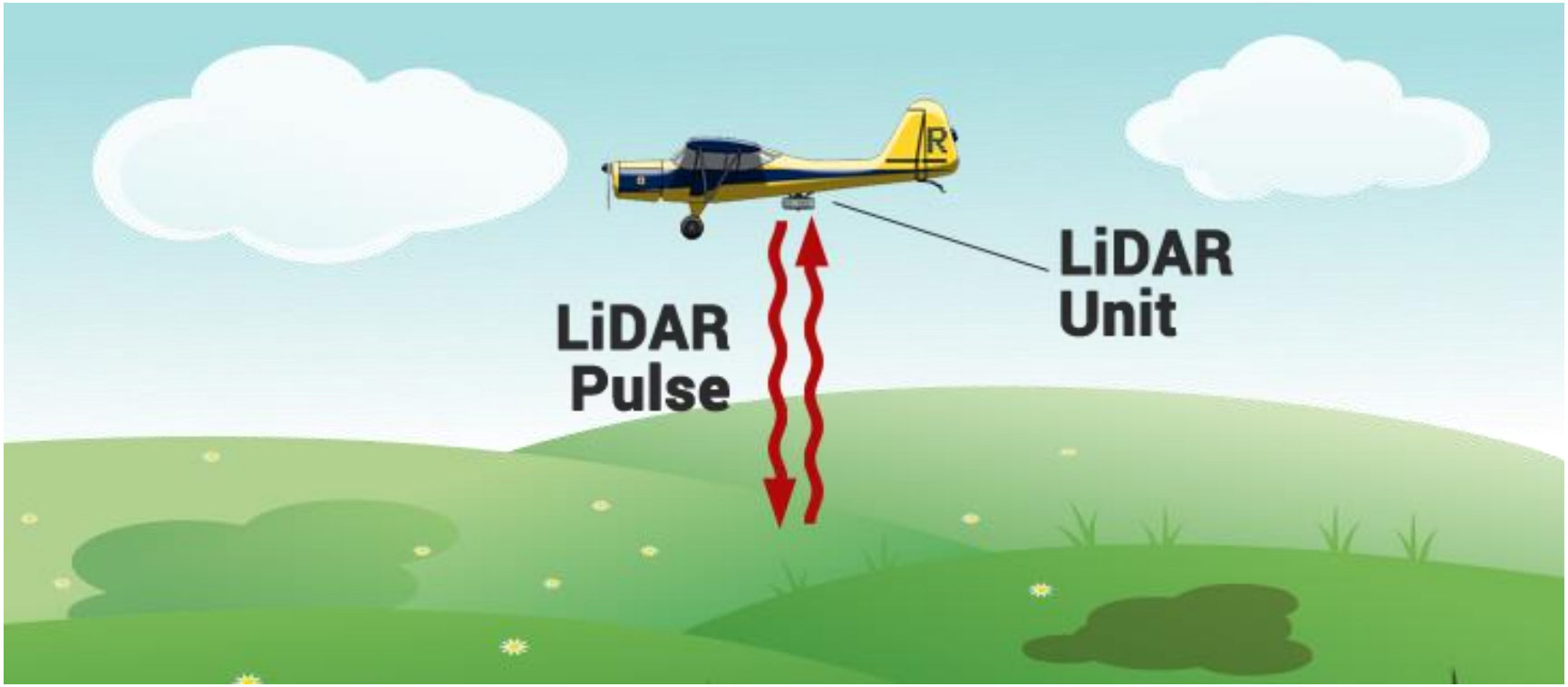
Each point in this cloud contains 3-dimensional spatial coordinates (X, Y, Z)

These point clouds can be used to generate derivative products, such as Digital Elevation Models (DEMs) and Digital Surface Models (DSMs).

LiDAR Components

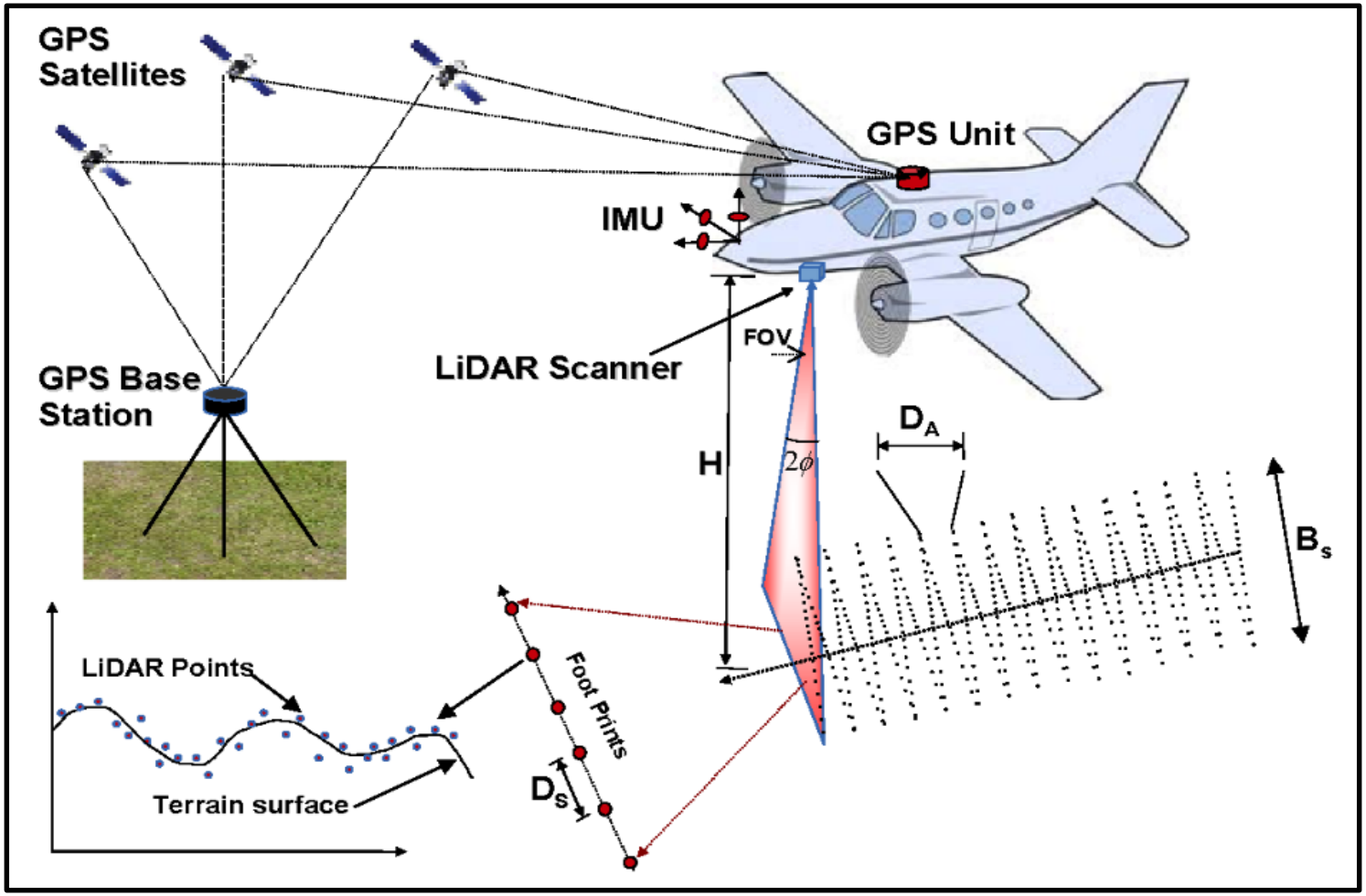
- Laser Scanner and Sensor
  - Upwards of 400,000 pulses per second
  - Sensor receives reflected echo from emitted pulse as waveform
- GPS – Global Positioning System
  - Tracks location of the plane as it collects data
- IMU – Inertial Measurement Unit
  - Tracks pitch, roll and yaw of the plane as it collects data
- Ground Station
  - Provides a ‘correction’ factor for the GPS in the plane

LiDAR Acquisition



Source: GISGeography.com, 2018

LiDAR Acquisition

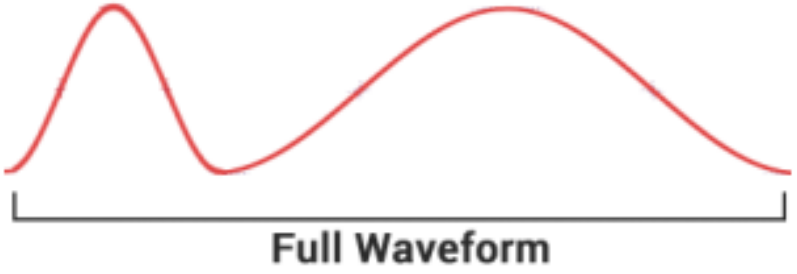


Source: Dashora, Lohani, & Deb, 2013

LiDAR Returns

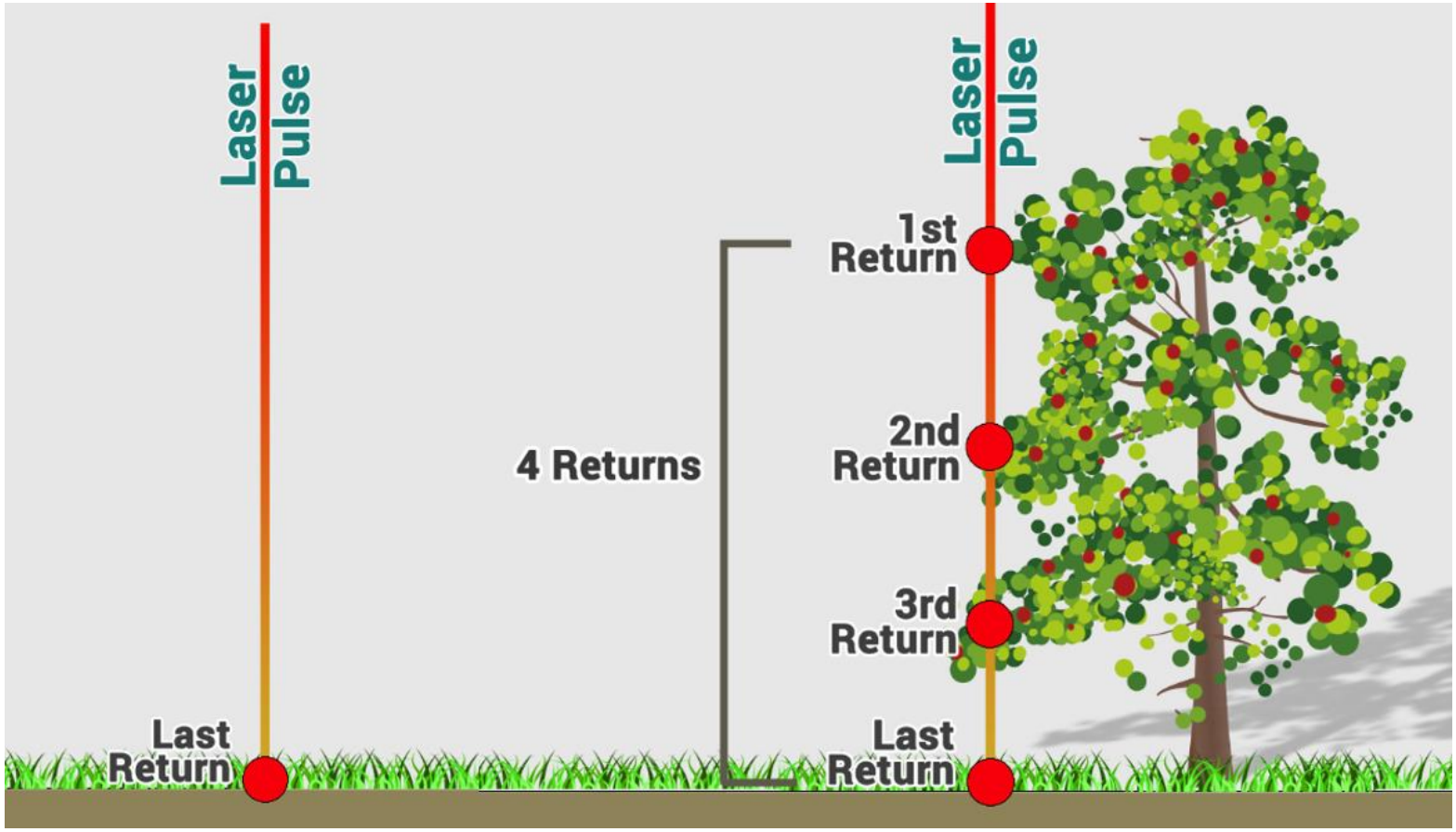
Discrete Returns

Waveform Returns



Source: GISGeography.com, 2018

LiDAR Returns



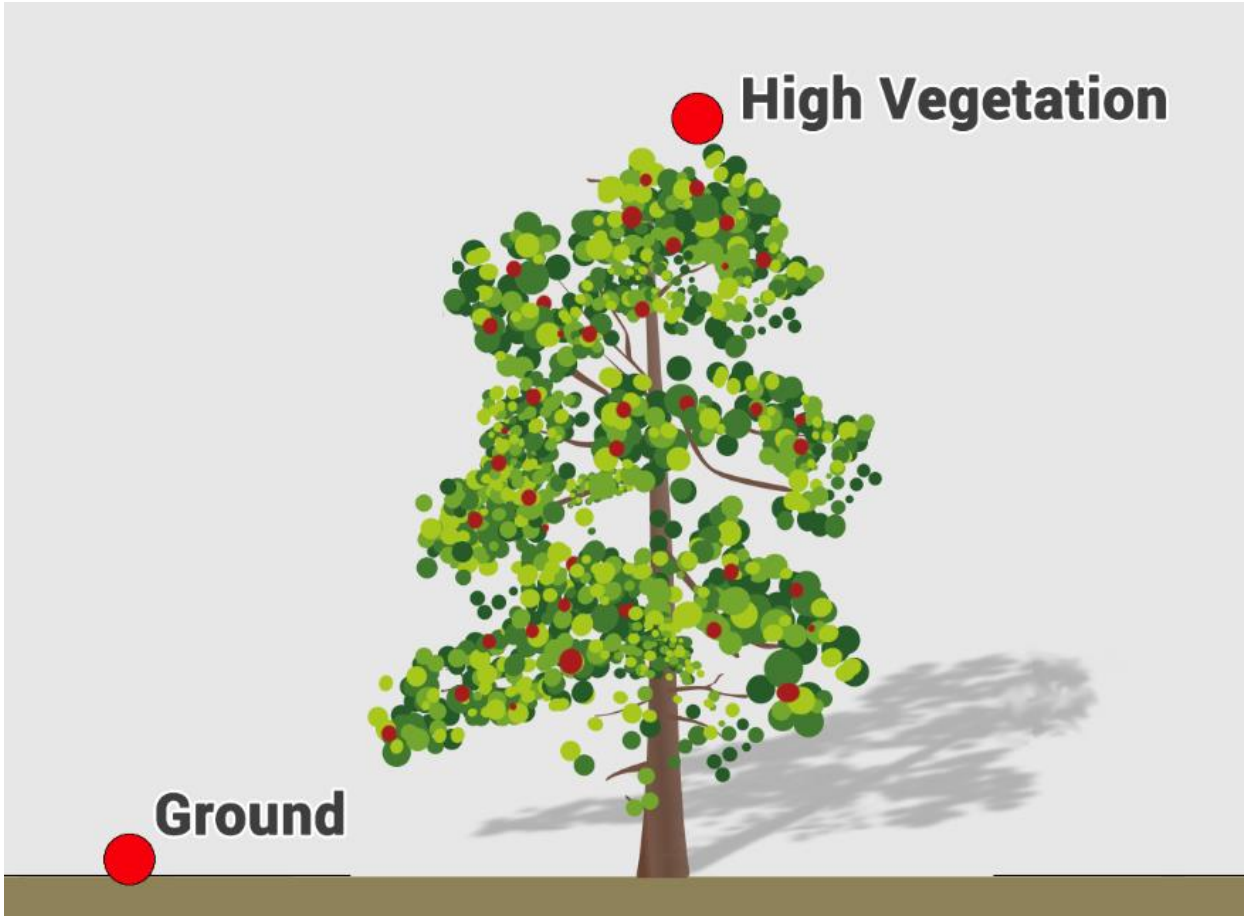
Source: GISGeography.com, 2018

Point Classifications

0 - Never classified
1 - Unassigned
2 - Ground
3 - Low Vegetation
4 - Medium Vegetation
5 - High Vegetation
6 - Building
7 - Low Point
8 - Reserved *
9 - Water
10 - Rail
11 - Road Surface
12 - Reserved *
13 - Wire - Guard (Shield)
14 - Wire - Conductor (Phase)
15 - Transmission Tower
16 - Wire-Structure Connector (Insulator)
17 - Bridge Deck
18 - High Noise
19-63 - Reserved
64-255 - User Definable

Source: ESRI

Point Classifications



Source: GISGeography.com, 2018

LiDAR Intensity

- Return strength of the laser pulse that generated the point, partly determined by the reflectivity of the object.

- Intensity images can aid in feature detection and can act as a supplemental dataset for aerial imagery when none is available (vintage or geography)

Source: ESRI

LiDAR Intensity

Source: Ellicott City LiDAR, 2018

Metadata

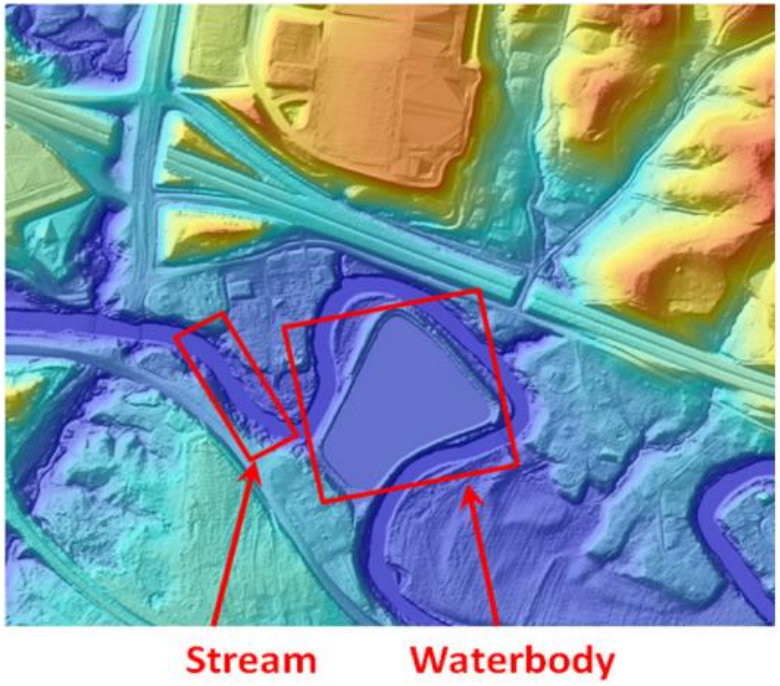
- The DATA about the data…
- When was the LiDAR collected?
- What is the resolution?
- NPS?
- Quality level?
- Spatial reference?
- Vertical accuracy?
- Hydrologic processing?

Source: Ellicott City LiDAR, 2018

Hydro-flattened

- Breaklines are used to force the surfaces of lakes and reservoirs to be flat, and rives to be flat from bank to bank.

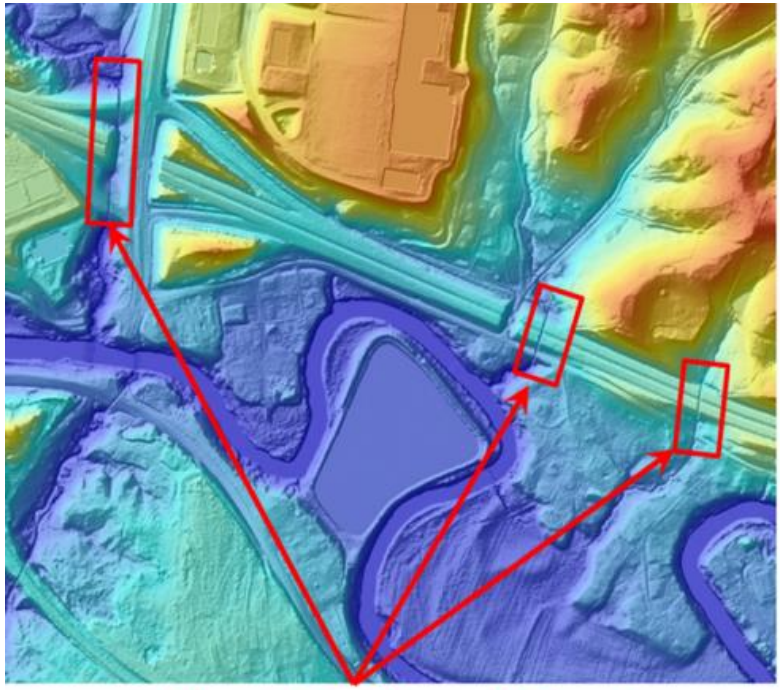
- Maintains downhill water surface gradient



Source: USGS

Hydro-enforced

- Includes hydro-flattening
- Adds treatment of narrower drains and culverts to enforce downward flow of water

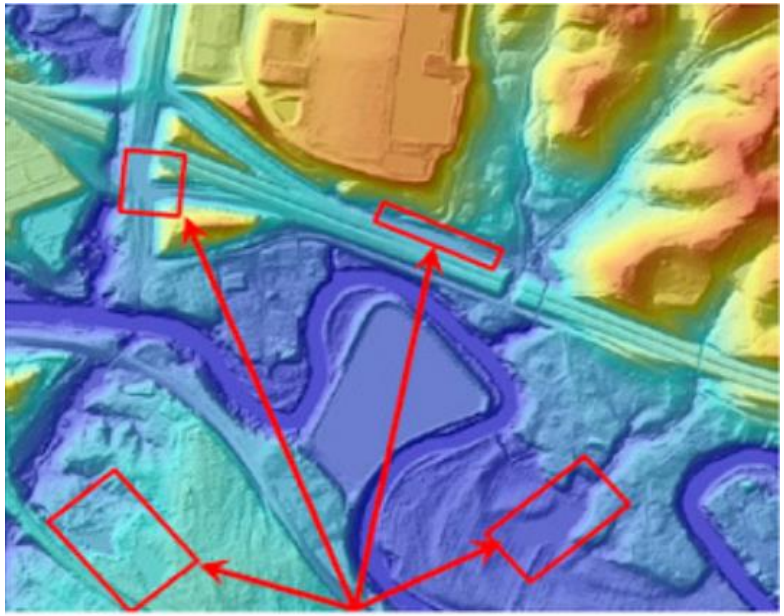


Culverts Cut Through Roads

Source: USGS

Hydro-conditioned

- Similar to hydro-enforcement
- Sinks in the dataset are filled to their pour points; may help identify where downward flow is impeded.



Filled Sinks for Hydro-Conditioning

Source: USGS

Aggregate Nominal Point Spacing and Density

[QL, quality level; pls/m^2, pulses per square meter; m, meter; ≤, less than or equal to; ≥, greater than or equal to]

Quality level	Aggregate nominal pulse spacing (m)	Aggregate nominal pulse density (pls/m^2)
QL0	≤0.35	≥8.0
QL1	≤0.35	≥8.0
QL2	≤0.71	≥2.0
QL3	≤1.41	≥0.5

Source: USGS

Exploring Maryland LiDAR

[REFERENCE_AccessingMarylandLiDAR]

Options for Exploring Elevation Data in Maryland

- **Download**
  - Maryland Statewide LiDAR Download Tool
    - https://lidar.geodata.md.gov:8443/ExpressZip
  - Predefined DEMs
    - https://imap.maryland.gov/Pages/lidar-dem-download-files.aspx
  - Predefined Point Cloud
    - https://imap.maryland.gov/Pages/lidar-download-files.aspx

Options for Exploring Elevation Data in Maryland

- **Topography Server**
  - ArcGIS REST Services Directory
    - https://lidar.geodata.md.gov/imap/rest/services

Options for Exploring Elevation Data in Maryland

- **Topography Viewer**
  - MD iMAP Topography Viewer
    - https://geodata.md.gov/topoviewer/

Additional Online Training

- LiDAR Training Documents
  - https://imap.maryland.gov/Pages/training-documents.aspx
    - Access Maryland LiDAR Topography Server
    - ArcGIS for Desktop LiDAR Tutorials
      - Extract from Image services
      - Access Image Service Raster Functions
      - Reclassify Raster Datasets
      - Generate Contours
      - Perform a Viewshed Analysis
      - Delineate a Watershed
      - Build LAS Datasets

Sources

- NOAA
- ESRI
- Dashora, A., Lohani, B., & Deb, K. (2013). Two-step procedure of optimisation for flight planning problem for airborne LiDAR data acquisition. *IJMNO, 4*, 323-350.
- https://gisgeography.com/lidar-light-detection-and-ranging/
- https://my.usgs.gov/confluence/download/attachments/592446371/FAQ13.pdf?version=2&modificationDate=1524671104812&api=v2
- https://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf