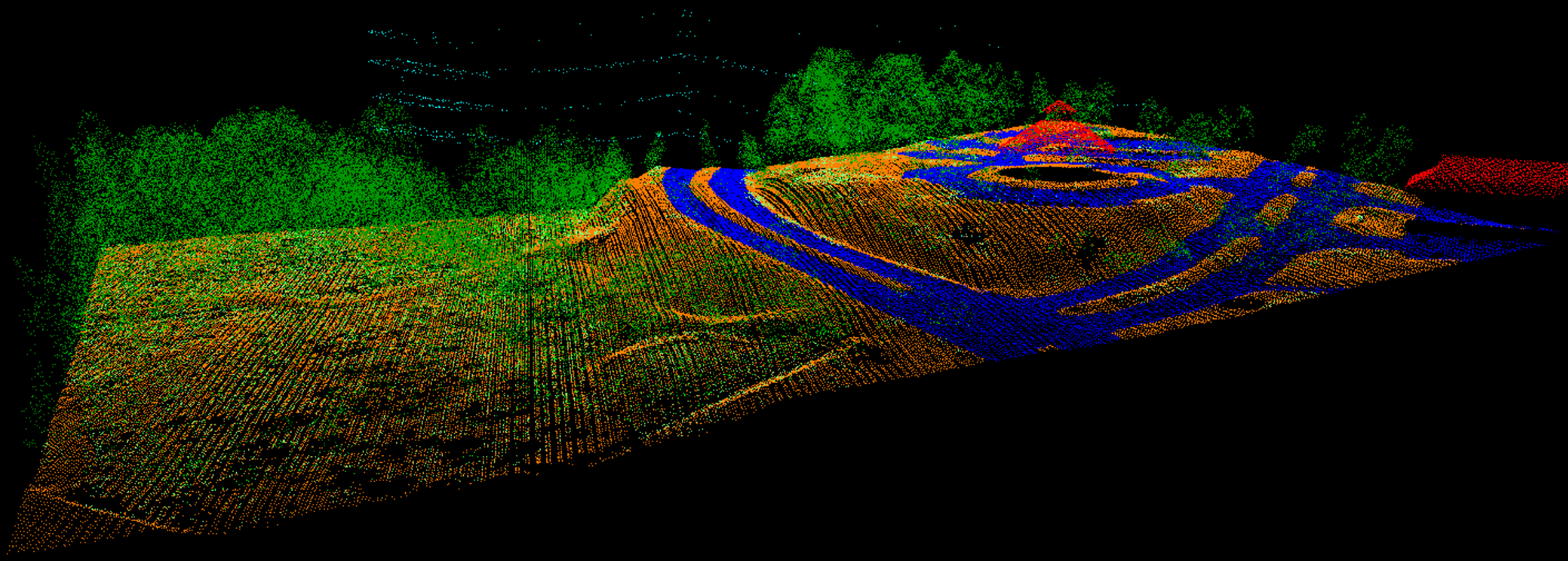
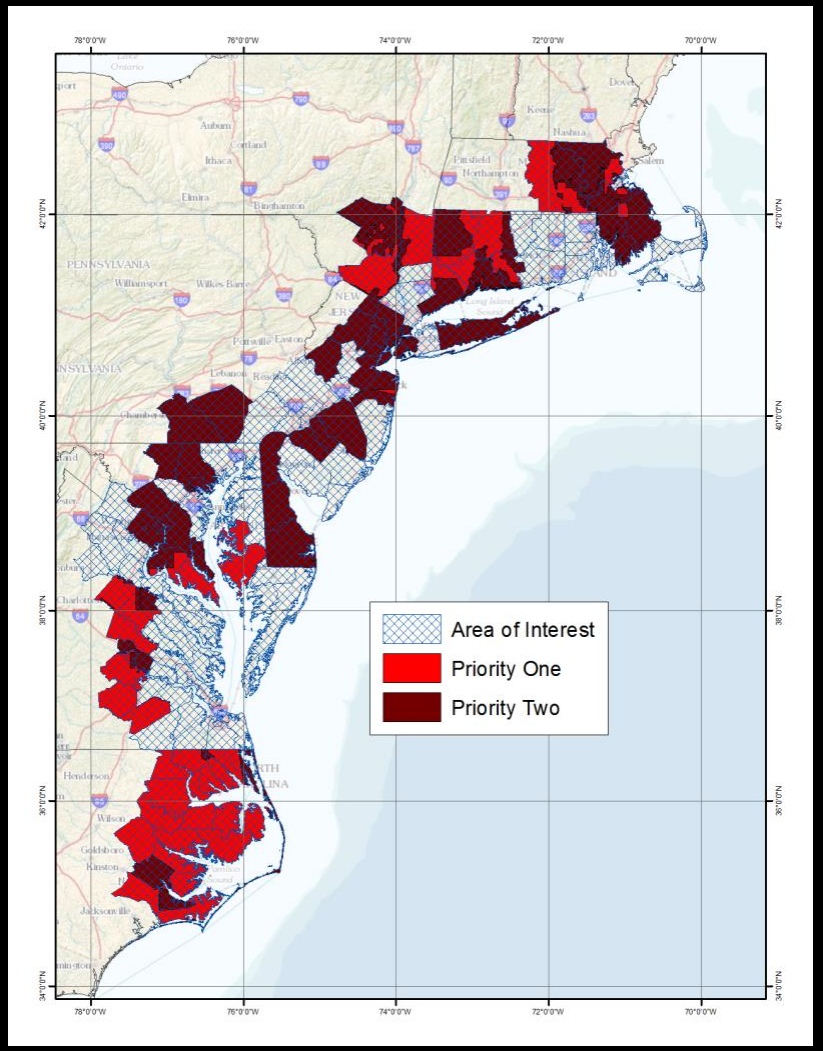


NC LiDAR-Derived Topography
Next Generation - QL2
Initiative Briefing

John Dorman
02/05/14

QL2 Topo – In the Beginning….

- Current statewide LiDAR-derived topography is circa 2001 – 2005 (8-13 years).
- Technological advances with sensor and data management have enable greater accuracy and efficiencies in acquisition and management of data.
- After Hurricane Sandy we were informed by USGS that Disaster Mitigation Funding would possibly be used for LiDAR-derived topographic data acquisition in Sandy impacted areas.
- Improved requirements for LiDAR at the national level was the driver for acquisition funding.
- NCEM – GTM / FPMP established the intent to acquire new QL2 statewide. GTM / FPMP began working with USGS and other federal and state agencies.



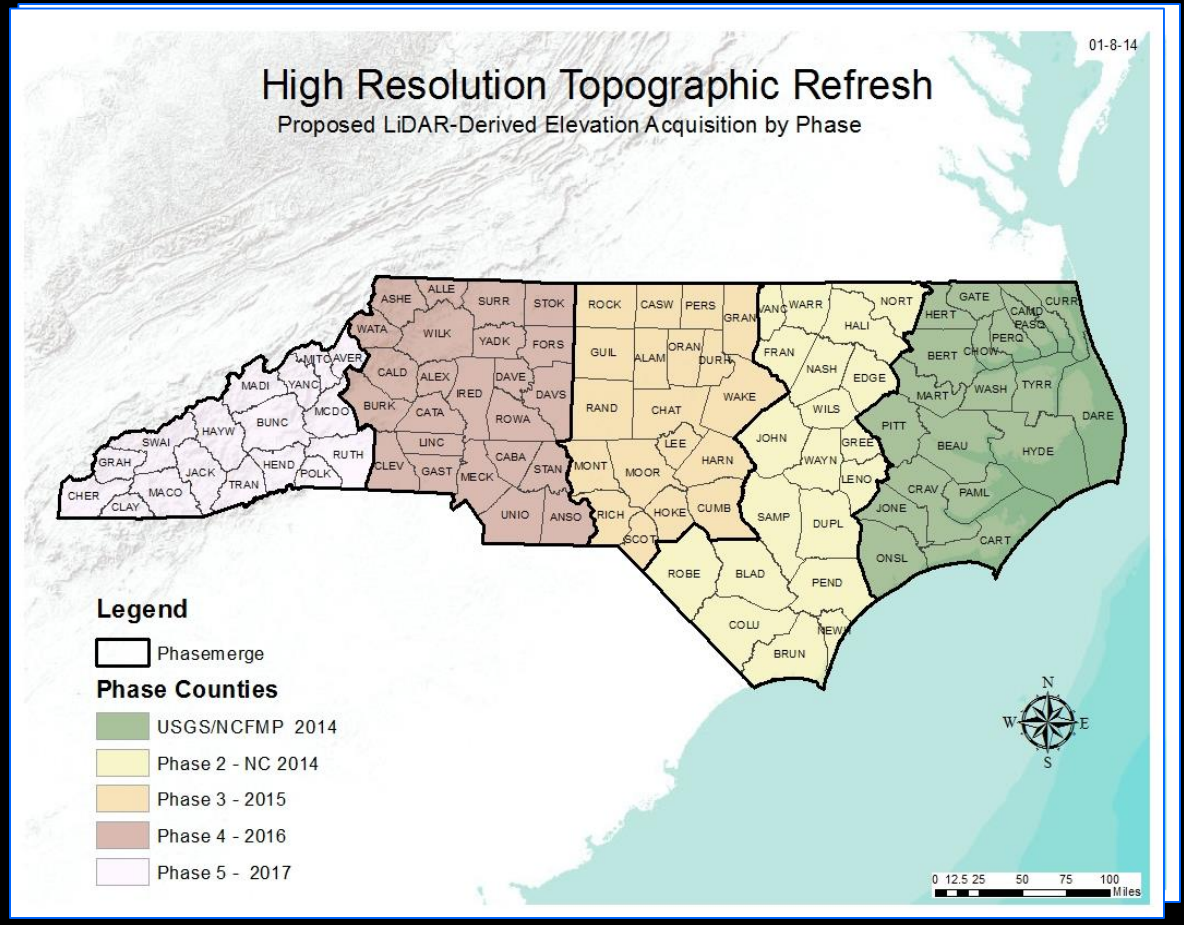
QL2 Topo – Topo-Bathy

- Topo-Bathy was the first LiDAR to be collected with the Sandy funding.
- This was collected by NOAA through USGS.
- The data will be combined with the land deliverable for final delivery.

QL2 Topo – Statewide Acquisition Plan

QL2 Statewide Plan

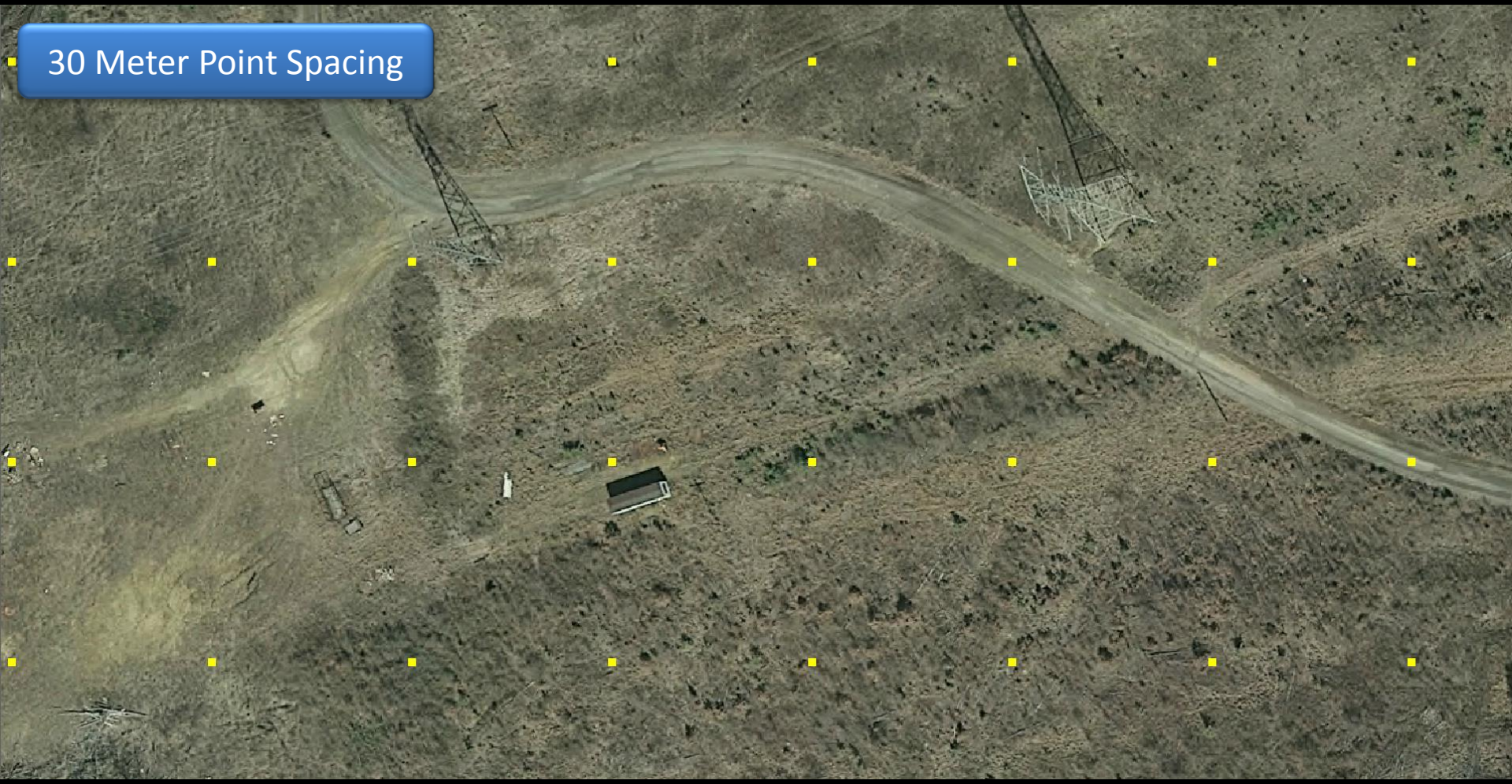
- 5 Phases / 4 Year
- Phase 1- USGS and Phase 2- NC are both acquired in 2014
- With the financial partnering by USDA – NRCS, Phase I added Onslow County.
- Therefore moving the NC collection Phase 2 to add Robeson County



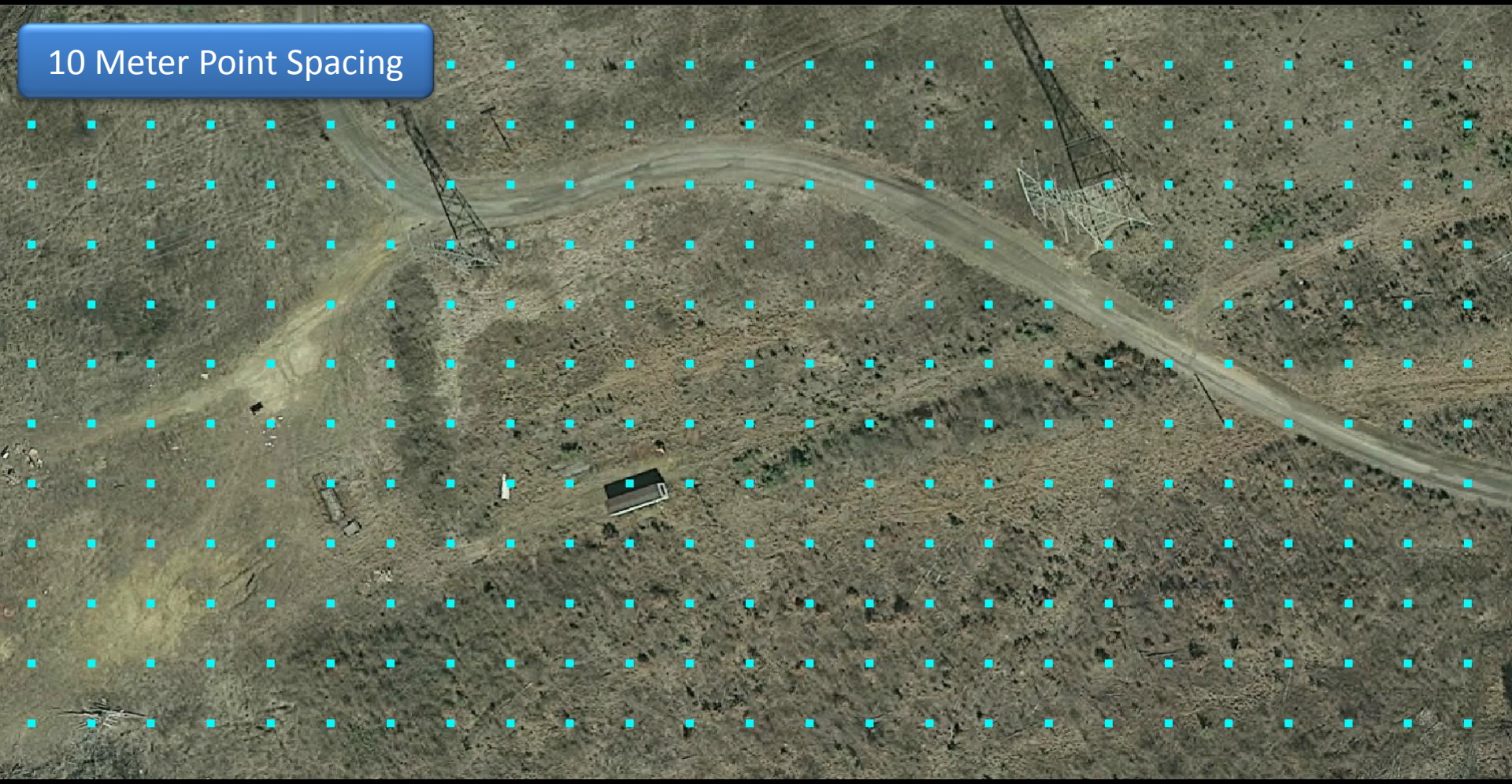
QL2 Topo – Acquisition / Data Specifications

- The 2014 LiDAR data collection will meet 2 points per square meter standard with nominal post spacing of 0.7 meters.
- All data will include multi-return and intensity values.
- Data collected will support a 9.25 cm (3.36 inches) RMSEz and 18.13 cm (6.58 inches) Fundamental Vertical Accuracy based on NDEP guidelines.

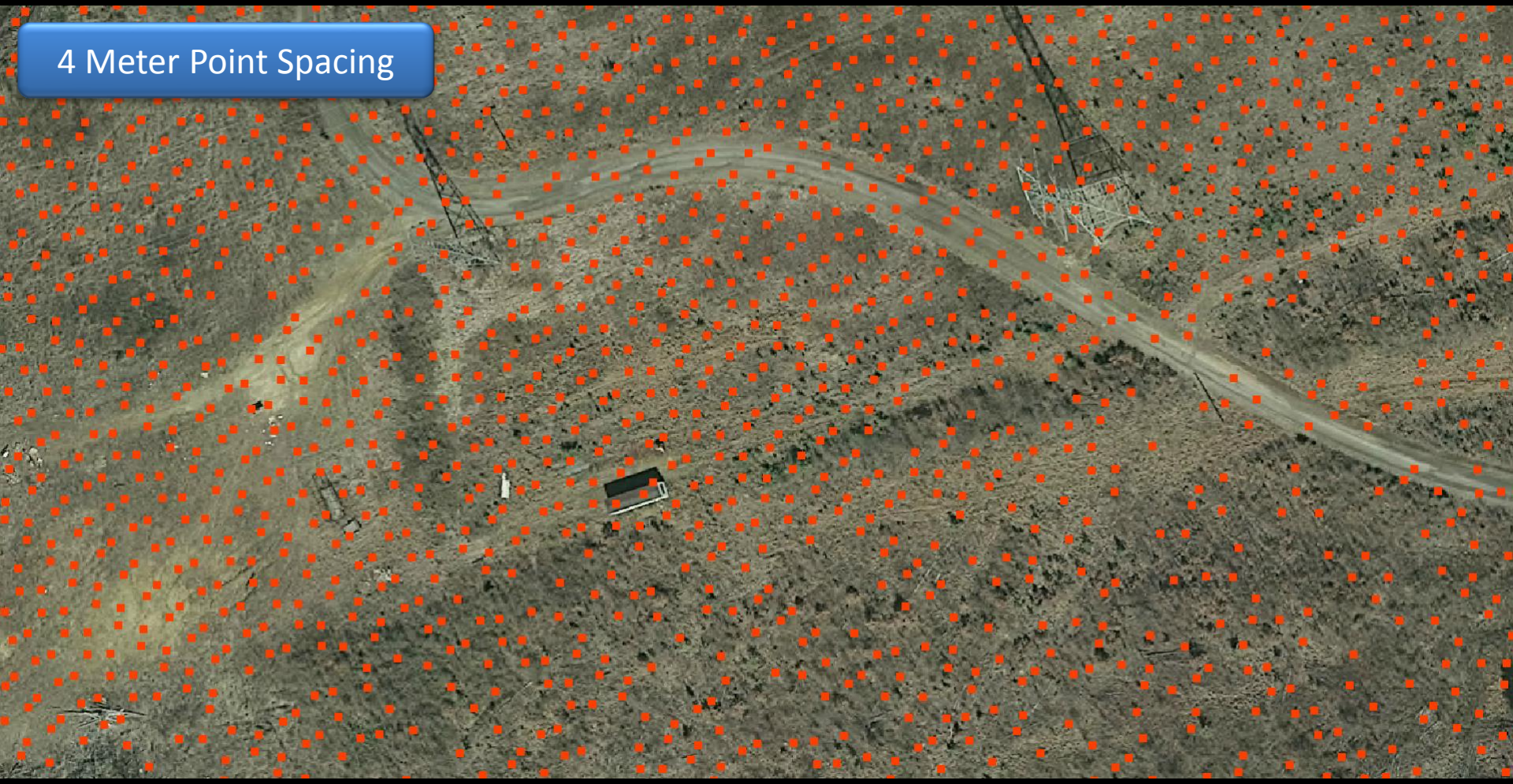
30 Meter Elevation Model



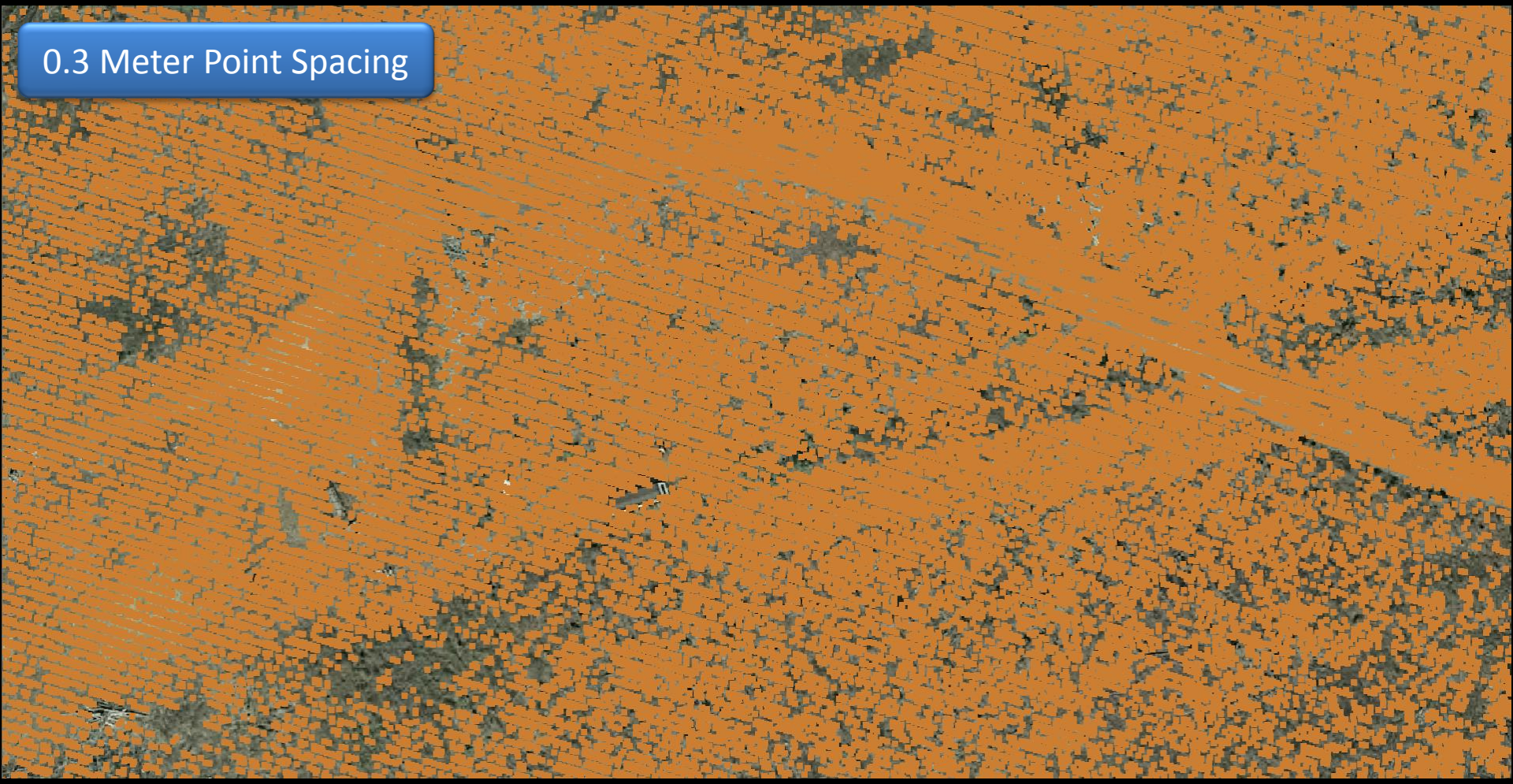
10 Meter Elevation Model



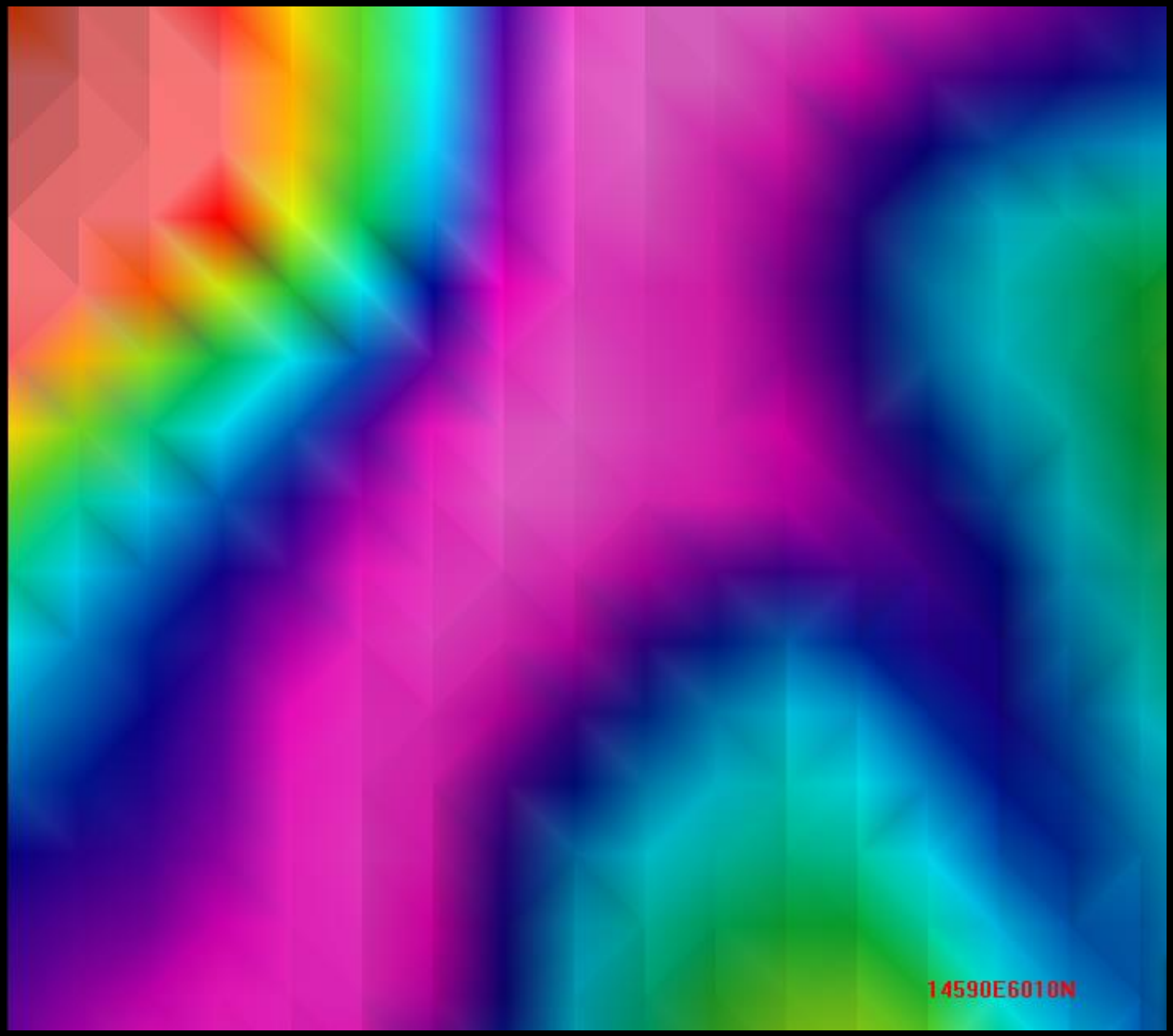
3 Meter Elevation Model (2003 NC LiDAR)



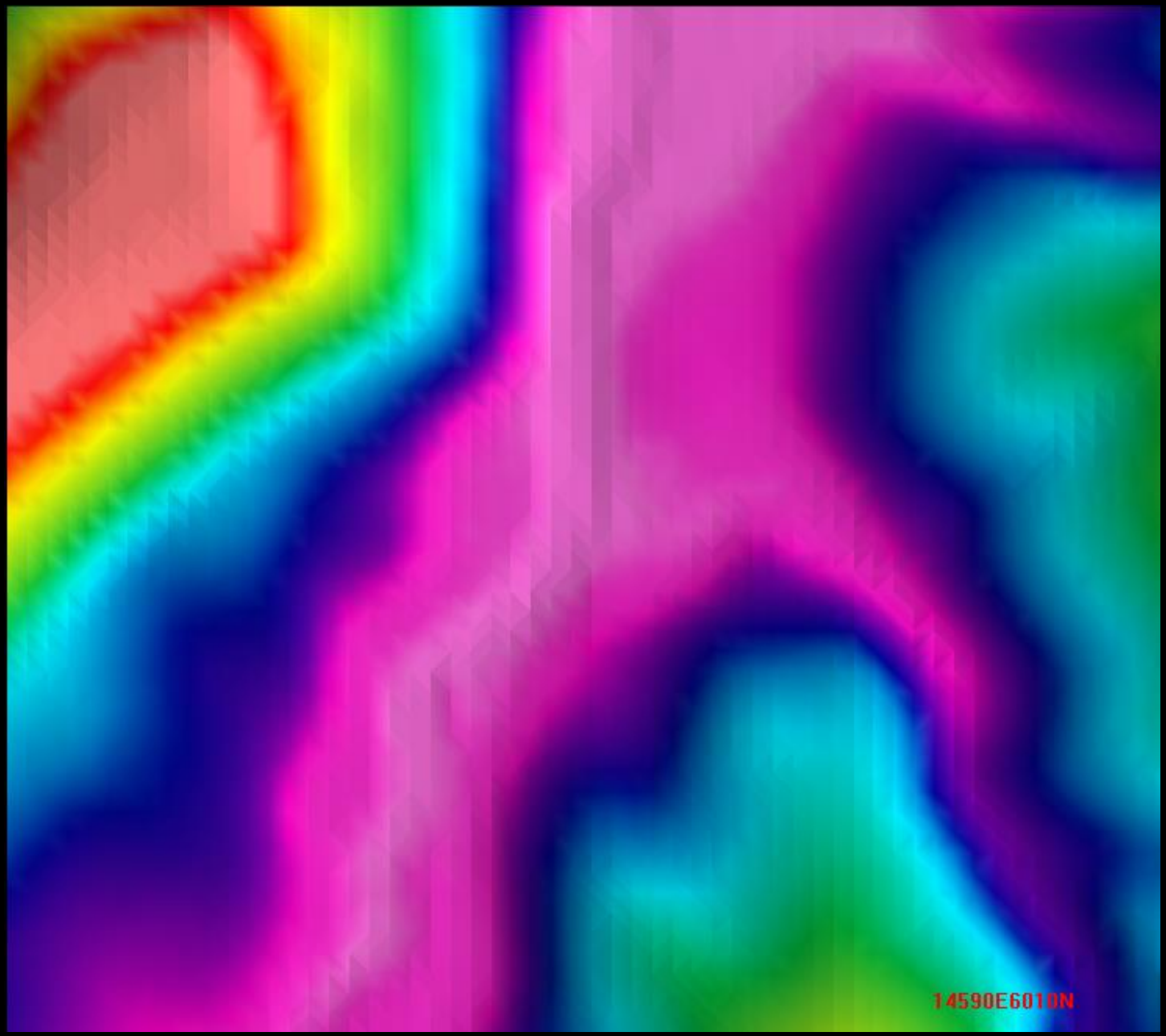
QL2 Elevation Model



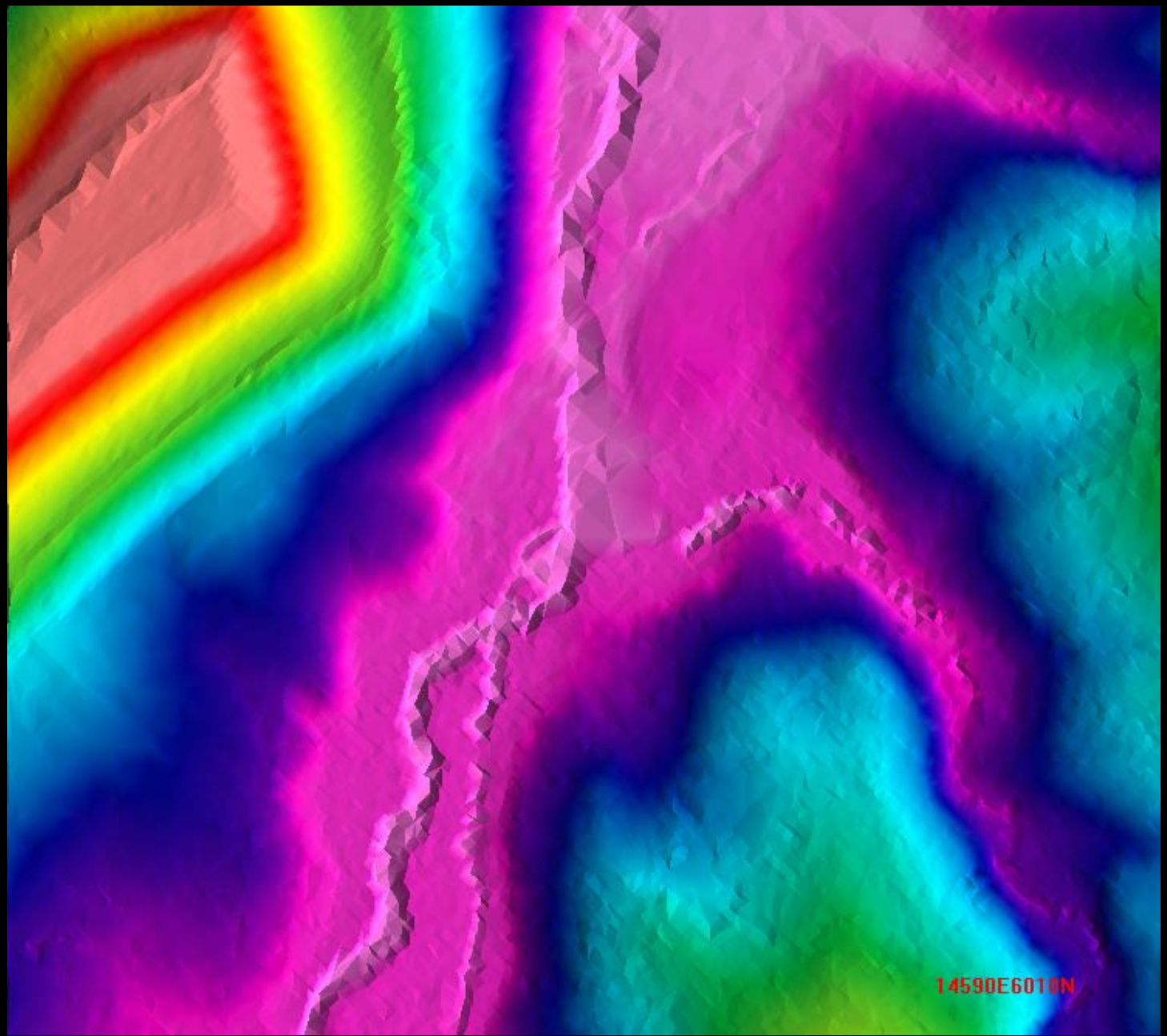
30 Meter Elevation Model



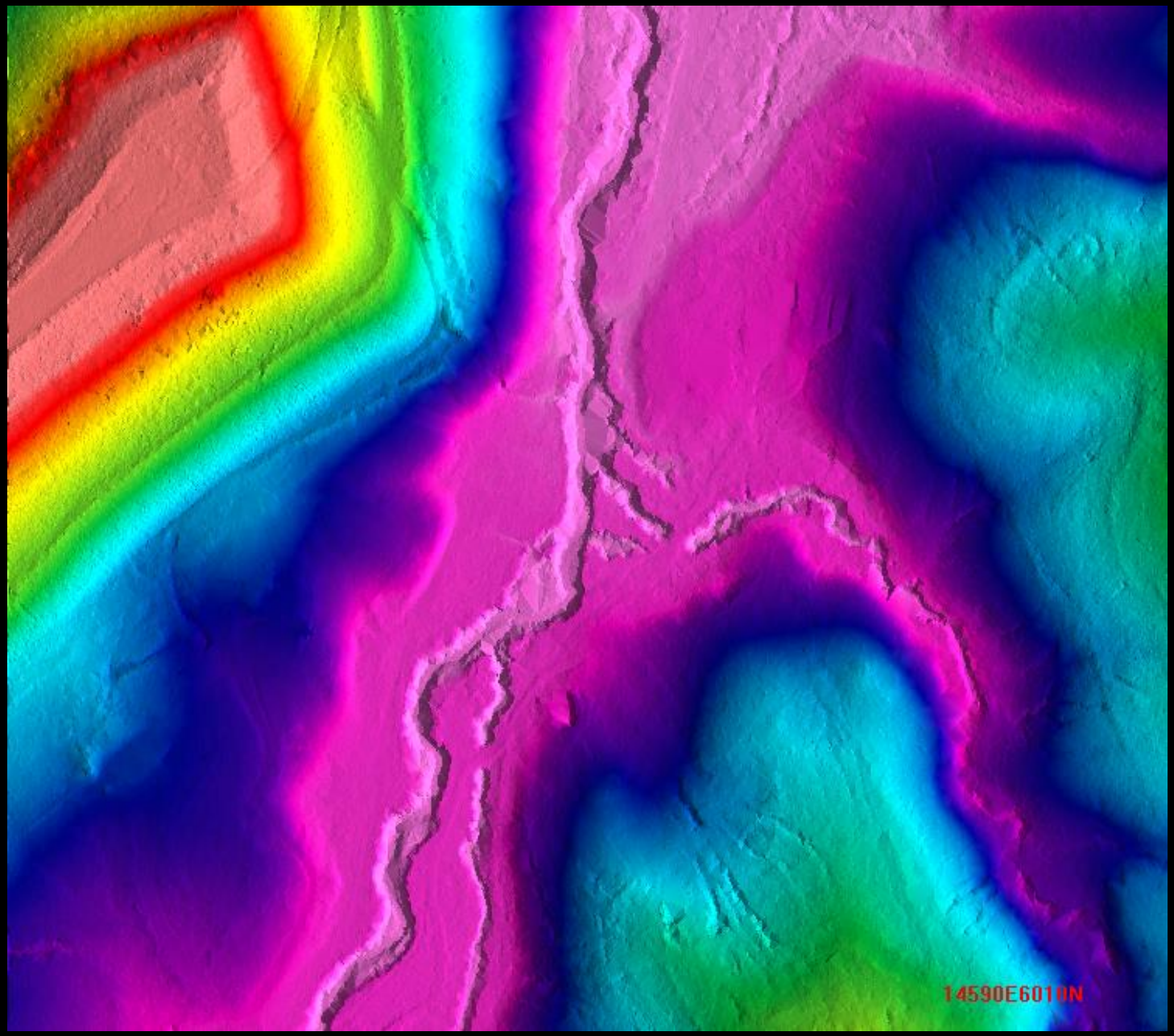
10 Meter Elevation Model



3 Meter Elevation Model (2003 NC LiDAR)

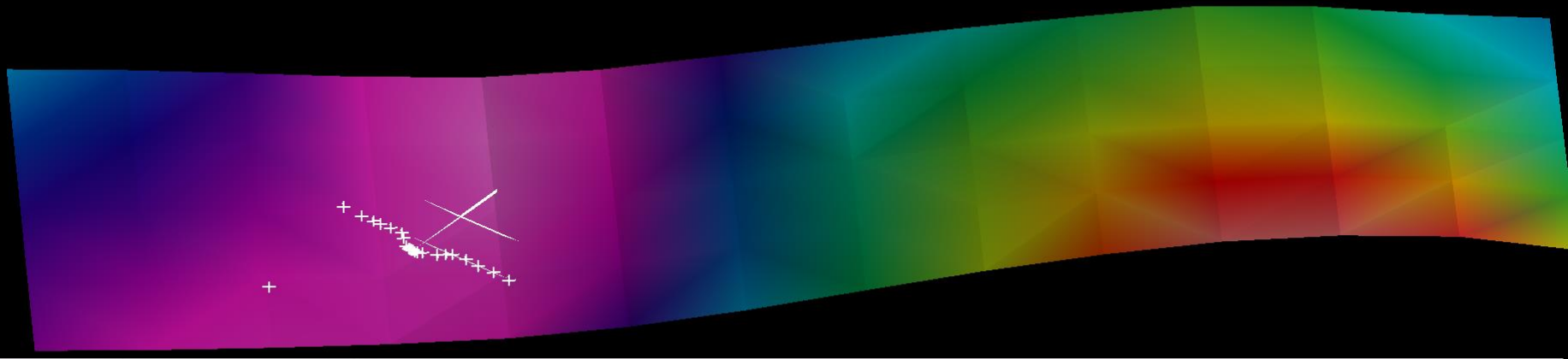


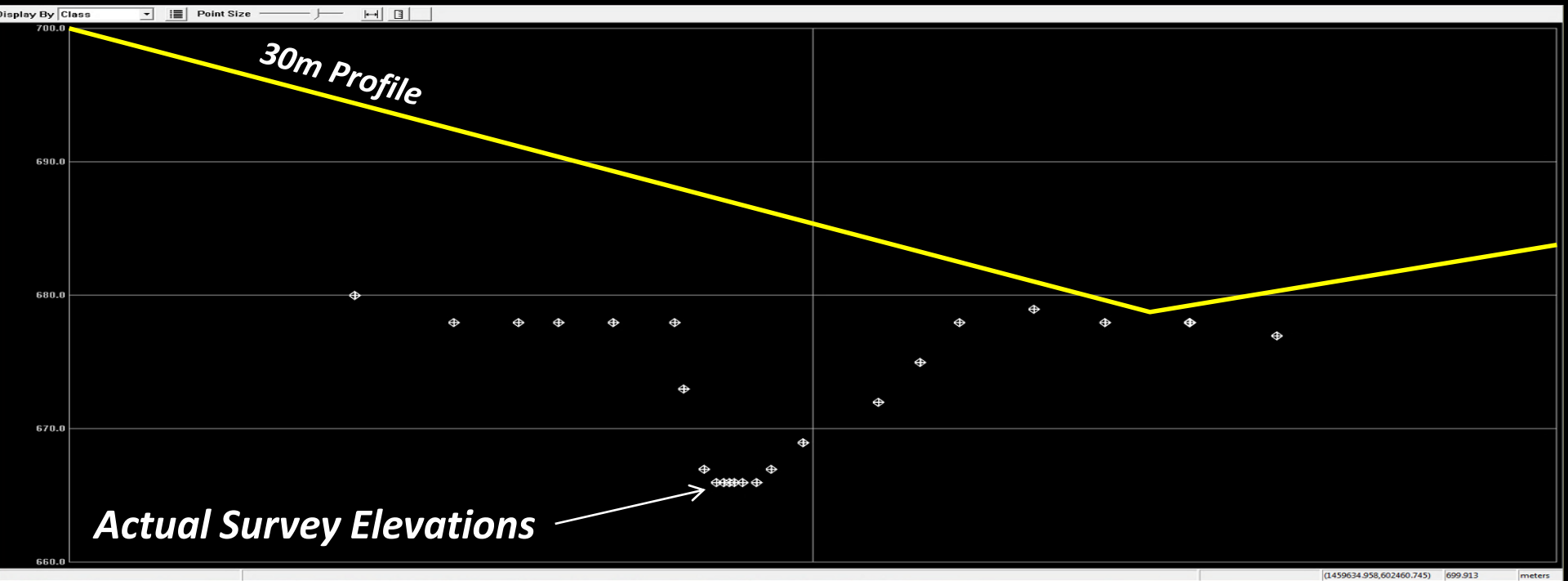
QL2 Elevation Model



30 Meter Elevation Model

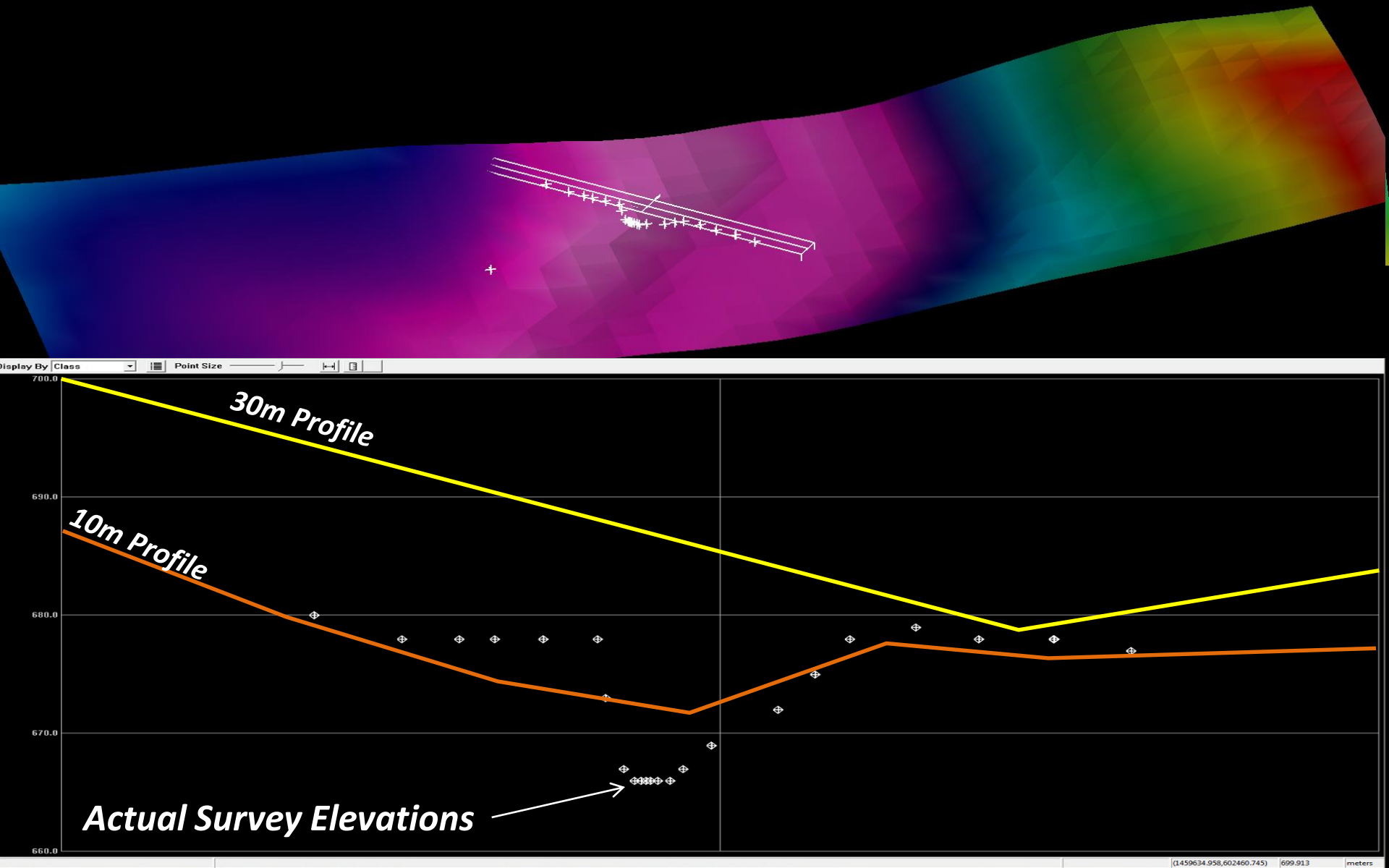
*Virtually no agreement with actual survey elevation data





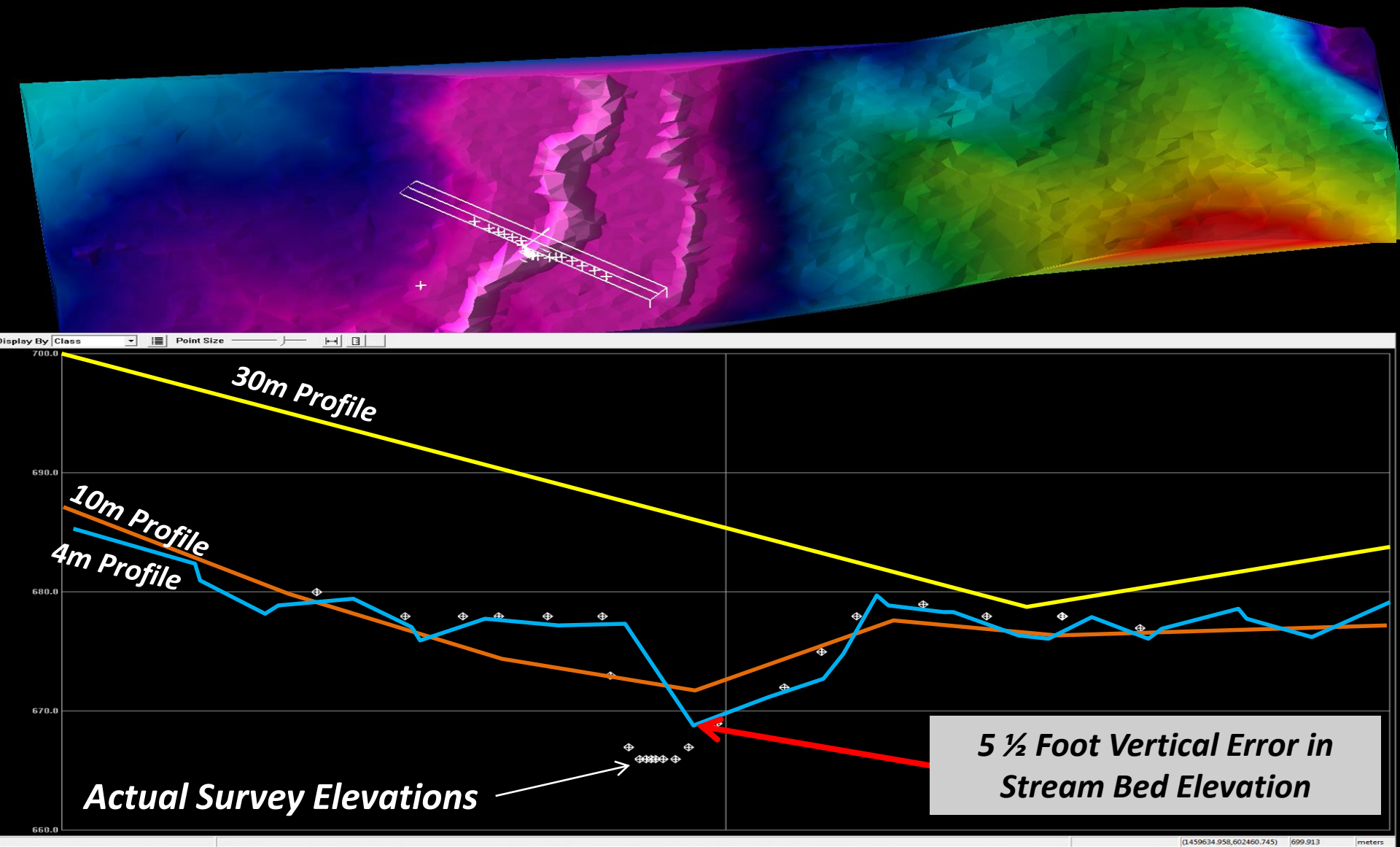
10 Meter Elevation Model

*Very few points matching actual survey data



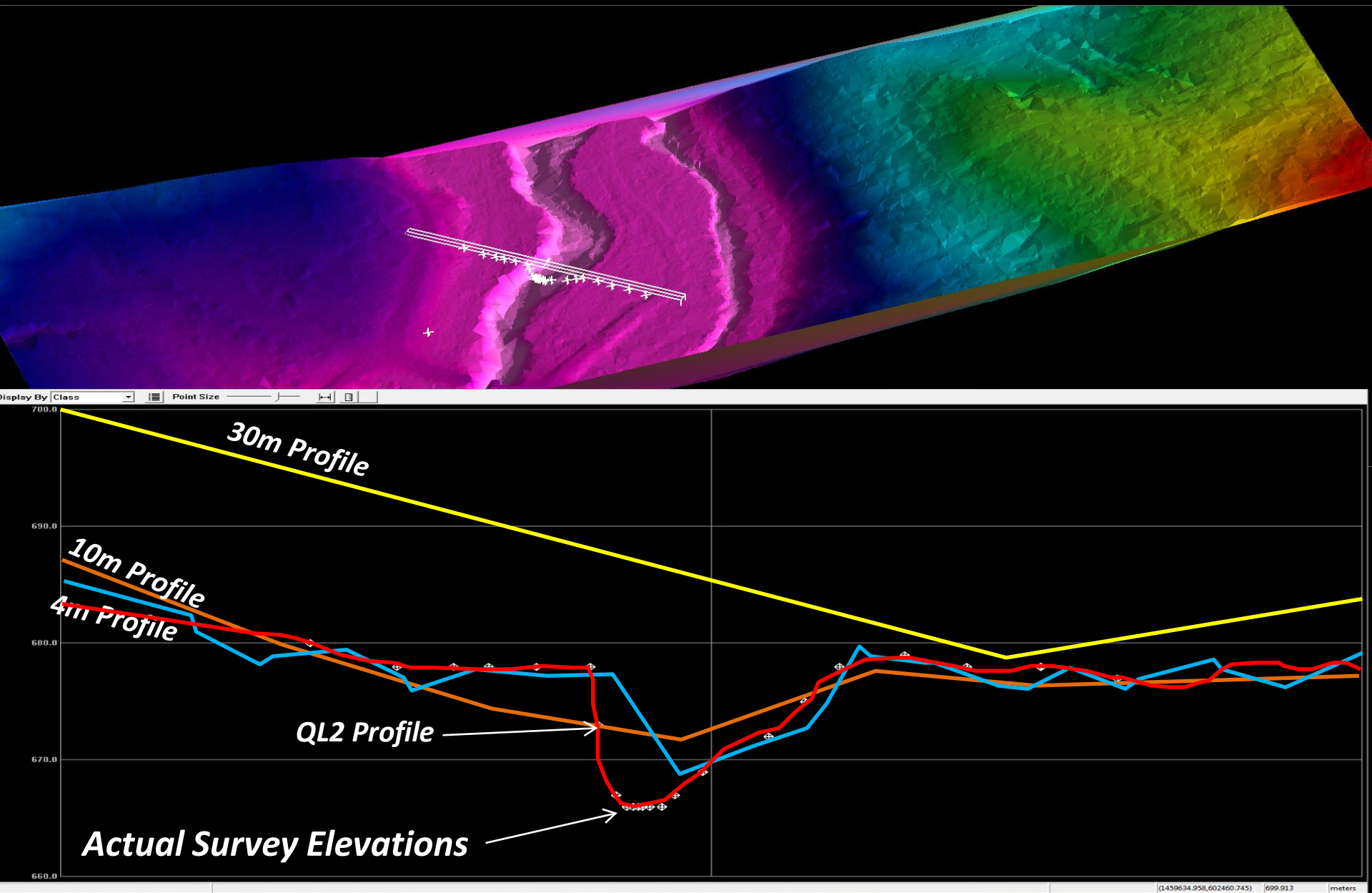
3 Meter LiDAR (2003)

*A more defined surface. Lacks true channel topographic definition.



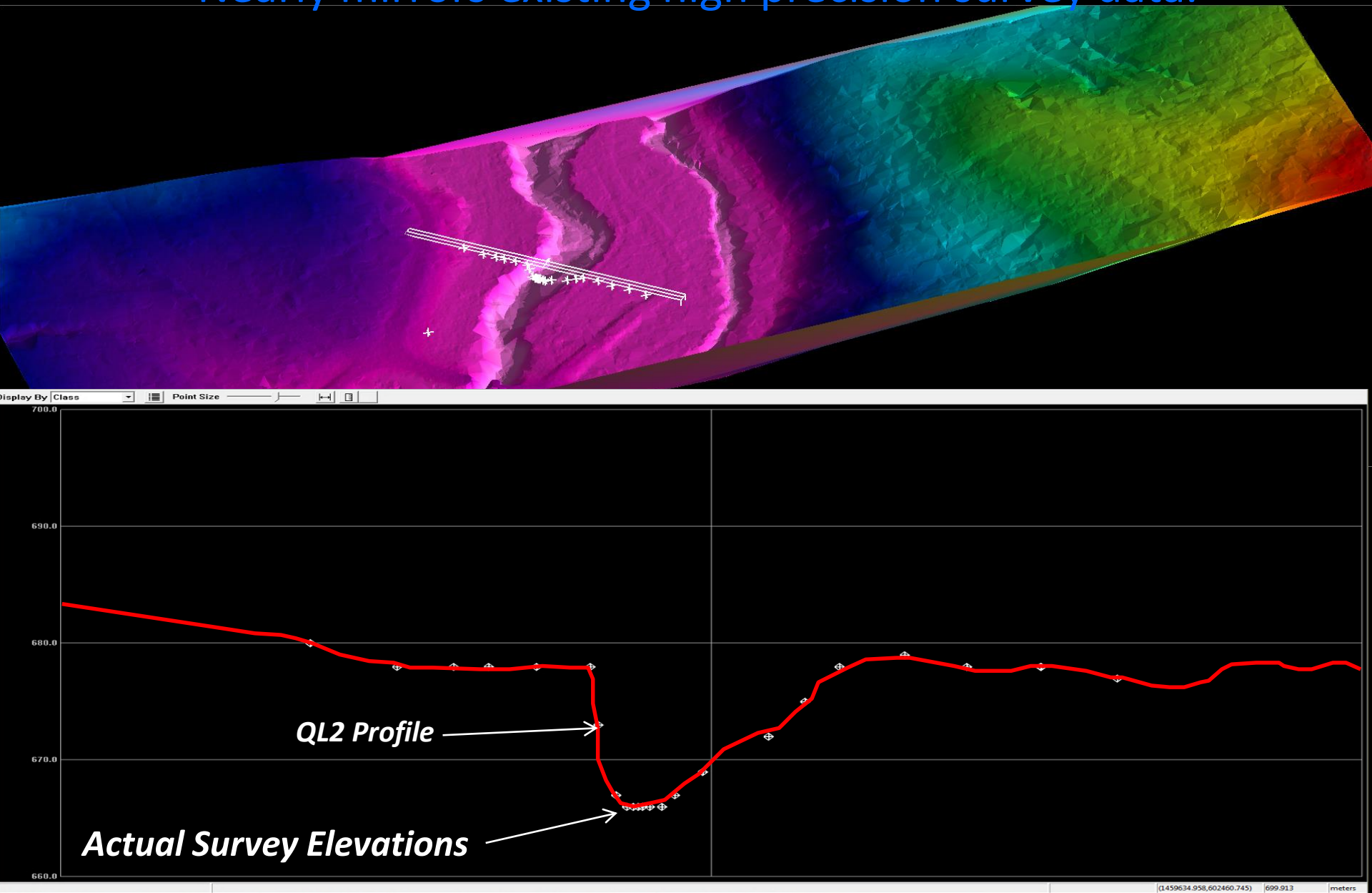
NC QL2 LiDAR (2014)

*Nearly mirrors existing high precision survey data.

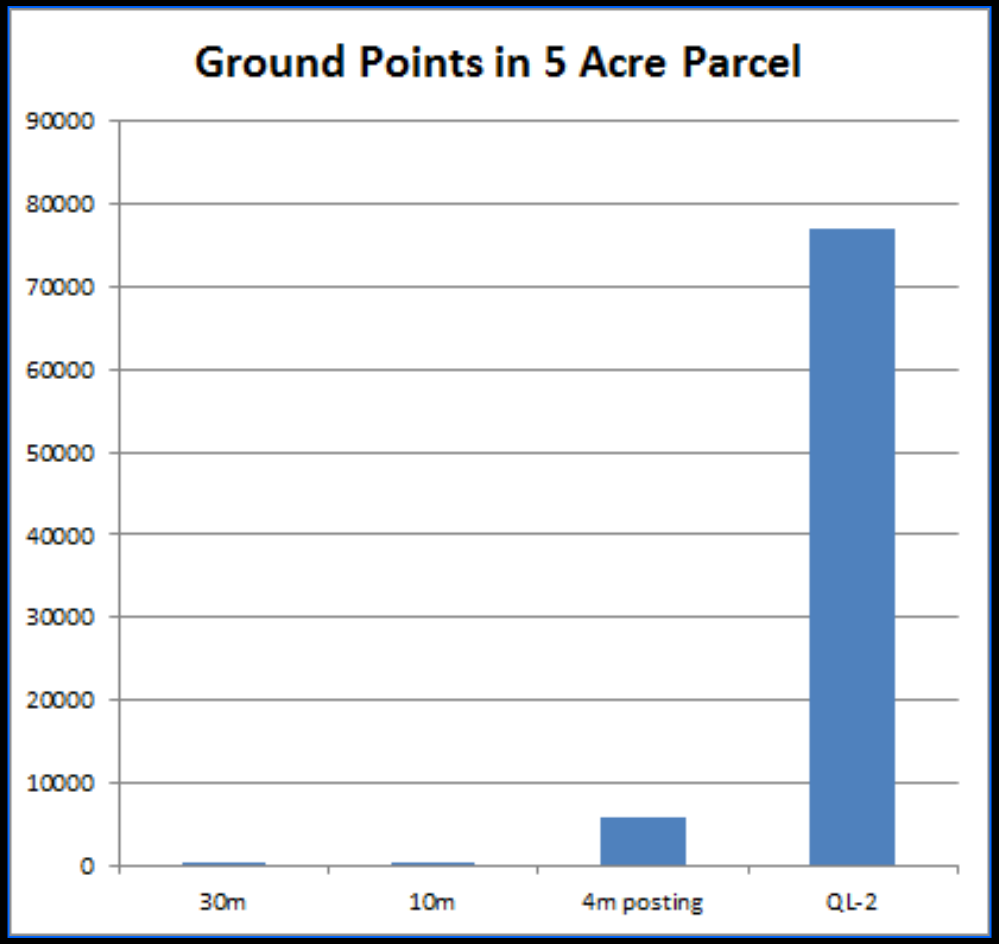


NC QL2 LiDAR (2014)

*Nearly mirrors existing high precision survey data.



QL2 Topo – Point Summary



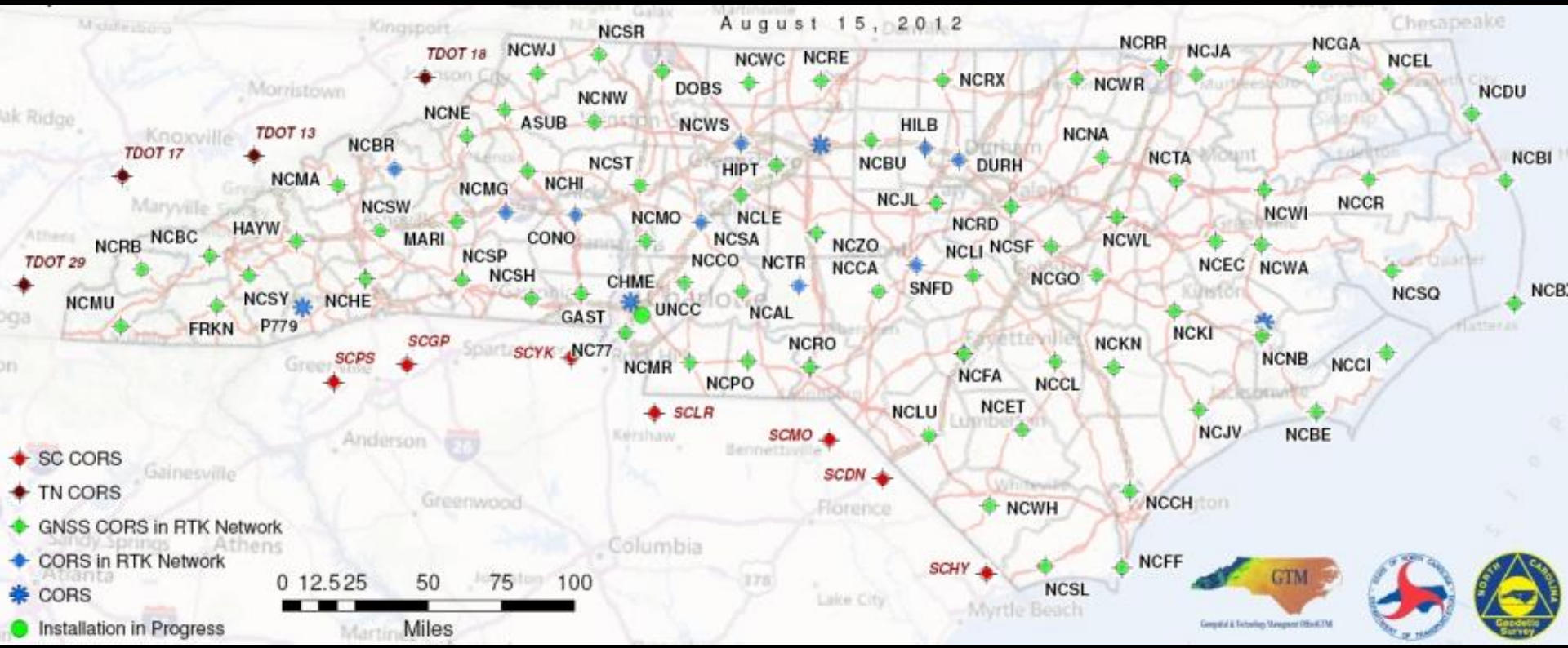
LIDAR Quality	Ground Points in 5 Acre Parcel
30m NED	32
10m NED	300
4m (circa 2003)	7,696
QL2	76,957

*QL2 is a 1,000% increase in analysis points

QL2 LiDAR
Quality Control / Validation

QL2 Topo – Validation / Quality Control

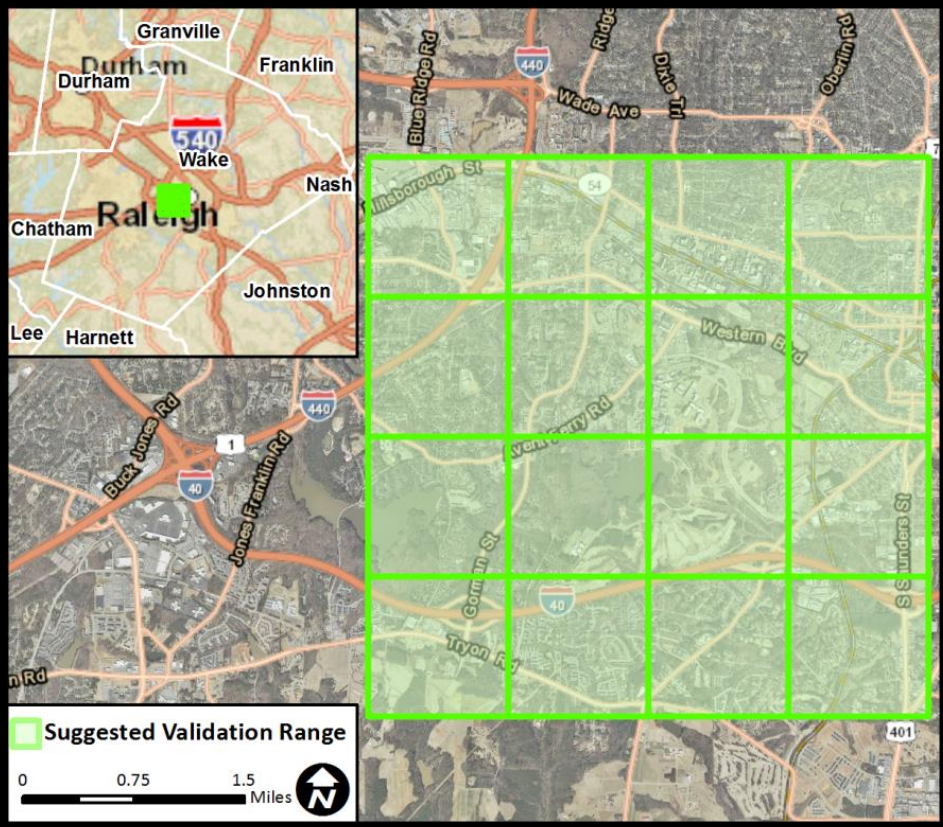
North Carolina Continual Operating Reference System. (CORS)



QL2 Topo – Validation / Quality Control

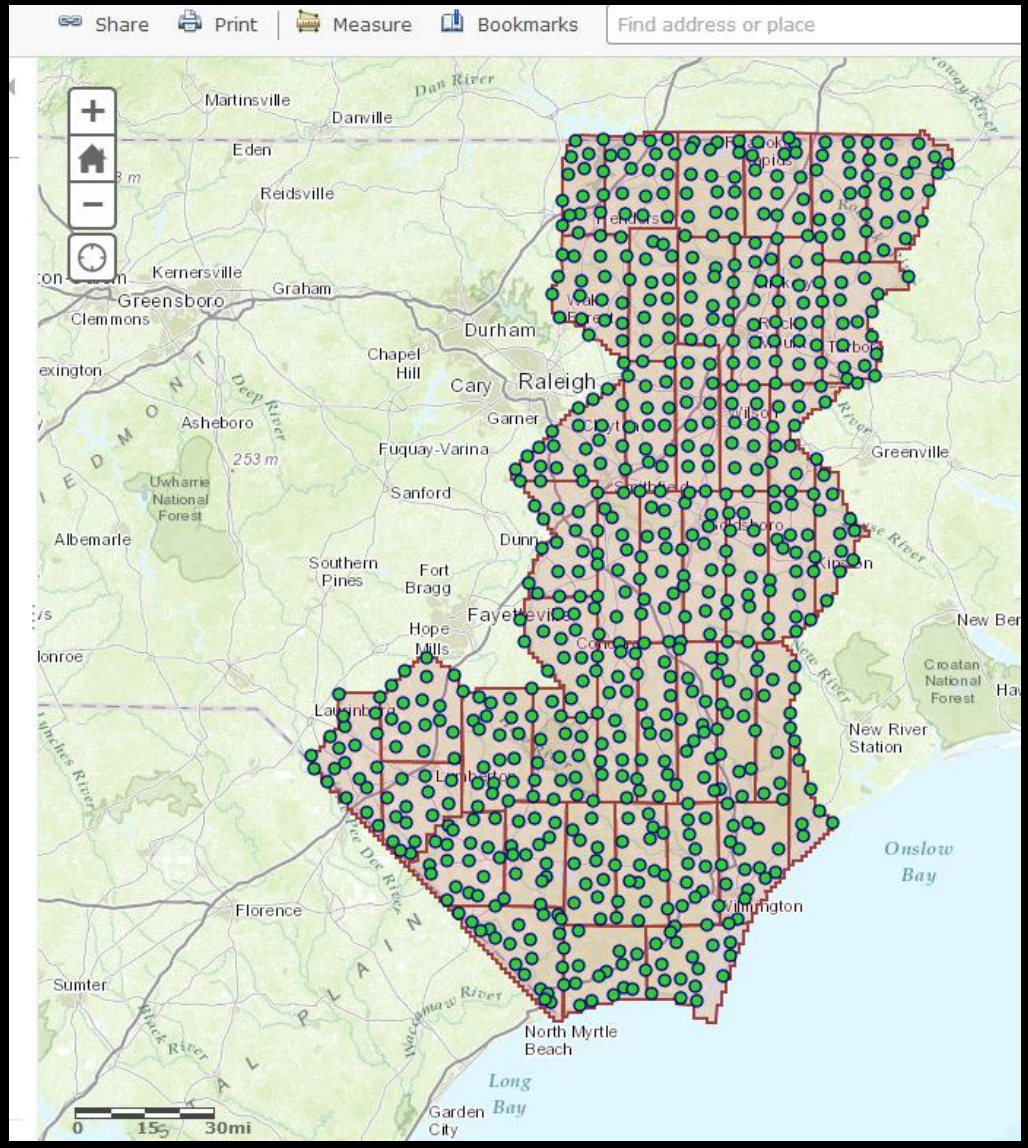
- In Situ Validation Range
- Flown by each vendor / sensor (including USGS's vendor) to check horizontal and vertical Accuracy of the collection.
- Purpose – Provide pre-flight checks and adjustments to sensors to match one another.
- Initial QC QL2 is providing accuracy of 6 cm (~2.4 inches)

Calibration Range

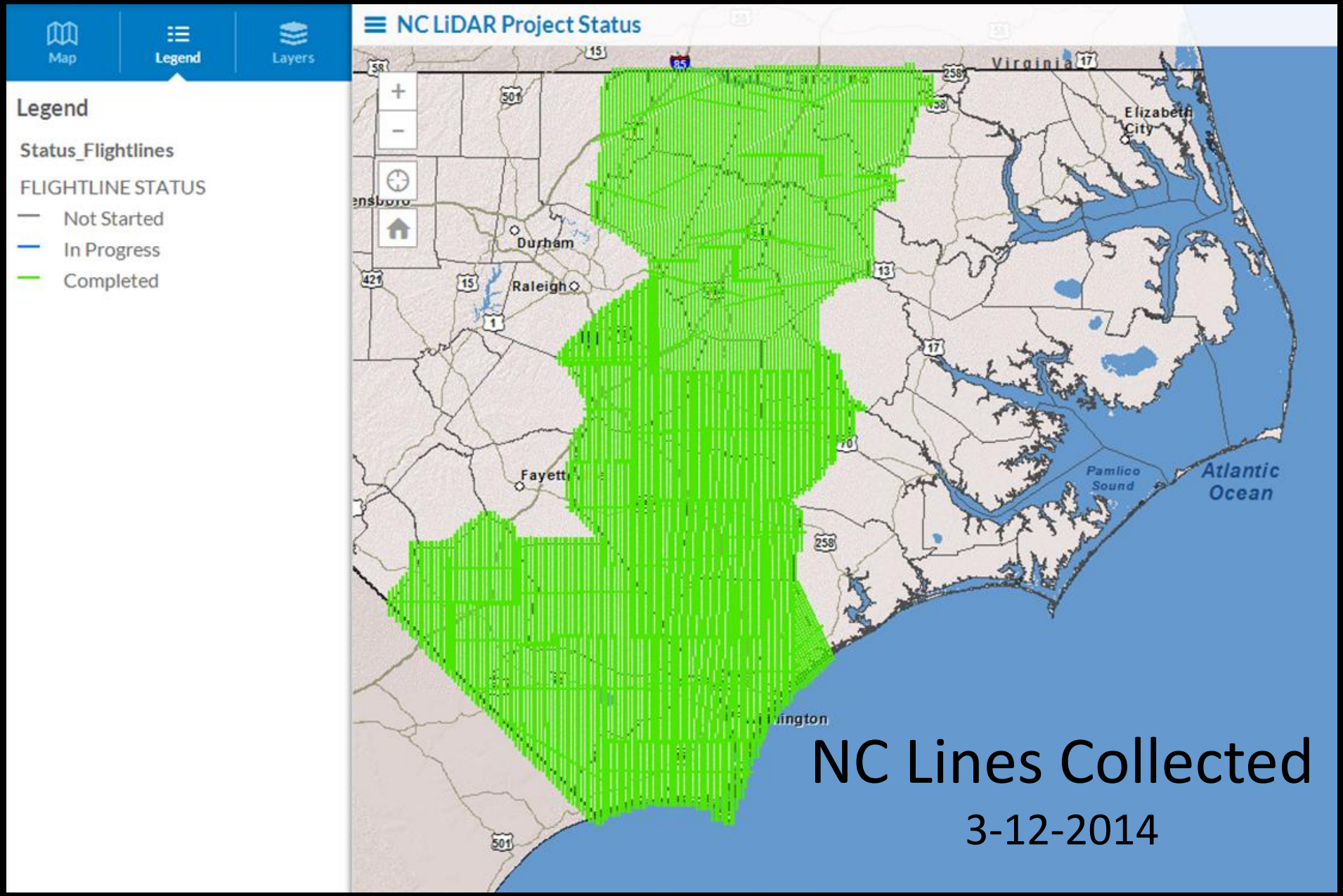


QL2 Topo – Validation / Quality Control

- Vendor Internal Control Collection for Flight is complete.
- NC Geodetic Survey will be acquiring and independently QC horizontal and vertical accuracy.
- 100 points per county / five different classes



QL2 LiDAR
Acquisition Status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Legend
Layers
NC LiDAR Project Status
Legend
Status_Flightlines
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In Progress
Completed
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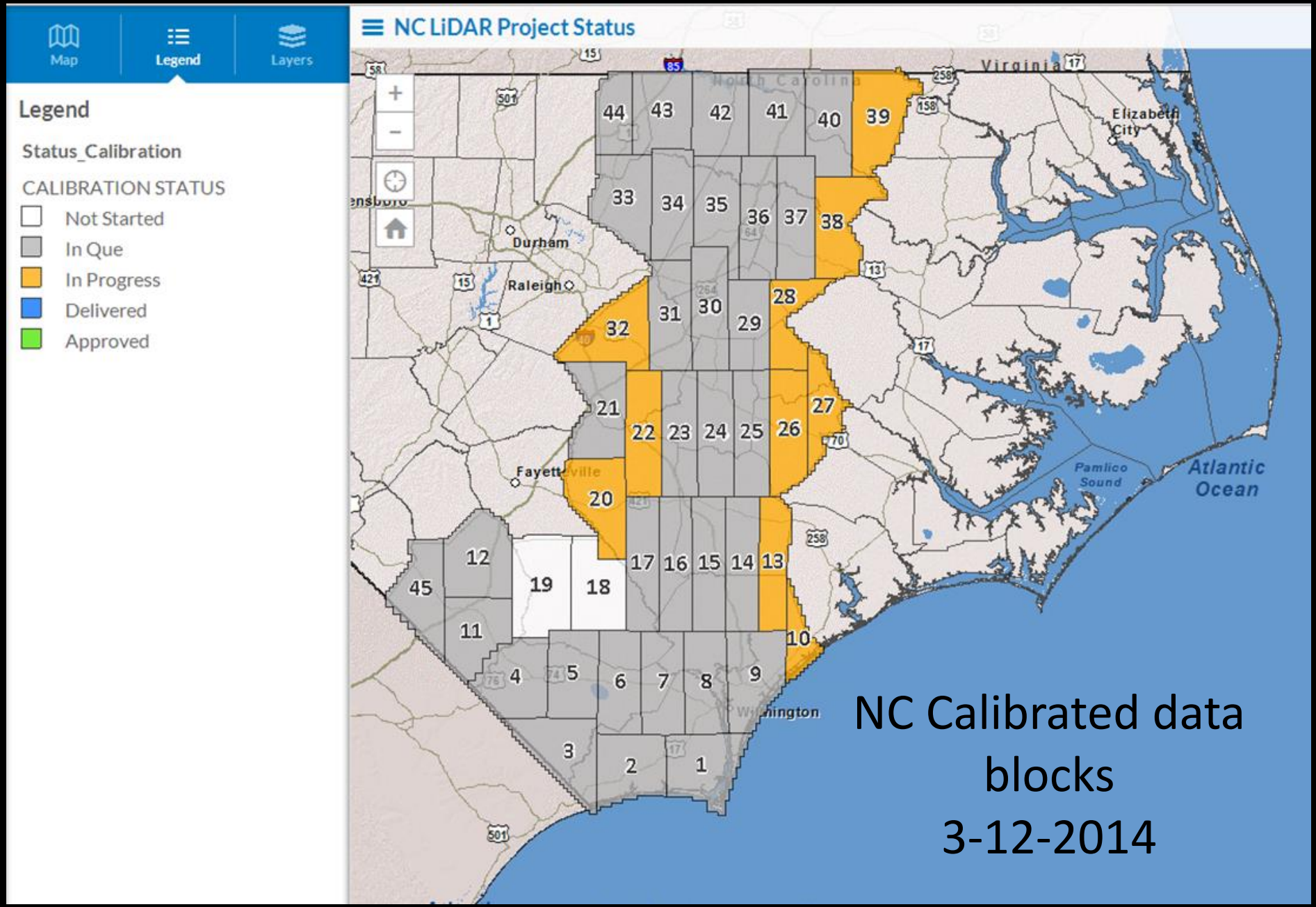
Raleigh
Fayetti
Virginia
Elizabeth City
Pamlico Sound
Atlantic Ocean
NC Lines Collected
3-12-2014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Legend
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Virginia
Pamlico Sound
Atlantic Ocean
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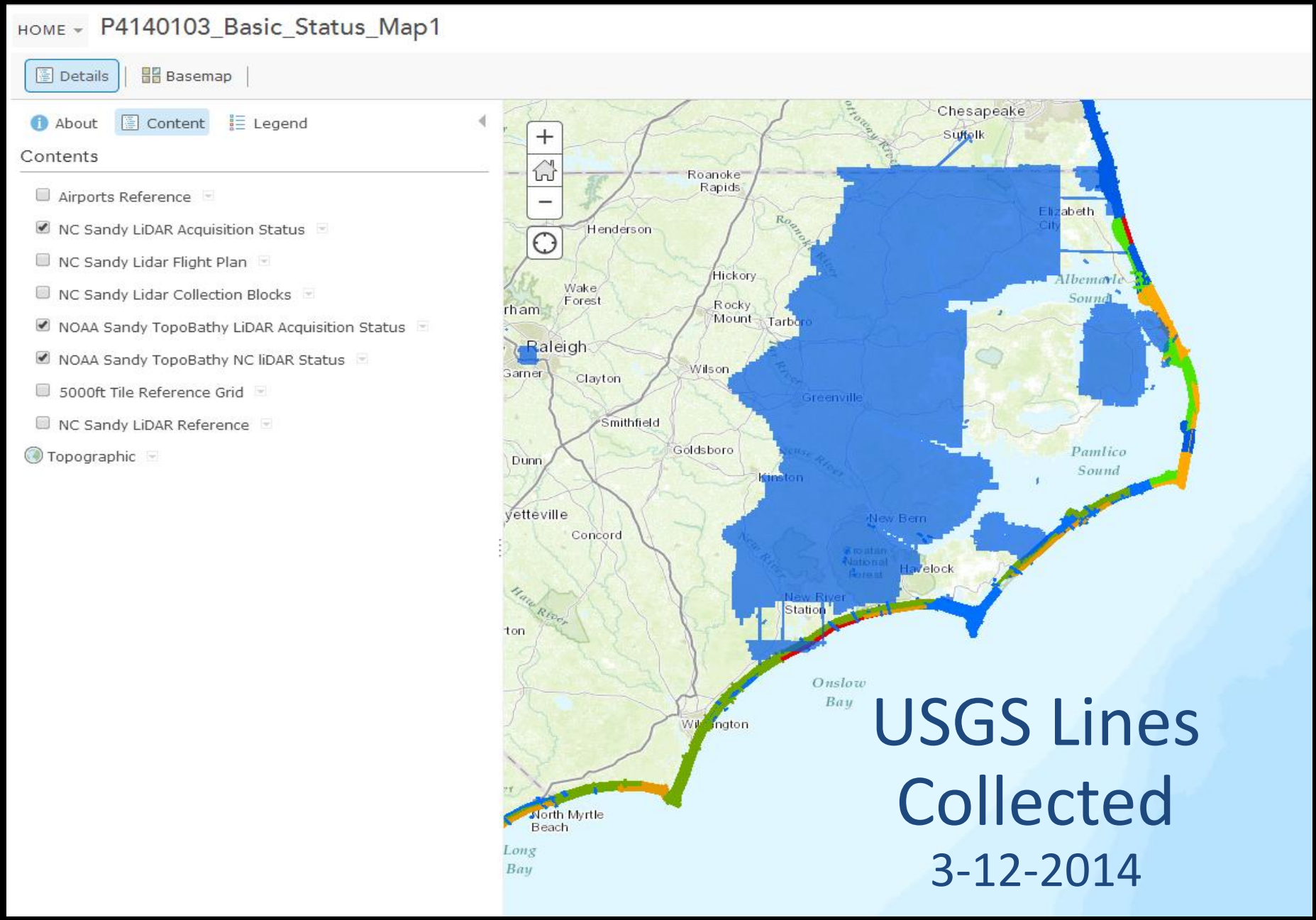
3-12-2014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Basemap
About
Content
Legend
Contents
Airports Reference
NC Sandy LiDAR Acquisition Status
NC Sandy Lidar Flight Plan
NC Sandy Lidar Collection Blocks
NOAA Sandy TopoBathy LiDAR Acquisition Status
NOAA Sandy TopoBathy NC liDAR Status
5000ft Tile Reference Grid
NC Sandy LiDAR Reference
Topographic
Chesapeake
Suffolk
Roanoke Rapids
Henderson
Elizabeth City
Albemarle Sound
Hickory
Wake Forest
Rocky Mount
Tarboro
Raleigh
Garner
Clayton
Wilson
Greenville
Smithfield
Goldsboro
Dunn
Kinston
Pamlico Sound
New Bern
Concord
Havelock
New River Station
Onslow Bay
North Myrtle Beach
Long Bay
USGS Lines Collected
3-12-2014


Futch Creek
Village Club
Middle Sound
Butler Creek

QL2 LiDAR

LiDAR Classification Process

QL2 Topo – Data Classifications

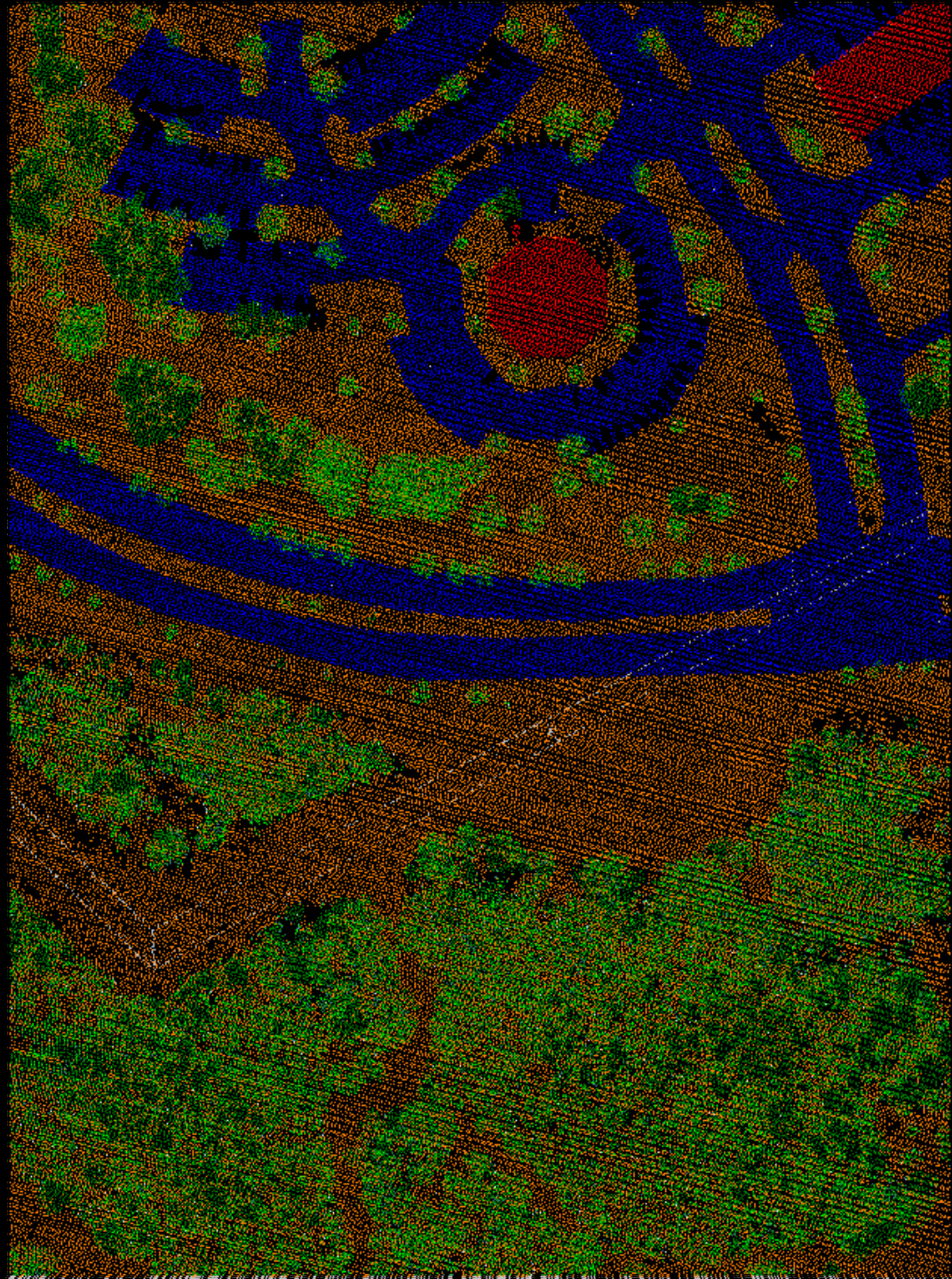
Class	Description
1	Processed Unclassified
2	Ground
3	Low Veg/Strata
4	Medium Veg/Strata
5	High Veg/Strata
6	Buildings (Automated)
7	Noise (High/Low)
9	Water (Hydro Cleaned Areas)
10	Bridge
12	Flight Line Overlap
14	Roads

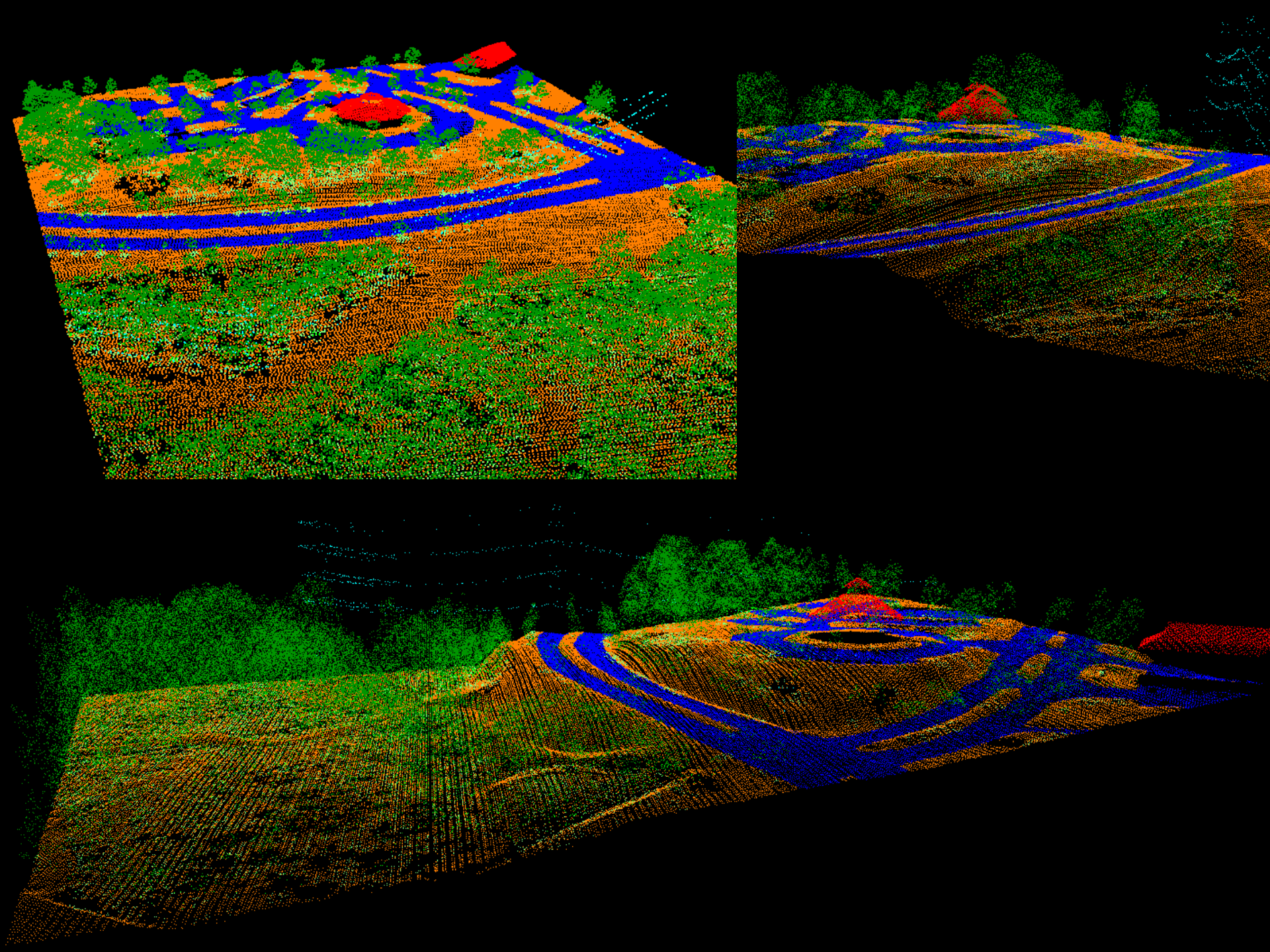
QL2 Topo - RGB Composite 3D Fly through

Movie

LiDAR Classification

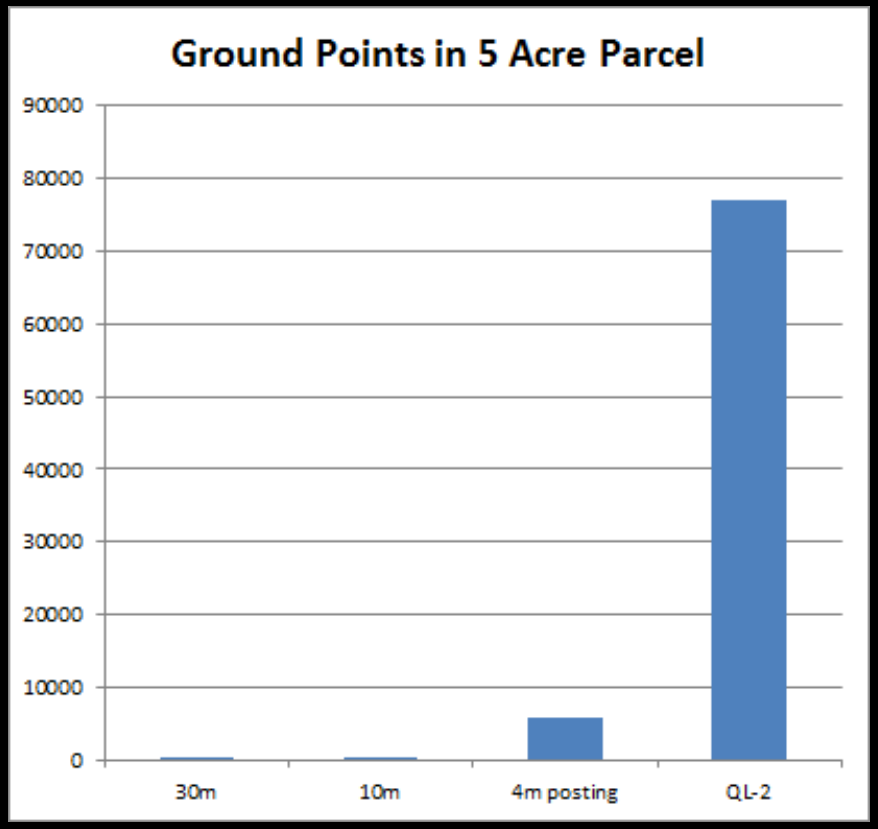
- Un-Classified Data
  - Ground/Bare Earth
    - Vegetation
      - Buildings
        - Roads/Impervious





QL2 Benefits

QL2 LiDAR – Point Summary



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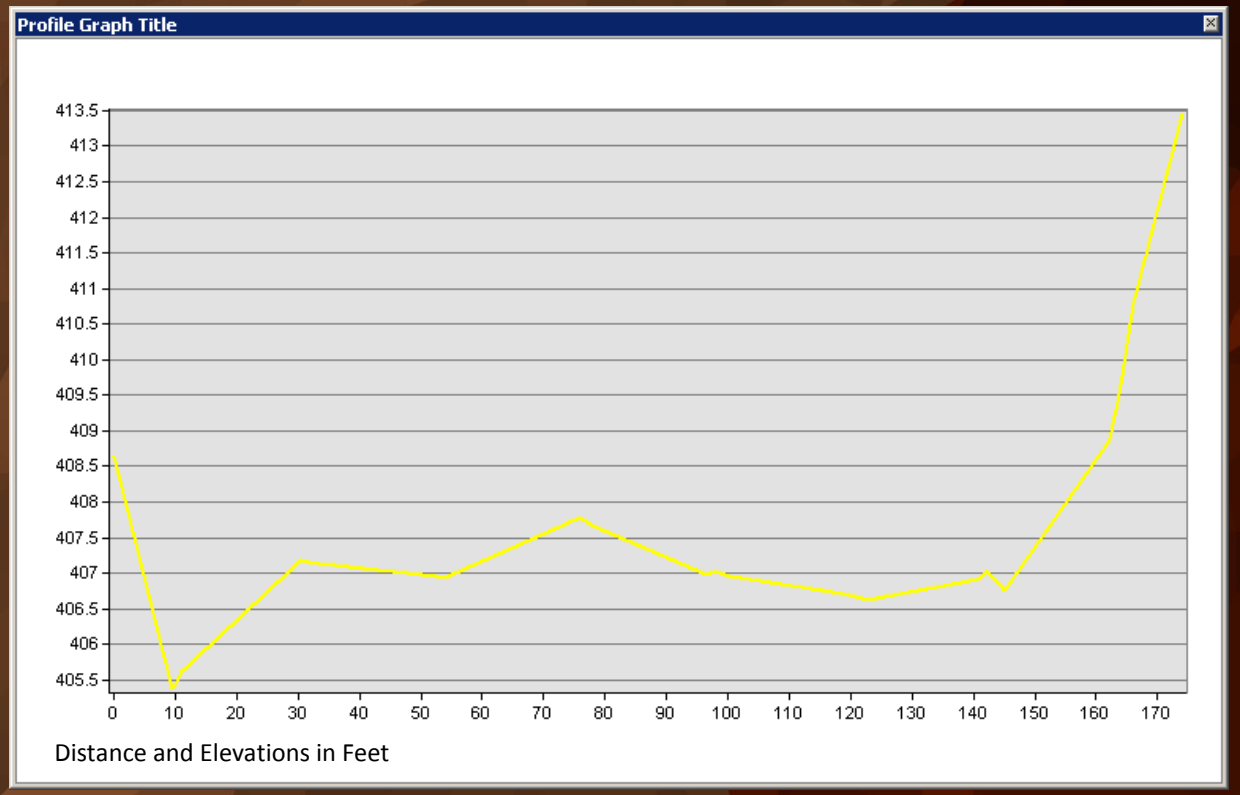
QL2 Topo - Road Profile Delineations

QL2 Topo - Road Profile Delineaton

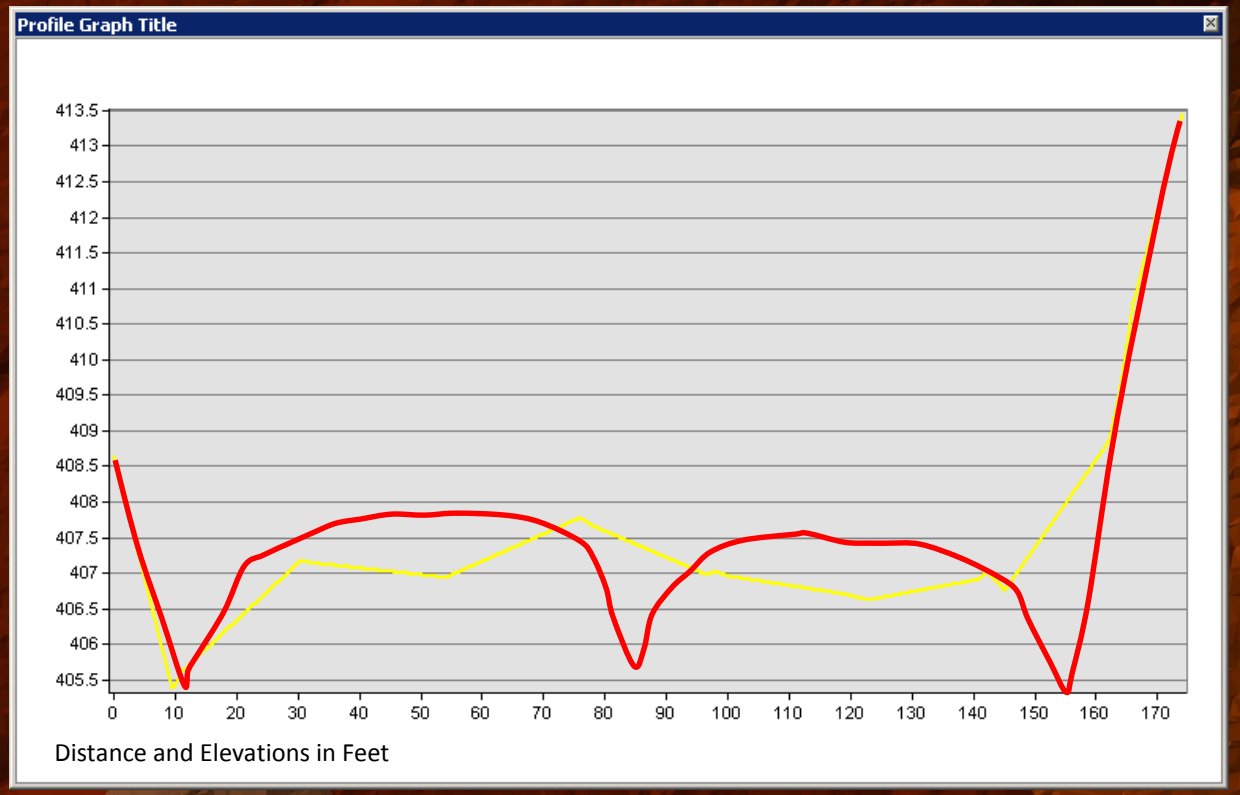
-Existing NC LiDAR TIN and Road Profile



QL2 Topo - Road Profile Delineations

-New QL2 NC LiDAR from 2014
-Much higher definition in road shape and extent

-Provides highly accurate dense data for preliminary designs
-Roads and Bridges are classified in LiDAR
-Create Roadway Ribbons
-Develop 3D road centerlines for analysis
-Aids in Edge of Pavement Detection



QL2 Topo - Land use/Land cover Detection

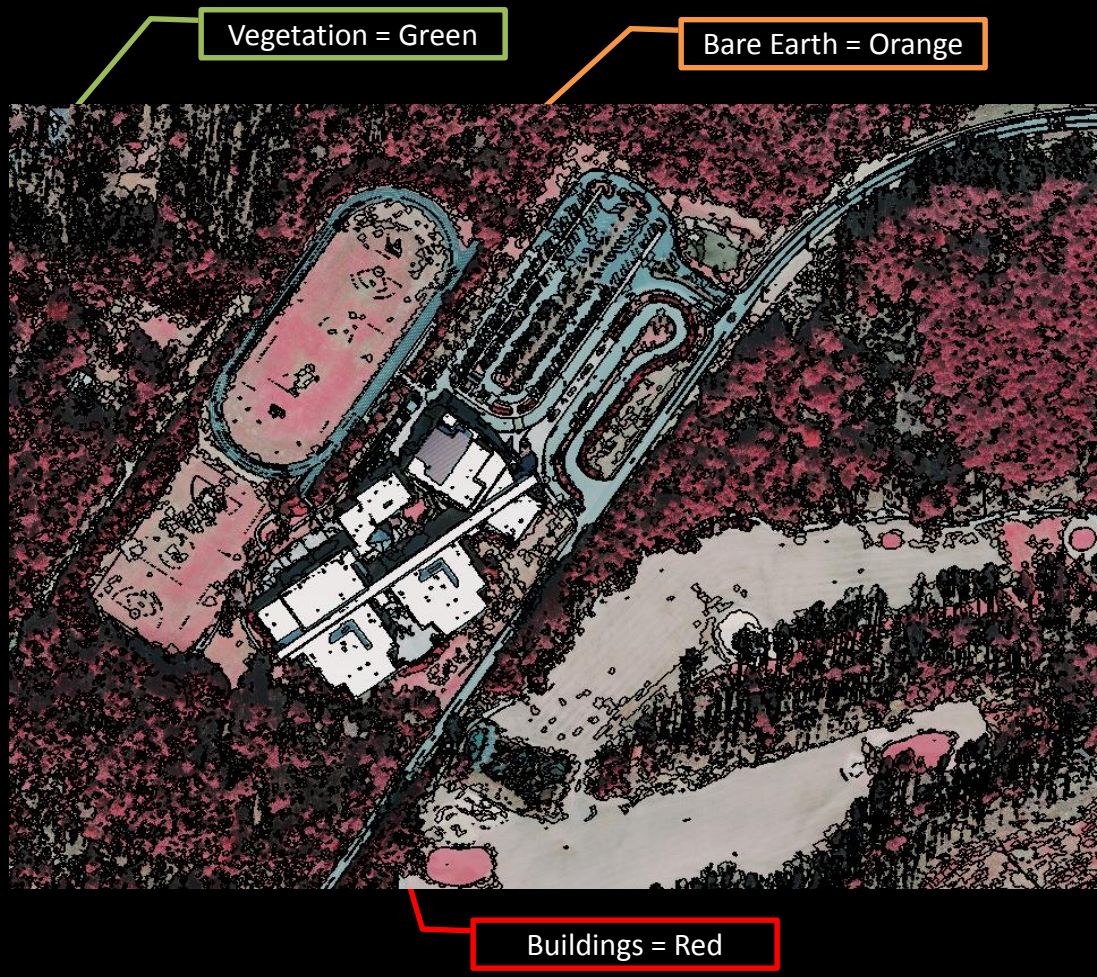
Uses a combination of the QL2 LiDAR Classification and available CIR Imagery

Remote Sensing Approach

- Seed Files
  - Orthos
  - CIR
  - Classified LiDAR

End Result

- Constructed Polygons for each land type selected
  - Examples
    - Roads
    - Bare Earth
    - Vegetated
    - Buildings
    - Grassy
    - Etc…



QL2 Topo - Land use/Land cover Detection

Remote Sensing versus Traditional/Manual

Traditional/Manual Approach

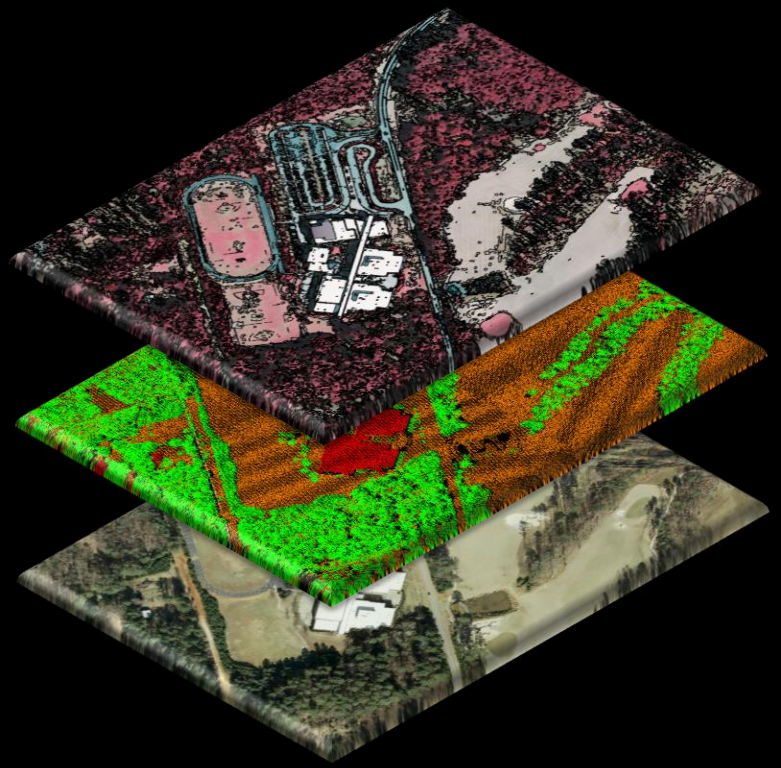
- Heads up digitizing from Orthos
- Highly labor intensive
- No automation
- Current NC layer is from 1996

Remote Sensing Approach

- Uses defined macros to extract features within the point cloud
- Batch routines after algorithm is developed
- Initial classification yields 90%+ results for an automated routine
- Manual filters can be geared towards accuracy requirements for the project

Estimated Cost Savings Examples

- Statewide Compilation
  - Traditional (from Imagery)
    - 52,000 labor hours
  - Remote Sensed
    - 7,700 labor hours
    - **85% Savings**



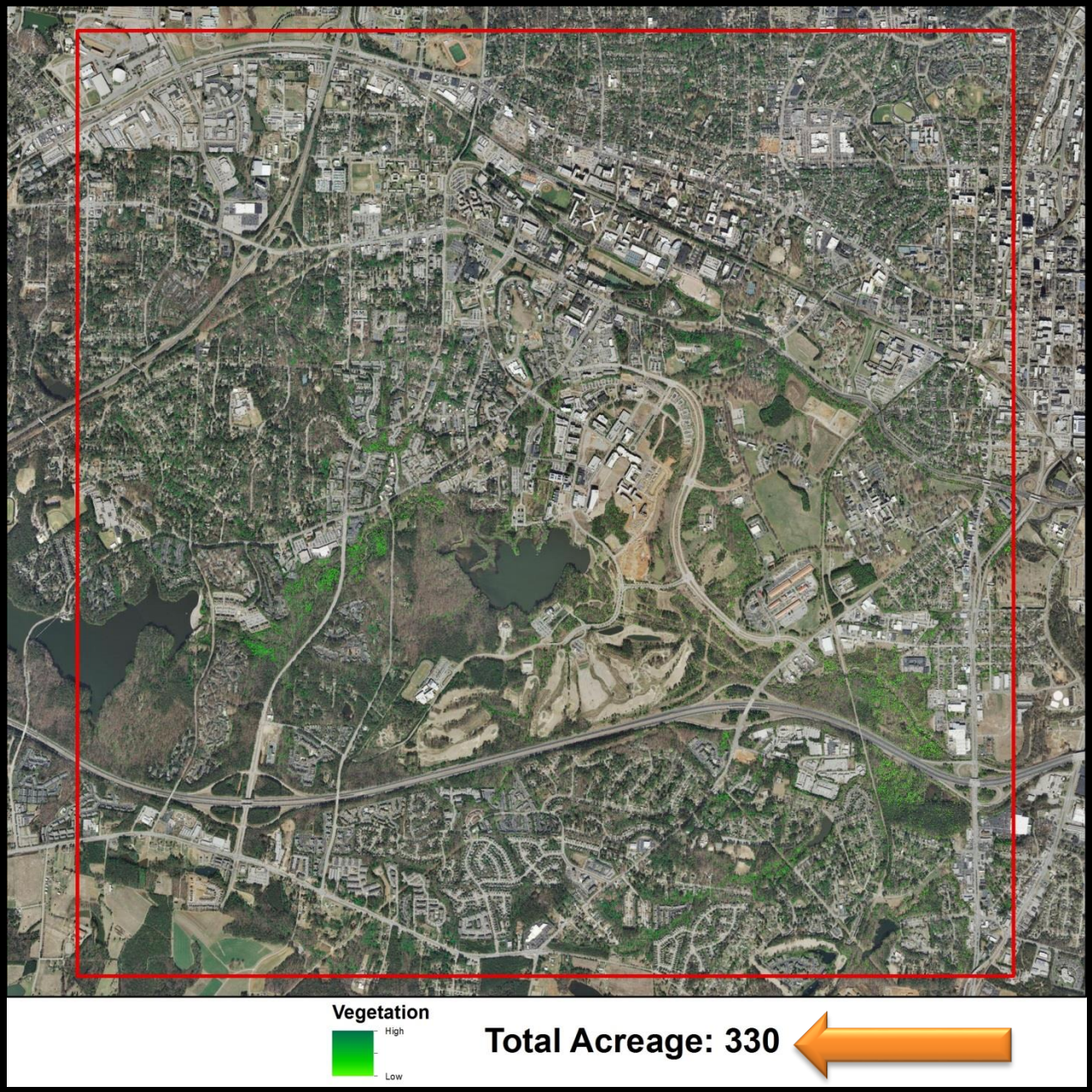
QL2 Benefits

Vegetation Canopy Detection/Calculations

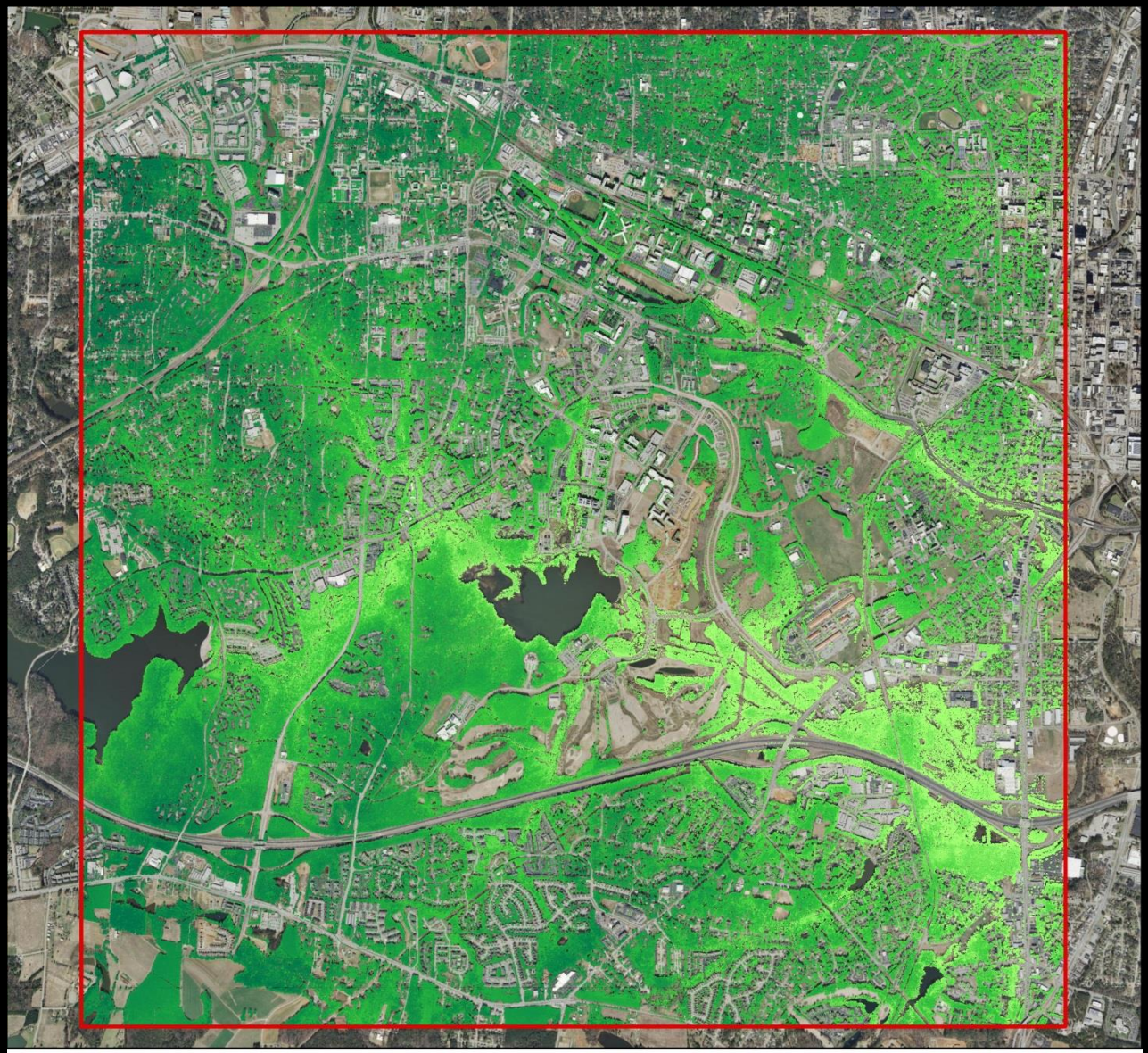
Vegetation Detection

Low – Shrubs

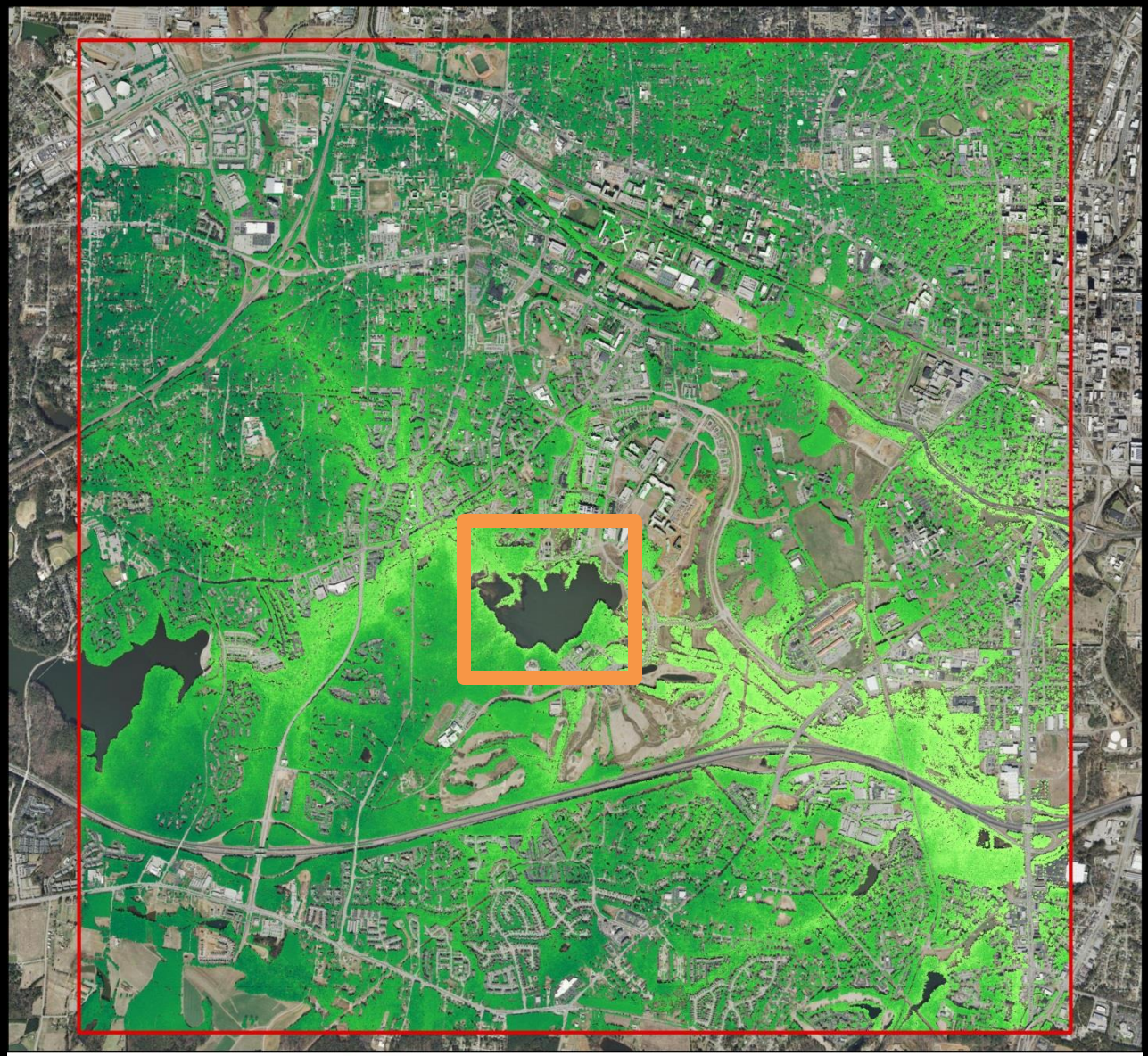
Medium – Bushes/small trees



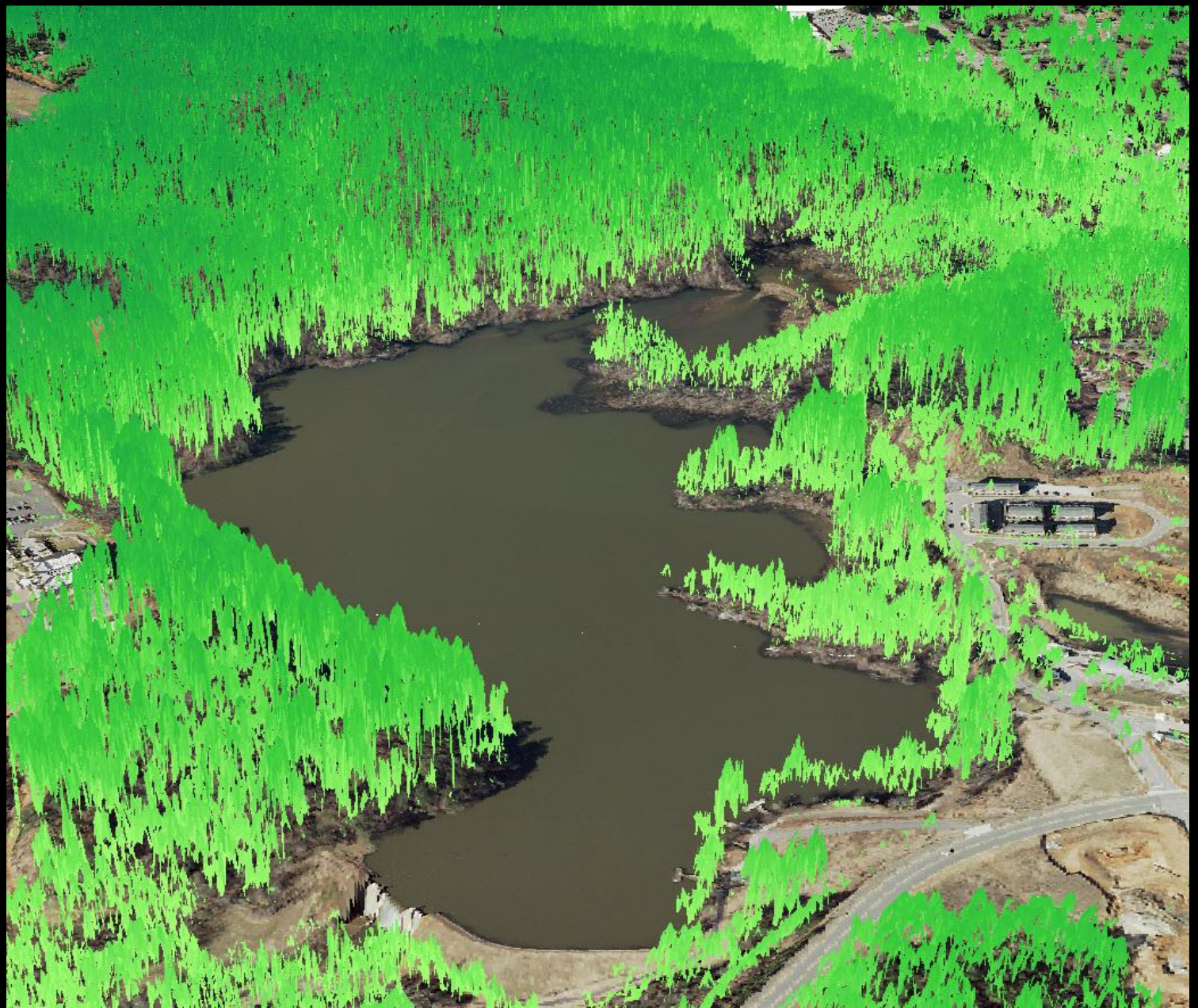
High – Large trees



Total Canopy Detection



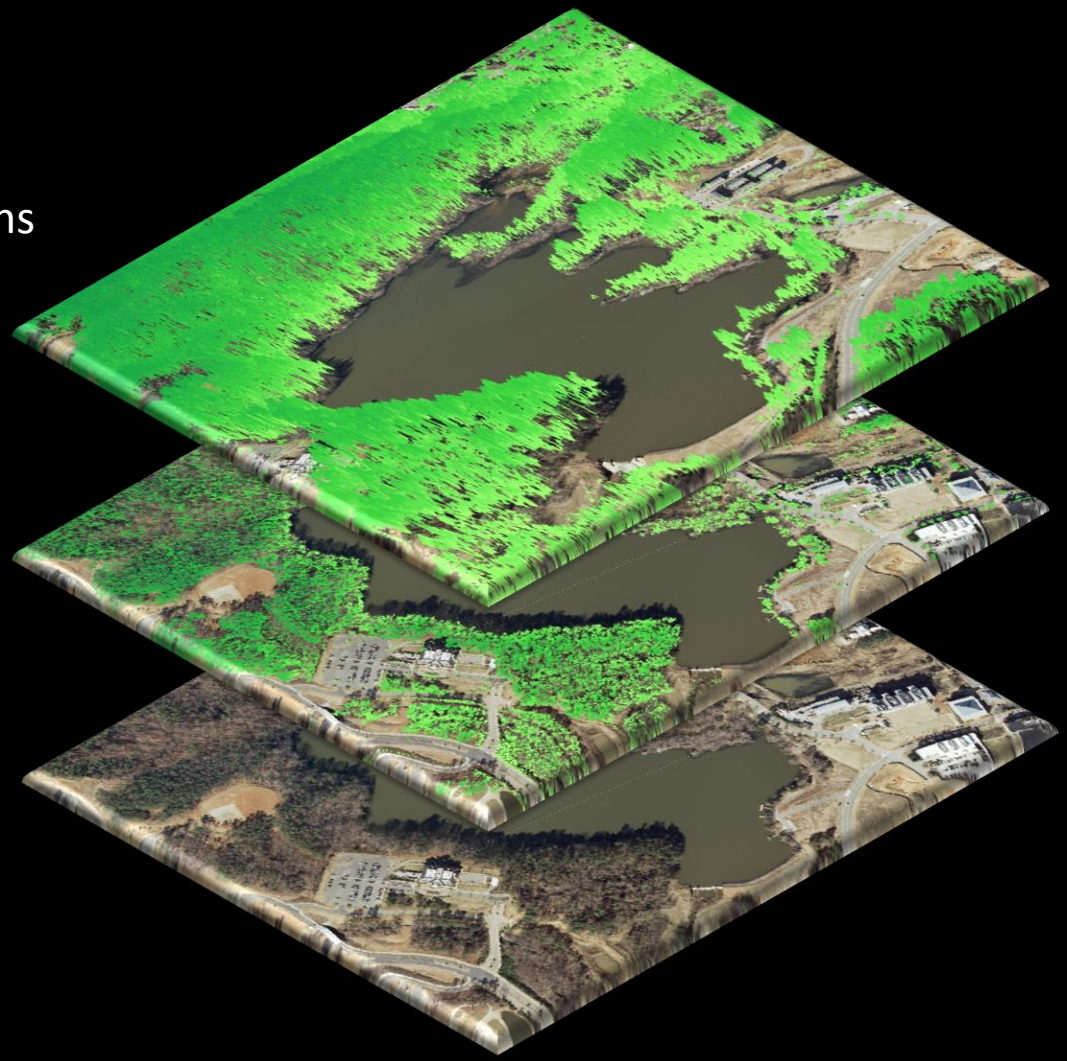
3D Volume of Vegetation



QL2 Topo - 3D Volume of Vegetation

What can you do with this data?

- Acreage and volumetric calculations
- Detection of vegetation type
  - Decidious vs Evergreen
- Canopy Height Detection
- Forest Ageing
- Wooded Biomass
- Tree Count Density
- Etc…

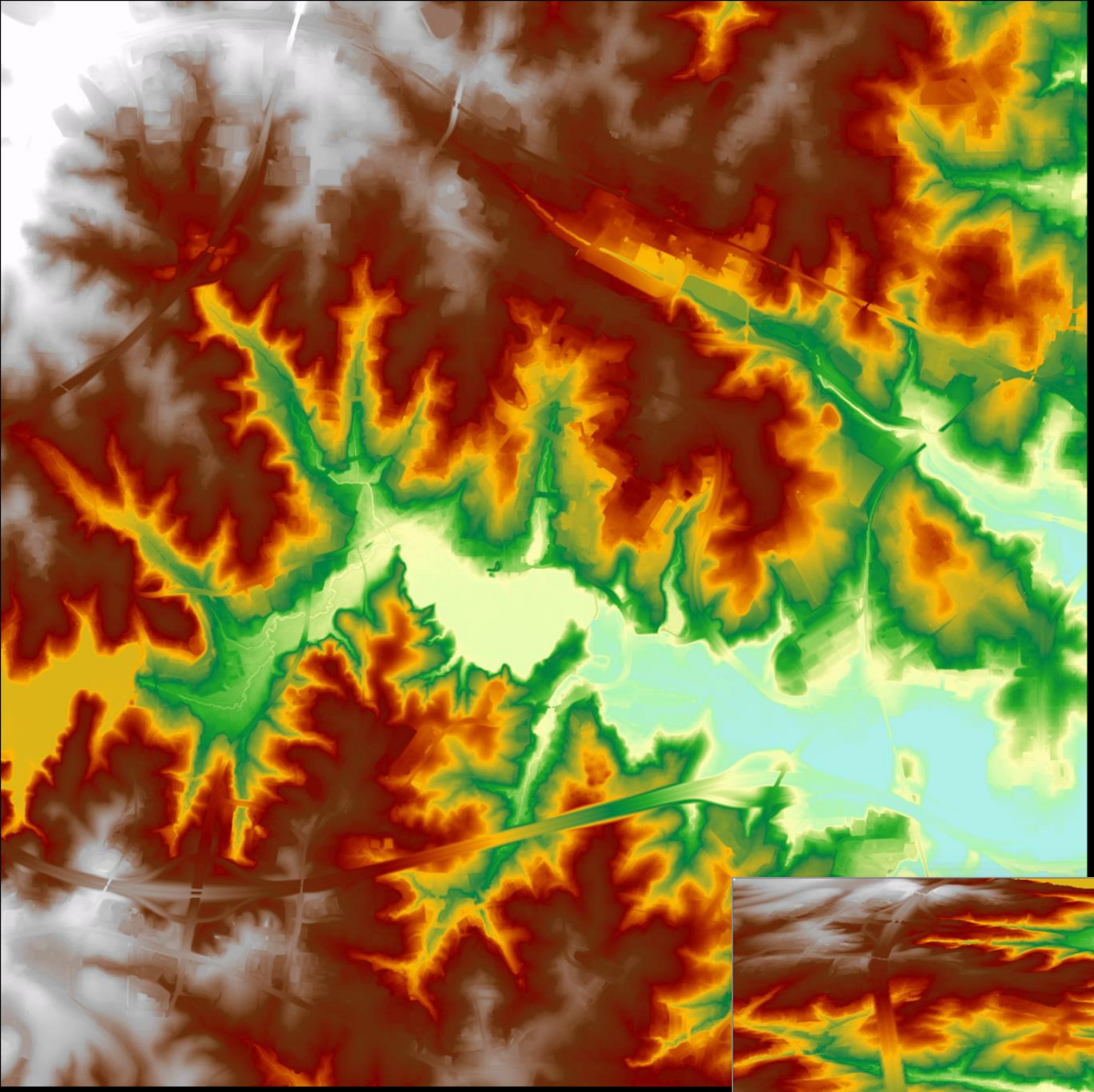


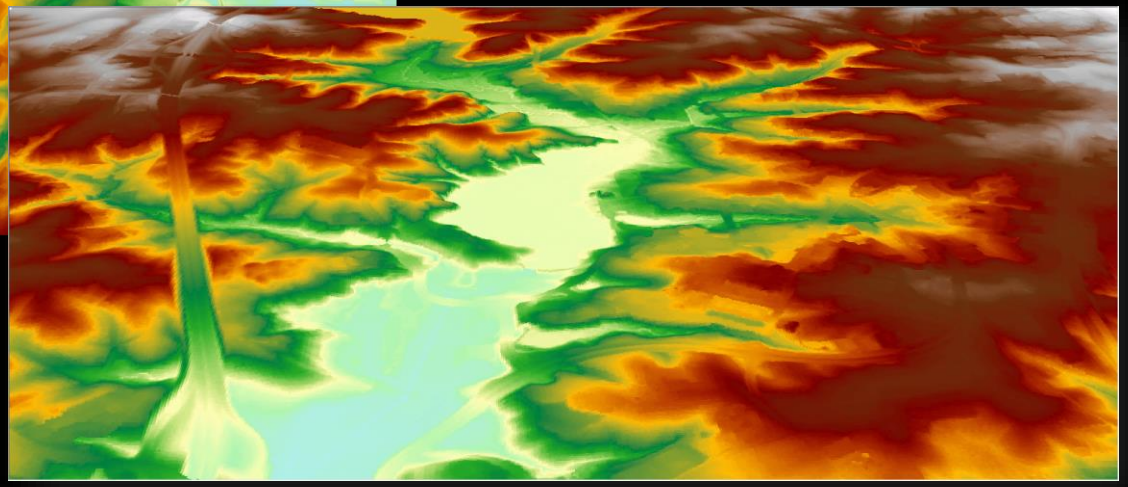
QL2 Benefits

Perennial/Intermittent Streams Identification

QL2 Topo Terrain

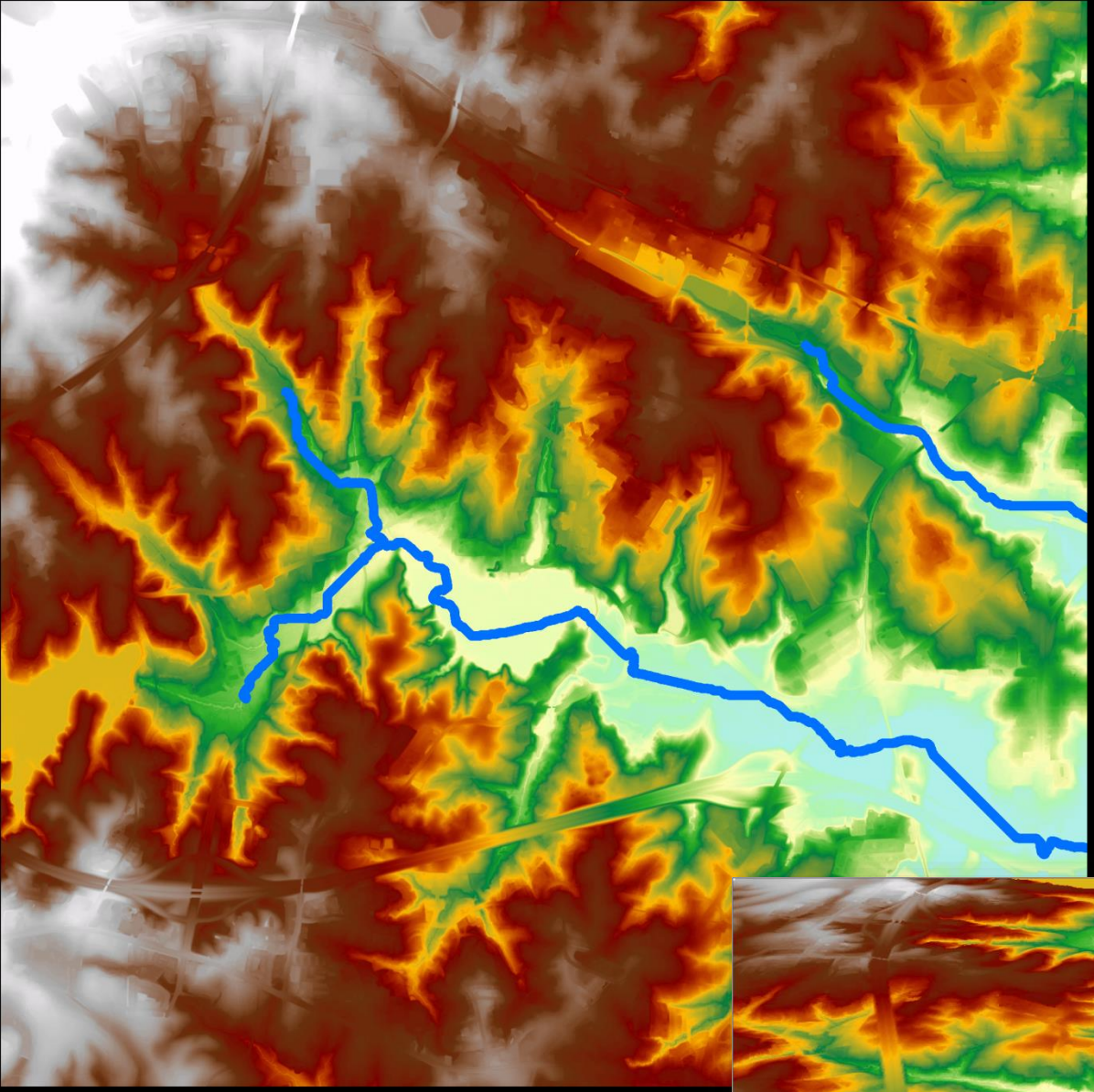
Automated detection of streams at any set Drainage Area

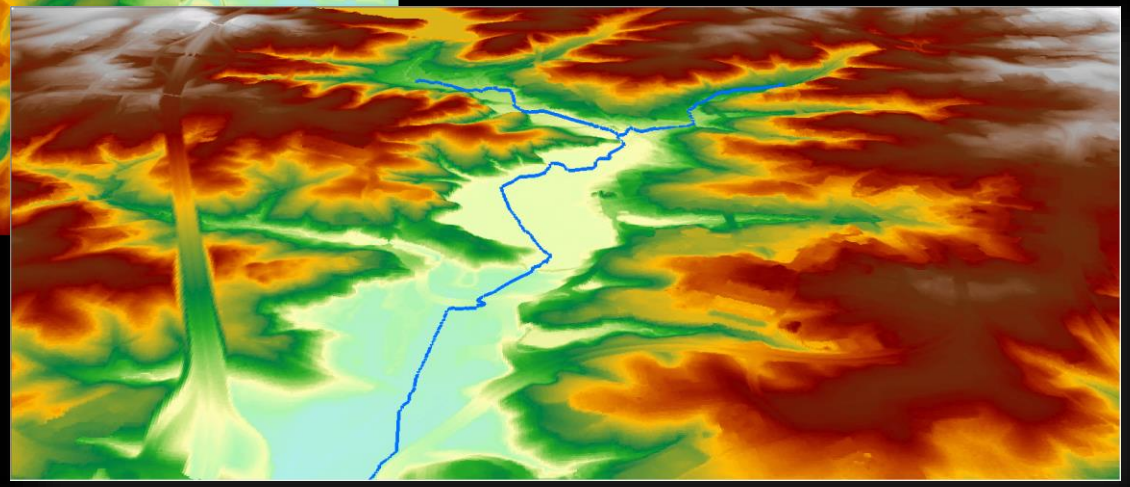




QL2 Topo Terrain

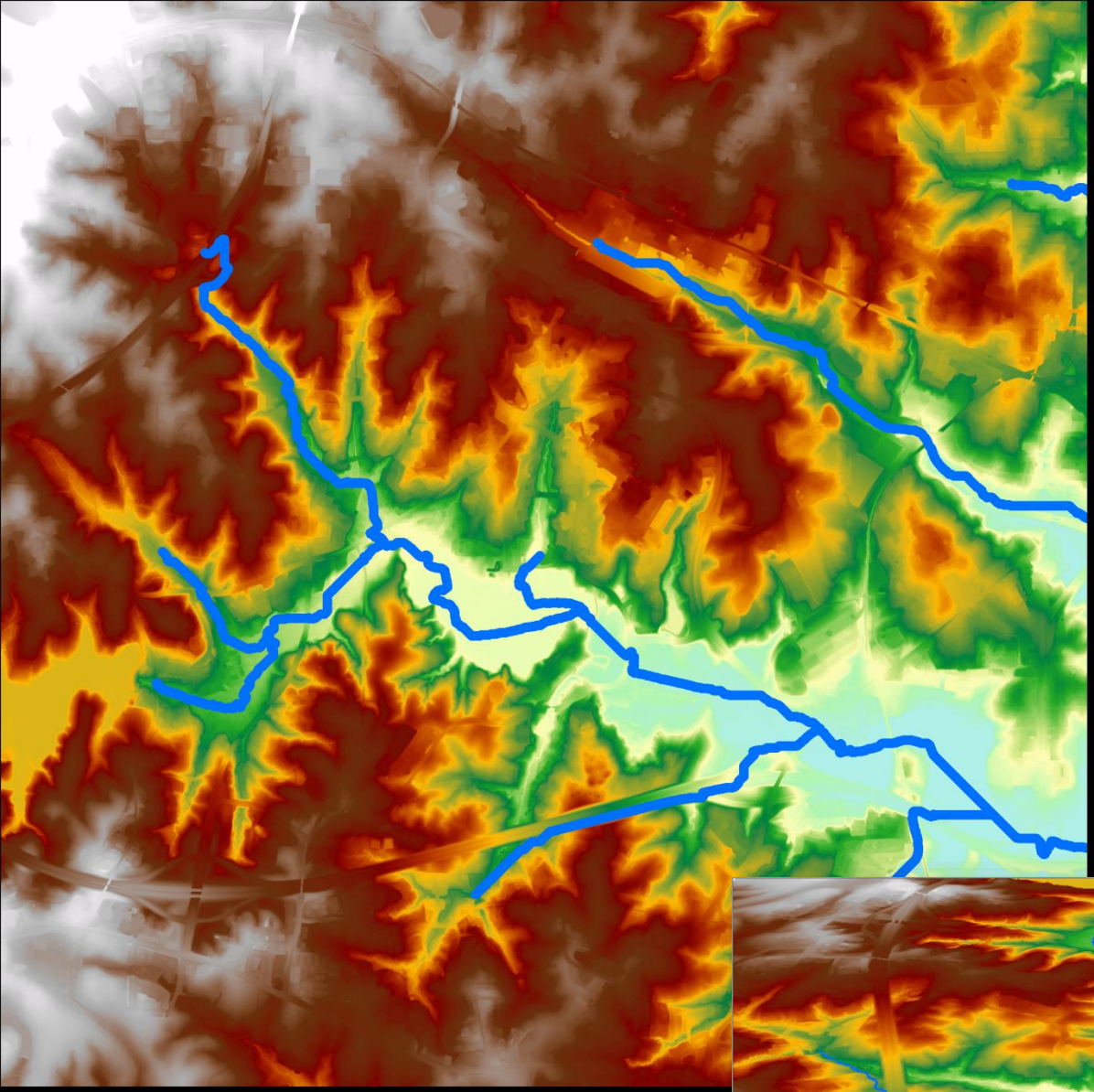
Drainage Area:
700 Acre or ~1 square mile

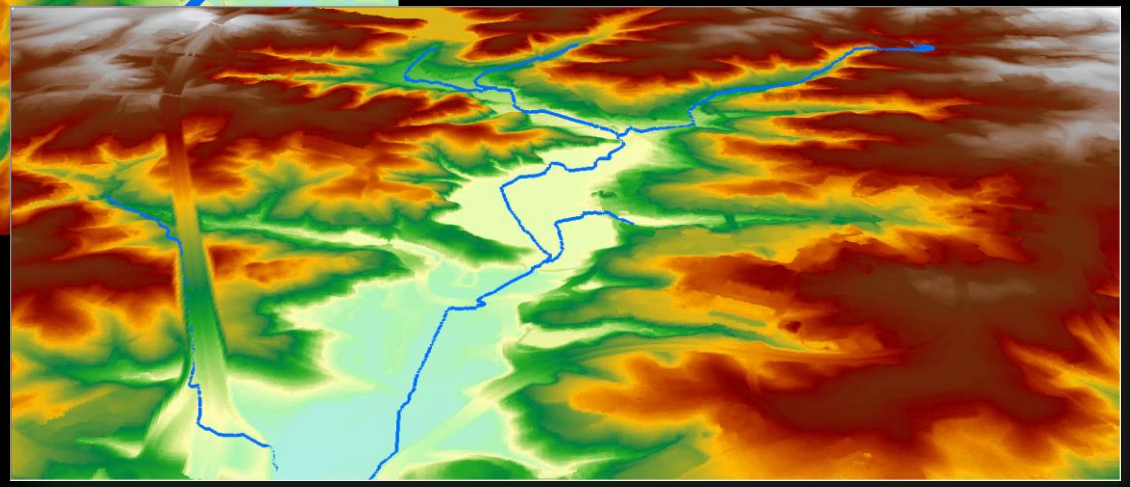




QL2 Topo Terrain

Drainage Area:
350 Acre or ~0.5 square mile

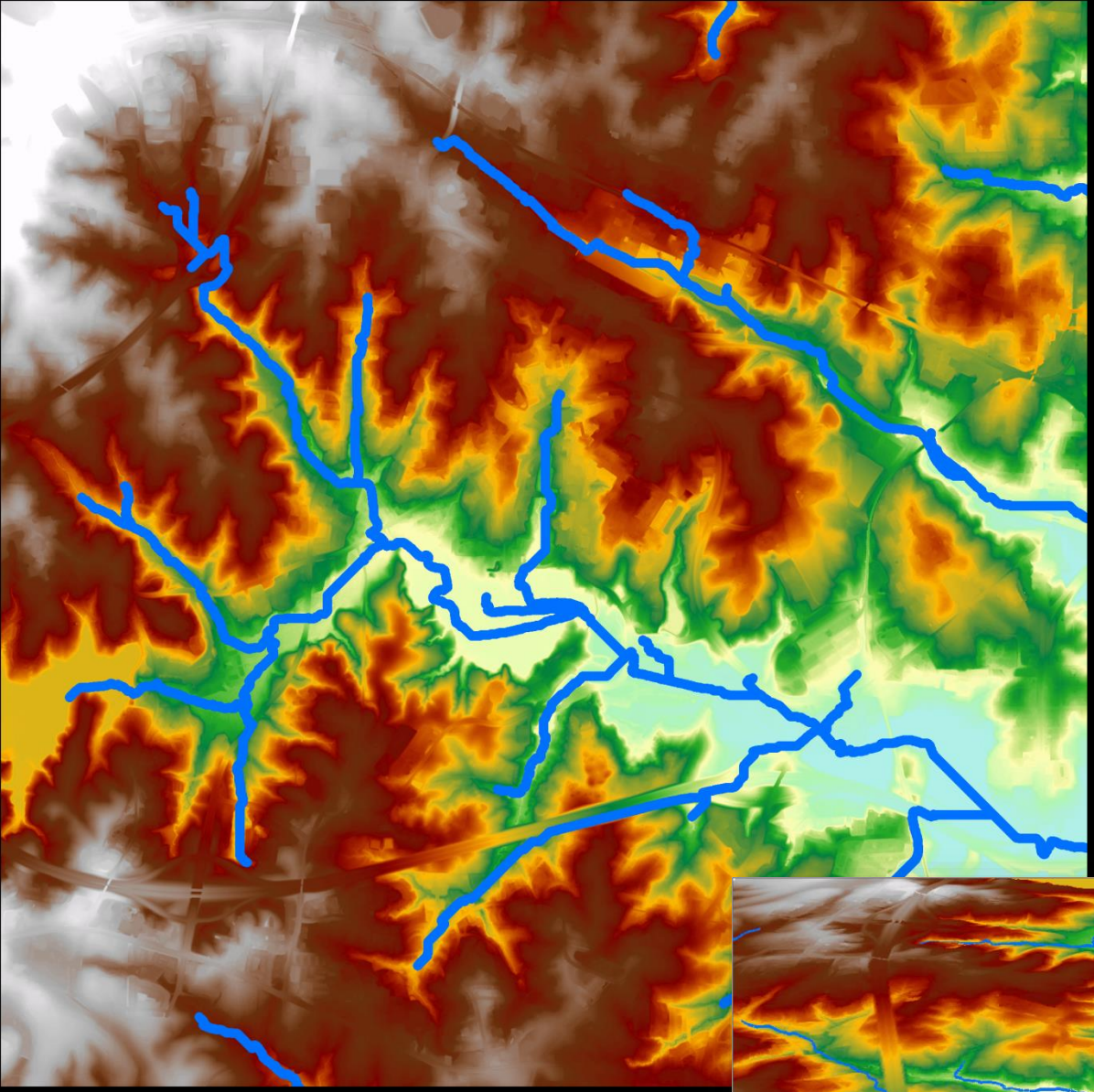


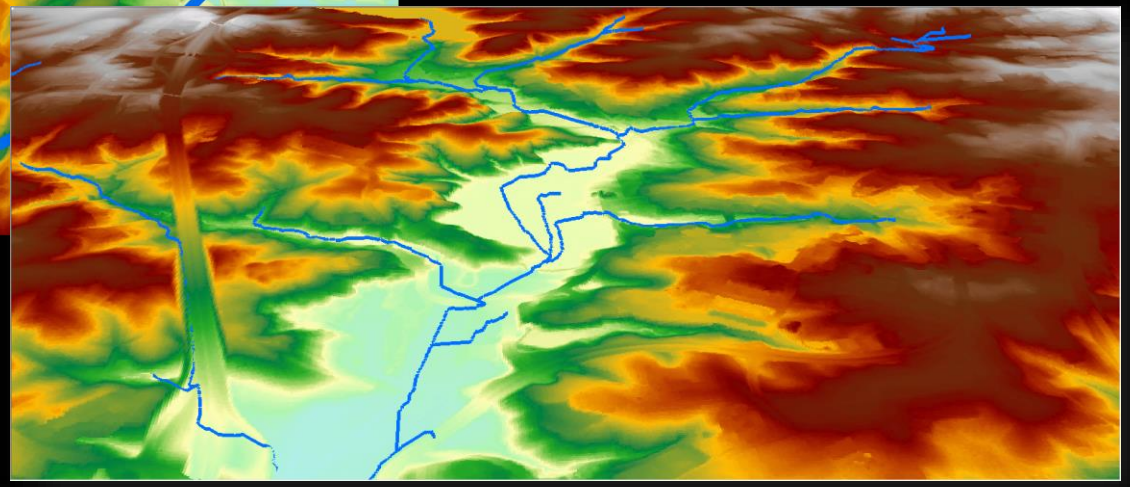


QL2 Topo Terrain

Drainage Area:

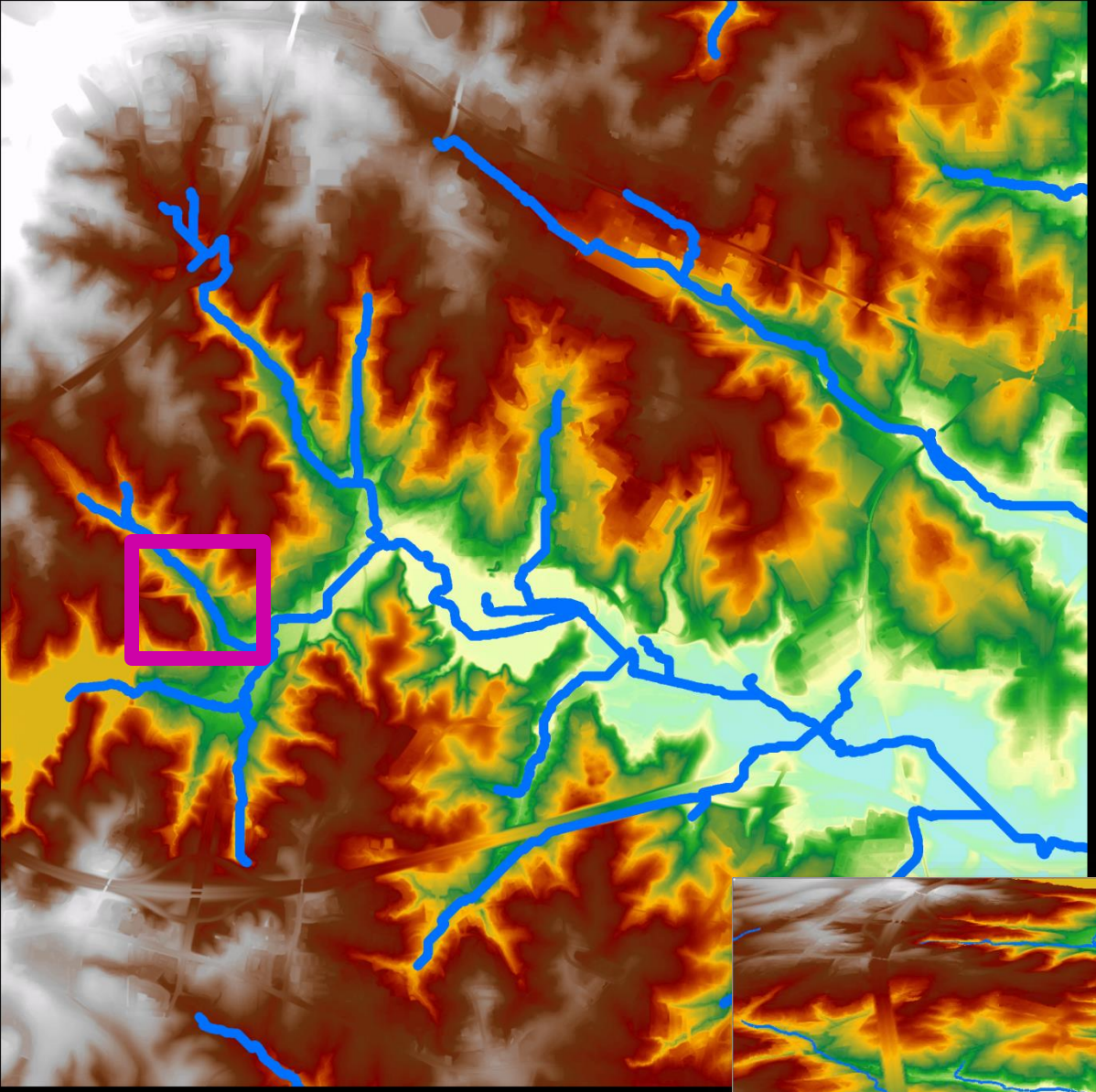
100 Acre or ~0.1 square mile

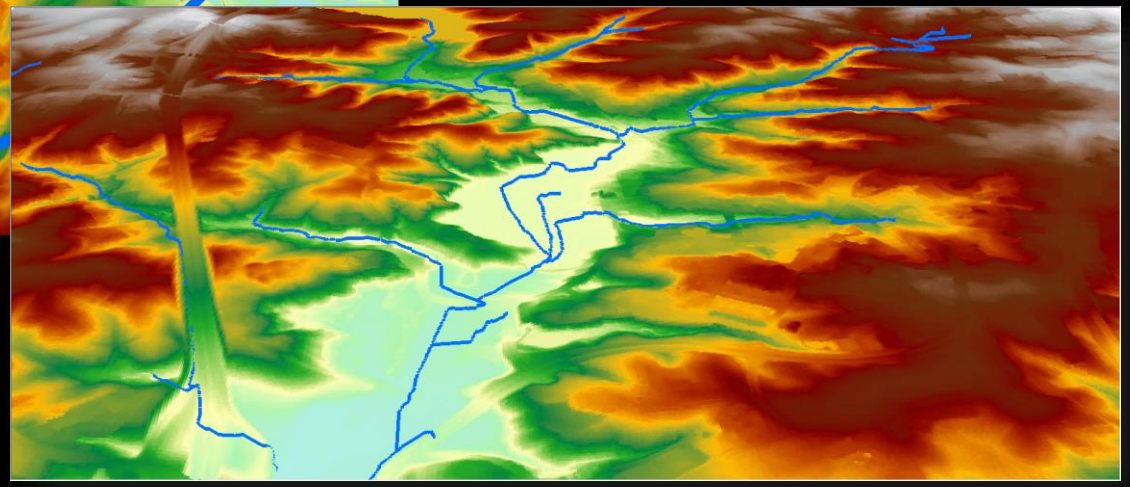




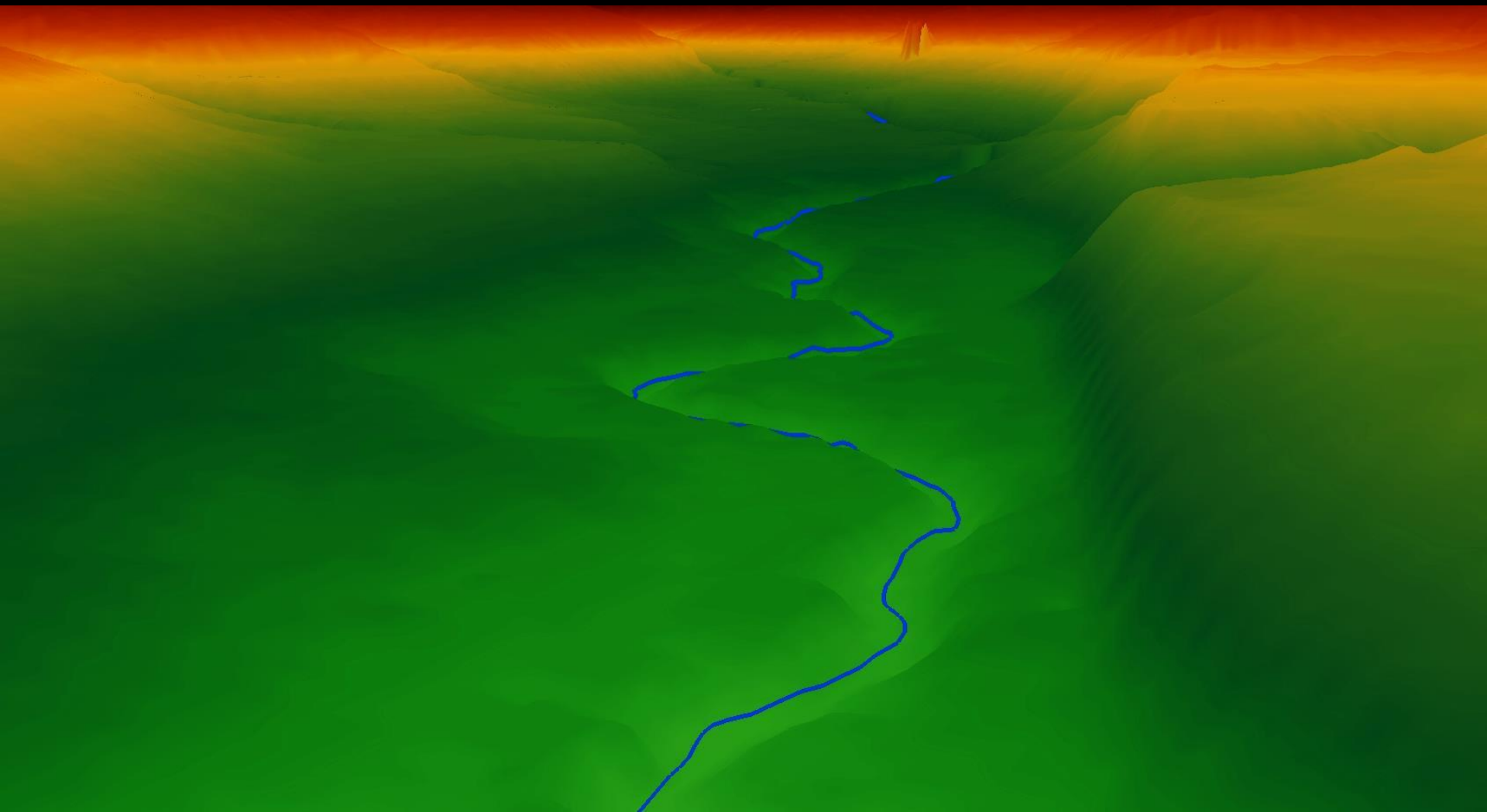
QL2 Topo Terrain

Drainage Area:
100 Acre or ~0.1 square mile





Perspective of QL2 Stream Level Detailed Delineations



QL2 Topo - Streams

Traditional/Manual Approach

- Heads up digitizing from Orthos or Terrain Data
- Highly labor intensive
- No automation
- Very expensive
- Only 19 Counties / No NHD @ 24k

Remote Sensing Approach

- Initial calculations yield quality results for an automated routine
- Does not account for culverts (not hydro-flattened or enforced)
- Can set most any desired drainage area
- Gives a quality approximation of stream locations

Estimated Cost Savings Examples

- Statewide Compilation
    - Traditional
        - 200,000 labor hours
    - Remote Sensed
        - **800 labor hours**
        - **99.6% Savings**

QL2 Benefits

Wetlands Analysis

Potential Wetland Identification

Uses a combination of the QL2 LiDAR Classification and available CIR Imagery

RGB Imagery + CIR Imagery + LiDAR Intensity Returns = Wetland Identification

QL2 LiDAR - Potential Wetland Identification

Remote Sensing versus Traditional/Manual

Traditional/Manual Approach

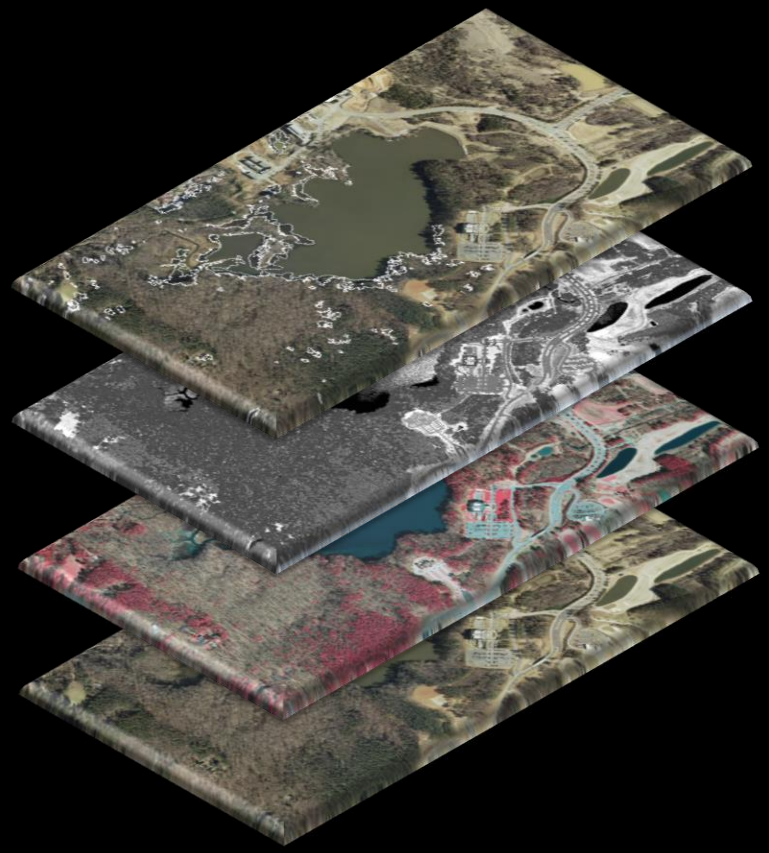
- Heads up digitizing from Orthos
- Highly labor intensive
- Inaccurate (best guess of operator)

Remote Sensing Approach

- Uses supervised scientific classifications from known wetlands
- Batch routines after algorithm is developed
- Initial potential identification for a 10 square mile area takes minutes versus hours

Estimated Cost Savings Examples

- Rowan County – 524 square miles
  - Traditional = 262 hours of labor
  - Remote Sensed = 86 hours of labor
  - **Savings = 67%**
- Sampson County – 947 square miles
  - Traditional = 474 hours of labor
  - Remote Sensed = 107 hours of labor
  - **Savings = 78%**



QL2 LiDAR – Support for Precision Farming

NC STATE UNIVERSITY

Subsurface Irrigation Installation

Addition of RTK GNSS to the tractor or implement could provide a map of irrigation line location and depth.

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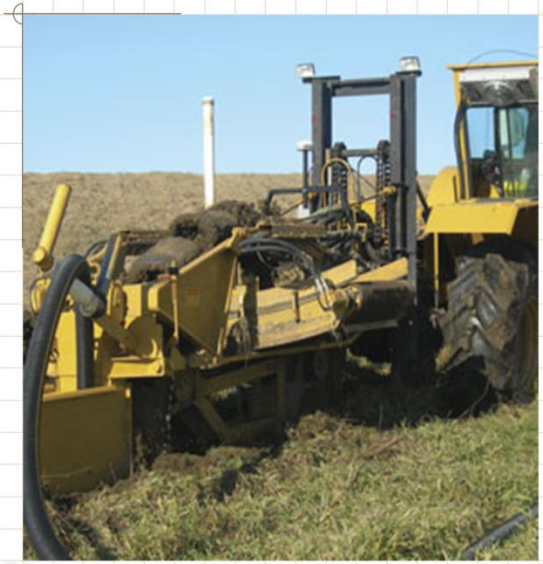
Subsurface Drainage Installation



Depth and slope maintained by RTK GNSS

http://www.trimble.com/Agriculture/WM-Drain.aspx, 2013

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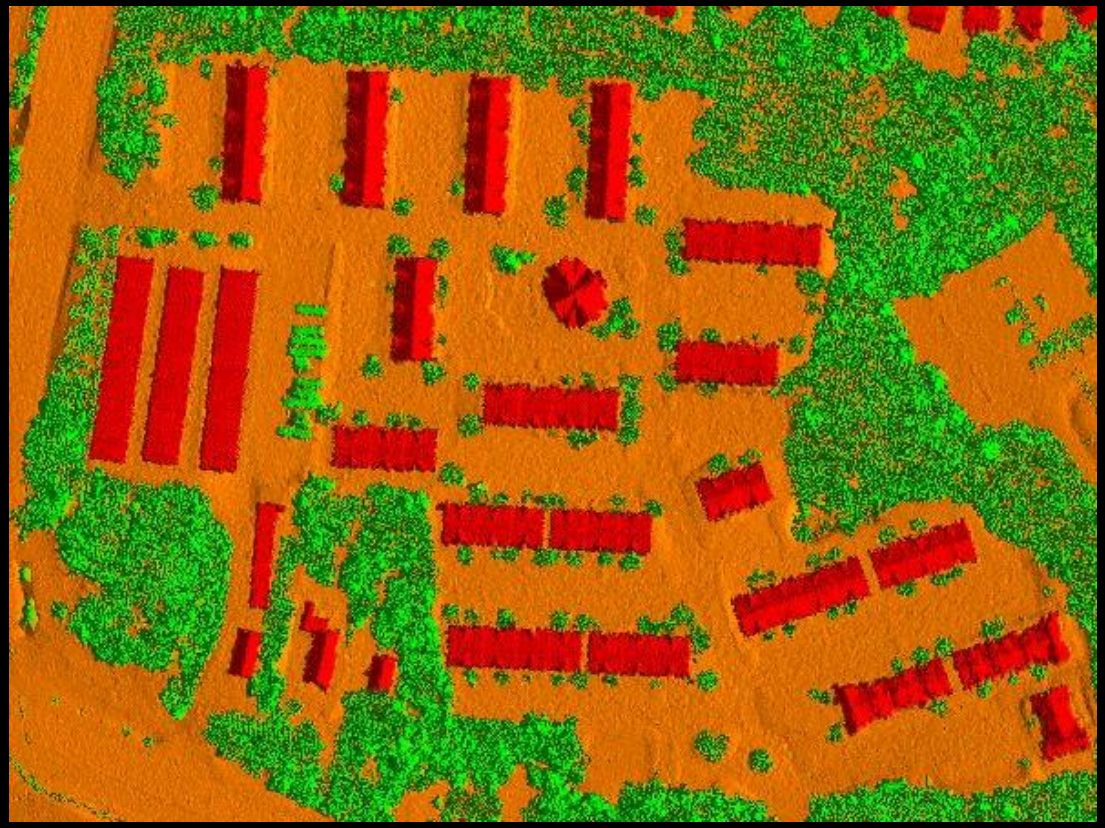
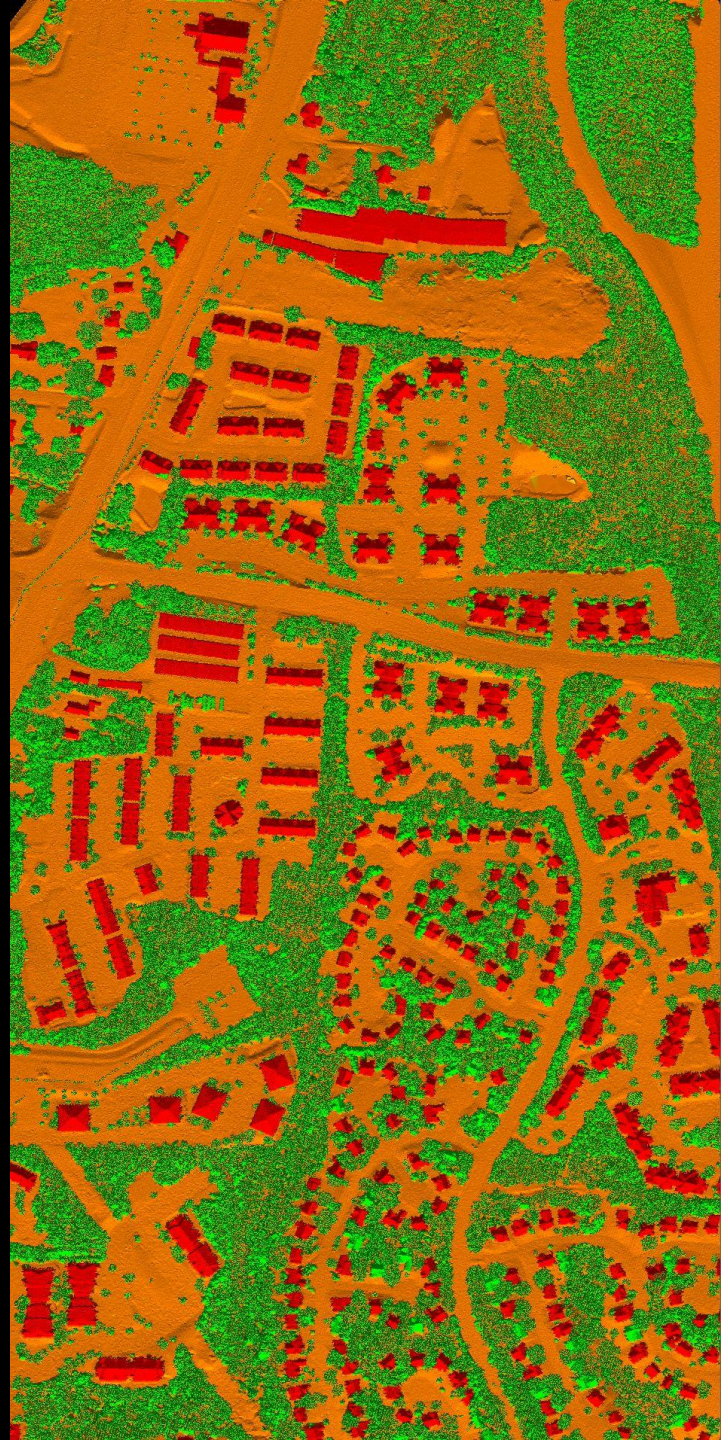
QL2 - Building Footprint Extraction and Updates

- Buildings are classified within the LiDAR point cloud
- Algorithm looks for planar surfaces with steep edges





QL2 - Building Footprint Extraction and Updates

- Examples
  - Building Footprint does not appear to match with the foundation of the building

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  - Building Footprint does not appear to match with the foundation of the building
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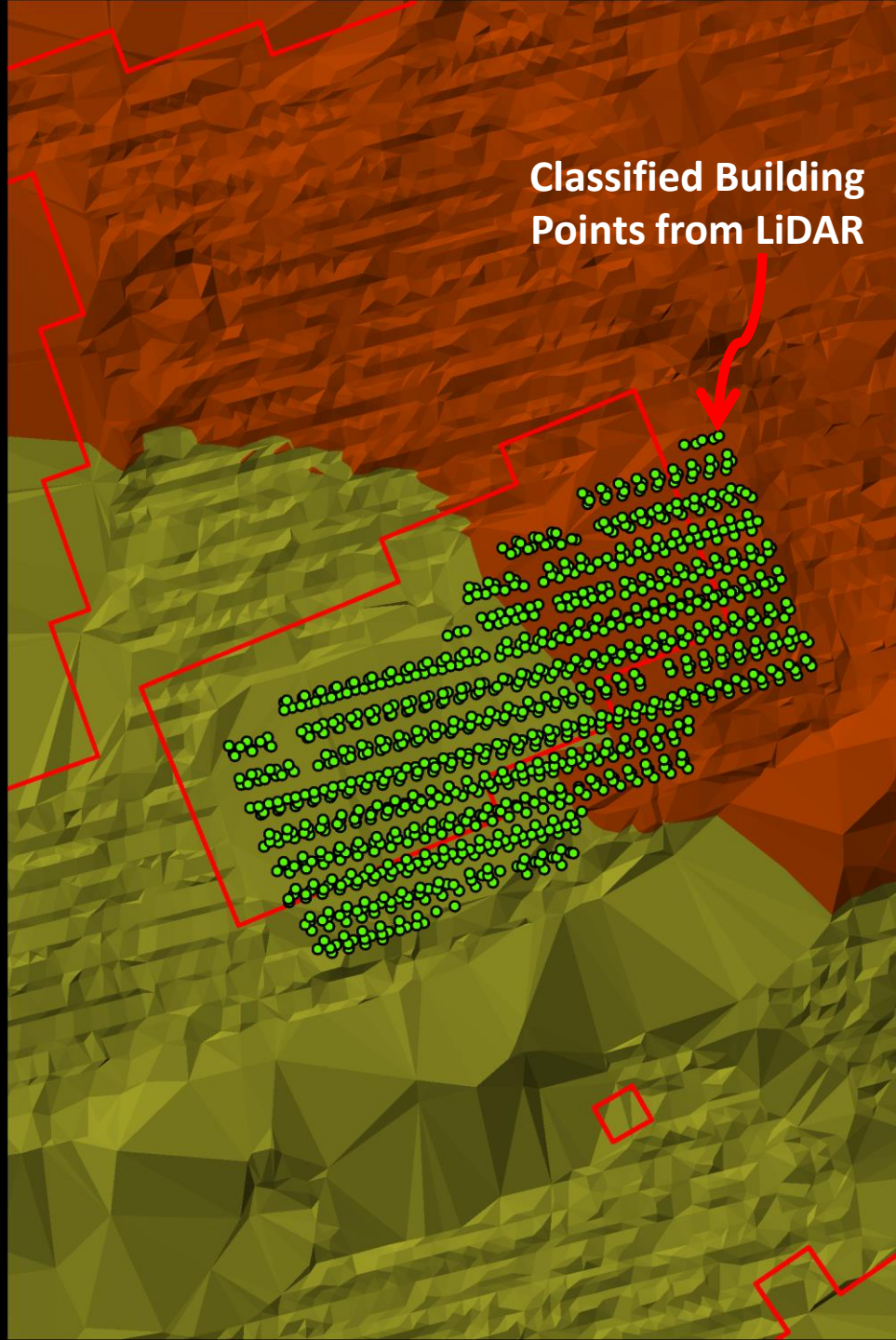
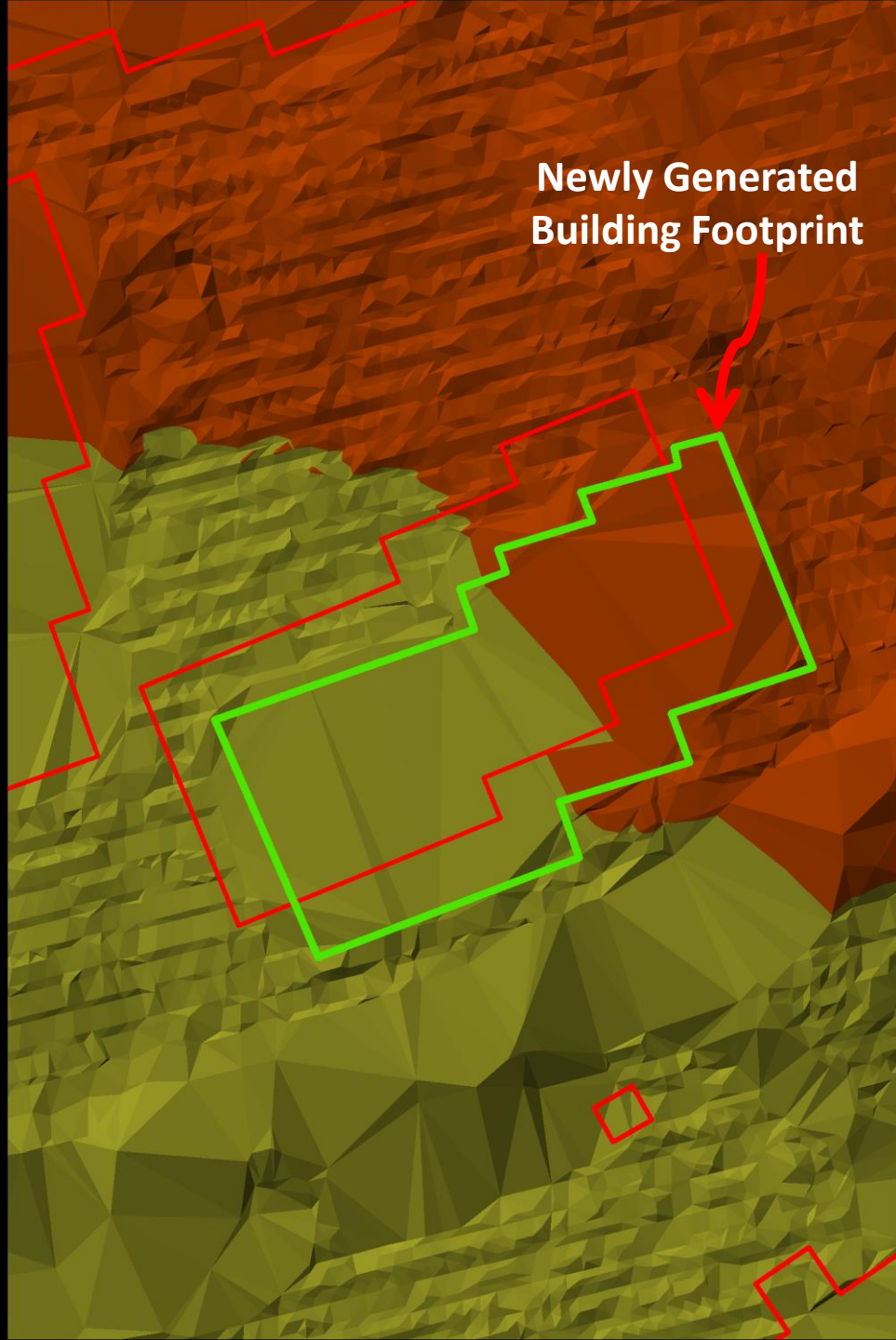


QL2 - Building Footprint Extraction and Updates

- Examples
  - Building Footprint does not appear to match with the foundation of the building
  - Let's take a closer look
  - New Building Footprint polygon



QL2 - Building Footprint Extraction and Updates

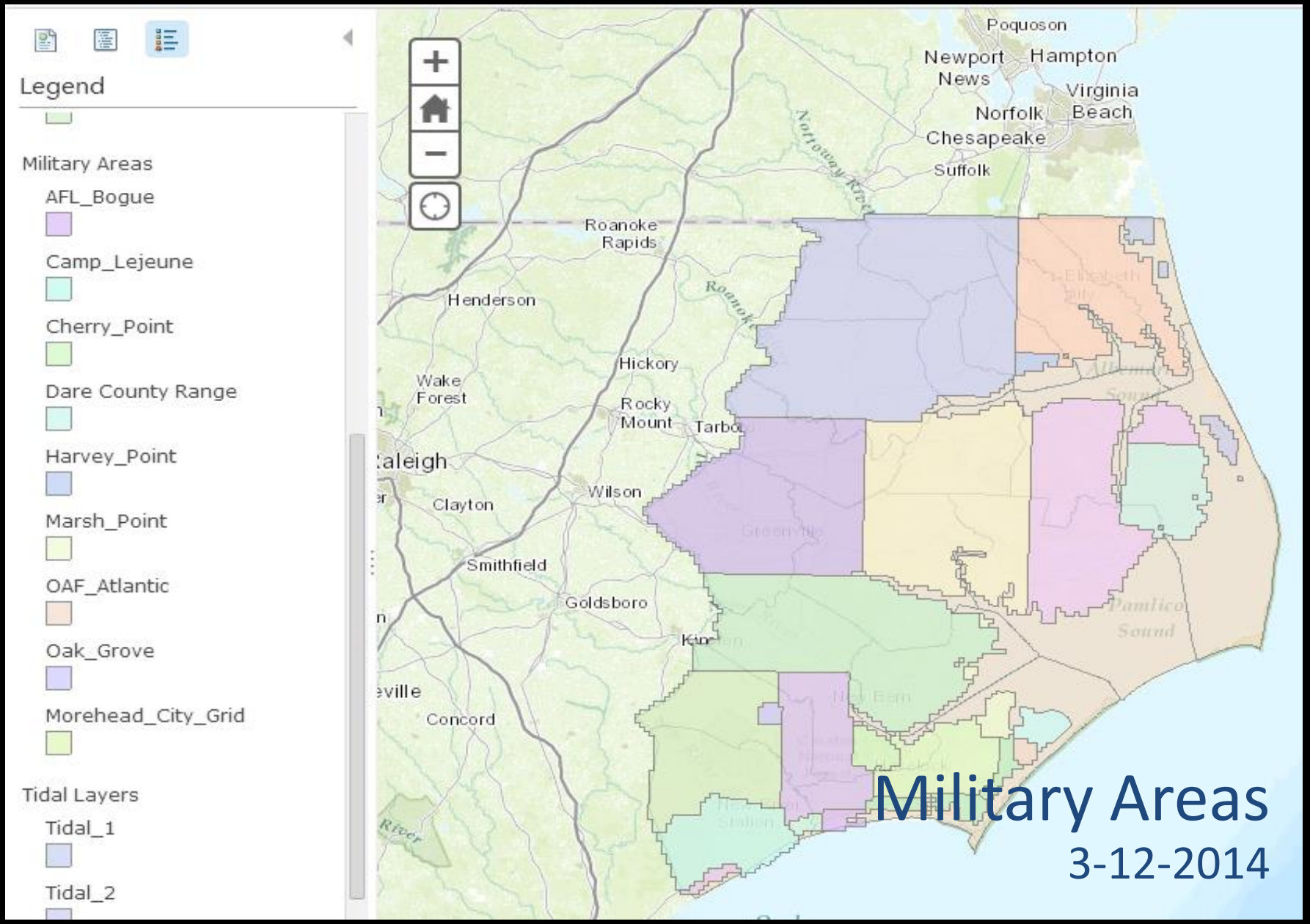
- Examples
  - Building Footprint does not appear to match with the foundation of the building
  - Let's take a closer look
  - New Building Footprint polygon
  - Much closer alignment to actual foundation

QL2 Topo - First Floor Elevations (FFE)

- Used to detect finished floor elevation in order to quantify damages based upon flooding depths
- Types that exist
  - Elevation Certificate
    - Costly ($500-$1,500)
    - High Precision Survey Grade
  - Remote Sensed FFE
    - More Cost Effective ($22)
    - Accuracy is +/- 0.5 feet
- The Future
  - Highest Adjacent Grade (HAG) determination from QL2 LiDAR
    - Batch routine entire Counties
    - Accuracy could be +/- 0.3 feet
    - Help remove homeowners from buying flood insurance if they are above the Base Flood Elevation (BFE) **/ No Cost to Homeowner**

QL2 Topo - Coordination Discussions

- USGS
- NOAA
- USDA - NRCS
- NCDOT
- NC Department of Agriculture
- NC911
- UNC systems
- Duke Power
- NC Forestry
- Military


Legend
Military Areas
AFL_Bogue
Camp_Lejeune
Cherry_Point
Dare County Range
Harvey_Point
Marsh_Point
OAF_Atlantic
Oak_Grove
Morehead_City_Grid
Tidal Layers
Tidal_1
Tidal_2
Poquoson
Newport News
Hampton
Virginia Beach
Norfolk
Chesapeake
Suffolk
Roanoke Rapids
Henderson
Hickory
Wake Forest
Rocky Mount
Tarboro
Raleigh
Wilson
Clayton
Smithfield
Goldsboro
Concord
Pamlico Sound
Military Areas
3-12-2014

LiDAR-Derived Topography (QL2)

Anticipated Cost, Current Funding, Funding Gap

	Project Summary	2014 Phase 1	2014 Phase 2	2015 Phase 3	2016 Phase 4	2017 Phase 5
Project Cost	$20,376,683	$3,096,683	$4,320,000	$4,320,000	$4,320,000	$4,320,000
Project Funding	$10,716,683	$3,096,683	$4,320,000	$1,100,000	$1,100,000	$1,100,000
USGS	$2,359,763	$2,359,763	$0	*	*	*
US DOA - NRCS	$100,000	$100,000	$0	*	*	*
GTM - NCFMP	$1,456,920	$636,920	$520,000	$100,000	$100,000	$100,000
NC DOT	$6,800,000	$0	$3,800,000	$1,000,000	$1,000,000	$1,000,000
Funding Gap	$9,660,000	$0	$0	**$3,220,000**	**$3,220,000**	**$3,220,000**

* Year by Year Determination based on Federal Appropriations

Questions

John.Dorman@ncdps.gov