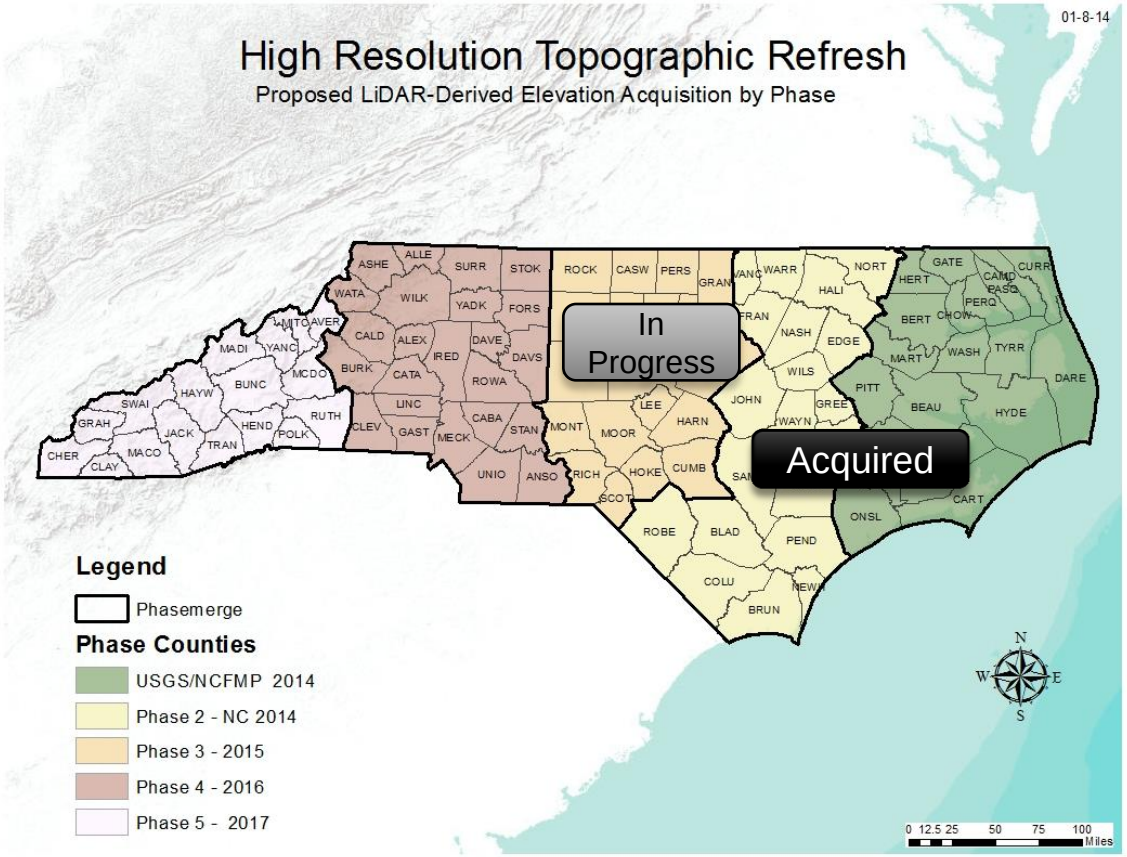
NCGS: Positioning NC today and for the future!

North Carolina
Geodetic Survey

Establishing and Maintaining
the Official Survey Base
in North Carolina

STATEWIDE PHASES



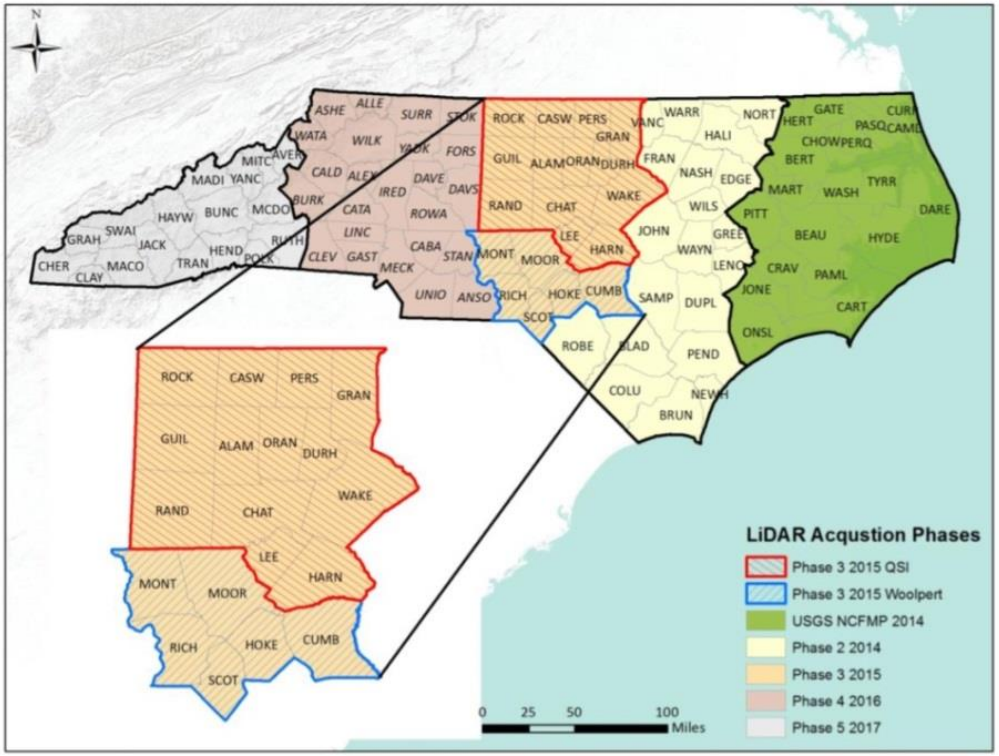
Original Plan

- The Plan put forward was a 5 phase 4 year plan
- Phase 1- USGS
- Phase 2- NC
  - Both occurred in 2014
- Phase 3 – NC (2015)

The Plan added Onslow County to Phase 1 with the Coordination effort of NRCS

Therefore moving the NC collection Phase 2 to add Robeson County

Phase 3 NC Collection 2015



- **3.5 million appropriated by the General Assembly based on value to the state**
- **1 million paid by NCDOT.**

State Specifications

Collection

- 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 FVA based on NDEP guidelines.

State Specifications

- Classification

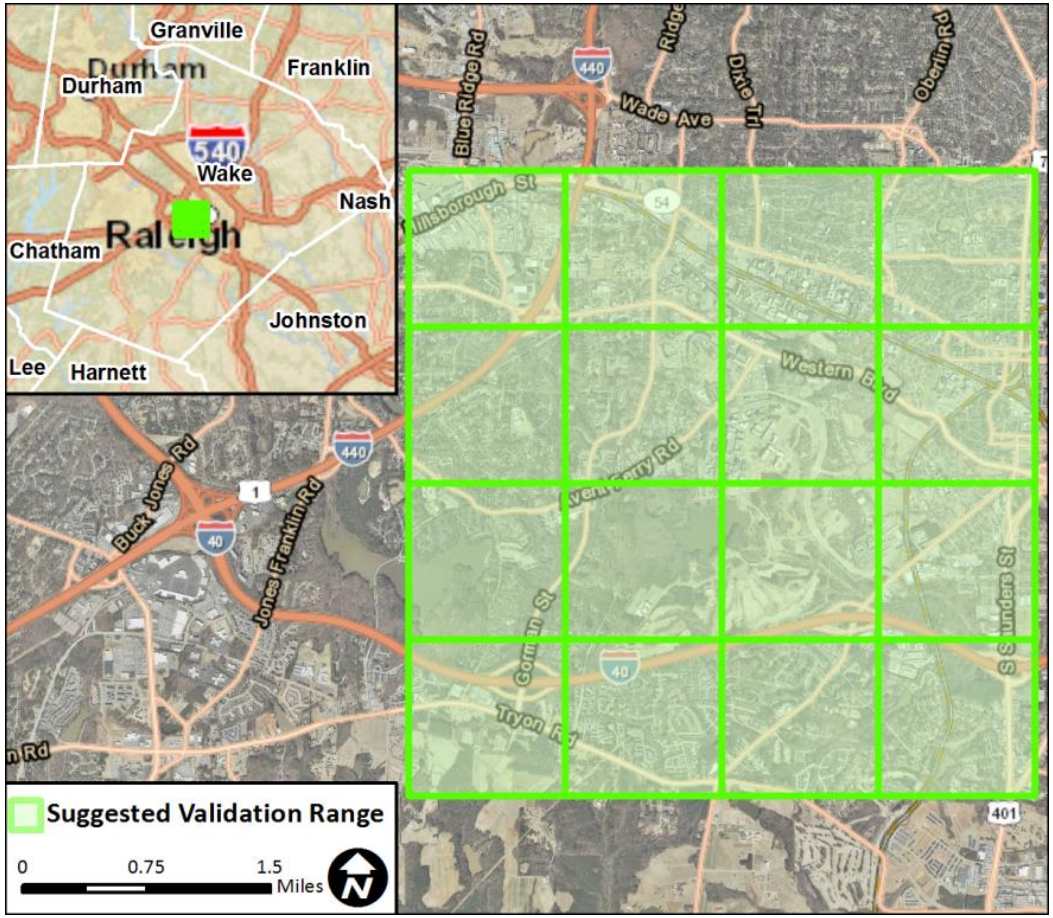
Class	Description
1	Processed Unclassified
2	Ground
3	Low Veg/Strata
4	Medium Veg/Strata
5	High Veg/Strata
6	Buildings (Automated)
7	Noise (High/Low)
9	Water (Hydro Cleaned Areas)
12	Flight Line Overlap
13	Roads
14	Bridges
17	Overlap Default
18	Overlap Ground
25	Overlap Water

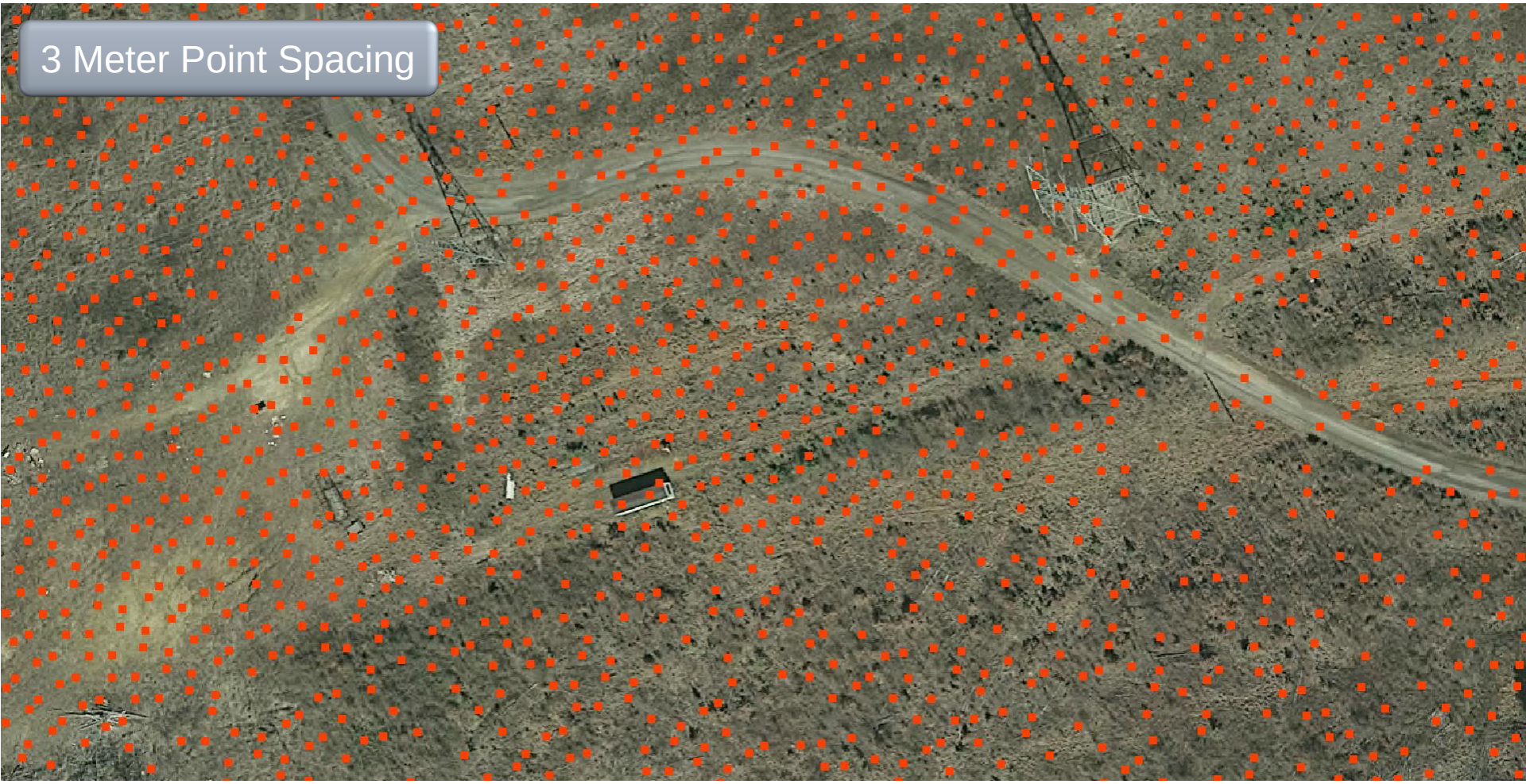
State Specifications

This project has set up an Validation Range

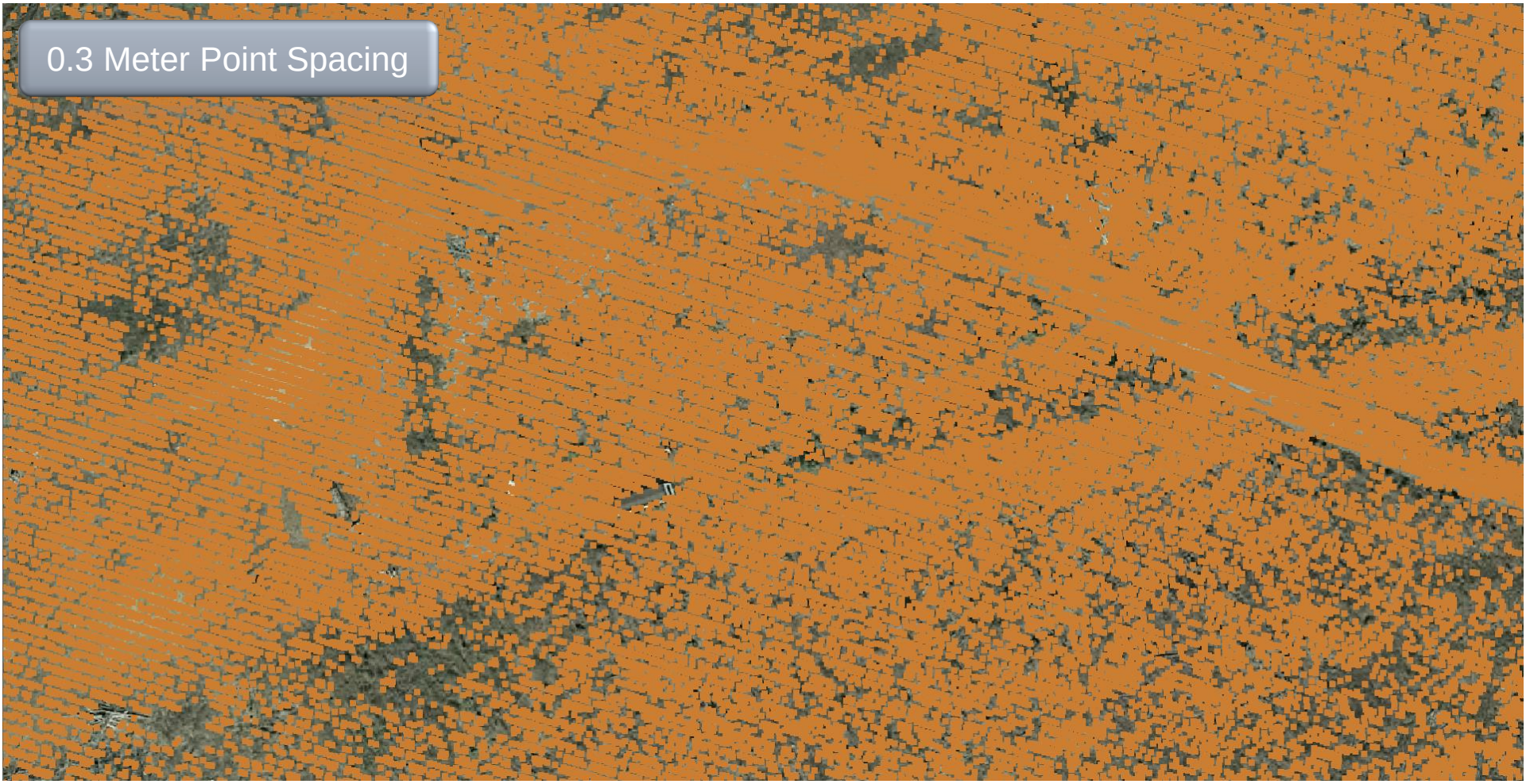
- Flown by each sensor to check horizontal and vertical Accuracy of the collection.
- Gives the teams the capability of adjusting the sensors to match on another
- USGS contractors utilized the validation range

Validation Range



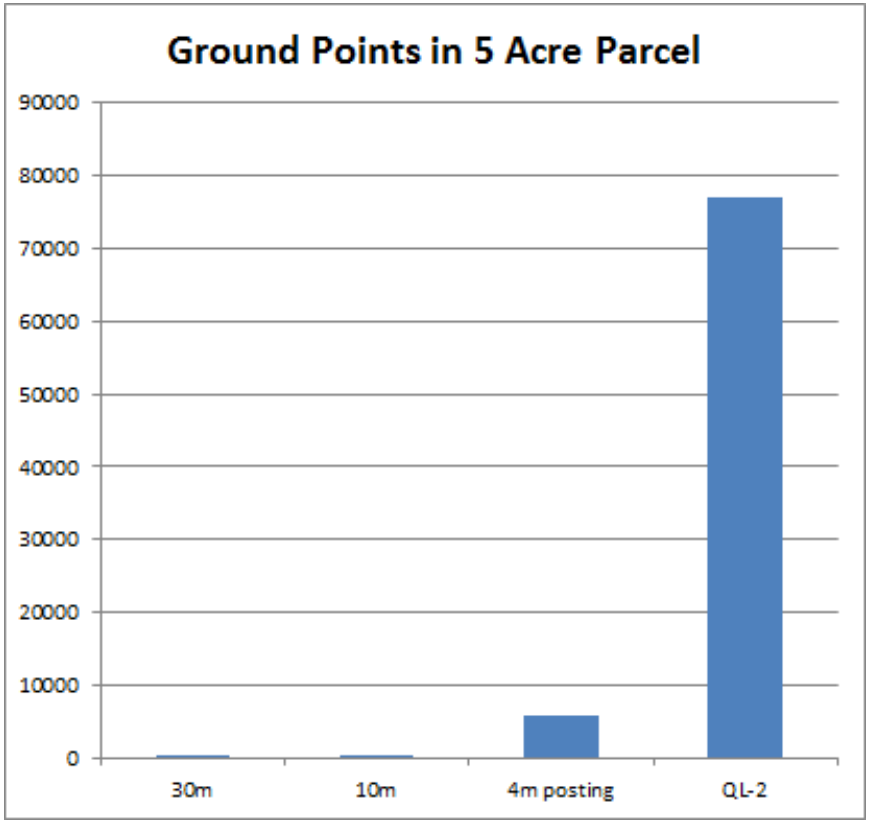


3 Meter Elevation Model (2003 NC LiDAR)

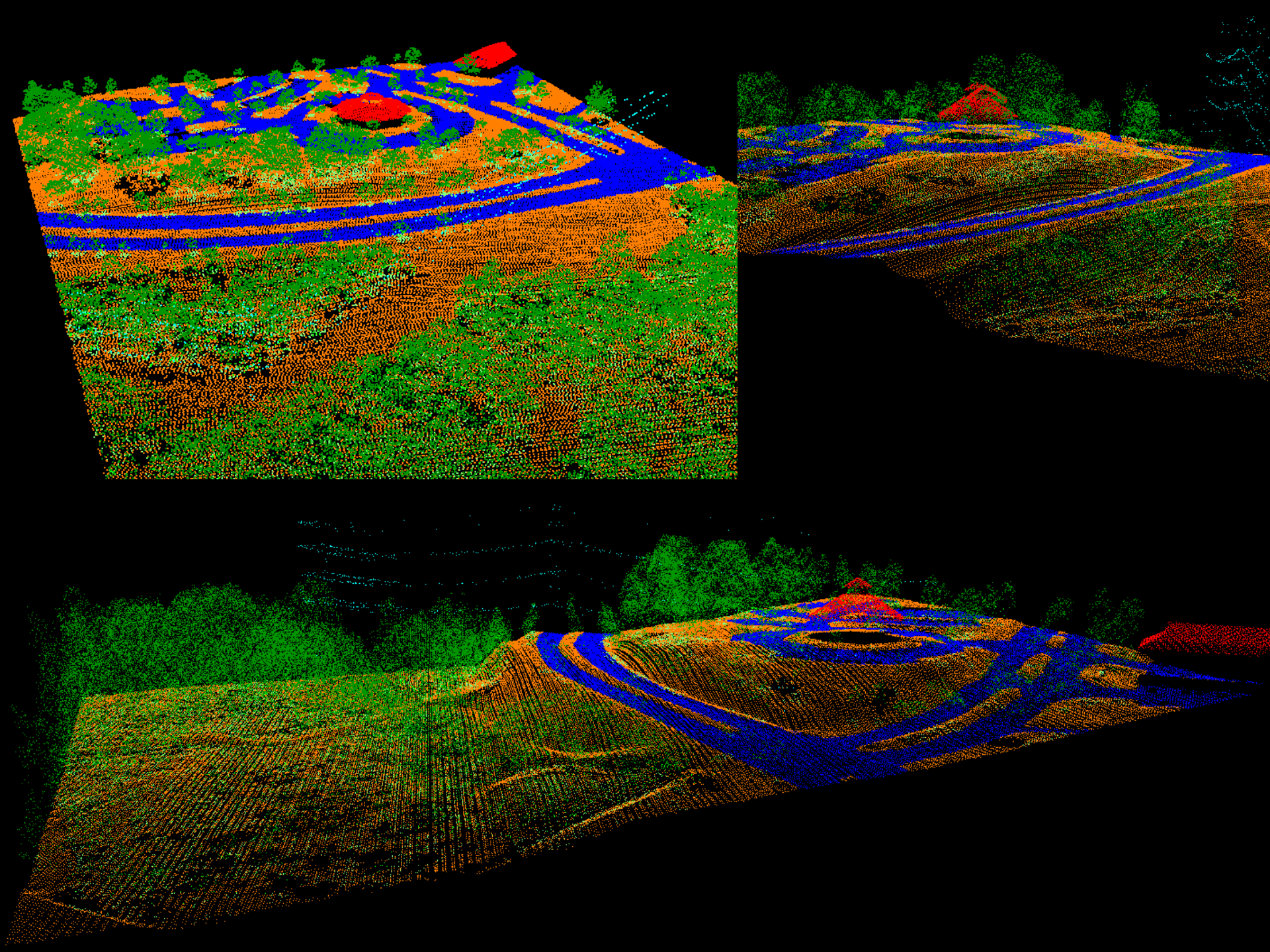


QL2 Elevation Model

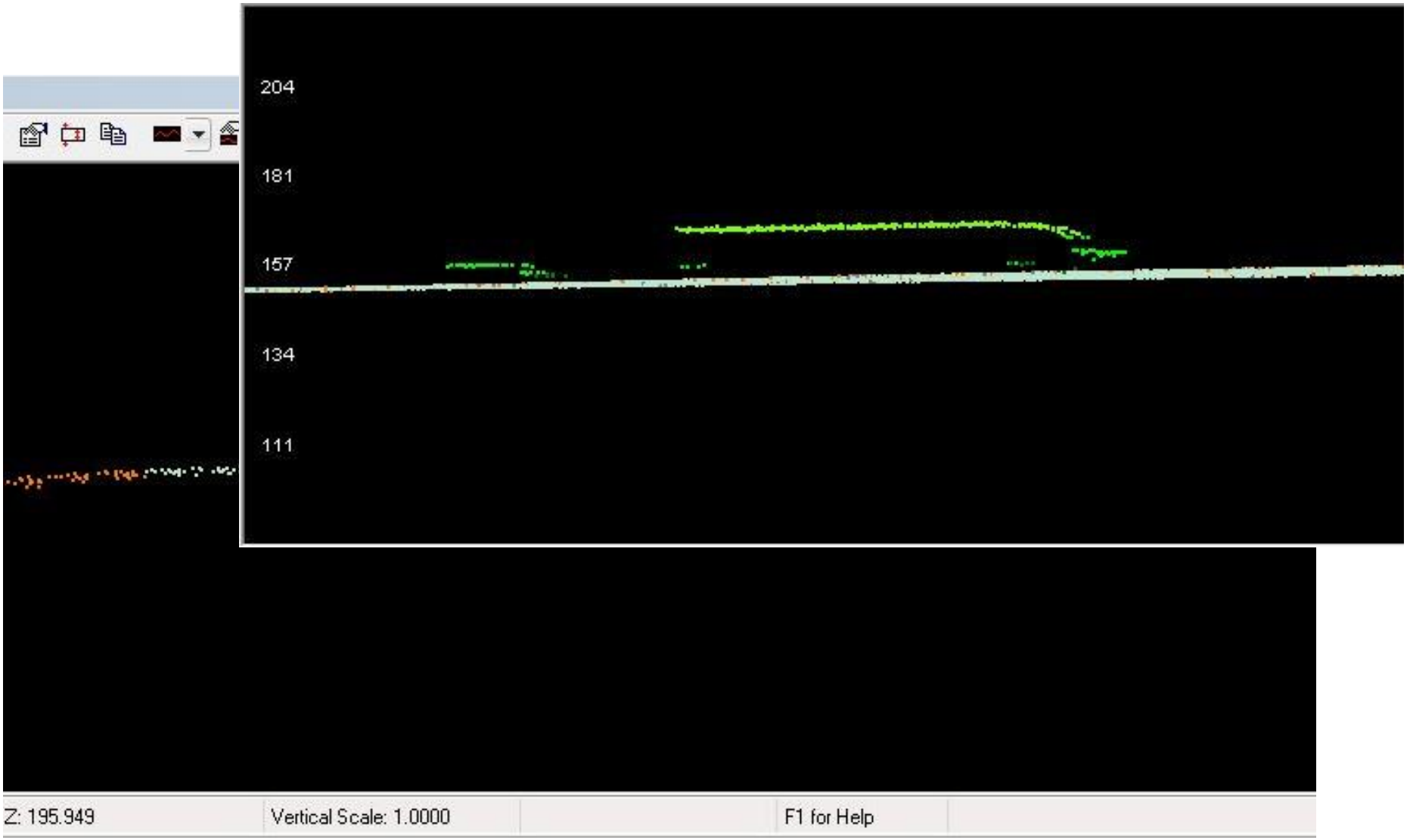
Summary



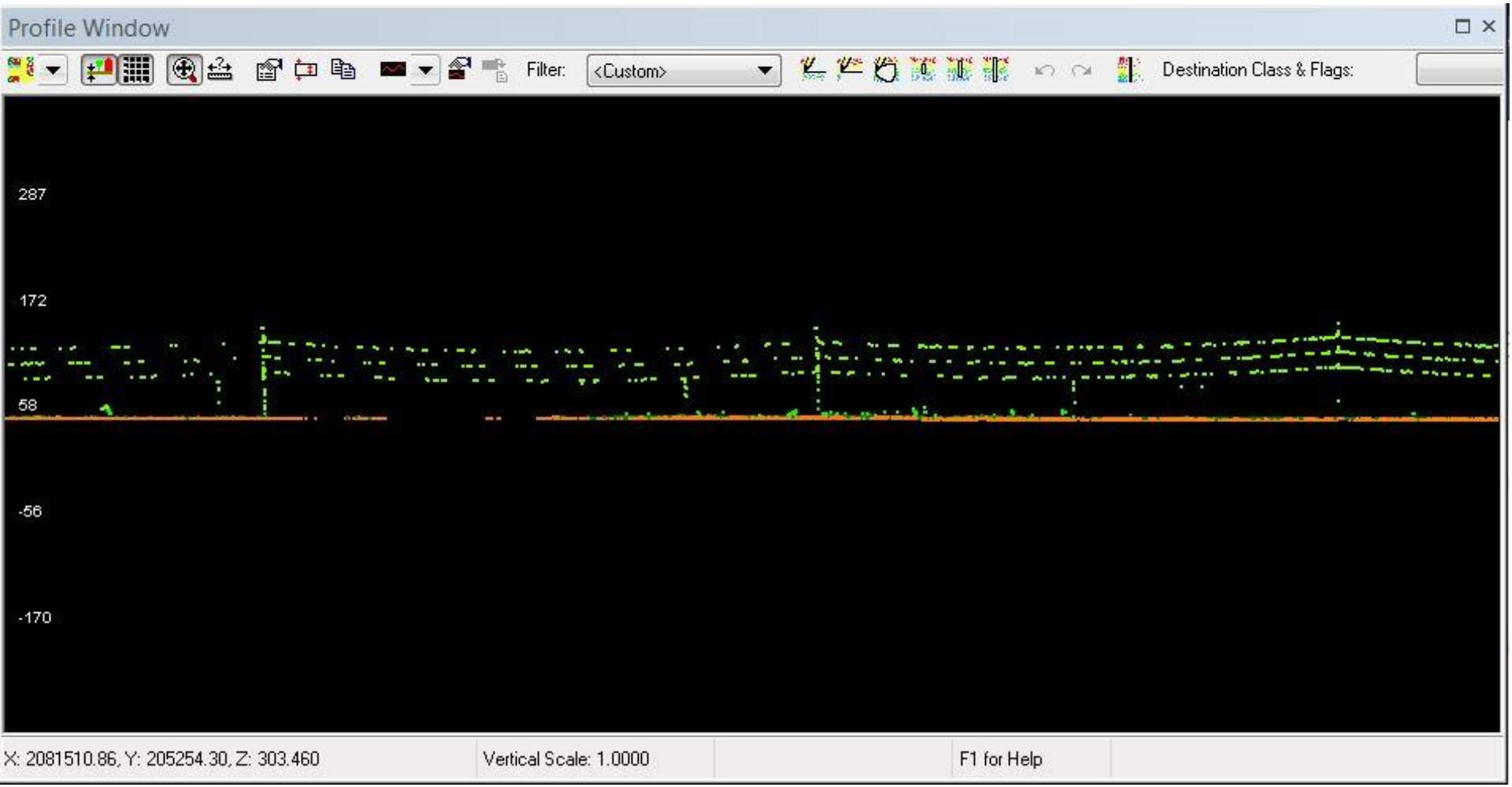
LIDAR Quality	Ground Points in 5 Acre Parcel
30m NED	32
10m NED	300
3m (circa 2003)	7,696
QL2	76,957

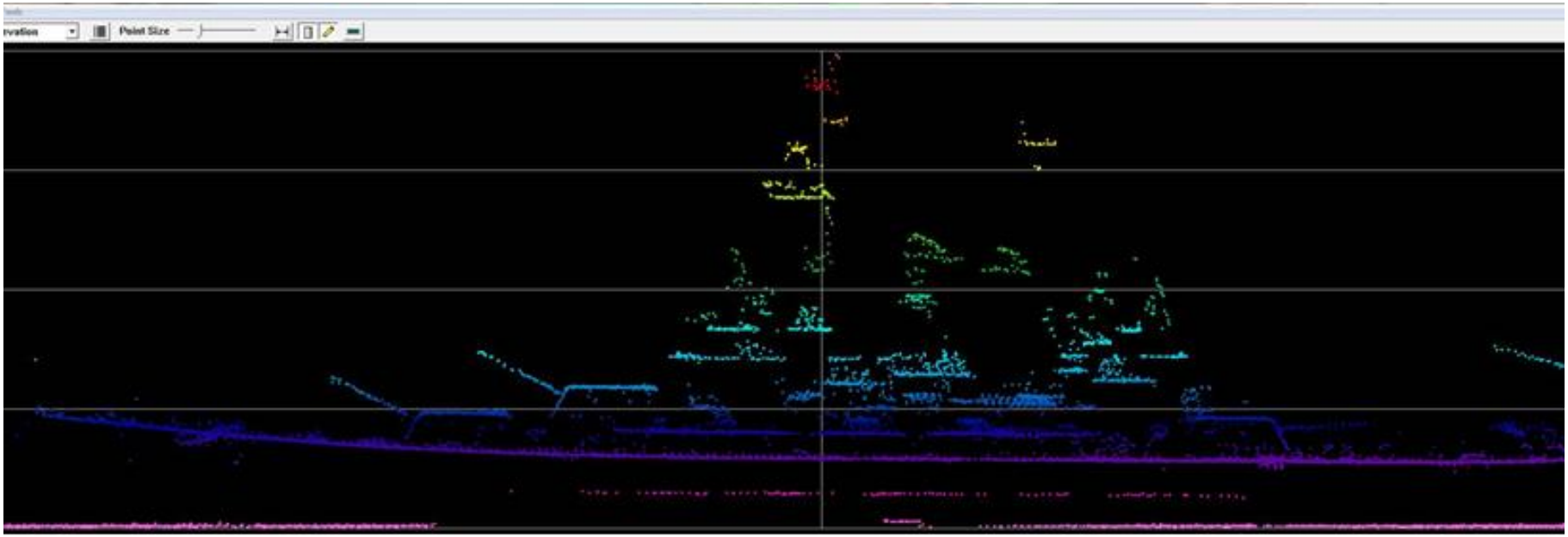


Vehicles



Utility Profile

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North Carolina Spatial Data Do...

rmp.nc.gov/sdd/

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SPATIAL Data Download

Login with NCID

A North Carolina ID (NCID) is required.

Don't have a NCID? Sign up here.

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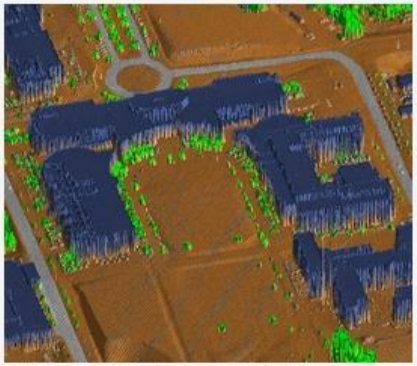
skaufman

PASSWORD:

••••••••

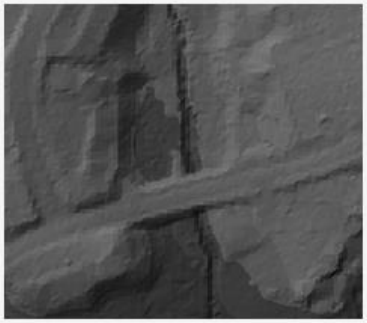
LOGIN

Login here for QL2 LiDAR



This data is Quality Level 2 (QL2) and was collected at a spacing of approximately 2 points per meter. All returns classified data is available.

Download legacy LiDAR at NC FRIS



All counties in North Carolina currently have legacy bare earth LiDAR from the initial statewide collection conducted from 2001-2005. This data was collected at a spacing of approximately 1 point per 3-4 meters.

beta This is a beta version of the Spatial Data Download site.

This is not the final version and you may encounter downtime, errors or bugs. If you do: **Email Your Feedback**

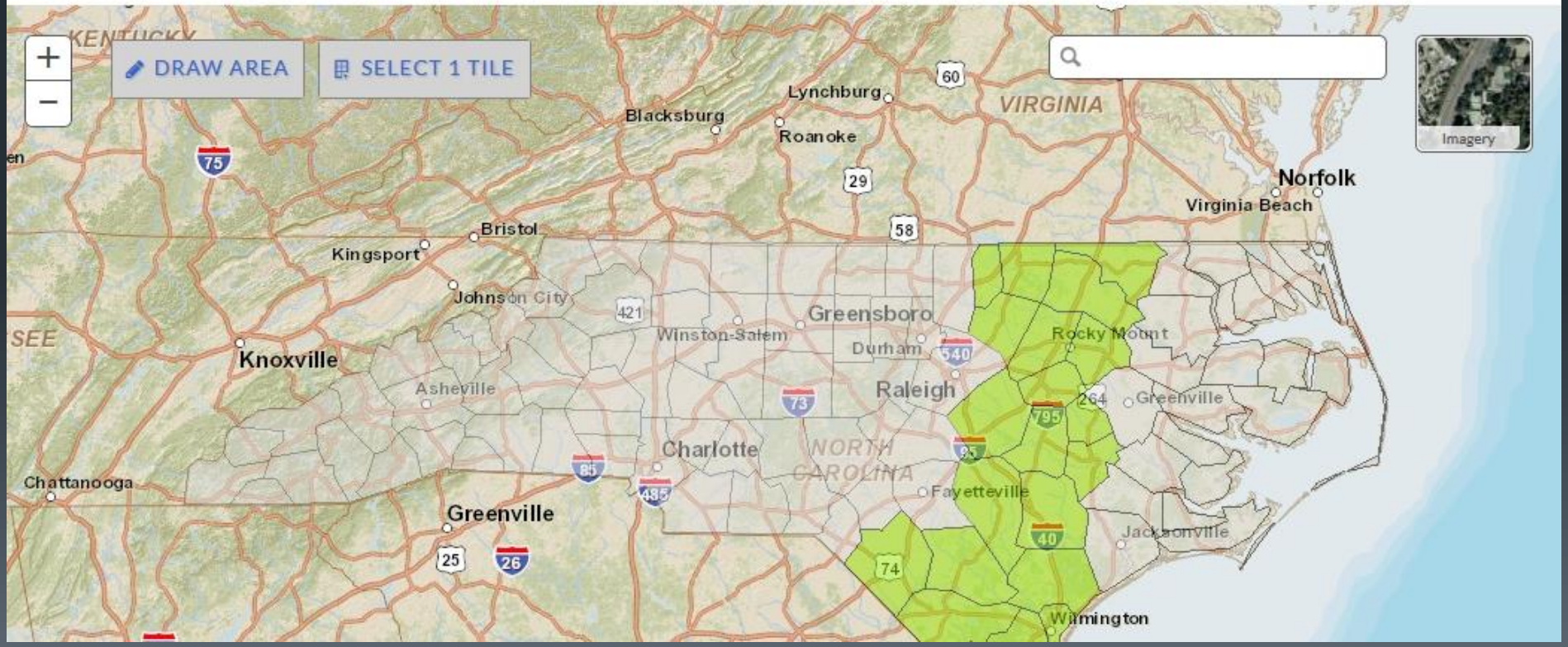
NCFMP will not be liable for any loss suffered by any party as a result of their use of the site. Any downloading of material is done at the users own risk and the user will be solely responsible for any loss that results from such activities.

QL2 LIDAR DATA DOWNLOAD

To request an entire city or county, go to the **Large Data Request** page. Download legacy LiDAR at **NC FRIS**

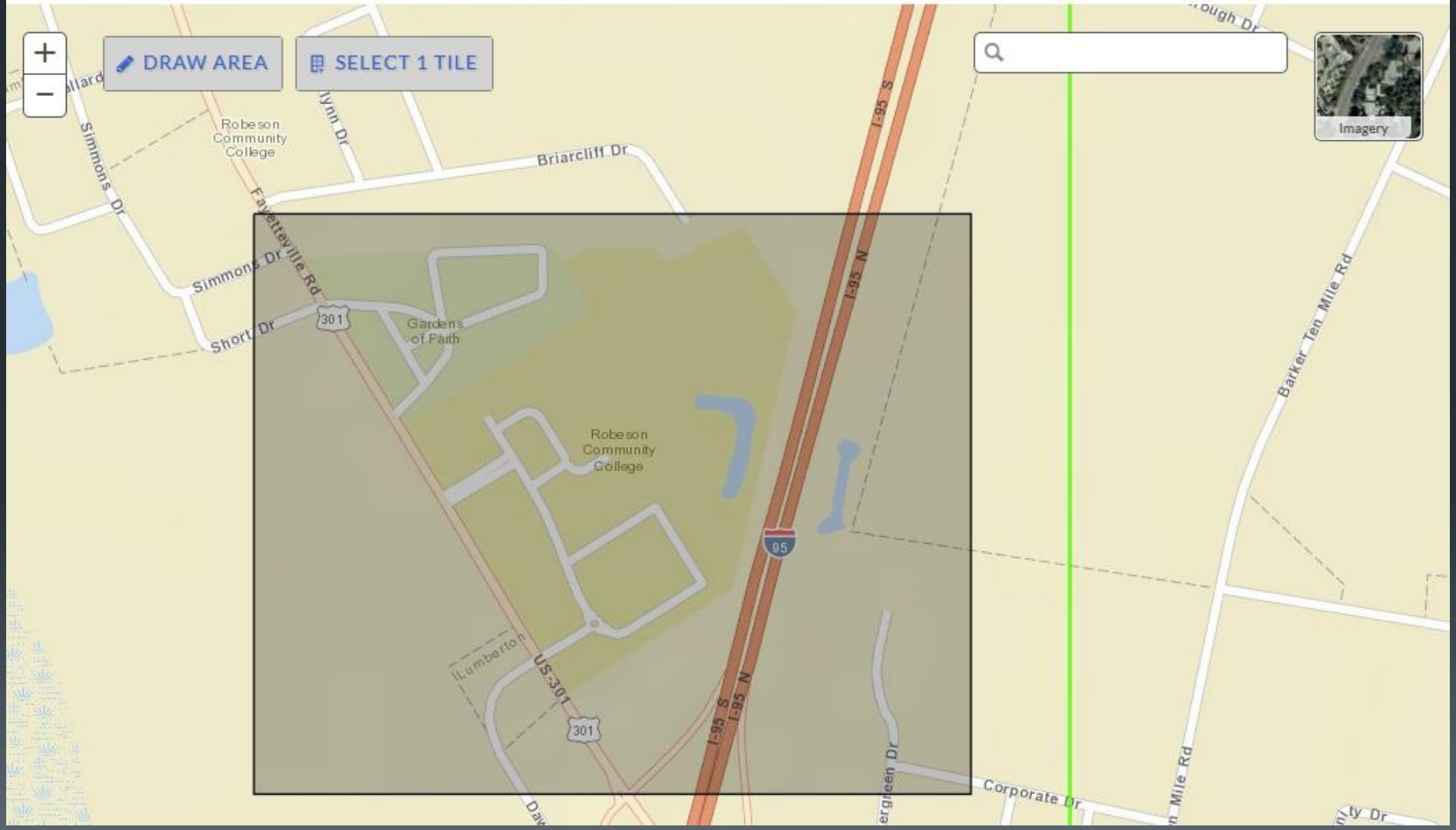
Select Area — Select File Output — Submit Request

QL2 LiDAR is available on the green areas on the map. To select an area crossing **multiple tiles**, click "Draw Area" and then draw a small box on the map. Areas must be less than 4 tiles.



QL2 LiDAR is available on the green areas on the map. To select an area crossing **multiple tiles**, click "Draw Area" and then draw a small box on the map. Areas must be less than 4 tiles.

Click Next to Continue NEXT



QL2 LIDAR DATA DOWNLOAD

To request an entire city or county, go to the **Large Data Request** page. Download legacy LiDAR at **NC FRIS**

Select Area — **Select File Output** — Submit Request

Select the classes of LiDAR you wish to include in your output .LAS file.

ALL CLASSES

This dataset contains all classes including ground, roads, vegetation and water

BARE EARTH

This dataset represents the earth's surface with all vegetation and human-made structures removed. The output .LAS file will contain classes 2 (Ground) and 13 (Roads).

INDIVIDUAL CLASSES

- Ground
- Strata/Vegetation
- Buildings
- Roads
- Bridges

PREVIOUS

SUBMIT REQUEST

This is a beta version of the Spatial Data Download site

QL2 LIDAR DATA DOWNLOAD

To request an entire city or county, go to the **Large Data Request** page. Download legacy LiDAR at **NC FRIS**

Select Area — Select File Output — **Submit Request**

Your request has been submitted!

Jobs are processed in the order they are received and may require up to 24 hours for processing. You will receive an email from **rmpclipandship@ncdps.gov** when your files are ready for download. Please make sure to add **rmpclipandship@ncdps.gov** to your safe sender list.

SUBMIT ANOTHER REQUEST | VIEW REQUEST HISTORY

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This is not the final version and you may encounter downtime, errors or bugs. If you do: **Email Your Feedback**

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SPATIAL Data Download

NC Floodplain Mapping Program
4105 Reedy Creek Drive
Raleigh, NC 27607

Phone: (919) 715-5711

Mailing Address
4218 Mail Service Center
Raleigh, NC 27699-4218

REQUEST SUMMARY

Click the column names to **sort** your requests.
Pending requests may take up to 24 hours to process. You will receive an email when your data is ready for download.
Click the Download button to access your completed data request files.

Status	ID	Date	Type	
Pending	61	3/11/2015 9:30:40 AM	Rectangle	
Complete	32	3/2/2015 1:54:51 PM	Rectangle	DOWNLOAD

Your Spatial Data Download Job #61 is complete.

Selected Area (NC State Plane Feet)

Min X: 1,996,197.63
Min Y: 335,246.80
Max X: 1,999,539.66
Max Y: 337,937.92

The the data will be available for download for 3 days.

Download Files

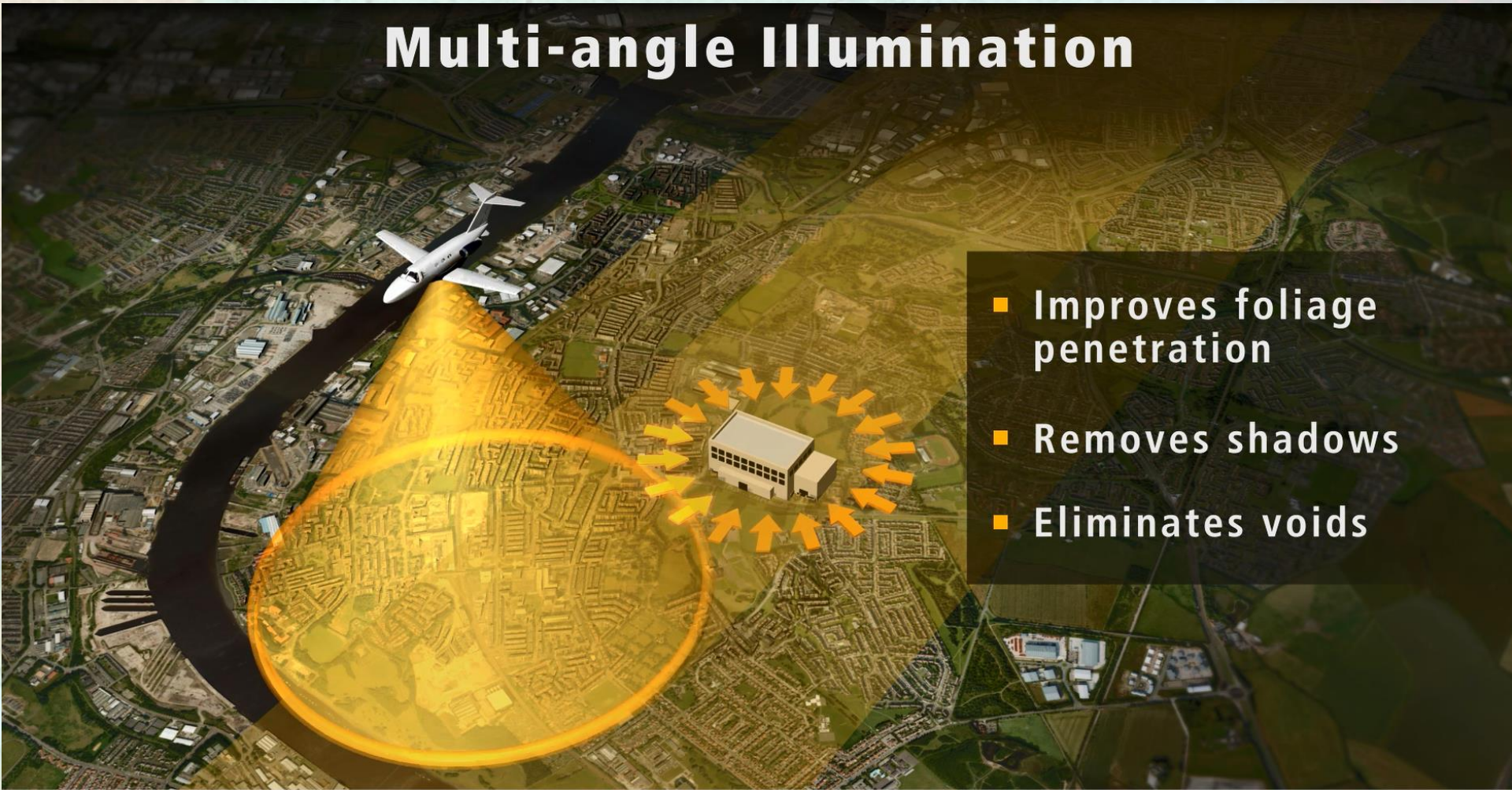
Files are zipped using open source 7-Zip compression (.7z file type). 7-Zip is free and does not require registration.
Download 7-Zip

If you have any questions, please contact Hope Morgan at hope.morgan@ncdps.gov or John Lay at john.lay@ncdps.gov.

Thank you for using Spatial Data Download!

E-mail correspondence sent to and from this address may be subject to the provisions of G.S. 132-1, the North Carolina Public Records Law, and may be subject to monitoring and disclosed to third parties, including law enforcement personnel, by an authorized state official.

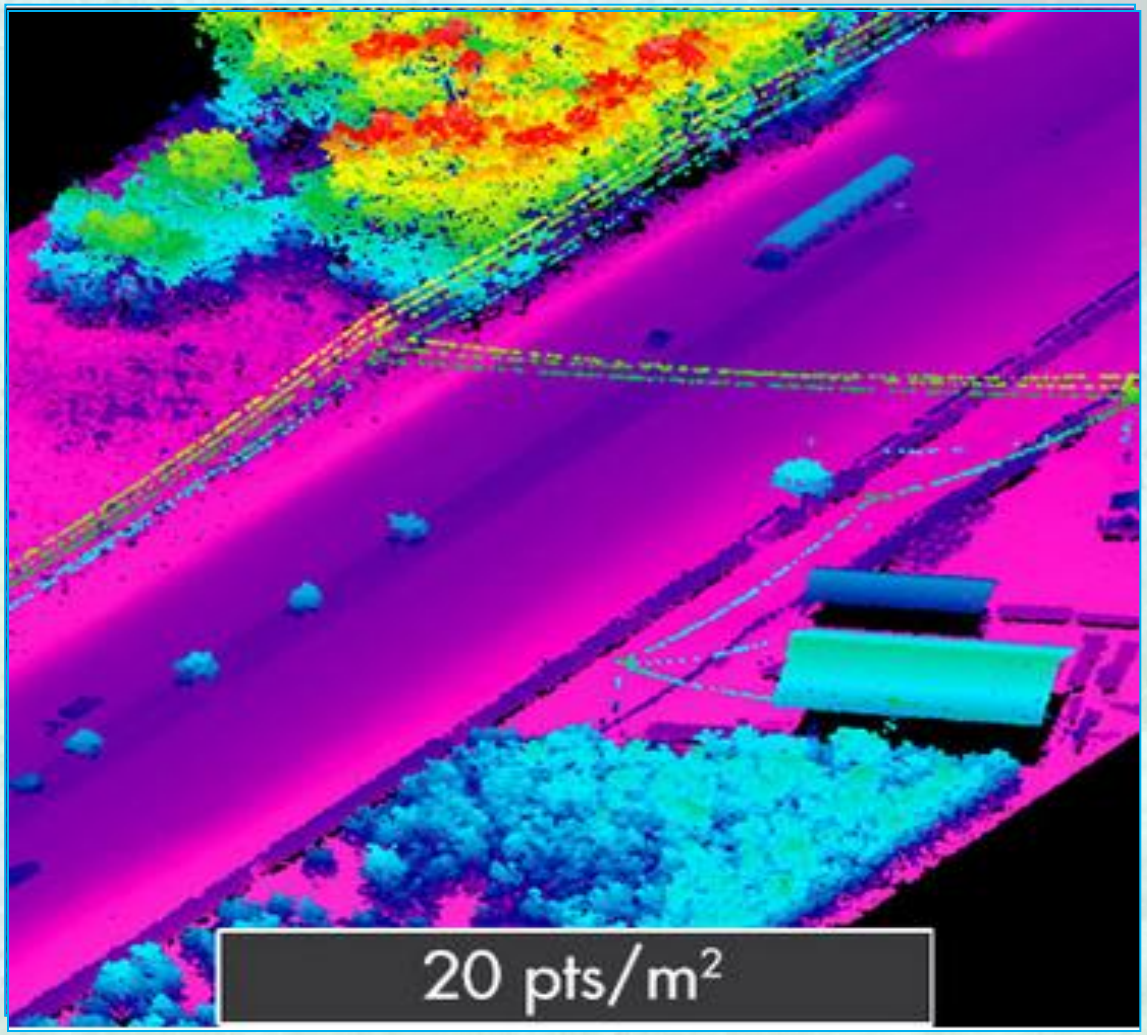
- Normal utility collection would be for corridors or circuit miles.
  - With the additional data you would be able to add new businesses or areas

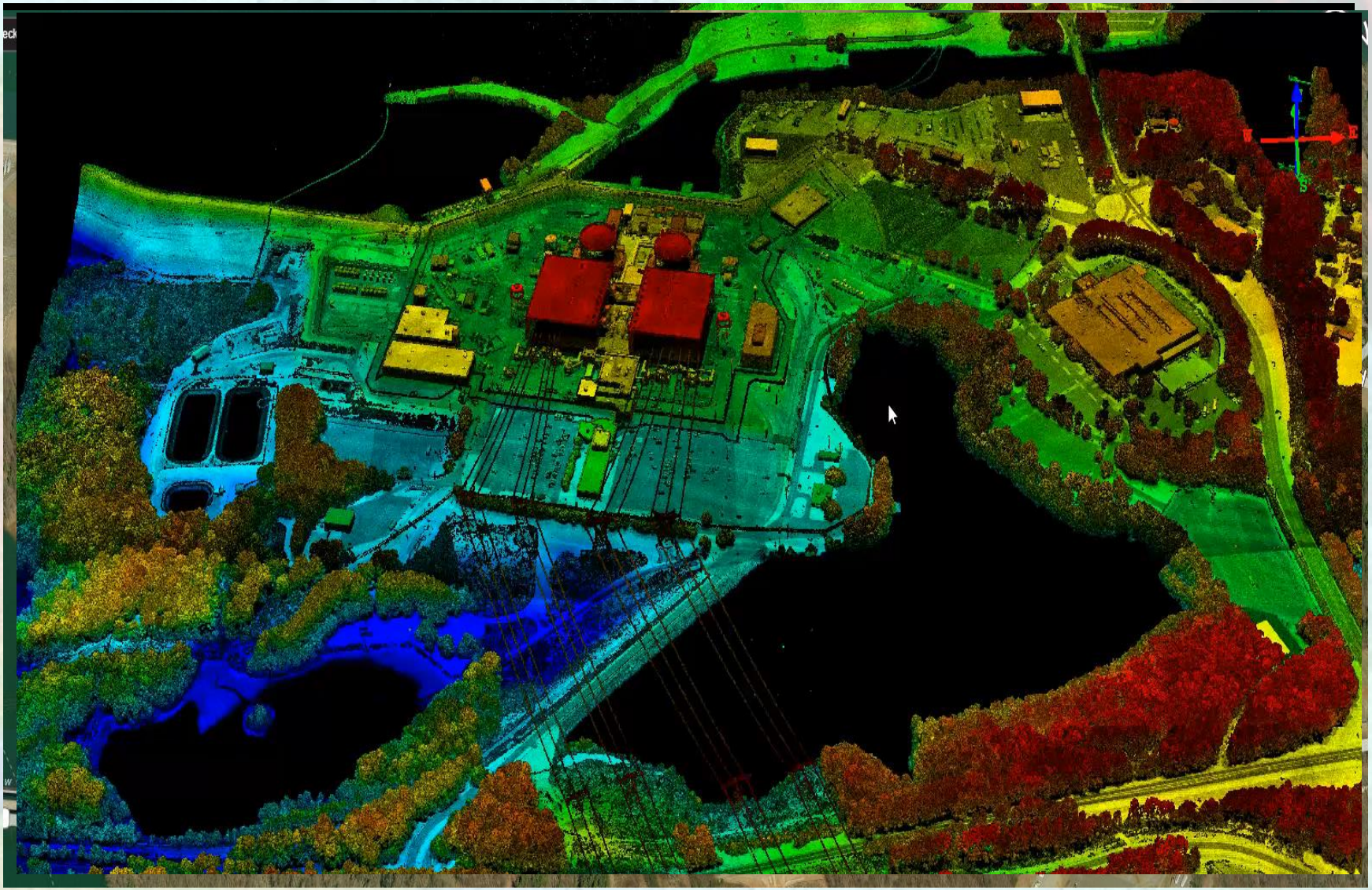


Second Generation Topography
Geiger / Photon Counting Acquisition

Geiger / Photon Counting

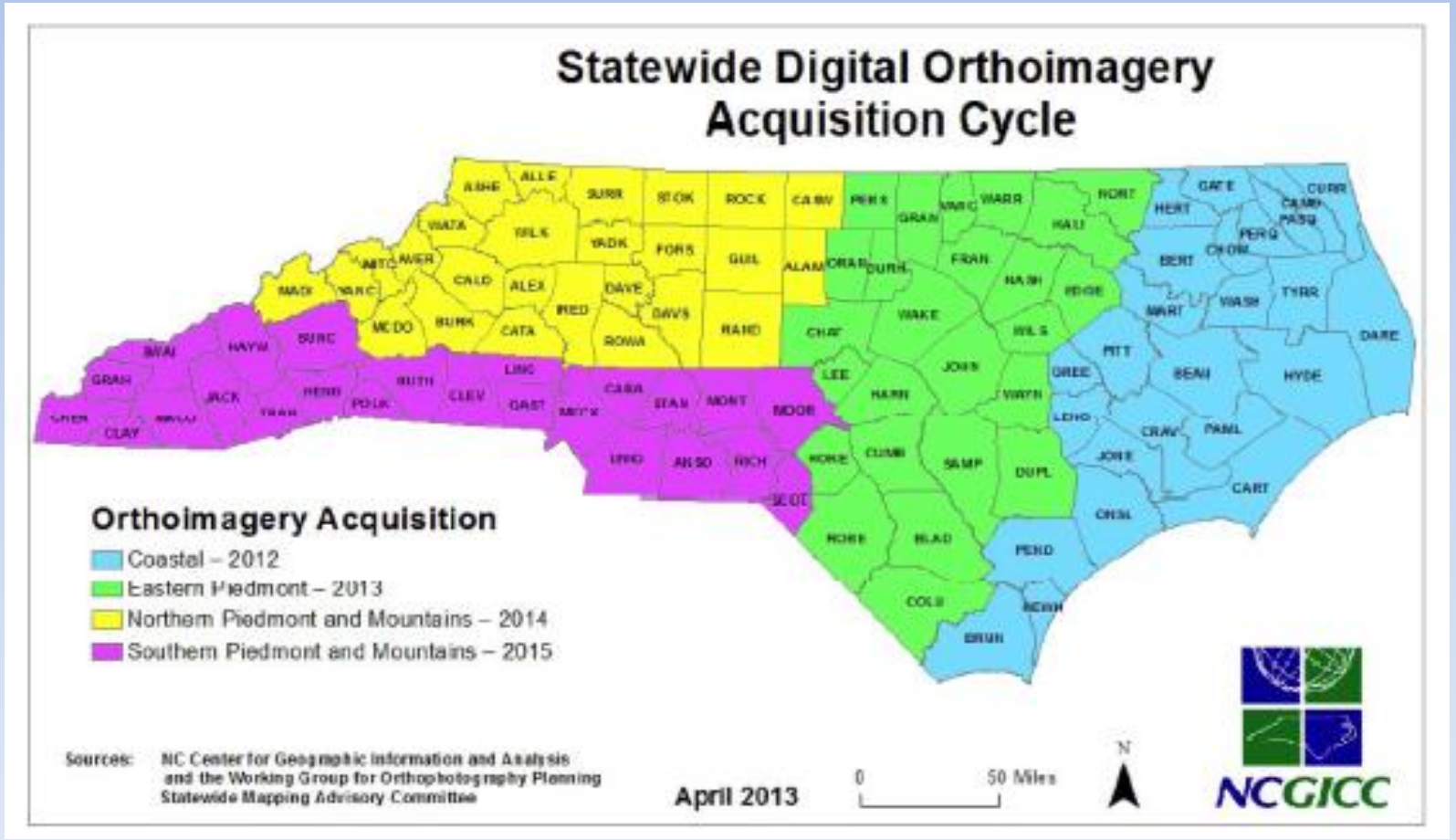
- Advancement in technology to efficiently split single pulse into 100x and receive each as unique points.
- Pilot tested in Mecklenburg County.
- 20 points per square meter with nominal post spacing of 0.7 meters.
- 8 ppm deliverable at same or reduced cost.
- Data collected will support a 9.25 cm (3.36 inches) RMSEz.

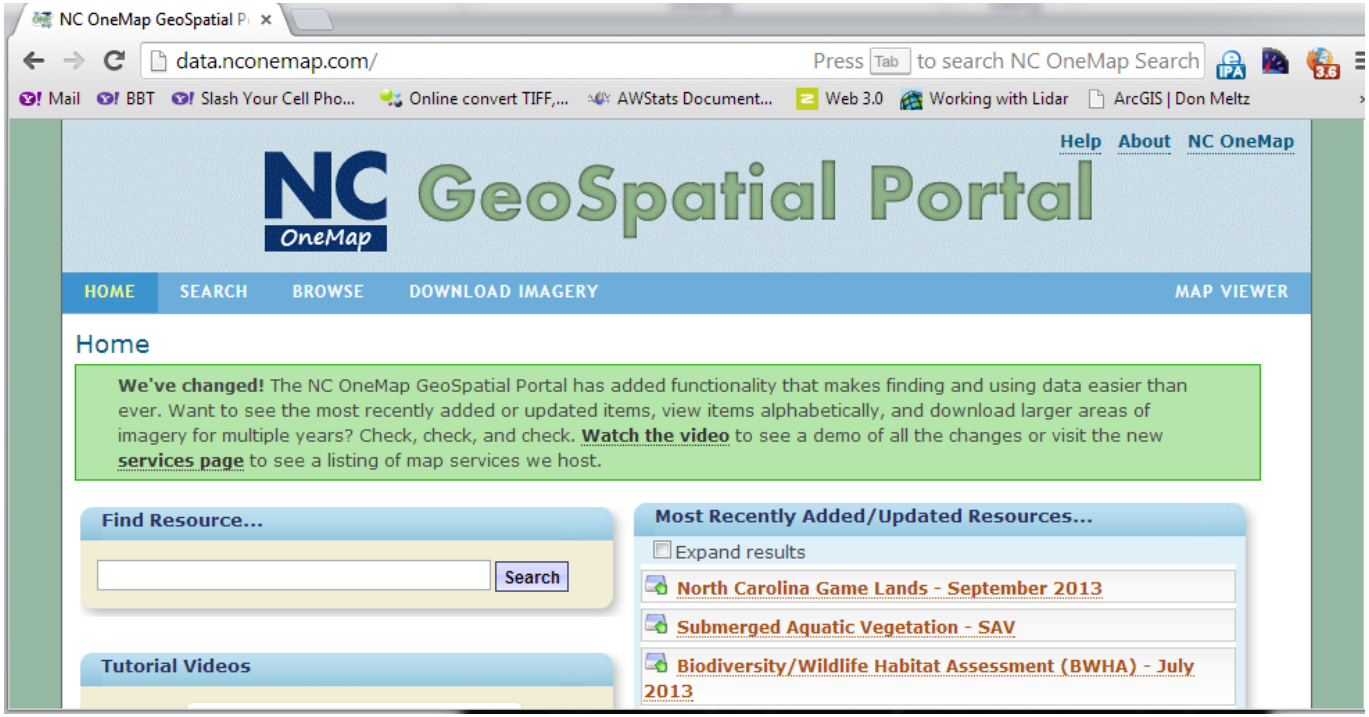




Statewide Imagery Project

North Carolina Statewide Digital Orthoimagery, Business Plan for Four-Year Acquisition and Urban Counties

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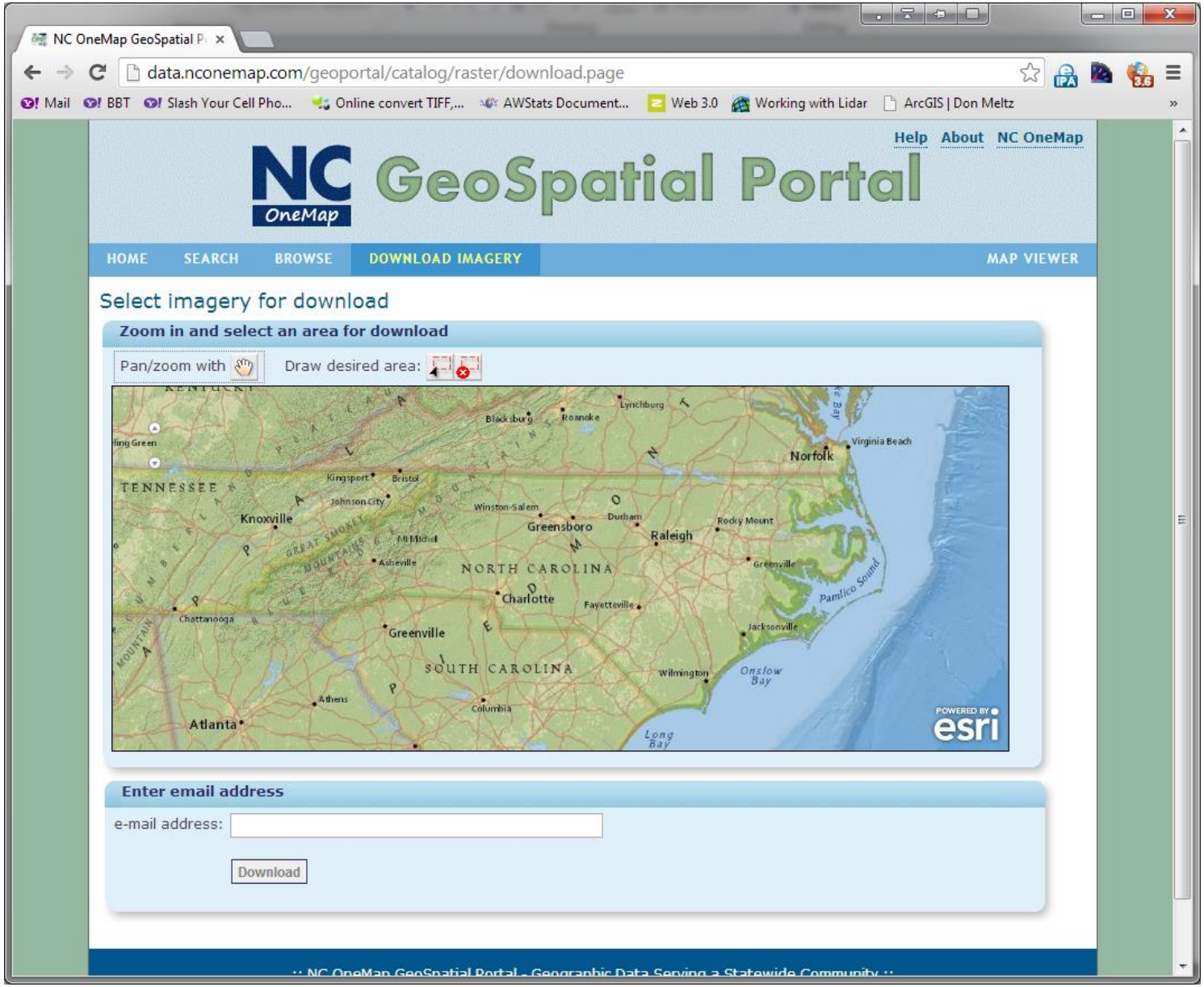
North Carolina Game Lands - September 2013
Submerged Aquatic Vegetation - SAV
Biodiversity/Wildlife Habitat Assessment (BWHA) - July 2013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Rocky Mount
Greenville
Jacksonville
Wilmington
Norfolk
Virginia Beach
Lynchburg
Roanoke
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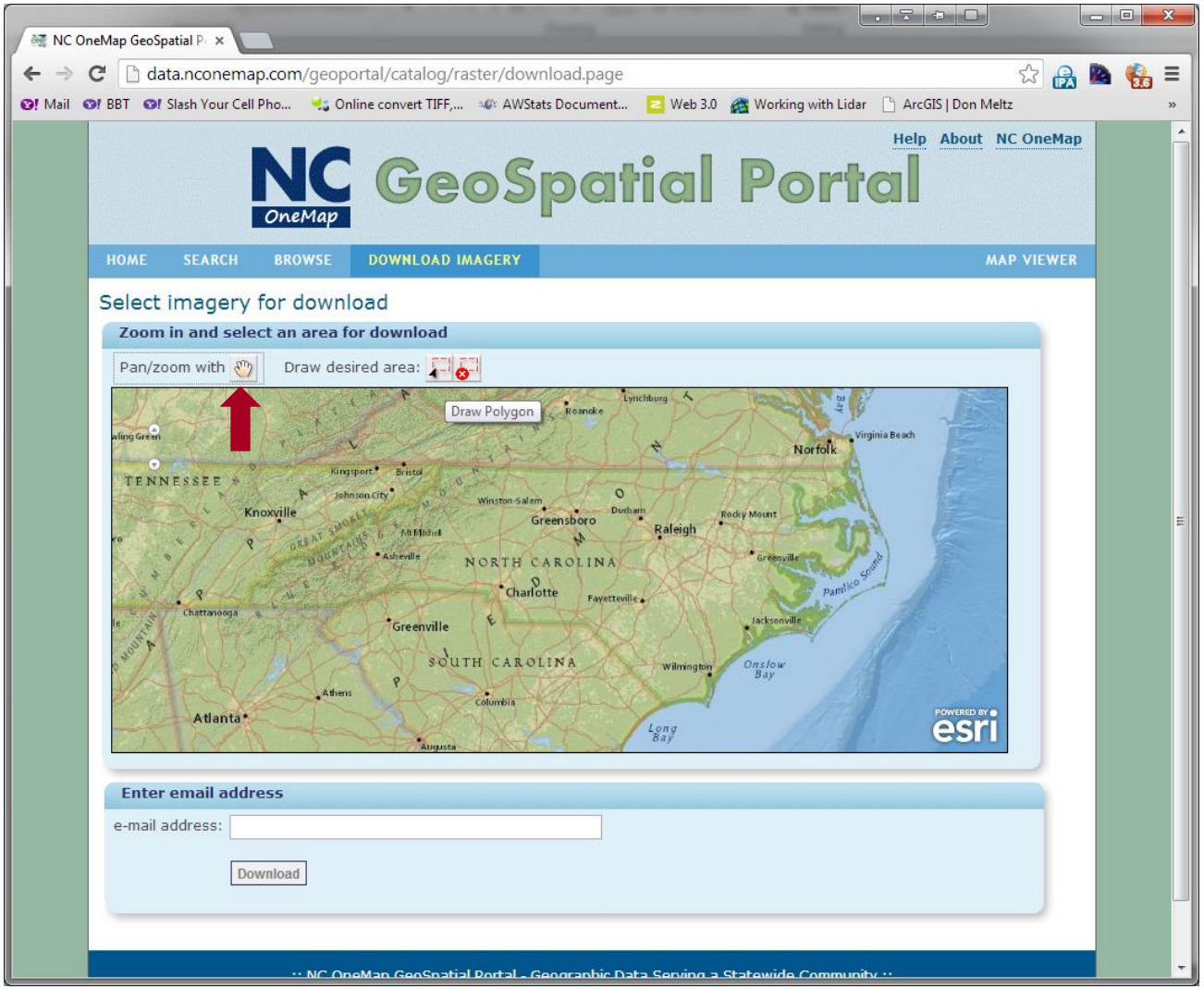
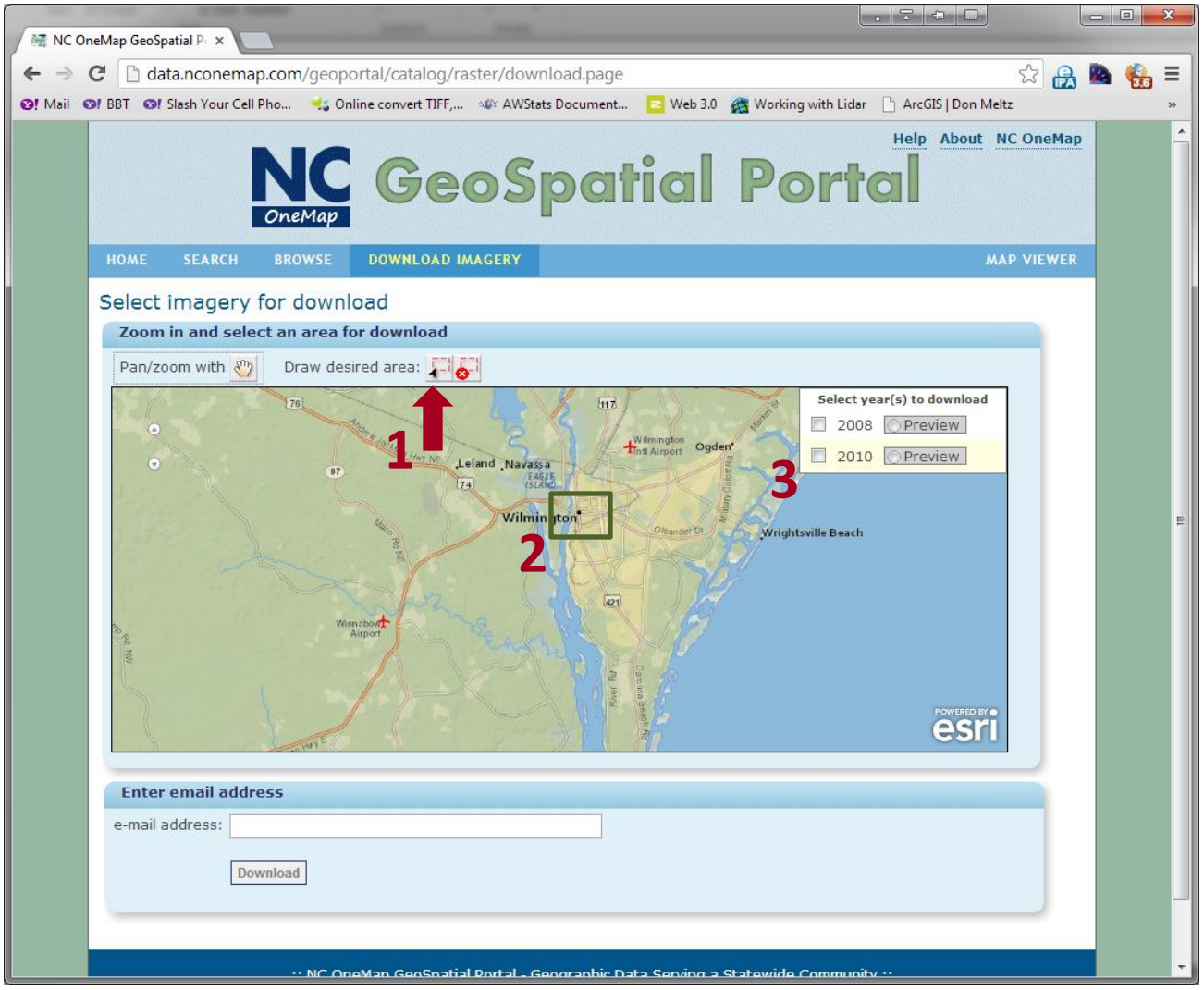
:: NC OneMap GeoSpatial Portal - Geographic Data Serving a Statewide Community ::

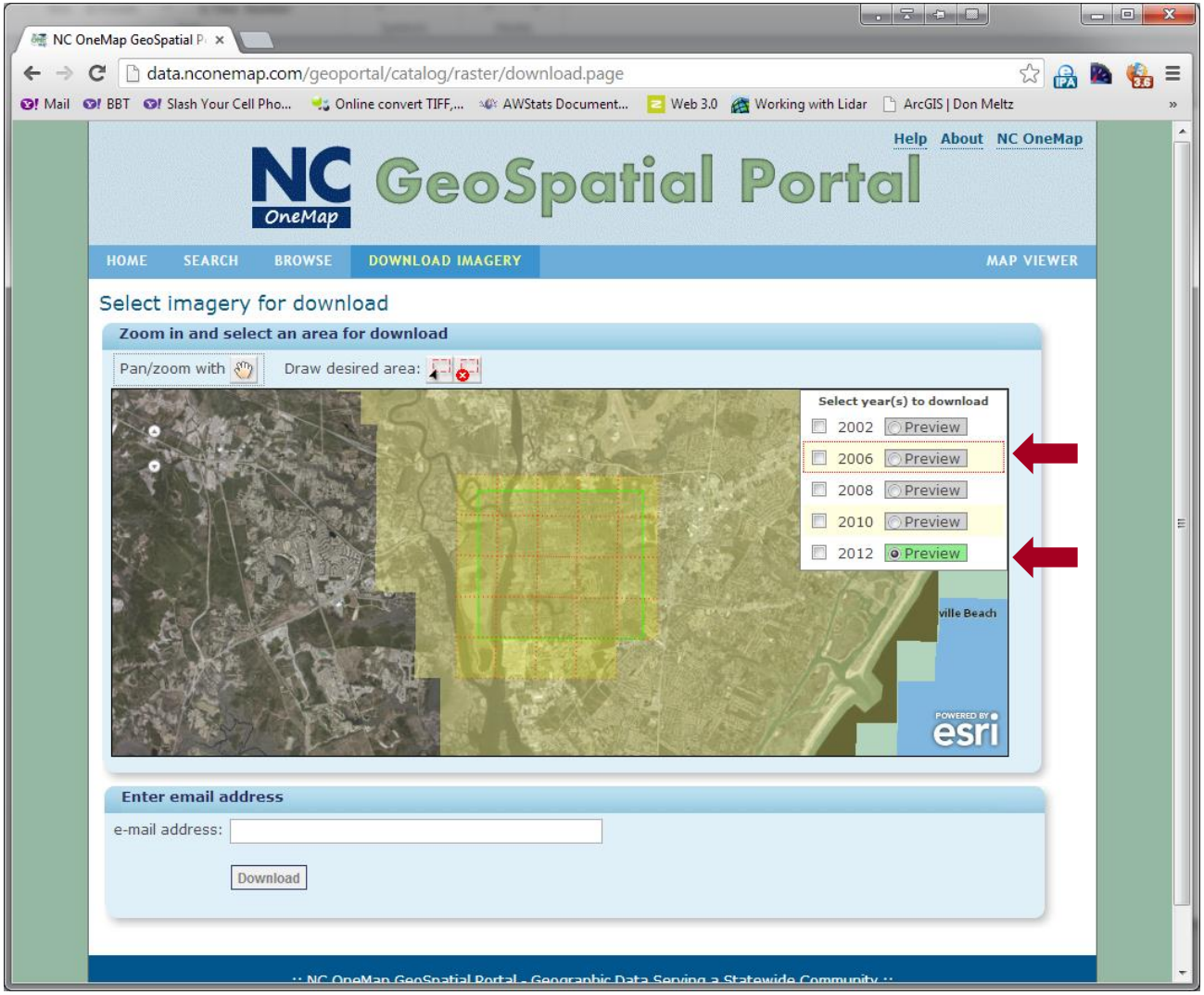
Step 1 - Zoom to area of interest (drag a box with mouse or use zoom tools



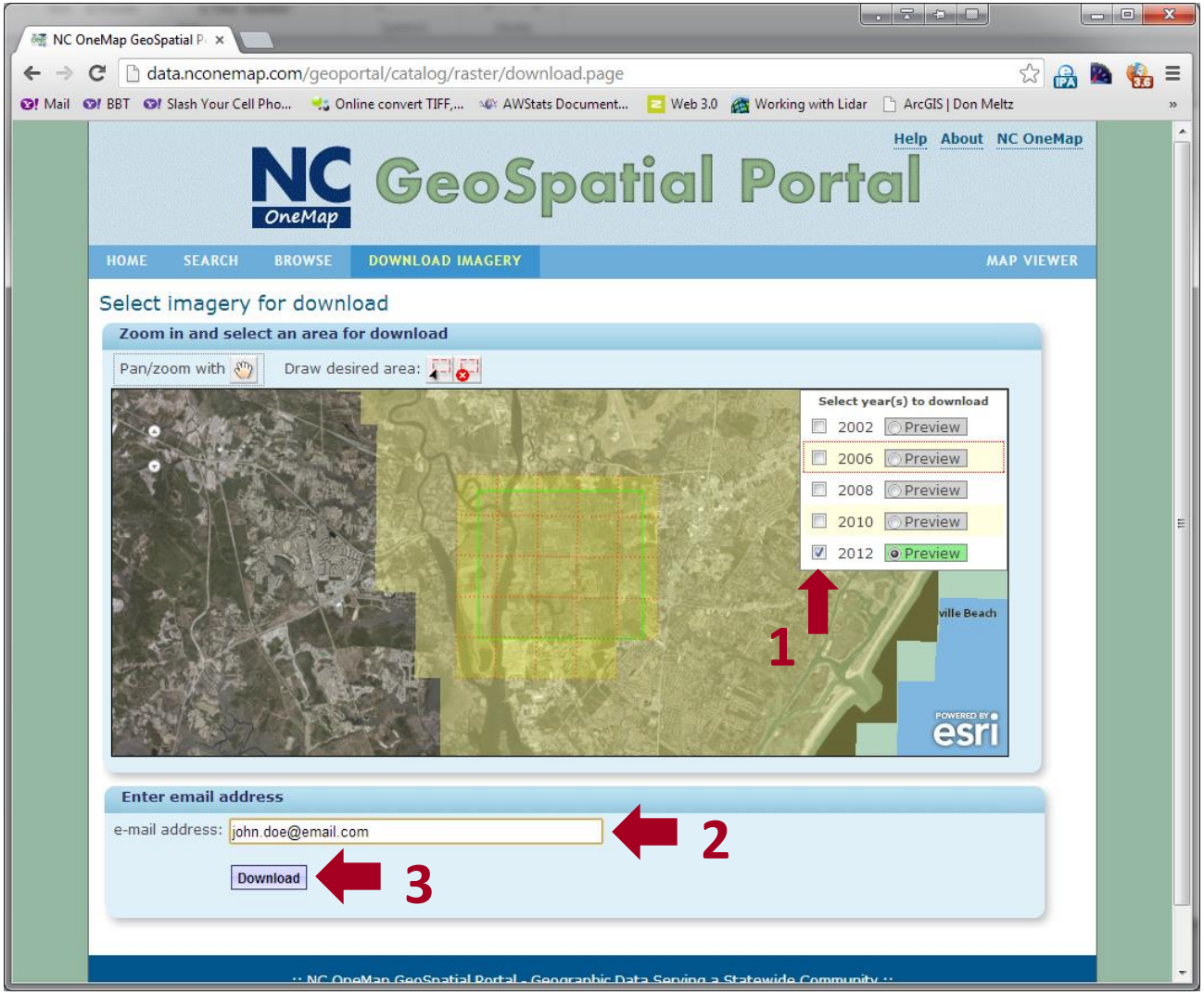
Step 2 - Get a list of available imagery by drawing a box to define the project area



Step 3 - mouse over year to see coverage extent; click respective year to preview



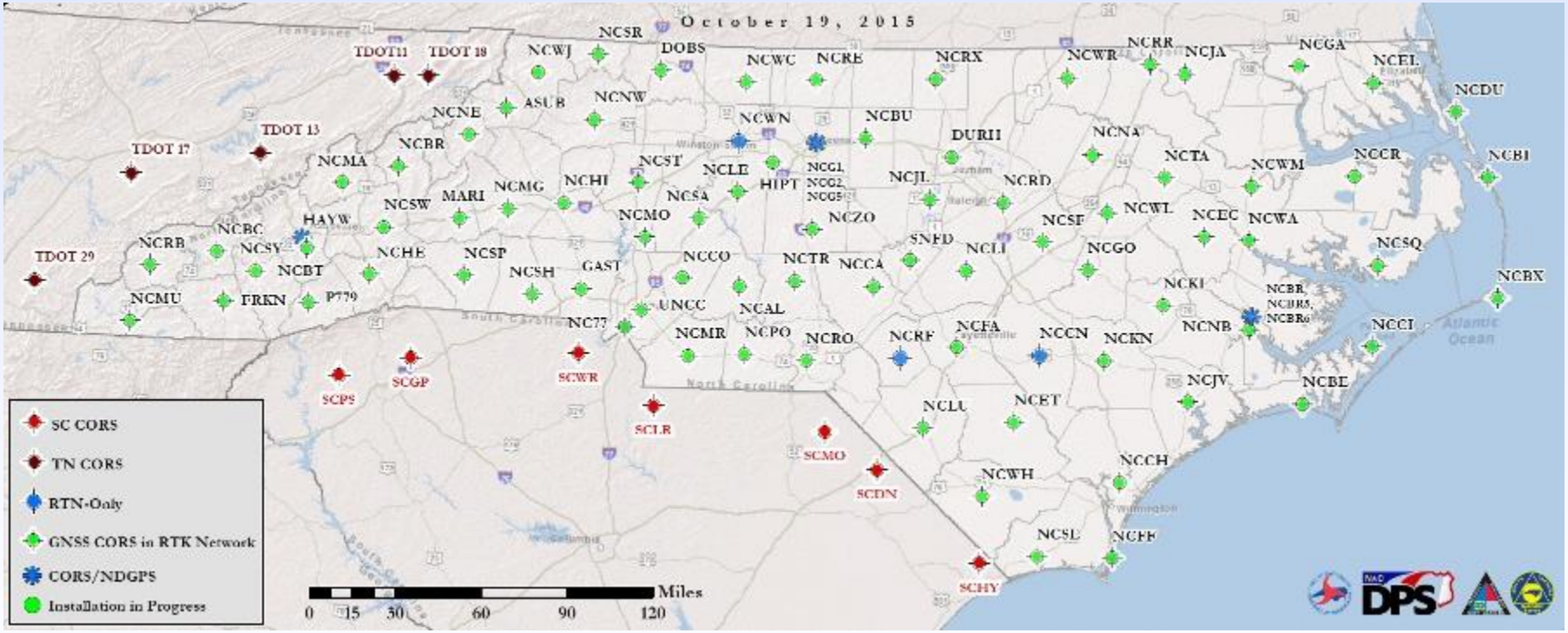
Step 4 - Select years to download, enter email address, click download



NC CORS Network

- Continuously Operating Reference Station (CORS)
  - A permanent and continuously recording Global Navigation Satellite System (GNSS) receiver, antenna (with a surveyed reference position), & support equipment
    - Composed of 94 CORS
      - 1 new CORS has been installed
        - Raeford (NCRF)
      - Receiver upgrade in 2015 at:
        - NCBI
        - NCWA
        - NCJV

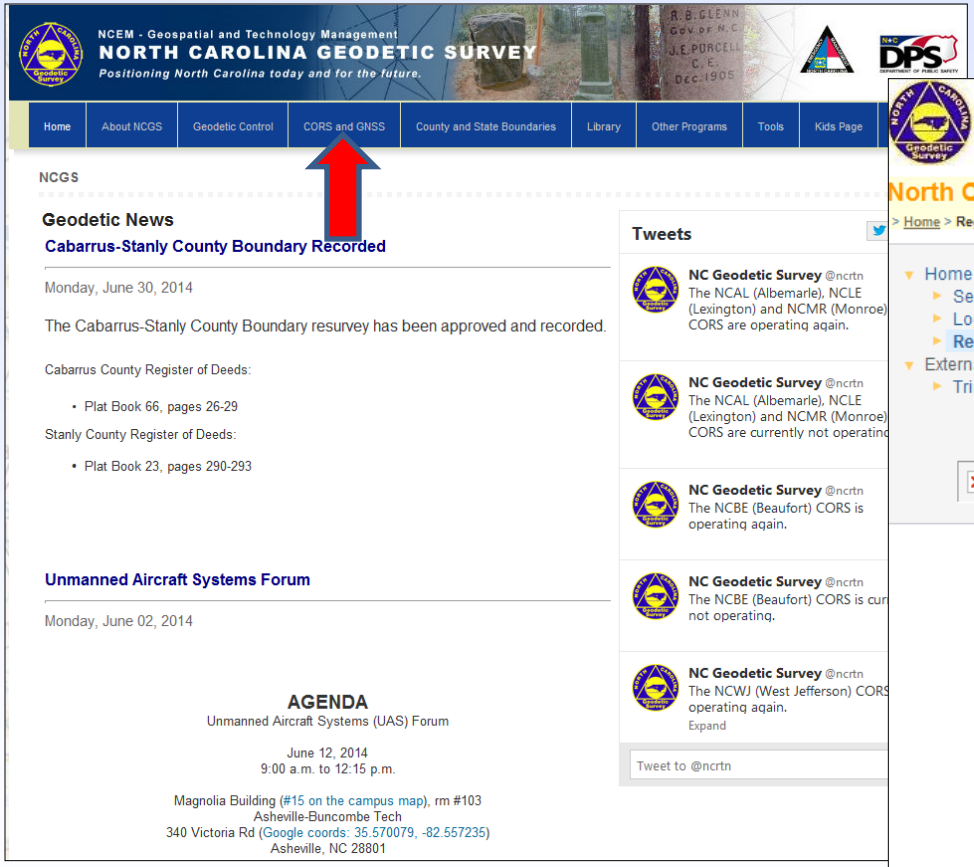
NC CORS Network

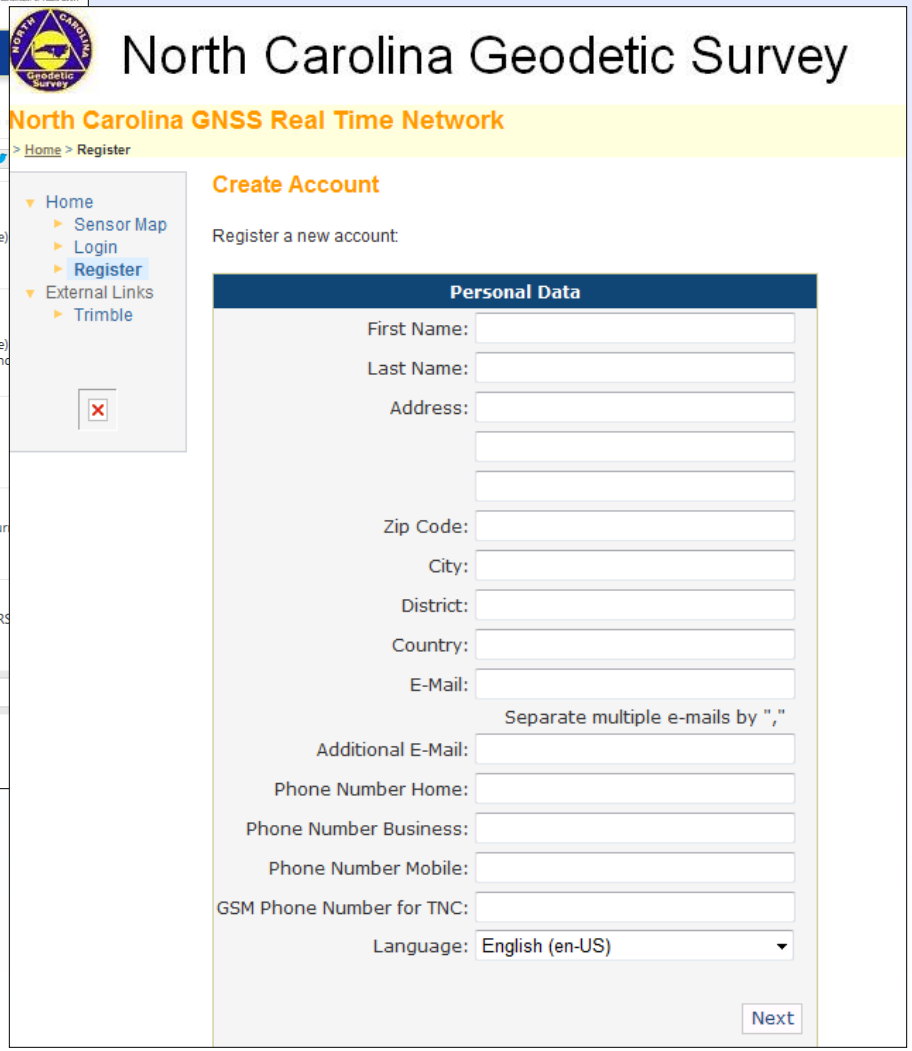


http://geodeticsurvey.nc.gov/Pages/CORS-and-GNSS.aspx

North Carolina Emergency Management

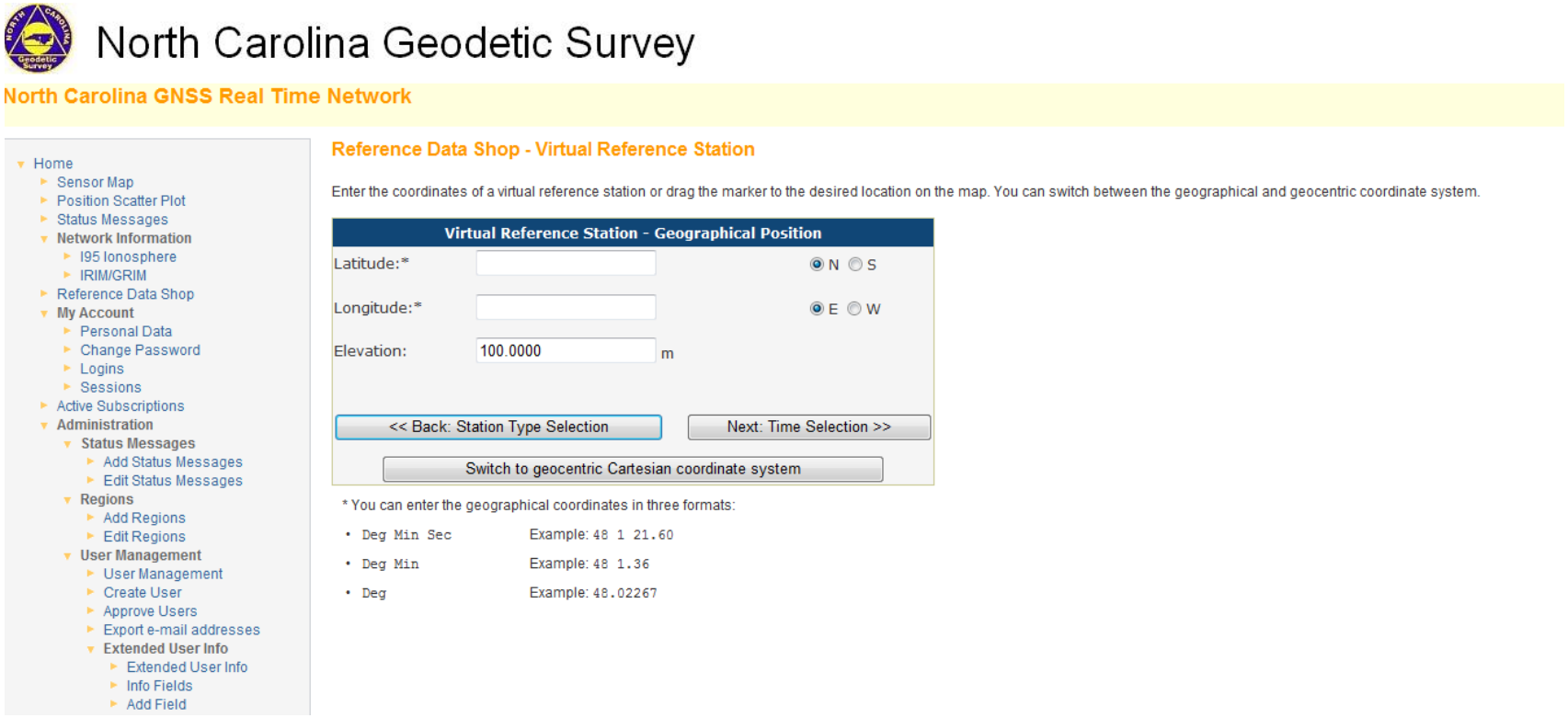
RTN port request





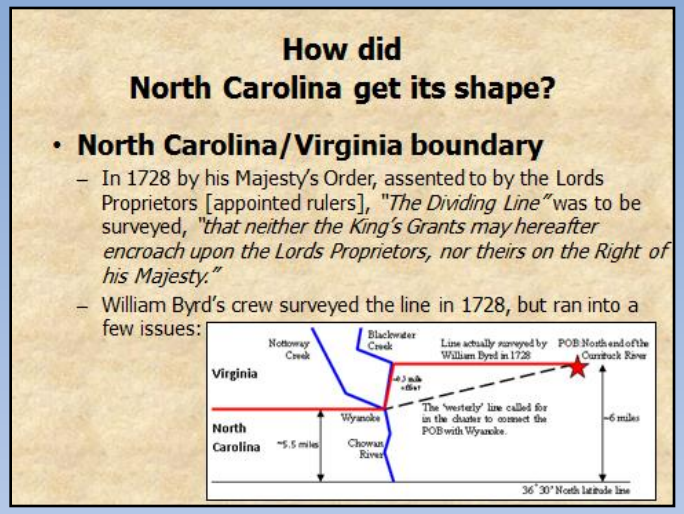
http://geodeticsurvey.nc.gov/Pages/CORS-and-GNSS.aspx

Virtual Reference Station

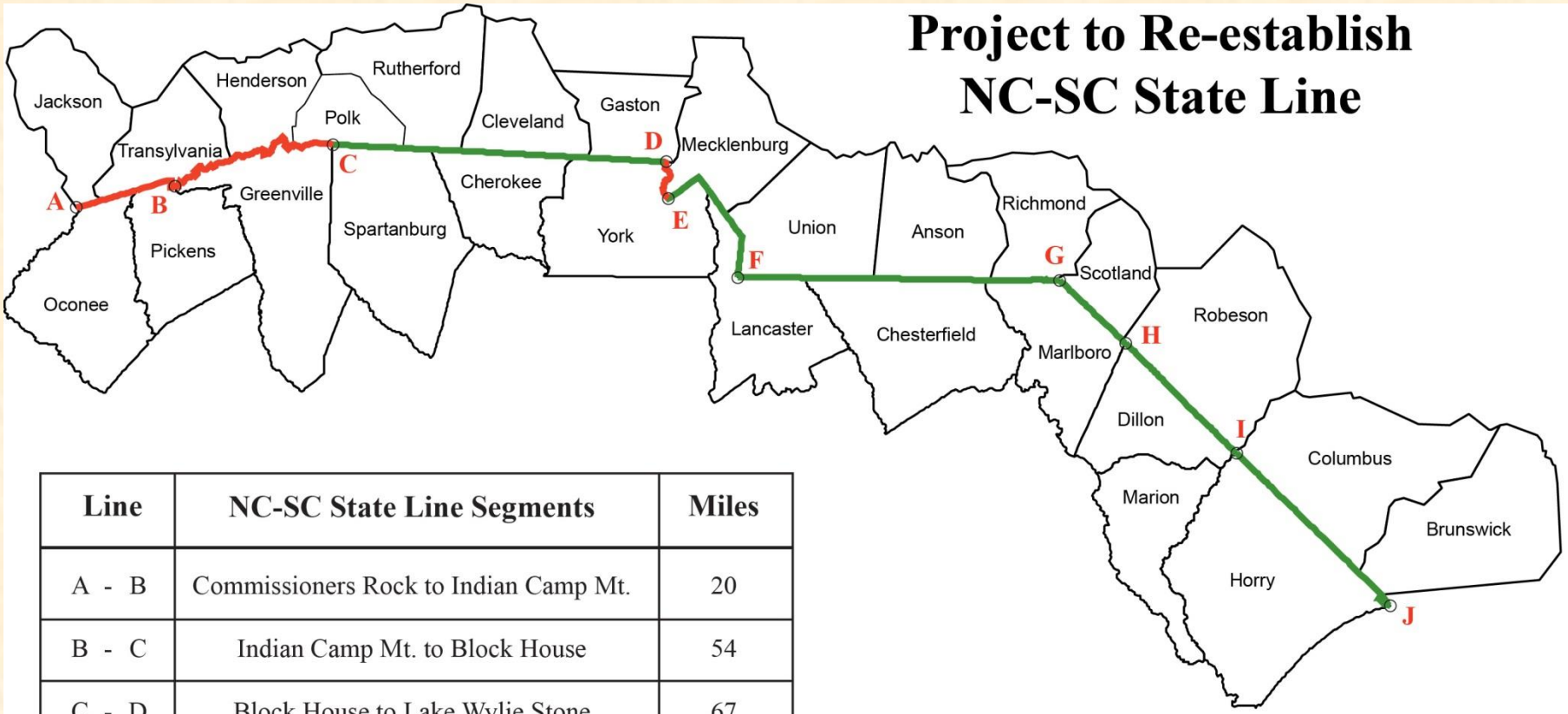


How did North Carolina get its shape?

- NC Boundary Commission recommends that we start work on the NC-VA boundary
- NC-SC boundary
  - S575 and H834



Project to Re-establish NC-SC State Line



Line	NC-SC State Line Segments	Miles
A - B	Commissioners Rock to Indian Camp Mt.	20
B - C	Indian Camp Mt. to Block House	54
C - D	Block House to Lake Wylie Stone	67
D - E	Center Line of Old Catawba River Bed	8
E - F	Lake Wylie to North Corner	30
F - G	North Corner to 1905 Marlboro County Break Point Monument	64
G - H	Marlboro County SE - NW Line	18
H - I	Dillon County Line	31
I - J	Horry County Line	42
	Total	334 miles

May 6, 2013 Status

Re-established boundary approved by the NC-SC Joint Boundary Commission — 82 miles

Re-established boundary tentatively approved by the NC-SC Joint Boundary Commission — 252 miles

County Boundary Surveys in Progress

- Mitchell-Yancey
- Cabarrus – Rowan
- Harnett – Wake
- Chatham – Harnett – Wake
- Alamance – Guilford
- McDowell – Mitchell
- Jackson – Macon
- Davie – Yadkin
- Bladen – Columbus – Brunswick
- Greene – Lenior
- Granville - Franklin

NC General Statutes on county boundaries

- **G.S. § 153A-17. Existing boundaries.**
  The boundaries of each county shall remain as presently established, until changed in accordance with law. (1973, c. 822, s. 1.)

- **G.S. § 153A-18. Uncertain or disputed boundary.**
  Provides directions and procedures for resurveying uncertain or disputed county boundary lines.

If adjacent counties along a boundary elect to change the county line from its original location (as defined by law), then ratification by the NC General Assembly is required.

G.S. 153A-18(a)
Resurvey of an uncertain county line

- Two or more counties may cause the boundary to be surveyed, marked, and mapped
- The participating counties may appoint special commissioners to supervise the surveying, marking, and mapping

Upon request of each county along the uncertain/ambiguous county line, the NC Geodetic Survey can provide assistance with resurveying the county line.

G.S. 153A-18(a)
Resurvey of an uncertain county line

- Each of the participating county's Board of Commissioners must ratify the resurvey with a resolution
- Each of the participating county's ratification resolution must be referenced on the map of resurvey with the following information: date & minutes page
- The map of resurvey must be recorded in:
  - Each of the participating county's Register of Deeds office
  - Secretary of State's office

Acceptance or Redefining

- **The participating counties may elect to either:**
  - Accept the resurvey line

    ~ or ~

  - Redefine the line (change) through legislative process

Overview of New Datums

Scott Lokken
NC Advisor

Gary Thompson
Chief, NC Geodetic Survey

NOAA's National Geodetic Survey

New Datums are Coming in 2022!

- Both a new geometric and a new geopotential (vertical) datum will be released in 2022.
- The realization of the new datums will be through GNSS receivers.
- NGS will provide the tools to easily transform between the new and old datums.

Why change datums/Realizations

- NAD27 based on old observations and old datum
- NAD83(86) based on old observations and new datum
- NAD83(95) based on new and old observations and same datum (original HARN)
- NAD83(2001) based on better observations and same datum
- NAD83(NSRS2007) based on new observations and same datum. Removed regional distortions and made consistent with CORS
- NAD83(2011) based on new observations and same datum. Consistent with new Multi Year CORS solution

NEW STANDARDS FOR GEODETIC CONTROL

TWO ACCURACY STANDARDS

local accuracy ---------- adjacent points
network accuracy ---------- relative to CORS

Numeric quantities, units in cm (or mm)
Both are relative accuracy measures
Do not use distance dependent expression
Horizontal accuracies are radius of 2-D 95% error circle
Ellipsoidal/Orthometric heights are 1-D (linear) 95% error

The NSRS has evolved

1 Million Monuments (Separate Horizontal and Vertical Systems) → 70,000 Passive Marks (3-Dimensional)

Passive Marks (Limited Knowledge of Stability) → ≈ 2,000 GPS CORS (Time Dependent System Possible; 4-Dimensional)

GPS CORS → GNSS CORS

ITRF2008

For the geodesy, geophysics and surveying communities, the best International Terrestrial Reference Frame is the "gold standard."

The global community recently adopted an updated expression for the reference frame, the ITRF2008.

International Earth Rotation and Reference System Service (IERS)

(http://www.iers.org)

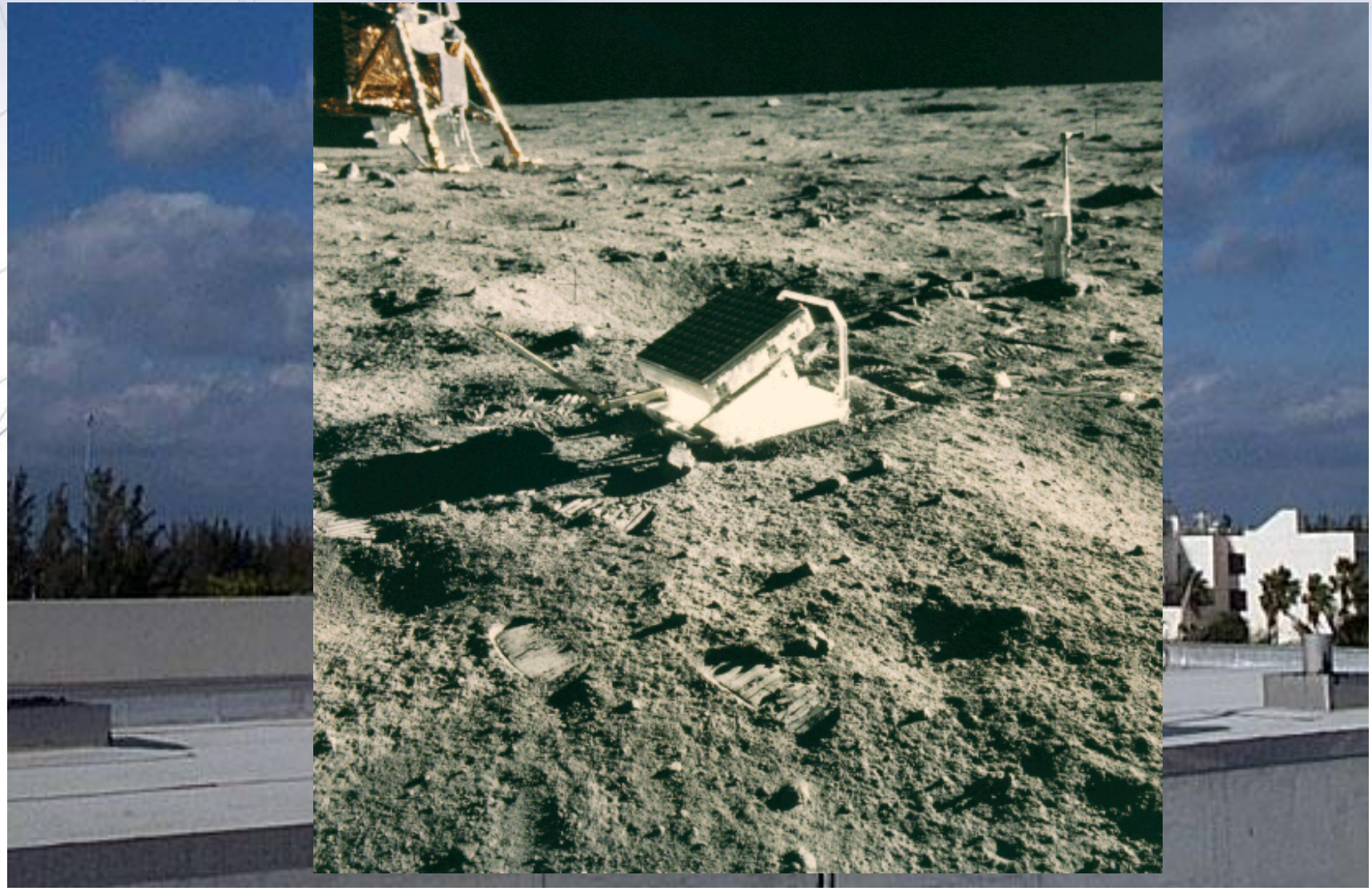
The International Terrestrial Reference System **(ITRS)** constitutes a set of prescriptions and conventions together with the modeling required to define origin, scale, orientation and time evolution

ITRS is realized by the International Terrestrial Reference Frame (**ITRF**) based upon estimated coordinates and velocities of a set of stations observed by:
-Very Long Baseline Interferometry (**VLBI**),
-Satellite Laser Ranging (**SLR**),
-Global Positioning System and GLONASS (**GNSS**), and
-Doppler Orbitography and Radio- positioning Integrated by Satellite (**DORIS**).

ITRF89, ITRF90, ITRF91, ITRF92, ITRF93, ITRF94, ITRF95, ITRF96, ITRF97, ITRF2000, ITRF2005, ITRF2008

International Terrestrial Reference Frame

4 Global Independent Positioning Technologies



GEODETIC DATUMS

HORIZONTAL

2 D (Latitude and Longitude) (e.g. NAD 27, NAD 83 (1986))

VERTICAL

1 D (Orthometric Height) (e.g. NGVD 29, NAVD 88, Local Tidal)

GEOMETRIC

3 D (Latitude, Longitude and Ellipsoid Height)

Fixed and Stable - Coordinates seldom change

(e.g. NAD83(1995), NAD83(NSRS2007), NAD83(CORS96), NAD83(2011))

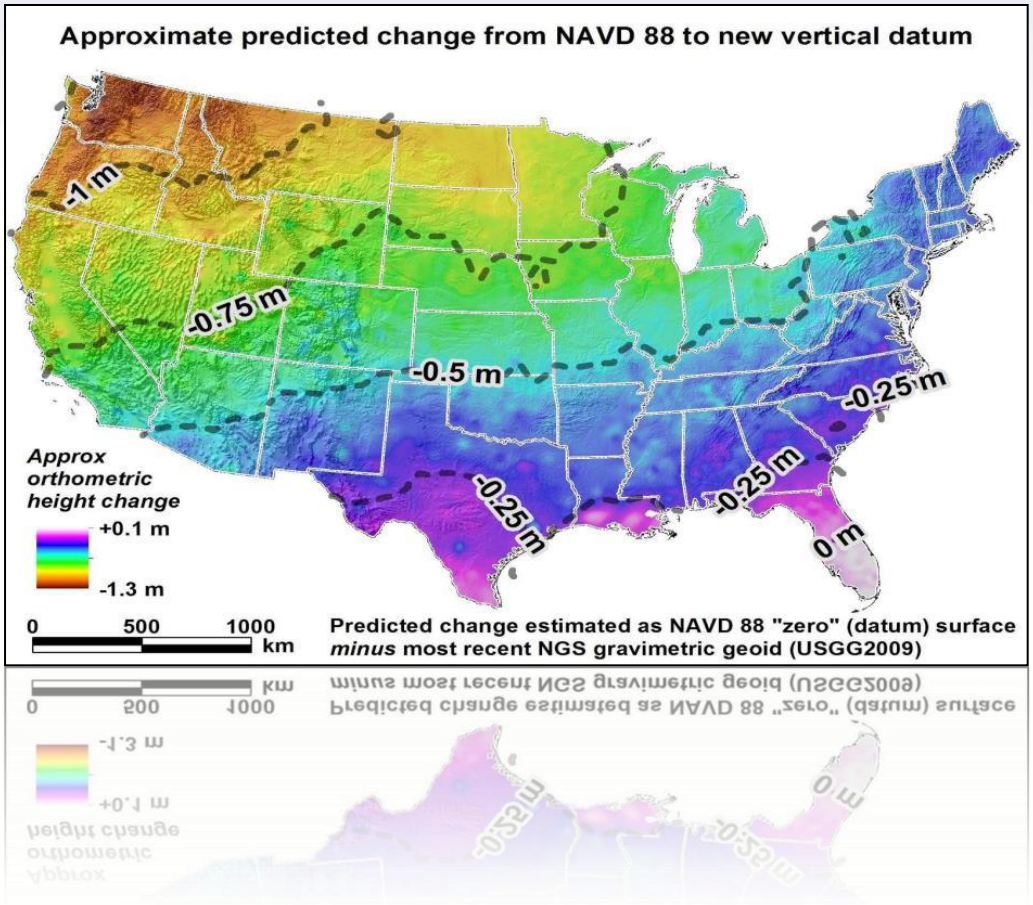
also

4 D (Latitude, Longitude, Ellipsoid Height, Velocities) Coordinates change with time

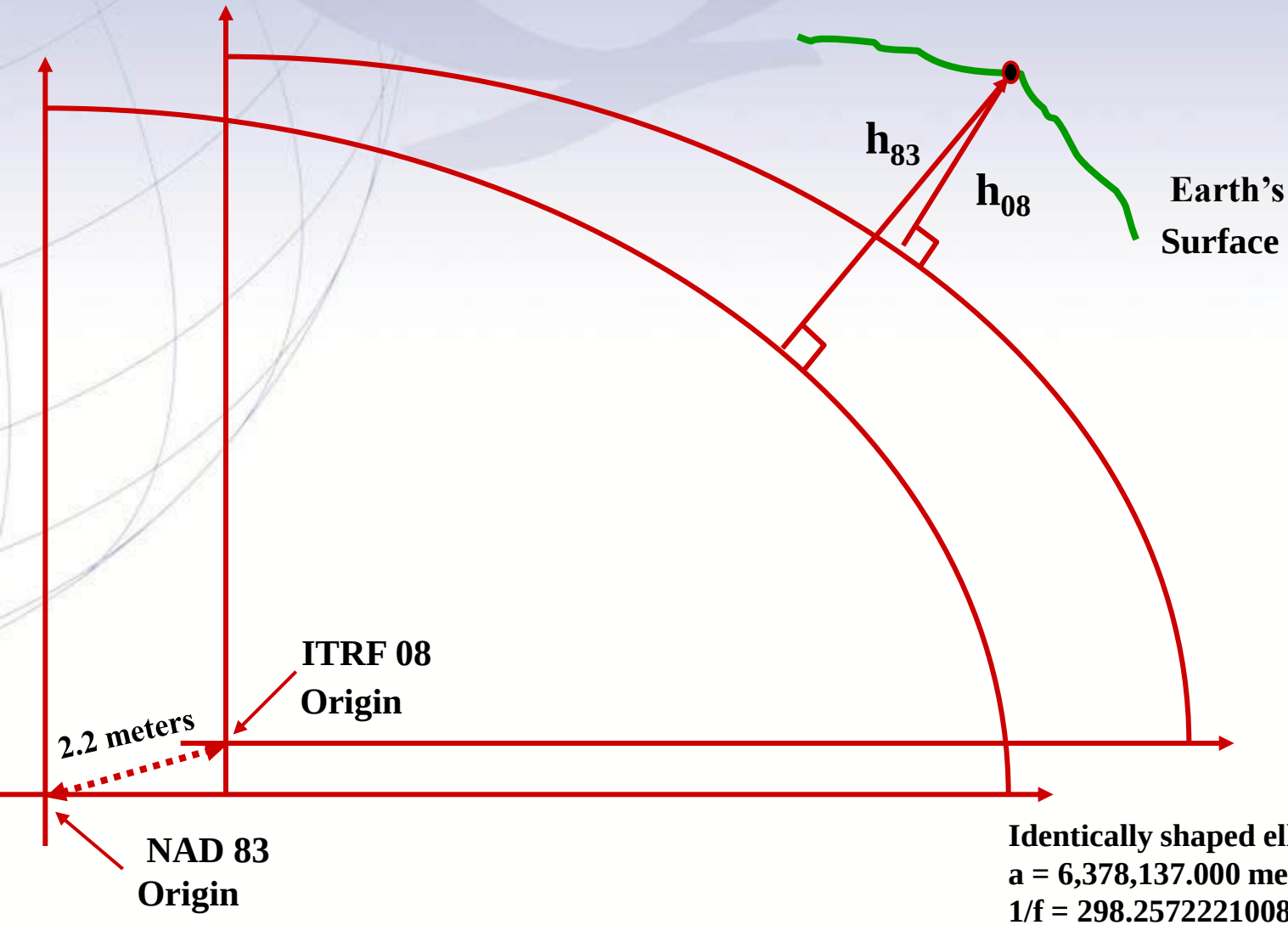
(e.g. ITRF00, ITRF08)

How will the new datums affect you?

- The new geometric datum will change latitude, longitude, and ellipsoid height by between 1 and 2 meters.
- The new vertical (geopotential) datum will change heights on average 50 cm (20"), with a 1 meter (39") tilt towards the Pacific Northwest.



Simplified Concept of NAD 83 vs. ITRF08



Identically shaped ellipsoids (GRS-80)
a = 6,378,137.000 meters (semi-major axis)
1/f = 298.25722210088 (flattening)

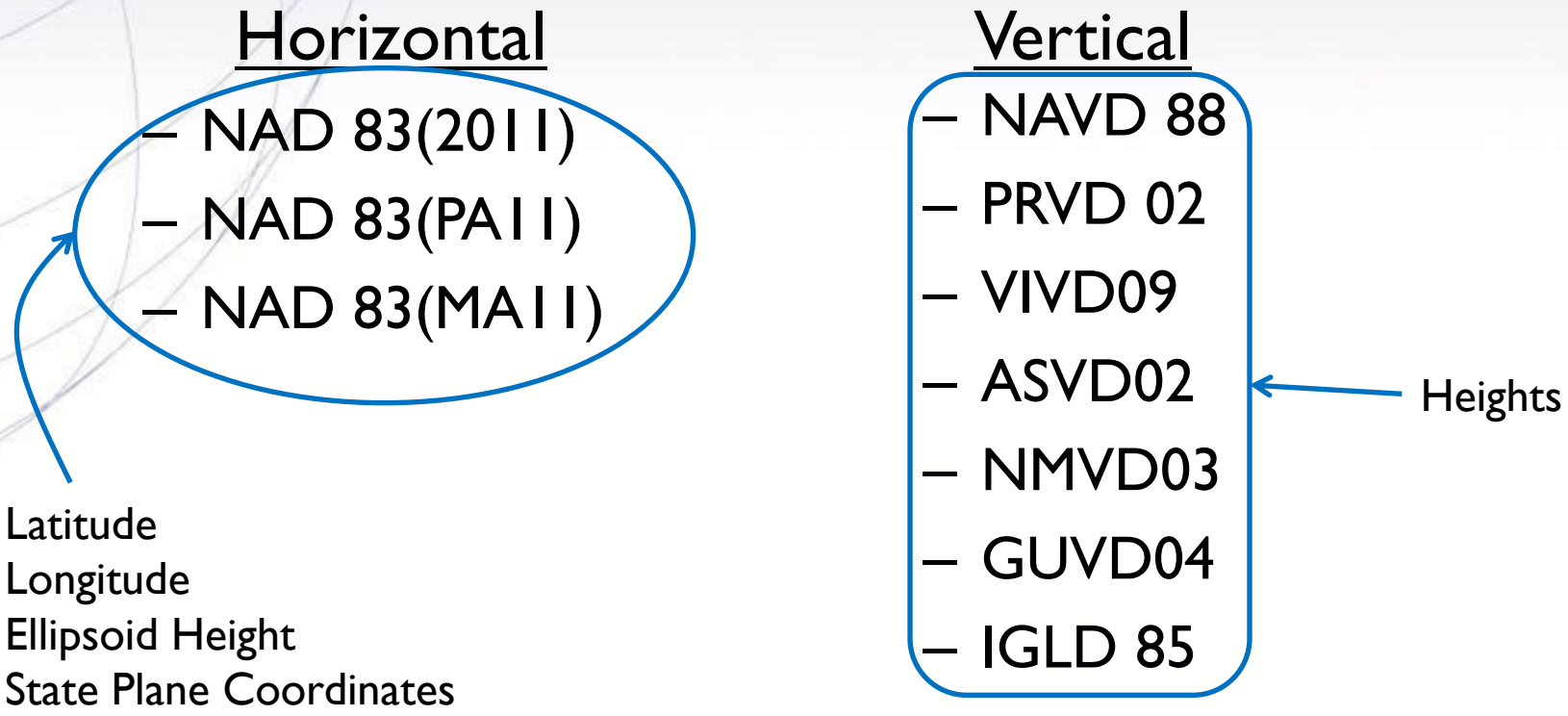
Questions: Themes

The questions provided to NGS fall into 3 major categories:

- Datum adoption
  - Speed, legal issues, impacts, transformations
- Datasheets
- State Plane Coordinates

Old vs New Datums

- What's being replaced:



Old vs New Datums

- The old way

Text based datasheets

```
NAD 83(2011) POSITION- 40 03 10.11448(N) 082 58 34.91800(W)    ADJUSTED
NAD 83(2011) ELLIP HT-   239.400 (meters)         (06/27/12)   ADJUSTED
NAD 83(2011) EPOCH    -  2010.00
NAVD 88 ORTHO HEIGHT -   273.3    (meters)       897.     (feet) GPS OBS
```

Observed changes viewed as "corrections" not "movement"

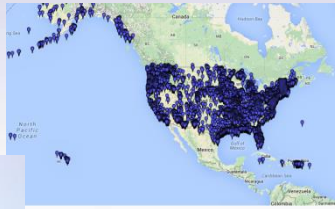
```
                        SUPERSEDED SURVEY CONTROL

NAD 83(2007)-  40 03 10.11456(N)     082 58 34.91884(W) AD(2002.00) 0
ELLIP H (02/10/07)  239.418  (m)                        GP(2002.00)
ELLIP H (03/08/05)  239.413  (m)                        GP(       ) 4 2
NAD 83(1995)-  40 03 10.11462(N)     082 58 34.91855(W) AD(       ) B
ELLIP H (08/20/96)  239.417  (m)                        GP(       ) 4 2
NAD 83(1986)-  40 03 10.12158(N)     082 58 34.92303(W) AD(       ) 1
NAD 27      -  40 03 09.89400(N)     082 58 35.26500(W) AD(       ) 1
NGVD 29 (09/26/89)  273.5    (m)  RAPSU86 model used    GPS OBS
```

Fragile, unchecked passive control

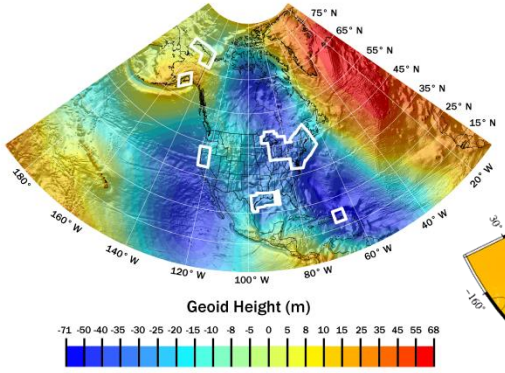
- The new way

Modern datasheets

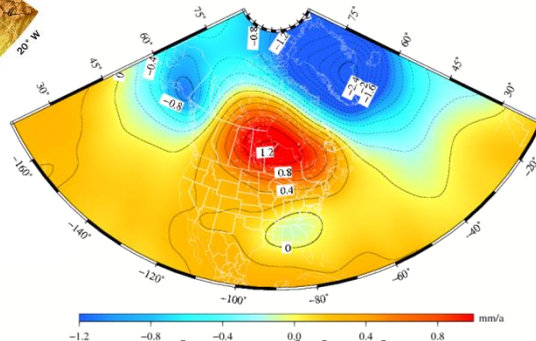


CORS

RTN



Geoid



Temporal Geoid Change

Terminology

- ~~Horizontal Datum~~
  - Geometric Reference Frame
    - Geocentric X, Y, Z
    - Latitude, Longitude, Ellipsoid Height
- ~~Vertical Datum~~
  - Geopotential Reference Frame
    - Geoid undulation
    - Orthometric height
    - Gravity
    - Deflection of the Vertical

Old vs New Datums

- Step 1: Do the best scientific positioning work we can in ITRF
  - Before any discussion of "plate fixed" or "map projections"
  - NGS's core goal must be the *scientific integrity of positions*
  - **New database**
  - **Replacement of static vector-based GNSS processing**

Old vs New Datums

- Step 2: Consider the question of "plate fixed":
  - Why do users want this?
    - Fixed latitude and longitude?
  - Nothing is "fixed" though
    - Plate is not just rotating; more than 1 plate
  - Who wins? Who defines "fixed"? Must all points maintain zero change?
    - Model and remove all real motion? (aka "HTDP")
      - If not removing *all* motion, why remove *any* motion?
        - » ITRF minus plate rotation vs just ITRF

State Plane Coordinates

- Barring user-requested changes, NGS may use existing SPC projections, boundaries and equations, but with new false northings & eastings (to distinguish from NAD 27 and NAD 83)

- User-provided plug-ins (pre-written code) for SPC or other projections may be possible

Tools for Transitioning

Geocon/Geocon11

News Item

National Geodetic Survey

Tuesday, August 12, 2014

NGS Announces Joint Release of GEOCON v1.0 and GEOCON11 v1.0

NGS is pleased to release two related products: **GEOCON v.1.0** and **GEOCON11 v1.0**. Each product transforms coordinates between specific realizations of the North American Datum of 1983 (NAD 83).

GEOCON v1.0 allows users to transform latitudes, longitudes, and ellipsoid heights between NAD 83("HARN") and NAD 83(NSRS2007). (NAD 83["HARN"] is an abbreviation for "the most recent pre-NSRS2007 realization of NAD 83 at any given point.") GEOCON also issues information about the quality of the transformation at each point and notifies users in the event of poor quality results.

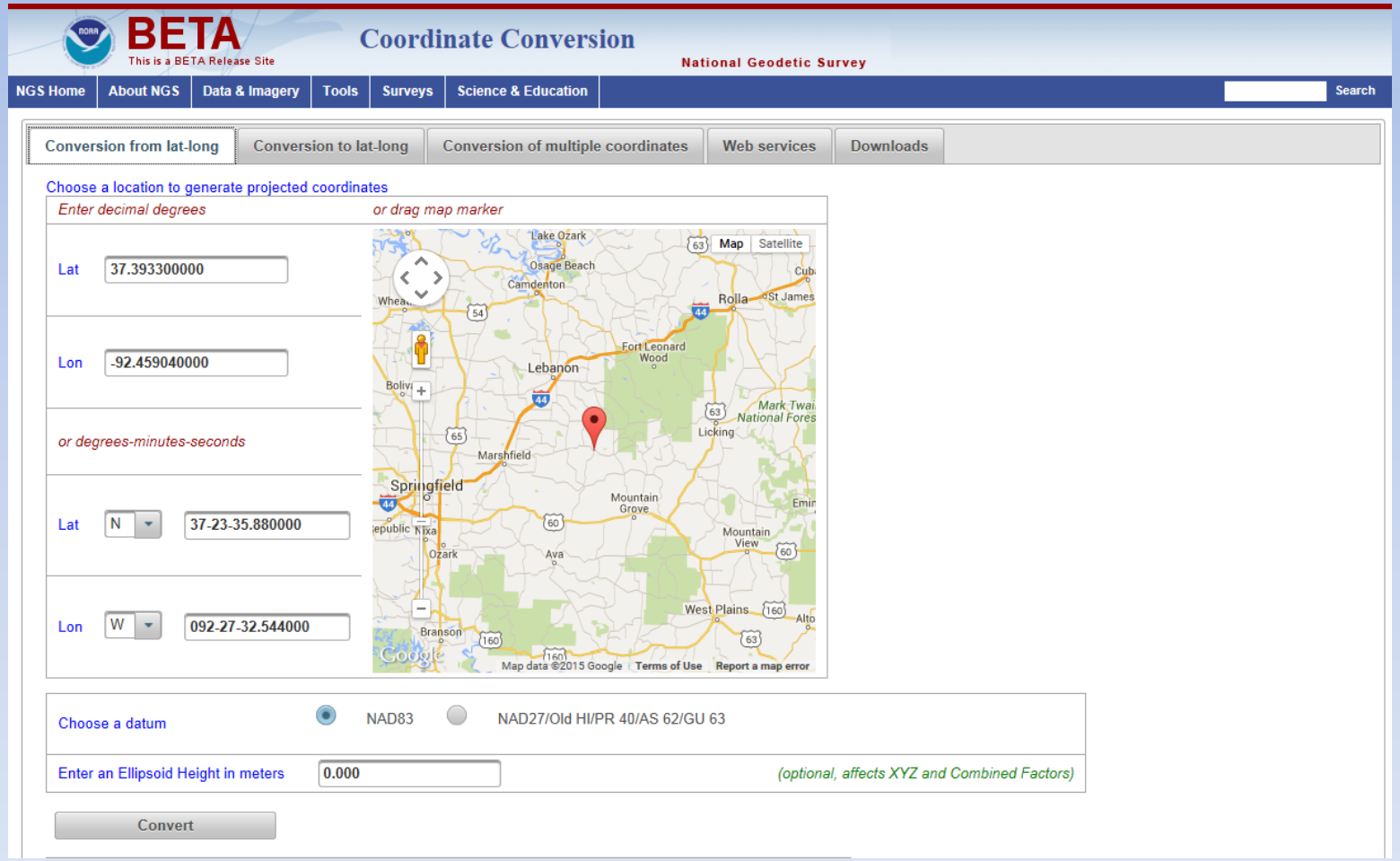
GEOCON11 v1.0 performs a similar task as GEOCON, but it transforms coordinates between NAD 83(NSRS2007) and NAD 83(2011). Similar to GEOCON, GEOCON11 issues information regarding the quality of the transformations to users.

You may find more information about **GEOCON v1.0** and **GEOCON 11 v1.0**, including operator and user guides, technical reports, and download instructions on the NGS website at: **http://www.ngs.noaa.gov/GEOCON/**. Information on **GEOCON11 v1.0** can be found at the above link or at: **http://www.ngs.noaa.gov/GEOCON11/**.

For more information, contact: **Dru Smith**

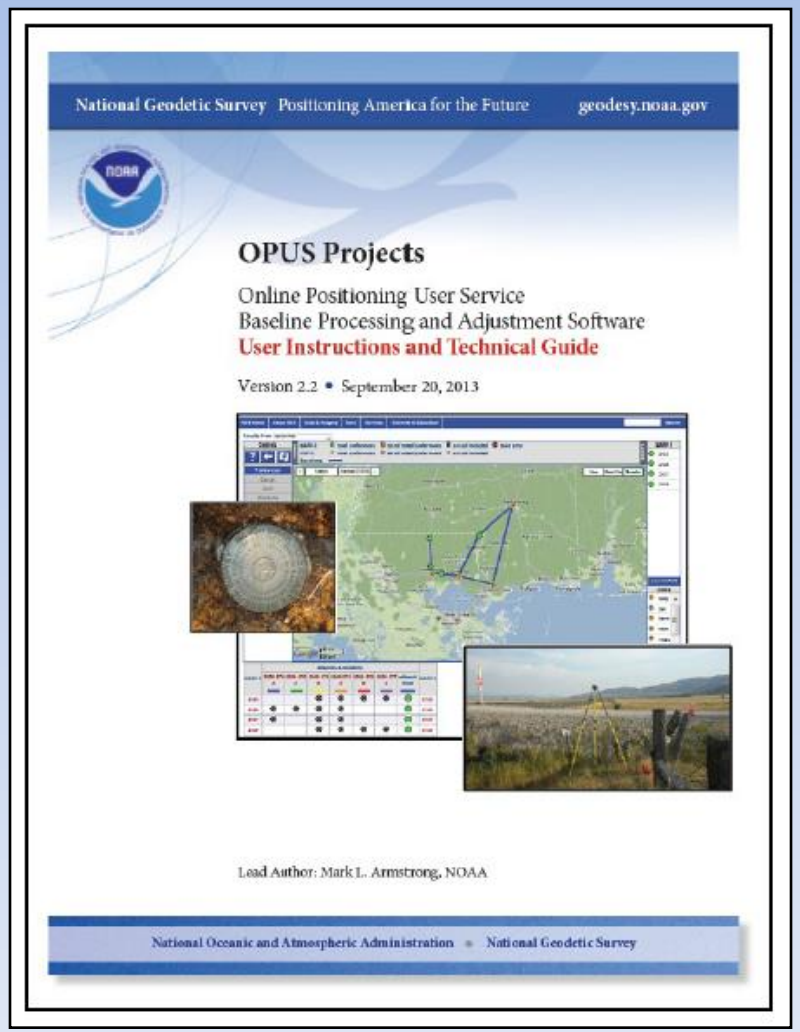
Website Owner: National Geodetic Survey / Last modified by NGS.webmaster Aug 12 2014

NGS Coordinate Conversion Tool



http://beta.ngs.noaa.gov/gtkweb/

OPUS Projects



Adoption and Outreach

Adoption: Legal / Feds

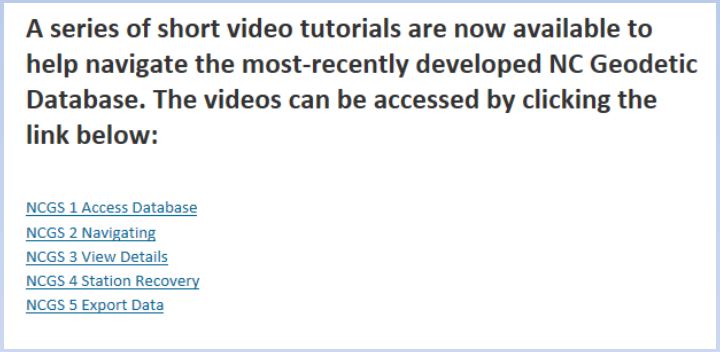
- The datums will be official once the FGCS approves them
- OMB A-16 then requires all federal, civil agencies to transition to the new datums
- Other groups may adopt at their own speed and need

Adoption: Legal / States

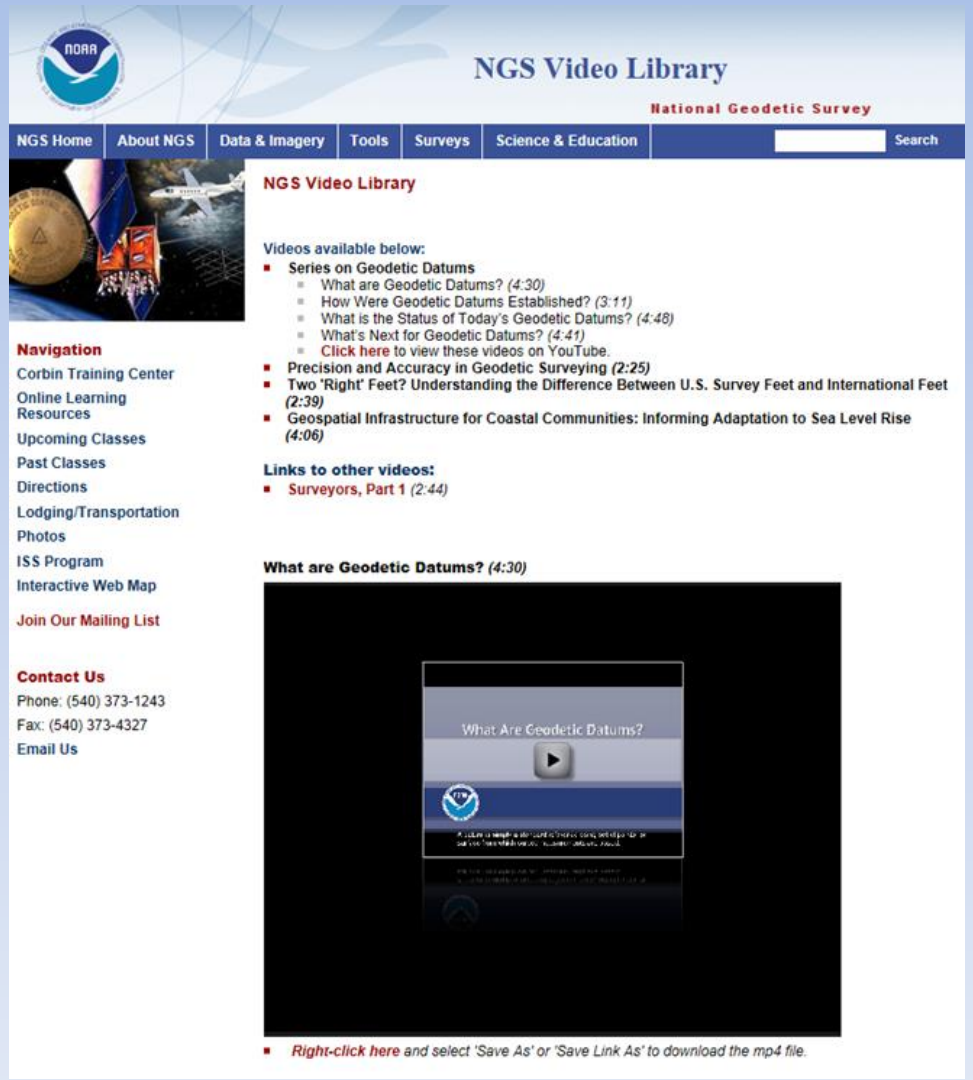
- NGS historically provided template acts for each state to help adopt changes
  - NAD 83
  - SPCS
- Has one major drawback: "NAD 83" is now *by-name* mandated in over 40 states.
- Would this be useful again?
  - **Only if "the latest coordinates of the NSRS as defined by the NGS" is the language used**
  - Avoids name-specific issues in the future

Publications/Videos

- Developed instructional videos
  - NCGS database
- Plan to develop additional instructional videos in 2016
  - Suggestions?
- NC-SC boundary video



Instructional Videos



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National Geodetic Survey

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Videos available below:

- **Series on Geodetic Datums**
  - What are Geodetic Datums? *(4:30)*
  - How Were Geodetic Datums Established? *(3:11)*
  - What is the Status of Today's Geodetic Datums? *(4:48)*
  - What's Next for Geodetic Datums? *(4:41)*
  - Click here to view these videos on YouTube.
- **Precision and Accuracy in Geodetic Surveying *(2:25)***
- **Two 'Right' Feet? Understanding the Difference Between U.S. Survey Feet and International Feet *(2:39)***
- **Geospatial Infrastructure for Coastal Communities: Informing Adaptation to Sea Level Rise *(4:06)***

Links to other videos:

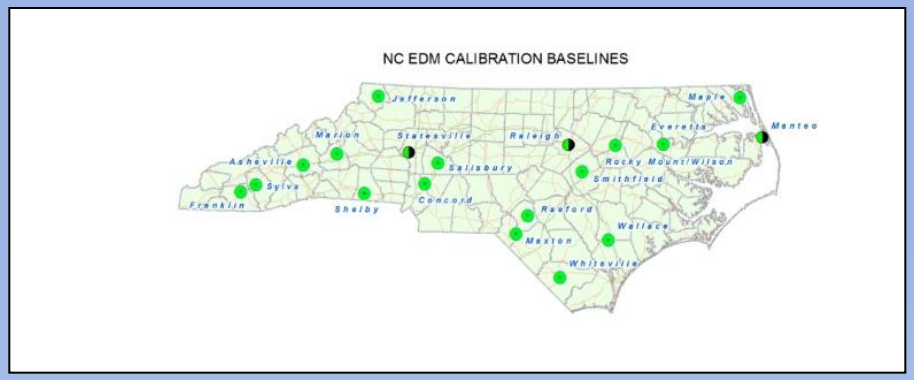
- Surveyors, Part 1 *(2:44)*

What are Geodetic Datums? *(4:30)*

- *Right-click here and select 'Save As' or 'Save Link As' to download the mp4 file.*

Future projects

- Check EDMI baselines
  - Asheville (replace)
  - Maxton (check)
  - Whiteville (check)
  - Maple (check)
  - Raleigh (replace)
  - Manteo (check)



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Presentation		CORS	Presentation	CORS
		CORS	Presentation	CORS
		CORS_11_03_2012	Presentation	CORS
		NC_SC_Boundary_Western_NC	Presentation	County and State Boundaries
		NC_State_Boundary_Archives	Presentation	County and State Boundaries
		Duke_2014	Presentation	County and State Boundaries
		GNSS_Elevation_Certificates_v3	Presentation	GNSS
		NGAT UAS Overview Surveys Meeting April 14	Presentation	Library
		Experience with Non-Metric Cameras	Presentation	Library
		UAS Business	Presentation	Library
		2012 Coastal Imagery Project (1)	Presentation	NCGS

NC SURVEYORS
Following
In Their
Footsteps
1939 PS
NORTH CAROLINA

Questions?

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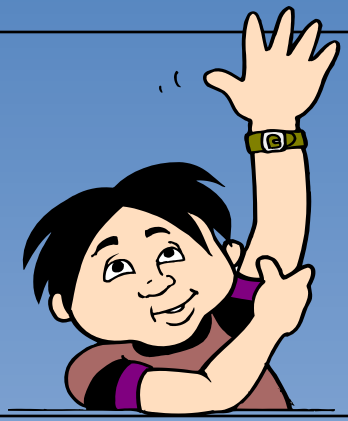
Email: gary.thompson@ncdps.gov



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