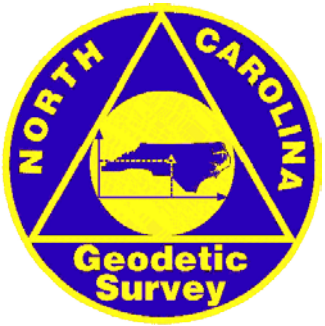
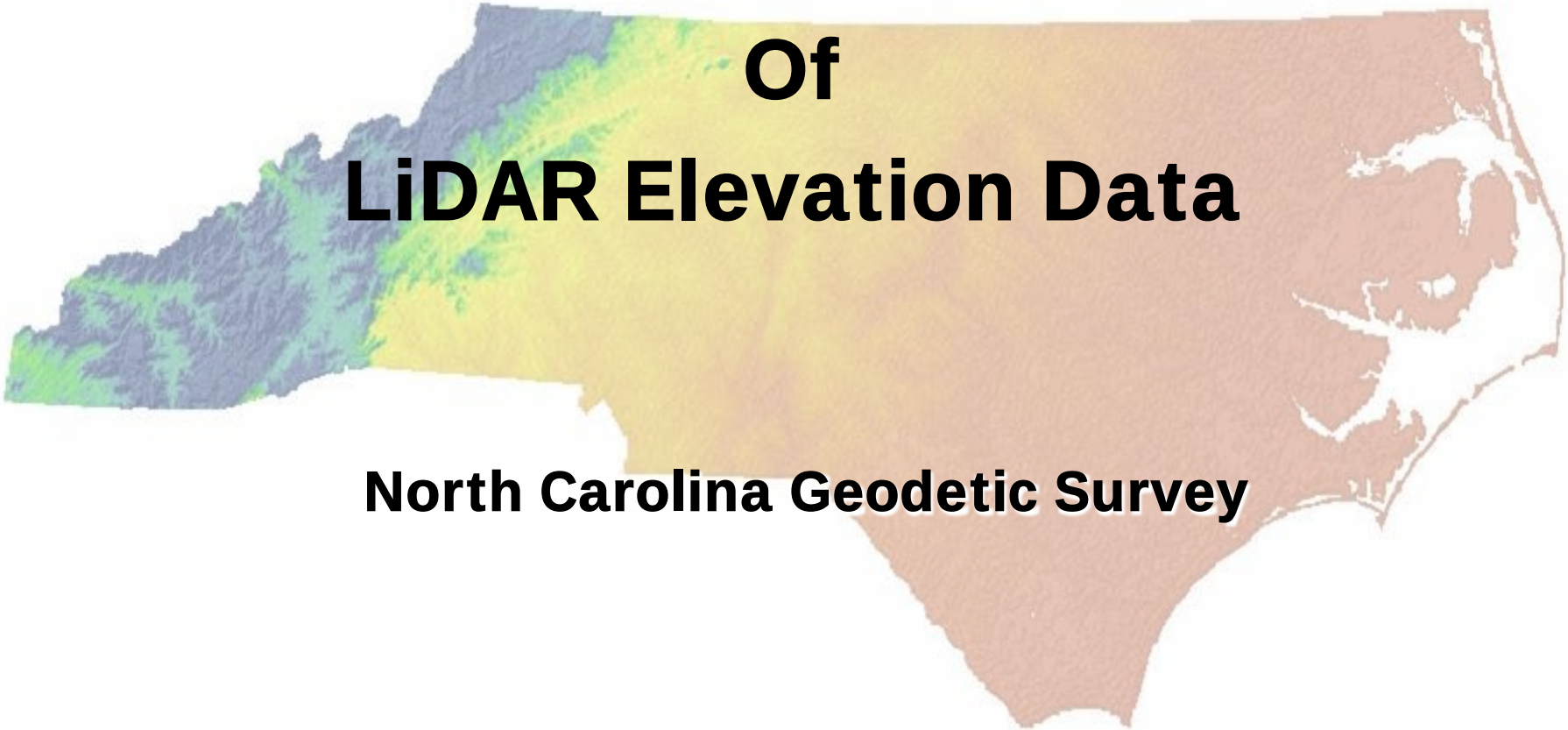


Quality Control Of LiDAR Elevation Data

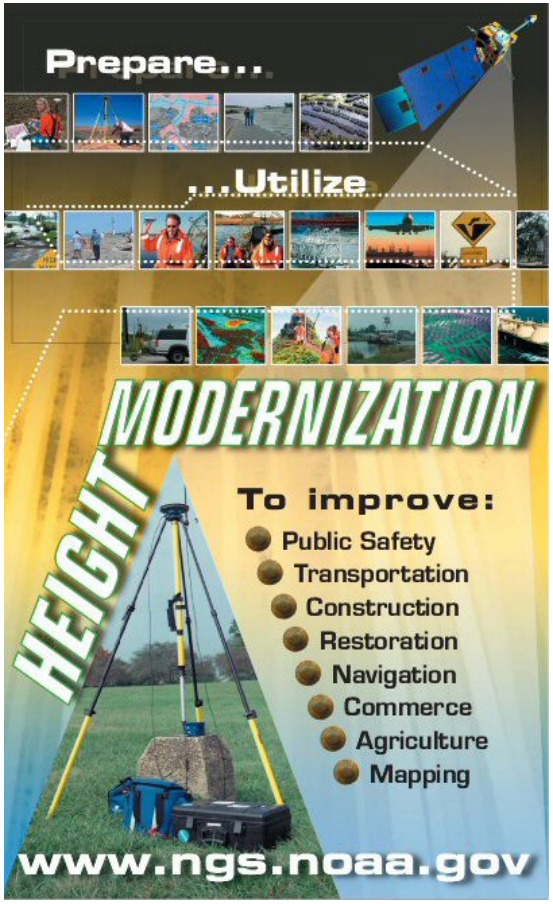


North Carolina Geodetic Survey

National Spatial Reference System Components

- Components needed to perform quality control surveys
  - National CORS
    - **A network of GNSS Continuously Operating Reference Stations (CORS)**
  - Network of passive monuments
    - **Permanently marked survey monuments**
  - Models and tools
    - **Geoid model, coordinate conversion & transformations etc.**

Height Modernization



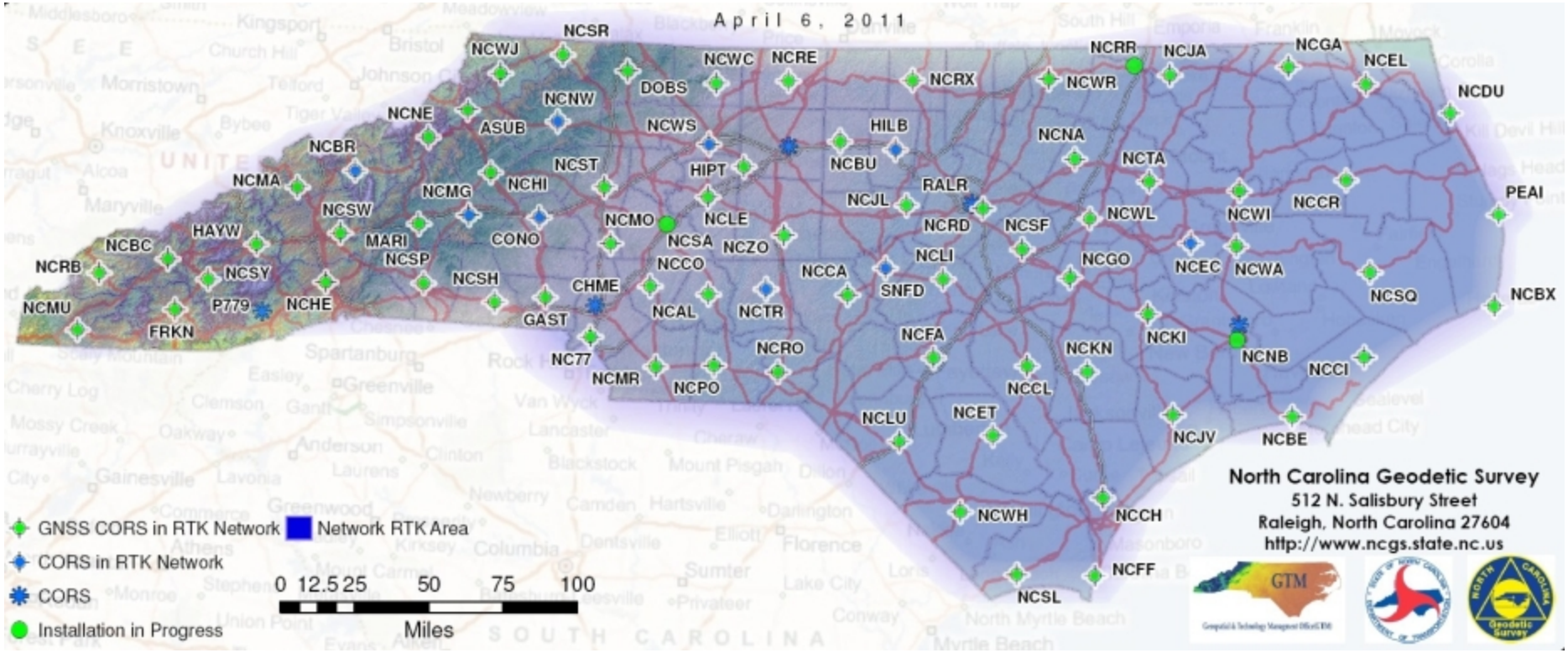
Height Modernization

Is a program within NOAA's National Geodetic Survey (NGS) that provides accurate height information by integrating Global Navigation Satellite Systems (GNSS) technology with existing survey techniques. For years, GNSS has been used to determine accurate positions (latitude and longitude), but now, by following Height Modernization standards, specifications and techniques, GNSS can efficiently establish accurate elevations for all types of positioning and navigational needs.

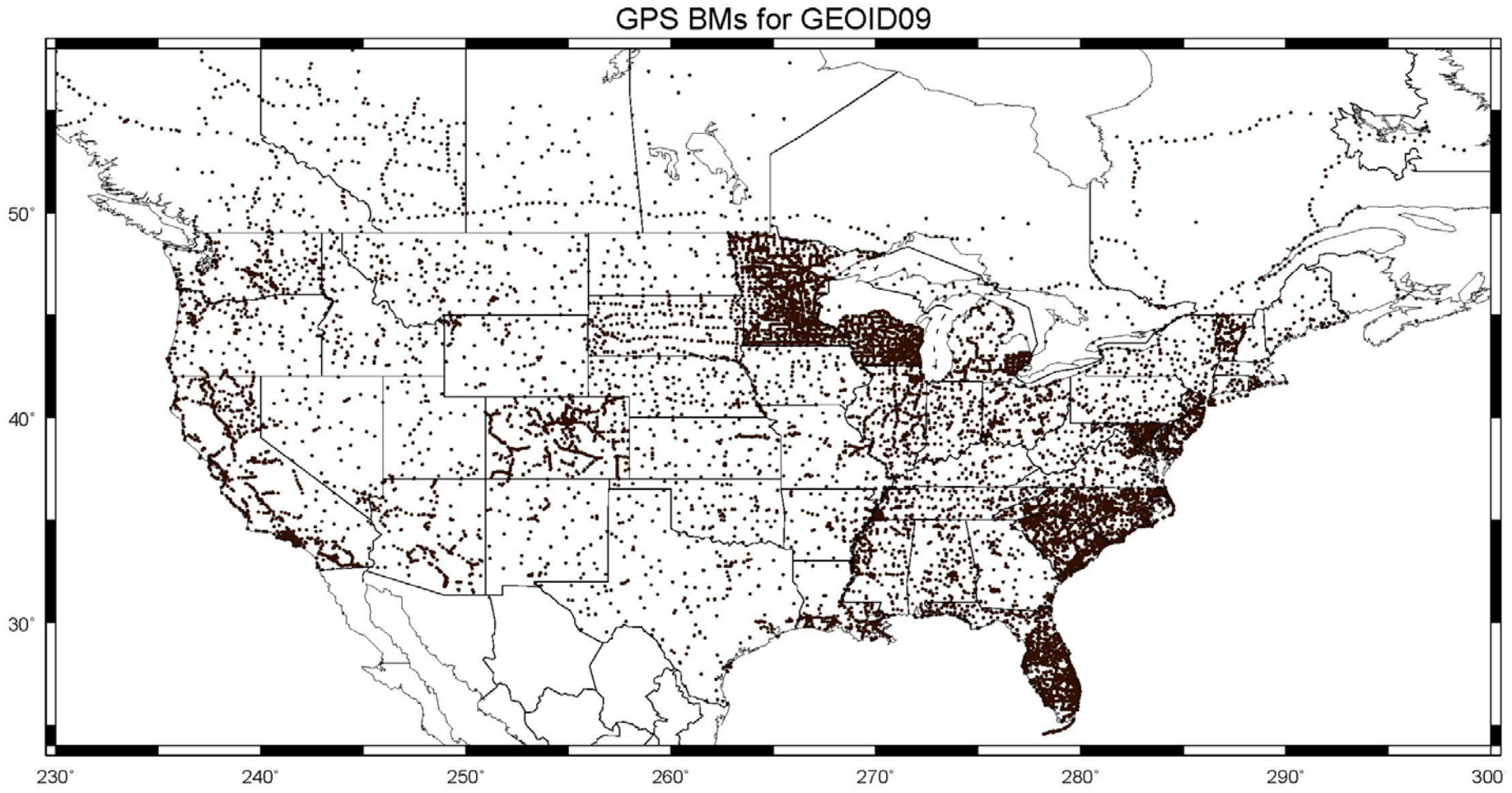
Vertical control

- Vertical control
  - Geodetic leveling
    - 1st, 2nd, and 3rd Order
  - GPS (National Height Modernization System)
    - 2 cm and 5 cm heights

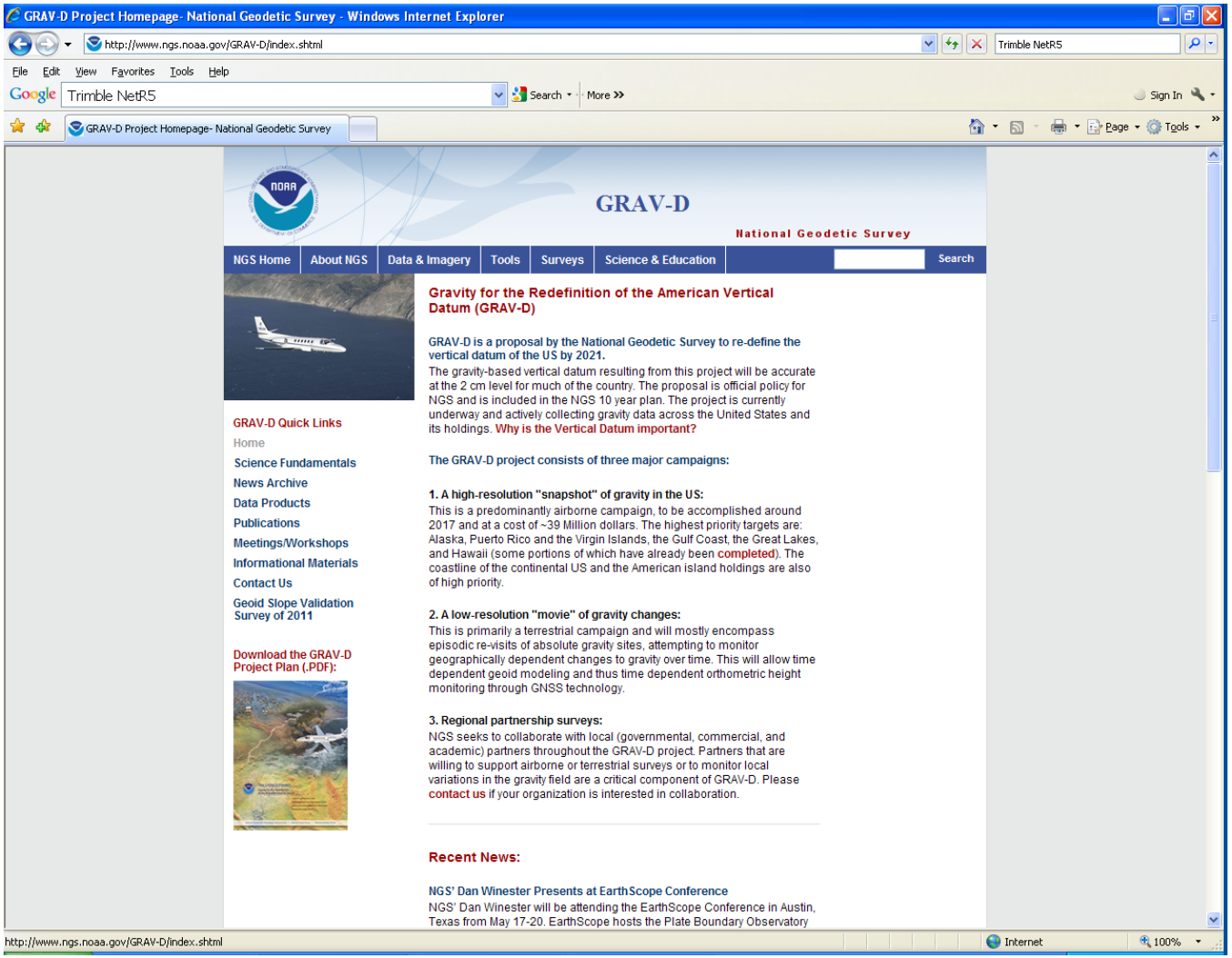
North Carolina CORS



Geoid09 Benchmarks



GRAV-D


GRAV-D Project Homepage- National Geodetic Survey - Windows Internet Explorer
http://www.ngs.noaa.gov/GRAV-D/index.shtml
Trimble NetR5
File Edit View Favorites Tools Help
Google Trimble NetR5 Search More
Sign In
GRAV-D Project Homepage- National Geodetic Survey
Page Tools
GRAV-D
National Geodetic Survey
NGS Home
About NGS
Data & Imagery
Tools
Surveys
Science & Education
Search
Gravity for the Redefinition of the American Vertical Datum (GRAV-D)
GRAV-D is a proposal by the National Geodetic Survey to re-define the vertical datum of the US by 2021.
The gravity-based vertical datum resulting from this project will be accurate at the 2 cm level for much of the country. The proposal is official policy for NGS and is included in the NGS 10 year plan. The project is currently underway and actively collecting gravity data across the United States and its holdings. Why is the Vertical Datum important?
The GRAV-D project consists of three major campaigns:
1. A high-resolution "snapshot" of gravity in the US:
This is a predominantly airborne campaign, to be accomplished around 2017 and at a cost of ~39 Million dollars. The highest priority targets are: Alaska, Puerto Rico and the Virgin Islands, the Gulf Coast, the Great Lakes, and Hawaii (some portions of which have already been completed). The coastline of the continental US and the American island holdings are also of high priority.
2. A low-resolution "movie" of gravity changes:
This is primarily a terrestrial campaign and will mostly encompass episodic re-visits of absolute gravity sites, attempting to monitor geographically dependent changes to gravity over time. This will allow time dependent geoid modeling and thus time dependent orthometric height monitoring through GNSS technology.
3. Regional partnership surveys:
NGS seeks to collaborate with local (governmental, commercial, and academic) partners throughout the GRAV-D project. Partners that are willing to support airborne or terrestrial surveys or to monitor local variations in the gravity field are a critical component of GRAV-D. Please contact us if your organization is interested in collaboration.
GRAV-D Quick Links
Home
Science Fundamentals
News Archive
Data Products
Publications
Meetings/Workshops
Informational Materials
Contact Us
Geoid Slope Validation Survey of 2011
Download the GRAV-D Project Plan (.PDF):
Recent News:
NGS' Dan Winester Presents at EarthScope Conference
NGS' Dan Winester will be attending the EarthScope Conference in Austin, Texas from May 17-20. EarthScope hosts the Plate Boundary Observatory
http://www.ngs.noaa.gov/GRAV-D/index.shtml
Internet
100%

Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy

3.2.2 Accuracy Test Guidelines

According to the Spatial Data Transfer Standard (SDTS) (ANSI-NCITS, 1998), **accuracy testing by an independent source of higher accuracy is the preferred test for positional accuracy.** Consequently, the NSSDA presents guidelines for accuracy testing by an independent source of higher accuracy. The independent source of higher accuracy shall the highest accuracy feasible and practicable to evaluate the accuracy of the dataset.

The data producer shall determine the geographic extent of testing. Horizontal accuracy shall be tested by comparing the planimetric coordinates of well-defined points3 in the dataset with coordinates of the same points from an independent source of higher accuracy. Vertical accuracy shall be tested by comparing the elevations in the dataset with elevations of the same points as determined from an independent source of higher accuracy.

Errors in recording or processing data, such as reversing signs or inconsistencies between the dataset and independent source of higher accuracy in coordinate reference system definition, must be corrected before computing the accuracy value.

A minimum of 20 check points shall be tested, distributed to reflect the geographic area of interest and the distribution of error in the dataset. When 20 points are tested, the 95% confidence level allows one point to fail the threshold given in the product specifications.

Objective of the QC Surveys

Establish quality control (QC) checkpoints to evaluate the vertical accuracy of the elevation data

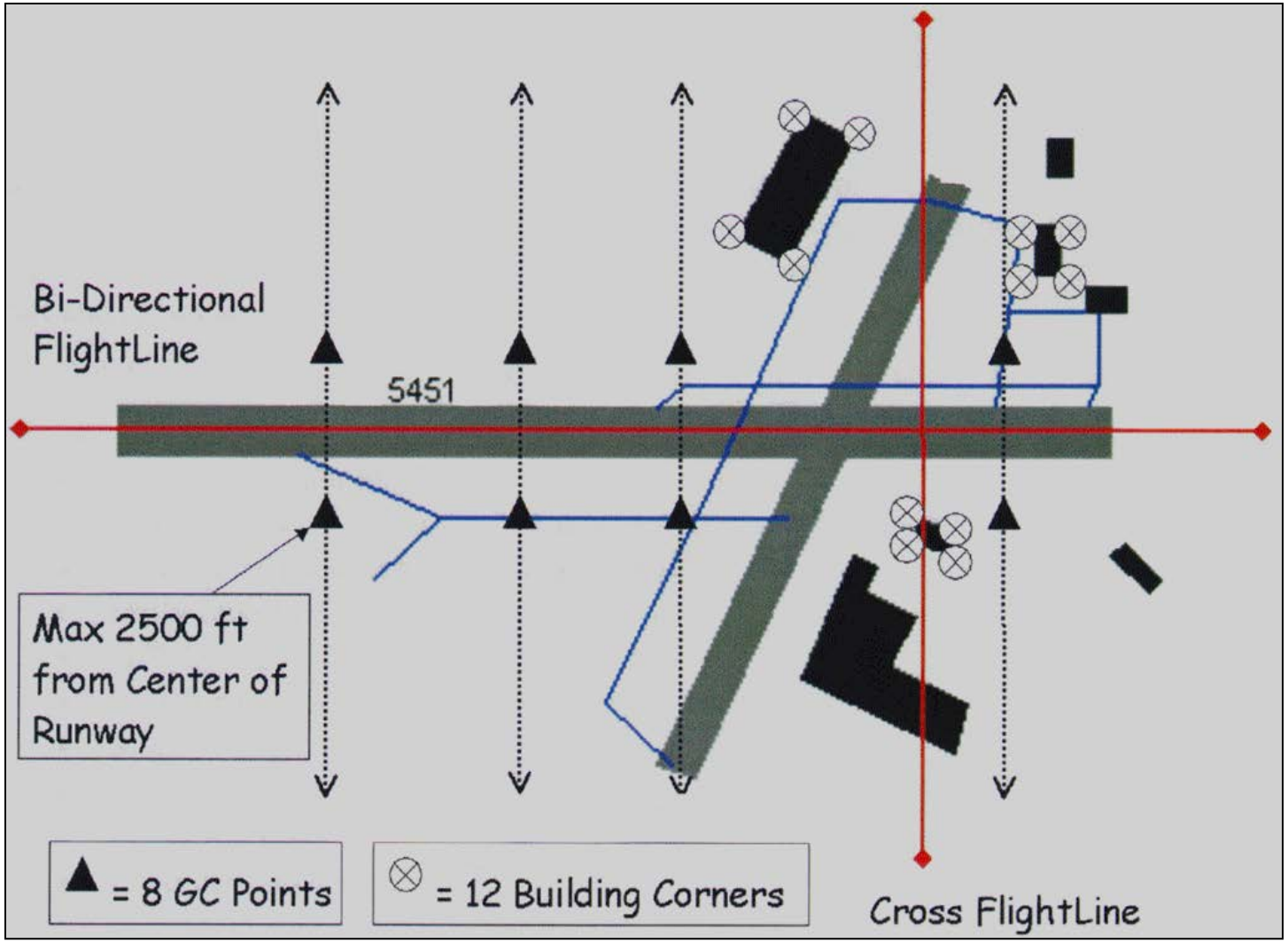
North Carolina Cooperating Technical State Mapping Program

Issue Papers 37 and 50: Quality Control of Light Detection and Ranging (LIDAR)Elevation Data in North Carolina for Phase II/III NCFMP

Boresight Validation

- Performed for each flight mission
- Removes systematic errors
  - Flight-to-flight variations on instrument mounting
  - Environmentally induced changes
- Performing a survey on a airport or roadway within the collection area is a reliable check
  - Validate the vertical for a feature with first returns on an unobstructed surface
  - Apply any vertical correction as necessary (a “z-bump”)

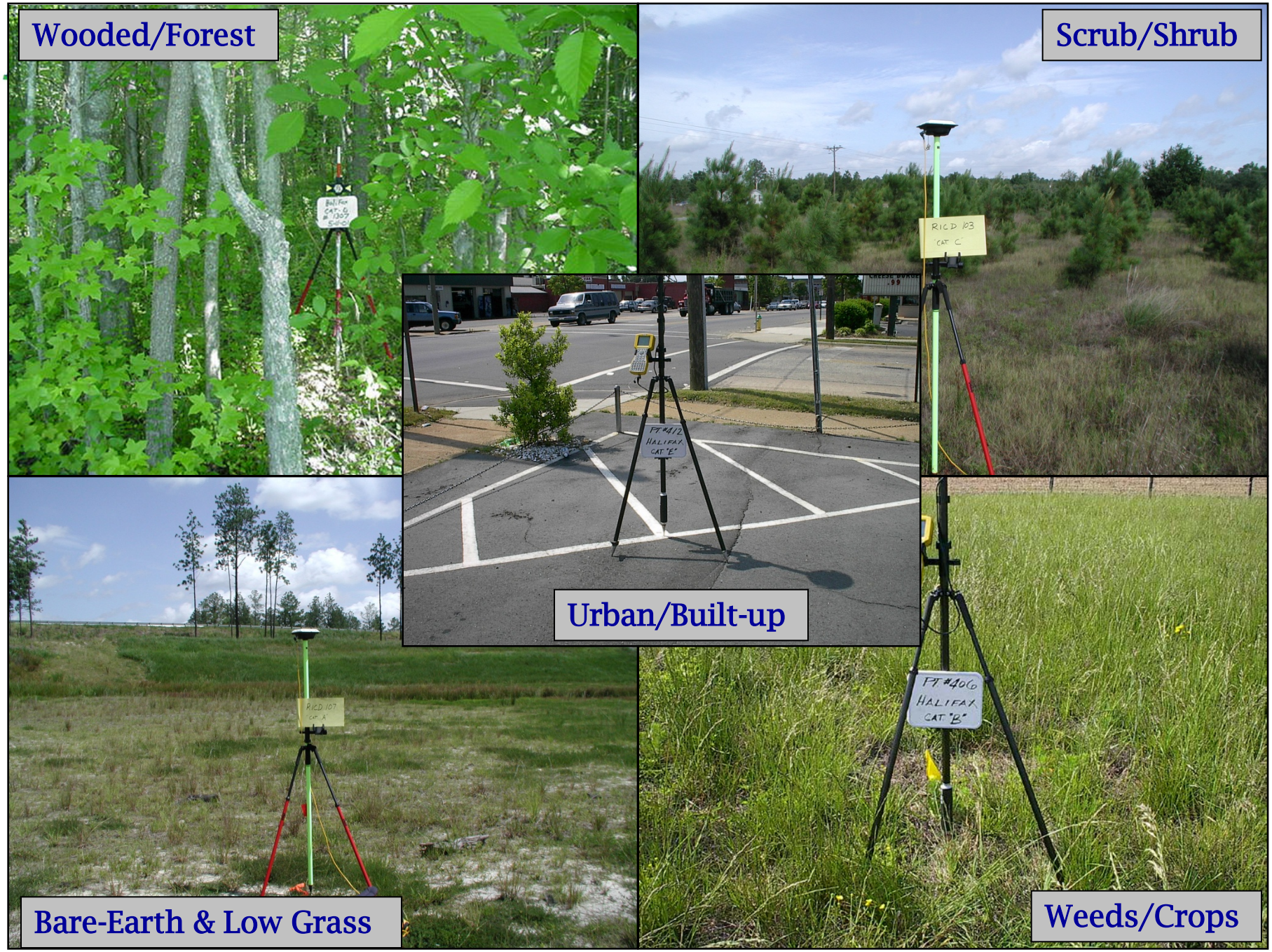
LiDAR Boresight Calibration Survey



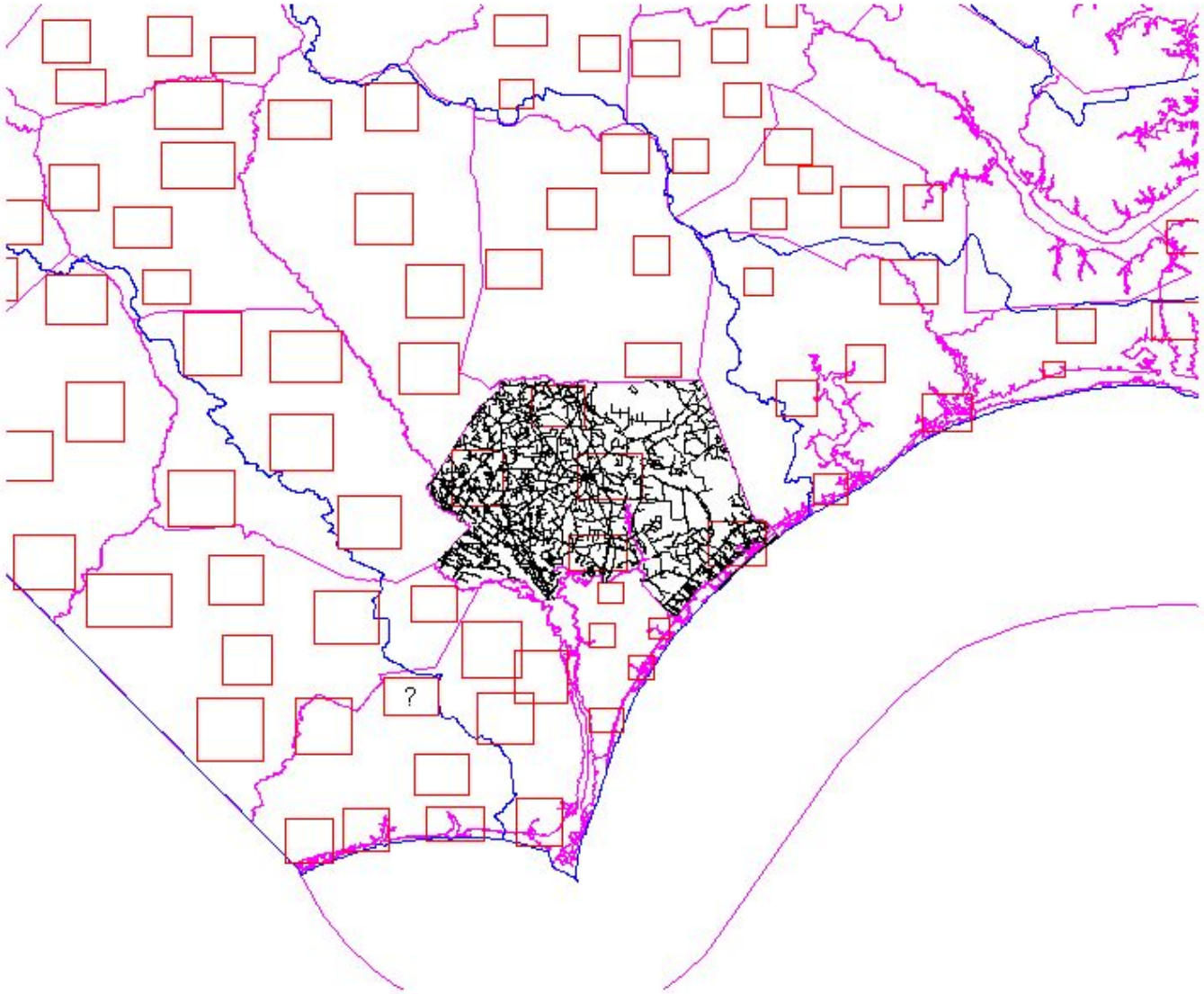
Checkpoint Land Cover Classes

FEMA requires TINs to be tested separately for major land cover classes that predominate within the floodplain being studied, with 20 or more checkpoints per class. NC selected 120 checkpoints per county:

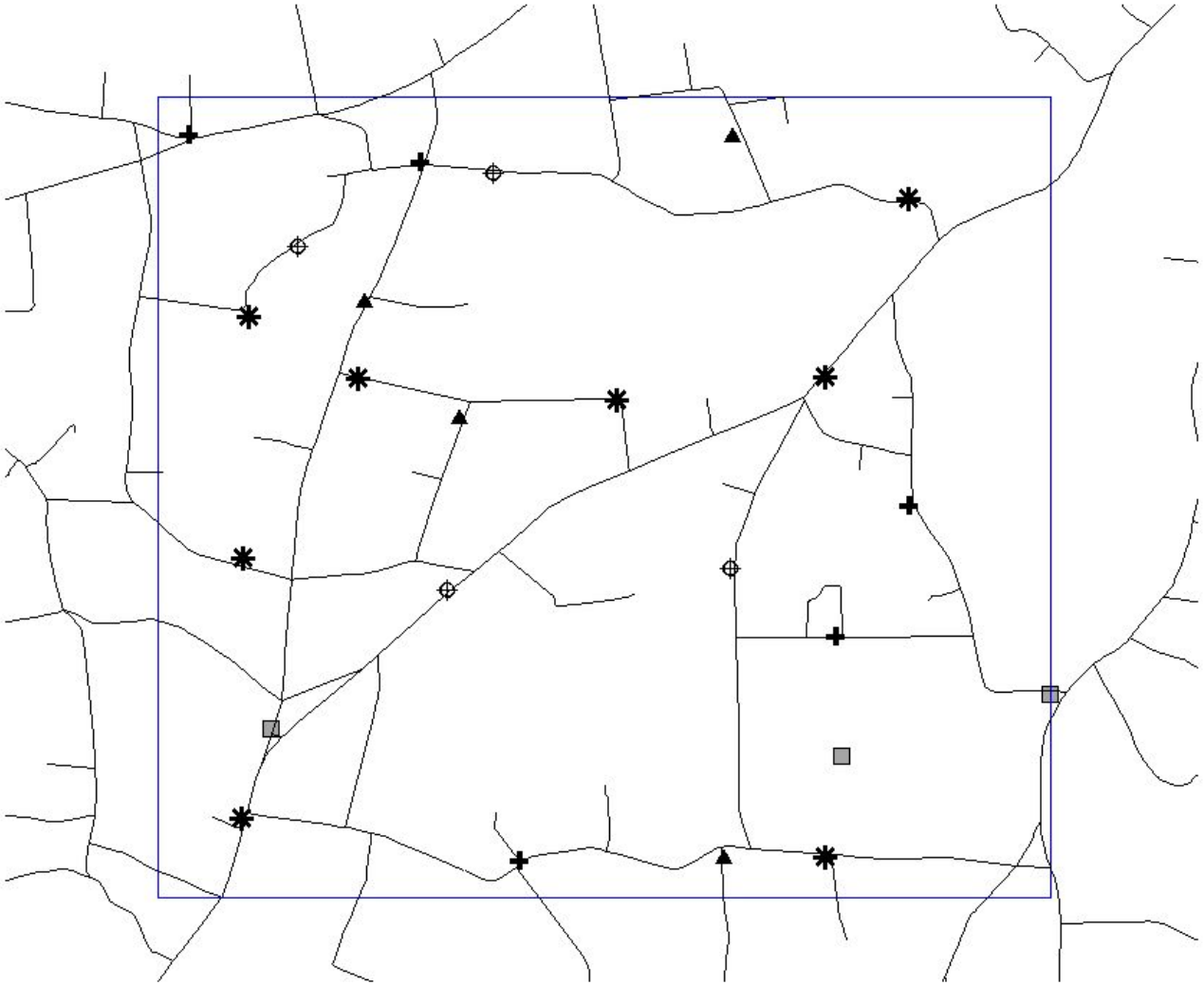
- 20 in open terrain (bare-earth and grass)
- 20 in weeds and crops
- 20 in scrub
- 40 in forests (higher weight than other areas)
- 20 in built-up or urban areas


Wooded/Forest
Scrub/Shrub
Urban/Built-up
Bare-Earth & Low Grass
Weeds/Crops

Typical QC Block Layout



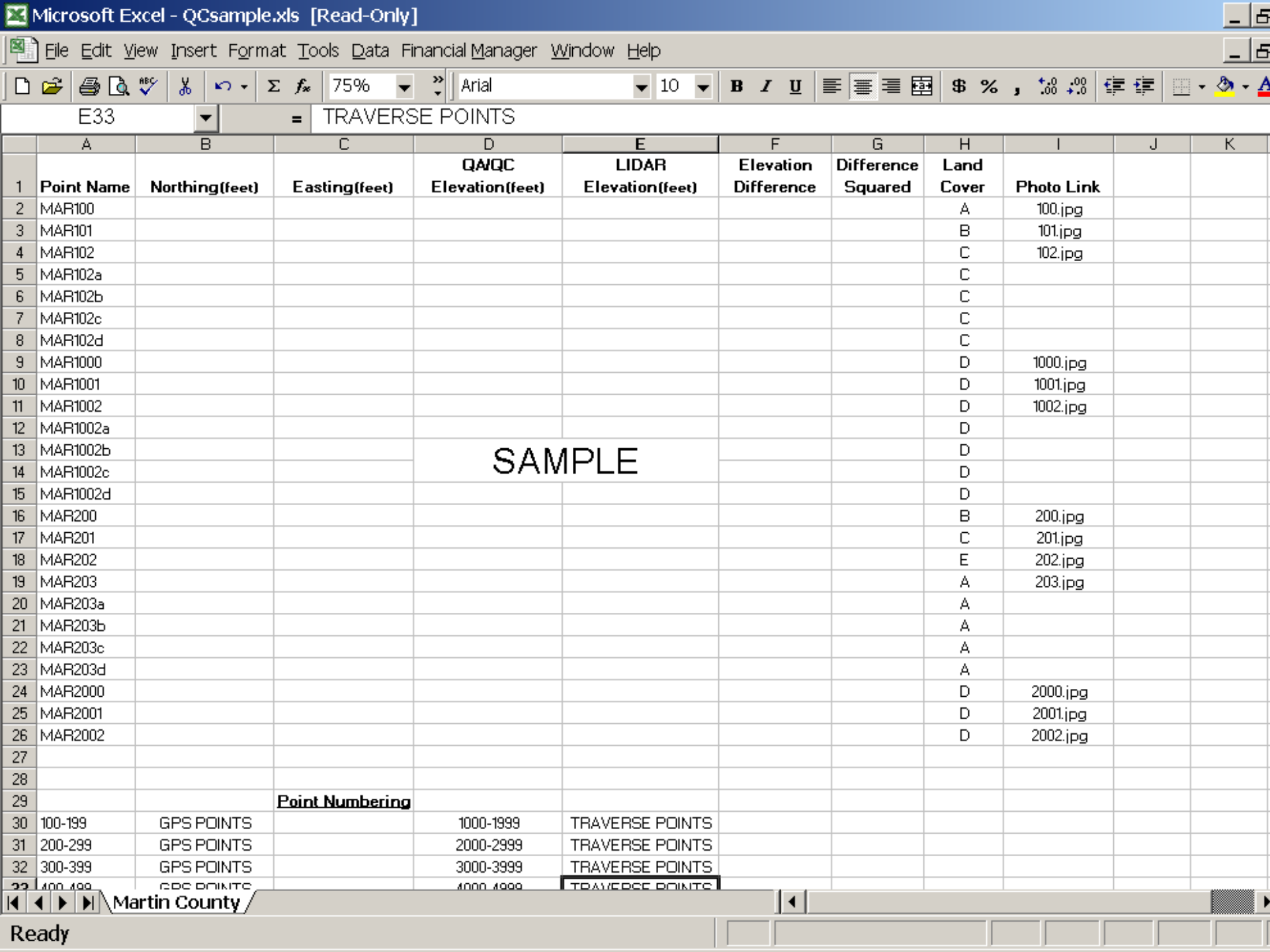
Greene County RTK QC Points



Dotroads
Extents.shp
Greene-qc-points.dbf
Bare earth, Low grass
High grass, Weeds, Crops
Brush lands, Low trees
Fully coverec by trees
Urban

N
W
E
S

2 0 2 4 Miles



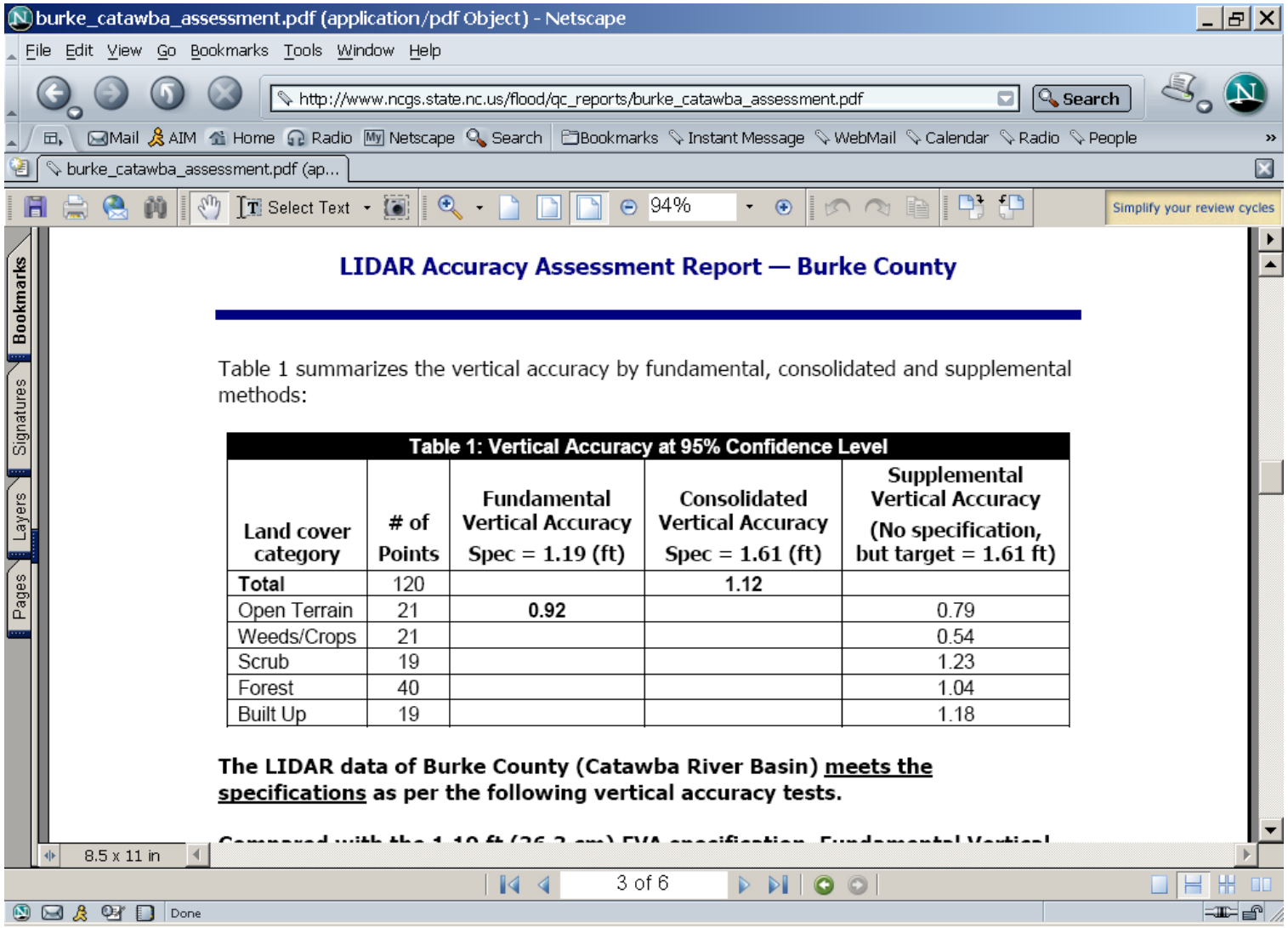
	A	B	C	D	E	F	G	H	I	J	K
1	**Point Name**	**Northing(feet)**	**Easting(feet)**	**QA/QC Elevation(feet)**	**LIDAR Elevation(feet)**	**Elevation Difference**	**Difference Squared**	**Land Cover**	**Photo Link**		
2	MAR100							A	100.jpg		
3	MAR101							B	101.jpg		
4	MAR102							C	102.jpg		
5	MAR102a							C			
6	MAR102b							C			
7	MAR102c							C			
8	MAR102d							C			
9	MAR1000							D	1000.jpg		
10	MAR1001							D	1001.jpg		
11	MAR1002							D	1002.jpg		
12	MAR1002a							D			
13	MAR1002b							D			
14	MAR1002c							D			
15	MAR1002d							D			
16	MAR200							B	200.jpg		
17	MAR201							C	201.jpg		
18	MAR202							E	202.jpg		
19	MAR203							A	203.jpg		
20	MAR203a							A			
21	MAR203b							A			
22	MAR203c							A			
23	MAR203d							A			
24	MAR2000							D	2000.jpg		
25	MAR2001							D	2001.jpg		
26	MAR2002							D	2002.jpg		
27											
28											
29			**Point Numbering**								
30	100-199	GPS POINTS		1000-1999	TRAVERSE POINTS						
31	200-299	GPS POINTS		2000-2999	TRAVERSE POINTS						
32	300-399	GPS POINTS		3000-3999	TRAVERSE POINTS						
33	400-499	GPS POINTS		4000-4999	TRAVERSE POINTS						

Objective of the QC Surveys

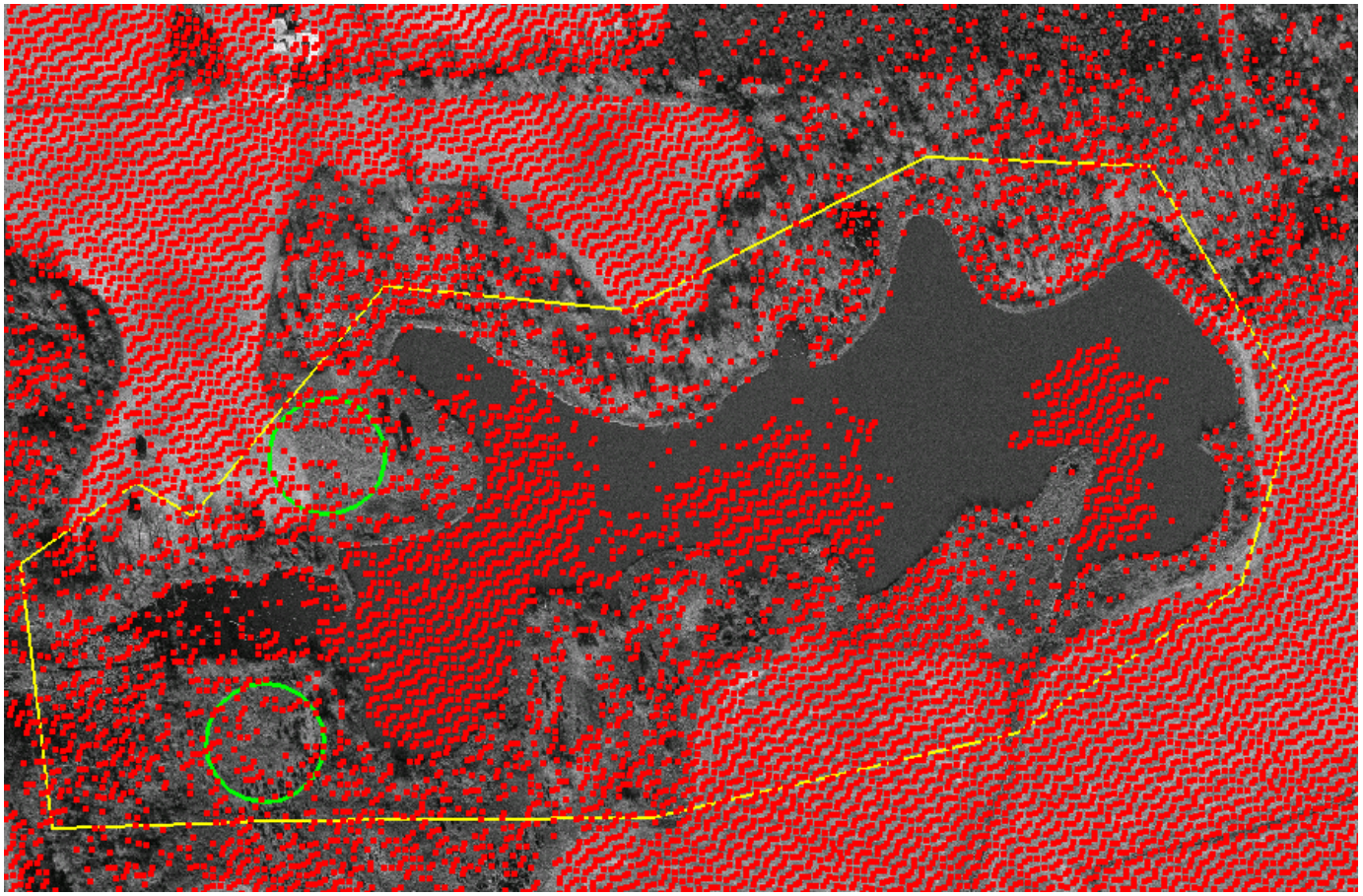
- Fundamental Vertical Accuracy (FVA)
  - Bare earth only
  - FVA standard is 1.19 feet at 95% confidence level
- Consolidated Vertical Accuracy (CVA)
  - All categories
  - FVA standard is 1.61 feet at 95% confidence level
- Supplemental Vertical Accuracy (SVA)
  - Computed for individual categories
  - FVA standard is 1.61 at 95% confidence level

QC Assessment Report

Burke County, Catawba River Basin



NCFMP LiDAR Derived Elevation Products



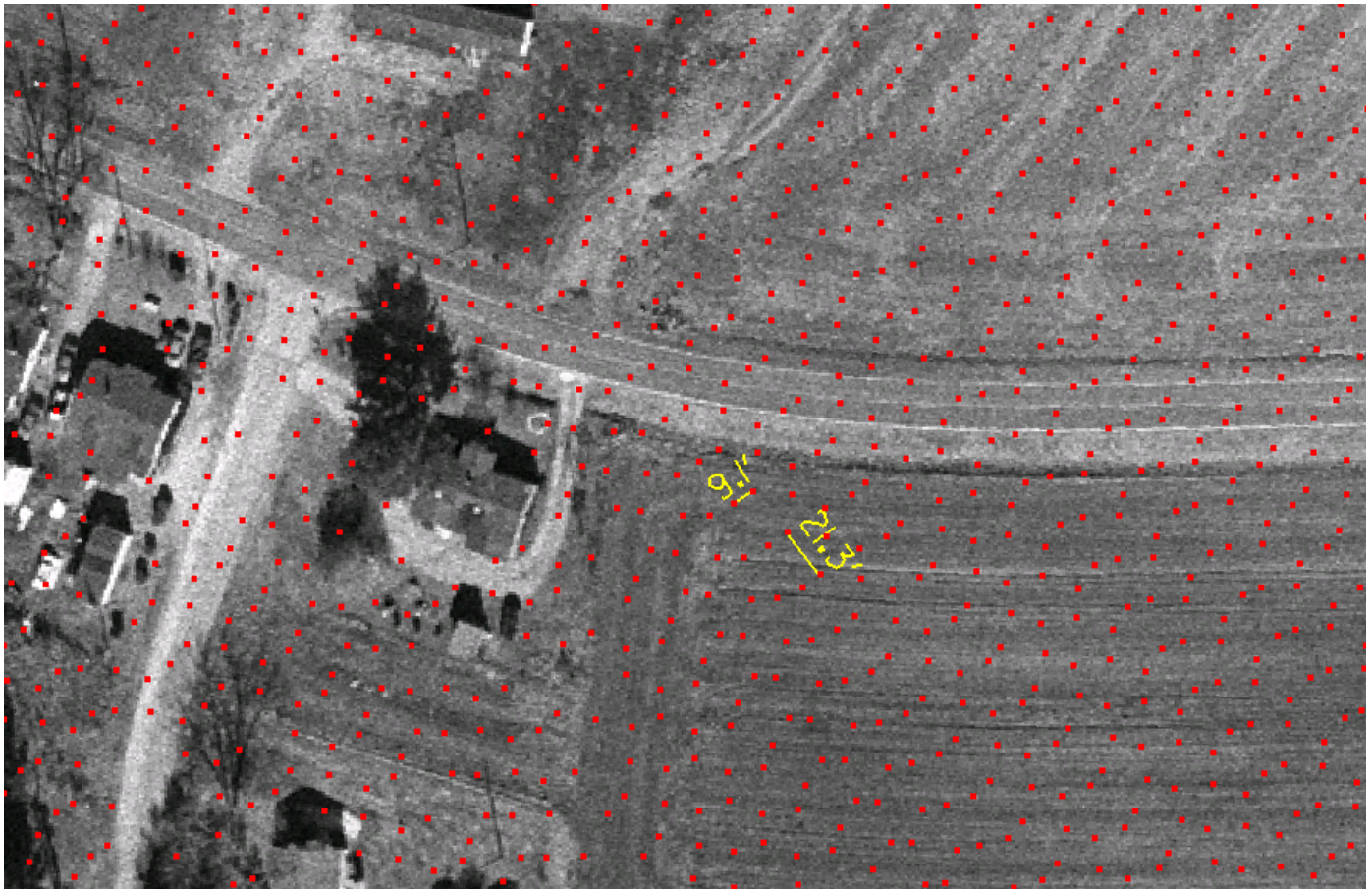
North Carolina Department of Transportation
Photogrammetry Unit

NCFMP LiDAR Derived Elevation Products

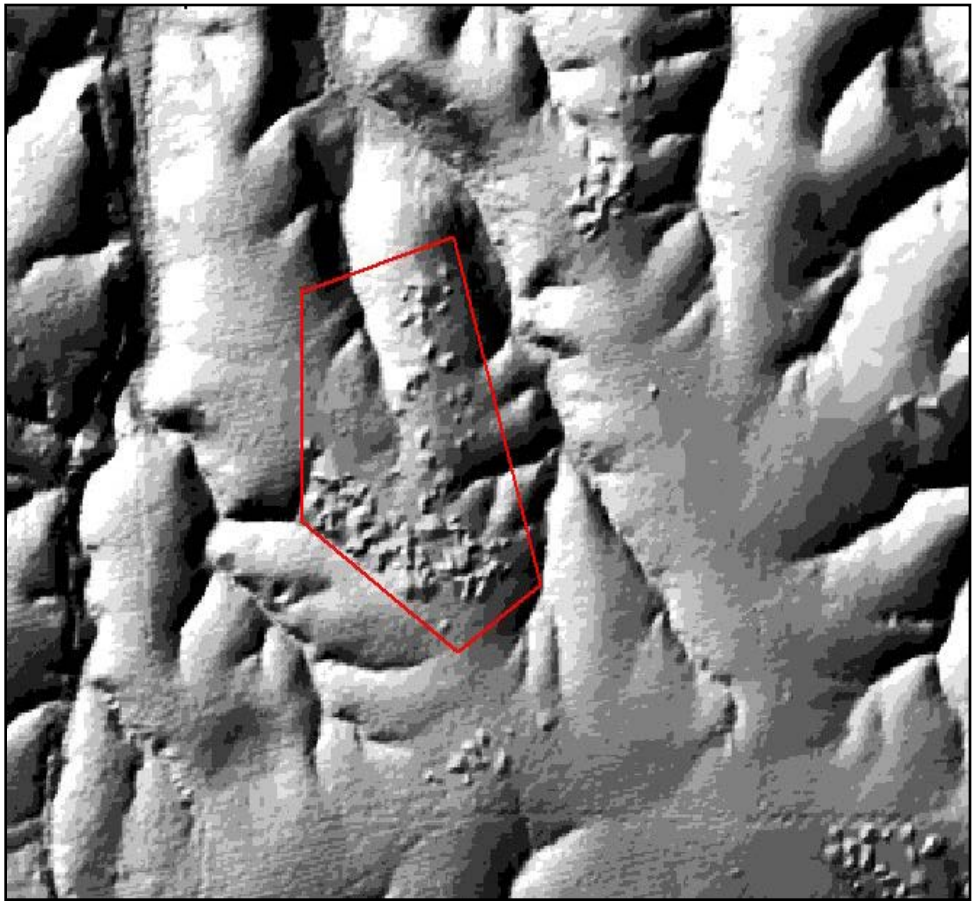
TIP NUMBER: R-2823

COUNTY: NASH

RIVER BASIN: TAR-PAMLICO



LiDAR “Artifacts”



- This is the second major issue for LIDAR QC.
- How do users objectively determine how clean a dataset is from artifacts?

Field-Surveyed Cross Sections

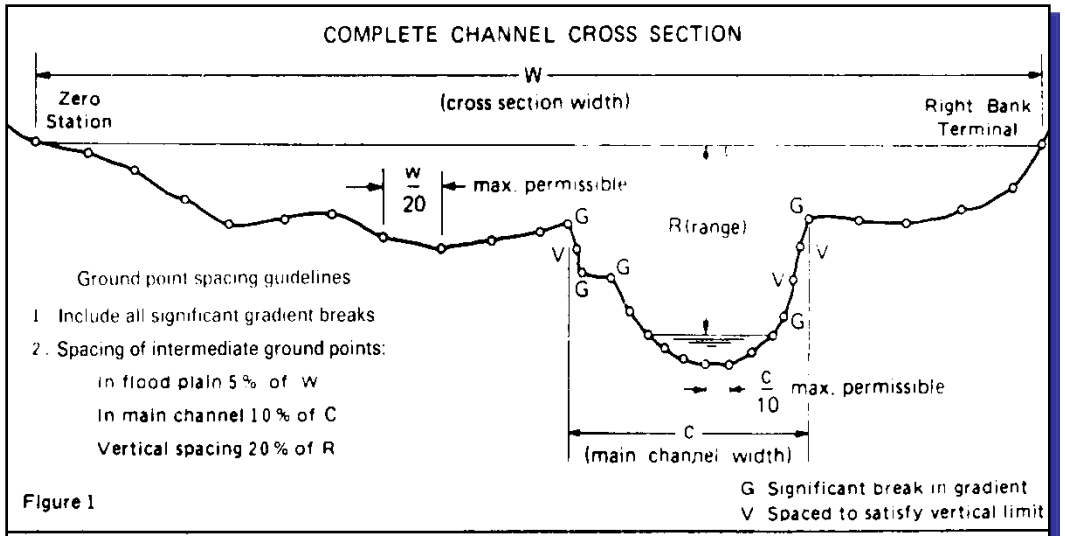


Figure 1

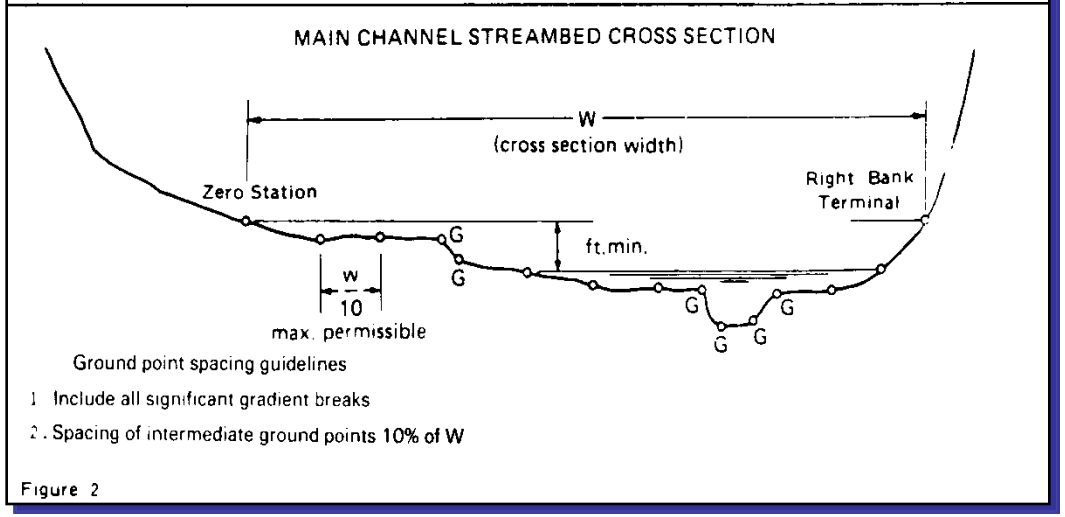


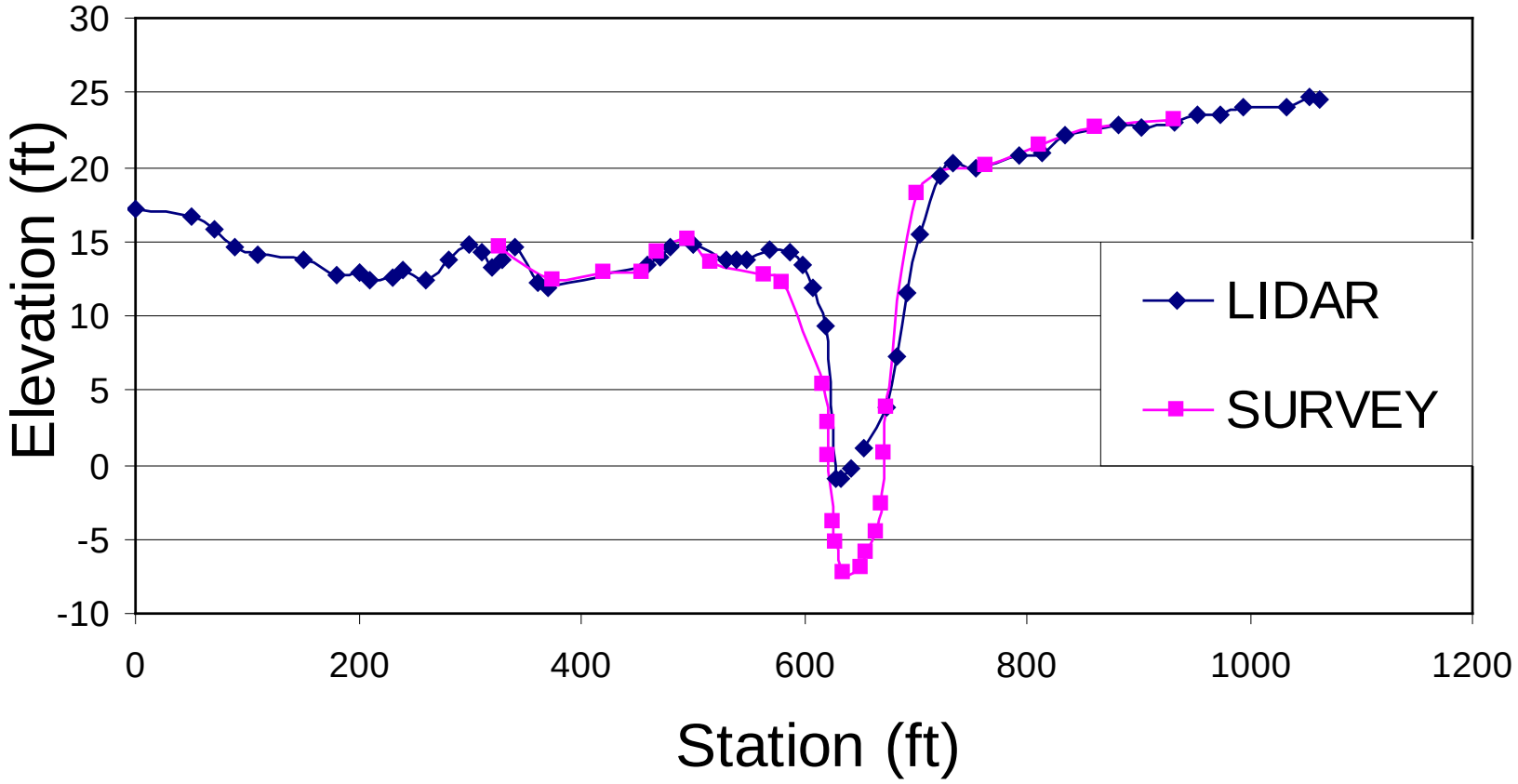
Figure 2

LiDAR/Field Cross-Sections

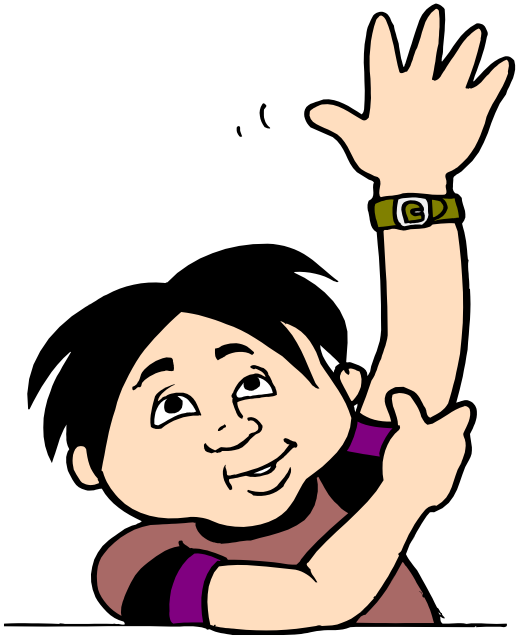
White Oak River Basin

LIDAR Elev.s from TIN vs. Field Survey Elev.s

Section: Upstream of Rhodestown Rd in Onslow County



Questions?



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