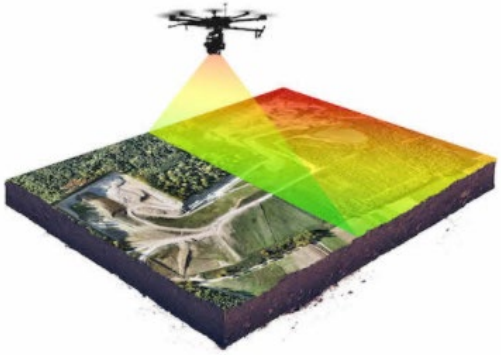
2021 Association of County Engineers of Alabama Conference
May 11, 2021

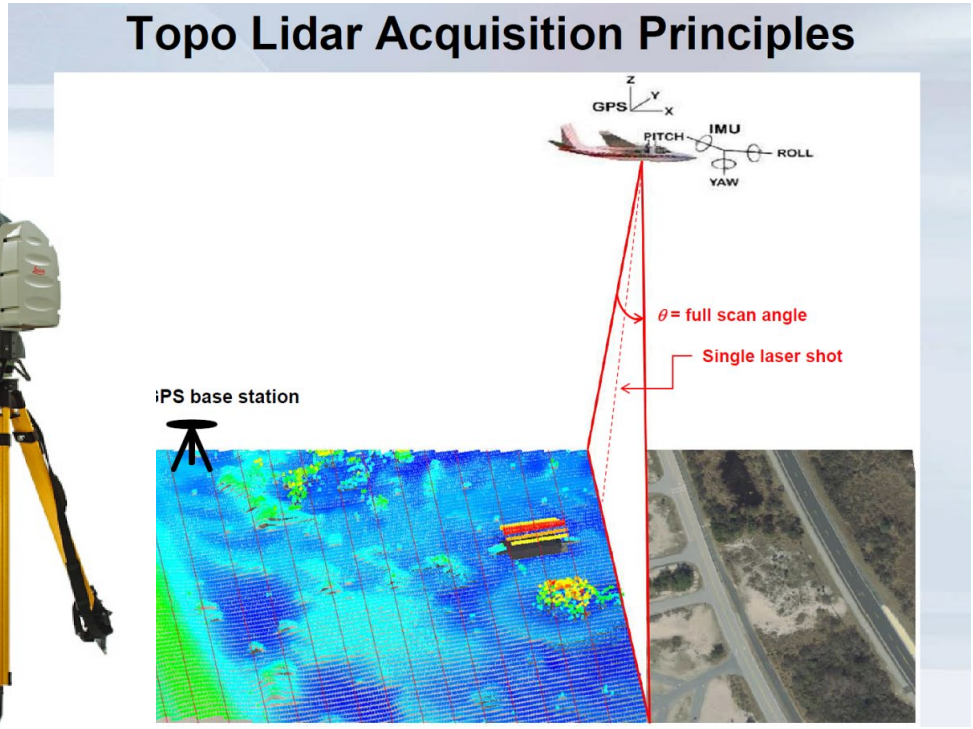
Statewide LIDAR Collection, ALDOT CORS Network, and Upcoming Changes to the National Spatial Reference System (NSRS)

- USGS 3D Elevation Program (3DEP)
  - Current Status
  - Projects underway
  - Future planning and needs
- ALDOT CORS Network
  - Current Status
  - Using the System
- Upcoming Changes to the NSRS
  - New 2022 Horizontal and Vertical Datums
  - New State Plane Coordinate Zones
  - U.S. Survey Foot
  - GPS on Benchmark Campaign

LIDAR

- Light Detection and Ranging – An active, airborne remote sensing technology that combines laser ranges, scan angles, post-processed position & orientation data from an integrated GPS/IMU system, and calibration data to generate dense, accurate, irregularly-spaced (*X,Y,Z,I) point data ("point clouds"), which can be used to create DEMs, DSMs, TINs, contours, building models, canopy models, etc., etc.*





LAS Point Cloud Data

Aerial LIDAR Accuracies and Limitations

- Each LIDAR beam has multiple returns. The first return will be the top of a reflective surface (tree, roof, etc). The last return may or may not be the ground.
- As with any remote sensed product, if it cannot "see" the ground, then it will not pick it up.
- Spot elevations tend to hit well in open areas, but the accuracy degrades as the vegetation gets thicker!
- Conventional LIDAR cannot penetrate water – requires a different type sensor.
- Dense vegetation, pipes and drains need to be field collected.
- Older products were bare earth DTM only with contours.
- Newer products are LAS format files with ALL point data included. Data is classified to include a bare earth set of points.
- Microstation can directly load LAS files!

Aerial LIDAR

- One Foot and Two Foot Contour accuracy
- Well suited for drainage and hydraulics analysis.
- Used for transportation projects, flood mapping, archeological studies, forestry, precision ag, stormwater, geology…….
- Preliminary design and setting preliminary right of way and construction limits.
- Can be used in design AFTER it has been field evaluated!
- All hard surfaces (pavement), drains, and areas with dense vegetation must be field surveyed!
- Any critical areas MUST be field verified and/or field surveyed!

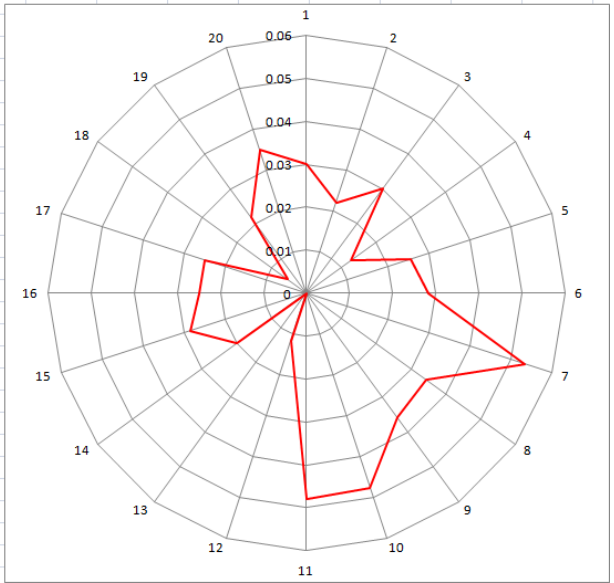
Collection methods

- Fixed wing aircraft. Typically one and two foot contour products but can be flown lower to achieve accuracy around 0.2 feet.
- UAS or Drone. Small project areas. Accuracies to within 0.2 feet or less.
- Mobile LIDAR. Collection along roadways. Accuracies to within 0.02 feet.
- Static or Tripod mounted scanner. Collects smaller areas. Accuracies to within 0.01 feet.

Microstation and TopoDOT

- LAS files (Point Cloud data) can now be loaded directly into Microstation and used to develop Inroads DTM files
- TopoDOT Manages Point Cloud data QA/QC and has automated routines for line-work, DTM development, and feature extraction.

Index	Point	Easting	Northing	Elevation	Deviation
1	785	2032928	1385572	350.75	0.03
2	788	2032977	1385558	349.44	0.022222
3	797	2033024	1385545	348.13	0.03
4	802	2033072	1385531	346.7	0.012857
5	653	2033601	1385380	335.41	0.025455
6	664	2033650	1385366	334.88	0.028333
7	665	2033652	1385378	334.42	0.053333
8	668	2033700	1385364	334.05	0.034286
9	669	2033697	1385353	334.46	0.035714
10	638	2033506	1385407	336.55	0.047778
11	648	2033553	1385394	335.95	0.048
12	633	2033457	1385421	337.33	0.011667
13	839	2033313	1385462	340.24	3.41E-13
14	844	2033361	1385449	339.15	0.02
15	853	2033409	1385435	338.13	0.028333
16	811	2033121	1385517	345.22	0.025
17	816	2033168	1385504	343.85	0.025
18	825	2033218	1385490	342.54	0.005385
19	830	2033265	1385476	341.37	0.022
20	993	2033270	1385482	341.16	0.035



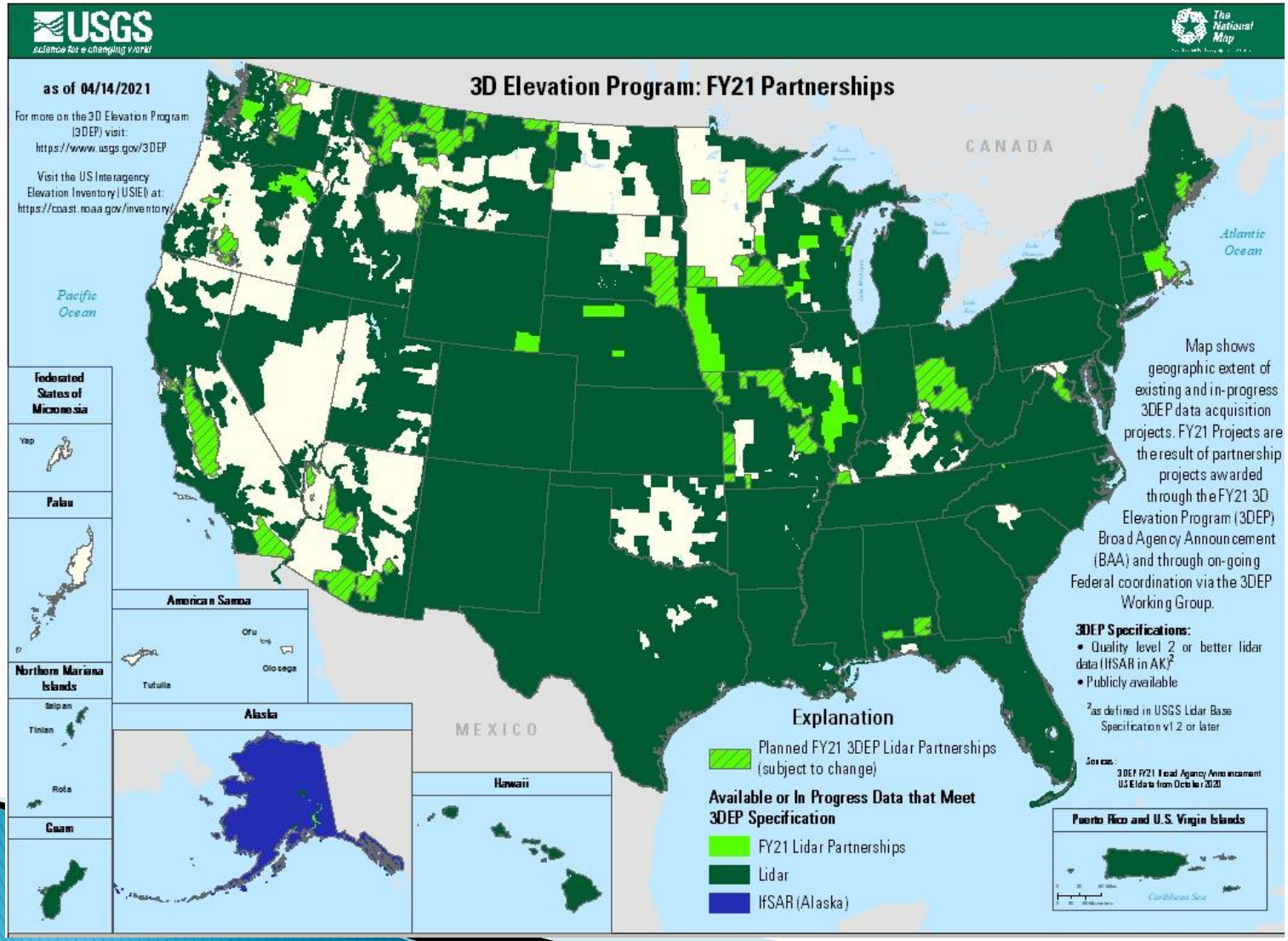
USGS 3D Elevation Program (3DEP)

- United States Geological Survey (USGS) program developed to coordinate the collection of LIDAR nation-wide
- Established minimum specifications for acquisition. Currently set at Quality Level 2 (QL2)
- Coordinates funding at the federal level.
- States coordinate to bring local funding partners together
- Main contributors are USGS, FEMA, NRCS, NOAA
- Local level has included TVA, County, City, and other state agencies.

USGS 3DEP

- Achieves a 25% cost saving (or more) by collecting data in larger projects.
- Goal is to completely refresh national elevation data holdings with new LIDAR elevation products.
- Currently in year 6. The original goal is to acquire national coverage in 8 years to serve a broad range of applications.

Project Awards – In FY 21 the 3DEP program offered partnership funding to 19 proposals in 13 states.

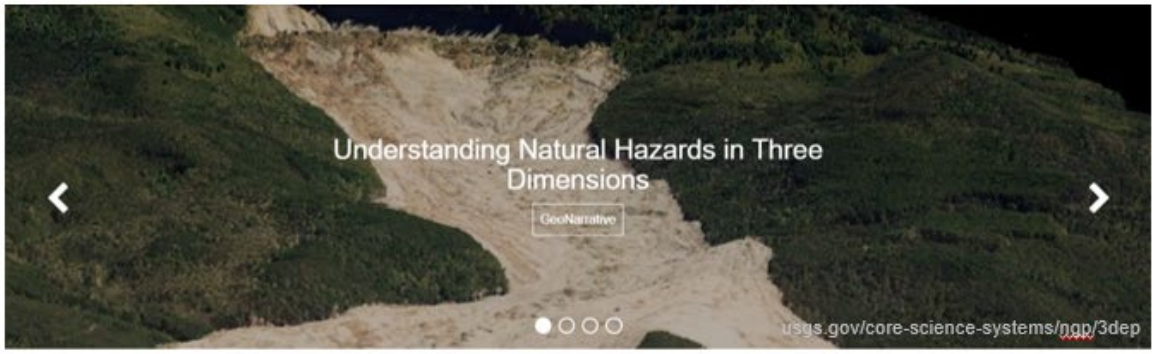


The National Geospatial Program

USGS science for a changing world

The National Map
Your Source for Topographic Information

Access 3DEP Data: nationalmap.gov/3dep/

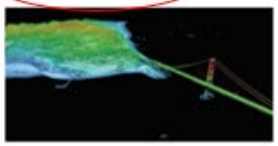


HOME
WHAT IS 3DEP?
GOVERNANCE
COLLABORATION AND PARTNERSHIPS
PROGRAM BENEFITS AND USES
STANDARDS AND SPECIFICATIONS
DATA & TOOLS
PUBLICATIONS
NEWS

Home

To respond to growing needs for high-quality elevation data, the goal of 3DEP is to complete acquisition of nationwide lidar (IfSAR in AK) by 2023 to provide the first-ever national baseline of consistent high-resolution topographic elevation data – both bare earth and 3D point clouds – collected in a timeframe of less than a decade.

Data Download and Visualization



Broad Agency Announcement (BAA)

3DEP Quick Links

- The National Geospatial Program
- Lidar Explorer
- USGS Lidar Specification
- User Engagement Office
- SeaSketch - U.S. Mapping Coordination
- U.S. Interagency Elevation Inventory

USGS science for a changing world

The National Map
Your Source for Topographic Information

Deliverables

- Classified Point Cloud – includes bare earth surface
- Bare Earth Surface Raster Digital Elevation Models
- Breaklines – as required for hydro flattening
- Control with QA/QC report
- Metadata, Project Report, Acquisition Report, and intensity images
- No contours due to cost – contours will be developed by NRCS on some projects – Auburn office.

Deliverables

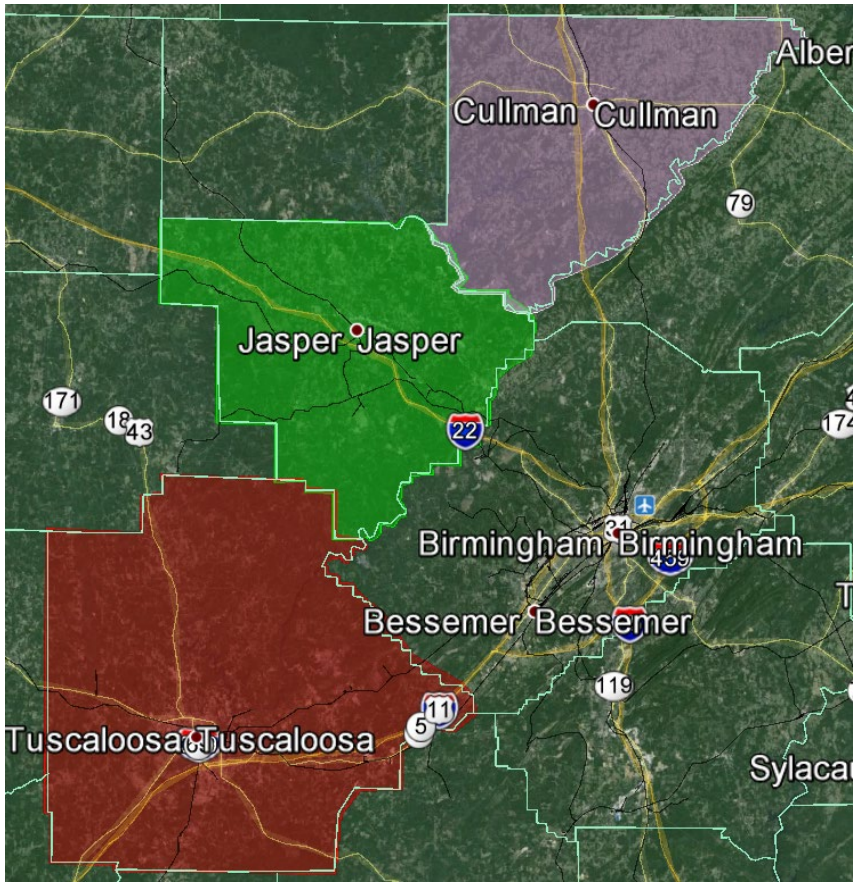
- All data collected thus far is Quality Level 2 (QL2).
- No less than 2 points per square meter
- RMSEz – less than or equal to 10 cm (0.33') – equivalent to a one foot contour
- Field survey for QA/QC of data
- All data will be available thru The National Map (USGS).

Table 1. Quality Levels for LiDAR Horizontal Resolution and Vertical Accuracy					
Elevation Quality Levels (QL)	Source	Horizontal Resolution Terms		Vertical Accuracy Terms	
		Point Density	Nominal Pulse Spacing (NPS)	Vertical RMSEz	Equivalent Contour Accuracy
QL 1	LiDAR	8 pts/m_2	0.35 m	9.25 cm	1-ft
QL 2	LiDAR	2 pts/m_2	0.7 m	9.25 cm	1-ft
QL 3	LiDAR	1 – 0.25 pts/m_2	1 – 2 m	≤18.5 cm	2-ft

2015 – 3DEP Grant Response

- Coordinated by the Alabama Geographic Information Program Office to acquire 2900 square miles of data.

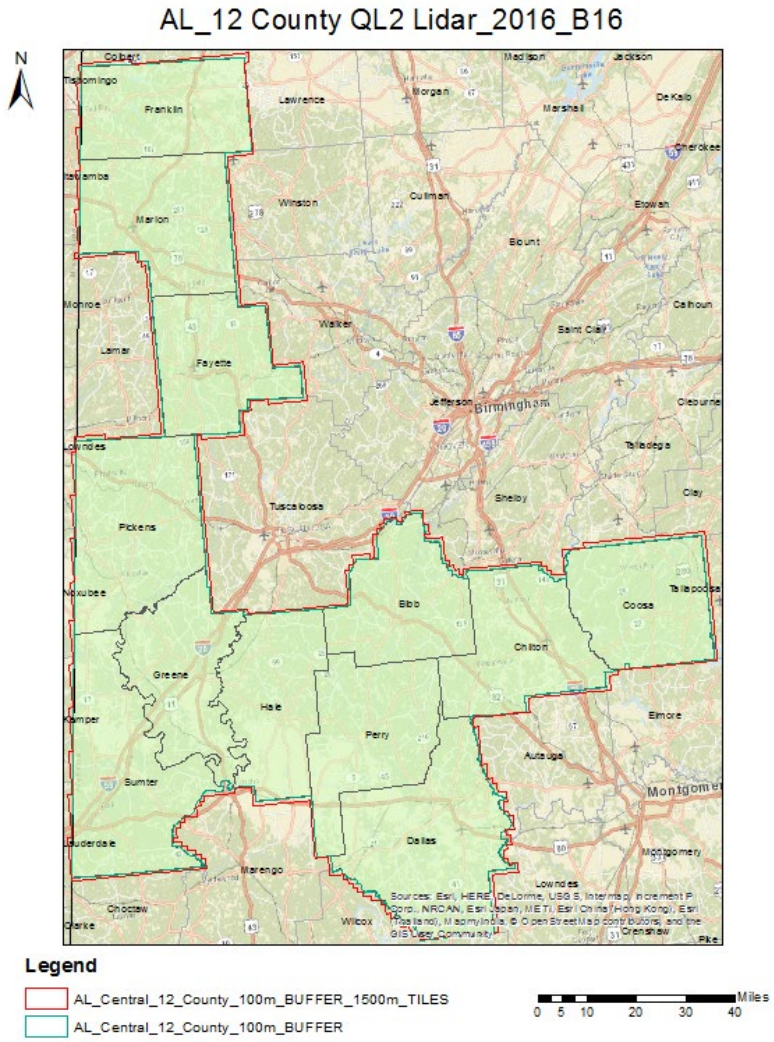
Funding Commitments	
Cullman County	$50,000
Tuscaloosa County	$50,000
Walker County	$50,000
NRCS	$50,000
ALDOT	$75,000
TVA	$15,000
sub-total	**$290,000**
Project Cost	$654,750
Grant Request	**$364,750**



2016 – 3DEP Grant Response

- Grant submitted from Alabama GIS Program Office and Office of Water Resources 8,843 square miles of LIDAR.

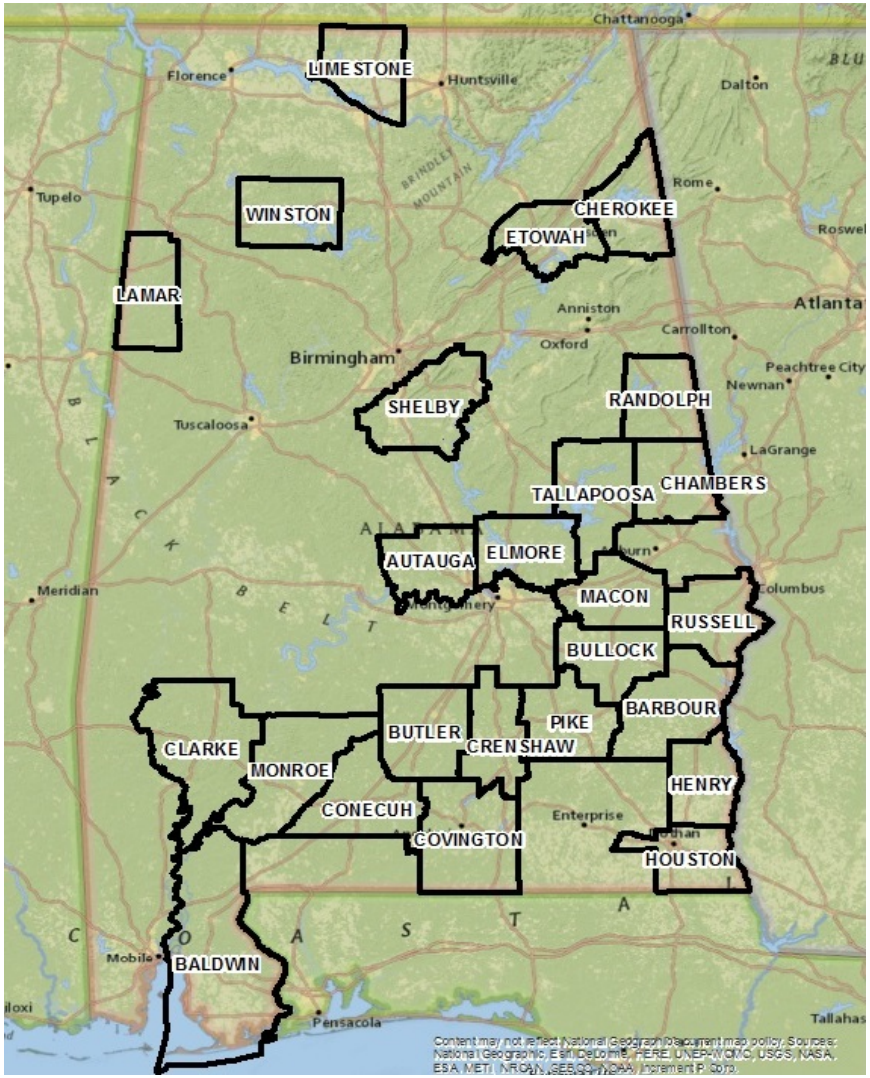
Funding Commitments	
Franklin County	$15,000
NRCS	$10,000
TVA	$5,000
OWR	$200,000
ALDOT	$200,000
sub-total	**$430,000**
Project Cost	$795,870
Grant Request	**$365,870**



2017 – 3DEP Grant Response

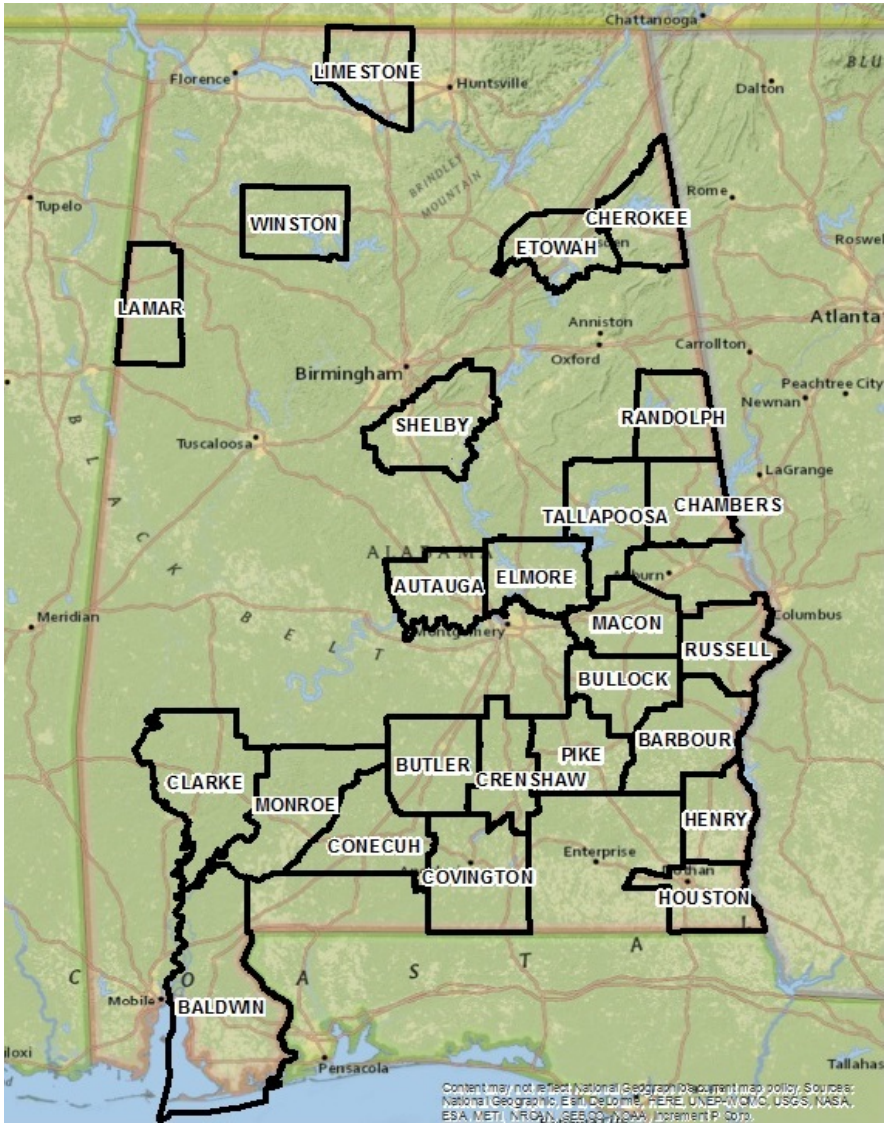
- Grant submitted from Alabama GIS Program Office for 18,845 square miles of LIDAR in 25 counties.

Funding Commitments	
Russell County	$5,000
NRCS - Auburn	$40,000
NRCS - Ft. Worth	$100,000
TVA	$25,000
OWR	$878,600
ALDOT	$100,000
sub-total	**$1,148,600**
Project Cost	$1,708,488
Grant Request	**$559,888**



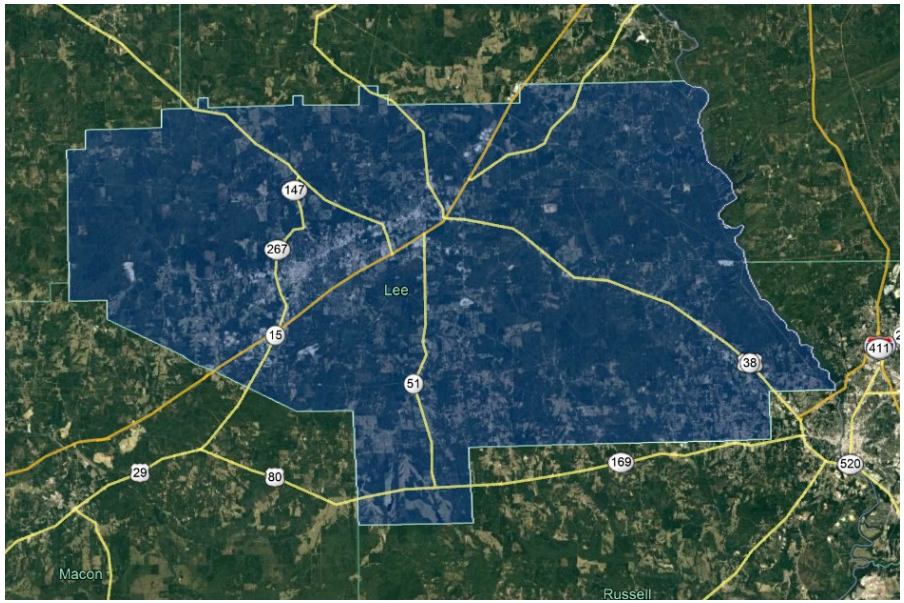
2017 – 25 County Project Status

- Acquisition began in February of 2017. Resumed in 2018 with re-flights in 2019
- Final delivery March of 2020.



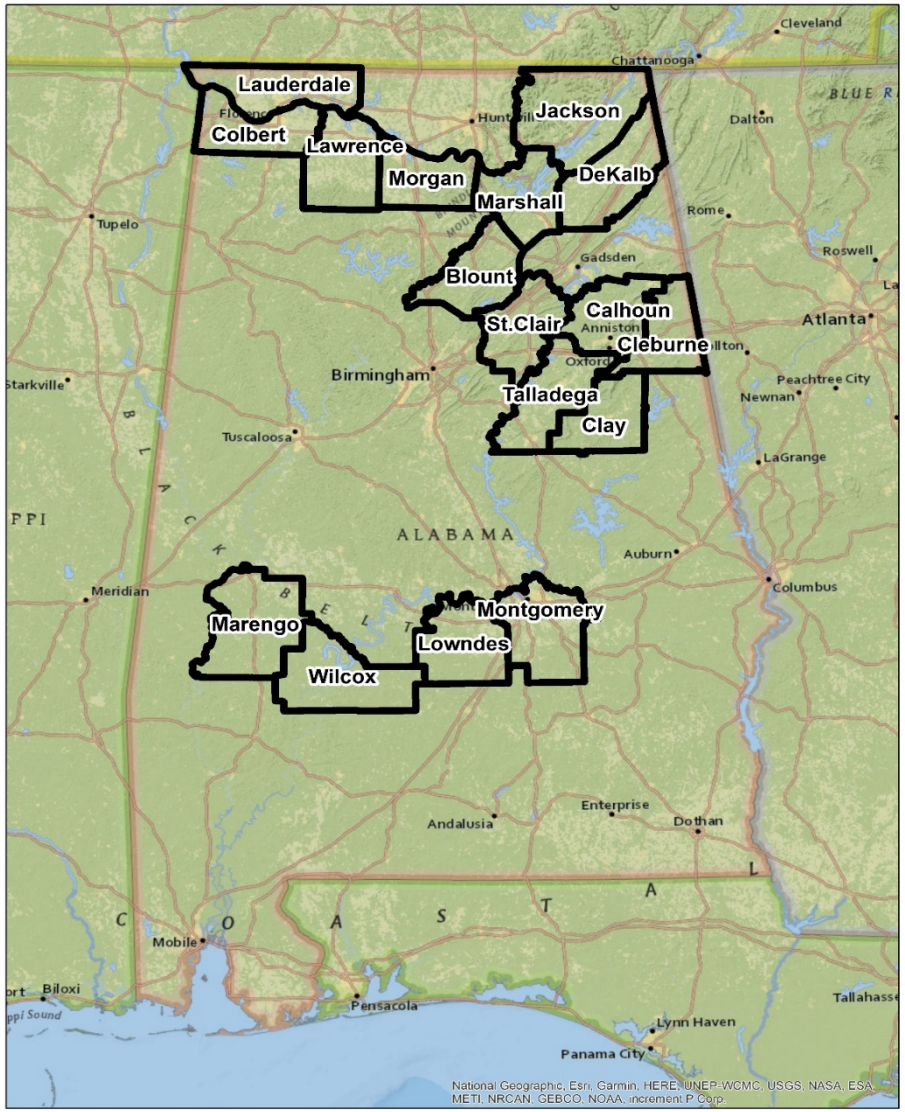
2019 – Madison and Lee Counties

- Madison County project initiated by Huntsville Utilities.
- Lee County project included with Georgia Geographic Information Office (GIO).
- Data acquired in 2019/2020 flying season.
- Data has been delivered to USGS and is going thru QA/QC.



2020 – 17 County Project Status

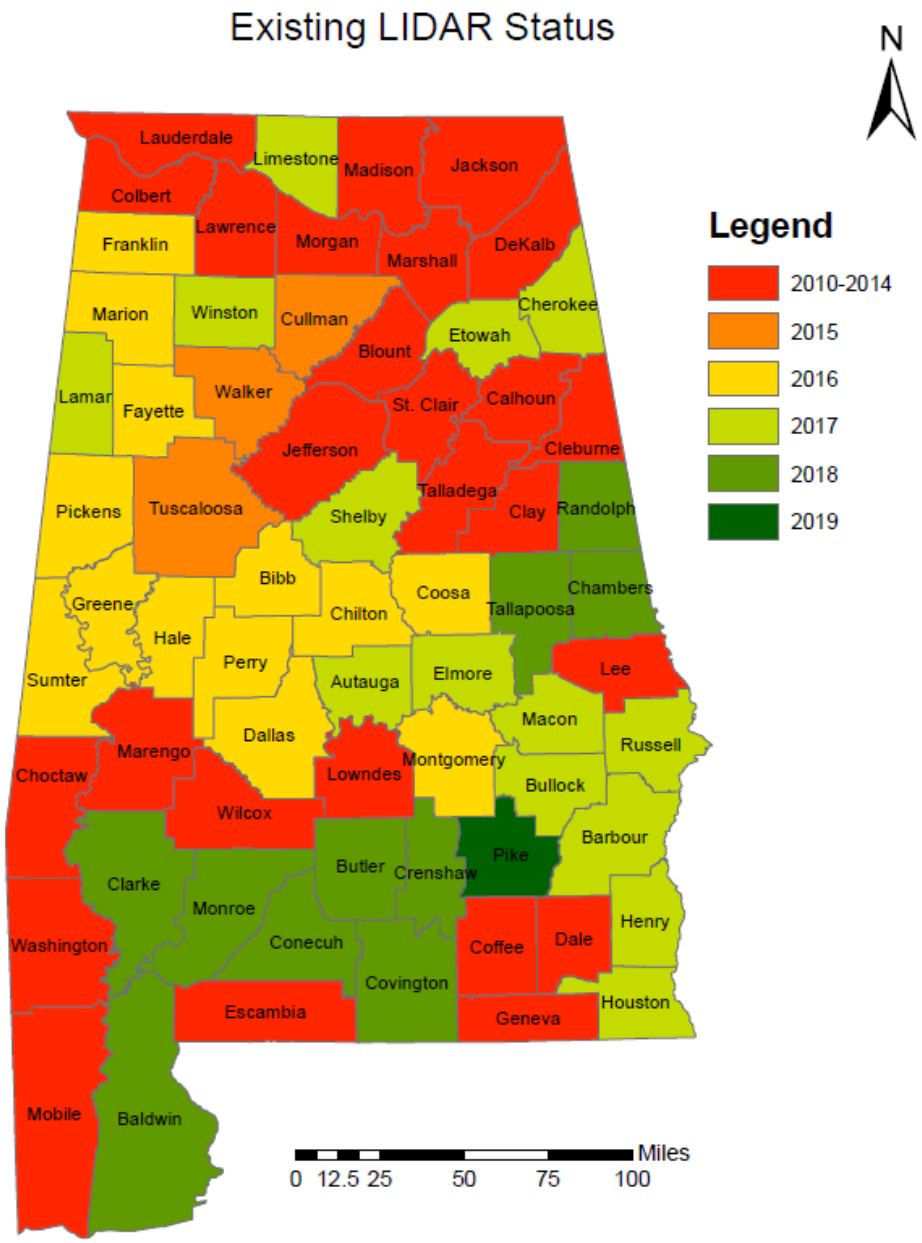
- Project proposal accepted by USGS in January of 2020.
- Acquisition began in December of 2020
- Project was put on hold due to funding issue.
- Final delivery was expected in fall of 2021, but this could change?



2021 – 4 County Project Status

- Project initiated by NRCS.
- Acquisition should began in December of 2021?
- Final delivery expected fall of 2022.
- Entirely funded by NRCS.

Current LIDAR Status



- County Wide LIDAR Collections
- Does not include projects that have not been delivered to USGS for QA/QC
- Counties in red (2010-2014) were collected at various specifications – mostly QL3 data.

Future Needs

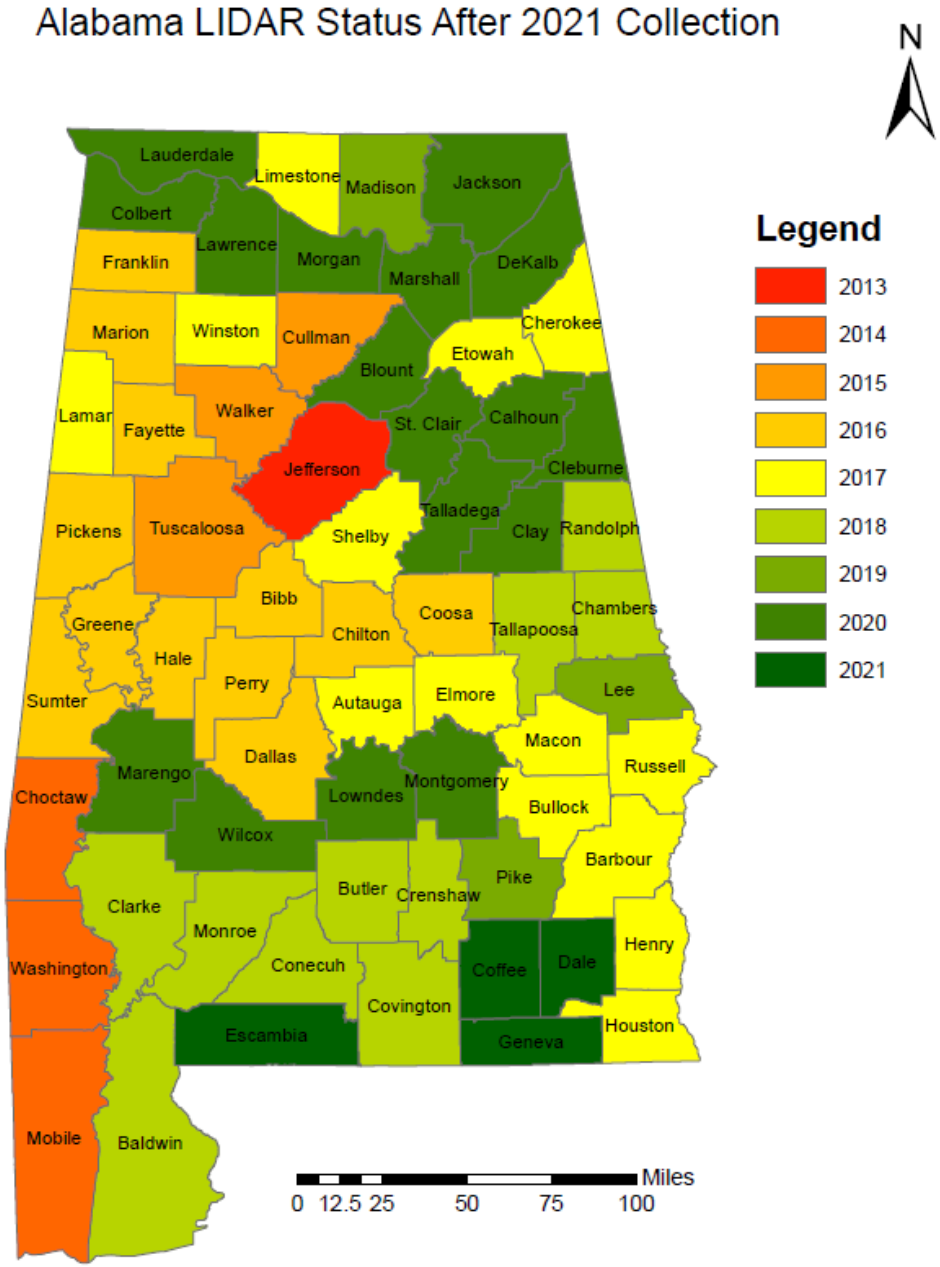
Upcoming 2021 USGS 3DEP Proposal

- Choctaw/921 miles/$138,150
- Jefferson/1125 miles/$168,750
- Mobile/1265 miles/$189,750
- Washington/1090 miles/$163,500

- Total
  - 4401 sq. miles = $660,150 +/-

Add Cullman, Tuscaloosa, Walker?
2900 miles/$435,000

Total for 7 counties = $1,095,150

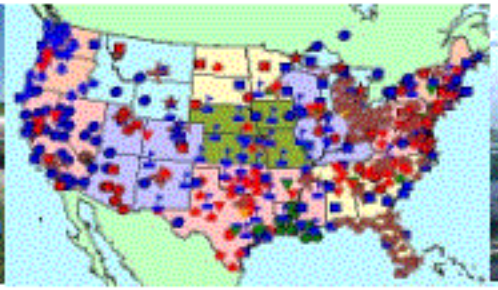


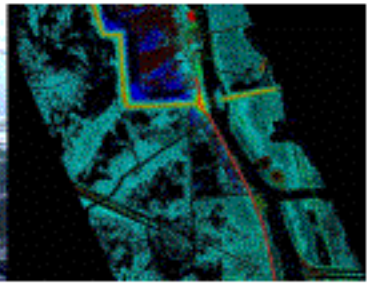
Summary

- Depending on the year data was collected, and the amount of development in a county we should be looking at a 6-8 year refresh rate at the least.
- Plan now – work with local agencies to gain support and funding.
- Communicate with state agencies about upcoming needs.
- Estimated cost of LIDAR is $150 per square mile +/-. Average county size of 800 square miles = $120,000.
- USGS and other federal partners are contributing 1/3 of the cost toward new projects. The remaining amounts need to come from local/state agencies.

ALDOT Continuously Operating Reference Station (CORS) Network

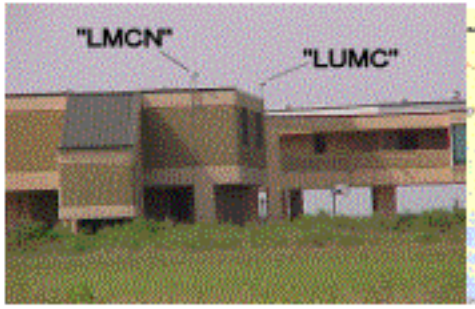
Height Modernization



Definition …

the establishment of accurate, reliable heights using GPS technology in conjunction with traditional leveling, gravity, and modern remote sensing information.




Height Modernization Program

- Initial grant funding to ADOR with funds provided to ALDOT for the survey work.
- Original grant ended in 2009.
- Re-initiated again in 2013 and led by the University of Southern Mississippi – Gulf Coast group – TA&M, LSU, USM, ALDOT, UF.
- Currently in year 7 of funding.
- Lower amount – mainly used for CORS maintenance and some geodetic work.

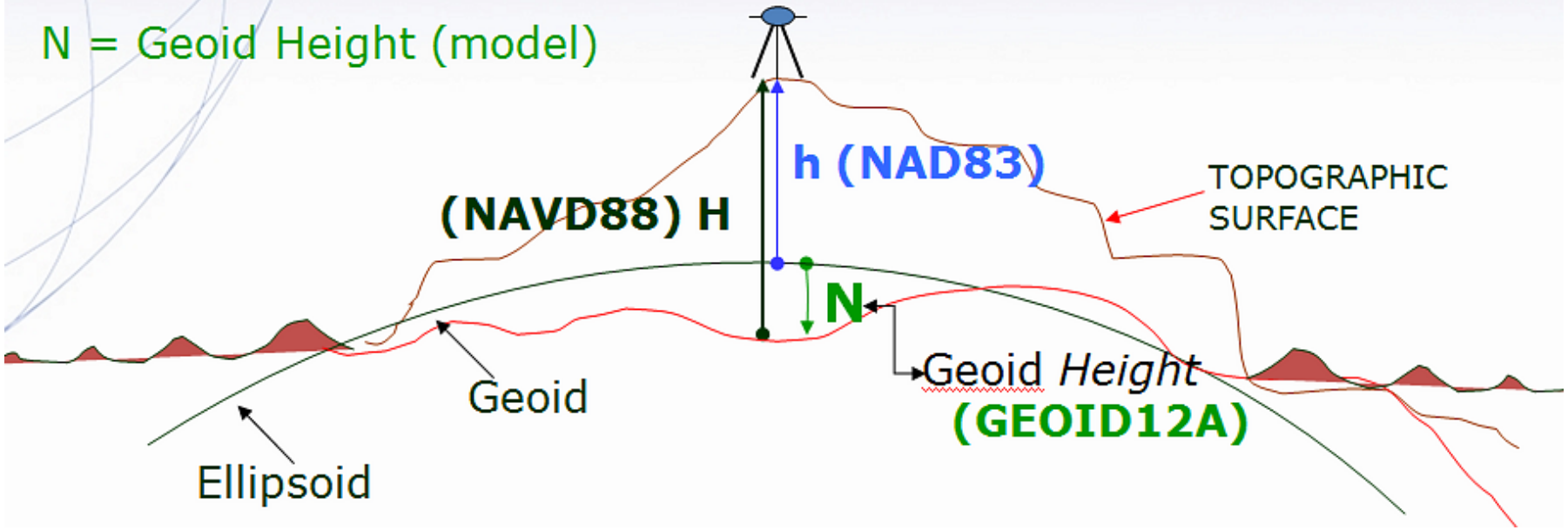
Ellipsoid, Geoid, and Orthometric Heights

H = Orthometric Height (leveling)

h = Ellipsoidal Height (GPS)

N = Geoid Height (model)

H = h - N



Improving Heights obtained with GPS = Improving the GEOID Model

1 -Establish Network of marks with GPS to obtain good Ellipsoid Heights

2 - Establish good leveled heights on marks with good ellipsoid heights

3 - Utilize GPS benchmarks in development of new GEOID models to improve 3-d positioning with GPS.

4 - Establish network of Continuously Operating Reference Stations (CORS) to provide access to reliable positioning with GPS

Leveling Projects to support Primary and Secondary GPS Projects and establish NAVD 88 Heights on ARP of CORS

Phase I – FBN Leveling

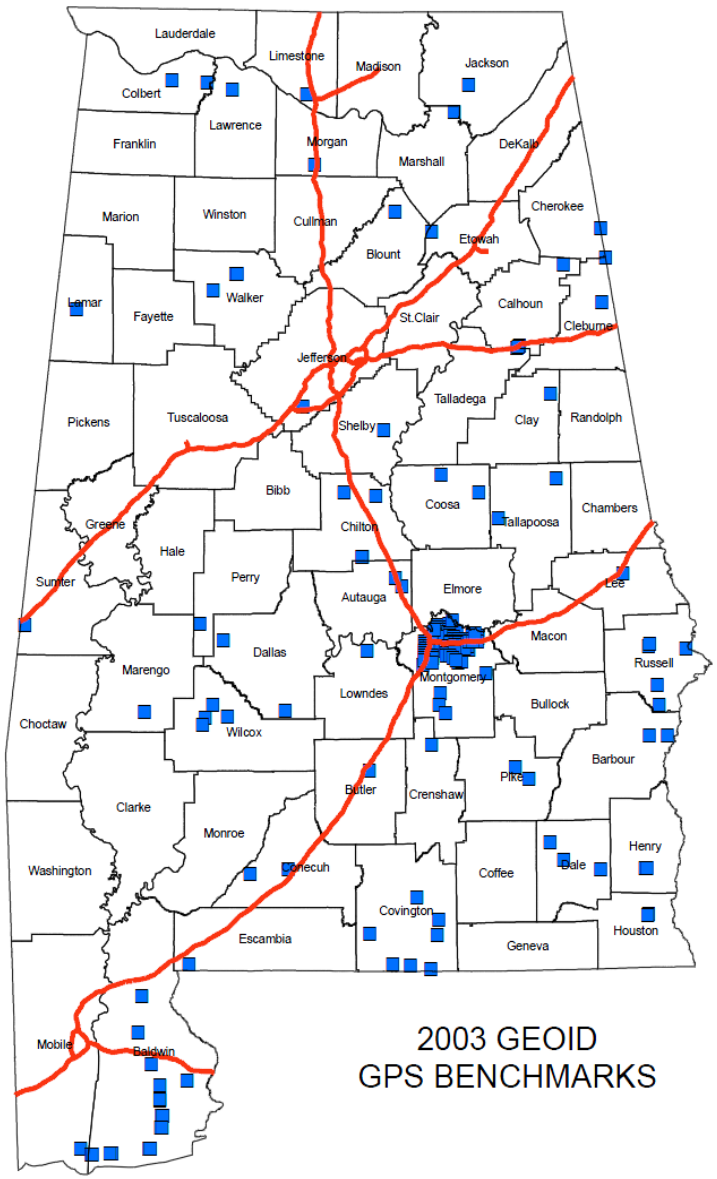
- Second Order Class I Leveling
- 545 miles w/ 324 new Benchmarks
- Field work is complete and has been published by NGS.

Phase II – CORS Leveling

- Second Order Class I Leveling to Antenna Reference Plane (ARP) of CORS sites
- Field work complete.
- Includes an additional 40 miles of First Order Class II leveling to verify Dauphin Island line.
- Includes ties to tidal benchmarks at Dauphin Island and Mobile Docks
- Phase II Leveling Total = 282 miles

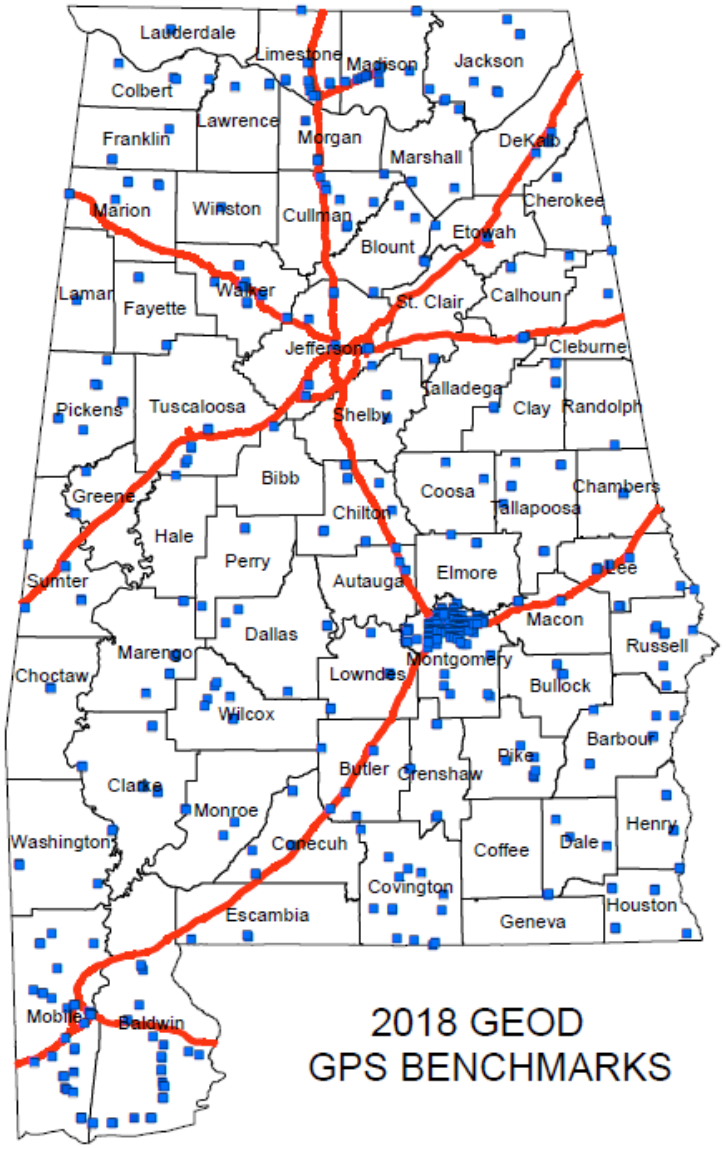
2003

- GEOID03 = 181 Marks



2018

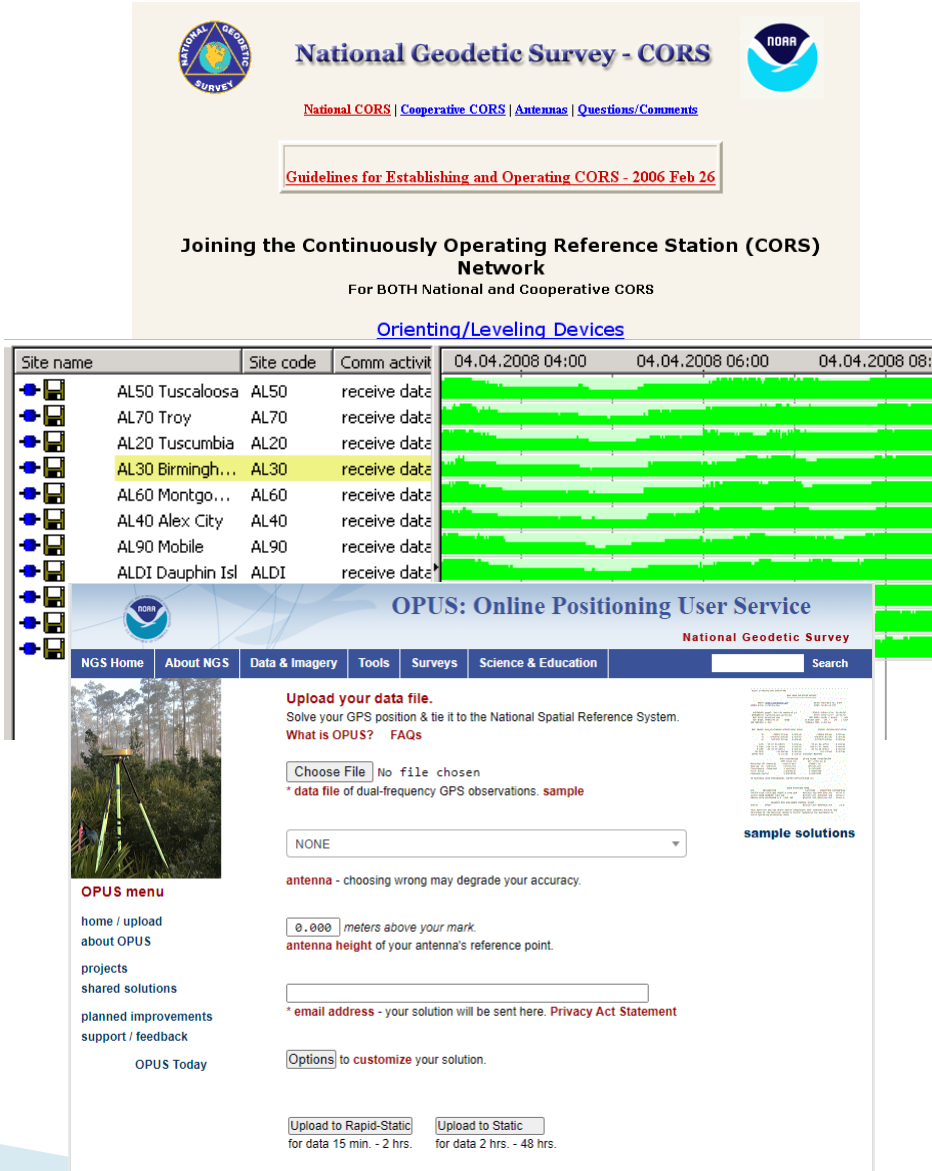
GEOID12A = 468 Marks

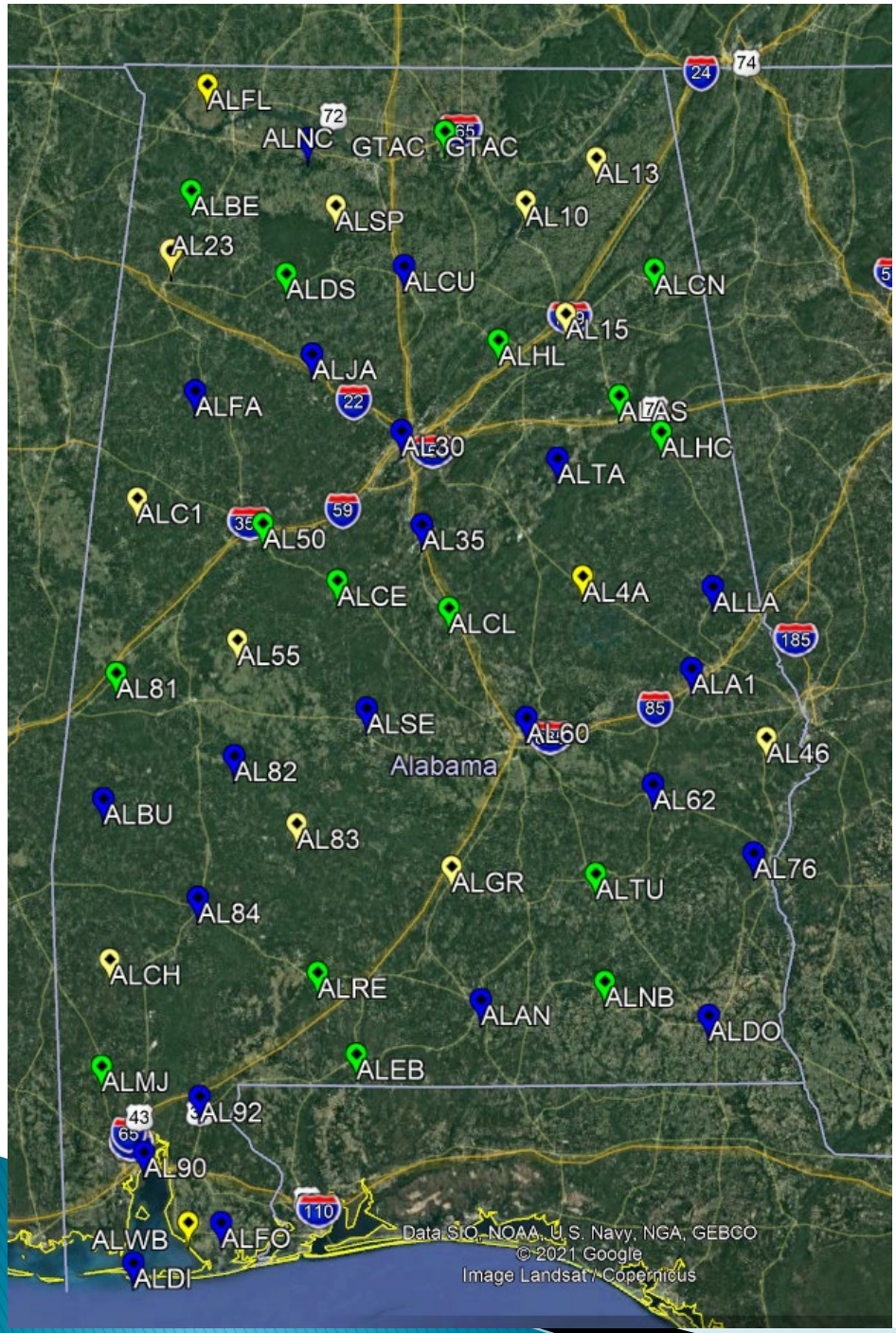


Alabama CORS Network

- **Reliable, Consistent, Easily Accessible Positioning.**

- NGS established guidelines for installation and maintenance to ensure quality, stable sites.
- GPS data is checked daily to verify position
- Rinex data provided through NGS User Friendly CORS web site to easily access data for post-processing.
- OPUS – On Line Positioning User Service.
- OPUS – S, OPUS – RS and OPUS – DB
- Easily broadcast Real Time Kinematic corrections to users in the field for fast, reliable positioning.





Status of Continuously Operating Reference Station Network as of April, 2021

-35 sites accepted as National CORS

- Remaining sites do not meet the spacing requirements required by NGS – 70 km.

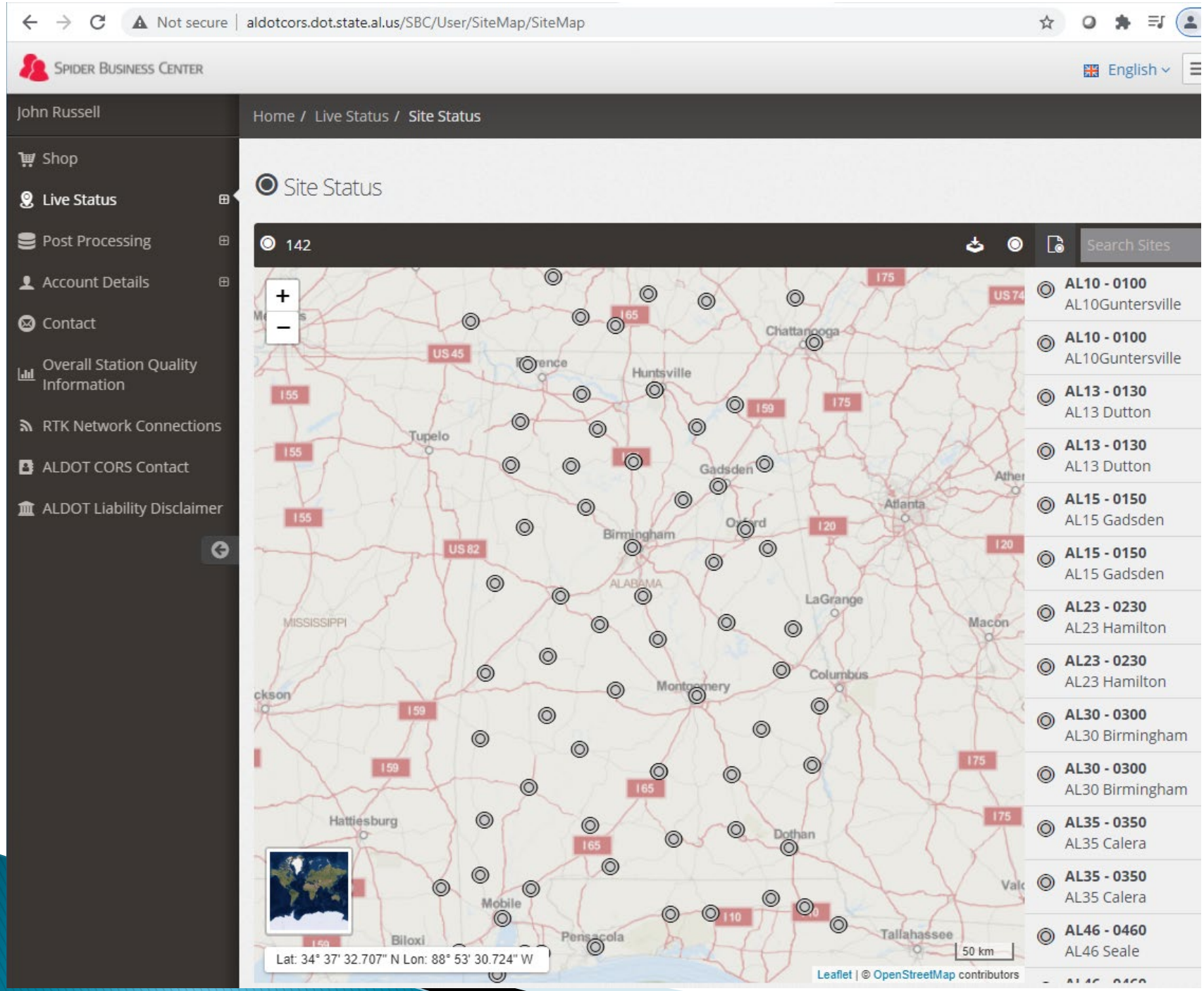
- 53 total sites operational

-1000+ users registered

CORS Data

http://aldotcors.dot.state.al.us/SBC

- First time – set up login and password and provide email.
- Provides notices to issues or problems with the network.
- Download Rinex Data from NGS and non-NGS sites.
- RTK Connection information.
- Site Overview and Quality
- Coordinate Computation Service
- Virtual Rinex Service


Not secure | aldotcors.dot.state.al.us/SBC/User/SiteMap/SiteMap
Spider Business Center
English
John Russell
Home / Live Status / Site Status
Shop
Live Status
Post Processing
Account Details
Contact
Overall Station Quality Information
RTK Network Connections
ALDOT CORS Contact
ALDOT Liability Disclaimer
Site Status
142
Search Sites
AL10 - 0100
AL10Guntersville
AL10 - 0100
AL10Guntersville
AL13 - 0130
AL13 Dutton
AL13 - 0130
AL13 Dutton
AL15 - 0150
AL15 Gadsden
AL15 - 0150
AL15 Gadsden
AL23 - 0230
AL23 Hamilton
AL23 - 0230
AL23 Hamilton
AL30 - 0300
AL30 Birmingham
AL30 - 0300
AL30 Birmingham
AL35 - 0350
AL35 Calera
AL35 - 0350
AL35 Calera
AL46 - 0460
AL46 Seale
Chattanooga
Huntsville
Tupelo
Gadsden
Atlanta
Birmingham
Oxford
LaGrange
Macon
Columbus
Montgomery
Hattiesburg
Dothan
Mobile
Biloxi
Pensacola
Tallahassee
ALABAMA
MISSISSIPPI
Lat: 34° 37' 32.707" N Lon: 88° 53' 30.724" W
50 km
Leaflet | © OpenStreetMap contributors

Monitoring data integrity

- Automated system that constantly computes baselines between stations.
- Flags the site and notifies the manager when a station is out of tolerance.

Status:

Status	Name	Communications	Last Change	Longitudinal [m]	Transverse [m]	Height [m]	CQ [m]
	AL10-AL13	Receiving Data	2021/05/04 12:59:59	-0.001	-0.000	-0.051	0.000
	AL10-AL15	Receiving Data	2021/05/04 12:59:59	-0.003	+0.005	+0.081	0.000
	AL10-ALCN	Receiving Data	2021/05/04 12:59:59	+0.011	+0.002	-0.052	0.000
	AL10-ALCU	Receiving Data	2021/05/04 12:59:59	-0.002	+0.001	+0.003	0.000
	AL10-ALHL	Receiving Data	2021/05/04 12:59:59	-0.005	+0.010	+0.046	0.000
	AL10-GTAC	Receiving Data	2021/05/04 12:59:59	-0.002	-0.006	-0.021	0.000
	AL50-AL30	Receiving Data	2021/05/04 12:59:59	+0.029	+0.001	+0.135	0.001
	AL50-AL35	Receiving Data	2021/05/04 12:59:59	+0.031	+0.009	+0.017	0.000
	AL50-AL55	Receiving Data	2021/05/04 12:59:59	+0.013	+0.003	-0.006	0.000

CORS Team

Manager (Office) – Kyle Green

- Monitors the system daily.
- Sets up users for access to the web page.
- Troubleshoots problems along the data chain
- Provides support to user questions/issues
- Provides notices to users about problems with the network and upcoming maintenance on hardware/software.

CORS Team

Manager (Field) – Robert Harris

- Inspects sites for maintenance issues.
- Performs troubleshooting on all aspects of the actual site and network connections
- Performs recon for new site installations
- Complete site installation to include mounts, power, network, and site logs.
- Performs computation of site positions on new installs.
- Configures and manages the web page.
- Troubleshoots problems along the data chain
- Provides support to user questions/issues

CORS – Results

Under ideal circumstances – See NGS RT Positioning Guidelines

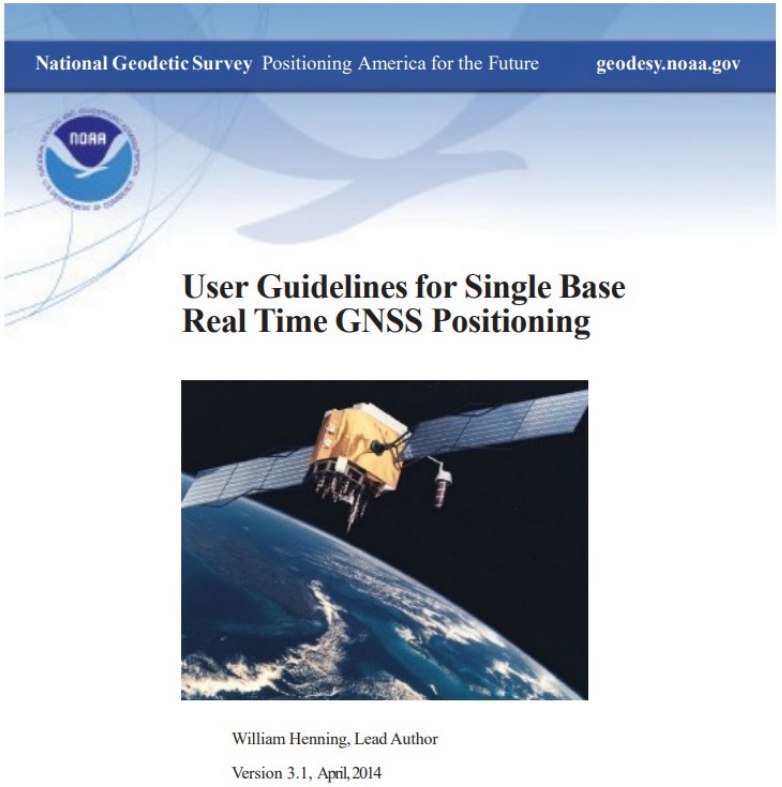
Single Base Line Solution

- Connects the user directly to a site, or to the nearest site
- Uses only one CORS to determine position
- Horizontal within 0.06 feet*
- Vertical can be out as much as 0.20 feet*

Network Solution

- Connects the user directly to the nearest site
- Uses data from the surrounding sites to model the error
- Horizontal within 0.03 feet*
- Vertical within 0.06 feet*

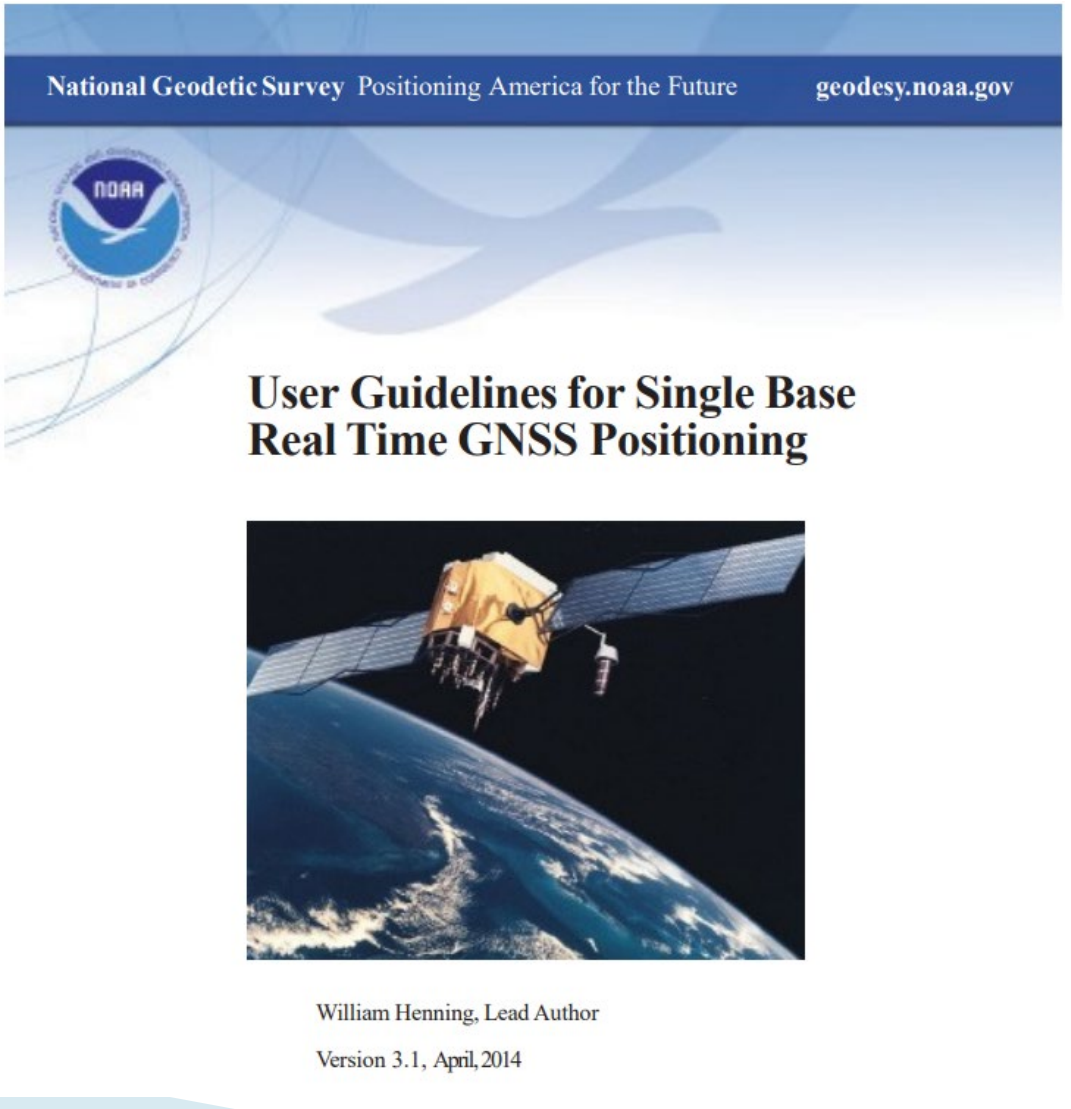
*** Repeatable values – may not tie this well due to local conditions and depends on distance to base. Closer to base = improved elevations. May not tie well into the project control.**



http://www.ngs.noaa.gov

User Guidelines for Real Time GNSS Positioning Version 3.1

- Equipment
- RT GNSS Positioning
- Field Procedures
- Communications
- Project design
- Office Work
- Best Practices
- Accuracy Classes



Accuracy Classes

ACCURACY CLASS SUMMARY TABLE				
	CLASS RT1	**CLASS RT2**	**CLASS RT3**	**CLASS RT4**
ACCURACY (TO BASE)	0.015 HORIZONTAL., 0.025 VERTICAL	0.025 HORIZONTAL., 0.04 VERTICAL	0.05 HORIZONTAL., 0.06 VERTICAL	0.15 HORIZONTAL., 0.25 VERTICAL
REDUNDANCY	≥ 2 LOCATIONS, 4-HOUR DIFFERENTIAL	≥ 2 LOCATIONS, 4-HOUR DIFFERENTIAL	NONE	NONE
BASE STATIONS	≥ 2 , IN CALIBRATION PROJECT CONTROL	RECOMMEND 2 IN CALIBRATION	≥ 1 , IN CALIBRATION	≥ 1 , IN CALIBRATION RECOMMENDED
PDOP	≤ 2.0	≤ 3.0	≤ 4.0	≤ 6.0
RMS	≤ 0.01 M	≤ 0.015 M	≤ 0.03 M	≤ 0.05 M
COLLECTION INTERVAL	1 SECOND FOR 3-MINUTES	5 SECONDS FOR 1-MINUTE	1 SECOND FOR 15 SECONDS	1 SECOND FOR 10 SECONDS
SATELLITES	≥ 7	≥ 6	≥5	≥ 5
BASELINE DISTANCE	≤ 10 KM	≤ 15 KM	≤ 20 KM	ANY WITH FIXED SOLUTION
TYPICAL APPLICATIONS	PROJECT CONTROL CONSTRUCTION CONTROL POINTS CHECK ON TRAVERSE, LEVELS SCIENTIFIC STUDIES PAVING STAKE OUT	DENSIFICATION CONTROL TOPOGRAPHIC CONTROL PHOTOPOINTS UTILITY STAKE OUT	TOPOGRAPHY CROSS SECTIONS AGRICULTURE ROAD GRADING SITE GRADING	SITE GRADING WETLANDS GIS POPULATION MAPPING ENVIRONMENTAL

Modernization of the National Spatial Reference System (NSRS)

- NAD 83 and NAVD 88 have shortcomings that are best addressed through defining new horizontal and vertical datums.
- NAD 83 is non-geocentric by 2.2 meters
- NAVD 88 has about a half-meter bias, and is tilted about 1 meter coast to coast relative to the best global GEOID models available.
- Both datums were derived from conventional (old-school) survey techniques at passive geodetic marks. This network deteriorates and moves with the earth's surface (subsidence, continental drift, construction).
- NAVD 88 is difficult to maintain (leveling costs).

Naming Conventions

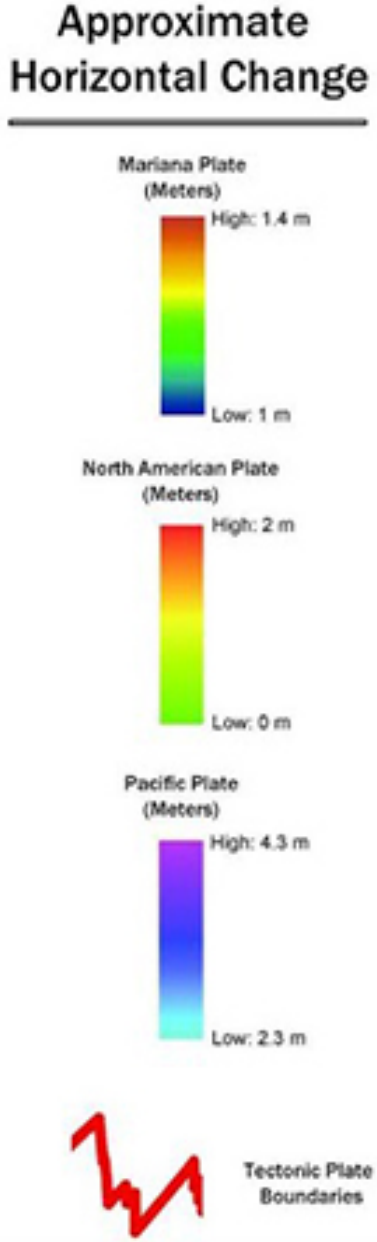
NATRF2022 – North American Terrestrial Reference Frame of 2022.

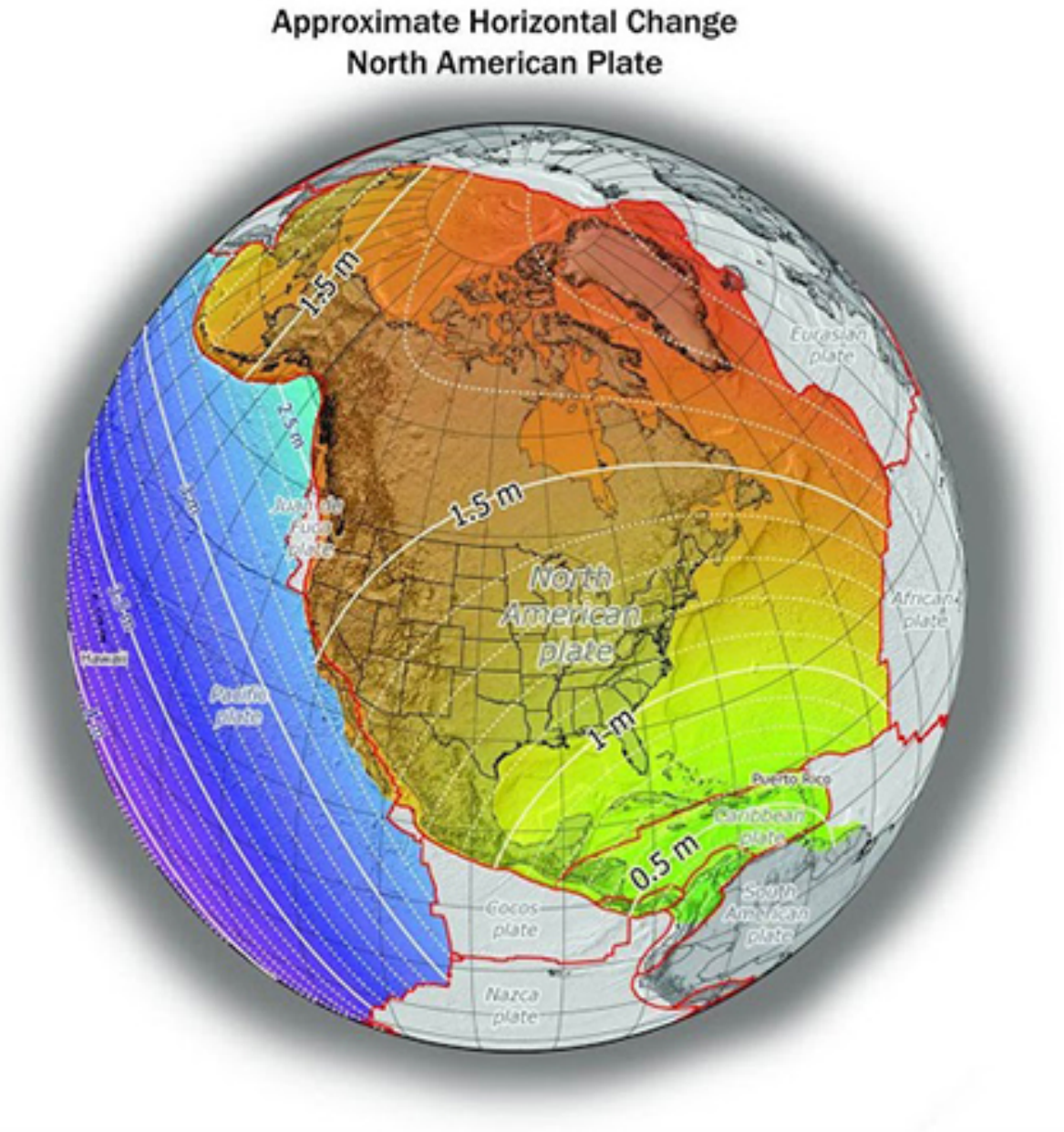
- Defined with years of satellite data observed at numerous CORS across the country.

NAPGD2022 – North American-Pacific Geopotential Datum of 2022

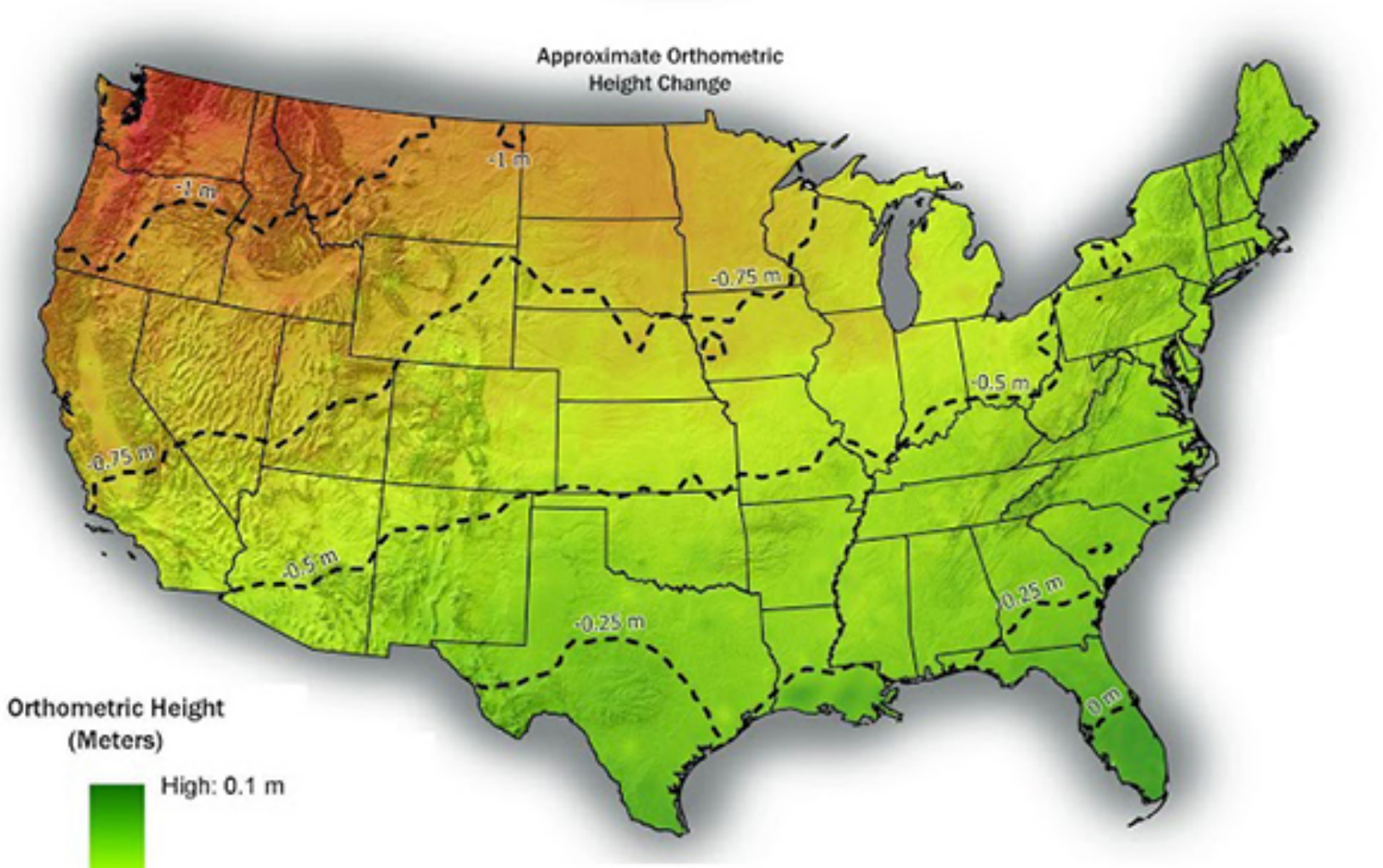
- Defined with airborne gravity acquired by NGS over the past 10 years.

What to expect: coordinates will change!





Elevations will change



How to prepare

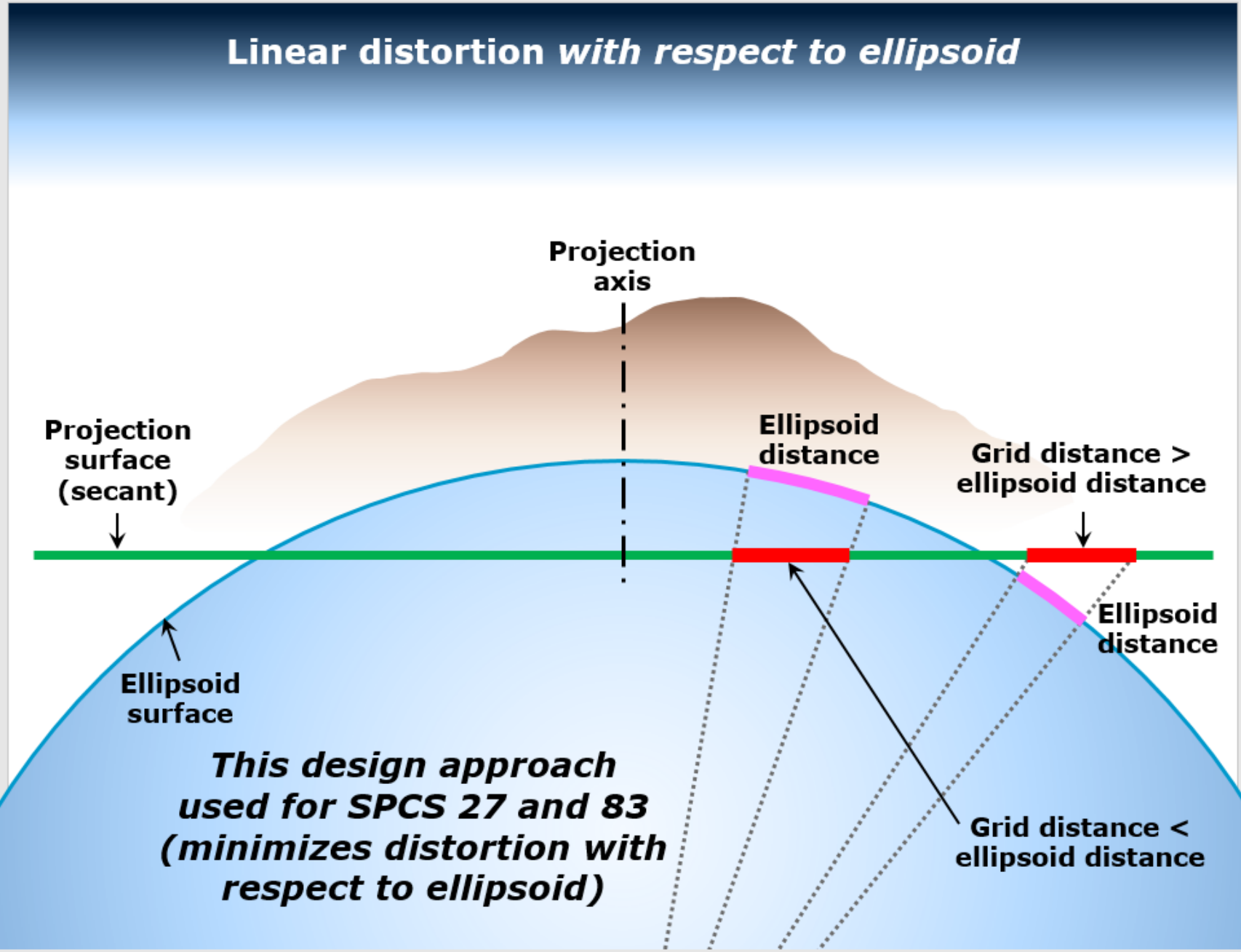
- Tools will be available to transform data from 83 to 22 (horizontal), and 88 to 22 (vertical). This tool will also allow you to transform coordinates between any known datums.
- NGS has been working with software developers to include these transformation models in software packages – CAD, GIS, Survey software. Depending on accuracy requirements, you may want to save original GPS data to be re-processed in the new 22 datums or prepare for new observations.
- Record and save your metadata! Which epoch? 83/86, 83/92, 83/96, 83/07, 83/11.
- GPS on Benchmarks to help improve the transformation tools!

Timeline

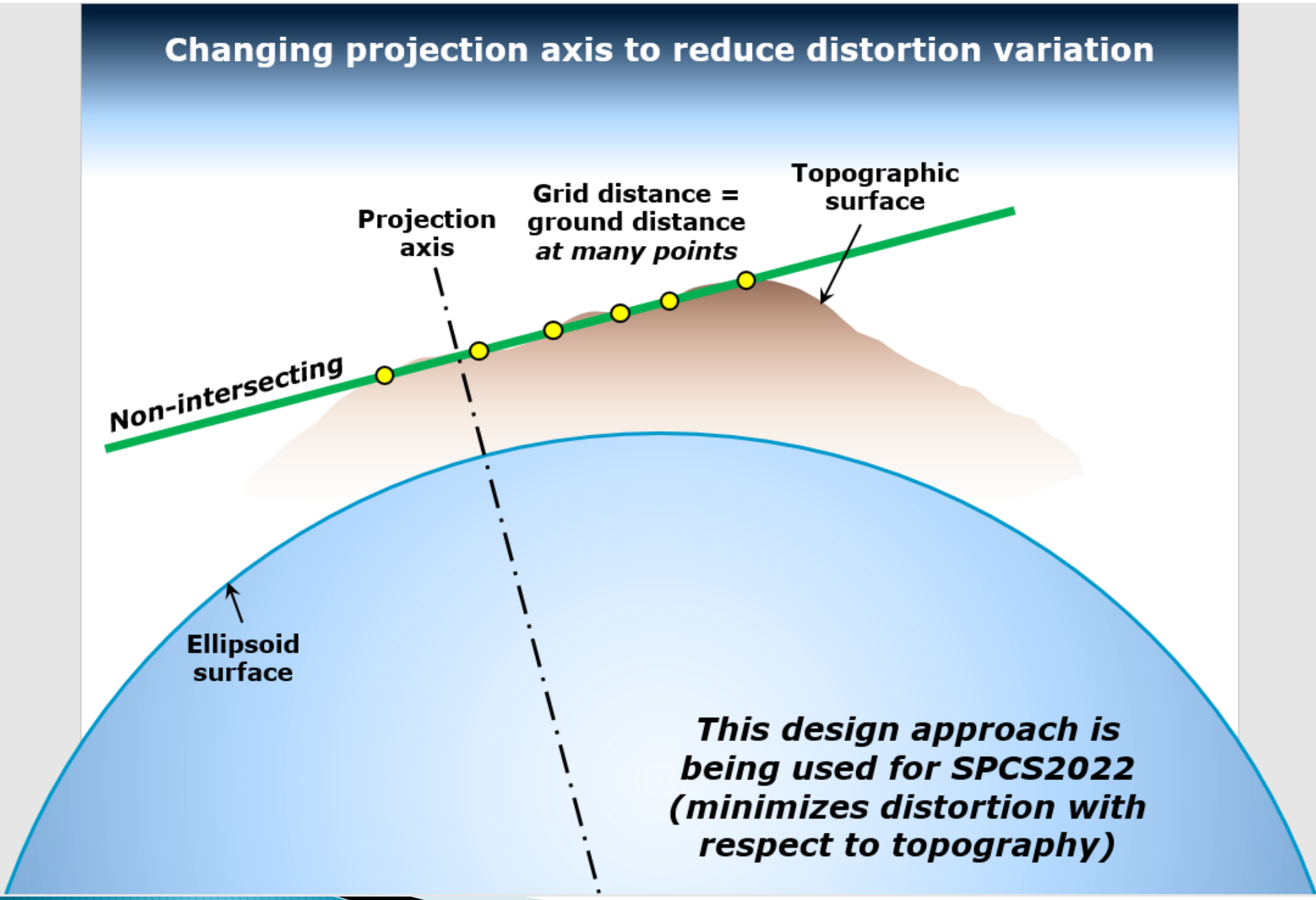
- Originally planned to be released in 2022.
- Vertical datum relies on airborne gravity data collected throughout the US and its territories. This program has had delays due to federal shut-downs, and 2020. Estimate another two years to complete.
- Development of the tools and transformation models are not complete.
- Realistically we are looking at the formal release of the 2022 datums in 2025, or later.

State Plane Coordinate Zones

- Existing Coordinate zones were designed in the early 1920's without the use of computing power, and without the vast amount of geodetic and elevation data currently collected.
- Estimated error ratios between grid and ground was based on heights at the ellipsoid, so the actual error ratios at the surface are worse – some as much as 1 part in 8,000.
- With the change to the 2022 datums, NGS is working with States to develop new zones with a goal of having the majority of the zone at less than one part in 20,000.
- New methods to develop State Plane Grids allow for tilting of the grid to match the existing ground surface reducing these errors.


Linear distortion with respect to ellipsoid
Projection axis
Projection surface (secant)
Ellipsoid distance
Grid distance > ellipsoid distance
Ellipsoid distance
Ellipsoid surface
This design approach used for SPCS 27 and 83 (minimizes distortion with respect to ellipsoid)
Grid distance < ellipsoid distance

Changing projection axis to reduce distortion variation



New State Plane Zones

NGS is allowing a maximum of 3 zone “layers”.

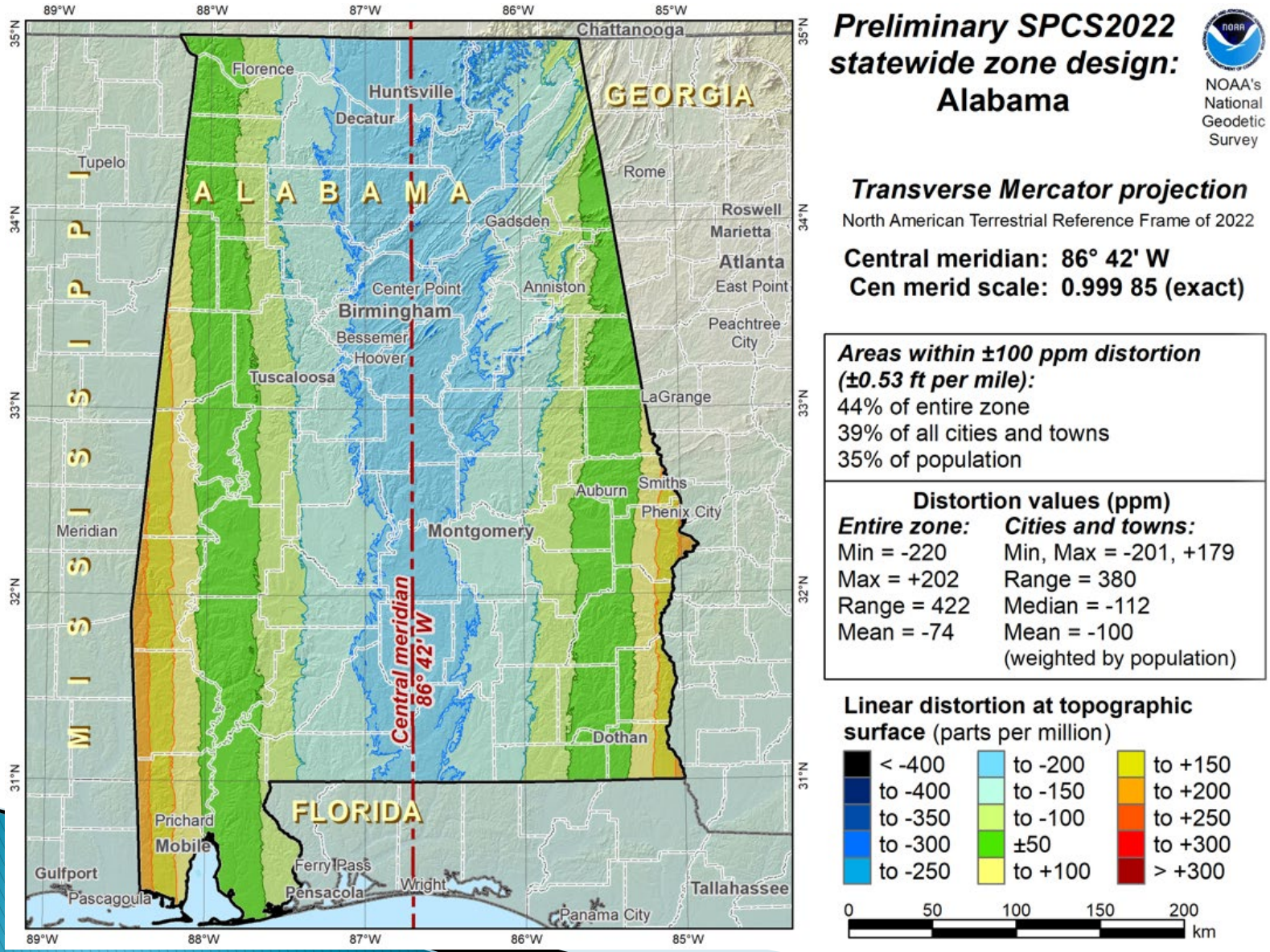
- One must be a statewide zone
- Most states will have a total of 2 layers

Alabama will have 3 layers with a total of 17 zones.

- The first layer will be a statewide layer to replace the UTM Zone 16 that is currently in use for statewide data.
- The second layer will divide the state into 3 zones running south to north.
- The third layer will be a group of smaller zones set up for major urban areas. At this time, there are 13 zones being proposed. This could change.
- NGS hopes to finalize the zones in 2022, but these will not be usable until 2025 or later when the new datums come on line.
- After the release of the 2022 datums, states will still be able to make changes to zones.

Statewide Layer

- This layer will probably be utilized mostly for statewide GIS applications. Maximum error will be no more than 1:5000. UTM had errors up to 1:2500.

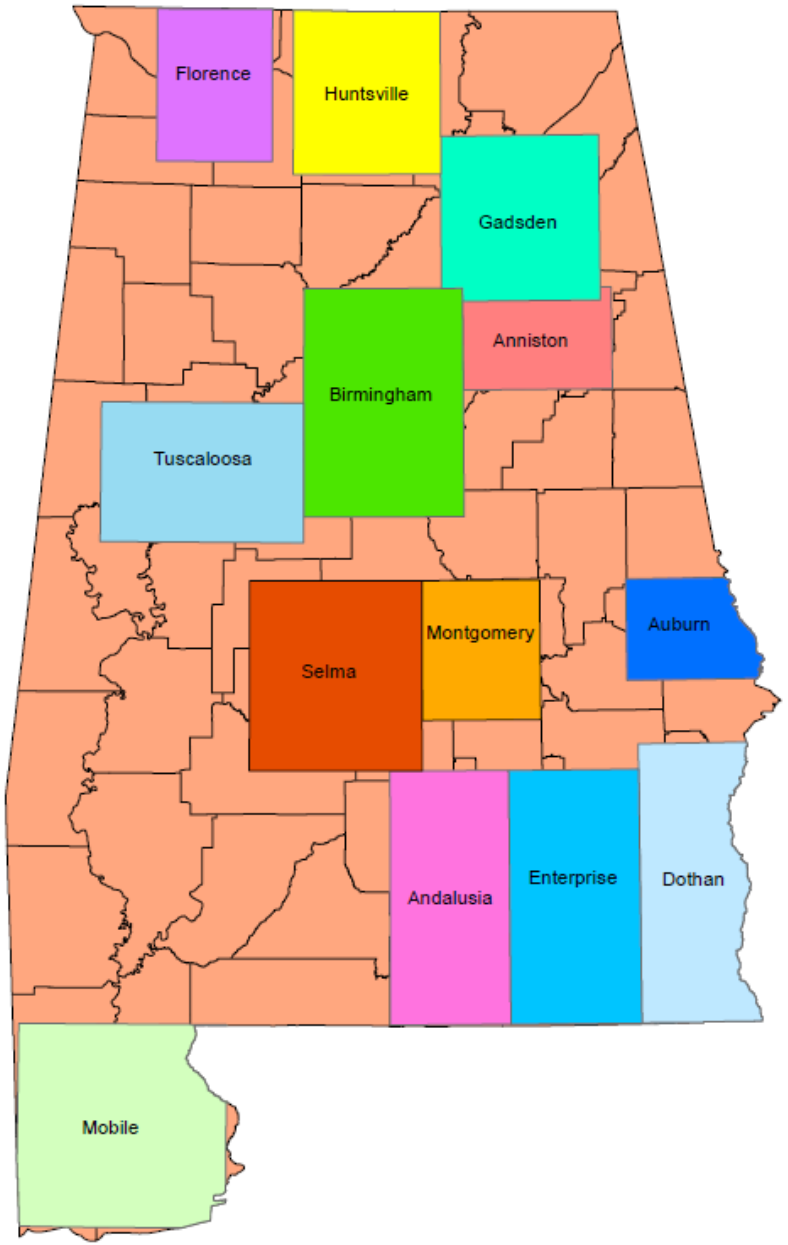


Layer 2 – replaces East and West Zones.

- The original east and west zones split major urban areas – Jeff/St.Clair, Montgomery/Autauga/Elmore, Madison/Limestone

Layer 3 – Smaller zones for urban areas.

- Decrease the amount of distortion or error for local surveyors.
- Preliminary designs, could possibly change.



U.S. Survey Foot will not be used in the new 2022 Datums

Two versions of the “foot” in current use.

- The “old” U.S. Survey Foot = 0.3048006096 M. Used by the survey community.
- The “newer” International Foot = 0.3048 M exactly. Used extensively in other industries.
- The two “feet” differ by 2 parts per million (ppm) or 0.01 ft/mile.
- Causes problems when coordinate systems are not correctly identified and transformed.

Why make the change?

- That was the original intent over 60 years ago. The 1959 legislation stated that the international foot would be used in the next datum change – NAD 83. It did not happen.

Two "feet" is inefficient and causes confusion

- Leads to survey errors that cost money
- Absurd to have "same" unit that differs by 2 ppm.
- Defeats purpose of having a length standard.

- Only recognized in the U.S. for some things.

- NGS Software will support backward-compatibility

Now is the time

- Many other changes will be made to the modernized NSRS
- Changes in foot trivial compared to other changes
- Otherwise U.S. survey foot problems will never go away.

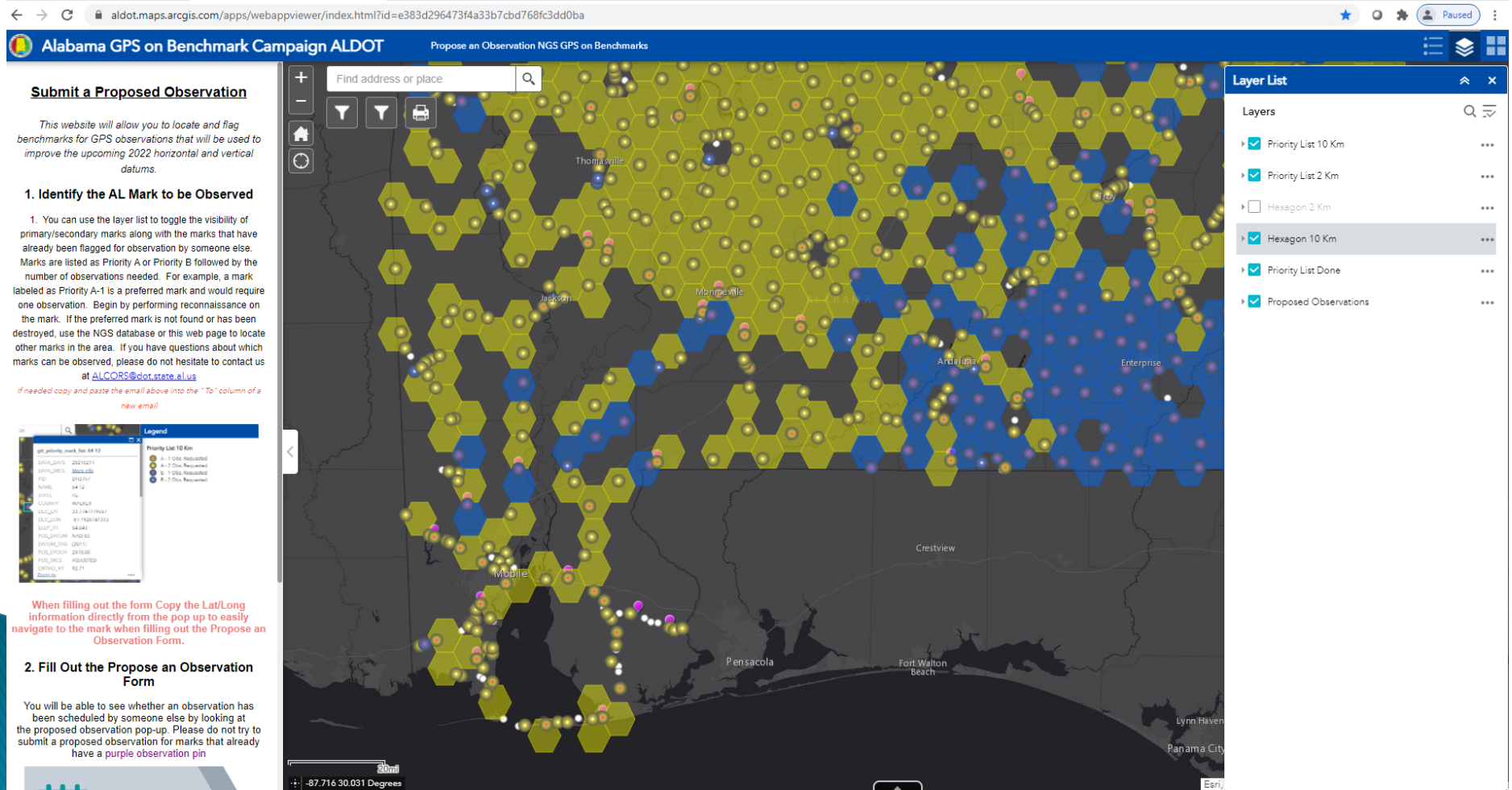
GPS on Benchmarks

- The new datums are being developed from the CORS network, and airborne gravity – geopotential datum.
- Elevation differences will be 0.8 – 1.2 feet across the state.
- Transformation models will be developed, but the accuracy of those models depend on the amount of current GPS data on existing benchmarks.
- Without this new GPS data, transforming data from NAVD 88 to NAPGD 22 would result in “mapping grade” accuracies.
- An accurate transformation model is needed to transform our good elevation data to the new datum.

What can we do?

- Find and observe GPS data on existing published benchmarks.
- Requires at least one 4-hour occupation with a survey grade receiver. Some benchmarks will require two observations.
- Follow the NGS guidelines for pictures and descriptions.
- Submit and share the data to OPUS.
- Marks are identified by priority – A or B, and the number of observations needed – 1 or 2.

https://aldot.maps.arcgis.com/apps/webappviewer/index.html?id=e383d296473f4a33b7cbd768fc3dd0ba



GPS on Benchmarks

Web links

- USGS 3DEP Program – https://www.usgs.gov/core-science-systems/national-geospatial-program
- ALDOT CORS Network – http://aldotcors.dot.state.al.us/SBC
- NGS – NSRS Modernization – https://geodesy.noaa.gov/datums/newdatums/index.shtml
- GPS on Benchmarks – https://aldot.maps.arcgis.com/apps/webappviewer/index.html?id=e383d296473f4a33b7cbd768fc3dd0ba
- NGS GPS on Benchmark page – https://geodesy.noaa.gov/GPSonBM/index.shtml

Questions, Comments?

John D. Russell, PLS
Surveying and Mapping Administrator
Alabama Department of Transportation
Maintenance Bureau
russellj@dot.state.al.us