



NGS Update: Southwest Regional Activity Supporting the Modernization of the NSRS

California Spatial Reference Center Coordinating Council
Spring Meeting with CLSA, Dec. 1, 2022

Lynda Bell, SW Regional Advisor (AZ, NM, UT)

NOAA's National Geodetic Survey

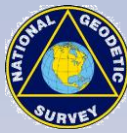


NOAA and the National Geodetic Survey

Our Nation's First Civilian Science Agency



For more than 200 years, NGS and its predecessor agencies have collaborated with public and private organizations to establish reference stations at precisely determined locations.



NGS Mission

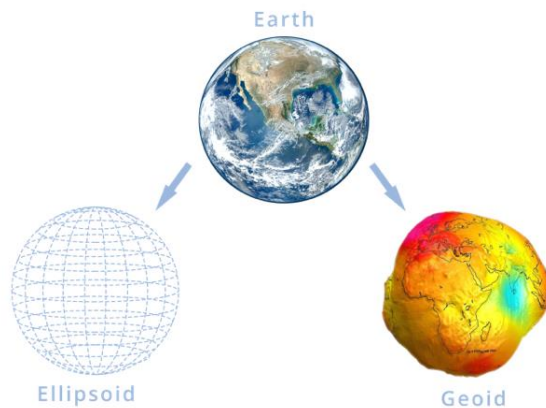
Define, maintain, and **provide access** to the *National Spatial Reference System (NSRS)*

“The NSRS is a consistent coordinate system that defines latitude, longitude, height, scale, gravity, orientation, and shoreline throughout the United States”



NSRS :Datums & Reference Frames

- A geodetic datum or reference frame is an abstract coordinate system with a reference surface (such as sea level) that serves to provide known locations to begin surveys and create maps
- NGS is improving GEOID Models for transforming heights between ellipsoidal coordinates and physical height systems.



- 1) Vertical Datums
- 2) Horizontal/Geometric Datums
- 3) Tidal Datums

What is NSRS Modernization?

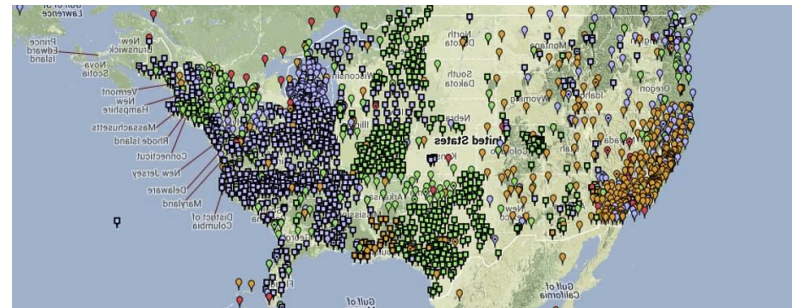
Improving the National Spatial Reference System

The National Geodetic Survey has been working over the last ten plus years to remove inaccuracies in the existing datums of the United States.

By tracking the dynamic nature of the Earth, and giving users tools to account for it, NGS will provide a new National Spatial Reference System that is semi-dynamic.

“By fully embracing the benefits of GNSS as the positioning tool of today, and of the future, NGS will effectively link the replacements for NAD 83 and NAVD 88 through a geocentric reference frame and gravimetric geoid model”

-Dr. Dru Smith, Chief Geodesist, National Geodetic Survey, 2010



How NGS is Improving the NSRS

- NAD83 and NAVD88 are still the official geometric (horizontal) and geopotential (vertical) datums of the NSRS
- These historic datums have been identified, however, as having shortcomings with NAD83 non-geocentric by ~2.2m and NAVD88 biased (~0.5 m) and tilted (~1.0 m coast to coast) relative to current global geoid models
- To improve the NSRS, NGS will replace all three NAD83 frames and all vertical datums with four new terrestrial reference frames and a geopotential datum.
- Relying primarily on GNSS data as well as on a gravimetric geoid model resulting from NGS's GRAV-D (Gravity for the Redefinition of the American Vertical Datum) Project

How do we support the Modernization of the NSRS?: By Precisely Measuring the Earth's Position in the Universe



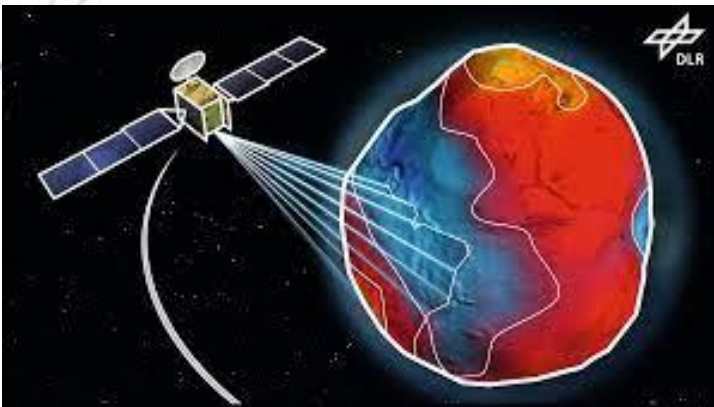
NASA Space Geodesy Profiles: Dr. Chopo Ma

Scientists from NASA's Space Geodesy Project discuss the techniques they use to precisely measure the Earth's position in the universe, determine the Earth's center of mass, calibrate satellites, observe sea level rise, and track the movements of the tectonic plates.

Setting a Geodetic Standard

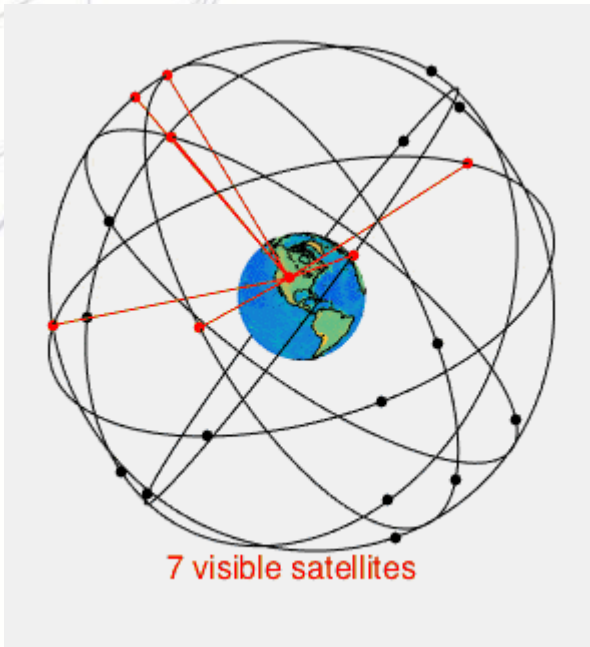
For 200 years, NGS and its predecessor agencies have collaborated with public and private organizations to establish reference stations at precisely determined locations.

More recently, NGS has fostered a network of **continuously operating reference stations (CORS)** where each CORS includes a highly accurate receiver that continuously collects radio signals broadcast by **Global Navigation Satellite System (GNSS) satellites** forming a network used to accurately position other points of interest.



High Accuracy GNSS Data Processing at NGS

NGS supports surveyors and others with high-accuracy Global Navigation Satellite System (GNSS) data, ground control marks, models and tools, guidelines and tutorials.



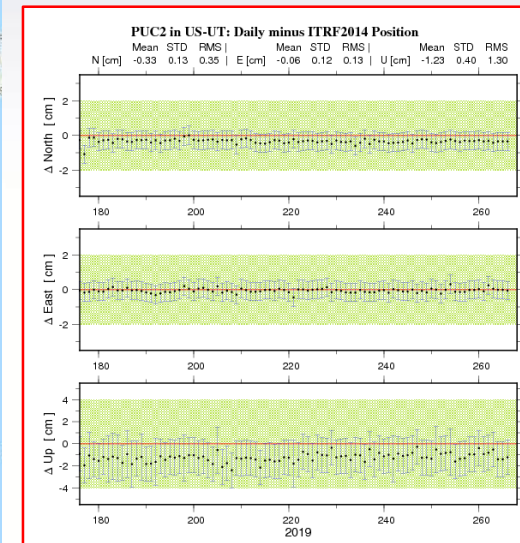
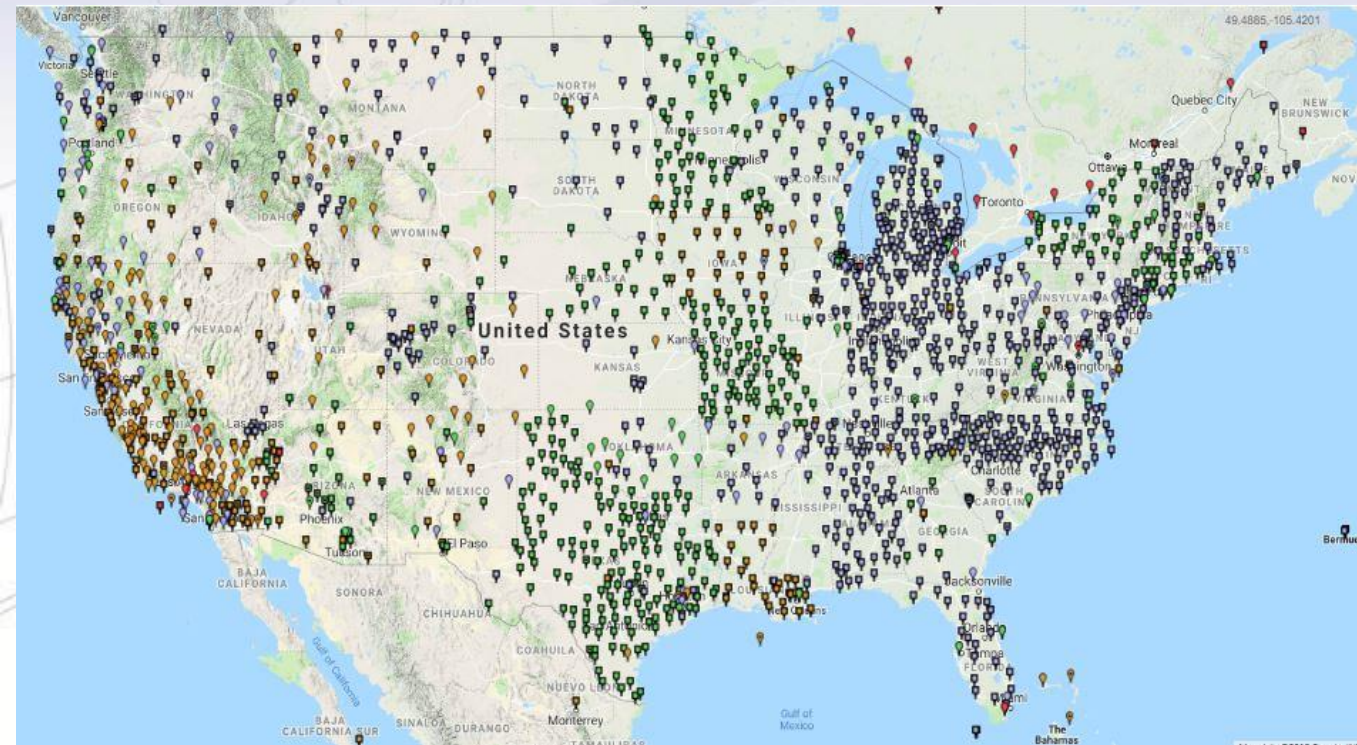
GNSS Tools

- [Online Positioning User Service \(OPUS\)](#): Tie your GPS observations to U.S. and international frames.
- [Antenna Calibration](#): Look up antenna biases for high-accuracy data processing.
- [Transformation tools \(Geodetic toolkit\)](#): Transform data between reference frames and datums.
- [Geoid Models](#): Convert GPS heights to orthometric (e.g., NAVD 88).
- [Orbits](#): See International GNSS orbit products.

GNSS Survey Methods

NGS is exploring a proposed new file format, [GNSS Vector Exchange \(GVX\)](#) to more consistently use GNSS vectors in survey networks.

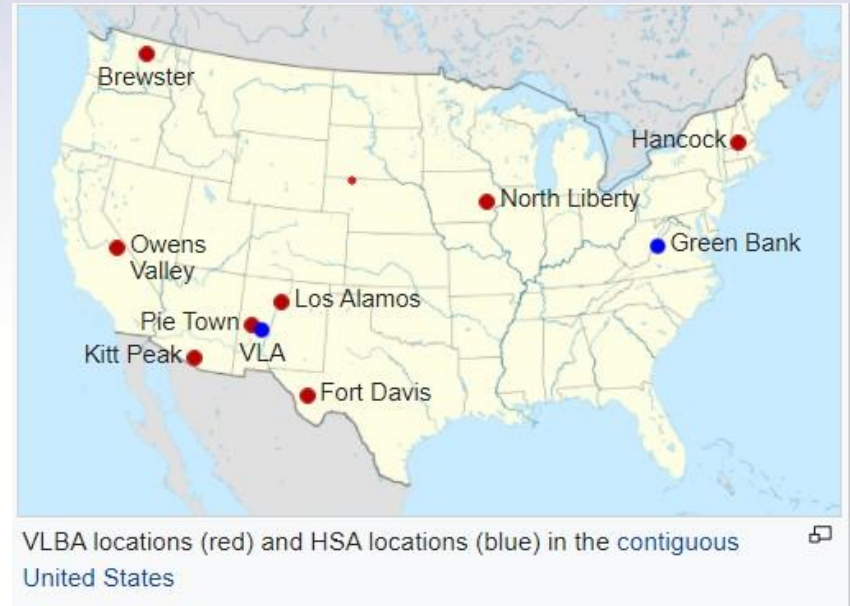
NOAA's Continuously Operating Reference Station Network (NCN)



NOAA's Continuously Operating Reference Stations (CORS):

NGS provides GNSS data files, station coordinates, and velocities from this nationwide array of tracking stations which are used for survey processing and geophysical research

Four Foundation CORS Sites in the SW Region



- Los Alamos – New Mexico
- Pie Town – New Mexico
- Apache Peak – New Mexico
- Kitt Peak – Arizona

Kitt Peak, AZ

Kitt Peak National Observatory Tucson, AZ Foundation CORS Reconnaissance 2022





Foundation CORS Site, McDonald Observatory, Texas

How to Prepare for the Future Release of NSRS 2022



NOAA is Replacing NAD 83 and NAVD 88. NOAA's National Geodetic Survey (NGS) will be replacing the datums of the National Spatial Reference System (NSRS), including the **North American Datum of 1983 (NAD 83)** and the **North American Vertical Datum of 1988 (NAVD 88)**. NGS will provide the tools to easily transform between the new and old datums. Read the NGS Ten-Year Plan and visit the **New Datums Web page** on our site to learn more.

Benefits

The new reference frames (geometric and geopotential) will rely primarily on **Global Navigation Satellite Systems (GNSS)**, such as the Global Positioning System (GPS), as well as on a gravimetric geoid model resulting from NGS' **Gravity for the Redefinition of the American Vertical Datum (GRAV-D)** Project.

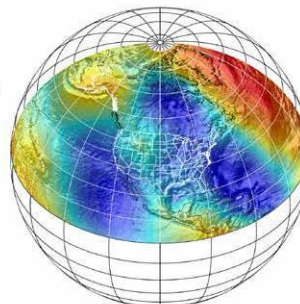
The target accuracy of differential orthometric heights (heights relative to sea level) in the geopotential reference frame will be 2 centimeters over any distance, where possible.

What You Can Expect

The magnitude of change with the new datums will vary depending on the datum you are using and your geographic location. The new geometric datum will change latitude, longitude, and ellipsoid height between 1 and 4 meters. In the conterminous United States (CONUS), the new vertical datum will change heights on average 50 centimeters, with approximately a 1-meter tilt towards the Pacific Northwest.

How You Can Prepare

- Learn if **legislation** or other formal documents referencing NAD 83 and NAVD 88 need to be changed in your state.
- **Transform existing data** to the latest NSRS datums and realizations; i.e. NAD 83 (2011), GEOID18, and NAVD 88.
- **Obtain precise ellipsoidal heights** on NAVD 88 bench marks, and visit the GPS on Bench Marks Web page to learn more.
- Require and provide **complete metadata** on all mapping contracts. See our website for more details.



The new datums will extend across CONUS and US territories. The terrestrial reference frames replacing NAD 83 will be consistent with geocentric global reference frames defining latitude and longitude. The geopotential datum replacing NAVD 88 will be based on a gravimetric geoid model, enhanced by data from NGS' Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project.

1. Transform your coordinates using NGS Coordinate and Transformation Tool (NCAT)
2. Record your metadata by knowing the datums and epochs of your geospatial files
3. Perform GPS on Bench Marks Operations.
4. Review State Plane Coordinate System of 2022 requirements
5. Prepare to update legislation, as needed

Densification of Survey Control through Partnerships

- Positioning – improvements in both vertical and horizontal positioning
- Ground truthing – improve base station positions for LIDAR, aerial, drone, photogrammetric, altimetric data
- Datum consistency - throughout multiple data sets used for digital elevation modeling



Enhancing SW Geodetic Control to Improve Positioning Data and Imagery in 2022

- Bringing downed NOAA CORS Network sites back online – six sites currently
- Building new CORS stations with improved stability and monumentation – Shallow and Deep Braced Monuments
- Building a new Foundation CORS array at VLBA's in NM and AZ



NGS/City of Phoenix Braced Monument Workshop



Partnership Work!



NGS siting new GNSS array at Kitt Peak National Observatory, AZ

Projects Supporting the NSRS in the SW Region

- New AZCORS AGIC Committee
- Braced Monument Workshops
- CORS Station Improvements
- GPS on Benchmarks
- OPUS Training
- Water Management
- Subsidence Monitoring
- Control Densification
- Partnership Work
- Foundation CORS



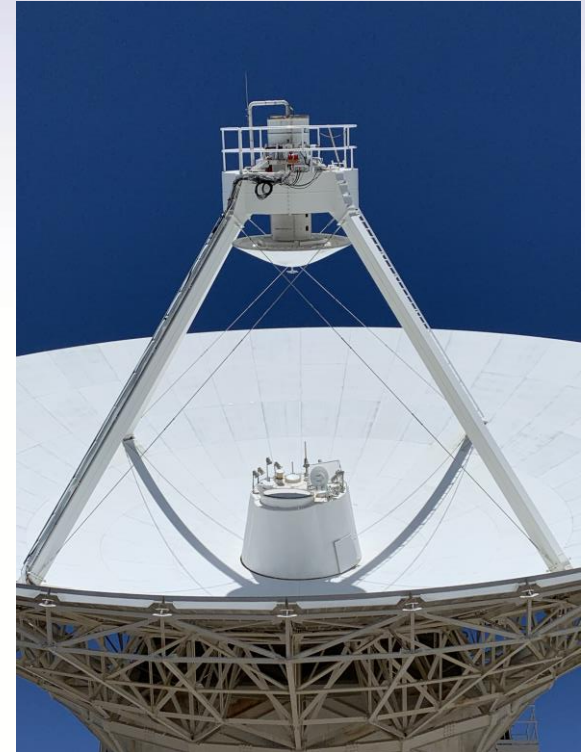
NGS Partnership Activity in New Mexico



National Park Service
Braced Monument NOAA
CORS Network Site



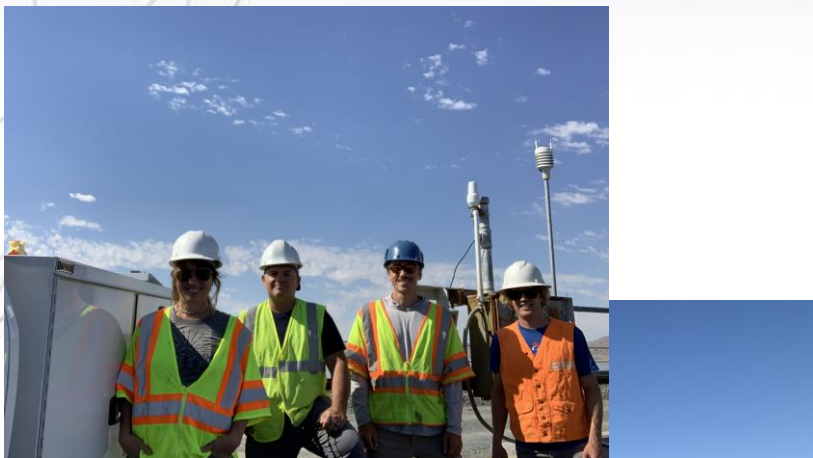
NPS Photo by Gavin Newman



NRAO's Very Long Baseline Array
Pietown, Los Alamos, Apache Point
NGS/NGA/ARL FCORS

NGS Partnership Activity in Utah

- USGS Great Salt Lake Datum and Hydrologic Survey
- Aseismic Restructuring of the Mormon Temple/Base Meridian Preservation



City of Phoenix, CAP, and NGS partner to build new Braced Monument CORS Stations in AZ



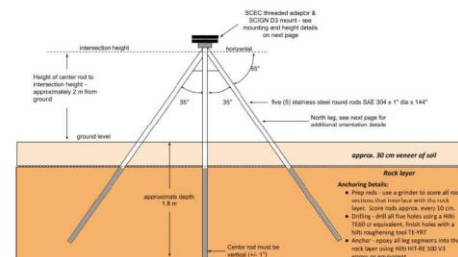
JOIN US! NOAA's NGS CORS Desert Hills Braced Monument Workshop

INSTRUCTOR: NOAA'S NATIONAL GEODETIC SURVEY'S CORS BRANCH CHIEF, JOHN GALETZKA

You are cordially invited to join us in this exciting training opportunity to participate in the construction of a future City of Phoenix/ NOAA CORS Network braced monument GNSS site. **NOAA's National Geodetic Survey's CORS Branch Chief, John Galetzka, will be your instructor with a city of Phoenix professional survey crew** leading the construction. Please come prepared to be part of this hands-on workshop and to get in the dirt! BYO support supplies for a morning of work—gloves, water, field clothes! **RSVP: lynda.bell@noaa.gov 240-988-5919, NGS SW Regional Advisor**

WED, March 23, 2022, 7am to 12 pm Build Workshop

THURS, March 24, 2022, 7am to 12 pm Wrap Up



**Desert Hill Trailhead City of Phoenix Parks
705 W Carefree Hwy, Phoenix, AZ**

Technical Crew
City of Phoenix Survey Team
Mike Deaton, Survey Engineer
Brian Fisher, CAP/NGS Station Coordinator
Lynda Bell, NGS SW Regional Advisor

A Partnership Project:
NOAA's National Geodetic Survey
City of Phoenix, AZ

Directions: Site located just behind (north of) the Equestrian Parking Lot. Park in main parking lot to the west of the site.

**705 W Carefree Hwy
Desert Hill Trailhead
City of Phoenix Parks
Phoenix, AZ**

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Tucson, AZ

National Geodetic Survey
"Positioning for America's Future"
geodesy.noaa.gov



Latest NGS Developments in Support of NSRS Modernization

<https://geodesy.noaa.gov/web/news/index.shtml>

- New DSWorld Online Tool Released
- Chesapeake Bay Vertical Land Motion Project Enters Year 4
- LASER, new adjustment tool completed
- NGS will be ingesting CORS data in Rinex 3.
- OPUS Projects Beta 5.1 with new GVX format option Released
- New Version of NCAT Released

GPS on Benchmarks Update

GPS on BenchMarks

***** NOTICE: NGS has extended the December 31, 2022 cut-off date for GPS on Bench Mark submissions! The new cut-off date to submit GPS on Bench Mark data for use in the 2022 Transformation Tool is now September, 30, 2023. *****

Recover, Observe, Report



Regardless of your objective, GPS on BM will always include three important steps: recover, observe, and report.

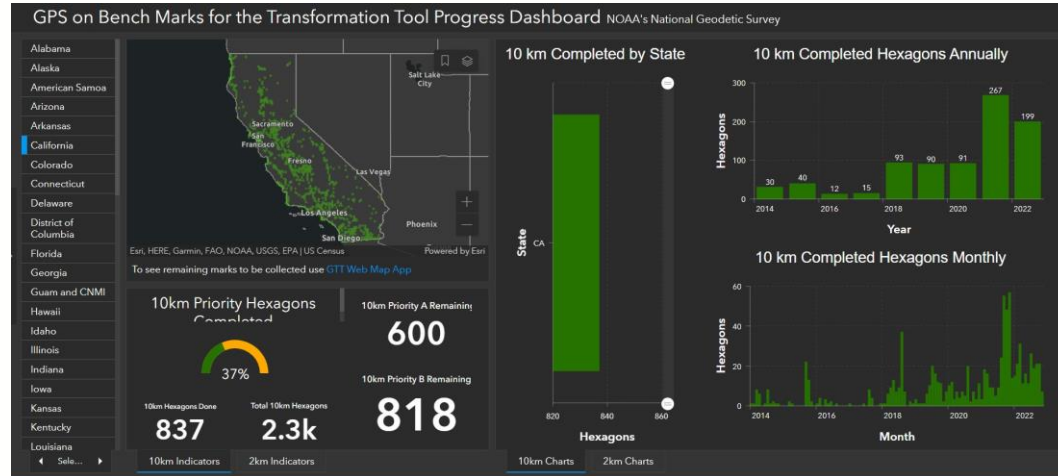
Recover: Use **GPSonBM web map** to identify priority marks in your area, or the **NGS Data Explorer** to look up the description of existing benchmarks. Follow the instructions on the **Recover page** to find bench marks of interest.

Observe: Follow instructions on the **Observe** page and record field notes, take digital photos, and collect GPS observations for the benchmark you visit.

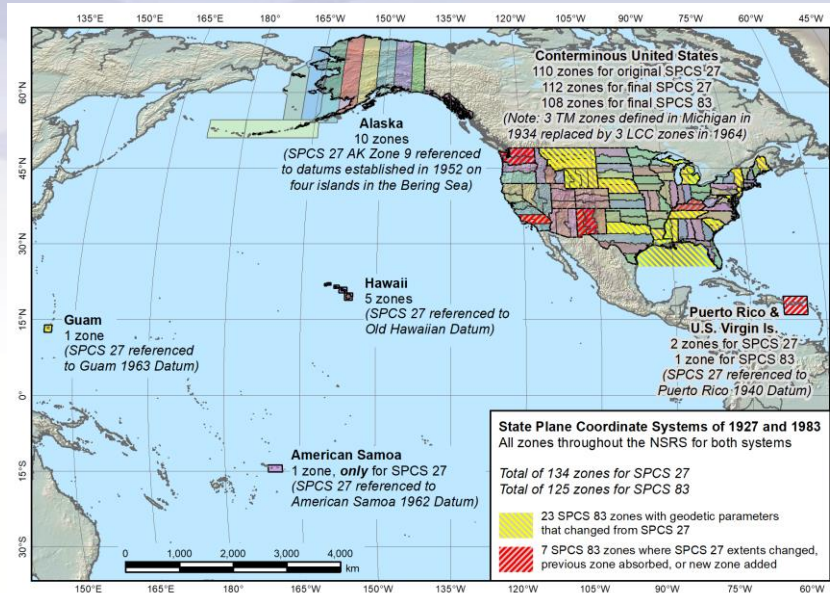
Report: Use the online **Mark Recovery Form** to submit your recovery notes and photos and **Share the OPUS Solutions** from your **GPS observations**.

GPSonBM Resources

<p>Web Map</p> 	<p>Dashboard</p> 	<p>Prioritized Marks</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="595 1135 653 1192">  <p>[~ 15MB]</p> </div> <div data-bbox="691 1135 749 1192">  <p>[~ 6MB]</p> </div> </div>
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SPCS2022 Update



Information on NSRS legislation that includes the U.S. survey foot is available under item #5 on the new datums “Get Prepared” web page (<https://geodesy.noaa.gov/datums/newdatums/GetPrepared.shtml>). It includes a legislation template (<https://cdn.ymaws.com/www.nsp.us.com/resource/resmgr/ngs/NSRS-Model-Legislation-Templ.pdf>), as well as actual example legislation from three states (<https://geodesy.noaa.gov/pub/SPCS/ExampleLegislation/>). The Washington and Kentucky statute has already been passed, and it is likely that the Alaska statute will become law the next time their legislature meets (presumably this year).

Thank you for supporting the NSRS from the
Beautiful Southwest!

<https://geodesy.noaa.gov>

