A New State Plane Coordinate System is in the Works

NOAA's National Geodetic Survey (NGS) is currently in the process of modernizing the National Spatial Reference System (NSRS). This modernization project will produce new datums that will replace NAD 83 and NAVD 88. As part of this update NGS is also updating the State Plane Coordinate System (SPCS). Despite a recently announced delay in the release of these products, they will still be referenced to 2022.

In October 2019 NGS published the policies and procedures outlining the design and modification criterion for SPCS 2022. Accordingly, SPCS 2022 will be referenced to the 2022 Terrestrial Reference Frames (TRFs) and based on the same reference ellipsoid as SPCS 83, the GRS 80. It will also be built on the same 3 conformal projection types as SPCS 83 and SPCS 27: Lambert Conformal Conic (LCC), Transverse Mercator (TM), and Oblique Mercator (OM).

One of the key elements of SPCS 2022 is the linear distortion design requirements. All SPCS 2022 zones are being designed to minimize linear distortion at the topographic surface rather than the ellipsoid surface, as was done for SPCS 83 and SPCS 27. Another relatively new element is the concept of zone layers. NGS will be producing one statewide zone layer for each state while each state will have the option of having up to two additional multiple-zone layers.

The statewide zone being produced by NGS will have a minimum linear distortion of ±50 parts per million (ppm) (0.3 ft/mile or 5 cm/km). What makes the additional layer options enticing to many states is the ability to create projections with even lower distortion, most often targeted for ±20 ppm. As published in the official SPCS 2022 Procedures (NGS 2019-1214-01-A2), if states wished to design their own multiple-zone low distortion projection (LDP) layer to be included as part of SPCS 2022, they had until March 31, 2020 to submit their proposals. By this year's proposal submission deadline, a total of 29 states, including Montana, had submitted proposals to design their own multiple-zone projection layer. Of these states, both the Montana and Colorado multiple-zone layers will only have partial coverage of the state with LDP zones (Figure 1). For states with NGS-approved proposals, the final design parameters are due to NGS no later than March 31, 2021*.

Many states, including Montana, have already adopted the use of LDPs (Figure 2). Some of these existing LDPs will be modified to meet NGS specifications and submitted for inclusion into SPCS 2022. But many states will be designing entirely new LDP zones for SPCS 2022. Designing LDP zones for SPCS 2022 is not limited to just those states with existing systems. For several of these states, such as North Dakota, this will be their first statewide multiple-zone LDP coverage.

Montana's existing LDPs are collectively known as the Rocky Mountain Tribal Coordinate System (RMTCS). The RMTCS has been incorporated into Esri's GIS software and AutoCAD, but not all existing LDPs are included in geospatial software. Because SPCS 2022 will be an official product of NGS it will have wide adoption by geospatial software vendors, making it easily accessible for the surveying, engineering, and GIS communities to access and use.



Figure 1: Number of SPCS 2022 Zone Layers per State. (Image courtesy of NGS)



Figure 2: Existing LDP systems and states with interest in developing them for SPCS 2022. (Image courtesy of NGS)

What are LDPs anyway?

Low Distortion Projection (LDP): "A mapping system that allows anyone doing surveying, engineering, and GIS development to coordinate and associate all projects onto on simple mathematical base." Author Unknown

An LDP is a projected coordinate system that minimizes linear distortion – the difference between projected (map grid) distance and true ground distance, often referred to as the "grid-to-ground" problem. One of the most common ways to handle this problem has been to scale State Plane Coordinates (the map grid) to the topographic surface (the ground). While this method does reduce linear distortion at the ground, it does not optimally minimize linear distortion, especially for projects with a large extent.

LDPs are based on conformal projection types which preserve the angles locally, preserving the shape of features. LDPs are specifically designed to optimally minimize distortion over the largest area possible. The advantages to using an LDP include:

- No additional scaling or modification is necessary.
- Data management is simplified by reducing the number of coordinate systems needed across large areas.
- Surveying workflows are simplified by eliminating the need to perform vendor-specific methods of scaling, rotating, and translating spatial data, such as horizontal "calibrations" or "localization."
- Generated coordinates are unique to every LDP zone and are distinct from other coordinate systems (such as SPCS 83) and are self-identifying (i.e. the LDP zone can be determined from the coordinates).

What does this mean for Montana?

As previously mentioned, Montana has received approval from NGS to produce our own projection layer to be included as part of SPCS 2022. Montana State Geodetic Co-Coordinators, Stew Willis and Corryn Greenawalt, are leading this effort and coordinating with stakeholders for the development of a multiplezone LDP layer for Montana. It is anticipated that this LDP layer will not completely cover the state but will include the major population areas. Eleven zones now have draft LDP designs completed and ten more are in consideration, pending funding (Figure 3). Once completed and approved by NGS, these LDP zones will become a part of the SPCS 2022 which will then be incorporated into a wide variety of geospatial software applications.



Figure 3: Draft LDP Zones and Potential LDP Zones for Montana

Details about Montana's RMTCS can be found in the Resources section of the MARLS website (<u>http://marls.com/resources/rmtcrs-information/</u>). For additional details on Montana's 2022 LDP zones endeavor contact the Montana State Geodetic Co-Coordinators, Stew Willis <u>stewart.willis@usda.gov</u> and Corryn Greenawalt <u>cgreenawalt@fvcc.edu</u>. More information about SPCS 2022 can be found at <u>www.ngs.noaa.gov/SPCS/</u>.

*Note: NGS recently announced a delay in the release of the modernized NSRS. While the NSRS and SPCS 2022 will not be released until sometime in 2024 or 2025, the deadlines outlined in the SPCS Policies and Procedures are not changing.

This article is submitted via the Northern Engineering & Consulting, Inc.'s Survey and GIS teams.