



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

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Dr. Howard Veregin and Mr. Richard Kleinmann
Chair and Co-Chair
Wisconsin Spatial Reference System 2022 Task Force
Wisconsin State Cartographer's Office
University of Wisconsin-Madison
550 N Park Street
Madison, Wisconsin 53706

Re: SPCS2022 Policy and Procedures exception requests for zones in Wisconsin

Dear Dr. Veregin and Mr. Kleinmann,

Thank you for contacting the National Geodetic Survey (NGS) regarding development of the State Plane Coordinate System of 2022 (SPCS2022) and acknowledging the work NGS has done in preparing SPCS2022 Policy and Procedures. We are pleased to know that Wisconsin is proactively preparing for the National Spatial Reference System (NSRS) modernization of 2022. The detailed background information you provided about the state's current and previous coordinate systems clearly illustrates the thought and investment behind those systems over their many years of use. It was also helpful to learn about the goals and rationale for a future state system to be referenced to the North American Terrestrial Reference Frame of 2022 (NATRF2022) and your desire to have it be part of SPCS2022.

NGS efforts for SPCS2022 are a significant departure from what we did for the 1983 and 1927 versions of the State Plane Coordinate Systems. While maintaining nationwide consistency, we endeavored to allow greater flexibility than in the past, so that the system will meet the varied needs of ALL stakeholders. Accommodating these stakeholder desires will allow for the rapid adoption of the modernized NSRS, as referenced in your letter. At the same time, these policy and procedures provide a clear and defined request, proposal, and submittal process that promote good design practice and define a consistent framework for a nationwide system. This latter point is important for effective management and distribution of SPCS2022—especially given the greater complexity and larger number of zones than the previous two SPCS versions.

Although we exhaustively thought of possible scenarios for our modernization efforts and the development of these policy and procedures, we realized that we could not capture everything. Therefore, we included the ability to request exceptions from the Policy and/or Procedures to allow for special cases or unanticipated situations. However, any exception granted must be based on specific, well-defined reasons. It is important that stakeholders making such requests be willing to step back and view their request in the larger context of a nationwide system. This should include careful consideration of whether exceptions truly are essential; evaluation of



viable alternatives that require no (or fewer) exceptions; and a willingness to compromise.

With that in mind, the remainder of this letter focuses on the various requests described in your August 15 letter. Your requests are categorized in the following four groups: 1) statewide zone layer; 2) multiple-zone low distortion projection (LDP) layer; 3) requirements for submitting LDP system designs; and 4) keeping the existing SPCS 83 zone extents as a third SPCS2022 layer.

1. *Statewide zone layer.* As indicated in your letter, an exception is not required for the statewide zone request. NGS has already designed a preliminary statewide zone using a Transverse Mercator projection with the desired central meridian (it is available for download at <ftp://www.ngs.noaa.gov/pub/SPCS/DistortionMaps/>). The preliminary design does not include grid origins, but if specified by NGS, the resulting coordinates will differ by at least 10,000 m from those for SPCS 83 and 27 zones, and any other SPCS2022 layer. If Wisconsin desires specific projected coordinate values (for example, that differ from the Wisconsin WTM 83 and 27 statewide zones), those can be requested by completing an *SPCS2022 Zone Request and Proposal Form* (<https://geodesy.noaa.gov/SPCS/policy.shtml>).
2. *Multiple-zone LDP system layer.* The letter requests that all necessary exceptions be granted to allow the Wisconsin Coordinate Reference System (WISCRS) be part of SPCS2022. Referencing the WISCRS manual implies that the desired zone extents and parameters are identical to those in WISCRS as currently defined. However, that intent is not entirely clear, and the letter does not specifically list the exceptions requested. To make the request more specific, it is split into two groups. The first is for two overall requests to allow using WISCRS in SPCS2022 at all. The second group consists of three alternatives for how parameters of the WISCRS-based SPCS2022 zones are defined.

The two requests listed below are for overall approval of exceptions that concern zone size and parameter uniqueness:

- a. *Zone size.* Use of WISCRS zones in SPCS2022 is in conflict with **SPCS2022 Procedures §6.e** for a minimum zone width of 50 km. NGS recognizes that the WISCRS has been in use for decades, and understands that it is defined in multiple commercial software packages and publicly available databases. Because of its history, large investment of resources, and widespread implementation, **this exception request is granted**. In essence, NGS is allowing these small zones to be “grandfathered” into SPCS2022 because of the long established use of the system.
- b. *Zone parameter uniqueness.* WISCRS uses 59 projection definitions for its 72 zones (one per county). Thus projection definitions are not unique, which is in conflict with **SPCS2022 Policy §I.D** and **SPCS2022 Procedures §6.f.ii**. Because a single zone that occurs in multiple counties can be identified readily without being a “separate” zone, **this exception request is NOT granted**. That is, all SPCS2022 zones in the LDP layer must have unique parameters, meaning that there will be 59 rather than 72 zones for SPCS2022.

Having an exception granted for zone size (no minimum size) but not for zone uniqueness (total of 59 rather than 72 zones) sets the stage for considering the three following alternatives for defining how WISCRS can be incorporated in SPCS2022 (in all cases the projection parameters must be determined by Wisconsin stakeholders, not by NGS):

- c. *Use existing WISCRS zone parameters without modification.* Using the current WISCRS definitions will result in SPCS2022 coordinates that differ from current WISCRS coordinates by the horizontal difference between the North American Datum of 1983 (NAD 83) and NAD 83 (2011) (about 1.3 meters in Wisconsin at epoch 2020.0). This is an undesirable outcome, since the new projected coordinates would differ by the same amount, which would likely cause confusion and problems. Although undesirable, the small coordinate differences are allowable per SPCS2022 policy, since WISCRS was never part of SPCS. However, this alternative is in conflict with **SPCS2022 Procedures §6.f.iii, §6.f.iv, §6.f.v, and §6.f.vi** concerning projection parameter specifications. Therefore, **this exception request is NOT granted.**
 - d. *Modify zone parameters such that SPCS2022 coordinates are the same as current WISCRS coordinates.* This alternative seeks to define parameters for SPCS2022 zones such that the resulting coordinates referenced to NAD 83 (2011) epoch 2020.0 are numerically the same as WISCRS referenced to NAD 83 (2011) epoch 2010.0, to within some tolerance (e.g., 5 mm). This approach perpetuates the previous projected coordinates even though the underlying reference frame is updated. A serious technical challenge with this approach is that it requires knowing NAD 83 (2011) latitude and longitude values before NAD 83 (2011) is available. NAD 83 (2011) epoch 2020.0 can be estimated from NAD 83 using the NGS Horizontal Time-Dependent Positioning (HTDP) tool, but the accuracy of the estimated coordinates are not known, and there is a significant possibility that the resulting coordinates will differ from existing WISCRS by more than the desired amount. This alternative requires exceptions to the same four SPCS2022 Procedures as the previous 2c alternative. For these reasons, **this exception request is NOT granted.**
 - e. *Modify zone parameters to satisfy all SPCS2022 Policy and Procedures other than minimum zone size.* For this alternative, the parameters for each of the 59 zones would be redefined by Wisconsin stakeholders such that they meet all SPCS2022 Policy and Procedures while achieving the desired distortion performance characteristics of WISCRS. **This alternative is the only one permitted by NGS for SPCS2022**, since it requires only the single exception for zone size (in item 2a above). While this alternative does not perpetuate WISCRS coordinate values, it does preserve the fundamental WISCRS characteristic of low distortion at the county level.
3. *Requirement for submitting a complete LDP design package.* The letter requests that NGS grant an exception that allows WISCRS to become part of SPCS2022 without the required design submittal. This request is in conflict with **SPCS2022 Procedures §3**. It

is based on the idea that NGS use the WISCRS manual as a substitute for the design submittal. However, this is not a viable substitute since exceptions are not granted to allow use of the WISCRS in its current form. Even if WISCRS was used in its current form, NGS still would not grant this exception for two reasons. First, the level of effort to provide the design submittal is small; it merely requires a single coordinate and linear distortion computation for each zone. Second, providing the coordinates and distortion is prudent, because it helps ensure that NGS and Wisconsin get the same results and serves as a simple error-trapping mechanism. Based on the foregoing, **this exception request is NOT granted.**

4. *Keeping existing SPCS 83 zones as a third layer.* The letter requests that the existing three SPCS 83 zone extents be allowed for SPCS2022, in addition to complete statewide coverage of the LDP zones. This request is in conflict with **SPCS2022 Policy §III.B.2.a.** The argument for supporting this request is that the existing three zones are used by several organizations in Wisconsin. But this argument is not persuasive for three reasons. First, if those three zones were used in SPCS2022, the coordinates would change by at least 10,000 m (per **SPCS2022 Policy §I.D**), and in a non-uniform way, so the organizations using the SPCS 83 zones would still need to adapt to a change. Second, since there will be large coordinate changes, it is not clear why the affected organization cannot instead use the statewide SPCS2022 zone. And third, it appears some of the organizations using the three zones have areas of responsibility that are statewide or extend outside a single zone, in which case the use of a single statewide zone seems more appropriate. While a statewide zone would have more linear distortion than the three SPCS 83-like zones, the statewide zone distortion is not vastly greater, and in any case the distortion of the three zones is still large enough that it cannot be ignored in typical engineering and surveying applications. If linear distortion is a material concern, then the LDP zones should be used. Based on the foregoing, **this exception request is NOT granted.** A three-zone layer can only be part of SPCS2022 if the LDP layer is not part of SPCS2022.

To summarize, NGS will grant Wisconsin an exception to the first bullet of §6.e.i. for minimum width of “50 km (31 miles) for a zone with a topographic height range of 250 m (820 ft) or less,” of its *Procedures for Design and Modification of the State Plane Coordinate System of 2022* document. Granting this exception will allow a system in SPCS2022 with the same low-distortion performance characteristics of WISCRS, although with different coordinate values. Because WISCRS was never part of SPCS, there is no minimum required change in coordinates. However, NGS recommends that the change in coordinates be large enough to distinguish clearly SPCS2022 from current WISCRS. A reasonable guide is a difference of greater than 10,000 m between overlapping SPCS2022 layers, and between any SPCS2022 layer and SPCS 83 or 27 coordinates.

Although NGS considered the interests of state stakeholders for SPCS2022, granting all (or even most) exception requests would result in widely disparate projection definitions and design approaches, and diminish the purpose of the policy and procedures. Because SPCS2022 will be substantially more complex than SPCS 83, there is a compelling need for uniformity where possible.

Thank you again for contacting NGS. We hope you understand and appreciate our desire to minimize exceptions to SPCS2022 Policy and Procedures. Upon review with Wisconsin stakeholders, please submit your final request and proposal forms to NGS.SPCS@noaa.gov. If you have additional questions, please contact our NGS Regional Advisor, John Ellingson, at john.ellingson@noaa.gov; or contact our SPCS2022 Project Manager, Michael Dennis, at michael.dennis@noaa.gov.

Sincerely,



Juliana P. Blackwell
Director

cc: John Ellingson, NGS Regional Geodetic Advisor
Michael Dennis, SPCS2022 Project Manager