Missouri Society of Professional Surveyors 64th Annual Meeting

State Plane Coordinate System of 2022

October 15, 2021

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Missouri Department of Agriculture
Land Survey Program

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Topics of Discussion

- New Datums
- Low Distortion Projection System
- State Plane Coordinate System Layers
- LDP Coordinate System Design
- Statewide Zone Layer
- Retirement of the U.S. Survey foot
- Timeline for the new system

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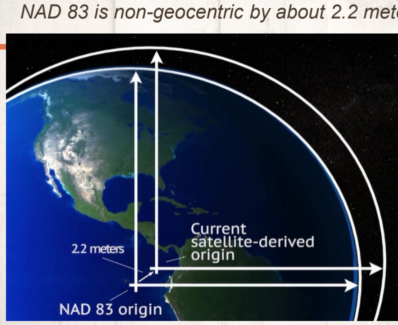
North American Datum of 1983 (NAD 83)

NAD 83 is non-geocentric by about 2.2 meters



Source: NGS website
https://www.ngs.noaa.gov/corbin/class_description/NGS_Datums_video_2_b/

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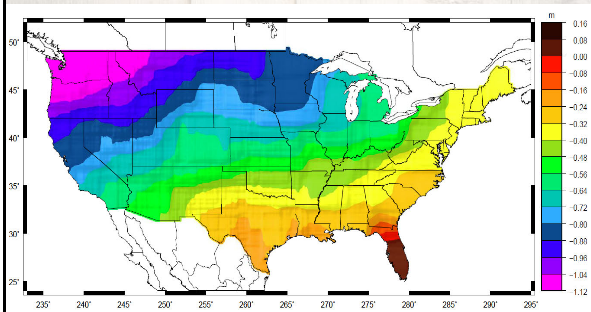
Bias and Tilt of NAVD 88



Source: NGS website
https://www.ngs.noaa.gov/corbin/class_description/NGS_Datums_video_2_b/

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Changes in the Future

- **NAVD 88 replaced with North American-Pacific Geopotential Datum of 2022 (NAPGD2022)**
- **NAD 83(2011) replaced with North American Terrestrial Reference Frame of 2022(NATRF2022)**
- **State Plane Coordinate System of 2022 (SPCS2022)**
- **Geoid2022**

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What is a LDP?

- **LDP = Low Distortion Projection**
  - Conformal map projections designed to cover the largest area with the least linear distortion

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Conformal

- At a point, angles are preserved and scale error is the same in all directions

Map Projections

- Used to convert a position from geographic (lat., long.) to rectangular (X,Y) coordinate values
- Represent a portion of the round ellipsoidal shaped earth to a “Developable” map projection that can be made into a flat surface
- Flat surface = Cartesian Coordinates (X,Y) = easier to calculate

Map Projections

- Earth’s Spherical surface cannot be transformed to a flat map without creating significant distortions

Map Projections

- **Two Types of Distortion**
  - Angular: Convergence angle for conformal projections
  - Linear: Difference between grid inverses (map distance) and corresponding ground/horizontal distances

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Linear Distortion

- **Can be positive or negative**
- **Positive distortion - the grid length is LONGER than the “true” horizontal length**
- **Negative distortion - the grid length is SHORTER than the “true” horizontal length**

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Linear Distortion

PPM	Ratio	feet/mile
5	1:200,000	0.0264
20	**1:50,000**	**0.1056**
50	1:20,000	0.264
100	1:10,000	0.528
200	1:5,000	1.056
300	**1:3,333**	**1.584**
500	1:2,000	2.64
1000	1:1,000	5.28

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Linear Distortion

- **Varies according to:**
  1. Earth curvature (distance from projection axis)
  2. Height above or below the projection surface

Horizontal Linear Distortion of Projected Coordinates due to Earth Curvature (From Michael Dennis)

Maximum zone width for secant projections (km and miles)	Maximum linear horizontal distortion, δ		
	Parts per million (mm/km)	Feet per mile	Ratio (absolute value)
25 km (16 miles)	±1 ppm	±0.005 ft/mile	1 : 1,000,000
57 km (35 miles)	±5 ppm	±0.026 ft/mile	1 : 200,000
81 km (50 miles)	±10 ppm	±0.05 ft/mile	1 : 100,000
114 km (71 miles)	±20 ppm	±0.1 ft/mile	1 : 50,000
180 km (112 miles)	±50 ppm	±0.3 ft/mile	1 : 20,000
255 km (158 miles) e.g., SPCS*	±100 ppm	±0.5 ft/mile	1 : 10,000
510 km (317 miles) e.g., UTM†	±400 ppm	±2.1 ft/mile	1 : 2,500

*State Plane Coordinate System; zone width shown is valid between ~0° and 45° latitude
†Universal Transverse Mercator; zone width shown is valid between ~30° and 60° latitude

Horizontal Linear Distortion of Projected Coordinates at Various Heights with Respect to Projection Surface (From Michael Dennis)

Height below (–) and above (+) projection surface	Maximum linear horizontal distortion, δ		
	Parts per million (mm/km)	Feet per mile	Ratio (absolute value)
±30 m (±100 ft)	±4.8 ppm	±0.025 ft/mile	~1 : 209,000
±120 m (±400 ft)	±19 ppm	±0.10 ft/mile	~1 : 52,000
±300 m (±1000 ft)	±48 ppm	±0.25 ft/mile	~1 : 21,000
+600 m (+2000 ft)*	–96 ppm	–0.50 ft/mile	~1 : 10,500
+1000 m (+3300 ft)**	–158 ppm	–0.83 ft/mile	~1 : 6,300
+4400 m (+14,400 ft)†	–688 ppm	–3.6 ft/mile	~1 : 1,500

*Approximate mean topographic height of North America (US, Canada, and Central America)
** Approximate mean topographic height of western coterminous US (west of 100°W longitude)
† Approximate maximum topographic height in coterminous US

Projected Coordinate Systems Include:

1. Projection Type
2. Geodetic Datum
3. Linear Unit

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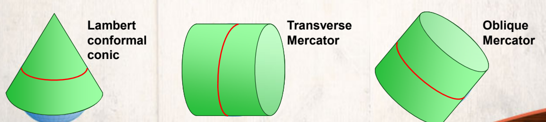
1. Common Projection Types for LDPs and State Plane Projections

- Below are three projection types typically used in LDPs

Ref: Building a State Plane Coordinate System for the future by Michael Dennis, NGS



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2. Geodetic Datum

- When the ellipsoid model is oriented and positioned in space, it forms a "horizontal geodetic datum"
- Examples
  - North American Datum of 1927 (NAD 27)
  - North American Datum of 1983 (NAD 83)
  - North American Terrestrial Reference Frame of 2022 (NATRF2022)

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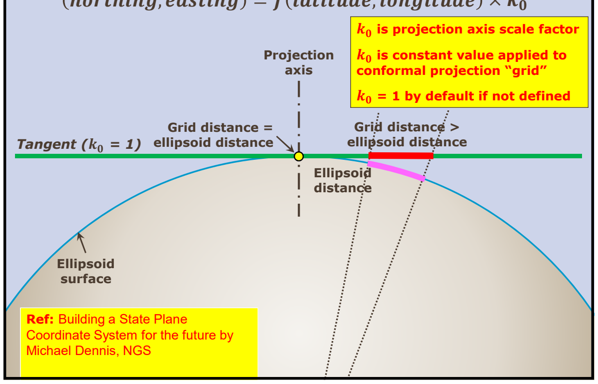
3. Linear Unit

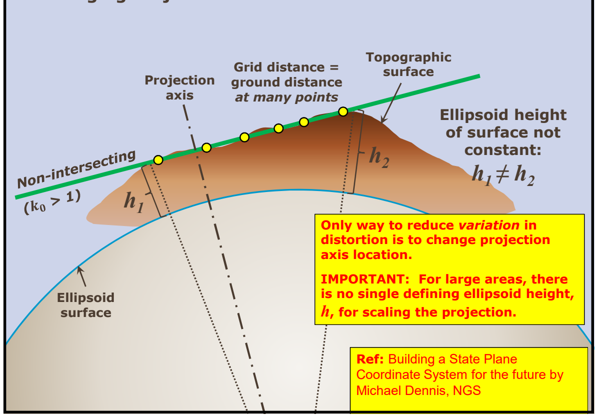
- **Examples**
  - U.S. survey foot
  - International foot
  - Meter

A Map Projection is a Mathematical Function

$$(northing, easting) = f(latitude, longitude) \times k_0$$



Changing Projection Axis to Reduce Distortion Variation



State LDP Statistics

State	Number of Zones	Max (ppm)	Min (ppm)	Percentage of State less than 10 (ppm)	Percentage of State less than 20 (ppm)
Kansas	20	26.0	-26.9	68.33%	98.80%
Iowa	14	25.9	-25.9	73.63%	99.61%
Oregon	39	Some areas greater than +/- 50 ppm			
Indiana	92 (57)	Extreme Value = About 24 ppm, 95% less than 13 ppm, 99% less than 18 ppm			
Nebraska	95	7 Zones Extreme Value > +/- 25 ppm			
Wisconsin	58	Extreme is about +/- 50 ppm			
Minnesota	86	Not Published			

State Plane Coordinate System of 2022

- Similar to existing State Plane Coordinate System
  - Based on same reference ellipsoid as SPCS 83 (GRS 80)
  - Same 3 conformal projection types as SPCS 83
- Differences
  - Referenced to 2022 Terrestrial Reference Frames (TRFs)
  - Zones designed "at ground"
  - Zone "layers"
- Stakeholder input

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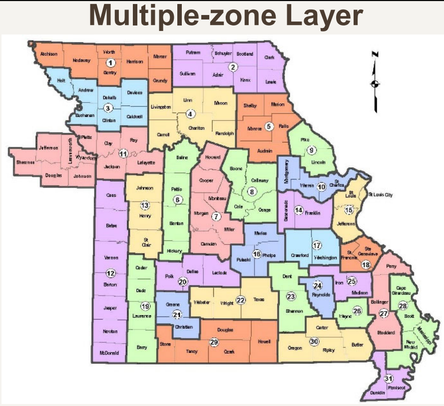
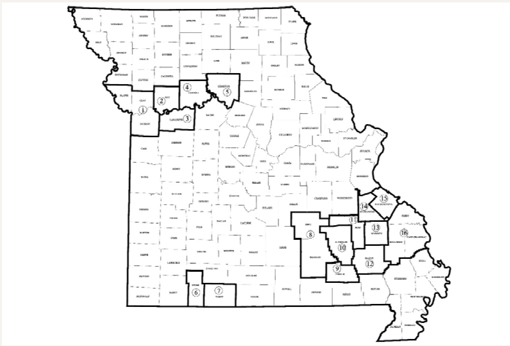
Multiple-zone Layer



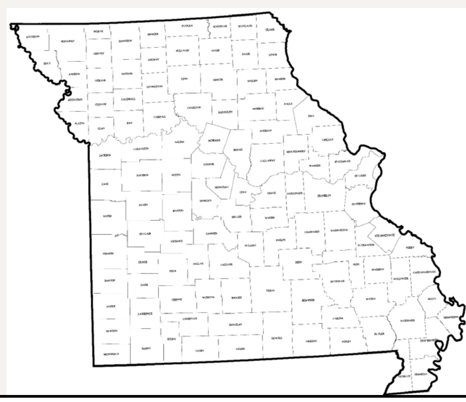
Low Distortion Projection System

Multiple-zone Layer



Partial Coverage Layer

Statewide Zone Layer



State Plane Coordinates

- **Currently only two layers**
  - Statewide Zone (Designed by NGS)
  - Multiple-zone Layer (Low Distortion Projection)

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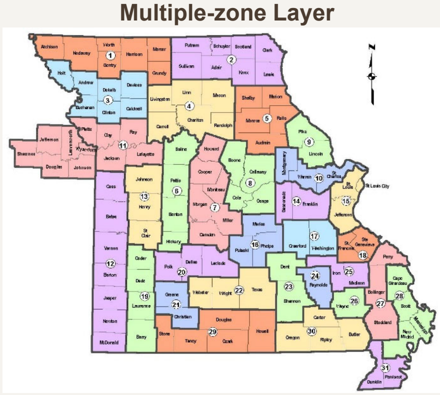
Multiple-zone Layer



Low Distortion Projection System

Preliminary LDP Design

- Created a point coverage of 26.8 million points over the entire state on 3 arc second grid (roughly 303 ft. N-S and 238 ft. E-W)
- Elevated points from the National Elevation Data set
- Reduced points to ellipsoid heights
- Computed distortion statistics moving the central meridian or standard parallel, using different scales and projection types

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Preliminary LDP Design

- Cities contained within the zone
- Counties' boundaries used as zone boundaries
- Counties with similar elevations were grouped together
- Zones were generally narrow as possible yet meeting the width requirements set by NGS
- Zones were configured to include as many counties as possible, while trying to keep as much of the zone as possible under 20 PPM linear distortion

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Preliminary LDP Design

- **Zones were named using most populated city**
- **Total of 31 Zones**
  - 17 Zones using a Lambert map projection
  - 14 Zones using a Transverse Mercator map projection
- **False Northing and Eastings differ from previous systems**

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Preliminary LDP Design

- **The Easting coordinates were designed to help identify the zone.**
- **The coordinate system is designed where the zone number x 1,000,000 equals the Easting coordinates in international feet**
  - Example: all Eastings in Zone 15 (St. Louis zone) will be in the fifteen millions of international feet

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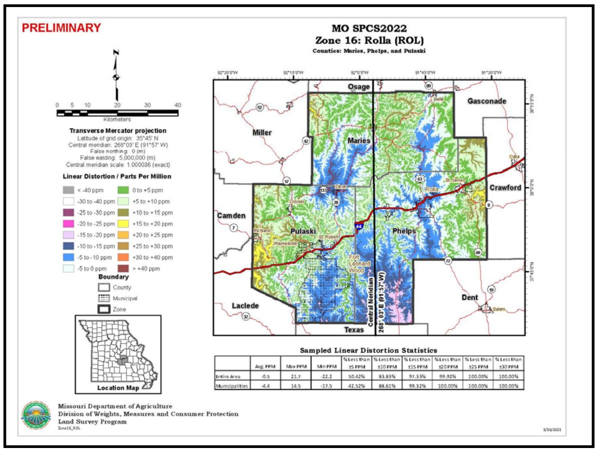
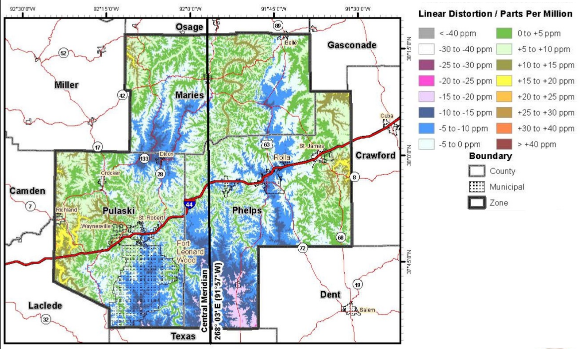


Sampled Linear Distortion Statistics

	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-0.5	21.7	-22.2	50.42%	83.83%	97.33%	99.92%	100.00%	100.00%
Municipalities	-4.4	14.5	-17.5	42.52%	88.61%	99.32%	100.00%	100.00%	100.00%

Preliminary Zone 16: Rolla



Preliminary Zone 16: Rolla Parameters

Transverse Mercator projection

Latitude of grid origin: 35°45' N

Central meridian: 268°03' E (91°57' W)

False northing: 0 (m)

False easting: 5,000,000 (m)

Central meridian scale: 1.000036 (exact)

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Preliminary Zone 16: Rolla Statistics

Sampled Linear Distortion Statistics

	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-0.5	21.7	-22.2	50.42%	83.83%	97.33%	99.92%	100.00%	100.00%
Municipalities	-4.4	14.5	-17.5	42.52%	88.61%	99.32%	100.00%	100.00%	100.00%

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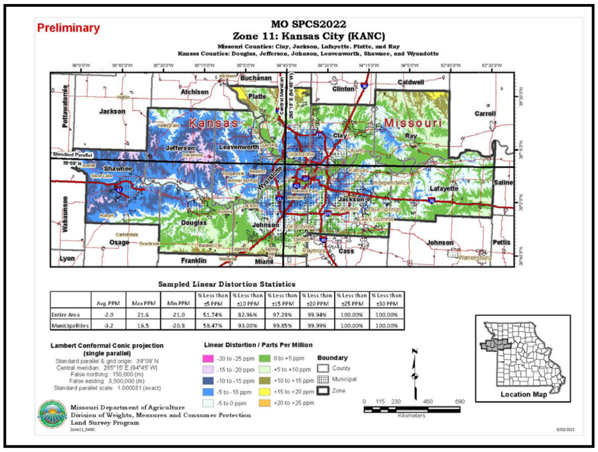
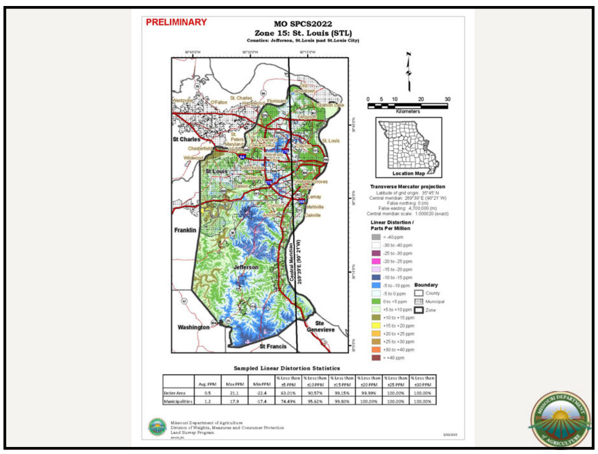
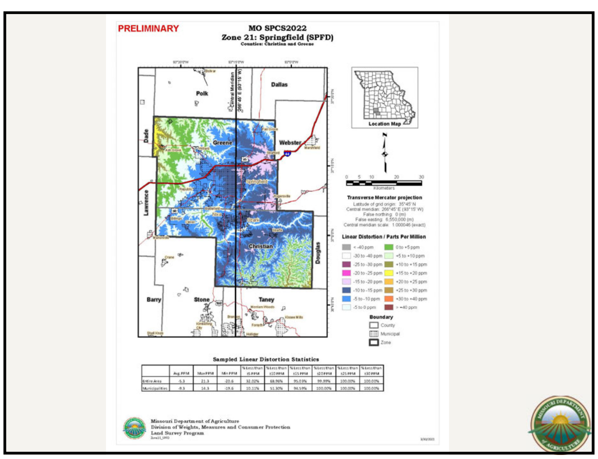
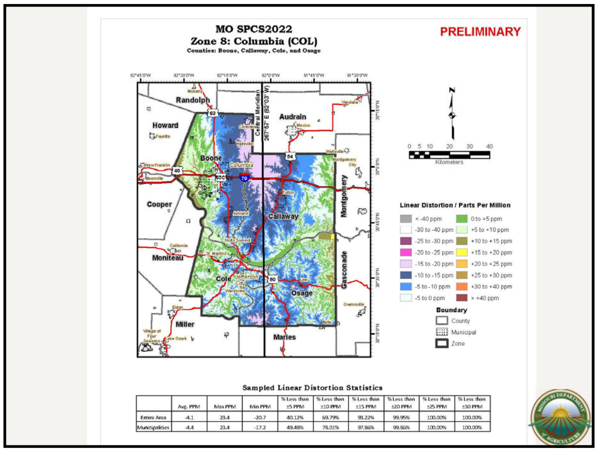
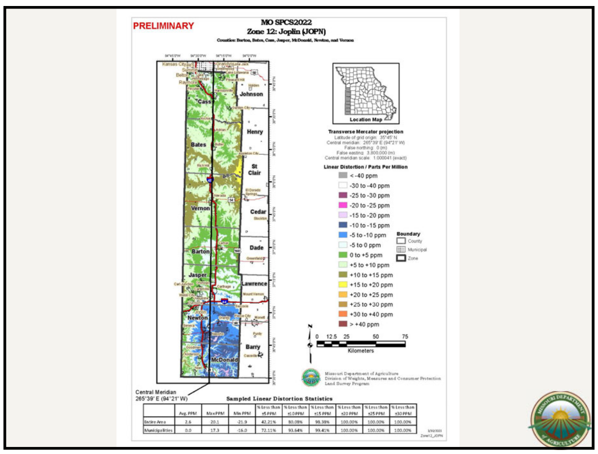

Preliminary
MO SPCS2022
Zone 11: Kansas City (KANC)
Missouri Counties: Clay, Jackson, Lafayette, Platte, and Ray
Kansas Counties: Douglas, Jefferson, Johnson, Leavenworth, Shawnee, and Wyandotte
Kansas
Missouri
Sampled Linear Distortion Statistics
	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-2.0	21.6	-21.0	51.74%	82.96%	97.28%	99.94%	100.00%	100.00%
Municipalities	-3.2	16.5	-20.8	58.47%	93.00%	99.85%	99.99%	100.00%	100.00%
Lambert Conformal Conic projection
(single parallel)
Standard parallel & grid origin: 39°09' N
Central meridian: 265°15' E (94°45' W)
False northing: 150,000 (m)
False easting: 3,500,000 (m)
Standard parallel scale: 1.000031 (exact)
Linear Distortion / Parts Per Million
Boundary
County
Municipal
Zone
Kilometers
Location Map
Missouri Department of Agriculture
Division of Weights, Measures and Consumer Protection
Land Survey Program
Zone11_KANC


PRELIMINARY
MO SPCS2022
Zone 15: St. Louis (STL)
Counties: Jefferson, St.Louis (and St.Louis City)
Kilometers
Location Map
Transverse Mercator projection
Linear Distortion / Parts Per Million
Boundary
County
Municipal
Zone
Sampled Linear Distortion Statistics
	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	0.5	21.1	-22.4	63.01%	90.57%	99.15%	99.99%	100.00%	100.00%
Municipalities	1.2	17.9	-17.4	74.49%	95.62%	99.80%	100.00%	100.00%	100.00%
Missouri Department of Agriculture
Division of Weights, Measures and Consumer Protection
Land Survey Program

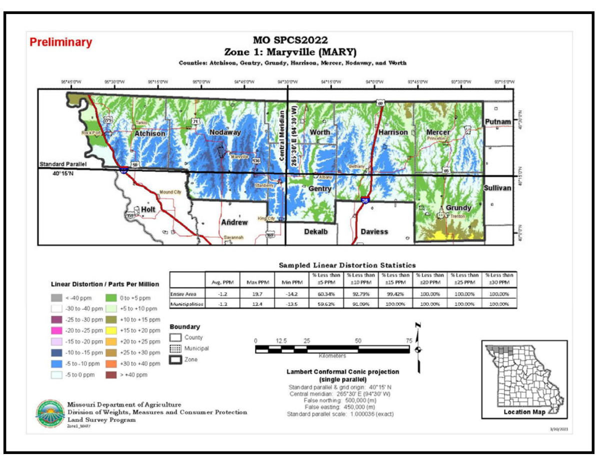

PRELIMINARY
MO SPCS2022
Zone 21: Springfield (SPFD)
Counties: Christian and Greene
Location Map
Transverse Mercator projection
Linear Distortion / Parts Per Million
Boundary
County
Municipal
Zone
Sampled Linear Distortion Statistics
	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-5.3	21.3	-20.6	32.02%	68.96%	95.03%	99.99%	100.00%	100.00%
Municipalities	-9.3	14.3	-19.6	10.11%	51.30%	94.59%	100.00%	100.00%	100.00%
Missouri Department of Agriculture
Division of Weights, Measures and Consumer Protection
Land Survey Program
Zone21_SPFD



	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-4.1	23.4	-20.7	40.12%	69.79%	93.22%	99.95%	100.00%	100.00%
Municipalities	-4.4	23.4	-17.2	49.48%	78.01%	97.86%	99.86%	100.00%	100.00%



	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	2.6	20.1	-21.9	42.21%	80.08%	98.38%	100.00%	100.00%	100.00%
Municipalities	0.0	17.3	-16.0	72.11%	93.64%	99.41%	100.00%	100.00%	100.00%



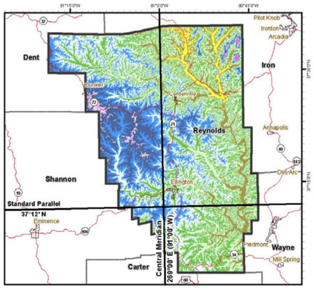
	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-1.2	19.7	-14.2	60.34%	92.79%	99.42%	100.00%	100.00%	100.00%
Municipalities	-1.2	12.4	-13.5	59.62%	91.09%	100.00%	100.00%	100.00%	100.00%

Multiple-zone Layer

Low Distortion Projection System

PRELIMINARY

MO SPCS2022
Zone 24: Ellington (ELTN)
Counties: Reynolds



Sampled Linear Distortion Statistics

	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-0.2	21.9	-24.8	46.45%	78.31%	96.29%	99.76%	100.00%	100.00%
Municipalities	0.8	11.5	-20.0	44.73%	75.30%	85.05%	99.87%	100.00%	100.00%

Location Map

0 5 10 20 30 Kilometers

Lambert Conformal Conic projection
Standard Parallel & grid origin: 37°12' N
Central meridian: 269°00' E (91°00' W)
False northing: 160,000 (m)
False easting: 7,470,000 (m)
Standard Parallel scale: 1.000033 (exact)

Linear Distortion / Parts Per Million
< -40 ppm; -30 to -40 ppm; -25 to -30 ppm; -20 to -25 ppm; -15 to -20 ppm; -10 to -15 ppm; -5 to -10 ppm; -5 to 0 ppm; 0 to +5 ppm; +5 to +10 ppm; +10 to +15 ppm; +15 to +20 ppm; +20 to +25 ppm; +25 to +30 ppm; +30 to +40 ppm; > +40 ppm

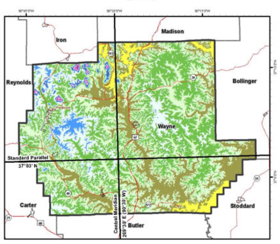
Boundary
County
Municipal
Zone

Missouri Department of Agriculture
Division of Weights, Measures and Consumer Protection
Land Survey Program
Zone24_ELTN

3/30/2021

PRELIMINARY

MO SPCS2022
Zone 26: Piedmont (PIED)
Wayne County



Sampled Linear Distortion Statistics

	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	5.5	20.6	-34.5	44.60%	75.85%	95.43%	99.84%	99.96%	99.99%
Municipalities	7.9	13.6	-2.6	13.31%	82.65%	100.00%	100.00%	100.00%	100.00%

0 3.25 6.5 13 19.5 26 Kilometers

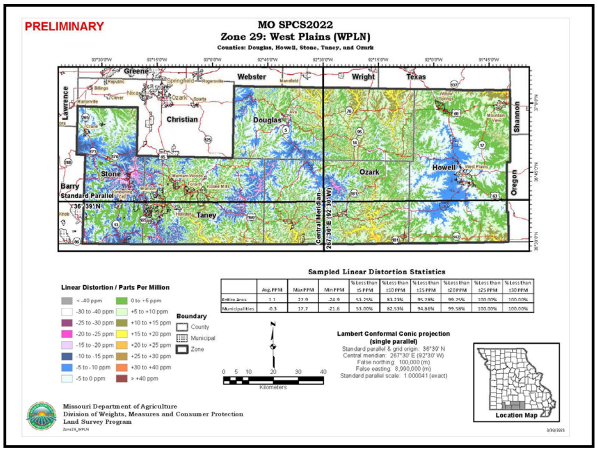
Lambert Conformal Conic projection (single parallel)
Standard parallel & grid origin: 37°03' N
Central meridian: 269°30' E (90°30' W)
False northing: 150,000 (m)
False easting: 8,080,000 (m)
Standard parallel scale: 1.000026 (exact)

Boundary
County
Municipal
Zone

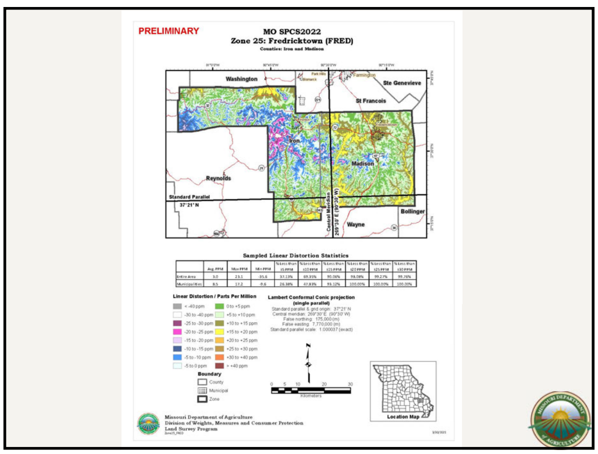
Linear Distortion / Parts Per Million
< -40 ppm; -30 to -40 ppm; -25 to -30 ppm; -20 to -25 ppm; -15 to -20 ppm; -10 to -15 ppm; -5 to -10 ppm; -5 to 0 ppm; 0 to +5 ppm; +5 to +10 ppm; +10 to +15 ppm; +15 to +20 ppm; +20 to +25 ppm; +25 to +30 ppm; +30 to +40 ppm; > +40 ppm

Location Map

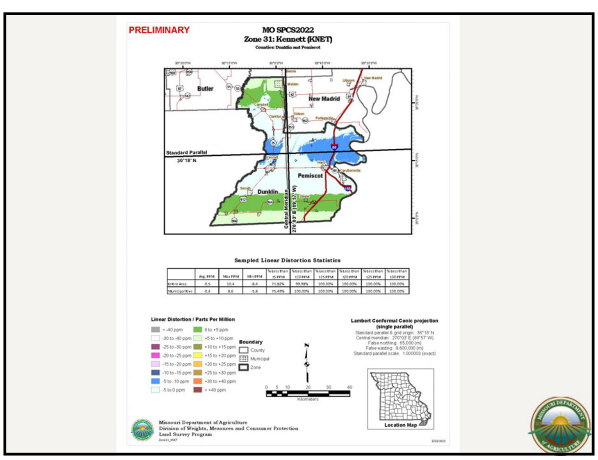
Missouri Department of Agriculture
Division of Weights, Measures and Consumer Protection



	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	1.1	27.9	-24.9	53.25%	83.23%	95.78%	99.75%	100.00%	100.00%
Municipalities	-0.3	17.7	-21.6	53.00%	82.53%	94.86%	99.58%	100.00%	100.00%

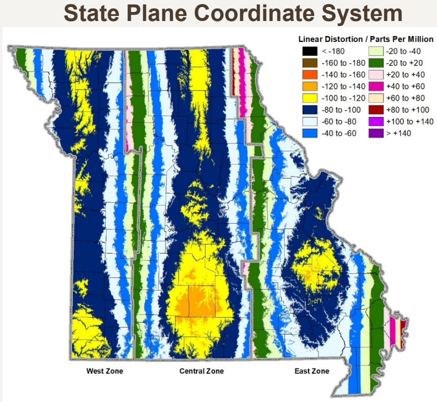


	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	3.0	23.1	-35.6	37.13%	69.35%	90.06%	98.08%	99.27%	99.76%
Municipalities	8.5	17.2	-9.6	26.38%	47.83%	93.12%	100.00%	100.00%	100.00%

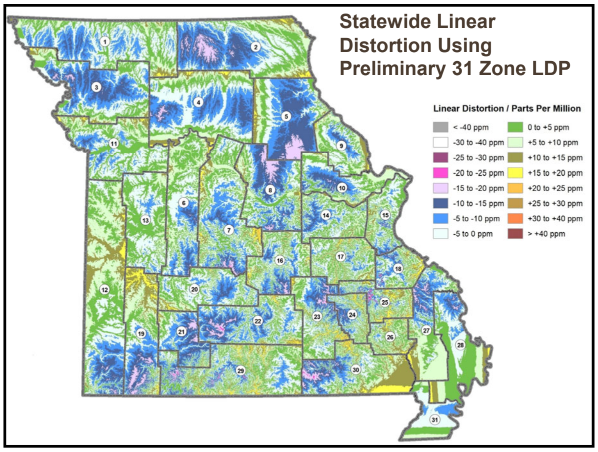


	Avg. PPM	Max PPM	Min PPM	% Less than ±5 PPM	% Less than ±10 PPM	% Less than ±15 PPM	% Less than ±20 PPM	% Less than ±25 PPM	% Less than ±30 PPM
Entire Area	-0.5	10.4	-8.4	71.82%	99.98%	100.00%	100.00%	100.00%	100.00%
Municipalities	-0.4	8.6	-5.8	75.49%	100.00%	100.00%	100.00%	100.00%	100.00%

Linear Distortion On the Existing Three Zone NAD 83 State Plane Coordinate System



Statewide Linear Distortion Using Preliminary 31 Zone LDP



Comparison Statistics

	Out of 114 Counties and St. Louis City	
Coor. System	Max (ppm)	Min (ppm)
NAD 83 SPCS	115.4	-143.5
Prel. 31 zone LDP	29.3	-35.6

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Comparison Statistics Cont.

	Out of 114 Counties and St. Louis City Percentage of Sampled Points Under					
Coor. System	+/- 5 ppm	+/- 10 ppm	+/- 15 ppm	+/- 20 ppm	+/- 25 ppm	+/- 30 ppm
NAD 83 SPCS	2.22%	4.61%	7.19%	9.80%	12.21%	14.80%
Prel. 31 zone LDP	48.35%	80.22%	96.16%	99.82%	99.98%	Appr. 100.00%

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What type of surveying practices result in about 5 PPM linear distortion?

- **Scaling points with one factor on a GPS project and measuring with GPS to a point with an elevation 100 feet above or below the point at which the factor was derived**
- **Not having a geoid model**
- **In a total station:**
  - Having the temperature off by 7 or 8 degrees F
  - Or having the pressure off by about a ½ inch of Mercury

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LDP Advantages

- **Grid distances closely match the ground distances**
- **Larger areas covered with less distortion**
- **Reduced convergence angle**
- **Clean zone parameter definitions, compatible with common surveying, engineering, and GIS software**

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LDP Advantages Cont.

- Easy to transform between other coordinate systems
- Maintains a relationship to the National Spatial Reference System (NSRS)
- Cover entire cities and counties making them useful for regional mapping and GIS
- Obtain distances near ground distances without site "calibration" or "localization" to control points

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LDP Advantages Cont.

- Preloaded into machine control grading systems
- Available and coded into popular survey and mapping software
- Work with MODOT VRS and OPUS

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LDP Disadvantages

- Will not perform well on very large projects
- Some linear distortion will be unavoidable
- Unfamiliar with new projection parameters
- Learning curve and associated cost for initial familiarization and transformation of existing mapping systems
- Most likely Grid North will be different from NAD83 and NAD27

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Surveying in SPCS2022

- **Start by checking distortion map of zone/area at project location**
  - Determine if scale/elevation factors are needed
- **Zone should be preloaded within software**
- **Select zone within data collector**
- **Date collector setup similar to our current process**

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Status of Zone Layout and Designs

- **Designs by NGS**
  - 159 zones (including 54 statewide zones)
- **Designs by state stakeholders**
  - 810 zones in 28 states
  - Range from 1 to 88 zones per layer (max in Ohio)
  - Essentially all are “low distortion projections”
- **Total = 969 zones for 56 states and territories**
  - Number may decrease, but will not increase

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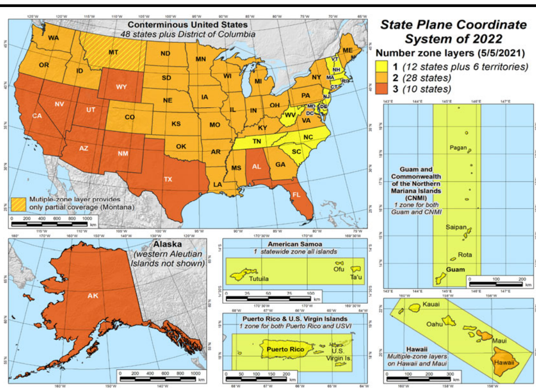
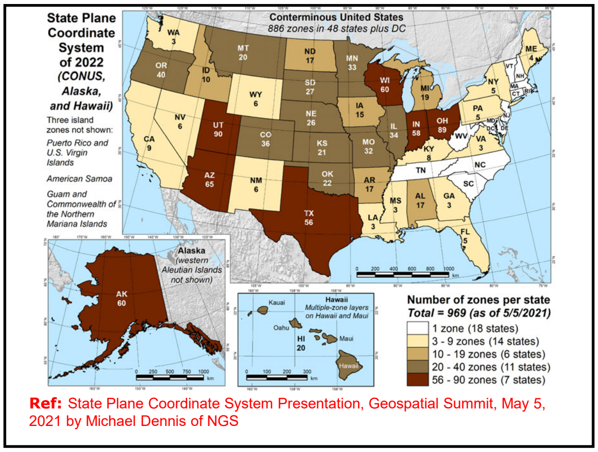
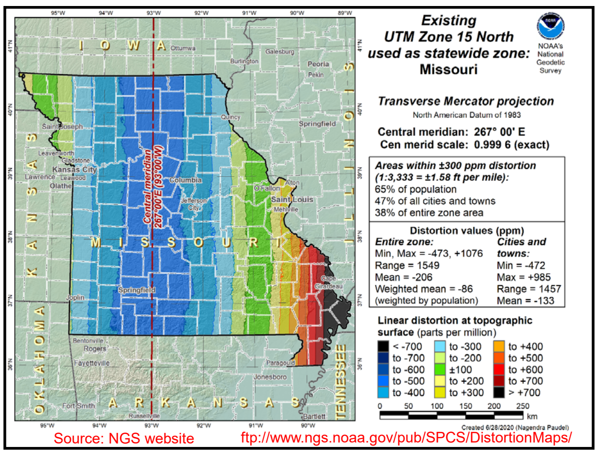
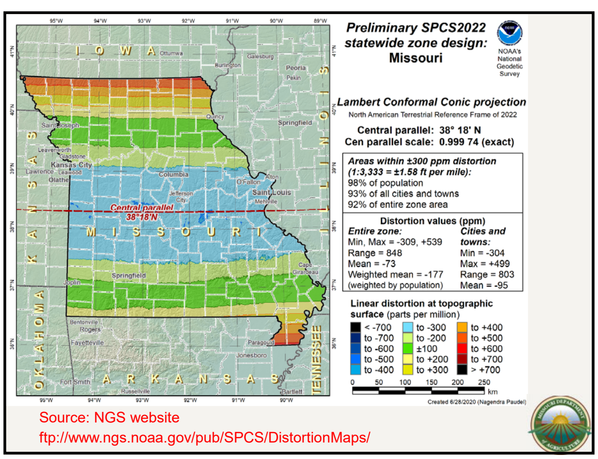
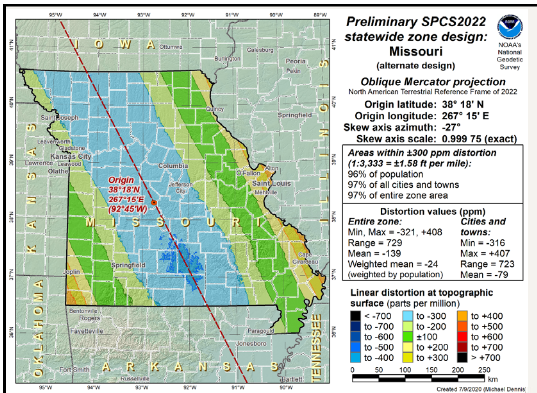


Ref: State Plane Coordinate System Presentation, Geospatial Summit, May 5, 2021 by Michael Dennis of NGS


State Plane Coordinate System of 2022 (CONUS, Alaska, and Hawaii)
Three island zones not shown:
Puerto Rico and U.S. Virgin Islands
American Samoa
Guam and Commonwealth of the Northern Mariana Islands
Conterminous United States
886 zones in 48 states plus DC
Alaska (western Aleutian Islands not shown)
AK 60
Hawaii Multiple-zone layers on Hawaii and Maui
HI 20
Number of zones per state
Total = 969 (as of 5/5/2021)
1 zone (18 states)
3 - 9 zones (14 states)
10 - 19 zones (6 states)
20 - 40 zones (11 states)
56 - 90 zones (7 states)
Ref: State Plane Coordinate System Presentation, Geospatial Summit, May 5, 2021 by Michael Dennis of NGS


Existing UTM Zone 15 North used as statewide zone: Missouri
NOAA's National Geodetic Survey
Transverse Mercator projection
North American Datum of 1983
Central meridian: 267° 00' E
Cen merid scale: 0.999 6 (exact)
Areas within ±300 ppm distortion (1:3,333 = ±1.58 ft per mile):
65% of population
47% of all cities and towns
38% of entire zone area
Distortion values (ppm)
Entire zone:
Min, Max = -473, +1076
Range = 1549
Mean = -206
Weighted mean = -86
(weighted by population)
Cities and towns:
Min = -472
Max = +985
Range = 1457
Mean = -133
Linear distortion at topographic surface (parts per million)
< -700
to -700
to -600
to -500
to -400
to -300
to -200
±100
to +200
to +300
to +400
to +500
to +600
to +700
> +700
Central meridian 267°00'E (93°00'W)
IOWA
KANSAS
MISSOURI
ILLINOIS
OKLAHOMA
ARKANSAS
TENNESSEE
Created 6/28/2020 (Nagendra Paudel)
Source: NGS website ftp://www.ngs.noaa.gov/pub/SPCS/DistortionMaps/


Preliminary SPCS2022 statewide zone design: Missouri
NOAA's National Geodetic Survey
Lambert Conformal Conic projection
North American Terrestrial Reference Frame of 2022
Central parallel: 38° 18' N
Cen parallel scale: 0.999 74 (exact)
Areas within ±300 ppm distortion (1:3,333 = ±1.58 ft per mile):
98% of population
93% of all cities and towns
92% of entire zone area
Distortion values (ppm)
Entire zone:
Min, Max = -309, +539
Range = 848
Mean = -73
Weighted mean = -177
(weighted by population)
Cities and towns:
Min = -304
Max = +499
Range = 803
Mean = -95
Linear distortion at topographic surface (parts per million)
< -700
to -700
to -600
to -500
to -400
to -300
to -200
±100
to +200
to +300
to +400
to +500
to +600
to +700
> +700
Central parallel 38°18'N
IOWA
KANSAS
MISSOURI
ILLINOIS
OKLAHOMA
ARKANSAS
TENNESSEE
Created 6/28/2020 (Nagendra Paudel)
Source: NGS website
ftp://www.ngs.noaa.gov/pub/SPCS/DistortionMaps/



Source: NGS website
ftp://www.ngs.noaa.gov/pub/SPCS/DistortionMaps/

Statewide Zone Comparison

	Areas within 300 PPM Distortion			
Coordinate System	Population	Cities and Towns	Entire Zone Area	Min/Max
NAD 83 UTM 15	65%	47%	38%	-473/+1076
SPCS2022 – LCC Projection	98%	93%	92%	-309/+539
SPCS2022 – OM Projection	96%	97%	97%	-321/+408

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Statewide Zone Advantages

- More geocentric
- Projection surface near the topographic surface
- Less distortion than NAD83 UTM Zone 15
- Easily transformed between coordinate systems
- Covers the entire state - useful for regional/statewide mapping and GIS
- Used with MODOT VRS & OPUS

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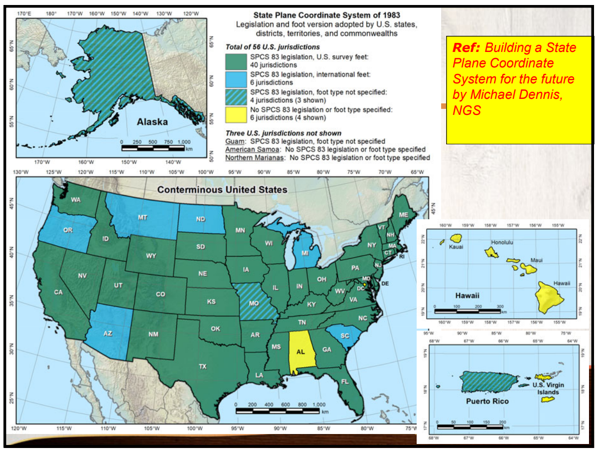
GPS on Bench Marks

- 2022 Transformation Tools
- "GPS on Bench Marks"
- The LSP, MODOT, MSPS chapters, Corps of Engineers and the private sector assisted in these efforts
- Land Survey Program plans to continue to assist with this project



Foot Definition Comparison

U. S. Survey Foot (sft) = 1200/3937 Meters
(sft = 0.304800609601 Meters)
International Foot (ift) = 0.3048 Meters

Distance comparison:
1 Mile = 1609.344 Meters
1609.344/. 0.304800609601 = 5279.99 sft
1609.344/0.3048 = 5280.00 ift

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Foot Definition Comparison Cont.

U.S. Survey Foot (sft) = 1200/3937 Meter
(sft = 0.304800609601 meter)
International Foot (ift) = 0.3048 Meter

Coordinate comparison:
ET 18 JWO – Harrison County
N: 482,396.207 meters
E: 900,585.283 meters

N: 1,582,661.56 sft vs. N: 1,582,664.72 ift
E: 2,954,670.22 sft E: 2,954,676.13 ift
Difference: 6.70'

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Foot Definition

- **Deprecation effective Dec 31, 2022**
  - NSRS modernization will happen later
- **For users of existing NSRS:**
  - Deprecation will have no effect
  - U.S. survey foot will still be supported
  - Difference in dates will NOT create a problem
- **Will give more time to make the transition**

U.S survey foot will ALWAYS be supported by NGS for State Plane Coordinate Systems of 1983 and 1927

Ref: Retirement of the U.S. Survey Foot Presentation, Geospatial Summit, May 5, 2021 by Michael Dennis of NGS

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SPCS2022 Stakeholders

- Missouri Department of Agriculture - Land Survey Program
- Missouri Department of Transportation
- Missouri Director - GIS
- Missouri Society of Professional Surveyors

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State Plane Coordinate System of 2022

Deadlines:

- **March 31, 2020 -** Requests for zones designed by NGS or proposals for zones designed by stakeholders
- **March 31, 2021 - Submittal of all final defining** parameters for NGS-approved designs by stakeholders
- **Finalize all designs in 2022 (maybe later…)**
- **Official release with rollout of modernized NSRS**

Likely after 2025
(Per NGS at Geospatial Summit in May 2021)

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Land Survey Program

- **Department of Agriculture**
- **Weights, Measures and Consumer Protection**
  agriculture.mo.gov/weights/landsurvey
- **Land Survey Program**
  1251A Gale Drive
  PO Box 937
  Rolla, MO 65402-0937
  Phone: (573) 368-2300
  Fax: (573) 368-2379
  Email: landsurv@mda.mo.gov

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Thank You
Ron Heimbaugh, PLS
Jess Moss, PLS
Land Survey Program

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- The Fate of the U.S. Survey Foot after 2022 A Conversation with NGS by Michael Dennis, NGS
  https://www.ngs.noaa.gov/web/science_edu/webinar_series/fate-of-us-survey-foot.shtml
- Ground Truth Design and Documentation of Low Distortion Projections for Surveying and GIS v. 22 (Dennis 2015)
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- Minnesota
  - https://www.dot.state.mn.us/surveying/pdf/mncoordsys.pdf
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- Nebraska
  - https://nebldpproject.blogspot.com/

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- US Department of Commerce, et al. "National Geodetic Survey NGS Training and Testing Center Video Library." Home, NOAA, National Geodetic Survey, 16 Dec. 2009, www.ngs.noaa.gov/corbin/class_description/NGS_Datums_video_2_b/
- "Policy and Procedures Documents for the State Plane Coordinate System of 2022." https://www.ngs.noaa.gov/SPCS/policy.shtml
- 1959 Federal Register Notice, Signed by NBS and C&GS directors, approved by Secretary of Commerce, June 25, 1959 https://geodesy.noaa.gov/PUBS_LIB/FedRegister/FRdoc59-5442.pdf

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