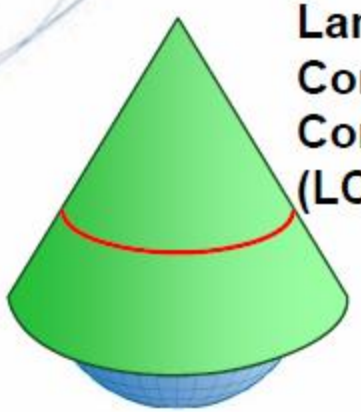
NJ SPCS 2022

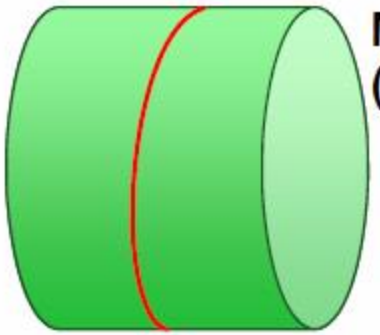
Preliminary Design Information

A New State Plane Coordinate System

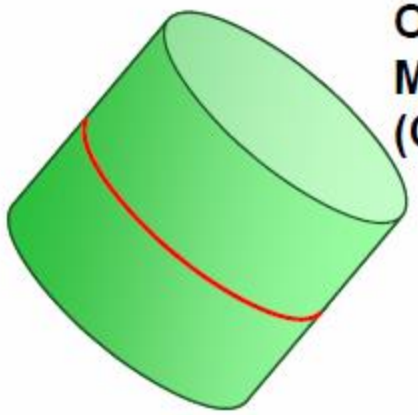
- **State Plane Coordinate System of 2022 (SPCS2022)**
  - Referenced to 2022 Terrestrial Reference Frames (TRFs)
  - Based on same reference ellipsoid as SPCS 83 (GRS 80)
  - Same 3 ***conformal*** projection types as SPCS 83 and 27:



Lambert Conformal Conic (LCC)



Transverse Mercator (TM)

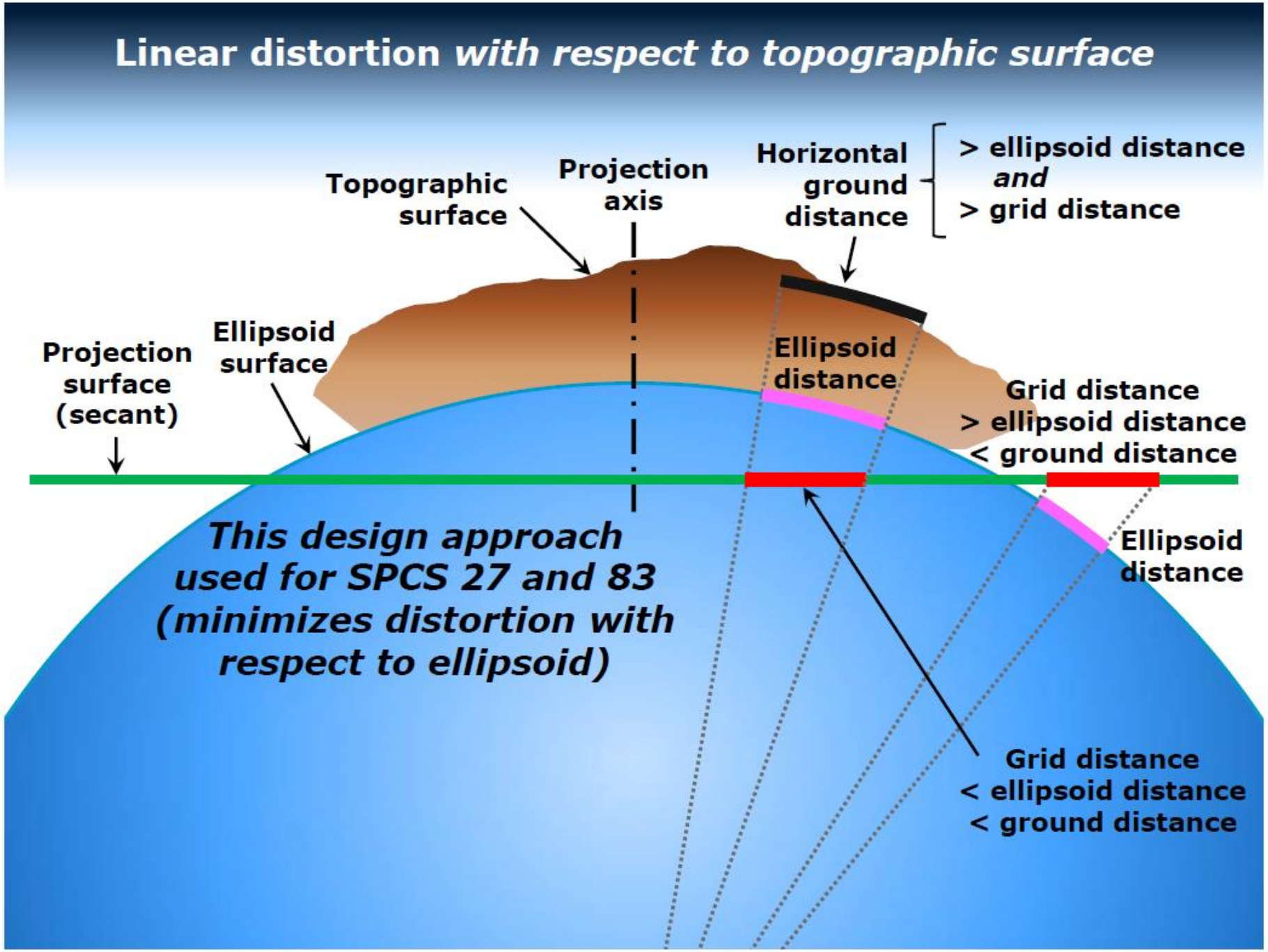


Oblique Mercator (OM)

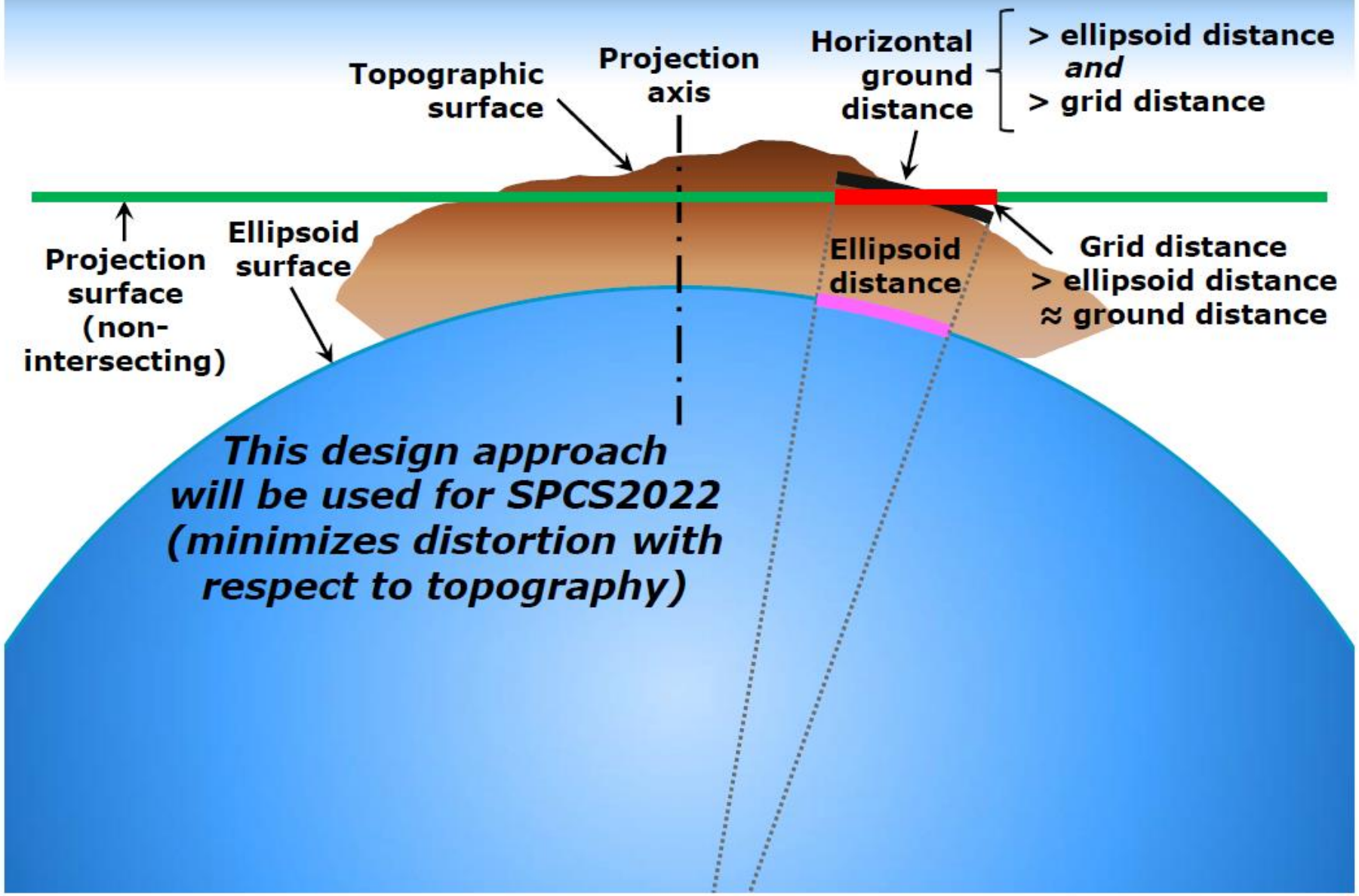
Linear distortion at topo surface

Policy § II.C and Procedures § 5.c.

- Distortion for design evaluated at **topo surface**
  - Minimize range and mean distortion in zone
  - Account for cities with distortion weighted by population
- Design ***not*** evaluated at the ellipsoid surface
  - Nobody lives or works on the ellipsoid
  - Likely used in past because it is easier
- Projection ***scaled*** to topo surface ("ground")
  - Reduces difference between "grid" and "ground"
  - Topographic ellipsoid height not part of definition


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

Linear distortion *with respect to topographic surface*



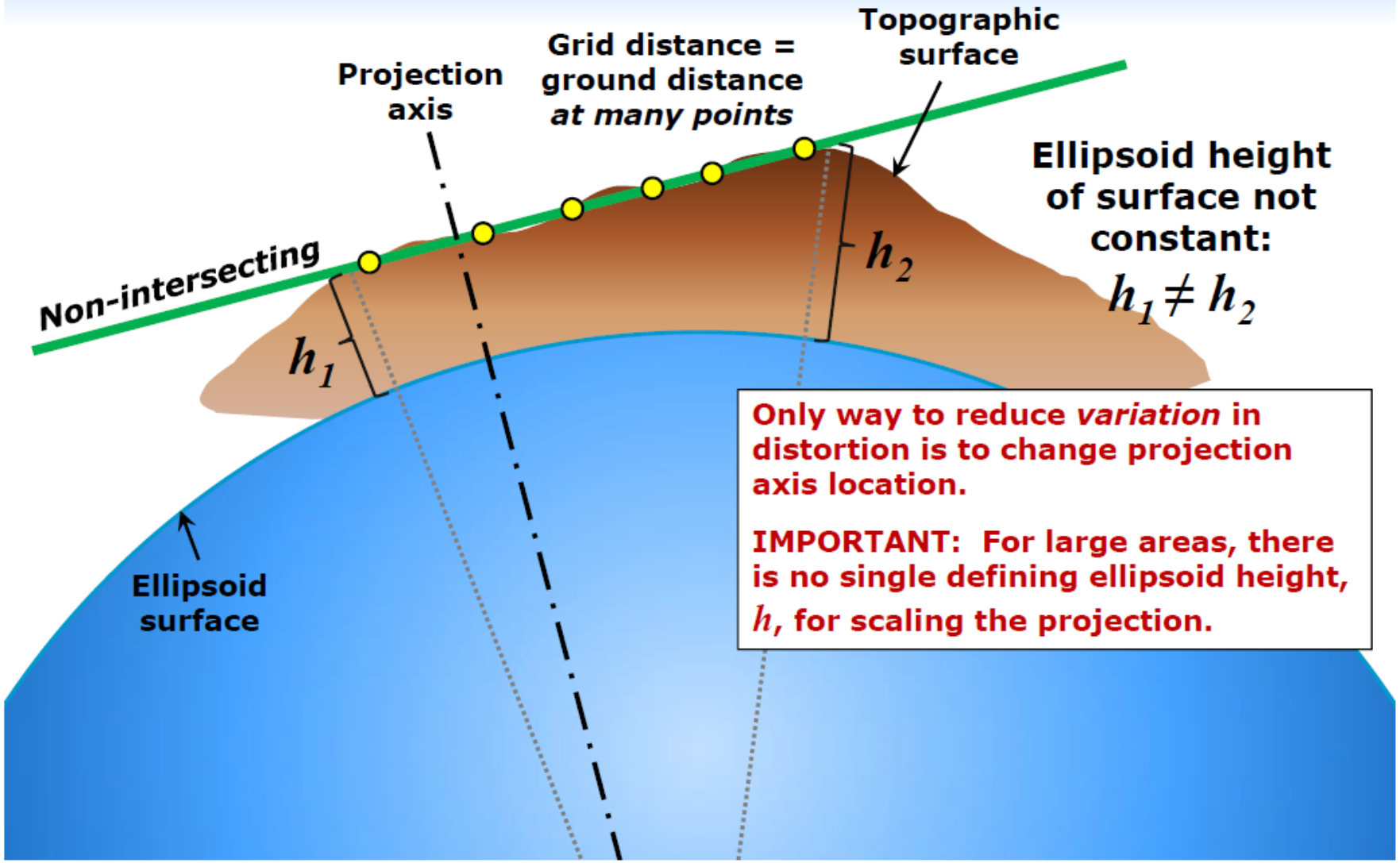
Linear distortion magnitudes

ppm = parts per million (mm/km)

- **±20 ppm** = 2 cm/km = 0.1 ft/mile = 1 : 50,000
  Often used as "low distortion" design criterion (***at ground***)
- **±50 ppm** = 5 cm/km = 0.3 ft/mile = 1 : 20,000
  Minimum design criterion for SPCS2022 designs by NGS (***at ground***)
- **±100 ppm** = 10 cm/km = 0.5 ft/mile = 1 : 10,000
  "Nominal" maximum State Plane value (***on ellipsoid***)
  Can be much greater at topo surface
- **±400 ppm** = 40 cm/km = 2.1 ft/mile = 1 : 2,500
  Maximum design criterion for SPCS2022 zones (***at ground***)
  Maximum UTM value (***on ellipsoid***)

Nominal distortion criterion (on ellipsoid) for SPCS 27 and 83 zones (although greatly exceeded for some zones in SPCS 83).

Changing projection axis to reduce distortion variation



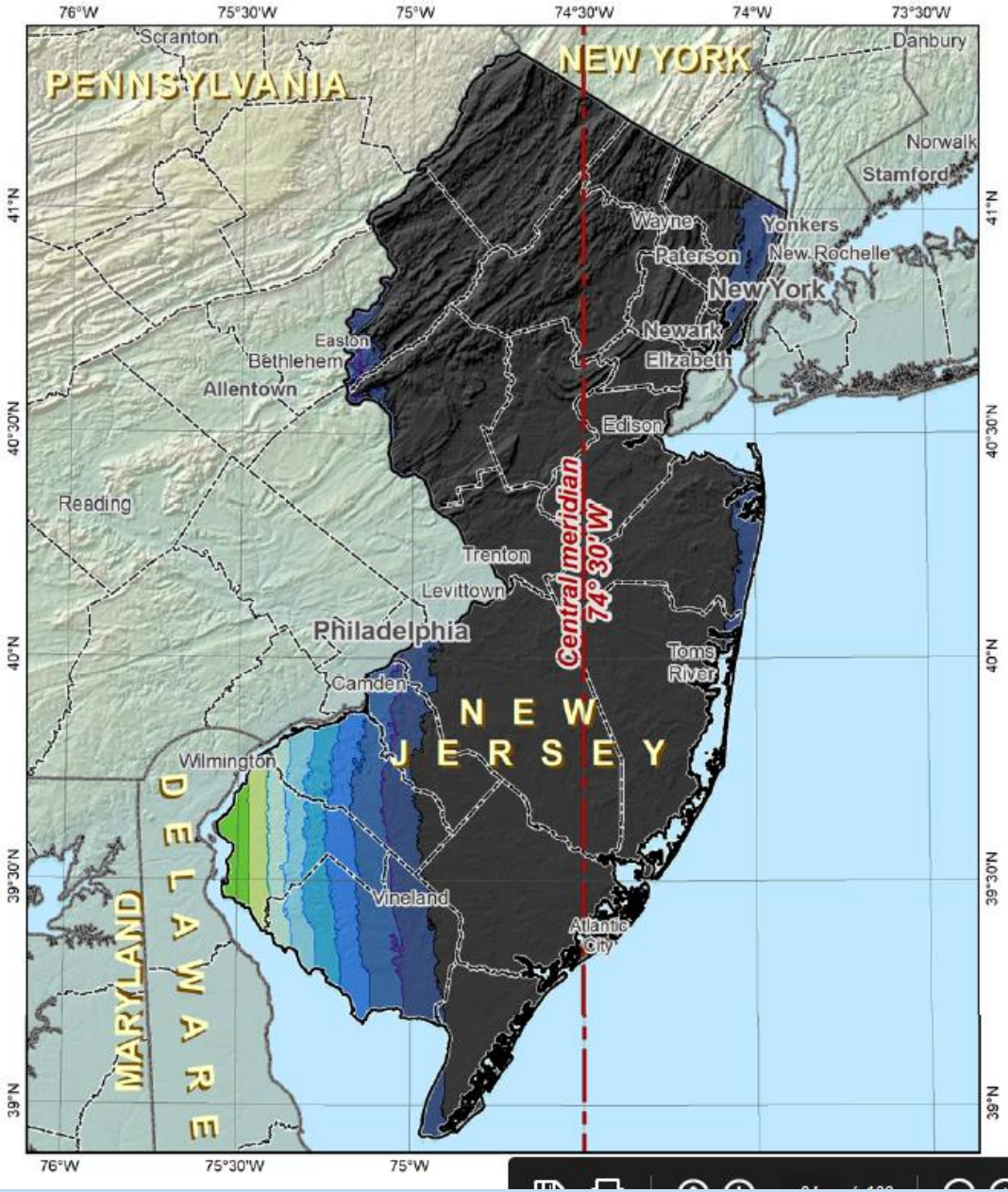
Only way to reduce *variation* in distortion is to change projection axis location.

IMPORTANT: For large areas, there is no single defining ellipsoid height, h, for scaling the projection.

What changes for default designs?

- Most zones will keep same extents and projection type
- Possible changes in projection types and zone extents
  - 1 or 2 OM zones for FL peninsula (currently 2 TM zones)
  - 1 OM zone for Hawaii (replaces 5 TM zones)
  - 1 OM zone for NJ (currently 1 TM)
  - Include Guam and CNMI in 1 TM zone (currently only Guam)
  - Define LCC zone for American Samoa (no SPCS 83 zone)
  - Redefine AK zones to better correspond to land use
  - Add zone for Washington D.C.

Examples follow of zones where proposed projection type and/or extents change.



Existing SPCS 83 design: New Jersey Zone

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Datum of 1983

Central meridian: 74° 30' W
Cen merid scale: 0.999 9 (exact)

Areas within ±20 ppm distortion (1:50,000 = ±0.11 ft per mile):
0.6% of population
1.4% of all cities and towns
1.8% of entire zone area

Distortion values (ppm)

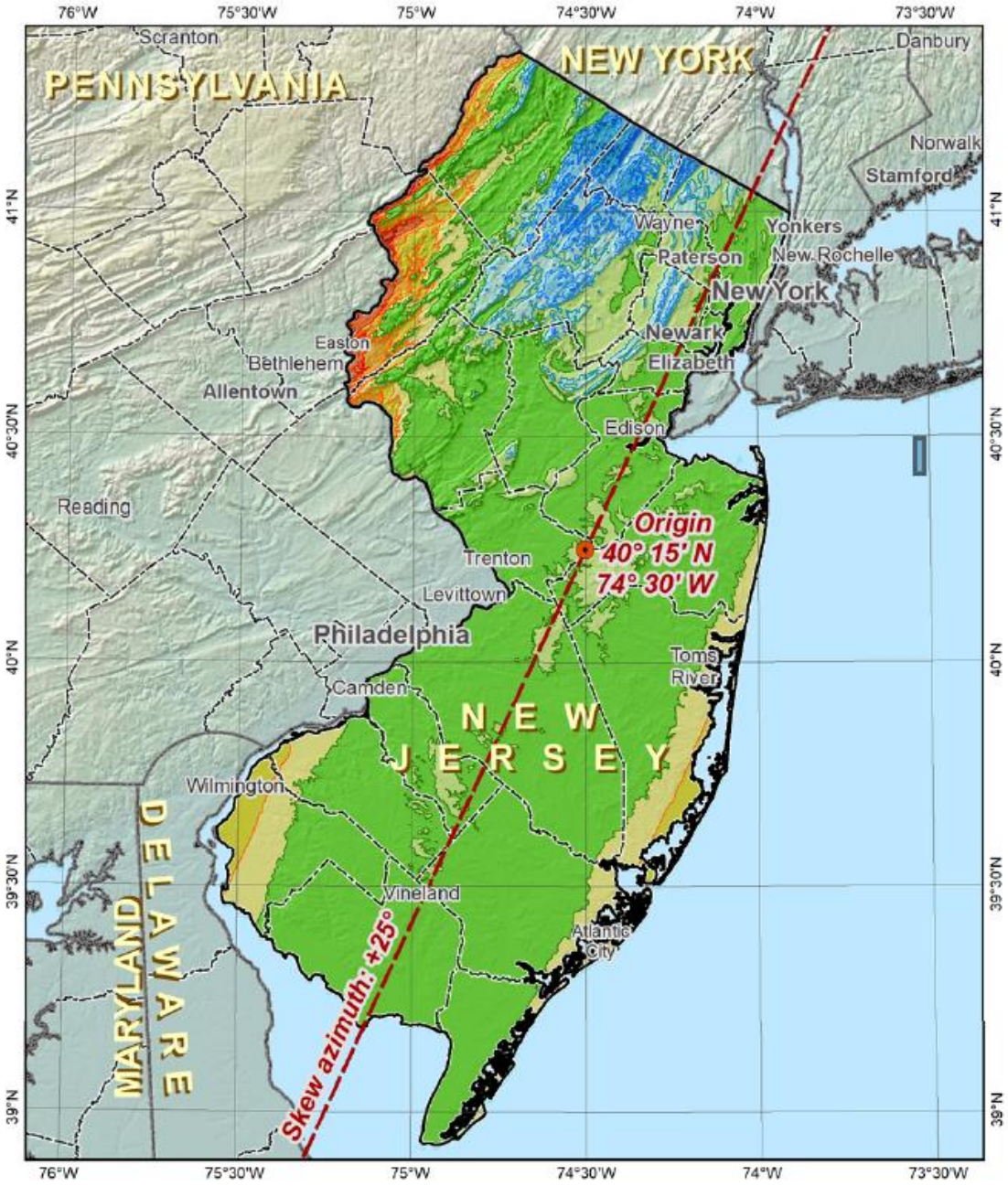
Entire zone:	***Cities and towns:***
Min = -175	Min, Max = -156, -2
Max = +7	Range = 155
Range = 182	Mean = -88
Mean = -92	(weighted by population)

Linear distortion at topographic surface (parts per million)

< -80	to -40	to +30
to -80	to -30	to +40
to -70	to -20	to +50
to -60	±10	to +60
to -50	to +20	> +60

0 25 50 75 100 km

Created 01/29/2019



Preliminary SPCS2022 default design: New Jersey Zone

(alternative 2)

NOAA's National Geodetic Survey

Oblique Mercator projection

North American Terrestrial Reference Frame of 2022

Origin latitude: 40° 15' N
Origin longitude: 74° 30' W
Skew axis scale: 0.999 99 (exact)
Skew azimuth: +25°

Areas within ±20 ppm distortion (1:50,000 = ±0.11 ft per mile):
94% of population
87% of all cities and towns
86% of entire zone area

Distortion values (ppm)

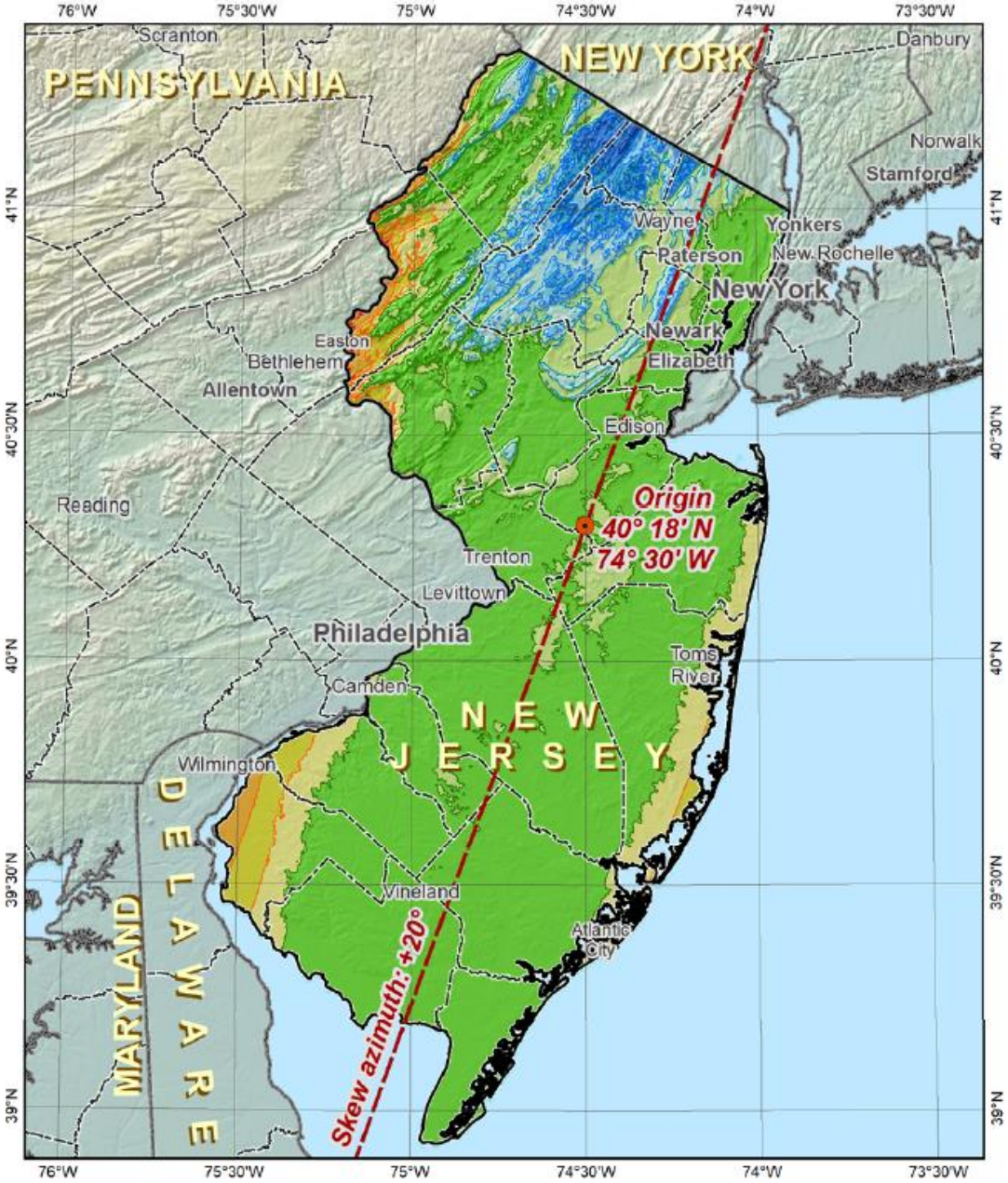
Entire zone:	*Cities and towns:*
Min = -60	Min, Max = -46, +54
Max = +66	Range = 99
Range = 126	Mean = -5
Mean = -3	(weighted by population)

Linear distortion at topographic surface (parts per million)

< -80	to -40	to +30
to -80	to -30	to +40
to -70	to -20	to +50
to -60	±10	to +60
to -50	to +20	> +60

0 25 50 75 100 km

Created 01/29/2019



Preliminary SPCS2022 default design: New Jersey Zone

(alternative 1)

NOAA's National Geodetic Survey

Oblique Mercator projection

North American Terrestrial Reference Frame of 2022

Origin latitude: 40° 18' N
Origin longitude: 74° 30' W
Skew axis scale: 0.999 99 (exact)
Skew azimuth: +20°

Areas within ±20 ppm distortion (1:50,000 = ±0.11 ft per mile):
94% of population
85% of all cities and towns
85% of entire zone area

Distortion values (ppm)

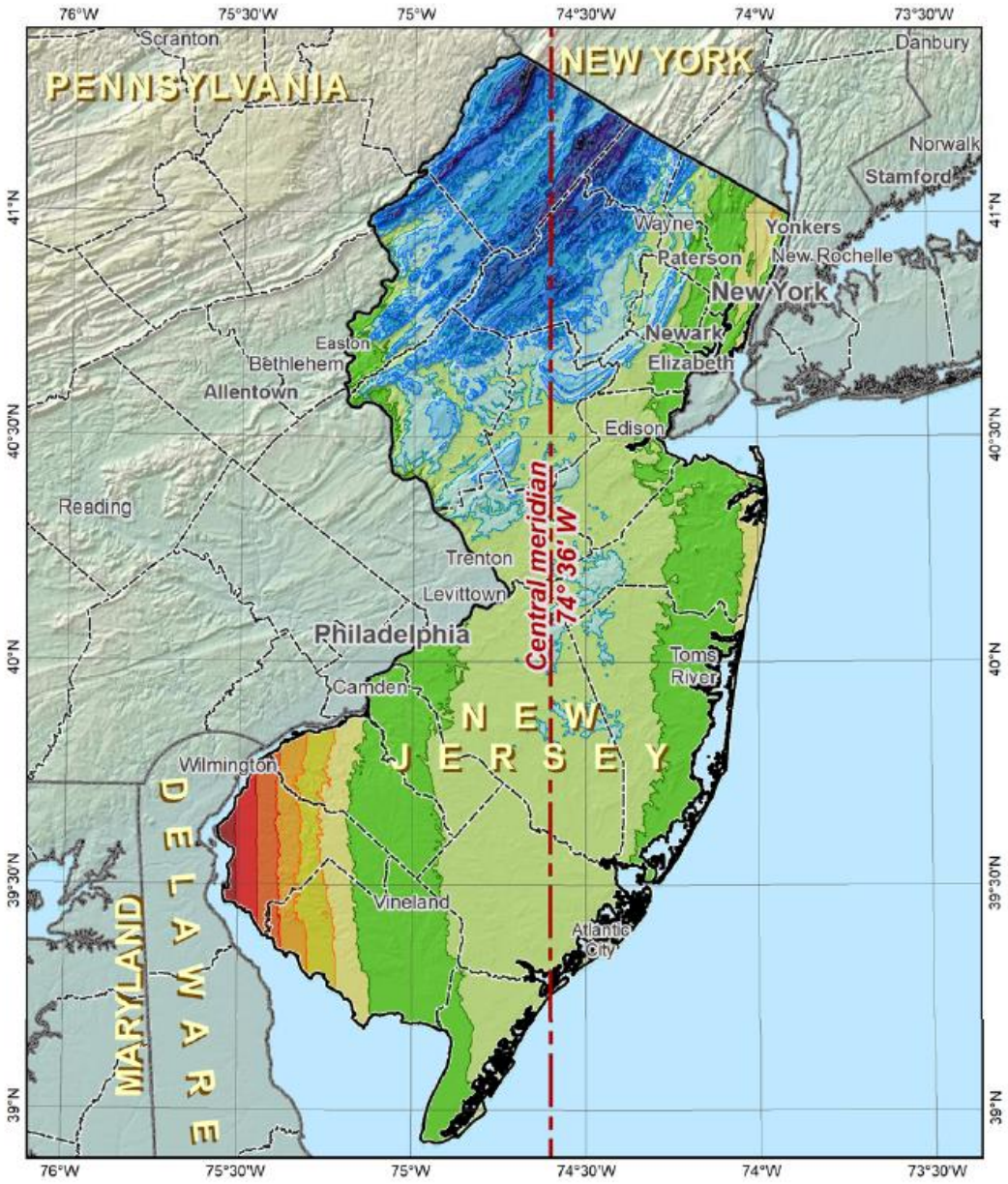
Entire zone:	***Cities and towns:***
Min = -67	Min, Max = -55, +45
Max = +52	Range = 100
Range = 120	Mean = -5
Mean = -4	(weighted by population)

Linear distortion at topographic surface (parts per million)

< -80	to -40	to +30
to -80	to -30	to +40
to -70	to -20	to +50
to -60	±10	to +60
to -50	to +20	> +60

0 25 50 75 100 km

Created 01/29/2019



Preliminary SPCS2022 default design: New Jersey Zone

(alternative 3)

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Terrestrial Reference Frame of 2022

Central meridian: 74° 36' W
Cen merid scale: 0.999 98 (exact)

Areas within ±20 ppm distortion (1:50,000 = ±0.11 ft per mile):
90% of population
74% of all cities and towns
65% of entire zone area

Distortion values (ppm)

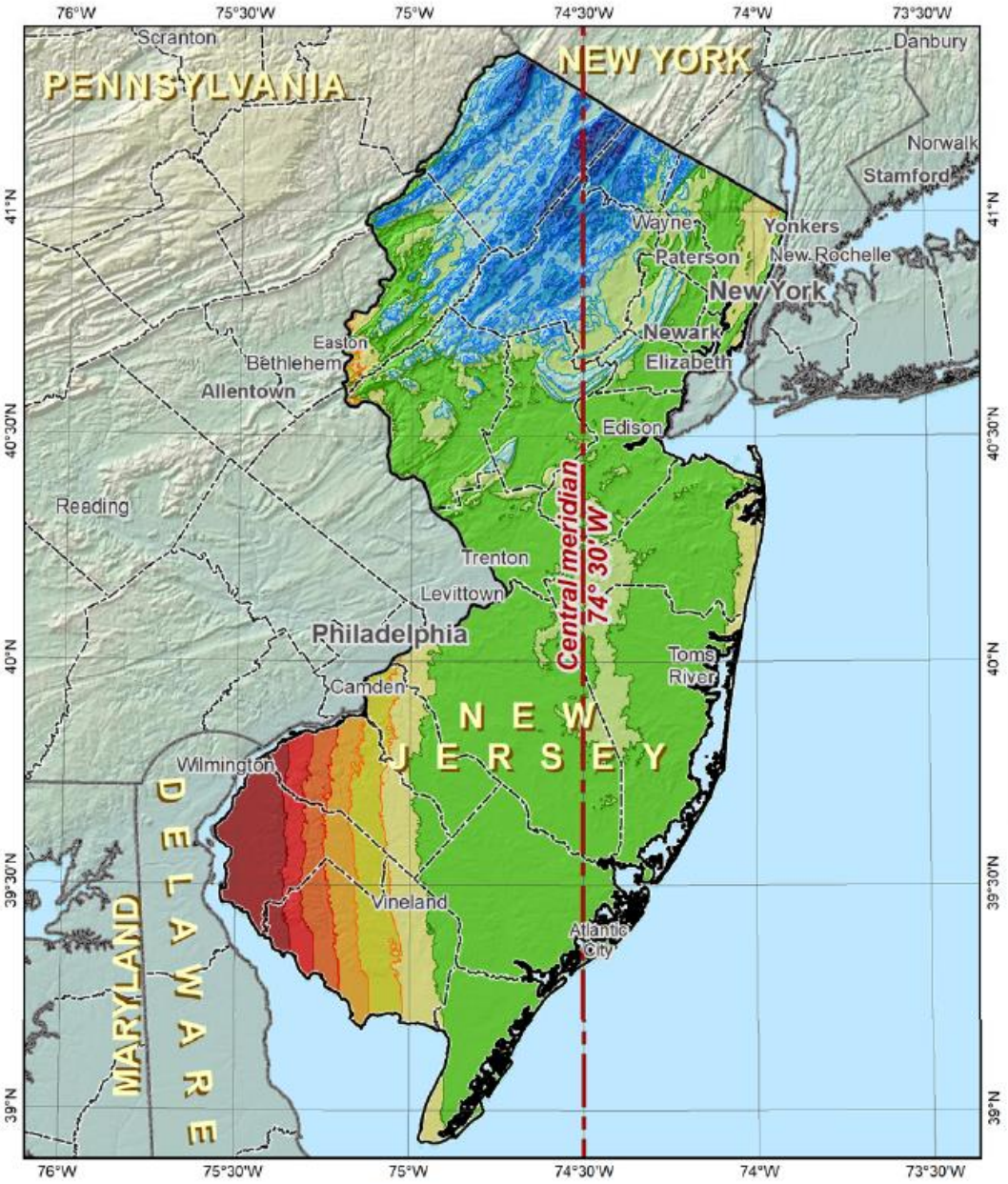
Entire zone:	***Cities and towns:***
Min = -97	Min, Max = -75, +61
Max = +69	Range = 136
Range = 166	Mean = -4
Mean = -15	(weighted by population)

Linear distortion at topographic surface (parts per million)

< -80	to -40	to +30
to -80	to -30	to +40
to -70	to -20	to +50
to -60	±10	to +60
to -50	to +20	> +60

0 25 50 75 100 km

Created 01/29/2019



Preliminary SPCS2022 default design: New Jersey Zone

(alternative 4)

NOAA's National Geodetic Survey

Transverse Mercator projection

North American Terrestrial Reference Frame of 2022

Central meridian: 74° 30' W
Cen merid scale: 0.999 99 (exact)

Areas within ±20 ppm distortion (1:50,000 = ±0.11 ft per mile):
88% of population
77% of all cities and towns
71% of entire zone area

Distortion values (ppm)

Entire zone:	***Cities and towns:***
Min = -85	Min, Max = -66, +88
Max = +97	Range = 155
Range = 182	Mean = +2
Mean = -2	(weighted by population)

Linear distortion at topographic surface (parts per million)

< -80	to -40	to +30
to -80	to -30	to +40
to -70	to -20	to +50
to -60	±10	to +60
to -50	to +20	> +60

0 25 50 75 100 km

Created 01/29/2019