Coordinate Systems

Reading question 1: What is the difference between a projection and a coordinate system?

Answer:
The **coordinate system** is a framework for uniquely defining the location of the features on the earth's surface using a set of values called coordinates. There are two coordinate systems: One is the Geographic Coordinate System (GCS) which represents locations on the Earth's curved surface using coordinates like latitude and longitude. Another one is the Projected Coordinate System (PCS) which transforms the GCS data onto a flat surface, resulting in linear units like meters, essentially creating a map view of the Earth's surface.
On the other hand, a **projection** is a method of transforming the three-dimensional surface of the Earth into a two-dimensional map. There are various projection methods such as cylindrical projection, conic projection, etc.

Reading question 2: What is the difference between a central meridian and the prime meridian?

Answer:
The **Prime meridian** is the longitude line on the earth with the value zero degree which runs from the north pole to the south pole. This line passes through Greenwich, England.
On the other hand, the **central meridian** is a specific longitude in a particular map projection used as a center reference line to represent geographic data in a projected coordinate system. It represents line x=0 and is chosen based on its position near the center of the mapped area.

Reading question 3: What does the Reference Latitude refer to?

Answer:
Reference Latitude, also known as the latitude of origin, refers to a specific latitude that serves as a reference line (y=0) for a particular map projection to minimize distortion.

Question 1: Examine the coordinate system for the *streets* feature class in the *Austin* geodatabase. What is the name of the coordinate system? Is it projected or unprojected? If projected, what is the projection? What are the map units?

Coordinate System: NAD 1983 StatePlane Texas Central FIPS 4203 (US Feet)
Projected/Unprojected: Projected
Projection name: Lambert Conformal Conic
Map units: US Survey Feet (0.3048006096012192)

Question 2: What is the name of the projection (not the coordinate system) used by the feature classes in the *Oregondata* geodatabase? What are the central meridian and the standard parallel(s)? Does it use the equator for the latitude of origin? If not, what is the latitude of origin?

Projection: Lambert Conformal Conic
Central Meridian: -120.5

Standard Parallel(s): **43.0, 45.5**
Latitude of Origin: **41.75**
***No, it did not use the equator as the latitude of origin.

Question 3: Determine the coordinates of the summit of Mount Rainier, Washington in (a) degrees-minutes-seconds, (b) UTM Zone 10 (in meters), and (c) Washington State Plane South (in US feet). Use the NAD1983 datum in all cases.

Degrees-minutes-seconds: **121.760490°W, 46.852830°N**
UTM Zone 10 (m): **594,493.563400m, 5,189,555.026100m**
Washington State Plane South (ft): **1,325,068.250098ftUS, 556,629.008579ftUS**

Question 4: What datum is used for the Africa Lambert Conformal Conic coordinate system? What datum is used for the North American Equidistant coordinate system? Why do they use different datums?

Africa Lambert: **WGS 1984**
North America: **North American Datum of 1983 (NAD 1983)**
The selection of a datum depends on the specific geographical location of the mapped area and the practical needs of the regions. WGS 1984 is a datum that was created for the entire globe, which provides a consistent framework for geographic data worldwide. It allows better geographic data integration across different regions of Africa and beyond. On the other hand, NAD 1983 is specifically designed for North America, making it more accurate for local applications within the continent.

Question 5: Create a new map. Examine the locations below and choose a good projection/Coordinate system from the predefined coordinate systems in ArcPro for maps of the following areas. Briefly explain your choice for each

Answer:
The choice of a projected coordinate system depends on many factors, including the part or location of the world that will be mapped, the scale of the map, and the purpose of the map. If both UTM and State Plane projections are available for an area to use, from my understanding,

- State Plane Projection is considered more suitable over UTM as it provides better accuracy during creating a localized map, especially for smaller areas like a single county or state.
- If there are different versions of State Plane, it would be better to use the recent and compatible one. For example, between NAD 1927 and NAD 1983, NAD 1983 is a more accurate geodetic datum.
- Also, if any area lies between two UTM zones or includes multiple state plane projections, it is better either to choose the specific zone considering the interested area of analysis or find another suitable projection avoiding these projections.

Humboldt County, CA: I think **NAD 1983 StatePlane California I FIPS 0401** will provide significantly higher accuracy within the state boundaries, especially for Humboldt County.

Grafton County, NH: Between these **NAD 1983 (2011) StatePlane New Hampshire FIPS Zone 2800** will give better precision for local applications.

State of Nevada: For this state, **UTM Zone 11N** is a more suitable choice than the state plane projection as there are a total of three State Plane projections for Nevada- NAD 1983 StatePlane Nevada Central, East, and West.

State of New Jersey: The most suited projection for this state is **NAD 1983 (2011) New Jersey StatePlane FIPS 2900**

England: The most used projection for local mapping in England is the **British National Grid.**

Mumbai, India: There is a specific projection for Maharashtra state where the city Mumbai is situated. I think the **WGS 1984 Maharastra** projection will be the best one to work with for Mumbai.

Antarctica (<u>true distances</u> required): As we are told the area of interest should not be too far from the central meridian, so maintaining that and considering the true distance factor, the **South Pole Azimuthal Equidistant** is the perfect coordinate system to use.

Question 6: You are working on a statewide Wyoming project and decide to define a custom coordinate system. Start with one of the **State Plane** zones for Wyoming, and modify it slightly to make it better for the whole state. Explain your approach and **Capture** (screen capture) the window showing the custom coordinate system description (**NOT** the map!) you created. Insert your image here.

Answer:
There are total state plane projections available for Wyoming State. After analyzing those, I concluded that all have used the same latitude of origin, but their central meridians are different because of the division and having different reference lines for precision use. Considering that I have used the State Plane of Eastside and changed its central meridians to the central meridian of the most westside state plane of this state so that this one modified version of projection can cover the whole state and be used for any area within this state boundary.

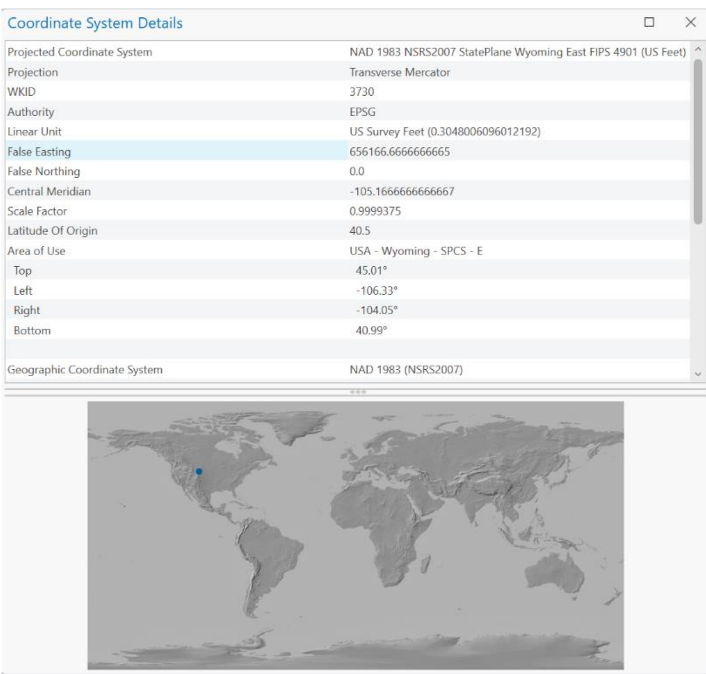

Figure 1 Before change

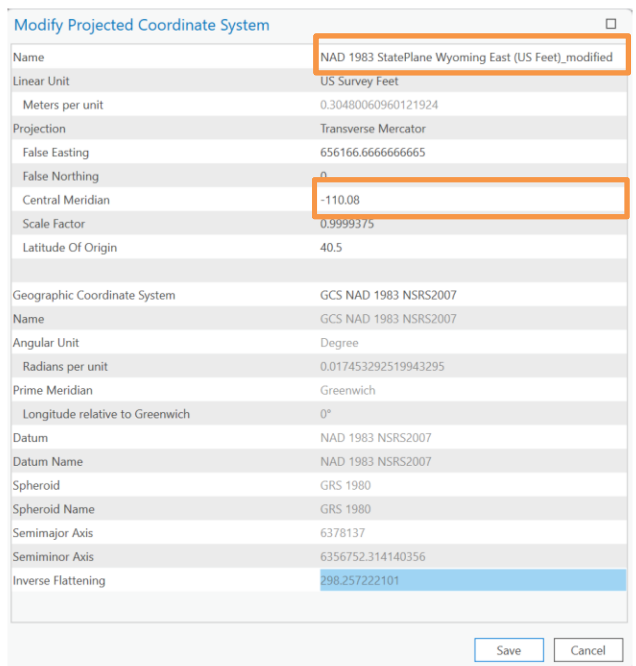

Figure 2 After change

Question 7: The *Austin* folder contains two shapefiles showing dog off-leash areas in Austin as points (*dog_offleash_areas.shp*) and polygons (*dog_offleash_bnds_shp*). Both shapefiles show the same locations (dog parks), and both are within the city of Austin. Both files have unknown coordinate systems problems (they are different problems) when you add them to the map. Describe the problem for each; then fix them and create a map showing both the points and polygons with a backdrop of the major transportation arteries in Austin.

- **NOTE:** Make a copy of the two dog park files and work on the copies. It is easy to mess up coordinate systems and difficult to return them to their original settings. This way if you mess up the file you can go back to the original file and try again.
- **NOTE:** YOU can assume that since the data was collected for the city of Austin, that the dog park locations are correctly mapped, they just have problems with their coordinate system.
- **HINT:** Start with a blank map and load the *arteries* feature class **first** to set the coordinate system for the data frame. Then add the offleash data sets to compare them to the arteries feature class.
- **HINT:** Remember to look at the extent units and values and also to use the Zoom to Layer tool when solving the issue.
- Take a screen **capture** of your map (zoomed to the extent of the parks) and insert it here. Be sure to include the table of contents with your image.

Answer:

From the initial investigation, it is clear that the coordinate system of the *dog_offleash_areas.shp* file is unknown, and we have to define that before using it. After looking into the extent values of *arteries* and *dog_offleash_areas*, they are quite similar to each other reference points. So, we can assume that both files are created using the same coordinate system and unit which is NAD 1983 StatePlane Texas Central FIPS 4203 (US Feet).

On the other hand, after including the *dog_offleash_bnds_shp* file in the map, it was shown totally in another region. In this case, not only is the coordinate system unknown but also the extent value is different from the other two files. From this information, we can assume that this map was created using a different coordinate system. We must define it before making any changes to the map. And, the coordinate system of this file is WGS 1984.

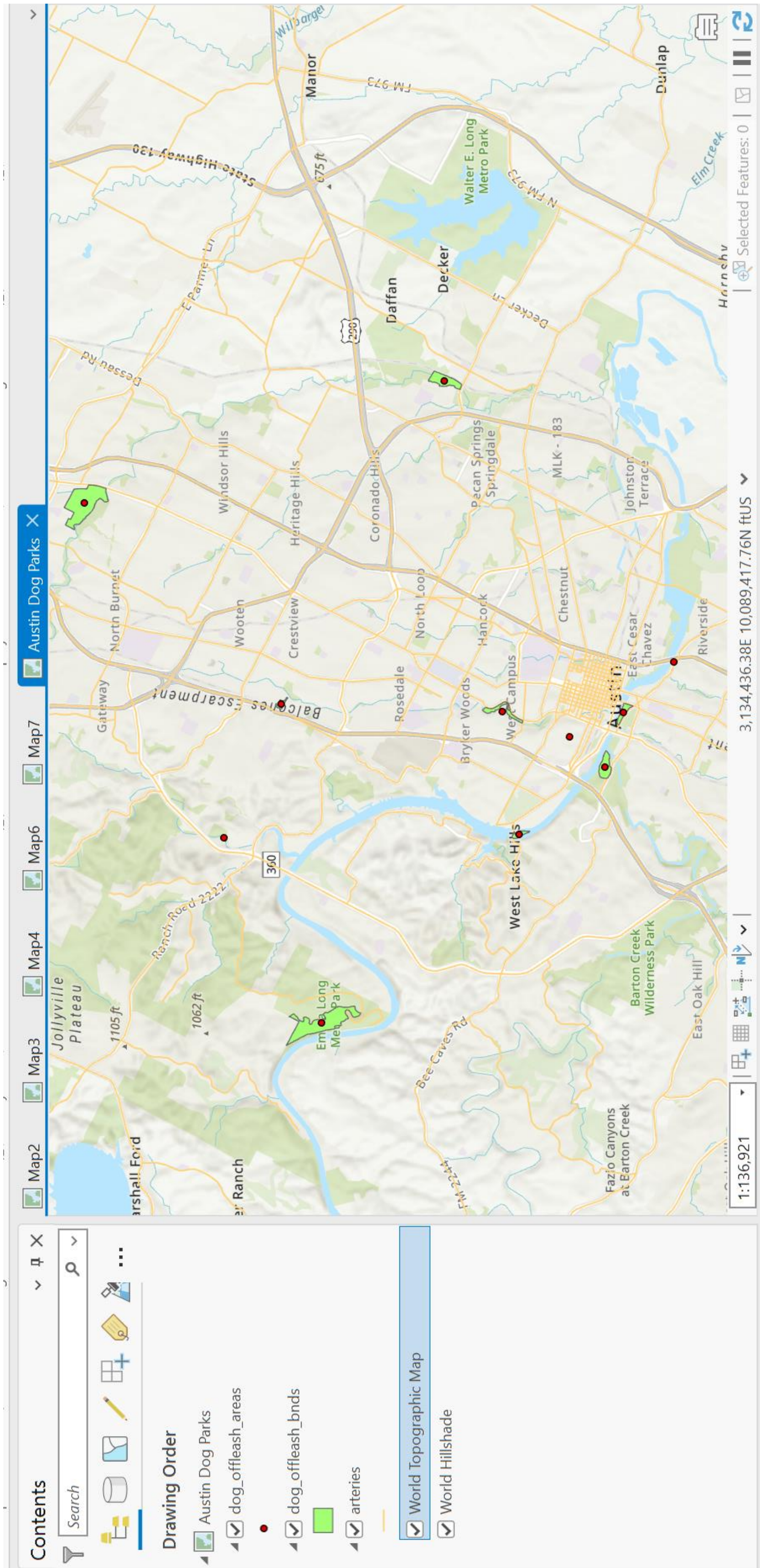

Figure 3 Projected layers of dog parks Austin