

A **projection** is the mathematical equivalent of shining a light through a transparent globe. The resulting, 2D image on the wall is the basis of a 'projected' coordinate system. Every projection consists of a coordinate, datum and an ellipsoid.

1. COORDINATES (X,Y,Z)

Locations described in a projected coordinate system are expressed in meters (or feet) both north and east of designated origins. Common coordinate systems are the Universal Transverse Mercator (UTM) and State Plane systems. In UTM, the nothing is measured from the South Pole or Equator and the false easting is measured from an arbitrary line. The State Plane System is a similar system but covers smaller areas with its origin based within each state. Think - where is the **ORIGIN** or center of the reference system i.e. where (0,0,0) is located.

2. Every set of coordinates needs a DATUM

A **datum** is where the coordinate grid is tied to the ground. It is simply a point of reference. There are 2 types of datums: local and global datums.

Local datums rely on land-based measurements. The most common in the US is the North American Datum 1927 (NAD27). It is centered at Meade Ranch, KS and optimized for North

America. Use of NAD27 has been replaced by the newer global datums recently. USGS topo maps were originally based on NAD27. There is ongoing efforts to move the maps and data to the newer NAD83, however, always check the stated datum to be sure. The amount of shift varies by location. For example, the set of northing and easting coordinate values in NAD27 results in a NAD83 location 80 meters offset in X almost twice as much in Y for Northern Nevada.

Global datums are based at the Earth's center of mass and are defined by satellite and other technology-based measurements. The most common global datums in the US are International Terrestrial Reference System (ITRS), World Geodetic System 1984 (WGS84) and North American Datum 1983 (NAD83).

Think - where is the **ORIENTATION** i.e. where is the ellipsoid centered on the Earth.

STAY ALERT: When recording, receiving or processing any coordinates ALWAYS be aware of the associated datum

3. Every datum is linked to an ELLIPSOID

An ellipsoid is a mathematical model approximating the shape of the earth. It is more theoretical than the geoid since it ignores contours such as mountains and valleys. Each datum is linked to a single ellipsoid, therefore, it is not necessary to specify the ellipsoid for every datum. ITRS is based on an IEG ellipsoid, WGS-84 on the WGS84 ellipsoid [not the Geodetic

Reference System 1980 (GRS-80) ellipsoid as commonly written in the literature], and NAD83 on a very close version of GRS-80.

Think - about the shape of the earth. In the simplest of terms, the ellipsoid is basically how tall (a) and wide (b) the planet is. Mathematically, the shape is described by the amount of flattening, $f = (a-b)/a$