Chapter 1: Mapping and Digital Data Fundamentals

- Mapping Fundamentals
  - What is a Map?
  - Projections
  - Coordinate Systems
  - Datums
- GIS Fundamentals
  - What is GIS
  - Introducing Vector and Raster Data
  - GIS Data Formats and Storage

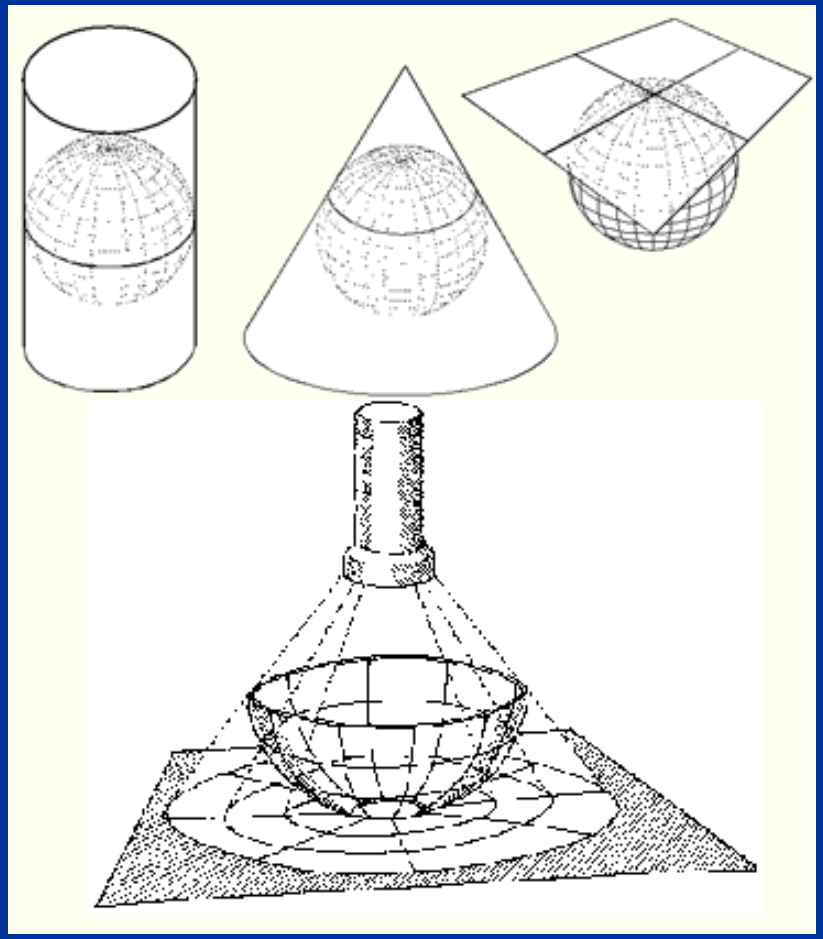
What is a Map?

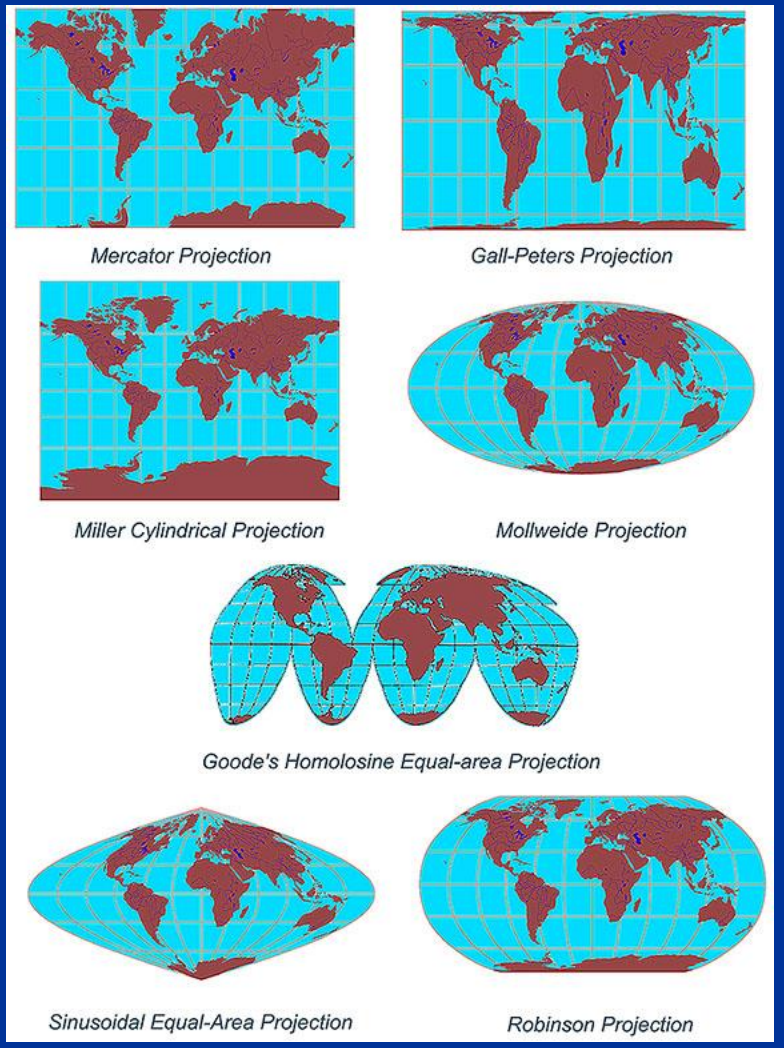
- A map is any representation of a geographic area – that is, a part or all of the earth's surface. That surface usually contains many things that the map-maker wants us to see in one image, for example, roads, cities, and lakes. Maps above all help us to graphically display spatial relationships.

Projections

- The earth is a somewhat lumpy spheroid (sphere-like) shape, not a flat plane.
- Map **projections** are attempts to portray the surface of the earth, or a portion of the earth, on a flat surface.
- If we were to place a light bulb inside a translucent globe and project the image onto a wall - we'd have a map projection.

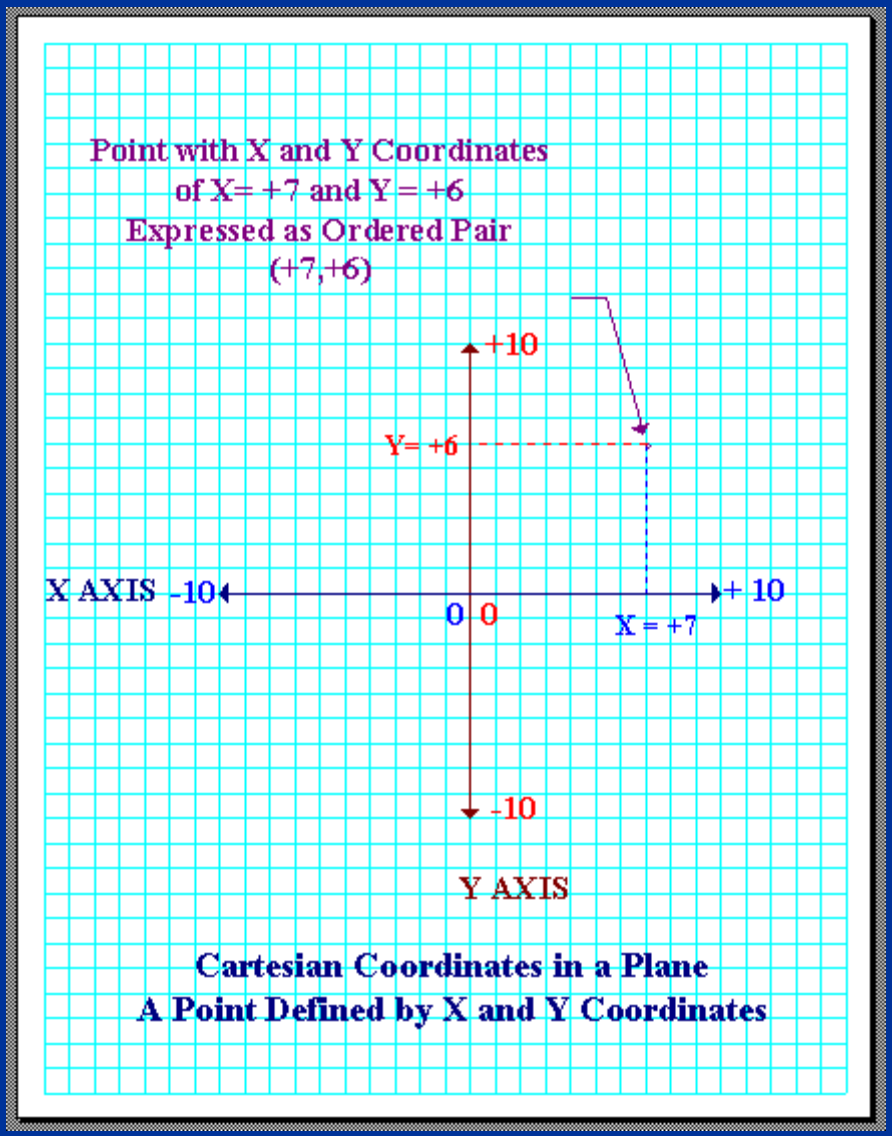
Examples of projections





Coordinate Systems

- Once map data are projected onto a planar surface, features must be referenced by a planar coordinate system.
- The geographic system (latitude-longitude), which is based on angles measured on a sphere, is not valid for measurements on a plane.
- Therefore, a Cartesian coordinate system is used, where the origin (0, 0) is toward the lower left of the planar section.


Point with X and Y Coordinates
of X= +7 and Y = +6
Expressed as Ordered Pair
(+7,+6)
+10
Y= +6
X AXIS -10
+ 10
0 0
X = +7
-10
Y AXIS
Cartesian Coordinates in a Plane
A Point Defined by X and Y Coordinates

VT's Coordinate System

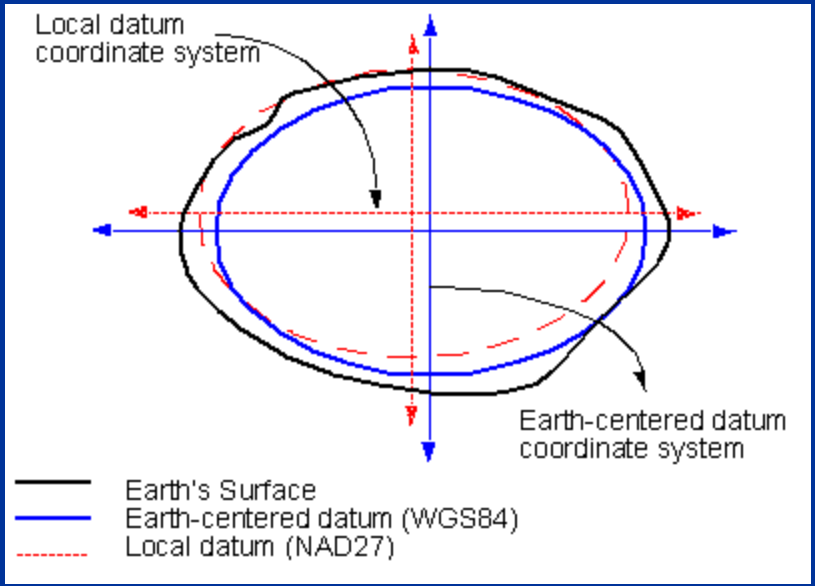
VT's geospatial data is generally in the following coordinate system:

Vermont State Plane Meters

Datums

- Geodetic datums define the reference systems that describe the size and shape of the earth (remember, the earth is a spheroid rather than a true sphere).
- Hundreds of different datums have been used to frame position descriptions since the first estimates of the earth's size were made by Aristotle.
- Datums have evolved from those describing a spherical earth to ellipsoidal models derived from years of satellite measurements.

Datum Differences



VT's Datum

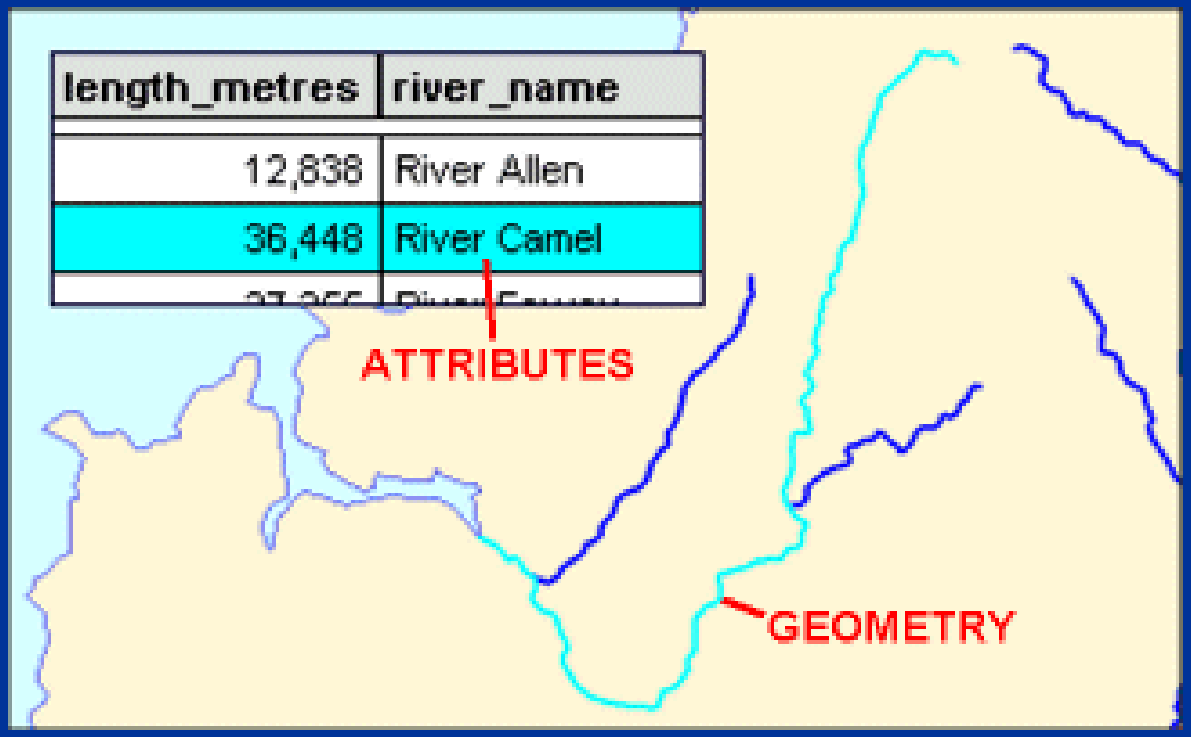
VT's geospatial data uses the North American Datum of 1983, and is referred to as NAD83

What is GIS?

- GIS stands for Geographic Information System.
- The earliest GIS programs were developed simply to allow map information to be stored in computerized form. This made maps easier to store, reproduce and update.

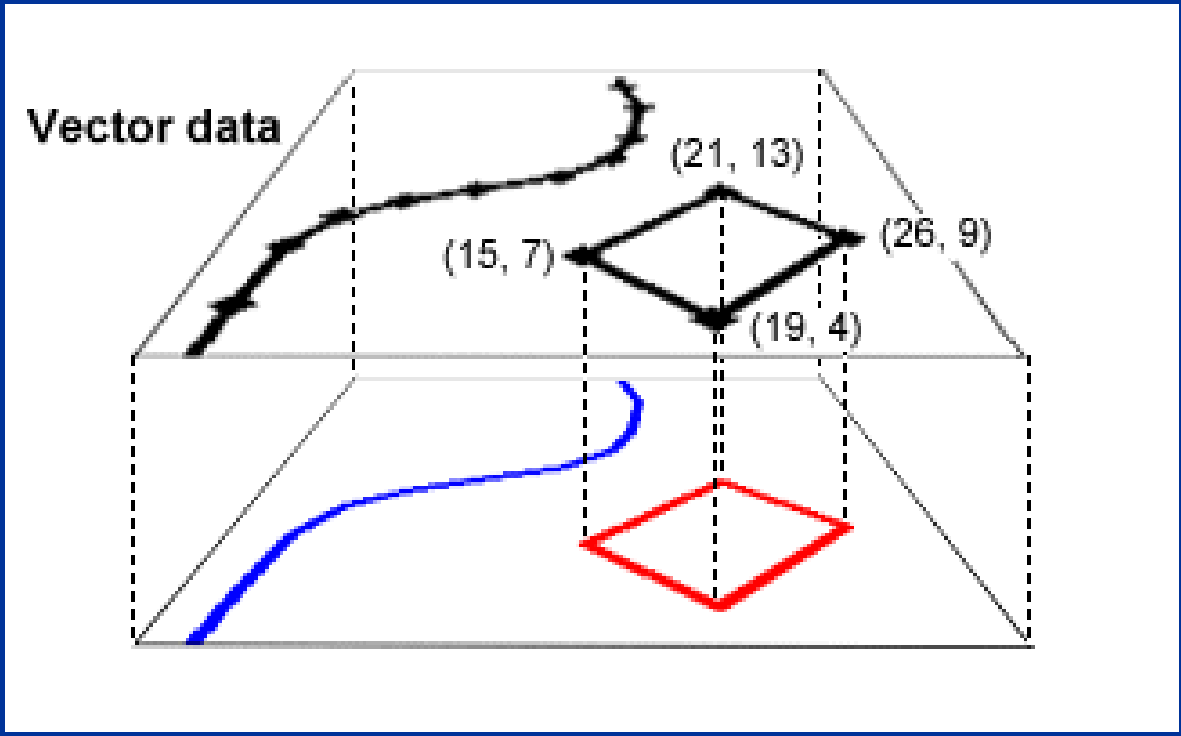
How Do Computers Understand Maps?

- The GIS must be able to store information about:
  - The **geometry:** the shape and location of the objects
  - The **attributes:** the descriptive information known about the objects, normally displayed on a map through symbology and annotation.


length_metres
river_name
12,838
River Allen
36,448
River Camel
ATTRIBUTES
GEOMETRY

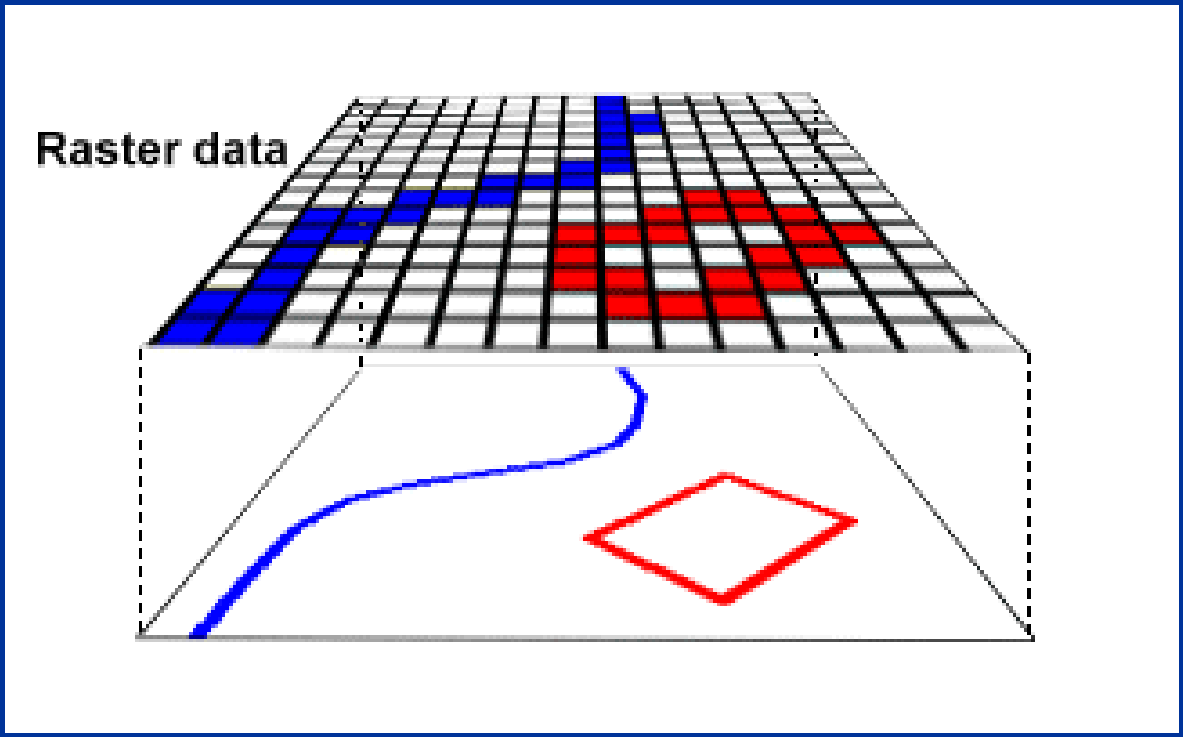
Introducing Vector and Raster

- In **vector** data the features are recorded one by one, with shape being defined by the numerical values of the pairs of **xy** coordinates.
  - A **point** is defined by a single pair of coordinate values.
  - A **line** is defined by a sequence of coordinate pairs defining the points through which the line is drawn.
  - An **area** is defined in a similar way, only with the first and last points joined to make a complete enclosure.

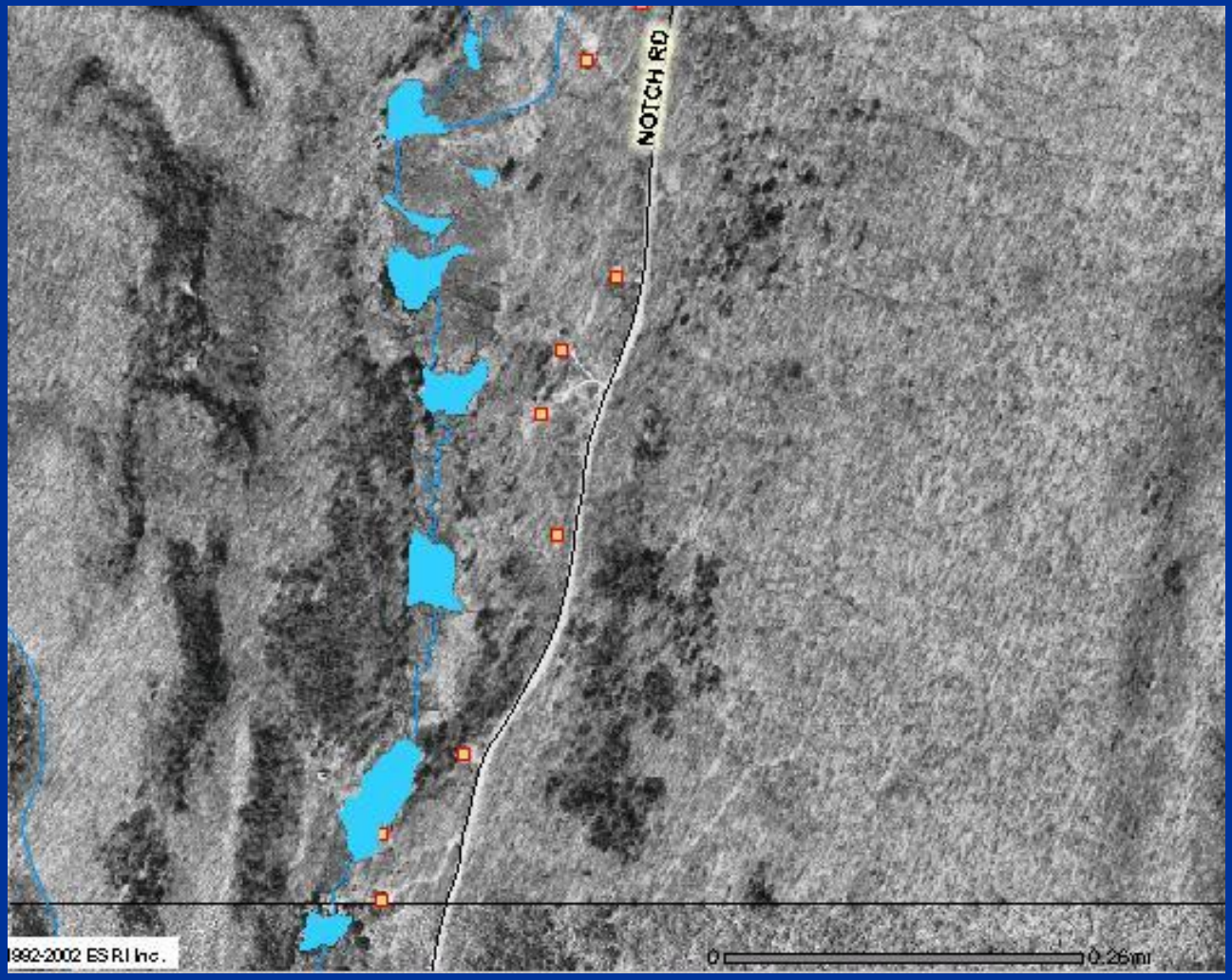

Vector data
(21, 13)
(15, 7)
(26, 9)
(19, 4)

Introducing Vector and Raster

- In **raster** data the entire area of the map is subdivided into a grid of tiny cells. A value is stored in each of these cells to represent the nature of whatever is present at the corresponding location on the ground. Raster data can be thought of as a matrix of values.


Raster data

Vector/Raster Example



Raster vs Vector?

- Both types of data are very useful, but there are important differences; the characteristics below are broad generalizations which do not necessarily apply in all circumstances.

- **Vector**
  - relatively low data volume
  - faster display
  - can also store attributes
  - less pleasing to the eye
  - doesn't dictate how features should look in a GIS

- **Raster**
  - relatively high data volume
  - slower display
  - has no attribute information
  - more pleasing to the eye
  - inherently stores how features should look in a GIS

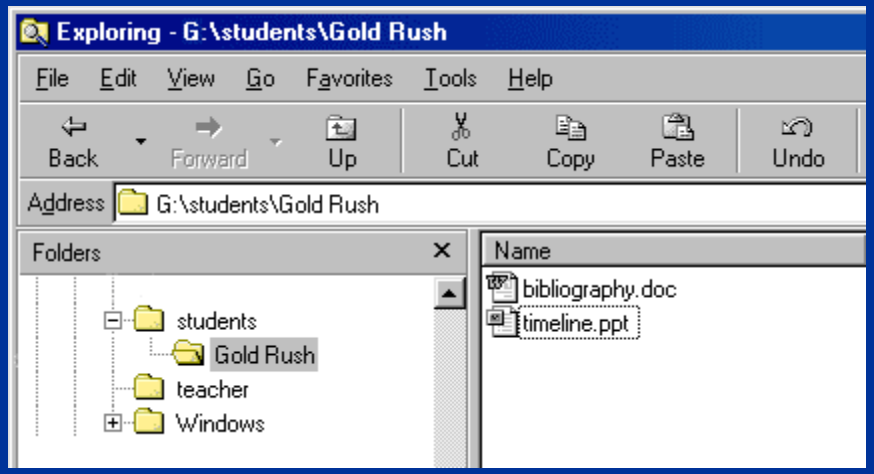
GIS Data Formats and Storage

- **Geographic Data Types**
  - *Shapefiles* are ESRI format files that hold vector-based data. Vector data layers are points, lines (arcs, polylines), and polygons (closed shapes with defined area). Shapefiles are actually sets of files (3 to 9!).
  - *Images (.tif, .jpg etc.)* are raster-based datasets that are made up of cells, organized in columns and rows, that contain data. Raster imagery may include digital versions of USGS quadrangle maps (Digital Raster Graphic, DRGs) and aerial photography (Digital Orthophoto Quads, DOQs).

File Management

- When saving many different data layers to a server or PC, files could potentially be lost and precious time wasted looking through hundreds of documents just to find a specific file.
- That is why it is critical to establish a strong and clear **file structure** before work begins.
- You can organize digital files in digital folders, much like paper files are stored within folders in a filing cabinet.

Example of File Management



First, decide how to organize the folders according to the amount and type of computer work you and your fellow GIS-users do. You could organize your GIS related files by data theme (roads, boundaries, natural resources, parcels…) or by department (listers, clerk, public works, planning, conservation…), or any other scheme that all users agree makes sense.

What You Need to Know:

All VT GIS Data should be in the following projection/coordinate system/datum:

VT State Plane Meters NAD 83.