

# Basics of GIS

## Floodplain Management and GIS Applications

Zac Collins CFM,  
Sr. GIS Analyst, Atkins Bozeman, MT

2012 Montana Floodplain Resource Seminar

# Class Agenda

2:30 – 3:30 Intro to Basic Elements and Terminology

3:30 – 3:40 Break

3:40 – 4:30 GIS exercise

4:30 – 5:00 Open Forum – Q&A



Dawson County, 2003  
Yellowstone River Ice Jam

# What is GIS?

- According to Environmental Systems Research Institute, Inc. (ESRI) GIS “integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.”
- A powerful software technology that allows a virtually unlimited amount of information to be linked to a geographic location.
- Allows a user to run analysis, simple and/or complex, on many different features within the map area.

# Types of GIS Features

- Three basic vector data types in GIS:

- Points

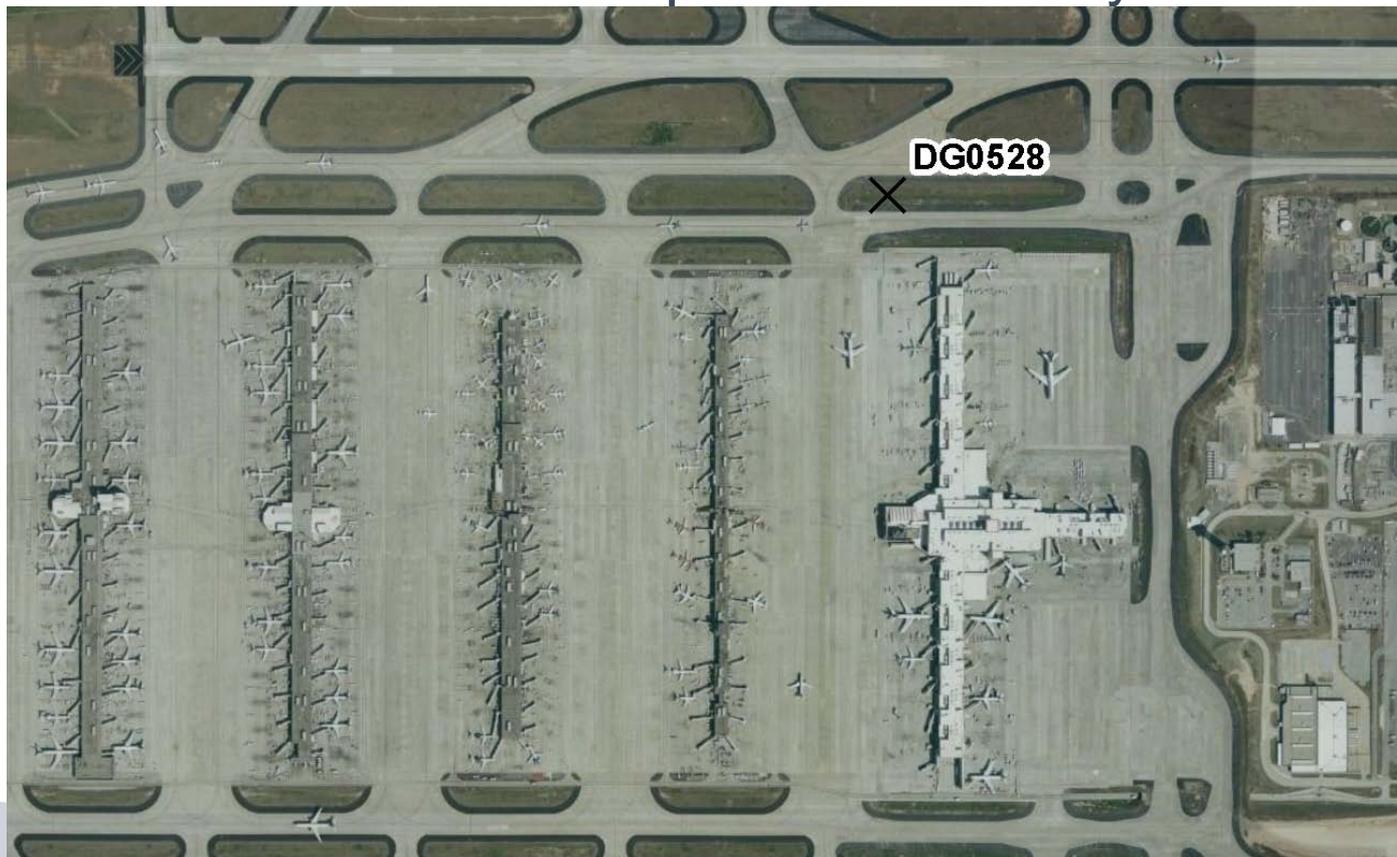
- Lines

- Polygons

Name	Type
Czoning.dbf	dBASE Table
frq1.dbf	dBASE Table
AVL	Folder
Austell_GIS.mdb	Personal Geodatabase
LOGO.TIF	Raster Dataset
add_label.shp	Shapefile
aoi.shp	Shapefile
city-lim.shp	Shapefile
city-lim-poly.shp	Shapefile
county limit line.shp	Shapefile
firehydrants.shp	Shapefile
forcemain.shp	Shapefile
halfway.shp	Shapefile
land-tiles.shp	Shapefile
liftstations.shp	Shapefile

# Points

- GIS points are representations of a particular feature at a particular location. For Example: Where are the USGS bench marks located with a particular county?



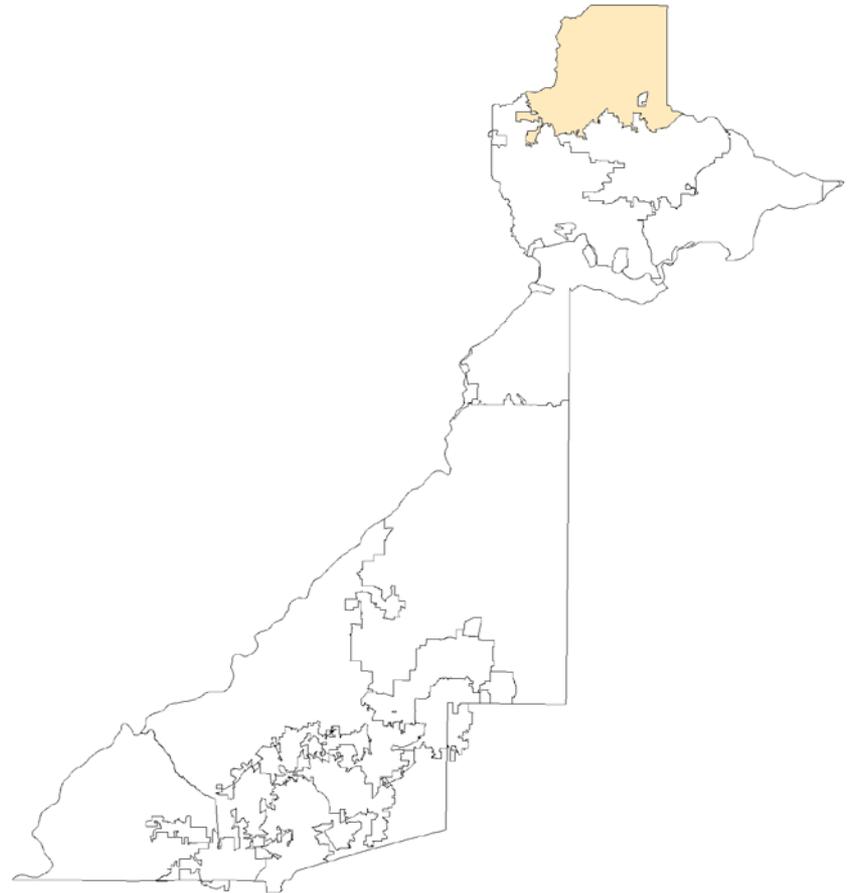
# Lines

- GIS lines are representations of a particular features boundary. For Example: What does the stream line for Johns Creek look like?



# Polygons

- **GIS polygons are representations of a particular features boundary. For Example: Where does the political boundary for the City of Milton extend to?**



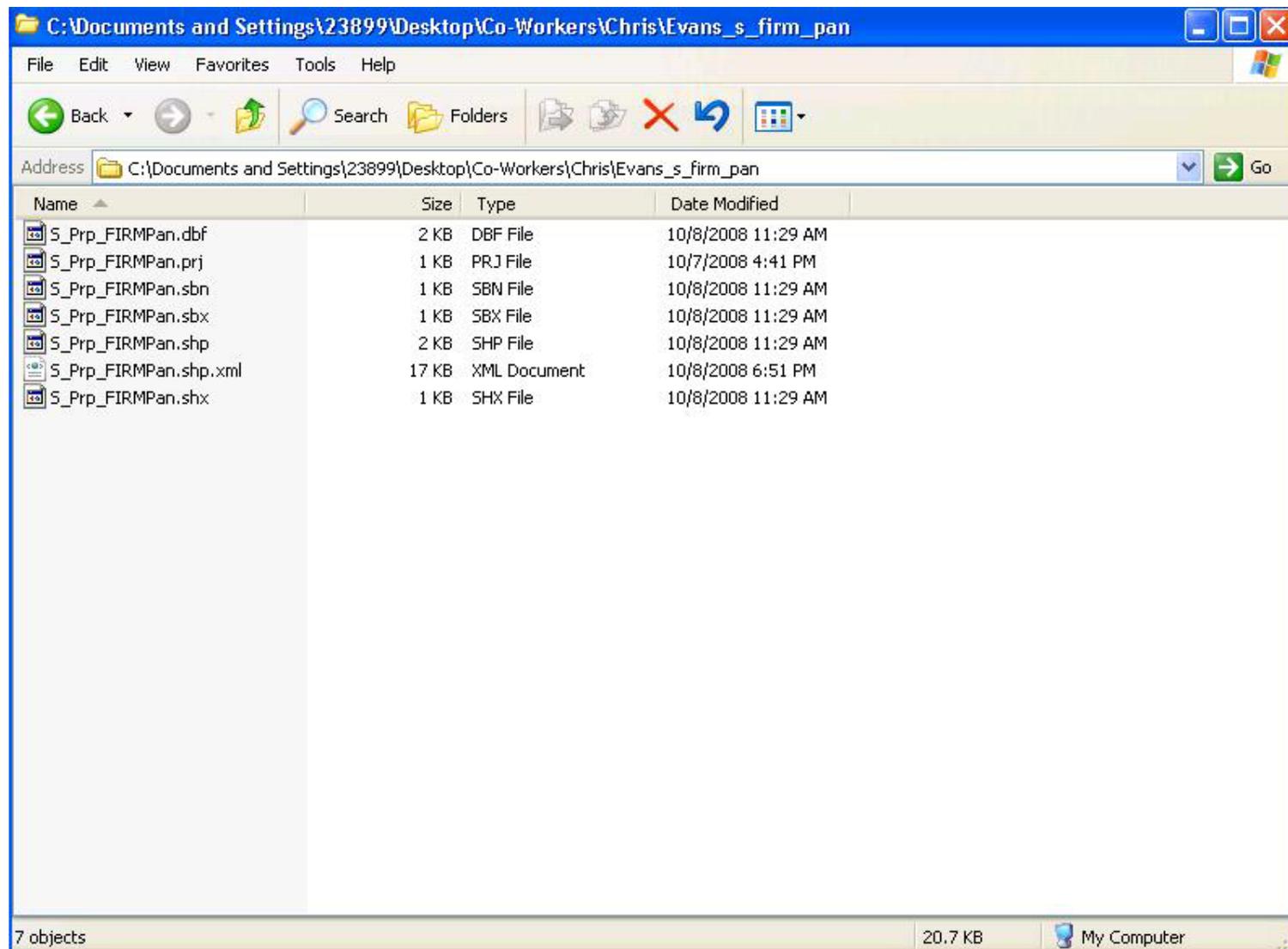
# Different Types of GIS Files

- Shapefiles
- Raster Data
- Feature Classes

# Shapefiles

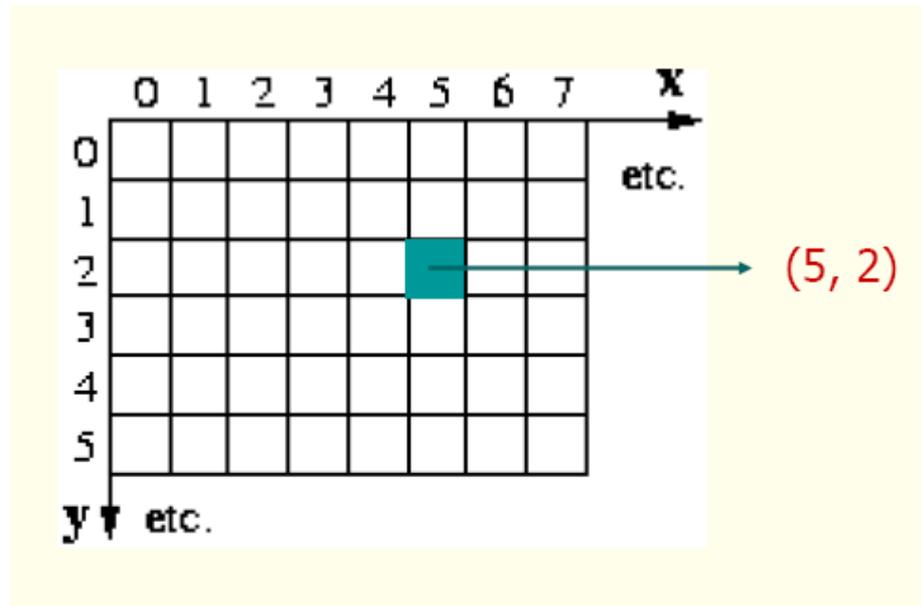
- Shapefiles are the files that make up a map
- ESRI shapefiles are made up of 3-7 different files when you look at them in Windows explorer
- **DO NOT** move or change the names of the files from Windows explorer. That is only to be done within ArcCatalog!!!!

# Shapefiles

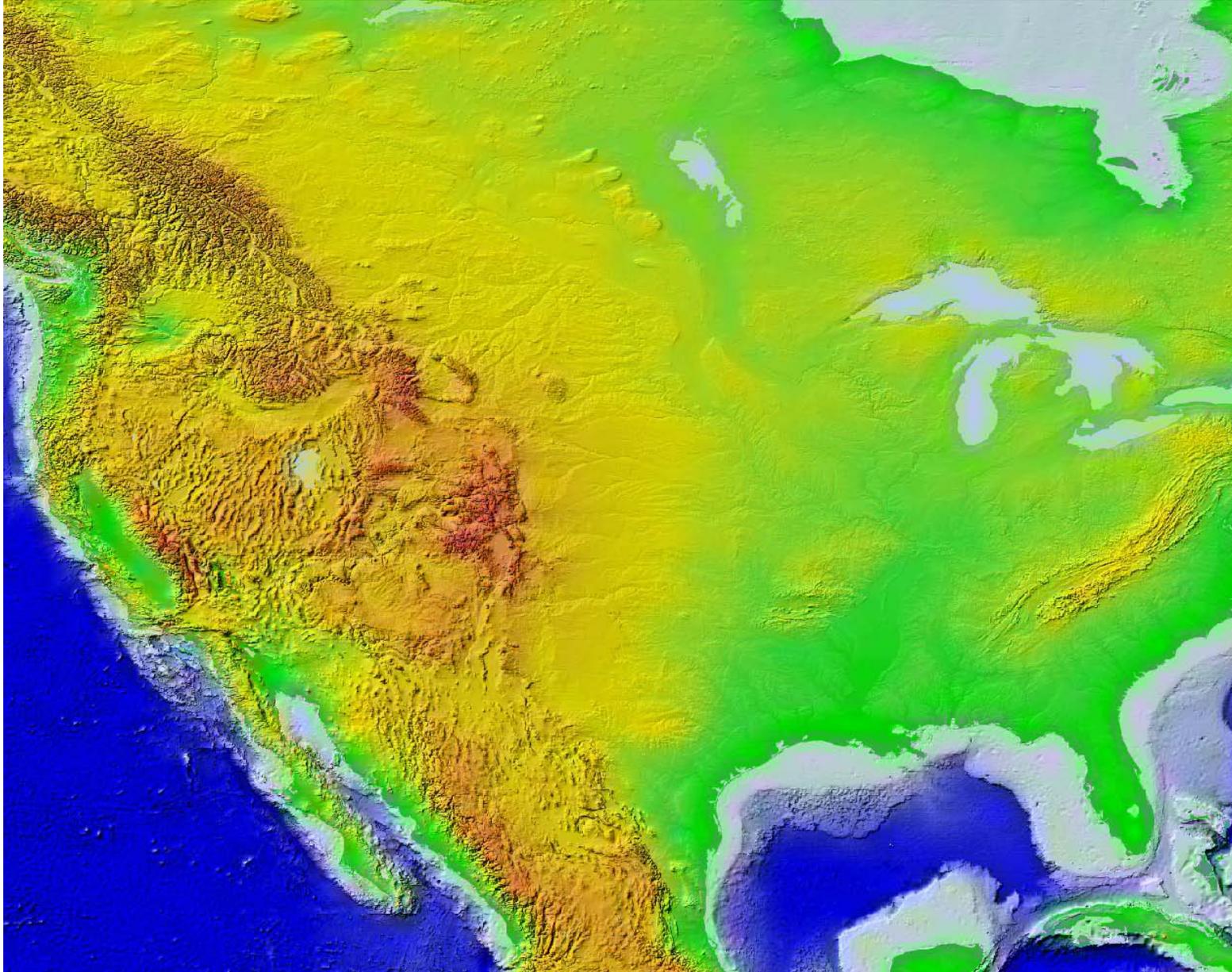


# Raster Data

- Raster data model stores spatial information by representing the geographic space with grids
- The structure of raster data therefore consists of grids of cells that are made up of pixels. Like in a picture
- Pixel: Individual rectangular grids (picture element).

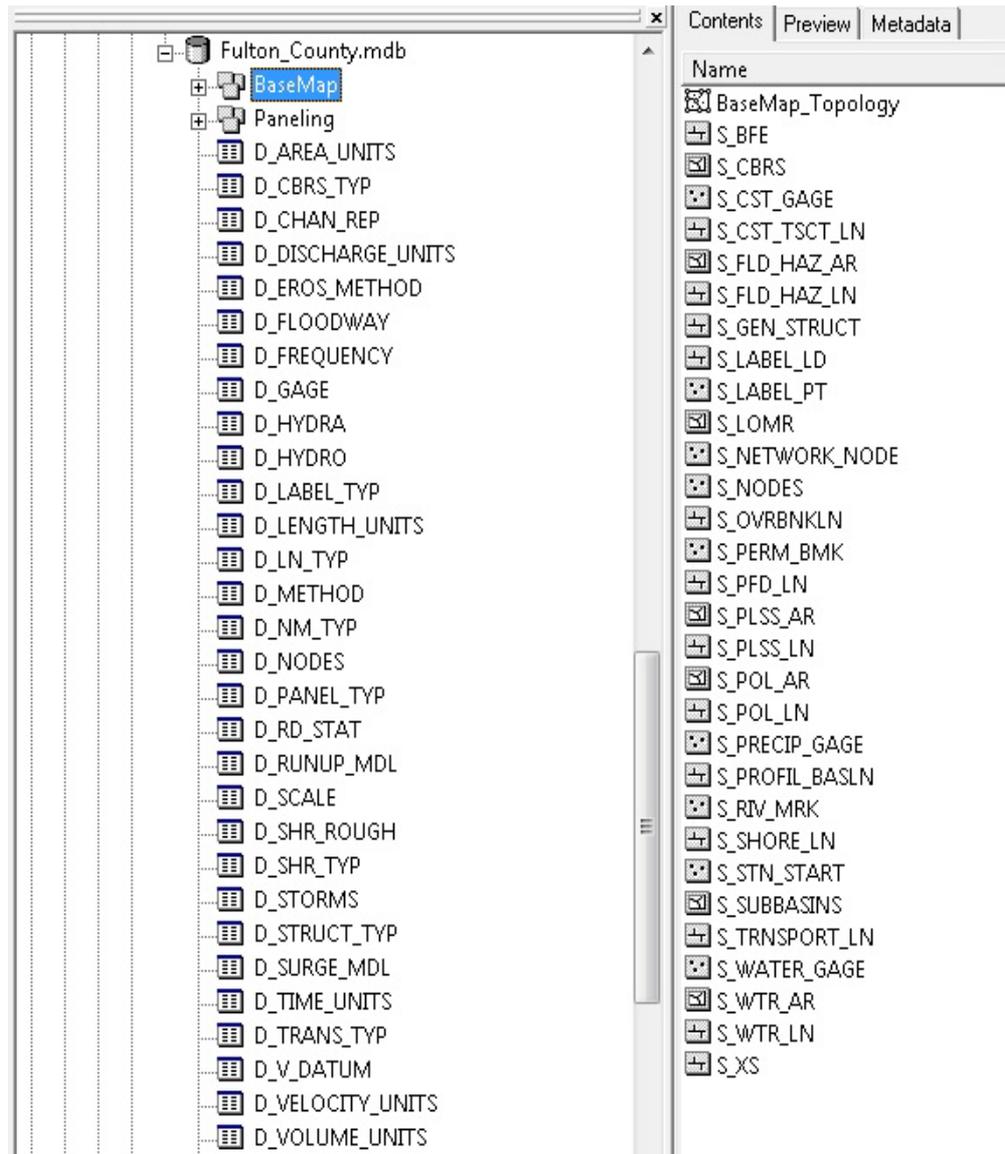


# Raster Data



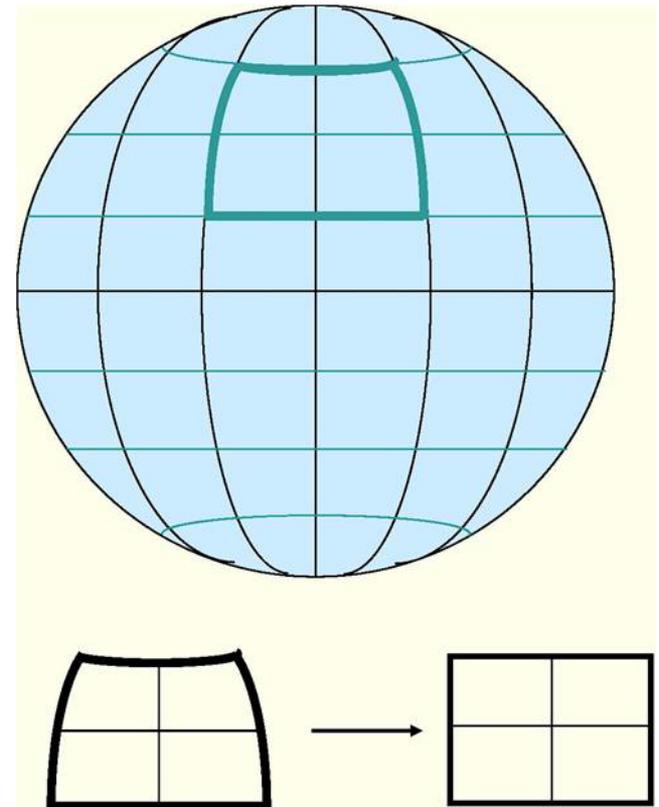
# Feature Class

- Is the is similar to a shapefile with one **BIG** difference is that it is located within a geodatabase.
- A geodatabase is a “storage” container for GIS feature classes. Think of a file cabinet.



# Projections

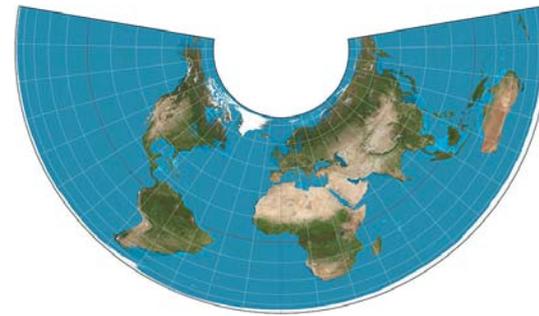
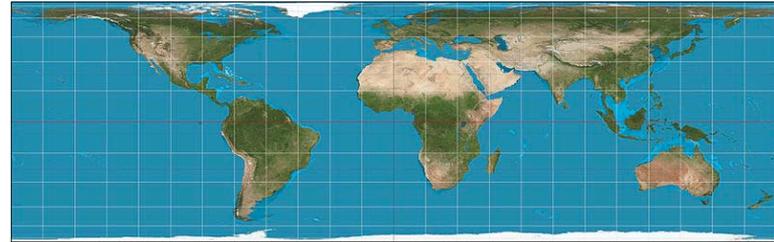
- A technique to depict with reasonable accuracy the spherical earth in two-dimensional media



# Projections

Examples of a few map projections:

- Cylindrical projection →
- Conical projection. →
- Projections are not absolutely accurate representation of geographic space.
- Characteristics of properties of map projections (impossible to preserve all at the same time for a large area):
  - Angles (shapes)
  - Distance
  - Directions



# Projections



Geographic  
Degrees  
Latitude:  $37^{\circ} 36' 30''$   
Longitude:  $55^{\circ} 45' 01''$



Universal Transverse Mercator  
Meters  
X: 412,648.41  
Y: 6,179,073.07

*Locations are expressed as latitude and longitude on the globe and as x and y coordinates on a map.*

# What Makes up a GIS?

# Data Layers Makes A GIS!

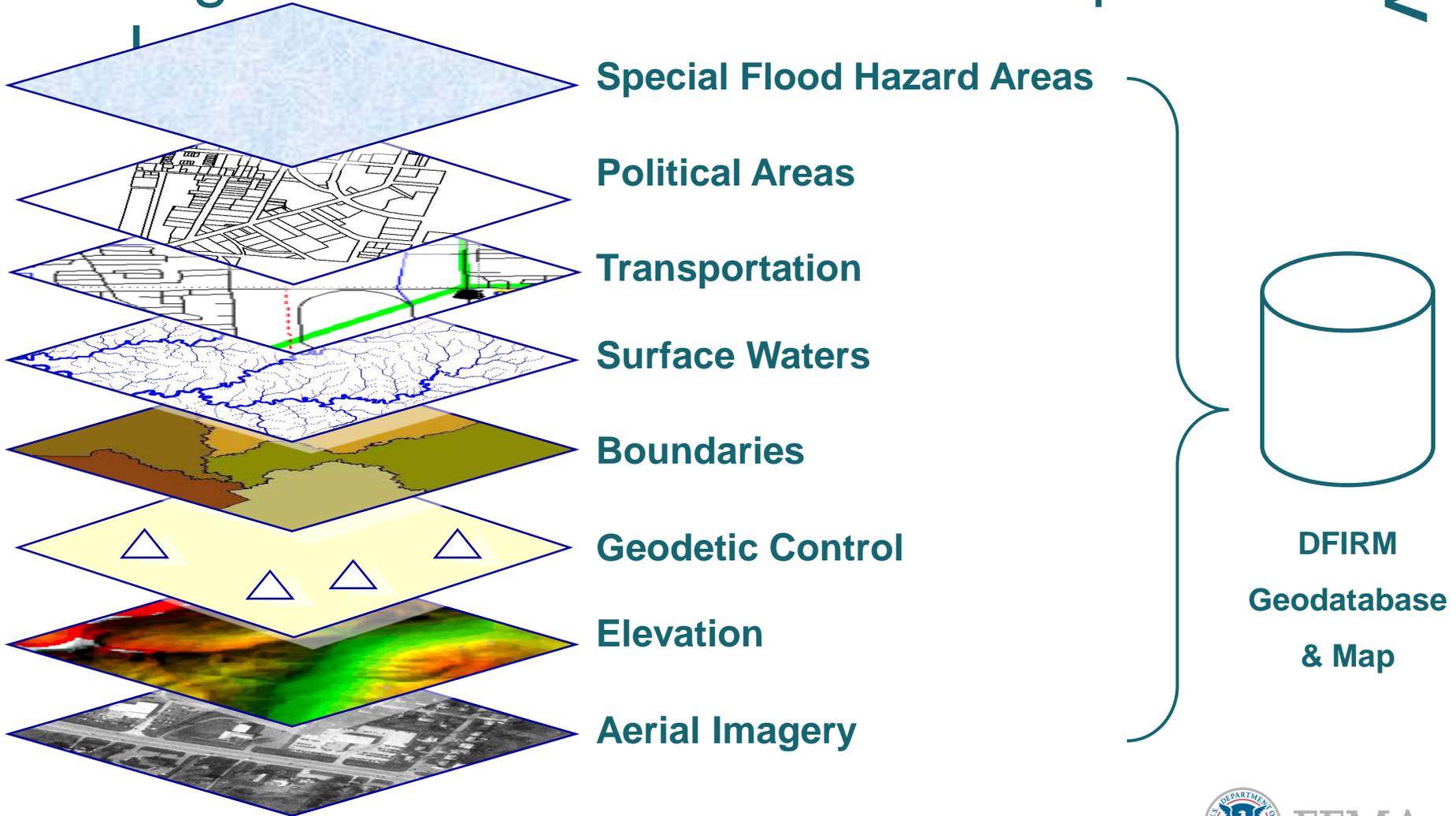


USGS scanned Geo-rectified topographic map called a digital raster  
 U.S. Geological Survey Geographic Data File (GDF) (a) (b) Data of roads.  
 graphic

## What is in the DFIRM Database?

# GIS has Layers

## Digital Flood Insurance Rate Maps have



# Base Map Data

- Base Map Data is a part of the data that makes up the final DFIRM Database.
- Examples:
  - Aerial Photos
  - Stream Lines
  - Political Boundaries
  - PLSS Boundaries
  - Transportation Information
  - USGS Bench Marks
- Most Base Map data is collected from the local community

# What is Done to the Data?

- When the Base Map data is collected it is “groomed” to meet FEMA DFIRM DB specification per Appendix L (*Guidance for Preparing Draft Digital Data and DFIRM Database*)
- Aerial photography is combined into a seamless image in grayscale (black/white)
- Proper attribution is giving to the data so that it meets Appendix L format

# Base Map Data in the DFIRM DB

Final DFIRM DB deliverables:

- Water lines/Water Bodies
- Transportation
- Political Boundaries/Political Lines
- PLSS Boundaries/PLSS Lines (if applicable)
- DFIRM Panel Layout
- USGS Quads
- USGS Benchmarks
- River Markers
- Flooding Features

# Flood Zone Data

The DFIRM DB delivers the following flooding related data:

- Flooding boundaries (Polygons/Lines)
- Base Flood Elevation (BFE) Lines (if applicable)
- Cross Section (XS) Lines (if applicable)
- Flooding Related structures (if applicable)
- Coastal Flooding Features (if applicable)

# Finding Data

- Montana GIS Portal
  - <http://gisportal.msl.mt.gov>
- Geospatial One Stop
  - [www.geodata.gov/](http://www.geodata.gov/)
- The National Map
  - <http://nationalmap.gov/>
- GIS Data Hotlist from NRIS:
  - <http://nriss.mt.gov/gis/other.asp#fed>

## Inside the DFIRM Panel

# Remember these Things were “Basic”

ATKINS



They have been modernized. So have maps...

# Advantages of DFIRM Production

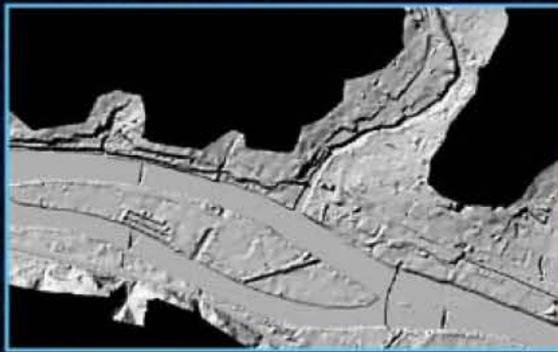
- Accurate flood hazard data is available in a GIS format
- As new data becomes available, revision process is simplified and expedited
- Flood hazard GIS layer can be put on top of other GIS layers – tool for analysis and decision making

# What is a Digital Flood Insurance Rate Map (DFIRM) ???



**BASE**

**+**



**TOPOGRAPHY**

**+**

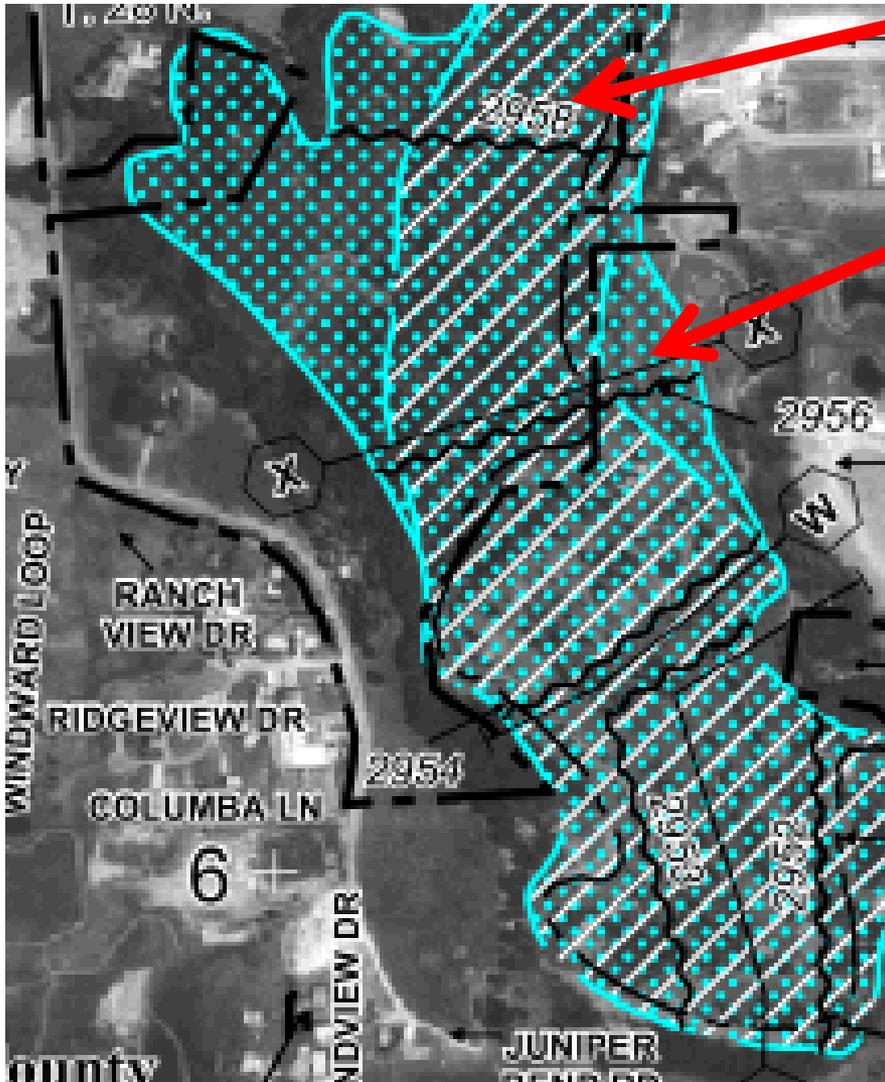


**FLOOD DATA**

**= DFIRM**



**FEMA**



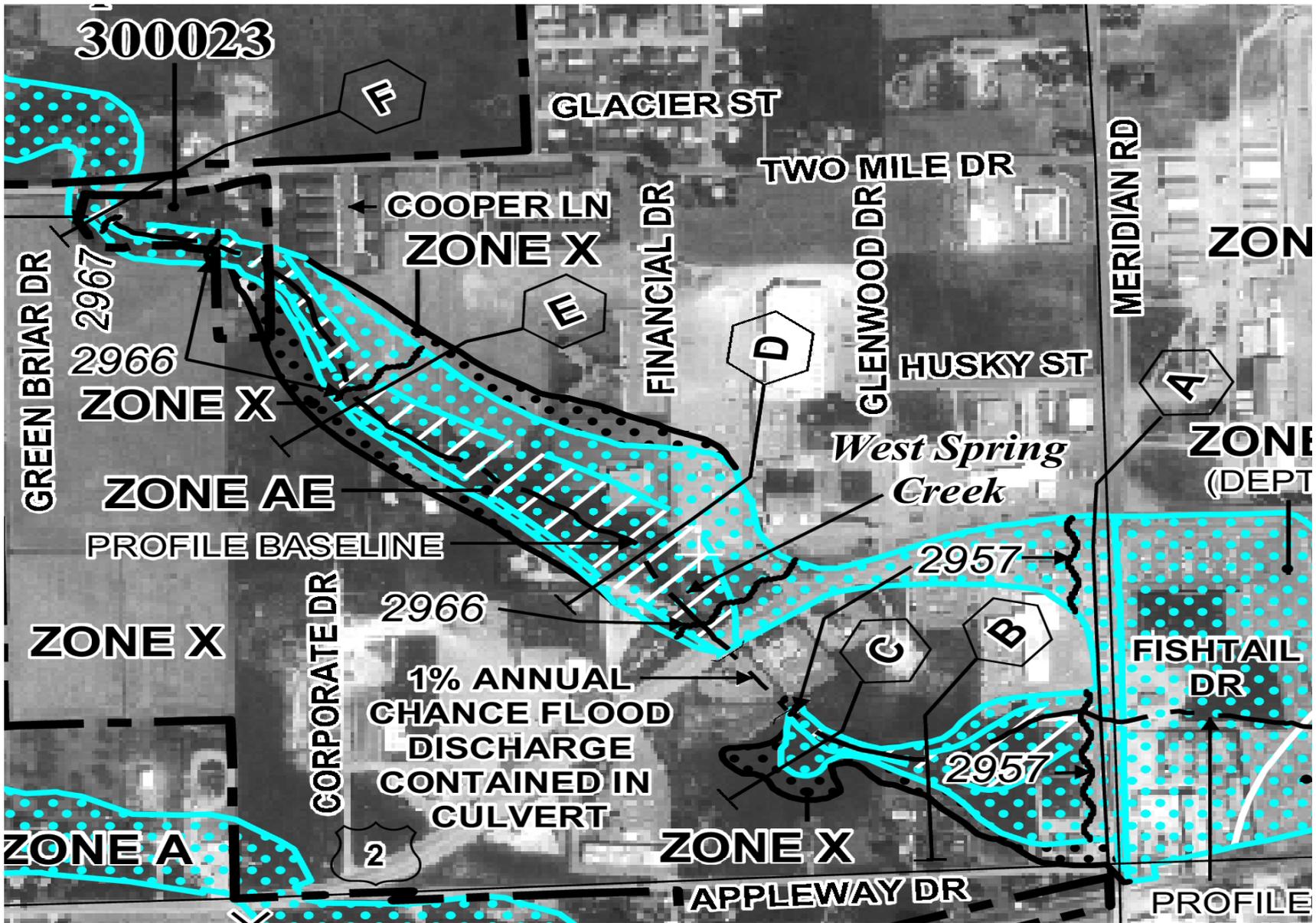
Floodway



"100-Year Floodplain"  
Special Flood Hazard Areas  
(SFHAs)

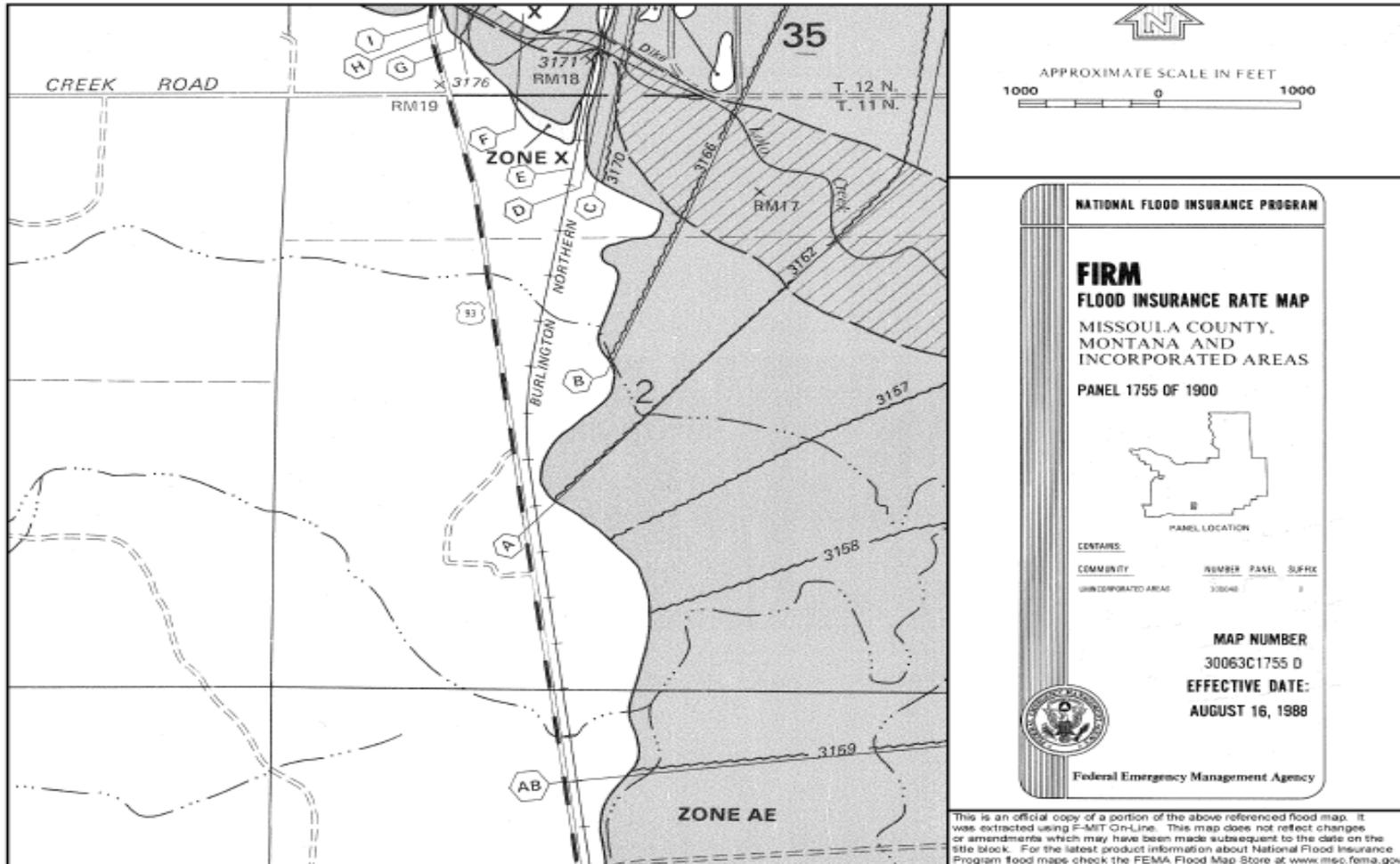
**Floodplain permits are required in mapped floodway and SFHAs**

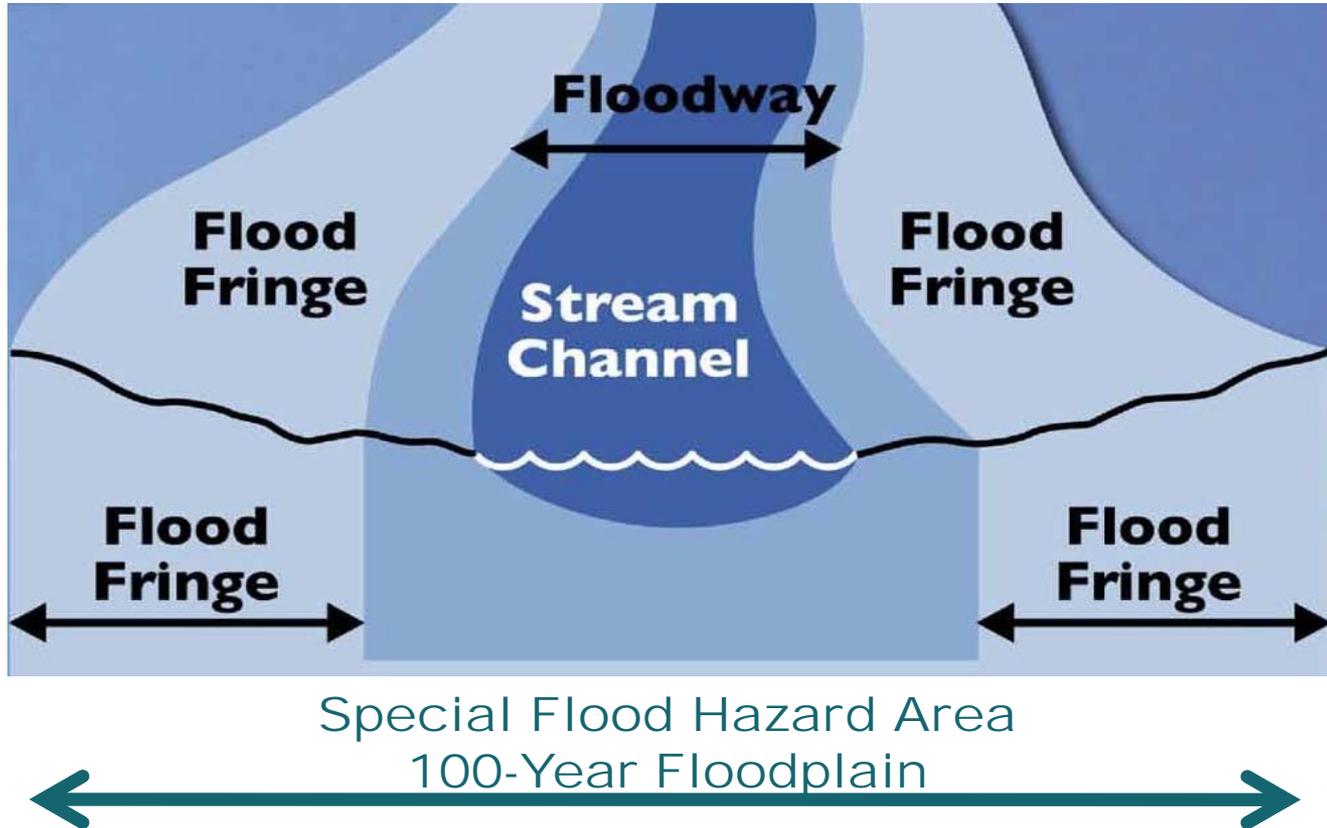
Digital Flood Insurance Rate Map (DFIRM) Flathead County. 2006





# Flood Insurance Rate Maps (FIRMS) also referred to as Flood Maps





In a “100-Year” Floodplain or Special Flood Hazard Area there is a 1% chance of flooding in a one year period.

# FEMA Map Modernization Program

- 5 –yr. program (2004-2009)
- Purposes:
  - Convert Paper Maps to Digital Format: Geographic Information Systems (GIS) Digital Flood Insurance Rate Map (DFIRM) Database
  - Perform new studies with funding available to address areas with mapping issues or no mapping.

# How Does Map Modernization Work?

- Digitize Flood Insurance Rate Maps (FIRM)
- Produce GIS based maps called Digital Flood Insurance Rate Maps (DFIRM).
- Incorporate Existing Data Studies (XDS)
- Increase the accuracy
  - Floodplain Boundary Standards (FBS) –increase floodplain boundary accuracy
  - New updated engineering analysis (Hydrologic and Hydraulic)

# Flood Map Modernization – What GIS data do you get?

## DFIRM Database:

- Geo-referenced flood layer
- Base Map information: roads, streams, water bodies, community political boundaries
- Aerial Imagery

# DFIRM LAYERS

• Political Area	S_POL_AR
• Political Line	S_POL_LN
• Water Line	S_WTR_LN
• Roads	S_TRANSPORT_LN
• Firm Panels	S_FIRM_PAN
• Base Flood Elevations	S_BFE
• Cross Sections	S_XS
• Structures	S_GEN_STRUCT
• Benchmarks	S_PERM_BMK
• PLSS Line	S_PLSS_LN
• Flood Hazard Line *	S_FLOOD_HAZ_LN
• Flood Hazard Polygon*	S_FLOOD_HAZ_AR
• LOMR	S_LOMR
• Public Land Survey System Dataset	S_PLSS_LN & S_PLSS_AR

\* Contains the flood way, 100 year and 500 year data

# Risk MAP Program – What GIS data do you get?

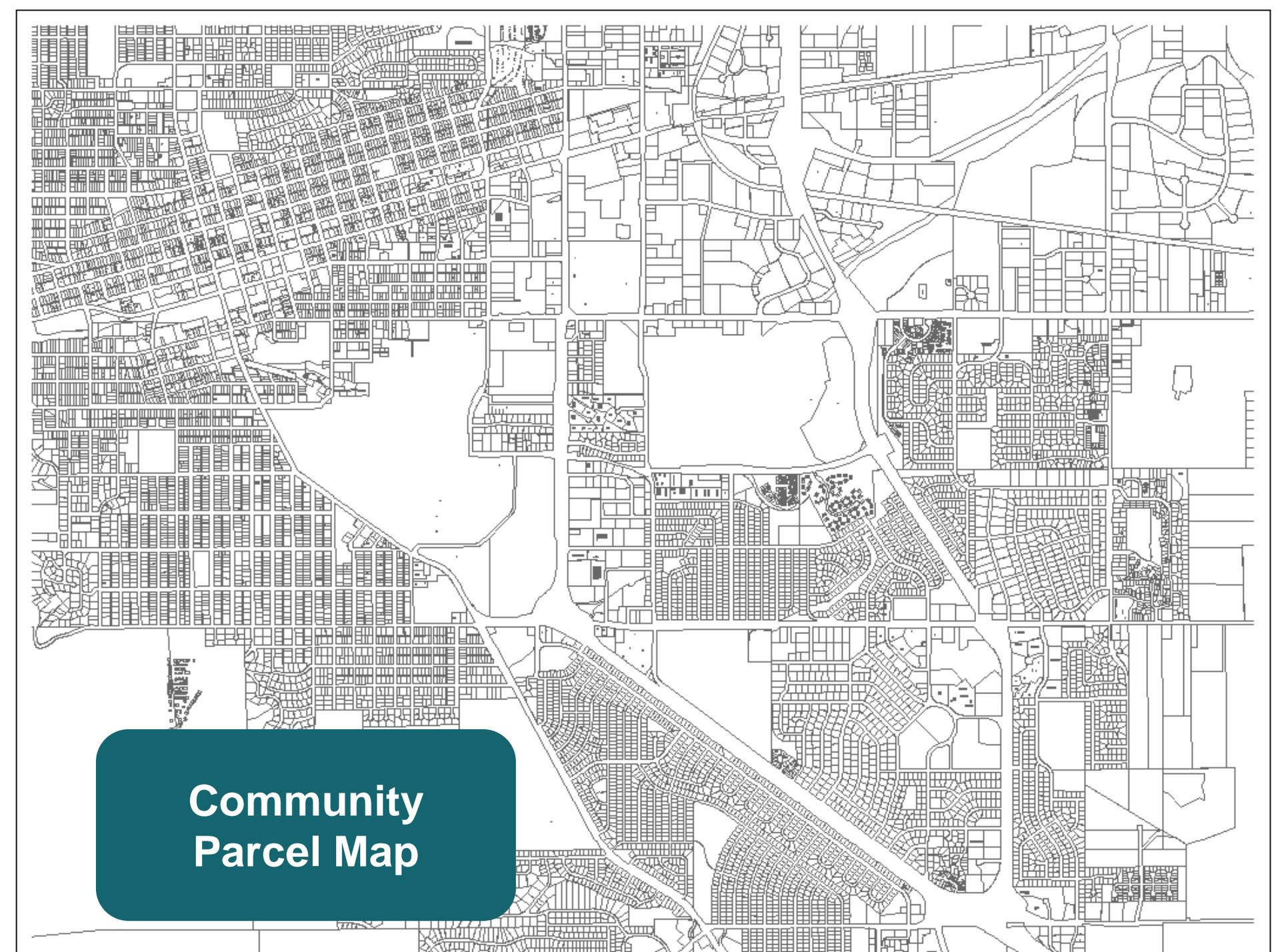
## Non-regulatory products:

- Discovery report and geo-database
- Flood Risk report and geo-database
- Coordinated Needs Management System (CNMS) geo-database

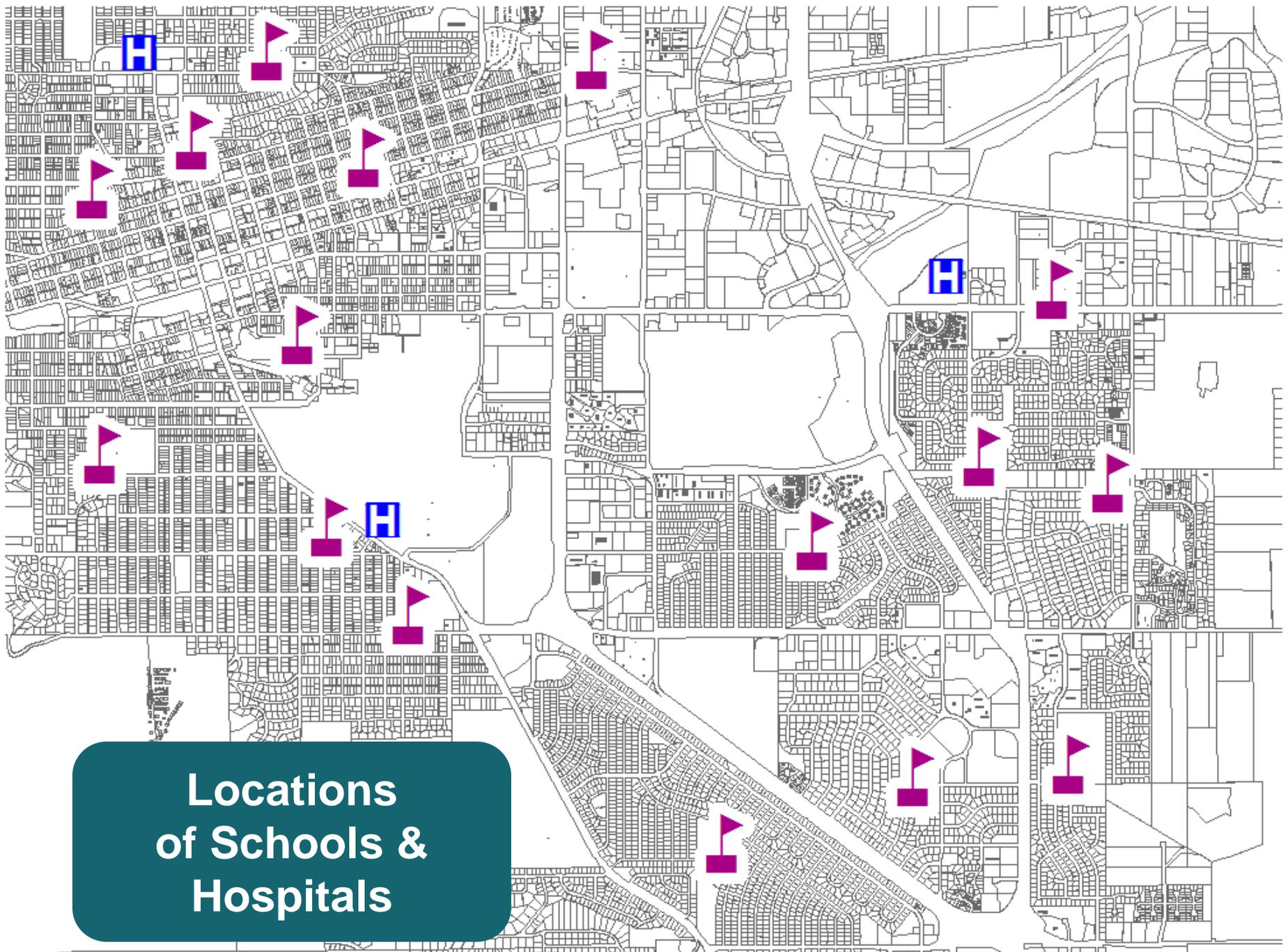
## Regulatory products:

- DFIRM database

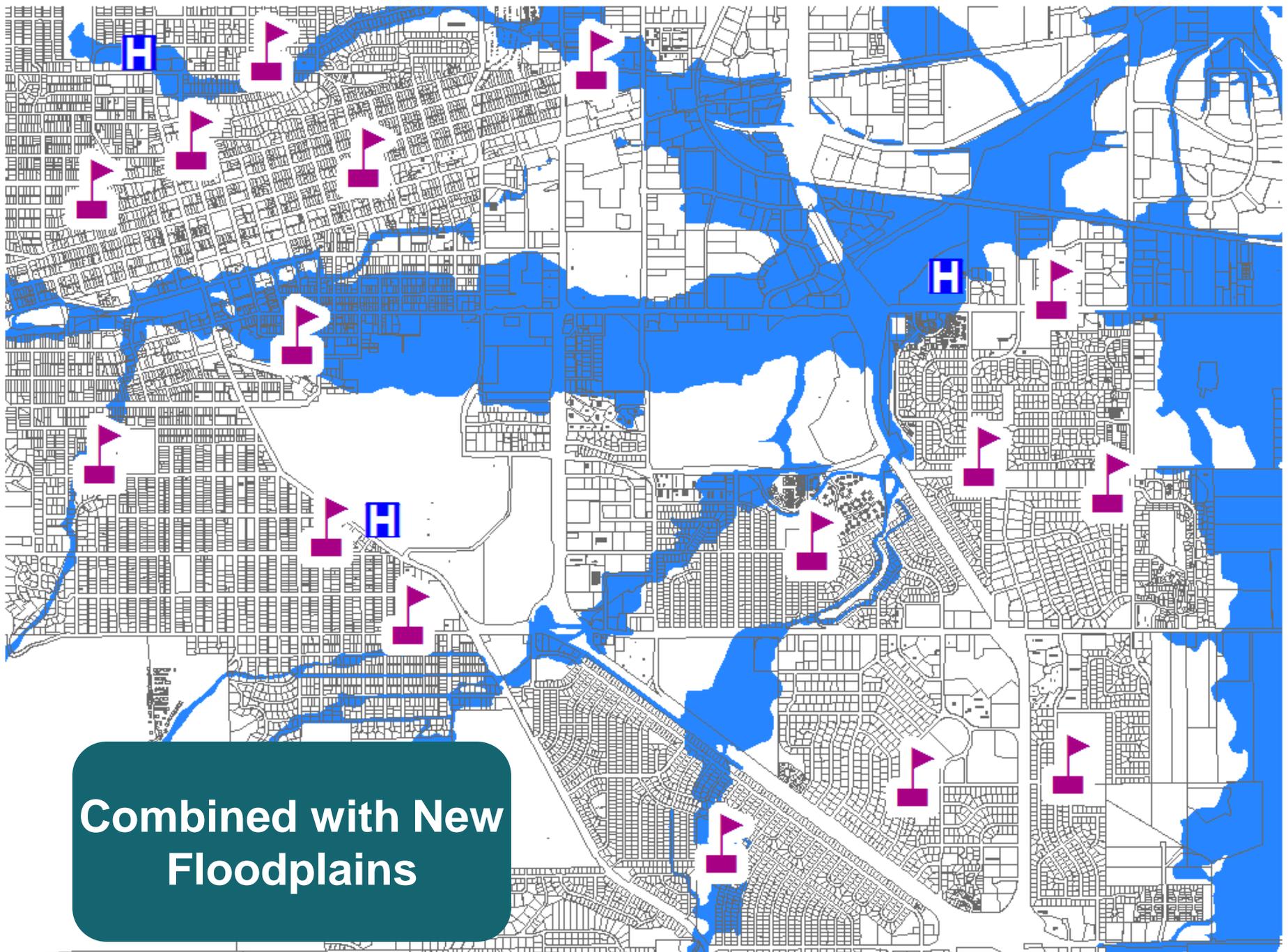
What is the benefit of having floodplain mapping information in a Geographic Information Systems format?

A detailed black and white line drawing of a city's parcel map. The map shows a dense grid of streets and individual lots. A prominent diagonal road runs from the bottom left towards the top right. There are several large, irregularly shaped areas that appear to be parks or undeveloped land. The overall layout is a mix of traditional grid patterns and more organic, winding street designs.

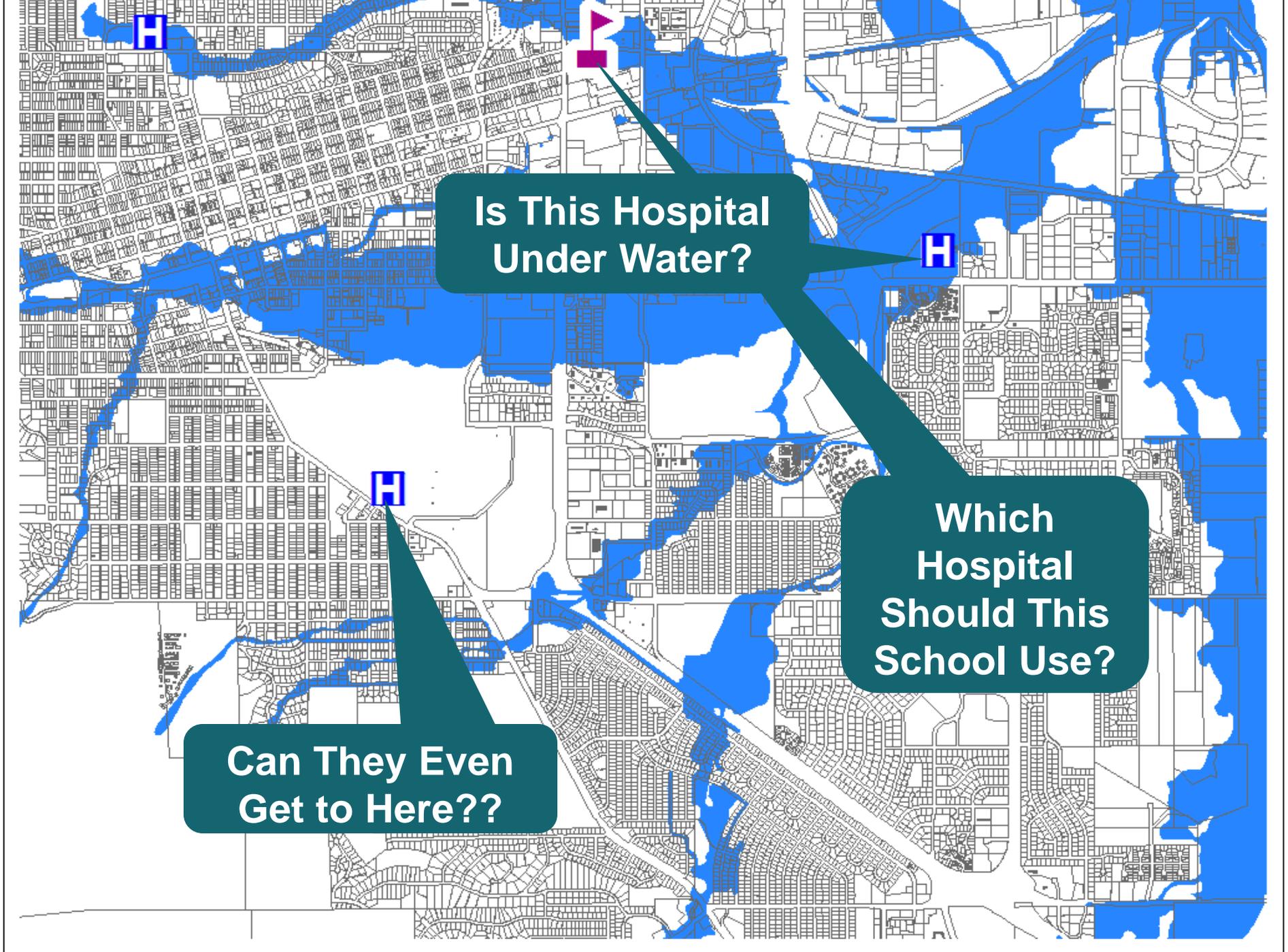
# Community Parcel Map



**Locations  
of Schools &  
Hospitals**



**Combined with New  
Floodplains**



**Is This Hospital Under Water?**

**Which Hospital Should This School Use?**

**Can They Even Get to Here??**

# FEMA Risk MAP Modernization Program

- 2010 →
- Purposes:
  - Convert Paper Maps to Digital Format: Geographic Information Systems (GIS) DFIRM Database
  - Perform new studies with funding available to address areas with mapping issues or no mapping.
  - Incorporate Mitigation Planning
  - Produce Non-Regulatory Flood Risk Information for Communities

# FEMA's RiskMAP Strategy

Analyze and *depict* risk so that Communities and the Public can **understand their risk and make informed decisions** to *safeguard or avoid* that risk.



# Questions?

