

## TEMPLATES FOR COUNTY PRE-DISASTER MITIGATION PLANS

### **Process For Making Maps**

The purpose of this section of the thesis is to outline the general process by which the templates were constructed. Procedures and conventions are discussed here in order to assist the reader in understanding and implementing the map templates.

### **Acquire Statewide Information**

The first step in construction of map templates was to establish the method of acquiring and organizing statewide information and the construction of a common base map. Additionally, the spatial reference system had to be set in ArcCatalog and conventions regarding symbology established. All of the base information was acquired in shapefile or geodatabase format from the CISDM project and NRIS. Both raster and vector data were utilized in the construction of map templates. The steps discussed here outline the construction, organization, and conventions utilized throughout this project. Additionally, base map content will be covered.

### **Geodatabase Construction and Conventions**

Mapmaking accomplished during this project required the use of nine geodatabases. Some of the data, such as the Hill County Cadastral and CAMA data were obtained in this format and used as is. Also, it quickly became apparent that multiple geodatabases would be required for organizational purposes as the number of map types, varieties of data, and areas mapped increased dramatically during the project. The geodatabase development process followed the general rules outlined below (Figure 5-1).

1. General statewide information that could potentially be utilized in all maps was compiled into the MT\_Template\_Base\_Data.mdb geodatabase, which contains thirteen feature datasets.
2. Separate geodatabases were constructed that paralleled the general categories of maps to be produced. These are the MT\_Template\_Natural\_Disasters.mdb, MT\_Template\_Man\_Made\_Hazards.mdb, and Hill\_Cty\_Inventory\_

Asset.mdb geodatabases. At risk populations and raster data were given their own geodatabases.

3. In each geodatabase, the general process was to develop a statewide feature dataset, such as MT\_Tornadoes, analyze the data, and then construct a county or reservation feature dataset, such as Valley\_Cty\_Tornadoes.
4. A separate geodatabase was constructed for all of the raster data used in the template project. In this case, all of its contents were either statewide or county specific raster datasets. Similar naming conventions were used for its contents.



Figure 5-1, Geodatabase Structure

### Spatial Reference System

Most, if not all, data acquired from NRIS came in the Montana State Plane coordinate system, NAD 83 (meters). This coordinate system works well for maps made of any portion of Montana and the area immediately surrounding it. All of the feature datasets and associated feature classes were constructed using these parameters. Additionally, the Min X: and Min Y: values of the X/Y Domain were set at 0 and the Precision was set to 1000. This means that each point is measured from the origins of the State Plane Coordinate System and stored precisely to 1/1000<sup>th</sup> of a meter, or 1 millimeter. The details of the spatial reference system for statewide data are shown in the figure below (Figure 5-2).

The Lambert Conformal Conic Projection works well for states in the mid latitudes, such as Montana. It is constructed by superimposing a cone over the sphere of the earth, with two standard parallels secant to the globe and intersecting it. Distortion is thereby minimized when a three dimensional surface is projected onto the two dimensional map. The projection is conformal, which means that there is no angular

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| Spatial Reference Information                  |
| Projected Coordinate System:                   |
| NAD 1983 State Plane Montana FIPS 2500         |
| Projection: Lambert Conformal Conic Projection |
| Central Meridian: -109.5                       |
| Latitude of Origin: 44.25                      |
| Standard Parallel 1: 45.0                      |
| Standard Parallel 2: 49.0                      |
| Planar Coordinate Information:                 |
| Distance Units: Meters                         |
| Map Units: Miles and Feet                      |
| Geodetic Model:                                |
| Horizontal Datum: NAD 1983                     |
| Ellipsoid (Spheroid) Name: GRS 80              |

Figure 5-2, Spatial Reference System

deformation around points. The spatial reference values of the coordinate system for individual county or reservation maps were re-projected accordingly in ArcMap using the Coordinate System Tab of the individual Data Frame Properties dialog box in order to rotate the area mapped so that north is toward the top of the page.

### Symbology

The symbology portion of the CISDM project was not established and promulgated at the time of this writing. The only existing symbol system discovered during the research for this project that is commonly used for disaster and emergency services was created by the Homeland Security Working Group (HSWG). Therefore, the majority of the symbols used in the creation of these maps are from the ArcGIS 9.1 symbol files. HSWG symbols were used where appropriate.

### Basemap Content

It was necessary to answer the fundamental question of what specific features the base map should contain before development of the map templates could continue. A partial attempt to resolve this issue was to attend sessions with county and district DES personnel hosted by GeoData Services, Inc., which were devoted specifically to answering this question. The result of this research is that currently there is no hard and fast answer regarding base map content. For this project, the features that appear in the Location Map for Hill County best display the most common conventions.

### **Acquire Thematic Data**

The next step in the template construction process was to identify and acquire the thematic data used for the construction of specific map templates. In most cases, this information was acquired as raw data from the most authoritative source available. An example of this was the tornado data acquired from the National Oceanographic and Atmospheric Administration's (NOAA) National Weather Service Storm Prediction Center. In the case of Natural Hazard information, every effort was made to find information covering the longest time period possible in order to portray the most complete historical record. Detailed processing instructions were included where necessary. As for man-made features, the most current information available was utilized and appropriate remarks were made regarding the timeliness of the data.

### **Process the Data**

Once statewide information was acquired and portrayed, it was necessary to select an appropriate county or reservation for template construction. In most cases, this selection process involved determining that part of Montana most frequently afflicted by the particular disaster. Once this selection was made, various methods were utilized to extract just the specific base map and disaster information needed for that county or reservation. The convention in this thesis has been to **bold** items where actual computer operations or steps are required. The objects acted upon are *italicized*.

### **ArcGIS Data View**

The next step focused on analysis of the data and was generally conducted within ArcGIS's Data View. This often involved joining tables, summarizing information, calculating various values of attributes, and so on. The goal here was to derive information in a format that would be useful to county or reservation PDM planners. Additionally, various types of explanatory information useful to the map reader were developed. An example of this was the compiling of information describing the Fujita Scale, a method of measuring tornado intensity.

### **ArcGIS Layout View**

The final step in the process was to use the features to construct the actual map. All of the cartographic principles covered in the previous section were incorporated into this process. It should be noted that many of the elements of the maps, such as background, font type, and so on, were standardized for this project. It should also be emphasized that these are not the only options. However, standardization of appropriate elements is generally considered correct for a folio of maps.

### **Location Maps**

Just as the purpose of a map is to communicate information, the purpose of a location map is to give a generalized overview of a geographical area. Moreover, it must be capable of communicating this information clearly to audiences that are not familiar with the area. More than one map may be required to achieve this end. This section of the thesis describes the considerations and construction processes involved in building a location map. To begin, some basic questions regarding the construction of any set of maps must be answered. Then, thought must be given to some issues regarding the content necessary to adequately tell the area's story. The final section will pertain to the actual construction of location maps. The basemap data acquisition and download processes are described here and a variety of content options are discussed and portrayed.

The first issue is to clarify the goal or intent of the map. In this case, both general and specific information regarding the location of natural and man-made features need to be utilized. Due to the variety of scales and extent required to portray this information, sample inset maps may need to be used.

The next question is to identify the intended audience. Because of the public nature of pre-disaster mitigation plans and the wide variety of users, these maps must work in the broadest possible sense. Even though the location map may portray state, county, or reservation level information, it will be reviewed and used by all levels of government as well as the general public. Much of the information contained in the maps will be common knowledge to the residents of the area. However, this may not be the case for everyone that needs to make use of pre-disaster mitigation plans. Moreover,

adequately telling a story on a map to an audience not familiar to the area is especially important when seeking funding from various agencies or for involving higher levels of government in mitigation projects.

The final question to answer prior to dealing with actual content has to do with the medium used to display the map. This has been discussed previously, but is stated again here for emphasis. All of the maps that appear in this thesis, not just this section, are designed to be printed in color on standard sized 8 ½” x 11” inch paper in thesis format.

The potential number and specific content of maps in the location map category is limited only by the needs and desires of the user, and this should be the fundamental criterion in their development. Additionally, just as the counties and reservations across the Montana landscape vary greatly, so will the content requirements for location maps. County or reservation location and size, topography, general population characteristics, major lines of communication, natural characteristics, aerial imagery, and public lands are just a few of the items that may be desired. Examples of most of these are included here. Hill County was chosen as the subject area for most of the maps constructed in this part and the Inventory Asset portion of this thesis. Public lands are also covered in that portion.

### **Location Map Methodology**

This section expands upon the data acquisition and processing steps introduced earlier. Additionally, the specific steps used in actual map construction are covered.

#### **Data Acquisition and Processing for Location Maps**

Most of the data utilized in these templates was obtained through the NRIS website at <http://nris.mt.gov/gis/>. Numerous types of information can be obtained here and the overall content is expanded and updated frequently. Along these same lines, the download procedures discussed here apply to other websites as well. A procedure for acquiring a single dataset will be discussed, although multiple datasets may be downloaded simultaneously. On the website’s home page, **Click** on *GIS Data List* and then **scroll** down the list until you reach the *Counties, U.S. Census Bureau*. **Click** on the

*data* button and **choose** the *shape file* type. This will download all the county boundaries in the shapefile format in the NAD 1983 Montana State Plane coordinate system in a zip file. The metadata will normally come in the zip file, but can be examined and downloaded separately. Once unzipped, the shapefile can often be imported directly into the appropriate feature dataset of a personal geodatabase because it contains a .prj file. This informs ArcCatalog what spatial reference system is used. Occasionally, especially with the raster data downloaded from this site, the spatial reference system will need to be defined in ArcCatalog. In either case, for raster or vector data, the procedure for defining the spatial reference system is much the same.

The process utilized for shapefiles will be described here. **Open** *ArcCatalog* and **navigate** to the *shapefile* just downloaded. **Right click** on *it* and **select** *properties*, which will open the *Shapefile Properties Dialog Box*. **Select** the Fields Tab and **click** on the field named *Shape*. This will bring up the *Shape Field Properties* in the lower portion of the dialog box. **Click** on the *button* to the right of the Spatial Reference heading. This will invoke the *Spatial Reference Properties Dialog Box*. **Use** the *Select* button to choose the appropriate Coordinate System taken from the metadata and **Click** *Add*. The appropriate spatial reference information should appear in the Details section of the Spatial Reference Properties Dialog Box (Figure 5-3). **Click** *OK* on this box and the *previous one* and the appropriate information should be registered in ArcCatalog. This can be verified by **checking** the information contained in the *Spatial Tab* of the Metadata Tab for the shapefile. The shapefile can now be imported into a geodatabase.

The metadata for each dataset should be examined for other items as well. All metadata obtained from this website conforms to the Federal Geographic Data Committee (FGDC) metadata content standards, which specify the format and content. More detailed information about metadata can be obtained from the FGDC website at <http://www.fgdc.gov/>. One of the more important segments of the metadata is the Horizontal Position Accuracy Report. In the case of our County Boundaries file, the horizontal accuracy is approximately fifty-one meters. Usage constraints are also normally provided; in this case it is not for use at scales greater than 1:100,000. This information regarding the precision and accuracy of the data should be considered carefully for each intended use.

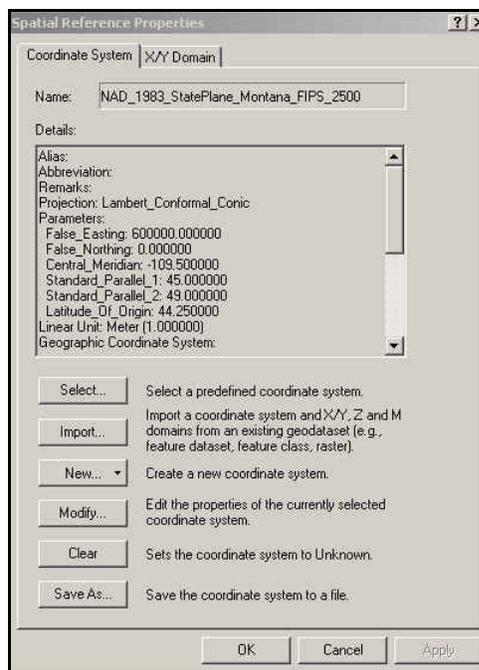


Figure 5-3, Setting the Spatial Reference System

Information regarding the source, processing method, and date of acquisition are also be provided in the metadata. Some of the questions to be answered when examining it include: is the data current enough, does it contain the necessary attribution, and did it originate from a credible source?

### Mapmaking-Location Map of Hill County

This is the most basic map of the series. Two data frames are provided; one that shows where the county is located in Montana and the other is the county base map itself. The Montana data frame enables the map-reader to quickly identify the geographic context of the main map. Keeping in mind the potential audience for pre-disaster mitigation plans, it is very possible that many of the readers are not familiar with the location of Hill County. One can also easily see the balance and symmetry achieved by placing the legend and inset map together on the right side of the page. The reader's eye flows naturally over the map from left to right, taking in all of the map elements, and then remains focused on the most important part of the map, which is Hill County. The map also demonstrates the suitability of the Lambert Conformal Conic projection for use in this context.

No special processes were used in the construction of this map. Most of the data, including the MT\_Hillshade layer, was acquired from NRIS in the form of zipped shapefiles containing **statewide** information. Once all of the information was downloaded, a straightforward process was utilized to transform it into feature classes within our MT\_Template\_Base\_Data.mdb geodatabase. A number of feature datasets were constructed in order to organize it all properly and provide the framework for adding more data (Figure 5-4). The major exception to this was the transportation features, which were acquired in the form of a personal geodatabase from the CISDM website.

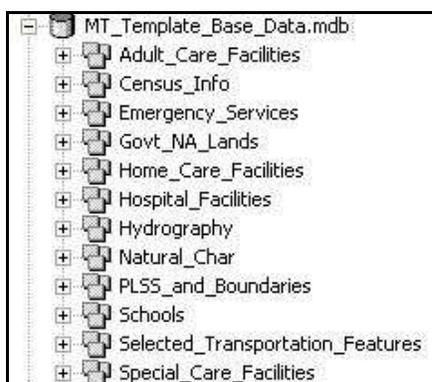


Figure 5-4, Base Data Feature Datasets

Once Hill County had been chosen as the subject for the location map, the **Clip** tool, found in ArcToolbox under Analysis Tools and then Extract, was used to **create feature classes** containing only data for Hill County. The segment of the MT\_Hillshade layer covering Hill County was extracted by **importing** the *feature* and **setting** the data frame *extent* of the Hill\_Cty\_Location Data Frame Properties dialog box to the boundary of Hill County. This was accomplished by **Enabling** the *Clip to Shape* function and **specifying** the *Hill\_Cty\_Boundary* layer as the shape. This *segment* of the MT\_Hillshade was then **exported** to form its own raster dataset within the MT\_Template\_Raster\_Data.mdb (Hill\_Cty\_Hillshade). Finally, the Hill County portions of the feature classes containing major roads, railroads, towns, major hydrographic features, and the Rocky Boy Reservation were added to the map. This is the limit of what can be portrayed before the map becomes cluttered. The reservation feature class was **set** to *display at 40% transparency* in order to allow the Hill\_Cty\_Hillshade layer to be seen. We should

also note that a significant portion of the Rocky Boys' Reservation is located in Choteau County to the south (Map 5-1).

#### Mapmaking: Geographic Coordinates Map of Hill County

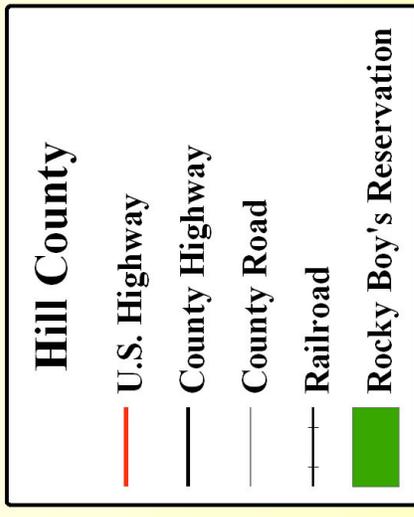
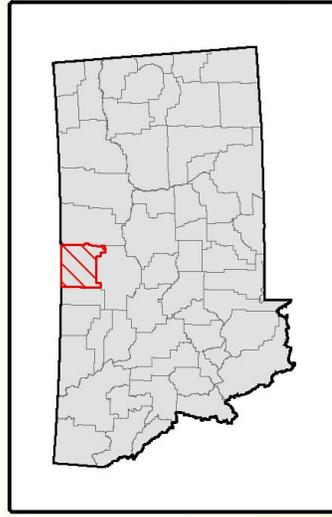
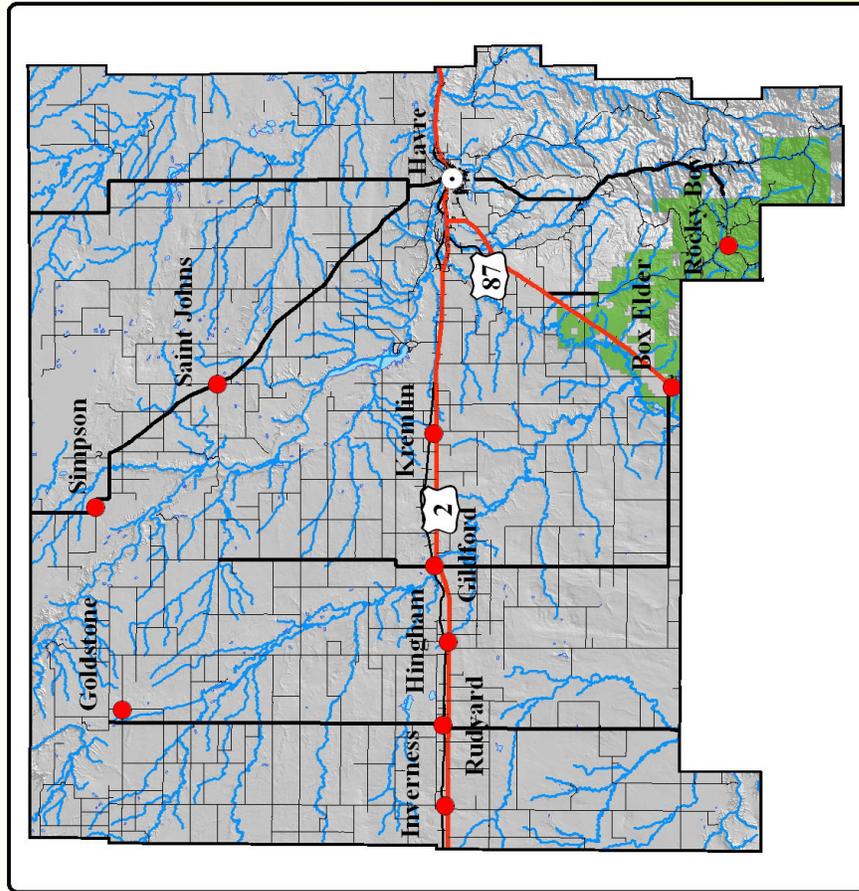
It is a simple matter to add a grid coordinate system, or graticule, to a map. This process will be demonstrated using the previous Location Map of Hill County (Map 5-1). The graticule will be developed in geographic coordinates (degrees, minutes, and seconds), but the process can be used for other coordinate systems.

Start by **opening** the *Hill\_Cty Data Frame Properties Dialog Box* and **Select** the *Grids Tab*. **Click** on *New Grid* to open the Grids and Graticules Wizard. In this section, we want to create a graticule, or a map divided by meridians and parallels. **Select** the appropriate *button* and give the Grid an appropriate name (such as LatLong). **Click Next** to move to the Create a Graticule window. **Leave** the default *Graticule and labels button* selected. Some experimentation is required to determine the appropriate Interval to set for the parallels and meridians. For the extent of Hill County, **settings** of *0 degrees, 20 minutes, and 0 seconds* worked well for both fields. **Click Next** and **Select** appropriate *Axes and Labels*. **Click Finish** on the *Create a graticule* dialog box. This completes the process of creating a new grid. Ensure the box next to *LatLong* is **checked** and it will be displayed over the Hill County map in the Layout View only. **Experiment** with the *Grid properties* on this tab in order to select the font, line colors and weights, tick marks, and so on. An example is shown on the following map (Map 5-2). It should be noted that at this scale, the graticule is appropriate for orientation purposes only, not for deriving specific geographic coordinates for a particular feature in Hill County.

#### Mapmaking: Selected Natural Characteristics of Hill County

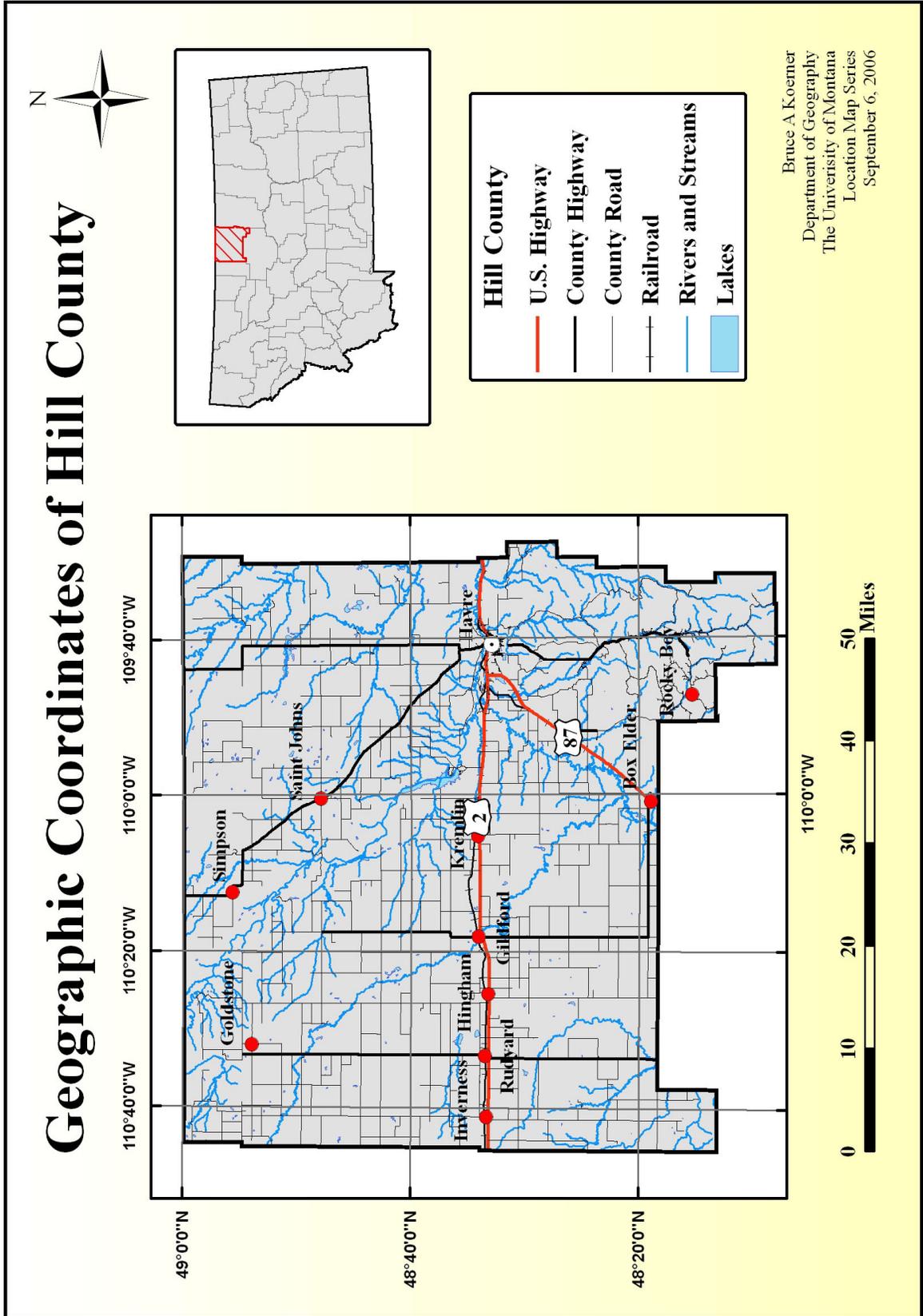
The NRIS website contains vast amounts of data that fall into the general category of natural characteristics. More importantly, old datasets are updated and new datasets are added to the library on a continuous basis. In our location map series, this type of information may be needed to give the pre-disaster mitigation plan reader more general information about the area. Most of these datasets are distributed as statewide features and need to be clipped using the processes described in the previous section. Also, the

# Location Map of Hill County



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The University of Montana  
Location Map Series  
September 6, 2006

Map 5-1, Hill County Location Map



Map 5-2, Geographic Coordinates of Hill County

metadata needs to be examined carefully to ensure the data is compatible with its intended use. As an example, the metadata for precipitation states that the information covers the period of 1971-2000, which should be sufficient for a PDM plan. The map displayed here depicts Climax Vegetation and Average Annual Precipitation for Hill County. Some of the other types of datasets available at the time of this writing include the following.

1. Conservation Districts
2. FWP Regional Fisheries Boundaries
3. FWP Regional Wildlife Boundaries
4. Soils data - 1:250,000 scale STATSGO
5. Various Types of Wildlife Distribution
6. Various Fish Species Native Ranges
7. Climax Vegetation
8. Land Use from USGS - 1:250,000 scale

Two data frames are used in this map. The Hill\_Cty\_Boundary feature was used to **clip** the *subject layers* to the proper size. The *output feature classes*, Hill\_Cty\_Climax\_Veg and Hill\_Cty\_Precip, were **exported** to the Hill\_Cty\_Features feature dataset. The attribute tables for both new feature classes were inspected to ensure they were complete. For annual precipitation in Hill County, it should be noted that although the majority of the county falls into the ranges of ten to thirteen inches of precipitation per year, some segments of the county receive as much as thirty-four inches per year. The Group Values Function of the Symbology Tab in the Hill\_Cty\_Precip layer properties dialog box was used to group some of the precipitation values (Figure 5-5). This simplifies the map and reduces the number of sequentially color-coded values from fourteen to six, a number that the human eye can comprehend. In order to focus attention completely on the natural characteristics subject matter, almost all other map features were removed (Map 5-3).

#### Mapmaking: Aerial Imagery of a Portion of Hill County

There are numerous types and sources of remotely sensed imagery available for Montana. One of the best types currently available for Location Maps is the National

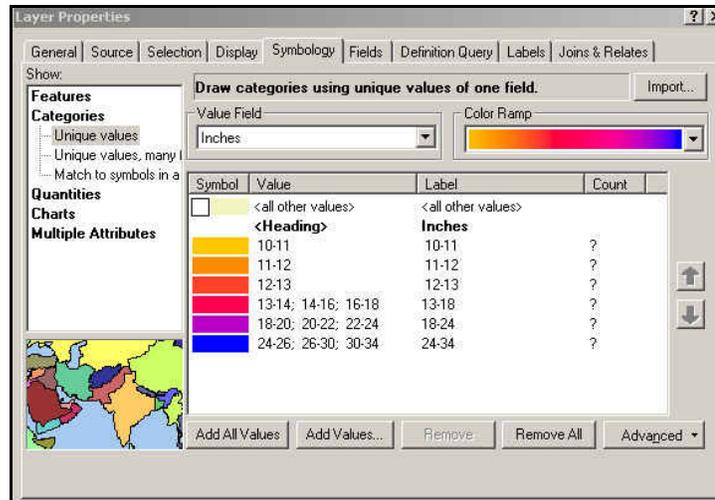


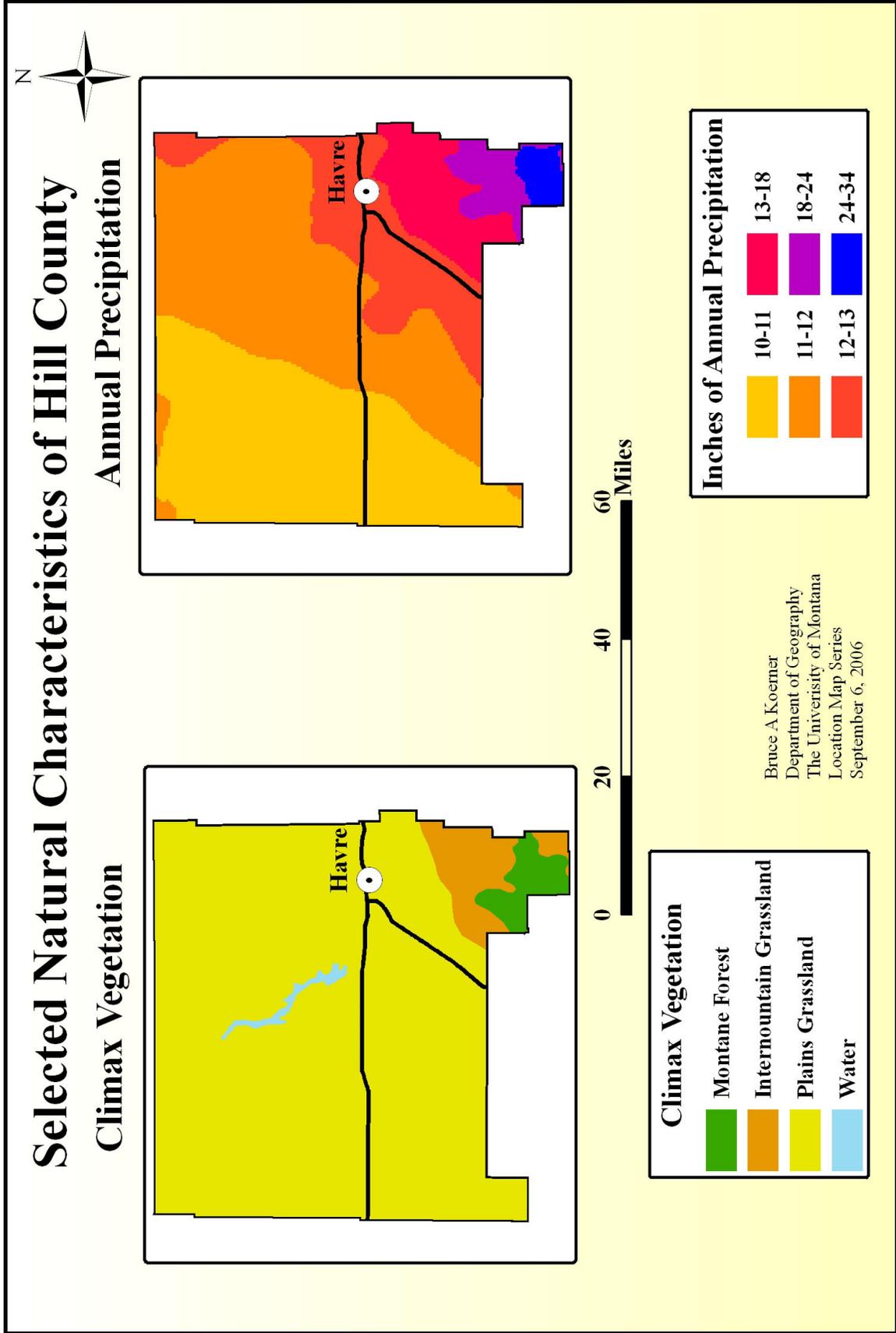
Figure 5-5, Precipitation Value Grouping

Agricultural Information Program (NAIP) imagery. This was compiled by the U.S. Farm Services Agency (<http://www.apfo.usda.gov/NAIP.htm>), and is designed to meet the standards of the U.S. Department of Agriculture for conservation and planning. These data are comprised of color digital aerial photos taken in 2005. They consist of 2,703 12x12-kilometer tiles that cover the entire state of Montana. They are orthorectified natural-color MrSID images with a ground resolution of one meter, and are registered to the Montana State Plane coordinate system, NAD83, units meters.<sup>1</sup> The figure provides a sample of a portion of the tiles that can be acquired for Hill County (Figure 5-6).



Figure 5-6, NAIP Tile Grid

<sup>1</sup> Montana Natural Resource Information System, "NAIP metadata" Accessed October, 2006. Available from <http://nris.mt.gov/gis/>.



Map 5-3, Natural Characteristics of Hill County

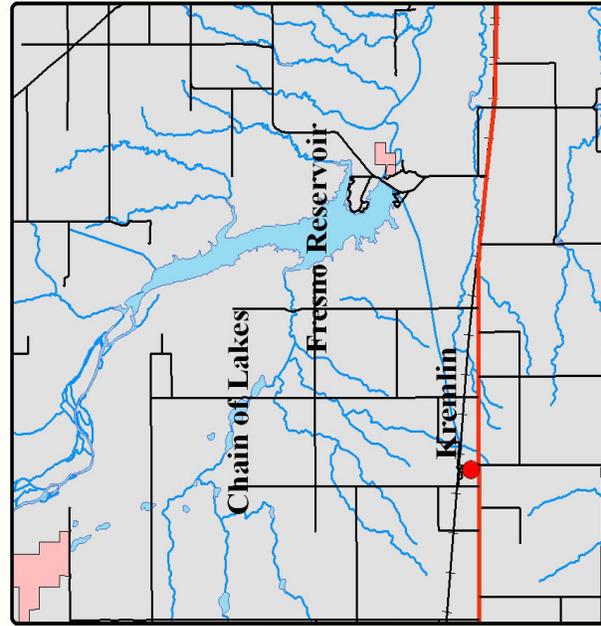
The download process for the NAIP imagery has been discussed previously. The appropriate tiles were acquired, unzipped, and their spatial reference systems defined in ArcCatalog. They were then imported into the MT\_Template\_Raster\_Data geodatabase.

For the location map described in this section, it was necessary to assume that providing details of Fresno Reservoir was important in the PDM planning and mitigation process. This dam is owned and operated by the U.S Bureau of Reclamation and used for irrigation, flood control, and supplying water to the area. Two data layers were included that show the general area and the NAIP imagery. MT Fish, Wildlife, and Parks property is displayed in both data layers. In this case, the central focus of the imagery is the dam and spillway area (Map 5-4).

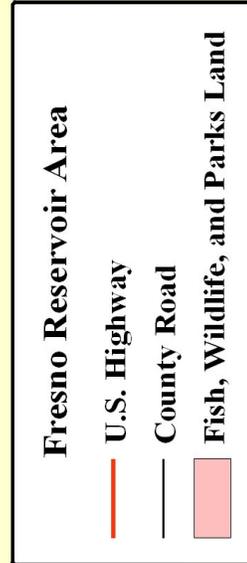
### **Location Map Summary**

The location map section served a variety of purposes. It provided the first example of using the processes, procedures, and conventions outlined in the first part of this section. Base map data was acquired and processed into the formats necessary for use in the map-making process. Thematic data necessary for communicating the required information about Hill County was gathered and manipulated using the same procedures. Although location maps usually do not involve much analysis, it was still necessary for the mapmaker to make use of selection and generalization processes in order to determine which map elements to portray. Much of this work was accomplished in ArcGIS Data View. Once completed, the actual map layouts were compiled in the ArcGIS Layout View. It was here that many standards of style, format, font types, and other map elements were established, thus simplifying the mapmaking process. Finally, the most important concept of this thesis was reinforced. The map templates constructed here are meant to provide ideas and concepts, demonstrating some of the products that can be produced to aid the pre-disaster planning and mitigation processes.

# Fresno Reservoir on the Milk River, Near Kremlin, MT



0 1 2 4 6 8 Miles



**Fresno Reservoir, Dam, and Spillway Area  
2005 NAIP Imagery  
Color, 1 Meter Resolution**

Bruce A. Koerner  
Department of Geography  
The University of Montana  
Location Map Series  
September 6, 2006

Map 5-4, NAIP Imagery of Fresno Reservoir