

# **MAPS Atlas**

Version 6.0

## **A Land and Climate Information System**

### **Authors**

J.M. Caprio, Professor Emeritus, Department of Land Resources  
and Environmental Sciences and Former State Climatologist

D.I. Cooksey, Research Assistant, Department of Land Resources  
and Environmental Sciences and Project Coordinator

C.M. Erlien, Research Assistant, Department of Land Resources  
and Environmental Sciences

J.S. Jacobsen, Associate Professor and Head, Department of Land Resources  
and Environmental Sciences and Extension Soil Scientist

G.A. Nielsen, Professor, Department of Land Resources and Environmental Sciences

R.R. Roche, Computer Specialist, Montana Agricultural Experiment Station

*All are with Montana State University*

**A product of the *Montana Agricultural Potentials System***

**Acknowledgments:**

Many people have contributed to the development and testing of *MAPS Atlas*. Their efforts on this project are appreciated. The authors would especially like to thank Bob Snyder for his work on the first version of *MAPS Atlas* (*MAPS Mailbox*), and for providing his technical expertise for version 5.0. Alma Roe and Bob Pearson are recognized for their efforts and recommendations on *MAPS Mailbox*. The Montana Agricultural Experiment Station, Extension Service, USDA. Soil Conservation Service, Montana Wheat and Barley Committee, Montana Department of Agriculture, Montana Department of Transportation and the MSU Geographic Information and Analysis Center have all participated in the early development of *MAPS Atlas*.

Questions or comments about *MAPS Atlas* can be directed to Diana Cooksey, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717, (406) 994-5684.

---

**Disclaimer**

Montana State University, program authors and participants shall have no liability or responsibility to any person or entity for any liability, loss or damage caused or alleged to be caused directly or indirectly by this database, including but not limited to, any interruption of service, loss of business or anticipatory profits or consequential damages resulting from the use of or operation of this database.

**Conditions of release or sale**

All computer databases distributed by Montana State University are on an "as is" basis without warranty. Distribution or resale without written permission of the department of origin is not permitted. Copyright 2000, Montana State University.

# INTRODUCING MAPS ATLAS

## Land and Climate Data in ArcView Format

Montana State University's **MAPS Atlas Version 6.0** is a geographic information system (GIS) database that provides estimates of 150 land and climate attributes for Montana. This system divides Montana into about 18,000 cells, each representing slightly more than 3 miles north and south by 2 miles east and west. The cell dimensions are 3 minutes of latitude by 3 minutes of longitude. **MAPS Atlas 6.0** presents **Montana Agricultural Potentials System (MAPS)** data in ArcView shapefile format so they can be used in ArcView, ArcGIS or ArcExplorer GIS software. This format is considerably more functional than the previous DOS version of **MAPS Atlas** (version 5.0).

**MAPS Atlas** was designed as a planning tool to provide information for people who make decisions about land use and natural resources. For example, professionals in construction, land use planning, consulting, energy and mining can use the information for site selection and environmental assessment. Agricultural businesses, researchers and producers can use the information to determine the potential for specialty crops, evaluate crop inputs or examine the potential for chemical contamination of groundwater.

**MAPS Atlas** provides ready access to nearly three million estimates of land and climate conditions in Montana. Realtors can show clients how climate differs between farms, ranches and other properties. Students can quickly gather information for use in reports on Montana environments and land resources. Anyone can use **MAPS Atlas** to estimate specific climatic conditions anywhere in the state at any time of year.

**MAPS Atlas** should be used only when site-specific information is unavailable. Most attribute values represent long-term average conditions for the area. Unusual conditions are not represented. Data provided by **MAPS Atlas** are estimated values derived from maps or extrapolated from specific sites. Actual conditions at a specific location within cells could be very different from the **MAPS Atlas** data

## Here's How it Works

You may use the **MAPS Atlas 6.0** data in either ArcExplorer or ArcView GIS (or the newer version ArcGIS) software. We recommend using ArcView (or ArcGIS) because it is much more flexible and functional than ArcExplorer. *Further references to ArcView GIS software in this manual should be considered to mean ArcView GIS and/or ArcGIS.*

ArcView GIS is a popular desktop mapping and Geographic Information System (GIS) software with spatial analysis capabilities. ArcView GIS allows you to create dynamic maps using data from many sources and across most popular computing platforms. It lets you work with maps, database tables, and business charts all in one application. ArcView GIS is available from ESRI, Inc. and from several dealers across the country. If you purchase

ArcView GIS, we highly recommend taking a 2-day ArcView training workshop, or an ArcView course over the Internet through ESRI's Virtual Campus.

ArcExplorer is a free, lightweight GIS data viewer developed by ESRI, Inc. and is included on the **MAPS Atlas 6.0** CD. ArcExplorer can work on its own with local data sets or as a client to Internet data and map servers. As a stand-alone application, ArcExplorer allows users to display and query a wide variety of standard data sources including ESRI shapefiles, ArcInfo coverages, and SDE layers. The **MAPS Atlas 6.0** data are in ESRI shapefile format. With ArcExplorer, it is possible to display a wide variety of image formats, pan and zoom through multiple map layers, display data using classifications, symbols, and labeling, and identify and query geographic and attribute data. For more information on ArcExplorer, please see ESRI's WWW site at [www.esri.com](http://www.esri.com).

**MAPS Atlas 6.0** combines all the data from the previous DOS version with a more powerful and flexible user interface through ArcView GIS or ArcExplorer. Although ArcExplorer is not as functional as ArcView, it allows the MAPS database to be viewed in a Windows environment, which offers several advantages over the DOS version.

### **What is Included in the Database**

The **MAPS Atlas 6.0** CD includes both ArcView projects (\*.apr) and ArcExplorer projects (\*.aep). Each version contains a main reference map of Montana showing the 18,000 MAPS cells and base map layers (known as themes) such as roads, waterways, sections, and townships, along with sample maps created from MAPS attribute data. The ArcView version includes a colored map for each of the 150 MAPS attributes. The ArcExplorer version includes six sample attribute maps, and users can create additional maps for other MAPS attributes.

All base map layers were obtained from the Montana State Library Natural Resource Information System (NRIS) and can be found in the \ma6\statedata folder. In addition, the statedata folder contains a file named statedata.doc which lists the base map layer files and their corresponding geographic features.

All map layers (themes) in the ArcView and ArcExplorer projects are in the State Plane 83 coordinate system, which uses the North American Datum of 1983. New map layers added to the MAPS database must be in the same coordinate system and datum.

## Details about the ArcView Version

The complete geographic database is presented as ArcView project files (\*.apr). The main project file, ma6.apr, shows MAPS cells, along with base map layers (themes), and several sample maps to introduce you to the system. Additional project files contain attribute maps grouped into eight categories, each category with its own project file:

1. growingseason.apr
2. daylength.apr
3. miscellaneous.apr
4. topography.apr
5. evapotranspiration.apr
6. precipitation.apr
7. soil.apr
8. temperature.apr

Values for all 150 MAPS attributes can be accessed from any map in the entire set. Attribute values can be viewed by pointing at a cell using the **Identify** tool in ArcView, or they can be used to define custom maps using specific values for several attributes. Custom maps may be created for a variety of applications. Custom maps may be used to show production potential for various crops based on criteria that you specify, such as the potential for certain types of recreation based on snowfall or rainfall estimates for an area, or any other application that you can imagine using the 150 MAPS attributes. For example a buckwheat growing potential map was created using the following 5 MAPS attributes:

- (023) Land Cover (Range, Forest, etc.)
- (003) Average Date of Last Freeze
- (004) Freeze Hazard Index
- (069) Average Annual Potential Evapotranspiration (Also Lilac Bloom Dates)
- (008) Mean Number of 90E F Days in July

ArcView allows even more elaborate programming, including weighting certain factors as more important than others. For example, in a crop production potential map, moisture may be weighted as more important than temperature.

## Details about the ArcExplorer Version

The complete geographic database is presented as ArcExplorer project files (\*.aep). The main project file, ma6.aep, shows MAPS cells and base map layers (themes). Additional project files contain sample attribute maps to introduce you to the system:

1. FrostFree.aep
2. DayLngJan.aep
3. ElevAvg.aep
4. PenEvapAnn.aep
5. Precip.aep
6. SoilpH.aep

Values for all 150 MAPS attributes can be accessed from any map in the entire set. Attribute values can be viewed by pointing at a cell using the **Identify** tool in ArcExplorer. Unlike in ArcView, custom maps using specific values for several attributes cannot be created in ArcExplorer.

## System Requirements

**MAPS Atlas 6.0** requires either ArcExplorer or ArcView GIS software running in a Windows® operating environment. The **Maps Atlas 6.0** CD contains a copy of ArcExplorer version 2.0. If you plan to use ArcView GIS software, you must purchase a license from ESRI or an authorized ESRI reseller. ArcView and ArcExplorer run on Microsoft® Windows® 98/2000/NT operating systems. The **MAPS Atlas 6.0** files occupy approximately 185 MB of hard drive space.

# INSTALLING AND USING MAPS ATLAS 6.0

The most efficient way to use the files on the *MAPS Atlas 6.0* CD is to copy them to the hard drive of your computer. The following folder structure must be reproduced on your computer in order for the files to load properly in ArcView. If you choose to copy the files to a different drive, the ArcView project files must be edited to reflect the pathway change. Please refer to ArcView documentation to perform these edits.

Copy the entire ma6 and ma6ae folders, including all subfolders, to the c: drive of your computer. After the files are copied, verify that the following folder structure and files exist on your machine. Please store the CD in a safe place as a backup.

Folder structure and files:

c:\ma6\\*.apr, ma6.shp, ma6.shx, ma6.dbf, \*.dbf (tables)

c:\ma6\manual\ManualMA6.pdf

c:\ma6\statedata\\*.shp, \*.shx, \*.dbf, \*.doc

c:\ma6ae\\*.aep, ma6c.shp, ma6c.shx, ma6c.dbf, ma6d.shp, ma6d.shx, ma6d.dbf

c:\ma6ae\ArcExplorer\aeclient.exe

You will also see \*.sbn and \*.sbx files in both main folders.

## Installing and Using ArcView with MAPS Atlas 6.0

To use ArcView GIS you must purchase a license from ESRI, Inc. or from one of the many dealers in the U.S. Installation instructions are included with the software. We strongly encourage taking a 2-day ArcView training workshop, or an ArcView course over the Internet through ESRI's Virtual Campus. For more information on ArcView and training courses please see ESRI's WWW site at [www.esri.com](http://www.esri.com). Please refer to the ArcView on-line documentation for basic information about geographic information systems and how to operate the software.

To view and work with *MAPS Atlas 6.0* data in ArcView, start an ArcView session and load one of the project files (\*.apr) from the c:\ma6 folder on your hard drive. Each project file contains a view entitled "Base Map - MAPS (Montana Agricultural Potentials System)" and a theme entitled "MAPS Cells" within that view. This theme is based on the ma6 shapefile (ArcView shapefiles are actually three separate files: \*.shp, \*.shx, and \*.dbf). All the attribute maps provided with *MAPS Atlas 6.0* are also based on the ma6 shapefile. The attribute maps are classified versions of the MAPS cells data layer.

Ma6.shp contains the geographic features, ma6.shx is an index file, and ma6.dbf contains the attribute information in the MAPS database. All 150 MAPS attributes are contained in the dbf file in two formats: codes and descriptions. The coded values are present in the ma6 table, but are hidden. The descriptive values are visible in the table. If you view the **Table-Properties** you will see that coded values appear first, but do not have check marks in the

“visible” field. The descriptive values for each MAPS cell appear later in the table and do have check marks in the “visible” field. As a result, descriptive attribute values only appear when the **Identify** tool is used, but coded values are available for numeric operations. Information about how to use the numeric codes to create custom maps is included in the **CUSTOM MAPS** section of this manual.

The ma6 project file (ma6.apr) contains 150 tables (\*.dbf files), one for each MAPS attribute. These tables define the codes and their values. The file names for the tables are based on the field name for the attribute containing the appropriate coded values (see the table of MAPS ATTRIBUTES later in this manual). For example, the table named malffs.dbf lists the 12 codes for attribute 001, mean length freeze-free season, and a description of each code. For the malffs field, a code of 1 means 10-30 days, a code of 2 means 30-50 days, and so on. These tables can be used to find code values when writing queries for custom maps. The other eight project files contain only the tables corresponding to the maps in that specific project.

### **Additional Notes and Tips for using the MAPS Atlas Database in ArcView**

**O** Copy and paste themes from one map to another: Only two themes (classified MAPS Cells and the Montana border) initially appear when viewing individual attribute maps. If you want to use additional themes such as cities or roads, you must first copy the themes of interest from the Base Map view (the Base Map view is included in each ArcView project file) and paste them into the attribute map view. You can do this by minimizing the attribute map view and then opening the Base Map view. Then simply select the theme(s) of interest in the Base Map legend (use the shift key to select more than one), choose **Edit-Copy Themes**, then close (or minimize) the Base Map view. Restore the attribute map view and paste the themes into this view.

**O** Identify tool: The **Identify** tool can be used to display information pertaining to a selected theme. For example, select the Sections theme, click the **Identify** tool, then click on an area of interest on the map view. A pop-up window will display the township, range, and section of the area of interest. When you use the **Identify** tool on the MAPS Cells theme, all 150 MAPS attributes are displayed. Zooming into a small area will ensure that only one MAPS cell is selected for the pop-up window display.

**O** To find a specific location on a map using township, range, section: If you are using an attribute map view, you must first copy the MAPS Cells, Townships and Sections themes from the Base Map view into the attribute map view. If you have a general idea of the area of interest, zoom into that area. Select the Sections theme and check the box so sections are visible. Open the theme table and be sure you can see the “Trs” field in the table. You may select the township, range and section in the table (this highlights the record in yellow) or click the **Find** tool and type the township, range and section (section is optional) in the box, then click **OK**. *The information is case and space sensitive, so it must be typed exactly as it appears in the “Trs” field.* The selected section will appear in yellow on the map. Because a section is such a small area on the map, be sure you are zoomed in enough to adequately see the highlighted area. If you have trouble, use the **Zoom to Selected** tool. You can then zoom out as needed. If you are interested in attributes of the MAPS cell in which this section is



located, turn on the MAPS Cells theme and use the **Identify** tool to click on the highlighted area. All 150 attributes will be displayed in the pop-up window.

## Installing and Using ArcExplorer with MAPS Atlas 6.0

ArcExplorer version 2.0 is provided free on the *MAPS Atlas 6.0* CD. If you have ArcView GIS software, you will not need to install ArcExplorer.

To install ArcExplorer, navigate to the c:\ma6\ArcExplorer\ folder using Windows Explorer. Double click on the file ae2setup.exe and follow the instructions. Please read the following installation notes *before* installing ArcExplorer.

### ArcExplorer Installation Notes

1. Uninstall any previous version of ArcExplorer prior to installing an updated version. Use the Add/Remove Programs utility in your Control Panel.
2. ArcExplorer includes a complete user guide with a tutorial in Adobe Acrobat format (PDF). You can download the latest Adobe Acrobat Reader from the Adobe Web site at [www.adobe.com](http://www.adobe.com). When you install ArcExplorer, the tutorial will be placed in \Program Files\ESRI\ArcExplorer\AETutor.
3. Installation of ArcExplorer 2.0 on Windows NT requires administrator privileges.
4. During the installation, files are put in the %TEMP% directory for utility purposes. A %TEMP% variable must be set and the %TEMP% directory should be writable.
5. ArcExplorer 2 with Windows NT requires installation of Service Pack 3, 4, 5, or 6a.

To view and work with *MAPS Atlas 6.0* data in ArcExplorer, start an ArcExplorer session and load one of the project files (\*.aep) from the c:\ma6ae folder on your hard drive.

Each ArcExplorer project contains two separate themes for MAPS cells. One is based on the shapefile ma6d.shp and appears in the legend with the theme name MAPS CELLS (DESCRIP). The other is ma6c.shp and appears in the legend with the theme name MAPS CELLS (CODES). You will choose one of these themes depending on what you are trying to do with the database. If you simply want to display the MAPS cells and use the **Identify** tool to find out descriptive values for MAPS attributes, use the MAPS CELLS (DESCRIP) theme. When you click on a MAPS cell, a window will pop up with descriptive attribute names and values for each of the 150 MAPS attributes. On the other hand, if you want to classify a theme using numeric values, use the MAPS CELLS (CODES) theme. Rather than descriptive names and values for the 150 MAPS attributes, this theme contains more cryptic names for the MAPS attributes and numeric codes for attribute values. You can try this in ArcExplorer by making one of the themes active, clicking on the **Identify** tool, and then clicking on a MAPS cell. It is helpful to zoom into a small area when you do this. Now make the other theme active and identify the same MAPS cell to note the difference in results. As you become more familiar with using ArcExplorer, choosing which theme to use for different purposes will become more clear.

The c:\ma6 folder contains tables that define the codes and their values. The file names for these tables are based on the field name for the attribute that contains the coded values (see the table of MAPS ATTRIBUTES later in this manual). For example, the table named malffs.dbf lists the codes for attribute 001, mean length freeze-free season, and descriptions of each code. For the malffs field, a code of 1 means 10-30 days, a code of 2 means 30-50 days, and so on.

### **Additional Notes and Tips for using the MAPS Atlas Database in ArcExplorer**

- O Because the MAPS database is fairly large, working with it in ArcExplorer can be slow, depending on the speed of your computer. Try to be patient when performing the more demanding operations like setting theme properties.
- O ArcExplorer automatically alphabetizes table fields, regardless of their order in the database. If you use ArcView, you will notice that the MAPS attributes are in attribute number order, not in alphabetical order.
- O Legends are created automatically from the values in the attribute table and cannot be changed.
- O You can use the **Map Tips** tool to choose the attribute you want to “pop up” when moving the cursor across the map. For example, let’s say you want to classify an attribute using the MAPS CELLS (CODES) theme because classification often works better with numeric attribute values. But you also want to scroll around the map and look at the descriptive attribute values for your chosen attribute. First, classify the desired field using the MAPS CELLS (CODES) theme and display it by marking the check box in the legend next to the theme name. Next, move the MAPS CELLS (DESCRIP) theme to the bottom of the legend and turn it on (note that it will be displayed underneath your classified theme, so it will not show on the screen). Now, make the MAPS CELLS (DESCRIP) theme active and choose the field corresponding to the field you classified using the MAPS CELLS (CODES) theme (refer to the table of MAPS ATTRIBUTES in this manual). You can now see your classified map, and when you move the cursor around the map, the descriptive values for your chosen attribute will pop up on the screen.

### **Conventions Used in This Manual**

Keys that you type and tools, buttons, or menus that you select using your mouse will be displayed in **bold** in the manual.

## Using Help

ArcExplorer and ArcView have extensive, on-line help systems. We recommend using **Help** first when you encounter a question or problem.

### Three ways to get help

1. *Need Help? Use the Help button.* When clicked it will provide you with information about the next item you click on (such as the view, a specific button, menu item, tool, etc.).
2. *For help about a specific dialog box, open the dialog box and then press the F1 key.* (e.g. Open **Theme-Select by Theme**, press F1)
3. *Use the Help menu.* You can search through Contents, use the Index, or Find a topic.

# MAPS ATLAS TECHNICAL SUPPORT

If you have a problem with *MAPS Atlas* please check the manual and the ArcView or ArcExplorer help system first. If you still cannot solve the problem you may contact **MAPS Atlas Technical Support** in one of the following ways:

- Fax: 406-994-3933 Anytime
- Email: [dcooksey@montana.edu](mailto:dcooksey@montana.edu) Anytime
- Phone: 406-994-5684 9:00 am to 3:00 pm, Mon through Fri

If you contact us by Fax or Email, please include a complete description of your problem, including error messages. Try to duplicate the problem and record what happened step-by-step. Include the following in your Fax or Email message:

- Name
- Computer Operating System
- GIS software version (ArcExplorer, ArcView 3.x, ArcGIS 8.x)

If you contact us by phone, please be ready with a complete description of your problem, including error messages. Try to duplicate the problem and write down what happened step-by-step. Be at your computer and have the following available:

- Name
- Computer Operating System
- GIS software version (ArcExplorer, ArcView 3.x, ArcGIS 8.x)

# ATTRIBUTE MAPS

A sample map for each of the 150 MAPS attributes is included in the ArcView version of *MAPS Atlas 6.0*. The ArcExplorer version contains six sample maps. In ArcView, the attribute maps are organized into eight different ArcView projects. In ArcExplorer, each of the six sample maps is presented in a separate project.

Here is a list of the attribute maps included in each ArcView project. Each project also contains all the base map layers (themes) and the MAPS cells layer (theme). The number in parentheses in front of each map name refers to the original MAPS identifier number for each attribute.

## ArcView Projects and Attribute Maps

### 1. growingseason.apr

- (001) Mean Length of Freeze-Free Season
- (002) Average Date of First Freeze
- (003) Average Date of Last Freeze
- (004) Freeze Hazard Index
- (005) Growing Degree Days (50E F Base)
- (006) Growing Degree Days May - Oct (40E F Base)
- (007) Growing Degree Days May - Aug (40E F Base)

### 2. daylength.apr

- (009) Day Length January
- (010) Day Length February
- (011) Day Length March
- (012) Day Length April
- (013) Day Length May
- (014) Day Length June
- (015) Day Length July
- (016) Day Length August
- (017) Day Length September
- (018) Day Length October
- (019) Day Length November
- (020) Day Length December

### 3. miscellaneous.apr

- (021) Climax Vegetation (62 Classes)
- (022) Land Ownership (BLM, Forest Service, etc.)
- (023) Land Cover (Range, Forest, etc.)
- (024) Geology (USGS Geology Map 1933)
- (030) Latitude
- (031) Longitude

- (102) Counties
- (149) Consumptive Water Use
- (150) Hydrological Drainage Basins

#### **4. topography.apr**

- (025) Mid-Range Elevation
- (026) Highest Elevation
- (027) Lowest Elevation
- (028) Elevation Difference (Relief)
- (029) Predominant Aspect
- (032) Percent Slope Categories Using 1978 Soil Map of Montana
- (033) Percent Slope Using Elevation Data

#### **5. evapotranspiration.apr**

- (034) Penman Potential Evaporation January
- (035) Penman Potential Evaporation February
- (036) Penman Potential Evaporation March
- (037) Penman Potential Evaporation April
- (038) Penman Potential Evaporation May
- (039) Penman Potential Evaporation June
- (040) Penman Potential Evaporation July
- (041) Penman Potential Evaporation August
- (042) Penman Potential Evaporation September
- (043) Penman Potential Evaporation October
- (044) Penman Potential Evaporation November
- (045) Penman Potential Evaporation December
- (046) Mean Annual Potential Evaporation (Penman)
- (047) Solar Thermal Unit Potential Evapotranspiration Annual
- (048) Solar Thermal Unit Potential Evapotranspiration February
- (049) Solar Thermal Unit Potential Evapotranspiration March
- (050) Solar Thermal Unit Potential Evapotranspiration April
- (051) Solar Thermal Unit Potential Evapotranspiration May
- (052) Solar Thermal Unit Potential Evapotranspiration June
- (053) Solar Thermal Unit Potential Evapotranspiration July
- (054) Solar Thermal Unit Potential Evapotranspiration August
- (055) Solar Thermal Unit Potential Evapotranspiration September
- (056) Solar Thermal Unit Potential Evapotranspiration October
- (057) Solar Thermal Unit Potential Evapotranspiration November
- (058) Thornthwaite Potential Evapotranspiration January
- (059) Thornthwaite Potential Evapotranspiration February
- (060) Thornthwaite Potential Evapotranspiration March
- (061) Thornthwaite Potential Evapotranspiration April
- (062) Thornthwaite Potential Evapotranspiration May
- (063) Thornthwaite Potential Evapotranspiration June

- (064) Thornthwaite Potential Evapotranspiration July
- (065) Thornthwaite Potential Evapotranspiration August
- (066) Thornthwaite Potential Evapotranspiration September
- (067) Thornthwaite Potential Evapotranspiration October
- (068) Thornthwaite Potential Evapotranspiration November
- (069) Average Annual Potential Evapotranspiration (also Lilac Bloom Dates)

## **6. precipitation.apr**

- (070) Mean Annual Precipitation
- (071) Mean Percentage of Annual Precipitation During April - July
- (072) Mean Percentage of Annual Precipitation During May - July
- (073) Mean Precipitation April - July
- (074) Mean Precipitation August - March
- (075) Mean Percentage of Annual Precipitation Which Falls in January
- (076) Mean Percentage of Annual Precipitation Which Falls in February
- (077) Mean Percentage of Annual Precipitation Which Falls in March
- (078) Mean Percentage of Annual Precipitation Which Falls in April
- (079) Mean Percentage of Annual Precipitation Which Falls in May
- (080) Mean Percentage of Annual Precipitation Which Falls in June
- (081) Mean Percentage of Annual Precipitation Which Falls in July
- (082) Mean Percentage of Annual Precipitation Which Falls in August
- (083) Mean Percentage of Annual Precipitation Which Falls in September
- (084) Mean Percentage of Annual Precipitation Which Falls in October
- (085) Mean Percentage of Annual Precipitation Which Falls in November
- (086) Mean Percentage of Annual Precipitation Which Falls in December
- (087) Mean January Precipitation
- (088) Mean February Precipitation
- (089) Mean March Precipitation
- (090) Mean April Precipitation
- (091) Mean May Precipitation
- (092) Mean June Precipitation
- (093) Mean July Precipitation
- (094) Mean August Precipitation
- (095) Mean September Precipitation
- (096) Mean October Precipitation
- (097) Mean November Precipitation
- (098) Mean December Precipitation
- (099) 50 Year Peak 24-Hour Precipitation
- (100) Mean Annual Snowfall
- (101) May - July Precipitation Amount Which is Exceeded 70% of Years

## **7. soil.apr**

- (103) General Soils of Montana
- (104) Soil Water Holding Capacity

- (105) Mean Annual Soil Temperature (Mean Annual Air Temp Plus 2E F)
- (106) Mean Annual Soil Temperature (Mean Annual Air Temp Plus 1E F)
- (107) Soil Depth Classes
- (108) Mean Annual R Factor (Universal Soil Loss Equation)
- (109) Average Soil pH
- (110) Highest Representative Soil pH

#### **8. temperature.apr**

- (008) Mean Number of 90E F Days in July
- (111) Average Number of Strong Chinooks Per 100 Years
- (112) Mean Annual Air Temperature
- (113) Mean January Temperature
- (114) Mean February Temperature
- (115) Mean March Temperature
- (116) Mean April Temperature
- (117) Mean May Temperature
- (118) Mean June Temperature
- (119) Mean July Temperature
- (120) Mean August Temperature
- (121) Mean September Temperature
- (122) Mean October Temperature
- (123) Mean November Temperature
- (124) Mean December Temperature
- (125) Mean Minimum January Temperature
- (126) Mean Minimum February Temperature
- (127) Mean Minimum March Temperature
- (128) Mean Minimum April Temperature
- (129) Mean Minimum May Temperature
- (130) Mean Minimum June Temperature
- (131) Mean Minimum July Temperature
- (132) Mean Minimum August Temperature
- (133) Mean Minimum September Temperature
- (134) Mean Minimum October Temperature
- (135) Mean Minimum November Temperature
- (136) Mean Minimum December Temperature
- (137) Mean Maximum January Temperature
- (138) Mean Maximum February Temperature
- (139) Mean Maximum March Temperature
- (140) Mean Maximum April Temperature
- (141) Mean Maximum May Temperature
- (142) Mean Maximum June Temperature
- (143) Mean Maximum July Temperature
- (144) Mean Maximum August Temperature
- (145) Mean Maximum September Temperature



- (146) Mean Maximum October Temperature
- (147) Mean Maximum November Temperature
- (148) Mean Maximum December Temperature

The following is a list of the sample maps presented as ArcExplorer projects. Unlike the ArcView projects, each ArcExplorer project contains only one attribute map. Each ArcExplorer project also contains all the base map layers (themes) and the MAPS cells layer (theme). The number in parentheses in front of each map name refers to the original MAPS identifier number for each attribute

### **ArcExplorer Projects and Attribute Maps**

FrostFree.aep	(001) Mean Length of Freeze-Free Season
DayLngJan.aep	(009) Day Length January
ElevAvg.aep	(025) Mid-Range Elevation
PenEvapAnn.aep	(046) Mean Annual Potential Evaporation (Penman)
Precip.aep	(070) Mean Annual Precipitation
SoilpH.aep	(109) Average Soil pH

## **FARMS Attributes**

**FARMS** attributes are nine special attributes that are used to match any farm or ranch with the most similar research center in the Western United States and Canadian Great Plains. If you want to run a match for a location in Montana but don't know the values for the FARMS attributes, they can be retrieved from ***MAPS Atlas*** and used as inputs for the FARMS computer program. Following is a list of the FARMS attributes. For more information about FARMS call 406-994-6034.

1. (030) Latitude
2. (031) Longitude
3. (025) Mid-Range Elevation
4. (070) Mean Annual Precipitation
5. (071) Mean Percentage of Annual Precipitation During April - July
6. (069) Average Annual Potential Evapotranspiration (also Lilac Bloom Dates)
7. (003) Average Date of Last Freeze
8. (002) Average Date of First Freeze
9. (100) Mean Annual Snowfall

# CUSTOM MAPS

## Sample Custom Maps

A custom map represents the entire state based on user-selected criteria. Custom maps are defined by selecting specific values of several attributes. Two sample custom maps are included in the ma6.apr ArcView project: Buckwheat Production Potential and Canola Production Potential. The Buckwheat Production Potential map shows buckwheat growing potential based upon land cover, average date of last freeze, freeze hazard index, average annual potential evapotranspiration, and mean number of 90E F days in July. The custom maps of crop growing potential are provided for demonstration purposes only.

## Defining a Custom Map

Custom maps may be created with *MAPS Atlas 6.0* if you are using ArcView. This capability is not available in ArcExplorer.

To begin making a custom map, open a new view and add the themes that you plan to use. Go into **View-Properties** and enter the name of your custom map in the **Name** field. In order to create a custom map in ArcView, you will need to use the **Query Builder** available from the **Theme-Properties** menu. Use the numeric code values rather than descriptive values when querying MAPS themes.

To create a custom map, you must create a logical expression by selecting a field, an operator and a field value from the choices available in the **Query Builder** dialog box. The components of the **Query Builder** dialog box are defined below.

**Fields:** Lists the fields (attributes) in the theme or table you are querying. If the Update Values choice is on, you can click once on a field to see all its values in the Values list. Fields that have been hidden do not appear in the Field list. If field name aliases have been defined, these aliases appear in the Fields list.

Double-click on a field to add it to the query text box. You may type the name of a field instead of clicking in the list. Field names are not case sensitive, so typing Area, area or AREA is all allowed.

**Operators:** Specify relationships between Fields and Values in a query. Either click or double-click an operator to place it in the query text box.

=	equals
>	greater than
<	less than
<=	less than or equal to
>=	greater than or equal to
<>	not equal to
()	expressions enclosed in parentheses are evaluated first.
AND	both expressions are true, e.g. [area] >= 100 and [area] <= 200
OR	at least one expression is true, e.g. [rainfall] < 20 or [slope] > 35
NOT	excludes, e.g. not [name] = "california"

**Values:** Lists the values for the chosen Field. Only unique values are listed. Double-click a value to place it in the query text box. If the value you want to use is not in the list, type it in the query text box. Values cannot be displayed for tables containing more than 32765 records (the *MAPS Atlas* table contains about 18,000 records).

**Update Values:** By default, the Values list updates each time you choose a Field. If there are many values, it may take a moment for the list to be updated. Turn off this choice if you don't want to update the values (e.g. if your query compares one field to another and you don't need to see their values, or if want to type specific values into the query text box).

Using the **Query Builder**, you create a logical expression. The attributes are joined by logical operators to define data classes. Data classes can be formed by specifying values for a single attribute or by joining multiple attributes with the logical operators AND and OR.

To represent descriptive values in a custom map, the query must reference the attribute field that contains descriptive values. For example, to map where the land cover attribute has the value "dryland crop", select the descriptive Field name *landcover* from the query dialog box and set it equal to "dryland crop".

To represent a range of numeric values in a custom map, the query must reference the attribute field that contains coded values. In order to determine which codes to use in your query, refer to the table that defines the codes and their values for the attribute(s) of interest. These tables reside in the c:\ma6 folder and can be added to a project by clicking on the **Tables** icon in the project window and then selecting **Add**. You can leave the table window(s) open for reference while you are writing the query. These tables are described in the Installing and Using ArcView with *MAPS Atlas 6.0* section of this manual.

The fields that contain coded values are hidden in the ma6.dbf table. In order for the field names to appear in the query dialog box, you must either 1) manually type them into the

query dialog box or 2) open the theme table and make the field visible by placing a check mark next to it in **Table-Properties**.

When a custom map is drawn in a view, the expression is evaluated for each *MAPS Atlas* cell, one cell at a time. All cells whose values satisfy the logical expression are filled in with the appropriate color.

In the following example we entered information pertaining to growing conditions required for buckwheat. The resulting custom map has two classes representing high and moderate potential for growing buckwheat. They are formed by using logical operators and the following five attributes:

Attribute Number Attribute Name

Attribute 023	Land Cover (Range, Forest, etc.)
Attribute 003	Average Date of Last Freeze
Attribute 004	Freeze Hazard Index
Attribute 069	Average Annual Potential Evapotranspiration (Also Lilac Bloom Dates)
Attribute 008	Mean Number of 90E F Days in July

Title: Buckwheat Production Potential

Definition

([Landuse] = 4) and ([Adlf] >= 8) and ([Adlf] <= 12)  
and ([Frzhz] >= 90) and ([Frzhz] <= 107)

Legend

Moderate

([Landuse] = 4) and ([Adlf] >= 8) and ([Adlf] <= 12) and ([Frzhz] >= 90)  
and ([Frzhz] <= 107) and (([July90] >= 1) and ([July90] <= 8) or  
([July90] = 255 ))

High

The resulting map was saved as the Buckwheat Production Potential view.

When joining attributes with logical operators to form a custom map, you must be very careful about how you use AND and OR in order to obtain the desired results.

When an expression containing the operator AND is evaluated, the conditions on both sides of the operator must be true for the expression to evaluate as TRUE. For example, with the expression ([gdd] = 1) and ([gdd40ma] = 1), both gdd (growing degree days 50 F base; attribute 005) and gdd40ma (growing degree days May-Aug 40 F base; attribute 007) have to have a value of 1 for the expression to be TRUE. The MAPS cell will display the designated color only if the expression is TRUE.

When an expression containing the operator OR is evaluated, either condition can be true for the expression to evaluate as TRUE. For example, with the expression ([gdd] = 1) or ([gdd40ma] = 1), the expression will evaluate as TRUE if either attribute 005 or attribute 007

has a value of 1. With AND, both conditions have to be true for the expression to evaluate as TRUE whereas with OR, either condition can be true.

Here is an example of the difference between AND and OR using attribute 023, Land Cover. Let's say you want to create a map showing all the areas that are either Dryland Crop or Irrigated Crop (all the crop areas). Looking at the classes for attribute 023 (refer to the landuse.dbf table), we see that the coded values we need are 4 and 5.

<u>Code</u>	<u>Value</u>
1	Forest
2	Water
3	Range
4	Dryland crop
5	Irrigated crop
6	Alpine, rock
7	Urban

To show dryland and irrigated areas on the map, we must write the definition as follows: ([landuse] = 4) or ([landuse] = 5). This tells ArcView to color in all the cells where attribute 023 equals 4 OR attribute 023 equals 5. If we were to write the definition using AND: ([landuse] = 4) and ([landuse] = 5), no cells would be colored because a ***MAPS Atlas*** cell can be either dryland or irrigated, but it can't be both (each cell has only one value for each attribute). The expression will evaluate as FALSE because both conditions cannot be true for one cell, resulting in no areas appearing in color on the map.

## Reference Files for Looking up Codes

For convenient reference while creating custom map definitions, the codes and descriptive values for all 150 attributes are stored in Microsoft Excel files. The codes and descriptions are grouped into eight files (corresponding to the ArcView project file categories):

- 1) [Growingseason.xls](#)
- 2) [Daylength.xls](#)
- 3) [Miscellaneous.xls](#)
- 4) [Topography.xls](#)
- 5) [Evapotranspiration.xls](#)
- 6) [Precipitation.xls](#)
- 7) [Soil.xls](#)
- 8) [Temperature.xls](#)

# MAPS ATTRIBUTES

In the *MAPS Atlas* database, attributes are designated by a number and a name. Each attribute has two corresponding database fields: one that contains descriptive values and one that contains numeric (coded values). Following is a table listing abbreviated *MAPS Atlas* attribute names, attribute numbers, field names, and the ArcView project group that contains the attribute map. More complete attribute names are given in the following ATTRIBUTE INFORMATION section.

The ma6 project file contains tables that define the codes and their values. The file names for these tables are based on the field name for the attribute that contains the coded values. For example, the table named malffs.dbf lists the codes for attribute 001, mean length freeze-free season, and code descriptions. For the malffs field, a code of 1 means 10-30 days, a code of 2 means 30-50 days, and so on. You can refer to these tables to find code values when writing queries for custom maps. These files are located in the c:\ma6 folder.

Attribute Number	Attribute Name	Field Name (descriptive values)	Field Name (coded values)	ArcView Group
001	Mean length freeze-free season	Frostfree	Malffs	1
002	Avg date first freeze	Firstfrz	Adff	1
003	Avg date last freeze	Lastfrz	Adlf	1
004	Freeze hazard index	Frzhaz	Frzhz	1
005	Growing deg days (50 F base)	Growdd	Gdd	1
006	Growing deg days May-Oct (40 F base)	Growddmo	Gdd40mo	1
007	Growing deg days May-Aug (40 F base)	Growddma	Gdd40ma	1
008	Mean # 90 deg days July	Ninetyjuly	July90	8
009	Day length Jan	Daylngjan	Daylenjan	2
010	Day length Feb	Daylngfeb	Daylenfeb	2
011	Day length Mar	Daylngmar	Daylenmar	2
012	Day length Apr	Daylngapr	Daylenapr	2
013	Day length May	Daylngmy	Daylenmay	2
014	Day length Jun	Daylngjun	Daylenjun	2
015	Day length Jul	Daylngjul	Daylenjul	2
016	Day length Aug	Daylngaug	Daylenaug	2
017	Day length Sep	Daylngsep	Daylensep	2

<b>Attribute Number</b>	<b>Attribute Name</b>	<b>Field Name (descriptive values)</b>	<b>Field Name (coded values)</b>	<b>ArcView Group</b>
018	Day length Oct	Daylngoct	Daylenoct	2
019	Day length Nov	Daylngnov	Daylennov	2
020	Day length Dec	Daylngdec	Daylendec	2
021	Climax vegetation	Climaxveg	Climax	3
022	Land ownership	Landowner	Ownership	3
023	Land cover	Landcover	Landuse	3
024	Geology	Geology	Geol	3
025	Mid-range elevation	Elevavg	Avelev	4
026	Highest elevation	Elevhigh	Helev	4
027	Lowest elevation	Elevlow	Lelev	4
028	Elevation difference	Elevrelief	Relief	4
029	Predominant aspect	Aspectpred	Aspect	4
030	Latitude	Latitude	Lat	3
031	Longitude	Longitude	Long	3
032	% slope using soil map	Slopesoil	Slope1	4
033	% slope using elevation data	Slopeelev	Slope2	4
034	Penman pot evap Jan	Penevapjan	Janevap	5
035	Penman pot evap Feb	Penevapfeb	Febevap	5
036	Penman pot evap Mar	Penevapmar	Marevap	5
037	Penman pot evap Apr	Penevapapr	Aprevap	5
038	Penman pot evap May	Penevapmay	Mayevap	5
039	Penman pot evap Jun	Penevapjun	Junevap	5
040	Penman pot evap Jul	Penevapjul	Julevap	5
041	Penman pot evap Aug	Penevapaug	Augevap	5
042	Penman pot evap Sep	Penevapsep	Sepevap	5
043	Penman pot evap Oct	Penevapoct	Octevap	5
044	Penman pot evap Nov	Penevapnov	Novevap	5
045	Penman pot evap Dec	Penevapdec	Decevap	5



<b>Attribute Number</b>	<b>Attribute Name</b>	<b>Field Name (descriptive values)</b>	<b>Field Name (coded values)</b>	<b>ArcView Group</b>
046	Penman pot evap ann	Penevapann	Annevap	5
047	Solar thermal unit pot evapotrans ann	Stupetann	Stuann	5
048	Solar thermal unit pot evapotrans Feb	Stupetfeb	Stufeb	5
049	Solar thermal unit pot evapotrans Mar	Stupetmar	Stumar	5
050	Solar thermal unit pot evapotrans Apr	Stupetapr	Stuapr	5
051	Solar thermal unit pot evapotrans May	Stupetmay	Stumay	5
052	Solar thermal unit pot evapotrans Jun	Stupetjun	Stujun	5
053	Solar thermal unit pot evapotrans Jul	Stupetjul	Stujul	5
054	Solar thermal unit pot evapotrans Aug	Stupetaug	Stuaug	5
055	Solar thermal unit pot evapotrans Sep	Stupetsep	Stusep	5
056	Solar thermal unit pot evapotrans Oct	Stupetoct	Stuoct	5
057	Solar thermal unit pot evapotrans Nov	Stupetnov	Stunov	5
058	Thornthwaite pot evapotrans ann	Thpetann	Annthpet	5
059	Thornthwaite pot evapotrans Feb	Thpetfeb	Febthpet	5
060	Thornthwaite pot evapotrans Mar	Thpetmar	Marthpet	5
061	Thornthwaite pot evapotrans Apr	Thpetapr	Aprthpet	5
062	Thornthwaite pot evapotrans May	Thpetmay	Maythpet	5
063	Thornthwaite pot evapotrans Jun	Thpetjun	Junthpet	5
064	Thornthwaite pot evapotrans Jul	Thpetjul	Julthpet	5
065	Thornthwaite pot evapotrans Aug	Thpetaug	Augthpet	5
066	Thornthwaite pot evapotrans Sep	Thpetsep	Septhpet	5
067	Thornthwaite pot evapotrans Oct	Thpetoct	Octthpet	5
068	Thornthwaite pot evapotrans Nov	Thpetnov	Novthpet	5
069	Pot evapotrans ann (lilac bloom)	Lilacpetan	Pe	5
070	Mean ann precip	Precip	Aap	6
071	Mean % of ann precip Apr-Jul	Mpapaprjul	Mapaj	6
072	Mean % of ann precip May-Jul	Mpapmayjul	Mapmj	6
073	Mean precip Apr-Jul	Pptaprjul	Apaj	6

<b>Attribute Number</b>	<b>Attribute Name</b>	<b>Field Name (descriptive values)</b>	<b>Field Name (coded values)</b>	<b>ArcView Group</b>
074	Mean precip Aug-Mar	Pptaugmar	Apam	6
075	Mean % of ann precip Jan	Mpapjan	Janprentan	6
076	Mean % of ann precip Feb	Mpapfeb	Febprentan	6
077	Mean % of ann precip Mar	Mpapmar	Marprentan	6
078	Mean % of ann precip Apr	Mpapapr	Aprprentan	6
079	Mean % of ann precip May	Mpapmay	Mayprentan	6
080	Mean % of ann precip Jun	Mpapjun	Junprentan	6
081	Mean % of ann precip Jul	Mpapjul	Julprentan	6
082	Mean % of ann precip Aug	Mpapaug	Augprentan	6
083	Mean % of ann precip Sep	Mpapsep	Seppreantn	6
084	Mean % of ann precip Oct	Mpapoct	Octprentan	6
085	Mean % of ann precip Nov	Mpapnov	Novprentan	6
086	Mean % of ann precip Dec	Mpapdec	Decprentan	6
087	Mean Jan precip	Pptavgjan	Janprecip	6
088	Mean Feb precip	Pptavgfeb	Febprecip	6
089	Mean Mar precip	Pptavgmar	Marprecip	6
090	Mean Apr precip	Pptavg apr	Aprprecip	6
091	Mean May precip	Pptavgmay	Mayprecip	6
092	Mean Jun precip	Pptavgjun	Junprecip	6
093	Mean Jul precip	Pptavgjul	Julprecip	6
094	Mean Aug precip	Pptavgaug	Augprecip	6
095	Mean Sep precip	Pptavgsep	Sepprecip	6
096	Mean Oct precip	Pptavgoct	Octprecip	6
097	Mean Nov precip	Pptavgnov	Novprecip	6
098	Mean Dec precip	Pptavgdec	Decprecip	6
099	50-yr peak 24-hr precip	Pptpeak	Hr24	6
100	Mean ann snowfall	Snowfallav	Snowfall	6
101	May-Jul precip exceeded 70% of yrs	Ppt70mj	Mayjul70	6

<b>Attribute Number</b>	<b>Attribute Name</b>	<b>Field Name (descriptive values)</b>	<b>Field Name (coded values)</b>	<b>ArcView Group</b>
102	Counties	County	Counties	3
103	General soils of Montana	Gensoils	Soil	7
104	STATSGO soil water holding capacity	Soilwater	Soilwhc	7
105	Mean ann soil temp (maat + 2)	Soiltemp2	Maatplus2	7
106	Mean ann soil temp (maat + 1)	Soiltemp1	Maatplus1	7
107	Soil depth classes	Soildepth	Soilsd	7
108	Mean ann factor R-univ soil loss eq	Factorr	Aavfr	7
109	Avg soil pH	Soilph	Asoilph	7
110	Highest representative soil pH	Soilphhigh	Hsoilph	7
111	# strong chinooks per 100 yrs	Chinook	Chinooks	8
112	Mean ann air temp	Airtempavg	Maat	8
113	Mean Jan temp	Tempavgjan	Meanjan	8
114	Mean Feb temp	Tempavgfeb	Meanfeb	8
115	Mean Mar temp	Tempavgmar	Meanmar	8
116	Mean Apr temp	Tempavgapr	Meanapr	8
117	Mean May temp	Tempavgmay	Meanmay	8
118	Mean Jun temp	Tempavgjun	Meanjun	8
119	Mean Jul temp	Tempavgjul	Meanjul	8
120	Mean Aug temp	Tempavgaug	Meanaug	8
121	Mean Sep temp	Tempavgsep	Meansep	8
122	Mean Oct temp	Tempavgoct	Meanoct	8
123	Mean Nov temp	Tempavgnov	Meannov	8
124	Mean Dec temp	Tempavgdec	Meandec	8
125	Mean min Jan temp	Tempminjan	Tminjan	8
126	Mean min Feb temp	Tempminfeb	Tminfeb	8
127	Mean min Mar temp	Tempminmar	Tminmar	8
128	Mean min Apr temp	Tempminapr	Tminapr	8
129	Mean min May temp	Tempminmay	Tminmay	8

<b>Attribute Number</b>	<b>Attribute Name</b>	<b>Field Name (descriptive values)</b>	<b>Field Name (coded values)</b>	<b>ArcView Group</b>
130	Mean min Jun temp	Tempminjun	Tminjun	8
131	Mean min Jul temp	Tempminjul	Tminjul	8
132	Mean min Aug temp	Tempminaug	Tminaug	8
133	Mean min Sep temp	Tempminsep	Tminsep	8
134	Mean min Oct temp	Tempminoct	Tminoct	8
135	Mean min Nov temp	Tempminnov	Tminnov	8
136	Mean min Dec temp	Tempmindec	Tmindec	8
137	Mean max Jan temp	Tempmaxjan	Tmaxjan	8
138	Mean max Feb temp	Tempmaxfeb	Tmaxfeb	8
139	Mean max Mar temp	Tempmaxmar	Tmaxmar	8
140	Mean max Apr temp	Tempmaxapr	Tmaxapr	8
141	Mean max May temp	Tempmaxmay	Tmaxmay	8
142	Mean max Jun temp	Tempmaxjun	Tmaxjun	8
143	Mean max Jul temp	Tempmaxjul	Tmaxjul	8
144	Mean max Aug temp	Tempmaxaug	Tmaxaug	8
145	Mean max Sep temp	Tempmaxsep	Tmaxsep	8
146	Mean max Oct temp	Tempmaxoct	Tmaxoct	8
147	Mean max Nov temp	Tempmaxnov	Tmaxnov	8
148	Mean max Dec temp	Tempmaxdec	Tmaxdec	8
149	Consumptive water use	Consumh2o	Consum	3
150	Hydrological drainage basins	Drainage	Drainages	3

# ATTRIBUTE INFORMATION

## **(001) TITLE: Mean Length of Freeze-Free Season**

CONTENT: Mean length of the freeze-free season for each of the 18,000 cells representing the state. Based on 29 years of historical weather data (compiled 1978).

MAP UNIT LEGEND: 12 classes (days); 10-30, 30-50, 50-70, 70-90, 90-100, 100-110, 110-115, 115-120, 120-125, 125-130, 130-135, 135-140.

MAP PURPOSE: Used to determine the suitability of given areas for specific crops. Most field crops require a minimum of 90 days freeze-free season. Some crops require more than 200 days freeze-free season.

### **Codes and values table: Malffs.dbf**

<u>Code</u>	<u>Value</u>
1	10 - 30 days
2	30 - 50 days
3	50 - 70 days
4	70 - 90 days
5	90 - 100 days
6	100 - 110 days
7	110 - 115 days
8	115 - 120 days
9	120 - 125 days
10	125 - 130 days
11	130 - 135 days
12	135 - 140 days

## **(002) TITLE: Average Date of First Freeze**

CONTENT: Average date of first freeze for each of the 18,000 cells representing the state. Based on 29 years of historical weather data (compiled 1978).

MAP UNIT LEGEND: 12 classes (dates); 8/03-8/08, 8/08-8/13, 8/13-8/18, 8/18-8/23, 8/23-8/28, 8/28-9/02, 9/02-9/07, 9/07-9/12, 9/12-9/17, 9/17-9/22, 9/22-9/27, 9/27-10/02.

MAP PURPOSE: The first freeze in the fall will terminate the season for freeze-sensitive crops. The time of fall foliage color change of some plants is related to the first freeze event.

**Codes and values table: Adff.dbf**

<u>Code</u>	<u>Value</u>
1	8/03-8/08
2	8/08-8/13
3	8/13-8/18
4	8/18-8/23
5	8/23-8/28
6	8/28-9/02
7	9/02-9/07
8	9/07-9/12
9	9/12-9/17
10	9/17-9/22
11	9/22-9/27
12	9/27-10/2

**(003) TITLE: Average Date of Last Freeze**

CONTENT: Average date of last freeze for each of the 18,000 cells representing the state. Based on 29 years of historical weather data (compiled 1978).

MAP UNIT LEGEND: 12 classes (dates); 5/05-5/10, 5/10-5/15, 5/15-5/20, 5/20-5/25, 5/25-5/30, 5/30-6/04, 6/04-6/09, 6/09-6/19, 6/19-6/29, 6/29-7/09, 7/09-7/19, 7/19-7/29.

MAP PURPOSE: The average date of last freeze in the spring is taken into account to decide when to seed certain crops, transplant sensitive plants into the garden, conduct growth retarding measures in deciduous orchards, schedule construction and other outdoor activities.

**Codes and values table: Adlf.dbf**

<u>Code</u>	<u>Value</u>
1	7/19 - 7/29
2	7/09 - 7/19
3	6/29 - 7/09
4	6/19 - 6/29
5	6/09 - 6/19
6	6/04 - 6/09
7	5/30 - 6/04
8	5/25 - 5/30
9	5/20 - 5/25
10	5/15 - 5/20
11	5/10 - 5/15
12	5/05 - 5/10

**(004) TITLE: Freeze Hazard Index**

CONTENT: Date of last freeze minus the date of lilac bloom equals the freeze hazard index number. The greater the positive number, the greater the freeze hazard. Dates used in this equation are Julian dates which are equivalent to the total number of days since the first day of the year (compiled 1989).

MAP UNIT LEGEND: Days; -10, -9, -8, ..., 8, 9, 10.

MAP PURPOSE: Useful for identifying areas prone to late spring freezes during the growing season. Climates of these areas tend to be detrimental to frost sensitive plants.

**Codes and values table: Frzhz.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
90	-10 days	106	6 days	123	23 days
91	-9 days	107	7 days	124	24 days
92	-8 days	108	8 days	126	26 days
93	-7 days	109	9 days	127	27 days
94	-6 days	110	10 days	128	28 days
95	-5 days	111	11 days	129	29 days
96	-4 days	112	12 days	130	30 days
97	-3 days	113	13 days	132	32 days
98	-2 days	114	14 days	133	33 days
99	-1 days	115	15 days	135	35 days
100	0 days	116	16 days	136	36 days
101	1 days	117	17 days	137	37 days
102	2 days	118	18 days	138	38 days
103	3 days	119	19 days	139	39 days
104	4 days	120	20 days	140	40 days
105	5 days	121	21 days		

**(005) TITLE: Growing Degree Days (50E Base)**

CONTENT: Available data on the average date when the daily maximum temperature reaches 70EF in the spring were utilized from weather stations with a long-term history. Corrections for these dates based on elevation changes were made, and corrected dates for the entire state were determined for the MAPS grid system. Growing degree days (base temperature 50EF) were computed for 33 weather stations in Montana for the period May 1-Oct. 31 for at least 40 years of data. A regression of growing degree days versus mean date when the daily maximum temperature reaches 70EF was run for the 33 stations. The data for each cell were then put into the regression equation to compute an uncorrected growing degree value. Correction factors were estimated for each of the 33 stations by subtracting growing degree day amounts (estimated by the regression equation) from the actual amounts. A map of hand-drawn area correction

contours was made and this map was used to correct the cellular uncorrected growing degree day values (compiled 1985).

MAP UNIT LEGEND: 12 classes; 0-800, 800-1000, 1000-1200, 1200-1400, 1400-1600, 1600-1800, 1800-2000, 2000-2200, 2200-2400, 2400-2600, 2600-2800, 2800-3000.

MAP PURPOSE: Useful for estimating whether the growing season is long enough to grow certain crops.

**Codes and values table: Gdd.dbf**

<u>Code</u>	<u>Value</u>
1	0 - 800
2	800 - 1000
3	1000 - 1200
4	1200 - 1400
5	1400 - 1600
6	1600 - 1800
7	1800 - 2000
8	2000 - 2200
9	2200 - 2400
10	2400 - 2600
11	2600 - 2800
12	2800 - 3000

**(006) TITLE: Growing Degree Days May-October (40E Base)**

CONTENT: This is the commonly used "wheat growing degree days." Mean daily temperatures above 40EF are accumulated from May, through October 31. Minimum temperatures below 40EF are taken as 40EF and maximum temperatures above 86E are taken as 86E (compiled 1989).

MAP UNIT LEGEND: Number of growing degree days.

MAP PURPOSE: Useful for estimating whether the growing season is long enough to mature certain crops.



**Codes and values table: Gdd40mo.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
9	900	21	2100	33	3300
10	1000	22	2200	34	3400
11	1100	23	2300	35	3500
12	1200	24	2400	36	3600
13	1300	25	2500	37	3700
14	1400	26	2600	38	3800
15	1500	27	2700	39	3900
16	1600	28	2800	40	4000
17	1700	29	2900	41	4100
18	1800	30	3000	42	4200
19	1900	31	3100		
20	2000	32	3200		

**(007) TITLE: Growing Degree Days May-August (40E Base)**

CONTENT: Compiled by accumulating daily units of mean daily temperatures above 40EF. Minimum temperatures below 40EF are taken as 40EF and maximum temperatures above 90EF are taken as 90EF (compiled 1989).

MAP UNIT LEGEND: Number of growing degree days.

MAP PURPOSE: Useful for estimating whether the growing season is long enough to grow certain crops.

**Codes and values table: Gdd40ma.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
42	420	65	650	79	790	92	920
43	430	66	660	80	800	93	930
46	460	67	670	81	810	94	940
47	470	68	680	82	820	95	950
50	500	70	700	83	830	96	960
52	520	71	710	84	840	97	970
55	550	72	720	85	850	98	980
59	590	73	730	86	860	99	990
60	600	74	740	87	870	100	1000
61	610	75	750	88	880	101	1010
62	620	76	760	89	890	102	1020
63	630	77	770	90	900	103	1030
64	640	78	780	91	910	105	1050

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
106	1060	141	1410	176	1760	211	2110
107	1070	142	1420	177	1770	212	2120
108	1080	143	1430	178	1780	213	2130
109	1090	144	1440	179	1790	214	2140
110	1100	145	1450	180	1800	215	2150
111	1110	146	1460	181	1810	216	2160
112	1120	147	1470	182	1820	217	2170
113	1130	148	1480	183	1830	218	2180
114	1140	149	1490	184	1840	219	2190
115	1150	150	1500	185	1850	220	2200
116	1160	151	1510	186	1860	221	2210
117	1170	152	1520	187	1870	222	2220
118	1180	153	1530	188	1880	223	2230
119	1190	154	1540	189	1890	224	2240
120	1200	155	1550	190	1900	225	2250
121	1210	156	1560	191	1910	226	2260
122	1220	157	1570	192	1920	227	2270
123	1230	158	1580	193	1930	228	2280
124	1240	159	1590	194	1940	229	2290
125	1250	160	1600	195	1950	230	2300
126	1260	161	1610	196	1960	231	2310
127	1270	162	1620	197	1970	232	2320
128	1280	163	1630	198	1980	233	2330
129	1290	164	1640	199	1990	234	2340
130	1300	165	1650	200	2000	235	2350
131	1310	166	1660	201	2010	236	2360
132	1320	167	1670	202	2020	237	2370
133	1330	168	1680	203	2030	238	2380
134	1340	169	1690	204	2040	239	2390
135	1350	170	1700	205	2050	240	2400
136	1360	171	1710	206	2060	241	2410
137	1370	172	1720	207	2070	242	2420
138	1380	173	1730	208	2080	243	2430
139	1390	174	1740	209	2090	244	2440
140	1400	175	1750	210	2100		

**(008) TITLE: Mean Number of 90EF Days in July**

CONTENT: Mean number of days the temperature reaches or exceeds 90EF in July (compiled 1989).

MAP UNIT LEGEND: Number of days  $\geq$ 90EF

MAP PURPOSE: Temperatures of 90EF or greater tend to reduce the yield of many crops.

**Codes and values table: July90.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	1	11	11
2	2	12	12
3	3	13	13
4	4	14	14
5	5	15	15
6	6	16	16
7	7	17	17
8	8	18	18
9	9	255	0
10	10		

**(009-020) TITLE: Day Length January-December**

CONTENT: Length of day at time of mid-month. Algorithms were developed for each month expressing day-length as a function of latitude using data for each degree of latitude from 45EN to 49EN (compiled 1988).

MAP UNIT LEGEND: Hours.

MAP PURPOSE: Day-length is a factor in various crop and evapotranspiration models. It also finds applications in decisions relative to recreation, travel, and scheduling outdoor activities.

**Codes and values table: Daylenjan.dbf through Daylendec.dbf (12 months).**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
83	8.3 hrs	90	9.0 hrs	97	9.7 hrs
84	8.4 hrs	91	9.1 hrs	98	9.8 hrs
85	8.5 hrs	92	9.2 hrs	99	9.9 hrs
86	8.6 hrs	93	9.3 hrs	100	10.0 hrs
87	8.7 hrs	94	9.4 hrs	101	10.1 hrs
88	8.8 hrs	95	9.5 hrs	102	10.2 hrs
89	8.9 hrs	96	9.6 hrs	103	10.3 hrs

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
104	10.4 hrs	116	11.6 hrs	153	15.3 hrs
105	10.5 hrs	117	11.7 hrs	154	15.4 hrs
106	10.6 hrs	118	11.8 hrs	155	15.5 hrs
107	10.7 hrs	119	11.9 hrs	156	15.6 hrs
108	10.8 hrs	135	13.5 hrs	157	15.7 hrs
109	10.9 hrs	136	13.6 hrs	158	15.8 hrs
110	11.0 hrs	137	13.7 hrs	159	15.9 hrs
111	11.1 hrs	148	14.8 hrs	160	16.0 hrs
112	11.2 hrs	149	14.9 hrs	161	16.1 hrs
113	11.3 hrs	150	15.0 hrs	162	16.2 hrs
114	11.4 hrs	151	15.1 hrs		
115	11.5 hrs	152	15.2 hrs		

### **(021) TITLE: Climax Vegetation**

CONTENT: Sixty-two classes of climax vegetation in Montana.

MAP UNIT LEGEND: Sixty-two classes subdivided into Eastern Glaciated Plains (1-6), Western Glaciated Plains (7-13), Eastern Sedimentary Plains (14-26), Western Sedimentary Plains (27-36), Foothills and Mountains (37-62) (compiled 1978).

MAP PURPOSE: Climax plant communities are recognized as being ecological standards used in monitoring natural ecosystems. Successful range and forest resource management are dependent upon an understanding of the potential natural plant community that might be expected in normal years from a given soil and climate. The potential is dependent upon interrelationships of soil, vegetation, climate, topography and the biota common to the site.

### **CLASSES:**

#### **EASTERN GLACIATED PLAINS**

1 Silty Range Site, 10-14" Precipitation Zone (P.Z.)

(Includes thin breaks too small or irregular to delineate)

Needleandthread, western and thickspike wheatgrass, green needlegrass, little bluestem, prairie junegrass, porcupinegrass, blue grama, native legumes, silver sagebrush, western snowberry, winterfat

2 Silty-Clayey Range Site Complex, 10-14" P.Z.

Silty: same as Site No. 1

Clayey: same as Site No. 3

3 Clayey and Shallow Clay Range Site Association, 10-14", P.Z.

Western and thickspike wheatgrass, green needlegrass, little bluestem, prairie junegrass, plains reedgrass, biscuitroot, milkvetches, American vetch, silver sagebrush, winterfat

4 Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14" P.Z.

Dense Clay: Western and thickspike wheatgrass, green needlegrass, prairie junegrass, big sagebrush, Nuttall saltbush, greasewood

Clayey: same as Site No. 3

Saline Upland: Alkali sacaton, western and thickspike wheatgrass, greasewood, Nuttall saltbush, inland saltgrass, bottlebrush squirreltail, Sandberg bluegrass

5 Saline Lowland Range Site, 10-14" P.Z.

Western and thickspike wheatgrass, alkali sacaton, alkali cordgrass, slender wheatgrass, Nuttall alkaligrass, inland saltgrass, Canada wildrye, sedge, greasewood, Nuttall saltbush

6 Sands and Sandy Range Site Association, 10-14" P.Z.

Sands: Prairie sandreed, needleandthread, Indian ricegrass, little bluestem, sand bluestem, sun sedge, native legumes, skunkbush sumac

Sandy: needleandthread, prairie sandreed, threadleaf sedge, little bluestem, sideoats grama, western and thickspike wheatgrass, native legumes, blue grama, skunkbush sumac, rose.

## **WESTERN GLACIATED PLAINS**

7 Silty Range Site, 10-14" P.Z.

Needleandthread, western and thickspike wheatgrass, green needlegrass, bluebunch wheatgrass, basin wildrye, prairie junegrass, native legumes, silver sagebrush, blue grama

8 Silty-Clayey Range Site complex, 10-14" P.Z.

Silty: same as Site No. 7

Clayey: same as Site No. 9

9 Clayey and Shallow Clay Range Site Association, 10-14" P.Z.

Green needlegrass, western and thickspike wheatgrass, bluebunch wheatgrass, needleandthread, prairie junegrass, plains reedgrass, milkvetches, scarlet globemallow, winterfat, prairie sandreed

10 Dense Clay-Clayey-Saline Upland Range Site complex, 10-14" P.Z.

Dense Clay: Western and thickspike wheatgrass, green needlegrass, basin wildrye, prairie junegrass, Nuttall saltbush, greasewood

Clayey: same as Site No. 9

Saline Upland: Alkali sacaton, western and thickspike wheatgrass, greasewood, basin wildrye, Nuttall saltbush, inland saltgrass, bottlebrush squirreltail, Sandberg bluegrass

11 Saline Lowland Range Site, 10-14" P.Z.

Alkali sacaton, western and thickspike wheatgrass, Nuttall alkaligrass, alkali cordgrass, slender wheatgrass, inland saltgrass, sedge, greasewood, Nuttall saltbush

12 Sands and Sandy Range Site Association, 10-14" P.Z.

Sands: Prairie sandreed, needleandthread, Indian ricegrass, threadleaf sedge, native legumes, yucca, skunkbush sumac

Sandy: Needleandthread, prairie sandreed, threadleaf sedge, bluebunch wheatgrass western and thickspike wheatgrass, native legumes, skunkbush sumac, blue grama

13 Subirrigated and Wetland Range Site Association

Tall reedgrasses, tufted hairgrass, slender and bearded wheatgrass, northern mannagrass, prairie cordgrass, tall sedges, basin wildrye, Canada wildrye, willows, cottonwood, boxelder

## **EASTERN SEDIMENTARY PLAINS**

14 Silty Range Site, 10-14" P.Z.

(Includes thin breaks too small or irregular to delineate)

Western and thickspike wheatgrass, little bluestem, needleandthread, green needlegrass, bluebunch wheatgrass, big bluestem, prairie junegrass, threadleaf sedge, native legumes, silver sagebrush, skunkbush sumac, winterfat, blue grama, western snowberry.

15 Silty Range Site, 15-19" P.Z.

Western and thickspike wheatgrass, green needlegrass, little bluestem, big bluestem, bluebunch wheatgrass, Idaho fescue, sideoats grama, native legumes needleandthread, prairie junegrass, silver sagebrush

16 Silty-Clayey Range Site Complex, 10-14" P.Z.

(Includes thin breaks too small or irregular to delineate)

Silty: same as Site No. 14

Clayey: same as Site No. 18

17 Silty-Clayey Range Site Complex, 15-19" P.Z.

Silty: same as Site No. 15

Clayey: same as Site No. 19

18 Clayey and Shallow Clay Range Site Association, 10-14" P.Z.

Western and thickspike wheatgrass, green needlegrass, little bluestem, bluebunch wheatgrass, prairie junegrass, native legumes, big sagebrush, Nuttall saltbush, winterfat

19 Clayey and Shallow Clay Range Site Association, 15-19" P.Z.

Green needlegrass, western and thickspike wheatgrass, bluebunch wheatgrass, basin wildrye, big bluestem, little bluestem, Idaho fescue, prairie junegrass, prairie sandreed, native legumes, big sagebrush, Nuttall saltbush, winterfat

20 Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14" P.Z.

Dense Clay: Western and thickspike wheatgrass, green needlegrass, basin wildrye, big sagebrush, Nuttall saltbush, greasewood, prairie junegrass

Clayey: same as Site No. 18

Saline Upland: Alkali sacaton, western and thickspike wheatgrass, greasewood, basin wildrye, Nuttall saltbush, inland saltgrass, bottlebrush squirreltail, Sandberg bluegrass

21 Sands and Sandy Range Site Association, 10-14" P.Z.

Sands: Prairie sandreed, needleandthread, sand bluestem, Indian ricegrass, little bluestem, sun sedge, native legumes, skunkbush sumac, yucca

Sandy: Needleandthread, prairie sandreed, threadleaf sedge, little bluestem, sideoats grama, big bluestem, native legumes, blue grama, skunkbush sumac, rose

22 Riverbreaks, 10-14" P.Z.

Ponderosa pine, Rocky Mountain juniper, western and thickspike wheatgrass, bluebunch wheatgrass, green needlegrass, prairie sandreed, little bluestem, greasewood, big sagebrush, needleandthread, Nuttall saltbush, basin wildrye, native legumes, shadescale saltbush, creeping juniper

23 Badlands, 10-14" P.Z.

Western and thickspike wheatgrass, green needlegrass, little bluestem, bluebunch wheatgrass, prairie sandreed, alkali sacaton, prairie junegrass, Nuttall saltbush, big sagebrush, American vetch, plains muhly, sideoats grama, greasewood, juniper

24 Forest-Grassland Complex, 12-14" P.Z., on Very Shallow to Deep Soils with a Frigid Temperature Regime and Light Brown, Loamy Surfaces on Rolling to Hilly Terrain

Forest: (50%) Ponderosa pine, Rocky Mountain juniper, little bluestem, bluebunch wheatgrass, sideoats grama, skunkbush sumac, western wheatgrass, native legumes

Grassland: (50%) Little bluestem, needleandthread, western wheatgrass, green needlegrass, bluebunch wheatgrass, prairie sandreed, big bluestem, native legumes, skunkbush sumac, yucca, prairie junegrass, blue grama



25 Forest-Grassland Complex, 15-19" P.Z., on Very Shallow to Deep Soils with a Frigid Temperature Regime and Light Brown, Loamy Surfaces on Undulating to Hilly Terrain

Forest: (60%) Ponderosa pine, bluebunch wheatgrass, Idaho fescue, little bluestem, sideoats grama, snowberry, native legumes, arrowleaf balsamroot, green needlegrass, common chokecherry, saskatoon service-berry

Grassland: (40%) Big bluestem, bluebunch wheatgrass, western wheatgrass, green needlegrass, needleandthread, prairie junegrass, basin wildrye, lupine, snowberry, saskatoon serviceberry, common chokecherry

26 Ponderosa Pine Forests on Moderately Deep to Deep Soils with a Frigid Temperature Regime and Light Brown to Brown Surfaces on Undulating to Steep Terrain, 15-19" P.Z.

Typical overstory composition is: Ponderosa pine 100%

## **WESTERN SEDIMENTARY PLAINS**

27 Silty Range Site, 10-14" P.Z.

Bluebunch wheatgrass, western and thickspike wheatgrass, needleandthread, green needlegrass, basin wildrye, threadleaf sedge, prairie junegrass, native legumes, big and silver sagebrush, skunkbush sumac, common chokecherry, blue grama

28 Silty Range Site, 15-19" P.Z.

Bluebunch wheatgrass, western and thickspike wheatgrass, Idaho fescue, green needlegrass, basin wildrye, needleandthread, native legumes, big sagebrush, sticky geranium, prairiesmoke

29 Silty-Clayey Range Site Complex, 10-14" P.Z.

Silty: Same as Site No. 27

Clayey: Same as Site No. 31

30 Silty-Clayey Range Site Complex, 15-19" P.Z.

Silty: Same as Site No. 28

Clayey: Same as Site No. 32

31 Clayey and Shallow Clay Range Site Association, 10-14" P.Z.

Western and thickspike wheatgrass, bluebunch wheatgrass, green needlegrass, big sagebrush, prairie junegrass, plains reedgrass, prairie sandreed, milkvetches

32 Clayey and Shallow Clay Range Site Association, 15-19" P.Z.

Bluebunch wheatgrass, Columbia and green needlegrass, Idaho fescue, basin wildrye, big sagebrush, western and thickspike wheatgrass, prairie junegrass, prairie sandreed, lupine, other native legumes, sticky geranium, prairiesmoke

33 Dense Clay-Clayey-Saline Upland Range Site Complex, 5-9" P.Z.

Dense Clay: Western and thickspike wheatgrass, inland saltgrass, Nuttall saltbush, big sagebrush, black sagebrush, bud sagebrush, shadscale saltbush, greasewood, Sandberg bluegrass, prairie junegrass

Clayey: Western and thickspike wheatgrass, bluebunch wheatgrass, prairie junegrass, plains reedgrass, big sagebrush, bud sagebrush, milkvetches, winterfat, blue grama

Saline Upland: Alkali sacaton, western and thickspike wheatgrass, greasewood, Nuttall saltbush, shadscale saltbush, fourwing saltbush, inland saltgrass, big sagebrush, bottlebrush squirreltail, Sandberg bluegrass

34 Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14" P.Z.

Dense Clay: Western and thickspike wheatgrass, green needlegrass, inland saltgrass, big sagebrush, Nuttall saltbush, greasewood, prairie junegrass, Sandberg bluegrass

Clayey: Same as Site No. 31

Saline Upland: Alkali sacaton, western and thickspike wheatgrass, greasewood, Nuttall saltbush, basin wildrye, inland saltgrass, big sagebrush, bottlebrush squirreltail

35 Riverbreaks, 10-14" P.Z.

Ponderosa pine, Rocky Mountain juniper, Douglas-fir (north slopes), bluebunch wheatgrass, western and thickspike wheatgrass, green needlegrass, prairie sandreed, basin wildrye, needleandthread, greasewood, big sagebrush, creeping juniper, native legumes, prairie junegrass

36 Forest-Grassland Complex, 12-14" P.Z., on Very Shallow to Deep Soils with Frigid Temperature Regimes and Light Brown, Loamy Surfaces on Rolling to Steep Terrain

Forest: (50%) Ponderosa pine, Rocky Mountain juniper, bluebunch wheatgrass, western wheatgrass, skunkbush sumac, snowberry, needleandthread

Grassland: (50%) Bluebunch wheatgrass, needleandthread, western and thickspike wheatgrass, green needlegrass, big sagebrush, prairie sandreed, native legumes, prairie junegrass

## **FOOTHILLS AND MOUNTAINS**

37 Silty Range Site, 10-14" P.Z.

Bluebunch wheatgrass, rough fescue\*, needleandthread, prairie junegrass, western and thickspike wheatgrass, green needlegrass, basin wildrye, threadleaf sedge, native legumes, big sagebrush, winterfat, Idaho fescue

\* Codominant with bluebunch wheatgrass west of the Continental Divide but insignificant on east side at this P.Z.

38 Silty Range Site, 15-19" P.Z.

Rough fescue, Idaho fescue, bluebunch wheatgrass, Columbia needlegrass, basin wildrye, spike fescue, parry danthonia, slender wheatgrass, lupine sticky geranium, arrowleaf balsamroot, prairiesmoke, big sagebrush, tall larkspur, prairie junegrass, timber danthonia, big bluegrass

39 Silty Range Site, 20-24" P.Z.

Rough fescue, Columbia needlegrass, Richardson needlegrass, mountain brome, bearded wheatgrass, slender wheatgrass, basin wildrye, Idaho fescue, lupine, sticky geranium, prairiesmoke, tall larkspur, big sagebrush, spike fescue, spike trisetum, purple oniongrass, nodding brome, quaking aspen, American bistort

40 Silty-Clayey Range Site Complex, 10-14" P.Z.

Silty: same as Site No. 37

Clayey: same as Site No. 42

41 Silty-Clayey Range Site Complex, 15-19" P.Z.

Silty: same as Site No. 38

Clayey: same as Site No. 43

42 Clayey and Shallow Clay Range Site Association, 10-14" P.Z.

Bluebunch wheatgrass, western wheatgrass, green needlegrass, basin wildrye, prairie junegrass, plains reedgrass, big sagebrush, milkvetches, American vetch, biscuitroot

43 Clayey and Shallow Clay Range Site Association, 15-19" P.Z.

Rough fescue (except south central Montana), bluebunch wheatgrass, Columbia needlegrass, western and thickspike wheatgrass, Idaho fescue, basin wildrye, lupine, sticky geranium, arrowleaf balsamroot, big sagebrush, prairiesmoke, prairie junegrass, deathcamas

44 Saline Lowland Range Site, 10-14" P.Z.

Basin wildrye, alkali sacaton, Nuttall alkaligrass, alkali cordgrass, slender wheatgrass, western wheatgrass, inland saltgrass, greasewood, silver buffaloberry

45 Sands and Sandy Range Site Association, 10-14" P.Z.

Sands: Prairie sandreed, needleandthread, Indian ricegrass, bluebunch wheatgrass, threadleaf sedge, native legumes, skunkbush sumac, yucca

Sandy: Needleandthread, bluebunch wheatgrass, native legumes, threadleaf sedge, big sagebrush, prairie junegrass, skunkbush sumac

46 Limy-Shallow-Very Shallow Range Site Complex, 10-14" P.Z.

Limy: Bluebunch wheatgrass, prairie junegrass, needleandthread, threadleaf sedge, western and thickspike wheatgrass, Sandberg bluegrass, native legumes, winterfat

Shallow: Bluebunch wheatgrass, rough fescue, needleandthread, big sagebrush, prairie junegrass, western wheatgrass, Sandberg bluegrass, gray horsebrush, phlox, native legumes

Very Shallow: Bluebunch wheatgrass, prairie junegrass, western wheatgrass, threadleaf sedge, phlox, needleandthread, Sandberg bluegrass, native legumes - mountain mahogany, limber pine, antelope bitterbrush, big sagebrush, and Rocky Mountain juniper in cracks and crevices of bedrock

#### 47 Subirrigated and Wetland Range Site Association

Tall reedgrasses, tufted hairgrass, American mannagrass, tall sedges, slender wheatgrass, bearded wheatgrass, basin wildrye, willows, shrubby cinquefoil, prairie cordgrass, elephanthead pedicularis, monkeyflower, native clovers, Indianpaintbrush, common blue-eyedgrass

48 Alpine Grassland on Deep to Moderately Deep, Well Drained to Poorly Drained Soils with Cryic Temperature Regimes and Dark Brown and Very Dark Brown Surfaces on Sloping to Steep Windswept Mountain Tops Above Timberline, 40-70" P.Z.

Tufted hairgrass, sedge, sheep fescue, alpine bluegrass, alpine timothy, native legumes, wolf willow, red mountainheath, white dryad, alpine bluebell, bluejoint, purple reedgrass, moss silene, yellow avens, tufted phlox, eriogonum, American bistort, shrubby cinquefoil

49 Forest-Grassland Complex, 15-19" P.Z. on Shallow to Moderately Deep Soils with a Frigid Temperature Regime and Brown to Dark Brown Surfaces under Grassland and Brown to Gray Surfaces under Forest on Sloping to Steep Terrain

Forest: (60%) Douglas-fir, common snowberry, white spiraea, Oregongrape, heartleaf arnica, Columbia needlegrass, Idaho fescue, bearded wheatgrass, kinnikinnick

Grassland: (40%) Bluebunch wheatgrass, Idaho fescue, Columbia needlegrass, basin wildrye, spike fescue, lupine, arrowleaf balsamroot

50 Rocky Mountain Juniper and Limber Pine on Shallow Soils with a Frigid Temperature Regime and Dark Grayish Brown Surfaces Developed from Limestone or Calcareous Sandstone Residuum on Moderately Steep to Very Steep Mountain Slopes - Rock Outcrop 40-70%, 10-14" P.Z.

Typical overstory composition is:  
Rocky Mountain juniper 60%  
Limber pine 40%

51 Douglas-fir and Ponderosa Pine Climax Forests on Deep Soils with Cryic or Frigid Temperature Regimes and Light Brownish Gray, Brown, or Grayish Brown Surfaces on Hilly to Steep Mountain Slopes, 16-22" P.Z.

Typical overstory composition is:  
Douglas-fir 60%  
Ponderosa pine 40%

52 Subalpine Fir, Douglas-fir, and Ponderosa Pine Climax Forests on Deep Soils with Cryic or Frigid Temperature Regimes and Grayish Brown, Light Brownish Gray, or Light Yellowish

Brown Surfaces on Moderately Steep to Very Steep Mountain Slopes East of the Continental Divide, 16-35" P.Z.

Typical overstory composition is:

Subalpine fir 50%

Douglas-fir 35%

Ponderosa pine 10%

Engelmann spruce 5%

53 Subalpine Fir and Douglas-fir Climax Forests on Deep Soils with Cryic Temperature Regimes and Pale Brown or Light Brownish Gray Surfaces on Moderately Steep to Very Steep Mountain Slopes, 20-45" P.Z.

Typical overstory composition is:

Subalpine fir 65%

Douglas-fir 25%

Engelmann spruce 10%

54 Spruce and Douglas-fir Climax Forests on Deep Soils with Cryic or Frigid Temperature Regimes and Brown or Grayish Brown Surfaces and Calcareous Subsoils on Strongly Sloping to Very Steep Mountain Slopes, 20-45" P.Z.

Typical overstory composition is:

Spruce 50%

Douglas-fir 40%

Subalpine fir 10%

55 Subalpine Fir, Douglas-fir, and Ponderosa Pine Climax Forests on Deep Soils with Cryic or Frigid Temperature Regimes and Grayish Brown, Light Brownish Gray, or Light Yellowish Brown Surfaces on Moderately Steep to Very Steep Mountain Slopes West of the Continental Divide, 16-70" P.Z.

Typical overstory composition is:

Subalpine pine 50%

Douglas-fir 35%

Ponderosa pine 10%

Engelmann spruce 5%

56 Douglas-fir Climax Forests on Deep Soils with a Frigid Temperature Regime and Light Gray Surfaces and Calcareous Subsoils on Gently Rolling to Hilly Mountain Foot Slopes and Strongly Sloping to Steep Mountain Slopes, 16-30" P.Z.

Typical overstory composition is:

Douglas-fir 90%

Grand fir 10%

57 Subalpine Fir, Douglas-fir, and Grand fir Climax Forests on Deep Soils with Cryic or Frigid Temperature Regimes and Light Gray or Pale Brown Surfaces on Steep to Very Steep Mountain Slopes, 30-70" P.Z.

Typical overstory composition is:

Subalpine fir 55%

Douglas-fir 35%

Grand fir 10%

58 Western Redcedar and Western Hemlock Climax Forests on Deep Soils with Frigid Temperature Regimes and Brown to Pale Brown or Light Gray Surfaces on Gently Sloping to Gently Rolling Valley Floors, 20-35" P.Z.

Typical overstory composition is:

Western redcedar 70%

Western hemlock 15%

Grand fir 15%

59 Grand Fir and Douglas-fir Climax Forests on Deep Soils with Frigid Temperature Regimes and Pale Brown or Light Gray Surfaces on Steep to Very Steep Mountain Slopes, 25-60" P.Z.

Typical overstory composition is:

Grand fir 45%

Douglas-fir 45%

Western redcedar 10%

& Western hemlock

60 Subalpine Fir Climax Forests on Deep Soils with Cryic Temperature Regimes and Brown or Strong Brown Surfaces on Steep to Very Steep Mountain Slopes, 60-100" P.Z.

Typical overstory composition is:

Subalpine fir 70%

Mountain hemlock 20%

Douglas-fir 10%

61 Hardwood Climax Forests on Alluvial Floodplains Along Major Rivers and Growing on Shallow to Deep, Well Drained to Poorly Drained Soils with Frigid Temperature Regimes

Typical overstory composition is:

East of Continental Divide:

Cottonwood 80%

Other hardwoods 20%

West of Continental Divide:

Cottonwood 80%

Conifers 20%

62 Rockland and Mixed High Elevation Vegetation Consisting of Forests, Krummholz, and Alpine Areas Growing on Shallow to Deep, Very Gravelly or Very Cobbly, and Stony Soils with Cryic Temperature Regimes, 40-110" P.Z.

Typical composition is:

Rockland 70%

Vegetation 30%

**Codes and values table: Climax.dbf**

<u>Code</u>	<u>Value</u>
1	Silty Range Site, 10-14" P.Z.
2	Silty-Clayey Range Site Complex, 10-14" P.Z.
3	Clayey and Shallow Clay Range Site Assoc., 10-14", P.Z.
4	Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14", P.Z.
5	Saline Lowland Range Site, 10-14" P.Z.
6	Sands and Sandy Range Site Assoc., 10-14" P.Z.
7	Silty Range Site, 10-14" P.Z.
8	Silty-Clayey Range Site complex, 10-14" P.Z.
9	Clayey and Shallow Clay Range Site Assoc., 10-14" P.Z.
10	Dense Clay-Clayey-Saline Upland Range Site complex, 10-14" P.Z.
11	Saline Lowland Range Site, 10-14" P.Z.
12	Sands and Sandy Range Site Assoc., 10-14" P.Z.
13	Subirrigated and Wetland Range Site Assoc.
14	Silty Range Site, 10-14" P.Z.
15	Silty Range Site, 15-19" P.Z.
16	Silty-Clayey Range Site Complex, 10-14" P.Z.
17	Silty-Clayey Range Site Complex, 15-19" P.Z.
18	Clayey and Shallow Clay Range Site Assoc., 10-14" P.Z.
19	Clayey and Shallow Clay Range Site Assoc., 15-19" P.Z.
20	Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14" P.Z.
21	Sands and Sandy Range Site Assoc., 10-14" P.Z.
22	Riverbreaks, 10-14" P.Z.
23	Badlands, 10-14" P.Z.



- 24 Forest-Grassland Complex, 12-14" P.Z.
- 25 Forest-Grassland Complex, 15-19" P.Z.
- 26 Ponderosa Pine Forests on Moderately Deep to Deep Soils P.Z.
- 27 Silty Range Site, 10-14" P.Z.
- 28 Silty Range Site, 15-19" P.Z.
- 29 Silty-Clayey Range Site Complex, 10-14" P.Z.
- 30 Silty-Clayey Range Site Complex, 15-19" P.Z.
- 31 Clayey and Shallow Clay Range Site Assoc., 10-14" P.Z.
- 32 Clayey and Shallow Clay Range Site Assoc., 15-19" P.Z.
- 33 Dense Clay-Clayey-Saline Upland Range Site Complex, 5-9" P.Z.
- 34 Dense Clay-Clayey-Saline Upland Range Site Complex, 10-14" P.Z.
- 35 Riverbreaks, 10-14" P.Z.
- 36 Forest-Grassland Complex, 12-14" P.Z.
- 37 Silty Range Site, 10-14" P.Z.
- 38 Silty Range Site, 15-19" P.Z.
- 39 Silty Range Site, 20-24" P.Z.
- 40 Silty-Clayey Range Site Complex, 10-14" P.Z.
- 41 Silty-Clayey Range Site Complex, 15-19" P.Z.
- 42 Clayey and Shallow Clay Range Site Assoc., 10-14" P.Z.
- 43 Clayey and Shallow Clay Range Site Assoc., 15-19" P.Z.
- 44 Saline Lowland Range Site, 10-14" P.Z.
- 45 Sands and Sandy Range Site Assoc., 10-14" P.Z.
- 46 Limy-Shallow-Very Shallow Range Site Complex, 10-14" P.Z.
- 47 Subirrigated and Wetland Range Site Assoc.
- 48 Alpine Grassland Above Timberline, 40-70" P.Z.
- 49 Forest-Grassland Complex, 15-19" P.Z.
- 50 Rocky Mountain Juniper and Limber Pine 10-14" P.Z.
- 51 Douglas-fir and Ponderosa Pine Climax Forests 16-22" P.Z.
- 52 Subalpine Fir, Douglas-fir, and Ponderosa Pine 16-35" P.Z.
- 53 Subalpine Fir and Douglas-fir Climax Forests 20-45" P.Z.
- 54 Spruce and Douglas-fir Climax Forests 20-45" P.Z.
- 55 Subalpine Fir, Douglas-fir, Ponderosa Pine Climax Forests 16-70" P.Z.
- 56 Douglas-fir Climax Forests 16-30" P.Z.
- 57 Subalpine Fir, Douglas-fir, Grand fir Climax Forests, 30-70" P.Z.
- 58 Western Redcedar and Western Hemlock Climax Forests, 20-35" P.Z.
- 59 Grand Fir and Douglas-fir Climax Forests, 25-60" P.Z.
- 60 Subalpine Fir Climax Forests, 60-100" P.Z.
- 61 Hardwood Climax Forests on Alluvial Floodplains
- 62 Rockland and Mixed High Elevation Vegetation, 40-110" P.Z.

**(022) TITLE: Land Ownership**

CONTENT: Indicates whether areas are predominantly under private ownership or public administration (compiled 1978).

MAP UNIT LEGEND: Nine classes; State ownership, administered by Park Service, administered by Fish and Wildlife Service, administered by Forest Service (FS), administered by Bureau of Land Management (BLM), administered by Bureau of Indian Affairs, checkerboard (mixed private and FS), checkerboard (mixed private and BLM), private.

MAP PURPOSE: Indicates predominant land ownership on a state-wide basis. Useful in determining land management policies at any location in Montana.

**Codes and values table: Ownership.dbf**

<u>Code</u>	<u>Value</u>
1	Private (prvt)
2	Checkerboard (prvt & BLM)
3	Checkerboard (prvt & FS)
4	Administered by BIA
5	Administered by BLM
6	Administered by FS
7	Administered by FWS
8	Administered by NPS
9	State ownership

**(023) TITLE: Land Cover**

CONTENT: Delineates major land cover types of Montana (compiled 1981).

MAP UNIT LEGEND: Irrigated crops, dryland crops, forest, range, alpine and rock outcrops, urban ( >20,000 population) and water.

MAP PURPOSE: Provides resource planners a basis for a comparative analysis of Montana's major types of land use (cover) in relation to biophysical characteristics of land and climate.

**Codes and values table:** Landuse.dbf

<u>Code</u>	<u>Value</u>
1	Forest
2	Water
3	Range
4	Dryland crop
5	Irrigated crop
6	Alpine, rock
7	Urban

**(024) TITLE: Geology**

CONTENT: The Geologic Map of Montana delineates rock types of Montana and their respective ages. The original map was at a scale of 1:2,500,000 and was subsequently enlarged to 1:1,000,000. This map is very generalized, particularly for the mountainous portions of the state (compiled 1978).

MAP UNIT LEGEND:

Abl	Lower Part of Belt Series
El	Lance Formation
Efu	Fort Union Formation
Km	Montana Group
Kc	Colorado Group
Kce	Claggett and Eagle Formations
Kbj	Bearpaw and Judith River Formations
Tv	Older Tertiary Volcanic Rocks
Ti	Intrusive Rocks
DC	Devonian to Cambrian Rocks
Cm	Mississippian Rocks
Kdl	Dakota Sandstone and Lower Cretaceous
J	Jurassic Rocks
Kj	Dakota Sandstone to Morrison Formation
AR	Archean Rocks
Abu	Upper Part of Belt Series
QA	Alluvium, Lake Deposits, Beach Sand, Marine Deposits, and Glacial Deposits
Ji	Older Intrusive Rocks
Mpc	Miocene and Pliocene Continental Deposits
TR	Triassic Rocks
Cp	Pennsylvanian Rocks
Qpv	Younger Volcanic Rocks and Interbedded Continental Deposits
Ab	Belt Series, undivided and other Algonkian Rocks
Ow	White River Group Lakes
Ews	Wasatch Formation

MAP PURPOSE: Can be used with other MAPS products, such as the General Soils Map of Montana to study the relationship between parent materials (bedrock) and soil types.

**Codes and values table: Geol.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	Ab Belt series,Algonkian rocks	15	Kc Colorado group
2	Abu Upper part of Belt series	16	Kce Claggett & Eagle form
3	Abl Lower part of Belt series	17	Kdl Dakota sand & lower Cretaceous
4	AR Archean rocks	18	Kj Dakota sand to Morrison form
5	Cm Mississippian rocks	19	Km Montana group
6	Cp Pennsylvanian rocks	21	Mpc Miocene & Pliocene cont dep
7	DC Denovian to Cambrian rocks	22	Ow (Phi w) White River group
8	Ews Wasatch form	23	QA Alluv,lake,sand,marine,glac dep
10	Efu Fort Union form	24	Qpv Young volc rocks,intrbd cont dep
11	El Lance form	25	Ti Intrusive rocks
12	J Jurassic rocks	26	TR Triassic rocks
13	Ji Older intrusive rocks	27	Tv Older Tertiary volcanic rocks
14	Kbj Bear Paw & Judith Riv form	28	Lakes

**(025, 026, 027) TITLE: Elevation - Mid-Range, Highest and Lowest**

CONTENT: The elevation maps include three data sets or map layers; lowest, average and highest elevations for each of the 18,000 cells representing the state (compiled 1987).

MAP UNIT LEGEND: 200 foot contour intervals are used for areas predominantly mountainous and 100 foot contour intervals are used for most non-mountainous areas.

MAP PURPOSE: Elevation maps are used by resource planners and mappers interested in estimating environmental qualities related to elevation such as: air temperature, soil temperature, precipitation, barometric pressure, vegetation, relief, drainage of both air and water, and the effect on watershed, forest, range and crop land potentials.

**Codes and values table: Avelev.dbf, Helev.dbf, Lelev.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
19	1900 feet	29	2900 feet	39	3900 feet	49	4900 feet
20	2000 feet	30	3000 feet	40	4000 feet	50	5000 feet
21	2100 feet	31	3100 feet	41	4100 feet	51	5100 feet
22	2200 feet	32	3200 feet	42	4200 feet	52	5200 feet
23	2300 feet	33	3300 feet	43	4300 feet	53	5300 feet
24	2400 feet	34	3400 feet	44	4400 feet	54	5400 feet
25	2500 feet	35	3500 feet	45	4500 feet	55	5500 feet
26	2600 feet	36	3600 feet	46	4600 feet	56	5600 feet
27	2700 feet	37	3700 feet	47	4700 feet	57	5700 feet
28	2800 feet	38	3800 feet	48	4800 feet	58	5800 feet

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
59	5900 feet	74	7400 feet	98	9800 feet	112	11200 feet
60	6000 feet	75	7500 feet	99	9900 feet	113	11300 feet
61	6100 feet	76	7600 feet	100	10000 feet	114	11400 feet
62	6200 feet	78	7800 feet	101	10100 feet	116	11600 feet
63	6300 feet	80	8000 feet	102	10200 feet	118	11800 feet
64	6400 feet	82	8200 feet	103	10300 feet	119	11900 feet
65	6500 feet	84	8400 feet	105	10500 feet	120	12000 feet
66	6600 feet	86	8600 feet	106	10600 feet	122	12200 feet
67	6700 feet	88	8800 feet	107	10700 feet	124	12400 feet
68	6800 feet	90	9000 feet	108	10800 feet	125	12500 feet
69	6900 feet	92	9200 feet	109	10900 feet	126	12600 feet
70	7000 feet	94	9400 feet	110	11000 feet	128	12800 feet
72	7200 feet	96	9600 feet	111	11100 feet		

**(028) TITLE: Elevation Difference (Relief)**

CONTENT: Differences in elevation in 100-foot increments for each of the 18,000 cells representing Montana (compiled 1987).

MAP UNIT LEGEND: Classes (in feet); 0, 100, 200, 300, . . . 6400).

MAP PURPOSE: To illustrate gross differences in statewide relief. Relief affects movement of water and air, rates of stream flow, sediment load, temperature inversions, Chinooks, wildlife habitat, recreational opportunities and scenic characteristics.

**Codes and values table: Relief.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	100 feet	16	1600 feet	31	3100 feet	45	4500 feet
2	200 feet	17	1700 feet	32	3200 feet	46	4600 feet
3	300 feet	18	1800 feet	33	3300 feet	48	4800 feet
4	400 feet	19	1900 feet	34	3400 feet	50	5000 feet
5	500 feet	20	2000 feet	35	3500 feet	51	5100 feet
6	600 feet	21	2100 feet	36	3600 feet	52	5200 feet
7	700 feet	22	2200 feet	37	3700 feet	53	5300 feet
8	800 feet	23	2300 feet	38	3800 feet	54	5400 feet
9	900 feet	24	2400 feet	39	3900 feet	55	5500 feet
10	1000 feet	25	2500 feet	40	4000 feet	56	5600 feet
11	1100 feet	26	2600 feet	41	4100 feet	58	5800 feet
12	1200 feet	27	2700 feet	42	4200 feet	59	5900 feet
13	1300 feet	28	2800 feet	43	4300 feet	64	6400 feet
14	1400 feet	29	2900 feet	44	4400 feet	255	0 feet
15	1500 feet	30	3000 feet				

**(029) TITLE: Predominant Aspect**

CONTENT: Aspect was computed for each cell by adding mid-range elevation gradient vectors for each of four pairs of cells, including diagonal pairs, surrounding the reference cell. Cells in a vector pair were on opposite sides of the reference cell. The four gradient vectors were added and the direction of the resultant vector was interpreted as the predominant aspect of the reference cell (compiled 1987).

MAP UNIT LEGEND: Eight compass points (45E each, in degrees clockwise from North) and level are used to indicate the predominant aspect of each of the 18,000 cells representing Montana.

MAP PURPOSE: To show the predominant aspect or exposure of Montana landscapes. Aspect together with slope modifies landscape climate.

**Codes and values table: Aspect.dbf**

<u>Code</u>	<u>Value</u>
1	337.5-22.5 or from NNW to NNE (N)
2	22.5-67.5 or from NNE to ENE (NE)
3	292.5-337.5 or from WNW to NNW (NW)
4	67.5-112.5 or from ENE to ESE (E)
5	Level
6	247.5-292.5 or from WSW to WNW (W)
7	112.5-157.5 or from ESE to SSE (SE)
8	202.5-247.5 or from SSW to WSW (SW)
9	157.5-202.5 or from SSE to SSW (S)

**(030) TITLE: Latitude**

CONTENT: Latitude values for each of the 18,000 cells representing the state (compiled 1987). The value given is the latitude at the center of the **MAPS Atlas** cell. The vertical dimension of each **MAPS Atlas** cell is .05 degrees (3 minutes) of latitude.

MAP UNIT LEGEND: Latitudes are in decimal degrees and vary from 44.425EN to 48.975EN.

MAP PURPOSE: The latitude map can be combined with the longitude and elevation maps to determine a precise site location statewide.

**Codes and values table: Lat.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	44.425 N	24	45.575 N	47	46.725 N	70	47.875 N
2	44.475 N	25	45.625 N	48	46.775 N	71	47.925 N
3	44.525 N	26	45.675 N	49	46.825 N	72	47.975 N
4	44.575 N	27	45.725 N	50	46.875 N	73	48.025 N
5	44.625 N	28	45.775 N	51	46.925 N	74	48.075 N
6	44.675 N	29	45.825 N	52	46.975 N	75	48.125 N
7	44.725 N	30	45.875 N	53	47.025 N	76	48.175 N
8	44.775 N	31	45.925 N	54	47.075 N	77	48.225 N
9	44.825 N	32	45.975 N	55	47.125 N	78	48.275 N
10	44.875 N	33	46.025 N	56	47.175 N	79	48.325 N
11	44.925 N	34	46.075 N	57	47.225 N	80	48.375 N
12	44.975 N	35	46.125 N	58	47.275 N	81	48.425 N
13	45.025 N	36	46.175 N	59	47.325 N	82	48.475 N
14	45.075 N	37	46.225 N	60	47.375 N	83	48.525 N
15	45.125 N	38	46.275 N	61	47.425 N	84	48.575 N
16	45.175 N	39	46.325 N	62	47.475 N	85	48.625 N
17	45.225 N	40	46.375 N	63	47.525 N	86	48.675 N
18	45.275 N	41	46.425 N	64	47.575 N	87	48.725 N
19	45.325 N	42	46.475 N	65	47.625 N	88	48.775 N
20	45.375 N	43	46.525 N	66	47.675 N	89	48.825 N
21	45.425 N	44	46.575 N	67	47.725 N	90	48.875 N
22	45.475 N	45	46.625 N	68	47.775 N	91	48.925 N
23	45.525 N	46	46.675 N	69	47.825 N	92	48.975 N



**(031) TITLE: Longitude**

CONTENT: Longitude values for each of the 18,000 cells representing the state (compiled 1987). The value given is the longitude at the center of the *MAPS Atlas* cell. The horizontal dimension of each *MAPS Atlas* cell is .05 degrees (3 minutes) of longitude.

MAP UNIT LEGEND: Longitudes are in decimal degrees and vary from 104.075EW to 116.025EW.

MAP PURPOSE: The longitude map can be combined with the latitude and elevation maps to determine a precise site location statewide.

**Codes and values table: Long.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	104.075 W	29	105.475 W	57	106.875 W	85	108.275 W
2	104.125 W	30	105.525 W	58	106.925 W	86	108.325 W
3	104.175 W	31	105.575 W	59	106.975 W	87	108.375 W
4	104.225 W	32	105.625 W	60	107.025 W	88	108.425 W
5	104.275 W	33	105.675 W	61	107.075 W	89	108.475 W
6	104.325 W	34	105.725 W	62	107.125 W	90	108.525 W
7	104.375 W	35	105.775 W	63	107.175 W	91	108.575 W
8	104.425 W	36	105.825 W	64	107.225 W	92	108.625 W
9	104.475 W	37	105.875 W	65	107.275 W	93	108.675 W
10	104.525 W	38	105.925 W	66	107.325 W	94	108.725 W
11	104.575 W	39	105.975 W	67	107.375 W	95	108.775 W
12	104.625 W	40	106.025 W	68	107.425 W	96	108.825 W
13	104.675 W	41	106.075 W	69	107.475 W	97	108.875 W
14	104.725 W	42	106.125 W	70	107.525 W	98	108.925 W
15	104.775 W	43	106.175 W	71	107.575 W	99	108.975 W
16	104.825 W	44	106.225 W	72	107.625 W	100	109.025 W
17	104.875 W	45	106.275 W	73	107.675 W	101	109.075 W
18	104.925 W	46	106.325 W	74	107.725 W	102	109.125 W
19	104.975 W	47	106.375 W	75	107.775 W	103	109.175 W
20	105.025 W	48	106.425 W	76	107.825 W	104	109.225 W
21	105.075 W	49	106.475 W	77	107.875 W	105	109.275 W
22	105.125 W	50	106.525 W	78	107.925 W	106	109.325 W
23	105.175 W	51	106.575 W	79	107.975 W	107	109.375 W
24	105.225 W	52	106.625 W	80	108.025 W	108	109.425 W
25	105.275 W	53	106.675 W	81	108.075 W	109	109.475 W
26	105.325 W	54	106.725 W	82	108.125 W	110	109.525 W
27	105.375 W	55	106.775 W	83	108.175 W	111	109.575 W
28	105.425 W	56	106.825 W	84	108.225 W	112	109.625 W

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
113	109.675 W	145	111.275 W	177	112.875 W	209	114.475 W
114	109.725 W	146	111.325 W	178	112.925 W	210	114.525 W
115	109.775 W	147	111.375 W	179	112.975 W	211	114.575 W
116	109.825 W	148	111.425 W	180	113.025 W	212	114.625 W
117	109.875 W	149	111.475 W	181	113.075 W	213	114.675 W
118	109.925 W	150	111.525 W	182	113.125 W	214	114.725 W
119	109.975 W	151	111.575 W	183	113.175 W	215	114.775 W
120	110.025 W	152	111.625 W	184	113.225 W	216	114.825 W
121	110.075 W	153	111.675 W	185	113.275 W	217	114.875 W
122	110.125 W	154	111.725 W	186	113.325 W	218	114.925 W
123	110.175 W	155	111.775 W	187	113.375 W	219	114.975 W
124	110.225 W	156	111.825 W	188	113.425 W	220	115.025 W
125	110.275 W	157	111.875 W	189	113.475 W	221	115.075 W
126	110.325 W	158	111.925 W	190	113.525 W	222	115.125 W
127	110.375 W	159	111.975 W	191	113.575 W	223	115.175 W
128	110.425 W	160	112.025 W	192	113.625 W	224	115.225 W
129	110.475 W	161	112.075 W	193	113.675 W	225	115.275 W
130	110.525 W	162	112.125 W	194	113.725 W	226	115.325 W
131	110.575 W	163	112.175 W	195	113.775 W	227	115.375 W
132	110.625 W	164	112.225 W	196	113.825 W	228	115.425 W
133	110.675 W	165	112.275 W	197	113.875 W	229	115.475 W
134	110.725 W	166	112.325 W	198	113.925 W	230	115.525 W
135	110.775 W	167	112.375 W	199	113.975 W	231	115.575 W
136	110.825 W	168	112.425 W	200	114.025 W	232	115.625 W
137	110.875 W	169	112.475 W	201	114.075 W	233	115.675 W
138	110.925 W	170	112.525 W	202	114.125 W	234	115.725 W
139	110.975 W	171	112.575 W	203	114.175 W	235	115.775 W
140	111.025 W	172	112.625 W	204	114.225 W	236	115.825 W
141	111.075 W	173	112.675 W	205	114.275 W	237	115.875 W
142	111.125 W	174	112.725 W	206	114.325 W	238	115.925 W
143	111.175 W	175	112.775 W	207	114.375 W	239	115.975 W
144	111.225 W	176	112.825 W	208	114.425 W	240	116.025 W

**(032) TITLE: Percent Slope Categories Using 1978 Soil Map of Montana**

CONTENT: Percent slope of each of the 18,000 cells representing the state (compiled 1985).

MAP UNIT LEGEND: Seven classes; nearly level (0-2% slope), gently sloping (2-4%), moderately sloping (4-8%), strongly sloping (8-15%), moderately steep (15-25%), steep (25-45%), very steep (>45%).

MAP PURPOSE: Useful in engineering decisions and erodibility analysis.

**Codes and values table: Slope1.dbf**

Code Value

- 1 Nearly level (0-2%)
- 2 Gently sloping (2-4%)
- 3 Moderately sloping (4-8%)
- 4 Strongly sloping (8-15%)
- 5 Moderately steep (15-25%)
- 6 Steep (25-45%)
- 7 Very steep (>45%)

**(033) TITLE: Percent Slope Using Elevation Data**

CONTENT: Percent slope of each of the 18,000 cells representing the state (compiled 1987).

MAP UNIT LEGEND: Percent.

MAP PURPOSE: Useful in engineering decisions and erodibility analysis.

**Codes and values table: Slope2.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	1%	11	11%	21	21%	31	31%
2	2%	12	12%	22	22%	32	32%
3	3%	13	13%	23	23%	34	34%
4	4%	14	14%	24	24%	35	35%
5	5%	15	15%	25	25%	37	37%
6	6%	16	16%	26	26%	39	39%
7	7%	17	17%	27	27%	40	40%
8	8%	18	18%	28	28%	43	43%
9	9%	19	19%	29	29%	47	47%
10	10%	20	20%	30	30%	255	0%

**(034-045) TITLE: Mean Monthly Potential Evaporation (PENMAN)**

CONTENT: The Average Monthly Potential Evaporation Map by Penman's method was derived from cell estimates of mean monthly values of net radiation, solar radiation, temperature, vapor pressure, albedo, and wind speed using available climatic data (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: Useful for hydrological considerations.

**Codes and values table:** Janevap.dbf through Decevap.dbf (12 months).

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	0.1 inches	23	2.3 inches	45	4.5 inches	67	6.7 inches
2	0.2 inches	24	2.4 inches	46	4.6 inches	68	6.8 inches
3	0.3 inches	25	2.5 inches	47	4.7 inches	69	6.9 inches
4	0.4 inches	26	2.6 inches	48	4.8 inches	70	7.0 inches
5	0.5 inches	27	2.7 inches	49	4.9 inches	71	7.1 inches
6	0.6 inches	28	2.8 inches	50	5.0 inches	72	7.2 inches
7	0.7 inches	29	2.9 inches	51	5.1 inches	73	7.3 inches
8	0.8 inches	30	3.0 inches	52	5.2 inches	74	7.4 inches
9	0.9 inches	31	3.1 inches	53	5.3 inches	75	7.5 inches
10	1.0 inches	32	3.2 inches	54	5.4 inches	76	7.6 inches
11	1.1 inches	33	3.3 inches	55	5.5 inches	77	7.7 inches
12	1.2 inches	34	3.4 inches	56	5.6 inches	78	7.8 inches
13	1.3 inches	35	3.5 inches	57	5.7 inches	79	7.9 inches
14	1.4 inches	36	3.6 inches	58	5.8 inches	80	8.0 inches
15	1.5 inches	37	3.7 inches	59	5.9 inches	81	8.1 inches
16	1.6 inches	38	3.8 inches	60	6.0 inches	82	8.2 inches
17	1.7 inches	39	3.9 inches	61	6.1 inches	83	8.3 inches
18	1.8 inches	40	4.0 inches	62	6.2 inches	84	8.4 inches
19	1.9 inches	41	4.1 inches	63	6.3 inches	85	8.5 inches
20	2.0 inches	42	4.2 inches	64	6.4 inches	86	8.6 inches
21	2.1 inches	43	4.3 inches	65	6.5 inches	87	8.7 inches
22	2.2 inches	44	4.4 inches	66	6.6 inches	88	8.8 inches

**(046) TITLE: Mean Annual Potential Evaporation (PENMAN)**

CONTENT: The Mean Annual Potential Evaporation Map by Penman's method was derived from cell totals of mean monthly potential evapotranspiration (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: Useful in hydrological considerations including water loss from lakes and ponds.

**Codes and values table: Annevap.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
21	21 inches	28	28 inches	35	35 inches	41	41 inches
22	22 inches	29	29 inches	36	36 inches	42	42 inches
23	23 inches	30	30 inches	37	37 inches	43	43 inches
24	24 inches	31	31 inches	38	38 inches	44	44 inches
25	25 inches	32	32 inches	39	39 inches	45	45 inches
26	26 inches	33	33 inches	40	40 inches	46	46 inches
27	27 inches	34	34 inches				

**(047) TITLE: Average Annual Solar Thermal Unit Potential Evapotranspiration**

CONTENT: The Average Annual Potential Evapotranspiration Map by the Solar Thermal Unit method was derived from beginning bloom date isophases for purple common lilacs (compiled 1986).

MAP UNIT LEGEND: Inches per year, ranging from 5 to 33.

MAP PURPOSE: This map is useful for estimating irrigation requirements for crops and other hydrological considerations.

**Codes and values table: Stuann.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
5	5 inches	13	13 inches	21	21 inches	29	29 inches
6	6 inches	14	14 inches	22	22 inches	30	30 inches
7	7 inches	15	15 inches	23	23 inches	31	31 inches
8	8 inches	16	16 inches	24	24 inches	32	32 inches
9	9 inches	17	17 inches	25	25 inches	33	33 inches
10	10 inches	18	18 inches	26	26 inches		
11	11 inches	19	19 inches	27	27 inches		
12	12 inches	20	20 inches	28	28 inches		

**(048-057) TITLE: Monthly Solar Thermal Unit Potential Evapotranspiration**

CONTENT: Solar thermal units are computed by taking the product of daily total solar radiation ( $\text{cal cm}^{-2}\text{day}^{-1}$ ) and mean daily temperature (EF) minus 31EF. Total units for the month are then multiplied by  $10^{-5}$  (compiled 1988).

MAP UNIT LEGEND: Inches per month.

MAP PURPOSE: Can be used to estimate rate of plant development and potential evapotranspiration.

**Codes and values table: Stufeb.dbf through Stunov.dbf (10 months)**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	0.1 inches	23	2.3 inches	45	4.5 inches	65	6.5 inches
2	0.2 inches	24	2.4 inches	46	4.6 inches	67	6.7 inches
3	0.3 inches	25	2.5 inches	47	4.7 inches	68	6.8 inches
4	0.4 inches	26	2.6 inches	48	4.8 inches	69	6.9 inches
5	0.5 inches	27	2.7 inches	49	4.9 inches	70	7.0 inches
6	0.6 inches	28	2.8 inches	50	5.0 inches	71	7.1 inches
7	0.7 inches	29	2.9 inches	51	5.1 inches	72	7.2 inches
8	0.8 inches	30	3.0 inches	52	5.2 inches	73	7.3 inches
9	0.9 inches	31	3.1 inches	53	5.3 inches	74	7.4 inches
10	1.0 inches	32	3.2 inches	54	5.4 inches	75	7.5 inches
11	1.1 inches	33	3.3 inches	55	5.5 inches	76	7.6 inches
12	1.2 inches	34	3.4 inches	56	5.6 inches	77	7.7 inches
13	1.3 inches	35	3.5 inches	57	5.7 inches	78	7.8 inches
14	1.4 inches	36	3.6 inches	58	5.8 inches	79	7.9 inches
15	1.5 inches	37	3.7 inches	59	5.9 inches	80	8.0 inches
16	1.6 inches	38	3.8 inches	60	6.0 inches	81	8.1 inches
17	1.7 inches	39	3.9 inches	61	6.1 inches	82	8.2 inches
18	1.8 inches	40	4.0 inches	62	6.2 inches	83	8.3 inches
19	1.9 inches	41	4.1 inches	63	6.3 inches	85	8.5 inches
20	2.0 inches	42	4.2 inches	64	6.4 inches	255	0.0 inches
21	2.1 inches	43	4.3 inches	66	6.6 inches		
22	2.2 inches	44	4.4 inches				

**(058) TITLE: Average Annual Potential Evapotranspiration (Thornthwaite)**

CONTENT: Derived from MAPS data on mean monthly potential evapotranspiration (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: Useful for estimating irrigation requirements for crops and for hydrological considerations.

**Codes and values table: Annthpet.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
118	11.8 inches	158	15.8 inches	190	19.0 inches	222	22.2 inches
120	12.0 inches	159	15.9 inches	191	19.1 inches	223	22.3 inches
121	12.1 inches	160	16.0 inches	192	19.2 inches	224	22.4 inches
122	12.2 inches	161	16.1 inches	193	19.3 inches	225	22.5 inches
123	12.3 inches	162	16.2 inches	194	19.4 inches	226	22.6 inches
124	12.4 inches	163	16.3 inches	195	19.5 inches	227	22.7 inches
125	12.5 inches	164	16.4 inches	196	19.6 inches	228	22.8 inches
131	13.1 inches	165	16.5 inches	197	19.7 inches	229	22.9 inches
133	13.3 inches	166	16.6 inches	198	19.8 inches	230	23.0 inches
134	13.4 inches	167	16.7 inches	199	19.9 inches	231	23.1 inches
136	13.6 inches	168	16.8 inches	200	20.0 inches	232	23.2 inches
137	13.7 inches	169	16.9 inches	201	20.1 inches	233	23.3 inches
138	13.8 inches	170	17.0 inches	202	20.2 inches	234	23.4 inches
139	13.9 inches	171	17.1 inches	203	20.3 inches	235	23.5 inches
140	14.0 inches	172	17.2 inches	204	20.4 inches	236	23.6 inches
141	14.1 inches	173	17.3 inches	205	20.5 inches	237	23.7 inches
142	14.2 inches	174	17.4 inches	206	20.6 inches	238	23.8 inches
143	14.3 inches	175	17.5 inches	207	20.7 inches	239	23.9 inches
144	14.4 inches	176	17.6 inches	208	20.8 inches	240	24.0 inches
145	14.5 inches	177	17.7 inches	209	20.9 inches	241	24.1 inches
146	14.6 inches	178	17.8 inches	210	21.0 inches	242	24.2 inches
147	14.7 inches	179	17.9 inches	211	21.1 inches	243	24.3 inches
148	14.8 inches	180	18.0 inches	212	21.2 inches	244	24.4 inches
149	14.9 inches	181	18.1 inches	213	21.3 inches	245	24.5 inches
150	15.0 inches	182	18.2 inches	214	21.4 inches	246	24.6 inches
151	15.1 inches	183	18.3 inches	215	21.5 inches	247	24.7 inches
152	15.2 inches	184	18.4 inches	216	21.6 inches	248	24.8 inches
153	15.3 inches	185	18.5 inches	217	21.7 inches	249	24.9 inches
154	15.4 inches	186	18.6 inches	218	21.8 inches	250	25.0 inches
155	15.5 inches	187	18.7 inches	219	21.9 inches	251	25.1 inches
156	15.6 inches	188	18.8 inches	220	22.0 inches	252	25.2 inches
157	15.7 inches	189	18.9 inches	221	22.1 inches	253	25.3 inches

**(059-68) TITLE: Average Monthly Potential Evapotranspiration (Thornthwaite)**

CONTENT: Derived from mean monthly temperature maps and day-length algorithm using Thornthwaite's equation (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: Used for classifying climates, evaluating the status of droughts, assessing irrigation requirements and other hydrological considerations.

**Codes and values table:** Febthpet.dbf through Novthpet.dbf (10 months)

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	0.1 inches	17	1.7 inches	33	3.3 inches	46	4.6 inches
2	0.2 inches	18	1.8 inches	34	3.4 inches	49	4.9 inches
3	0.3 inches	19	1.9 inches	35	3.5 inches	50	5.0 inches
4	0.4 inches	20	2.0 inches	36	3.6 inches	51	5.1 inches
5	0.5 inches	21	2.1 inches	37	3.7 inches	52	5.2 inches
6	0.6 inches	22	2.2 inches	38	3.8 inches	53	5.3 inches
7	0.7 inches	23	2.3 inches	39	3.9 inches	54	5.4 inches
8	0.8 inches	24	2.4 inches	40	4.0 inches	55	5.5 inches
9	0.9 inches	25	2.5 inches	41	4.1 inches	56	5.6 inches
10	1.0 inches	26	2.6 inches	42	4.2 inches	57	5.7 inches
11	1.1 inches	27	2.7 inches	43	4.3 inches	58	5.8 inches
12	1.2 inches	28	2.8 inches	44	4.4 inches	59	5.9 inches
13	1.3 inches	29	2.9 inches	45	4.5 inches	60	6.0 inches
14	1.4 inches	30	3.0 inches	47	4.7 inches	255	0.0 inches
15	1.5 inches	31	3.1 inches	48	4.8 inches		
16	1.6 inches	32	3.2 inches				

**(069) TITLE: Average Annual Potential Evapotranspiration**

CONTENT: The Average Annual Potential Evapotranspiration Map by the Solar Thermal Unit method was derived from beginning bloom date isophanes for purple common lilacs (compiled 1986).

MAP UNIT LEGEND: The potential evapotranspiration amounts (11.5 to 33.0 inches) are correlated with map values ranging from 1 to 21. Please note that in order to display all evapotranspiration values for the state, you must include values from two groups (1-12 and 13-21).

MAP PURPOSE: This map is useful for estimating irrigation requirements for crops and other hydrological considerations.



**Codes and values table: Pe.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	11.5-12.5 inches >6/24	12	24.0-25.0 inches 5/12-5/15
2	12.5-13.5 inches 6/19-6/24	13	15.5-18.0 inches 6/04-6/09
3	13.5-14.5 inches 6/14-6/19	14	18.0-20.5 inches 5/30-6/04
4	14.5-15.5 inches 6/09-6/14	15	20.5-22.0 inches 5/27-5/30
5	15.5-17.0 inches 6/04-6/09	16	22.0-23.5 inches 5/24-5/27
6	17.0-19.0 inches 5/30-6/04	17	23.5-25.0 inches 5/21-5/24
7	19.0-20.0 inches 5/27-5/30	18	25.0-26.5 inches 5/18-5/21
8	20.0-21.0 inches 5/24-5/27	19	26.5-29.0 inches 5/15-5/18
9	21.0-22.0 inches 5/21-5/24	20	29.0-31.5 inches 5/12-5/15
10	22.0-23.0 inches 5/18-5/21	21	31.5-33.0 inches <5/12
11	23.0-24.0 inches 5/15-5/18		

**(070) TITLE: Mean Annual Precipitation**

CONTENT: Illustrates average annual precipitation distribution based on the thirty year period of 1941-70. This map is considered to be the best statewide average annual precipitation map available (compiled 1978).

MAP UNIT LEGEND: In low precipitation areas (6-20 inch annual rainfall) 2 inch increments are used, in moderate precipitation areas (20-40 inches) 10 inch increments are used, and in high precipitation areas (40-120 inches) 20 inch increments are used.

MAP PURPOSE: The Average Annual Precipitation Map is used by resource planners to optimize water resource planning and development.

**Codes and values table: Aap.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	4 - 6 inches	9	20 - 30 inches
2	6 - 8 inches	10	30 - 40 inches
3	8 - 10 inches	11	40 - 50 inches
4	10 - 12 inches	12	40 - 60 inches
5	12 - 14 inches	13	50 - 60 inches
6	14 - 16 inches	14	60 - 80 inches
7	16 - 18 inches	15	80 - 100 inches
8	18 - 20 inches	16	100 - 120 inches

**(071) TITLE: Mean Percentage of Annual Precipitation during April 1 to July 31**

CONTENT: Data were based upon manually drawn isolines for areas below 5,000 feet elevation and having less than 100 inches of average annual snowfall. Areas above 5,000 feet and with more than 100 inches of snowfall were determined by algorithm (compiled 1988).

MAP UNIT LEGEND: 17 classes; .5 percentage point increments from 22.5 to 65.0.

MAP PURPOSE: This map helps one comprehend the variation in annual distribution of precipitation. Areas with the higher percentages tend to realize greater crop yields for given amounts of annual precipitation with all other crop variables equal.

**Codes and values table: Mapaj.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
2	22.5 - 25.0	11	45.0 - 47.5
3	25.0 - 27.5	12	47.5 - 50.0
4	27.5 - 30.0	13	50.0 - 52.5
5	30.0 - 32.5	14	52.5 - 55.0
6	32.5 - 35.0	15	55.0 - 57.5
7	35.0 - 37.5	16	57.5 - 60.0
8	37.5 - 40.0	17	60.0 - 62.5
9	40.0 - 42.5	18	62.5 - 65.0
10	42.5 - 45.0		

**(072) TITLE: Mean Percentage of Annual Precipitation during May 1 to July 31**

CONTENT: Illustrates the percentage of annual precipitation received in each of the 18,000 cells representing the state (compiled 1978).

MAP UNIT LEGEND: 19 classes; 2.5 percentage point increments from 10.0-57.5.

MAP PURPOSE: Helpful in conveying information about annual precipitation distribution.

**Codes and values table: Mapmaj.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	10.0 - 12.5	8	27.5 - 30.0	15	45.0 - 47.5
2	12.5 - 15.0	9	30.0 - 32.5	16	47.5 - 50.0
3	15.0 - 17.5	10	32.5 - 35.0	17	50.0 - 52.5
4	17.5 - 20.0	11	35.0 - 37.5	18	52.5 - 55.0
5	20.0 - 22.5	12	37.5 - 40.0	19	55.0 - 57.5
6	22.5 - 25.0	13	40.0 - 42.5		
7	25.0 - 27.5	14	42.5 - 45.0		

**(073) TITLE: Mean Precipitation April 1 to July 31**

CONTENT: Mean monthly precipitation for April, May, June, and July; based on 29 years of historical weather data (compiled 1987).

MAP UNIT LEGEND: 19 classes (inches); 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10-12, 12-14, 14-16, 16-18, 18-20, 20-22, 22-24, 24-26, 26-28, 28-30, 30-35.

MAP PURPOSE: Mean precipitation from April 1 to July 31 reflects the precipitation during the main growth period of most field crops. Precipitation during this period is useful to estimate potential productivity of the majority of crops grown in Montana.

**Codes and values table: Apaj.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	2 - 3 inches	7	8 - 9 inches	13	18 - 20 inches
2	3 - 4 inches	8	9 - 10 inches	14	20 - 22 inches
3	4 - 5 inches	9	10 - 12 inches	16	24 - 26 inches
4	5 - 6 inches	10	12 - 14 inches	17	26 - 28 inches
5	6 - 7 inches	11	14 - 16 inches	18	28 - 30 inches
6	7 - 8 inches	12	16 - 18 inches	19	30 - 35 inches

**(074) TITLE: Mean Precipitation August 1 to March 31**

CONTENT: Contains the mean monthly precipitation for eight months (August to March) based on 29 years of historical weather data (compiled 1987).

MAP UNIT LEGEND: 23 classes (inches); 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10-12, 12-14, 14-16, 16-18, 18-20, 20-22, 22-24, 24-26, 26-28, 28-30, 30-40, 40-50, 50-60, 60-70, 80-90 (there are no cells with values in the 70-80 range).

MAP PURPOSE: Mean precipitation for the period August 1 to March 31 reflects the precipitation during that part of the year after most field crops have already completed their major growth or have been harvested. Precipitation received during this period is useful for decisions related to fall planted wheat, soil moisture, and mountain snowpack.

**Codes and values table: Apam.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	2 - 3 inches	9	10 - 12 inches	17	26 - 28 inches
2	3 - 4 inches	10	12 - 14 inches	18	28 - 30 inches
3	4 - 5 inches	11	14 - 16 inches	19	30 - 40 inches
4	5 - 6 inches	12	16 - 18 inches	20	40 - 50 inches
5	6 - 7 inches	13	18 - 20 inches	21	50 - 60 inches
6	7 - 8 inches	14	20 - 22 inches	22	60 - 70 inches
7	8 - 9 inches	15	22 - 24 inches	24	80 - 90 inches
8	9 - 10 inches	16	24 - 26 inches		

**(075-086) TITLE: Mean Monthly Percentage of Annual Precipitation**

CONTENT: Determined by algorithm using geographic factors, annual precipitation and percent of annual precipitation that occurs April 1 to July 31 (compiled 1988).

MAP UNIT LEGEND: Percent.

MAP PURPOSE: The mean monthly percent of annual precipitation maps help one comprehend the variation in annual precipitation distribution.

**Codes and values table: Janprentan.dbf through Decprentan.dbf (12 months)**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
7	1	25	3	45	5	63	6
8	1	26	3	46	5	64	6
9	1	27	3	47	5	65	7
10	1	30	3	48	5	66	7
11	1	31	3	49	5	67	7
12	1	32	3	50	5	68	7
13	1	33	3	51	5	69	7
14	1	34	3	52	5	70	7
15	2	35	4	53	5	71	7
16	2	36	4	54	5	72	7
17	2	37	4	55	6	73	7
18	2	38	4	56	6	74	7
19	2	39	4	57	6	75	8
20	2	40	4	58	6	76	8
21	2	41	4	59	6	77	8
22	2	42	4	60	6	78	8
23	2	43	4	61	6	79	8
24	2	44	4	62	6	80	8

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
81	8	113	11	145	15	177	18
82	8	114	11	146	15	178	18
83	8	115	12	147	15	179	18
84	8	116	12	148	15	180	18
85	9	117	12	149	15	181	18
86	9	118	12	150	15	182	18
87	9	119	12	151	15	183	18
88	9	120	12	152	15	184	18
89	9	121	12	153	15	185	19
90	9	122	12	154	15	186	19
91	9	123	12	155	16	187	19
92	9	124	12	156	16	188	19
93	9	125	13	157	16	189	19
94	9	126	13	158	16	190	19
95	10	127	13	159	16	191	19
96	10	128	13	160	16	192	19
97	10	129	13	161	16	193	19
98	10	130	13	162	16	194	19
99	10	131	13	163	16	195	20
100	10	132	13	164	16	196	20
101	10	133	13	165	17	197	20
102	10	134	13	166	17	198	20
103	10	135	14	167	17	199	20
104	10	136	14	168	17	200	20
105	11	137	14	169	17	201	20
106	11	138	14	170	17	202	20
107	11	139	14	171	17	203	20
108	11	140	14	172	17	204	20
109	11	141	14	173	17	205	21
110	11	142	14	174	17	206	21
111	11	143	14	175	18		
112	11	144	14	176	18		

**(087-098) TITLE: Mean Monthly Precipitation**

CONTENT: Derived by algorithm using geographical factors, annual precipitation and percent of annual precipitation from April 1 to July 31 (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: These maps are useful for determining average precipitation for periods shorter than a year. The information has various applications in such areas as agriculture, hydrology and recreation.

**Codes and values table: Janprecip.dbf through Decprecip (12 months)**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	0.1 inches	30	3.0 inches	62	6.2 inches	112	11.2 inches
2	0.2 inches	31	3.1 inches	61	6.1 inches	113	11.3 inches
3	0.3 inches	32	3.2 inches	63	6.3 inches	114	11.4 inches
4	0.4 inches	33	3.3 inches	64	6.4 inches	115	11.5 inches
5	0.5 inches	34	3.4 inches	65	6.5 inches	116	11.6 inches
6	0.6 inches	35	3.5 inches	66	6.6 inches	117	11.7 inches
7	0.7 inches	36	3.6 inches	67	6.7 inches	118	11.8 inches
8	0.8 inches	37	3.7 inches	68	6.8 inches	119	11.9 inches
9	0.9 inches	38	3.8 inches	69	6.9 inches	120	12.0 inches
10	1.0 inches	39	3.9 inches	70	7.0 inches	121	12.1 inches
11	1.1 inches	40	4.0 inches	71	7.1 inches	124	12.4 inches
12	1.2 inches	41	4.1 inches	72	7.2 inches	127	12.7 inches
13	1.3 inches	42	4.2 inches	74	7.4 inches	128	12.8 inches
14	1.4 inches	43	4.3 inches	76	7.6 inches	129	12.9 inches
15	1.5 inches	44	4.4 inches	77	7.7 inches	130	13.0 inches
16	1.6 inches	45	4.5 inches	78	7.8 inches	131	13.1 inches
17	1.7 inches	46	4.6 inches	79	7.9 inches	132	13.2 inches
18	1.8 inches	47	4.7 inches	82	8.2 inches	133	13.3 inches
19	1.9 inches	48	4.8 inches	84	8.4 inches	134	13.4 inches
20	2.0 inches	49	4.9 inches	85	8.5 inches	135	13.5 inches
21	2.1 inches	50	5.0 inches	86	8.6 inches	136	13.6 inches
22	2.2 inches	52	5.2 inches	87	8.7 inches	137	13.7 inches
23	2.3 inches	53	5.3 inches	88	8.8 inches	138	13.8 inches
24	2.4 inches	54	5.4 inches	89	8.9 inches	139	13.9 inches
25	2.5 inches	55	5.5 inches	90	9.0 inches	140	14.0 inches
26	2.6 inches	57	5.7 inches	91	9.1 inches	167	16.7 inches
27	2.7 inches	58	5.8 inches	92	9.2 inches	168	16.8 inches
28	2.8 inches	59	5.9 inches	93	9.3 inches	169	16.9 inches
29	2.9 inches	60	6.0 inches	111	11.1 inches	171	17.1 inches

**(099) TITLE: Fifty Year Peak 24 Hour Precipitation**

CONTENT: Illustrates the maximum amount of precipitation received in a 24-hour period in each of the 18,000 cells.

MAP UNIT LEGEND: 19 classes (inches); 0.0-2.2, 2.2-2.4, 2.4-2.6, 2.6-2.8, 2.8-3.0, 3.0-3.2, 3.2-3.4, 3.4-3.6, 3.6-3.8, 3.8-4.0, 4.0-4.2, 4.2-4.4, 4.4-4.6, 4.6-4.8, 4.8-5.0, 3.0-3.4, 3.4-3.8, 3.8-4.2, 4.2-4.6.

MAP PURPOSE: There is demand for peak 24-hour precipitation data in connection with problems of engineering design, erosion and flood control.

**Codes and values table: Hr24.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	0.0 - 2.2 inches	11	4.0 - 4.2 inches
2	2.2 - 2.4 inches	12	4.2 - 4.4 inches
3	2.4 - 2.6 inches	13	4.4 - 4.6 inches
4	2.6 - 2.8 inches	14	4.6 - 4.8 inches
5	2.8 - 3.0 inches	15	4.8 - 5.0 inches
6	3.0 - 3.2 inches	16	3.0 - 3.4 inches
7	3.2 - 3.4 inches	17	3.4 - 3.8 inches
8	3.4 - 3.6 inches	18	3.8 - 4.2 inches
9	3.6 - 3.8 inches	19	4.2 - 4.6 inches
10	3.8 - 4.0 inches		

**(100) TITLE: Mean Annual Snowfall**

CONTENT: Mean annual snowfall is represented in each of the 18.000 cells representing Montana. Data are based on weather records from 1958-1972 (compiled 1978).

MAP UNIT LEGEND: Nine classes, (inches); 0-25, 25-50, 50-100, 100-200, 200-300, 300-500, 500-700, 500-800, 500-1000.

MAP PURPOSE: Provides data for engineering design, resource planning and development, and evaluating avalanche potential.

**Codes and values table: Snowfall.dbf**

<u>Code</u>	<u>Value</u>
1	0 - 25 inches
2	25 - 50 inches
3	50 - 100 inches
4	100 - 200 inches
5	200 - 300 inches
6	300 - 500 inches
7	500 - 700 inches
8	500 - 800 inches
9	500 - 1000 inches



**(101) TITLE: May-July Precipitation Amount Which is Exceeded in 70% of Years**

CONTENT: This map illustrates the likelihood of receiving a given amount of precipitation in each of the 18,000 cells representing Montana (compiled 1988).

MAP UNIT LEGEND: Inches.

MAP PURPOSE: Application in agricultural management decisions.

**Codes and values table: Mayjul70.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
16	1.6 inches	52	5.2 inches	90	9.0 inches	157	15.7 inches
17	1.7 inches	54	5.4 inches	93	9.3 inches	158	15.8 inches
22	2.2 inches	55	5.5 inches	97	9.7 inches	160	16.0 inches
24	2.4 inches	56	5.6 inches	98	9.8 inches	164	16.4 inches
25	2.5 inches	57	5.7 inches	100	10.0 inches	165	16.5 inches
28	2.8 inches	60	6.0 inches	102	10.2 inches	166	16.6 inches
29	2.9 inches	61	6.1 inches	107	10.7 inches	172	17.2 inches
30	3.0 inches	62	6.2 inches	108	10.8 inches	176	17.6 inches
31	3.1 inches	63	6.3 inches	110	11.0 inches	177	17.7 inches
32	3.2 inches	64	6.4 inches	113	11.3 inches	179	17.9 inches
33	3.3 inches	65	6.5 inches	114	11.4 inches	181	18.1 inches
34	3.4 inches	67	6.7 inches	116	11.6 inches	183	18.3 inches
35	3.5 inches	68	6.8 inches	118	11.8 inches	192	19.2 inches
36	3.6 inches	70	7.0 inches	119	11.9 inches	193	19.3 inches
37	3.7 inches	71	7.1 inches	124	12.4 inches	201	20.1 inches
38	3.8 inches	73	7.3 inches	127	12.7 inches	203	20.3 inches
39	3.9 inches	74	7.4 inches	129	12.9 inches	213	21.3 inches
40	4.0 inches	75	7.5 inches	131	13.1 inches	218	21.8 inches
42	4.2 inches	76	7.6 inches	137	13.7 inches	219	21.9 inches
43	4.3 inches	78	7.8 inches	138	13.8 inches	226	22.6 inches
44	4.4 inches	79	7.9 inches	139	13.9 inches	229	22.9 inches
45	4.5 inches	80	8.0 inches	141	14.1 inches	235	23.5 inches
46	4.6 inches	81	8.1 inches	146	14.6 inches	245	24.5 inches
47	4.7 inches	83	8.3 inches	148	14.8 inches	247	24.7 inches
48	4.8 inches	84	8.4 inches	150	15.0 inches	255	25.5 inches
49	4.9 inches	89	8.9 inches	152	15.2 inches		
51	5.1 inches						

**(102) TITLE: Counties**

CONTENT: Coded cells represent each Montana county (compiled 1982).

MAP UNIT LEGEND: Codes (001, 003, 005, ... 111) represent the alphabetical sequence of Montana's 56 counties.

MAP PURPOSE: To identify cells representing each county so that climate and land qualities can be evaluated for specified counties.

**Codes and values table: Counties.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	Beaverhead	39	Granite	77	Powell
3	Big Horn	41	Hill	79	Prairie
5	Blaine	43	Jefferson	81	Ravalli
7	Broadwater	45	Judith Basin	83	Richland
9	Carbon	47	Lake	85	Roosevelt
11	Carter	49	Lewis & Clark	87	Rosebud
13	Cascade	51	Liberty	89	Sanders
15	Chouteau	53	Lincoln	91	Sheridan
17	Custer	55	McCone	93	Silver Bow
19	Daniels	57	Madison	95	Stillwater
21	Dawson	59	Meagher	97	Sweet Grass
23	Deer Lodge	61	Mineral	99	Teton
25	Fallon	63	Missoula	101	Toole
27	Fergus	65	Musselshell	103	Treasure
29	Flathead	67	Park	105	Valley
31	Gallatin	69	Petroleum	107	Wheatland
33	Garfield	71	Phillips	109	Wibaux
35	Glacier	73	Pondera	111	Yellowstone
37	Golden Valley	75	Powder River		

**(103) TITLE: General Soils of Montana**

CONTENT: Illustrates 133 soil map units which are associations of taxonomic great groups.

MAP UNIT LEGEND: Codes are used to delineate the soil types of Montana (compiled 1978).

MAP PURPOSE: The General Soils Map of Montana can be combined with other MAPS products to compare soil-type related characteristics.

**Codes and values table: Soil.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
2	Me1	37	Vb2	70	Vb1	103	Tb1
3	Lg1	38	Et	71	Vh2	106	Hf3
4	Ct1	39	Ph1	72	Th1	107	Tp1
5	Mf3	40	Ph2	73	Hf2	108	Kf
6	R	41	Dt1	74	Ap2	110	Ct2
7	Lg2	42	Gg2	75	Vb4	111	Hf4
8	Ig	43	Ap3	76	Nb2	112	Av5
9	Ib3	44	Og2	77	Np1	114	Th4
10	Gb5	45	WAT	78	Ap7	115	Tp4
11	Sg2	46	Ma	79	Mo3	117	Th2
12	Gb4	47	Av2	80	Nh2	118	Nh3
13	Aw	48	Me4	81	Nh1	121	If3
14	Og3	49	Gf5	82	Np4	122	Gb1
15	Mo4	50	If4	83	Np2	123	Ib2
16	Sg1	51	Gb6	84	Tb2	125	Me2
17	Pp1	52	Tp5	85	Av1	126	Tp2
18	Ap1	53	Dt2	86	If2	127	Lg3
19	Ug1	54	Ap4	87	Gf1	128	Vb6
20	Sg3	55	Gf4	88	Mo6	131	Ap6
21	Sh	56	X	89	Me3	132	B
22	Vh1	57	Nh5	90	Mo2	134	Np5
23	Nh4	58	Th3	91	Tp3	135	Me5
24	Og4	59	Hf1	92	Gg1	136	Th5
25	Oh	60	Ug2	93	Av3	137	Pb1
26	Ap5	61	Th6	94	Kb4	138	Kb2
27	Og1	62	Np6	95	Mf2	139	Mo1
29	Av4	63	Nh6	96	Gb3	140	Vb3
30	St	64	Kt	97	Jf	141	Gf3
31	Ot	65	Pb2	98	Jb	142	Mo5
32	Mf1	66	Nb1	99	Kb1	144	Kb3
33	Vb5	67	Fg	100	If1	145	Lt
34	Gf2	68	Pb3	101	Ib1	146	Np3
35	Pp2	69	Mf4	102	Tb3	147	Vh3
36	Gb2						

## CLASSES:

### INTERMOUNTAIN AND PIEDMONT SECTION

*AV Entisols, Inceptisols, Mollisols of nearly level to sloping terraces, fans and flood plains*

Av1	Fluvaquents-Torriorthents-Calciorthids
Av2	Xerochrepts-Xerifluvents-Haplaquolls
Av3	Ustochrepts-Ustifluvents-Haplaquolls
Av4	Argiborolls-Haploborolls-Fluvaquents
Av5	Haploborolls-Argiborolls-Camborthids

*Aquic-Cryic:*

*B Mollisols of nearly level cold, wet basins*

B	Cryaquolls-Cryoborolls
---	------------------------

*Xeric-Frigid:*

*Ct Mollisols of nearly level to strongly sloping outwash terraces, fans and benches*

Ct1	Haploxerolls-Xerochrepts-Xeropsamments
Ct2	Haploxerolls-Natrargids

*D Mollisols and Alfisols of nearly level to sloping lacustrine terraces*

Dt1	Haploxeralfs-Argixerolls
Dt2	Natrixerolls-Argixerolls

*E Inceptisols and Entisols of nearly level to strongly sloping outwash terraces and fans with forest cover*

Et	Xerochrepts-Xerorthents-Ustochrepts
----	-------------------------------------

*Fg Mollisols of undulating to rolling glacial moraines*

Fg	Haploxerolls-Natrixerolls
----	---------------------------

*Ustic-Frigid:*

*Gb Mollisols of nearly level to highly dissected, sloping, steep benches and terraces*

- Gb1 Argiborolls-Haploborolls
- Gb2 Argiborolls-Lithic Haploborolls-Haploborolls
- Gb3 Argiborolls-Eutroboralfs-Haplaquolls
- Gb4 Argiborolls
- Gb5 Argiborolls-Calciborolls
- Gb6 Calciborolls

*Gf Mollisols of sloping to steep foothills*

- Gf1 Argiborolls-Lithic Argiborolls
- Gf2 Argiborolls-Haploborolls
- Gf3 Calciborolls-Haploborolls
- Gf4 Haploborolls-Ustorthents
- Gf5 Haploborolls-Lithic Haploborolls

*Gg Mollisols of undulating to rolling piedmont glacial moraines*

- Gg1 Argiborolls-Haploborolls
- Gg2 Argiborolls-Haploborolls-Calciborolls

*Ustic-Frigid/Cryic:*

*Hf Mollisols and Entisols of sloping to steep foothills*

- Hf1 Haploborolls-Argiborolls-Cryoborolls
- Hf2 Haploborolls-Cryoborolls-Paleboralfs
- Hf3 Argiborolls-Haploborolls-Cryoborolls
- Hf4 Ustorthents-Lithic Haploborolls

*Ustic-Cryic:*

*Ib Mollisols of nearly level to highly dissected, sloping, steep benches and terraces*

- Ib1 Cryoborolls
- Ib2 Cryoborolls-Cryaquolls
- Ib3 Cryoborolls-Cryoborolls, shallow

*If Mollisols and Inceptisols of sloping to steep foothills*

- If1 Cryoborolls-Lithic Cryoborolls
- If2 Cryoborolls
- If3 Cryoborolls-Cryochrepts-rock outcrop
- If4 Cryoborolls-Cryochrepts-Ustochrepts

*Ig Mollisols of undulating to rolling piedmont glacial moraines*

- Ig Cryoborolls

*Aridic-Frigid:*

*Jb Mollisols and Aridisols of nearly level to highly dissected, sloping, steep benches and terraces*

- Jb Argiborolls-Calciorthids

*Jf Mollisols, Aridisols, and Entisols of foothills*

- Jf Argiborolls-Haplargids-Torriorthents, shallow

*Kb Aridisols of nearly level to highly dissected, sloping, steep benches and terraces*

- Kb1 Calciorthids-Torriorthents
- Kb2 Calciorthids-Haplargids-Argiborolls
- Kb3 Calciorthids-Argiborolls-Camborthids
- Kb4 Calciorthids

*Kt Aridisols of nearly level to dissected, sloping, and steep lacustrine terraces*

- Kt Camborthids-Natrargids

*Kf Aridisols and Mollisols of sloping to steep foothills*

- Kf Calciorthids-Argiborolls

*Udic-Frigid/Cryic:*

*Lt Cryic Inceptisols and Entisols of nearly level outwash terraces with forest cover*

- Lt Cryochrepts-Cryorthents

*Lg Inceptisols and alfisols of undulating to rolling valley and foothill glacial moraines with forest cover*

- Lg1 Cryochrepts-Eutroboralfs-Eutrochrepts
- Lg2 Cryoboralfs-Cryoborolls
- Lg3 Cryochrepts-Cryoboralfs

*Udic-Cryic:*

*Ma Inceptisols (Andic) of steep and very steep forested mountains*

- Ma Cryochrepts-Cryandepts (mixed lithology)

*Me Inceptisols and Alfisols of steep and very steep forested mountains*

- Me1 Cryochrepts-Cryoboralfs-Eutroboralfs (glacial deposits over quartzite, argillaceous, and dolomitic lithology)
- Me2 Cryochrepts-Cryoboralfs (argillaceous & quartzitic lithology)
- Me3 Cryochrepts-Cryoboralfs-Cryoborolls (granitic and crystalline lithology)
- Me4 Cryochrepts-Cryoboralfs-Lithic Cryoborolls (mixed lithology)
- Me5 Cryochrepts-Cryoboralfs-rock outcrop (granitic and crystalline lithology)

*Udic/Ustic-Frigid/Cryic:*

*Mf Inceptisols of steep and very steep forested mountains*

- Mf1 Cryochrepts-Ustochrepts-Eutroboralfs (mixed)
- Mf2 Cryochrepts-Ustochrepts-Cryorthents
- Mf3 Cryochrepts-Ustochrepts-Cryoboralfs (calcareous lithology)
- Mf4 Cryochrepts-Ustochrepts-Lithic Cryoborolls (argillaceous and quartzitic lithology)

*Mo Mollisols, Inceptisols, and Alfisols of steep and very steep mountains with open forest-grass cover*

- Mo1 Cryoborolls-Cryochrepts-Cryoboralfs (mixed lithology)
- Mo2 Cryoborolls-Cryochrepts-Ustochrepts (calcareous lithology)
- Mo3 Cryoborolls-Cryoboralfs-Cryochrepts (mixed lithology)
- Mo4 Cryochrepts-Cryoborolls-Haploborolls (mixed lithology)
- Mo5 Cryoborolls (mixed lithology)
- Mo6 Eutroboralfs-Argiborolls-Lithic Cryoborolls (granitic and crystalline lithology)

*Udic-Cryic:*

*R Mountain peaks and sloping to very steep alpine grasslands*

R Rock outcrop, talus, Cryoborolls & Cryochrepts (mixed lithology)

## **GREAT PLAINS SECTION**

*Aridic/Ustic-Frigid:*

*Ap Entisols, Aridisols, Inceptisols, and Mollisols of nearly level to sloping low terraces, fans and flood plains*

Ap1 Torrifluvents-Salorthids  
Ap2 Camborthids-Torrifluvents-Torriorthents  
Ap3 Camborthids-Natrargids-Torrifluvents  
Ap4 Ustochrepts-Ustifluvents-Argiborolls  
Ap5 Ustifluvents-Haploborolls-Argiborolls  
Ap6 Haploborolls  
Ap7 Haploborolls-Argiborolls-Ustifluvents

*Aquic-Frigid:*

*Aw Mollisols and Entisols of nearly level wet basins, low terraces, and flood plains*

Aw Haplaquepts-Torriorthents-Haplaquolls

*Ustic-Frigid:*

*Nb Mollisols of nearly level to highly dissected, sloping and steep benches and terraces*

Nb1 Argiborolls  
Nb2 Haploborolls

*Np Mollisols and Entisols of gently to strongly sloping sedimentary bedrock plains*

Np1 Agriborolls-Ustorthents  
Np2 Argiborolls-Lithic Argiborolls  
Np3 Argiborolls-Haploborolls-Ustochrepts  
Np4 Calciborolls-Haploborolls



Np5 Haploborolls-Argiborolls-Ustochrepts  
Np6 Haploborolls-Ustochrepts-Ustorthents

*Nh Entisols, Mollisols, and Inceptisols of dissected, rolling to steep sedimentary bedrock plains and hills*

Nh1 Haploborolls-Calcioborolls-Argiborolls  
Nh2 Ustochrepts-Haploborolls-Argiborolls  
Nh3 Ustorthents-Lithic Haploborolls-Argiborolls  
Nh4 Ustorthents-Ustochrepts  
Nh5 Ustochrepts-Ustorthents  
Nh6 Ustorthents-Haploborolls

*Og Mollisols and Entisols of undulating to rolling glacial till plains*

Og1 Argiborolls-Haploborolls  
Og2 Argiborolls-Haploborolls  
Og3 Argiborolls-Ustorthents  
Og4 Argiborolls-Ustorthents

*Oh Entisols and Mollisols of dissected, hilly glacial till plains*

Oh Ustorthents-Argiborolls

*Ot Mollisols of nearly level to sloping glacial outwash and stream terraces*

Ot Haploborolls-Argiborolls

*Aridic-Frigid:*

*Pb Mollisols and Aridisols of nearly level to highly dissected, sloping, and steep benches and terraces*

Pb1 Argiborolls-Camborthids  
Pb2 Calciborolls-Calciorthids  
Pb3 Haploborolls-Camborthids-Argiborolls

*Pp Mollisols and Aridisols of gently to strongly sloping sedimentary bedrock plains*

Pp1 Argiborolls-Haploborolls-Lithic Argiborolls  
Pp2 Argiborolls-Haplargids-Lithic Torriorthents

*Ph Entisols and Mollisols of dissected, rolling to steep sedimentary bedrock plains and hills*

- Ph1 Torriorthents, shallow-Argiborolls-Camborthids
- Ph2 Torriorthents, shallow-Lithic Torriorthents-Torrifluvents

*Sg Mollisols and Aridisols of undulating to rolling glacial till plains*

- Sg1 Argiborolls-Haploborolls
- Sg2 Argiborolls-Paleargids-Natrargids
- Sg3 Argiborolls-Torriorthents-Natrargids

*Sh Entisols and Aridisols of dissected, hilly glacial till plains*

- Sh Torriorthents-Natrargids-Torriorthents, shallow

*St Mollisols of nearly level to sloping glacial outwash and stream terraces*

- St Argiborolls-Haploborolls

*Tb Aridisols of nearly level to highly dissected, sloping, and steep benches and terraces*

- Tb1 Haplargids-Haploborolls-Argiborolls
- Tb2 Natrargids-Hapargids
- Tb3 Camborthids-Torriorthents

*Tp Aridisols of gently to strongly sloping sedimentary bedrock plains*

- Tp1 Camborthids-Haploborolls-Argiborolls
- Tp2 Camborthids-Torriorthents, shallow
- Tp3 Camborthids
- Tp4 Camborthids-Torriorthents, shallow
- Tp5 Haplargids-Camborthids-Natrargids

*Th Entisols and Aridisols of dissected, rolling to steep sedimentary bedrock plains and hills*

- Th1 Torriorthents-Camborthids
- Th2 Torriorthents, shallow-Camborthids-Torriorthents
- Th3 Torriorthents, shallow-Torriorthents-Camborthids
- Th4 Torriorthents-Torriorthents, shallow-Camborthids
- Th5 Torriorthents-Lithic Torriorthents-Camborthids
- Th6 Torriorthents-Natrargids

*Ug Aridisols of undulating to rolling glacial till plains*

- Ug1 Paleargids-Natrargids-Argiborolls

*Aridic/Ustic-Frigid:*

*Vb Aridisols, Mollisols, and Entisols of clayey, nearly level to sloping terraces, fans, benches and lacustrine basins*

- Vb1 Argiborolls-Eutroboralfs
- Vb2 Camborthids-Torriorthents-Argiborolls
- Vb3 Camborthids-Natrargids

**(104) TITLE: Soil Water Holding Capacity**

CONTENT: Illustrates a soil's capacity for plant available water. Available water is the amount of water in a soil that can be absorbed by plant roots (compiled 1993).

MAP UNIT LEGEND: Total soil profile available water holding capacity rounded to the nearest inch.

MAP PURPOSE: Useful in soil conservation, determining a soil's productive capacity, and irrigation management.

**Codes and values table: Soilwhc.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Values</u>	<u>Code</u>	<u>Value</u>
17	1.7 inches	43	4.3 inches	69	6.9 inches	95	9.5 inches
18	1.8 inches	44	4.4 inches	70	7.0 inches	96	9.6 inches
19	1.9 inches	45	4.5 inches	71	7.1 inches	97	9.7 inches
20	2.0 inches	46	4.6 inches	72	7.2 inches	98	9.8 inches
21	2.1 inches	47	4.7 inches	73	7.3 inches	99	9.9 inches
22	2.2 inches	48	4.8 inches	74	7.4 inches	100	10.0 inches
23	2.3 inches	49	4.9 inches	75	7.5 inches	101	10.1 inches
24	2.4 inches	50	5.0 inches	76	7.6 inches	102	10.2 inches
25	2.5 inches	51	5.1 inches	77	7.7 inches	103	10.3 inches
26	2.6 inches	52	5.2 inches	78	7.8 inches	104	10.4 inches
27	2.7 inches	53	5.3 inches	79	7.9 inches	105	10.5 inches
28	2.8 inches	54	5.4 inches	80	8.0 inches	106	10.6 inches
29	2.9 inches	55	5.5 inches	81	8.1 inches	107	10.7 inches
30	3.0 inches	56	5.6 inches	82	8.2 inches	108	10.8 inches
31	3.1 inches	57	5.7 inches	83	8.3 inches	109	10.9 inches
32	3.2 inches	58	5.8 inches	84	8.4 inches	110	11.0 inches
33	3.3 inches	59	5.9 inches	85	8.5 inches	111	11.1 inches
34	3.4 inches	60	6.0 inches	86	8.6 inches	112	11.2 inches
35	3.5 inches	61	6.1 inches	87	8.7 inches	113	11.3 inches
36	3.6 inches	62	6.2 inches	88	8.8 inches	114	11.4 inches
37	3.7 inches	63	6.3 inches	89	8.9 inches	255	Water or
38	3.8 inches	64	6.4 inches	90	9.0 inches		Rock
39	3.9 inches	65	6.5 inches	91	9.1 inches		Outcrop
40	4.0 inches	66	6.6 inches	92	9.2 inches		
41	4.1 inches	67	6.7 inches	93	9.3 inches		
42	4.2 inches	68	6.8 inches	94	9.4 inches		

**(105) TITLE: Mean Annual Soil Temperature (Mean Annual Air Temp Plus 2EF)**

CONTENT: Estimated average annual soil temperature. Estimates were derived by adding 2EF to mean annual air temperature (compiled 1988).

MAP UNIT LEGEND: 29 classes (EF); Temperatures for each cell are reported to the nearest whole EF. The state-wide range is from 22EF to 50EF.

MAP PURPOSE: Useful in managerial decisions in agriculture and engineering.

**Codes and values table: Maatplus2.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
22	22 F	30	30 F	38	38 F	46	46 F
23	23 F	31	31 F	39	39 F	47	47 F
24	24 F	32	32 F	40	40 F	48	48 F
25	25 F	33	33 F	41	41 F	49	49 F
26	26 F	34	34 F	42	42 F	50	50 F
27	27 F	35	35 F	43	43 F		
28	28 F	36	36 F	44	44 F		
29	29 F	37	37 F	45	45 F		

**(106) TITLE: Mean Annual Soil Temperature (Mean Annual Air Temp Plus 1EF)**

CONTENT: Estimated mean annual soil temperature. Estimates derived were by adding 1EF to mean annual air temperature (compiled 1989).

MAP UNIT LEGEND: 29 classes (EF); Temperatures for each cell are reported to the nearest whole EF. The statewide range is from 21EF to 49EF.

MAP PURPOSE: Useful in managerial decisions in agriculture and engineering.

**Codes and values table: Maatplus1.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
21	21 F	29	29 F	37	37 F	44	44 F
22	22 F	30	30 F	38	38 F	45	45 F
23	23 F	31	31 F	39	39 F	46	46 F
24	24 F	32	32 F	40	40 F	47	47 F
25	25 F	33	33 F	41	41 F	48	48 F
26	26 F	34	34 F	42	42 F	49	49 F
27	27 F	35	35 F	43	43 F		
28	28 F	36	36 F				

**(107) TITLE: Soil Depth Classes**

CONTENT: Six predominant soil depth classes are illustrated in each of the 18,000 cells representing the state (compiled 1985).

MAP UNIT LEGEND: 6 classes of predominant soil depths; shallow-moderately deep (10-40 inches), moderately deep (20-40 inches), moderately deep-deep (20-60+ inches), deep (40-60+ inches), shallow-deep (10-60+ inches), water.

MAP PURPOSE: Has implications in agriculture, industry, and real estate.

**Codes and values table: Soilsd.dbf**

<u>Code</u>	<u>Value</u>
1	Shallow-mod deep (10-40 inches)
2	Mod deep (20-40 inches)
3	Mod deep-deep (20-60+ inches)
4	Deep (40-60+ inches)
5	Shallow-deep (10-60+ inches)
6	Water

**(108) TITLE: Mean Annual R Factor (Universal Soil Loss Equation)**

CONTENT: R factor is an index of the annual erosiveness of rainfall used in the Universal Soil Loss Equation. The R values are based on data obtained from 1958-1972 average of annual snowfall, climatological data and from isopluvials of 2 year - 6 hour precipitation (compiled 1978).

MAP UNIT LEGEND: 10 classes ( $10^7$  J/ha); 10, 15, 20, 25, 30, 50, 75, 100, 125, 150.

MAP PURPOSE: To show the distribution of R, one of the factors affecting runoff, erosion and sediment production.

**Codes and values table: Aavfr.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	10	6	50
2	15	7	75
3	20	8	100
4	25	9	125
5	30	10	150

**(109) TITLE: Average Soil pH**

CONTENT: Values were derived from pH ranges for soil series reported in the Soil Conservation Service form - 5 data base. The values are averages based upon several soil series that represent each map unit in the General Soil Map (1:1,000,000 scale) of Montana. They are not weighted according to the relative abundance of each soil series. The averages are arithmetic means of the low and high values given for representative soils (compiled 1988).

MAP UNIT LEGEND: Average pH ranging from 5.8 - 8.2.

MAP PURPOSE: Represents the distribution of average soil pH values throughout the state for general projects that are influenced by pH. Soil pH influences the availability and fixation of plant nutrients, ion mobility, leaching, toxicity, volatilization, groundwater pollution and soil productivity.

**Codes and values table: Asoilph.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
58	5.8	67	6.7	76	7.6
59	5.9	68	6.8	77	7.7
60	6.0	69	6.9	78	7.8
61	6.1	70	7.0	79	7.9
62	6.2	71	7.1	80	8.0
63	6.3	72	7.2	82	8.2
64	6.4	73	7.3	255	Water or rocks
65	6.5	74	7.4		
66	6.6	75	7.5		

**(110) TITLE: Highest Representative Soil pH**

CONTENT: Values were derived from pH ranges for soil series reported in the Soil Conservation Service form - 5 data base. The values are based upon soil series that represent each map unit in the General Soil map (1:1,000,000 scale) of Montana. Values reported are the highest value given for the representative soils (compiled 1988).

MAP UNIT LEGEND: Highest representative pH ranging from 6.5 - 9.1.

MAP PURPOSE: Represents the distribution of high soil pH values throughout the state for general projects that are influenced by pH. Soil pH influences the availability and fixation of plant nutrients, ion mobility, leaching, toxicity, volatilization, groundwater pollution and soil productivity.

**Codes and values table: Hsoilph.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
65	6.5	75	7.5	84	8.4
66	6.6	76	7.6	85	8.5
68	6.8	77	7.7	86	8.6
69	6.9	78	7.8	88	8.8
70	7.0	79	7.9	89	8.9
71	7.1	80	8.0	90	9.0
72	7.2	81	8.1	91	9.1
73	7.3	82	8.2	255	Water or rocks
74	7.4	83	8.3		

**(111) TITLE: Average Number of Strong Chinooks Per 100 Years**

CONTENT: Illustrates the average number of strong Chinooks per 100 years (compiled 1978).

MAP UNIT LEGEND: Map values range from 0-300 and delineate Chinook frequency per 100 years.

MAP PURPOSE: Chinook frequency is useful when considering areal difference in winter climates of the state.

**Codes and values table: Chinooks.dbf**

<u>Code</u>	<u>Value</u>
1	0 - 75
2	75 - 100
3	100 - 150
4	150 - 175
5	175 - 200
6	200 - 225
7	225 - 250
8	250 - 275
9	275 - 300
10	100 - 125
11	125 - 150



**(112) TITLE: Mean Annual Air Temperature**

CONTENT: Computed from derived mean monthly maximum and minimum temperature maps (compiled 1988).

MAP UNIT LEGEND: (EF); 20-48.

MAP PURPOSE: Temperature is one of the most commonly referenced of climatic elements. It is important in designating crop potential areas. Many other applications can be found in agriculture, recreation, business and travel.

**Codes and values table: Maat.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
20	20 F	28	28 F	36	36 F	44	44 F
21	21 F	29	29 F	37	37 F	45	45 F
22	22 F	30	30 F	38	38 F	46	46 F
23	23 F	31	31 F	39	39 F	47	47 F
24	24 F	32	32 F	40	40 F	48	48 F
25	25 F	33	33 F	41	41 F		
26	26 F	34	34 F	42	42 F		
27	27 F	35	35 F	43	43 F		

**(113-124) TITLE: Mean Monthly Air Temperature\***

CONTENT: Computed from derived mean monthly maximum and minimum temperature maps (compiled 1988).

MAP UNIT LEGEND: (EF); Jan. 99-127\*\*, Feb. 2-33, Mar. 6-37, Apr. 17-47, May 28-57, Jun. 37-65, Jul. 43-73, Aug. 41-72, Sep. 33-61, Oct. 24-50, Nov. 9-37, Dec. 1-31.

MAP PURPOSE: Temperature is one of the most commonly referenced of climatic elements. It is important in designating crop potential areas. Many other applications can be found in agriculture, recreation, business and travel.

\* The mean monthly air temperature is the average of the mean daily air temperatures for the given month. The mean daily air temperature is the sum of the daily maximum and minimum air temperatures divided by two.

\*\* The actual January temperature is the code minus 100. Mean January temperature in Montana ranges from -1EF to 27EF.

**Codes and values table:** Meanjan.dbf through Meandec.dbf (12 months)

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
2	2 F	29	29 F	50	50 F	102	2 F
3	3 F	30	30 F	51	51 F	103	3 F
4	4 F	31	31 F	52	52 F	104	4 F
5	5 F	32	32 F	53	53 F	105	5 F
6	6 F	33	33 F	54	54 F	106	6 F
7	7 F	28	28 F	55	55 F	107	7 F
8	8 F	29	29 F	56	56 F	108	8 F
9	9 F	30	30 F	57	57 F	109	9 F
10	10 F	31	31 F	58	58 F	110	10 F
11	11 F	32	32 F	59	59 F	111	11 F
12	12 F	33	33 F	60	60 F	112	12 F
13	13 F	34	34 F	61	61 F	113	13 F
14	14 F	35	35 F	62	62 F	114	14 F
15	15 F	36	36 F	63	63 F	115	15 F
16	16 F	37	37 F	64	64 F	116	16 F
17	17 F	38	38 F	65	65 F	117	17 F
18	18 F	39	39 F	66	66 F	118	18 F
19	19 F	40	40 F	67	67 F	119	19 F
20	20 F	41	41 F	68	68 F	120	20 F
21	21 F	42	42 F	69	69 F	121	21 F
22	22 F	43	43 F	70	70 F	122	22 F
23	23 F	44	44 F	71	71 F	123	23 F
24	24 F	45	45 F	72	72 F	124	24 F
25	25 F	46	46 F	73	73 F	125	25 F
26	26 F	47	47 F	99	-1 F	126	26 F
27	27 F	48	48 F	100	0 F	127	27 F
28	28 F	49	49 F	101	1 F		

**(125-136) TITLE: Mean Minimum Monthly Air Temperature\***

CONTENT: A regression model was determined from the monthly normal publication data and was used to generate temperatures for each cell using the appropriate MAPS variables. An elevation correction was applied to the higher elevations where weather data were sparse (compiled 1988).

MAP UNIT LEGEND: (EF); Jan. 89-119\*\*, Feb. 89-127\*\*, Mar. 93-128\*\*, Apr. 4-34, May 15-43, June 51-22, Jul. 25-55, Aug. 24-55, Sep. 16-44, Oct. 9-37, Nov. 98-130\*\*, Dec. 90-126\*\*.

MAP PURPOSE: Temperature is one of the most commonly referenced of climatic elements. It is important in designating crop potential areas. Many other applications can be found in agriculture, recreation, business and travel.

\* The mean minimum monthly air temperature is the average of the given month's minimum daily air temperatures.

\*\* The actual Jan., Feb., Mar., Nov., and Dec. temperature is the code minus 100. For example, mean minimum January temperature in Montana ranges from -11EF to 19EF.

**Codes and values table:** Tminjan.dbf through Tmindec.dfb (12 months)

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
4	4 F	27	27 F	50	50 F	106	6 F
5	5 F	28	28 F	51	51 F	107	7 F
6	6 F	29	29 F	52	52 F	108	8 F
7	7 F	30	30 F	53	53 F	109	9 F
8	8 F	31	31 F	54	54 F	110	10 F
9	9 F	32	32 F	55	55 F	111	11 F
10	10 F	33	33 F	89	-11 F	112	12 F
11	11 F	34	34 F	90	-10 F	113	13 F
12	12 F	35	35 F	91	-9 F	114	14 F
13	13 F	36	36 F	92	-8 F	115	15 F
14	14 F	37	37 F	93	-7 F	116	16 F
15	15 F	38	38 F	94	-6 F	117	17 F
16	16 F	39	39 F	95	-5 F	118	18 F
17	17 F	40	40 F	96	-4 F	119	19 F
18	18 F	41	41 F	97	-3 F	120	20 F
19	19 F	42	42 F	98	-2 F	121	21 F
20	20 F	43	43 F	99	-1 F	122	22 F
21	21 F	44	44 F	100	0 F	123	23 F
22	22 F	45	45 F	101	1 F	124	24 F
23	23 F	46	46 F	102	2 F	125	25 F
24	24 F	47	47 F	103	3 F	126	26 F
25	25 F	48	48 F	104	4 F	127	27 F
26	26 F	49	49 F	105	5 F	128	28 F

**(137-148) TITLE: Mean Maximum Monthly Air Temperature\***

CONTENT: A regression model was determined from the monthly normals publication data and was used to generate temperatures for each cell using the appropriate MAPS variables. An elevation correction was applied to the higher elevations where weather data were sparse (compiled 1988).

MAP UNIT LEGEND: (EF); Jan. 8-36, Feb. 15-42, Mar. 20-49, Apr. 30-60, May 42-72, Jun. 51-80, Jul. 61-91, Aug. 58-88, Sep. 51-77, Oct. 40-66, Nov. 21-48, Dec. 12-40.

MAP PURPOSE: Temperature is one of the most commonly referenced of climatic elements. It is important in designating crop potential areas. Many other applications can be found in agriculture, recreation, business and travel.

\* The mean maximum monthly air temperature is the average of the given month's maximum daily air temperatures.

**Codes and values table: Tmaxjan.dbf through Tmaxdec.dbf (12 months)**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
8	8 F	29	29 F	50	50 F	71	71 F
9	9 F	30	30 F	51	51 F	72	72 F
10	10 F	31	31 F	52	52 F	73	73 F
11	11 F	32	32 F	53	53 F	74	74 F
12	12 F	33	33 F	54	54 F	75	75 F
13	13 F	34	34 F	55	55 F	76	76 F
14	14 F	35	35 F	56	56 F	77	77 F
15	15 F	36	36 F	57	57 F	78	78 F
16	16 F	37	37 F	58	58 F	79	79 F
17	17 F	38	38 F	59	59 F	80	80 F
18	18 F	39	39 F	60	60 F	81	81 F
19	19 F	40	40 F	61	61 F	82	82 F
20	20 F	41	41 F	62	62 F	83	83 F
21	21 F	42	42 F	63	63 F	84	84 F
22	22 F	43	43 F	64	64 F	85	85 F
23	23 F	44	44 F	65	65 F	86	86 F
24	24 F	45	45 F	66	66 F	87	87 F
25	25 F	46	46 F	67	67 F	88	88 F
26	26 F	47	47 F	68	68 F	89	89 F
27	27 F	48	48 F	69	69 F	90	90 F
28	28 F	49	49 F	70	70 F	91	91 F

**(149) TITLE: Consumptive Water Use**

CONTENT: Amount of consumptive use of water in Montana (compiled 1978).

MAP UNIT LEGEND: Six classes: high, moderately high, moderate, moderately low, and low. Mountainous areas are not classified.

MAP PURPOSE: Assists in water use analysis for resource planning and development purposes.

**Codes and values table: Consum.dbf**

<u>Code</u>	<u>Value</u>
1	High
2	Mod high
3	Mod
4	Mod low
5	Low
6	Mountainous

**(150) TITLE: Hydrological Drainage Basins**

CONTENT: Four major river basins in Montana and their tributaries (compiled 1988).

MAP UNIT LEGEND: 85 tributaries associated with four major river basins. Map values ranging from 1-99 represent tributaries in the Missouri River Drainage; 100-199 are tributaries in the Yellowstone River Drainage, 200-233 are tributaries in the Clark Fork Drainage (Columbia); 255 represents the St. Mary River Drainage (Hudson Bay). Key to major drainage basins: A-Missouri/Upper Missouri; B-Missouri/Missouri-Smith; C-Missouri/Missouri-Sun-Marias; D-Missouri/Missouri-Musselshell; E-Missouri/Milk; F-Missouri/Missouri-Fort Peck; G-Missouri/Little Missouri, H-Yellowstone/Upper Yellowstone; I-Yellowstone/Middle Yellowstone; J-Yellowstone/Lower Yellowstone; K-Columbia; L-Columbia/Flathead; M-Columbia/Upper Clark Fork; N-Columbia/Lower Clark Fork; O-Hudson Bay.

MAP PURPOSE: This map enables environmental descriptions of watersheds, including predictions of response to changes based upon characteristics of soil, climate, topography, and other related factors.

**Codes and values table: Drainages.dbf**

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
1	A Red rock	5	A Boulder
2	A Beaverhead	6	A Madison
3	A Ruby	7	A Jefferson
4	A Big Hole	8	A Gallatin

<u>Code</u>	<u>Value</u>
11	B Missouri abv Holter Dam
12	B Smith
13	B Missouri:Holter Dam to Sun
17	B Dearborn
21	C Sun
22	C Cut Bank
23	C Two Medicine
24	C Willow
25	C Teton
26	C Marias
27	C Missouri:Sun to Marias
31	D Musselshell abv Roundup
32	D Flatwillow Cr incl Box Elder Cr
33	D Musselshell below Roundup
34	D Arrow
35	D Judith
36	D MO:Marias thru Bull Whacker Cr
37	D MO betw Bull Whacker & Musselshell
40	E Milk abv Fresno Res
41	E Sage
42	E Big Sandy
43	E Peoples
44	E Milk betw Fresno Res & Whitewater Cr
45	E Whitewater
46	E Frenchman
47	E Beaver
48	E Rock
49	E Milk bel Whitewtr thru Porcupine Cr
51	F Dry
52	F MO below Musselshell to Fort Peck
53	F Redwater
54	F Poplar
55	F Big Muddy Cr
56	F Missouri below Fort Peck Dam
61	G Box Elder
62	G Little MO abv Little Beaver Cr
63	G Little Beaver
64	G Beaver

<u>Code</u>	<u>Value</u>
65	G Little MO below Little Beaver Cr
66	G Belle Fourche abv Cheyenne
101	H Shields
102	H Yellowstone abv & incl Bridger Cr
103	H Boulder
104	H Sweet Grass
105	H Stillwater
106	H Clarks Fk of Yellowstone
107	H Yellowstone:Bridger Cr to Clarks Fk
111	I Pryor
112	I Shoshone
113	I Little Bighorn
114	I Big Horn below Greybull
115	I Yellowstone:Clarks Fk to Big Horn
116	I Rosebud
117	I Tongue abv/thru Hanging Woman Cr
118	I Tongue below Hanging Woman Cr
119	I Yellowstone:Big Horn to Tongue
121	J Little Powder
122	J Powder below Clear Cr
123	J Yellowstone:Tongue to Powder
124	J O'Fallon
125	J Yellowstone below Powder
201	K Yaak
202	K Fisher
203	K Kootenai
211	L Middle Fk Flathead
212	L South Fk Flathead
213	L Swan
214	L Flathead abv & thru Flathead Lk
221	M Rock
222	M Blackfoot
223	M Clark Fk abv Blackfoot
224	M Flint
225	M Bitterroot
231	N Flathead below Flathead Lk
232	N Clark Fk:Blackfoot to Flathead
233	N Clark Fk below Flathead
255	O St Mary

## **AGENCY AFFILIATION**

(with attribute numbers)

Department of Earth Sciences, Montana State University, (032).

Department of Plant, Soil and Environmental Sciences, Montana State University, (001-150).

Montana Agricultural Experiment Station, Montana State University, (47, 58, 69).

## **FUNDING SOURCES**

(with attribute numbers)

Montana Agricultural Experiment Station, Montana State University, (001-024, 028-150).

J.E. Fait and Montana Wheat and Barley Committee, (025-027).

P.W. Smith, (023).

MSU Water Resource Center, (070).

## **PROJECT LEADERS**

(with attribute numbers)

J.M. Caprio, (001-020, 030, 031, 034-069, 071-101, 105, 106, 112-150).

G.R. Carlson, (030-031).

J.E. Fait, (025-027, 033).

G.L. Ford, (001-003, 021, 024, 047, 069, 070, 072, 074, 099, 100, 103, 108, 111, 149).

R.W. Irwin, (022, 102, 103).

J.R. Lane, (105, 106).

W.W. Locke, (032).

C. Montagne, (024).

G.A. Nielsen, (021-029, 070, 099, 100, 102-110).

G.L. Schmid, (150).

P.W. Smith, P.O. Kresge, E.O. Skogley, and J.E. Taylor, (023).

R.D. Snyder, (04, 022, 025-033, 073, 102, 104-106, 150).

# REFERENCES

(with attribute numbers)

- American Society of Civil Engineers. 1973. Consumptive use of water and irrigation water requirements. M.E. Jensen, (ed.) 026-027, 068-069, 095. (034-045)
- Bennett, I. 1965. Monthly maps of mean daily insolation for the United States. *Solar Energy*. 9:3, 145-158. (034-045)
- Caprio, J.M. Agricultural Climatologist, Montana Agricultural Experiment Station, Montana State University, Bozeman, MT. (005)
- Caprio, J.M. 1966. Pattern of plant development in the Western United States. *Western Regional Research Publ. Montana Agricultural Experiment Station Bulletin* 607. (069)
- Caprio, J.M. 1973. Impacts of induced rainfall on the Great Plains of Montana. *Montana Agricultural Experiment Station Research Report* 42. pp. 115-119. (047, 069)
- Caprio, J.M. 1974. The solar thermal unit concept problem related to plant development and potential evapotranspiration in phenology and seasonality modeling. *Ecological Studies*. Vol. 8. H. Leith, (ed.) New York: Springer-Verlag. pp. 353-364. (047-057, 069)
- Caprio, J.M. 1981. Snow barrier potential for harvesting moisture in transects across chinook areas in Montana. *Montana Agricultural Experiment Station Research Report* 174. pp. 3-9. (111)
- Fait, J.E. 1987. Elevation maps - their generation, editing and use in the Montana Agricultural Potentials Systems (MAPS). Senior thesis (P&S 470) project, Dept. of Plant and Soil Science, Montana State University, Bozeman, MT. (025-029)
- Ford, G.L. 1978. A computer graphic system for interactive display of land qualities and potentials. Ph.D. Thesis, Montana State University, University Microfilms. Ann Arbor, Mich. (Diss. Abstr. 39:3086-B). (001-003, 021, 070, 072, 074, 099, 100, 103, 108, 111, 149)
- Idso, S.B., and R.D. Jackson. 1969. Thermal radiation from the atmosphere. *J. Geophys. Res.* 74:5397-5403. (034-045)
- Land Status Map of Montana. 1967. Scale 1:1,000,000. U.S. Department of the Interior. Bureau of Land Management, Montana State office, Billings, MT. (022)
- Lane, J.R., G.A. Nielsen, and J.M. Caprio. 1989. Mean annual soil temperatures in Montana: A comparison of four methods of estimation. Draft manuscript. Dept. of Plant & Soil Science, Montana State University. (105, 106)



Montagne, C., L.C. Munn, G.A. Nielsen, J.W. Rogers, and H.E. Hunter. 1982. Soils of Montana Bulletin 744. Montana Agricultural Experiment Station, Montana State University, Bozeman, MT. (104, 107, 109, 110)

Montana Agricultural Experiment Station. 1978. General soil map of Montana. In cooperation with U.S. Department of Agriculture, Soil Conservation Service, and Forest Service, Bozeman, MT. (032, 103)

Montana Agricultural Experiment Station. Folder No. 81. Data based upon weather records from 1921-50. (003)

Montana Agricultural Experiment Station. Folder No. 82. Data based upon weather records from 1921-50. (002)

Montana Agricultural Experiment Station. Folder No. 83. Data based upon weather records for 1921-50. (001)

Montana Agricultural Experiment Station Bulletin 607. 1966. Pattern of plant development in the western United States. (033)

Montana Water Resources Board. An atlas of water resources in Montana by hydrologic basins. Inventory Series Report No. 11 (circa 1970). (150)

National Oceanic and Atmospheric Administration Atlas 2. Vol. 1. 1973. (099)

NOAA/USDA. 1983. Use of growing degree units in corn production. Weekly Weather and Crop Bulletin 70. July 6, 1983. (005, 006, 007)

NOAA/USDA. 1976. Using the growing degree day. Weekly Weather and Crop Bulletin 63. April 20, 1976. (005, 006, 007)

NOAA/USDA. 1982. Monthly normals of temperature, precipitation and heating and cooling degree days. 1951-1980 Montana. Climatology of the U.S. No. 81. Environmental Data and Information Service, National Climatic Center, Asheville, NC. (112-148)

Penman, H.L. 1963. Vegetation and hydrology. Tech. Comm. No. 33, Commonwealth Bureau of Soils, Harpenden, England. 125 pp. (034-046)

Ross, R.L. and H.E. Hunter. 1976. Climax vegetation of Montana based on soils and climate. Soil Conservation Service, U.S. Department of Agriculture, Bozeman, MT. (021)

Smith, G.D., F. Newhall, L.H. Robinson, and D. Swanson. 1964. Soil-temperature regimes and their characteristics and predictability. SCS-TP-144, U.S. Department of Agriculture, Soil Conservation Service, Washington, DC. (105, 106)

Smith, P.W. 1981. Development of a Montana landcover map from landsat imagery. Thesis for fulfillment of a Master of Science Degree in Soil Science. Montana State University, Bozeman, MT. (023)

Soil Conservation Service, USDA. 1975. Map of average annual snowfall, 1958-72. Bozeman, MT. (100)

Soil Conservation Service, USDA. 1976. Map of average annual value of factor R. Bozeman, MT. (108)

Soil Conservation Service. USDA. 1977. Average annual precipitation - Montana (based on 1940-70 base period). (070, 071, 073-075, 098, 101)

Soil Conservation Service. USDA. 1978. General soil map of Montana. Extension Misc. Publication No. 16. Montana State University, Bozeman, MT. (103)

Soil Conservation Service, USDA. 1986. Montana cooperative snow survey annual data summary - water year 1986. (071)

Tables of sunrise, sunset and twilight. 1946. U.S. Naval Observatory, Washington, D.C. Supplement to the American Ephemeris. (009-020)

Thornthwaite, C.W. 1948. An approach toward a rational classification of climate. Geograph. Rev., 38, 55. (058-068)

U.S. Geological Survey. 1960. Geologic map of the United States. U.S. Government Printing Office, Washington, D.C. (024)

U.S. Geological Survey National Atlas. Montana. 1:1,000,000 Albers. 1973. U.S. Department of Interior, USGS, Denver, CO. (030, 031, 102)

U.S. Naval Weather Service. 1969. World-wide airfield summaries. Volume VIII, Part 2. (034-045)

Weather Bureau. 1965. Climatograph of the United States No. 86-20, Montana. U.S. Government Printing Office, Washington, D.C. (008)

## **DATABASE SOURCE**

(attribute identification numbers in parenthesis follow each citation)

Algorithm based entirely on long-term precipitation records for the period May 1 to July 31. MAPS monthly database for May, June, and July precipitation used for computing individual cell values. (101)

Average annual precipitation and average percent of annual precipitation from April 1 to July 31 data files. (073, 074)

Caprio, J.M., Agricultural Climatologist and State Climatologist, Montana Agricultural Experiment Station, Montana State University, Bozeman, MT. (001, 002, 003)

County boundaries from USGS National Atlas; Montana (FIPS) codes assigned to all cells in each county. (102)

Derived from the MAPS highest elevation, lowest elevation and predominant aspect data layers. (033)

Derived mathematically from mid-range elevation data by Bob Snyder, MAPS Analyst, Montana State University, Bozeman, MT. (029, 033)

Determined by algorithm using geographical factors, average annual precipitation and percent of annual precipitation that falls April 1-July 31. (075-086)

Developed algorithm for each month expressing mid-month day-length as a function of latitude. Mid-month values for each whole degree of latitude were obtained from tables. (009-020)

Geologic Map of Montana. 1933. Montana Bureau of Mines and Geology. Francis A. Thomson Director. In cooperation with U.S. Geological Survey. Prepared by George W. Stose, O.A. Ljungstedt, and A.J. Collier. (024)

Index map of major, sub-major and minor drainage basins. (150)

Land Status Map of Montana. 1967. Scale 1:1,000,000. Bureau of Land Management. (022)

LANDSAT satellite imagery obtained between 1972-1976. (203)

Latitude was derived from the MAPS coordinate system. The latitude at the center of a row of cells is determined by multiplying the computer identifier by .05 and adding 44.375 to the product. To get the latitude of the northern edge of the cells, add 44.400 to the product (instead of 44.375). (030)  
Longitude was derived from the MAPS coordinate system. The longitude at the center of a column of cells is determined by multiplying the computer identifier by .05 and adding 104.025 to the

product. To get the longitude of the western edge of the cells, add 104.050 to the product (instead of 104.025). (031)

Long term weather station data. (005)

Map generated from MAPS database for mean monthly temperature, mean monthly net radiation and mean monthly vapor pressure. Wind speed for all months was assumed as 388 kilometers per day east of the continental divide and 266 kilometers per day west of the continental divide. Mean monthly net radiation was estimated by computing net long wave radiation on a clear day as a function of air temperature and assuming that the earth's surface albedo is 22 percent (see American Society of Civil Engineers, 1977, pp 26-28). (034-045)

Map of Consumptive Use. 1:1,000,000 scale. Soil Conservation Service, U.S. Department of Agriculture, Bozeman, MT. No date given. (149)

Map generated for potential evapotranspiration. It converts an average date of first bloom phase of purple common lilacs to average potential evapotranspiration. The relation is different east and west of the Continental Divide. (047, 069)

Map generated from MAPS databases of mean monthly temperature and daylength, both of which were derived from developed algorithms. (058)

MAPS data of monthly average solar radiation and mean monthly temperature. (048-057)

Mean annual air temperature values in the MAPS automated mapping system at Montana State University. The database was developed by J.M. Caprio, Professor of Agricultural Climatology and State Climatologist. (105, 106, 112)

Mean monthly precipitation data available from the U.S. Weather Service and the Snow Survey Office of the Soil Conservation Service. (071)

Montana Agricultural Experiment Station with cooperation of the Soil Conservation Service and Forest Service, United States Department of Agriculture. (103)

Monthly algorithms (May, June, and July) which provided the basis for determining monthly percent of annual precipitation. (072)

Monthly maps of potential evaporation computed by the Penman Method. (046)

Monthly values used are from the MAPS file for each mean monthly temperature. An algorithm was used to compute day-length on the 15th of each month. (059-068)  
National Climatic Data Center, Asheville, NC. (006-008)

NOAA monthly normals of temperature, precipitation and heating and cooling degree days, 1951-1980, Montana and J.M. Caprio, Agricultural Climatologist, Montana Agricultural Experiment Station, Montana State University, Bozeman, MT. (112-124, 125-136, 137-148)

Relief was derived mathematically from the highest and lowest elevation values recorded for individual cells. Elevations were obtained by placing a grid cell overlay on 1:250,000 scale topographic maps and recording values representing the highest isoline and lowest isoline in each cell. Since isolines seldom correspond with cell boundaries, a correction factor of 100 ft. was added to the relief for cells having 100 ft. isoline intervals; 200 ft. for cells having 200 ft. isoline intervals. (028)

R.L. Ross and H.E. Hunter, Soil Conservation Service, U.S. Department of Agriculture, Bozeman, MT. (021)

Snow Survey Unit, Soil Conservation Service, United States Department of Agriculture, Bozeman, MT. (099, 100)

Soil Conservation Service, USDA, Bozeman, MT. (108-110)

Soil Conservation Service and U.S. Weather Bureau records. (070)

Soils of Montana, USDA - SCS Bulletin 744 Table 4. Based on soil depths of reference soil series for soil map units. (107)

Soils of Montana, USDA - SCS Bulletin 744 Table 5. Based on available water capacity of reference soil series for soil map units. (104)

Unpublished compilation of data by Dr. W.W. Locke, Earth Science Department, Montana State University, Bozeman, MT. (032)

Unpublished freeze hazard map produced by J.M. Caprio, Plant & Soil Science Department, Montana State University, Bozeman, MT. (042)

U.S. Geological Survey 1:250,000 scale topographical maps. Coded by Julie Fait and David Webb. (025-027)

U.S. Weather Service Climatological Data 1921-70. (111)

Weather Service climatological data. Based on algorithm-derived percent of annual precipitation that occurs each month. (087-098)