



Best Practices & Standards: *Spatial Reference*

Date of Adoption: June 04, 2009

Introduction:

The Montana Association of Geographic Information Professionals (MAGIP) is a non-profit professional association that works to foster technical cooperation and promote the development of sound policy and practices that will support the efficient and effective use of geographic information systems in Montana. As such, the Technical Committee recognizes that a set of formalized best practices will not only encourage the use of standards but will make it easier to share data and save GIS practitioners work and time.

A best practice can be defined as the most efficient and effective way of achieving a goal or objective, improving business results through repeatable procedures that have proven themselves over time for large numbers of people. For a best practice to be effective, it must allow for the easy transfer of ideas, knowledge, and standards, while at the same time remaining flexible and adaptable to change as business needs and technology change.

It is important to note that the adoption of a best practice by MAGIP is not a mandate for its use, nor is a best practice applicable to every situation. Only in the instance where a best practice is recognized as a standard (Metadata in the Montana GIS Portal, for example) is it required and enforced. By committing to use a best practice, however, an individual acknowledges the benefits to one's organization and to the Montana GIS community as a whole.

Overview:

Geographic Information Systems store geographic data for any given area in separate layers—for example, roads may be stored in one layer, parcels in another, and buildings in a third. A spatial reference describes where those features are located in the real world. To effectively enable data from each layer to integrate when it is displayed and queried with GIS software, each layer must reference locations on the earth's surface in a common way. Coordinate systems provide the framework to do just that, while also allowing data in different regions to reference the Earth's surface in different ways that better suit the locale.

In an effort to promote data sharing and improve the spatial accuracy of integrated geographic data in Montana, MAGIP has adopted use of the State Plane NAD83 HARN Coordinate System as a best practice for the spatial reference of GIS data in the state of Montana.

Description:

The State Plane Coordinate System is a set of 126 geographic zones designed for specific regions of the United States. The system uses a Cartesian coordinate system to specify locations rather than a more complex spherical coordinate system, allowing for the use of "plane surveying" methods. By thus ignoring the curvature of the Earth, complex calculations are simplified and computed at a faster rate. Most state plane zones are based on either a Transverse Mercator projection or a Lambert conformal conic projection, depending on the shape of the state and its zones. In a state like Montana, where the distance from east-to-west is longer than north-to-south, the Lambert conformal conic projection is used because it is good at maintaining accuracy along an east-west axis.

Originally, the state plane coordinate systems were based on the North American Datum of 1927 (NAD27). This datum, using the Clarke Ellipsoid of 1866 as its foundation, was computed with a single survey point in Meades Ranch, Kansas as the datum point. Many years later, the more accurate North American Datum of 1983 (NAD83),

which was computed as a geocentric reference system with no datum point, became the standard. NAD83 has been officially adopted as the legal horizontal datum for the United States by the Federal government, and has been recognized as such in legislation in 44 of the 50 states, including [Montana](#). The computation of the NAD83 removed significant local distortions from the network which had accumulated over the years, using the original observations, and made the NAD83 much more compatible with modern survey techniques.

Even more recently, there has been an effort to refine the accuracy of the NAD83 datum using Global Positioning System (GPS) observations. These efforts, beginning with Tennessee in 1986 and finishing with Indiana in 1997, are known as “High Accuracy Reference Networks” (HARNs) and were undertaken to support the use of GPS by Federal, state, and local surveyors, geodesists, and other applications. Montana’s HARN, specifically, was implemented in 1992. Throughout the process, some 16,000 survey stations throughout the United States were upgraded to A-order or B-order status, with Horizontal A-order stations having a relative accuracy of 5 mm +/- 1:10,000,000 relative to other A-order stations and Horizontal B-order stations having a relative accuracy of 8 mm +/- 1:1,000,000 relative to other A-order and B-order stations.

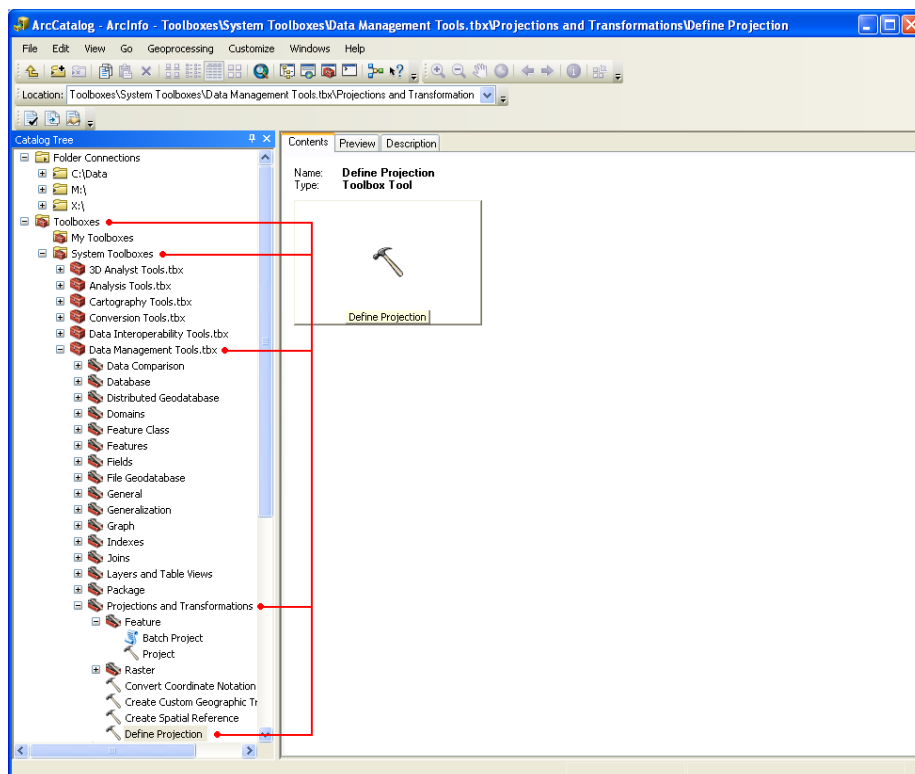
As described, the NAD83 HARN is simply a refinement of the coordinates of the NAD83. The NAD83 HARN has the same origin, orientation, and reference ellipsoid—that is, the same definition—as the NAD83, but its accuracy has been improved through the inclusion and support of GPS observations. The coordinates of the HARN are shifted (variously, depending on location) by +/- 10 cm, but the coordinate shift is likely not an issue for most GIS data. Moreover, any GPS derived coordinates collected at any point since the implementation of the Montana HARN in 1992 are, in fact, HARN-based coordinates.

Because of these improvements to the spatial accuracy of the NAD83, and the fact that any GPS data collected in Montana after 1992 is HARN-based, the State Plane NAD83 HARN Coordinate System should now be used as the spatial reference for GIS data in the state of Montana.

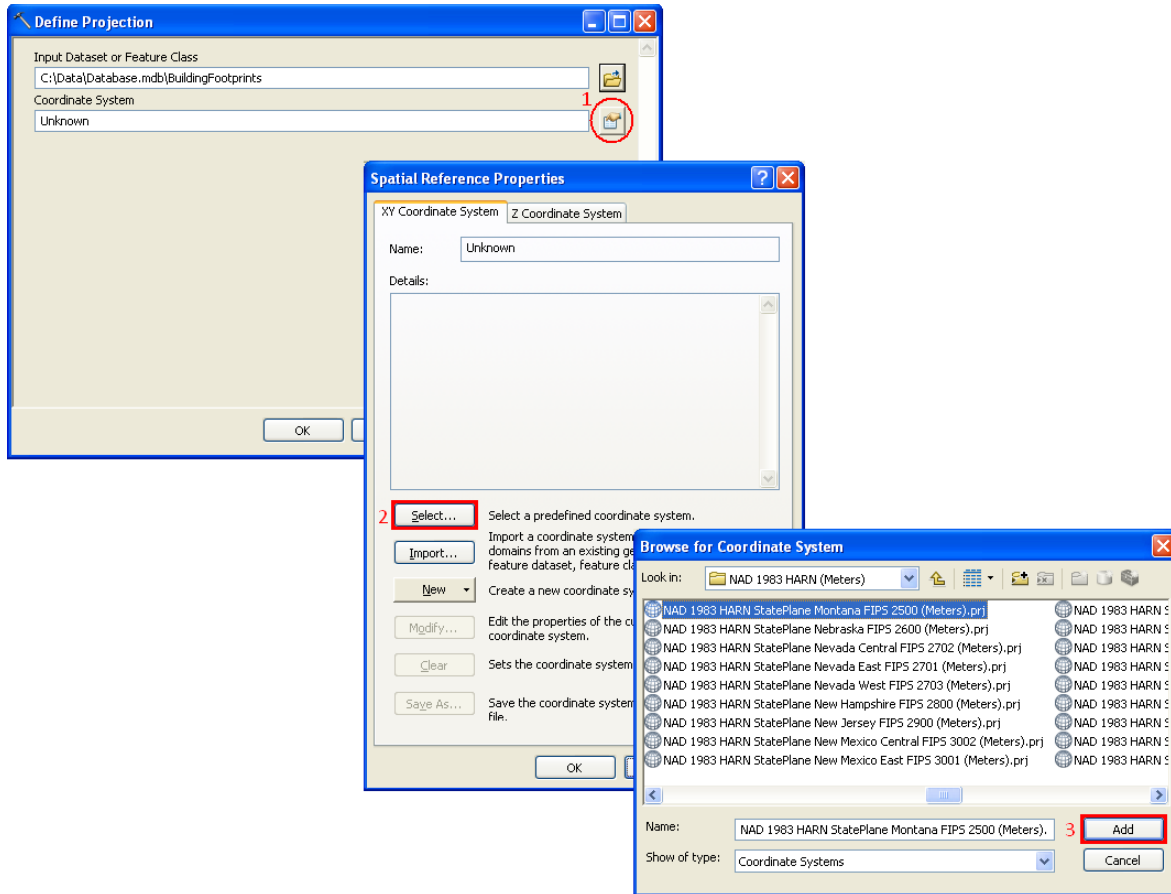
Implementation:

1) Defining Data Projections Using ESRI’s ArcCatalog

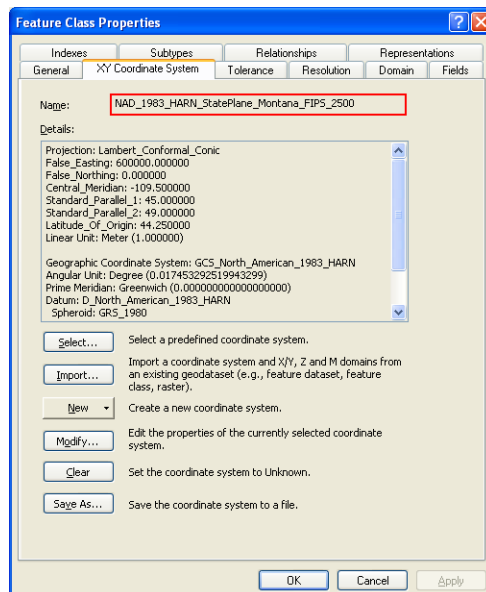
In ArcCatalog, browse the Toolboxes in your Catalog Tree to find the Define Projection tool (System Toolboxes | Data Management Tools | Projections and Transformations | Define Projection). Double click the tool to open the Define Projection window.



Browse to the feature class or shapefile for which you would like to define the projection and then click the Coordinate System icon to define the Spatial Reference Properties. Click the Select button to browse for the NAD83 HARN projection file (Projected Coordinate Systems | State Plane | NAD 1983 HARN (Meters) | NAD 1983 HARN StatePlane Montana FIPS 2500 (Meters).prj). Click Add to select the projection file, OK to assign the spatial reference properties, and OK to define the projection.



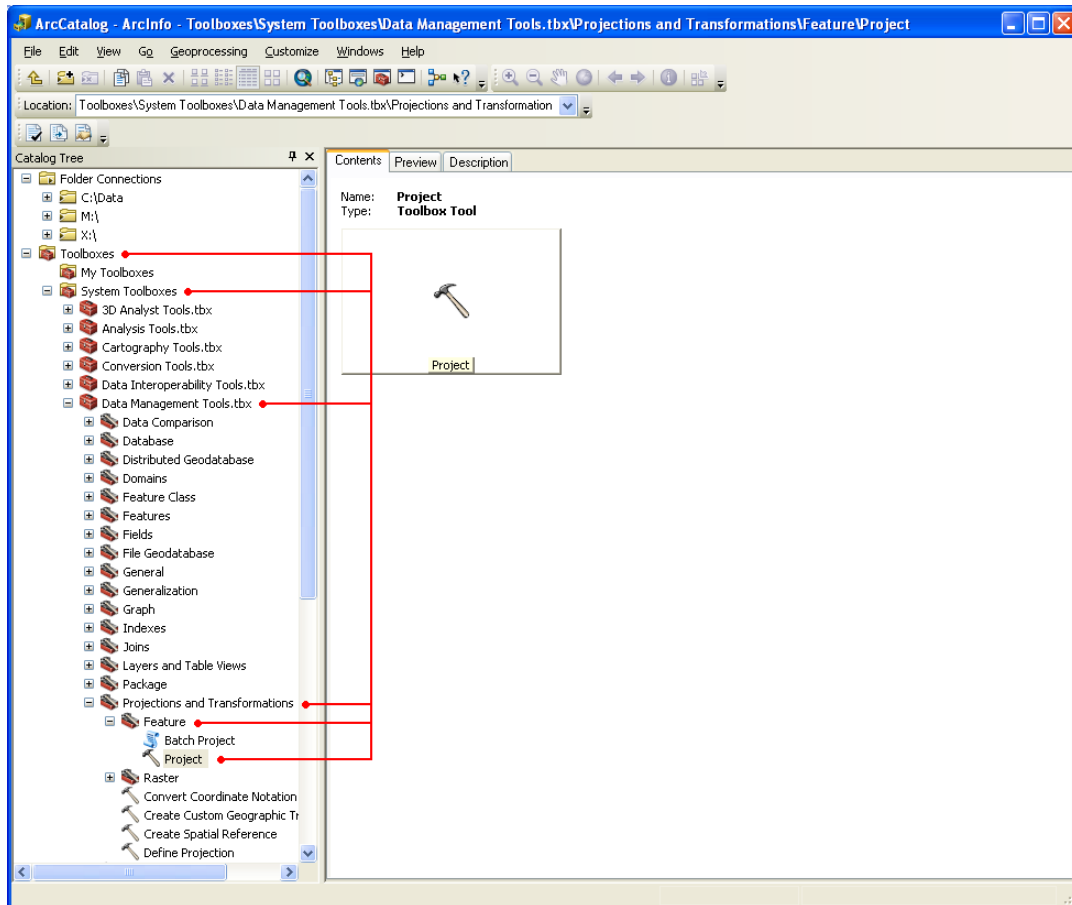
After running the Define Projection tool, the Results window indicates if the process was successful. You can also verify that the correct projection was assigned by right clicking on the feature class or shapefile in the Catalog tree and viewing its Properties. The XY Coordinate System tab will display the coordinate system that was just defined.



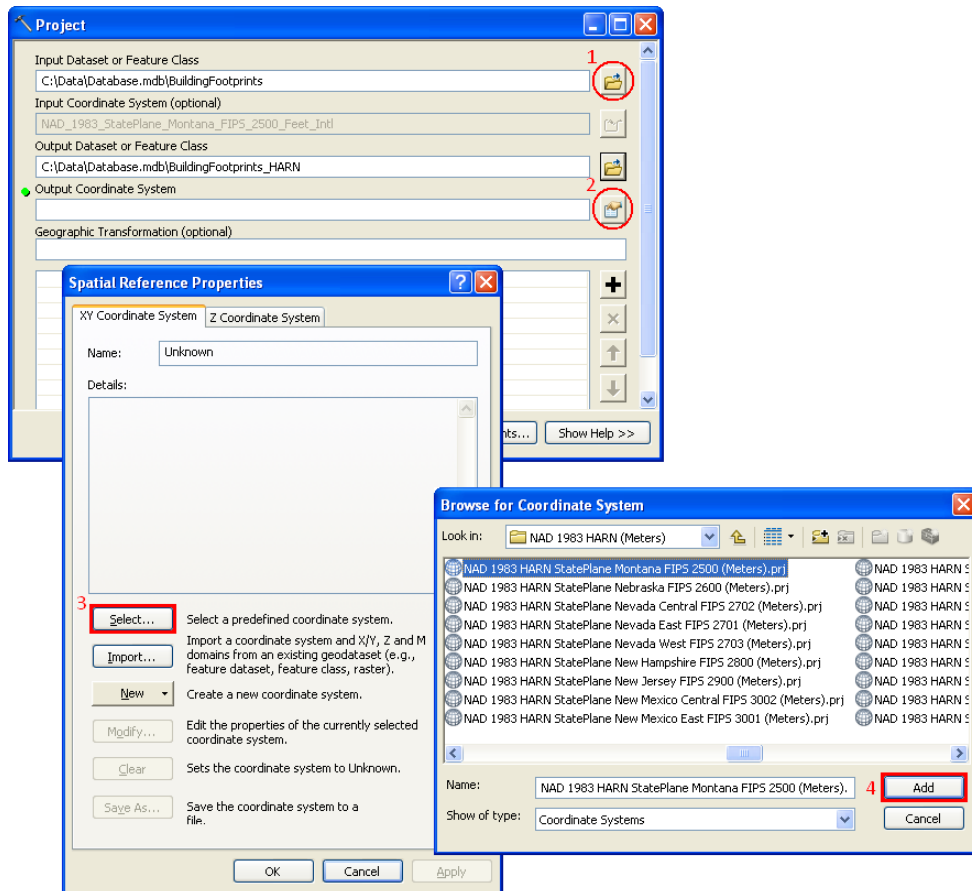
2) Projecting Data Using ESRI's ArcCatalog

Data that is currently defined in another projection must be projected into the State Plane NAD83 HARN Coordinate System using the ArcToolbox Project tool. In previous versions of ArcGIS, feature classes defined in the NAD 83 projection that spanned the entire state of Montana had to first be split into two feature classes along the 111th meridian prior to projecting the data to HARN Meters. [ArcGIS 10 has incorporated a new grid file](#), however, providing the option to project entire datasets without the painstaking efforts involved in splitting and then merging datasets.

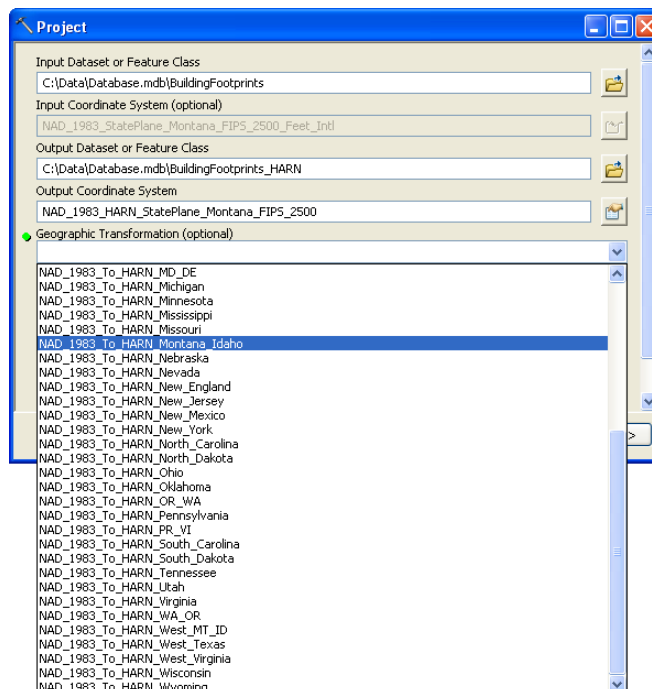
In ArcCatalog, browse through the Toolbox contents to find the Project tool (Toolboxes | System Toolboxes | Data Management Tools | Projections and Transformations | Feature | Project). Double click the tool to open the Project dialog.



Browse to the feature class or shapefile you would like to project and then click the Output Coordinate System icon to define the Spatial Reference Properties. Note that the Output Dataset or Feature Class field will auto-populate. If you wish to name the new feature class differently (or save it in a different location), make the necessary changes in this field. Click the Select button to browse for the NAD83 HARN projection file (Projected Coordinate Systems | State Plane | NAD 1983 HARN (Meters) | NAD 1983 HARN StatePlane Montana FIPS 2500 (Meters).prj). Click Add to select the projection file and OK to select the Spatial Reference Properties.



Once the coordinate system has been selected, you will then need to choose the Geographic Transformation appropriate for the location of your data. As previously mentioned, all data located in the state of Montana can now be projected using one Geographic Transformation file (NAD_1983_To_HARN_Montana_Idaho). Select the file from the Geographic Transformation dropdown and click OK to run the Project tool.



References:

[ESRI – An Overview of Spatial References](#)
[Montana Code Annotated 2009 – Montana Coordinate System](#)
[National Geodetic Survey](#)
[Wikipedia – State Plane Coordinate System](#)

Document History:

February 19, 2009	Approved NAD83 for Submission to MLIAC by MAGIP Board of Directors
March 05, 2009	MLIAC Recommended Change to NAD83 HARN
June 04, 2009	NAD83 HARN Adopted by MAGIP and MLIAC
May 04, 2010	Documentation Standardized by MAGIP Technical Committee
June 15, 2010	Geographic Transformation Update Added by MAGIP Technical Committee
April 26, 2011	ArcGIS 10 Implementation Update Added by MAGIP Technical Committee