

STATE OF MAINE
STANDARDS FOR DIGITAL PARCEL FILES

**Presented to the Maine Geolibrary Board
by the
Digital Parcels Standards Committee
June 15, 2011**

Version 2.2 June 15, 2011

6/15/11

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1. INTRODUCTION

For the GIS Needs and Requirements Analysis mandated by the legislature, a survey was issued to a wide group of Maine GIS stakeholders in October of 2001. As part of that survey and interviews conducted by a contractor, GIS users were asked to identify data layers that would most benefit their operations, but which were not available to them. Of the layers requested, property parcels (digital cadastral maps) had the highest priority. Consequently the final report¹ recommended the development of parcel data as a statewide data layer and the development of detailed standards for digital parcel data.

Property Maps are one of the most important local government information assets. It is a fundamental base for many municipal activities. Although GIS parcel data cannot replace detailed ground surveys, the data does assist municipal officials with functions such as accurate property tax assessment, planning and zoning. Towns can link their maps to their assessor's databases and display local information. Officials can show tax-payers how proposed development or changes in municipal services and regulations will affect them and their neighbors. In many towns, parcel data also helps to provide public notices, plan bus routes, and carry out other municipal services.²

In January of 2003, under the auspices of the Maine Geolibrary Board, a Digital Parcel Standards Committee was formed to develop published standards for digital tax parcel data. The committee was composed of representatives from the following public and private sector organizations: Bureau Information Services, Central Maine Power Company, City of Bath, City of Portland, Department of Conservation, Department of Transportation, Greater Portland Council of Governments, Hancock County Planning Commission, Island Institute, James W. Sewall Company, Maine Revenue Service, Maine State Archives, Northern Maine Development Commission and the State Planning Office.

The Committee, thru meetings and electronic review, worked out the basic standards for the acceptance of parcel (cadastral) spatial and tabular data into the Geolibrary. These standards were formalized into a publication which was then presented along with certain recommendations to the Geolibrary Board on May 21st, 2003. The standard was updated in December of 2010.

2. DEFINITIONS

ASCII – American Standard Code for Information Interchange. The de facto standard for code numbers used by computers to represent Latin letters, numbers and punctuation.

Assessor's Database – The database of property assessment information maintained by the assessor; it is also referred to as the tax list, property list, CAMA system, CAMA database, appraisal database etc.

Attribute – A single element of non-graphic (e.g., name of owner, property area, property value) information stored in a database field and usually, in the context of this standard, associated with a single geographic feature (e.g. a property parcel on a map).

Base Map – A map portraying basic reference features on the earth's surface (both natural and cultural) onto which other, specialized, features (e.g., property boundaries, water

¹ Applied Geographics Inc., State of Maine GIS Needs Assessment & Requirements Analysis and Strategic Plan to Develop The Maine Public Library of Geographic Information, January 2002, page 29, page 22

² Vermont Center for Geographic Information, Handbook, Part 3 – Guidelines Section A, Municipal Property Mapping, December 2000, ver. 2.0

mains) are placed. A common example is a U.S. Geological Survey topographic map.

CAD – Computer Aided Design. Also sometimes called computer aided drafting, CAD systems assist in 2 and 3 dimensional engineering, architectural design and can be used for cartographic purposes.

Cadastral Map - A map showing the boundaries of the subdivisions of land for purposes of describing and recording ownership and taxation.

CAMA -Computer Assisted Mass Appraisal, an automated system for maintaining property data, valuing property, notifying owners, and ensuring tax equity through uniform valuations.

COGO – Coordinate geometry. A system for encoding and manipulating bearings, angles and distances from survey data into a digital system

Comma Delimited File– A flat ASCII text file in which the information such as the unique ID and field values are separated by a comma.

Digital Parcel File – A specific type of vector Spatial Data and is a representation of the boundary information originally depicted and maintained on a city or town assessor's maps. Besides fee ownership boundaries that may appear in this file or files, include public and private rights of way and various different kinds of easements. These files are typically created in and maintained using GIS software.

Digitizing - The process of converting features on a physical map into digital format. The x,y coordinates of the map features are recorded and stored as spatial data. Digitizing can be done manually on a digitizing tablet, on which the map is registered to a coordinate system and the features traced or by scanning the map and converting the image to vector data either with special software or by manual overtracing on screen.

Feature Attribute Table – A digital table, also known as an FAT, used to store the attributes of a specific feature class. The *Feature Attribute Table* is linked directly to a *Spatial Data File*. Examples are an ArcView shapefile Dbase table (.DBF), an Arc/Info Polygon Attribute Table (.PAT)

Original Manuscript – When referring to the Data Standards for Maine Geographic Information Systems, 2002, for parcel mapping the 'original manuscript' may include paper tax maps that have been scanned, deed descriptions, or existing digital parcel data. However, in some cases where these data are known to conflict with more accurate data, such as orthophotos with identifiable cadastral features, GPS'd monuments, or more accurate digital data, these latter sources may be considered as the 'original manuscript' for the purposes of parcel data.

Parcel – The polygon representing the boundaries of legal ownership or interest on a city or town assessor's maps.

Polygon – A closed figure of three sides or more bounded by line strings intersecting at nodes.

Raster – A digital image file in which spatial data expressed as a matrix of discrete units called cells or pixels. Examples are an Arc/Info grid (cells) or a geotiff (pixels).

Registration - The process of finding reference points on a map or image document and assigning them coordinates from their known positions in the real-world. Once coordinates are specified for enough points on the map/image document, the entire digital document may be mathematically transformed to real-world coordinates for GIS display and analysis.

Related Database - An attribute table that can be temporarily associated with a *Feature Attribute Table* by making a connection between a record in the *Feature Attribute Table* and a corresponding record in the related attribute table.

Scan - The process of making a digital image of a document (e.g., a map, text document, or photo). A scanned document can be displayed on a computer screen, but until locations on the document are assigned ("registered") to map coordinates, it cannot be overlaid with map features in a GIS database.

Spatial Data – A digital file showing the location, shape of and relationships between geographic features. Spatial data can be in either vector or raster format. An example of a vector *Spatial Data File* would be a shape file. An example of a raster *Spatial Data File* would be a GeoTiff file.

Vector – A digital file in which geographic locations are represented by x and y coordinates. Points are located with a single x,y pair, lines defined by a series of x,y pairs and areas are defined by the line segments that enclose that area, or polygons.

3. STANDARDS FOR SPATIAL DATA

3.1 Digital Parcel Standards Level I

All digital parcel files submitted to the Geolibrary must conform to at least Standards Level I.

- 1) The parcel maps must exist as digital vector data.
- 2) The digital data must be a single data layer or file containing a seamless depiction of all of a town's property boundaries and other legal interests shown on the physical maps.
- 3) The data must conform to the spatial standards as described in sections 3.6 and 3.7 of the *Data Standards For Maine Geographic Information Systems*, June 27, 2002. (appendix A)
- 4) The data can be in digitizer units or real world units. If in real world units, the projection system, datum, units and zone if applicable must be specified.
- 5) Annotation is not required.

3.2 Digital Parcel Standards Level II

- 1) The digital data submitted must conform to the minimum specifications of Level I.
- 2) The digital data must be georeferenced to as many well defined points as possible on an orthophoto or vector base data that meets National Map Accuracy Standards for 1" = 400' or better. Well-defined points are those that are easily visible on the orthophoto or vector base and that represent features easily identifiable on the digital parcel data. Examples would be road intersections, railroad to railroad or railroad to road intersections and the intersections of fence lines or stone walls.
- 3) The digital data must meet all requirements of the *Data Standards For Maine Geographic Information Systems*, June 27, 2002

3.3 Digital Parcel Standards Level III

- 1) The digital data submitted must conform to the minimum specifications of Level II.

- 2) The digital parcel data must be digitally recompiled to fit all coincident features on an orthophoto or on vector base data.
 - A) The orthophoto or the vector base data must meet National Map Accuracy Standards for 1 inch = 400 feet or better.
 - B) Property boundaries are often coincident with clearly defined and visible features. These include features such as stone walls, hedges and tree lines. When appropriate as determined by the map compiler, parcel boundaries should be registered as accurately as possible to features visible on the orthophoto or digital base map.
 - C) Roads should nominally lie completely within the rights of way shown on the parcel data. An exception to this requirement would be if in the judgment of the map compiler the street were not in fact built within the right of way or there are undeveloped rights of way or newly constructed roads for which no representation exists on the orthophoto or in a road centerline file
 - D) Where discrepancies between adjacent town lines are more than the accuracy stated above, an attempt must be made to reconcile the difference. If the differences cannot be reconciled, then overlaps, gaps and gores must be separate polygons indicated as being "In Dispute".
- 3) The digital data must meet all requirements of the *Data Standards For Maine Geographic Information Systems*, June 27, 2002

3.4 Digital Parcels at Surveying/Engineering Accuracy

In Maine, the larger and more populated municipalities are likely to have some or all of their digital parcel data at a surveying and engineering level of accuracy. These are presented as a very high level of accuracy for parcel mapping, but not a recommended standard for the majority of Maine communities.

- 1) The digital data must conform to the minimum specifications of Level III.
- 2) The digital parcel data must be located in relationship to cadastral markers. Suitable cadastral markers may include those sorts of features referred to in land records, such as deeds, survey plans, survey plats and other land surveying records which purport to monument or mark property lines or points geometrically related to property lines. The intent is to more accurately associate the parcel data with points that are directly related to the underlying land record information.
- 3) The data must be referenced to geodetic control points of the National Geodetic Surveyor (or successor), the Maine Department of Transportation and/or points established by other parties using geodetic grade surveying equipment and methods.
- 4) The data need not include every cadastral marker in a given location, but should include sufficient cadastral reference points to accurately reproduce the intent of the original land records used in the compilation of the mapping.
- 5) To correct errors in the parcel data and to close lots geometrically, the available information—the bearing, course, and distance of parcel lines— will be entered into a COGO software system. This information is then referenced to cadastral markers.

3.6 Spatial Data Formats

All spatial data files submitted to the Geolibrary must be in one of the following standard formats.

Level I:

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- Autodesk Data Exchange Format (.DXF) A vector transfer format that has become the de facto standard for transfer of data between CAD systems. Arc/Info, ArcView and most GIS software will read and/or convert a DXF file.
- Arc/Info Export file (.E00) A vector transfer format, either ASCII or compressed into binary used to transfer files between different versions of ARC/INFO. This is preferred over submitting Arc/Info coverages.
- Shapefile. A vector format consisting of at least 3 types of files (.SHP .SHX .DBF) openly published and available for use by all GIS vendors.
- Comma delimited ASCII file. An interchange format for spatial data in which, for each feature, the unique ID number and corresponding coordinates are carried on a single line separated by commas. The feature attribute table is supplied as a separate file.
- MapInfo Interchange Format (.MIF). A vector transfer format, MIF files transfer graphics, MID files transfer attributes. Arc/Info will convert a .MIF file.
- Spatial Data Transfer Standard SDTS. A standard format used by federal agencies to support all types of vector and raster data.
- ESRI Geodatabase.
- KML/KMZ.

Level II or higher:

- Shapefile. A vector format consisting of at least 3 types of files (.SHP .SHX .DBF) openly published and available for use by all GIS vendors.
- ESRI Geodatabase.

4. STANDARDS FOR ATTRIBUTE DATA

Attribute field names must be kept under 10 characters in length to avoid truncating the field name during conversion operations. For example, a shape file with the field name CARTOGRAPHIC will be truncated to CARTOGRAPH if the shape file is converted to ArcInfo. File names should be kept under 8 characters in length to conform to the “eight and three” standard.

4.1 Required Feature Attribute Table Fields

These fields are required to be in a feature attribute table directly associated with the corresponding digital parcel file. For example, if the digital parcel file is a shapefile, then these items must be in the Dbase file (.DBF)

STATE_ID

A unique, statewide identifier for each parcel. The township geocode constitutes the first five numbers of the identifier followed by MAP_BK_LOT for each parcel in the township. (Character field)

MAP_BK_LOT

A municipal designation field which carries the map, block and lot or other unique identifier assigned to each parcel by the municipal assessor. This field is the link to the municipal databases. It may not be possible to make this link between the assessor’s database and the digital parcel map for every parcel or property record – a one to one relationship. This standard requires only an initial effort to make the linkage as complete as possible. (character field)

PARENT

The map_bk_lot listing in the assessor’s database where information about a parcel may be found. Some Maine towns organize their tax assessing database so that only one bill is sent to each property owner. If the property owner holds several lots only one listing in the assessor’s database will be made to serve for all of them. In these cases one map-block-lot designation will be assigned to the combined listing. For the remaining lots, the parent field contains a pointer to the appropriate map-block-plot listing listing.(See Appendix B)

PROP_LOC

The physical address of the property, if applicable. (character field)

PROPLOCNUM

The physical address number of the property (numeric field)

4.2 Required Related Database Fields³

These fields are required to be in a related database table, which can be linked to the corresponding feature attribute table. The table should be of a standard type such as DbaseIV or comma-delimited ascii.

MAP_BK_LOT

A municipal designation field which carries the map, block and lot or other unique identifier assigned to each parcel by the municipal assessor. This field is the link to the feature attribute table.

Due to privacy and security concerns, the municipal officers of each municipality shall, pursuant to a public hearing, vote as to which if any of the following 8 fields are to be populated for use in the state Geolibrary.

1)OWNER1

Name of first owner of record (character field)

2)OWNER2

Name of second owner of record (character field)

3)OWN_ADDR1

Owner's address first line (character field)

4)OWN_ADDR2

Owner's address second line (character field)

5)OWN_CITY

Owner's city or town. (character field)

6)OWN_STATE

Owner's state if not Maine (character field)

7)OWN_ZIP

Owner's zip code, plus four if available. (character field)

8)OWN_CNTRY

Owner's country if not U.S.A. (character field)

LS_DATE

Last sale date (date field)

LS_PRICE

Last sale price (numeric field)

LS_BOOK

Last sale Registry of Deeds book (character field)

³ Some of the following items are reprinted, courtesy of MassGIS, from *MassGIS Standard for Digital Parcel Files and Related Data Sets*, Version 1.0, July 2001, The Massachusetts Office of Geographic and Environmental Information, 251 Causeway St, Boston, MA, 02114

LS_PAGE
Last sale Registry of Deeds page (character field)

4.3 Suggested Related Database Fields

LAND_VAL
The current total assessed value for land (numeric field)

BLDG_VAL
The current total assessed value for building(s) (numeric field)

LAND_USE (numeric field)
municipal current use code

LAND_USE_DESC
Description of the current use code

LOT_SIZE
The assessed area (numeric field, allowing for up to two decimal places)

SIZE_UNITS
The area units (character field; valid values are "S" for square feet and "A" for acres)

LIV_UNITS
Number of living/dwelling units, apartments and condominiums, if available (numeric field)

BLDG_SIZE
Building area (square feet) for commercial/industrial properties as defined by the state use codes.(
numeric field)

YEAR_CREATED
The date a lot was created by split or subdivision (numeric field)

SOURCE
Boundary feature source (character field; valid values are DEED, SUBDIVISION, ROAD PLAN, SURVEY, OTHER).

PLAN_ID
Identifying information for plan (example: subdivision or road plan) used to update the digital file (character field).

UPD_DATE
The date of update to the property boundary. Should include the year and month of the update (character field).

RES_AREA
Total residential living area in square feet. This is a useful attribute when evaluating development proposals relative to surrounding residences, but a difficult one to create because it requires adding areas from multiple fields in the assessor's database (numeric field).

CI_AREA

Total building area for commercial/industrial properties in square feet. This is a very useful attribute for evaluating proposed and existing development, but it is difficult to create because it requires adding areas from multiple fields in the assessor's database (numeric field).

Feature Level Metadata (See Appendix C for an explanation of feature level metadata)

FMSRC	source
FMSRCORG	source originator
FMPROC	process
FMUPDORG	organization of edit
FMUPDAT	date of edit

Required Fields – Feature Attribute Table				
Field Name	Type	Size	Decimal Places	Notes
STATE_ID	C	30		
MAP_BK_LOT	C	24		
PARENT	C	24		
PROP_LOC	C	50		
PROPLOCNUM	N	10		

Required Fields – Related Database				
Field Name	Type	Size	Decimal Places	Notes
MAP_BK_LOT	C	24		link to feature attribute table
OWNER1	C	50		
OWNER2	C	50		
OWN_ADDR1	C	50		
OWN_ADDR2	C	50		
OWN_CITY	C	24		
OWN_STATE	C	2		standard USPS abbreviations
OWN_ZIP	C	10		
OWN_CNTRY	C	24		
LS_DATE	D	8		YYYYMMDD
LS_PRICE	N	9		

LS_BOOK	C	6		
LS_PAGE	C	4		

Recommended Fields – Related Database

Field Name	Type	Size	Decimal Places	Notes
LAND_VAL	N	9		
BLDG_VAL	N	9		
LIV_UNITS	N	4		
LOT_SIZE	N	6	2	
LOT_UNITS	C	1		must enter S for sq ft or A for acres
BLDG_SIZE	N	6		in square feet
LAND_USE	N	6		
LAND_USE_DESC	C	24		
YEAR_CREATED	N	4		YYYY
SOURCE	C	10		
PLAN_ID	C	24		
UPD_DATE	D	8		YYYYMMDD
RES_AREA	N	6		in square feet
CI_AREA	N	6		in square feet

Recommended Feature Level Metadata Fields- Related Database

FMSRC	C	12		
FMSRCORG	C	12		
FMPROCSS	C	12		
FMUPDORG	C	12		
FMUPDAT	D	8		

Appendix A

**DATA STANDARDS FOR
MAINE GEOGRAPHIC INFORMATION SYSTEMS**

**Presented to the Information Services Policy Board
by
GIS Executive Committee Chair, Richard Dressler
June 27, 2002**

**Approved by the ISPB
June 27, 2002**

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1. INTRODUCTION

This document provides guidelines covering the digital conversion of geospatial data into geographic information system (GIS) format. The overall goal is to ensure that a high quality, well-documented GIS database is built for the State of Maine. The document objectives are three-fold:

1. Set technical specifications for geospatial data automation and development;
2. Provide basic guidance in map compilation/recompilation; and
3. Provide standard procedures for documenting the history of each geospatial data layer and source map to aid users of the Maine GIS database in determining the viability of those data for specific applications.

All proposals, agreements, contracts and grants for GIS data automation should require that these standards be met or exceeded.

If agencies are planning projects that will generate large amounts of digital data, it is recommended that a pilot project be performed on a small area covering all aspects of the process from map compilation to the actual application. A pilot project insures that all systems and procedures used do in fact generate adequate data. The project should cover at least two study area modules (e.g. quad sheets) so that edge matching capabilities can be assessed. GIS personnel should participate in all aspects of the pilot project.

2. MAP COMPILATION/RECOMPILATION

The ultimate quality of a GIS database is as dependent on the quality of the source map as it is on the care used in the digital automation process. Whether new map data are being compiled onto a basemap or old maps are being recompiled onto a new base, certain basics need to be addressed. Precise automation procedures, although very important, will not improve an inferior source map. Georeferenced, rectified photographs and images, as well as vector basemaps may serve as source maps. Important considerations are:

2.1 Map Scale

- o Varies with intended use and companion data layers
- o Data submitted for inclusion in the Maine GIS database will conform to National Map Accuracy Standards (NMAS) for scale.

The choice of a basemap is the first step in the map compilation/recompilation process. Mapped data at any scale may be input to the system, but digital maps retain the accuracy of their original source map regardless of the scale at which they are plotted. Thus, a 1:100,000 map retains its original accuracy even when plotted at a 1:24,000 scale. The map scale also determines the best use of the final data. The following table illustrates how applications vary depending on the scale of the original map.

TABLE 1: Relationship among scale, use, and number of maps

MAP SCALE	MAP UTILITY	# MAP SHEETS TO COVER MAINE
Small scale 1:500,000	Statewide studies, planning	1
1:250,000	Statewide studies, planning	13
1:100,000	Regional studies, planning	35

1:62,500	Detailed studies, local planning	appx.	200
1:24,000	Detailed studies, local planning	appx.	800
1:12,000	Parcel level studies, detailed local planning	appx.	3,200
1:5,000	Parcel level studies	appx.	18,400
Large scale			

USGS 7.5 minute quadrangle series have served as the standard digital basemap for agency data development since 1990. The 1:24,000 scale properly balances the economic and accuracy considerations of data development for most planning and natural resource activities. Basemaps of larger scales or different sources may be considered, but the decision must be carefully judged relative to the intended use, the scale of currently available digital data and the proposed basemap's quality.

Data submitted for inclusion in the Maine GIS database will conform to National Map Accuracy Standards (NMAS). For maps on publication scales larger than 1:20,000, not more than 10% of the points tested will be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. The following table shows the NMAS for some common map the scales:

TABLE 2: Common Scales and NMAS horizontal accuracy requirements

Scale	Engineering Scale		NMAS
	Feet	Meters	
1:500,000	1" = 7.89 miles	+/- 833.33	appx. 254
1:250,000		+/- 416.66	appx. 127
1:100,000	1" = one mile	+/- 166.67	appx. 51
1:63,360		+/- 105.60	appx. 32
1:24,000	1" = 2000'	+/- 40.00	appx. 12
1:12,000	1" = 1000'	+/- 33.33	appx. 10
1:4,800	1" = 400'	+/- 13.33	
1:1,200	1" = 100'	+/- 3.33	appx. 1

A map resulting from the combination of two or more maps, photographs, or images of differing scale retains the accuracy of the least accurate source map. It is, therefore, important to consider the scales of data layers you expect will be most commonly used with the maps being prepared when choosing a scale for your data. This will have a bearing on both the technical and economic aspects of a project.

2.2 Map Media

o Stable-base mylar

Whenever possible, the mapped data should be drafted on the most scale-stable medium available. Shrinking and swelling in non-stable base media due to changes in atmospheric conditions can have a profound effect on the spatial accuracy of the final digital product. The following represents, from most to least desirable, the media to be used as the mapped data source for automation:

1. Mylar original
2. Mylar contact reproduction from mylar original
3. Non-stable base paper from mylar original
4. Non-stable base paper

Manuscript maps should not be folded. They should be stored in flat files or rolled up in map tubes.

2.3 Coordinate Reference

- o Minimum of four reference points

Each map, photograph or image included in the Maine GIS database through digitizing or other means must have a minimum of four reference points (tics) for which the geographic coordinates are known and are printed on the map. Coordinates may be latitude/longitude pairs, or other units consistent with the projection of the map. If no coordinate reference is provided on the map, reference points must be calculated. Increasing the number of "quality" reference points will increase the accuracy of the registration.

2.4 Projection

- o Projection of a map must be known and defined.

Prior to digitizing, and for later digital manipulation of map information, the projection of a map must be known. Maps are printed in many different projection systems. For example, most U.S. Geological Survey maps at 1:24,000 and 1:62,500 scales are in the Transverse Mercator or polyconic projection, although many other projection systems can be handled by current GIS technologies. Once in digital form, a map can be transformed from one projection to any other. The current standard projection for data in the Maine GIS database is Universal Transverse Mercator (UTM), North American Datum 1983 (NAD83), Zone 19, Meters. To facilitate inclusion in the Maine GIS database, data should be submitted in this standard projection and projection should be defined.

2.5 Line Work

- o Maximum line width of 0.013 inch

Lines to be digitized will be drafted with a standard 00 technical drafting pen producing a line width of no more than 0.013 inch. Lines that are too thick introduce subjectivity on the part of the digitizer operator.

2.6 Coincident Features

- o Compile/recompile coincident features to avoid topological error.

Coincident features are those that are common to two or more data layers. For example, the mean high water mark of a pond may serve as a boundary for a residential zone, a soil type, and a wildlife management area; the mean high water mark, soil boundary and management area boundary are coincident features; therefore, coincident features should be digitized only once. Regardless of the care taken in digitizing, slight differences may lead to problems with small "slivers" if the layers are topologically joined. To avoid this phenomenon, use and reuse coincident features in new data layer development.

Coincident features should be clearly symbolized and labeled. During manual map compilation or recompilation a coincident feature should be symbolized in drafting and labeled by source. A standard method is to draft coincident features with a dashed line. If a coincident feature is to be extracted from an existing digital map and added to a new digital data layer, it should be attributed with information on the source from which it is extracted. Dashed line symbology may also be incorporated as an attribute value to allow the feature to be displayed and/or selected as a coincident feature.

2.7 Data not Recompiled on Standard Basemaps

In some cases it may not be feasible to recompile existing data on a standard basemap. The preparation of these data for entry into the Maine GIS database must be considered on a case-by-case basis with GIS personnel. The issues of media, coordinate reference, projection, and line work are particularly important under those circumstances.

3. DATA AUTOMATION SPECIFICATIONS

3.1 Automation Technique

o Features automated by heads up digitizing will be attributed with information on the source, and the process, used to add the feature to the data set and will equal or exceed NMAS standards for scale, of the original map, photograph, or image.

Tablet digitizing and scanning are currently the most commonly used techniques for automating maps. The selection of an automation technique depends on issues such as the complexity and quality of the source map, type of scanner, and the number of maps.

Data automation by heads-up digitizing has become more common with the increased availability of online scanned high resolution imagery. This is an interactive process in which data is created using previously scanned and georeferenced images such as scanned topographic sheets or photography. The process is similar to conventional tablet digitizing, but rather than using a digitizing tablet and a cursor, the user creates the data layer on the screen with the mouse and typically with referenced imagery as a background. The attention of the user is focused up on the screen, and not on a digitizing tablet. The accuracy of heads-up digitizing as a method of data automation depends on the type of image being used and the experience of the operator. For example, drafting features from a scanned topo sheet is easier to do with precision because the features have already been cartographically interpreted and drawn. By contrast, accurate drafting of features from a photograph requires the use of more photo-interpretation skill.

3.2 Compatibility

o Final format will be compatible with this standard.

As Maine's state government GIS network evolves, emerging systems will use ARC/INFO or will be fully compatible with ARC/INFO through a common data interchange format so existing digital spatial data can be shared.

Therefore, all data developed for the Maine GIS database must be in a format that is easily converted to an interchange format compatible with other components of the statewide GIS.

3.3 Digitizer Tolerances

o Strictly follow software and hardware vendor guidelines for digitizing

There are several digital tolerances which affect the accuracy and resolution of a digital map that can be explicitly defined during the map automation process. The tolerances recommended by the vendor should be strictly adhered to when digitizing or editing data on a particular system.

o RMS error not to exceed 0.005

The Root Mean Square Tolerance (RMS) defines the error incurred when predefined tics are used to register a map on the digitizing board for automation. In order to maintain the spatial relationship of map features during digitizing, the RMS error must be kept as low as possible when a map is registered on the digitizing table. The recommended maximum RMS error is 0.005.

o Tolerance equivalent to 0.005 digitizer units

The tolerance defines the minimum distance separating line coordinates, and the tolerance set corresponds to the resolution of the digitizer.

3.4 Cartographic Accuracy

- o Digitize map features to within the equivalent of 0.01 inches of the original manuscript.

Digitizing spatial data involves taking a hard copy map and tracing it with a cursor to produce a digital file. Errors and distortions can easily occur in the tracing process. These errors are often small or negligible, but this may not always be the case. Careful, consistent and systematic digitizing, plus thorough verification are essential to adequately retain the quality of the source maps.

- o Scanned data will be georeferenced and vectorized to within the equivalent of 0.01 inch of the original manuscript

- o Data collected with Global Positioning System (GPS) equipment will have an accuracy equal to or greater than the base data to which it will be added.

Base stations and differential correction should be used to maximize the accuracy of GPS data collection. An accuracy assessment and documentation of method, collection parameters, and technology that affect data accuracy should be provided with the data.

Required standards for feature accuracy are:

- o 90 percent of the planimetric features on the digital map will be within 0.01 inch of the centerline of that feature on the manuscript map when plotted at the original scale.
- o 100 percent of all features will be within 0.02 inch.

The 0.01 inch interval is equivalent to a standard 0.01 plotter pen width. When a proof hardcopy plot of the digital map is overlaid on the original basemap, discrepancies in line work will be seen as an open space between the plotted feature and the original manuscript. Discrepancies in point data are more difficult to judge.

It should not be assumed in conversion between data formats, i.e. shapefile to coverage or coverage to SDE layer, that cartographic accuracy will be preserved. Careful management of tolerances and precision of the work environment will greatly improve the results of such a conversion and the conversion process should be documented.

3.5 Data Capture

- o Use a minimum number of coordinates to define a line.

Storing many layers of statewide digital data requires efficient use of available computer storage, so digitize the minimum number of vertices needed to accurately represent the cartographic feature within the 0.01 inch accuracy limit.

- o Digitize the exact center of a point map symbol

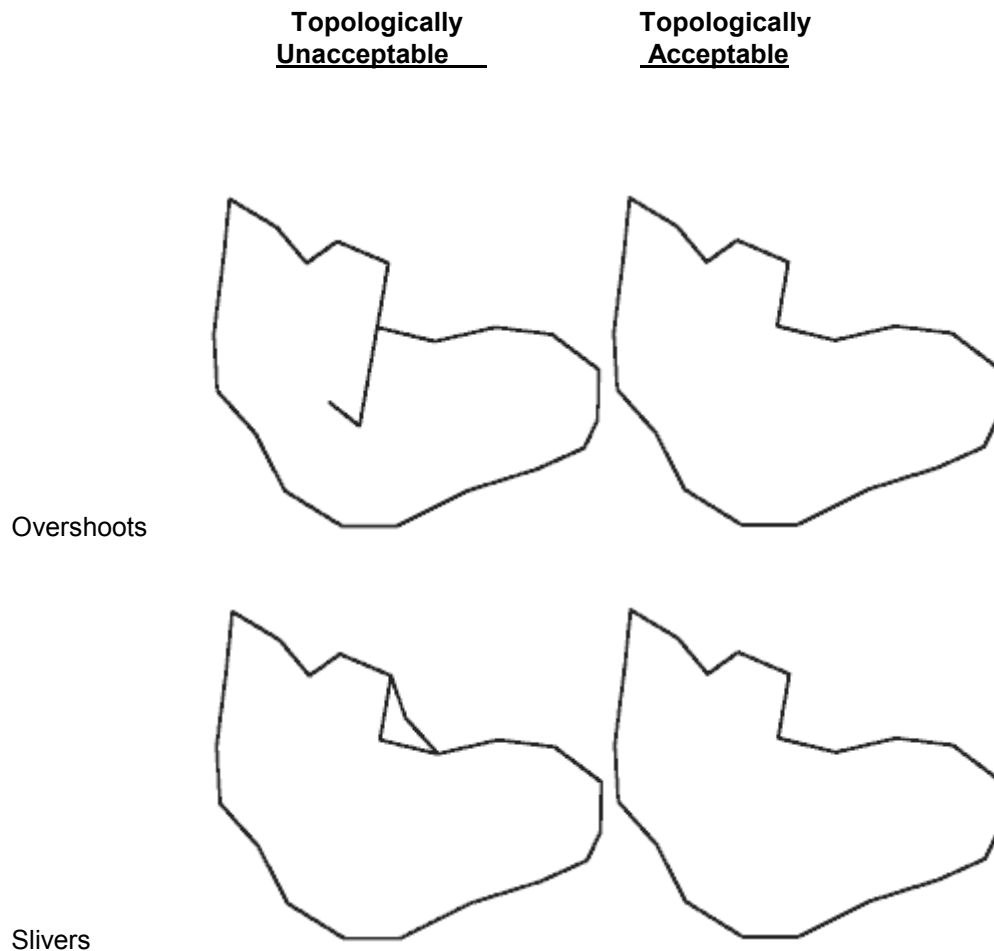
If possible, point locations should be entered directly into the system for exact known coordinates such as latitude and longitude rather than by digitizing. When digitizing points from a source map, digitize the exact center of the point map symbol.

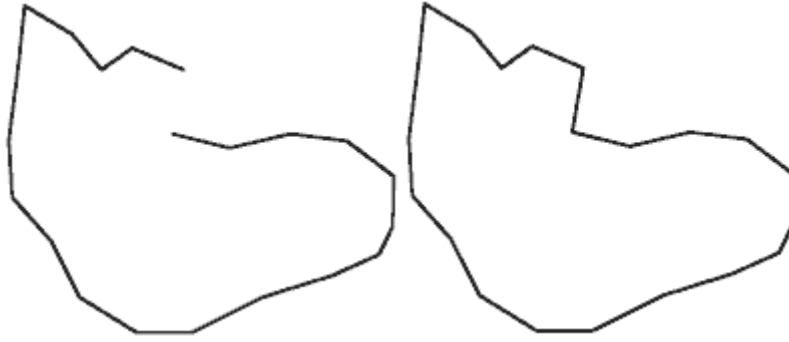
3.6 Spatial Topology

- o No overshoots
- o No slivers
- o No open polygons (e.g. undershoots)
- o No label errors
- o No unresolved node errors
- o No unresolved line segment intersections

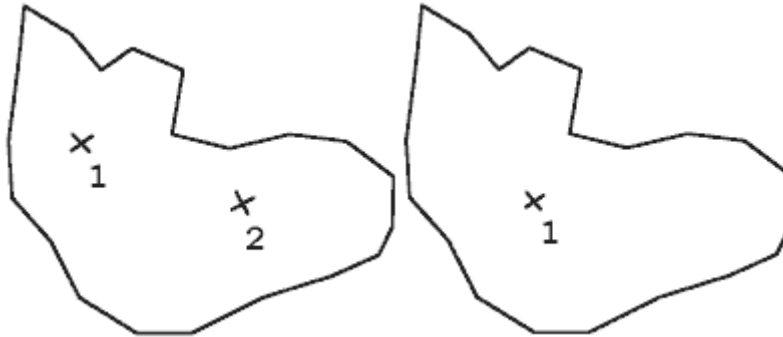
Digital data submitted for inclusion in the Maine GIS database will be topologically clean and free of errors. All points, lines, and polygons will have a single unique user-id number. Figure 1 shows graphic examples of acceptable and unacceptable topological conditions.

FIGURE 1: Graphic examples of unacceptable and acceptable topological data conditions for digital data





Open polygons



Multiple user-ids

3.7 Edge Matching

o Contiguous features should be edge matched or closed.

Line segments (arcs) that intersect the boundaries of a coverage must be accurately edge matched with the corresponding arcs in the adjacent coverages. Computer edge matching techniques ensure an exact match. In lieu of an exact match, arcs must be matched to within 0.01 inch, centerline to centerline.

o Closure lines should be attributed as "closure".

In the absence of more accurate data, where edgematching line segments from adjacent coverages would move a feature or features a distance that exceeds NMAS standards for scale, the addition of a closure line is the preferred. A closure line is an arbitrary feature drawn to close a polygon or arc. Features that represent closure lines should be attributed accordingly.

o Map features should not to extend beyond prescribed dataset boundaries.

Arcs must not extend beyond (overshoot) nor fall short of (undershoot) the dataset boundary.

3.8 Coding Accuracy

- o 99.5 percent of all attributes will be coded correctly.

The most serious problem is miscoding a feature. Coding an area of glacial till as a sand and gravel deposit is an example of this type of error. Other errors in attribute coding include any occurrence of misspelling or omissions. All attributes will be coded correctly.

3.9 Accuracy Assessment

The following assessments will measure data accuracy:

- o 90 percent of all features within 0.01 inches when reproduced at the scale of original manuscript map
- o 100 percent of all features within 0.02 inches when reproduced at the scale of original manuscript map
- o Topology complete and accurate
- o 100 percent of all attributes coded correctly

It is the responsibility of the producing agency to verify that the original data have been encoded within the accuracy limits set by these standards. Ninety percent of the cartographic features on a map will be digitized within 0.01 inches measured from the centerline or center point of a feature. One hundred percent of all cartographic features will be digitized within 0.02 inches.

There are many ways to formulate a scheme to assess data accuracy. Methodology to assess data accuracy should be developed with the automation contractor or within the producing agency if data are automated in house.

If all criteria are met, then note in the documentation (next section) that the digital map meets these standards.

3.10 Proof Plots

- o Mylar proof plots
- o Pen width - 0.01 inch

For each digital map created, a mylar proof plot of that map should be made to verify that the original data have been digitized within the accuracy requirements of these standards. The proof plot should be plotted on mylar at the same scale as the manuscript. All lines on the proof should use a line width of 0.01 inch or less and be drawn with liquid ink pens. Point data should be represented with the "+" symbol.

3.11 Attribute Coding

- o Choose attribute coding schemes that are well defined and in common use.
- o Names of new datasets should not be the names of existing datasets in the Maine GIS database.
- o Begin all dataset names, item names, and attribute codes with a letter.
- o Eliminate punctuation, i.e. hyphens, pound signs, periods from dataset names, item names and attribute codes.
- o Limit the length of dataset names and item names to 8 characters or digits.

- o Define items according to intended use, i.e. numeric data types for statistical data or for data that will be used for calculation, characters data types where these functions are not anticipated.

- o Limit the length of attribute codes to 12 characters or digits.

- o Eliminate the use of the Boolean values 0 and 1 as attribute codes.

- o Wherever practicable utilize character attribute codes, i.e. previously defined acronyms or abbreviations in common use.

Naming conventions, item length, and punctuation recommendations are based on format conversion and compatibility requirements. For example, conversion to shapefile format changes some characters (# - .) to underscores; item names over 8 places are truncated; the Boolean values 0 and 1 impact the results of geographic analysis. An effort will be made over time to consider these limitations in item names and to eliminate the use of these characters in data included in the Maine GIS database.

- o Use Standard Geocodes for Maine.

As an information service to state agencies and the public, Standard Geographic Codes for Maine, are available for download through the Maine Office of Geographic Information Systems (MEGIS) Data Catalog. The published table contains the first official Standard Geographic Code endorsed and adopted by the Governor of Maine, on July 1, 1971. Geocodes have undergone subsequent revisions, all of which were "officially" rolled back to this 1971 list by Maine's Information Services Policy Board (ISPB), as of January 2000. In 1971, all Maine state agencies were requested to implement these five digit geocodes, in agency information systems, to build a base of data for Maine's Minor Civil Divisions (MCDs) and to promote data sharing. Data coded by MCD may subsequently be summarized by any other type of region, administrative district, natural area, etc. The first two digits of the geocode represent the federal code (FIPS) for Maine counties, the remaining three digits uniquely identify each of Maine's MCDs and Reservations.

Prior to the development of important new data sets, a detailed series of data layer specific content standards that expand on existing standards should be completed. Attribute coding and content for all new data sets will expand on adopted standards and reflect coordination with federal and regional content standards. For example, coding of a soils database will follow the conventions of the USDA Soil Conservation Service. Nationally recognized formats also exist for coding of data layers such as wetlands and land use. When devising a new scheme, it is important to allow for as many different foreseeable uses of the data as possible. For example, in a land use coding scheme, it is preferable to have individual codes for different types of agricultural use (e.g. cropland and pasture) than a single code specifying agricultural use. The individual codes may be aggregated, but the single code cannot be broken into its components.

3.12 Database Attributes

- o Add and properly define a database field to store a standard geographic reference.

Standard geographic reference exist at all levels of government and in the private sector, for example the U.S. Board of Geographic Names responsible for the Geographic Names Information System (GNIS), the National Bureau of Standards, Federal Information Processing Codes (FIPS). Many Maine state agencies maintain standard geographic reference information relating to their programs. Examples include the Maine State Planning Office, Standard Geographic Codes for Maine Minor Civil Divisions (GEOCODES), Maine Bureau of Parks and Lands, Coastal Island Registry (CIREG), Maine Inland Fisheries and Wildlife Maine Information Display and Analysis System (MIDAS). An effort is ongoing to promote the standardization of database attributes by working with agencies who serve as primary sources for geographic references. To take full advantage of Maine's growing capability to process, analyze and

display geographic information, databases developed within state government, whose records relate to a geographic feature, should include a minimum of one field that stores a related standardized geographic reference from a primary source, such as:

- o Standard Geocode for Maine Minor Civil Divisions
- o Federal Information Processing Standard or FIPS Code
- o Latitude and longitude to the nearest second
- o Universal Transverse Mercator Eastings and Northings to 6 and 7 digits, respectively.
- o Coastal Island Registry Number
- o MIDAS Number
- o Tax Map Identifier and Lot Identifier
- o Street Address

Georeferenced databases can be linked in the GIS environment for analysis and display with the spatial data that makes up the Maine GIS database. Georeferences can be very specific, for example: latitude and longitude locations for storage tanks and hospitals. Some data, for example disease occurrences or demographic data, can be assigned a less specific georeference like a geocode or a census geographic unit. Many phenomena can be mapped including: bus routes and school bus stops, chemical and oil spills, contamination, hazardous material locations, storage tanks, administrative districts, emergency service locations, disease occurrences, demographic characteristics, clients, services, natural and biological resources.

4. FGDC DOCUMENTATION

o Federal Geographic Data Committee (FGDC) compliant documentation is required for all data to be included in the Maine GIS database.

The FGDC Content Standard for Digital Geospatial Metadata (CSDGM) has been adopted by the GIS EC as the documentation or "metadata" format for all data included in the Maine GIS database. Participating agencies are responsible for providing documentation in FGDC compliant metadata format for geospatial data products. The metadata must be stored and maintained by the agency developing and maintaining the geospatial data.

FGDC metadata is the required documentation of all geospatial data products produced through partnerships, grants or contracts with federal agencies. Federal agencies collecting or producing geospatial data, either directly or indirectly (e.g. through grants, partnerships, or contracts with other entities), are required to ensure, prior to obligating funds for such activities, that data will be collected in a manner that meets all relevant standards adopted through the FGDC process. (Executive Order 12906, published in the April 13, 1994, edition of the Federal Register, Volume 59, Number 71, pp. 17671-17674. COORDINATING GEOGRAPHIC DATA ACQUISITION AND ACCESS: THE NATIONAL SPATIAL DATA INFRASTRUCTURE)

Metadata is "data about data". Like a style guide, the FGDC CSDGM defines what information belongs in a metadata record and the order in which it is presented. The goals and objectives of Maine's FGDC compliant documentation can be summarized as follows:

1. to provide a history of each geospatial data set included in Maine's GIS database with standardized information on content, location, purpose, accuracy, condition, quality, collection and development processes, scale, projection, feature attribution, and other characteristics of geospatial data necessary to determine the utility of a map for a specific purpose;
2. to protect Maine's investment in geospatial data by minimizing the risk of data loss, and minimizing the recreation of existing data, through systematized documentation of geospatial information; and
3. to promote data sharing by providing information about Maine geospatial data holdings to external catalogues, clearinghouses, and brokerages and by providing information on the processing and interpretation of spatial data received through a transfer from an external source.

4.1 Basics of FGDC

FGDC compliant documentation or metadata tells you the who, what, why, how, when and where of geospatial data. The standard organizes a metadata record into seven main sections.

- o Identification Information
- o Data Quality Information
- o Spatial Data Organization Information
- o Spatial Reference Information
- o Entity and Attribute Information
- o Distribution Information
- o Metadata Reference Information

4.2 Technical Support for FGDC

Technical support for content development of FGDC metadata and information on FGDC compliant software for metadata development is available through the MEGIS, Data Center, Technical Support phone line at (207) 287-6144. A link to additional FGDC resources is available under "Standards and Guidelines", MEGIS homepage, <http://apollo.ogis.state.me.us>.

4.3 More About FGDC

Maine FGDC compliant metadata is published through the MEGIS internet Data Catalog. FGDC metadata documents are also the basic components of the National Geospatial Data Clearinghouse, and FGDC compliant metadata for Maine's geospatial data can be made available to clearinghouse nodes nationwide. The National Geospatial Data Clearinghouse is a distributed online catalog of digital spatial data, part of the National Spatial Data Infrastructure (NSDI) (Executive Order 12906). NSDI goals are to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability.

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Appendix C

Maine GIS Feature Metadata Recommendation 2000

The Maine GIS Feature Metadata Recommendation was presented to the GIS Technical Group in October 2000, by the GIS Technical Group feature metadata subcommittee, and was submitted to the GIS EC in December of the same year. Additional information on this initiative and other Maine GIS recommendations is available at <http://megis.maine.gov>.

FEATURE METADATA RECOMMENDATION Brief

The use of FM items and codes in feature attribute tables is recommended, to provide accessible readable standardized notation that describes the quality and currency of each geospatial feature's location. Recommended FM items are FMSRC, FMSRCORG, FMPROCSS, FMUPDORG, FMUPDDAT with two optional items FMSRCDAT and FMNOTE. These items are recommended for use to record the following information about the location of a feature: the source used to identify the feature's location, the source originator, the process used to incorporate the feature, also the organization of edit and date of edit if applicable. It is recommended that the items be populated with standardized and defined FM codes. FM codes for use in these items, like the items themselves, are designed to be unique references, as short, clear and self-explanatory as possible. All have been listed, standardized, and defined so that each represents a single information type and entity. For example what is meant by the item FMSRC coded 24k, tigers90, gps, engplan, sketch, or roughsvy, FMSRCORG coded usgs, medot, uscb, FMPROCSS coded closure, edgematch, or screendig is specific and defined. Codes are in text, all lower case and include no hyphens, punctuation or spaces. Codes for use in source originator and organization of edit are organizational acronyms that have been confirmed. Wherever possible federal agencies carry the "us" prefix and state agencies carry the postal prefix "me" for the state of origin, i.e. medot, medhs, megis. The FM subcommittee has defined this set of items and related codes with reference to elements in FGDC metadata. The FM recommendation is flexible and will function in most GIS environments independent of FGDC metadata or specific metadata tools; however, because coordination of feature attribute tables with FGDC metadata maximizes available information and minimizes attribute load, parallel or subsequent development of FGDC metadata, and use of cross references to same, is assumed and recommended.