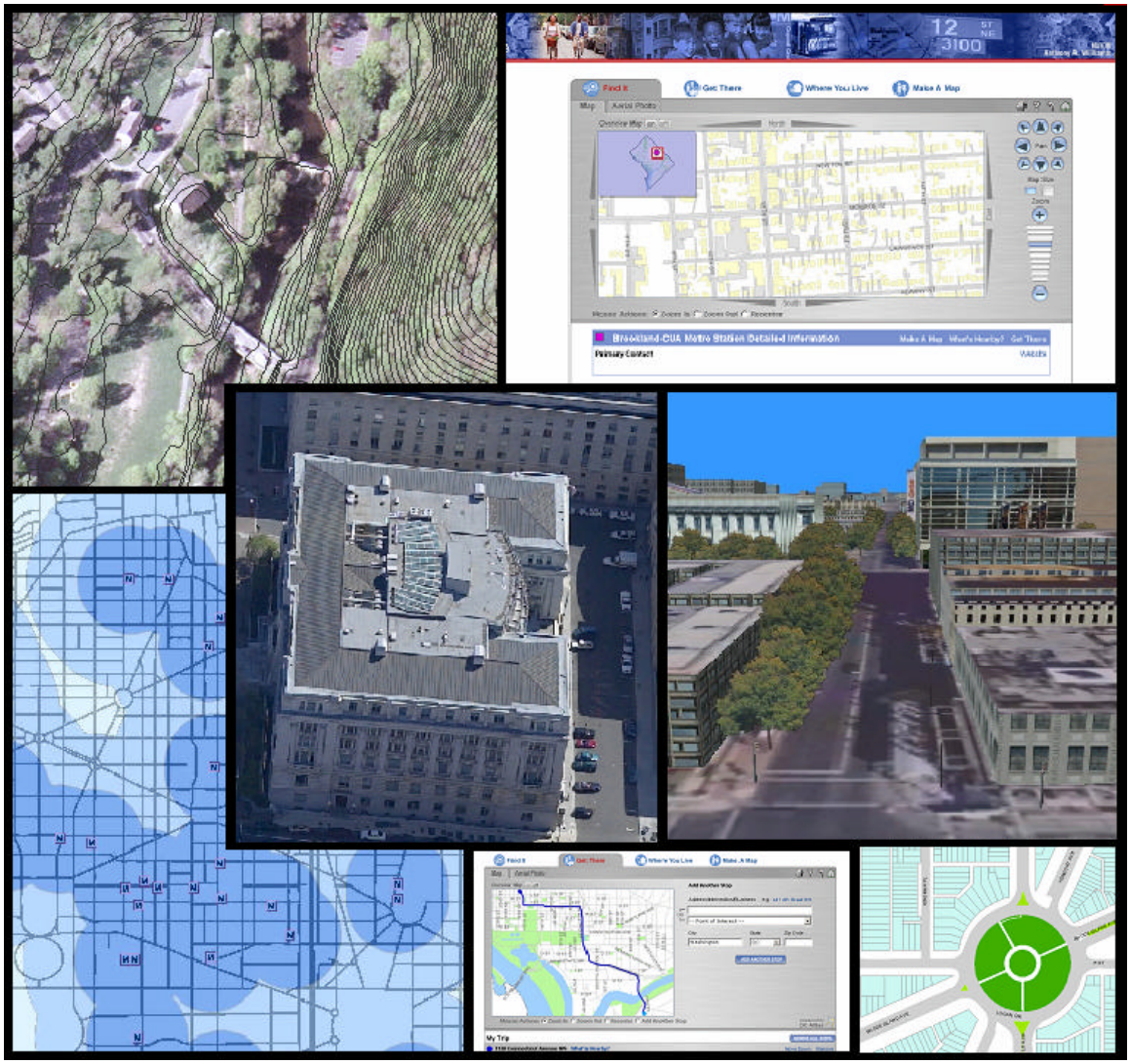
DISTRICT OF COLUMBIA GOVERNMENT
Federated Geospatial Data Model



August 2005

Introduction

The purpose of the federated data model is to clarify the roles of District government agencies in building and maintaining geospatial data sets. The goal is to share in the creation, use, and maintenance of GIS datasets at the least possible cost, while providing District government staff, citizens, the media, and other users easy access to this resource. Specific objectives are:

- Providing all users access of geospatial data of known quality
- Planning geospatial data development activities
- Eliminating the redundant purchase and/or creation/maintenance of geospatial data.
- Increasing awareness of the availability of existing GIS datasets
- Ensuring the completeness and accuracy of information describing the datasets (metadata)
- Establishing geospatial data standards and encouraging adherence to them
- Clarifying data distribution policies, ensuring public access to information and establishing technical procedures for restricting distribution of sensitive data sets
- Facilitating the coordination of geospatial data gathering, maintenance, and enhancement with cooperating federal and regional agencies and authorities
- Providing the framework to develop and maintain the DC GIS enterprise database consistent with data from numerous source agencies

1.0 DC GIS Federated Model

A federation is defined as “a group of various bodies or parties that have united to achieve a common goal.” The common goal here is the efficient and effective application of resources to develop, maintain, and disseminate GIS data throughout the District government. The parties to the federation are agencies of the District of Columbia government, each of which collects and maintains geospatial data to meet its unique missions, but coordinates its activities and shares the results of its work.

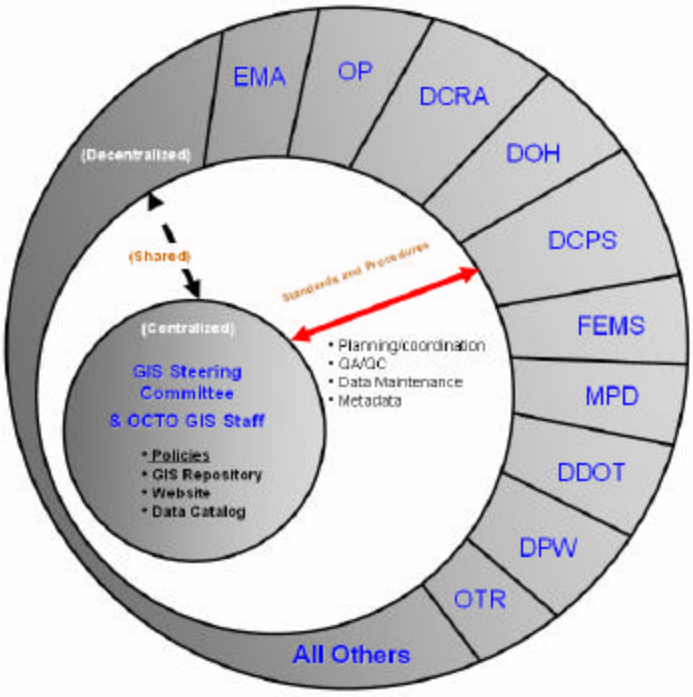


Diagram 1: DC GIS Federated Model

As shown in Diagram 1, the District’s federated geospatial model is partitioned into three key sections:

The outer rim consists of front line agencies in the District government. Each of these agencies uses GIS to help accomplish its public service mission. As

participants in the federation, each has accepted responsibility for particular datasets, but not the entire DC GIS database.

The center consists of the GIS steering committee and the OCTO GIS staff. The role of the center with regard to geospatial data includes hosting common services such as the geospatial data catalog, the DC GIS web site, and the enterprise data repository. The center provides DC agencies and the public a one-stop shop for disseminating geospatial data and metadata. The center also handles intergovernmental relations where the primary focus is geospatial.

Standards are what connect the rim to the center. Adhering to standards is a responsibility of all federation participants. Standards and procedures enable the distribution of data and services between the centralized and decentralized portions of the model. By having standardized methods in place, data and services can flow among the groups in the federation. Shared tasks include data QA/QC, maintenance, metadata creation and update, communications, and application development.

To further understand how the Federated Model works in other local governments, two examples are given below: the Mayor's Office of Information Services (MOIS) in Philadelphia, Pennsylvania and the Enterprise Systems Division (GIS) in Fairfax County, Virginia. Of these models the Districts model is based more closely on Fairfax County.

The Mayor's Office of Information Services (MOIS) in Philadelphia, Pennsylvania.

The MOIS serves as an approval department for all City agencies and departments throughout Philadelphia. All GIS activities must first be approved by the MOIS before they can proceed with funding, procurement, and implementation. Once the agencies have been given approval, they can proceed on their own. However, because they are a part of the City, they must also adhere to the standards and procedures administered by the MOIS. Thus, reflecting a federated model, central authority is held by the MOIS, and decentralized authority and responsibilities are held by the participating agency.

County of Fairfax, Virginia – Enterprise Systems Division (GIS)

The second example of how the federated model is being used effectively outside of the District can be seen in the Enterprise Systems Division (ESD) in Fairfax County, Virginia. This serves as a centralized data repository for various datasets throughout the County, including many outside the county government. ESD maintains a robust enterprise database that attracts participation. For department layers that are a part of the database, Fairfax County GIS:

- Negotiates and assigns data ownership to the appropriate department,
- Requires that the department compile and submit their data maintenance, quality control, and metadata plans, and
- Negotiates and tracks a data maintenance cycle.

ESD offers options and support to interested parties to get them started. ESD handles the basemap layers, which are contracted out for maintenance.

Thus, by providing its data catalog and services to whoever has access to the Internet, Fairfax County attracts new users by showing them the vast number of datasets available in their enterprise database. By attracting new users, Fairfax County is able to add new, decentralized sections to their federation.

2.0 Guidelines and Benefits

This model allows agencies to benefit from the vast number of datasets that the District developed and maintains. This is the attraction of it. Through its framework, standards, and procedures, keeping the database current and robust will be easier.

DC GIS will construct and maintain a robust, enterprise GIS database.

Prior to being included in the DC GIS federation, specific guidelines must be met in order to keep data quality standards and practices at a sustainable level for all members of the model. Some agencies have already sufficiently developed their GIS program to be able to meet some of these guidelines.

1. *Identify a primary GIS contact(s) at the agency.*

Each agency will have a primary GIS contact responsible for all activities and communication within the federation. Typically, this is the GIS Manager or Principle Analyst, the employee who has the most GIS knowledge, experience, and authority within the Agency. The GIS Contact notifies and certifies all data updates from their agency before inclusion in the enterprise GIS database.

2. *Negotiate the layers that each agency will own and maintain and determine update cycles for each.*

OCTO GIS has assigned provisional authority of datasets to particular agencies, and has estimated update cycles in the DC GIS data catalog. Every dataset has an “originator,” or agency possessing the most background and knowledge of the dataset, assigned to it. However, that does not mean the agency will automatically assume responsibility for maintenance. This must be negotiated to ensure the agency has the resources and capability to fulfill ownership requirements, as well as buy-in. In addition, OCTO GIS and the agency must agree to practical update cycles.

3. *Maintain a consolidated geospatial data maintenance plan.*

An overall data maintenance program should be in place at each agency as part of the federation. To help foster this, each agency will develop a maintenance plan. It will detail how the agency will handle its maintenance responsibilities including agency-specific QA/QC

methodology and data standards. While OCTO GIS sets overall data accuracy standards, each agency develops and operates internal QA/QC procedures that validate and verify its data. In addition, each agency will be assigned to populate its metadata following DC GIS standards.

In general, the maintenance plan will specify and describe the following items:

- The layers the agency is responsible for, with update cycles
- Source materials for each layer
- Data dictionary
- Agency data standards
- Data and metadata maintenance process
- Agency QA/QC methodology
- Distribution constraints, including security and confidentiality requirements
- Change management procedures

3.0 DC GIS Standards

The purpose to establishing GIS standards is to ensure complete interchangeability of map layers and attached databases and graphics between systems in different agencies.

3.1 Standards and Specifications Incorporated by Reference

Various national and international bodies establish and maintain geospatial standards. The District's goal is to adhere to recognized geospatial standards. This section incorporates these standards by reference.

District agencies may choose not to adhere to a particular a standard that is impractical in a given situation. In those cases the exception should be noted in project documentation and OCTO GIS should be consulted. National standards specifically referenced in this document, such as the FGDC metadata standard (see below), are not optional.

Standards and specification adopted by reference included those established by:

- The Federal Geographic Data Committee (FGDC) -- www.fgdc.gov/standards/standards.html. The FGDC establishes geospatial standards for the United States government. FGDC standards facilitate the development, sharing, and use of geospatial data.

- Open Geospatial Consortium (OGC™) (www.opengeospatial.org). The Open Geospatial Consortium, Inc. (OGC) is a nonprofit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location-based services. Many of the specifications, documents, and guidance provided by OGC have been adopted as industry standards. Others are fairly new and not mature.

3.2 GIS Software

The District GIS software standard consists of the products of the Environmental Systems Research Institute (ESRI). This includes the ArcGIS line of desktop software products, Arc Spatial Data Engine (ArcSDE), the geodatabase software; and Arc Internet Map Server (ArcIMS), for web distribution. Other software packages and vendors can be accommodated. Please consult your agency's OCTO GIS liaison.

3.3 Database Software

Oracle and SQL Server are the database standards. For GIS, Oracle 9i or greater is the standard. For personal geodatabases, Microsoft Access is the standard. Personal geodatabases are the standard for transferring files that possess topology or other specialized SDE rules and metadata.

3.4 Geographic Coordinate System

For horizontal coordinates, the standard is the Maryland state plane coordinate system of the North American Datum of 1983 (NAD83), as updated in 1991. For vertical coordinates, the standard is the North American Vertical Datum of 1988 (NAVD88). Coordinates are stored in meters.

Note: For the planimetric update in 2005, the projections will be the same but the coordinates will be stored in feet. Updates to this standard are likely in 2005.

3.5 GIS Layer Naming Conventions

Layers published in the DCGIS database should follow a naming convention denoting their theme and geography type, sometimes including a year where needed ("<Name or abbreviated name><geography type abbreviation>"). The geography type is "Pt" for point, "Ln" for line, and "Ply" for "polygon." The following details this convention for Public Schools:

- Point Layer – PubSchPt
- Polygon Layer – PubSchPly
- Line Layer – PubSchLn

For a layer that has data for a particular year, such as census tracts. The format is "<Name or abbreviated name><last two digits of the vintage year><geography type abbreviation>." For 2000 Census Tracts, that would be "Tract00Ply." Feature dataset names shall not exceed 25 characters in length.

3.6 Topology Within Map Features

Within a given dataset submitted for inclusion in the DC GIS, the database will be topologically clean and free of errors. They shall be free of undershoots, overshoots, and sliver polygons unless required to correctly depict the map theme.

3.6 Topology Among Map Features

This standard is designed to ensure that lines and polygons in the DC GIS that are supposed to be coincident are identical. Common lines from the DC GIS Snapbase or vector property derived datasets shall be exactly coincident to the original source lines. For layers where topology is constructed, they will be free of dirty areas before incorporation into the enterprise database.

To ensure that agency layers are compatible with District government base maps, the DC GIS Snapbase is used to construct selected boundary and thematic layers, such as many political and administrative layers (wards, voting precincts, ANCs, SMDs, police districts, police service areas, and others). The Snapbase contains many basemap features, including street centerlines, hydrography, railroads, and selected planimetric features. The purpose is to topologically develop layers from a common digitizing base. The following is the current Snapbase digitizing methodology at OCTO GIS:

- To develop each polygon in an administrative layer, an analyst selects each line required for it from the Snapbase. Once all of the arcs (lines) are selected, the analyst copies them into a new coverage.

- For boundaries not in the Snapbase, the analyst digitizes and attributes arcs to close the polygons built from the Snapbase.

- For updates and changes to the boundaries, the analyst "untags" old lines, adjusts them to the new boundaries, "retags" them, and then builds the new topology and edits accordingly.

- The original Snapbase linework has items in the attribute table for each geography the Snapbase constructs. A value of zero means the line does not represent that particular geography. A value of one means the line forms part of the particular geography. In that way, each geography can be saved and reconstructed from the Snapbase.

- Currently the analyst performs all of this work in workstation ArcInfo, version 7.X employing the old topology model.

A list of those DC GIS layers derived from the snapbase is maintained by OCTO in the DC GIS data catalog. Currently they are:

Current Snapbase – Derived Layers		
Layer Name:	File Name:	Originator:
Architect of the Capitol Lines	AOCLn	AOC
Architect of the Capitol Lines	AOCPly	AOC
ANC Lines - 2002	ANC02Ln	BOEE
ANC – 2002	ANC02Ply	BOEE
ANC – 1990	ANC90Ply	BOEE
ANC Lines - 1990	ANC90Ln	BOEE
SMD Lines - 2002	SMD02Ln	BOEE
SMD – 2002	SMD02Ply	BOEE
SMD – 1990	SMD90Ply	BOEE
SMD Lines - 1990	SMD90Ln	BOEE
Voting Precinct Lines - 2000	VotePre00Ln	BOEE
Voting Precincts - 2000	VotePre00Ply	BOEE
Voting Precincts - 2002	VotePre02Ply	BOEE
Voting Precinct Lines - 2002	VotePre02Ln	BOEE
Census Tract Lines - 2000 - DC	Tract00Ln	Census Bureau
Census Tract Lines - 2000 - DC	Tract00Ply	Census Bureau
Census Tracts - 1930 - DC	Tract30Ply	Census Bureau
Census Tracts - 1940 - DC	Tract40Ply	Census Bureau
Census Tracts - 1950 - DC	Tract50Ply	Census Bureau
Census Tracts - 1960 - DC	Tract60Ply	Census Bureau
Census Tracts - 1970 - DC	Tract70Ply	Census Bureau
Census Tracts - 1980 - DC	Tract80Ply	Census Bureau
Census Tracts - 1990 - DC	Tract90Ply	Census Bureau
Elementary School Boundaries	EsBndyPly	DCPS
Middle School Boundaries	MsBndyPly	DCPS
School Election Districts	ScheDisPly	DCPS
Enterprise and Empowerment Zones	EntZonePly	EOM
High Tech Development Zones	TechZonePly	EOM
Business Improvement Districts	BidPly	Individual BIDs
Police District Linework	PolDistLn	MPD
Police Districts	PolDistPly	MPD
Police Service Areas	PolSAPly	MPD
Police Service Area Line work	PolSALn	MPD
Police ROC Areas	PolROCPly	MPD
Police ROC Lines	PolROCLn	MPD
Central Employment Areas	CEAPly	NCPC
Street Centerlines - SIS	SISScLn	OCTO, DDOT

Ward Lines - 2002	Ward02Ln	OP
Wards – 2002	Ward02Ply	OP
Ward Lines - 1990	Ward90Ln	OP
Wards – 1990	Ward90Ply	OP
Assessment Neighborhoods	AsnBhdPly	OTR
Assessment Sub neighborhoods	AsSubNbhdPly	OTR
Taxi Zones	TaxiZonePly	TC
Zip Code Lines	ZipCodeLn	USPS
Zip Codes	ZipCodePly	USPS

Table 4: Potential Snapbase – Derived Layers

It is the responsibility of OCTO GIS to maintain and distribute the Snapbase. Street centerlines, a primary source of the Snapbase are maintained by DDOT.

Note: Use of the Snapbase as the principal method for creating DC GIS topology is under review. It is a goal of OCTO to incorporate topology rule in the DC GIS geodatabase utilizing ArcSDE. Updates to the topology standard are likely in 2005.

3.7 Planimetric Mapping

When creating future planimetric datasets at OCTO GIS, the standards below will be followed:

- Datasets contained within the planimetric feature dataset are only mapped using aerial photography and photogrammetric principles.
- They shall meet exceed American Society of Photogrammetry and Remote Sensing standards for large scale mapping and 1:1000 scale.
- The planimetric layers include**:**

Planimetric Layer Name	Planimetric File Name (*.shp)
Airports and Helipads	AirPly
Buildings	BldgPly
Bridges and Tunnels – Hidden	BrgHidePly
Bridges and Tunnels	BrgTunPly
Cultural Features	CulturePly
Curbs	CurbLn
Electric Substations	EsubStnPly
Hydrography	HydroLn
Metro Polygons	MetroPly
Metro Points	MetroPt
Miscellaneous Polygons	MiscPly

Miscellaneous Points	MiscPt
Miscellaneous Transportation Features	MiscTrnLn
Obscured Areas	ObsAreaPly
Other Traffic Signs	OtherTrfPt
Overhead Traffic Signs	OvrhdTrfLn
Railroads	RailRdLn
Roads – Hidden	RoadHidePly
Roads	RoadPly
Building Spot Elevations	RoofElevPt
Sewer Polygons	SewerPly
Sewer Points	SewerPt
Sidewalks – Hidden	SidewlkHidePly
Sidewalks	SidewlkPly
Alley Centerlines	SISAlleyLn
Drive Centerlines	SISDriveLn
Ramp Centerlines	SISRampLn
Street Centerlines – SIS	SISScLn
Service Road Centerlines	SISSvcRdLn
Structure Lines	StructLn
Structure Polygons	StructPly
Swimming Pools	SwmPoolPly
Topography – One Meter Contours	TopoLn
Topography – Five Meter Contours	TopoLn_5m
Topography – Ten Meter Contours	TopoLn_10m
Spot Elevations	TopoPt
Trees	TreePt
Utility Poles	UtilPolePt
Water Bodies	WaterPly
Wooded Areas	WoodPly

Table 5: Planimetric Layer and File Names

3.8 Addressing

The DC GIS has adopted detailed addressing standards. The standards can be found in a companion document *District of Columbia Master Addressing Implementation Plan Standards for Addressing, December 2001.*

3.9 Geocoding and the Master Address Repository

The Master Address Repository (MAR) will serve as the source repository for addressing information in the District. The MAR will provide District agencies with an authoritative single source for accurate address data **within the District of Columbia**. Each address contained in the Master Address Repository will be linked to a specific geographic feature that is contained within the DC GIS. The MAR will provide the capability to agencies to match their address information against it for validation and verification. The toolset accompanying the MAR will output x,y coordinates for verified addresses as well as a list of addresses requiring more research.

Agencies are encouraged to adhere to the following guidelines when creating or appending geospatial by geocoding addresses:

- Use the MAR (point geocoding against address points) as the primary method for geocoding
- If the above method fails, use the MAR to validate individual address components (street name, quad, zip code, etc) and rerun.
- Use interpolation between address points as the secondary method of geocoding
- Use street centerlines address ranges as the tertiary method of geocoding
- Note in the record which of the above methods was used to geocode each point
- If geocoding against the MAR was successful, store the AID (address identification number) returned by the MAR in your local database.
- If the MAR fails or returns suspect results, report them to OCTO GIS.

3.10 Minimum Attribute Table Column Names

For most datasets at OCTO GIS, a common set of items exists to name, locate, link, and ID each record. These items are:

- **GIS_ID** (String, 16) – This item contains the primary DC GIS key for the dataset. GIS IDs will be implemented as a standard for capturing and managing features at OCTO GIS. Each feature that is created or updated by staff at OCTO GIS will automatically have a unique GIS ID associated with it. Automated programs and checks will ensure the assignment and uniqueness of these ids.

- **NAME** (String, 60) – This item contains the primary or common name of the feature.

- **AID** (Integer) (if appropriate) – A foreign key to the Master Address Repository

- **WEB_URL** (String, 125) (if appropriate) – This item holds the web link related to the site. In most cases, this contains a link to the web site of the organization the feature represents. It can also be an appropriate “dc.gov” link where available. Otherwise, it should be an indirect url to a web site describing the feature, such as a non-profit organization. Commercial urls should be avoided (i.e. McDonalds, Starbucks, etc.).

- **Feature updated date** – A time stamp recorded at the time a change was made to an individual feature.

A layer may not require all of these items, but the analyst should review these specifications in designing the attribute table appropriately: Each layer will have a GIS_ID.

Column names shall not exceed 25 characters in length. Hyphens and spaces are not allowed. Instead, underscores can be used to separate column words. Column names should be in all uppercase.

3.11 GIS File Format and Transfer

Since DC GIS will soon harness the functionality of ArcGIS 9.0, such as topology, cartographic representation and versioning, it is critical to preserve the integrity and consistency of these rules and settings. Therefore, all data transactions at OCTO GIS will use ArcSDE 9.0 on the geodatabase. Agencies responsible for data maintenance should also utilize this standard for all data activities. GIS files shared among agencies must also be in a geodatabase or in ArcSDE export format. **Shapefiles are not to be used**, except for public data distribution. Shapefiles may also be used for some minor interagency file sharing, **except where the layers employ topology**.

3.12 Vector Property Map

The District has used the “ownerpoints” and scanned tax maps as the source for mapping land ownership. However, by June 2005, the District government will replace that limited property map with the vector property map, which contains the boundaries and dimensions of every record and tax lot in the District. This will then become the standard property map that every agency should use for creating derivative layers such as land use and zoning. The “ownerpolys” layer will be a hybrid of record and tax lots merged into one District-wide polygon layer and linked to the public extract database on square, suffix, and lot.

3.13 Data Distribution and Security

OCTO GIS serves as the central repository data for all published District data, and provides web distribution services. The DC Office of Planning (OP) also provides data at low cost and provides CD data distribution and hard copy mapping services.

Consistent with the District of Columbia Official Code (2001 Edition, Division I. Government of District. Title 2. Government Administration. Chapter 5. Adminstrative Procedure. Subchapter II. Freedom of Information), DC GIS shall normally make digital data available to all District and Federal agencies and the public at large at no cost, subject to security, confidentiality and licensing restrictions. When substantial costs are incurred, agencies may charge fees up to the amount of those costs. This policy sets up three levels of data distributions:

- Public – Data that is made available to everyone.

- Government – Data that is made available only to other District agencies and cooperating Federal and regional governments. Metadata distribution may also be limited to government, but by default is shared with the public.
- Restricted – Data that is restricted for security or confidentiality reasons. Restricted data is handled on a case-by-case base. Metadata for these datasets may also be restricted on a case-by-case basis.

3.14 Cartography

There are currently no DC GIS cartographic standards. However, the DC Office of Planning has developed ArcGIS layer files that include standard symbology, layer groupings, and display scales for their internal use. Based on this experience, the Office of Planning has been asked to lead a coordinated effort to create DC GIS cartographic standards for printed maps. After a print standard is in place, cartographic standards for the web will be developed. OCTO will lead a coordinated effort to develop the web standards.

3.15 Geospatial Metadata

Metadata or "data about data" describes the content, quality, condition, and other characteristics of data. Metadata is a vital part of **the federated model**. Given the abundance of data from various sources, tracking and providing information on a dataset basis is critical for maintaining and distributing data. It also enables users to wisely use the data.

Metadata must meet the FGDC standard FGDC approved the Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998) in June 1998.
(www.fgdc.gov/metadata/metadata.html)

– and –

XML generated by ArcCatolog is the District standard format for interagency metadata transfer and sharing.

OCTO GIS currently enforces the creation of metadata for each dataset that it produces in ESRI's ArcCatalog software application (the preferred metadata – editing application of OCTO GIS). ArcCatalog is used for composing and updating metadata for it follows the Federal Geographic Data Committee (FGDC) standards for metadata. The FGDC editor is used to edit the metadata. The *FGDC Classic* format is the preferred output format when creating metadata at OCTO GIS.

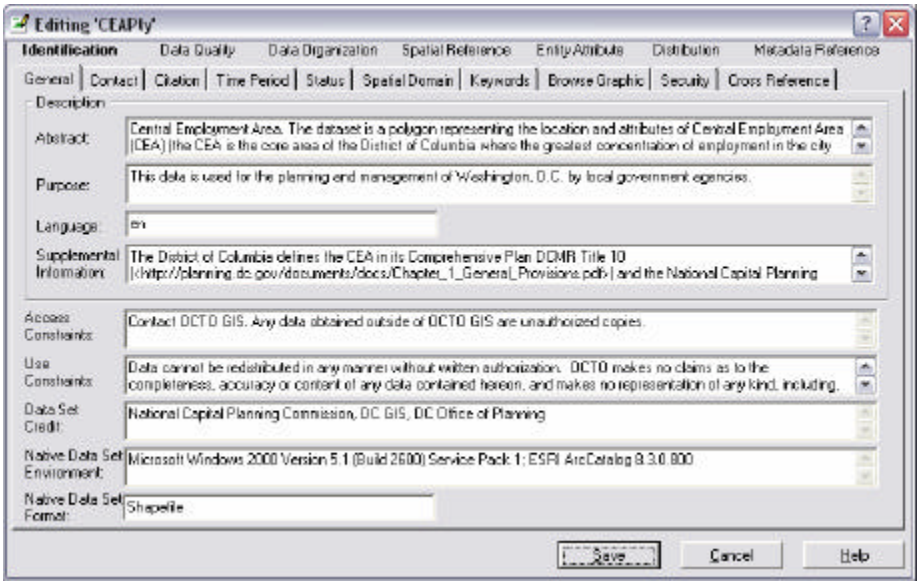


Diagram 4: ArcCatalog FGDC Metadata Editor

All metadata that is made available online on the OCTO GIS website is in XML format. For information on what fields are required for specific datasets, contact the OCTO GIS Data Coordinator (see Appendix 2 – Contact List).

The FGDC standard groups metadata into seven descriptors. They are the key areas where the analyst enters information about the dataset, shown as the keywords along the top of Diagram 4. The following sections detail the contents of each descriptor (highlighted rows are required items by FGDC and DC GIS).

3.15.1 Identification

Element	Field Type	Description
Originator	text	The name of the organization or individual that developed the data set.
Title	text	The name by which the data set is known.
Abstract	text	A summary of what is in the data set.
Purpose	text	Why the data set was developed.
Time Period of Content Date	date	A single date for which the data set corresponds to the ground or for which the user can be confident of accuracy and completeness. (If multiple dates or a range of dates apply to the data set, use "Currentness Reference" to list them and to explain further.) This date is set to the publication date or date of last update.

Currentness Reference	text	The basis on which the Time Period of Content Date is determined. List what the date is referring to (e.g. ground condition, date of quad map that was digitized, etc.) If multiple dates or a range of dates apply, list and explain. This is typically set to the publication date of the dataset.
Progress	text	Development status as reflected in domain choices.
Maintenance and Update Frequency	text	The frequency with which changes and additions are made to the data set after the initial data set is completed.
Spatial Extent of Data	text	Describe the geographic area covered by the data set.
West Bounding Coordinate	real	Western-most coordinate of the limit of coverage expressed in longitude, in decimal degree units.
East Bounding Coordinate	real	Eastern-most coordinate of the limit of coverage expressed in longitude, in decimal degree units.
North Bounding Coordinate	real	Northern-most coordinate of the limit of coverage expressed in latitude, in decimal degree units.
South Bounding Coordinate	real	Southern-most coordinate of the limit of coverage expressed in latitude, in decimal degree units.
Place Keywords	text	Words or phrases summarizing an aspect of the place of the data set.
Theme Keywords	text	Words or phrases summarizing an aspect of the theme of the data set.
Theme Keyword Thesaurus	text	Reference to a formally registered thesaurus or a similar authoritative source of theme keywords.
Access Constraints	text	Restrictions and legal prerequisites for accessing the data set. These include any access constraints applied to assure the protection of privacy or intellectual property, and any special restriction or limitation on obtaining the data set.
Use Constraints	text	Restrictions and legal prerequisites for using the data set after access is granted (ex. transferring to others).
Contact Person	text	A person within the development or managing group who can receive inquiries regarding the content or development of the data set. This may not be the same as the distributor.
Contact Organization	text	The name of the organization that can receive inquiries regarding the content or development of the data set.
Contact Person Position	text	The position of the Point of Contact Person.

Contact Address	text	The mailing address of the Contact Person.
Contact City	text	The city of the Contact Person.
Contact State or Province	text	The state or province of the Contact Person.
Contact Postal Code	text	The ZIP or other postal code of the Contact Person.
Contact Voice Phone	text	The voice telephone number, including area code, of the Contact Person.
Contact Fax Phone	text	The facsimile telephone number, including area code, of the Contact Person.
Contact E-mail Address	text	The Internet mail address of the Contact Person. This is typically set to dcgis@dc.gov.
Browse Graphic File Name	text	A "Browse Graphic" is any type of graphic file that provides an illustration of the data set. If a browse graphic is available on the internet, provide the file name Uniform Resource Locator (URL), including the "http://".
Browse Graphic File Description	text	A text description of the illustration.
Associated Data Sets	text	Information about other, related data sets that are likely to be of interest (e.g. derived from common sources, similar theme, etc.)

Table 7: FGDC Identification

3.15.2 Data Quality

Element Name	Field Type	Description
Attribute Accuracy	text	An explanation of how accurately the entities have been identified or how accurately values have been assigned in the data set. This can be the results of quantitative analysis, steps taken to ensure accuracy during development, or known deficiencies.
Logical Consistency	text	An indication of topological problems such as overshoots, undershoots, unwanted intersections, unclosed polygons, missing or duplicate labels, etc.
Completeness	text	Information about omissions, selection criteria, generalization, definitions used, and other rules used to derive the data set that may affect the completeness of content of the data.
Horizontal Positional Accuracy	text	An explanation of the accuracy of the horizontal positions (coordinates) of spatial objects and a description of the tests or line of reasoning used to arrive at the estimate.

Vertical Positional Accuracy	text	An explanation of the accuracy of the vertical positions (coordinates) of spatial objects and a description of the tests or line of reasoning used to arrive at the estimate. This only applies to datasets with a vertical component such as topography.
Process Step(s)	text	Information about the sources of data used to construct the data set and steps used to process the data. For each processing step provide, where possible, the following: source data name, source data scale, source data date, description of processing steps performed, scanning or digitizing specifications, hardware & software used, processing tolerances, etc.
Source Information	integer	The information of the source documents used to create or update the layer. Information includes general source information such as scale denominator, type of source media, source citation abbreviation, and source contribution. It also includes source citation information: title, originator, publication date, online linkage, and geospatial data presentation form.

Table 8: Data Quality

3.15.3 Data Organization

Element Name	Field Type	Description
Native Data Set Environment	text	A description of the data set in the producer's processing environment including the software name and version number. The user may also enter the computer operating system, file name and data set size if desired. (Note: Transfer formats will be listed in Section 6.)
Geographic Reference for Tabular Data	text	Description of the types of geographic features, addressing schemes, geocodes or other means through which locations are referenced in the data set.
Spatial Object Type	text	The system of objects used to represent space in the data set.
Vendor Specific Object Types	text	The spatial objects used in terms used by the software. Counts of these objects may also be entered (e.g. columns = 100, rows = 200, lines = 300, points = 400, etc.) Additional values may be used if the domain choices are not complete for a data set.
Tiling Scheme	text	Description of the physical partitioning of the data set (e.g. counties, USGS 7.5 minute quad sheets, etc.).

Table 9: Data Organization

3.15.4 Spatial Reference

Element Name	Field Type	Description
Horizontal Coordinate Scheme	text	The scheme used to define horizontal coordinates as depicted by the domain choices.
Ellipsoid	text	Identification given to establish representation of the Earth's shape.
Horizontal Datum	text	The datum used in the horizontal coordinate system. "NAD83 (96)" represents the 1996 adjustment based on the High Accuracy Reference Network (HARN).
Horizontal Units	text	The horizontal distance units. User may specify additional units not listed in domain. NOTE: "feet" is assumed to be U.S. survey feet.
Distance Resolution	text	The minimum distance measurable between two points, expressed in distance units of measure (e.g. the minimum allowable distance between two verticies).
Altitude Datum	text	The level surface of reference from which altitudes are measured, if applicable. NGVD29 = National Geodetic Vertical Datum of 1929; NAVD88 = North American Vertical Datum of 1988. This only applies to datasets with a vertical component such as topography.
Altitude Units	text	Units in which altitudes are measured. This only applies to datasets with a vertical component such as topography.
Depth Datum	text	The surface of reference from which depths are measured, if applicable.
Depth Units	text	Units in which depths are measured.

Table 10: Spatial Reference

3.15.5 Entity Attribute

Element Name	Field Type	Description
Entity and Attribute Overview	text	A summary of the information contained within the data set.

Entity and Attribute Detailed Citation	text	A reference to one or more detailed sources of information on the content of the data set; for example, a digital or hardcopy data dictionary. For every column in the table, contains information for label, type, width, precision, definition, and definition source.

Table 11: Entity Attribute

3.15.6 Distribution

Element Name	Field Type	Description
Publisher	text	The name of the organization or individual that made the data set publicly available. This will often be the same as the Originator (1.1 - 8.1).
Publication Date	date	The date when the data set is published or otherwise made publicly available.
Distributor Contact Person	text	A person who can receive inquiries regarding the distribution of the data set.
Distributor Organization	text	The name of the organization that can receive inquiries regarding the distribution of the data set.
Distributor Position	text	The position of the Distributor Contact Person
Distributor Address	text	The mailing address of the Distributor.
Distributor City	text	The city of the Distributor.
Distributor State or Province	text	The state or province of the Distributor.
Distributor Postal Code	text	The ZIP or other postal code of the Distributor.
Distributor Voice Phone	text	The voice phone number, including area code, of the Distributor.
Distributor Fax Phone	text	The facsimile telephone number, including area code, of the Distributor.

Distributor E-mail Address	text	The Internet mail address of the Distributor. Typically, this is set to dcgis@dc.gov.
Distributor's Data Set Identifier	text	The identifier by which the distributor knows the data set.
Distribution Liability	text	Statement of the liability assumed by the distributor.
Transfer Format Name	text	The name of the format(s) in which the distributor will make the data available. The user may list as many formats as desired and may use additional formats not listed in the domain.
Transfer Format Version Number	text	Vendor version number of the data format within which the data may be transferred.
Transfer Size	text	An estimate of the size of a transfer file in megabytes.
Ordering Instructions	text	Instructions for obtaining the data set. Include instructions for obtaining custom orders. It typically contains “Most DC GIS datasets can be downloaded from "http://dcgis.dc.gov" on the data center page. Orders can also be made by contacting OCTO GIS at "dcgis@dc.gov", especially for datasets not available for download.”
Online Linkage	text	The name of an Internet site or other online resource that contains the data set. Entries should follow the Uniform Resource Locator (URL) convention of the Internet. Include "http://" or "ftp://" , etc. in URLs.

Table 12: Distribution

3.15.7 Metadata Reference

Element Name	Field Type	Description
Metadata Date	date	The date that the metadata were created or last updated.
Metadata Contact Person	text	The name of the person responsible for the metadata information
Metadata Contact Organization	text	The name of the organization responsible for the metadata information.
Metadata Contact Position	text	The position of the Metadata Contact Person

Metadata Contact Address	text	The mailing address of the Metadata Contact.
Metadata Contact City	text	The city of the Metadata Contact.
Metadata Contact State or Province	text	The state or province of the Metadata Contact.
Metadata Contact Postal Code	text	The ZIP or other postal code of the Metadata Contact.
Metadata Contact Voice Phone	text	The voice phone number, including area code, of the Metadata Contact.
Metadata Contact Fax Phone	text	The facsimile telephone number, including area code, of the Metadata Contact.
Metadata Contact E-mail Address	text	The Internet mail address of the Metadata Contact.
Metadata Standard Name	text	The name of the metadata standard or guidelines used to document the data set.
Metadata Standard Version	text	Identification of the version of the metadata standard or guidelines used to document the data set.
Metadata Standard Online Linkage	text	The name of an Internet site or other online resource that contains a description of the metadata standard or guidelines. Entries should follow the Uniform Resource Locator (URL) convention of the Internet. Include "http://" in URLs.

Table 13: Metadata Reference

4.0 Quality Assurance / Quality Control (QA/QC)

A primary goal of the DC GIS is to make geospatial data and metadata available. Quality variations among data sets are normal. For example, a point layer of geodetic monuments must be extreme accurate to be useful. While it may be almost impossible to produce a complete and accurate layer of lead underground water service pipes, such a data set is extremely useful to people who understand its limitations. Ultimately, the OCTO GIS Director has the authority to select from the data made available by agencies the data sets deemed to be appropriate and of sufficient quality to make available through the DC GIS. The following QA/CC guidelines should be followed when submitting data to the DC GIS:

4.1 Quality Assurance Procedures

The inclusion of accurate, complete, timely and useful geographic and tabular data is Integral to the success of the OCTO GIS program. The QA/QC steps assess these parameters and identify errors, as well as consequent steps of resolution.

Given the breadth of GIS data in the District, the QA/QC plan is composed of numerous checks and processes, some exact and some inexact in scope. In addition, the metrics are a mix of precise and imprecise measures. Moreover, there is some subjectivity the operator utilizes in performing the QA/QC processes. This flexibility allows the plan to assess almost any type of spatial and tabular data. Also, it generates the best quality of data feasible through effective management and execution of the processes.

Agency QA/QC involves making certain the data meets its standards for source materials. OCTO or centralized QA/QC involves ensuring the data meets specifications and standards for inclusion in the enterprise database.

This section of the maintenance plan defines and describes these processes and metrics the OCTO GIS staff will use in the QA/QC program. The QA/QC steps will be:

1. Assess the initial quality of the data
2. Identify errors
3. Define resolution of the errors
4. Fix the data

Throughout these efforts, personnel will generate status reports measuring the progress of the QA/QC effort. Errors are marked in shapefiles with appropriate information. In the end, the data is ready for publication to the enterprise database.

Originally, OCTO GIS defined metrics and procedures for the DC Guide web application effort. These processes worked on dated technology, namely coverages and shapefiles in workstation Arc/Info. Efforts are underway to update these processes to the geodatabase and employ the ArcGIS 8.X and 9.0 releases.

4.2 Error Handling

OCTO GIS addresses errors in a systematic manner. When a technician or manager identifies an error, it is recorded in a database or assessment report. As more agencies take on maintenance tasks, the data originator will also notified of errors. By notifying the data originator as well as recording the error in - house, the data originator can be made aware of the changes that must occur in its data maintenance tasks.

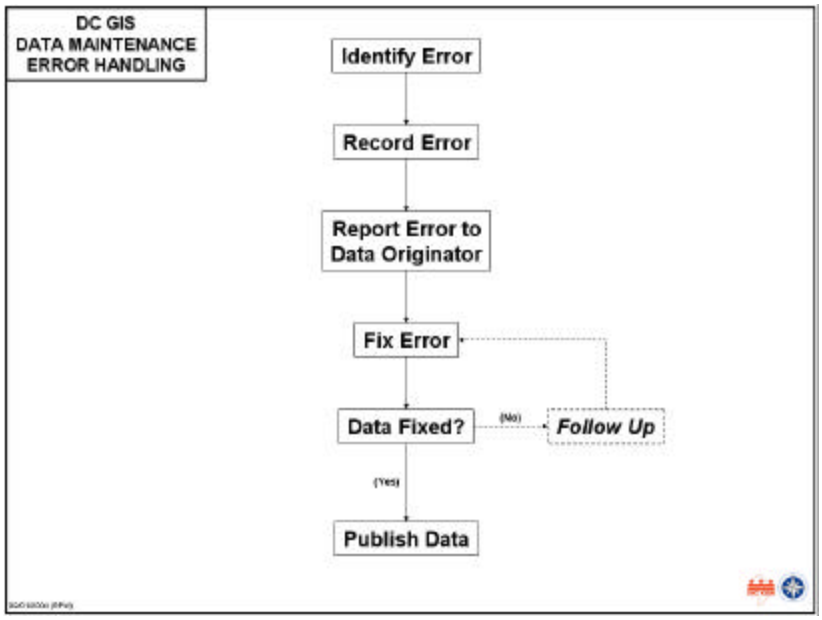


Diagram 3: DC GIS Data Maintenance Error Handling

After the error has been identified and all involved personnel are informed, appropriate agency personnel will update the data in order to remove the error. If the error cannot be removed to the point of in – house acceptance criteria, the data originator is notified. At this time, OCTO GIS can either look for a new dataset from a different data originator or request an updated dataset from the initial data originator.

Once the data is corrected, it is quality controlled (QC'd) prior to publication. Specific guidelines outlined in this plan. are to be followed when correcting the data, based on the data type; i.e., an image is QC'd with different guidelines than a point feature class. Both the agency and OCTO perform their respective QA/QC.

The data is classified as either restricted or non – restricted status before it is published to consumers. Datasets that are restricted can only be sent to a select number of consumers who are given access to such data types. Unrestricted datasets can be distributed to any agency or person who requests the data. Based on this, the dataset gets published to the appropriate databases.

4.3 Quality Control Guidance

Quality Control (QA/QC) is a vital part of GIS work because they allow users to ensure a level of accuracy and quality for all published datasets. Standardizing QC efforts is equally important, because otherwise data could be made available that needs to be QC'd prior to its publication. Handling these datasets can be burdensome without a standardized process for handling specific types of data. Hence, efficient standardized QC processes will be developed and incorporated into the maintenance program at OCTO GIS.

While source agencies will have varying levels of agency QC standards, having published core standards for data distribution and storage permits appropriate QA/QC tools to be developed and incorporated into customized ArcGIS map documents. OCTO GIS has already developed several programs that ensure the data meets several of the standards listed in section five. Moreover, exploiting ArcSDE attribute domains, subtypes, and topology will further check and standardize data. OCTO GIS intends to work with agencies to license and/or develop tools to help spatial data editors measure and improve adherence to quality goals.

Types of checks that can be automated include:

Single Column Attribute Tests

Unique Values

Detects non-unique values for a column. Useful for columns that are being used as primary keys or columns that represent feature identifiers where uniqueness is required.

Coded Domains

Detects invalid values based on pre-established geodatabase Coded Domains, existing DBMS tables or a user-defined list of valid values. All values for a tested column must contain only valid values.

Coded Ranges

Detects out-of-range values based on pre-established geodatabase Range Domains or user-defined minimums and maximums. All values for a tested column must contain only valid values.

Single Values

Detects values other than the specified single value for a column. All values for a column must equal the specified value.

NULL Values

Detects NULL, blank and/or zero values for a column. Can detect NULL occurrences if NOT NULL constraints are disabled while loading the data into the geodatabase. Also detects blank and/or zero values occurring in legacy INFO tables.

Non – Standard Values

Detects non-standard keyboard values such as !@# and ? in a column. A list of these values may be configured for each column.

Column Format

Detects values that do not match the specified format. May set format to uppercase, lowercase, numeric, or non-numeric.

Column Length

Detects values that are not the specified length.

Multiple Column Attribute Tests

Custom SQL Query
Reports results of a user-defined query to the database. Read-only queries are allowed.

Multiple Column Unique
Detects non-unique values for multiple columns. This test is useful when searching for non-unique Book/Page/Parcel combinations.

Referential Integrity Test

General Table Relationship
Detects unmatched relationship keys between two tables in a join. No orphan table rows are allowed.

Spatial Relationship Test

Distance
Calculates the distance from geometries in one feature class to geometries in another. A distance tolerance may be used. Additionally, attribute filters may be applied to either feature class. A spatial filter may be applied to the test to limit the scope of the features tested. This test detects features that cannot participate in a geometric network because they lack coincidence.

In addition to the standardized QC documentation and software, custom QC tools must be developed and incorporated into the regular maintenance procedures. One of those tools will be the new OCTO GIS website. One aspect that will assist in future QC efforts at OCTO will be the new error tracking system, called Error Reporting and Review Online Registry System (ERRORS). It will be a portion of the website that focuses on issue monitoring. Internal and external users of the site will be able to:

- Report errors that they find in the data.
- Track each error issue's status as it is being resolved; i.e., Status = Error Submitted, Status = Error under Review, Status = Error Pending, Status = Error Resolved (see note for distribution instructions), etc.
- Get notification that their dataset has been updated and is published or in the queue.

Having this portion of the new website in place will help various agencies and users that use OCTO GIS's datasets to communicate more easily, as well as stay informed about datasets that are made available through OCTO GIS. On the other hand, this system will also handle agency and public feedback on datasets. The DBA will run daily statistics on the datasets in order to generate a progress report so that staff and data maintenance can be monitored. The report will list who is currently creating features, how many features they have created, what project they are working on, and how many hours they have been working on data creation for the project. More sections of this report will be generated when additional needs arise.

5.0 DC GIS Data Catalog

The DC GIS Data Catalog is a database maintained by OCTO GIS for all geospatial layers and key attribute tables in the DC GIS inventory, under development, or planned. Currently, portions of the DC GIS data catalog are made available on the Internet. The Internet site filters the list so that only completed datasets are listed. In the future the entire data catalog will be made available on the DC GIS Intranet page so that agencies can have access information on planned and in progress data sets.

It is the job of every Federation member to help keep the DC GIS data catalog up-to-date. Web tools will be provided; before that, updates to the catalog should be sent to Mario Field.

The current Data Catalog is part of the Data Services section on the OCTO GIS homepage. It is a database and web-based interface that allows users to query and search OCTO GIS's data holdings. The interface allows the user to query, search, and browse the catalog (see Diagram 5). From these functions, the user can view pertinent information on each dataset with access to the full metadata. The data catalog editor is part of the internal data center. This part allows designated staff to update the catalog's contents.

Name	Originator	Feature Type	Detailed Metadata	Summary Metadata	Download*
Airports and Helipads	OCTO	Polygon			
Alley centerlines	OCTO, DDOT	Polyline			
Bridges and Tunnels	OCTO	Polygon			
Bridges and Tunnels - Hidden	OCTO	Polygon			
Building spot elevations	OCTO	Point			
Buildings	OCTO	Polygon			
Cultural features	OCTO	Polygon			
Curbs	OCTO	Polyline			
Drive centerlines	OCTO, DDOT	Polyline			
Electric SubStations	OCTO	Polygon			

Page 1 2 3 4 Results per page: 10

* Metadata on this website is displayed in styles defined in the Federal Geographic Data Committee's (FGDC) *Content Standard for Digital Geospatial Metadata (CSDGM)* and the Environmental Systems Research Institute (ESRI) profile of the CSDGM.

Diagram 5: Online OCTO GIS Data **Catalog**

5.1 Structure

The data catalog at OCTO GIS is made up of specific fields that define the structure of the geodatabase. Featured below is a table that outlines the geodatabase names, their corresponding label on the Internet (internet name), as well as, a description for each field.

DC DATA CATALOG FIELD NAMES AND DESCRIPTIONS		
Geodatabase Name	**Internet Name**	**Description**
ANALYST	Analyst	OCTO GIS staff member assigned to research and acquire the dataset.
ATTRDESCRIPTION	Attributes	Dataset attributes, field listing.
CENTRALGIS	Central Gis?	Setting for whether the dataset is part of the central GIS database.
CITIZENATLAS	Citizen Atlas?	Setting for whether the dataset is part of the DC Guide application.
COMMENTS	Comments	Extra comments on the dataset.
COREID	CoreID	Primary key field / unique identification number.
CRITICALFACILITIES	Critical Facilities?	Setting for whether the dataset is part of the Critical Facilities in support of Emergency Preparedness.
DATACATALOG	Show in DataCatalog?	Setting for whether the dataset is listed on the online data catalog.
DATERECEIVED	Data Received	Date OCTO received or published the dataset.
DCATLAS	DC Atlas?	Setting for whether the dataset is part of the DC Atlas application.
DCGOVDATA	DC Gov Data?	Setting for whether the dataset is DC Government data.
DESCRIPTION	Description	Enhanced explanation of the dataset.
EMERGENCY	Emergency?	Setting for whether the dataset is part of the emergency data group.
FEATURECLASS	SDE Feature Class	Geodatabase feature class name.
FEATUREDATASET	SDE Feature Dataset	Geodatabase feature dataset name.
FILETYPE	File Type	Dataset file type (Shapefile, Access Table, JPEG, etc.)
LIMITATION	Limitation	Distribution and access limitation on the dataset.
LOCATION	Metadata Location	Path location to the dataset's detailed metadata.
NAME	Name	Dataset common name.
NEXTSTEPS	Next Steps	Next steps in processing the dataset.
ORIGINATOR	Originator	DC agency that is the authoritative source on the data.
OTHERFILENAME	System File Name	File name of the dataset on the system.
PRIORITY	Priority	Priority of processing the dataset.
PROVIDER	Provider	DC agency that provided the dataset to DC GIS.
REALPROPERTY	Real Property?	Setting for whether the dataset is part of real property data group.

SAFETY	Safety?	Setting for whether the dataset is part of the safety data group.
STATUS	Status	Data processing status.
TYPE	Feature Type	Dataset feature type – point, polygon, polyline, tabular or image.
UPDATEFREQ	Update Frequency	Dataset update frequency.

Table 14: DC Data Catalog Field Names and Descriptions

5.2 Procedures

In order to manage the data catalog at OCTO effectively, set procedures are required for integrating datasets within the catalog. Those procedures must stay general so that all personnel can implement them at any time on various data types and formats.

In general, a technician locates the updated or new layers that need to be integrated into the data catalog. Once the new file is found, usually located in the DCGISDATA theme directory at OCTO, a Zip file (*filename.ZIP*) is generated. The Zip file contains the updated or new layer, as well as metadata for the layer in XML format.

Once the metadata has been correctly formatted within ESRI's ArcCatalog Metadata editor, it is exported to HTML format. Using the metadata available in this format, a web link is made off of the OCTO website that shows the full metadata file for the layer.

After the file has been exported to HTML format, it is emailed to the OCTO GIS Systems Administrator so that it can be transferred to the OCTO FTP site; this process enables the Administrator to publish the file to the web.

For all files that are currently in the catalog and need to be updated, the OCTO Data Catalog Editor should be used in order to update the file properly. For more information on using the Editor for this purpose, see Section 1.2: DC Guide Database – Steps to Load and Filter D&B Monthly Updates.

On the other hand, the OCTO Data Center editor is also used to integrate new files into the catalog. This tool allows users that have been granted permission to delete, update, and add records to the catalog,+ using an easy–to–use web interface (see the *Data Center Editor* images on next two pages).

After all updates have been made, users check the website to see if there are any discrepancies in the information that has just been uploaded. If any edits are needed, they can be dealt with at that time. Otherwise, the files are uploaded, the metadata is made available and the website is that much more valuable to all users.

Data Center Editor: Dataset Information

The Data Center Editor is the web–enabled interface that allows analysts at OCTO GIS to update important information about datasets that are updated and published by the agency. The image below features the initial section of the interface, which captures information concerning a dataset's attributes, ownership, and processing. Currently, OCTO uses this application.

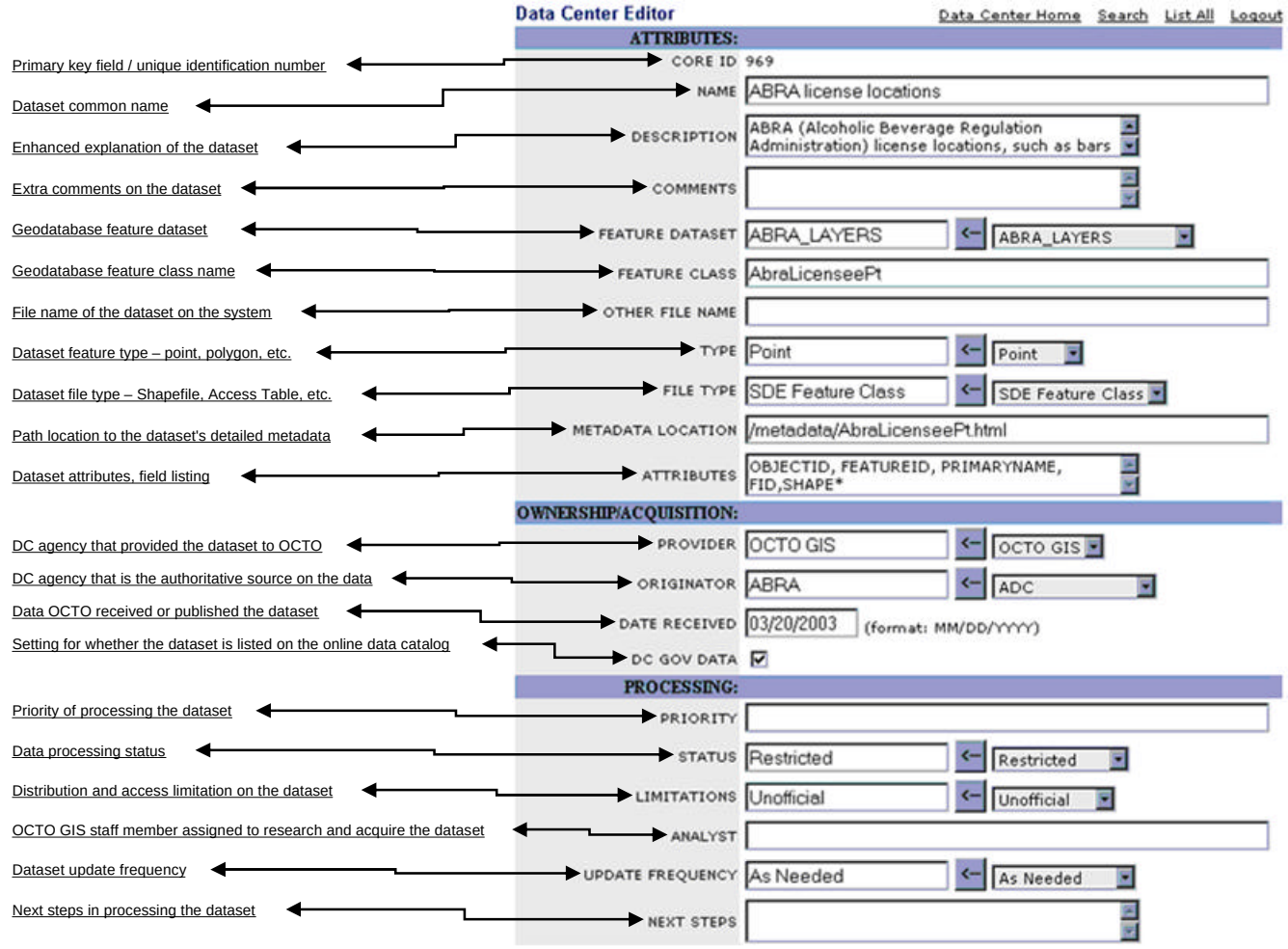


Diagram 6: Data Center Editor

Data Center Editor: Classifications

The Data Center Editor is the web–enabled interface that allows analysts at OCTO GIS to update important information about datasets that are updated and published by the agency. The image below features the second and final section of the interface, which captures information about the dataset's uses, application, and download parameters (for the web site).

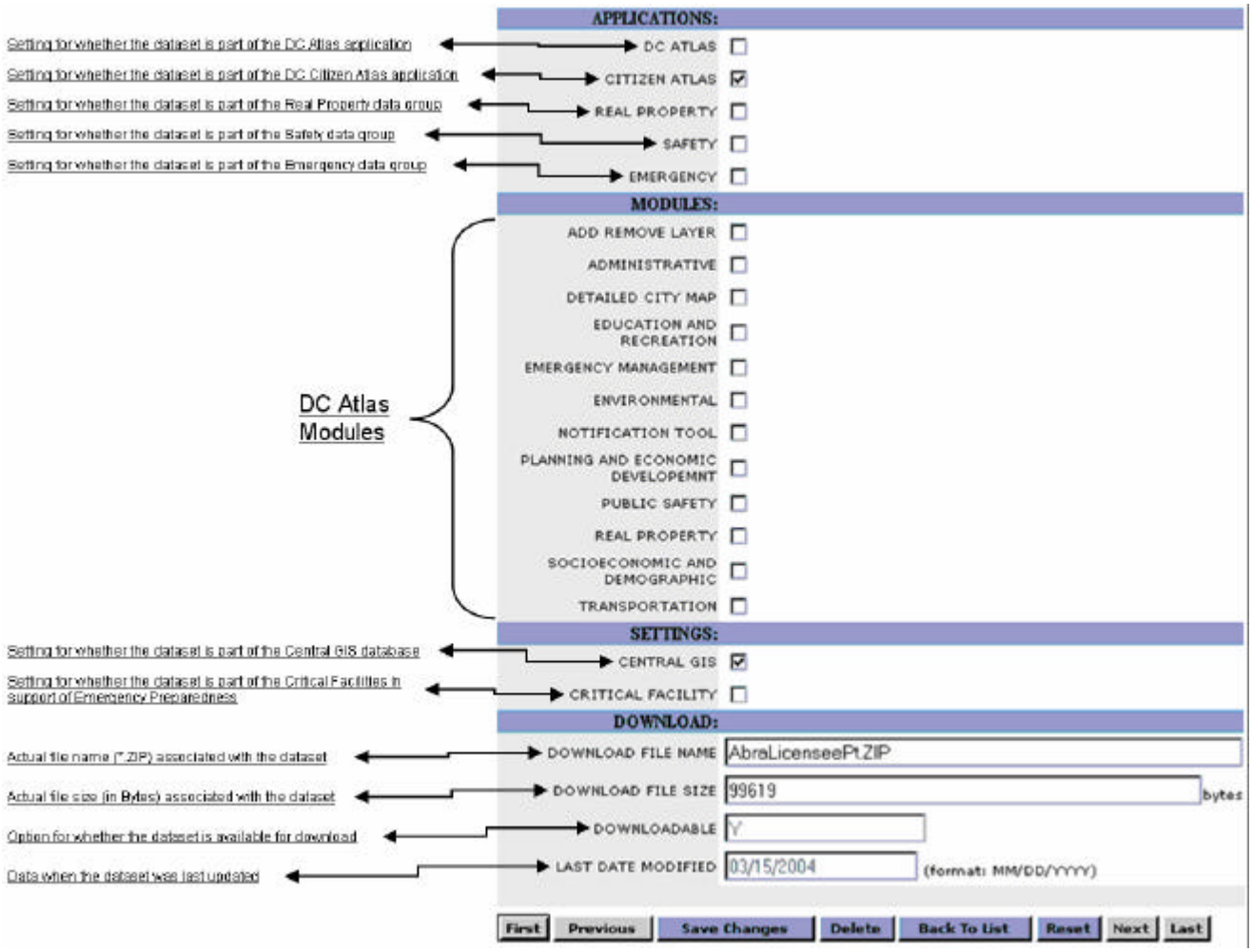


Diagram 7: Data Center Editor **(Part 2)**

6.0 Layer QA/QC Guidelines

Types of Checks

The following are the types of checks that are performed on layers maintained by OCTO GIS:

1. Visual Checks
   - Description: Using a "geographic eye," staff perform a structured visual sweep of the data, using on-screen and/or paper checkplots, looking for various inconsistencies and patterns. Compiled data is also visually compared to source documents, both for location and attribute accuracy.
   - Software: ArcGIS, Acrobat, and other software such as Explorer and Access.

2. Edge-matching Checks
   - Description: This is also a visual check, but to review the spatial capture, connectivity, and attribution of data across tile boundaries. This is only performed on datasets clipped using a regular grid.
   - Software: ArcGIS

3. Automated Checks
   - Description: Staff compare the data to the associated metadata and/or a database dictionary and identify discrepancies between the two. More simply, staff execute data report scripts on the data that list data structure, format, and contents for visual comparison to source information.
   - Software: ArcGIS

4. Specialized Checks
   - Description: Staff view and query the directionality, connectivity, topology, and source document information of the data.
   - Software: ArcGIS

5. Edit Verification (Edit Check)
   - Description: Upon delivery or repair of data, staff visit every error they had identified and determine if the fix was performed to specifications.
   - Software: ArcGIS

6. Field Verification (Field Check)
   - Description: Staff compare a sample of the contents of the GIS data with what exists in the field. Also, staff can determine the spatial accuracy of GIS data through survey techniques.
   - Software: ArcMap, ArcCatalog, and survey techniques

Quality Measures

In the Federated data model it is essential that quality be measured and reported in the metadata. Below is a list of measures that are used to assess and rate the quality of spatial and tabular data. The table at the end of this part cross-references the metrics with the processes contained in the QA/QC steps. The metrics table further discusses these measures and places acceptance threshold values on each as percentages.

Spatial Accuracy:

- The difference between the coordinates extracted from the GIS data and those determined by a more accurate method, such as survey or GPS techniques. It is measured horizontally and vertically for 3D data, and the spatial source scale determines the acceptable threshold. For geocoding, this metric represents how correctly the address record matched to the correct address point.

Attribute Accuracy:

- The closeness of values contained in a dataset to those outlined in metadata, a database dictionary, or valid values tables. Also, the closeness of attribution between the digital data and what exists in the real world, or a sample thereof.

Usability:

- The completeness, timeliness, consistency, and suitability of the data.

Metadata Adherence:

- How closely the data meets documented standards and specifications.

Specialized:

- The conformity of data to specialized parameters; such as directionality, connectivity, and topology. Also includes the match of digital data with the source materials.

Database Management System (Optional):

- The success of loading the data into the Geodatabase. In addition, this metric includes the match of the Geodatabase schema to the documented database model (see Table 6).

6.0.1 Digital Orthophotography QA/QC Guidelines

There are numerous factors affecting quality that are inherent to digital orthophoto production. OCTO staff review the orthophotography, using a set tiling scheme such as the WGIS planimetric mapping tiles, and reject based on the results of the overall evaluation. However, if significant errors occur in any one of these categories, OCTO can reject the orthophotography.

	Visual	Edge-Match	Automated	Specialized	Data Loading	Edit Check	Field Check
Spatial Accuracy							X
Usability	X	X	X	X			X
Attribute Accuracy	X	X	X	X			X
Metadata Adherence			X				
Specialized	X			X			
Web Content	X						
GeoDB Load					X		
Edits Performed						X	

Table 6: QA/QC Check Processes and Measures Cross Reference Table

The evaluation categories include (from *"Imaging Primer: Now that's a Good Looking Orthophot," by Scott Hix; GeoWorld, November 1999).*

- Spatial Accuracy
- Edge-matching
- Radiometric Consistency
- Brightness
- Shadows
- Contrast
- Artifacts and/or Scratches

Category 1: Spatial Accuracy:

Features on the ground surface in the orthophotography will be within the mapping tolerance(s) of the true position of that feature. If these tolerances are not met, OCTO will reject the orthophotography. The most precise means of measuring spatial accuracy is by comparing imagery coordinates with actual survey-derived coordinates of prominent point features. A more cursory test can be done by overlaying prominent point features contained in the planimetric layers and measuring their spatial "fit" to the ortho.

Category 2: Edge-matching

When mosaicking, it is possible that the ortho-rectified imagery from each source photo may not precisely join or geometrically edge-match to the adjacent ortho rectified image. OCTO will reject imagery containing large offsets at the boundaries of adjacent images.

Category 3: Radiometric Consistency

Inconsistent radiometry, or image appearance, is one of the most visible aesthetic issues in orthophotography. Unbalanced radiometry can produce areas appearing as "checker-board" appearances. When viewed at high resolution, seams between photos may appear as a hard line between distinctly different color, brightness, or contrast levels. Radiometry is verified by visual inspection of the digital orthophoto with the original unrectified image. The digital orthophoto should have the same or better image quality as the original unrectified input image.

OCTO GIS will reject imagery if: 1) no radiometric corrections have been applied to imagery; 2) sharp contrast exists at photo seams; or 3) there are major radiometric differences among photographs.

Category 4: Brightness

OCTO expects the orthophotos to meet normal visual aerthetics and specifications. Usually this is established at the beginning of the orthophoto project with review before production. Ground features that are not obscured should be clearly visible. Also, staff should be able to interpret ground features. OCTO GIS may reject imagery if ground features aren't interpretable in bright areas and/or the imagery's overall brightness doesn't meet acceptable standards.

Category 5: Shadows

It is nearly impossible to obtain orthophotography that avoids shadows of buildings or cliffs. However, there should be acceptable detail in shadow and bright areas, and the imagery should contain minimal shadows. OCTO GIS may reject imagery if ground features are not interpretable in shadow areas or flown after peak sunlight hours when shadows become more apparent.

Category 6: Contrast

Setting acceptable contrast specifications is a subjective and client-specific task, and depends on the othophotography’s intended use. OCTO sets contrast criteria before the orthophoto production based on aesthetics and use. However, any acute contrast errors will be identified and documented for further investigation.

Category 7: Foreign Artifacts and Scratches

Hair, lint, dust and scratches can be introduced to orthophotography during photo capture, film processing and scanning. A low level of foreign artifacts that doesn’t obscure ground features

usually is acceptable. The industry threshold is five or more artifacts and scratches present per tile are grounds for rejection. Also, imagery should be rejected if scratches obscure ground features.

There are also issues not included in the review criteria because they are inherent to the creation of any digital orthophoto. However, they can impact the aesthetic quality of the digital orthophotography. OCTO examines the imagery against these issues and documents the more significant occurrences for further investigation.

Issue 1: Radial Displacement

All elevated features (buildings, trees, power lines, and others) are subject to radial displacement. This causes the features to appear to lean, which can obscure data, such as a street behind a leaning building. Also, when a seam line between two photos comes in contact with elevated features, the effect may detract from the aesthetic quality of the image. Usually, forested areas and other select vertical features (i.e. power lines) are not corrected for lean.

However, bridges, tall buildings, and areas of steep terrain (features that show the most visual distortion due to radial displacement) should be corrected in the imagery and show little or no radial displacement. Existence of this distortion can be grounds for rejection. For true orthophotography, OCTO-GIS expects little or no lean present for all vertical features.

Issue 2: Water Reflections

Usually, the vendor does not apply color balancing to the imagery for water bodies. Given that different sun angles can create noticeable differences in water throughout the image catalog, the image aesthetics may suffer. A uniform value over the water can be applied to balance the imagery, but this degrades the original data. Only significant degradations of aesthetic quality can serve as a basis for rejection. OCTO will discuss options with the vendor and outline specifications before orthophoto production.

Issue 3: Seams Running through Buildings

For mosaicking, the photography is cut along seam lines, and the placement of these lines can affect the visual quality of the image. Usually, seam lines occur along “ground” features, such as roads and open fields. But, seam lines can also occur in elevated features. The problems are caused by radial displacement of a single elevated feature from two different angles.

There should be a complete absence of seam lines in all vertical features. OCTO-GIS will note areas where seam lines cut vertical features for further review.

6.0.3 Web URL QA/QC Guidelines (Summarized)

Given the dynamic nature of web site addresses, OCTO GIS staff must perform a regular and consistent check of these sites and research new addresses where needed. Then, the database must be updated to keep the associated applications fresh. OCTO developed a

"URL checker" program to check the connection to web sites contained in the database. It requires access to the web as well as ORACLE or TOAD to process the information. Staff will check the web addresses in the database once a month on three consecutive days, running the program at night.

Staff run the URL checker, which extracts all of the urls that are suspect. Then personnel review these records and research correct urls for each, following the standards for populating the WEB_URL item. The Database Administrator updates the database with the corrected web links.