



U.S. Fish & Wildlife Service

A Plan for Development of the Wetlands Master Geodatabase

Executive Overview

**Branch of Habitat Assessment
U.S. Fish and Wildlife Service
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What is the Master Geodatabase for Wetlands?

A geodatabase is a storage mechanism for spatial and attribute data that makes it easier and more intuitive to use geographic information systems (GIS) software across many applications. The geodatabase supports multiple formats of spatial data including map information (raster or vector), attribute data, text, images, and metadata. This makes it ideal for storing, editing, analyzing, serving and archiving natural resource inventory information that contains multiple data formats (map, images and text).

Geographic data, supporting documents, spreadsheets and reports, have been stored in operating system files along with other forms of computer data and have not been integrated into a related dataset (Figure 1). Because these data pieces were in different formats (text vs. image vs. map data), direct linkage was difficult for a number of technical reasons. Documentation describing the same geographic area can now be linked to make the data more accessible and easier to use.

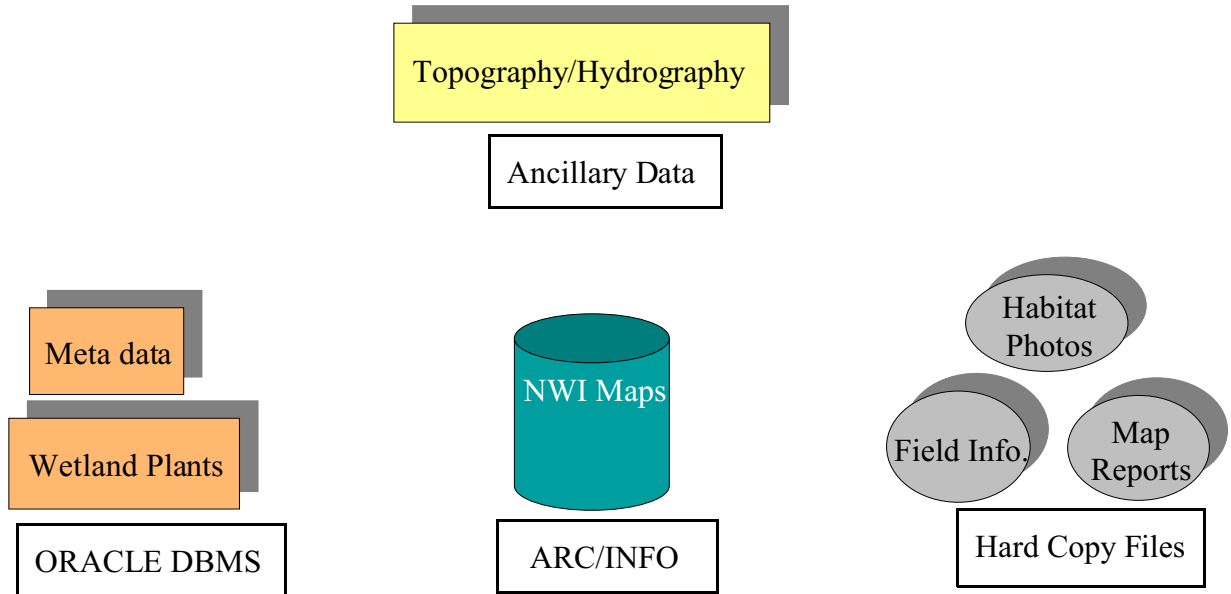


Figure 1. Geographic wetlands data, supporting documentation, related databases and ancillary data sources stored in various formats would be easier to use in an integrated system such as a Master Geodatabase.

To overcome the disadvantages of a file-based storage configuration, modern data processing projects store data in Relational Data Base Management Systems (RDBMS). A RDBMS stores data in row and column arrays called tables. When geographic data are stored in the tables of a RDBMS the collection of tables is called a geodatabase.

Using the geodatabase the Service can move away from the static archive of wetland map data and start to address the integration of multiple types of resource information to compose a true inventory. This means that map data, report information, field observations, habitat photos, plant and soils data that the NWI has collected over the past 26 years can be linked and easily accessed as part of the master geodatabase.

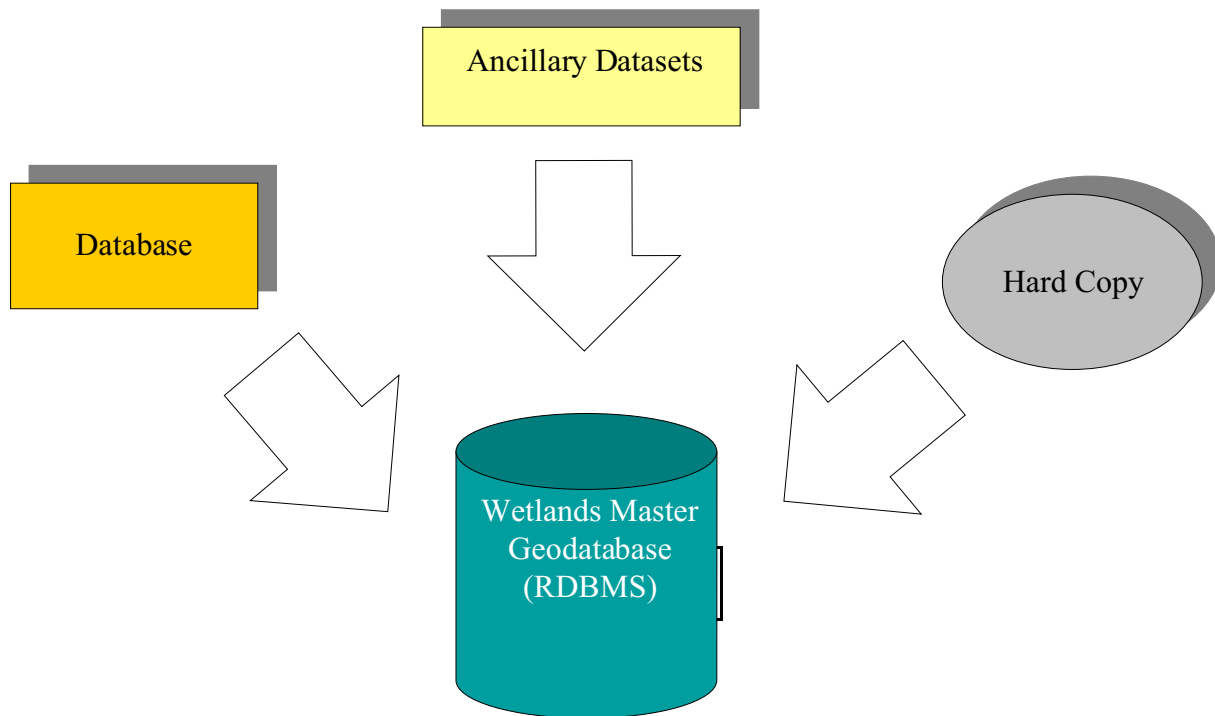


Figure 2. The Wetlands Master Geodatabase provides the capability to integrate geographically related data into a Relational Data Base Management System (RDBMS).

Meeting the Needs of the Service

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information to the public on the extent and status of the Nations wetlands. Resource managers increasingly need contemporary information on aquatic habitats to address increasingly complex issues. Migratory birds, fishes and endangered species need sufficient quality habitat as part of the landscape. Current map information coupled with other habitat data and landscape characteristics in digital formats can provide resource managers, and the diverse clientele of the Service, with more powerful tools for resource assessments. These resource management responsibilities and priorities of the Service must be supported by the aquatic habitat information produced by the National Wetlands Inventory.



The Service is often asked to provide scientific information to other Federal agencies, industry and the public. These types of analyses rely on digital information to provide fast, efficient and scientifically sound mechanisms for resolving resource management issues. The common structures, methodology and exchange formats provided by the geographic information system technologies greatly facilitate this process.

The *Emergency Wetlands Resources Act of 1986* directs the Service to map our Nation's wetlands and produce scientific information on their characteristics. The Service has completed digital wetlands maps for 42 percent of the Nation. The Service will continue to refine Internet delivery of updated digital data to keep pace with growing demand for wetlands information to use in resource mapping and management applications and support the Administrations Electronic Government initiatives to achieve operational efficiencies and enhance customer service.

The Geodatabase is ideal for storing, editing, analyzing, serving and archiving natural resource inventory information.

The concept for a comprehensive Wetlands Master Geodatabase (MGD) stems from past successes in producing and distributing wetlands maps and wetlands status and trends information. With the advent of computer technologies that now allow the integration of

large relational databases with spatial information and display, the Master Geodatabase provides the Service an opportunity to capitalize on years of data collection effort by developing scientifically sound, technologically relevant tools for data analysis, distribution, archiving and updating aquatic resource information.

Complementing the National Strategy

The National Strategy for the National Wetlands Inventory was designed to increase the

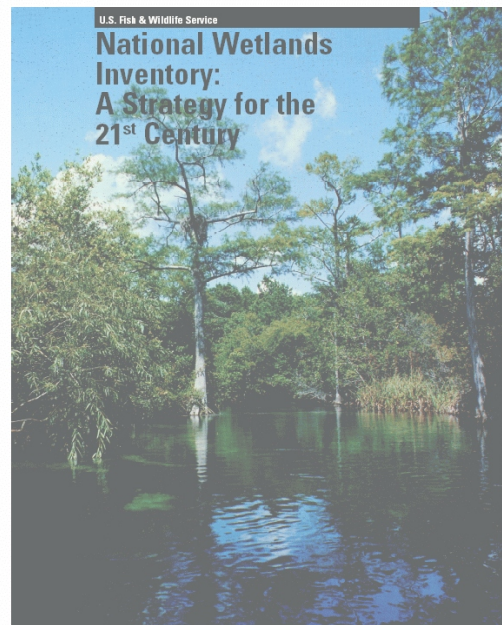
availability and application of digital information for natural resource planning and management in support of Service conservation programs. It outlines three program goals including the strategic mapping of wetlands and aquatic habitats, completion of wetland trend analyses and assessments, and identifying and assessing threats to aquatic habitats that may be at risk.

To complement existing resource mapping and digitizing efforts, the Service is intensifying technical efforts to assimilate and analyze geo-based data sets.

In relation to the first goal, the challenge is to strategically update digital wetlands information and make these data available to natural resource decision makers. The Service will need to expand and improve the availability of digital wetlands data to accomplish this goal. The Service's wetlands mapping and map updating efforts will be made easier by implementing the Wetlands Master Geodatabase model. Although wetlands data

management is centralized, it is to the Service's advantage to promote multiuser editing during wetlands mapping and map updating projects. The master geodatabase can support a wide range of users that are geographically distributed across the United States (Regions, field offices, cooperators, etc.). The geodatabase permits simultaneous editing by multiple users and allows versions of the geodatabase to be created, by the geodatabase administrator, for the stages of a project, reconcile differences between versions and update the master version of a geodatabase. This greatly streamlines the traditional project design of the NWI while retaining technical interaction with cooperators and the Regions for quality control reviews and the creation of interim products.

There also needs to be a concerted effort to analyze and assess wetlands and other aquatic habitat data at the watershed, ecosystem and national levels. The Strategy indicates these assessments should *1) provide scientifically based applications for wetlands and water resource data already available from various resource agencies and 2) expand the capability of the Inventory to integrate digital map data with other resource information to produce timely and relevant management and decision support tools.* The development of the MGD is in direct response to the need to upgrade digital information and improve data access and enhance analytical capability. The MGD will provide a seamless layer of digital data in geodatabase format, link Service databases and provide technologically advanced mechanisms to edit, store, distribute and archive resource inventory data.



Master Geodatabase Architecture and

Planning Efforts

Forming Key Partnerships

The Service has developed and maintains a close working relationship with the U.S. Geological Survey's (USGS) Water Resources Division in Madison, WI. USGS maintains expertise in technical areas of cartography, computer assisted mapping, and geographic information systems. The USGS has been a close partner with the Service in specialized technologies for heads-up updating of wetland digital map files, digital file conversion, data capture, data verification and in the development of innovative geospatial data handling.

The initial efforts between the Service and USGS involved a plan to develop and test customized software tools that could be used to update digital wetland maps using Arc/Map. The tools that were developed were designed to facilitate feature attribution using the wetland classification alphanumeric. This was done on-screen using the personal geodatabase format of Arc/Map.

As work progressed, other issues were identified that needed to be addressed as part of the map update process far beyond the customized tool development. These included updating metadata files, redefining cartographic tasks to address digital data assimilation, quality control and verification of ArcMap products, hardware and software operations and maintenance, cataloging, archiving and data storage. As a result, the partnership has expanded so that both the Service and USGS are actively engaged in the system design and implementation of the Wetlands Master Geodatabase.

Government - Corporate interaction has yielded tremendous technical benefit for MGD development.

Both the Service and USGS recognized that technical expertise and peer review at the highest level was going to be important to ensure that intricate database design criteria, hardware and software performed to meet Service expectations. The creation of a Master Geodatabase for the national wetland dataset is an ambitious and very involved undertaking. There are issues of data quality, database design and administration, data storage and web serving, client-server interactions, map output, meta data tracking, security and compliance with data standards.



The Service and USGS initiated contact with the GIS specialists at Environmental Science and Research, Inc. (ESRI) regarding the Wetlands Master Geodatabase project. Input from ESRI was requested because they represented the defacto industry standard in the development of environmental geo-spatial data configuration and systems design.

ESRI agreed to provide technical help and oversight of the geodatabase design and has afforded the Service use of advanced software functionality not yet released, technical feedback and interaction at the developmental level. Such interactions have yielded tremendous benefits to the Service in the development of this data model.

Master Geodatabase Design and Data Model

There are two important yet distinct purposes for the creation of the Wetlands Master Geodatabase. The first is to improve the editing, storage and distribution capability of the wetlands digital data. The second objective is to greatly enhance the Service's capability to use ancillary GIS data sets and integrate digital map data with other resource information to produce timely and relevant management and decision support tools (Figure 3).

To accomplish this, the Service and its partner organizations addressed two major elements of the MGD development process:

- The development of the design and architecture for the MGD.
- Testing and peer review to further develop a technically sound approach and implementation plan.

There are a number of current issues that limit the utility of the Service's wetland digital data. Some of the most important include: There is no versioning system currently in use and map updates are not being fully implemented. The FTP server is not optimum technology and creates potential data security concerns, and at present, the data suffers from lack of standardization and integration into a transactional database.

These and additional issues relating to data quality and integrity, are addressed in no fewer than 14 design steps built into the MGD planning and architecture. The MGD will provide a standardized map update process; the creation of a wetlands relational database with temporal version capability; the incorporation of non-digital data and; a true seamless data storage and retrieval system. By implementing modern database technology, the MGD permits client-server database access with greatly improved interface to the Service users as well as the public. These improved capabilities coupled with enhanced access help the Service realize the objectives of providing scientifically based applications for wetlands and water resource data.

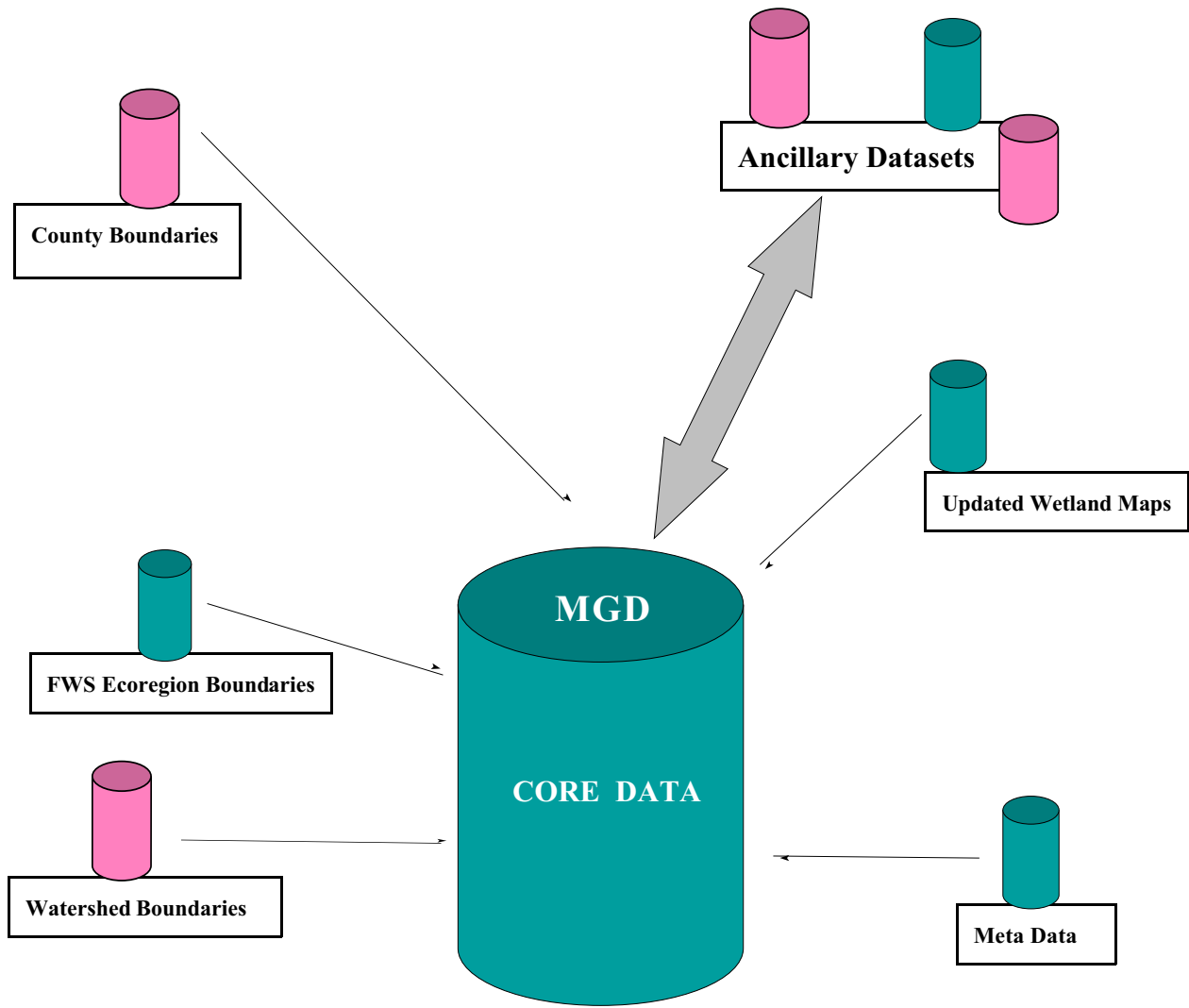
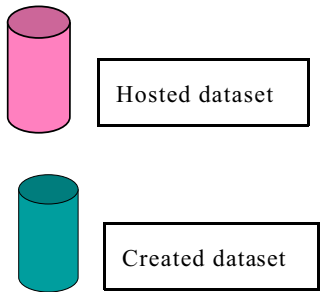


Figure 3. The MGD is a store of geographic information inside a relational database system. It is linked to other data sources to enhance its functionality. The Service's wetlands information forms the MGD core data.



Specifically, the MGD involves the conversion of 25,683 map coverages to a seamless SDE Geodatabase¹ stored on Oracle 9i RDBMS. This database would allow remote access and editing of the data by the Regional Wetland Coordinators in all Service Regions, cooperators and contractors that are granted permissions. The data will include multiple feature classes, including wetlands (point, line and poly), uplands and riparian. The mapped features will store wetlands attributes and have related tables that include various supplemental information pertaining to who, where and when the data were updated. The data will be divided into five geographic Wetland Mapping Areas (the conterminous United States, Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands, and the Pacific Trust Territories) to improve data storage and access (Figure 4).

Some of the major products of this effort include:

- National Wetlands Master Geodatabase.
- Storage with the option of serving large raster datasets (images, DRGs and DOQs).
- Hardcopy map output utilizing Maplex capabilities.
- Serving data and images using ArcIMS.
- Web-based serving of cartographic products utilizing Maplex.

Creation of the Wetlands MGD would allow remote access and editing of the wetlands map data by all Service Regions and provide better service to the public.

¹Work completed under contract to NWIC has converted coverages to ArcSDE for purposes of serving data on the Wetlands Mapper. Additional work is needed to review, revise and compile the map data and create a true seamless geodatabase as described here.

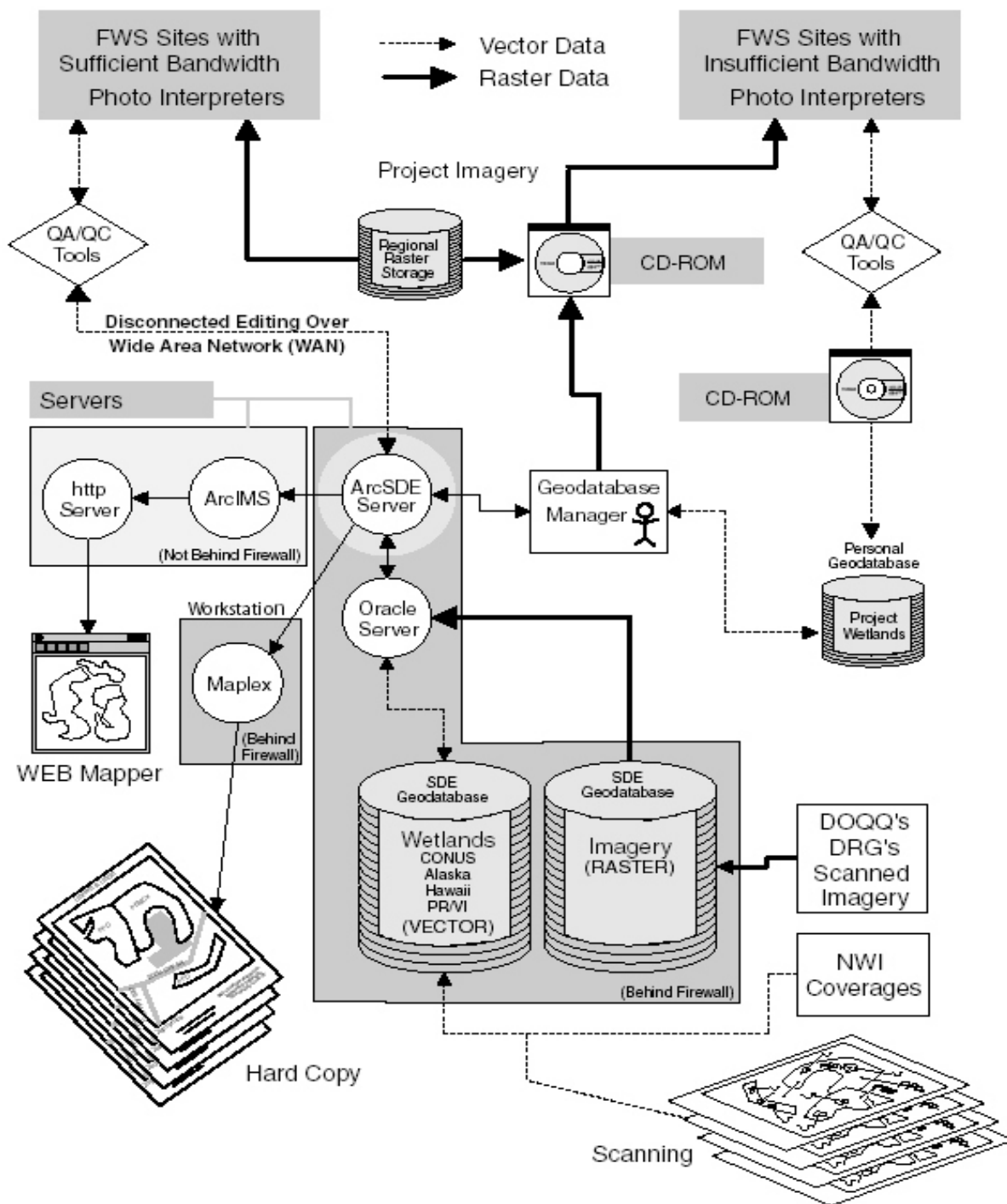


Figure 4. Data flow diagram for the Wetlands Master Geodatabase (This illustration has been simplified for display purposes).

Addressing Project Charter, Data Standards, Information Quality Guidelines and Security

Within the scope of how the Service conducts business there is an ever growing importance and sensitivity to data quality and integrity. There are administrative requirements for information technology systems, computer systems and internet security. Both the Department and the Service have published Information Quality Guidelines that will be specifically addressed as part of the MGD implementation plan(s). In addition, advances in information technology and geographic information systems have influenced public expectations for greater utility and functionality from Government data sources. The development of the Wetlands Master Geodatabase is a positive response to handling the heightened awareness for data security while meeting the increasing demands for data integrity and applications.

To adequately address automated data integrity and security concerns a series of documents have been or will be prepared. These include the following:

Automated Information System and Data Project Charter - The purpose of this document is to provide a project charter in compliance with Federal Information Resources Management Regulations.

Wetlands Master Geodatabase Security Plan - This plan will address hardware, software, data access and security issues specific to operation of the MGD.

The MGD Data Security Plan will standardize and formalize spatial data creation and QA/QC processes.

National Wetlands Inventory Wetlands Mapping Standards and Protocols - This document will present the revised mapping and data automation standards as well as the protocols for map data collection and dissemination. This will serve as an operations tool but also help fulfill requirements for updated information quality information.

Addressing Information Quality Guidelines, U.S. Fish and Wildlife Service, Wetlands Master Geodatabase - This report will meet the requirements of Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554) for Federal agencies to publish Information Quality Guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by a Federal agency, and to provide administrative mechanisms allowing the public to seek and obtain correction of information maintained and disseminated by the agency.

Appended Technical Documentation

A technical MGD Data Model and Entity Relationship Diagram have been generated for the Conus and Alaska portions of the MGD. These data models breakdown the components of the dataset and establish the relationships of each component. This was done based on user needs assessments as defined by the Service in structuring the overall MGD architecture. These and other technical documentation for the MGD are included in a series “Technical Documentation Reports” generated as part of this plan. Topics covered by these reports or documents include the following:

- Wetlands Master Geodatabase Data Model and Tables (Conus and Alaska)*
- Technical Entity Relationship Diagram (Conus and Alaska)*
- Wetlands Master Geodatabase Project Scoping*
- Technical Data Flow Model for the MGD*
- MGD Hardware and Software Plan*
- Wetlands Master Geodatabase Schema*
- Critical Questions for Wetlands MGD Development*
- Organization and Plan for Ancillary Datasets (MGD)
- Plan for Web design and Public Interface of the MGD
- Transition Plan for NWIC Computer Systems and Network
- MGD Data Security Plan
- Automated Information and Data Project Charter*
- Addressing Information Quality Guidelines: Wetlands Master Geodatabase

*Indicates preliminary version completed as of 2-25-03. Some documents subject to revision pending implementation and testing.