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Utilizing GIS technology for brownfields redevelopment

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ABSTRACT

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Typically, when developers, banks and other organizations have an interest in a piece of property they perform an extensive information search to determine if the site is worth purchasing. This search could consist of tax and title information, the location of utilities and major roadways in the area, information on population demographics and environmental contaminant data. An information search of this type could take days, weeks or even months to compile. With a geographic information system (GIS), this search could take a matter of minutes and is displayed in an easy to understand graphic or map form along with a report.

GIS technology is consequently changing the way economic development organizations, states and municipalities communicate with potential purchasers of properties. With GIS technology these organizations can select brownfields or other properties based on ownership, demographics and/or predetermined zoning criteria and market the properties based on the needs of the developer.

This thesis will propose development "blueprints" for Brownfield Pilots to consider when implementing a GIS. These blueprints or recommended strategies will be based on accepted GIS development phases, case studies that involved developing GISs for economic development and environmental applications and on responses to a questionnaire sent to Brownfield Pilots to determine their GIS development techniques and implementation status.

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by
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APPROVAL PAGE

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LIST OF ABBREVIATIONS

AM-FM	Automated Mapping and Facility Management
CAD	Computer Aided Design and Drafting
CIP	Capital Improvement Plan
CEDO	Council of Economic Development Organization
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CSRA	Central Savannah River Area
DITT	Department of Information and Technology Transfer
DLG	Digital Line Graph
EDGIS	Economic Development Geographic Information System
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
EVMWD	Elsinore Valley Municipal Water District
FGDS	Federal Geographic Data Standards
GAO	Government Accounting Office
GARIS	Geographic Army Reserve Information System
GDNR	Georgia Department of Natural Resources
GEDR	Georgia Economic Development Roundtable
GIS	Geographic Information System
GSMAB	Georgia State Mapping Advisory Board
GUI	Graphical User Interface
HUD	Housing and Urban Development
IDA	Industrial Development Authorities
LDP	Locational Data Policy
NJDEP	New Jersey Department of Environmental Protection
NMAS	National Map Accuracy Standards
NPL	National Priorities List
NYDEC	New York Department of Environmental Conservation
OIRM	Office of Information Resources Management
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RDC	Regional Development Center
RFP	Request for Proposal
SCIP	South Carolina Infrastructure and Economic Development Planning Project
SIC	Standard Industrial Code
SQL	Structured Query Language
TIGER	Topologically Integrated Geographic Encoding and Referencing
UDC	Unified Development Council
USC	University of South Carolina
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compounds

CHAPTER 1

INTRODUCTION

1.1 Project Definition and Objective

The objective of this thesis is to propose a blueprint or model for brownfield pilots to follow when considering developing and implementing a Geographical Information System (GIS) for redevelopment or brownfield applications. The thesis will recognize successful approaches to GIS development and implementation and identify where improvements could be made.

Chapter two begins by explaining the fundamental concepts behind brownfields redevelopment and GIS technology. Chapter three will then identify several economic development and environmental GIS applications, unrelated to brownfields, that have been developed and implemented successfully. Chapter four follows with an identification and assessment of the key development and implementation phases that make any GIS system design and application successful, especially at the municipal or local level. Chapter five will report the findings of a survey questionnaire that was sent to Brownfield Pilots in an attempt to identify which Pilots are utilizing GIS technology and to identify GIS development and implementation strategies that have been successful at Brownfield Pilots.

The final chapter will highlight significant findings and present recommendations for Brownfield Pilots to consider when implementing a GIS for redevelopment applications. Recommendations for future work in the GIS/Brownfields area will also be considered. The recommendations will be based on the survey results and the authors knowledge of GIS and brownfield issues.

CHAPTER 2

BACKGROUND

2.1 Brownfield Fundamentals

Consider this hypothetical scenario. A development group needs a warehouse and approximately five acres of open land for a business project. Good transportation for shipping and receiving along with an adequate workforce is a must. A piece of land is found with a warehouse that is right next to a truckline railroad in the heart of the city they are interested in. The developers are ready to make a deal on the property, but their environmental consultants warn them that the property was previously used by a now bankrupt chemical company and the soil and groundwater beneath it are contaminated with various chlorinated compounds and volatile organic compounds (VOCs) used by the company. The levels of contamination are not to the level that would endanger the health of workers on site, but they exceed the levels allowed by federal and state regulations. The development group is warned that if they buy the property, they'll be paying to clean it up.

The development group ends up buying a "greenfield" site a few miles outside of town and builds a warehouse from scratch. Since there is no rail access, trucks will need to be purchased to haul goods to and from the site. The net result of this scenario is that there is greater expense for the development group, less tax revenue for the city and more urban sprawl. In addition, the original site remains contaminated.

The U.S. Environmental Protection Agency (EPA) is now considering these types of properties for redevelopment potential. The EPA Brownfields Economic Redevelopment Initiative is designed to empower states, communities and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up and reuse Brownfields. A brownfield is a site that has actual or perceived contamination and an active potential for redevelopment or reuse. Since 1995, EPA has funded over one hundred brownfield pilots, at up to $200,000 each, to support creative demonstrations of brownfield solutions. The Pilots are intended to provide EPA, states, tribes, municipalities and communities with useful information and strategies as they continue to seek new methods to promote a unified approach to brownfields site selection and marketing, site assessment, environmental cleanup and redevelopment. Appendix A provides a Brownfields Economic Redevelopment Initiative Work Plan Summary from New York City.

The term brownfields is derived from its contrast with greenfields, a reference to development on properties previously undisturbed or considered "clean." Brownfields may have had many different prior uses, such as strip malls, steel mills and gasoline stations. Properties may range in size from half an acre to hundreds of acres, both with and without buildings.

The U.S. Government Accounting Office (GAO) estimates that there are up to 600,000 potential national brownfield properties. These properties may have a central location, good transportation access, an ample workforce and utilities in place. As noted in the hypothetical example above however, the stigma of contamination has deterred investors and developers from redeveloping these properties.

2.2 Ten Steps to a Profitable Brownfields

The following ten steps, which can serve as a planning tool for successful brownfield projects, are taken from the experiences of several successful brownfield projects [Chisholm and Jackson 1997].

Step 1: Establish State Partnering / Support

Brownfields legislation is being passed by a number of states. Common elements of this legislation includes granting immunity from state enforcement where the cleanup has been accepted and the use of risk-based cleanups where the future use of the site is taken into account. Risk-based cleanups involve removing contamination to a sufficient level for a planned future use. For example, if the site will be used for industrial purposes only, the cleanup criteria will only need to meet the industrial (and not the residential) cleanup criteria set by the state regulatory agency. Other areas where states are providing creative incentives for brownfield projects include:

- Immunity and covenants not to sue
- Issuing bonds and providing grants and loans
- Limiting liability
- Providing tax incentives in the form of credits and other write-offs
- Providing organizational support through EPA grants
- Use of economic development agencies

Step 2: Secure Federal Support / Incentives

Federal grants are provided by EPA to municipalities for promoting brownfield projects. Other government agencies are also promoting brownfields. The Department of Housing and Urban Development (HUD) is setting aside $400 million to be used as loan guarantees and block grants. Block grants offer states an opportunity to develop programs and policies based on local needs rather than a one-size-fits-all federal perspective.

EPA's budget for brownfield seed projects has increased from $8 million in 1996 to a proposed $85 million in 1998 (Chisholm and Jackson 1997). In addition, a revolving clean-up loan fund similar to the former federal program for constructing wastewater treatment plants is being considered for brownfields. These funds would provide low interest loans to those that invest in brownfield properties.

Step 3: Identify Mitigation Costs / Future Use Assumptions Up Front

If given the proper incentives, a site investigation could proceed in a limited amount of time and with limited funds. Choosing sites with a limited list of contaminants or sites where the contaminants are not migrating to groundwater can lower costs and reduce the required site investigation time. In other words, cleanup costs for areas zoned for residential use are much greater than areas zoned for industrial use because of regulatory cleanup standards. Once cleanup costs and future uses are studied, uncertainties are reduced and the project is more promising.

Step 4: Partnering with the Public

Working groups made up of local citizens, elected officials, business representatives and neighborhood property owners can help gain support. Brownfield projects that are not well perceived can create opposition and public opposition can affect the properties market value.

Step 5: Great Location

As with all real estate success, a brownfield properties location is vital to success. Location factors for brownfield sites are dependent on future use, but could include:

- Transportation access (highway, rail, airport and waterways)
- Classification of neighboring land use
- Proximity to public transportation
- Proximity to workforce / employers
- Other infrastructure

Step 6: Partnering with Local Municipalities

Local municipalities can provide tax incentives, provide utilities and facilitate the brownfield project with economic development organizations. Remember that a local municipality has the most to gain in relocating a developer to a brownfield site. This gain comes from an increased tax base, employment and increased property values. Another reason to partner with local municipalities is that local municipalities and communities usually know which sites are the best candidates for brownfield projects.

Step 7: Partnering with Insurance Concerns

Insurance companies have typically been a "hard sell" regarding brownfield properties and typically look to two key factors in accepting a risk:

(1) A good estimation of the site contamination and cleanup cost; and

(2) Acceptance by environmental agencies of the risk-based cleanup plan.

Step 8: Partnering with Lending Institutions

When financing a proposed brownfields project, four major points should be considered: liability; viability; profitability and image. The main issue for lending institutions is whether a project is potentially economical. Lending institutions want to avoid foreclosure of failed projects. Therefore, it is important to evaluate the proposed market area before approaching the lending community. Also remember that public perception of the property is very important to market value and could influence a lenders decision.

Step 9: Partnering with Adjacent Landowners

Adjacent landowners/tenants have a strong interest in the successful outcome of a brownfields project. Projecting a long-term vision of the project, along with effective long-term planning and coordination of other local stakeholders will allow nearby property owners to become equity partners.

Step 10: Establishing Effective Agreements

Buyers, sellers, lenders and insurers of brownfield properties need well defined contractual agreements. Though not as well-defined and formal, brownfield project sponsors should seek agreements with the following stakeholders:

- Future property users (e.g., developers)
- Municipalities
- Adjacent landowners
- Economic development agencies/commissions

2.3 GIS Fundamentals

The world in which we live is analyzed spatially. On a regular basis, decisions are made involving distance, direction, adjacency and location. To make these decisions, an efficient method of storing and analyzing spatial information is required. One such method is called a Geographic Information System (GIS).

A GIS is a computer-based system capable of assembling, storing, manipulating, analyzing and displaying geographically referenced information (i.e., data identified according to their locations). For example, the location of utilities for a potential brownfields site or the locations where environmental contaminants exceed clean up levels on the site are key considerations in using this information.

A GIS can utilize information from many different sources. The primary requirement for source data is that the locations of the variables are known. Locations may be expressed in terms of x, y and z coordinates or longitude, latitude and elevation. More general location systems based on coordinates or longitude, latitude and elevation include zip codes and highway markers. In most cases, any variable that can be located spatially and digitized into a form a computer can recognize and use can be fed into a GIS.

Computer Aided Design and Drafting (CAD) and Automated Mapping and Facility Management (AM-FM) systems also work with georeferenced data. They can perform many of the same operations as a GIS. What distinguishes a GIS from these other information systems is the ability to integrate and analyze location specific information. A GIS makes it possible to link, or integrate, information that is difficult to associate through any other means. Thus, a GIS can use combinations of mapped variables to build and analyze new variables. While a computer-aided mapping system may represent a road simply as a line, a GIS may also recognize that road as the border between wetland and urban development, or as a link between Broad Street and McCarter Highway.

The way maps and other data have been stored or filed as layers of information in a GIS also distinguishes it from other information systems and makes it possible to perform complex analysis. This analysis includes operations such as graphic display, buffering, examining "what if" scenarios and spatial overlay. Graphic display techniques make relationships among map elements visible, heightening one's ability to extract and analyze information. With a GIS you can "point" at a location, object, or area on the screen and retrieve recorded information about it from off-screen attribute data in database files. Most GISs store attribute data in a series of relational database tables. These records can be combined so long as a common item exists in two or more tables.

For example, a user could make a query on brownfields site information by simply inputting (or choosing) desired physical and/or economic parameters and characteristics that must be met for their continued interest in a piece of property. Physical attributes that a user may be looking for in a redevelopment project include lot size, building square footage, river access and the availability of utilities. Economic attributes could range from obtaining tax requirements for the property to determining the areas population by age, income and education level for retail marketing purposes.

A GIS can also recognize and analyze the spatial relationships among mapped phenomena. Buffering is the process of constructing or generating new areas or boundaries around points, lines, or areas. With GIS, conditions of adjacency (what is next to what), containment (what is enclosed by what) and proximity (how close is something to something else) can be determined. Utilizing a buffer operation, a user can generate a zone showing all hazardous waste sites within a given radius of a site.

These types of buffer operations could also be useful for other local government development tasks. For example, a GIS can be used to find the names and addresses of all the property owners who own land that is located within a certain distance of one or more land parcels zoned for economic redevelopment.

A GIS system also has the ability to perform "what if" scenarios, making it a powerful modeling and decision making tool. For example, if a factory located near a wetland were to accidentally release chemicals into the river, a GIS could determine how long would it take for the pollutant to enter the wetland reserve. The GIS could simulate the route of materials along a linear network. Furthermore, it is possible to assign values such as direction and speed to the digital stream and "move" the contaminants through the stream system to determine potential impacts on the wetland reserve.

Spatial overlay is another GIS procedure in which two or more data layers are combined and then planar enforced. A logical overlay involves finding those areas where a specified set of conditions occur or do not occur together. For example, a municipality may define desirable brownfield sites as those areas that are zoned for industrial use, publicly owned and that have high unemployment rates. If zoning, parcel ownership and unemployment are represented as separate data layers in the GIS, then an overlay operation could be used to identify the locations where these conditions occur together (Figure 1). A list of analytical capabilities that a GIS can perform is attached as Appendix B.

A GIS is a powerful site inventory and marketing tool. Whether the user is a municipality using a GIS for selecting and marketing brownfield sites, or a buyer using a GIS to determine if a property has the physical and economic features they are looking for, this visual tool can enhance decision making by providing a sophisticated, yet simple to operate platform for evaluating properties and their attributes.

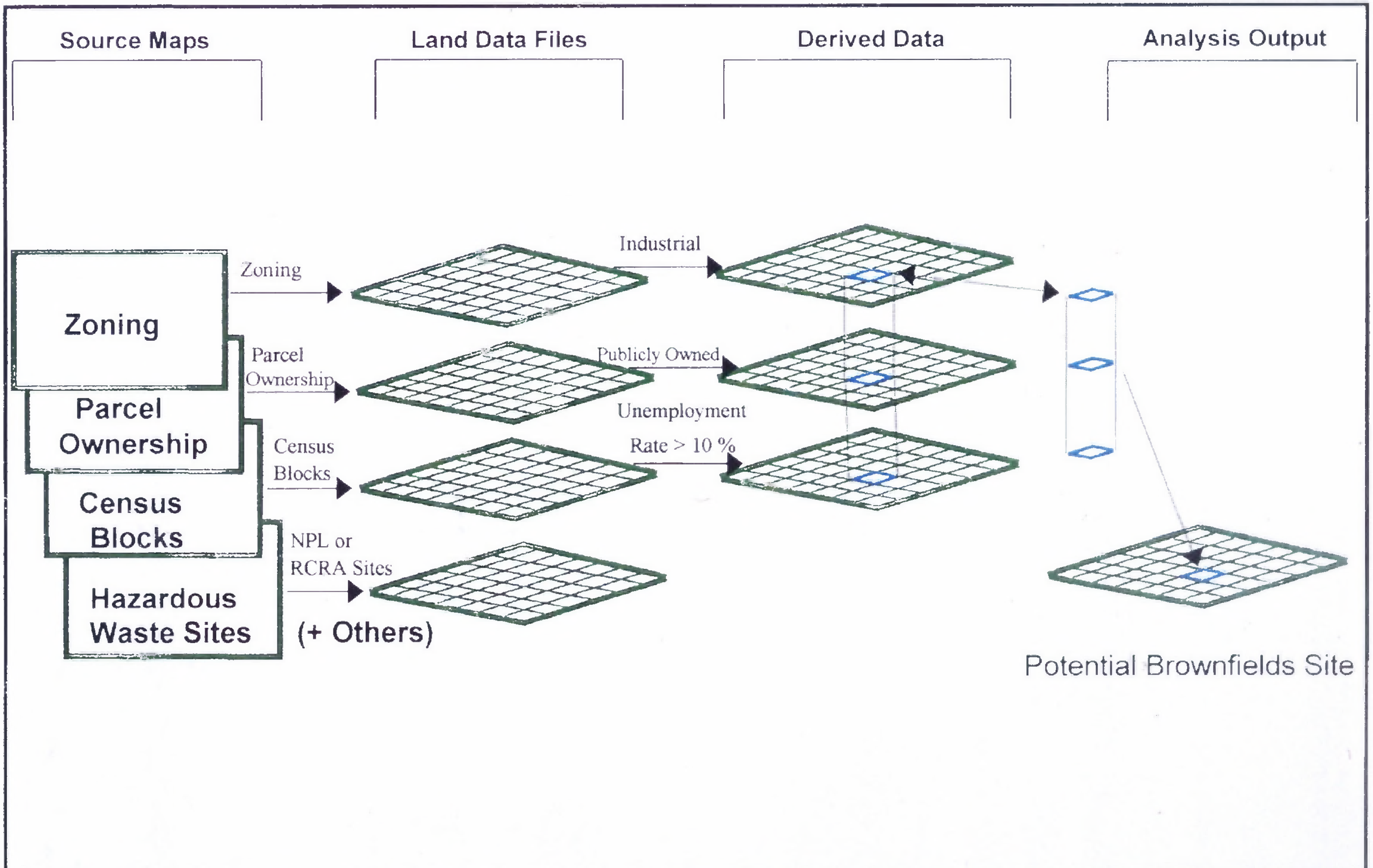


Figure 1 Using Spatial Overlay to Determine the Location of Potential Brownfield Sites.

CHAPTER 3

CASE STUDIES IN GIS DEVELOPMENT AND IMPLEMENTATION

The site selection process now requires greater environmental and economic information than ever before. Environmental information is required due to stricter environmental regulations and the liabilities associated with contaminated properties. The need for enhanced economic information is required not only for marketing analysis, but also for a potential purchaser to determine if a site is worth purchasing based on economic parameters such as assessed land value and liability cost concerns. The following pages will examine how GIS is being utilized in economic development and environmental management applications, highlighting applications that have been designed and implemented successfully.

3.1 GIS and Economic Development

The economic development profession has become increasingly more reliant on the improvements in information system technology to assist in the rapid and accurate assimilation of data into information that is meaningful and that can be used as a decision tool in economic development offices at state and local levels. Furthermore, as the economic development profession moves from one in which computers are used simply to improve worker productivity to one in which information systems are extended to provide support to all levels of the organization, it will begin to see information systems as a strategic resource that will become increasingly more important.

In the past the economic development professional utilized existing land data, with its many physical, economic and demographic characteristics, in a multitude of paper and electronic forms. At the most basic level land data is organized into parcel records, which in turn becomes part of property maps, tax maps, and at the higher level, the official land cadastre. Because these land cadastres come from different geographic regions and organizations they frequently are not defined in a similar fashion and thereby cause problems with data compatibility, management, accuracy and control. Therefore, there is a strong need to modernize and standardize existing land record management systems. A modernization and standardization of existing land record systems would help to maximize the accessibility of the vast amount of available information, minimize the information handling cost to organizations and improve the organizations overall economic and competitive advantage as information resource management is improved.

The question now facing local and state development agencies and Brownfield Pilots is "What economic development technology for modernizing land records can I use?" The answer among many economic development professionals is a GIS. A GIS can not only display the location map of an industrial site, but it can also allow the user to highlight attributes of that site.

Two projects that have designed and implemented a GIS successfully for economic development applications are the Central Savannah River Area Economic

Development Geographic Information System (CSRA EDGIS), which was designed to support the site selection process, and the South Carolina Infrastructure and Economic Development Planning Project (SCIP), which was based on inter-governmental cooperation and a unique government/university partnership.

3.1.1 The Central Savannah River Area Economic Development Geographic Information System (CSRA EDGIS) Project

The CSRA is comprised of 16 counties in East Georgia. The CSRA RDC (Regional Development Center) was created in 1989 as a result of the Georgia Planning Act. Membership in the CSRA RDC is required for each city and county in the CSRA. In 1989, CSRA RDC had 58 local government members (Smersh 1995). Aside from planning, the CSRA RDC offers services in the areas of grant writing and administration, historic preservation, small business loans and information systems.

Since 1988, CSRA's Department of Information and Technology Transfer (DITT) has worked with the Chamber of Commerce, Industrial Development Authorities (IDA) and other regional economic development stakeholders to develop a working regional model for economic improvement in the region. This regional model is incorporated in the CSRA Unified Development Council (UDC). The CSRA UDC is designated as the region's Council of Economic Development Organization (CEDO).

In late 1988, the DITT developed an information system for various economic and planning objectives. Today, CSRA has a fully operational information system which is regarded as the most advanced among the state's regional development centers. An offshoot of this information system is the CSRA EDGIS.

The guiding principal behind the development of the CSRA EDGIS was to cultivate data exchange between all parties. Within the economic development process there are a number of stakeholders including business prospects, developers, state agencies, regional development agencies, local government and local businesses. The main role of the CSRA EDGIS is to facilitate the distribution of information between the participants in order to locate and site new facilities.

On the state level, the CSRA EDGIS requested assistance from Atlanta Gas Light Company, Georgia Department of Community Affairs, Georgia Department of Industry, Georgia Trade and Tourism, Georgia Department of Natural Resources (GDNR), Georgia Power Company, Municipal Electric Authority of Georgia and the Oglethorpe Power Corporation. Except for the GDNR, all statewide agencies are members of the Georgia Economic Development Roundtable (GEDR), a group that represents Georgia statewide developers.

GEDR has matured into an advisory council for GIS activities. GEDR gets together as needed to discuss new developments and to suggest actions. The group also assists in research relating to the development of a standard statewide economic development database.

Within the CSRA UDC, the Chamber of Commerce and IDA interact directly with business prospects and developers. As the direct contact, the UDC assists in determining developer data needs and data requirements. According to the council, the primary data needs of developers includes assistance in data collection and an easy to understand presentation of the data. The major data requirement for developers according to the UDC is the ability to access a vast amount of information on properties (from national data to site specific information) in the same presentation and usually "as soon as possible."

The CSRA EDGIS was designed so that the GIS would bridge the gap between information needs of developers and the information available from statewide and local development officials. Taking advantage of GIS technology, the structure of the EDGIS was designed into a distributed network.

The distributed network for economic development purposes requires close working relationships between both local and statewide officials. A distributed network requires extensive efforts to coordinate hardware designs, software configurations, the definitions of data and digitizing standards. In Georgia, efforts to develop "close" or partnering relationships among all parties was facilitated by creating three different working groups.

The Georgia State Mapping Advisory Board (GSMAB) is asked to make research recommendations for land records modernization and land information system implementation. Additional responsibilities of the GSMAB include coordinating data acquisition, sponsoring educational programs, developing technical specification and standards and contracting for the technical work.

The GSMAB made numerous recommendations during its first year of existence. The recommendations that impacted economic development and GIS activities the most were the establishment of mapping standards, creation of a data dictionary, development of a GIS data exchange network, establishment of GIS training programs for policy level officials and guidelines concerning the means by which land records should be maintained.

Closely linked to the efforts of the GSMAB are the efforts associated with the Georgia Quality Coordinated Planning Program. This group requires that each Georgia county or municipality develop comprehensive plans that document economic development efforts within their jurisdictions. Development of GISs are expected to increase across the state in response to the data manipulation requirements of these planning efforts.

The third group working on developing GIS and economic development partnerships is the Data Standards Work Team. This group is responsible for researching the technical aspects of the development of a statewide network. A portion of the team's responsibilities are to establish procedures by which a statewide GIS network can be developed.

The results of the CSRA EDGIS project can be categorized into seven factors that affect the implementation and development of a GIS:

1. Development of data for a GIS is very expensive in both actual funds and personnel time. The ability to utilize Topologically Integrated Geographic Encoding and Referencing (TIGER) files and Bureau of Census information can speed development time significantly and provide tangible cost savings. It is important to keep in mind that Bureau of Census TIGER files and maps are designed to show only the relative positions of elements. Thus, the level of positional accuracy in TIGER data is not suitable for high-precision measurement

applications such as engineering problems, property transfers, or other uses that might require highly accurate measurements.

2. The availability of staff expertise in GIS technology. The CSRA RDC achieved experience through both formal training and hands-on operations. However, when an economic development GIS is established in a state or local organization, competitive pressures will require immediate operation of the system. This pressure will require a highly experienced and trained staff from the conception of the GIS through design and implementation.
3. Another GIS development factor is the issue of data sources. There are many different data sources of land related information including the private sector and federal, state, city and county governments. Each collects map data and attribute data. However, the types and accuracy's of the data vary widely.
4. Establish a naming system that supports automated data processing and manipulation procedures. Managing a large number of files without a strict naming procedure is very difficult. For this factor and factor #3, an agreed upon data dictionary and mapping standards would be beneficial. Appendix C provides an example of the data dictionary and mapping standards used by the CSRA RDC.
5. Another EDGIS implementation and development factor is the presence of a sound database design. An EDGIS utilizes both map data and attribute data. For one item of map data there may be multiple attributes. CSRA EDGIS research demonstrated it was more effective to plan for the inclusion of attribute data than to adjust the EDGIS to accommodate new data.

6. An often overlooked GIS development factor is the need for quality assurance. The map and attribute data must be reviewed by both statewide and local development organizations for its usability in the site selection process.
7. The last EDGIS development factor, and possibly the most important, is to build partnerships with all stakeholders involved in GIS and economic development. This includes both developers (or other potential users) and federal, state, city and county organizations. Assuring that all parties are involved from the conception of the GIS to the design and implementation stages of the system will lead to its success.

The development of an EDGIS by the CSRA RDC shows that an EDGIS can be successfully developed and implemented for use in a site selection process. Since the site selection process involves many organizations, an EDGIS must be designed to function as a distributed network, including all participants in the process. Furthermore, access to the EDGIS by nontechnical users will result in the greatest competitive advantage for an economic development organization. Through the use of user oriented menu systems, a business prospect can query a database at the speed and in the manner that they wish. Such a design allows the use of an EDGIS network to a large portion of the development community; and therefore, multiplies the number of possible benefits.

3.1.2 The South Carolina Infrastructure and Economic Development Planning Project (SCIP)

The SCIP project was established to serve the following three applications:

1. A policy and resource allocation tool for infrastructure development in the state;
2. An economic development tool for the site selection process; and
3. A community development and regional strategic planning tool.

During the first three years of the SCIP project all of the components of the system were implemented, an extensive statewide database was created and more than 1000 map products have been generated (Black 1990). All of the participants in the design and implementation of the SCIP system acknowledge that the key to its success has been the relationship between the South Carolina State Development Board, the University of South Carolina (USC) and various other state and local organizations.

The three major principles that guided the development of the SCIP GIS implementation strategy were: (1) A close partnership with the USC as the technological foundation of the program; (2) Extensive cooperative relationships with other state agencies and economic development organizations; and (3) A statewide distributed network of regional centers (Figure 2). What resulted was an approach to GIS design and implementation that may be a useful model for other organizations, including Brownfield Pilots.

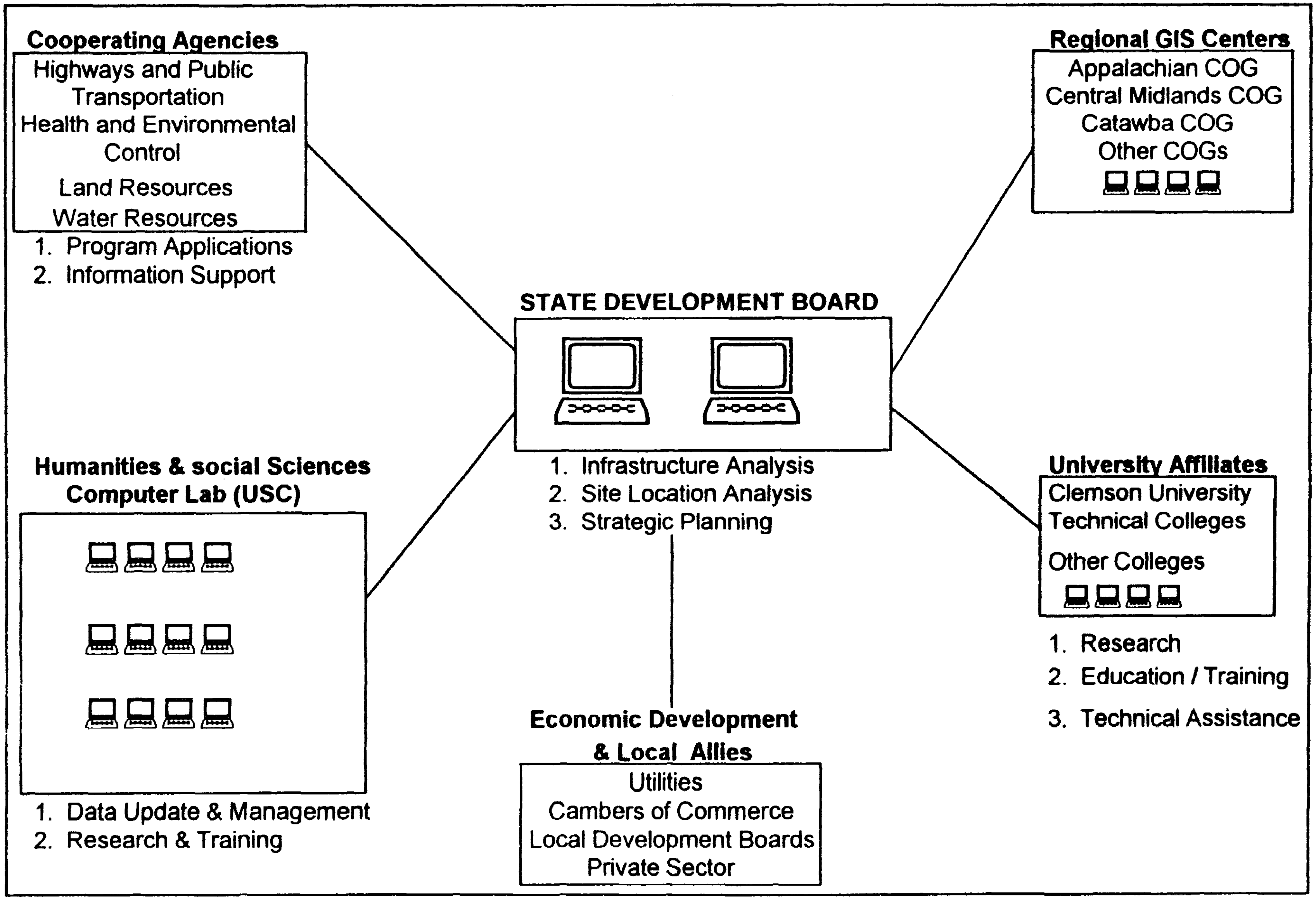


Figure 2 The South Carolina Infrastructure & Economic Development Planning Project (SCIP) GIS.

The key aspects of this design and implementation strategy included the following eight components:

1. Collaborative Linkages and Administrative Support

The basis of the SCIP project lies with the need to coordinate a wide range of information that is collected and maintained by several different agencies. In order to obtain and utilize this information it was essential for SCIP to establish good institutional linkages with other agencies. In the SCIP project this was accomplished by establishing a number of data definition committees that developed the appropriate components of the database.

The SCIP project achieved intergovernmental cooperation due in large part to the support of the very highest executive levels of the Development Board, the Governor and the legislation. Since the mission of the Development Board is to promote statewide economic growth, other agencies are willing to cooperate to provide the necessary information for the Board to meet its objectives.

2. A Statewide "Information Utility" with Local Government Inputs

Another important aspect of the SCIP project is the collaboration with local governments. From the inception of the project there was a strong association with ten regional planning commissions. These planning commissions are viewed as allies in the project that can utilize the resources from the project to meet their own needs. Each of the commissions received funds to help create several layers of the database and continue to be directly involved in the marketing of the SCIP system.

In addition to specific incentives for regional and local governments to cooperate in the SCIP project there was also an element of self-interest to provide the required data. These interests relate to the power of a map to display information. For example, some of the more reluctant participants became aware of the need to make sure that there were no gaps in their part of the state when maps of water and sewer capacity were being prepared for prospective clients.

3. A Sophisticated Distribution Network

One of the main goals of the SCIP project was to develop a computing environment in which the staff of the Development Board would be active users of the system. Therefore, a system had to be implemented that gave them full access to all the data and resources. In order to meet this need a distributed workstation network was created and implemented.

The USC staff was responsible for the design and support of the network system. The databases are created and maintained at USC. The storage and maintenance of data on one file server minimizes redundant data storage and insures data integrity. The network is connected via a high speed fiber optic linkage that operates between state and local government offices and the university.

4. Reliance on Existing Spatial Databases

Another goal of the SCIP project was to assemble detailed spatial information on a statewide basis. It was essential for the project to develop and maintain uniform information throughout the state. These requirements were met by using TIGER files from the Census Bureau and 1989 landcover classification data based on SPOT satellite imagery (Black 1990). The TIGER files provide an inexpensive source of transportation and hydrological data in the state and serve as an excellent basemap for statewide planning in South Carolina. In conjunction with TIGER files, SPOT imagery will provide a way to identify various geographical information. For example, instead of inferring the geographic location of sites from their addresses it is possible to identify vacant tracts of land that are suitable for development from the image base. Table 1 presents SCIP Project spatial data layers that are currently being utilized.

5. Utilization of Commercially Available Software

Commercially available software (ArcInfo) was chosen for the SCIP project to ensure that technical support was available as it was needed.

6. A Proactive Marketing Approach

Every few months during SCIP database development, a group of economic development organizations and the development community were informed of developments with the system and provided with tangible products. An important step in this process was the ability of the project to quickly conduct a pilot study that provided proof of concept.

7. Unique Funding Strategies

A creative funding strategy was developed by the SCIP project that utilized a wide variety of sources to meet their needs of a statewide comprehensive system. One of

Table 1 South Carolina Infrastructure Planning Project (SCIP) Data Layers

A. Transportation
1. Highway Location (DLG)
2. Railroad Location (DLG)
3. Rail Terminals and Cargo Loading Sides (DLG)
4. Airport Location (DLG)
5. Port Location (DLG)

B. Water Supply Systems
1. System Extent and Location
2. System Capacities
3. System Output (Use)
4. Hydrology (DLG)

C. Wastewater Systems
1. Systems Extent and Location
2. Systems Capacities
3. System Output (Use)

D. Hydrographic Features
1. All hydrological features including streams, lakes, reservoirs, and wetland areas (DLG)

E. Business and Industry
1. Industrial Directory
2. Available Buildings
3. Available Sites

F. Demographics and Economics
1. County Boundaries
2. Census County Division Boundaries
3. Census tracts
4. Zip Code Boundaries

G. Miscellaneous
1. Major electrical power transmission lines
2. Geographic Names Information coordinate points for all schools, churches, etc...

H. Land Cover (Satellite)
1. Agriculture
2. Water
3. Forests
4. Urban
5. Wetlands, etc.

I. Street Names and Address Ranges

J. Census Data Divisions
1. Counties
2. CCD's
3. Tracts
4. Blocks

K. Highway Traffic Counts

L. New Roads

M. Business Firms (Dun & Bradstreet)

N. Named Hydrographic Features

O. Air Quality

P. Landcover/Landuse

Q. Flood Plains

From Black (1990)

the most important sources of funds was $500,000 from the Coordinating Council for Economic Development. This group overseas the allocation of a $10 million highway fund obtained from gasoline taxes for funding road improvements. These funds were used by SCIP to purchase the initial hardware and software components and to establish the organization of the project. These funds were also leveraged to obtain a $250,000 grant from HUD for the collection of the water and wastewater data and to establish a regional GIS center at the Appalachian Council of Governments (Black 1990).

8. Long-Term Agreements Between USC and the Development Board

Even though there is a good working relationship between USC and the Development Board, it was essential that the SCIP project be operated in a business-like manner. In order to accomplish this goal the two groups worked out a formal written contract that will be reevaluated at the end of each contract period (every five years).

The success of the SCIP project demonstrates that with the proper combination of cooperative agreements, managerial support and the involvement of potential users, it is possible for organizations to design and implement a successful economic development GIS system. The SCIP project serves as a model for state and local agencies interested in creative funding ideas, database development techniques and networking to organizations throughout a region.

3.2 GIS and Environmental Management

There are numerous environmental applications of GIS technology including site assessment and cleanup, wildlife management, pollution monitoring, risk analysis, vegetation mapping and environmental justice. Environmental queries such as "Display all wetlands within a 10-mile radius of ABC Chemical," or "Show all storage facilities not inspected for three years," are easily answered by a GIS. Most of the data in these GIS applications are publicly available. For example, information on leaking underground storage tanks would come from a state or federal environmental agency, hydrological data would come from United States Geological Survey (USGS) and soil maps would come from county or federal agricultural agencies.

GISs are not only being utilized in specific environmental management and assessment tasks, such as developing natural resource data repositories or determining the fate and transport of pollutants at hazardous waste sites, but they are also being used by federal agencies like the EPA to manage large environmental inventories. In fact, EPA is one of the largest consumers of spatial data in the civilian government.

In 1987, the EPA's Office of Information Resources Management (OIRM) established a national GIS program to manage, coordinate and promote integrated use of spatial data. The National GIS Program in OIRM was established to provide both leadership and support to Agency decision-makers and program offices. The GIS Program is responsible for participating in the review and evaluation of new GIS related technologies, promoting the sharing of GIS data and is responsible for coordinating with external organizations regarding GIS activities. Although OIRM serves in the primary leadership role for EPA's GIS development and implementation, the Regions also serve as key focal points for EPA's spatial applications development.

3.2.1 U.S. Environmental Protection Agency Region 2

In EPA's Region 2 office, the main goals of the GIS program are to provide EPA staff with desktop tools for GIS and to integrate spatial analysis into the way the Region does business. Therefore, the Region 2 GIS team needed to develop an infrastructure to support regional analysis and decision making and to develop an active partnership with the states and other federal agencies to share data. To plan this effort, Region 2 completed a conceptual GIS database design in 1993 (USEPA Region 2, 1994). This GIS design involved:

1. A survey and analysis of user needs
2. An inventory and evaluation of data sources and
3. Development of a conceptual database design.

3.2.1.1 Survey and Analysis of User Needs: One of the features of the Region 2's GIS design was to incorporate current and future system uses based on interviews with Regional and state GIS users. A survey of GIS needs was conducted and documented by Region 2 staff from September 1991 to July 1992 (USEPA Region 2, 1994). This survey addressed the functions of each office or division, the types of environmental decisions made and data requirements and sources. Participants in the survey included more than 100 individuals from the divisions and offices of Region 2, as well as personnel from the New York State Department of Environmental Conservation (NYDEC) and the New Jersey Department of Environmental Protection (NJDEP). The survey and analysis of user needs provided basic information for the design of the Region 2 GIS system and was designed to provide information in the following areas:

- What types of environmental decisions are made in each division or branch?
- What types of information are routinely used in these decisions?
- What is the source of this information?
- How can GIS be used to improve environmental decisions?
- What are the essential data needs?

Although the user needs assessment identified over 100 functions performed by Region 2 that may have been supported by a GIS, the following nine broad functions were identified in the survey as areas that would most likely support GIS applications in EPA Region 2:

1. Strategic Planning
2. Environmental Analysis
3. Program Evaluation
4. Permitting
5. Compliance Monitoring and Enforcement
6. Public Information
7. Remediation
8. Emergency Response
9. Operational Support

Each of these functional groups represents a collection of similar types of activities that relate to broad GIS applications. The nine groups can be thought of as a conceptual model of major environmental functions that represent the shared system needs among offices or divisions. Within each of these functional groups, the GIS application requirements most frequently mentioned during the user needs survey included the following:

- The need to integrate data from various EPA databases and to see the integrated information in spatial form.
- The need to view and understand integrated data in relation to surrounding environmental conditions and human activities.
- The need to query EPA-regulated facilities within a specific geographic area or distance from a particular site.
- The need to query all types of permit conditions, status, compliance data, enforcement and inspection records for a single or multiple sites.
- The need to query area data surrounding a site of interest (e.g., monitoring data, environmental conditions).
- The need to provide analytical capabilities (e.g., combine with models).

3.2.1.2 Inventory and Analysis of Data Sources: The second step in Region 2's GIS implementation and development, the inventory and evaluation of data sources, was conducted to determine the usefulness and acceptability of data for inclusion in the GIS database. The database inventory provided a catalog or reference of the types of geographic data used by or available to EPA Region 2. The inventory was used to select relevant data for incorporation into the Region 2's GIS. Appendix D represents this inventory (categorized by data type) of geographic data used and/or generated by EPA Region 2 (as reported during the user needs survey). Appendix E provides two examples of metadata (information that defines spatial and attribute data) from Region 2's data library.

In Region 2, data inventory efforts were focused on finding digital data sources. Several publications were used to further investigate potential digital spatial and attribute information for Region 2's GIS. These sources included the following:

- *Guide to Selected National Environmental Statistics in the U.S. Government,* USEPA Office of Policy, Planning and Evaluation, April 1992.
- *Office of Water Environmental and Program Information Systems Compendium,* USEPA Office of Water, November 1991.
- *International GIS Sourcebook*, GIS World, 1990, 1991-1992.
- *Information Systems Inventory (ISI)*, USEPA Office of Administration and Resources Management, May 1991.
- *Database inventory*, USEPA Region II, Office of Policy Management, May 1992.
- *Site Assessment Information Directory - Region II*, USEPA, October 1991.
- *Catalog and Directory of New England States and Regional GIS Organizations and Activities*, USEPA Region I, January 1992.
- *EPA Region III GIS Center On-line GIS Digital Data List, GIS Digital Tape Library*, USEPA Region III, February 1, 1991.
- *New York GIS Users Inventory*, Syracuse Department of Forestry, 1990.

- *New Jersey Computerized Mapping Inventory*, State Mapping Advisory Committee of New Jersey, 1992.

Region 2 is also able to obtain data from EPA national databases and federal and state agencies such as the USGS and NJDEP. The Region requested data dictionaries and mapping and digital standards from NYDEC and NJDEP. A copy of NJDEP's mapping and digital standards is included as Appendix F.

Data evaluation examines characteristics of potential data sources to assess the suitability for inclusion into a GIS database. An assessment and evaluation of data sources provides an indication of which sources may be used to develop a database, the type of investigation, the preparation and processing of the data that may be required, data storage and management requirements and the standards and agreements that may be needed over time for long-term data maintenance. EPA Region 2 examined several characteristics of each data source for inclusion into their GIS database. These characteristics included the following:

- *Name of Data Item*: Provides the common name of the data, along with the acronym and coverage name, shown exactly as given by the data provider.
- *Map Features, Attributes and Key Identifiers*: Describes points, lines and areas on a map and what they represent. Also provides descriptive data about map features and identifies potential key linkages between map and attributes.
- *Availability/Source*: Identifies data holder and distributor.
- *Data Collection Method*: Includes a description of source materials used, steps taken to prepare source materials for automation, data entry methods and data processing steps.

- *Time Period Covered*: Provides an indication of the availability of historic as well as current data.
- *Currency/Update Frequency*: Provides information on the temporal accuracy of map and attribute data.
- *Geographic Coverage*: Provides information on extent of coverage (In this case, specific to Region 2).
- *Coordinate System, Projection*: Since all data must be registered to the same coordinate system in a GIS database, these factors must be known about each data source in order to incorporate the information they contain into the GIS.
- *Format*: Examples of format type include map, attribute, text or image.
- *Sample*: Was a hard-copy or digital sample of the data provided?
- *Scale*: Provides information on the level of detail available.
- *Accuracy/Quality*: Can be affected by source material, map scale, digitizing skills and the width of lines used to represent features. Accuracy can be described in a number of ways, such as meeting National Map Accuracy Standards (NMAS) or accurate within a specified linear distance (e.g., a feature shown on a map may be ± 5 meters of its real-world position). Accuracy of attribute data can be described in terms of completeness and currency.
- *Software*: Knowing the software used to automate, manage, display and/or analyze the data is necessary to understand the data structure and the level of processing that may be required to make data compatible.

- *Security Requirements*: Describes current data accessibility and indicates potential data security requirements.

3.2.1.3 Development of a Conceptual Database Design: The EPA Region 2 database design addressed factors such as the general categories of data elements, database organization for cartographic and tabular data items, the appropriate keys for linking related files of data, methods of collection and update and the compatibility with existing state GIS data development efforts. The database design allows the Region to efficiently store and manage data from EPA's national database systems (e.g., RCRIS, CERCLIS), other federal agencies and state and local governments. Figure 3 provides an example of how EPA Region 2's database is organized. The Region's current GIS spatial data layers are included in Appendix G.

Several objectives guided the development of EPA Region 2's conceptual database design. These objectives included:

- The database should be simply designed for ease of use and maintenance.
- The database should be relational in structure and capable of being implemented in the Region's database management system (ORACLE).
- The database must support analysis and decision making at multiple levels.
- The database must maintain some level of data interpretation/integration to ensure consistency between related data sets.

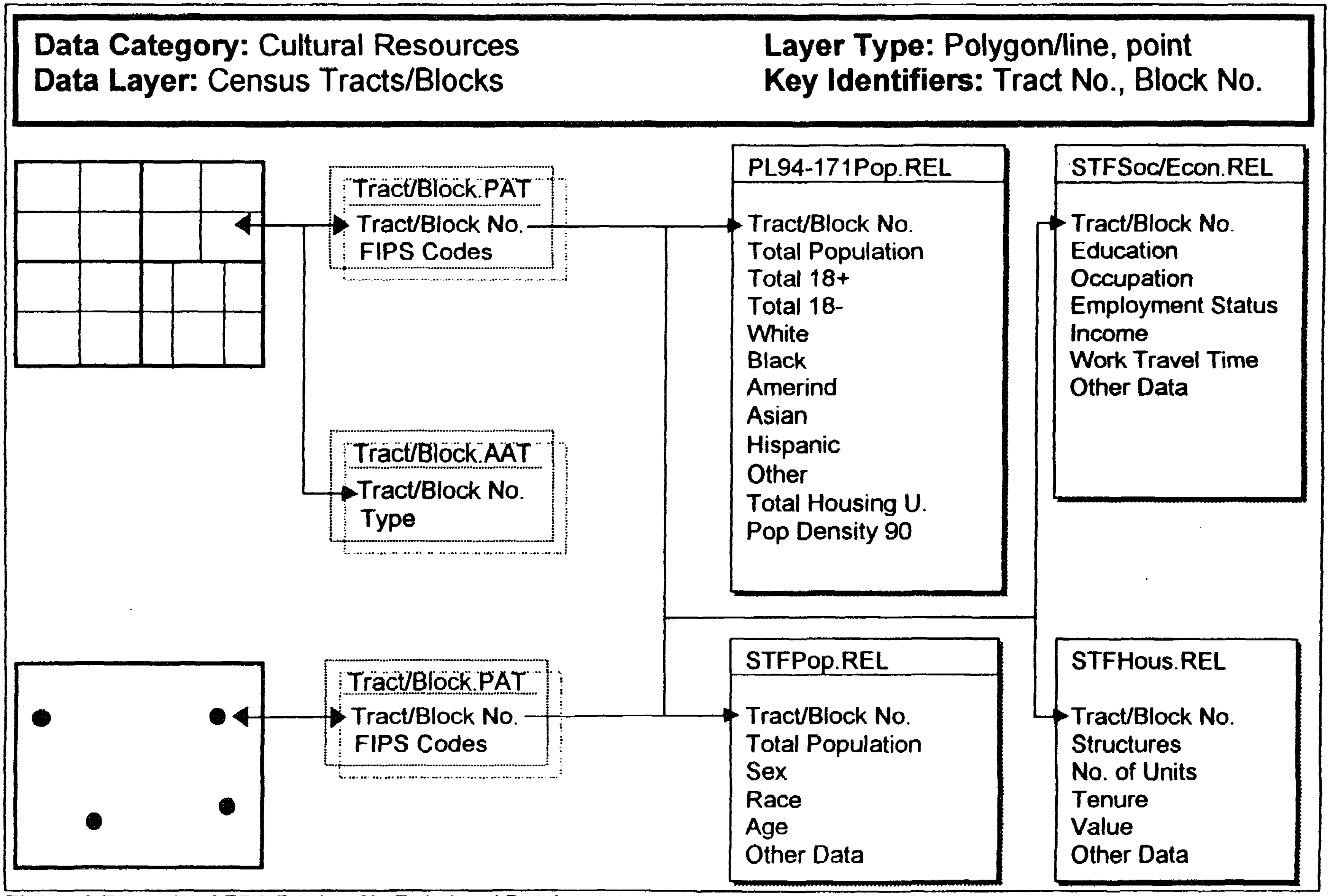


Figure 3 Example of EPA Region 2's Relational Database.

- The GIS database should be multiscaled. Three levels of detail may be required depending on the application: small scale (1:100,000 or smaller); medium scale (1:24,000); and large scale (1:1,200).
- The development of standards and procedures for cooperative development, exchange and maintenance of data over time.
- Storing the most elemental form of the data whenever possible to support a "logical view" of the database. The logical view is how the database appears to be structured to the user as apposed to how it is physically organized.

One of the primary principles of EPA Region 2's GIS design is that of the shared database. The shared database design implies that EPA offices with different functions and responsibilities have common data needs. For example, most of Region 2's divisions and branches require census tract and population data for spatial analysis. However, it is not necessary for each division to store, manage and update this information independently when the data can be accessed electronically in a shared database. A list of EPA Region 2 users is attached as Appendix H.

The establishment of a commonly shared database will depend upon on the development of accepted standards for data content, codes, scale and accuracy. A shared database should also have well defined maintenance and update mechanisms, rules for data access and open channels for communication and coordination.

One issue related to Region 2's shared database design that was raised during the GIS user survey was the concern expressed over the quality of data in EPA databases, particularly locational data quality. Region 2 GIS personnel feel that a methodology needed to be devised to upgrade the quality of their locational data, in accordance with the implementation of EPA's Locational Data Policy (LDP). The purpose of EPA's LDP is to ensure the collection and documentation of accurate, consistent, latitude/longitude coordinates for all facilities, sites and monitoring points regulated by EPA under federal environmental laws. The required elements under EPA's LDP include:

- Latitude/longitude coordinates in a specific format
- Documentation of the method used to obtain the coordinates
- Estimation of the accuracy of the measurement
- Description of the entity that the latitude/longitude coordinates represent

EPA is currently completing a nationwide address matching project to provide baseline coordinates for all EPA-regulated facilities. The locations will be stored in EPA's Envirofacts database, which is available to the public on the Internet.

3.2.2 Geographic Army Reserve Information System (GARIS)

One area where GIS technology brings immediate benefits is in managing multiple facilities. The U.S. Army Reserve manages environmental data at 1,400 facilities throughout the United States and overseas (Keyworth and Healey 1996). Environmental and facilities management of Army Reserve Centers is handled at the regional level. This provides many opportunities for the Army Reserve to use their GIS system called the Geographic Army Reserve Information System (GARIS).

GARIS was conceived by the U.S. Army Reserve as a pilot program in New England with the potential for nationwide implementation. The program is one of the first multisite, multistage GIS projects of its kind in the nation. GARIS provides instant access to comprehensive facility information. Users can retrieve, query, analyze and print facility-specific data for GIS applications such as:

- Complying with environmental regulations
- Relocating personnel and equipment
- Prioritizing facilities for wastewater system upgrades
- Planning pollution prevention projects
- Managing facility maintenance or construction contracts

The GARIS system was designed and developed in several phases. These phases included a needs assessment phase, a system design phase and a training, data maintenance and sustainability phase.

3.2.2.1 Needs Assessment: Users at all levels of the Army Reserve were interviewed. The information gathered during this stage was then used to establish the required features and functions of the system and to anticipate potential queries. Some of the queries that were identified included: "Display all steel underground storage tanks at Facility A that are more than 20 years old," and "Show all oil/water separators not inspected in the last year."

3.2.2.2 System Design: Using information from the GARIS needs assessment, a conceptual design and system specifications were developed. Selections were made regarding hardware, operating system and software by considering existing and potential needs and the need to support multi-user local and wide area network environments. A structured query language (SQL) database server was chosen to use the full power of a relational database management system.

A key decision in GARIS system development concerned how and to what extent to design the system to comply with company, industry, national and international standards. Standards are particularly important to maintain data consistency when the system will manage information for multiple facilities, or where data are transferred to or from other systems. The decision was made to base GARIS on the Tri-Service Spatial Data Standards being developed under the direction of the U.S. Army, Navy and Air Force. These standards have also played a critical role in the development of Federal Geographic Data Standards(FGDS), designed for use by both government and private industry.

3.2.2.3 Training, Data Maintenance and Sustainability: Besides resources for system development and installation, additional resources for GARIS were allocated to maintain the system. These resources included initial and refresher training, gathering and incorporation of data, system maintenance and support and hardware and software updates. Since GARIS provides a structured data repository, information can be entered over time as needed or as resources permit. Current and future subject areas for the GARIS system include:

- Hazardous waste management
- Cultural resources management
- Characterization of contaminated areas
- Stormwater discharge management

3.2.3 The Elsinore Valley Municipal Water District (EVMWD) GIS

The Elsinore Valley Municipal Water District (EVMWD or District) is a water and wastewater utility located in southern California. EVMWD currently has 24,000 water connections and 12,000 wastewater connections (Otway, Modrich and Buckley 1995). In addition to an expected growth rate of about three percent per year, EVMWD plans on expanding their services through acquisition of other water and wastewater utilities. In order to manage their water and wastewater system, EVMWD needed the mapping capabilities of a GIS.

3.2.3.1 Implementation Planning: Because of the high costs usually associated with implementing and maintaining an operational GIS environment, EVMWD felt is was important to identify and address all operational and technical issues in a logical and prioritized manner. EVMWD started the GIS development process by hiring a contractor to help formulate their GIS implementation strategy. The document, prepared in 1992, established the scope of the GIS system and the schedule for implementation and budget.

According to EVMWD, a key factor in the success of the project and the rapid completion of the implementation plan was the placement of the consultant project manager in an office at the water district. This arrangement provided an environment in which the consultant was dedicated to the project and could work with EVMWD staff and management on-site. As questions arose, the on-site consultant was able to communicate with the EVMWD staff immediately, thus resolving important issues more quickly.

One of the first tasks of the implementation plan was to develop a EVMWD GIS steering committee comprised of EVMWD management personnel whose mission was to conduct management review sessions during which major study findings were presented, priorities established and recommendations discussed and approved.

Three review sessions were held during the development of the EVMWD GIS project. The first discussed short and long term GIS application needs. The second discussed GIS database development strategy and costs, and the third session presented software and hardware recommendations. The sessions assured that the overall goals of the EVMWD were always in focus and that there would be no surprises.

In order to accurately determine and define the GIS needs of the various departments within the EVMWD, a three-step procedure was implemented. First, a review of was conducted of existing water district documents. These documents provided preliminary information on the functions and needs of each department. Second, interviews were conducted with the staff of each of the EVMWD's departments to develop and confirm GIS data needs. Third, the findings of were presented to the GIS steering committee for review, comment and to establish implementation priorities. EVMWD found that the task of setting priorities was important because a wide variety of needs were identified. However, not all needs were essential to everyone and therefore did not require immediate implementation.

The most significant cost in implementing a GIS program is developing the GIS database (e.g., converting paper maps and other data to digital form). To minimize the cost to EVMWD, the contractor prepared a GIS database development strategy outlining the data conversion process, where and in what format the information needed for the GIS existed and a preliminary cost estimate to convert it. EVMWD was fortunate in that the base map (e.g., street center lines and parcel boundaries) for the District's service area had been converted to digital format by the County of Riverside. This provided an effective starting point upon which the other layers of information were built.

The implementation plan for EVMWD was based on the full development of a GIS over four phases. In phase I, a pilot program was conducted in which the GIS database was developed for a small part of the District's service area. This initial phase enabled EVMWD to confirm the program requirements and costs without a large investment. When the pilot program was completed, the District proceeded with Phases II through IV, in which the GIS database was expanded, additional hardware and software were purchased to support more users and additional applications were implemented. The phased-approach used by EVMWD allowed them to control the development costs and schedule of the GIS program.

3.2.3.2 Data Sharing: The one element that contributed more than any other to the implementation of EVMWD's GIS is the County of Riverside's GIS data sharing program. Much of the county is mapped through the counties GIS system and the county makes this information available to other public agencies. Therefore, centerline and parcel base maps were readily available and immediately installed at EVMWD. More than 200 additional layers of information are also available through modem connection with Riverside County's main frame computer (Otway, Modrich and Buckley 1995). Riverside County also makes its personnel available on site to implement, operate and maintain GIS systems for client public agencies.

When planning environmental management GIS programs, sound development and design stages are critical to provide a foundation for successful implementation as well as for smooth system and data maintenance. Poor decisions made in early GIS development stages can result in unexpected costs for training, data management, data collection and system updating. The EPA Region 2, GARIS and EVMWD GIS systems have established that it is critical to get all stakeholders or users involved early on in GIS development and to share standardized data in a distributed network whenever possible.

CHAPTER 4

PHASES IN GIS DEVELOPMENT

Developing and implementing a GIS is more than simply buying or obtaining the appropriate GIS hardware, software and data. Too often, hardware, software and data become the primary focus of GIS decisions. Instead, GIS development should be viewed in terms of user needs and user applications the system is expected to support. The philosophy that "applications must drive system design" will lead to a clear vision of GIS functionality [Antennucci 1991] (Figure 4).

GIS development and implementation must be viewed as a process. The GIS implementation "cycle" is based on the philosophy that one first decides what the GIS should do and then (as a second activity) decide on how the GIS will accomplish each task. Under this philosophy, the needs are described first, available resources (e.g., funds for GIS data acquisition, GIS development, personnel, training) are inventoried second, preliminary designs are created and tested third and GIS hardware, software and data are acquired fourth.

4.1 Stages in GIS/Brownfields Development

The GIS development phases identified below are borrowed from John Antenucci's book *Geographic Information Systems: A Guide to the Technology* (Antenucci 1991) and from Stan Aronoff's book *Geographic Information Systems: A Management Perspective* (Aronoff 1991). For the purpose of this thesis, the phases will be modified for brownfield applications.

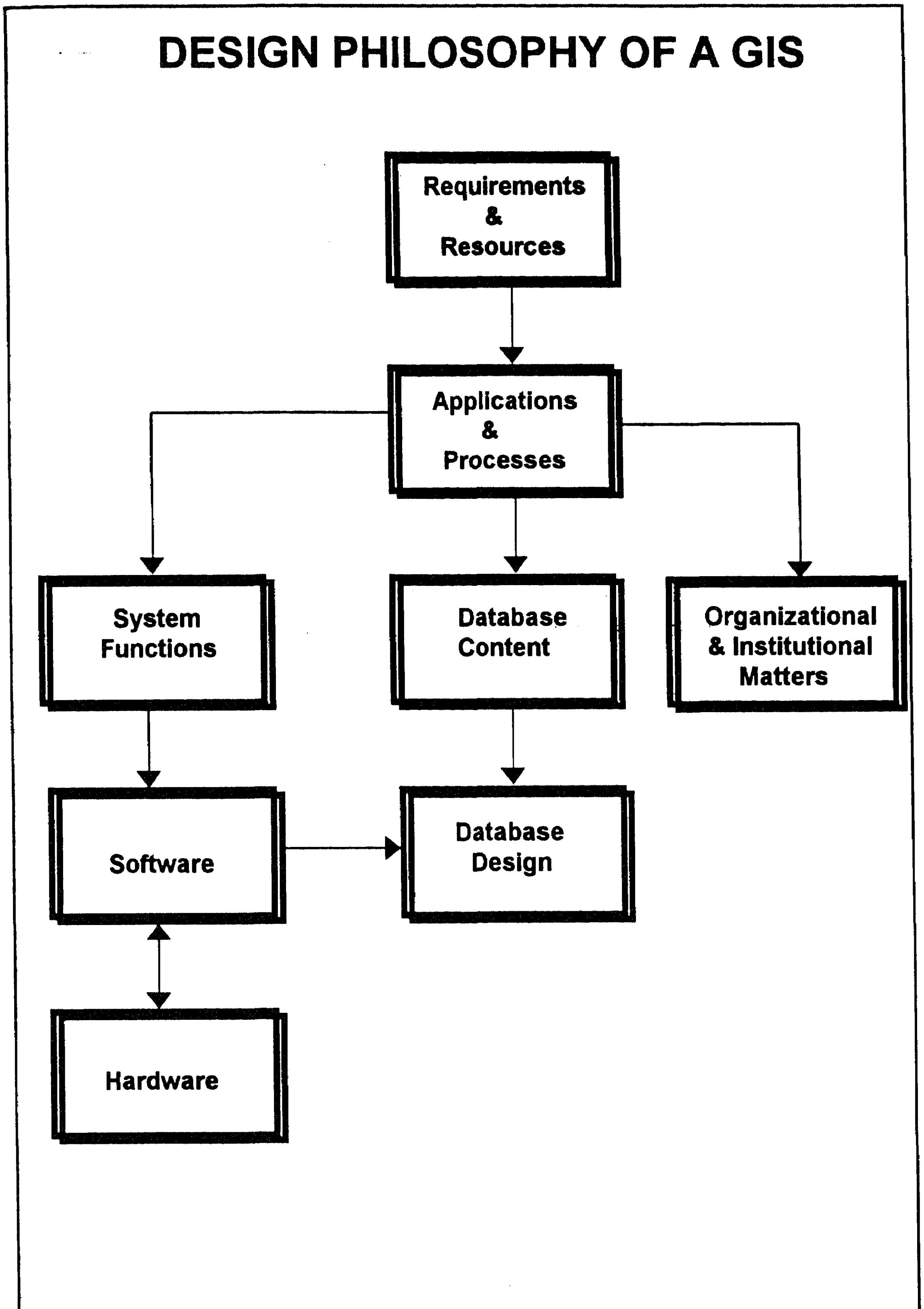


Figure 4 Applications Must Drive System Design (Antennucci 1991).

There are six broad stages and seventeen steps to successful GIS/Brownfields implementation:

- Awareness
- Concept

Step 1: Requirements analysis

Step 2: Feasibility evaluation

- Design

Step 3: Implementation plan

Step 4: System design

Step 5: Data base design

- Development

Step 6: System acquisition

Step 7: Data base acquisition

Step 8: Organization, staffing and training

Step 9: Operating procedure preparation

Step 10: Site preparation

- Operation

Step 11: System installation

Step 12: Pilot project

Step 13: Data conversion

Step 14: Applications development

Step 15: Conversion to automated operations

- Audit

Step 16: System review

Step 17: System expansion

4.1.1 Awareness Stage

The awareness phase is the beginning of the GIS development process. It involves ensuring support from all levels of an organization(s). For Brownfield Pilots this includes building partnerships and obtaining support/advice from all GIS/Brownfield stakeholders including:

- Federal, state, city and county planners, managers and decision-makers
- Federal, state and local regulatory agencies
- Economic development organizations
- Community development organizations
- Area developers
- Area business leaders
- Insurance interests
- Financial Institutions (e.g., lenders, banks)
- State and local GIS advisory committees or boards
- Local academia

The awareness phase also includes ensuring that the potential user community (e.g., developers, city personnel, financial institutions) are aware of what GIS is and what it can do for them.

4.1.2 Concept Stage

Step 1 - Requirements Analysis

The requirements analysis (or needs assessment) is the foundation of a successful GIS implementation plan. This analysis includes the identification of activities relying on map and graphic information throughout the organization(s). The organization's requirements are identified from an analysis of its operations, by identifying user needs and by anticipating future needs and conditions.

A GIS requirements analysis could use questionnaires, workshops or interviews with users to obtain the required information. The requirements information should be documented in a standard form for use in subsequent steps. This documentation describes the scope of the participation, the objectives of the GIS system and the GIS functions required.

For brownfield applications, the needs assessment should involve obtaining GIS data and functional requirements by interviewing and/or sending questionnaires to the brownfields user community. In other words, find out how developers obtain important site information without using GIS technology and then tailor GIS application development to query those needs. At this point, GIS data and GIS functions (e.g., overlay analysis, buffering) should be prioritized according to the frequency of use in order to determine resource allocation and to target future uses and projects. For example, if the three most requested pieces of information include purchase price, lot size and contaminant information, the Pilot should prioritize and obtain these data layers or attributes first (See Table 2).

Table 2 Recommended GIS Data Layers for Brownfield Applications

Data/Layer	Potential Source(s)	Used for Marketing & Economic Development	Used for Environmental	Priority (Hi - 1; Lo - 3)
Vacancy (Comm, Indus, Res)	City / Brokers	X		1
Parcel Ownership	Assessor	X		1
Area	Assessor	X		1
Landuse	Assessor	X		1
Zoning	City	X		1
Parks / Open Space	City	X	X	2
Freeways	City	X		1
Rail	City	X		2
Sea / Air Ports	City	X		2
Resident Age		X		2
Resident Income	Census	X		3
Resident Education	Census	X		3
Resident Occupation	Census	X		3
Unemployment	Census	X		2
Crime	Police Dept	X		1
Air Quality	Regulator		X	2
Truck Haul Routes	City	X		1
Power Plants	City		X	1
Incinerators	City		X	1
NPL Sites	Regulator		X	1
Leak / Release Sites	Regulator		X	1
Community Group Boundaries	City	X		2
Soil Types	USGS		X	2
Depth to Bedrock	USGS		X	3
Drink/Production Wells	Water Dept		X	1
Bodies of Water	TIGER	X	X	1
Monitoring Wells	Regulator		X	2
Soil Borings	Regulator		X	2
Water Bearing Zones	Regulator		X	2
Utilities	Utility Co.	X		1
Total Tax by Parcel	City	X		1
Topography	USGS	X	X	2
Water & Sewer Lines	City	X	X	1
Orthophoto	Various	X	X	1

Upon completion of the requirements analysis, a Brownfields Pilot will have all the information needed to plan for the development and implementation of a GIS system. This information can be grouped into the following categories:

- Applications to be developed and GIS functions required. - A requirement analysis will identify tasks (based on the responses of the user community) that can be done more efficiently with a GIS. For each application identified, certain functions such as query and display, overlay analysis and buffering will be required. Appendix I provides examples of standard forms that Pilots could use in obtaining GIS application, features and functions information for the requirements analysis.
- Data needed in the database. - A requirement analysis will identify the data needed for user applications. Appendix J provides an example of a potential brownfields master data list.
- Data maintenance procedures. - By looking at work flow and processes within each Pilot, responsibilities for data creation, updates and maintenance will become known. GIS custodians should be assigned for each spatial data layer in order to ensure that data standards and data maintenance procedures are met on time. A Brownfields Pilot could also us a data characteristics matrix (See Table 3) to keep track of spatial data as it is acquired and/or updated.

A common mistake in performing a requirements analysis that a Brownfields Pilot needs to stay away from is to simply take an inventory of the maps and spatial

Table 3 Data Characteristics Matrix

Data Layer	**Source**	**Currency**	**Resolution**	**Geographic Coverage**	**Frequency of Use**
Zoning	City	1997	1:10,000 base	Passaic County, NJ	Widespread
Parcel Area	Assessor	1997	1:5,000 base	Passaic County, NJ	Widespread
Hydrography	USGS	1992	1:100,000 base 1:24,000 base	Statewide Coastal areas, various others	Occasional
”					
“					
”					
“					
”					
“					
data layer *x*					

data currently used in a municipality or other organization. The problem with this "data inventory" approach is that it tends to focus only on data internal to the organization. The need for data is better determined by looking at the potential GIS applications and how the data will be used by each application and the users.

Step 2 - Feasibility Evaluation

The feasibility evaluation involves identifying the extent to which a GIS is practical and cost-effective. The feasibility evaluation is based on the requirements analysis and depends on the size and complexity of the organization and the diversity of potential GIS applications.

If not already identified, the goals and objectives of the GIS should be recognized in the feasibility study. For brownfield applications, the evaluation goals and objectives should include identifying the feasibility of sharing GIS data between federal, state and local sources and determining if a GIS is a practical decision-making tool for local project officials and area developers. Additionally, brownfield projects can utilize information from other Pilots that have completed a GIS/Brownfields system in order to determine effective and practical GIS solutions for economic redevelopment.

By the end of the feasibility evaluation step, the Brownfields Pilot should have produced a report that includes recommendations for the system to be acquired and the financial and staff resources needed to support GIS implementation. For the evaluation process to have been successful, the criteria of the evaluation must reflect those of the organization. In other words, the criteria must reflect the needs of those who will actually be using the system (e.g., developers and city planning personnel). It is important that these organizational issues be addressed early on so that the interests of the appropriate groups are represented.

4.1.3 Design Stage

If the feasibility study supports a decision for the Brownfields Pilot to acquire and implement a GIS, the process moves to the design stage. In the design phase, plans for implementation, system design and database design are prepared.

Step 3 - Implementation Plan

The implementation plan describes how technology, information and people will be formed into an operating information system. In particular, the implementation plan: (1) Identifies and describes individual tasks; (2) Assigns responsibilities for each task; (3) Indicates the resources committed; (4) Defines relationships among tasks; (5) Identifies products and milestones; and (6) Establishes a schedule.

Preparing the implementation plan begins with identifying all the tasks involved in the implementation of a GIS. The most important task in GIS implementation is the design and development of the database. Database development includes acquiring the data identified in the needs assessment, converting the data (if required) and entering the data into the GIS. Database development usually is the single most expensive part of the implementation process, accounting for approximately 75% of total costs.

For Brownfield Pilots, the implementation plan should involve estimating the time and resources (including personnel) needed to develop their GIS system. This cost estimate will depend on a number of issues including whether or not the GIS system is a shared or networked system and if the data is available in the scale and database required for the applications determined in the needs assessment.

The Pilot may also want to set deadlines and completion dates during the implementation step. For example, the Pilot could set dates for when the GIS hardware, software and data should be acquired and how often the data will be updated. The Brownfields Pilot should also set a goal for when priority data should be converted (if needed), when standards documentation should be in place and when a usable GIS system will be available to the user community.

Step 4 - System Design

There are many GIS systems (hardware and software) available in the marketplace, each with individual strengths and weaknesses that should be evaluated according to the organization's requirements. Selection of the system can be a formal or informal process. Most government organizations use a formal process based on a request for proposal (RFP). Appendix K provides an example of the RFP that New York City prepared to request GIS/Brownfields services.

For Brownfield Pilots, it is important to keep in mind who will be using the system. Since a large portion of the user community (e.g., developers, banks) may not have a great deal of GIS experience, the Pilot should look into providing GIS training and obtaining user-friendly systems and software packages. Pilots should also design the system for growth, since the need for economic development and redevelopment will extend well into the future.

The system design builds on the conceptual design of the alternative selected and defined in step 2 and is guided by the implementation plan from step 3. Because several systems are available on the market, the specifications at this stage are defined as functional requirements rather than as specific systems or software packages.

Preparing the system design requires expertise in hardware, software and communications. The designer should be familiar with available systems and the methods of system design. The time required to design a GIS system depends on the size and complexity of the system.

Step 5 - Database Design

A database design is produced in conjunction with the system design. The database design deals with the contents, specifications, relationships and sources of data to be included into the GIS database. The database design is a refinement of the conceptual design developed in the feasibility evaluation and is prepared for each of the data layers to be included in the database.

In the database design step, Brownfield Pilots need to evaluate source materials to identify source documents or procurement methods for each required map feature and nongraphic attribute. Once again, it is recommended that Pilots look into a shared GIS system (with agreed upon standards and metadata) where the spatial and attribute data are obtained from federal, state and local organizations in a networking environment. If no existing source of a needed data layer or attribute can be identified, a decision must be made to pay for and obtain the feature or layer from other means (e.g., field measurement or aerial photographs).

The Pilot should also evaluate the source materials to verify the area covered by each map feature. Once these source materials are evaluated, the database design document can be prepared by the Pilot and reviewed by the potential suppliers and users of the GIS data to verify the sources completeness and usefulness. Figure 5 represents a simple brownfields GIS database.

4.1.4 Development Stage

In the development stage of the GIS implementation process, an organization acquires GIS hardware, software and data conversion services for graphic and nongraphic information. Among public and government organizations, a formal procurement process (e.g., RFP) is usually involved for the acquisition of the system and database development. These services are based on each organization's specific situations and needs.

Step 8 - Organization, Staffing, and Training

While the approaches to GIS organization vary from project to project, certain issues need to be addressed in every case. The organizational structure may be centralized, with one group providing GIS services, or it may be distributed, with participants operating independently of the others. Distributed networks should work well for Brownfield Pilots. Networks were utilized and data was shared in the SCIP

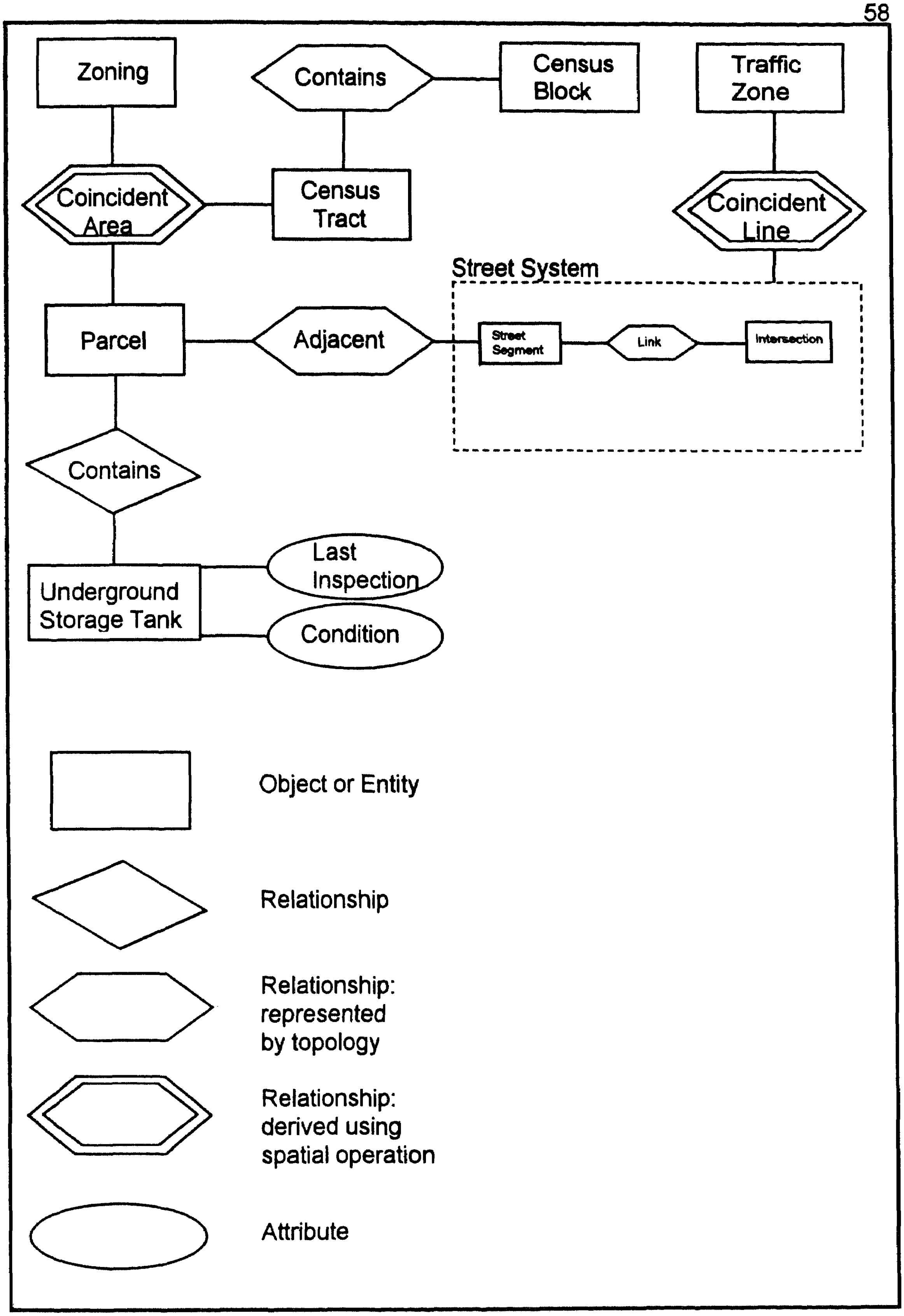


Figure 5 Example of a Simple Brownfields GIS Database.

and CSRA EDGIS projects that were examined earlier in this thesis. If data and resources are shared among the participants, standards for compatibility among the system and database must be established. Also, written rules may be beneficial between the various participants in the Pilot in order to clarify roles and responsibilities.

During GIS development and implementation, personnel should be assigned or designated to perform certain functions within the various organization(s). The personnel required include an implementation project manager, a system manager and a database administrator. In addition, a GIS/Brownfields system needs system analysts, operators or users and programmers.

GIS training at Pilots should take place at all levels, including managers, staff and potential users. The training may be provided by the system vendor, knowledgeable Pilot personnel or others, such as a GIS consulting organization. In addition, the Pilots should encourage GIS staff and users to attend GIS workshops, conferences and other events.

Step 9 - Operating Procedure Preparation

Operating procedures are developed to cover the operation and management of the GIS system. The procedures also cover data maintenance, data updates and application and use of the system in the participating organization(s).

Step 10 - Site Preparation

The site preparation step includes: (1) Selecting optimal locations for the individual devices; (2) Preparing and allocating adequate space for all components; and

(3) Installing an adequate power supply, environmental controls and communication lines and devices. In Brownfield Pilots, efforts should be made to locate GIS technology so that developers and other users have access to a useable system. Potential locations could include libraries, community kiosks and state or local offices.

4.1.5 Operational Stage

The GIS system is considered to have reached the operational stage after system installation and when end-users are making effective use of the system. In the operational stage, the Pilot should have developed sufficient expertise to handle routine tasks in an effective manner.

Step 11- System Installation

The system installation step begins with the delivery of the system and ends with the initial operation of the GIS hardware and software. When all components have been installed, tests should be conducted by knowledgeable Pilot personnel. Initially, a site test is performed to verify successful installation and operation of all hardware and software. These tests are usually performed by the system vendor and can be verified by the Pilot.

Step 12 - Pilot Project

A pilot test requires brownfields project staff sufficiently trained to develop applications, operate the system and conducts the tests. Its outcome usually leads to design refinements. Objectives and goals of the pilot study should include the following:

- Verifying the usefulness of GIS technology to Pilot personnel and users
- Verifying the costs and benefits estimated in the feasibility evaluation
- Verifying procedures for database development
- Providing hands-on training for organizational staff and end users

Step 13 - Data Conversion

The GIS database is usually developed through a combined effort with in-house staff and a contractor. Database specifications are defined in terms of the system's data management software. As data becomes available, they are digitized (if required) and loaded into the GIS.

Step 14 - Applications Development

During the requirements analysis, brownfield applications should have been identified. GIS applications support standard, often-used functions of the GIS. They may link together a series of tasks, retrieve data or perform calculations. Remember to upgrade applications to keep pace with changing developers or other user needs.

Step 15 - Conversion to Automated Operations

The conversion of manual operations and activities is an on going process in any GIS system. In particular, as components of the database are completed, loaded and verified, a transition is made to automated operations.

4.1.6 Audit Stage

In the audit stage of GIS development and implementation, the Pilot will evaluate all aspects of the GIS system and plan improvements and expansion for the system.

Step 16 - System Review

A GIS system must remain flexible to shifting Brownfield Pilot directives, advancements in technology, introduction of new techniques and turnover in staff. Periodic audits by the Pilot will play an important role in keeping a GIS project on track. A review of a GIS system should include a review of the original goals and objectives and a review of end user satisfaction.

Step 17 - System Expansion

Documentation from the system review will provide the Pilot with the information needed on whether on not to expand the system. Expansion issues will arise when demands are increased on the system by the brownfields user community.

4.2 Factors that Affect GIS/Brownfields Development

Efforts to implement GIS systems over the past twenty years have been both successful and unsuccessful. Some of the keys to success include maintaining support from all levels of the organization(s), system and data sharing and involving users in application and function development. The following is a list of factors that could affect GIS implementation at a Brownfields Pilot:

- Whether the GIS was evaluated to see if it fits the Pilot's long-term goals
- Obtaining support from top management of all participating Pilot organizations
- The continuing involvement of an area brownfields "champion" to promote GIS
- The development of partnerships and the sharing of information within the Pilot
- A commitment to the long-term with long-term resources
- Use of outside experts when and if needed
- Ensuring that priority and future applications (based on user needs) drive the choice of GIS systems
- Choosing the first applications carefully. Select ones with high success potential and visibility. (e.g., applications were the municipality selects a highly marketable site using GIS or were a developer uses the system to purchase a brownfields property based on the developers needs)
- When choosing GIS vendors for hardware and software, take into account vendor reliability and system flexibility

CHAPTER 5

SURVEY QUESTIONNAIRE RESULTS AND DISCUSSION

A survey questionnaire was mailed to 90 Brownfield Pilots in an attempt to obtain information regarding their GIS development and implementation status. Although there are currently 115 National and Regional Brownfield Pilots, 90 questionnaires were mailed out because 25 new pilots were selected after the questionnaires went out (Spring 1997) and therefore, could not effectively respond to the questionnaire.

Of the 90 questionnaires sent out, 17 were returned (≈19%). The low return rate was expected because the U.S. EPA Brownfields Program is an initiative that is still maturing and many pilots around the country are in the initial stages of forming their redevelopment goals and objectives. Additionally, of the 17 questionnaires that were returned, nearly half (7/17 or 41%) described their GIS development stage as "preliminary." However, the returned questionnaires will still be regarded as representative to what is happening in the GIS/Brownfields area at this time and the following results and discussion are based on the 17 returned questionnaires. Appendix E provides a copy of the questionnaire that was sent to the 90 Brownfield Pilots.

The questionnaire was comprised of 26 questions. The questions covered everything from the types of hardware and software in use, to the GIS implementation challenges that were encountered. In the following pages, the outcomes of the survey will be discussed.

The first two questions on the survey are introductory in nature and were designed to determine the number of brownfield projects who had developed, or are currently developing a GIS system. As previously stated, ≈19% (17/90) of the surveys were returned, representing the approximate percentage of the projects who are currently involved in developing and/or implementing a GIS system for brownfield applications. The results did find two pilots that have GIS systems already developed and "trial tested," where a developer has come in and purchased a brownfields property based partly on the queries they made about a site.

Question 3 was asked to determine the number of Brownfield Pilots who are developing a GIS separate from a state, municipal or county system. 47% (8/17) of the respondents plan on developing a GIS separate from an existing local system.

Question 4 was a follow-up to question 3. If the results showed that a Pilot was planning on developing a GIS separate from a municipal or county system, they were asked to identify long-term goals or applications. Aside from economic development/redevelopment, the most popular long-term application objectives for GIS systems were neighborhood planning, crime tracking and community development.

Although the results show that various database software packages are being utilized for brownfield applications, ArcInfo and ArView are the GIS software packages that a majority of Brownfield Pilots are using/planning to use. The results show that 12 out of 17 (70%) Brownfield Pilots are using the two Environmental Systems Research Institute (ESRI) software packages for their economic redevelopment applications. Furthermore, although various database packages are being used, the database software that is being used for brownfield applications to the greatest extent was found to be Microsoft's Access (17%). Figures 6 and 7 illustrate the GIS and database software being utilized by Brownfield Pilots.

The use of a GIS/Brownfields system would be beneficial to both city officials for planning purposes and to developers for brownfields site selection according to the responses to question 7. Environmental applications and use by community groups were also considered as possible applications for a GIS/Brownfields system.

Questions 8, 9, and 10 on the survey dealt with GIS data issues. Question 8 explored which brownfields stakeholders were responsible for determining data needs, question 9 examined where the required data was obtained, and question 10 dealt with the challenges of acquiring data. The results show that city personnel, such as planners and managers, are the individuals that are most often consulted in determining data needs for a GIS/Brownfields system. Of those that responded, 58.8% (10/17) said that city officials and/or other city staff will determine GIS data

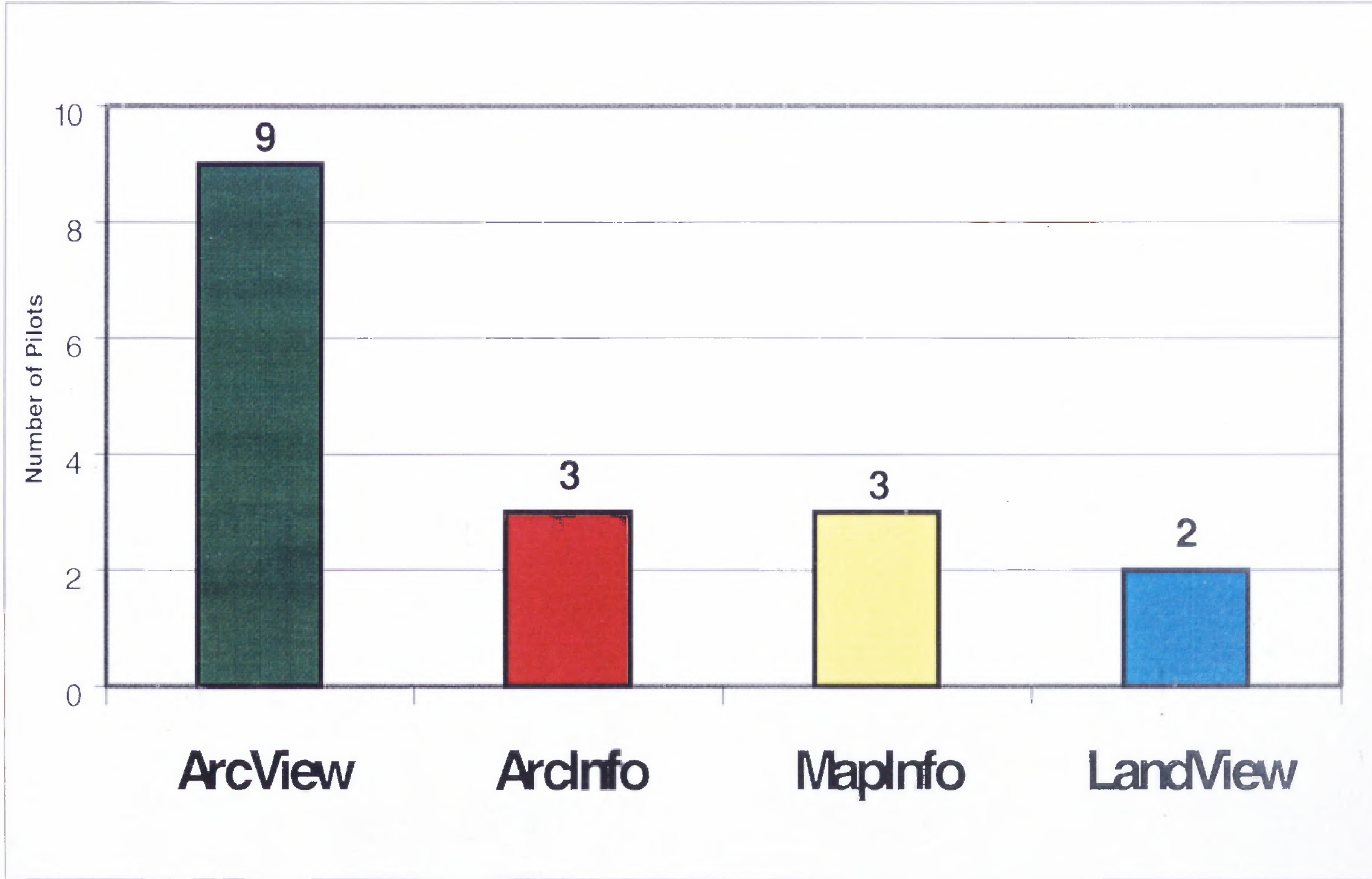


Figure 6 GIS Software Currently Being Used by Brownfield Pilots.

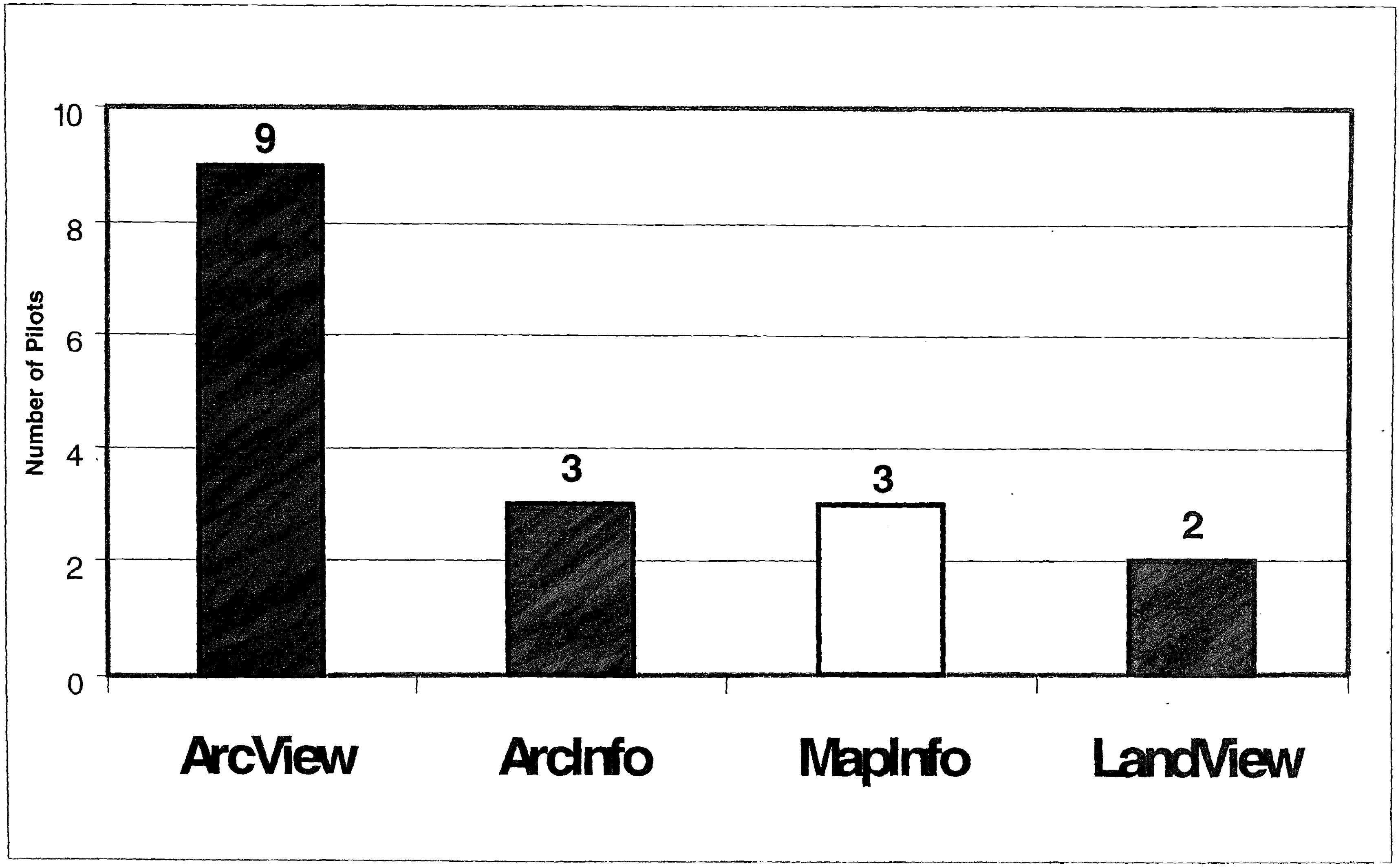


Figure 6 GIS Software Currently Being Used by Brownfield Pilots.

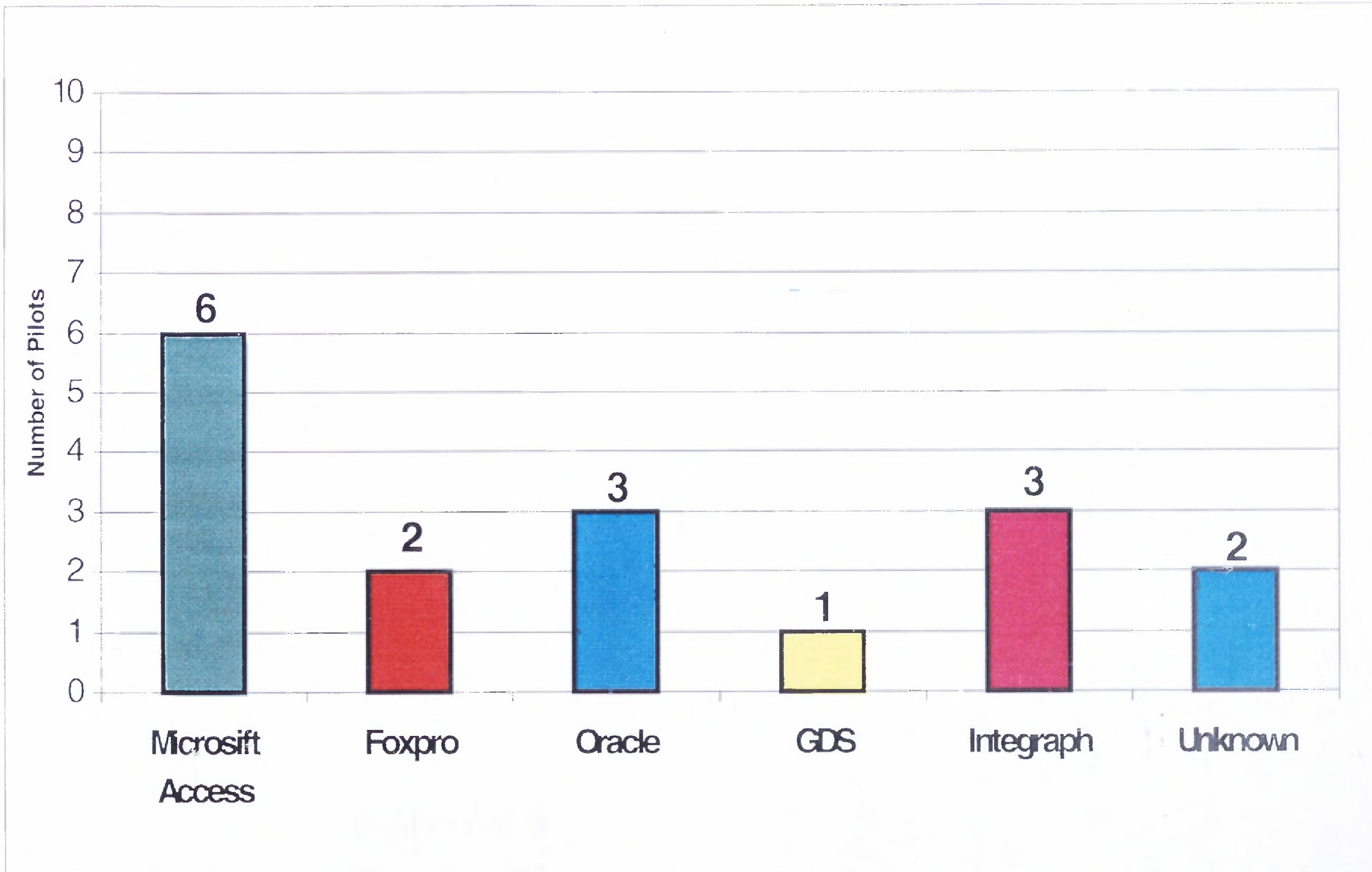


Figure 7 Database Software Currently Being Used by Brownfield Pilots.

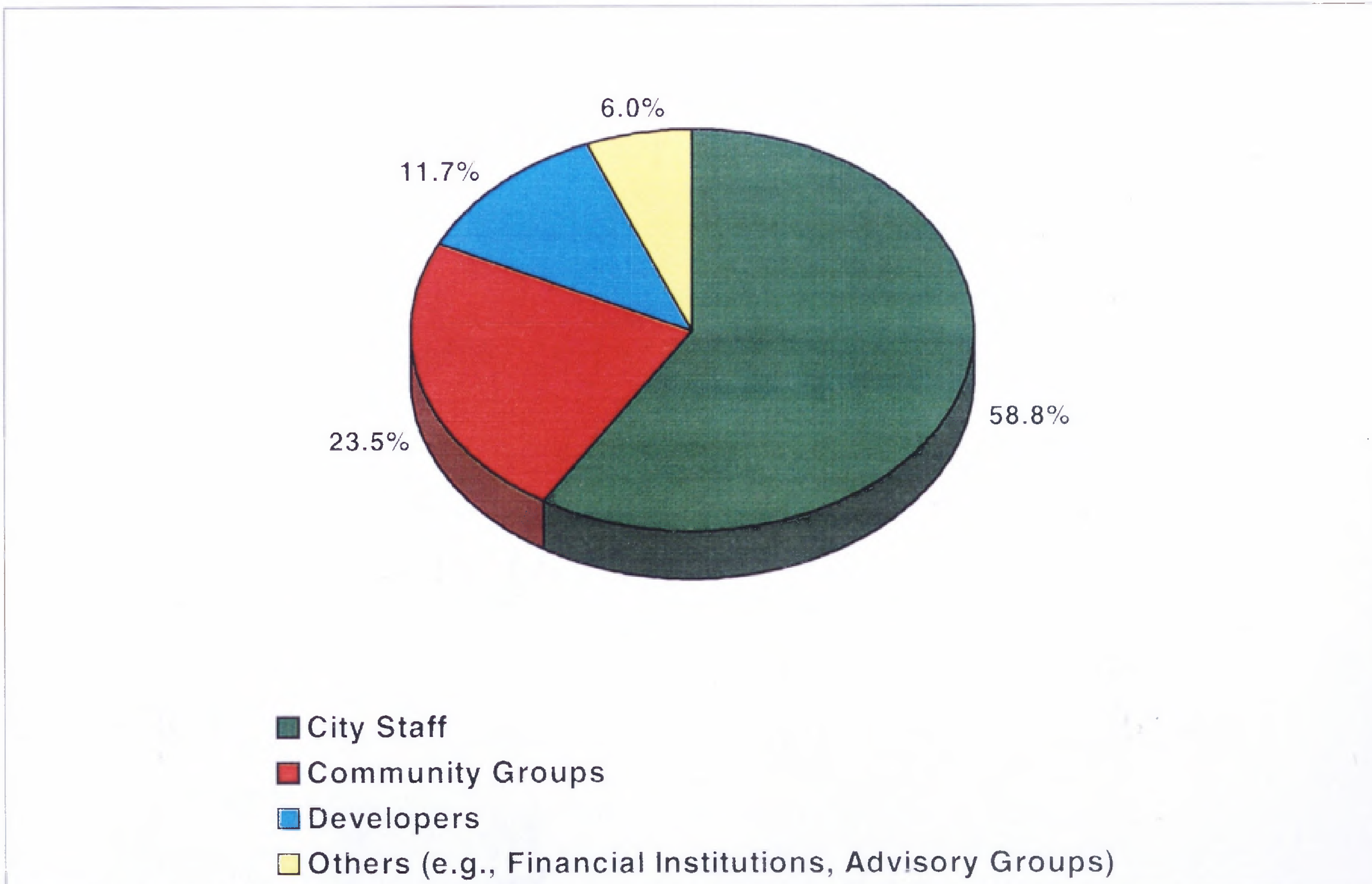


Figure 8 Who is Determining GIS Data Needs at Brownfield Pilots.

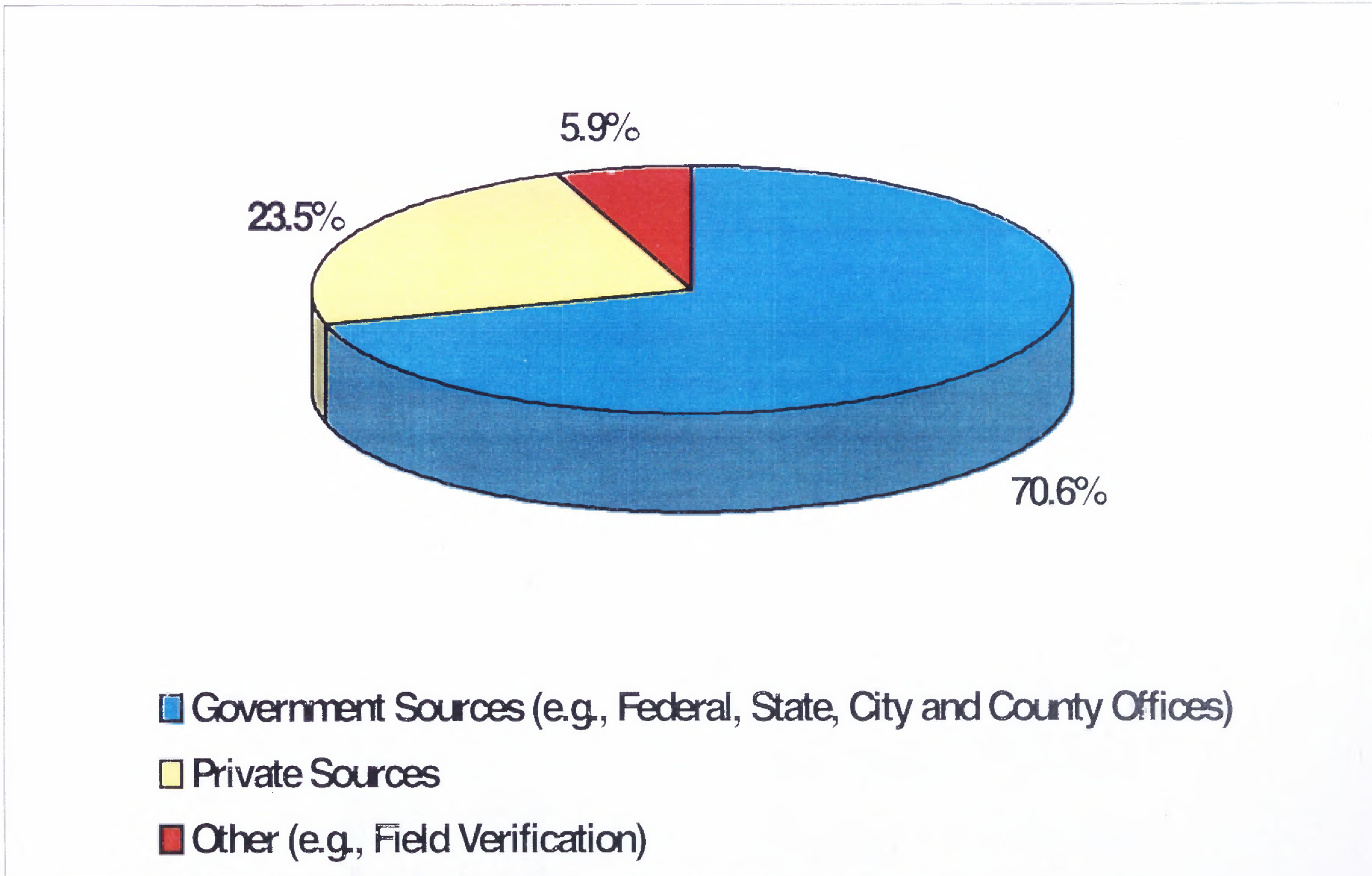


Figure 9 Where are Brownfield Pilots Obtaining GIS Spatial Data.

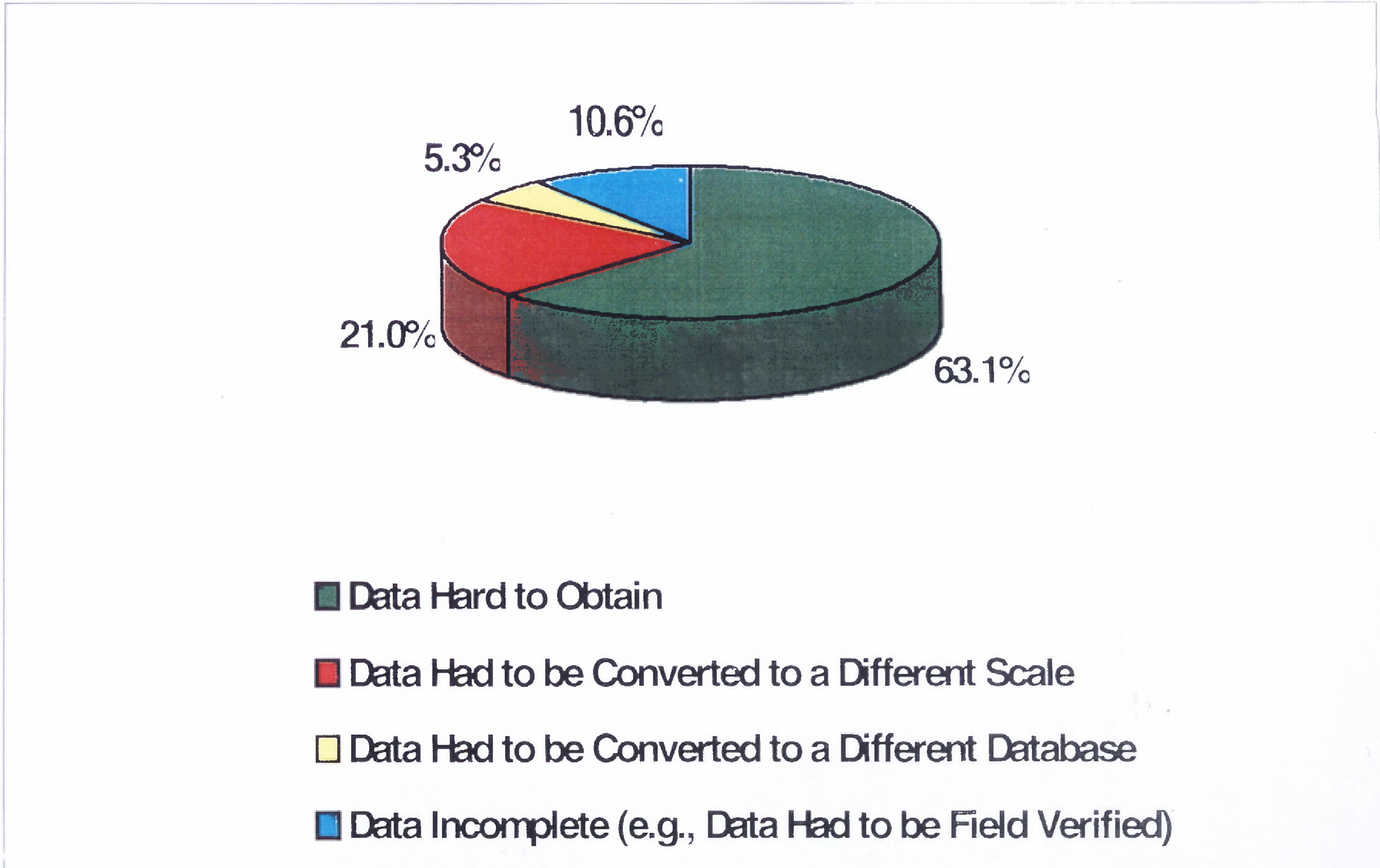


Figure 10 Challenges to Obtaining Quality GIS Data at Brownfield Pilots.

a non-profit community development office, a state government office, at the local university and on the Web.

The location of terminals for public access to GIS/Brownfields data is also being considered by Brownfield Pilots. Although only 35% (6/17) of the respondents answered the question regarding access to GIS terminals, the public access locations that are mentioned most often include the Web, non-profit organizations and city offices.

According to the results for question 20, in-house training is/will be the most productive way to train users of a GIS/Brownfields system (71%). Local universities, seminars and workshops and consultants were also mentioned as possible GIS training mechanisms.

Questions 21 through 23 were asked to determine successful GIS/Brownfields strategies and the challenges encountered in GIS/Brownfields development, data acquisition and implementation. According to the survey, public partnerships and the achievement of economic development objectives were the two benefits expected the most from developing a GIS system for Brownfields applications (47% and 35% respectively). Other possible benefits noted from the respondents included community involvement, job creation and spin-off redevelopment.

The costs for initial GIS system development and implementation, as well as the costs for on-going maintenance and training were also considered in the questionnaire. Only 29% (5/17) of those surveyed responded to this question. For those that did respond, costs for initial system development and implementation ranged from $750,000 to $18,000, while estimated costs for on-going training and system and database maintenance ranged from $67,000/year to 2,800/year (Figures 11 and 12).

The variation in costs for initial GIS system development and implementation and for on-going maintenance and training were probably due to the following:

- A difference in the comprehensiveness of the GIS system. The Pilot that estimated costs at $750,000 for GIS development/implementation and $67,000/year for maintenance and training was developing a large city wide system not only for brownfield applications, but for municipal applications as well.
- Little experience developing and implementing a cost-effective GIS system for a brownfields project.
- The inability to quantify GIS costs at this time. A majority of Brownfield Pilots interested in GIS have not had the chance to explore GIS cost issues.

Once again, it is important to keep in mind that these results were based on a total of 17 returned questionnaires. Statistically, this does not represent a large enough population (17 of 90 Brownfield Pilots) to represent a quality sample. However, even though the number of responses was low it is the belief of the author that the results are representative of the GIS development and implementation issues that Brownfield Pilots have or will have in the future.

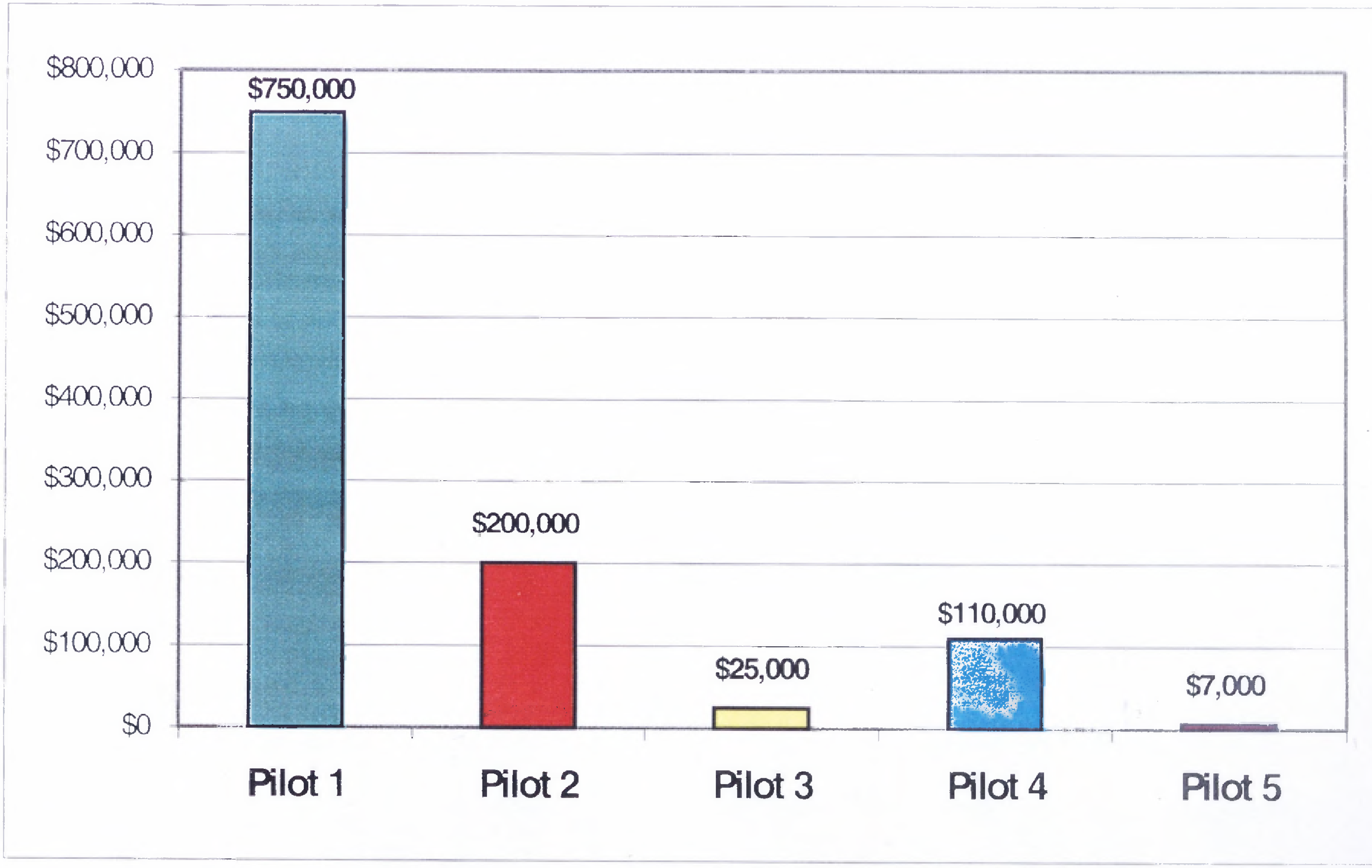


Figure 11 Initial (or Start-up) Costs for Establishing a GIS at Brownfield Pilots.

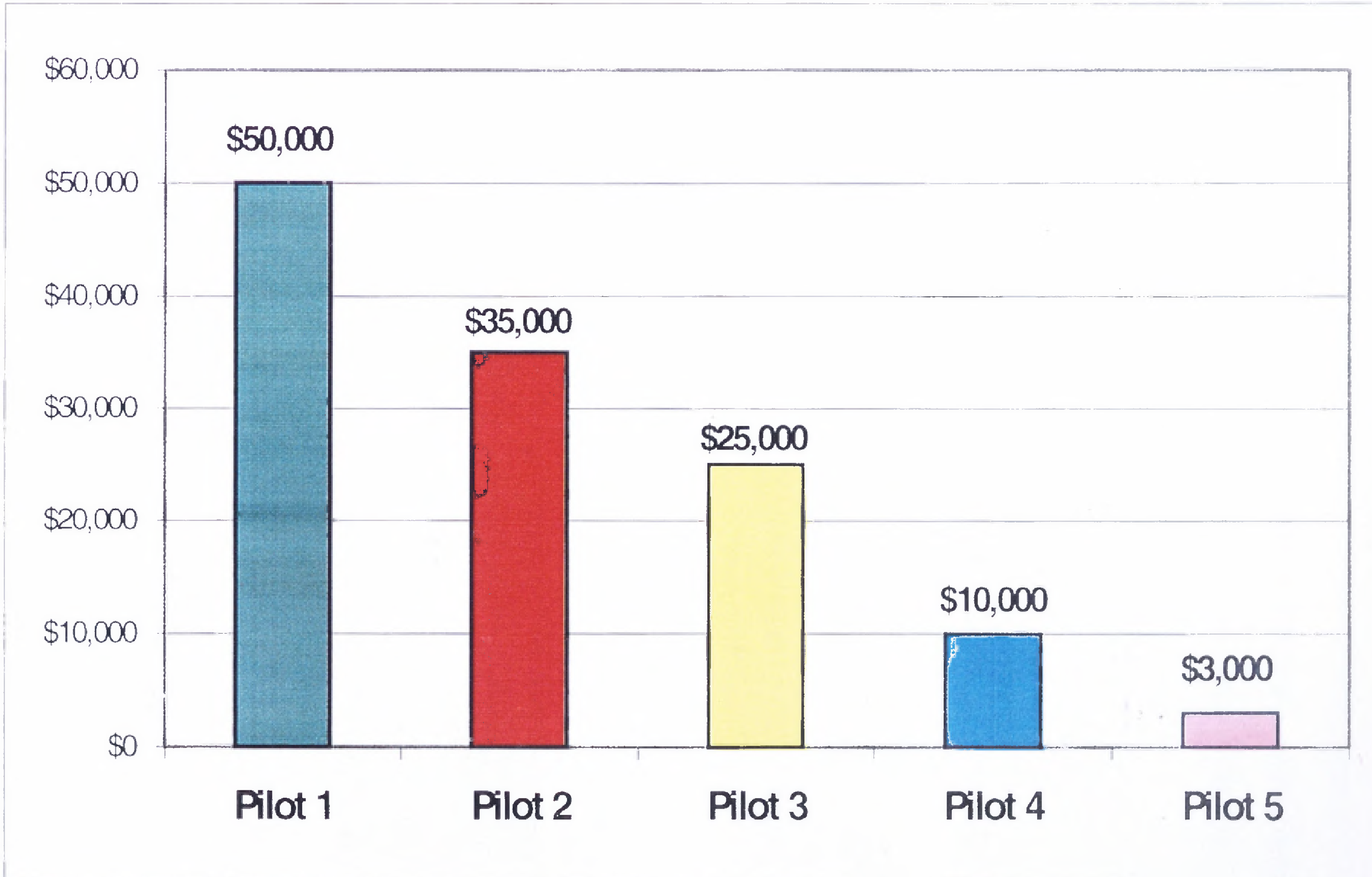


Figure 12 Costs (per Year) of Maintaining a GIS at Brownfield Pilots.

The two GIS implementation issues that rated the most challenging were data quality (5/17 or 35%) and trouble obtaining data (35%). Additional challenges to GIS implementation included difficulties with system design, costs, introducing GIS into an organization and obtaining information from private landowners.

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

The main objectives of this thesis were: 1) To determine the number of Brownfield Pilots that are using GIS technology; 2) To determine the GIS development and implementation challenges that the Pilots have encountered; 3) To recommend key implementation strategies or approaches for Brownfield Pilots to consider when implementing a GIS; and 4) To recommend future work in the GIS/Brownfields area.

6.1 GIS/Brownfields Implementation Challenges

Although only 17 (≈ 19%) Pilots responded to the questionnaire, the results are considered a representative sample of the GIS implementation issues and challenges that Brownfield Pilots are now facing. These challenges deal primarily with obtaining quality, useable spatial and attribute data, and include issues of data accuracy, data availability, data cost and the conversion of data to a useable scale or format. Some of the data availability and data cost challenges can be resolved by developing GIS partnerships in which data is shared in a distributed network involving universities, government offices, state and local organizations and the private sector. Data accuracy and data conversion challenges can be resolved by establishing data standards and LDPs within the distributed network. These recommendations will be discussed in greater detail in the following sections.

6.2 GIS/Brownfields Implementation Recommendations

6.2.1 User Recommendations

The groups that will most likely utilize a GIS/Brownfields system are city planners and decision-makers, developers and business leaders, financial institutions and citizens with community interests. Although the results show that these groups were considered when determining data needs, developers and financial institutions (e.g., those with a "vested interest" in brownfields redevelopment) need to be consulted more often when determining GIS data requirements. These stakeholders are the ones that have the most to gain or lose from the redevelopment of brownfield properties because they are the ones purchasing the sites and guaranteeing the loans. According to Ian Kahn, president of Brownfield Remediation Services Ltd., of Solon, Ohio, "Developers must be involved with municipalities in identifying sites, otherwise they won't get cleaned up." Kahn went on to say that governments "think in terms of months and years and must realize that developers think in terms of days and weeks and want the process to move quickly or they will lose interest."

Developers can describe exactly what they look for in a property (e.g., access to transportation, a large building with utilities) before purchasing it and can use GIS as a quick decision making tool. Therefore, more effort should be made to market and/or target developers as the primary beneficiaries of GIS technology. Brownfield Pilots may also want to consider setting up GIS/Brownfields demonstrations early on in the implementation process so that developers get a better understanding of what GIS can do for them.

6.2.2 Data Recommendations

Acquiring quality, useable data can be the most expensive element of building a GIS system. According to the results of the questionnaire, obtaining quality GIS data and converting the data to a different scale or database were some of the biggest challenges presented to Brownfield Pilots interested in implementing a GIS. These challenges can be addressed by: 1) Setting up or adopting data and mapping standards and locational data polices (LDPs) in the Pilot Region and 2) Building partnerships and/or agreements with area brownfield organizations and universities to share GIS spatial and attribute data within a distributed network.

LDPs and data standards provide a structure for the creation and maintenance of an integrated, accurate database. They ensure consistency, uniformity and quality in data gathering and data automation. LDPs and standards also promote accurate gathering and transfer of data from both manual and digital sources. They also create a common understanding of the quality expectations for digital GIS data. The development of GIS LDPs and data standards and procedures is not only important for guiding Brownfields Pilot database development efforts, but also for providing consistency in any cooperative data development and data sharing efforts. Appendix F provides a good example of mapping and digital standards developed by the New Jersey Department of Environmental Protection (NJDEP). Additionally, a data characteristics matrix similar to the one represented in Table 3 could be helpful to Pilot organizations for managing their GIS database.

Partnerships and/or agreements in Brownfield Pilots can be reached with government agencies, the private sector, regulated utilities, nongovernmental organizations and universities. Brownfield Pilots can enter into partnerships or agreements with area organizations for GIS data and cost sharing. An elected coordinating body would be responsible for maintaining and disseminating the shared brownfields database or central GIS repository. This coordinating body could be an EPA Regional office, a local university, or a contracted private firm. The data could be shared in the Pilot region via magnetic media or on-line should communications links exist. A representative committee within the coordinating body can act to resolve data, user, or other relevant issues. Through the coordinating body, all Pilot participants would work together to form an area-wide brownfields or economic redevelopment GIS and share the GIS resources created there. The SCIP project that was examined in Chapter 3 is a good example of a GIS that was built as a shared regional system with a coordinating body. GIS partnerships like SCIP not only provide a framework for GIS data sharing among organizations, but they also establish mechanisms to leverage resources and funding.

6.2.3 Funding Recommendations

GIS data was obtained from government sources (58%), private sources (20%), and by various other means (e.g., community surveys, field verification). While getting data in digital format from private sources may be necessary in some situations, more effort should be made by Brownfield Pilots to obtain GIS data at minimal cost. As already noted, one of the ways that the costs of data can be managed is by sharing data costs in a consortium of participating organizations. The following list provides additional funding strategies that could be available to Brownfield Pilots:

- Tap into the general fund of a state's, city's, or county's departmental budget.
- Obtain funds from infrastructure improvement projects. For example, using bond revenues from an airport improvement project that determines GIS technology is necessary to plan and monitor the project.
- Obtain funds by increasing recording fees for property transactions.
- Include GIS in a cities or counties capital budget and share base mapping costs with a local agency. For example, split costs 50/50 with the local water management district or other local utility.
- Obtain federal, state or private grant monies. For example, in Cleveland, Ohio, funds for a GIS were obtained from the Cleveland Foundation, which provides matching grants for local development projects that cannot be completely funded.
- Obtain in-kind financing. For example, if a local university wanted to be involved with a GIS/Brownfields project, they could volunteer to maintain the database for free. In return, the university would have access to the database.
- Consider including GIS in a Capital Improvement Plan (CIP). CIPs allow local governments to survey needs and set priorities, develop financing strategies and to sell the program to the public.
- Consider the use of special tax revenues. Voters usually find the retail sales tax less of a burden than increased property taxes. If your state passes a new gas tax for highway or infrastructure improvements, find out whether the legislation includes planning, design and information system costs.

- Consider conducting GIS and brownfields education programs to create more community interest. With a better understanding of GIS and brownfields issues, funding may get easier.

6.2.4 Database Design Recommendations

The recommendations for Brownfield Pilots regarding database design include designing a GIS/Brownfields system for expansion and growth (with possible inclusion into a county or municipal GIS system) and developing a user-friendly, relational database. The following are recommendations for the design of a GIS/Brownfields database:

- The database should be multiscaled. Three levels of detail are recommended: small scale (1:100,000 or smaller); medium scale (1:24,000); and large scale (1:1,200).
- The database must have analysis and decision making capabilities at various levels including different resolutions and different scales.
- The database should be simply designed for easy use and maintenance.
- The database should be relational in structure.

In a relational database attributes can be stored in any number of tables and accessed or made available through a structure termed "relate." A relational database structure that uses relates can be efficient for data storage. A relate structure takes advantage of the relational data model and establishes logical linkages between two tables or files, a from-table and a to-table. Relationships between two tables are established through a common data item in each table. The common item is called a key. For example, if a Brownfields Pilot was interested in determining the owner or owners of a certain parcel, a key file could be used to support one-to-many and many-to-many relationships among tables (Figure 13).

6.2.5 Application and Query Development Recommendations

Application and query development are vital elements in the implementation of a GIS system at a Brownfields Pilot. Applications and queries should be developed based on user needs. The following site selection criteria are based on a brownfield properties potential marketability. The criteria are based on information gathered from interviews, literary sources and the GIS/Brownfields questionnaire found in Appendix L. The criteria are followed by GIS applications and queries that a Pilot or developer could use when selecting brownfield properties to redevelop.

6.2.5.1 Siting Criteria that make Brownfield Properties Marketable:

1. Vacant parcels
2. Parcels with Buildings in good condition
3. Parcels where taxes are delinquent for more than six months
4. The site is zoned for the buyers intended use (e.g., industrial, commercial or residential)
5. The size of the site is greater than two acres
6. The site has transportation (e.g., rail, roads, airport) adjacent or accessible
7. The site has suitable geology/topography for construction
8. The site (if developed for residential purposes) is located in an area where there is access to schools, urban parks
9. The site is adjacent to other businesses or industrial parks

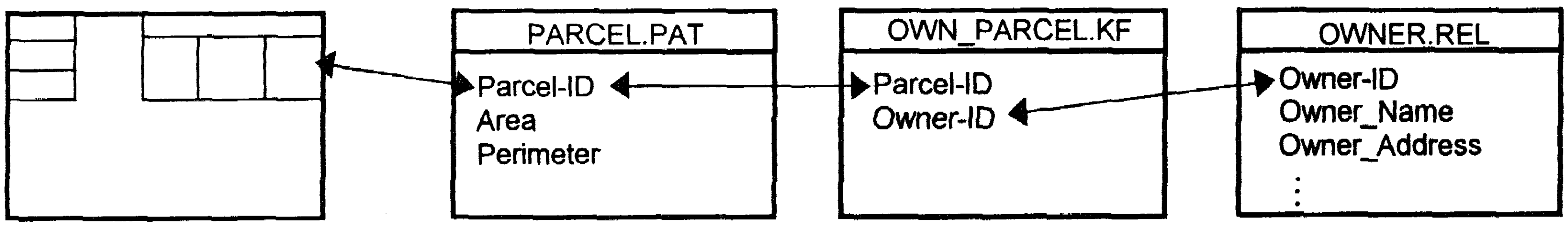


Figure 13 Relational Database Table Structure Showing Common Attributes.

10. The contaminants, their quantities and the media where the contaminants were found have been identified and quantified at a site (e.g., at least a Phase I site assessment has been done)
11. There is a high (> 10%) unemployment rate in the area around a site
12. There is an increasing poverty rate in the area around a site
13. There is a good demographic in an area around a site (e.g., 40% of the working population is between 20 and 40 years old with at least a high school education; or if a retail developer is interested in the property, there is a good customer base located in the area around the site)
14. There is only one owner of the site
15. If the buyer is an industrial or commercial business, there is an adequate base of potential suppliers in an area around a site
16. There is a low crime rate in the area around a site
17. The property is publicly owned
18. There aren't any competitors (determined by SIC code) in the area around a site
19. The site has a building with utilities in place (e.g., sewer, electric, water)
20. The site is located in a federal or state enterprise zone
21. Property taxes are low and the site is available immediately

6.2.5.2 Siting Criteria that make Brownfield Properties more Difficult to Market:

1. The parcel has two or more owners
2. The parcel is privately owned
3. The site is < two acres in size

4. The site does not have transportation access
5. There are no buildings on the site, or there are buildings in poor condition
6. The contaminants at the site have not been identified or quantified
7. There is unsuitable geology and/or topography for construction at the site
8. The site is located in a wetland and/or floodplain
9. The site is not zoned for use for what a potential developer has in mind (e.g., the site is zoned for industrial use, but the developer requires a property zoned for commercial use)
10. The site does not have adequate utilities
11. Leaking underground storage tanks or other environmental concerns have been found on or near the property
12. The site does not have a good demographic for what the developer has in mind for the property (e.g., there is not an adequate customer base for a retail business)
13. The property taxes for the parcel are high
14. The site will not be available for at least one year
15. The prior owner of a site was a large chemical company with a history of environmental non-compliance

Table 4 GIS Application and Queries that could be Used to Eliminate Properties from a Brownfields Site Inventory

GIS application #1: Eliminate properties from consideration by identifying and displaying site criteria that make sites unmarketable
Query A: Display all sites with more than one owner.
Query B: Display properties that are privately owned and that are less than 2 acres in size.
Query C: Display vacant properties where the geology and/or topography make it unsuitable for construction.
Query D: Display properties where the following criteria are met: ① There are leaking underground storage tanks on the property; and ② Where there is a groundwater drinking source within ½ mile of the site.
Query E: Display all properties that are greater than 2 miles from a major road.

Table 5 GIS Application and Queries that could be Used to Target Broad Geographic Areas for Brownfields Site Selection

GIS Application #2: Target broad geographic areas (e.g., market large tracts of land that have job creation potential, waterfront/downtown areas that are attractive to businesses and/or large vacant areas suitable for a residential housing development)
Query A: Display all properties that are > 10 acres, zoned for industrial use and where the surrounding area (a 10 mile buffer) has an unemployment rate > 10%.
Query B: Display properties that meet the following criteria: ① Are within ½ mile of the Missouri River; and ② Zoned for commercial use.
Query C: Display all properties that are zoned for residential use and where the state regulatory agencies residential clean-up levels for all environmental contaminants are met.
Query D: Display all residentially zoned properties > 10 acres with at least one building in good condition that also have one of the following: ① A major highway within 1 mile or ② Access to public transportation within ½ mile.
Query E: Display properties where the following criteria are met: ① Zoned for commercial use; ② Suitable geologically for construction of a large mall; and ③ Within 15 miles, 40% of the population is between 16 and 30 years old.

Table 6 GIS Applications and Queries that could be Used by Brownfield Pilots to Prioritize Site Selection

GIS Application #3: Prioritize sites based on the need of the Brownfields Pilot to market a site
Query A: Display sites where taxes have been delinquent for more than 6 months.
Query B: Display vacant properties zoned for industrial or commercial use.
Query C: Display all vacant parcels where there is a rising poverty rate.
Query D: Display areas where the unemployment rate > 10%.

Table 7 GIS Applications and Queries that could be Used by Developers for Selecting Brownfield Sites

GIS Application #4: Potential buyers (e.g., developers and lenders) use GIS to select brownfield sites based on their needs
Query A: Display brownfield properties that have access to transportation (e.g., adjacent to a rail line or major highway), that are zoned for commercial use and where the crime rate is low.
Query B: *Show the locations of brownfield properties that meet the following:* ① Purchase price is between \$500,000 and \$950,000; ② The site is ≥ 5 acres; and ③ There is at least one building in good condition with working utilities.
Query C: Display brownfield sites that are vacant, > 20 acres, have suitable geology and topography for construction of a large warehouse and have at least 2 chemical suppliers within 10 miles of the site.
Query D: Display all brownfield sites that are > 10 acres, zoned for residential use and that have access to parks and schools.
Query E: Display all brownfield sites zoned for industrial use, where property taxes are less than \$2000/month and where a phase I site assessment has been completed and documented.

6.3 Recommendations for Future Work

Recommendations for further work in the GIS/Brownfields area include:

1) Developing specific modules that could be linked to properties in the GIS database; and 2) Utilizing interactive GIS Web capabilities. Modules can provide additional information for buyers on the feasibility of purchasing a brownfields property. These modules would be linked to specific sites where additional information may be required by a buyer. For example, a development group that is interested in a brownfields property may want more information on the potential costs to clean-up a site. If the GIS database provided link to an environmental remediation module, the development group could obtain information on rememdiation types and their associated costs (with a ± cost range factored in). In this way, the developers could get the "overall value" of the property. The following three modules would be helpful to developers and others interested in purchasing brownfield properties:

1. A phase I environmental assessment module - A phase I environmental assessment (if completed and documented) could include information on the sites previous land use and/or owner, the types and quantities of environmental contaminants found at the site and the media where the contaminants were found.
2. An environmental remediation module - This module would include information on the types of remediation technologies available for a particular site and the remediation time based on contaminants, media and contaminant amounts. This module could also contain information such as how effective the technologies were at other sites and if there is public financing available for using innovative remediation technologies.

3. An economic analysis module - The economic analysis module would contain information on the availability of grants or loans for purchasing a particular site, remediation costs and other relevant funding support and/or funding mechanisms available for specific sites. All the modules would also contain a phone and/or address contact for additional information.

Advances in interactive GIS Web sites make the placement of brownfield GIS databases on the Internet an attractive possibility. Organizations such as NJDEP are finding that it is more economical to have their staffs access data via the Web then by supplying a wired intranet. Furthermore, new software tools that vendors have made available make it possible to provide a focused graphical user interace (GUI) that can provide limited or unlimited access to data and steer users towards their goals with a easy to operate design. According to Phil Tagami, a city planning commissioner and managing partner in a development firm, Web-based GIS is a breakthrough for planners and developers. "As a developer, I used to feel like Indiana Jones when I went looking for zoning and development information in a city. What this technology does is put the necessary information right out there on the fly. You can now look and understand what the issues are. When we're in a hearing and a developer who wants to put up a building says there is an adjacent lot for parking 28 cars, we can instantly call up the digital orthophoto of that parcel and see it only holds six cars."

With a Web-based GIS system the public and brownfield developers could find up-to-date economic and environmental data on a parcel at no cost, 24-hours a day. Using Web browsers, brownfield developers can view data and maps that contain timely, rather than static information. The click of a button could bring a brownfields developer to a page that can be searched by address or parcel number and contain information on zoning, parcel size and the distance of the parcel from freeways or the nearest airport. Two examples of GIS Web-based technology that is currently used for development and redevelopment applications can be found at http://www.pitt.edu/~prises or http://www.oaklandnet.com/maproom/.

As one can see, GIS can be a powerful tool to help Brownfield Pilots, governments, utilities, economic development organizations and others more efficiently address the complexities of spatial and attribute data. GIS provides the mechanism to integrate land use, ownership, environmental assessment, infrastructure and financial information, allowing for the description, prediction and monitoring of alternative management options. Developers and other decision makers in the site selection process want clear, concise and accurate information about brownfield properties. A clear understanding of GIS and a well designed implementation strategy will result in the realization of many of these benefits and in a cost-effective operation that will support management and decision making activities for developers and Pilots over the short and long term.

The power and potential of GIS means that it will cause changes to the way we think about and organize data. Implementing a GIS requires a long term commitment in terms of resources and technology, but the returns can be enormous. GIS technology will allow Brownfield Pilots, governments, utilities, non-profit organizations and the private sector to work more closely together at less cost for all.

APPENDIX A

Brownfields Economic Redevelopment Initiative
Work Plan Summary
Developed By New York City

September 26, 1996

The NYC Brownfields Economic Redevelopment Initiative
Work Plan Summary

New York City, through Deputy Mayor Fran Reiter's Office of Economic Development and Planning was awarded a $200,000 Brownfield Pilot Demonstration Program Grant from the U.S. Environmental Protection Agency in March 1996, which became effective in July 1996. The term of the City's Brownfield Initiative is two years. The Project Coordinator for this effort is Annette Barbaccia, Director of the Mayor's Office of Environmental Coordination.

The objective of the New York City Brownfields Initiative is the creation of a framework for the identification of short and long term measures that will accelerate the pace and enlarge the scale of cleanups and redevelopment of the City's brownfield sites. These vacant and under-utilized properties represent great economic potential for the City. The reuse of brownfields creates employment opportunities, revitalizes economically depressed communities, results in environmental cleanup, and decelerates sprawl into previously undeveloped land, or "greenfields."

Role of the New York City Partnership

As the City's Cooperative Partner, the nonprofit NYC Partnership has worked closely with the Mayor's Office of Environmental Coordination to develop the NYC Brownfields program, apply for federal funding, and is helping to organize and carry out activities under the Brownfields Initiative. The Partnership is assisting the City in the overall administration of the grant during its two-year term, including the organization, scheduling, and conducting of various meetings and the coordination of overlapping tasks. The Partnership will also help coordinate private sector participation and community support for Task Force activities; assist in baseline research and synthesis of data, writing, and analysis in connection with the Task Force; and help with the production and distribution of deliverables.

Task Force Members

The cornerstone of the Brownfields Initiative is the development of a public/private Task Force comprised of stakeholders, including leaders in real estate, banking, community development, environmental protection, law, as well as other professionals and representatives from city, state, and federal agencies. Task Force members will participate in a series of activities through six working subgroups. Subgroup activities will be aimed at yielding innovative solutions to the barriers to brownfields cleanup and redevelopment. The Task Force will help prioritize brownfield issues, identify brownfield sites, assist with baseline research, review and critique work prepared, and contribute creative and constructive ideas and analysis.

Task Force Subgroups

Task Force subgroups are charged with completing a series of tasks and producing related deliverables. Representatives from the Mayor's Office of Environmental Coordination, the Partnership, the City's Department of Environmental Protection, Department of City Planning, and Economic Development Corporation have been appointed to chair each subgroup.

The six subgroups will meet independently approximately every two weeks and will interact with each other when subgroup activities overlap. It is anticipated that each subgroup will generally spend the first six months conducting baseline research, the second six months analyzing issue areas, and the next 6-12 months coming up with recommendations and testing out innovative solutions.

- During the baseline research period, data and documentation will be gathered on a range of issues, such as brownfield innovations around the country; criteria for creating an inventory of brownfield sites; guidelines for testing and sampling sites; state and federal legal and regulatory practices and requirements; lending and insurance procedures, etc. One of the key interim products of the research period will be the characterization of brownfield sites in NYC by past and existing uses, zoning, type of potential contamination, location, size of the site, market constraints, surrounding neighborhoods, etc. This characterization of sites will inform additional research and help direct Task Force efforts. Five demonstration sites will be selected that illustrate these issues and where innovative approaches can be applied.

- The analysis phase will entail the examination of the data gathered in the research phase and additional data gathering on subject areas arising out of Task Force discussion. Some of the issues discussed will include the applicability of brownfields innovations around the country to NY; the strengths and weaknesses of past and existing site assessment and testing procedures; the costs and benefits of risk-based standards; the key components of a Voluntary Cleanup Program; and obstacles and incentives to private investment. This analysis will be conducted against the backdrop of the most relevant "categories of sites" identified during the first phase. It is anticipated that Task Force discussion and analysis will benefit from first-hand data and activities in connection with the five demonstration sites.

- The third phase of the Initiative will entail the identification of recommendations for reclaiming brownfields in NYC. This phase will include the testing out of Task Force recommendations on the demonstration sites, consensus building among stakeholders, and implementation of innovations.

Subgroup activities will be coordinated through a Steering Committee comprised of representatives from City agencies and the New York City Partnership, including chairs of each subgroup. The Steering Committee meets on a bimonthly or as-needed basis.

Work Plan

An expanded work plan has been prepared for each subgroup. This plan is essentially a road map which lays out a series of possible directions Task Force efforts may travel to achieve objectives, while allowing for flexibility and creativity to develop new or alternative directions. The "map" identifies several important avenues which should converge in the final stages of analysis, yielding thoughtful, coordinated, innovative brownfield redevelopment strategies.

Reports

1) Brownfields Inventory and Context Report - A report shall be prepared that describes the brownfield sites in New York City. The discussion of these sites shall be put in a larger framework that will focus on the history of uses, neighborhood context, trends in abandonment and disinvestment and by categories of issues. The categorization of these sites will assist in the selection of the five demonstration sites and the development of solutions in subsequent tasks;

2) Laws and Regulations Summary - A description of existing and proposed federal, state, and local laws/regulations that govern the assessment, remediation and reuse of brownfield sites in New York City shall be prepared. The focus of this report shall be on how the implementation and perception of these laws and regulations have affected the reuse of brownfield sites in New York City, and specifically how they relate to the five demonstration sites;

3) Assessment of Brownfield Programs/Initiatives Nationwide and Relevancy to NYC - A report shall be prepared summarizing the brownfield programs/initiatives that have been developed nationwide as they relate to New York City issues and concerns. Emphasis will be on culling out specific components of these programs that are relevant to the issues raised by community groups and the Task Force, particularly at the five demonstration sites;

4) Insurance/Investment/Market Constraints and Opportunities Reports - This report shall identify insurance, investment and market constraints and opportunities associated with brownfield sites;

5) Examination of Existing Testing, Sampling and Remediation Guidelines/Practices in NYC - A report summarizing how the testing, sampling and pre-remediation efforts have been conducted in New York City shall be prepared. It will identify issues and concerns with existing practices, particularly where there has been a lack of clarity and certainty.

Emphasis will be on how these practices can be made more efficient and effective related to context and end use issues;

6) Pilot Demonstration Sites Report - Five pilot demonstration sites shall be identified along with a strategy of how they will be assessed and reused. A description of existing and past uses for each site shall be included. A site specific work plan, HASPs, and QAPs shall be prepared for all selected sites. In some cases, actual sampling and testing may be conducted during the time frame for this project, in other cases the sampling and testing shall be facilitated through other mechanisms - such as disposition agreements, memorandums of understanding, etc. Also included shall be a description of the end use and development proposed or anticipated at these sites; and

7) Recommendations Report - Based on all the efforts conducted, a recommendations report shall be prepared that will discuss short and long term solutions to appropriately expedite the assessment and reuse of brownfield sites.

Brownfield Initiative Task Force Subgroups

Subgroup 1 **Characterization of Brownfield Sites in NYC; Analysis of Prototypical Sites Within This Universe** -- Using primary and secondary data on land use, zoning, past use, ownership, etc., develop an understanding of the likely number of affected brownfield sites in the city, of relationships between former uses and potential levels of contamination, and of other patterns and locational characteristics of the NYC brownfields situation.

Subgroup 2 **Laws and Regulations Affecting Assessment and Reuse** -- Focus on effects of existing laws, regulations and judicial decisions on brownfields redevelopment. This subgroup will also consider other legal/regulatory programs nationwide and their relevance to New York City issues and concerns.

Subgroup 3 **Investment, Insurance and Market Opportunities and Constraints** – Focus on the liability and risk issues and market constraints which have been identified by lenders, developers and insurers as obstacles to brownfields investment. Programmatic approaches to facilitate investment shall also be identified.

Subgroup 4 **Testing, Sampling & Pre-Remediation Efforts - Health Risks/End Uses** – This subgroup will review existing testing, sampling, and remediation efforts within the City and State to identify the appropriateness and efficiencies of these practices. Recommended modifications and programmatic approaches shall be developed based on a review of the relationship of health risks to end uses.

Subgroup 5 **Review of Brownfields Programs and Approaches, NYC and Nationwide** – Identify and examine approaches used elsewhere and determine the applicability to New York City.

Subgroup 6 **Existing Local, State and Federal Programs and Policies Affecting Brownfields Sites** – Identify local, state and federal funding and development initiatives and controls relevant to the reuse and redevelopment of brownfield sites. This will not focus on environmental remediation programs and regulations directly related to testing, sampling, and remediation of sites. It will focus on other programs, controls/initiatives that affect and are affected by the issues associated with brownfields. For example, this subgroup will focus on zoning controls/initiatives, the acquisition and disposition of industrial lands by public agencies, NEPA, SEQR, and CEQR.

APPENDIX B

GIS Analytical Capabilities

Overlay: The ability to perform point-, line- and area-in-area analysis. The ability tp perform geographic area aggregation and disaggregation.

Geocoding: The ability to geolocate databases through relationships to other databases that contain the needed primary geographic identifiers. One common type of geocoding is address matching, a technique of linking data from separate files by means of a common attribute, the street address.

Modeling and Scenario Management: The ability to create models based upon real data and then accept or reject, from one or more scenarios, the model for incorporation into the real data set.

Network Analysis: The ability to simulate flows or movement through a network and the ability to tie the results to network features. Network analysis works with defined routes and events (e.g., fate and transport of pollutants in a hydrologic system).

Site Evaluation: The ability to determine an area site using selection criteria. This includes the ability to buffer selected points, lines, or areas as part of the site selection process.

Terrain Modeling: The ability to perform surface analyses including calculation of elevation, area, volume, slope and aspect; measurement of surface distances; analysis of proximity; generation of contours; and generation of profile graphs.

Thematic Display: The ability to create thematic displays, including automatic statistical calculations, histograms and cartographic legends.

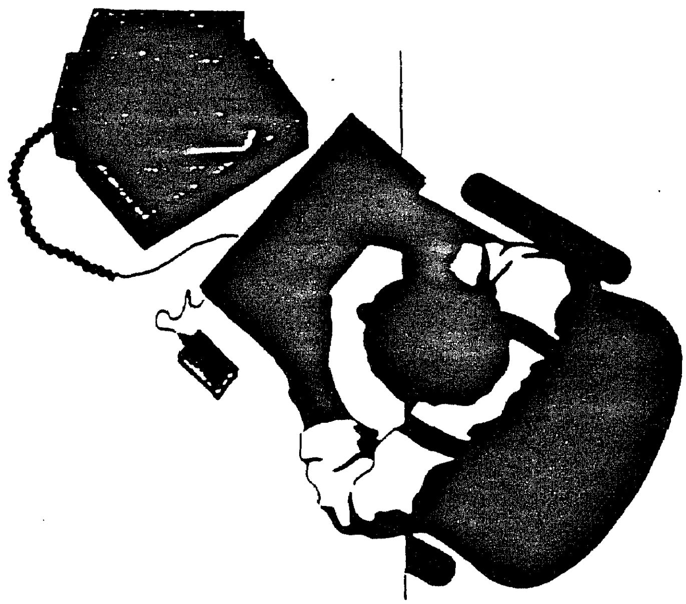
Route Calculations: The ability to generate optimum routes for balancing stop times, loading and schedules. Provides map itinerary and travel instructions.

Temporal Analysis: The ability to perform time change analysis on data sets, to display rate of change patterns and to provide step-wise progression through data sets simulating an animation effect.

APPENDIX C

Data Dictionary and Mapping Standards
Utilized by the Central Savannah River Area
Regional Development Council (CSRA RDC)

CSRA Regional Development Center
Data Dictionary, Standards and Development



Prepared By:
Michael F. Blanchard

Last Edit Date:
June 17, 1996

TABLE OF CONTENTS

INTRODUCTION

This section describes how coverages, files, and item (field) names are structured at the CSRARDC. The "meat" of this section are the actual descriptive tables themselves, but before they are shown, it is important to describe the tables and the order in which they will appear.

COVERAGE NAMING CONVENTIONS

The basic ArcInfo unit is the coverage. At the CSRARDC, each coverage has a name that represents the digital data stored within it. This name follows the pattern shown below:

First three characters :	Coverage Name Code
Second three characters:	County Identification (FIPS)
Last two characters :	City Identification (First two characters of city name.)

The last two characters are used only when a city is involved.

Examples of Use:
PAR317WA - Parcel map, Wilkes County, City of Washington.
RDS073 - Road Centerline map of Columbia County

For special circumstances, coverages may be named as best as they can. However, it is a good idea to keep with the same naming conventions as much as possible. For Example: RDSCSRA for CSRA Road Centerlines, or COUGA for Georgia Counties.

Below is a list of Coverage Name Codes used at the CSRARDC.

Feature Description	Code	Type
Airports	AIR	Poly
Aquifer Recharge Area	AQU	Poly
Available Building	AVB	Point
Building / Structure Footprint	BLD	Poly
Census Block	BLK	Poly
Census Block Group	BGR	Poly
Census Tract / Block Numbering Area	BNA	Poly
City Boundary	CIT	Poly
Current Land Use	CLU	Poly
County Boundary	COU	Poly
Dumpster / Greenbox Location	DMP	Point
GA DNR Landcover Data	DNR	Poly
Endangered Species Locations	END	Point
Electric Service Area	ESA	Poly
Fire Station	FIR	Point
Flood Plains	FLD	Poly
Future Land Use	FLU	Poly
General Community Facilities	GCF	Poly
Groundwater Susceptibility to Pollution	GSP	Poly
Buffer Around Historic Sites	HBF	Poly
Historic Sites	HIS	Point
Major Highways	HWY	Line

Hydrology (Line)	HYL	Line
Hydrology (Polygon)	HYP	Poly
Industrial Parks	IPK	Poly/Point
Landfill	LDF	Poly/Point
Manufacturing Sites	MFG	Point
Medical / Health Care Facility	MED	Point
Mine Locations	MNE	Point
Parcels	PAR	Poly
Police Station	POL	Point
Prime Farmland	PFL	Poly
Parks (Local)	PRK	Poly/Point
Parks (State)	SPK	Poly
Area Geotechnically Poorly Suited for Siting a Sanitary Landfill	PSL	Poly
Public Land	PUB	Poly
Road Centerline	RDS	Line
Road Edge	RDE	Line
Right-of-Way	ROW	Line
Railroad	RRS	Line
River Basin	RVB	Poly
Sewer Service Area	USA	Poly
Sewage Treatment Discharge Point	USD	Point
Sewer Lift Station	USF	Point
Sewer Lines	USL	Line
Sewage Treatment Plant	USP	Point
Soil Association	SOA	Poly
Soil Type	SOI	Poly
Soil Susceptibility to Pollution	SSP	Poly
Telephone Lines	UTL	Line
Telephone Service Area	UTA	Poly
Topography	TOP	Line
Electrical Utility Lines	UEL	Line
Electric Power Generation Site	UEG	Point
Natural Gas Pipeline	UGL	Line
Petroleum Pipeline	UPL	Line
Vegetation Cover	VEG	Poly
Wetlands	WET	Poly
Wildlife Management Area	WMA	Poly
Water System Service Area	UWA	Poly
Water System Distribution Line	UWL	Line
Water System - Hydrants	UWH	Point
Water System - Treatment Plant	UWP	Point
Water System - Supply Reservoir	UWR	Poly
Water System - Storage Tanks	UWS	Point
Water System - Well	UWW	Point
Water Shed Area	WTS	Poly
Zoning	ZON	Poly

CSRA County Codes

County Name	Code	County Name	Code
Burke	033	Lincoln	181
Columbia	073	McDuffie	189
Emanuel	107	Richmond	245
Glascock	125	Screven	251
Hancock	141	Taliaferro	265
Jefferson	163	Warren	301
Jenkins	165	Washington	303
Johnson	167	Wilkes	317

CSRA City Abbreviations

County	City / Place Name	Abbrev
Burke	Girard	gi
	Keysville	ke
	Midville	mi
	Sardis	sa
	Vidette	vi
	Waynesboro	wa
Columbia	Grovetown	gr
	Harlem	ha
	Evans	ev
	Martinez	ma
	Wildwood Park	ww
Emanuel	Adrian	ad
	Garfield	ga
	Nunez	nu
	Oak Park	op
	Stillmore	st
	Summertown	su
	Swainsboro	sw
	Twin City	tc
Glascock	Gibson	gl
	Mitchell	mi
	Edgehill	ed
Hancock	Sparta	sp
Jefferson	Avera	av
	Bartow	ba
	Louisville	lo
	Stapleton	st
	Wadley	wa
	Wrens	wr
Jenkins	Millen	mi
Johnson	Adrian	ad
	Kite	ki
	Scott	sc
	Wrightsville	wr

County	City / Place Name	Abbrev
Lincoln	Lincolnton	li
McDuffie	Dearing	de
	Thomson	th
Richmond	Augusta	au
	Blythe	bl
	Fort Gordon	fg
	Hephzibah	he
Screven	Hilltonia	hi
	Newington	ne
	Oliver	ol
	Rocky Ford	ro
	Sylvania	sy
Taliaferro	Crawfordville	cr
	Sharon	sh
Warren	Camak	ca
	Norwood	no
	Warrenton	wa
Washington	Davisboro	da
	Deepstep	de
	Harrison	ha
	Oconee	oc
	Riddleville	ri
	Sandersville	sa
	Tennille	te
Wilkes	Rayle	ra
	Tignall	ti
	Washington	wa

ATTRIBUTE TABLES

Every coverage has attribute tables (actually INFO files) that correspond to their features. The attribute tables frequently used by the CSRARDC are as follows:

AAT - Arc Attribute Table, for Lines.
PAT - Point Attribute Table, for Points
PAT - Polygon Attribute Table, for Polygons.
TAT - Text Attribute Table

In order to maintain consistency between attribute tables for similar features in different directories, it is necessary that standards be adopted for the tables. Some of the most common attribute tables are listed below. The items listed below are those that are added AFTER the User-ID of the table, the User-ID and previous items being generated by Arc/Info.

The coverage attribute tables listed below are in alphabetical order according to the three-character coverage name code.

AIR

Feature Name	Airports				
Coverage Name	AIRxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	AIRTYPE	15	15	C	
	RUNWAYS	2	2	I	
	RWLENGTH	5	5	I	
	ELEVATION	4	4	I	
	LOCATION	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

AQU

Feature Name	Aquifer Recharge Areas				
Coverage Name	AQUxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	AQUIFER	3	3	I	
	NAME	60	60	C	
	PROVINCE	30	30	C	
Data Source	GA DNR / USGS				
Standard Input Scale	Best Available				
Method of Data Input	Distributed by DCA				

CIT

Feature Name	City Boundary				
Coverage Name	CITxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

CLU

Feature Name	Current Land Use				
Coverage Name	CLUxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	CLU	4	4	C	
	CLU_CODE	4	4	C	
	ACRES	8	8	N	2
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

COU

Feature Name	County Boundary				
Coverage Name	COUxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

EDU

Feature Name	Schools				
Coverage Name	EDUxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

GCF

Feature Name	General Community Facilities				
Coverage Name	GCFxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

GSP

Feature Name	Groundwater Susceptibility to Pollution				
Coverage Name	GSPxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	GSP	3	3	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	GA DNR / USGS				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

HIS

Feature Name	Historic Sites				
Coverage Name	HISxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	NATLREG	1	1	C	
	YBUILT	4	4	I	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

HYL

Feature Name	Line Hydrology (streams, rivers, etc)				
Coverage Name	HYLxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

In the event that the CSRA's existing data has been replaced with 1:24,000 data from the UGA Vinson Institute of Government, the coverage AAT will look like the table below. The FNAME item has been replace by VIGs NAME item. The LOCASE item found in original VIG data has been removed to save space, and DLG/DCA coding has been added along with the RDC FCODE item.

Attributes	Name	Width	Output	Type	Decimals
	NAME	100	100	C	
	CLASS	16	16	C	
	SYMBOL	4	4	I	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Carl Vinson Institute of Government, Athens, GA				

HYP

Feature Name	Polygon Hydrology (lakes, ponds, etc)				
Coverage Name	HYPxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitizer				

In the event that the CSRA's existing data has been replaced with 1:24,000 data from the UGA Vinson Institute of Government, the coverage AAT will look like the table below. The FNAME item has been replace by VIGs NAME item. The LOCASE item found in original VIG data has been removed to save space, and DLG/DCA coding has been added along with the RDC FCODE item.

Attributes	Name	Width	Output	Type	Decimals
	NAME	100	100	C	
	CLASS	16	16	C	
	SYMBOL	4	4	I	
	FCODE	3	3	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Carl Vinson Institute of Government, Athens, GA				

PFL

Feature Name	Prime Farmland (percentage of land in)				
Coverage Name	PFLxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	FARMLAND	30	30	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Atlas of Georgia				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

RDS

Feature Name	Road Centerlines				
Coverage Name	RDSxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FDPRE	2	2	C	
	FNAME	30	30	C	
	FTYPE	4	4	C	
	FDSUF	2	2	C	
	LEFTADD1	11	11	I	
	LEFTADD2	11	11	I	
	RGTADD1	11	11	I	
	RGTADD2	11	11	I	
	FCODE	3	3	C	
	ROUTE	8	8	C	
	SURFACE	2	2	C	
	CONDITION	4	4	C	
	LANES	2	2	I	
	SPEEDLIM	2	2	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

RRS

Feature Name	Railroad Track				
Coverage Name	RRSxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

TOP

Feature Name	Topography				
Coverage Name	TOPxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	ELEV	4	4	I	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UEA

Feature Name	Electric Service Area				
Coverage Name	UEAxxx				
Feature Class	Polygon				
Attributes	Name	Width	Output	Type	Decimals
	ELECTRIC	2	2	I	
	PROVIDER	20	20	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

UEG

Feature Name	Electric Utility Power Generation Facility				
Coverage Name	UEGxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	PWRTYPE	9	9	I	
	MEGAWATT	9	9	N	3
	YBUILT	4	4	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UEL

Feature Name	Electric Utility Power Transmission Lines				
Coverage Name	UELxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	KV	3	3	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UPL

Feature Name	Petroleum Pipelines				
Coverage Name	UPLxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	DIAMETER	5	5	N	2
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UGA

Feature Name	Natural Gas Service Area				
Coverage Name	UGAxxx				
Feature Class	Line (for DCA, Poly for all else)				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	PROVIDER	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

UGL

Feature Name	Natural Gas Utility Pipelines				
Coverage Name	UGLxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	DIAMETER	5	5	N	2
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UGD

Feature Name	Natural Gas Utility Distribution Lines				
Coverage Name	UGDxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	DIAMETER	5	5	N	2
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

USD

Feature Name	Sewage Disharge Point				
Coverage Name	USDxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	DISCHARGE	20	20	C	
	OWNER	20	20	C	
	YBUILT	4	4	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

USF

Feature Name	Sewage Lift / Pump Station				
Coverage Name	USFxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	YBUILT	4	4	I	
	GPM	9	9	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

USL

Feature Name	Sewage Lines				
Coverage Name	USLxxx				
Feature Class	Line				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	DIAMETER	5	5	N	2
	MATERIAL	8	8	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

USA

Feature Name	Sewer Service Area				
Coverage Name	USAxxx				
Feature Class	Line (for DCA, Poly for all else)				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	PROVIDER	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	Best Available				
Method of Data Input	Digitizer				

UST

Feature Name	Sewage Treatment Plant				
Coverage Name	USTxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	GPDCAP	9	9	I	
	GPDPERM	9	9	I	
	GPD	9	9	I	
	GPDPEAK	9	9	I	
	APPLTYPE	20	20	C	
	DISCHARGE	20	20	C	
	YBUILT	4	4	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UWA

Feature Name	Water Service Area				
Coverage Name	UWAxxx				
Feature Class	Line (for DCA, Poly for all else)				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	PROVIDER	20	20	C	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	Best Available				
Method of Data Input	Digitize, scan, vendor, or GPS				

UWL

Feature Name: Water System Distribution Line
Coverage Name: UWLxxx
Feature Class: Line
Attributes:

Name	Width	Output	Type	Decimals
FNAME	30	30	C	
FCODE	3	3	C	
OWNER	20	20	C	
DIAMETER	5	5	N	2
MATERIAL	8	8	C	
MAJOR1	3	3	C	
MINOR1	4	4	C	
DATE	8	10	D	
SOURCE	20	20	C	

Data Source: Indicated in Coverage
Standard Input Scale: Best Available
Method of Data Input: Digitizer

UWH

Feature Name: Water System - Hydrant Locations
Coverage Name: UWHxxx
Feature Class: Point
Attributes:

Name	Width	Output	Type	Decimals
FNAME	30	30	C	
FCODE	3	3	C	
GPM	6	6	I	
MAJOR1	3	3	C	
MINOR1	4	4	C	
DATE	8	10	D	
SOURCE	20	20	C	

Data Source: Indicated in Coverage
Standard Input Scale: 1:24,000
Method of Data Input: Digitize, scan, vendor, or GPS

UWR

Feature Name: Water System - Reservoirs
Coverage Name: UWRxxx
Feature Class: Polygon
Attributes:

Name	Width	Output	Type	Decimals
FNAME	30	30	C	
FCODE	3	3	C	
GALCAP	9	9	I	
RESTYPE	1	1	C	
MAJOR1	3	3	C	
MINOR1	4	4	C	
DATE	8	10	D	
SOURCE	20	20	C	

Data Source: Indicated in Coverage
Standard Input Scale: 1:24,000
Method of Data Input: Digitize, scan, vendor, or GPS

UWS

Feature Name	Water System - Storage Tanks				
Coverage Name	UWS				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	TANKTYPE	1	1	C	
	GALCAP	9	9	I	
	YBUILT	4	4	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UWT

Feature Name	Water System - Treatment Plants				
Coverage Name	UWTxxx				
Feature Class	Point				
Attributes	Name	Width	Output	Type	Decimals
	FNAME	30	30	C	
	FCODE	3	3	C	
	OWNER	20	20	C	
	GPD	9	9	I	
	GALCAP	9	9	I	
	YBUILT	4	4	I	
	MAJOR1	3	3	C	
	MINOR1	4	4	C	
	DATE	8	10	D	
	SOURCE	20	20	C	
Data Source	Indicated in Coverage				
Standard Input Scale	1:24,000				
Method of Data Input	Digitize, scan, vendor, or GPS				

UWW

Feature Name	Water System - Wells / Withdrawal Sites
Coverage Name	UWWxxx
Feature Class	Point
Attributes	

Name	Width	Output	Type	Decimals
FNAME	30	30	C	
FCODE	3	3	C	
OWNER	20	20	C	
GPM	9	9	I	
YBUILT	4	4	I	
MAJOR1	3	3	C	
MINOR1	4	4	C	
DATE	8	10	D	
SOURCE	20	20	C	

Data Source	Indicated in Coverage
Standard Input Scale	1:24,000
Method of Data Input	Digitize, scan, vendor, or GPS

ZON

Feature Name	Zoning
Coverage Name	ZONxxx
Feature Class	Poly
Attributes	

Name	Width	Output	Type	Decimals
ZONING	6	6	C	
ZONDATE	4	4	I	
DATE	8	10	D	
SOURCE	20	20	C	

Data Source	Indicated in Coverage
Standard Input Scale	1:24,000
Method of Data Input	Digitize, scan, vendor, or GPS

ITEM DESCRIPTIONS

Each attribute table described above has "items", or fields in which data is stored. The items that compose the AATs and PATs used at the RDC are described in the following pages. These items are supplied along with the input width, output width, item type, number of decimals, and some alternatives for the data entry in each item. item types are as follows:

D Date
N Numeric
I Integer
C Character
B Binary

ITEM NAME	W	O	T	D	DEFINITION/CHOICES
ACRES	8	8	N	2	Number of Acres in a Ploygon
ADA91-92	4	4	I		Average Daily Enrollment 1991-1992
APPLTYPE	20	20	C		Method of Waste Water Release POND SPRAY FIELD
CAPACITY	5	5	I		Persons that can safely occupy a building
CFCC	3	3	C		Census Feature Class Code
CLU	4	4	C		Land Use for a polygon or point. AF - Agriculture/Forestry C - Commercial I - Industrial PI - Public/Institutional PRC - Parks/Recreation/Conservation R - Residential TCU - Transportation/Comm/Utility UU - Undeveloped/Unused WTR - Body of Water RD - Road NIC - Not in City INC - Incorporated Area

CLU_CODE	4	4	C		DCA Land Use Code for a polygon or point. 1 - Residential 2 - Commercial 3 - Industrial 4 - Public/Institutional 5 - Transportation/Comm/Utility 6 - Parks/Recreation/Conservation 7 - Agriculture/Forestry 8 - Undeveloped/Unused 0 - Body of Water 0 - Road 0 - Not in City 0 - Incorporated Area
CNTY or CNT90	3	3	C		FIPS Code for a county.
DATE	8	10	D		The date when the coverage or source was last updated.
DIAMETER	5	5	N	2	Diameter (inches) of a pipe or line.
DISCHARGE	20	20	C		Treated waste water release point
ELECTRIC	2	2	I		Code for the provider of electricty. 6 - Hart County EMC 15 - Rayle EMC 16 - Jefferson EMC 17 - Washington EMC 24 - Oconee EMC 25 - Planters EMC 26 - Excelsior EMC 27 - Canoochee EMC 28 - Altamaha EMC 29 - Little Ocmulgee EMC 93 - City of Elberton 94 - City of Sandersville 95 - Savannah Electric & Power Co 96 - City of Sylvania 97 - City of Washington 98 - Georgia Power Company 99 - Unassigned
ELEV	4	4	I		Elevation of contour lines.
ENRL1992	4	4	I		School Enrollment for Academic Year 1992
FARMLAND	1	1	C		Area within a polygon that is "Prime Farm Land" G - More Than 50% Prime Farmland M - 25% - 50% L - Less Than 25% W - Water

				U - Urban Land
FCODE	7	7	C	Feature Identification Code See "RDC/DCA Coding Scheme"
FDPRE	2	2	C	Feature Direction Prefix N,NW,NE,S,SE,SW,E,W
FDSUF	2	2	C	Feature Direction Suffix N,NW,NE,S,SE,SW,E,W
FNAME	30	30	C	Feature Name for place or thing.
FLU	4	4	C	Future Land Use AF - Agriculture/Forestry C - Commercial I - Industrial PI - Public/Institutional PRC - Parks/Recreation/Conservation R - Residential TCU - Transportation/Comm/Utility UU - Undeveloped/Unused WTR - Body of Water RD - Road NIC - Not in City INC - Incorporated Area
FLU_CODE	4	4	C	DCA Land Use Code for a polygon or point. 1 - Residential 2 - Commercial 3 - Industrial 4 - Public/Institutional 5 - Transportation/Comm/Utility 6 - Parks/Recreation/Conservation 7 - Agriculture/Forestry 8 - Undeveloped/Unused 0 - Body of Water 0 - Road 0 - Not in City 0 - Incorporated Area
FTYPE	4	4	C	Type of feature, usually road-related Rd, St, Ave, Ct, Cir, Dr, Blvd, Hwy
GALCAP	9	9	I	Gallons of a substance that an object can hold.
GPD	9	9	I	Gallons Per Day. Gallons of a substance processed daily. Type of substance is derived from context
GPDCAP	9	9	I	Gallons Per Day - Capacity.

GPDPEAK	9	9	I	Peak number of Gallons treated per day of a substance.
GPDPERM	9	9	I	Gallons Per Day that are permitted to be treated.
GPM	9	9	I	Gallons Per Minute that can be pumped or process
GRADES	8	8	C	Grades of students that attend schools.
GSP	1	1	C	Ground Water Suscept to Pollution. H - High (Drastic Rating > 181) M - Medium (Drastic Rating 141-181) L - Low (Drastic Rating < 141)
KV	3	3	I	Power-handling ability of transmission lines in kilovolts 46, 115, 230, 500.
LEFTADD1	11	11	I	Beginning address on left of road
LEFTADD2	11	11	I	Ending address on left side of road
MAJOR1	3	3	C	Community Facilities Major Code See "RDC/DCA Coding Scheme"
MINOR1	4	4	C	Community Facilites Minor Code See "RDC/DCA Coding Scheme"
MATERIAL	8	8	C	Construction Material of an object. STEEL, PVC, ALUMINUM, PLASTIC
NATLREG	1	1	C	National Register Status of an Historic Site Y - Nat'l Register Site N - Not on Nat'l Register P - Potential Site S - Submitted for status as a Site
NWICODE	8	8	C	National Wetlands Inventory Code PEM1Hh, etc..
PWRTYPE	1	1	C	Power Generation Type of an Electric Power Plant. N - Nuclear C - Combustion H - Hydro
RESTYPE	1	1	C	Origin/Type of Reservoir. N - Natural Reservoir M - Man-Made Reservoir

RGTADD1	11	11	C		Beginning address on right of road
RGTADD2	11	11	C		Ending address on right of road.
OWNER place.	20	20	C		Agency or Person with administrative rights to a
PROVIDER	20	20	C		Name of Utility Provider. GEORGIA POWER COMPANY CITY OF SWAINSBORO
SOA	30	30	C		Soil Association for an area. GEORGEVILLE-WEDOWEE-APPLING
SOIL	30	30	C		Soil Type
SOURCE	20	20	C		Source of data in coverage. USGS, U.S. Soil Cons Svc, GA DNR
SYMBOL	4	4	I		A number that represents a symbol from an Arc/Info symbolset. Used to provide a default symbol for representing features.
SPEEDLIM	2	2	I		Speed Limit on a segment of road. 55, 65, 25
TANDEM	1	1	C		Tandem trailer status of a road Y - Tandem trailer trucks allowed. N - Tandem trailer trucks not allowed.
TANKTYPE	1	1	C		Type of Water Storage Tank. E - Elevated G - Ground U - Underground
TEACHERS	3	3	I		Number of teachers at a school.
TRANMIN	5	5	N	2	Transit Time of an arc (in minutes)
YBUILT	4	4	I		Year in which structure was built
WSOURCE	20	20	C		The source of a stream of water.
ZONDATE	4	4	I		Year in which zoning is effective
ZONING	6	6	C		Zoning category of an area.

RDC - DCA DLG3 CODING SCHEME

Georgia RDC's are required by contract to comply with the Georgia DCA Supplemental Contract, which specifies that RDC's are to maintain data bases of planning information at certain levels of accuracy, with certain data collected, etc.. This section describes DLG3 Major and Minor Codes for required Community Facilities data, and the corresponding Feature Codes used by the RDC.

Note: The Major and Minor Codes described below are no longer in use by DCA as they pertain to the supplemental contract.

Category / Feature	Major Code	Minor Code	FCODE	DCA Status
Hydrography - Line				
River	050	0412	HLR	REQ
Major Stream	050	0412	HLM	REQ
Creek or Branch	050	0412	HLC	REQ
Shoreline	050	0412	HLL	REQ
Hydrography - Poly				
Reservoir	050	0101	HPR	REQ
Covered Reservoir	050	0102	HPC	REQ
Industrial Water Impoundment	050	0107	HPI	REQ
Sewage Disp Pond / Filter Plant	050	0109	HPS	REQ
Major Lake or Pond	050	0421	HPM	REQ
Lake or Pond	050	0421	HPL	REQ
Boundaries - Political				
Incorporated Area	090	0101	CIT	REQ
County with FIPS Code	092	0___	COU	REQ
Boundaries - Polygon				
National Park / Battlefield	090	0103	NPB	REQ
National Gorest / Grassland	090	0104	NFG	REQ
Natioanl Wildlife Refuge	090	0105	NWR	REQ
National Scenic Waterway	090	0106	NSW	REQ
Indian Reservation	090	0107	NIR	REQ
Military Reservation	090	0108	NMR	REQ
Federal Prison	090	0110	NPR	REQ
State Park / Rec Area / Lake	090	0130	SPK	REQ
State Wildlife Refuge	090	0131	SWR	REQ
State Forest / Grassland	090	0132	SFG	REQ
State Prison	090	0133	SPR	REQ
County Game Preserve	090	0134	CGP	REQ
County Park or Recreation Area	090	0135	CPK	REQ
City Park or Recreation Area	090	0136	MPK	REQ
Survey Markers - Point				
Horizontal Control Point				
3rd order or better (perm mark)	105	0300		REQ
Horizontal and Vertical Control Station				
3rd order or better	105	0301		REQ
Vertical Control Station				
3rd order or better (tablet)	105	0310		REQ

Category / Feature	Major Code	Minor Code	FCODE	DCA Status
Roads - Line				
Interstate Route	172	___	I	REQ
Interstate Ramp	172	___	IR	REQ
US Route	173	___	U	REQ
State Route	174	___	S	REQ
County Route	176	___	LC	REQ
DOT Functional Class	178	___	LU	REQ
Municipal Street	170	0210	LM	REQ
Utilities Boundaries Line				
Indefinite Boundary - Water	090	0201	WSA	REQ
Indefinite Boundary - Sewer	090	0201	STA	REQ
Indefinite Boundary - Gas	090	0201	NGA	REQ
Local Utility Distribution Line - Line				
Sewer Line	200	0209	STL	REQ
Sewer Line Diameter - Inches	229	0___	STL	REQ
Water Line	200	0604	WSD	REQ
Water Line Diameter - Inches	264	0___	WSD	REQ
Gas Line	200	0606	NGD	REQ
Gas Line Diameter - Inches	266	0___	NGD	REQ
Railroads - Line				
Railroad	180	0201	TRR	REQ
Abandoned Railroad	180	0603	TRA	REQ
Dismantled Railroad	180	0604	TRD	REQ
Pipelines/Transmission Line - Line				
Natural Gas Pipeline	190	0201	UGL	REQ
Petroleum Pipeline	190	0201	UPL	REQ
Electric Power Transmission Line	190	0202	UEL	REQ
Pipeline/Transmission Facilities - Point				
Power Generating Station	190	0400	UEG	REQ
Hydroelectric Plant	190	0402	UEH	REQ
Telephone Utility				
Telephone Lines			UTL	NR
Telephone Service Area			UTA	NR
Miscellaneous Transport - Line				
Landing Strip	190	0403	TAS	REQ
Miscellaneous Transport - Point/Poly				
Commercial Airport	190	0403	TAC	REQ
General Aviation Airport	190	0403	TAG	REQ
Heliport	190	0404	TAH	REQ

Category / Feature	Major Code	Minor Code	FCODE	DCA Status
School Campus - Poly/Point				
University	200	0650	EDU	REQ
College (4-year)	200	0650	EDC	REQ
Junior College	200	0650	EDJ	REQ
Vocational / Technical	200	0652	EDV	REQ
High School	200	0651	EDH	REQ
Middle School	200	0651	EDM	REQ
Elementary School	200	0100	EDE	REQ
Private School	200	0100	EDP	NR
Magnet School	200	0100	EDG	NR
Special Education Facility	200	0100	EDS	NR
Administrative Facility	200	0100	EDA	NR
Government Facility				
Municipal Building	200	0404	GMB	REQ
Fire Station	200	0660	GFD	REQ
Police Station	200	0661	GPD	REQ
Federal Courthouse	200	0405	GFC	REQ
County Courthouse	200	0405	GCC	REQ
City or Town Hall	200	0407	GCH	REQ
Post Office	200	0406	GPO	NE
Federal Jail / Prison	200	0409	GFJ	REQ
State Jail / Prison	200	0409	GSJ	REQ
County Jail / Prison	200	0409	GCJ	REQ
City Jail / Prison	200	0409	GMJ	REQ
Public Works			GPW	NR
General Federal Government			GGF	NR
General State Government			GGS	NR
General County Government			GGC	NR
General Municipal Government			GGM	NR
Medical Facility				
Hospital	200	0408	MHH	REQ
Clinic	200	0408	MHC	NR
Nursing Home	200	0408	MHN	NR
Solid Waste Management Facility				
Landfill	200	0431	SWF	REQ
Municipal Landfill	200	0670	SWM	REQ
Other Landfills	200	0671	SWO	REQ
Miscellaneous				
Regional Development Center			RDC	NR
Industrial Park	200	0160	IPK	REQ
Dam	050	0406	DAM	NR

Category / Feature	Major Code	Minor Code	FCODE	DCA Status
Cultural Facilities				
Civic Center	200	0663	CFC	REQ
Church	200	0402	CFR	REQ
Cemetery	200	0420	CFB	REQ
Library	200	0662	CFL	REQ
Museum	200	0663	CFM	REQ
Other Cultural Facility	200	0663	CFO	REQ
Historic Site			CFH	NR
Communications Facilities				
Radio	200	0433	CMR	NR
TV	200	0433	CMT	NR
Recreational Facilities				
Marina	200	0140	RFM	REQ
Fairgrounds	200	0445	RFF	NR
Stadium	200	0456	RFS	NR
Golf Course	200	0123	RFG	NR
Sewerage System				
Sewage Treatment Plant	200	0421	UST	NR
Sewer Line			USL	NR
Sewage Treatment Service Area	090	0201	USA	REQ
Lift Station			USF	NR
Water System				
Water System Distribution Line			UWL	NR
Water System Treatment Plant	200	0422	UWT	NR
Water Intake	050	0405	UWI	NR
Water Storage Tank	200	0604	UWS	NR
Well			UWW	NR
Water System Service Area	090	0201	UWA	REQ

Additions

FILE NAMES

You will see many types of file and directory names in the GIS areas on the Sparc10. Below are definitions of some file "suffixes" and directory names that should identify what they are:

aml Arc Macro Language File. A set of ArcInfo instructions that perform a specified task. Ex: pmn033.aml

apr ArcView 2.0 file.

core A file generated when programs "bomb out". Delete it.

doc User-prepared documentation for some process.

e00 ArcInfo Export File. A coverage that has been "Exported" for purposes of backup of storage. Ex: rdc245.e00

eps Encapsulated PostScript File, suitable for printing on theTektronix Thermal Printer. Ex: pmn033.eps

gra An ArcInfo Graphics File, suitable for plotting on the Calcomp 1043. Ex: min163.gra

info A directory that holds the INFO files for all of the coverages in a workspace.

mc A Map Composition. Actually a directory.

plt Plotfile generated for use with HP DesignJet Plotter.

File Beginnings:

xx__ Temporary Files created by Arc/Info processes. Delete them if no ARCEDIT sessions are in active in the directory.

COVERAGE TEXT STANDARDS

Due to the numerous and varied tasks that the CSRARDC is required to perform, it is recommended that anno subclasses be used to keep track of text. A number of conventions have been established concerning Arc/Info coverage annotation. These are general guidelines to follow and are not necessarily law, though the use of them is strongly recommended!

To set up a coverage for anno subclasses:

BUILD <cover> ANNO.<subclass>

General Subclass names:

Small text readable on E size maps:	anno.e
Text that can be seen on A and B size maps:	anno.ab
Road Index to accompany the map:	anno.index
Major Highways only:	anno.hwy
Interstate	anno.int
US Highway	anno.ushwy
GA Highway	anno.gahwy
Other Major Road	anno.major
Landmarks	anno.lmark

City Street/Road Coverages are left to the discretion of the user, since different sizes may be needed to make the text readable on a map.

Census Tracts/BNA and Block Group Maps are left to user discretion as well because of the need for fit and customization. Try to make areas of similar size have similar text sizes, though.

APPENDIX D

Inventory (Categorized by Data Type) of Geographic Data Used and/or Generated by EPA Region 2

Administrative Boundaries: This data defines the boundaries of various administrative and special management areas such as governmental units, water district service areas and zoning districts.

Cultural: Data includes boundaries of features such as census tracts, land use, land parcels and historical and archaeological sites.

Transportation/Utilities: Transportation spatial data including roads, railroads and other networks that have characteristics of connectivity and direction of flow.

Terrain Features: Includes data such as geology, soils, land cover features, natural hazard areas and floodplains.

Biological Resources: Includes spatial data on wetlands and environmentally sensitive habitats.

Water Resources and Water Quality: This data encompasses groundwater, surface water (e.g., streams, lakes, ...), estuaries and marine water resources.

Air Quality: Air quality features include ambient air monitoring stations, air attainment zones, weather patterns and climate zones.

Regulatory Information: Existing and potential regulatory sites and areas such as waste disposal sites, permitted air and water discharge points and underground storage tanks are included in this data.

APPENDIX E

An Example of Metadata from the EPA Region 2 Spatial Library

NAME	**1990 Census of Population and Housing Summary Tape Files**
DESCRIPTION	1990 detailed census data for population and housing by varying geographic coverages published as a series of four types of summary tapes (SFT 1–4).
MAP FEATURES	
ATTRIBUTES	Population items include household relationship, sex, race, age, marital status, and Hispanic origin (STF 1 & 2), as well as social and economic characteristics (STF 3 & 4). Housing items include number of units in structure, rooms, tenure, value, congregate housing, and vacancy (STF 1 & 2), as well as year moved in, number of bedrooms, plumbing and kitchen facilities, telephone, vehicles, heating fuel, water and sewer, year built, condo status, farm residence and shelter costs.
KEY IDENTIFIERS	
AVAILABILITY/SOURCE	Bureau of Census
DATA COLLECTION METHOD	
TIME PERIOD COVERED	1990
CURRENCY/UPDATE FREQ	1990/ten-year update cycle
GEOGRAPHIC COVERAGE	New York, New Jersey, Puerto Rico, Virgin Islands
COORDINATE SYSTEM	
PROJECTION	
RESOLUTION	
DATA CATEGORY	Cultural Resources
FORMAT	Attribute
STATUS	Digital
SAMPLE	No
SCALE	
ACCURACY/QUALITY	STF 1 & 2 contain 100% data—accurate to block level. STF 3 & 4 contain sample data—accurate to block group level.
SOFTWARE	Software independent—ASCII or EBCDIC format
SIZE	STF 1 = 1,000 items for each geographic area
SECURITY REQS	None
COMMENTS	

NAME: Population Estimates and Projections

DESCRIPTION: Estimates of population in between census years, and projections of future population.

MAP FEATURES:

ATTRIBUTES: Population estimates and projections by state by age, sex, race and Hispanic origin; yearly county population estimates, biennial population estimates for incorporated places and minor civil divisions, metro and nonmetro areas; population migration by region; population density and growth rate.

KEY IDENTIFIERS:

AVAILABILITY/SOURCE: Bureau of Census

DATA COLLECTION METHOD: State population totals are estimated from vital statistics, school enrollment, net migration and Medicare enrollment. State age and sex estimates take into account births, deaths, and net migration.

TIME PERIOD COVERED:

CURRENCY/UPDATE FREQ: 1990/updated annually

GEOGRAPHIC COVERAGE: New York, New Jersey, Puerto Rico

COORDINATE SYSTEM:

PROJECTION:

RESOLUTION:

DATA CATEGORY: Cultural Resources

FORMAT: Attribute

STATUS: Hard copy

SAMPLE: No

SCALE:

ACCURACY/QUALITY:

SOFTWARE:

SIZE:

SECURITY REQS:

COMMENTS:

APPENDIX F

Mapping and Digital Standards from the New Jersey Department of Environmental Protection (NJDEP)

New Jersey Department of Environmental Protection

Geographic Information System

Mapping the Present to Protect New Jersey's Future

Mapping and Digital Data Standards

prepared by:

New Jersey Department of Environmental Protection
Office of Information Resources Management
Bureau of Geographic Information Analysis
CN 428
Trenton, NJ 08625

August 1995

SUMMARY

The New Jersey Department of Environmental Protection (DEP) has developed a Geographic Information System (GIS) for use by the Department for the storage and analysis of cartographic (mapped) and related environmental scientific and regulatory database information. A GIS is a computer mapping system used in the analysis of geographic data and databases. By Administrative Order, Commissioner Shinn has required that mapped information be submitted to the DEP according to the standards of this document such that the data can be input to the DEP/GIS. This document details three important GIS concepts regarding the creating, capturing and delivery of mapped information.

First, all basemaps regardless of scale must meet a definable standard, such as the United States National Map Accuracy Standard (NMAS), referenced in this document, or be of survey quality. This will guarantee true positional accuracy of data layers. The NJDEP has produced a series of photobase maps at quad (1:24000) and quarterquad (1:12000) scales which meet NMAS and which are available from DEP Mapsales (609) 777-1039.

Secondly, geographic data shall be mapped in state plane coordinates (SPC). SPC means a geographic reference system in the horizontal plane describing the position of points or features with respect to other points in New Jersey. The official survey base of the state is known as the New Jersey State Plane Coordinate System whose geodetic positions have been adjusted on the North American Datum of 1983 (NAD83) as per Chapter 218, Laws of New Jersey 1989. Although this official survey base is defined in meters, the NJDEP will accept and prefers state plane coordinates in survey feet.

Thirdly, geographic data must be delivered to the DEP in digital format, as shown in Table 2 of this document. There are several different formats such as a simple space delimited ASCII file of coordinates, a .DXF file from AutoCad, or an Arc/Info export file, depending on the mapping requirements.

For more information concerning GIS, GIS standards, the user community in New Jersey, data availability, and GPS, the <u>1995 GIS Resource Guide</u> is available from the Bureau of Geographic Information & Analysis (BGIA), CN 428, Trenton, NJ (609) 984-2243 for the cost of reproduction ($20).

Note: Rules, contracts and/or other regulatory documents from the DEP may specify items required such as formats or media.

MAPPING AND DIGITAL DATA STANDARDS
FOR THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
GEOGRAPHIC INFORMATION SYSTEM

1.0 INTRODUCTION

Geographic Information System (GIS) technology has become a state-of-the-art tool for innovative efforts nationally to protect the natural environment and public health. The New Jersey Department of Environmental Protection (DEP) acquired GIS software (ARC/INFO) in 1987 to provide technical and analytical support to the DEP's decision-making process. To adequately protect the environment, the NJDEP must make decisions based on sound, accurate spatial data. This document details the basic standards for creating, converting and encoding analog spatial data into a digital form for use on a GIS.

The DEP/GIS administered by the Bureau of Geographic and Information and Analysis (BGIA). The BGIA is responsible for the day to day operations of the system, training, data base development, pilot applications, GIS research, and user support. In support of these roles, the BGIA has establish a core set of standards for all data development and input for the DEP/GIS. Basic standards will assure consistent data quality and documentation, compatibility between data sets, and facilitate interactive analysis and assure the quality of results derived from the DEP/GIS. For more information concerning GIS, aerial photography, geodetic control, and global positioning (GPS), the 1995 GIS Resource Guide, is available from the BGIA, (609) 984-2243.

Geographic data must be delivered to the DEP in digital format, according to Table 2 of this document. This can be as simple as an ASCII file of coordinates, space delimited on 3.5' diskette, to a .DXF file from AutoCad, to an Arc/Info export file, depending on the mapping requirements.

2.0 BASEMAPS

Cartographic (locational) data input into the GIS must be derived from or mapped to georeferenced basemaps that meet or exceed National Map Accuracy Standards (NMAS) or be of survey quality. Recompiling data from sources which are not planimetric to georeferenced basemaps is always required. Basemaps at any scale should always meet NMAS at a minimum (Section 8.0). Data (point locations) derived from GPS technology must also meet a standard and be documented (Section 7.0).

The concept of a stable base georeferenced basemap or overlay is referred to as "GIS compatible" throughout this document. Stable base site maps of large scale, produced by surveying, mapping or photogrammetric firms may qualify as GIS compatible if they contain a minimum of four registration tics in the New Jersey State Plane Coordinate System, North American Datum 1983 (NAD83), the official survey base of New Jersey.

Over the years the DEP has produced several series of quality basemaps which are GIS compatible. In several cases these maps are synoptic and statewide, such as the photo basemaps associated with the 1991 and 1986 overflights. In other cases the basemaps cover specific areas only, such as the 1977-78 Tidelands photo basemaps. The basemaps described here were produced on stable base mylar, are photo-images, and meet a definable mapping standard. These maps in mylar and paper are acceptable basemaps which should be used whenever possible to generate GIS compatible data and/or to use as a recompilation base. The various basemap sources are described below.

All the maps described herein with the exception of the 1991/92 products are referenced in NAD27. For this reason, the 1991 basemap quads (1:24000) and quarterquads (1:12000) series, referenced in NAD83, are highly recommended over all other sources listed for mapping at these scales (See Basemap Availability).

1991 Aerial Photographs and Basemaps

In February and March of 1991 the DEP and the USGS flew a joint high altitude aerial mission over New Jersey producing a set of quarterquad centered color infrared (CIR) photos at 1:40000. These frames are available from the USGS National Earth Science Information Center (703) 648-6045. The frames are available for review at the Tidelands Element, 9 Ewing Street, Trenton. The DEP then created a set of hardcopy chronoflex quarterquad (1:12000) and photoquad basemaps (1:24000) for

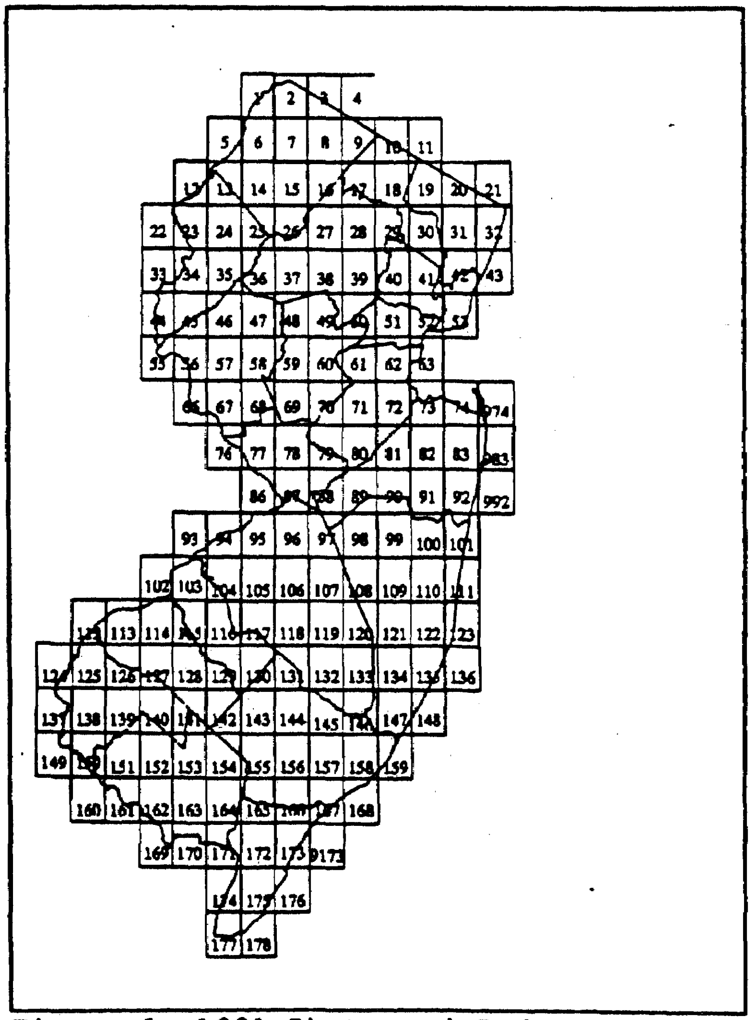


Figure 1: 1991 Photoquad Index

the public and regulated community to meet the requirements of DEP mandated mapping (Figure 1, Table 1). This series of maps is referenced in SPC in NAD83. Paper prints are available from Mapsales. This series of maps represents the best maps at these two scales for mapping. Soft copy digital images of both quads and quarterquads are also available at both scales (See Basemap Availability).

1986 Freshwater Wetlands Quarterquad Maps (1:12000)

The passage of the Freshwater Wetlands Act of 1987 required the DEP to produce a composite map of the freshwater wetlands for the state. The Department recommended and subsequently produced a set of 624 chronoflex photo quarterquads for the entire state from the March 1986 overflight. The quarterquads meet NMAS. The maps represent a good source for both photo-interpretation and recompilation at a county, municipal or site level.

1986 Photoquad Basemaps (1:24000)

The Department sponsored a statewide overflight in March 1986 and produced a complete set of stable base photoquads at 1:24000. The control for the production of these basemaps was the mylar USGS 7.5-Minute topoquads. The photoquads have been widely used both to create data layers and to recompile other data sources from paper or non-planimetric sources. Paper prints are available from Mapsales.

1977/78 Tidelands Basemaps (1:2400)

The DEP produced a series of 1:2400 base maps for the coastal zone including all tidal areas in the state to delineate the State's claim to all tide-flowed lands. The series consists of 1628 photo basemaps. These maps are rectified products which meet NMAS below the ten foot contour. The photo-image is late summer of 1977 and 1978.

USGS 7.5-Minute Series Topoquad Basemaps (1:24000)

The USGS has published an entire series of 172 topographic maps for the state at a scale of 1:24000. The base information ranged from the late 1940's to the 1980's with photo-updates into the 1990's. Because these maps vary in source date, and because the DEP has produced more accurate and current basemaps (1991), the USGS Topoquads series is not recommended except as reference.

Table 1: Photoquad Number and Name.

1	MILFORD PA-NJ
2	PT. JERVIS S. NJ-NYPA
3	UNIONVILLE NY-NJ
4	PINE ISLAND NY-NJ
5	LAKE MASKENOZHA PA-NJ
6	CULVERS GAP NJ-PA
7	BRANCHVILLE NJ
8	HAMBURG NJ
9	WAWAYANDA NJ-NY
10	GREENWOOD LAKE NY-NJ
11	SLOATSBURG NY-NJ
12	BUSHKILL PA-NJ
13	FLATBROOKVILLE NJ-PA
14	NEWTON WEST NJ
15	NEWTON EAST NJ
16	FRANKLIN NJ
17	NEWFOUNDLAND NJ
18	WANAQUE NJ
19	RAMSEY NJ-NY
20	PARK RIDGE NJ-NY
21	NYACK NY-NJ
22	STROUDSBURG PA-NJ
23	PORTLAND NJ-PA
24	BLAIRSTOWN NJ
25	TRANQUILITY NJ
26	STANHOPE NJ
27	DOVER NJ
28	BOONTON NJ
29	POMPTON PLAINS NJ
30	PATERSON NJ
31	HACKENSACK NJ
32	YONKERS NJ-NY
33	BANGOR PA-NJ
34	BELVIDERE NJ-PA
35	WASHINGTON NJ
36	HACKETTSTOWN NJ
37	CHESTER NJ
38	MENDHAM NJ
39	MORRISTOWN
40	CALDWELL NJ
41	ORANGE NJ
42	WEEHAWKEN NJ-NY
43	CENTRAL PARK NY-NJ
44	EASTON NJ-PA
45	BLOOMSBURY NJ
46	HIGH BRIDGE NJ
47	CALIFON NJ
48	GLADSTONE NJ
49	BERNARDSVILLE NJ
50	CHATHAM NJ
51	ROSELLE NJ
52	ELIZABETH NJ-NY
53	JERSEY CITY NJ-NY
55	RIEGELSVILLE PA-NJ
56	FRENCHTOWN NJ-PA
57	PITTSTOWN NJ
58	FLEMINGTON NJ
59	RARITAN NJ
60	BOUND BROOK NJ
61	PLAINFIELD NJ
62	PERTH AMBOY NJ-NY
63	ARTHUR KILL NY-NJ
66	LUMBERVILLE PA-NJ
67	STOCKTON NJ-PA
68	HOPEWELL NJ
69	ROCKY HILL NJ
70	MONMOUTH JUNCTION NJ
71	NEW BRUNSWICK NJ
72	SOUTH AMBOY NJ-NY
73	KEYPORT NJ-NY
74	SANDY HOOK NJ-NY
76	LAMBERTVILLE PA-NJ
77	PENNINGTON NJ-PA
78	PRINCETON NJ
79	HIGHTSTOWN NJ
80	JAMESBURG NJ
81	FREEHOLD NJ
82	MARLBORO NJ
83	LONG BRANCH NJ
86	TRENTON WEST PA-NJ
87	TRENTON EAST NJ-PA
88	ALLENTOWN NJ
89	ROOSEVELT NJ
90	ADELPHIA NJ

Table 1: Continued

91	FARMINGDALE NJ	136	LONG BEACH NE NJ
92	ASBURY PARK NJ	137	DELAWARE CITY DEL-NJ
93	FRANKFORD PA-NJ	138	SALEM NJ
94	BEVERLY PA-NJ	139	ALLOWAY NJ
95	BRISTOL PA-NJ	140	ELMER NJ
96	COLUMBUS NJ	141	NEWFIELD NJ
97	NEW EGYPT NJ	142	BUENA NJ
98	CASSVILLE NJ	143	NEWTONVILLE NJ
99	LAKEHURST NJ	144	EGG HARBOR CITY NJ
100	LAKEWOOD NJ	145	GREEN BANK NJ
101	POINT PLEASANT NJ	146	NEW GRETNA NJ
102	PHILADELPHIA PA-NJ	147	TUCKERTON NJ
103	CAMDEN NJ-PA	148	BEACH HAVEN NJ
104	MOORESTOWN NJ	149	TAYLORS BRIDGE DEL-NJ
105	MOUNT HOLLY NJ	150	CANTON NJ-DEL
106	PEMBERTON NJ	151	SHILOH NJ
107	BROWNS MILLS NJ	152	BRIDGETON NJ
108	WHITING NJ	153	MILLVILLE NJ
109	KESWICK GROVE NJ	154	FIVE POINTS NJ
110	TOMS RIVER NJ	155	DOROTHY NJ
111	SEASIDE PARK NJ	156	MAYS LANDING NJ
112	MARCUS HOOK PA-NJ-DEL	157	PLEASANTVILLE NJ
113	BRIDGEPORT NJ-PA	158	OCEANVILLE NJ
114	WOODBURY	159	BRIGANTINE INLET NJ
115	RUNNEMEDE NJ	160	BOMBAY HOOK DEL-NJ
116	CLEMENTON NJ	161	BEN DAVIS PT. NJ-DEL
117	MEDFORD LAKES NJ	162	CEDARVILLE NJ
118	INDIAN MILLS NJ	163	DIVIDING CREEK NJ
119	CHATSWORTH NJ	164	PORT ELIZABETH NJ
120	WOODMANSIE NJ	165	TUCKAHOE NJ
121	BROOKVILLE NJ	166	MARMORA NJ
122	FORKED RIVER NJ	167	OCEAN CITY NJ
123	BARNEGAT LIGHT NJ	168	ATLANTIC CITY NJ
124	WILMINGTON S. DEL-NJ	169	FORTESCUE NJ
125	PENNS GROVE NJ-DEL	170	PORT NORRIS NJ
126	WOODSTOWN NJ	171	HEISLERVILLE NJ
127	PITMAN WEST NJ	172	WOODBINE NJ
128	PITMAN EAST NJ	173	SEA ISLE CITY NJ
129	WILLIAMSTOWN NJ	174	RIO GRANDE NJ
130	HAMMONTON NJ	175	STONE HARBOR NJ
131	ATSION NJ	176	AVALON NJ
132	JENKINS NJ	177	CAPE MAY NJ
133	OSWEGO LAKE NJ	178	WILDWOOD NJ
134	WEST CREEK NJ	974	SANDY HOOK EAST
135	SHIP BOTTOM NJ	983	LONG BRANCH EAST
		992	ASBURY PARK EAST
		9173	SEA ISLE CITY EAST

Basemap Availability

Paper prints of 1986 and 1991 photo basemaps may be obtained from NJDEP Mapsales (609) 777-1039, as well as paper prints of most USGS quadrangles. Paper prints from the 1977/78 series are available from the Tidelands Element (609) 292-2573. Other basemaps that meet NMAS may be available from the private sector.

Mylar photo basemaps from 1991, 1986 and 1977/78 and the digital imagery from 1991 may be obtained from the DEP contractor, MARKHURD, Minneapolis, MN. (1-800-MAP-HURD).

3.0 MAP COMPILATION

Mapped information comes from a variety of sources which are not always GIS compatible. Consequently, each source must be evaluated to determine whether redrafting is necessary to prepare the data for entry into the GIS. Much of the data required for the GIS can be derived directly from the photo-interpretation of aerial photos to rectified photo basemaps.

3.1 Photo-interpretation

Today's GIS data development efforts rely to a large degree on the derivation of themes from the stereoscopic interpretation of aerial photos. The DEP has used this technique in conjunction with various photo basemaps to produce land use/land cover and freshwater wetland coverages, for instance. The DEP maintains an extensive library of current and historical photos in color infrared, color and panchromatic photographs from the 1930's to the present. The bulk of this photography is held by the Tidelands Management Program (TMP). The TMP, offers light tables, photo basemaps and stereoscopes as well as some instruction on set up to assist the public and regulated community. This service is available at a modest fee and is well worth the effort, particularly if the data are to be captured in the GIS.

Delineators should be intimately familiar with the classification system being employed prior to producing data for input into the GIS. Care should be taken in choosing an appropriate standard classification system. If non-standard classification systems are used, the contractor shall fully describe the system.

3.2 Recompilation

Recompilation involves the redrafting of features from one source to a more accurate, planimetric source based on identifiable features. This method is commonly used to give more accuracy to data which has been delineated on sources of unknown or unspecified quality or paper manuscripts. It is also commonly used to transfer data delineated on or to unrectified photography to a rectified or orthophoto basemap based on a series of local fits of common photo-identifiable features, such as roads.

To date, this technique has been employed to redraft the U.S.D.A., Natural Resource Conservation Service (NRCS) soils data from the soil survey atlas sheets to orthophotoquads. The technique for accomplishing this is detailed in Photobase Map Compilation (USDA, 1984). This manuscript is an excellent technical guide for recompilation.

Other data sources without photo-images may be recompiled to planimetric sources by using other coincident features. For instance, grids on source data may be generated and plotted to planimetric basemaps and used as a guide for the redrafting of information which would otherwise not be usable in a digital form. This has been used to draft historical purveyor boundaries from old atlas sheets to the photoquads, for instance. Whatever the technique, a data dictionary form must be completed describing the recompilation techniques employed.

4.0 DATA AUTOMATION

The conversion of analog data to digital data is a critical step in the creation of a digital database in the GIS. GPS derived points are captured digitally and do not require automation (Section 7.0). Tablet digitizing is the most common method, however, scanning is gaining popularity particularly when large data development projects are involved. For tablet digitizing, manuscripts lines should be clear and complete with no gaps or shortfalls. Operators should not interpret and digitize at the same time. The digitizer should concentrate solely on capturing the exact nature of the linework. All maps shall be edge matched prior to digitization to eliminate cartographic errors and reduce digital problems.

Heads up digitizing is a new digitizing technique which is useful for capturing data or updates from digital imagery. The BGIA is presently evaluating this technique and will issue standards in the near future.

Digital accuracy shall be evaluated by proof plotting the digital data to the base at the same scale as the manuscript and overlaying the data to the original map. The linework should be digitized in such a way as to create a digital copy which is within +/- one line width of thr original. Edits can be flagged and corrected such that the standard is met.

The coding of features should follow an approved classification system as adopted by state and federal agencies. These codes follow specifications of organizations responsible for deriving and maintaining the data. For example, the DEP uses the Cowardin _et al_. (1979) system for the Classification of Wetland and Subaqueous Lands in the United States as adopted by the National Wetlands Inventory of the U.S. Fish and Wildlife Service. In addition the Department supports a modified version of Anderson _et al_. (1976), USGS, for classifying land use/land cover. For prototype classification schemes, clear concise documentation describing the classes is required.

All attribute coding shall be 100% correctly coded. Code sheets shall also be provided, listing the code and full description of each code. All documentation shall be delivered in hard copy and on diskette. Codes shall also be described in the Data Dictionary (Section 9.0).

5.0 DATA TRANSFER

At a minimum, for the delivery of coordinates and simple database, data shall be submitted in an ASCII flat file format on 3.5 diskette. For instance, data from a word processor can be saved to an ASCII text file for delivery.

For GIS binary files (coverages) the digital format shall be an export format compatible with the DEP/GIS according to Table 2. The NJDEP GIS is ARC/INFO and ARCVIEW2 running on a UNIX based SUN network with a SUN 1000 server. For submittal to the Department, please use any of formats in Table 2, listed here in order of preference (Arc/Info Export, .DXF, flat ASCII). In the future, the Department will support the federal FGDC universal standard.

Large cartographic digital data sets shall be delivered on 8mm exabyte tape or 150 mb 1/4" tapes in UNIX format using tar or cpio (high or low density, please specify). DOS formatted data can be delivered on QIC120 mb tapes. Small data sets may be delivered on 3 1/2" (1.4 mb format) diskette in the format specified (DOS or UNIX). For diskettes with text or files, the data shall be on a DOS formatted disk, in space delimited format file (SDF, no delimiters). Please send all files uncompressed unless decompression software is supplied.

TABLE 2: NJDEP COMPATIBLE CONFIGURATIONS

PLATFORM	*SUN SPARC STATION*	*PC*
OPERATING SYSTEM	UNIX	DOS
FORMAT	ARC/INFO *IMPORT *EXPORT DXF	FLAT ASCII (SDF) ARC INFO *IMPORT *EXPORT DXF
SOFTWARE	TAR CPIO	VARIOUS
MEDIA	150 MB TAPE 3 1/2" HD 1.44MB CD-ROM EXABYTE	5 1/4" (1.2MB) 3 1/2" MB 120/250MB QIC120 *COLORADO *MAYNARD

6.0 DOCUMENTATION

Each digital data layer must be fully documented by the producer (Section 9.0). Associated text files which described details of the coverage are stored as readme files associated with the Dictionary files and coverage. Contractors must describe the data in detail with the submission and include aspects of the DEP Data Dictionary at a minimum.

7.0 GLOBAL POSITIONING SYSTEM

The NAVSTAR Global Positioning System (GPS) has become an accepted and widespread technology for capturing mappable features digitally for use in a GIS, particularly for points (wells, outfalls, etc.) and lines (trails, site boundaries, etc.). The system is based on a constellation of orbiting satellites that enable users with GPS receivers to determine 3D positions anywhere on or near the earth's surface. A GPS receiver must be able to "see" 4 or more GPS satellites in order to determine positions.

The range of accuracy afforded by GPS is +/- 100 meters to sub-centimeter. The accuracy of any coordinates collected with GPS will depend on several factors: Receiver type (carrier phase vs. code based), the GPS conditions under which the coordinate data is collected (number of satellites and satellite geometry), whether the quality of the locations are enhanced through differential processing, and the data collection technique (field procedures) by the GPS receiver operator. GPS accuracies are not expressed in absolute terms. Rather they are expressed as a value such as 5 meters 2dRMS. What this really means is that roughly 95% of the horizontal (x,y) values are within 5 meters of truth.

Receiver Classes and Accuracy Capabilities

The two general classes of GPS receivers provide two very different methods by which GPS signals are processed and therefore accuracy capabilities. Carrier phase receivers use characteristics of the GPS signal (i.e. wavelength) to determine positions, while code based (C/A code) receivers rely on information imbedded in the signal.

Using correct GPS survey techniques and under the right conditions, carrier phase receivers can produce extremely accurate locations (even to a few millimeters 2dRMS). Carrier phase receivers should be used for determining locations that require a high level of accuracy. For a GIS, carrier phase receivers should be used for establishing a very accurate geodetic control network on which very accurate base maps could be generated. GIS feature locations can be determined with carrier phase receivers if the mapping project requires features to be mapped to a very high degree of accuracy (to within 1 meter). Carrier phase GPS operation is more difficult and sometimes impossible in areas that are less GPS friendly. These would include areas with significant obstructions (buildings and tree canopy) that might block or weaken GPS signals.

In most cases, feature mapping for a GIS can be accomplished with data collected with a code based GPS receiver. The DEP recommends that code based GPS receivers for GIS data collection be 6 or more channels (enabling better performance under adverse conditions), and be capable of storing position fix data (allowing post processed differential corrections). All GPS data collected for NJDEP's GIS must be differentially corrected, either in a post process step or in real time. If correct procedures and proper techniques are employed, code based receivers should provide a degree of horizontal accuracy acceptable for most mapping applications (to within 5 meters 2dRMS). Code based receivers cannot be relied upon for accurate elevation data. Elevation values derived by code based GPS receivers may be in error 2 to 4 times the error of the horizontal measurement.

For point features (well locations, sampling stations, pollution sources, etc.) a sample of 200 positions fixes must be collected with PDOP $\leq$ 6. Linear features (trails, shoreline boundaries, etc.) may also be mapped using GPS by storing position fixes while tracing the feature on foot or in vehicle.

Sources of GPS Base Data

There are several sources of GPS base data in New Jersey. This reference data is necessary for differential GPS. For greater accuracy, users should obtain base data from the source nearest the project area.

The DEP/BGIA operates a Trimble Navigation Pathfinder Community Base Station in Trenton. This station stores GPS base data and makes the files available through an electronic bulletin board system (BBS). The phone number to access the BBS is (609) 633-0511. The logging hours of the receiver are Monday through Friday, 7am to 7pm. The BBS is operational seven days a week, 24 hours a day. The base data collected by this station can only be used to differentially correct data from Trimble code based receivers (Pathfinder series). In order for the data to be compatible with other GPS receiver manufacturer's (such as Magellan, or Garmin) file formats, the Trimble file format must be converted to RINEX format. DEP does not provide RINEX base files.

The U.S. Environmental Protection Agency's Region II office located in Edison operates a similar station. The phone number to access the BBS is (908) 321-6663. The logging hours of the station are seven days a week, 7am to 7pm. The BBS is operational seven days a week, 24 hours a day.

The National Oceanic and Atmospheric Administration (NOAA) operates a Continuously Operating Reference Station (CORS) at Sandy Hook, as part of a network of stations to support post processing applications. This station provides code range and carrier phase GPS data in the RINEX format. Data can be obtained via the INTERNET (ftp proton.ngs.noaa.gov) and is available for 21 days. This station also broadcasts differential GPS corrections to support real-time positioning and navigation applications. For more information contact the National Geodetic Survey at (301) 731-3208.

For more information refer to the 1995 GIS Resource Guide.

8.0 NATIONAL MAP ACCURACY STANDARDS

United States National Map Accuracy Standards
U.S. Bureau of the Budget, Revised June 17, 1947

With a view to the utmost economy and expedition in producing maps which fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, standards of accuracy for published maps are defined as follows.

1. **Horizontal accuracy.** For maps on publication scales larger than 1:20,000, not more than 10% of the points tested shall be in error by more than 1/30 inch. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings); etc. In general what is well-defined will also be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. In this class would come timber lines, soil boundaries, etc.

2. **Vertical Accuracy**, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.

3. **The accuracy of any map may be tested** by comparing the positions of points whose locations or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of such testing.

4. **Published maps meeting these accuracy requirements** shall note this fact on their legends, as follows: "This map complies with National Map Accuracy Standards."

5. **Published maps whose errors exceed those aforestated shall** omit from their legends all mention of standard accuracy.

6. **When a published map is a considerable enlargement** of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20000-scale map drawing," or "This map is an enlargement of a 1:24000-scale published map."

7. **To facilitate ready interchange and use of basic information for map construction** among all Federal mapmaking agencies, feasible and consistent with the uses to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and latitude, or 7.5 minutes, or 3-3/4 minutes in size. (from Thompson, 1987).

9.0 DATA DICTIONARY

The following is a sample data dictionary for the Integrated Terrain Unit for Burlington County, NJ. In the future, DEP Data Dictionaries will conform with FGDC standards.

DATA DICTIONARY
****

COVERAGE NAME: buritum

DATA DESCRIPTION: Integrated Terrain Unit for Burlington County.

KEYWORDS: landuse, soils, burlington, geology, floodprone

CONTACTS
****

AGENCY: BGSA
NAME: Larry Thornton/John Tyrawski
ADDRESS: CN 428
Trenton, NJ 08625
PHONE: 984-2243

MANUSCRIPT MAP INFORMATION
****

BASEMAP: Photo-Quad
State Plane
MAP DATE: 1986
SCALE: 24000

COORDINATE SYSTEM: NJ
DATUM: NAD27
MAP ACCURACY: NMAS

PROJECTION: Polyconic
MAP MEDIA: Mylar

GEOGRAPHIC AREA: County
FEATURE TYPE: Poly

MAPPING METHODOLOGY AND MAPPING SOURCES:
Land use/land cover interpreted from 1986 JSS CIR (1:58000) photos. Geology recompiled from 1906 (1:63360) Atlas Sheet. Soils recompiled from 1971 SCS Soil Survey. Floodprone areas recompiled from paper USGS flood maps (polys closed by contractor & coded as such).

MAPPING CRITERIA:
Land use/land cover mapped using modified Anderson et al. (1976) classification system. Minimum mapping unit = 2.5 acres. Other sources rescaled to 1:24000 and recompiled to 1986 photoquads based on coincident features.

MAPPING ACCURACY AND DATA LIMITATIONS:
Basemap (photoquad) feature position are good to about +/- 60 feet or better. Delineated lines good to about +/- 20 feet from locations on manuscript.Freshwater wetlands and geology are general, more detail in FWW and Cogeomap coverages.

MAP AUTOMATION
****

AUTOMATION DATE: June 1990
COORDINATE SYSTEM: NJ State Plane
DATUM: NAD83

AUTOMATION METHODS: scan
PRODUCTION STAFF: ESRI & AIS, Redlands, CA
AUTOMATION STATUS: complete
DATA AVAILABILITY: QIC150, 8mm Exabyte tape in ARC/INFO, Export, DXF

CARTOGRAPHIC QUALITY:
Data has not been systematically plotted on mylar and checked to basemap. Nodeerrors, labelerrors and slivers resolved. ###9 codes not field checked.

DISTRIBUTION RESTRICTIONS: Requires Data Distribution Agreement.

MAP AUTOMATION
****

DATABASE: Info

ITEM NAME		DESCRIPTION
LAND-USE	-	Land use/land cover code (4 digit).

PRIM-GEOL - Primary geology
SEC-GEOL - Secondary geology
SURFICIAL-GEOL - Surficial geology
FLOODPRONE - Floodprone areas
SOIL-INCLUSIONS - Soil inclusions for polys that had soil polygons of less than 2.5 acres.
SOIL-LABEL - SCS soil label
SOIL-CAPS - SCS soil labels in capitals for reselects.

LOOKUP AND/OR RELATED DATA FILES:
Lookup tables for land use/land cover, soils, geology and floodprone areas.

ATTRIBUTE QUALITY:
Frequencies run to check for valid attributes. Land use codes containing ###9 require field verification.

LOOKUP TABLE DESCRIPTIONS:

BURBDRK.LUT	Bedrock geology (primary,secondary).
BURSOILS.LUT	Soils (consult the Soil Survey).
BURFLOOD.LUT	Floodprone areas.
BURSOILINC.LUT	Soil inclusions.
BURLU.LUT	Land use/land cover.
BURSURF.LUT	Surficial geology.

10.0 REFERENCES

Anderson, J.R., *et al.*, 1979, *A Land Use and Land Cover Classification System for Use with Remote Sensor Data*, U.S. Department of Interior, Geologic Survey Professional Paper 964. 28pp.

Cowardin, L.M., *et al.*, 1976, *Classification of Wetland and Deepwater Habitats of the United States*, U.S. Department of Interior, U.S. Fish and Wildlife Service, FWS/OBS-79/31. 103pp.

U.S. Department of Agriculture, Soil Conservation Service, 1984, *Photobase Map Compilation, Technical Specifications*, National Instruction No. 170-301. 30pp

LLT
8/15/95

APPENDIX G

EPA Region 2 GIS Spatial Data Layers

LAYER	DESCRIPTION	LIBRARIES
AIR_LOC	AIRS Database Monitoring Locations	NY, NJ, PR
AQUIFERS	Primary and Sole Source Aquifers from NYDEC	NY
BDRK_GEO	Bedrock Geology from NY State	NY
CENS_EQ	Census STF3-A Demographic Data	NY, NJ, PR
CERC_FAC	CERCLIS Facilities	ALL
DLG24_H	USGS DLG Hydrology Data, 1:24,000 Scale Line Data	PR
DLG100_H	USGS DLG Hydrology Data, 1:100,000 Scale Line Data	Hydro
FRDS_LOC	Federal Drinking Water Database	NY, NJ
DLG100_R	USGS DLG Streets 1:100,000	NJ
DUMP_STS	Open Water Sediment Disposal Sites	Hydro
GIRAS_LU	USGS 1:250,000 Land Use Data	NY, NJ
GNIS_BLD	Geographic Names Information System (GNIS), Government Buildings, Churches, Hospitals	ALL
GNIS_HYD	GNIS, Hydrologic Features	ALL
GNIS_PHY	GNIS, Physical Features	ALL
GNIS_PPL	GNIS, Populated Places	ALL
GNIS_SCH	GNIS, Schools	ALL
HUC_CODE	Hydrologic Unit Codes	NY
ITUM_GEO	Integrated Terrain Unit Map (ITUM) of Bedrock Geology from NJDEP	NJ
ITUM_SOI	ITUM of Bedrock Soil from NJDEP	NJ
ITUM_FLD	ITUM of Flood Zones from NJDEP	Hydro
ITUM_LU	ITUM of Bedrock from NJDEP	NJ
INDEX	County Boundaries, Title Boundaries	ALL
TRI_FAC	Toxic Release Inventory Facility Data	ALL

LAYER	DESCRIPTION	LIBRARIES
LUSE_77	Puerto Rico Department of Natural Resources Land Use	PR
MUNI_BND	Municipal Boundaries	ALL
NA_RES	Native American Reservation Boundaries	NY
NAV_CHAN	USACOE Federal Navigation Channels Polygon Coverage of Dredged Channels	Hydro
NJDEPWMA	NJDEP Watershed Management Areas	Hydro
NJ_SHRTP	NJDEP Shoreline Type	Hydro
NJ_FRWET	NJDEP Fresh Water Wetlands	Hydro
NJDEP_H	Line Hydrology from NJDEP	Hydro
NJDEP_LK	Lakes and Reservoirs from NJDEP	Hydro
NPL_SITE	Polygon Coverage of NPL Sites	ALL
NWI_WET	National Wetlands Inventory	PR, Hydro
PCS_FAC	Permit Compliance System Facilities	ALL
QUAD_BND	USGS 7.5 Minute Topological Quadrangle Boundaries	NY, NJ
RFI	US EPA Reach File 1- Hydrology River Traces Derived from 1:500,000 Scale NOAA Charts	Hydro
RF3_ALPH	Reach File 3 Alpha River Traces Derived from 1:500,000 Scale USGs Maps	Hydro
SEDIMENT	USACOE Sediments. Polygon Coverage of Sediment Types (i.e., sandy clay, sand...)	Hydro
SHP_LANE	USACOE Shipping Lanes into NY-NJ Harbor	Hydro
SHP_ANCH	USACOE Ship Anchorage Areas	Hydro
STATSGO	State Soils Data	NY, NJ
STORET	STORET Monitoring Locations	ALL
SURF_GEO	Surficaila Geology for New York from New York State Museum	NY
TIGER_AD	Address Matched Roads from TIGER	ALL

LAYER	DESCRIPTION	LIBRARIES
TIGER_BK	Census Blocks with 1990 Population Data	NY, NJ
TIGER_A	Roads from Census TIGER Files	ALL
TIGER_RR	Railroads from Census TIGER files	ALL
TIGER_TR	Census Tracts with 1990 Population Data	ALL
TIGER_SH	Shoreline from TIGER Files	ALL
USGS_SOILS	Soils Data 1:24,000 Digitized by USGS	PR
WESSX_AD	Addressed Matched Road Network from TIGER 94 Produced by Wessex	ALL
ZIP_CODE	Zip Code Boundaries	NY, NJ

Non Library National Data

LAYER	DESCRIPTION
NE_USA	Generalized Coverage of non-Region 2 States in the Northeast United States in UTM 18
CANADA	Ontario and Quebec Provinces of Canada in UTM 18

EPA Region 2 Raster Data

TYPE	LAYER	DESCRIPTION
GRID	BTH_NYB	Bathymetry Data from NOS Digital Bathymetry Database - New York Bight 78 Meter Grid
GRID	BATH_LKO	Bathymetry Data from NOS Digital Bathymetry Database - Lake Ontario 70 Meter Grid
GRID	BATH_CRB	Bathymetry Data from NOS Digital Bathymetry Database - Caribbean 70 Meter Grid
GRID	BATH_DEM	Merged Bathymetry and Digital Elevation Model
GRID	DEM250-N	Digital Elevation Model 94 Meter Grid
GRID	DEM250-S	Digital Elevation Model 92 Meter Grid
GRID	DEM250HS	Hill Shaded Digital Elevation Model of NY-NJ
GRID	PR_HS	Hill Shaded Digital Elevation Model of Puerto Rico
GRID	MRLC_LU	Land Use from 1990 LANDSAT Classification
Map catalog of tiff images	PR_QUAD	Scanned 1:24,000 Quadrangle Maps of Puerto Rico
Map catalog of tiff images	NY_QUAD	Scanned 1:24,000 Quadrangle Maps of New York
Map catalog of tiff images	NJ_QUAD	Scanned 1:24,000 Quadrangle Maps of New Jersey
Map catalog of BIL images	PR_DOQS	Digital OrthoPhoto Quarter Quads of Western Puerto Rico
Map catalog of BIL images	NJ_DOQS	Digital OrthoPhoto Quarter Quads of Selected Areas in New Jersey
Map catalog of GRIDS	DEM24K	1:24,000 Digital Elevation Model of Selected Quads in New York

APPENDIX H

GIS Users in EPA Region 2

Federal Agencies

USGS Water Resources Division, NY
USGS Water Resources Division, NJ
Federal Aviation Administration, NY
U.S. Forest Service, NY
Soil Conservation Service, NY
Soil Conservation Service, NJ

State/Regional Agencies

NY Division of Equalization and Assessment
NY Legislative Task Force
NY Parks Management and Research
NY Parks and Recreation
NY Power Authority
NY State Cultural Education Center
NY State Transportation Department
NY State Emergency Management
NY State Public Service Department
Port Authority of NY and NJ
Adirondack Park Agency, NY
NJ State Planning

Universities

Cornell University, NY
Hunter College, NY
NY State University, Albany
NY State University, Amherst
NY State University, Buffalo
NY State University, Syracuse
Syracuse University, NY
Princeton University, NJ
Rutgers University, NJ
New Jersey Institute of Technology, NJ

Local Agencies

Cortland County Planning Department, NY
Erie County Water Authority
Onondaga County Planning, NY
Putnam County Real Property Tax Service, NY
Suffolk County Public Works Department, NY
Suffolk County Water Authority, NY
Suffolk County, Health Services Department, NY
Warren County Real Property Tax, NY
Westchester County, NY
City of Buffalo, NY
City of Rochester, NY
City of Niagara Falls, NY
New York City Housing Preservation
New York City Planning Department
New York City Parks Department
New York City Department of Environmental Protection
Town of Yorktown, NY
Atlantic County Public Health Department, NJ
Cape May County Health Department, NJ
Cumberland County Planning Department, NJ
Hunterdon County, NJ
Monmouth County, NJ
City of Camden Redevelopment Agency, NJ
City of East Orange, NJ

GIS Contacts in the Caribbean

USGS, Caribbean District
Puerto Rico Environmental Quality Board
Puerto Rico Department of Natural Resources
Puerto Rico Planning Board
University of Puerto Rico, Graduate school of Public Health
Virgin Islands Territorial Emergency Management Agency
Virgin Islands Department of Planning and Natural Resources
Virgin Islands Water and Power Authority
Virgin Islands Department of Public Works

APPENDIX I

Examples of Standard Forms that could be Used for a GIS Requirements Analysis

GIS Application Description

Application Identification #:
Application Name:
Department:
Defined by:

Purpose and Description:

Type of Application:

Display	Display/Map Scale:
Query	Query Key:
Query and Display	Response Time:
Map Analysis	Frequency:
Spatial Model	

Data Required:

Features:	Attributes:

Prepared by:
Approved by:
Date:

Map Display

Application Identification #:
Application Name:
Department:
Defined by:

Graphical Output Sample: **Screen:** **Hard Copy:**

Symbol/Legend

Prepared by:
Approved by:
Date:

APPENDIX J

An Example of a Brownfields Master Data List

Brownfields Master Data List*

Entity	Attributes	Spatial Object
Zoning	zoning_code, area	Polygon
Parcel	section_block_lot#, owner_name, owner_address, site_address, area, depth, front_footage, assessed_value, last_sale_date, last_sale_price, size	Polygon
Ownership	owner_name, owner_address,	None
Building	building_ID, date_built, building_material, building_assessed_value	Footprint
Street_segment	name, address_range, type, width, length,	Polygon/Line
Street_intersection	street_names, length, width, intersecting_streets, traffic_flow_conditions	Polygon/Line
Traffic_zone	zone_ID#, area	Polygon
Census_tract	tract_#, population	Polygon
Census_Block	block_#, population	Polygon
Soil	soil_code, classification	Polygon
Potential Pollution	feature_ID, source type, lat/long	Poly/Line/Pt
Aquifer Boundaries	feature_ID, type, depth	Polygon
Digital Aerial Photo	image, xmin, ymin, xmax, ymax	Raster
Superfund Sites	site_ID, name, NPL flag, spill flag	Point or Node
Drink/Production Wells	well_ID, type/use, depth	Point or Node

** Partial list of entities & their attributes that could be included on a Brownfields Master Data List.*

APPENDIX K

New York City RFP for GIS/Brownfields Services

Request for Technical Services

Pursuant to a US EPA grant to the City of New York to conduct a pilot study on the remediation and reuse of "brownfields" (vacant or underutilized sites whose redevelopment is impeded by actual or potential contamination due to past industrial or commercial use), the New York City Partnership, which has been selected as the City's prime contractor for this NYC Brownfields Economic Redevelopment Initiative, is seeking proposals for technical services to produce the data products described in the attached scope of work.

It is expected that the total price to produce the deliverables described will be below $10,000.

The following maps and data sets will be provided to the vendor (if desired) in electronic form, for use on this project only, and must be returned to the City upon project completion **(N.B.: Many of these data sets will require significant effort to put in a form compatible with the project needs. The vendor must be able to accept the data set in the format in which it is available [e.g., RPAD is available only on magnetic stock].)**:

Tax Block and Lot (COGIS, NYC)

Real Property Assessment Data (RPAD, NYC)

Spills Database (NYS DEC)

Freshwater wetlands (NYS DEC)

NYS Registry of Inactive Hazardous Waste Disposal Sites (NYS DEC)

RCRA Hazardous Waste Transfer, Storage, and Disposal Facilities (EPA/NYS DEC)

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS, EPA)

Toxic Release Inventory Facilities (EPA)

All deliverables must be provided to the NYC Partnership and the Director of the Mayor's Office of Environmental Coordination (MOEC) within 100 days of contract execution. Preliminary deliverables must be provided at least monthly after contract approval. Minimum deliverables for the first month will include items #1 and #2 in the scope below for at least one borough. Minimum deliverables for the second month will include items #1 and #2 for all five boroughs. Submissions will be considered final upon written approval from the Director of MOEC and Jody Kass from the NYC Partnership.

The Contractor will be expected to meet and confer with City representatives and members of a public-private Task Force convened as part of the overall Brownfields Initiative as requested to discuss project design, and to make revisions to the deliverables as requested during the term of the Agreement. The consultant will be expected to make revisions to interim and draft products based on written comments by the Director of the MOEC.

Invoices will be submitted only with the submission of deliverables, but not more than monthly. Invoices must show number of hours expended, and document the proportion of the overall project represented by the deliverables submitted. Payment of invoices will be processed upon submission of deliverables deemed acceptable by the Partnership and the City, and will not exceed the proportion of total project costs reflected by the completed deliverables submitted.

This contract will be awarded to the qualified bidder who is rated most highly by a selection panel composed of Partnership representatives and City personnel. In selecting the contractor, the following criteria will be considered:

- Total project cost.
- Number of technical-staff hours committed.
- Accessibility to City personnel for technology-transfer and consultation purposes.
- Prior experience on similar projects.

Proposers should submit a brief statement specifying:

- The total project cost.
- The total number of technical-staff hours that will be expended on the project.
- The amount of time during which project staff will be available for in-city technology-transfer/consultation with City staff.
- The proposer's relevant prior experience on similar projects.
- The key personnel who will be involved in the project, their respective roles, their qualifications, and their individual hourly rates.
- Two references, with name, phone number, and identification of the project you did for them.

Submissions in response to this request for services should be addressed to Jody Kass, Director of Technical Services, New York City Partnership, One Battery Park Plaza, 4th floor. All responses must be received by 4:00 p.m., February 26, 1997. Any questions should be faxed to 212/344-3344. Proposals may also be faxed to that number. <u>Proposals received after 4:00 p.m., February 26 will not be considered.</u>

Scope of Work for Services to Develop a Geographic Data Base for the NYC Brownfields Initiative

Using ArcView 3.0 software,

1) Produce a base-map using the COGIS and LION data sets for the five boroughs of New York City.

2) Convert the RPAD data set into a format that can be linked to COGIS, and then link specific fields requested by the City's designated project manager to COGIS.

   Among the fields to be included are:

- zoning;
- vacancy; occupancy rate;
- land use
- building type;
- floor area
- ownership (public or private);
- assessed valuation;
- tax rate;
- lot size.

3) Geo-code (to the extent practicable given data limitations) the following data sets to LION or COGIS:

   a) NYS registry of inactive hazardous waste disposal sites.

   b) RCRA (Hazardous Waste Transfer, Storage, and Disposal Facilities).

   c) CERCLIS

   d) Spills data

   e) TRI sites

4) Input the following layers (to the extent practicable given the limitations of electronic data and/or the amount of digitizing required) **(N.B.: certain data sets may require formatting or other changes in order to be usable in this project)**:

a) Community Board boundaries.

b) Empowerment, Enterprise, and Economic-Development Zones.

c) Urban renewal areas.

d) Truck routes.

e) Rail lines.

f) Water bodies/Coastal zone (Note: given the high proportion of industrial sites along the NYC waterfront, as well as the legal and regulatory status of contaminated sites adjacent to surface water, the accuracy of this data layer is of especial significance for this project.).

g) Freshwater wetlands.

h) US Census data (population, race, age, income).

i) Soils (USGS).

j) For the aquifers in Brooklyn and Queens (Note: given the environmental and regulatory significance of contaminated sites over aquifer areas, the accuracy of this data layer is of especial significance for this project.):

k) City Council boundaries.

- Water levels.
- Groundwater flows.

5) As requested by the City, provide preliminary data sets to allow preliminary analysis/sorting of specified data bases to meet overall project workflow/schedule needs (e.g., the set of vacant, City-owned, industrially-zoned parcels) prior to the completion of all deliverables.

Deliverables

The final deliverables for this project will include the data sets described above in the ArcView Shape File format. An ArcView project file will be created to provide immediate use of these data sets for brownfield analysis. CD Roms will be made for each borough, configured as separate ArcView projects. At least 2 copies of each CD will be provided.

All data and software products generated pursuant to this Agreement will be the property of the City of New York. All data and software products shall be considered proprietary, and not provided to any party other than the City of New York, the US EPA, or its authorized agents, under direction from the City of New York.

APPENDIX L

GIS/Brownfields Survey Questionnaire

GIS/BROWNFIELDS QUESTIONNAIRE

1. Do you work with a Brownfields Project?
   (If yes, please continue; if no, you may disregard this questionnaire -- thank you)

   - ☐ Yes
   - ☐ No

2. Do you have or are you developing/planning to develop a GIS system for Brownfields Applications? (If yes, please continue; if no, you may disregard this questionnaire -- thank you)

   - ☐ Yes
   - ☐ No

3. Do you plan on building Brownfields applications into a municipalities or counties existing GIS system?

   - ☐ Yes
   - ☐ No

4. If the GIS/Brownfields system is going to be separate from an existing county or municipal GIS system, what are your proposed long-term applications with the GIS system?

   ____
   ____
   ____
   ____
   ____

5. What type(s) of hardware and software are used for the GIS/Brownfields system?

Hardware/Platform	Software

6. What stage of GIS development are you currently in? (Please check one)

- ☐ Preliminary development stages
- ☐ GIS developed but not implemented
- ☐ Fully implemented and waiting for a trial
- ☐ Trial tested
- ☐ Other (please explain) ______________________________
  ____

7. What will be the primary use (application) of the GIS/Brownfields system ? (Check all that apply and rank them in order of primary use (1) to least used application)

- ☐ City or local uses (e.g., infrastructure)
- ☐ Municipal Brownfields site selection
- ☐ Environmental uses
- ☐ Use by developers (financial institutions e.g.,) for site selection/marketing tool
- ☐ Use by community groups
- ☐ Other applications (please specify) ______________________________

8. Who was involved in determining data needs? (check all that apply)

- ☐ City personnel (e.g., planners, managers)
- ☐ Developers
- ☐ Financial institutions
- ☐ Community groups
- ☐ Others (please specify) ______________________________
  ____

9. Where was the required data obtained? (check all that apply)

- ☐ Federal government
- ☐ State government
- ☐ Local government
- ☐ County government
- ☐ Private organizations
- ☐ Other (please specify) ______________________________
  ____

10. Were there any problems with data acquisition? (check all that apply)

- ☐ Data had to be converted
- ☐ Data hard to obtain
- ☐ Data had to be converted to a different scale
- ☐ Data had to be converted to a different database system
- ☐ Other (please specify) ______________________________

____

11. Please attach a list of the base maps that the GIS will use/plan to use for Brownfields applications.

____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

12. Please attach a list of the data layers that the GIS will use/plan to use for Brownfields applications.

____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

13. Please attach a list of the queries/potential queries that the GIS will use/plan to use for Brownfields applications.

____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

14. What is/will be the cost (best estimation) for the GIS/Brownfields system from development to implementation?

Investment or Initial Costs	Ongoing or Maintenance Costs
Training $ ______________	Staffing $______________
Staffing $ ______________	Marketing $______________
Hardware $______________	Data Updates $______________
Software $______________	Training $______________
Data $______________	System updates $ ______________
Marketing $ ______________	Other costs$ ______________ (please explain)
Other costs (please explain) $ ______________	

15. Where will the GIS/Brownfields system(s) be physically located? (please check all that apply)

- ☐ City office (please specify departments)
  ____
  ____
  ____
- ☐ County office (please specify departments)
  ____
  ____
  ____
- ☐ Other location (please specify) ______________
  ____

16. Where will terminals be available for accessing the system? (please check all that apply)

- ☐ Public libraries
- ☐ Kiosks
- ☐ Other public locations (please specify) ______________
  ____

17. Who will have access to the system? (please check all that apply)

- ☐ City personnel
- ☐ Developers
- ☐ Financial institutions
- ☐ Community groups
- ☐ Others (please specify) ______________
  ____

18. Will there be any fees associated with the system's use?

☐ Yes (please specify) ____________________

☐ No

19. Will there be any data layers that will have limited access due to privacy or security issues? (please specify and briefly explain)

____

____

____

20. What are (do you foresee) as the most productive way to train users/potential users?

☐ Local universities

☐ Seminars

☐ In-House training

☐ Other (please specify) ____________________

____

21. What has been successful with regard to GIS/Brownfields development, data acquisition and implementation?

☐ Public/Private partnerships

☐ Achieved economic development objectives

☐ Others (please explain other items or ideas that you felt worked well)

____

____

____

____

____

____

____

22. What have been the challenges with regard to GIS/Brownfields development, data acquisition and implementation? (please check all that apply and rank them according to most challenging or largest hurdle to overcome (1) to least challenging)

- ☐ Costs
- ☐ System design
- ☐ Trouble obtaining data
- ☐ Data quality
- ☐ Introducing GIS into the organization
- ☐ Introducing GIS into the community
- ☐ Obtaining information from private landowners
- ☐ Others (please specify) ______________________________

23. How did you resolve these challenges?

____
____
____

24. Have there been any real-use demonstrations/success stories of using GIS/Brownfields systems and/or applications at your Brownfields sites?

- ☐ Yes (please attach any information you have)
- ☐ No

25. Is there any information that was included in this questionnaire that should remain confidential?

- ☐ Names of companies/organizations
- ☐ Costs
- ☐ Other (please specify) ______________________________

26. Can other Brownfields Projects contact you to share information on GIS/Brownfields issues?

- ☐ Yes
- ☐ No

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