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The Tennessee Valley Authority's Geographic Information System: A Study of Implementing a Regional Agency's GIS in Local Government Planning

A Thesis
Presented for the
Master of Science in Planning
Degree
The University of Tennessee, Knoxville

Russell K. Davis
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This thesis is dedicated
to the Lord Jesus Christ for
providing me with the strength and courage
I needed to complete the requirements for
the Master of Science in Planning

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ABSTRACT

Geographic Information Systems (GIS) are computer based data processing tools that are becoming more and more integrated in local governments. This thesis investigates the feasibility of using a regionally applied GIS, specifically the Tennessee Valley Authority's (TVA's) GIS, in local government planning. It also tries to convey a sense of how local governments are currently viewing developments in GIS technology in regards to their own specific needs and how these developments can be applied in their various departments.

A short history of GIS is presented, and the basic components and capabilities of a GIS are discussed. Along with this discussion, directions and trends in GIS development and use are reviewed for future reference. The applications of GIS in local government planning, including problems and opportunities, are examined to construct a foundational reference for the case studies. An abbreviated history of TVA is presented that includes information that led to the development of TVA's current GIS configuration and application areas. These application areas and the status of TVA's GIS is discussed, including GIS use in TVA's Reservoir Lands Planning Division.

Conclusions for the thesis were formed from the information gathered during the performance of seven case studies of local governments in the east Tennessee area. These case studies were conducted to develop a basis for comparing local governments that are currently using GIS and those that are not, to a regional agency's efforts of applying a GIS. GIS is a tool that is becoming more widely used every day. Many local

governments have discovered the benefits that a GIS can bring to their departments and many more are considering applying GIS to their daily operations. Some local governments have also discovered that installing a GIS may be prohibited by political, monetary or other constraints. Using another agency's already installed and efficiently running GIS is often a viable alternative to installing a new system. However comparisons must be made on the available data in the data base to the information needs of local governments. This type of comparison was performed and revealed that some, but not all of the data on TVA's data base is applicable.

Trends in GIS technology indicate that GIS development is moving toward integration of various isolated systems into a global, or unified, system. Local governments must become aware, through education and application, that GIS technology is here to stay and is getting more complex and involved every day. If local governments postpone installing GISs they may soon be left behind, using outdated methods of operation in a high-tech world.

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CHAPTER I
INTRODUCTION

Foreword

During the past two decades, local governments have experienced significant changes in the use of the computer as a tool for the storage and analysis of data. Planning agencies in particular have been involved in using the computer to increase the efficiency and effectiveness of information dissemination. The implementation of geographic information systems (GIS) in various local government departments, such as the planning, engineering and public utilities departments, has dramatically changed the way many local governments operate. A typical planning department will collect or have access to information about population demographics (age, sex, race, income); land uses (residential, commercial, industrial); public facilities (educational, health services, utilities) and transportation services. "The type of analysis that is now possible with the computer has the potential to enable local governments to foresee problems before they arise and to plan for their prevention and/or resolution" (Berkman, 1988). Local governments that are using GIS have the potential to enhance their current functions and to increase the number of functions that can be performed. Along with local government, GISs are being used more and more in many different types of agencies, both public and private, and on many different levels of applications, including region-wide applications. An example of a regional agency currently using GIS technology is the Tennessee Valley Authority.

In 1980, the Tennessee Valley Authority (TVA) installed its first interactive GIS at TVA's Office of Natural Resources and Economic Development in Norris, Tennessee. This GIS was a raster based system that was held on TVA's computer mainframe. The system was upgraded in 1985 to support the remote workstations in TVA field offices and to increase their data-analysis capabilities. Over the years, the GIS has undergone a series of other upgrades to help it to maintain its usefulness and increase its capabilities. At TVA, GIS services are used as a tool for the effective inventory, integration and interpretation of spatial data by all TVA programs, as well as by other federal, state and local agencies in the region. As TVA's GIS capabilities are enhanced, efforts to market GIS services to other agencies will increase. As federal budgets shrink, expenditures to develop GIS capabilities in other agencies may become more difficult to justify. The GIS operations that TVA conducts may become increasingly attractive to local governments, particularly planning departments, that are conducting short-run planning efforts. These operations include strategic planning and operational land management. This thesis explores the feasibility of using TVA's GIS in local government planning applications.

Problem Statement

Geographic Information Systems are quickly becoming an integral part of the planning process. Many local, regional and state planning agencies have begun to benefit from the speed, adaptability and accuracy that a fully functional GIS can offer. Unfortunately, "because geographic information systems are not cheap and require

specialized staff," building a GIS from the ground up is often an unrealized dream for many local governments (Burrough, 1986). Often, problems encountered with implementing GIS technology can be attributed to the early resistance shown by local governments to adopt Data Base Management System (DBMS) technology. As DBMS technology grew, local governments failed to implement it due to its inability to address spatial problems. This has resulted in separate "islands" of information that now must be aggregated if GIS is to become a reality in a particular local government, a difficult task under even the best of circumstances.

Other areas of obstruction to the implementation of GIS in local government include physical and political limitations. A particular local government may simply not have the physical space or the proper budgetary considerations for even the installation of the hardware and software, much less the construction of the data bases. Closely tied to these limitations are the political considerations that are encountered during the education process of the future GIS users and the introduction of the GIS within the various departments of the local government. Locally elected officials often have different political agendas resulting in a clash of priorities over funding; moreover, the various departments that would share in the use of data bases may not be willing to change their present, and familiar, methods of operation.

Even if the GIS is properly installed and is fully functional, the task of data capture for interpretation into usable information can overwhelm personnel who have no experience with this type of technology. Also, the fundamentals of obtaining the data from remote sensing, digitizing and field observations can be confusing and laborious,

and converting the data into information through an unfamiliar GIS can be extremely time consuming and labor intensive. Very little documentation exists that explains the complex implementation procedures required by GIS. This problem is compounded by the fact that there are no generally accepted definitions or standards whereby a GIS user can base his or her use, or the capabilities, of various systems. With the heavy influx of computer technology into the everyday workings of government and business, it seems logical that the planning efforts of local government should be conducted with much speed and ease. However, "while computers have been used for some time in local government to do tasks involving much data handling, there is a lack of comprehensive management information systems that provide anything more than assistance to conduct daily business" (Southern Rural Development Center, 1983).

From 1980-1985 in the state of Tennessee "middle and east Tennessee experienced the greatest amount of growth as well as (had) the greatest potential to support growth" (Tennessee State Planning Office, 1980). It is obvious that local governments in the east Tennessee area are having to deal with issues of information management stemming from increased urbanization that they may not be fully equipped to handle. A GIS would greatly enhance the ability of these local governments to store, manipulate and analyze their specific data, resulting in increased efficiency of their information management operations.

Purpose and Need For The Study

The purpose of this thesis is to determine if a regionally applied GIS, such as TVA's, is a practical tool for use by local government planning departments. Often, "local governments need, but can not afford, the benefits that a true GIS can offer" (Smart, 1992). By studying TVA as an example of a regional agency effectively implementing GIS technology, it is the researcher's hope that this study will enhance local governments' understanding of GIS and increase the awareness of viable alternatives to accessing this technology without installing their own GIS. Although the thesis specifically addresses TVA's use of GIS, the conclusions drawn from this study should be generalizable to most regional agencies and local governments. Readers should note that this study will not address the technical questions of actual integration of hardware, software and data conversion within a local government. This type of information is site specific, so it is not practical to provide as part of a general study such as this.

Determining if a regional GIS such as TVA's is a practical tool for use by local governments is important for various reasons. The benefits for local government can include; 1) gaining expertise in establishing priority areas for GIS application that would directly contribute to positive growth; 2) developing a frame of reference for determining the most applicable databases to be developed first should officials decide to implement their own GIS; and 3) determining if direct control of the data bases is a responsibility that is needed or wanted. The benefits for the regional agency can include; 1) determining the feasibility of getting data to local governments via modem, networking or physical transportation; 2) An evaluation of the appropriate roles that it would play

as a GIS consultant; 3) the possible development of a linkage between itself and local governments that would enhance communication and technology transfer; 4) determining the importance of using a regionally applied GIS by local government for future reference; and 5) building support for GIS use in the region.

Methodology and Scope

This thesis is exploratory in nature. The data gathered and analyzed for this study is qualitative and descriptive, and suggestive rather than definitive. Case studies were performed on selected local governments to examine their current planning methods that involve the use or non-use of GIS. During the case studies, personal interviews were conducted with various people, including departmental officials and technicians, who have a good working knowledge of their particular department and are users of planning information relevant to GIS. Personal interviews were conducted because of the typically higher response rate to the questions, the opportunity for further in-depth probing of the answers, the opportunity for clarification of questions, and the opportunity for gathering information through observations during the interview.

Case studies were conducted on seven local governments in order to gather information on the use or non-use of GIS in local government planning efforts. The GIS departments of Knoxville and Johnson City, Tennessee were studied as examples of local governments that have an established and productive in-house GIS. The applicable departments of Alcoa, Tennessee (Blount County), Cleveland, Tennessee (Bradley County), Morristown, Tennessee (Hamblen County), Chattanooga, Tennessee (Hamilton

County) and Sullivan County (Blountville, Tennessee) were studied as examples of local governments that do not presently have an in-house GIS, but are familiar with the concept and the areas where GIS can be applied. These case study subjects were chosen due to their proximity and access to TVA, and because they are a representative sample of local governments in east Tennessee (see Figure 1). Finally, the Maps and Surveys Division of TVA was studied to gather information on a regional agency's attempts at implementing GIS technology. The information gathered from these case studies was compared and contrasted to develop answers to the primary and supporting research questions and to draw conclusions on the feasibility of using a regionally applied GIS in local government.

A literature review of applicable books, articles, magazines and other sources of information was conducted to gather data on two areas of GIS information; 1) what GIS is, and how and why it is used; and 2) GIS use in local government. By examining relevant material, a better understanding of the need for GIS in local government was obtained. Many of the questions used in the case study interviews were derived from the literature review.

Primary Research Question:

Is it feasible for a regional agency, with regard to both time and money, to make available on a contractual basis the use of its GIS capabilities to support local government planning?

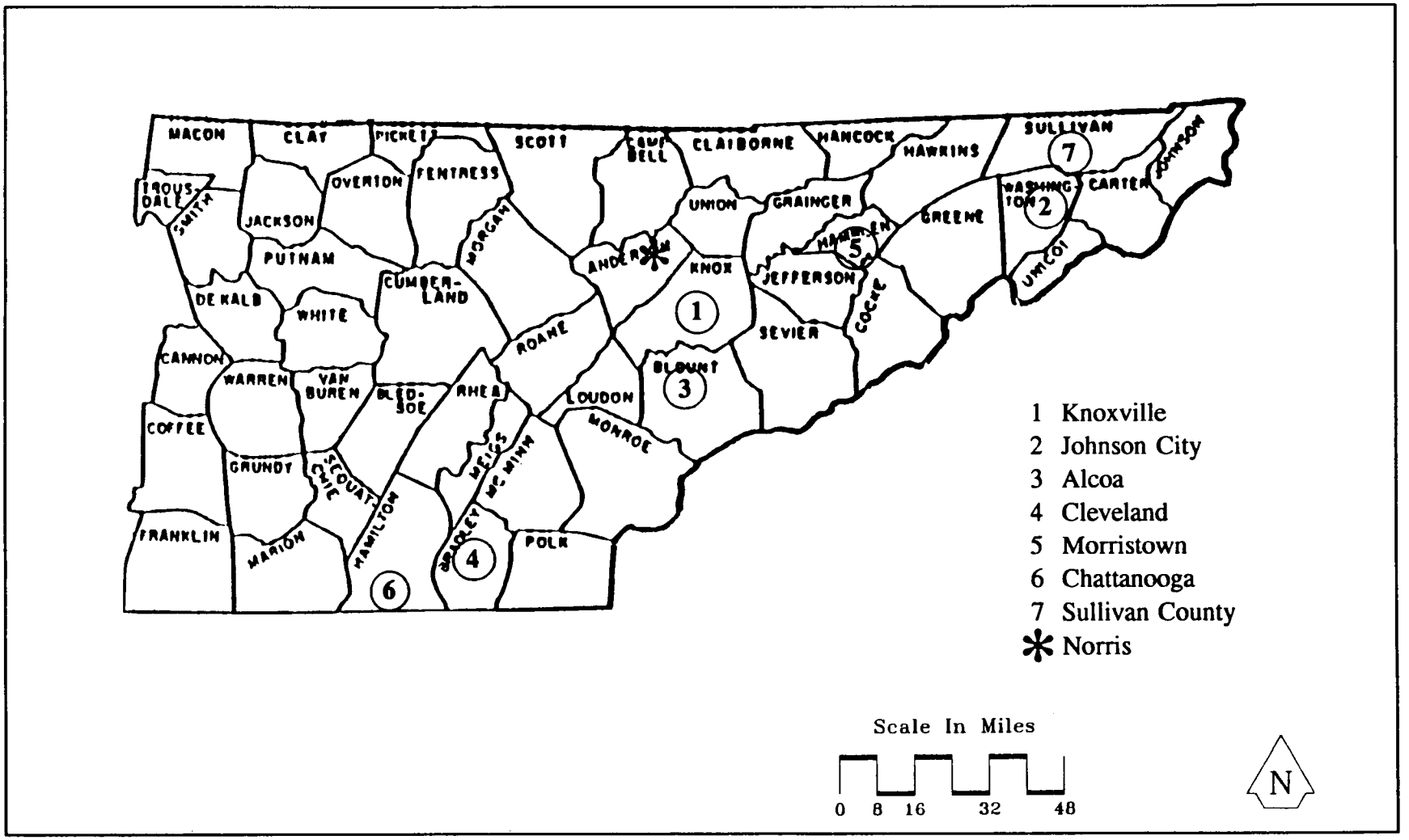


FIGURE 1
Case Study Locations

Supporting Research Questions:

1) Where local governments have adopted GIS support, what were the deciding factors that prompted its use in their planning efforts?
2) What departments, and who specifically, were involved in the decision to use a GIS?
3) What computer hardware, software and data are currently used by local governments to produce information for planning?
4) How do local governments use their GIS and what problems does it create or solve?
5) What are the thresholds for which it makes sense for local governments to use GIS in the following situations: A) to contract for GIS services and B) to install their own in-house GIS?

Definitions

In order to complete this research, two terms must be operationalized; "local government" and "Geographic Information System". Local government will be defined as "any agency which has a resident population occupying a defined area that has a legally authorized organization and governing body, a separate legal identity, the power to provide certain public or governmental services, and a substantial degree of autonomy including legal and actual power to raise at least part of its revenue" (Blair, 1964). Geographic Information System will be defined as "an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information" (ESRI, 1991).

Organization of the Thesis

This thesis is organized into five chapters. Chapter I is an introduction providing background material critical to the understanding of the purpose of the thesis and establishing a vocabulary for the following chapters. Chapter II is a literature review that further explains GIS and its use in local government. Chapter III further describes TVA and its use of GIS. Chapter IV presents an analysis and evaluation of the findings from the case studies of the local governments. Chapter V concludes the thesis with a summary and conclusions drawn from comparing the case studies, and offers suggestions for further research.

CHAPTER II
LITERATURE REVIEW

Explanation of Geographic Information Systems

History of Geographic Information Systems

The growth of information technology has typically been a cyclical process. First the technology is developed, then refined, then marketed and finally absorbed by the general population. The most recent advancement of information technology, the development of the digital computer, has been no different. The digital computer has been in existence since the 1940's, but it was not until the development of the micro-processor in the 1960's that it became available for use by small businesses, and more recently, the general public.

The current and potential impacts of the rapid growth of computer technology are complex and numerous, and many of them have a regional dimension. For example, by using GIS technology, planners can more accurately determine the prime potential locations of new manufacturing and service industries. This will in turn help the planners develop a more accurate forecast for the change in economic activities within and among the regions containing these industries. The impact of the digital computer to the planning profession has been far reaching and has become vital to the profession's continued influence on urban and regional development.

The planning profession can be defined as an information processing profession. As data are gathered on local, regional and state levels, they are processed into usable information for the development of plans. Thus, information is of central importance to

the planning profession at any scale. The introduction of computers has revolutionized how raw data is processed into useful information, and as the use of computers grows, new applications will be constantly developed that increase the efficiency of this process.

Computers have been used for mapping and spatial analysis since the late 1960's. Through the course of time, computer technology has developed parallel with other fields that involve data capture, analysis and information presentation. These fields include cadastral and topographic mapping, thematic cartography, civil engineering, geography, mathematical studies of spatial variation, soil science, surveying and photogrammetry, urban and rural planning, utility networking, and remote sensing and image analysis. As these various fields matured in their abilities to apply computer technology, much duplication of effort occurred. Applications tended to overlap and eventually the various efforts resulted in the formation and development of the general purpose geographic information system.

With the exception of military applications, the first early attempts at manipulating spatial data with computer technology were largely done in academic circles. In the late 1960's, a number of forums were held at the Harvard Laboratory for Computer Graphics for the purpose of discussion and information exchange on the emerging technology. At this time, there was no GIS industry such as there is today, but only a small number of independent groups with computer applications of geographic data. As GIS technology developed, a number of actual applications were attempted. Among these early pioneering attempts were the development of the Canada Geographic Information System (CGIS) for the purpose of digitizing the Canada Land Inventory and the development of

The U.S. Census DIME File System. These early application attempts led to more sophisticated research and development in both the public and private sectors resulting in a gradual maturation of the software.

As GIS technology developed, so did basic computer technology. The hardware needed for graphics applications such as terminals, plotters, scanners and digitizers became more sophisticated and less expensive. By the mid 1980's, the combination of high speed, high quality, adaptability, and low price made GIS technology a viable alternative for use by both public and private agencies. The current interest in this technology by planning agencies is a result of the above factors combined with an increased awareness of the availability and functionality of the technology.

Components of a Geographic Information System

A basic GIS is made up of various computer components (see Figures 2 and 3). The components include hardware, software and key personnel who are properly trained in the correct operation of the GIS. The central processing unit (CPU), the disk drive storage unit and the display device are the three fundamental hardware components. Included in the array of hardware for the GIS are the input and output devices. The two most common input devices are the digitizer and the scanner. These are used to convert raw data taken from maps and documents into digital form and send them to the computer for processing into usable information. Output components include plotters and printers. Highly sophisticated output devices are now available that have the ability to produce high quality professional hard copies of the needed information.

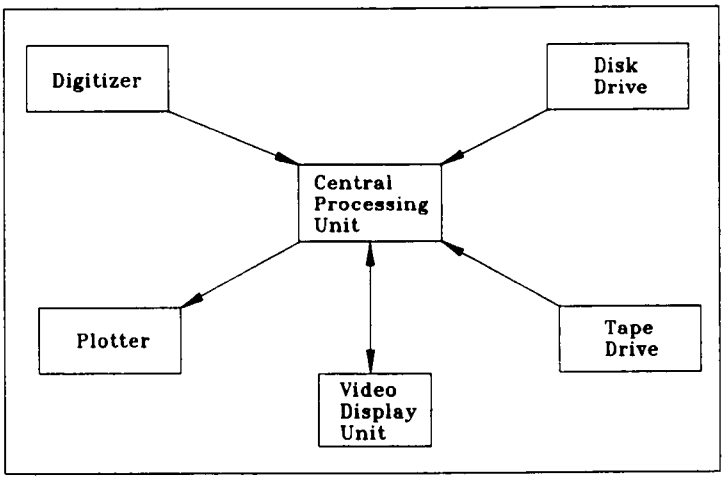


FIGURE 2
The Major Hardware Components of a Geographic Information System

Derived from: Burrough, 1986

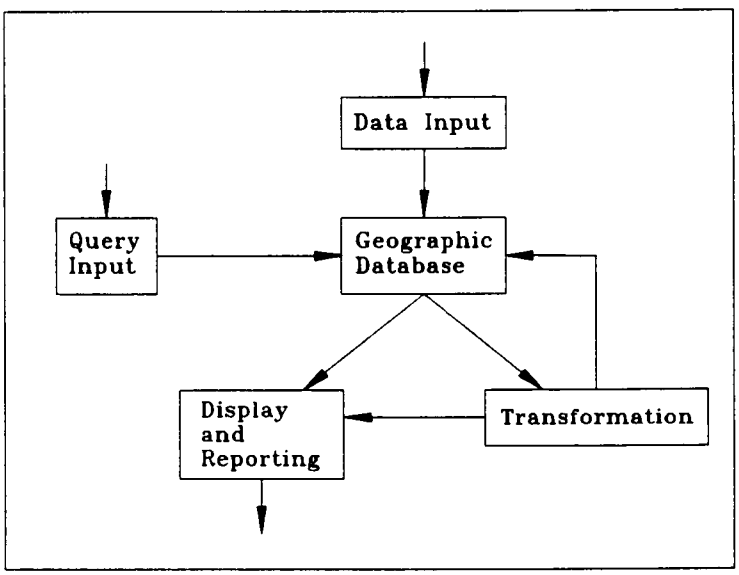


FIGURE 3
The Major Software Components of a Geographic Information System

Derived from: Burrough, 1986

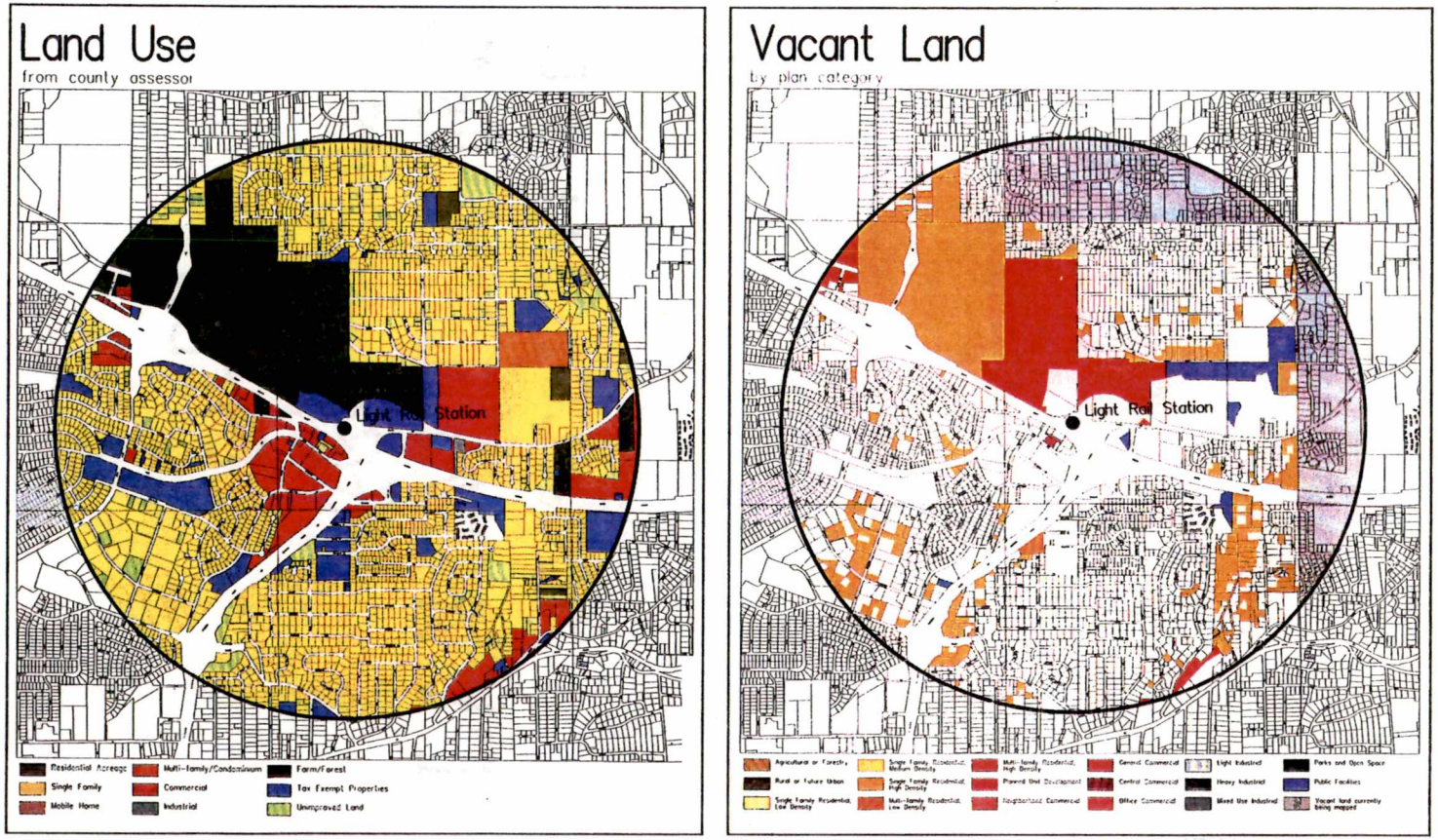
The personnel who use the GIS include managers, system administrators, data base experts and analysts. Each of these team members have specific functions that are performed to produce the needed information. Many software packages are now available for various applications of GIS. Any software package for a GIS has five basic subsystems:

1) Data Input and Verification
2) Data Storage and Data Base Management
3) Data Output and Verification
4) Data Transformation
5) User Interface

Capabilities of a Geographic Information System

The basic purpose of any GIS is to perform spatial analysis on geographic features. All true GISs have this ability plus added functions that allow it to perform observations and measurements, to describe and explain various data, and to aid in forecasting. These functions interact for the user to carry out an educated decision making process. The spatial operations that a GIS can perform answer five fundamental questions; 1) What is at...? (location), 2) Where is at...? (condition), 3) What has changed since...? (trends), 4) What spatial patterns exist? (patterns) and 5) What if...? (modeling) (ESRI, 1991).

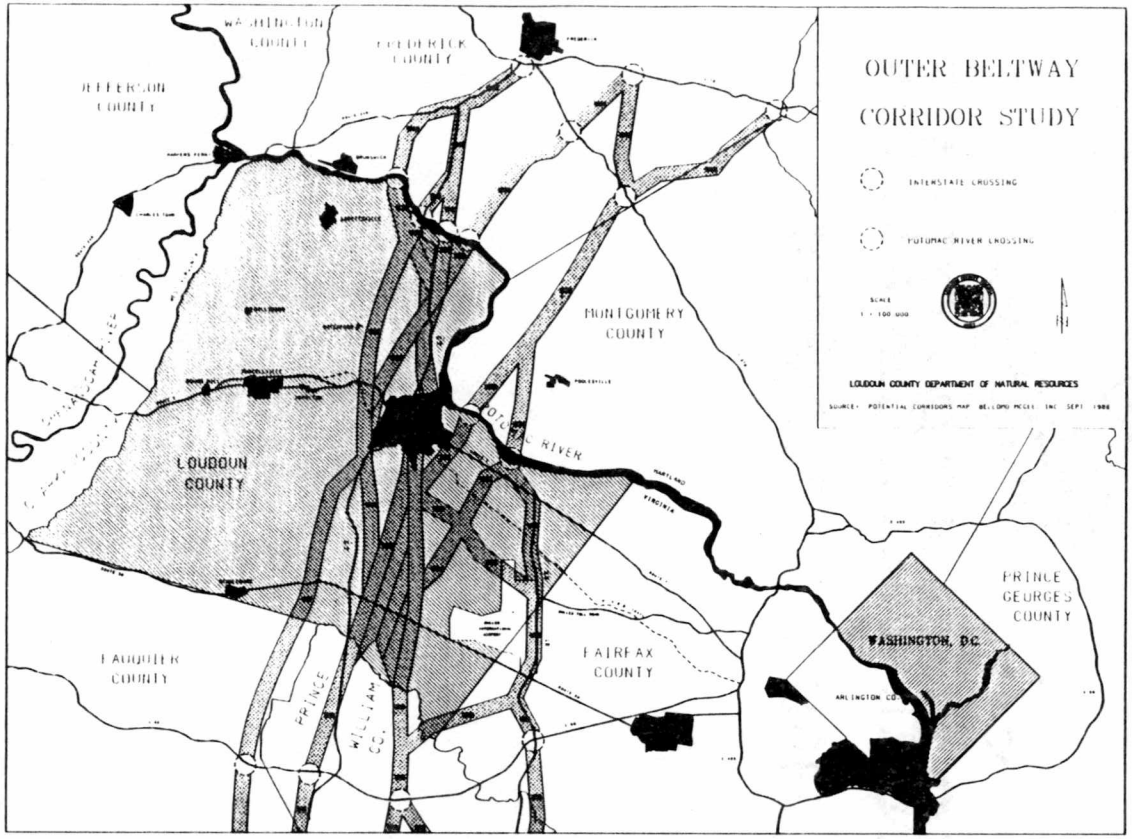
"Any visual display of geographic data can constitute a map", but a GIS is much more than a computer system for making maps (Ray, 1992). Although it has the ability to create maps at various scales, projections and colors, principally it is an analytical tool (see Figures 4 and 5). "A GIS does not store a map in the conventional sense; nor does



Metro GIS Applications
Portland, Oregon

FIGURE 4
GIS Map Examples Created With ARC/INFO

Source: Dangermond, 1992



Outer Beltway Corridor Study
Leesburg, Virginia

FIGURE 5
GIS Map Example Created With ARC/INFO

Source: Dangermond, 1989

it store a particular image or view of a geographic feature. Instead, a GIS stores the data from which you can create the desired view drawn to a particular purpose" (ESRI, 1991). The data that is used to create the map is stored in a geographic data base. This concept is the fundamental difference between a GIS and a computer mapping system.

A GIS answers two basic queries; aspatial and spatial. Aspatial queries are not referenced to geographic coordinates and do not require the stored values of latitude and longitude. These types of queries are based on the stored attribute, or descriptive, data in the GIS data base. Spatial queries are referenced to geographic coordinates and can only be answered by using latitude and longitude data and other geographic coordinate information. In the GIS data base geographic features are stored as a series of x,y coordinates that represent the actual location, in real-world units, of the geographic feature in question. Complementary with the geographic data are attribute data. Each geographic feature represented in the data base has corresponding attribute data that provide basic information describing the geographic feature. The GIS has the ability to link different data sets, which contain both geographic and attribute data, using a unique identifier of a specific feature that is common to both data sets. The GIS uses this linked data set or separate data sets to create the desired map or view.

Directions and Trends in GIS Technology

"For years, people have been attracted to geographic information system technology for the many applications and benefits it offers within their own discipline. Many of the organizations that are using GIS, however, are finding that this technology

has an even greater benefit: the ability to integrate information across an organization so that it can be shared, interrelated, and used among different departments or groups" (Dangermond, 1989). GIS technology is currently moving from large, local applications on limited project areas to more comprehensive area-wide systems. This is reflected in the trend of moving toward smaller decentralized workstations that can be used for specific projects or as an entry point into a larger area-wide data bases.

A fundamental problem that has plagued the GIS industry for many years is the sheer volume of data that is generated during applications. This is due in part to attempting to map the complexity of the earth's surface and to the various methods that scientists are employing to represent actual geographic features. These various methods create data that are not transferable among specific systems which results in duplication of data. Systems being developed today are many times more powerful than those of just a few years ago and contain much more memory. Further, the ways in which spatial relationships are described are usually application specific and thus are not transferable to separate applications. Newer and better methods of standardizing and reducing the natural discrepancies of geographic data are being developed. Artificial Intelligence (AI) is one method that is being applied to solve this problem. AI replicates the interactive human logic process by applying a number of weighting scales to retrieve selected data from various systems for analysis.

The use of and need for GIS is continually increasing. More and more interest is being shown in applying this technology in a variety of ways. Furthermore, hardware prices are declining while processing power is increasing. As new applications for GIS

are discovered, many more potential benefits will be realized. Possible future applications of GIS include more accurate geodetic control of real world coordinates and linking non-GIS produced data bases to the GIS. Other developments include the complete integration of digital data bases that are available in local governments, the automation of review procedures that involve spatially referenced data such as land use review, and the use of advanced modeling techniques.

GIS in Local Government

Problems

Implementing a GIS in local government is not a new idea. Much research has been done on this topic and has resulted in some very fundamental, but important guidelines. Any local government has at its disposal a wealth of data and information that it uses in its day-to-day activities. This information must be managed in the most efficient manner possible to ensure correct and timely application of the information to the activities that a local government pursues. Martin Myerson in his book titled "Building the Middle Bridge For Comprehensive Planning" identified five standard information intensive activities of local governments:

1) Central Intelligence Function
2) Pulse-Taking Function
3) Policy Clarification Function
4) Detailed Development Plan Function
5) Feedback and Review Function

The central intelligence function consists of collecting and analyzing all of the data from the various departments within a particular local government. This process

was once done entirely by hand, and often still is in many places, but is now in the process of becoming automated through the use of various computer systems such as GIS. The manual method of the central intelligence function was time and labor intensive and required the personnel who carried out this function to spend more time in collecting the data than in analyzing it. A common occurrence of this old process was the duplication and non-consistency of the same information in various departments.

The pulse taking function requires that local government officials, planners included, to constantly keep the public appraised of all developments that are occurring, or will occur, in a community. Gathering information in advance and disseminating it to the public reduces the risk of the occurrence of adverse public reaction when new development occurs. If this is not accomplished, the local government must assume a reactive role when a proactive role is much more desirable. The implementation of computers in local government has helped reduce the time needed to react to a potential crisis situation and has increased the level of analysis that can be performed.

The policy clarification function necessitates the development of many alternative policies for evaluation and final selection. Planners and other government officials typically require much data for this evaluation and decision making process, but having at hand a plethora of data does not necessarily ensure the quality of the information that is generated. Computer technology has automated this evaluation process and has helped cull the unneeded or incorrect data. This allows a much more intelligent decision making process to occur.

The detailed development plan function is very fundamental in local government. This process is typically carried out in the planning departments of local governments, although other departments such as utilities and engineering can provide assistance and information. The planning activities within local governments help provide communities with the public goods that individuals or groups can not provide for themselves due to either excessive cost or logistical limitations. These goods can include public works such as water, sewer and gas, municipal services such as police and fire departments, public recreation areas and transportation systems. Finally, the planning process is undertaken to provide the optimum use of scarce resources. Planning requires the collection of spatial information; this is most commonly found in the form of paper maps. Computer map making applications have drastically reduced the time required for coordination of various map scales and the elimination of data that may not be consistent in style and format.

The feedback and review function is a vital function of the planning process. Planning is not a static local government function. It requires the continued monitoring of information and sending feedback to various departments and people to ensure that plans remain flexible and current. By establishing a centralized information system such as a GIS, local government can improve the flow of information through the development of more accurate text and graphic presentations.

Each of these information intensive activities requires specialized and unique information. The process of generating information from various data has been occurring for many years, but local governments today are faced with the problem, or opportunity,

of utilizing new technology to their benefit. The rapid growth of computer technology has out-paced the ability of many local governments to keep abreast and implement the changes in their daily functions. In many local government agencies, data collection and information generation is still conducted using methods that are often considered obsolete. Hanging files and flat files are often still considered standard equipment for referencing maps. Tax roll books stored in large reference rooms are still used a primary resource of data. Compounding this problem is the unwillingness of various departments in local government to integrate their respective data for the purpose of building a common data base. This reluctance is often based on an aversion to change and a feeling of intimidation by new technology.

This approach to information management is no longer acceptable with today's conventional standards of high technology implementation in analysis and resolution of data. The older methods of data collection and storage result in discrete 'manual' data bases whose usefulness is limited by duplication, inaccessibility and lack of integration. Duplication of record keeping activities by various departments within a particular local government is a common problem and results in inefficient procedural practices. Duplication is expensive and results from what has historically been the various agencies protecting their own 'turf'; specifically the data bases, either manual or automated, that are built or used only within the narrow confines of that particular agency.

Once information is collected and stored, it is useful only if it can be readily accessed. A common concern is the different requirements that each agency has in regards to information. An example of this is map scale. A specific agency such as the

property assessor's office may require that their maps be at a large scale (i.e. 1:50) while the planning department may require that their maps be at a small scale (i.e. 1:200). These varying requirements create the problem of ineffective inter-departmental information exchange. Furthermore, the retrieval of information from traditional methods of manual storage such as libraries and map files is time-consuming and often inaccurate.

Information integration among the various departments in local government is a vital step in the progressive growth and maturation of the government. Unfortunately, this step is all-to-often ignored due to differences in available computer hardware and software, map scale and data format. Also, procedural and political jurisdiction differences are common elements that compound this problem. Local governments now have the opportunity, through implementation of computer technology, to begin automating their information systems. Complete automation may not be a feasible alternative, but partial automation may be. By using a stand-alone workstation networked to an accessible data base that contains all of the needed data, the user can in effect become an efficient GIS user without having to implement or have access to a complete, large scale geographic information system.

By looking at both the theoretical and the realistic implementation of GIS in local government, the risk of raising and failing to meet unrealistic expectations is reduced. Fundamental implementation problems can include staffing and equipment costs, institutional changes, legal problems related to the public records law, and difficulties and costs associated with building and managing a data base. Typically, GIS personnel in

local governments experience a high turnover rate. Many local governments can not afford to pay the competitive salaries that are offered by private firms. Personnel trained to be efficient GIS users are often lured to more lucrative positions by these firms, thereby creating a high demand for trained personnel by those governments using GIS. The state and Federal governments also often act as competitors for these personnel.

Institutional changes that may occur can be physical, functional, or staff related. As the hardware for the GIS is installed, modifications to the architectural layout of the area where the GIS is housed may be necessary. GIS hardware often has specialized space requirements, and support areas for the peripherals, such as plotters and digitizers, may need to be adjusted accordingly. GIS implementation often crosses the political boundaries of many local government departments. This fact raises the problem of cooperation and coordination of use among these various departments. The consistent problem of specialized 'turf' areas may still exist even after implementation. To overcome this, proper planning must be carried out beforehand to ensure that the GIS is neatly fitted into the organizational structure of the local government. In most cases, staff changes will occur as a GIS is being implemented. New support personnel will be either hired from outside or trained from within among existing personnel. Either method will cause shifts in the hierarchy, and job descriptions and responsibilities.

Public information requirements may also cause problems. The public records law of the state of Tennessee requires that "all county records shall be open for public inspection by any citizen of Tennessee during business hours of the various county offices" (University of Tennessee, 1990). There is a question now of which part of a

GIS data base is to be specified as 'record' and which is proprietary information. "Due to the enormous cost of data base acquisition, the commercial potential of many GIS products, and the cost of answering public requests, a number of installations have opted for trying to recover some of the costs for the GIS by selling GIS products instead of just giving them away" (Salmon, 1986). Whether or not attempts at cost recovery such as this are legal is not entirely clear at this point in time.

A final problem for local governments to consider when implementing a GIS is the cost of building and managing a data base which is one of the most expensive operations in tooling up for GIS use. Data capture can be carried out by in-house personnel through scanning or digitization, or by contracting out for aerial flyovers and data conversion. Either method is time consuming and expensive; the choice depends on the time allotted for data capture and conversion, and, of course, budgetary constraints. In order for a GIS to be useful, its data base must be continually updated. Stemming from the problem of data capture are "the questions of who is responsible for updating the data, how the accuracy of the updates can be checked in a cost efficient manner, and who has access to a particular piece of data" (Land, 1990).

Opportunities

Many small local governments have traditionally held a negative view of using computer applications in their daily functions. As mentioned above, this resistance has largely been focused on the inability of Data Base Management Systems (DBMSs) to process spatial or spatially related data. This resistance may be partially justified since

the majority of activities performed by local governments require the processing of spatial data.

The development and recent proliferation of GIS interest can readily be explained by the tremendous ability of GIS to input, store and manipulate spatially referenced data. Varieties of computer software have been developed and are now available that can either input and/or process spatial data. These software include:

1) Automated Mapping/Computer Assisted Mapping (AM/CAM)
2) Automated Mapping/Facilities Mapping (AM/FM)
3) Computer Aided Drafting and Design (CADD)
4) Geographic Information Systems (GIS)
5) Land Information Systems (LIS)

All of these software are efficient in the operations they are designed to perform, but an automated GIS can perform each of these operations plus generate and manipulate non-input data from the existing data base. In essence, GISs have been available for many years, but only in manual form. The storing, filing retrieval and analysis of the geographic data present on paper maps and the thematic data in reference material are fundamental operations of an automated GIS, but they are performed at extremely higher degrees of efficiency and accuracy.

It is very likely that over the next few years, automated GISs will be replacing manual methods at an ever increasing rate. To those personnel who are familiar with a mode of operations that is rapidly becoming outdated, the potential of converting to an automated system can be frightening. In order to ensure that GIS implementation occurs with the creation of as few problems as possible, it is essential that the uses defined for

the GIS be consistent with the long-range objectives of the local government. Evaluation of a complete plan that analyzes the needs of specific departments will help make the GIS uses consistent with the needs of the local government. Huxhold (1991) has defined five long-range objectives that will help the GIS uses conform to the long-range objectives of the local government:

1) Obtain high-level support. Explaining GIS capabilities to high-level decision makers brings to their attention the opportunities for improving government and gives them confidence that those who are advocating the GIS are competent and can make the project succeed.

2) Identify all potential applications. Considering all of the geographic information needs of the local government ensures that no future improvement opportunities are omitted from consideration. This is important due to the fact that many local government officials assume that the capabilities of a GIS will not meet the information needs of the local government.

3) Prioritize applications for orderly implementation. This ensures that applications are scheduled and prioritized in the order that will reap the most benefits for the local government. It also ensures that data base development is carried out in a manner that allows immediately needed data to be gathered first and then supplemented with other data.

4) Obtain maximum benefits organization-wide. A GIS can allow information sharing opportunities that had never before been known or possible. This prevents specialized interests from hindering the full realization of the capabilities of the GIS.

5) Identify resource requirements. The GIS technical staff must present elected officials with a complete and accurate system cost analysis in order to prevent any future requests for funding to complete the system's installation. When costs escalate after project initiation, the credibility of those in charge of the project is weakened.

Keeping the implementation of the GIS consistent with the long-range objectives of the local government prevents unexpected disappointments and unrealized expectations.

GIS technology has been expanding into many levels of Federal, state and local governments as well as in the private sector. Many of the GISs in use today are off-the-shelf software applications, but many more are custom designed packages that are formulated for specific applications. Regardless of the area or type of application, GIS implementation will repeatedly result in expanded opportunities for increased efficiency of job performance for the user. Along with the standard improvements a GIS can offer, such as faster and more accurate analysis of data, higher resolution graphics and the opportunity for data generation, a GIS can offer other, less obvious opportunities. These opportunities can include ease of access to data, improvements in the inventory of the surrounding natural and created environments, and the storage of data in a more central and universally accessible place.

Coordination of inter-departmental activities can be one of the first occurrences after a GIS is implemented. This coordination can help reduce or eliminate the old turf struggles among departments and facilitate the exchange of data by either formal or informal means. Supporting this coordination is the establishment of standards and specifications of existing data while they are being converted into digital format. This will help increase the interchangeability of the data and enhance its potential for multiple use of the same data. By building one multi-user data base, the chance of redundancies and inconsistencies of data is eliminated. This will help improve and enhance the level of communication among various departments and increase the opportunity for rapid data exchange between field workers and office staff.

Determining the user requirements of various departmental staff before the GIS is implemented will reduce the disparities between system capabilities. Existing computer systems could possibly be linked to the GIS in order to integrate the GIS into a broad-scale Information Resource Management (IRM) strategy. The IRM would facilitate the integration of data from different sources such as paper maps, digital remotely sensed data, analog aerial photography and survey data. All of these data would be placed in the GIS data base which would act as a central depository of spatially referenced data. Along with state-of-the-art computer mapping and geographic data analysis, the GIS itself has the ability to perform coordinate transformation. This process takes the data from the sources mentioned above and converts the digital coordinate (x,y) points into coordinates that are representative of actual points on the earths' surface for the creation of geographically referenced data.

A final opportunity offered by the implementation of a GIS is more effective organizational realignment. The introduction of any type of computer system will change the way any organization operates. Identifying information requirements of various departments and system managerial control points, such as department heads and system managers, can help to optimally place the GIS within the organization, but will also require job shifting and retraining of personnel.

CHAPTER III
THE TENNESSEE VALLEY AUTHORITY AND ITS GIS

The Tennessee Valley Authority

Historical Purpose of TVA

The Tennessee Valley region is located in the southeastern United States and is home to over 8 million people. The region includes all of Tennessee and parts of Mississippi, Alabama, Georgia, North Carolina, Virginia and Kentucky, and encompasses 201 counties in 91,000 square miles. Its borders are diverse and are defined by the operations performed by the various departments within TVA. These operations include, but are not limited to, the electric power service area, the Tennessee River watershed, and the environmental education service area (see Figure 6).

In 1933, the Tennessee Valley region was an extremely rural and impoverished area, and was suffering from the effects of the Great Depression. Its three million residents were in a class of poverty that was producing illiterate and technically unskilled people who were working farms that they mostly did not own. The combination of the lack of knowledge of proper agricultural techniques and the natural conditions of the region, namely steep slopes, heavy winter rainfall, and little ground frost or snow cover, helped produce a serious erosion problem. "By 1930, about 85% of the Valley's 13 million acres of cultivated land was seriously eroded" (TVA, 1983). Along with these problems was the rampant flooding of the Tennessee River. "This is a region of heavy rainfall, and in the wettest seasons, the water often cascades down the mountains, hills

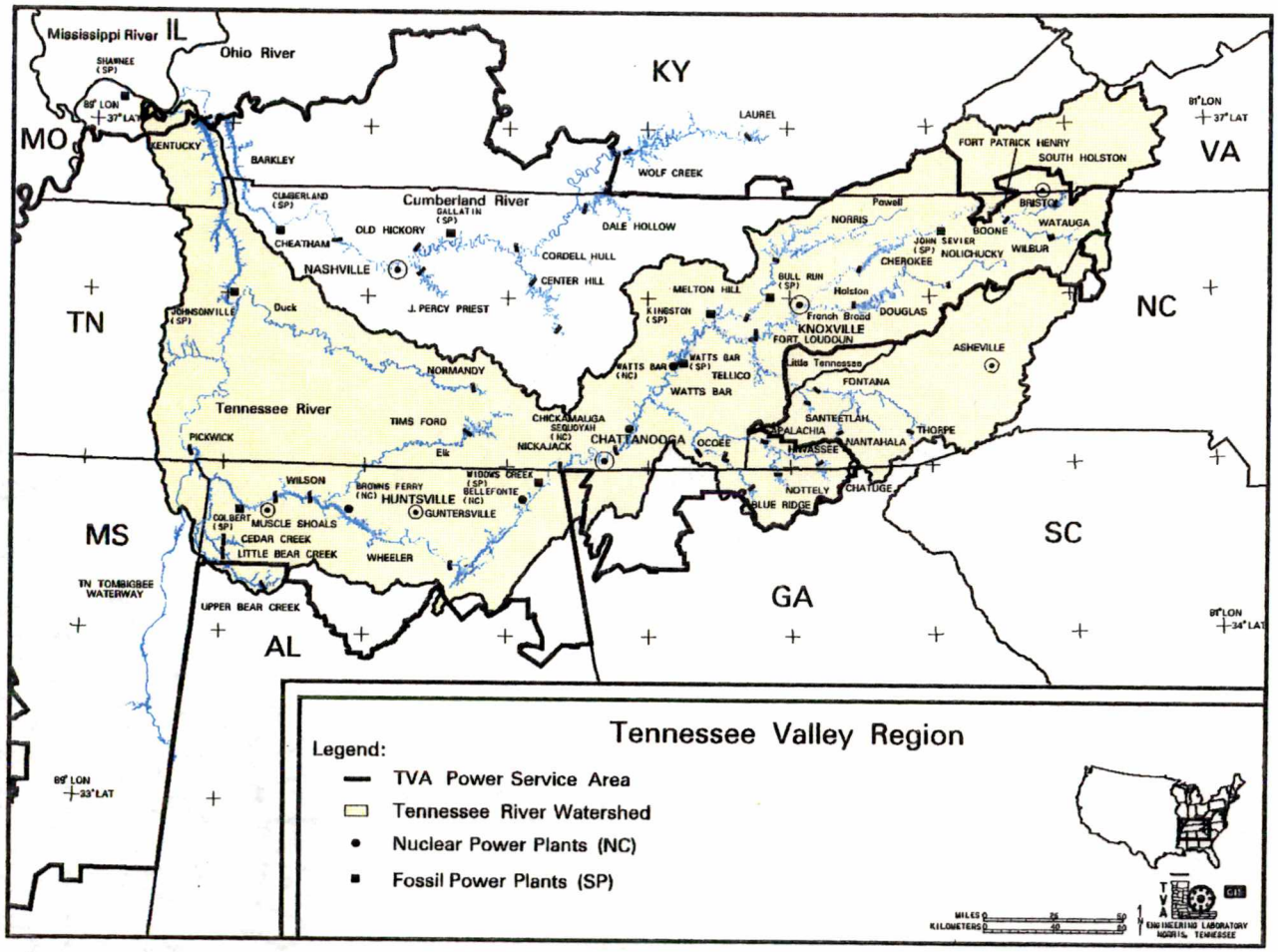


FIGURE 6
The Tennessee Valley Region

Source: Jolly, 1992

and valleys. It not only carries the topsoil into the rivers, but, if not properly controlled, also floods the farms highways and streets" (Callahan, 1980). The Federal government recognized these problems and realized the potential of increase in economic development in the river valley. Several senators saw the river as a means of transportation and a source of hydroelectric power, and in 1933, as part of President Franklin Roosevelt's New Deal, the Tennessee Valley Authority (TVA) was formed to establish control over the river for the purpose of power generation, navigation and flood control. "The fledgling agency was also charged with providing aid to farmers, restoring soil and forest resources, and revitalizing the economy of the region" (TVA, 1991). During its history, the missions of TVA have evolved to include, along with those mentioned above, fossil fuel and nuclear power generation, water quality control, waste management, agricultural and environmental education, wildlife preservation, pollution control and other areas of significance for the region (see Figures 7, 8 and 9).

TVA's Geographic Information System

Status of TVA's Geographic Information System

To carry out its missions, TVA has, since its beginnings, collected, managed and analyzed various types of data and information. With the advent of GIS technology, TVA was able to eliminate the laborious and time consuming methods of information management such as paper hanging files, and attribute data files. In 1973, TVA's Division of Forestry, Fisheries and Wildlife Development, under the direction of Tom

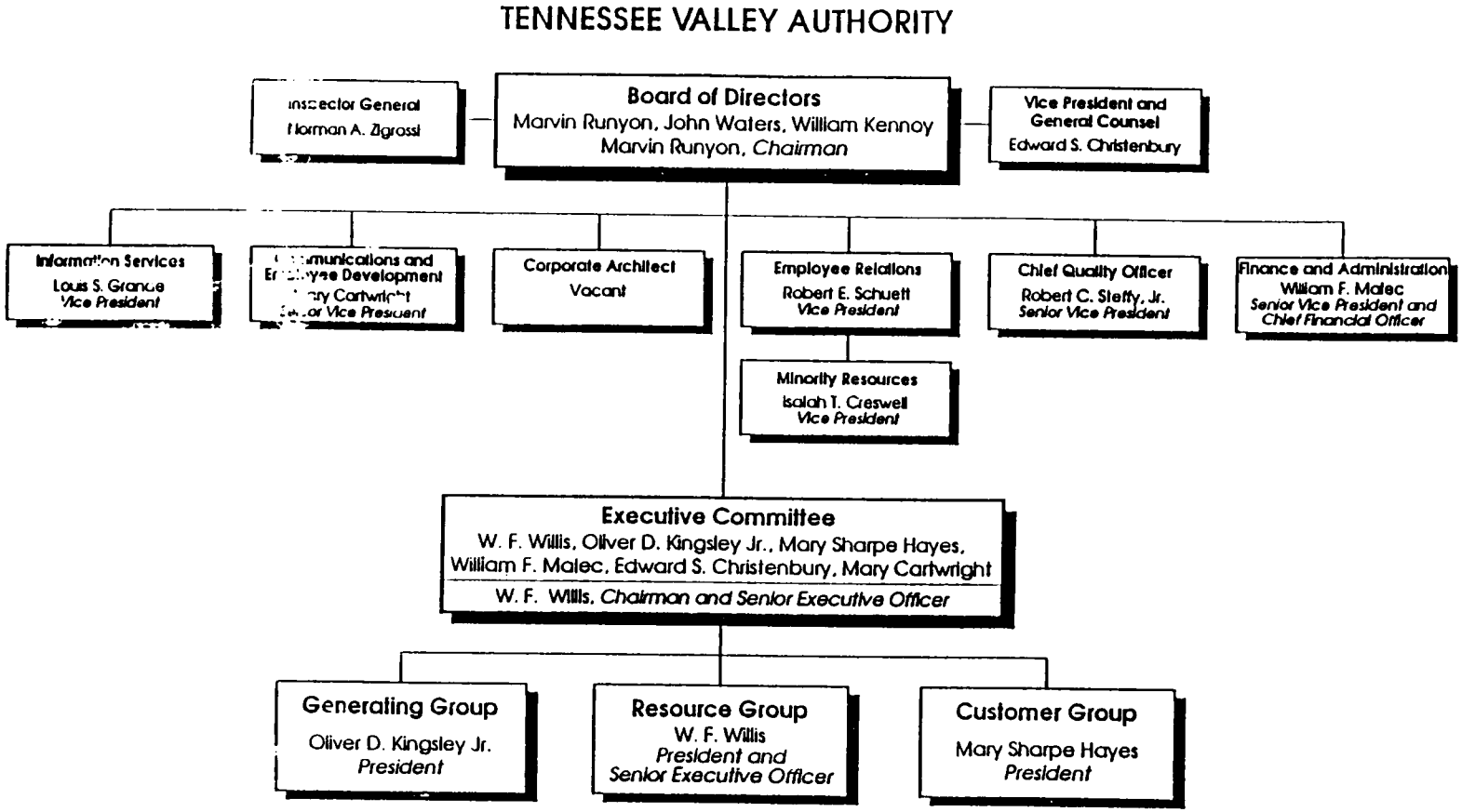


FIGURE 7
TVA Organization: First Level

Source: Jolly, 1992

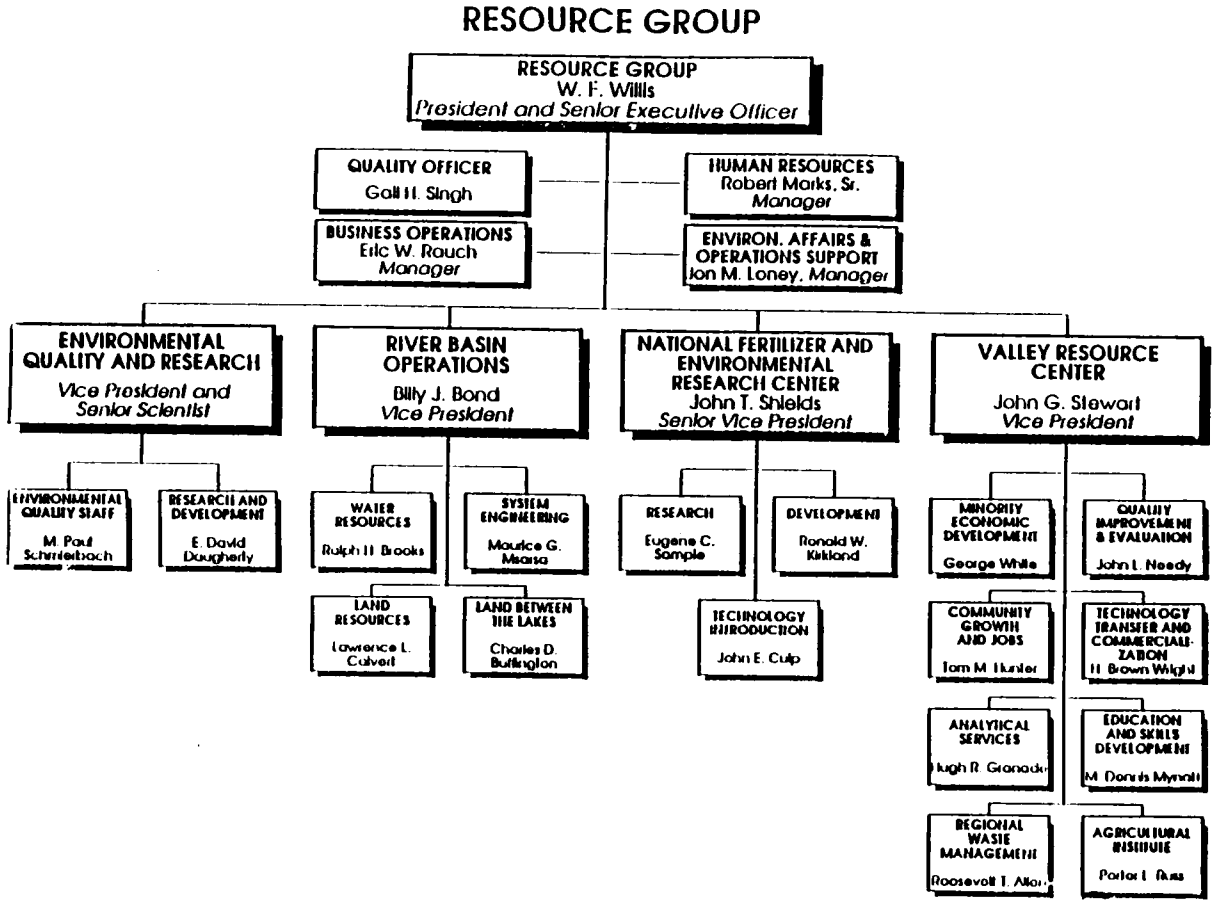


FIGURE 8
TVA Organization: Second Level

Source: Jolly, 1992

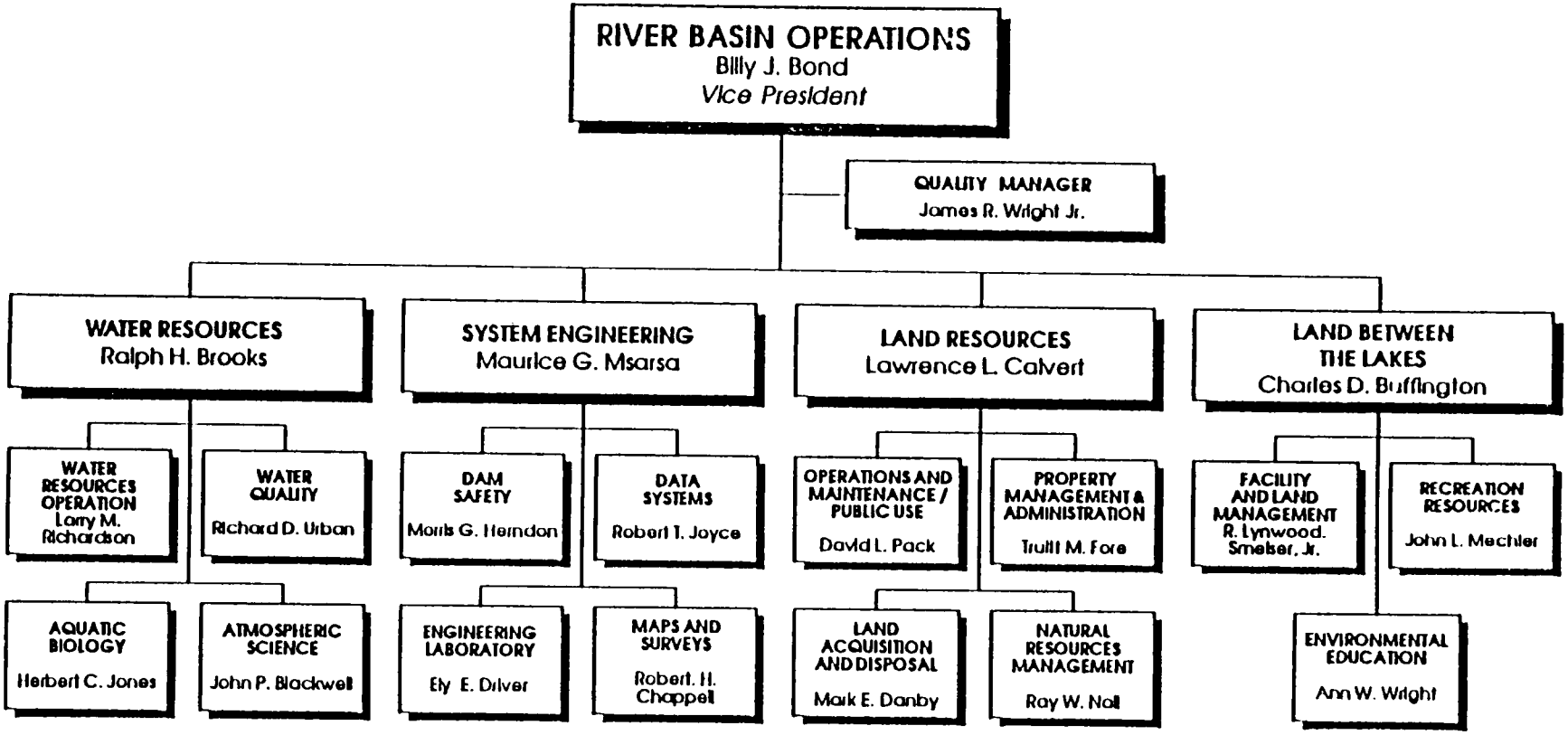


FIGURE 9
TVA Organization: Third Level

Source: Jolly, 1992

Ripley, began researching the feasibility of implementing GIS technology within TVA. TVA's interest in GIS stemmed from the 1973 Jackson bill. Under this bill, the National Science Foundation began promoting land use modeling and providing funding for research projects that needed GIS technology. The first GIS installed at TVA was a raster based system held on TVA's computer mainframe. Initial turn around with the GIS was about one operation per day. The graphics were very fundamental, but the spatial analysis was of high quality for that time. Initial resistance was confronted with the implementation of this project and has continued to be a problem to this day. This problem stems from upper management's resistance to change, poor communication between upper and lower management and the time required to implement the newest available technology. "Education of upper level management in GIS technology and better bottom up and top down communication are the keys to overcoming this problem" (Rowland, 1992).

In the mid 1970's, project implementation started with power plant site screening and transmission line routing for the electric power generating divisions of TVA. Also, a few land management uses were implemented, but these were mostly done in cooperation with agencies such as The Tennessee Wildlife Resources Agency. As time progressed, TVA began applying its GIS to more and more areas in its regional management efforts. In 1980, TVA received funding approval to upgrade their GIS technology to a vector based system. A vector based system's foundational data building method is based on connecting arcs to nodes (points) as opposed to a raster based system which has a data construction method based on placing data bits into a grid formation for

future analysis. Through a competitive procurement, an Intergraph system was purchased and installed. In 1985, another competitive procurement was performed and again the Intergraph Corporation was chosen for the GIS upgrade. In January 1992, Environmental Systems Research Institute (ESRI) of Redlands, California was awarded a contract to install its ARC/INFO system at the Office of Natural Resources and Economic Development in Norris, Tennessee, thereby replacing the Intergraph system. The selection was based mostly on the software capabilities of ARC/INFO. The Relational Data Base Management System (RDBMS) of the new ARC/INFO system is also being converted to a new RDBMS called Oracle, so essentially the new GIS will be ARC/ORACLE.

Changing from an Intergraph system to an ARC/INFO system requires data base conversion. Unfortunately, complete data base conversion is not possible for this division. Therefore, only those data bases which are currently being implemented and those data bases which will be used for future applications will be converted. The older data bases will either be discarded or converted if needed. Hardware for the new system will consist of individual workstations (one per desk) that are 20 times faster, have two times the memory and one half the disk space of the entire present Intergraph system. The funds for obtaining these various Automated Data Processing (ADP) systems were acquired through capital accounts funded by the electrical power divisions of TVA. The costs were reimbursed through depreciation of the equipment. The first GIS cost approximately $600,000, the second was about $1.4 million and the ARC/INFO system currently being installed costs $750,000. Officials at TVA have perceived a trend in GIS

technology of a steady decrease in hardware costs with an increase in software costs. Hardware is becoming more powerful, but cheaper to produce. Software, on the other hand, is specific to the type of application needed to be performed, so is necessarily expensive.

Present GIS applications at TVA are done project by project which results in a "piecemeal" development of data bases of greatly varying accuracy and currency. Currently, TVA conducts approximately 100 projects per year using the GIS. Work is also conducted with other federal agencies such as The Forest Service and The Army Corps of Engineers. TVA is moving toward putting the tool on the customer's desk to facilitate better communication between the user and the customer, or "from over the counter to over the shoulder" (Rowland, 1992). "In two years, it is estimated that TVA will have 10 to 20 times the number of workstations outside the department as within" (Rowland, 1992). Networks will also be constructed to form Local Area Networks (LAN) and Wide Area Networks (WAN) among various TVA divisions (see Figure 10). No networks are planned for the present, or for the future, for linking TVA with the region's local governments.

Among the most prevalent of TVA's current projects is the formation of the Automated Land Information System (ALIS). The Land Resources Division of TVA, which deals with reservoir land management, has recognized the need for a comprehensive and integrated ALIS to support multiple projects and multiple users, as well as support the division's daily operations through interactive analyses and immediate access to information. The Land Resources Division decided that the existing

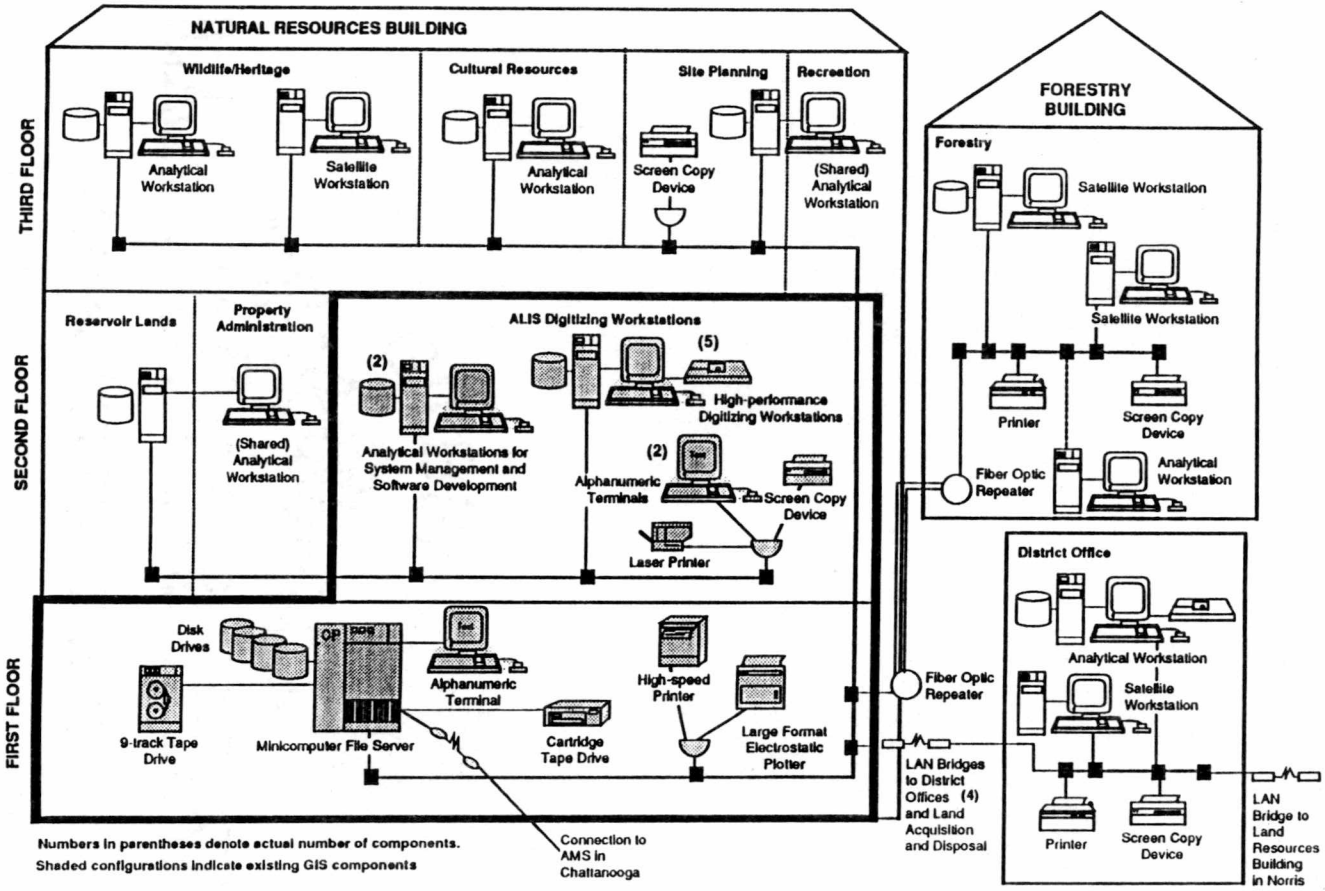


FIGURE 10
Future GIS Configuration, Norris, Tennessee

Source: Curtis, 1992

pattern of GIS development within TVA was inefficient and redundant, and should be superseded by a more effective and organized development approach. ALIS will support a wide range of the Division's business functions including property management, natural and cultural resource management, land acquisition and disposal, operations and maintenance/public use on TVA reservoir land and other resource development functions for the entire Tennessee Valley region. ALIS will also address the automation of several information management needs such as the administration of land rights and permits, inventory of resource conditions, land and facility record keeping, and mapping and reporting.

By having a greater number of TVA divisions networked to the system than is now possible, ALIS will expand data use among the various divisions and increase the analysis capabilities of these divisions for performing land use reviews, environmental evaluations such as Environmental Assessments (EA) and Environmental Impact Statements (EIS), monitoring shoreline development and encroachments, natural and cultural resource management, and the analysis of sensitive environmental issues and policies. Implementation of the ALIS will address the currency, accuracy, consistency and security of TVA records that are kept in both manual and digital format. The full implementation of ALIS within all of the relevant divisions within TVA is expected to take 10 years and cost approximately $11.9 million, however the initial start-up of the system and the system applications to the pilot project is expected to begin by July, 1992.

As with the development or updating of any GIS, data base development or conversion is always the most expensive step. Currently, development of data bases for

the GIS is project driven and they are formed as needed, basically creating a geographic 'snapshot in time'. As mentioned above, only the necessary existing data bases will be converted to conform to the new GIS configuration. ALIS will require that TVA retain only two data bases, each of which will be continually updated and revised to facilitate the use of a more 'real-time' data base. The large-scale data base supports applications that relate specifically to the reservoirs and reservoir lands, and includes data on the area within a one quarter-mile boundary around each reservoir. This data base is at a source data scale of 1:500, with portions of the data base at a larger scale as specific projects require. It covers an area of approximately 1,400 square miles and will use Global Positioning System (GPS) during development for precise placement.

The small-scale data base contains less detail, but provides continuous coverage of the entire Tennessee River Valley and supports the needs of several regional analyses including forestry, wildlife management, and cultural resources development, and other applications that extend beyond TVA-owned lands. Development consists of translation of Digital Line Graph (DLG) files which are being prepared for the United States Geological Survey (USGS) by other organizations within TVA. Scale and data coverage varies in this data base depending on the source and the use of the data. Each division will have access to the data bases, but will only be able to manipulate its own specific data through the workstations. These divisions will be required to maintain and update these data as needed and when appropriate. From these punctual updates, an update cycle program will be constructed to ensure timely corrections to the data base.

GIS services at TVA are set up similar to a consulting firm, although the agency does not actively seek customers, but rather offers assistance when asked. Since TVA has no congressional appropriations for its GIS applications, which often costs $1.5 million per year, contracting out for various projects is one of the most logical methods of acquiring funds. The most likely potential customers are small local governments within the region which are interested in GIS use, but have not yet implemented their own system. Customer needs are very diverse, ranging from analysis to data base construction to graphics and report production. The advantages of using the GIS in this manner are threefold; first, there is a monetary savings by creating needed maps automatically rather than manually; second, there is a qualitative savings in the rapid communication and decision making process; and third, these services result in a more efficient record keeping process. Along with consulting, TVA also works with various GIS user groups in the region offering technical assistance for their GIS application needs.

In October 1991, TVA underwent a reorganization of its GIS division. Since then, the new organizational structure of the division has helped to increase the effectiveness of implementing this technology. TVA has a networked GIS station located in Chattanooga, Tennessee, but this station serves mainly as a support for the main system in Norris by providing the Chattanooga offices with the ability to create high quality graphics and, on a limited basis, perform data analysis. The entire GIS configuration at TVA is managed by the Maps and Surveys Department, and has been used on an *ad hoc* basis for various projects, resulting in many different data bases of

varying degrees of accuracy and currency. The 110 people working within the department perform cartography (both manual and digital), photogrammetry, remote sensing (SPOT or LANDSAT based), field surveying, cadastral mapping, and GIS implementation.

Future directions in GIS at TVA involve a continued progressive growth including the proper implementation of the newest technologies. Also, the development of better relationships with customers outside the agency is foreseen. "This would possibly lead to about 200-400 direct users within the next two years" (Rowland, 1992).

Current Planning Application Areas of TVA's GIS

TVA's GIS has been, and is being, used for aiding a wide range of land reservoir planning, management, and administrative activities. Application areas range from the general, reservoir-wide to the site-specific. "There are 23 multi-purpose reservoirs in the seven state TVA system with a combined total of 300,000 acres of land, 660,000 acres of water surface, and 11,000 miles of shoreline. These land and water resources are managed for multiple uses such as forestry, wildlife, fisheries, recreation and navigation" (Curtis, 1986). Other GIS application areas that are common to TVA include the more than 1,500 outside requests for the use of reservoir land. These requests are varied and range from commercial and industrial site screening to the construction of private boat docks.

Planning has been a function within TVA since the agency's inception. As TVA holdings grew and more land was acquired, TVA's "Land Use Forecast System" of plan

making was used to develop plans to accommodate these lands and ensure their reaching of their potential. This system was a non-rigorous process and was based on little actual data concerning land suitability, land capability, regional needs, or public values. The land use staff would simply assign a land use to a piece of property in order to hold the land under TVA control. As TVA properties were acquired, the land uses that were assigned consisted mostly of economic development uses or power generation uses, and early forecasts were focused on steam plant construction, industry, or navigation terminal sites. Norris, Tennessee is an example of a TVA planned community that is the result of the original planning practices at TVA. By the 1950's, the last master plan for TVA owned land was developed; this plan was for the Melton Hill lake area.

Since the 1950's, TVA has done little construction of new reservoirs, the only one being Tellico Lake. This area was envisioned to be a new community such as was constructed in Norris, but old problems that occurred in the traditional planning process at TVA became apparent during this time. These problems included designating far too much property for industrial development, forecasting too far in the future for development considerations, and lack of local land use controls to ensure the property would have the desired use. In the early 1970's, Richard Freeman, an attorney and proponent of proper planning practices, was hired to direct the planning operations at TVA. Mr. Freeman later went on to serve on TVA's Board of Directors. At that time, TVA had no set land planning process, but relied on the old forecasting process. This had resulted in many land use conflicts, thereby raising the anger of many local developers.

In 1979, the Reservoir Land Planning Process was developed at TVA to help facilitate the growing use demand of its lands and to help balance the competing forces of public and private use, environmental considerations and developmental pressures, and national, regional and local values. It focused on the individual reservoirs and the surrounding lands and used factual information, considered public needs and values, and looked at land capability and suitability. This new process replaced the old forecasting process and rationalized the uses of TVA property. The old planning process emphasized three main uses; recreation, power generation, and industry. The Reservoir Land Planning Process retained the power generation and industry uses and added, among others, forestry, wildlife habitats, wetlands, agriculture, management of lands for natural resource management and environmental protection.

As the new planning process is initiated for each reservoir, a team of individuals is constructed. This team consists of a team leader, who is a TVA planner, and team members consisting of various TVA specialists whose input is needed for that particular reservoir. Each reservoir team is unique and is only in place for that one reservoir, although team members may work on more than one reservoir. This method of team development has been very effective to the planning process; no additional core planners are needed and the use of TVA specialists reduces the need for much help outside the agency. The only outside contracting done by TVA for this process is for recreation planning and economic feasibility analysis which are functions no longer performed by TVA in any of its divisions.

TVA reservoir lands have traditionally been highly sought after sites for a variety of uses. Since providing river navigation is a primary function of TVA, these lands have often been the motivation for economic development within the region. Demands for the use of TVA lands have steadily increased over time which results in an intense effort at maintaining proper land use records. One of the original purposes of TVA was to manage the lands in the TVA region as a single integrated resource rather than as an aggregation of many uses. The agency is still concerned with integrated land management, but problems of information exchange and timely access to data have prevented complete fulfillment of this function. Although many barriers still exist, the problem of efficient information management has been reduced by the use of the GIS.

With the advent of GIS technology, TVA planners and resource managers began to see a way of moving towards implementation of integrated land management. The installation and subsequent upgrades of TVA's GIS provided the agency with a tool that would allow for complete inventory of the resource valley, and for evaluating the diverse demands on the use of the land in regards to its capability and suitability to support various type of development. Since the implementation of the Reservoir Land Planning Process, GIS capabilities have been used for aiding the development of almost every recent reservoir plan. The needed data has been captured, manipulated and converted into information (in the form of common scale maps) for the effective communication of the plans to TVA officials and the general public. The GIS has mostly been used as a central storehouse for data and not for much data analysis, however some derivations have been performed. Most of the data used for the development of the reservoir plans

are contained in the data base, although some data has to be gathered from outside sources. These data include archaeological data, topographic interpretations, and water quality data.

Although the ALIS will greatly enhance GIS capabilities at TVA, fundamental problems in implementation still occur. Among the most prevalent of these problems, as it is in most GIS implementations, is the expense of data base development. At TVA, one-third of the cost associated with the development of a reservoir plan is spent on data conversion. Another problem is the user's unfamiliarity with computer applications and the analytical processes of a GIS. TVA's GIS users and managers look to the GIS as a way of moving from mechanical overlaying of data on transparencies to using computer aided data analysis processes. A final problem in GIS implementation is that the user is continually behind the technology. GIS as a computer industry is constantly growing and changing, so the instant a system is installed, it becomes old technology which can create a feeling of frustration among the users. The solution is determining what the wants and needs of the organization are and knowing what capabilities are provided by the computer. Continuous upgrading of hardware and software can be expensive, so focusing on the system requirements can help overcome this feeling of helplessness.

Traditionally, reservoir land planning at TVA has focused on 1) building data bases to identify what lands TVA owned; 2) identification of land capabilities (i.e. recreation, industry, navigation, wildlife, etc.); 3) sorting through private requests for land uses and 4) allocation of land uses for specific parcels. With the advent of ALIS in TVA planning activities, most of these traditional functions will be replaced. The

construction of the two data bases will include the previously mentioned functions plus others that will facilitate a faster and more accurate planning process. As noted above, TVA is continually upgrading and expanding its GIS for the purpose of increasing its effectiveness in reservoir operation and management. Currently, GIS applications at TVA are separated into two major categories: 1) Strategic Planning and 2) Operational Land Management (Curtis, 1986).

Strategic Planning

The purpose of using GIS in strategic planning applications is not just to produce computer-aided land development plans, but to support the land use decisions formulated by the reservoir planning staff. Support functions include developing a reservoir resource data base, interpreting and analyzing the data, and developing a reservoir plan. During the strategic planning process at TVA, the public is invited to provide input on regional and local land use concerns that are deemed important in determining future directions for TVA lands. Private citizens, local, state and Federal agencies are given the opportunity to discuss these and other issues and to provide information on the data needs and the analyses to be conducted during the planning process.

Reservoir Resource Data Base Development

The establishment of a resource data base is fundamental to proper GIS implementation. By building a complete inventory of the natural resource conditions existing in the reservoir areas, TVA has access to common and integrated physical, biological, cultural, economic and demographic data. The large and small scale data

bases developed with ALIS will be used for all future reservoir plans. The data bases have 27 graphic layers with many sub-features for each layer, and include both geographic and descriptive data (see Table 1). All of the data is properly referenced to real-world coordinates in the selected map projection.

Resource Data Analysis

After all data are put into the two data bases, the reservoir planning team will use the GIS to selectively retrieve and analyze data to provide a variety of information. These include:

1) Data Interpretations
2) Capability Analyses
3) Suitability Analyses
4) Conflict/Compatibility Determinations.

Interpreted data are derived from manipulating the more technical data descriptions. For example, "various soil interpretations including prime farmland, farmland of state-wide importance, and erosion hazards are derived from detailed Soil Conservation Service (SCS) county soil survey data" (Curtis, 1986). Capability analyses are performed to provide information to a variety of resource program staffs and are taken from the interpretation of the resource data, fieldwork, and professional judgement about the land's ability to support a given use. Examples of capability data types include forest management, industrial development, navigation development, recreation development, and wildlife management. These analyses are combined with other analytical methods to develop use capability rankings for all reservoir land. Criteria

TABLE 1
ALIS Data Bases: Graphic Layers and Features

Graphic Layer	Features or Elements
Large-scale Data Base (1:500)	
Geodetic Control	GPS Points Reservoir Traverse Monuments Property Corner Monuments and Numbers Range/Township Lines (where existent) Latitude/Longitude Grid UTM Grid
Planimetric/Topographic	Building Outlines Dams Railroads Roads Rivers Marine Service Stations Levees Fill Bridges Barge Terminals Mooring Cells Elevation Points Contour Lines Normal Summer Pool Minimum Drawdown Contour Maximum Shoreline Contour Ordinary Shoreline Contour Subsurface Detail (water depths for navigational areas) Lakes Reservoirs
Floodplain	100-year Floodplain 500-year Floodplain
Political/Administration Boundaries	State Boundaries County Boundaries Municipal Boundaries Administrative Boundaries

TABLE 1 (Continued)

Graphic Layer	Features or Elements
Large-scale Data Base (continued)	
Geology	Geologic Formation (polygons)
Soils	Soil Mapping Units (polygons) Soil Sample Points
Demographics	Census Tracts
Property	Fee Acquisition Parcels Flowage Easement Acquisition Parcels Sold Disposal Parcels Transferred Parcels Subdivision Lots Dam Reservation Parcels Easements Leased Land Licensed Land Rights-of-Way TVA Dam Reservation Boundaries
Wildlife Management	Important Fishery Habitats Endangered Mussel Beds (known and expected) Threatened and Endangered Species Aquatic Plant/Vector Control Areas Wetland Wildlife Habitat Small Wild Areas Natural Areas Habitat Protection Areas
Cultural Resources	Archaeological Sites Historical Structures Historic Sites
Recreation Sites	Commercial Sites Informal Sites Sailing Lines Harbor Limits

TABLE 1 (Continued)

Graphic Layer	Features or Elements
Large-scale Data Base (continued)	
Recreation Sites (continued)	Quasi-Public Camps Beaches Public Sites Play Facilities Water Access Sites Commercial Marina
Forestry	Stand Boundaries Compartments Forest Industry Sites
Industry	Industry Sites
Reservoir Land Use	Tract Boundaries Allocated Use Forecast Use Land Cover/Land Uses
Water Related Facilities	Navigation Lights Navigation Dayboards Safety Harbor Entrance Marker River Mileage Markers Water Intake/Discharge Facilities
Private Shoreline Alterations	Boat Docks Boat Slips Boat Lifts Boat Launches
Small-scale Date Base (Scale Varies)	
Geodetic Control	Latitude/Longitude UTM Grid
Topographic	Contours

TABLE 1 (Continued)

Graphic Layer	Features or Elements
Small-scale Data Base (continued)	
Hydrographic Features	Rivers Streams
Political Boundaries	State Boundaries County Boundaries
Transportation	Roads Trails
Cultural Features	Major Buildings
Forestry	CFI Points
Soils	Soil Polygons
Wildlife Management	Threatened and Endangered Species
Off-Reservoir Facilities	

Source: Jolly, Rebecca. TVA Systems Engineer. Personal Interview, Norris, TN, May 14, 1992.

for determining capability rankings include engineering and physical characteristics of the land, engineering properties of the soil, access to transportation and labor pools, and economic criteria.

Land suitability analyses are performed by overlaying capability analysis maps with various resource data. These data can include wetlands, floodplains, threatened or endangered wildlife habitats, archaeological sites and prime farmlands. Other types of traditional land use planning data are also used in this type of analysis. These include adjacent land use, visual quality concerns, and input from the general public. Land use suitability maps are generated using the GIS to indicate the degree of compatibility or conflict between the use and environmental or other concerns. The TVA planners address whether the land should be committed to a certain proposed use based on the evaluation of all considerations. The GIS is also used to develop composite suitability maps that identify competing uses for the land, and whether or not these uses are compatible. "The nature and extent of this potential conflict are evaluated and alternatives for resolution or mitigation are identified for use in plan development" (Curtis, 1986).

Reservoir Plan Development

TVA's land use planners use the above information in a group discussion format to develop plans for TVA lands and to resolve land use conflicts. The plan's fundamental development is accomplished by allocating tracts of land for single or multiple uses. As the preliminary land use allocations are made, the new tract

boundaries are entered into the GIS data base along with any applicable attribute information. A plan map is then generated for review by TVA officials and any appropriate changes are made. The final plan is then sent in digital format to the Automated Mapping System (AMS) in TVA's Mapping Services Branch for production of the final plan map.

Operational Land Management

As the growth of GIS technology expands the focus of potential application areas, emphasis is increasingly placed on the timely and direct access to the data bases. TVA field managers and resource specialists require this access for proper on-the-ground plan implementation activities and decision making. The focus of GIS implementation is evolving from a centralized integrated data base to a more distributed, but networked, workstation concept where each user has access to the available data bases regardless of distance from the central storage area. TVA currently has GIS equipment installed in three field offices; Paris and Athens, Tennessee; and Muscle Shoals, Alabama. These workstations are linked to the central processing unit and disk drives located in Norris, Tennessee via dedicated telephone phone lines. Each of these stations support the entire array of data entry, updating, retrieval, analysis, and display functions that are available at the central facility.

Land Management Prescription Development

As in local planning agencies, TVA develops an overall comprehensive plan, called the reservoir plan, for use in managing its reservoir lands. Also as in local

planning agencies, TVA develops more specific plans for guiding site specific, on-the-ground management activities. These plans are referred to as land management prescriptions. For example, TVA foresters and wildlife biologists often work together on tracts of land allocated for forestry and wildlife management to determine specific site conditions and to develop alternative land management prescriptions. The development of the management prescriptions require the building of an extensive inventory of timber stands and analysis of wildlife habitats, developmental hazards and site accessibility. The GIS is used to store the inventory data and to perform the needed analyses. From the results of the analyses, alternative management strategies are developed and tested through the strategic planning process.

Environmental Impact Assessment

According to the National Environmental Policy Act (NEPA), one of the duties of TVA is to perform environmental impact assessments of potential uses on TVA lands. "Each year TVA receives more than 1,500 requests for the sale, lease, transfer, or license of its reservoir land. Requests include such uses as roads, pipelines, transmission lines, commercial marinas, industrial development, navigation facilities, private docks and launching ramps, and municipal facilities" (Curtis, 1986). Use of the GIS makes available much of the needed mapped and attribute data about the land in question, thus greatly reducing the time needed to carry out impact analyses. Such information is the foundation of a formal environmental impact assessment. Ease of access permits TVA resource staff to rapidly assess potential impacts and respond quickly to land use

requests. This allows the staff to focus total attention on the consequences of the proposed uses rather than on recompiling needed resource data.

The GIS also allows the reviewer to examine the wider-scale impact of the proposed use rather than having to look just at the specific site. Cumulative effects of various uses that are in close proximity to one another are now easily examined. This results in a higher level of understanding and better communication among the resource planners.

Land Records Management

Land records management is at best a difficult and complicated process. Methods of managing land records at TVA have been continually evolving over the past 60 years and have resulted in a highly complex assortment of fee, sold, and transferred land; long-term leases and easements; short-term licenses; water use permits; deed restrictions; and covenants. Keeping abreast of the continually changing land records by manual methods is labor intensive, very time consuming and expensive.

The TVA field offices have direct networked access to the GIS for more effective management of the landrights data. Much of the needed data is entered into the main data base during the reservoir land planning process, but keeping the data current is too time consuming. However, the remote workstations in the field are now able to update the data base as soon as the changes occur. Also, through remote terminals, the field offices on tributary reservoirs where no plans have been developed now have the ability

to convert landrights data that are in manual map and descriptive form into digital format.

Facilities Management

TVA district field offices are responsible for managing a wide array of capital facilities. These include transportation, utility, recreation and structure facilities. In addition to these facilities, the field offices are responsible for maintaining the grounds around the power generation and distribution areas, dam reservations and other landscaped areas. The GIS is used by remote workstations to develop a data base of the facilities including information on geographic location, description, cost of maintenance, maintenance schedule, and organizational responsibilities. This data base is used to more effectively plan, budget and schedule these activities.

Computer Aided Design and Drafting (CADD)

Although the primary function of GIS is to manipulate geographic data, it can also be used as a highly proficient CADD system. The GIS is often used in field offices to perform engineering design and drafting procedures. Examples of these procedures include road and parking lot layout, design of boat ramps and fishing piers, and development of landscape planting plans. This use is consistent with TVA objectives of obtaining as many multiple uses of its systems to increase its cost effectiveness as much as possible.

TVA is obviously implementing its GIS to its fullest use and obtaining the benefits in its various departments. The capabilities of the GIS and the large amount of

data held in the data bases are not only very valuable and useful to TVA, but could also be helpful to local governments. The next chapter explains how local governments in the region determine their information management needs and whether TVA's GIS and its data bases might be useful for local government needs.

CHAPTER IV
ANALYSIS AND EVALUATION OF FINDINGS

Introduction

This chapter presents information collected during the execution of the case studies set forth in Chapter I. The objective here is to provide a comparison/contrast foundation for analyzing the two types of cases, one being a local government that has successfully implemented a GIS and the other being a local government that desires to, but has not yet implemented GIS technology. Analysis of GIS implementation in these two types of local government yielded valuable information on the fundamental considerations of implementing a regionally applied GIS in local government.

Case studies were performed on seven local governments in east Tennessee. Two of these, Knoxville/Knox County and Johnson City, are examples of local governments that have successfully implemented a GIS. Their GISs are being used by a variety of departments within their respective agencies for both replacing outdated information management techniques and adding new areas of application. The remaining five, Alcoa, Cleveland, Morristown, Chattanooga and Sullivan County, are examples of local governments that have not yet installed a GIS, but either are planning to soon, or have some knowledge of the technology and what it has to offer. The contacts for each of these case studies were as follows; Keith Stump in Knoxville/Knox County, Don Kiel in Johnson City, Chip Woods in Alcoa, David Ellis in Cleveland, Phillip Lynn in Morristown, Yuen Lee in Chattanooga, and Tony Shipley in Sullivan County.

Analysis of the Case Studies

Knoxville/Knox County/Knoxville Utilities Board (KGIS)

In the early 1980's, various staff members of the Knoxville Metropolitan Planning Commission (MPC) began discussions on how to update existing map records and perform more efficient data analysis. John Lutz, then a staff member of MPC, was the initiator of the research into installing a GIS in Knoxville. At that time, there were 18 'official' sets of base maps of the city and the county. This was creating much confusion among various departments due to map inaccuracies, repetition of data, and non-matching of map edges. As this problem became more noticeable, Mr. Lutz assisted in forming an initial policy committee consisting of himself, David Reese of KUB, Hollis McPhetridge of Knox County, Bob Bowers of the City of Knoxville, Dick Moran of Knox County Computer Center, John Whitehead of Knox County Property Assessment and Charles Smart of the Tennessee Valley Authority to begin issuing requests for proposals (RFPs) to various GIS consultants to determine which system to install. PlanGraphics of Frankfort, Kentucky was selected to install Intergraph, a raster based GIS, as the start-up system. This system was selected due to its accurate mapping and analysis capabilities. Initial funding for the GIS was provided by means of a $5 million bond issue which has recently been repaid.

Currently, the three main users of this GIS are the city of Knoxville, Knox County, and Knoxville Utilities Board (KUB) including the water, gas, power and information services. The combination of these three entities forms the only tri-partite GIS ownership/usership in the country. At the present time, yearly funding of the GIS

is currently accomplished by each entity contributing one-third of the cost. But beginning fiscal year 1993, funding costs will be allocated according to the amount of usage by each entity. In the city, the main user is MPC which uses the GIS for almost all of its planning efforts. In the county, the main user is the Property Assessor's office which uses the GIS for all property data updates and evaluations. The Codes Enforcement office is connected to the GIS via a workstation, but it is not currently using the technology for its activities. The largest user by far is KUB which uses data concerning all utilities in the city and the county. Data base configuration for KGIS consists of one data base that is accessed by all users. Each user has its own hardware for access and is responsible for the updating and currency of its own data.

According to Keith Stump, KGIS Data Base Administrator, the organizational structure of KGIS has been very effective in implementing the GIS to its fullest potential, including managing its resources, budgeting, and training personnel. The policy board now consists of the Mayor, the County Executive, and the General Manager of KUB. John Lutz, who reports directly to the policy board, is currently the Director of KGIS and is responsible for maintaining a support liaison office structure between the GIS users and the policy board. There are currently no plans for changing this structure in order to attempt to improve its effectiveness.

The main benefit that has come from implementing this GIS is the standardization of the base maps for the city and the county. This standardization has resulted in the development of a rapid process of updating any data on the data base. The most common uses of the GIS include the generation of graphic representations of data at

common scales, and developing current property owner attributes and boundaries. Future directions of KGIS indicate a migration of the hardware to a workstation based environment. Other than this, no significant changes are foreseen for KGIS's hardware, software or organizational structure.

Obstacles encountered during the implementation and current use of KGIS include the users not taking full advantage of the capabilities offered by the GIS, the users not having a geography-based educational background, coordination between the various departments within the government, and GIS staff not providing the resources needed to maintain and update the data. In many local governments that are using GIS, employees who are comfortable with the *status quo* of operations often do not want the changes brought about by the installation of a GIS, and often do not want to share information with other departments. The keys to overcoming these problems are 1) education of both the user and the non-user, including the general public, in the fundamentals and theory of GIS, and 2) proper coordination among departments; efficient use of GIS requires coordination and cooperation among departments if full potential is to be realized.

Johnson City Geographic Information System (JCGIS)

According to Don Kiel, JCGIS Director, interest in implementing GIS technology in Johnson City, Tennessee began in 1984 thanks to the efforts of various city officials who had gathered information on this technology at trade shows and conferences. This information was presented to the city leaders, and in 1984 the decision was made to purchase and install a GIS. Since the initial uses of the GIS were foreseen to be

transportation related, funding was sought and obtained through a grant provided by the Federal Urban Mass Transit Administration. The initial cost of the GIS was $75,000. Since that time total cost of the system, including upgrades of hardware and software, has exceeded $300,000.

The system was established on an incremental use basis with three city departments as the main users; the Regional Water and Sewer Department, the Planning Department, and the Transit Department. Although this organizational structure was at first successful, indecision about present and future implementation became more prevalent. This problem was overcome in 1986 by the establishment of the Johnson City Geographic Information System department. This department provides centralized direction and coordination of the GIS for all of its applications in the various departments of the city, maintains proper project flow during actual applications, and updates and manages the city's data bases. Currently, the operating budget of the department is about $100,000 per year. This includes monetary contributions by other departmental users to GIS funding requests based on a project-by-project basis. Yearly funding is obtained through the city; there are no direct computer charges assessed to the individual departments that use the GIS.

The organizational structure of the city's government consists of the mayor, the city manager, who is the primary daily decision maker for the city, and five city commissioners. The GIS department is under the direction of the Management Services department which is headed by the assistant city manager. Mr. Kiel states that this structure has been fairly effective in implementing the GIS. Problems occur because

there is no direct involvement by the city manager, and the department is physically removed from city hall, which causes poor and lengthy communication. What is needed is more direct involvement of the city manager to enhance inter-departmental communication.

The current GIS configuration in Johnson City is an ARC/INFO based system running on a mini-computer platform. This system was chosen for its ability to share data bases with different formats, a problem the city encountered during previous hardware and software upgrade attempts. Use of the GIS in various departments of the city depends on the timing of needed programs and projects. Some departments are typically heavy users of the GIS and often have projects that need to be performed before others, so these department's projects usually take precedence. Current on-line users are the three mentioned above, but others, including the police, fire and engineering departments are expected to be on-line for direct access within two to three years.

The first data base formed for the city consisted of all of the property parcel tax maps. The formation of this data base was a pilot project that further defined the boundaries between public and private property, helped test the newly installed GIS, and indicated what was needed for future data base development. In addition, the tax map data served as a skeleton for the addition of more data on the parcels. This particular layer has been the most productive and commonly used layer in the data base. Data that is needed for the current GIS configuration include topography, elevations, location of building structures, water features and soil structures. The staff of JCGIS is currently too small to justify the use of a staff person for full time digitization of these data, so

putting these data into the data base has been a very slow process. "We would like to see expansion (of the current data base) into a regional data base that would include all county property parcels" (Kiel, 1992).

The most common use of the GIS at this time is to help support the rapid and active annexation process of Johnson City. The city is currently undertaking a series of corridor annexations on the nearby major highways leading into the city. The GIS has the capability to create presentation maps of common scale that can represent these annexations in relation to the rest of the city, resulting in higher quality information for city officials. Other benefits of the GIS to the city include allowing the option of using the GIS for various projects, particularly those that may have been impossible without the GIS, and automating all of the city's maps. Examples of those projects that were once impossible, but are now routine with the help of the GIS include; 1) attaching a limitless amount of attribute data to each land use parcel within the city and having the data instantaneously accessible, 2) the creation of a street map index based on the parcel data base, and due to the speed of the GIS, updating of the index every six months, and 3) creation of Digital Elevation Models (DEM) for determining precise locations of various structures on the surrounding terrain.

Among the biggest problems of using the GIS is demonstrating the benefits to the city's leaders and quantifying the benefits for future support. Along with this problem is the need to promote and maintain interest in the capabilities and uses of the GIS among the various departments of the city. Reluctance to using computer technology has been a significant hinderance in full implementation of the GIS within the city. Other

obstacles include maintaining adequate funding, and closing the technology gap between active, knowledgeable users and GIS uneducated non-users. "GIS is not user friendly. It does not allow a non-active user to have easy access into the system, and asking for funds from non-user higher ups is nearly impossible" (Kiel, 1992).

Future directions of JCGIS include expansion of use into other departments and changing from a mini-computer platform to a workstation platform. These changes will promote the development of a Local Area Network (LAN) within the entire city and will encourage use of the GIS by current non-users. The workstation environment will also add the capability of converting remotely sensed images into digital format for use by the GIS, and support the display and processing of the images. This function is not currently available at JCGIS. Accessing the TVA data base for obtaining relevant data for future use has been considered at JCGIS, although communication between these two agencies has not been consistent which has hindered this process. Networking between these agencies is a possibility at this time, but the immaturity of the available hardware at JCGIS in facilitating this process has not allowed it to occur. "Fiber optic technology deregulation may help this process occur at a faster and more efficient rate" (Kiel, 1992).

Alcoa, Tennessee (Blount County)

Chip Woods, Director of the Public Works Department in the city of Alcoa, Tennessee has been interested in applying GIS technology to his department's work efforts although he has not yet done so to date. He learned about the capabilities of GIS by attending trade shows and conferences and by studying the efforts of KGIS. This

department is responsible for the maintenance of the city's land fill, the water distribution system, the water treatment plant, street maintenance including storm drains and brush pick-up, and the sanitation division's work including solid waste collection of both commercial and residential properties, and maintenance of the sewer system.

The controlling government of Alcoa consists of the board of commissioners and the city manager, who is the immediate supervisor of Mr. Woods. The commission is responsible for setting the governing policies and the city manager is responsible for effective implementation of these policies. Mr. Woods states that his particular department is always striving to perfect its methods and procedures, but he sees no necessary changes in the government's structure to improve its effectiveness.

Current computer application within the government consist of a number of stand-alone PCs that are equipped with standard software including spreadsheet, word-processing and graphic applications. The Public Works department has a few specialized software programs for use in surveys and hydraulic calculations, but these are unique to this department. The Electrical department houses the city's only digitizing tablet and available AutoCAD software. AutoCAD is currently used to convert the city's base maps into digital format, although storage of data and records is performed in both manual and analog form. The Public Works Department does not perform actual planning operations, but it does work closely with the Planning Department in helping to review subdivision plats for proper additions of water and sewage facilities.

Current progress in implementing GIS in Alcoa consists of a few initial fundamental steps. The entire city has been aerially photographed and consultants have

been hired to convert this and the AutoCAD formatted data into a form that can be used by a GIS. No decisions have been made on the specific types of hardware and software that will be used during the start-up phases of implementation. It not known now exactly which data will be included in the data bases that will be constructed, and decisions are still being made on which data is pertinent at this time and which can be added later; these decisions are commonly based on affordability. Accessing TVA's data bases has not been considered as an alternative for gaining additional data, but this idea was received as a viable option. Funding for the GIS will be provided by contributions of 30% of the total cost by the Water and Sewer Department, the Electrical Department, and the general budget of the city. Implementation of the GIS is expected to begin fiscal year 1993 and be completed in three years.

Benefits that a GIS would bring to this department include a complete inventory of all utility lines, especially those that have been buried for aesthetic reasons. This inventory would facilitate a more accurate utility line improvement and updating process. Other benefits for the government as a whole include using the data base as a starting point for construction of any new utility lines for new developments. Other departments that have expressed interest in accessing the GIS include the Electric Department, and the Planning Department. Also, the Blount County government has expressed interest in using the GIS for enhancing its emergency 911 system. The only new directions that are foreseen for the departments that will be using the GIS are those that increase the efficiency of current work efforts, and further emphasis on existing programs. This

includes a rerouting of the brush pick-up system and developing a curb-side recycling program.

Obstacles to implementation of the GIS include budgetary constraints and the little interest shown by past city managers to using the technology. Also, most of the employees that would be using the GIS have expressed an aversion to learning the new processes that would result from implementation. Even though these problems are hard to overcome, it is fortunate that all of the relevant department heads have been cooperative in seeing this project through to completion.

Cleveland, Tennessee (Bradley County)

The Bradley County Election Commission, under the direction of David Ellis, has been exploring the use of GIS implementation in the city of Cleveland, Tennessee. The Election Commission covers all elections, local, state and Federal, for Bradley County and keeps up-to-date records on each registered voter that lives in the county. These records include the voter's name, address, phone number and political division and are used for offices such as the school board, the county commission, the state representative, and congressional seats. The county has recently implemented the 911 system which required updating each record to the new addressing system.

Mr. Ellis, the county's Registrar-At-Large, has recently completed a redistricting process for the county voters. During his research, he found six 'correct' copies of Bradley County base maps, and many of these, among other errors, had different street names for the same street. Overcoming this problem is one of the main reasons Mr.

Ellis is interested in implementing GIS. Consultations have been performed with other relevant departments such as the Highway Department, the County Engineer, the State Engineer, The Department of Transportation, and the Chamber of Commerce, to determine the level of desire and need of a GIS in Bradley County.

Updates to the county's base maps are currently done on a piece-meal basis resulting in non-consistency of data among departments. Even though this is a problem that is widely known, it is difficult to correct since neither department has the budget nor the authority to create a single set of correct base maps. Current record keeping efforts in the county are based on state mandated laws that require that at least two copies of most records be held in applicable departments. City and county officials, headed by the Election Commission, have gone to the state government and helped implement changes in the laws that have reduced the amount actual paper data that is held. Even though this was considered a victory to the city and county officials, record keeping in Bradley County is still done in old-fashioned manual methods and each department is displaying the typical 'my turf' attitude when it comes to sharing their particular data. "If you want to provide (government) services at the most economical rate, you must consider GIS" (Ellis, 1992).

Current computer applications in the Election Commission include six Zenix hardware terminals that run a specialized program that contains all data relevant to each registered voter in the county. This type of hardware system is typical to the other departments within the county and city. During the research and installation of this system, Mr. Ellis began attending trade shows and conferences and began to become

interested in the abilities of GIS to simplify the record keeping processes. He began consulting with other departments that would be interested in this technology and has slowly developed a city and county-wide interest in GIS implementation. As interest in GIS grew, consultants were sent RFPs and the PlanGraphics consulting firm was chosen to install the Intergraph hardware and software system. This system was chosen because of its ability to perform 'engineering' applications and 'what if' scenarios. A final implementation date has not yet been set, but all of the components, including interdepartmental interest and funding considerations, are in place.

The data bases for the GIS will be built by digitization and by collecting any and all relevant data from surrounding government entities including state and federal agencies. TVA data bases are considered to be at too large a scale to be usable for Bradley County. Applicable data for the county include emergency 911 addresses, architectural renderings, land uses, parcel data, deeds, school system data including student attributes and bus routes, real estate attribute data, and utilities. Funding for the GIS will be the responsibility of the city government, the county government and the utilities department with each entity providing a third of the cost. After the GIS is installed and running, each of these entities will be charged a small monthly fee for the maintenance of the data base and the hardware and software.

The only new direction that is foreseen for the city and county from GIS implementation is the enhancement of the existing 911 response system. All other applications will be improved upon, but not changed. Benefits that can be gained from the GIS include a more accurate prediction of voter response, correct management of all

of the types of divisions of the city that are applicable to the various departments, having building blueprints for emergency response crews, and a reduction of the work load of city personnel.

Obstacles to GIS implementation include inter-departmental agreements on which department is responsible for maintaining the data base, which will contribute funding and which is responsible for repairs when the system malfunctions. Also, there are discrepancies on which department will audit the data base for updates, who will be the data base manager and who will provide him/her with the authority. Although these obstacles are large, they are fundamental to any new GIS implementation process in a local government and easy to overcome by following the proper procedures.

Morristown, Tennessee (Hamblen County)

Phillip Lynn, Morristown's City Engineer, is attempting to implement a GIS for the city's and county's use. The city engineering office is responsible for all engineering efforts and construction functions for the city of Morristown. The office of the City Engineer is directly responsible to the City Administrator's office which answers to the mayor and the four member council. The engineering office is one of several that is equal in status in the hierarchy of Morristown's government; included in this level of government is the planning department with whom the engineering department closely works. The engineering department does not assist in long range planning activities, but does perform short-range planning for specific projects. No changes are needed to

improve this form of government; only if the city began to grow at a faster than expected rate would modifications to the government's structure be valid.

Current computer applications in the city of Morristown include a few stand-alone PCs that are running standard office software applications. The engineering department has a small, limited capability GIS called MAP/INFO, but this has proved to be insufficient to the needs of this department. This department has also been using AutoCAD for the purpose of storing as many of its maps in digital form as possible. Although this has been fairly effective, new technological developments have dictated that this department convert this data into a format that is compatible to a GIS. Research is currently being done into how to accomplish this in the most efficient manner possible. The problem with this process is that there is not enough manpower available for a full-time effort on this project. Organization of records and data is accomplished by traditional manual methods of hanging files for maps and file drawers for attribute data.

Mr. Lynn has learned about GIS through reading various trade journals and attending engineering conferences and trade shows. He has been a user of AutoCAD for 10 years and has been staying current on developments to the GIS field. He feels that a GIS would help the city of Morristown by filling "holes" in the available data. By this he means collecting data that is needed but is not yet available. The GIS would also help the data be more readily accessible for the intergovernmental users. Any data that is needed by these various departments currently has to be manually accessed and retrieved, which causes a backlog of work within the government and inevitably raises the expense of the project at hand. Using a GIS would also increase the speed of implementation of

various projects. Mr. Lynn foresees the creation of a multi-agency, multi-departmental GIS which would greatly enhance the communication, data updating and data exchange efforts of these departments. The latest available information for the city of Morristown is consistently 12-24 months old.

The data bases that will be built for the GIS will include property ownership data, land values, TIGER files (Census data), and utilities. Topographical data is the only data that is seen as needed, but is not readily available, for enhancing the city's work efforts. Access to TVA's data bases has been considered, but it is felt that these data bases would not hold any usable data for the city. Property information will be the key identifier for all of the data in the data base. These particular data are held in the Hamblen County Tax Office which would act as the home base for the GIS.. Initial funding for the GIS will come strictly from tax revenue, and future yearly budgetary funds for the GIS will be taken from the individual departmental users based on the amount and form of usage.

Specific hardware and software configurations have not been considered at this point, but ARC/INFO's capabilities have been explored and it has been determined that it is not compatible with Morristown's needs. The general configuration of the GIS will be a system of workstations that form a Local Area Network (LAN) connecting each applicable department within the city government.

Obstacles to implementing the GIS up to this point include converting the available digital files to a form that is GIS compatible and inputing the data that is still in paper form. No political problems have occurred that traditionally hinder GIS

implementation, although this may change as future development occurs and new data needs are seen and are addressed.

Chattanooga, Tennessee (Hamilton County)

Yuen Lee, Principal Planner for the Chattanooga/Hamilton County Regional Planning Commission (RPC), has been interested in implementing GIS in her department for some time, but has not yet done so. The RPC is the planning organization responsible for performing planning functions for Hamilton County, Chattanooga and surrounding small municipalities such as Signal Mountain and Soddy-Daisy. There are three basic operations performed in the (RPC); 1) advanced planning, 2) operations (zoning, subdivision plat review, etc.), and 3) downtown/riverfront planning. The RPC attempts to balance its planning functions between the city and the county, but past funding problems have dictated that most of their planning efforts concentrate on the city.

The RPC serves directly under the 15 member Chattanooga Planning Commission, but is not an actual part of the Chattanooga or Hamilton County government hierarchy. The Planning Commission acts as an advisory board to the city's executive board which consists of the Chairman of the Planning Commission, the Mayor of Chattanooga, and the County Executive. Even though the RPC is not a formal division of the area's governments, it is still closely tied to these governments and acts and reacts with them daily, often in the form of having its paper work (i.e. payroll checks) processed through the city's system, and in the functions it performs.

Current computer systems in the RPC consist of a few WANG terminals that are used strictly for word-processing, two IBM compatible computers that are used for transportation planning efforts, bookkeeping and small analysis projects, and one Macintosh for desk-top publishing. Organization of the RPC's data and records is performed through manual methods. Maps are stored on Mylar and attribute data is mostly kept in filing cabinets. A Data Base Management System (DBMS) is used to keep most of the subdivision and zoning data, and efforts are currently underway to convert the Mylar maps to digital form although these are strictly for graphic representation and will not be geo-referenced.

Ms. Lee began learning about GIS when she was a student at The University of Tennessee's Graduate School of Planning. She has kept current with changes in GIS technology through reading trade magazine articles and attending conferences and workshops. Even though implementing and using a GIS is not her primary job responsibility, she feels she must keep current on the technology since it is becoming so prevalent in the industry.

Past GIS implementation attempts in the city of Chattanooga have been sporadic and piecemeal at best. The city was using a small GIS in the late 1970's called IMGRID for the purpose of site screening and land use analysis, but this proved to be inadequate to the data analysis needs of the city and the county. In 1982, the Power Board attempted to implement a GIS in conjunction with the Planning Commission, but the attempt was meager and it rapidly failed. The Power Board has a large budget, but was unwilling to use much of it for the GIS. In 1984, ERDAS, a package for analyzing

remotely sensed data, was installed. This again proved to be inadequate as its geographic information processing abilities are very limited. In 1990, Don Gibbs of the City of Chattanooga Public Works Department began using a small GIS for his department's work efforts and began to try to develop interest in GIS among the County officials, the Power Board and the Water Department. This attempt failed due to budgetary and political constraints and the GIS was never fully developed. Currently, there is not a GIS in active and productive use in either Chattanooga or Hamilton County, but since prices of GIS hardware are dropping, the county is again exploring the use of GIS.

In 1988, the Environmental Protection Agency (EPA) began a pilot project studying the effects of storm water drainage on ground water. Chattanooga was chosen as the city on which to perform the project and to act as a model for other cities. The EPA collected all necessary data and used ARC/INFO to process the data into information. The project was finished in 1990 at which time the EPA left the city, but donated the data to the city officials. This data is still available for use and will be so considered when and if a GIS is implemented.

Ms. Lee sees a number of ways that a GIS would help her department in specific and the city and county in general. The most important is the reduction of duplication of data, resulting in quicker and easier access. Better analysis methods could be used for the RPC's planning efforts and data would be more accurate and reliable. Finally, the GIS would possibly introduce a more productive method of communication for the various departments in the governments.

New directions and benefits that a GIS would offer the RPC include having access to data that is needed, but is not yet available. These data include soil structure, geology, and groundwater. These data would make analysis of the county more effective and easier to accomplish. New applications of analysis include ground-water protection, neighbor planning and zoning patterns. A final benefit is the reduction of needed manpower for the performance of analysis and planning efforts. Data bases for the GIS would be built around existing data and integration of the currently needed data. Initial funding for the GIS would be provided by grant money that was obtained by the EPA project and applying for other grants from the state and Federal governments. Yearly budgeting is seen as coming from earmarked donations by the city and county. The donations would go to a general GIS fund set aside for specific uses.

Specific GIS hardware and software has not been chosen but research has been conducted into the capabilities of ARC/INFO and it is felt that this system offers the greatest potential for applications. Accessing the United States Geographical Survey's (USGS) and TVA's GIS has been considered as an alternative or addition the Chattanooga GIS. Funds are available for the addition of a workstation that has the capability to read the data in these two agency's data bases, and consultations have occurred among these agencies, but no final decisions have been made.

Sullivan County (Blountville, Tennessee)

The Sullivan County Reappraiser's Office, under direction of Tony Shipley and under control of the Reappraiser and Property Assessor's Office, has considered

implementing GIS technology for the more efficient execution of its duties. "This organization operates much in the same way as it operated in the 1800's" (Shipley, 1992). The Reappraiser's office is responsible for state mandated reappraising of all property parcels within Sullivan County. A three year effort is required to perform the reappraisals for all of the 80,000 parcels in the county, and this effort is begun again every fourth year. The reappraisals consider data such as land use analysis, soils (types and quality), topography, and property improvements.

Sullivan County is a legal government entity that represents the county (both rural and urban) and the portions of all cities that fall within the county's borders. The county has a very complex political strata consisting of both city and county officials. Due to the annexation efforts of Kingsport and Johnson City, polarization of these officials has occurred along rural and city lines. This has resulted in an unstable political arena that fosters difficult work and communication efforts. The biggest problem in the county that relates to GIS implementation is that the county has no mapping and engineering departments, and the people who are doing this type of work within county departments have no formal training in cartography or geography. These problems are non-existent in the near-by cities (i.e. Kingsport, Bristol and Johnson City) which makes them more progressive and more apt to implement new technologies.

Mr. Shipley emphasized that the major change that should be made to Sullivan County government is the establishment of more mid-level positions in the county. Currently, there are many elected official positions and many clerk level positions, with few positions in between. In-house changes to the methods of data and record keeping

in the Reappraiser's office include the installation of a digitizing tablet, and collecting all data that is in digital form and have it centrally served by a mini-computer that is accessible by entrance terminals at each clerk's desk. The digitizer would be used to duplicate, enhance and eventually take over the process of conducting 'cuts and splits' of the property parcels. Current computer applications in this office consist of stand-alone PCs that are running standard office software. The Property Appraiser's office is networked to Nashville, Tennessee for the purpose of accessing and storing applicable property information, but there are no information systems currently being implemented in this office. Data organization within this department is done by traditional methods of hanging files and tax roll books.

Mr. Shipley learned about GIS through his work as a Targets Intelligence Officer in the Army Reserve. He acts as a manger of intelligence within his unit thus has had much contact with GIS related concepts and has much hands-on experience with military applications. He has been the sole initiator for use of GIS in Sullivan County, but is increasing the interest of other county officials. Future directions that are foreseen for this office, if Sullivan County implements GIS, include a reduction of the in-house staff, retraining the staff for other, more applicable jobs such as field data collection and digitizing, streamlining of the management, and the possibility of selling the collected data to other departments such as real estate offices, banks, appraisers and emergency response crews.

Hardware and software that Mr. Shipley is considering include IBM workstations that support ARC/INFO, and Hitachi digitizers. Preliminary data to be collected for the

data bases include land parcel data, utilities, and rights-of-ways (ROWs). This would expand after implementation to include data that is applicable to other departments. There is a problem of communication and competition among the various department of Sullivan County which is preventing the possibility of networking the existing computer system. Mr. Shipley feels that this will be a significant factor in future data exchange attempts with the GIS.

Gathering of initial funds for the GIS has begun. The method used is simply foregoing traditionally applied annual expenses such as new car purchases and earmarking those dollars for the GIS. This method was effective until the County placed a freeze on all of the department's budgets two years ago, but this is not expected to continue past this fiscal year. The yearly budget for the GIS will be supported by charging users for the requested data and turning this money directly back into the operating budget. No sharing of costs among departments is foreseen in the near future due to their current lack of understanding of GIS concepts and their different political agendas.

Problems encountered in implementing GIS in Sullivan County are two-fold. First, education is a key factor. The county officials must be educated in what GIS can do for the county government as far as increasing its effectiveness and raising its revenue. The various departments within the government must become educated in how the GIS can enhance their work efforts and increase communication and cooperation. Secondly, separate political agendas are a factor. Polarized government officials must learn to work together and understand the benefits that a GIS can offer, and realize that

the GIS would not change the course of the government itself, but just improve the government's service to the public. Department heads must overcome the 'my turf' attitude and be more willing to share their respective data for more effective work processes. If these problems are overcome, implementation of GIS can be relatively painless and very effective.

Comparison of the Case Studies

For the purpose of conducting the research for this thesis, case studies were performed on seven local governments in the East Tennessee area. Two of these local governments have successfully implemented GIS technology and the other five have attempted to implement, or have researched the feasibility of implementing a GIS, but have not yet done so. Knoxville and Johnson City, Tennessee have successfully implemented a GIS within their respective governments. Although Knoxville is using the Intergraph system and Johnson City is using the ARC/INFO system, both have successfully integrated their GISs in most of the various departments within their governments and have used their GISs for many applications. Each of these departments has become, or is becoming, a proficient user of the GIS for its specific applications. There are still a few departments in each government that have not yet become users, but through the ability of local and wide area networks (LAN and WAN), they have the potential to become active participants in the use of the GISs.

A contributing factor to the success of the GIS is the network configurations. Each of the two governments has a WAN that connects each individual terminal or

workstation to the GIS data base. This allows the various departmental users to access their own relative data without disturbing other department's data which results in reduced costs in time and money for data access. Other benefits of the GISs are comparable for each government; standardization of base map data, easy and rapid access to data, and increased and enhanced abilities of departments to perform their respective jobs. Obstacles to effective use of the GIS's are also comparable. These include interdepartmental conflicts about sharing data, aversion to using new technology, and educating the city officials in the capabilities that GIS has to offer.

The remaining five case studies were conducted to gather information on local governments that have not yet begun to use GIS technology. The case studies were performed on either county or city governments depending on which was interested in GIS technology, and include Alcoa, Tennessee (Blount County), Cleveland, Tennessee (Bradley County), Morristown, Tennessee (Hamblen County), Chattanooga, Tennessee (Hamilton County) and Sullivan County (Blountville, Tennessee). All of these local governments are constantly changing and maturing which makes them excellent candidates for the successful use of GIS.

All of these governments are currently using standard PC-based office application software including spreadsheets, word-processing and data base managers. These applications have offered users the opportunity to become familiar with basic computer applications and become accustomed to using this technology in their daily operations. Some of these governments, including Alcoa, Morristown and Chattanooga have begun to convert their data to digital form for the purpose of future integration into a GIS and

are using this data and CAD software, such as AutoCAD, for the production of high quality map graphics. Planning for GIS implementation has reached varying stages within each of these governments. Cleveland, Alcoa and Sullivan County have not yet begun to integrate any form of GIS technology within their respective governmental departments, but steps have been taken to acquire remotely sensed data, plan for initial and future funding, integrate the GIS in various departments and provide for data base development. Chattanooga and Morristown have had previous failures in implementing GIS, but are still pursuing this technology as a valuable resource to the government.

Obstacles to integrating GIS have been common throughout each of these governments and are similar to those encountered in Knoxville and Johnson City. The most prevalent problem seems to be education. City officials who have the power to help GIS implementation become a reality often do not understand the potential benefits GIS can bring to their governments. Overcoming this obstacle is a tremendous task and often takes much lobbying and persuasive efforts on the part of the departments who wish to use the GIS. Other obstacles include the standard poor attitude of the various departments within a government about sharing resources. data or assistance with other departments, obtaining adequate initial funding, and gaining comprehensive and continuing support among the potential departmental users.

CHAPTER V
SUMMARY AND CONCLUSIONS

Summary

Geographic Information Systems are rapidly becoming an integral part of our society. Many agencies, both public and private, are becoming more and more interested in what GISs have to offer and what they can do for their organization. Even though GIS technology has existed for more than 20 years, it has been only within the past 10 to 15 years that larger municipalities have shown an interest in using this technology, and it has been only very recently, with hardware prices dropping and software capabilities increasing, that small local governments have been able to actively pursue implementing this technology.

GISs have the ability not only to produce high quality graphics, but also to store, manipulate, and analyze a large variety of data for the generation of many types of information. This ability has far-reaching effects in a local government, and projects that were previously performed under laborious conditions or were considered impossible can now be performed with great ease and high accuracy. GIS trends indicate that local governments will soon have to contend with four major changes in their standard and historical methods of operation. Theses four changes are:

1) Data Integration. New developments in information management are increasing the ability of GIS to integrate more diverse data types. "Creating a rich multi-media environment that includes maps; satellite images; aerial photography; architectural and engineering drawings; land records; survey information; scientific, demographic, and business data; document images; photographs; videos; and sound...in digital form" (Forrest, 1992).

2) Technology Integration. Differences between GIS, AM/FM, CAD, satellite imagery and other computer software designed to manipulate spatial data are rapidly disappearing. GISs now routinely offer capabilities that were previously only found in separated technologies.

3) System Integration. Geographic information processing is being incorporated into other more standard information systems and computer applications. These combinations are creating hybrids that offer the user previously unheard of applications.

4) Creation of a New Geographic Infrastructure. Current applications of GIS are extremely diverse and include market analysis, site selection, property development, urban planning, emergency response, etc. These applications are slowly being incorporated into an 'information infrastructure' that over time, and through the use of communication advances such as fiber optics and Integrated Services Digital Network (ISDN), will cause these uses to function as an integrated whole.

These changes are beginning to occur, so local governments need to be conscious and aware of how data are processed and should begin applying these new technologies as much as possible.

GISs are typically used within a local government in specific applicable departments such as the engineering department, the utilities department, and the planning department. Among these various departments, the planning department is usually a high level user. Implementing GIS in a local government's planning department can often disrupt the *status quo* of operations. Installing new computer equipment can be disruptive to the physical layout of the office and using the hardware and software can be intimidating to personnel who are used to familiar, more traditional methods of operation.

On the other hand, the opportunities that a GIS can bring to a local government far outweigh and quickly distance the initial problems. More efficient and accurate data

analysis and manipulation can be performed and the generation of high quality graphics is a ready possibility. Graphic and attribute data can be converted from manual to digital form; this conversion will reduce data duplication, eliminate edge matching problems, create standards for map generation and provide a central storage area for data use by other departments within the agency. Having data in a central storage area enables the agency to integrate information across its organization so that it can shared, interrelated, and used among different departments or groups. This data and information sharing ability is a key factor in the success of the implementation and use of the Tennessee Valley Authority's GIS.

With the inception of the Tennessee Valley Authority in 1933, and with its help and intervention, the Tennessee Valley region began to overcome its poverty, illiteracy and environmental problems. TVA began its regional revitalization efforts with the construction of a series of hydro-electric dams that were intended to tame the Tennessee River and generate electricity. This provided many new jobs to the area's residents and ultimately helped revitalize the region's economy. Through its work in its original missions of power generation, navigation and flood control, and through its growth and expansion into other areas of regional concern, TVA established new standards in power generation, fertilizer production and natural resource management. While setting these standards, the agency has always collected, managed and analyzed various types of data and information. This process was carried out in time-consuming, laborious manual methods until the introduction of GIS technology within the agency.

With the establishment of its first GIS in the early 1970's, TVA ushered in a new era of computer technology use within the agency. TVA is currently converting its GIS to an ARC/INFO based system that will serve its various interagency users through a wide area network (WAN) of workstations. The two data bases for the GIS contain a wide variety of data that is applicable not only to reservoir planning, but to forestry, water quality, archaeology, wildlife management and other TVA functions. The data bases are built at two scales for the purpose of containing the general data for large areas within the TVA region, and to include enough detail to offer assistance and relevance to site specific applications. This GIS configuration is expected to become fully operational in July, 1992.

TVA is applying its GIS to a number of uses including its Reservoir Lands Planning operations. The Reservoir Lands Planning Division of TVA performs two basic operations; strategic planning and operations management. Both of these operations are performed for each TVA owned reservoir by a planning team that consists of a TVA planner, acting as team leader, and a number of TVA specialists from other applicable divisions. This team's function is to develop a land use plan for the specific reservoir on which it is assigned. After completion of each reservoir plan, the team is dissolved and a new team is formed for the development of the next reservoir plan. This method of operation is known as the Reservoir Land Planning Process. This process is greatly supported by the capabilities of TVA's GIS and will be enhanced by the implementation of the Automated Land Information System (ALIS).

The formation of the ALIS is among the most prevalent of TVA's current projects. The ALIS has been designed to support multiple projects and multiple users and provide interactive analyses and immediate access to information. The system will expand information use and analysis capabilities for land use reviews, environmental evaluations, monitoring shoreline development and encroachments, natural and cultural resource management, and the analysis of sensitive environmental issues and policies. Initial start-up of the system and the system applications to the pilot project is expected to begin by July, 1992.

Conclusions

Changes in the way a local government organizes and manages its respective data are inevitable and must be reckoned with in order for that government to maintain its desired level of growth and productivity. Using obsolete data and information management techniques will adversely affect each individual within that local government and those in the surrounding area. Growth processes will be slowed, developers will incur increased costs, and in the end, the taxpayer, as always, will suffer. GIS offers a way of avoiding these problems by providing a method of information management that is unparalleled in capabilities. The functions of local government require information that is similar to the information used by any governmental agency, but it can be specific for any particular local government (see Table 2). By not having, and or using, a GIS, many local governments are forfeiting a large potential for improvement not only in the daily workings of the government, but in the daily lives of its citizens. This unmet

TABLE 2
Functions and Applications of Local Government

Functions	Applications
Health and Safety	Building Codes Disaster Preparedness Fire Services Health Services Police Services Safety Services Sanitation
Public Works	Buildings and Structures Forestry Services Transportation Utilities Planning Engineering General
Recreation and Culture	Cable Television Services Community Events Historic/CulturalPreservation Recreational Facilities Education
Urban Development	Business Regulation Economic Development Environmental Amenities Harbor Management Housing Land-Use Control/Mapping Neighborhood Preservation Planning Demographic Analysis General
Administration	Equipment Maintenance Information Services Records Management

TABLE 2 (Continued)

Functions	Applications
Finance	Budget Administration Property Assessment Revenue Collection
Management	Coordination of Services Elections Legislative Activities Long-Range Planning Policy Development Districting Land-Records Management

Source: Huxhold, W. An Introduction to Urban Geographic Information Systems. Oxford University Press; Oxford, UK, 1991.

potential may someday be the deciding factor between prosperous growth or stagnating stability.

Although some local governments have successfully implemented GIS technology and have begun to reap the benefits, this has typically occurred in larger municipalities. Those smaller governments that have shown an interest in GIS, but have not yet begun to install a GIS, will soon begin to fall behind because of their indecisiveness or inability to do so. Perhaps these smaller local governments are thinking of using GIS in too small a scale. Examining the tri-partite configuration of KGIS proves that local governments can work cooperatively in implementing GIS technology for the benefit of all of those involved. It is highly feasible that small local governments can join forces in sharing funding, gathering needed data, and training users for installing a shared, networked GIS. GIS is a tool that can enhance any government's processes if it is understood and used

to its full potential. Unfortunately, problems encountered along the way very often cause governments to cancel or postpone their GIS programs. It is unfortunate that more and better coordination among Federal, state and local agencies for GIS has not occurred. "The state (of Tennessee) has had a slow and weak start in coordinating GIS use" (Ellis, 1992). Piecemeal GIS installation among local governments may result in a "patchwork quilt" of data bases, basic GIS hardware and software and standards of installation and operation.

Education of city officials who control budgetary and capital allocations is a fundamental key in establishing a GIS in a local government. Many city officials still retain the concept that GIS is simply a tool for producing high quality graphics, so those department heads or departmental workers who are familiar with the capabilities of a GIS should be obliged to inform their superiors of the potential that a GIS can offer their government. As the education process proceeds, those who are teaching the non-GIS literate people should try to instill a sense of becoming receptive to new technology. Older, manual methods of information management can take on a new light and be seen as obsolete as faster, more accurate and more efficient methods of information management are introduced.

Local level government officials are often apprehensive of any changes in operating procedures for fear of losing their positions through departmental reorganization. But new technology will often improve departmental operating procedures and reduce the need to hire new employees by enhancing the efficiency of the performance of current employees. Newer generations of elected officials are more

informed on technological developments and are more willing to learn about GIS, but these officials must be allowed to lead without interference from older, entrenched methods of governmental procedures. "Future GIS users should not be prevented from realizing the full benefits of the perfect GIS world because of perceived limitations by today's generation of users" (Keating, 1992).

After a GIS is successfully installed and running in a local government, communication becomes "the most important key in keeping the GIS a vital resource" (Kiel, 1992). Efforts to expand use to the various departments within the local governments must be constantly enforced. If new departmental users begin to realize the benefits of the GIS, they can help to discover more and more application areas that involve not only their department, but other departments as well. A problem exists of proving to the departments that are hesitant to use the GIS that it will not displace or replace the department's personnel, but that the department will be able to retain its workers and possibly provide them with opportunities for education and advancement. If the GIS is being used as an extension of a separate department set up just for the GIS, this department can act as an in-house consulting firm for the other departments and provide technical assistance for the users that are not familiar with the GIS. This department can also act as a distribution center for maps for the general public, thereby creating a new source of revenue for the local government.

TVA often acts as just such a distribution center for maps, but the data held in the GIS data base is perceived by many of the local government officials interviewed in the case studies as being at too large a scale and unattainable, thereby not suitable for

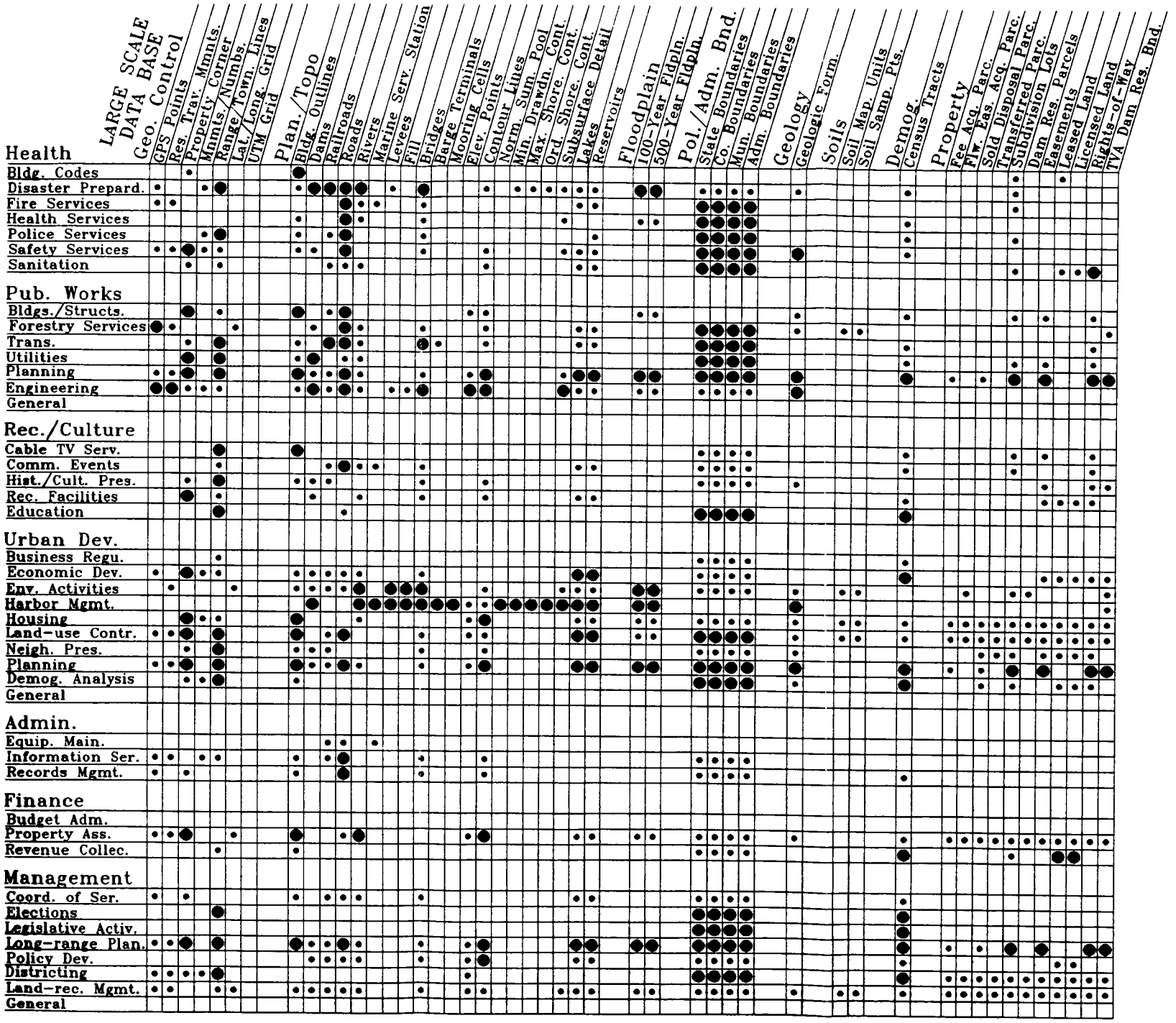
use. Even with this perception, Alcoa and Chattanooga were very interested in accessing data on TVA's data base that pertained to the surrounding rivers and river basins. This data would be very applicable to assessing flood damage control, and planning for river based operations. TVA's data base is an excellent storehouse of a variety of data that could be used by local government, although not all of the data is applicable.

The accuracy, scale and amount of coverage of the data has a large bearing on its usefulness. The data in TVA's data bases are remotely sensed and captured for its GIS to a very accurate degree by satellite platforms, and contains data at a large scale for the area within a one quarter-mile boundary around the reservoirs, and data at a small scale for the entire TVA region. These two data bases are particularly useful for the local governments that are located near the TVA reservoirs, but all local governments within the TVA region would find them helpful. The scale of the two data bases is comparable to the common scales used by local governments in their mapping operations. The large scale data base is being built at a scale of 1:500 and the small scale data base will be variable in its scale depending on the source and the use of the data. Local governments often use larger scales such as 1:800, which has less detail and is more general in the information that a map at that scale can present. A scale of 1:500 can present a significant amount of detail, although more detail is often needed by various departments within a local government.

By comparing the functions, and thereby the information needs, of local government to the available data in TVA's data base (Table 1), a comparison of supply and demand can be formed (see Figure 11). The functions of local government all

Graphic Layers and Features of TVA's Data Bases

Functions of Local Government

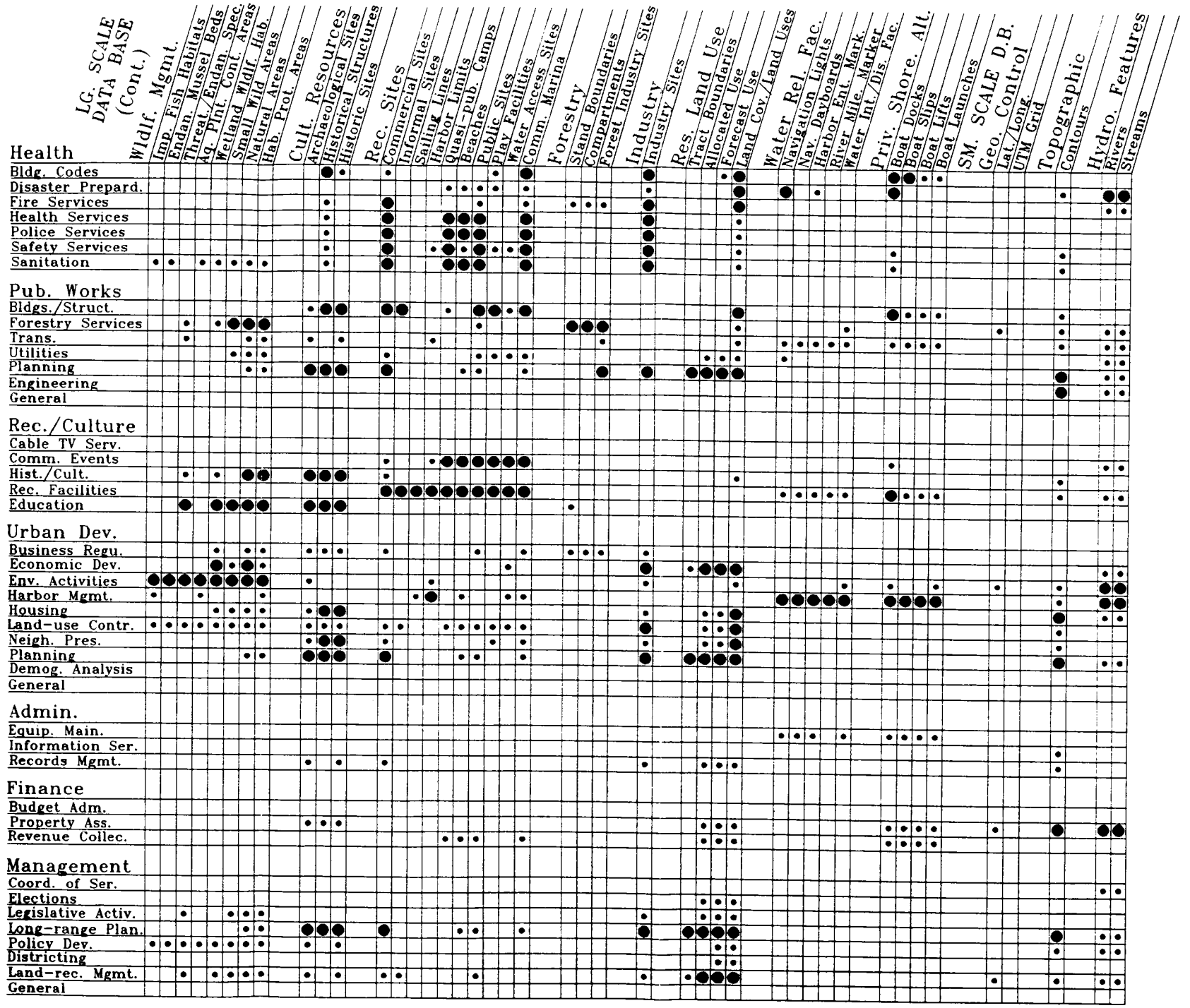


- **Very Useful**
- **Somewhat Useful**

FIGURE 11
Currently Available TVA GIS Data of Potential Use by Local Government

Graphic Layers and Features of TVA's Data Bases

Functions of Local Government



- **Very Useful**
- **Somewhat Useful**

FIGURE 11 (Continued)

Graphic Layers and Features of TVA's Data Bases

Functions of Local Government

	SMALL SCALE DATA BASE (Cont.) Political Boun.		Transportation		Cult. Features	Forestry	Soils	Wildlf. Mgmt.	
	St. Boundaries	Co. Boundaries	Roads	Trails	Major Bldgs.	CFI Points	Soil Polygons	Threat/Endan. Spec.	
Health									
Bldg. Codes					●				
Disaster Prepard.	•	•	●	•	●				
Fire Services	●	●	●	●	●		•		
Health Services	●	●	●	•	●				
Police Services	●	●	●	•	●				
Safety Services	●	●	●	●	●				
Sanitation	●	●	•	•	●		●		
Pub. Works									
Bldgs./Strutc.					●				
Forestry Services	●	●	●	●		●	●	•	
Trans.	●	●	●	•	•			•	
Utilities	●	●	•		●		•		
Planning	●	●	●	•	●		●		
Engineering	•	•	●	•	•		●		
General									
Rec./Culture									
Cable TV Serv.	•	•			•				
Comm. Events	•	•	•	•					
Hist./Cult. Pres.	•	•		•	•			•	
Rec. Facilities				●					
Education	●	●	•					●	
Urban Dev.									
Business Regu.	•	•							
Economic Dev.			•		•		•		
Env. Activities	•	•	•				●	●	
Harbor Mgmt.									
Housing	•	•							
Land-use Contr.	●	●		•	•		•	•	
Neigh. Pres.					●				
Planning	●	●	●	•			●		
Demog. Analysis	●	●							
General									
Admin.									
Equip. Main.	•	•	•						
Information Ser.	●	●							
Records Mgmt.									
Finance									
Budget Adm.									
Property Ass.	•	•	•	•	●				
Revenue Collec.	•	•							
Management									
Coord. of Ser.	•	•	•						
Elections	●	●							
Legislative Activ.	●	●						•	
Long-range Plan.	●	●	●	•	●		●		
Policy Dev.	•	•						•	
Districting	●	●							
Land-rec. Mgmt.	•	•	•	•	•		●	•	
General									

● **Very Useful**

• **Somewhat Useful**

FIGURE 11 (Continued)

demand specialized types of data which TVA's data bases may or may not be able to provide. The following matrices show in graphic form which data in TVA's data bases are applicable to the information needed by local governments. The reader should note that some of the most applicable data that is in TVA's data bases include those found under the headings of Planimetric/Topographic, Political/Administrative Boundaries, Wildlife Management, Cultural Resources, Recreational Sites, Reservoir Land Use, and Transportation. These data are common to local government needs and can be used in many areas of local government.

This comparison shows that many, but not all, of the data in TVA's data base can be used by local governments. It is at a scale that is applicable to that used in local governmental departments, but it may not have the widest coverage that is needed by these departments. Even so, TVA has an opportunity to add many valuable data to its data base that would be of tremendous use to local governments. It is up to those local government officials who are interested in using GIS technology to examine TVA's GIS and its data bases for applicability to their specific needs and to inform their superiors that this resource is available for use. TVA has the capabilities at hand to support local government planning efforts, but it is not willing to spend time or money on advertising for customers. They are willing to contract their services, but will only do so if asked.

The state of Tennessee has the opportunity to coordinate local government use of GIS and to include the efforts of TVA in the coordination process. By coordinating these independent attempts into an aggregated effort, the Tennessee state government can

effectively build a statewide data base that could potentially be accessible to any GIS user in the state.

Suggestions For Further Research

From the conclusions drawn from this research, it is evident that many local governments are seriously considering using GIS in their various departments. How and to what extent this technology should be incorporated in the daily activities of a local government is a concern that must be faced by all local governments in the near future. This research contributes information to help determine the feasibility of using a regional GIS in local government. However, there are still areas that require further research that would help to more completely answer this question. Suggestions for further research include:

1) Constructing innovative methods for obtaining funding for GIS. Most of the local governments in the case studies were relying on outside sources of funding for their GIS. Perhaps interdepartmental donations or setting aside portions of the yearly budget would be valid methods of obtaining funds.

2) Developing more effective organizational structures for GIS administration. Although only a few local governments in the case studies had suggestions for improvements in their particular government's structure, it seems that if GIS implementation is a slow and laborious procedure there should be ways to enhance and speed up the process.

3) Creating more efficient communication channels among governmental departments. As mentioned earlier, communication is a key factor in helping effective data sharing among departments to occur. Developing better and more open communication channels should help the various departments realize the need for more efficient information management techniques.

4) Establishing network configurations for GIS use and data dissemination between local governments and regional agencies. Developments in fiber optic technology has rapidly increased the ability of various governmental agencies to become networked with each other. By providing coordination and enhancing communication efforts among these agencies, GIS users can promote and help implement the networking process and thereby greatly expand the amount of data that is available for use.

5) Creating effective techniques of education for potential GIS users. Providing education to upper-level city officials is fundamental to obtaining governmental support for GIS implementation. Training these officials in both the theory and application of GIS use should enhance their understanding and help them appreciate the value of GIS to a local government.

6) Consulting other regional agencies (i.e. regional planning agencies) to determine if they are using GIS technology and if their data bases are applicable for use by local governments. Interviews with area development districts that were conducted for this research have indicated that they often act a depositories for various types of data and information. For example, Robert Freeman, Director of the East Tennessee Development District, mentioned that local census data is collected and stored in each development district office. This type of information may provide a supplement or addition to another regional agency's data bases.

BIBLIOGRAPHY

Altenhoff, D., Varlemann, D., and Wegener, M. *Evaluation of Local Street Design and Land Use Alternatives Using ARC/INFO.* Second International Conference on Computers in Urban Planning and Urban Management; Oxford, UK, 1991.

Babbie, Earl. *The Practice of Social Research.* Wadsworth Publishing Co.; Belmont, CA., 1989.

Baumann, R. et. al. "An Analytical Framework for Improving the Effectiveness of Geographic Information Systems" *Geographic Information Systems in Government.* Deepak Publishing; Hampton, VA, 1986.

Berman, H. *Urban Planning Information Systems and Electronic Data Processing.* Unpublished Document. p. 173, 1988.

Berry, J. "GIS is Never Having To Say You're Sorry". *GIS World.* Vol. 5, No. 5, June 1992, p. 30.

Blair, George S. *American Local Government.* Harper & Row; New York, NY, 1964.

Buchan, L. et. al. "Empowering Local Land Use Planning Officials Through Use of Land Information Technology" *Urban and Regional Information Systems Association; 1991 Annual Conference Proceedings*, Vol. 1, p.79.

Burrough, P.A. *Principles of Geographic Information Systems for Land Resources Assessment.* Clarendon Press; Oxford, 1986.

Callahan, N. *TVA: Bridge Over Troubled Waters.* A.S. Barnes and Co., Inc.; Cranberry, NJ, 1980.

Challender, S. "Legislation for the Creation of a State Geographic Information Database in Utah" *Urban and Regional Information Systems Association; 1991 Annual Conference Proceedings*, Vol. 4, p.29.

Cooke, Donald. "Overcoming Obstacles to Spatial Data Sharing". *GIS World.* Vol. 5, No. 5, June 1992, pps. 82-83.

Curtis, Robert. Manager, TVA Reservoir Lands Planning. Personal Interview, Norris, TN, May 22, 1992.

Curtis, R. and Rowland, B. *Land Management Planning Applications of a Geographic Information System.* Tennessee Valley Authority, Office of Natural Resources and Economic Development, 1986.

Dangermond, J. *ARC/INFO Maps, 1989.* Unpublished Document, Environmental Systems Research Institute, 1989.

Dickey, J.W. and Roy, G.G. "Information Technologies and Their Implications". *Informatics and Regional Development.* Avebury; Brookfield, VT, 1988.

Edwards, J. KGIS Data Base Manager. Personal Interview, May 14, 1992.

Ellis, David. Bradley County Registrar-At-Large. Personal Interview, Cleveland, TN, May 27, 1992

Enache, M. "Maximizing the Value of Information in Urban Policy-Making" *Urban and Regional Information Systems Association; 1991 Annual Conference Proceedings*, Vol. 1, p.65.

Environmental Systems Research Institute. *Understanding GIS: The ARC/INFO Method.* ESRI; Redlands, CA, 1991.

Forrest, D. "Reflections on the Future; Trends in Geographic Information Processing". *GIS World.* Vol. 5, No. 5, June 1992, p. 26.

Freeman, Robert. Director, East Tennessee Development District. Personal Interview, Knoxville, TN, March 1992.

French, S. and Raymond, B. "Analyzing Rural Development Policies Using Geographic Information Systems". *Urban and Regional Information Systems Association, 1991 Annual Conference Proceedings*, Vol 1, p.1.

Gray, Elaine. *Automation In Local Government: A Partially Annotated Bibliography.* Council of Planning Librarians; Chicago, IL, 1990.

Grey, A.G. and Johnson, D. *TVA's Regional Development Planning; The First Twenty-five Years.* ACSP and AESOP International Congress; Oxford, UK, 1991.

Hargrove, E.C. and Conkin, P.K. *TVA: Fifty Years of Grass Roots Bureaucracy.* University of Illinois Press, 1983.

Hobday, V. *The Municipal Handbook.* Municipal Technical Advisory Service; The University of Tennessee, 1987.

Hodges, Gil. Sullivan County Tax Assessor. Personal Interview, Blountville, TN, May 15, 1988.

Huxhold, W. *An Introduction to Urban Geographic Information Systems.* Oxford University Press; Oxford, UK, 1991.

Huxhold, W. "The GIS Profession" *Urban and Regional Information Systems Association; 1991 Annual Conference Proceedings*, Vol. 2, p.56.

Jolly, Rebecca. TVA Systems Engineer. Personal Interview, Norris, TN, May 14, 1992.

Keating, Robert. "Building Accuracy into GIS". *GIS World.* Vol. 5, No. 5, June 1992, pps. 32-34.

Keil, Don. Director, Johnson City GIS. Personal Interview, Johnson City, TN, May 15, 1992.

Kindrachuk, E. "Dealing With Spatial Data Exchange Issues". *GIS World.* Vol. 5, No. 5, June 1992, pps. 76-79.

Kleckner, R. "Geographic Information System Coordination in The Federal Government" *Geographic Information Systems in Government.* Deepak Publishing; Hampton, VA, 1986.

Kurtz, K. "Geographic Information Systems Based Applications With a Worldwide Database" *Geographic Information Systems in Government.* Deepak Publishing; Hampton, VA, 1986.

Land. Jorg. *Geographic Information Systems In Local Government Planning: A Review of Current and Potential Applications.* Thesis, The University of Tennessee, Knoxville, 1990.

Lee, Yuen. *Data Requirements and Data Availability For Economic Development Planning in Knoxville.* Thesis, The University of Tennessee, Knoxville, 1981.

Lee, Yuen. Manager, Division of Advanced Planning and Research, Chattanooga, Tennessee. Personal Interview, June 9, 1992.

Lynn, Phillip. City Engineer, Morristown, Tennessee. Personal Interview, Morristown, TN, June 3, 1992.

Masser, I. and Blakemore, M. *Handling Geographical Information: Methodology and Potential Applications.* Longman Group UK Limited, 1991.

Muchane, Muiruri K. *Implementing A Geographic Information System: Guidelines For Local Governments.* Thesis, The University of Tennessee; Knoxville, 1990.

Myers, W., et. al. "Geographic Information Systems in Distributive Computing Environments" *Geographic Information Systems in Government.* Deepak Publishing; Hampton, VA, 1986.

Nixon, S. and Riemer, H. "PCs vs. Workstations; Looking Beyond the Hype". *GIS World.* Vol. 5, No. 5, June 1992, pps. 48-56.

Opitz, Bruce. *Geographic Information Systems in Local Government.* Deepak Publishing; Hampton, VA, 1986.

Parent, P. "In-House Staff Makes Low-Cost Move to GIS Possible". *GIS World.* Vol. 5, No. 5, June 1992, pps. 66-71.

Ray, J. Professor, The University of Tennessee, Knoxville. Academic Class Notes. April, 1992.

Rowland, Bruce. GIS Director, The Tennessee Valley Authority, Maps and Surveys Department. Personal Interview, Norris, TN, 1992.

Rudnicki, Ryan. "Cost-Effective GIS Development Strategies for Local Governments: The Case of Hays County Texas". *Urban and Regional Information Systems Association; 1989 Annual Conference Proceedings*, Vol. 4, p.100.

Rutter, Lawrence. *The Essential Community: Local Government in the Year 2000.* The International City Management Association; Washington, D.C., 1980.

Salmon, E. "Constructing the Legal Risk Decision Matrix for GIS Cost Recovery Models" *Urban and Regional Information Systems Association; 1989 Annual Conference Proceedings*, Vol. 5, p.293.

Schamandt, J. and Wilson, R. *Growth Policy in The Age of High Technology: The Role of Regions and States.* Unwyn Hyman; Boston, 1990.

Schoten, Hank J. "The Role of Geographical Information Systems in Physical Planning". *Informatics and Regional Development.* Avebury; Brookfield, VT, 1988.

Schrader, D. "Linking CAD to PC Databases: A low Cost Approach to Implementing a Geographic Information System" *Urban and Regional Information Systems Association; 1991 Annual Conference Proceedings*, Vol. 4, p.205.

Shipley, Thomas. Data Systems, INC. Personal Interview, Cleveland Tennessee, April 4, 1992.

Shipley, Tony. Sullivan County Property Assessor. Personal Interview, Blountville, TN, May 8, 1992.

Sinton, David. "Reflections on 25 Years of GIS". *GIS World*, Insert, February 1992.

Smart, C. and Rowland, B. "GIS in The Tennessee Valley Authority". *Journal of Forestry*, pg. 36,37, September 1986.

Smart, Charles. Systems Analyst, The Tennessee Valley Authority, Maps and Surveys Department, Personal Interview, Norris, TN, 1992.

So, F.S., Hand, I. and McDowell, B.D. *The Practice of State and Regional Planning.* American Planning Association; Chicago, IL, 1986.

So, F.S. and Getzels, J. *The Practice of Local Government Planning.* American Planning Association; Chicago, IL, 1988.

Southern Rural Development Center. *Information Systems in Local Government Planning.* Southern Rural Development Center; Mississippi State, MS, 1983.

Stump, K. KGIS Data Base Administrator. Personal Interview, Knoxville, TN, May 14, 1992.

Sutcliff, Anthony. *The History of Urban and Regional Planning.* Facts on File; New York, 1981.

Tennessee State Planning Office, *Growth Areas in Tennessee.* Planning and Management Section, 1980.

Tennessee State Planning Office, *Land Use Mapping In Tennessee.* Natural Resources Section, 1972.

Tennessee Valley Authority, *The First Fifty Years: Changed Land, Changed Times.* Unpublished Document, 1983.

Tennessee Valley Authority, *The Tennessee Valley.* Unpublished Document, 1991.

The University of Tennessee, *Tennessee County Government Handbook.* County Technical Assistance Service, The University of Tennessee, 1990.

Thwaites, A.T. and Oakly, R.D. *Regional Economic Impact of Technological Change.* Frances Printer; London, 1985.

Unwin, D. *Introductory Spatial Analysis.* Methuen and Co.; London, 1981.

Wear, S. "Current Applications of Geographical Information Systems in the State of New York" *Geographic Information Systems in Government.* Deepak Publishing; Hampton, VA, 1986.

Wegener, Michael. "Information Technology, Society and The Future of Planning". *Informatics and Regional Development.* Avebury; Brookfield, VT, 1988.

Wentworth, Michael. "Implementation of a GIS Project in a Local Government Environment". *Urban and Regional Information Systems Association; 1989 Annual Conference Proceedings*, Vol. 2, p.198.

Winterfield, Richard. Personal Interview, Knoxville, TN, April 28, 1992.

Woods, Chip. Director, Department of Public Works, Personal Interview, Alcoa, TN, June 5, 1992.

Youmans, Timothy. *Information Systems In Local Government Planning: Standards and Guidelines for The Use of Microcomputers.* Thesis, The University of Tennessee, Knoxville, 1984.

APPENDICES

APPENDIX A

CASE STUDY QUESTIONNAIRE FOR LOCAL GOVERNMENTS WITH GIS

Part I: General

1) Please describe the events that led to the development and installation of your GIS? Who was the project initiator, what departments were involved, what were specific essential activities, what were the plans of action etc.?

2) Please describe the current organizational structure of your GIS department and provide a brief historical account of its development.

3) How effective has the organizational structure been in the administration of your GIS?

4) Please describe any changes that you would make, if you could, to the organizational structure to improve GIS services.

5) What is the title and responsibilities of the person directly in charge of the GIS organization?

6) What is the relationship of your GIS to the rest of your local government? What other departments share in the use of the GIS?

7) Please describe the relationship of the GIS department to the rest of your local government.

8) What future directions are planned for your GIS and how were these plans formulated?

Part II: Benefits

9) What benefits have been derived from your GIS?

10) What are the more preferred features of your system?

11) What are the most common uses of your GIS?

Part III: Funding

12) How much did your system cost?

13) How was it funded?

14) How was the cost shared between departments?

15) Did you have any other sources of funding?

Part IV: Selection of Components

16) How was the selection of the specific components of your GIS decided upon?

Part V: Data Base Conversion/Construction

17) Specifically, what data bases were formed initially, and which databases are now used the most frequently?

18) What data bases not currently operational in your system do you wish you had?

19) How often do your data bases change?

Part VI: Obstacles to Effective Operation of the GIS

20) What have been the most prevalent obstacles to the effective implementation of your GIS?

Part VII: Changes in Information Needs

21) What changes in information needs have you observed in local government?

22) How do these changes relate to changes in your local communities?

APPENDIX B

CASE STUDY QUESTIONNAIRE FOR LOCAL GOVERNMENTS WITHOUT GIS

Part I: General

1) Please provide a description of your department as it relates to the rest of the departments in your local government.

2) What is your department's function in your local government?

3) Please describe the current organizational structure of your local government and relate your organization's function to that structure.

4) Please describe any changes that you would make, if you could, to improve the organizational structure of your local government.

5) What computer and/or information systems are currently being used within your department or local government?

6) How are you currently organizing and storing your thematic and attribute data?

7) Since you have been the initiator for installing a GIS within your local government, please describe your responsibilities to your local government.

8) How did you learn about GIS?

Part II: Benefits

9) In general, how do you see a GIS helping your department?

10) How would a GIS help the efficiency of your department's performance within your local government?

11) What new roles or applications would your department undertake with the installation of a GIS?

12) In regards to your department's current roles in your local government, in what areas would you apply your GIS?

13) How would other departments within your local government share in the use of the GIS?

Part III: Funding

14) What would be the source of funding for the GIS?

15) Will the cost be shared between departments?

Part IV: Selection of Components

16) What GIS hardware and software components have you considered?

17) Would you prefer a vector or raster based system? Why?

Part V: Data Base Conversion/Construction

18) Specifically, what data bases will you form for initial and long-term use?

19) Have you examined TVA's data bases for applicability to your needs, and possible future accessing?

20) Do you currently have any data that is in digital form and ready for use in a GIS? If so, how was this data obtained and for what use was it intended?

Part VI: Obstacles to Installation of the GIS

21) What have been the most prevalent obstacles to installing a GIS in your local government?

Part VII: Future Needs

22) Do you foresee your local government as having a need for accessing TVA's GIS or would a small in-house GIS be better suited to your information needs?

23) What changes in information needs have you observed in your department specifically and in your local government in general?

24) How do these changes relate to changes in your local communities?

VITA

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