DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR ABANDONED INDUSTRIAL PROPERTIES IN THE MAHONING RIVER CORRIDOR

by

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Urs, Subramanyaraje NG

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ABSTRACT

One field in which the application of geographic information system technology has literally exploded in the past five years is environmental studies. In this field, it is often necessary to assimilate positional information on a number of variables that can impact environmental quality, often over a wide geographic area. GIS technology is particularly useful in studies of the distribution and movement of pollutants in the environment.

The objective of this project was to map the location and characteristics of "brownfield" sites surveyed in the Mahoning River Corridor Redevelopment Study and hence to promote the reuse of former industrial properties, in lieu of "greenfield" sites (or virgin land), for new industrial and commercial development. The base map was developed using USGS DLG maps and then the site maps were created and added using AutoCAD tools to represent the existing geographic conditions of the Mahoning Valley. A coherent data base on abandoned industrial properties was created that includes information on such site characteristics as access to roads, railways, water lines and sewer lines, presence of pollutants, and ownership.

With such a large geographic area of interest, the use of digital maps and files in developing this GIS has created a new way to quickly provide information on available properties to prospective investors. This GIS database can furnish input information for various market analyses and development of remediation and/or site improvement plans. This geographic information system is intended to serve as a starting point for the development of a comprehensive database on brownfield properties in the Mahoning River Corridor.

DEDICATION

To The Lord with Love

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CHAPTER 1

INTRODUCTION

1.1 Geographic Information Systems

The term geographic information system is commonly abbreviated as GIS. Several definitions of a geographic information system are possible depending upon the focus of attention. In general, a geographic information system is defined as a system which has the ability to collect, manipulate, analyze and display spatial information along with the associated attribute data. The modern GIS uses advanced cartographic techniques including a stable base map with color separation of features and can be coupled to many kinds of software to supply input data. Today there are thousands of GISs in use at different levels of management, including both government and private industry as well as in science and engineering research.

A geographic information system basically consists of a database with a facility or tools for the automation, analysis, display and management of geographic information. A geographic information system can represent almost any kind of information depending on the nature of use and the user's purpose. In environmental engineering, GIS technology is particularly useful in studies of the distribution and movement of pollutants in the environment. The information for such studies could be hydrography, soil characteristics, hazardous materials data, climatic conditions, etc. of a site or area. For example, the movement of a chemical spill can be analyzed, and queries related to environmental impacts can be answered, using information on the behavior of the chemical, hydrography of the spill area, topography, soil characteristics and other relevant parameters from the GIS.

GIS is extensively used in modeling, analyzing and maintaining facilities networks such as water lines and sewer lines in a community. Any accidents or problems that need immediate attention can be identified, and work orders processed. The data input for any software model can be provided from the GIS database to conveniently achieve accurate results. The software model may be a hydrologic model, water quality model, or any other civil or environmental engineering application. If the input data consists of a very large number of entries, the GIS database can save considerable effort in supplying the data. Manual data entry, which is very time consuming and sometimes not practically feasible, can be facilitated or even avoided by using a GIS database.

1.2 Brownfield Development

The Mahoning River Corridor contains many abandoned industrial properties. Some of them need little or no cleanup (depending on the intended use - industrial, commercial or residential) and are fit for further growth and development of the industrial belt. In order to promote the use of such properties, which are often neglected by developers and industrialists due to fear of contamination, some states have enacted legislation encouraging "brownfield development". In June 1994, Ohio Governor George V. Voinovich signed Senate Bill 221 into law. The purpose of this bill is to encourage redevelopment and reuse of the abandoned industrial properties that are, or may be, contaminated by either hazardous substances or petroleum products. The extent of cleanup required for a particular piece of property depends on how that property will be used in the future. The law resulted in the "Ohio Voluntary Action Program" (VAP) and created a potential for economic growth of industry in the Mahoning River Corridor area. In order to successfully achieve the objectives of the program, the VAP must provide a realistic and low-cost alternative for developers. The probable activities and costs of clean up for redevelopment include the following:

1. A Phase I property assessment.
2. A Phase II property assessment.
3. The services of a certified professional (issuing a No Further Action Letter).
4. The services of a certified laboratory (issuing a No Further Action Letter).
5. Cleanup activities.
6. Entering into an operation and maintenance agreement.
7. Variance proceedings.
8. Obtaining a consolidated standards permit.
9. Site-specific technical assistance provided by Ohio EPA.
10. Submitting a No Further Action letter for a Covenant Not to Sue.

The person or company undertaking the voluntary action may recover these costs from parties who are responsible for the contamination, except when the contamination is caused by petroleum or natural gas from a well.

The Voluntary Action Program offers financial relief to those undertaking voluntary actions by

1. making low interest state loans available;
2. abating real estate taxes for ten years on the increased value of the property due to the cleanup;
3. allowing those undertaking voluntary actions to make agreements with local governments for ten year tax abatements for development projects.

Another important aspect is the extent of legal responsibility of the owner after the cleanup. When the program cleanup requirements are satisfactorily met, the Ohio EPA can issue the property owner a Covenant Not to Sue. This covenant protects all owner(s) or operator(s) associated with the property from being legally responsible to the State of Ohio for additional cleanup actions in the future. This protection applies only when the property complies with any conditions on the covenant, such as land use restrictions or maintenance of engineering controls. Restrictions on the use of the property, the No Further Action Letter, and the Covenant Not to Sue are recorded in the County Recorder's office, and the Covenant Not to Sue transfers with the title of the property to any new owner. The Covenant Not to Sue does not affect the claims or rights of federal authorities or third parties. (Kwasniewski and Carlson, 1995)

1.3 Mahoning River Corridor Redevelopment Study

With the decline of steel and related local industries in the late 1970's and early 1980's, many former industrial sites and buildings were left vacant. To a large extent these lands and structures are generally believed to be contaminated and therefore unsuitable for redevelopment. The study of industrial sites suggests that contamination at former industrial sites is usually confined to relatively small areas - meaning that much of the vacant property in the Mahoning River Corridor is likely to be free from serious environmental concern and therefore ready for new development.

The Mahoning River Corridor Redevelopment Study (MRCRS) was performed by the YSU Technology Development Corporation (TDC) with funding support from the Ohio Department of Development. The goal of this project was to identify those sites which can be feasibly redeveloped, identify each community's preferred development alternatives, and outline the steps necessary to begin the redevelopment process. The specific objectives of this project were to :

1. examine the existing condition of former industrial sites;
2. identify environmental (or other) impediments to redevelopment that may exist;
3. estimate the cost to remove any redevelopment barriers identified;
4. focus development efforts on those former industrial sites that are free of actual environmental hazards (or other impediments) and/or can be feasibly redeveloped, given currently available resources;
5. determine each community's preferred development alternative for each feasible site, based on the community's needs and an assessment of the market;
6. prepare preliminary cost estimates and create a plan to attract private development (where applicable); and
7. disseminate the information widely throughout the community, particularly to real estate and development professionals.

A total of 32 brownfield sites within the Mahoning River Corridor, between Newton Falls, OH and Lowellville, OH, were identified for study. A limited environmental evaluation (LEE) was performed on each site. Then composite soil samples were collected and analyzed for a limited number of contaminants, including PCBs and heavy metals. (Technology Development Corporation, 1992)

1.4 Objectives of Present Study

In order to promote the economic development of the Mahoning River Corridor, a database summarizing all the evaluation and analysis reports is needed in order to efficiently respond to the inquiries of prospective investors. The YSU-TDC has funded the development of the GIS described in this thesis in order to provide MRCRS data to prospective investors more efficiently. The goal was to develop a preliminary GIS database which contains information on brownfield properties that is required by potential buyers or investors. The GIS so developed will reduce the time required to answer the investors' questions and can be more powerful and accurate in providing such information. The GIS was designed to provide graphical representation of the industrial sites along with attribute tables containing other pertinent information (e.g. zoning, utilities, etc.) for the redevelopment of the properties. With future updating and expansion, and suitably designed interactive programs for database maintenance, this GIS database should prove to be useful in encouraging brownfield redevelopment. Thus the present project was a continuation and further development of the MRCRS.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of GIS Development Process

The development of a GIS involves several steps, including identification of functional requirements, hardware/software acquisition and installation, personnel training, and data conversion. A typical time line for GIS projects is shown in Figure 1.1. The hardware and software components of a GIS can sometimes be bought and delivered within one month, but a functional populated database for most custom applications typically requires much longer to develop. Several years are often required to create the database for a large GIS project, and the creation can cost much more than the GIS hardware/software itself. The creation of a GIS database, or GIS data conversion, almost always represents the most significant investment in any GIS project.

Data conversion involves populating a database to meet the requirements of a GIS. Typically, conversion transforms data from existing formats, such as paper records and maps, to the digital format required for the specific GIS product. The two main types of GIS data formats are raster and vector data sets. Vector data use sets of X,Y coordinates to locate three basic types of landscape features: points, lines, and areas. For example a typical water map identifies a spring as a dot (one X,Y coordinate pair), a stream as a squiggle line (a set of connected X,Y coordinates), and a lake as a glob area (a set of connected X,Y coordinates closing on itself and implying its interior). Raster data use an imaginary grid of cells to represent the landscape. Point features are stored as individual

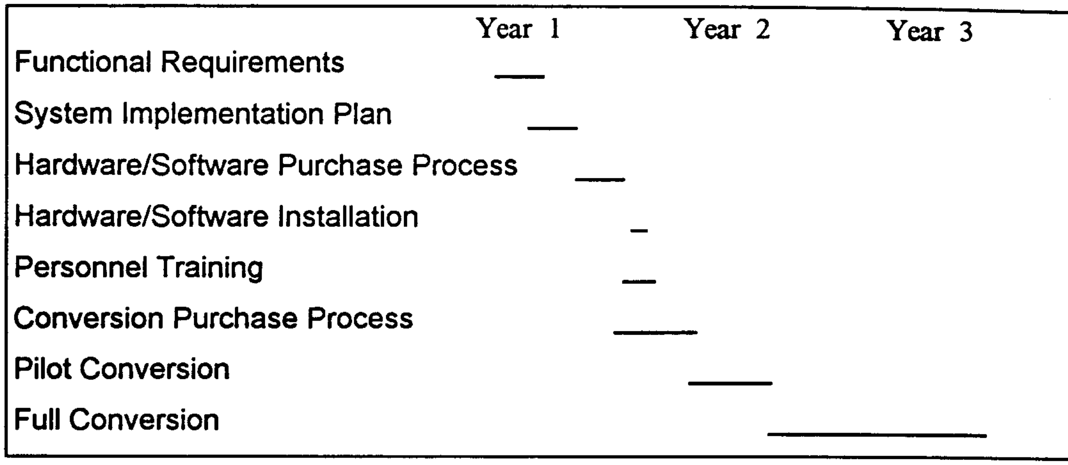


Figure 1.1 Typical GIS Project Schedule

column/row entries in the grid, lines are identified as a set of connected cells; and areas are distinguished as all of the cells comprising a feature. Prior to the data conversion, the database has to be structured to support planned application requirements and to model the desired environment. Entities, attributes, and data relationships must be defined through a database design process. Database design and the subsequent populating of the database with data represent the most important aspects of conversion.

2.2 Integration of GIS, Engineering and Drafting Software

To understand how civil/environmental engineering (CEE) and GIS can best work together it is first necessary to understand the corresponding data models. At the heart of a GIS is a topological data structure that provides the intelligence for spatial and network analysis. Civil/Environmental data models also frequently carry some topological data characteristics other than those represented by a GIS. Both of these data models (GIS & Civil/Environmental) have a symbiotic relationship with a third data model - Computer Aided Drafting (CAD). The integration of CAD with GIS and engineering models provides insight into how applications such as civil/environmental engineering can be integrated with GIS in a way that does not compromise the integrity of the individual data models. The historic developments involving these data models can be described as the three phases of computer-aided engineering.

2.2.1 Batch Processing

Early computer applications were performed in batch mode. Civil engineers used mainframe and minicomputers to perform calculations, compute formulas, and solve algorithms. Complex interactive processes could be performed faster, usually with less error on the computer. One of the first applications, coordinate geometry (COGO), was used to enter survey data and compute geometric constructions. Many of these calculations are still used today in modern programs.

The computations were run blind, meaning the user could not see the results of the geometric design until a report was printed on a hard copy. Most engineers communicated their design through the skills of the draftsman who specialized in creating professional drawings the engineers could review, mark up for changes, and finally send out to the field as construction drawings.

2.2.2 Computer Aided Drafting

The next major development was the advent of computer aided drafting (CAD). CAD technology automated the draftsman's job by creating very clean and precise drawings that could be viewed on the screen and sent to a plotter. Productivity gains were made primarily from the ability to copy parts of one drawing into a new drawing with simple modifications. This technology revolutionized the tools of the draftsmen in much the same way that the word processor replaced the typewriter.

CAD evolved into its own data model based on the entities required to draft a design onto a sheet of paper - e.g., lines, arcs, text, and solids. These entities could be created and stored efficiently within the CAD data model. As CAD became a large part of the engineer's office production, software companies began to add on certain engineering design tools to the CAD system and hence CAD actually became computer-aided drafting and design (CADD). But in most respects the CAD industry was automating the desk of the draftsman, not the engineer. Engineers who wanted to use these design tools were required to spend an inordinate amount of time becoming proficient CAD draftsmen rather than creative design engineers. Conforming to the CAD data model would eventually lead to compromising the efficiency and capacity of the design.

2.2.3 Parametric-Three Dimensional (3D) Land Model

The third phase of computer-aided engineering provides a data model to empower the engineer. For civil/environmental engineers this means eliminating the barriers of a CAD-based data model by working directly inside a parametric 3D land model. The types of data the civil/environmental engineer uses to design, analyze, and edit are not supported within the CAD data model. At the core of the 3D land model resides the digital terrain model (DTM), a representation of the surface upon which the design will be placed. From the DTM, the civil engineer will create contour maps, interpolate cross sections, compute volumes, and create the design. The user should be able to create multiple surfaces that can be used for existing and proposed conditions, as well as the many subsurface layers required for more complex designs such as landfills or mines.

In addition, the engineer needs to interact with the data in a different way than is supported by the CAD data model. The civil or environmental engineer must be able to design sewer systems, complete hydrology studies, visualize the DTM surface in a perspective view or complete all phases of a complex roadway design. The data model must understand the type of information required for design, give the engineer a place to maintain the data, and express the design data in a format that can be conveyed to others.

The data model and the interface between user and data must be fully optimized. For a system to be productive, the civil/environmental engineer must be able to create surface models and contour data with 10,000 points in seconds and up to 100,000 points in less than a few minutes. The ability to read in these points, create the digital terrain model, and perform analysis and design can be realized with a data model specifically built with the civil engineer in mind.

Finally, the data model must support a complete suite of civil and environmental engineering design applications. The following capabilities should be available: coordinate geometry and legal descriptions, contouring, profiles and cross sections, 3D views, site design, sewer design, hydrology, and roadway design. In addition, the ability to capture data through photogrammetry, global positioning systems (GPS), and other data collectors increases the accessibility of the data model.

In GIS, graphics is simply one view of a spatial data model that supports a range of analytic and geoprocessing capabilities. In CEE software, graphics is simply a view of the 3D land model that supports a range of design capabilities. What is needed is a seamless link between the two data models that would provide the mechanism for sharing data without compromising the integrity of that data. Only by reading and writing data directly can all the design and analytical information be accessible for both civil and environmental engineering design and GIS analysis.

2.3 Descriptions of Selected GIS Software

Three of the most popular GIS software programs are ArcCAD, GRASS and ARC/INFO. The structure and capabilities of these programs are described here to give the reader an appreciation for differences in the hardware requirements and features available.

2.3.1 ArcCAD & ArcView

ArcCAD is a geographical information system engine for AutoCAD. It adds powerful database management and spatial analysis tools to the graphic editing and geometric construction capabilities of AutoCAD. These GIS tools are integrated within the AutoCAD environment and provide the ability to create, manipulate, analyze, and display topologically correct geographic data in digital form. ArcCAD is characterized by a topological and georeferenced database linked to an AutoCAD drawing and the GIS functions which operate on that georeferenced data. ArcCAD also provides extensions to the AutoCAD programming interface through Application Development Software (ADS), providing a comprehensive set of developer tools for customization of the software.

ArcCAD was developed by Environmental Science and Research Inc. (ESRI) during 1992 and is totally owned by ESRI. ArcCAD & ArcView can be installed on PCs and run on DOS or Windows platforms. ArcCAD is mainly used to create entities and link them with the data information located in the database. On the other hand, ArcView is loaded on the Windows platform to perform functions such as reading, displaying and making queries on the database from the spatial information. ArcCAD and ArcView provide many commands for creating, managing, analyzing and displaying geographic data. Their capabilities are described under the following subsections.

2.3.1.1 Topology Creation:

ArcCAD provides commands to create and maintain correct topology for ArcCAD databases and to create the feature attribute tables (database files) which store thematic data about the map features contained in those databases. Polygon, line and point features with attributes can be created from either AutoCAD drawing entities or from ARC/INFO coverages. An ARC/INFO coverage is explained in detail in the later sections. In addition to building polygon and line topology, the commands used to create topology can perform geometric analysis on linear features to identify new intersections, perform line generalization, and automatically resolve overshoot and undershoot errors after digitizing using AutoCAD commands. Topology creation and maintenance play an important role in database automation.

2.3.1.2 Associating Attributes with Map Features:

Using the relational database management system data model, ArcCAD provides tools which allow association of descriptive tabular data with the map databases. Database tables can be built and maintained to hold all descriptive data about points, lines, or areas on a map. Database tables can be edited and new fields can be added to these tables; related tables can be merged; or a subset of fields can be extracted from the tables. New field values for any feature (point, line or polygon) can be calculated or changed, and a set of features can be selected based upon their attributes. In addition, new data files containing descriptive information about map features can be created.

2.3.1.3 Display and Query:

ArcCAD includes an extensive set of commands used to facilitate and enhance the display of map features. Point, line, and polygon features can be displayed using a wide variety of standard and user-defined point, line, and area symbols. Attribute values may be used to control the symbolization of features. Features may be displayed as entities using any combination of AutoCAD entity properties. Display of features using entity properties may also be controlled through attributes. By combining these methods with AutoCAD's graphic design tools, ArcCAD can be used to create high-quality cartographic products. ArcCAD's interactive query functions use maps as graphic windows into a geographic database. The cursor is used to select any set of features for both graphic and attribute display. One can also ask to see only those features which match specified criteria; for example, all parcels whose zoning characteristics are inconsistent with the current land use map could be displayed. ArcCAD also has functions that create or select drawing entities as a result of a GIS query and create or select GIS features as a result of a drawing query.

2.3.1.4 Spatial Analysis:

In 1989, ESRI initially launched an effort to develop an easy-to-use viewer technology for GIS. This was the first attempt at engineering a product based on industry standards for usability and graphical user interface (GUI) design that also incorporated basic desktop mapping features. The result was ArcView version 1, a very successful product for simple GIS visualization and query. This tool has been popular both within the existing ARC/INFO user community as well as with thousands of new GIS users.

ArcView is a software tool that creates an environment to display and query the contents of a spatial database. ArcView lets one explore the database, display all or part of its contents, ask questions, display or save results, and pass information or graphics to other applications. ArcView simplifies display and query of geographic data by helping to manage the data in a file called " view " with a file extension of <Filename>.av. ArcView can open existing views or create new ones, and it contains all the information that must be managed and displayed, however it does not contain the data itself. Since the view is dynamic, it reflects the most current status of the database. If there are any changes made to the database, it directly reflects the change without having to change the view. Since ArcView runs on a Windows platform, only one view is handled at a time. On the other hand, since UNIX is a multi-user operating system any graphic interface running on a UNIX or similar platform can analyze more than one view at a time. (ESRI, 1991)

2.3.2 Geographical Resources Analysis Support System (GRASS)

GRASS is the Geographical Resources Analysis Support System originally developed by researchers in the Environmental Division of the U. S. Army Corps of Engineers Construction Engineering Research Laboratory (USACE, CERL-EN) in Champaign, Illinois. It is a public domain, raster and vector GIS, image processing and graphics production system. GRASS is designed for interfacing with RIM (a Relational Database Management System), MAPGEN (a cartographic output generator for plotters), GCTP (a coordinate translation package), pbmplus (an image manipulation package), and xgen (a language for generating X-windows interfaces). GRASS can be used for preparing geographical data that are eventually used in some other system, or for processing and analyzing geographical data, including displaying the results. In the former case, geographical data are imported or digitized, converted, edited, analyzed and processed in GRASS and then exported to some other system (e.g., a modeling, decision support or expert system), where they are used to build a geographical information database. For analysis, GRASS offers a number of analytical tools and functions for problem oriented displays. With the 1993 release of version 4.1, the system consists of some 300 different computer programs implementing a broad range of functions. GRASS works on the operating systems called Linux and some of the capabilities of the GRASS 4.1 program are: (GRASS User Information, ftp site: moon.cecer.mil.com)

- Image Processing.
- Map Digitizing.
- Map Calculations - example: to find the distance between two points on the map.
- Watershed Analysis - example: computing the watershed area of a given basin in the map.
- Data extraction for DLG-3, DEM and TIGER formats.

2.3.3 ARC/INFO

2.3.3.1 ARC/INFO Overview:

ARC/INFO is a GIS toolkit used for processing the geographic data to perform many customized tasks. This GIS tool also integrates all the data types like vector, raster, photographs, scanned documents, satellite images and CAD drawings with a tabular database management system (DBMS).

ARC/INFO can be run on Unix and Windows NT operating system platforms with its latest released version being 7.1.1 for Unix and V 7.1 for Windows NT. Since ARC/INFO has the capability to input AutoCAD drawings and also import DBF files. All the information on the ArcCAD can be easily transferred. Some of its optional extensions to perform various advanced functions are:

- ARC NETWORK for network analysis.
- ARC GRID for spatial modeling.
- ARC TIN for terrain analysis.
- ARC COGO for parcel mapping
- ArcStorm for data management.
- ArcScan for raster data scanning.
- ArcPress for production cartography.

With these extensions, ARC/INFO provides powerful GIS capabilities, and is the system of choice for many federal, state and local government agencies. A fully functional geographic information system can be developed using ARC/INFO. This tool is extremely flexible, since it can accept data from scanners, global positioning systems (GPS), and commercial and government sources in over 35 different data formats. Some of the specific tasks performed by ARC/INFO are:

- Create and maintain geographic information.
- Manage large, multi-user spatial databases.
- Integrate multiple data types.
- Perform sophisticated spatial analysis.
- Produce high quality maps for publication.
- Create turnkey GIS applications for end users.

2.3.3.2 Built in Features:

Some of the built in features of ARC/INFO are:

- ArcTools - Access geoprocessing functions through a menu interface.

- ARCPLOT - Create high quality maps and perform advanced analysis and visualization on spatial data.

- ARCEDIT - Construct and maintain spatial databases of coverages, tables and grids with advanced topological editing functions.

- Open Development Environment (ODE) - Customize ARC/INFO by automating complex operations and building eazy-to-use menus.

- Georelational data model - Represent and analyze real-world geographic features such as streets parcels and wells and manage descriptive data about features in a database management system (DBMS).

- Analysis and decision support - Perform advanced spatial analysis using

ARC/INFO software's extensive set of geoprocessing tools that support image integration, polygon overlay, raster geoprocessing, surface modeling and RDB MS integration.
(ESRI, 1997 Web Site: //www.esri.com)

2.4 Mahoning River Corridor Redevelopment Study (MRCRS)

The Mahoning River Corridor Redevelopment Study (MRCRS) provided preliminary site assessments for "Brownfield" properties in ten townships or cities along the Mahoning River. The sites listed in Table 2.1 were included in the MRCRS project.

A limited environmental evaluation (LEE) was performed by MS Consultants of Youngstown, OH for YSU-Technology Development Corporation (TDC). Composite soil samples were taken from each site and analyses were performed in laboratories at

Table 2.1 Sites Evaluated in the Mahoning River Corridor Redevelopment Study.

Braceville --	Site 1 : Caparanis and Site 2 : Luther	**Niles --------**	N-1; N-2; N-3 N-4
Campbell --	C-1; C-4; C-9	**Poland ------**	P-1
Girard ------	Latell ; Columbia Iron & Metal; Breuer Ohio Leather Works and Syro/Conrail	**Struthers ---**	S-3; S-9; S-11 and Struthers Baseball Assoc.Expn. Site.
Lowellville -	L-1; L-6; L-8; Sharon Slag and L-2.	**Warren -----**	Grinnell; Kleese and Findley Welding.
Newton ---- Falls	Falls & Tube Manufacturing	**Youngstown -**	Republic Steel and USX

Youngstown State University. The analyses targeted mainly the heavy metals (including cadmium, chromium, barium, lead, silver, arsenic, selenium, and mercury), polychlorinated biphenyls (PCB) and polynuclear aromatic hydrocarbons (PAH). These are some of the main pollutants in the Mahoning River and the corridor.

Once the sample analysis was completed, the pollutant concentrations existing at the site were compared to the permissible pollutant concentrations as established by the USEPA. A typical chemical analysis report (for heavy metals) was made available to the project coordinator as shown in Table 2.2.

Table 2.2 Typical Chemical Analysis Report

SAMPLE	Ag	Ba	Cd	Cr	Hg	Pb	Se	As
RCRA Remedial Action Limit in mg/L	5.00	100.00	1.00	5.00	0.20	5.00	1.00	5.00

It was observed that, at most of the sites, the main pollutant concentrations were well within the permissible RCRA remedial action limits. Some of the contaminant concentrations may have decreased with respect to time. As a result of such encouraging findings, some of the industrial sites are being sold to investors.

In some cases, further investigations, such as full Phase I or Phase II assessments were performed. There were four sites on which Phase I assessments were conducted and two sites on which Phase II assessments were performed. Some of the sites, on which a

Phase II was conducted, gave a complete picture of the site conditions from the environmental point of view and it was possible to estimate the expenses that are going to be incurred for its clean up.

CHAPTER 3

GIS DEVELOPMENT PROCESS

3.1 Base Map Development

3.1.1 Extraction of USGS Base Map

In order to develop the base map for this project, a United States Geological Survey (USGS) map was used as the source of the spatial information. The USGS map was a 1:100,000 Scale Digital Line Graph (DLG) with Hydrography and Transportation data available on CD- ROM. The relevant information for the Youngstown area is located in Area 2 representing the Middle Atlantic States. To perform the extraction of the DLG quadrangles, an IBM or compatible personal computer equipped with a CD-ROM drive and a EGA/VGA graphic display is required.

The file extraction program (EXTRACT) is designed to facilitate the selection and copying of DLG data files from the CD-ROM. There is also an option to select different layers for extraction, namely Roads, Railroads, Hydrography & Minor Transportation Roads. All of these layers were selected and only the relevant quadrangles representing Youngstown and its vicinity were extracted. The data files for each 1:100,000 scale quadrangle are contained in individual subdirectories under the main directory \100k_DLG. These subdirectories are named using the first eight characters of the quadrangle name. For example: YOUNGSTO is the subdirectory for Youngstown. Within each of the subdirectories are four files, one for each data layer. The file names are in the following format:

XXXYYYYY.ZIP

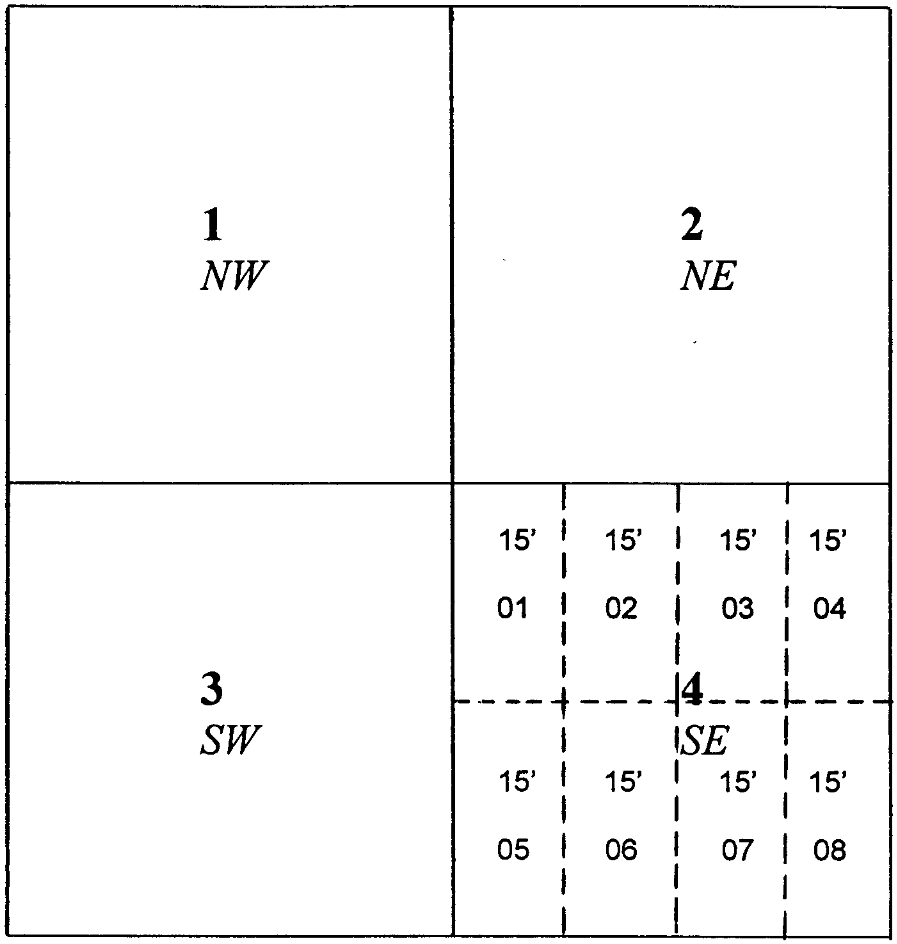
where XXX	=	Code assigned to the 1: 100,000 scale quadrangle. This code and the quadrangle name are in the file FILE.OUT in the DLGSOFT subdirectory.
YYYYY	=	Layer name: RAIL - Railroads ROADS - Roads and Trails MTRAN - Miscellaneous Transportation HYDRO - Hydrography
ZIP	=	Extension added by the software to compress the data.

The data files are stored in a compressed format on the CD-ROM. The files are automatically decompressed when the data are transferred to the hard disk. The desired data are extracted and written to an output file on a floppy disk or hard disk. The file naming convention for output files is as follows:

AABCCDEE

where AA	=	Two character identification code for the 1:250,000 scale quadrangle area of coverage for this file.
B	=	Numeric code representing the quadrant of the 1:250,000 scale quadrangle within which the area of coverage falls.
CC	=	Indicator of the data overlay category. RD = Roads HY = Hydrography RR = Railroads MT = Miscellaneous Transportation
D	=	Indicator of cell size. S = 7.5 minute F = 15 minute
EE	=	Section/cell number within the 1:100,000 scale map

For example, the Youngstown Road DLG files are represented as "CL4RDF01......08" (8 Files), as shown in Figure 3.1



AABBCDEE = CL4RDFEE   Where 'EE' ranges from 01 to 08 in SE quadrant of the 1:250,000 scale quadrangle.

Figure 3.1 Arrangement of all quadrangles in a single layer of ACAD drawing.

A total of 32 files were extracted, 8 for each layer on the 15 minute quadrangles times four layers, representing Roads, Railroads, Hydrography & Miscellaneous Transportation. In the laboratory, the extraction was done by networking the PC with the one which possessed a CD-ROM drive, as the available memory in the PC with the CD-ROM drive was not enough for the extraction. Once the extraction of the DLG files was complete, the DLG (Digital Line Graph) format of the USGS Maps was converted to DXF format. All of these files were renamed by adding an file extension specification DLG (example: CL4RDF01 renamed as CL4RDF01.DLG). The renaming was done in order to make these files readable by the program "DLG2DXF" to facilitate the conversion from DLG to DXF format. Since DLG files were not compatible with the AutoCAD program, all thirty-two files were converted to DXF format by using a simple DLG to DXF conversion program which is freely available at the Bureau of Land Management FTP site (FTP site address: blm.gov). After renaming, these files were ready for input to program "DLG2DXF", the result of which was a DXF file format (example: CL4RD01.DXF). Each of the converted DXF files represented one quadrangle on the map. The quadrangles were then imported to AutoCAD by using the utilities feature. Each quadrangle was imported on the same layer (for example Roads) and saved as a block under a unique name. This resulted in eight blocks (quadrangles) representing a single layer (for example Roads) within the base map drawing 'MAHONING.DWG'. These blocks were inserted with high precision into the appropriate layer of the base map using the 'Tools' feature in AutoCAD. The same process was applied to enter the other features of the drawing in different layers, namely Hydrography and Railway. The base map was then complete, and consisted of three layers which could only be distinguished by color as shown in the Figure 3.2, where

- Roads are represented by Red
- Hydrography is represented by Blue
- Railway lines are represented by Black.

The line thickness was the only criterion to distinguish different kinds of roads on the map. However, the original base map represented all types of roads by means of a set of lines with the same thickness. So the line thickness for roads like interstate highways, expressways and state routes were modified and suitable labels added. The labeling was done on a separate layer of the map called 'Names'. Since this involved a lot of manual work and time, only those roads within the vicinity of MRCRS sites and all major highways were modified in order to make the spatial information more meaningful and generate a base map as shown in Figure 3.3.

On opening a new drawing file from the AutoCAD main menu, all the blocks were inserted in the drawing using the snap mode so that any errors while stitching the blocks together in the drawing may be corrected to some extent. The same procedure was repeated for all the rest of the layers and a drawing file was created with four layers representing the Roads, Railroads, Hydrography and Miscellaneous Transportation in the Youngstown area.

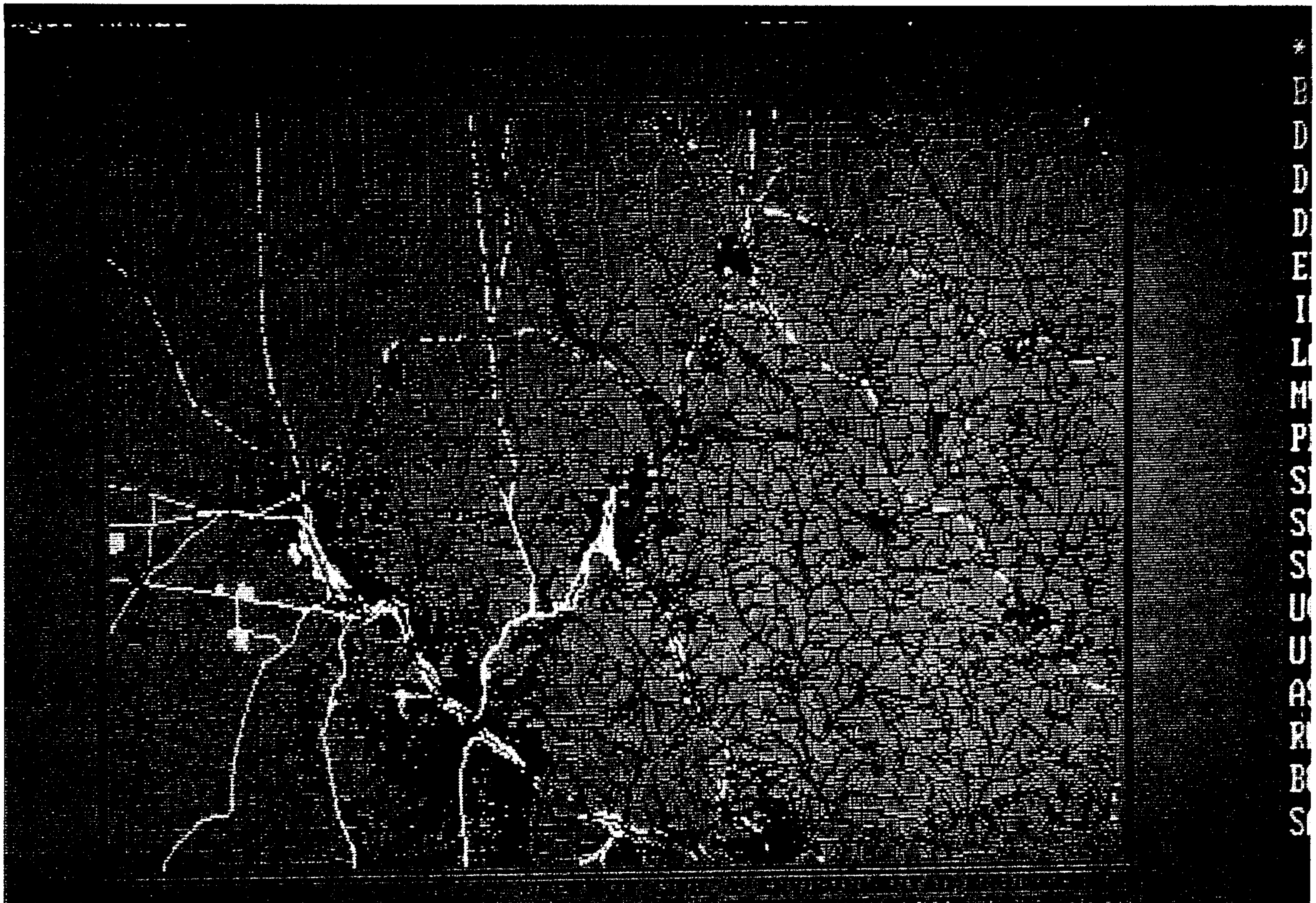


Figure 3.2 Base map representing Roads, Hydrography and Railway

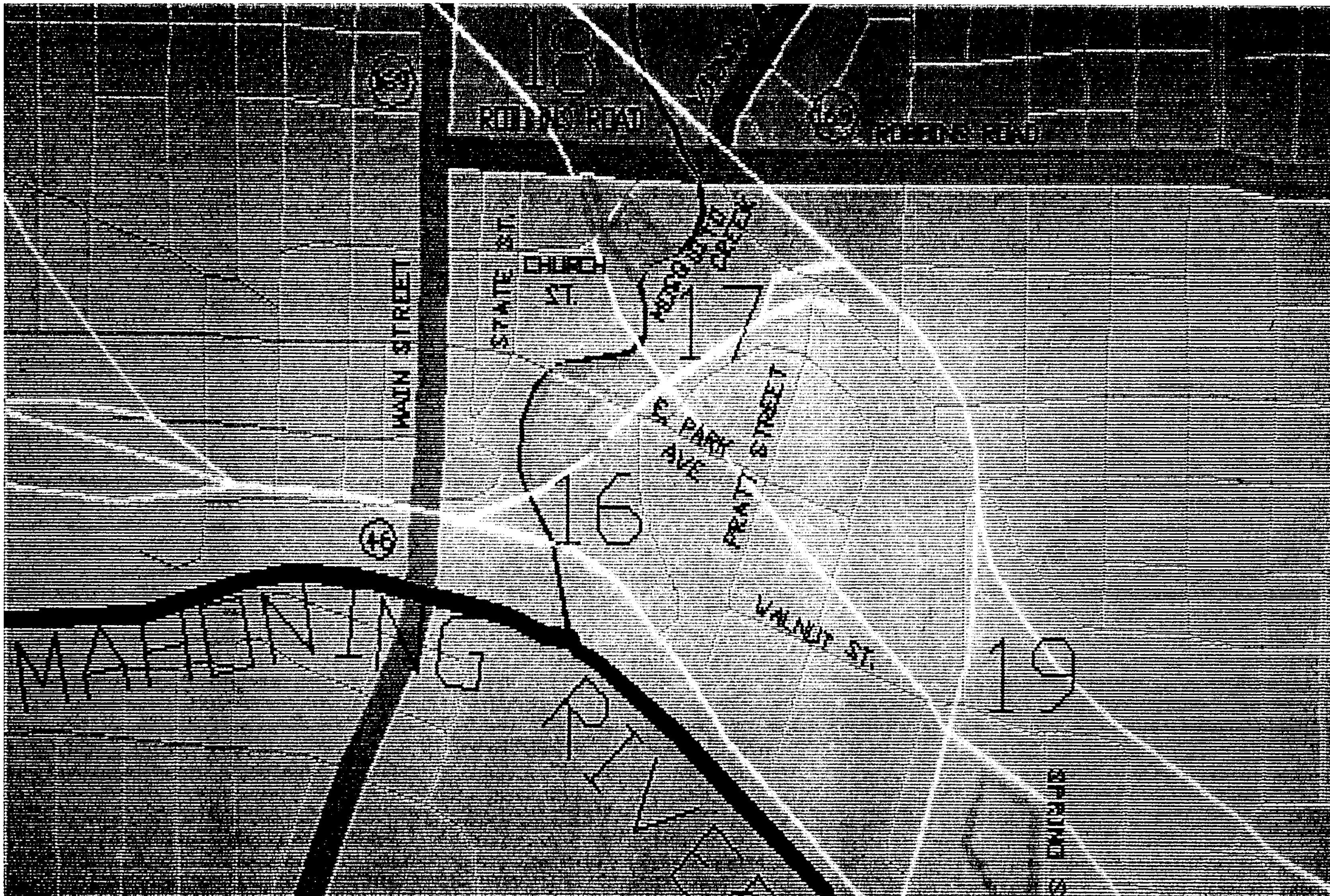


Figure 3.3 Base map with distinguishable Road types with different thickness.

3.1.2 Addition of MRCRS Sites

After extracting the basemap from the CD-ROM and then bringing the digital map details in AutoCAD, the next important step was to insert the MRCRS site maps to scale in order to create the spatial information in the GIS. Creation of spatial information can be either in the raster or vector format, but in this case, since the base map was derived from the DLG format all the spatial information is in the vector format. This does not restrict the information system to any type of map format for further development. Since the MRCRS site maps were in the hard copy form, it was necessary to digitize each of these site maps. The precision and accuracy of site maps was considered good enough for the nature of the GIS being developed. All 32 industrial site maps were digitized using a HP SummaSketch digitizer. Since all maps were drawn to scale, the process of drafting directly to scale on the computer was not required. Then the digitized site maps were inserted at the respective locations in the base map without sacrificing the accuracy of the drawing. Each digitized site map was saved as a block in the AutoCAD environment. In retrospect, it would have been more convenient to add the site map by digitizing directly on the base map, rather than digitizing site maps individually and then inserting into the base map.

The insertion of these sites individual industrial sites on the base map was very important step in developing the spatial information. A problem was encountered during the insertion of the site maps. The site map represented the true property boundary, and a higher level of detail than the base map. For example, the base map represented the intersection of roads as sharp corners while the site map showed the true curving of the road intersections. This discrepancy could have been resolved, but after discussing the accuracy that is required for such spatial information and its use, it was decided that approximate insertion of the site maps onto the base map was adequate. The accuracy of the individual site maps was not sacrificed in the insertion process. Figure 3.4 shows the details of the spatial and attribute information for site #16. Most of the site maps consisted of the site boundary (property line) of the industrial property without extensive details within the property itself. In order to overcome this deficiency in the spatial information, selected details on site characteristics were included in the attribute table portion of the information system.

3.2 Database Development

3.2.1 Sources of Information

The main source of information regarding the current state of industrial sites was the Limited Environmental Evaluation (LEE) reports prepared by MS Consultants for YSU-TDC. Phase II assessments were done on two sites, namely Falls Steel Tube & Manufacturing in Newton Falls and Ohio Leather Works in Girard. The information regarding the property value and ownership on certain sites was also available from assessment reports prepared for undergraduate projects by YSU Civil and Environmental Engineering students Amy Park and Joseph Slifka (Park, 1994; Slifka, 1994). Several discussions were held on various issues, including the type of information that is required in the database, nature of the probable inquiry from developers, and the capability of the

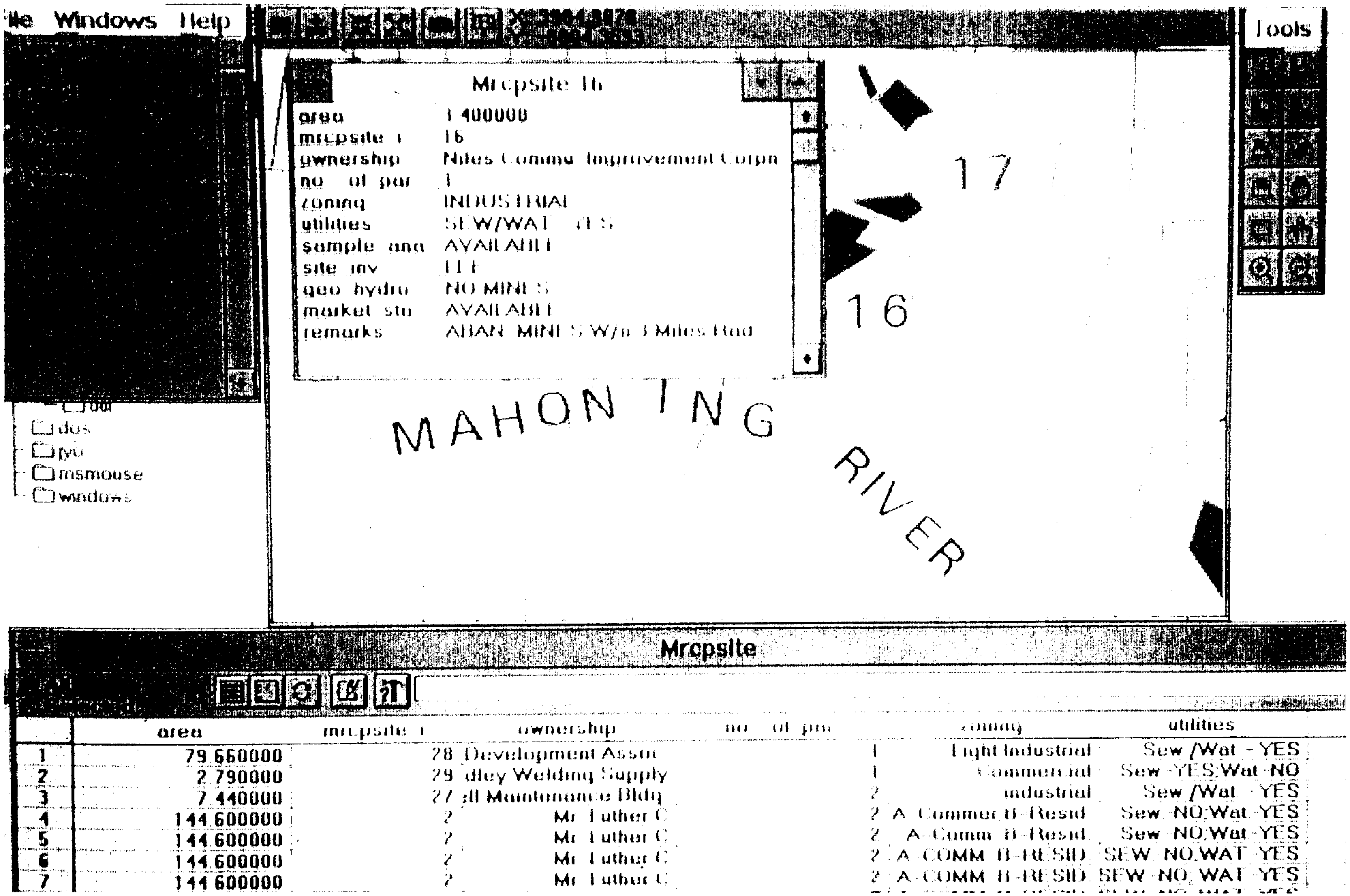


Figure 3.4 Spatial and Attribute information details

type of computer system to be employed. Since some of the industrial sites had already been sold, strategies for expanding upon this success were established through discussion with MRCRS project coordinator Laura Lyden of YSU-TDC. Information about the industrial sites was also gathered from the Mahoning County Auditors office, Youngstown Fire Department, Youngstown State University Library, Professor Ann Harris of YSU's Geology Department, Mahoning County Engineer's Office, Youngstown Planning Department, Youngstown Public Library and Ohio Department of Natural Resources. The above agencies and department were contacted either directly by the MS Consultants or by Amy Park. After evaluating the available information and the nature of the user's requirements, the database was designed. Selected information that is relevant for the redevelopment of the industrial sites in the Mahoning River Corridor was assembled and a spreadsheet table was prepared to provide a preliminary concept of the database. The spreadsheet showing all the information of the industrial sites that exist in the database is shown in Table 3.1. The goal was to develop a preliminary, rather than an exhaustive, attribute database. Further development or expansion of the existing database is expected once additional user needs are identified.

The structure of the attribute table was finalized keeping in mind the current requirements of the user's probable interaction with the prospective buyers or developers. It is intended that, in the future, this attribute data can be analyzed to respond to specific user queries, or even to evaluate demographic and economic trends and the success of brownfield redevelopment programs.

Table 3.1 List of MRCRS sites present in the database.

Sl.NO	MRCP-SITE	LOCATION / ADDRESS	OWNERSHIP	No.of Parcel	PARCEL I.D. #s	SITE AREA In Acres	ZONING	UTILITIES	SITE SAMPLE ANALYSIS	GEO/HYDRO	REMARKS/COMMENTS
	BRACEVILLE										
1	Site-1	East- Mahoning River South- SR 5 for approx. 3100ft West + North - C.L. of Mahoning River	Mr. J. Caparanis	2	54-020-054-00 54-020-055-00	72.36	Commercial	Sewer Lines- NO Water Lines- YES (is under constrn.)	DONE W/n LIMITS	- NO MINES - NO AB. MINES	
2	Site-2	Between Benedict-Levittsburg Rd. East - Mahoning River South - SR 82	Mr. Luther C	2	54-016-013-00 54-016-008-00	144.80	A= Commercial B= Residential	Sewer Lines- NO Water Lines- YES (is under constrn.)	DONE W/n LIMITS	- NO MINES - NO AB. MINES	
	CAMPBELL										
3	C-1	North- SR 289 (Wilson Ave.) In the City of Campbell		131		43.00	Light Industrial	Sewer Lines- Water Lines-			
4	C-4	North- SR 289 East- Youngstown City line In the City of Campbell	1.Mrs. Velma S. Otterman 2.Mr. Daniel Fazzini	7	46-002-0-015.00-0 46-001-0-018.00-0 46-002-0-014.00-0 46-001-0-131.00-0 46-001-0-130.00-0	43.00	Light Industrial	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES - AB. MINES Within 2 Miles - G.W. Yield 3- 10 gal/min	
5	C-9	Warhurst Street in the City of Campbell West - 6th street	M/s Y.S & T COMPANY	1	46-003-0-403.00-0	8.08	Residential (R-2)	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
	GIRARD										
6	Latell	Between State RT. 422 and Conrail (+Mahoning River)	Mr. John Latell	1	643-855	26.95	Light Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
7	Columbia Iron & Metal	North - Interstate 80 South - Squaw Creek East & West - Conrail R.R.	M/s Columbia Iron & Metal Company	1	14-010-096-00	27.57	Industrial & Commercial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 5 Miles	
8	Breuer	Between St.Route 422 and Armhurst Ave. in the City of Girard	M/s Breuer Associates 510, Burns Road Vinegrove, KY 40175	1	14-584100	4.95	Commercial	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES Nearest is 5 MI. - NO AB. MINES	
9	Ohio Leather Works	North of State Street in the City of Girard. Bounded by Conrail R.R., St.Rt.422 and Mahoning River	M/s Ohio Leather Works	5	NO I.D.	27.00	Heavy Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
10	Syro/ Conrail	South - Squaw Creek Between St.Rt.422 & Mahoning River	M/s Consolidated Rail Corporation	2	NO I.D.	32.00 A=9.2 B=22.8	Light Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	

Table 3.1 continued

Sl.NO	MRCP-SITE	LOCATION / ADDRESS	OWNERSHIP	No.of Parcel	PARCEL I.D. #s	SITE AREA In Acres	ZONING	UTILITIES	SITE SAMPLE ANALYSIS	GEO/HYDRO	REMARKS/COMMENTS
	LOWELLVILLE										
11	L-1	Riverfront property between Washington & Monroe Streets in the village of Lowellville	1. Village of Lowellville 2. State of Ohio 3.M/s MDM Enterprises	5	40-9-0-002.00-0 40-9-0-013.00-0 40-9-0-014.00-0 40-9-0-015.00-0 40-9-0-016.00-0	1.72	Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- MINES FOUND Within 0.5 Mile Radius	
12	L-6	Along the St. Rt 289 in the Village of Lowellville	1. Mr. Ralph Conti 2. Bevery Zarlingo	3	40-3-0-037.00-0 40-3-0-036.00-0 40-3-0-034.00-0	26.43	Commercial & Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- MINES FOUND Within 0.5 Mile Radius	
13	L-8	Along the Mahoning River in the Village of Lowellville	1. Grace Skelton 2. Charles Silverman 3. Falcon Foundry 4. MDM Enterprises	13	40-009-0-001.00-0 40-009-0-002.00-0 40-009-0-002.01-0 40-009-0-003.00-0 40-009-0-003.01-0 40-009-0-004.00-0 40-009-0-004.01-0 40-009-0-005.00-0 40-009-0-005.01-0 40-009-0-006.00-0 40-009-0-006.01-0 40-009-0-007.00-0 40-009-0-007.01-0	3.50	Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- MINES FOUND Within 0.5 Mile Radius	
14	Sharon Slag	Lowellville Road in the Village of Lowellville	M/s Sharon Slag Inc.	1	40-007-0-014.00-0	37.32	Industrial	Sewer Lines- YES Water Lines- YES	NOT DONE	- MINES FOUND Within 0.5 Mile Radius	
15	L-2	Jackson Street in the Village of Lowellville	M/s M & C Donofrio	1	40-010-0-013.00-0	3.30	Residential	Sewer Lines- YES Water Lines- YES	NOT DONE	- MINES PRESEN Within and 'Adjacent to site	
	NILES										
16	N-1	South of E. Park Ave., adjacent to Mosquito Creek in the City of Niles	Niles Community Improvement Corporation	1	NO I.D.	3.40	Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 3 Miles	
17	N-2	North of E. Park Ave., adjacent to Mosquito Creek in the City of Niles	City of Niles	1	NO I.D.	2.45	Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 3 Miles	Used as transformer storage area for the City of Niles for about 1 1/2 Years
18	N-3	Along Robbins Ave., in the City of Niles	1. Mr. Michael D Joseph 2. Mr. Joseph Leo Joseph	2	25-018-050-00 25-018-047-00	2.70	General Commercial(B-3)	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 3 Miles	

Table 3.1 continued

SI.NO.	MRCP-SITE	LOCATION / ADDRESS	OWNERSHIP	No.of Parcels	PARCEL I.D. #s	SITE AREA In Acres	ZONING	UTILITIES	SITE SAMPLE ANALYSIS	GEO/HYDRO	REMARKS/COMMENTS
25	Struthers Baseball Association. Expansion Site	North- Lowellville Road West- Narcissa Street South- Katherine Street	M/s TSY Associates M/s D. N. Vasavari	2	38-026-0-029.00-0 38-026-0-031.00-0	15.03	Industrial A	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
26	LTV	North- Conrail Railroad West- State Street South- Bridge Street	M/s LTV Steel Co.	3	38-005-0-219.00-0 38-005-0-220.00-0 38-005-0-221.00-0	30.52	Industrial A Industrial B	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
	WARREN										
27	Grinnell	Paige and Dana Street City of Warren	M/s Grinnell Maintenance Building Project Area. No Ownership is Listed for 0.53 acres	2	38-035B-163-00 38-035B-201-00 38-035B-202-00	7.44 (6.96+ 0.53)	Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES	No records of abandoned mines
28	Kleese	Southeast corner of Parkman Road & State Route 5, City of Warren	M/s Kleese Development Association	1	40-011A-003-01	79.66	Light Industrial	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES	No records of abandoned mines
29	Findley Welding	Bounded by Park Ave. & Conrail RR North- North River Road	M/s Findley Welding Supply	1	NO I.D.	2.79	Commercial	Sewer Lines- YES Water Lines- NO (Possible extension of Sewer lines)	DONE W/n LIMITS	- NO MINES - NO AB. MINES	Findley has its own Septic Tank
	YOUNGSTOWN										
30	Republic Steel	Along E. Front Street between Market Street and South Ave. Adjacent to the Mahoning River, in the City of Youngstown.	M/s A & A Investments	1	NO I.D.	32.76	Heavy Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
31	USX	Along the eastern bank of the Mahoning River north of Interstate 193 in the City of Youngstown.	M/s USX Realty Development	1	53-094-0-156.00-0	134.23	Heavy Industrial	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES - AB. MINES Within 2 Miles	
	NEWTON FALLS										
32	Falls Tube & Manufacturing Industrial Development Site	Between East and West branches of the Mahoning River in the City of Newton Falls	M/s Falls Steel Tube & Manufacturing Co.	5	NO I.D.	11.00	**** Info. Not Available******	Sewer Lines- YES Water Lines- YES		- NO MINES - NO AB. MINES	

Table 3.1 continued

SI.NO	MRCP-SITE	LOCATION / ADDRESS	OWNERSHIP	No.of Parcel	PARCEL I.D. #s	SITE AREA In Acres	ZONING	UTILITIES	SITE SAMPLE ANALYSIS	GEO/HYDRO	REMARKS/COMMENTS
19	N-4	Behind the Niles Manufacturing & Finishing Co., at 465 Walnut Street (Property lies within the old industrial section of the City of Niles)	Mr. Robert K Hendricks	1	25-019-001-00	15.54	Heavy Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - NO AB.MINES - GWT approx. 300 feet below	Primary Site 7.00 acres Resl.Property 8.54 acres
20	Niles City Dump	McKees Lane and Belmont Ave., in the City of Niles	City of Niles	2	NO I.D.	22.18	Heavy Industrial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	Cells were dug approx. 25-30' x 60' for city garbage dumping
	POLAND										
21	P-1	North- P&LE Railroad West- Lowellville Road East- Ohio/Pennsylvania State line South- US 224	1. Mr. John Kotchmar 2. Mrs. Val Livorini 3. D & R Perrotty	8	NO I.D.	50.00	Residential Industrial Commercial	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
	STRUTHERS										
22	S-3	CASTLO Industrial Park, Struthers		3	38-005-0-185.00-0 38-005-0-205.00-0 38-009-0-038.00-0	41.50 (A=1.50 B=40.00)	Industrial A	Sewer Lines- YES Water Lines- YES	DONE W/n LIMITS	- NO MINES - AB. MINES Within 2 Miles	
23	S-9	State Street, Struthers	M/s D. N. Vasvari Corp.	17	38-020-0-013.00-0 38-020-0-009.00-0 38-020-0-008.00-0 38-020-0-007.00-0 38-020-0-006.00-0 38-020-0-010.00-0 38-020-0-011.00-0 38-020-0-012.00-0 38-020-0-004.00-0 38-020-0-014.00-0 38-020-0-015.00-0 38-020-0-016.00-0 38-020-0-017.00-0 38-020-0-018.00-0 38-020-0-019.00-0 38-020-0-020.00-0 38-020-0-021.00-0 38-020-0-022.00-0	6.69	Residential A Commercial A	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES - NO AB. MINES	Strip mined at one time
24	S-11	State Street, Struthers	Mr. Joseph Bonish Sr.	8	38-020-0-040.00-0 38-020-0-004.01-0 38-018-0-393.00-0 38-018-0-394.00-0 38-006-0-168.00-0 38-006-0-167.00-0 38-006-0-167.01-0 38-006-0-168.01-0	46.78	Residential A Commercial A Industrial B	Sewer Lines- YES Water Lines- YES	NOT DONE	- NO MINES - NO AB. MINES	Strip mined at one time

3.2.2 Input of Attribute Data

The two most fundamental parts of GIS are the spatial information and the tabular data representing a drawing entity. Once all the spatial information was converted to the digital form, the structure of the attribute table was then designed. In order to design the attribute table, several factors were considered, including user interaction with the database, storage requirements of the database and future development of the database. After discussion with the YSU-TDC, it was decided to enter only that information presented in the spread sheet (Table 3.1). All available information pertaining to each of the thirty-two industrial sites was included in a unique attribute table for that site. In some cases, an industrial site consisted of several parcels. In those cases, additional attribute tables were created for each parcel in the same industrial site. All the attribute information was stored in the DBF format, so that the same information can be easily migrated to any other database system. In the future when the expansion of the database is required, the same data files (in DBF format) could be used to develop a GIS using ARC/INFO.

This unique attribute data set is linked to various entities in the drawing, the entity being in the form of a polygon (representing an MRCRS site). Before the attribute table or a data file is created, it is necessary to identify or create themes which store features and attribute data in the form of a GIS data set. ArcCAD has a built-in feature to create links between various features and their respective attributes. A polygon representing an MRCRS site is identified and its attribute data is defined by the following procedure:

Using the command 'defthm', a theme is created (for example MRCRS) representing a feature class (polygon). This theme name refers to a set of AutoCAD entities and linked theme features or to a database file. After creating the theme, the next step is to use the 'build' command, which automatically creates a polygon attribute table for a theme. The entity feature link information thus created is stored in link files. Link files are stored in a directory that has the same name as the current drawing with the extension of '.LNK'. This directory is accessed every time the GIS is brought up on the system, which means ArcCAD reestablishes the relation between different entities and its attribute information when ArcCAD is booted on the system (sometimes by default ArcCAD is booted up alongwith the AutoCAD). At this point an empty data set is created representing each MRCRS site which has a feature class 'polygon'. The next step is to populate these data sets with the desired information using the built-in features of ArcCAD functions. Using 'addrec', records are added to each attribute table representing the various MRCP sites. All data in Table 3.1 was added in this way.

Chapter 4

RESULTS AND DISCUSSION

4.1 Overview of the Final Product

The goal of developing a preliminary database was achieved and it was successfully transferred to the YSU Technology Development Corporation. The GIS consists of typical information required for the redevelopment of brownfields in the Mahoning River Corridor. The environmental evaluation and analysis reports furnished by the YSU TDC, and the reports of Slifka (1994) and Park (1994) formed the input to the GIS database. This information system provides the infrastructure for the user to communicate with prospective buyers of the brownfield property and providing the required information. The system is also capable of furnishing graphical information on all the MRCRS sites along with associated attribute information. Sample views of the final GIS were presented in Figures 3.2, 3.3, and 3.4.

The information from site maps of an industrial area (site), in addition to soil and water quality, ground water elevation (where available), size and location, ownership details and remediation options (if necessary) must be considered in order to provide a solid basis for decision making related to redevelopment. When this project was being initiated to develop a GIS database, the benefits of bringing all the spatial information (drawings) into AutoCAD format were discussed. The GIS software package ArcCAD offers utilities to import drawings (by swaping to AutoCAD mode) from other formats. The structure (or format) of the existing drawings was converted to digital form to make the spatial data more meaningfull and fully functional on the system.

4.2 Summary of Operating Procedure

The operating procedure used for the GIS depends on the nature of interaction with the database. If it is just an inquiry, windows mode must be activated in order to view the information. On the other hand, if the user is trying to update or manipulate any kind of information, AutoCAD must be activated from the DOS mode. Both cases are explained below.

4.2.1 Inquiry and Viewing the Information

Inquiry and viewing (Display) of the GIS data is done by using ArcView, which runs on the Windows platform. Depending on the security level, the user may be restricted to only inquiry and display of the existing data. The inquiry and display is done by using the following steps.

STEP 1. Bring up the Program Manager of MS WINDOWS.

STEP 2. Double click on the icon 'ArcView'.

STEP 3. Click on the 'File' option and select the desired view by choosing the 'Open' option, which then prompts the user to navigate through the ArcView files in the system (Several views can be displayed depending on the questions asked by the prospective investors or developers. Creation of a view is explained in section 4.2.1.2.).

STEP 4. After selecting the view all the layers or features that are selected in creating the view will be displayed in the list at the left of the dialog box. Now the user can choose among the features available to be displayed on another window right next to the ArcView window.

STEP 5. When a view is selected and opened, a 'Tool Palette' appears to the right of the window, from which various functions may be performed, such as 'Identify', 'Measure Box', etc. The Identify tool helps in querying the database.

STEP 6. Querying the database is done by picking the identify tool from the tool palette and clicking the left mouse button on the drawing (View) or any MRCRS site. Then immediately the attribute table having all the information pertaining to that polygon (MRCRS site) appears on the screen. (see Figure 4.1)

4.2.1.1 Inquiry to the Attribute Information

The attribute table which is associated with the drawing contains all the attribute information for all MRCRS sites. In order to display or do an inquiry to the theme data file, the user moves the pointer (using the mouse) over to the arrow to the right of the theme name in the Table of Contents window and scrolls down until 'Table' is selected. Then, using the 'Tool' palette, various functions and queries can be conducted on the data.

Various other tools such as zoom in, zoom out, etc., can be used depending on the user's interaction with the drawing. More details on these features are given in the ArcView User Manual (ESRI 1991). This discussion is only designed to explain how to bring up different views on the screen. The use of features other than the ones mentioned here is at the user's discretion.

4.2.1.2 Creating a View

To create a view, the user must first select 'Open' from the file menu, and then a file browser appears on the screen. The user then types in the new name for the view that is to be created. The 'Add' option in the file menu is selected in order to add theme(s). After navigating through the data files in a known directory where the data is residing

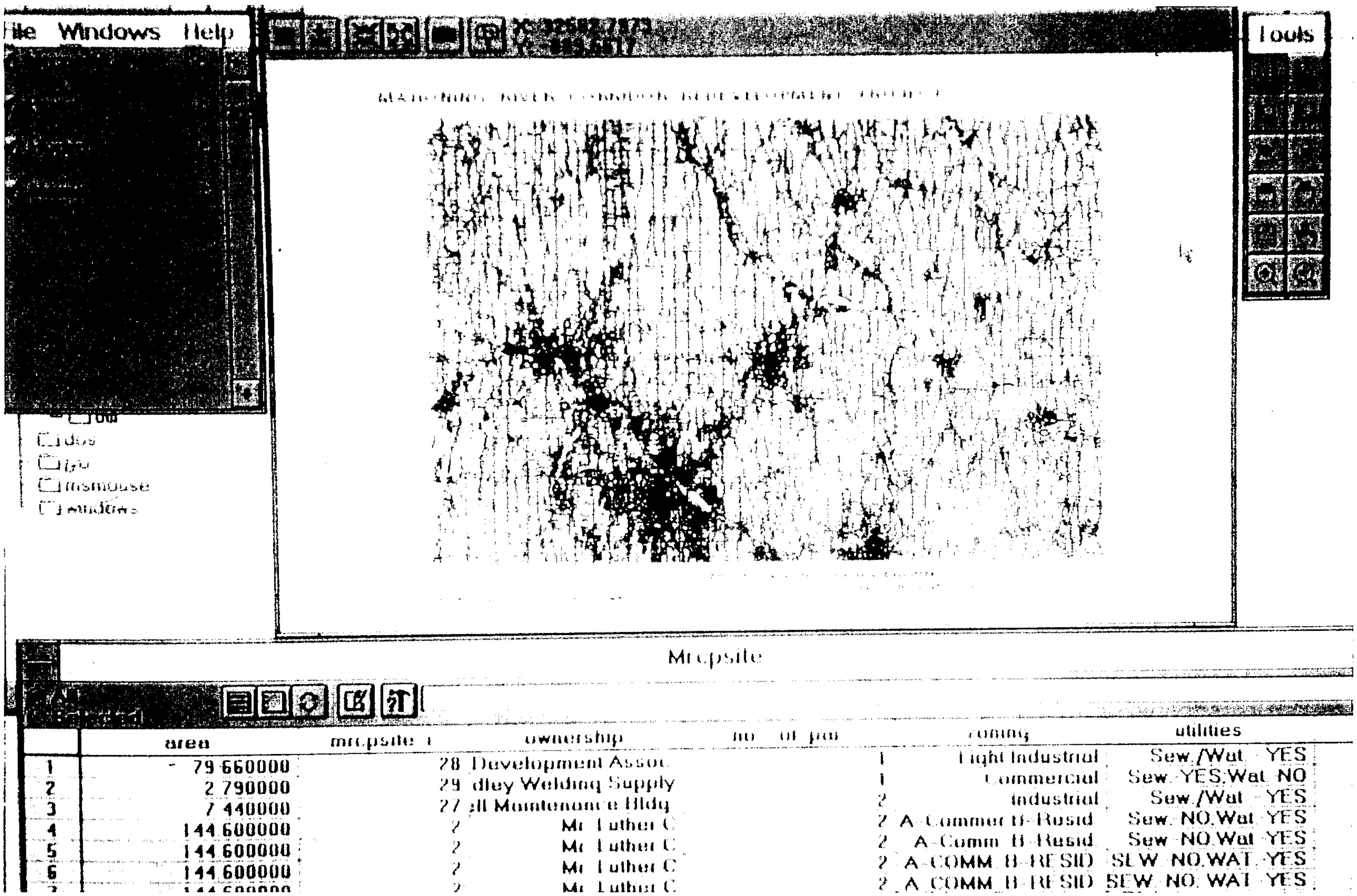


Figure 4.1 Inquiry and Display of a created view using ArcView

(/arcview/data/), the datafile is highlighted and then the user clicks on 'OK'. The selected theme(s) appear on the window. At the time of quitting the window, the 'Save' option is selected to save the view.

4.2.2 Manipulating and Updating the Information Manipulating and updating the GIS applies to two major categories of the information system, namely spatial data, and attribute data. Unless the GIS maintenance work is related to some of its application programs that are tailored to the user needs, most of the ArcCAD built-in functions provide enough tools to make the information current. Since this data base is only at the very elementary stage of development, at this level most of the manipulation and updating of the information system is involved with the addition, change, or deletion of the spatial information and the data file which contains the attribute information. On the other hand, when the maintenance work needs to be done at the application program level, the updates and changes will usually be limited to the application program itself.

4.2.2.1 Manipulation / Update of Spatial Information

Most of the spatial data that needs to be changed in the event a change in user environment is accomplished by AutoCAD. One example would be adding more details to the drawing such as adding more MRCRS sites or deleting the ones that have been sold. Others include creating a different view or data file in order to compile statistics related to brownfield sites or redeveloperment activities.

Adding a site map to the existing base map could be done in the same way that the original MRCRS site maps were inserted into the base map. Any changes to the already existing site map are made by using AutoCAD tools under the 'Edit' option.

4.2.2.2 Manipulation / Update of the Attribute information

The attribute information is in the form of data files similar to Dbase format. Any information that needs to be modified or deleted could be changed by using ArcCAD tools. Several commands in ArcCAD are available which enable the user to create, delete and modify the structure of database files. For example 'addrec' allows the user to interactively add new values to a theme. Some of the commands that are used to manipulate the data information are Copydb, Loaddb, Delrec, etc,. ArcCAD keeps track of, and updates, feature attribute tables, and manages relationships between features and their corresponding tabular records. ArcCAD also provides commands that can be used to perform logical and arithmetic operations on the rows and columns of any database file.

4.2 Project Summary

The GIS developed for Mahoning River Corridor brownfield properties was transferred to the YSU-TDC (now the Center for Engineering Research and Technology Transfer, or CERTT) and installed on their computer system. A demonstration was conducted for the Mahoning Valley Brownfields Working Group. Thus, local government and economic development officials are aware of this tool's availability and potential. The

GIS developed in this project provides a basis for expansion to a more comprehensive database on Mahoning Valley brownfield sites.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

The objective of this project was achieved by developing a preliminary GIS database for the Mahoning River Corridor Redevelopment Study (MRCRS) project. This GIS has the capability of rapidly furnishing information about industrial sites in the Mahoning River Corridor, and could be used to promote redevelopment. In order to help the user to furnish answers to the frequently asked questions by developers and other prospective investors, this GIS is fully equipped with the following features:

- Graphics (AutoCAD drawing) which give information about site location and its neighborhood.
- Ownership details, number of parcels, area and the geometry of the site.
- Water line and sewer line availability and any existing future plans of extending this facility to certain sites if applicable.
- Ground water details like ground water table, mines or abandoned mines, if present.
- Limited Environmental Evaluation results.

The spatial information used during the development stage of this information system corresponds to the standards set by the U.S. Geological Survey since all the map information was supplied by them in DLG format. As new releases or updates become available from USGS, the same procedures used in this project can be implemented to update the GIS. Any additional spatial information that needs to be brought into the system can be easily added by creating another layer by swapping from ArcCAD to AutoCAD Not all brownfield sites are on the information system, only priority sites selected in the MRCRS. As the sites are sold and/or redeveloped, they may be removed from the database. Also, as additional information becomes available, new sites can be inserted in the base map along with their respective attribute information. The geographic coverage of the spatial information can also be expanded as and when the requirements exists, or on demand from the user. This expansion of the existing spatial information can be accomplished by attaching the adjoining quadrangles from the USGS supplied DLG maps available on CD-ROM.

The attribute data is in the form of a DBASE file, which is a relational database management system. This type of database is very flexible; it is possible to generate various kinds of reports and graphs using Dbase functions and programs. For example, the percentage change in the brownfield acreage available (or redeveloped) between any two dates could be determined. Some of the fields which are numeric, such as Site Area, No. of Parcels, etc. could be used for logical computations in programs that are developed in the future. Manipulating, maintaining and expanding this preliminary database will play a very important role in determining the future usefullness of this GIS. Also, continued development of application programs for this database is equally important in order to get the maximum benefit from this GIS. At any point in time, the same spatial information can be used for other types of projects, such as GIS for environmental planning, tax details, building inventory or any other similar information system. The major difference would be in the attribute information.

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