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UNIVERSITY OF REDLANDS

Using GIS to support Midland County Parks and Recreation Department's
Trail Management Plan

A Major Individual Project Report submitted in partial satisfaction of the requirements for the
degree of Master of Science in Geographic Information Systems

by

Bryan Joseph Rayo

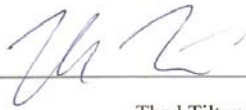
Committee in charge:
Mark Kumler, Ph.D., Chair
Thad Tilton

December 2004

Using GIS to support Midland County Parks and Recreation Department's
Trail Management Plan

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Bryan Joseph Rayo

The report of Bryan Rayo is approved.

A handwritten signature in blue ink, appearing to read 'Thad Tilton', positioned above a horizontal line.

Thad Tilton

A handwritten signature in blue ink, appearing to read 'Mark Kumler', positioned above a horizontal line.

Mark Kumler, Ph.D., Chair

December 2004

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ABSTRACT

Using GIS to support Midland County Parks and Recreation Department's

Trail Management Plan

by

Bryan Joseph Rayo

Trail management is an important function performed by the Director of the Parks and Recreation Department, Midland County, Michigan. The Director has determined that a GIS system is a necessary tool for aiding him with the different management issues surrounding the twenty-one mile rail-trail and other numerous hiking, mountain biking and cross country ski trails located throughout the county.

As of 2003, the National Park Service Inventory and Monitoring program has only been implemented on the federal level in 270 I&M parks with plans to spread to all national parks. Seeing how the program has grown over the last decade, with major strides in the past five years, the Director of Parks and Recreation determined that Inventory and Monitoring could, and should, be used within Midland County Parks system, with the Pere Marquette Rail-Trail being the pilot study for management of the park systems' natural resources.

The project describes an extension built in ArcGIS, an ArcPad applet and an ArcIMS that help the director with organization, operation and management of the different trails within the county and the Inventory and Monitoring program.

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1 Project Overview and Background Information

1.1 Introduction

Trail management is an important function performed by the Director of the Midland County, Michigan Parks and Recreation Department. The director has determined that a GIS system is a necessary tool for aiding him with the different management issues surrounding the twenty-one mile Rail-Trail and other numerous hiking, mountain biking and cross country ski trails located throughout the county. The project will result in an extension built in ArcGIS, an ArcPad applet and an ArcIMS application that help the director with organization, operation and management of the different trails within the county.

1.2 Description of Client

Midland County (Michigan) Parks and Recreation Department is comprised of seven parks and approximately 2,000 acres, which is roughly four percent of the area of the county. The Director of the Parks and Recreation Department is responsible for:

- The acquisition, development and management of seven county park areas; totaling over 2,000 acres of parkland (all park areas capitalize on water based recreation areas)
- Maintenance of all county facility grounds (Courthouse, County Services Building, Pinecrest County Farm, Animal Control Building, Juvenile Detention Facility)
- Supervision of 6 full-time employees and 16 seasonal employees and many volunteers.

“GIS is important in managing and identifying all aspects of the park for current and future planning.” (Paul D. Pounders, Director of Parks and Recreation Department)

1.3 Project Area Description

Midland County is located 51 miles northwest of the city of Flint and 20 miles west of the Saginaw Bay (see Figure 1). More specifically the Trail Management Plan is focused on the twenty-one mile long Pere Marquette Rail-Trail running from the City of Midland to the Midland/Isabella county line.

One of the parks is the Pere Marquette Rail-Trail of Mid-Michigan, located on a former CSX railroad right-of-way, and stretching from downtown Midland to the outskirts of Clare, a distance of approximately 30 miles (21 miles of it under the jurisdiction of the Parks and Recreation Department) (see Figure 2). The trail provides many barrier-free, non-motorized recreation and transportation opportunities on an asphalt surface.

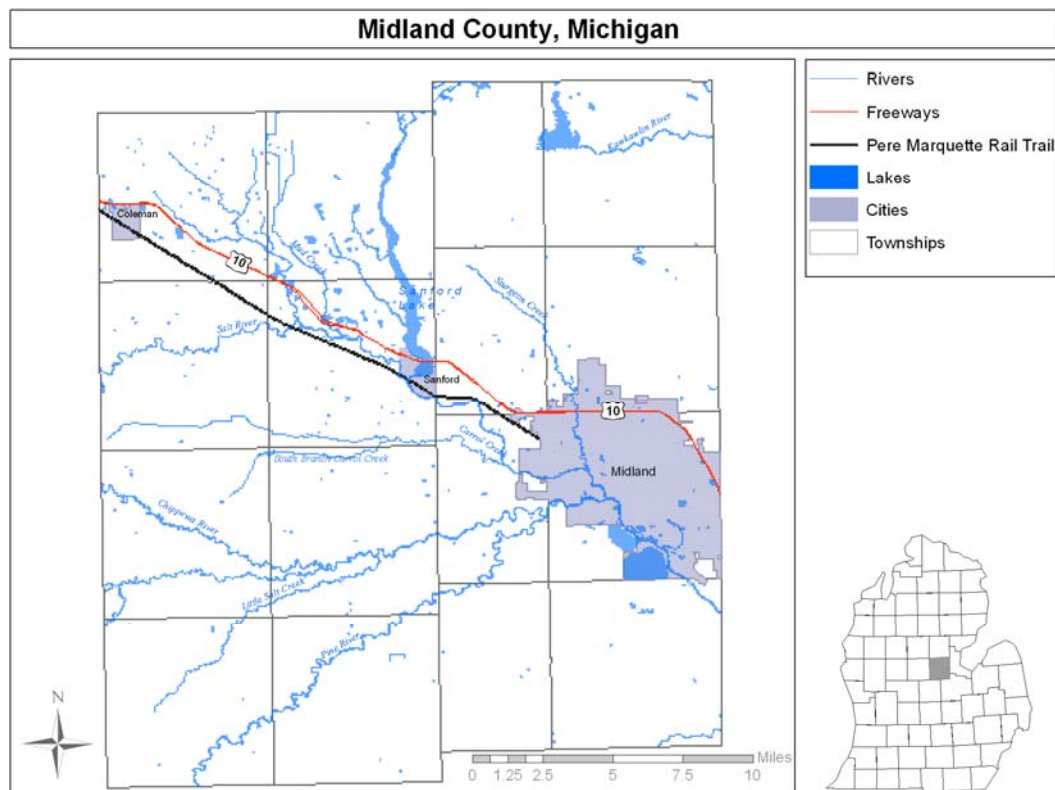


Figure 1. Study area – Midland County, MI

The original six miles of the trail was paved in 1994, followed by seven more miles that were paved in 1995. The remaining 21 miles were paved in 1996. It is due to the changing nature of the trail that the director decided upon a GIS system to aid in management of the Pere Marquette Rail-Trail.



Figure 2. Pere Marquette Rail-Trail.

1.4 Problem Statement

The Director of Midland County (Michigan) Parks and Recreation Department needs a more efficient way to manage the county's largest and most maintenance intense park, the twenty-one mile long Pere Marquette Rail-Trail. Currently, the director is utilizing old, non-georeferenced paper maps and 1998 aerial photography to develop and maintain the county's trail system. The director needs a more efficient way to visualize and interpret the park's infrastructure along with the park's resources. The Parks and Recreation Department needs a better tool for trail management. Some of the trail management aspects the director has highlighted include locating new buildings, park entrances, rail-trail access points, utility crossings, points of interest, new greenways, business easements, potential highway crossings, county drains, and bridges.

The Parks and Recreation Department decided to implement the National Park Service Inventory and Monitoring Program to support the maintenance of the Pere Marquette Rail-Trail and the other trails and parks found throughout the county.

1.5 GIS-Based Solution

GIS offers a unique toolset that can be utilized by the Director of Parks and Recreation Department of Midland County to both visualize and analyze the parks system, more specifically the Pere Marquette Rail-Trail (Lang 1999). For this project an Internet application, handheld application and desktop application are integrated to allow for viewing of data over the World Wide Web, field collection and analysis, and management of the data.

1.5.1 Objectives

The objectives of the project were threefold:

1. To develop a GIS extension, an ArcPad applet and an ArcIMS service for the Midland County Parks and Recreation Department to better aid in trail management; and,
2. To gain experience in ESRI software development and customization; and,
3. To gain experience in the development and implementation of a yearlong project for the Midland County Parks and Recreation Department.

1.5.2 Scope

The ArcIMS application was designed to be available on the internet. It was developed specifically for use by the Director of Parks and Recreation Department and for constituents. The Internet site allows users to visualize specific park information, such as locations of restrooms, parking lots, trails, etc. The application shall include basic zoom and pan functionality.

The ArcPad application is available to any PDA running the Windows CE operating system. It was developed specifically for the park rangers to collect data in the field. Functionality shall include data creation, deletion and minor analysis.

The ArcGIS Extension is available to any computer running ESRI's ArcGIS 9.0. It was developed specifically for the director to perform managerial tasks specific to the needs of the Parks and Recreation Department.

1.5.3 Methodology

The project methodology describes steps taken to define and complete the project:

- Acquiring necessary data from the Director of Parks and Recreation as well as other reliable sources found within the State of Michigan;

- Performing a needs assessment for the director to determine the correct path of the project;
- Develop a geodatabase for Midland County Parks and Recreation Department;
- Develop understanding and implementation procedures for National Park Service Inventory and Monitoring Program on county level;
- Develop ArcGIS extension(s) for trails management and Inventory and Monitoring;
- Develop ArcPad applet for park rangers;
- Develop ArcIMS service for director and the public.

2 User Needs Assessment

2.1 User Needs Analysis

2.1.1 Description of Best Approach

A user needs assessment was conducted over the course of a month through face-to-face meetings and telephone conversations. The object of the user needs assessment was to find out as much as possible about the current workflow of the director and the park rangers. Performing the needs assessment allowed for the creation of both high-level and business-level use cases.

2.1.1.1 High-Level Use Case

The high level use case was created to determine the necessary actors and actions found within the Parks and Recreation Department in order to successfully manage the trail systems throughout the county (see Figure 3). The people outside of the system represent the different users within the Parks and Recreation Department. The objects within the system are the corresponding actions the users perform which needed to be incorporated into the Trail Management Plan.

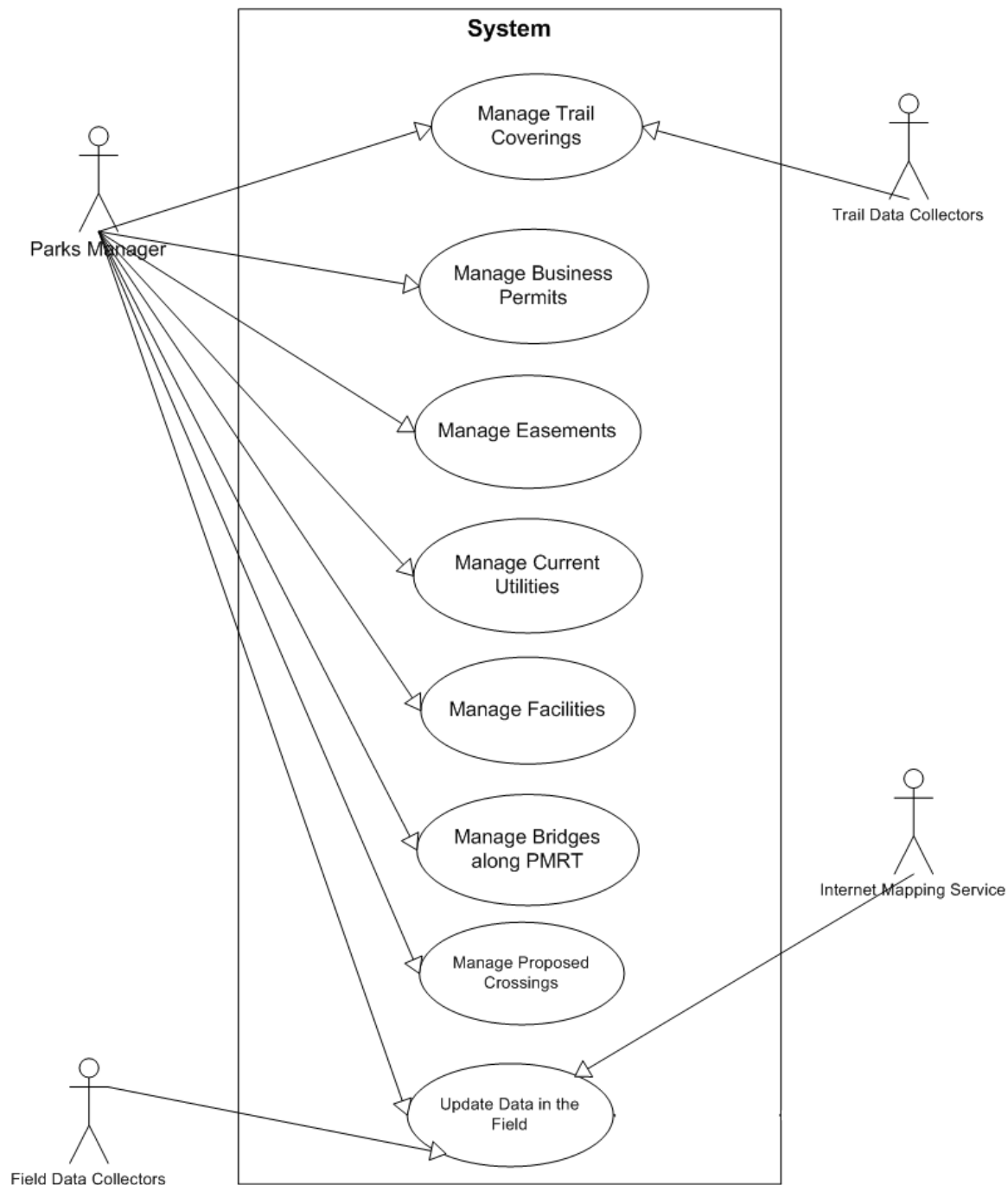


Figure 3. High-Level Use Case describing the system, players and their interactions.

2.1.1.2 Business-Level

From the high-level use case, a business-level use was produced to break down the action further. The primary actor in this particular business level is the director and the scenario that is explained is how the Trail Management Plan will aid the addition and management of the Business Permits dispersed by the Parks and Recreation Department (see Figure 4).

Use Case	Manage Business Permits
Level	Business
Summary	The Director of Parks and Recreation is required to keep track of all business permits associated with the Pere Marquette Rail Trail
Actors	Director of Parks and Recreation Department
Pre-Conditions	Currently, the Director of Parks and Recreation Department maintains all business permits in an Excel spreadsheet.
Post-Conditions	The Director of Parks and Recreation Department will have available a management tool capable of displaying all necessary non spatial and spatial data.
Primary Scenario	
1. Prospective Business requests permit. <i>Businesses request permits for access along the Pere Marquette Rail Trail. The permit grants the business an easement allowing them to have access to the rail trail.</i>	
2. The Director of Parks and Recreation Department finds potential access site. <i>The Director locates the potential access site and determines whether there is an existing permit at the location.</i>	
3. The Director of Parks and Recreation Department grants business permit. <i>The Director grants a permit to the requesting business allowing them access to a specific part of the trail.</i>	
4. The Director of Parks and Recreation Department manages business permits. <i>The new business permit can be added to other existing permits. All spatial and non spatial data associated with the business permits can be explored accurately.</i>	
Notes: The Director of Parks and Recreation Department has a responsibility for keeping track of all business permits associated with the Pere Marquette Rail Trail. The business permits are an important source of income for the Parks and Recreation Department.	

Figure 4. Business Use Case describing the Management of Business Permits.

2.2 User's Requirements

2.2.1 Specifics of What Park System Needed From a GIS

The client expected the production of an Inventory and Management extension for ArcGIS. Along with the extension, an ArcPad applet was needed to collect and edit the county's data while in the field. An ArcIMS service was discussed and determined as a necessary component to display the county's park data over the Internet for use by the public to be able to research, find, and get directions to the eight different parks in the county.

2.3 Current Work Environment

2.3.1 Current Hardware, Software and Data

Currently, Midland County Parks and Recreation Department utilizes Dell Computers running Windows Professional 2000, with a minimum processing speed of 1.2 GHz and 256 MB of RAM. Along with Windows Professional 2000, the Parks and Recreation Department is utilizing ESRI's ArcGIS 9.0 and ArcPad 6.0.3 software on their desktops.

The Parks and Recreation Department is utilizing Dell's Axim handheld, running Windows CE 2003 and ArcPad 6.0.3. At present, the department has only one PDA but is planning to purchase more for some of the rangers.

The Parks and Recreation Department does not have a dedicated server for ArcIMS or licensing purposes. The County's Information Systems Department has agreed to allow the Parks and Recreation Department to host its ArcIMS application on the county's server. The Director plans to purchase only one license of ArcGIS 9.0 for the time being, making a license server unnecessary at this point. The county's servers are currently running Windows Server 2003 and IIS 6.0 (Internet Information Services) as their Web Server software.

3 Deliverables

3.1 *ArcPad*

An ArcPad applet was developed for the park rangers to use in the field. The applet allows rangers to create new features and identify and edit existing ones. Specific forms were created for each Inventory and Monitoring shapefile. There are four forms in total, one for refuse collection, one for visitation collection, one for forest disease data and one for forest dieback information. The applet also allows for effortless changing of editable shapefiles, making it easier for the rangers while in the field.

3.2 *ArcIMS*

An ArcIMS service was created for the Parks and Recreation Department. The Intranet service will be used by the director and rangers for viewing the parks' data and integrating new data produced or edited in the field. The internet ArcIMS shall also be used by the public as a tool to locate and research the parks in the county.

The ArcIMS service was designed as a frameless, single web page. There are no pop-up windows in the application, due to new and improved pop-up blockers in place on most computers. The ArcIMS application was designed for the lowest common denominator, so a new connector/link was used as the intermediary between the user's browser and the ArcIMS Application server (more information in section 8.1.4).

3.3 *ArcGIS Extension*

An Inventory and Management extension was developed for use within the ArcGIS 9.0 platform. Utilization of ArcObjects and Visual Basic was necessary in the development of the extension. The Inventory and Management extension's main functionality is report writing; this is used by the director to display updates and changes in the parks' data in text file or html formats.

The extension utilizes ArcPad controls in ArcGIS to aid in connection between the Inventory and Management program shapefiles and the Parks and Recreation Department's personal geodatabase.

3.4 *Personal Geodatabase*

An ESRI personal geodatabase was created as the main data repository for all of the Parks and Recreation Department data. The personal geodatabase format was chosen for its stability and ease of importing both shapefiles and coverages. The personal geodatabase format was selected for two additional reasons: the Parks and Recreation Department does not have more than 2 gigabytes of data (the personal geodatabase size limit), and the department does not have ESRI's RDBMS gateway SDE.

4 Data and the Personal Geodatabase

4.1 Sources

Data for the project was compiled from two different sources: The State of Michigan and through field collection utilizing a GPS device. It was necessary to use data from the state because the Parks and Recreation Department did not have any geospatial data at the beginning of the project. Base data, aerial imagery, roads, hydrology, and administrative boundaries were some of the layers downloaded.

The State of Michigan gave a solid foundation to build from, but there was no park specific data. It was crucial to get out in the field with a mid- to high-grade GPS unit to capture the large amount of trail specific data across the county. Data was collected over the course of a week with the director overseeing all aspects of the information gathering process.

4.1.1 State of Michigan

The State of Michigan has a GIS data library available online, for free, called the Michigan Geographic Data Library (<http://www.michigan.gov/cgi>). It is possible to download base layers here clipped to a specific geographic administrative boundary: for this project the extent was the County of Midland. All data downloaded from the state was in shapefile format, except for the DOQQ's (Digital Orthophoto Quarter Quadrangles) which were in the MrSID (Multi-resolution Seamless Image Database) format.

All downloaded data from the state was part of the 4b Framework, established in early 2004. The Michigan Geographic Framework was created by the Michigan Center for Geographic Information to establish a consistent, statewide seamless base of information. Framework data was originally based upon the Census Bureau's TIGER/Line files at a 1:24,000 scale. Over the past few years there have been six revisions of the data, starting with version 1a and now ending with 4b. Through each revision the data became more accurate through help from local governments, the Michigan Department of Natural Resources, and Michigan's Department of Transportation.

All data, including the DOQQ's, were in the Michigan GeoRef Coordinate System. The GeoRef projection is different from the State Plane Coordinate Systems used by most states in the United States. Instead of the three different zones; north, central and south, the GeoRef Coordinate System utilizes only one (Lusch 2000). A benefit of the GeoRef Coordinate System is the decrease in distortion that can be found in most State Plane systems. State Plane Coordinate Systems favor states trending either east – west or north-south. Due to the Upper Peninsula, the trend of Michigan goes from southeast to northwest, making the GeoRef well suited for the odd shape of the state (Lusch 2000).

4.1.2 Field Collection

Along with the data downloaded from the state, a GPS unit was used to collect the sizable amount of trail specific data in the field (see Figure 5). A commercial grade Garmin unit

was used, as well as a Beacon on Belt (BOB) remote antennae to collect the most accurate data possible. The BOB allows for real time correction through communication with the Coast Guard tower, where the tower is at a known location, in the Saginaw Bay, roughly thirty miles to the east.

The Garmin unit was set to collect all data on the Michigan GeoRef coordinate system. This was used to minimize distortion between the state's and field collection data. With the aid of the BOB, accuracy was sub-meter at best and slightly over 1.5 meters at worst.

Collection of the trail specific data was further supported by use of a Midland County Parks and Recreation vehicle and the knowledge of the Pere Marquette Rail-Trail by the director. The GPS unit was attached to the roof of the vehicle and it was driven down the center of the Pere Marquette Rail-Trail, stopping at necessary data locations. Such items as bridges, restrooms, and street intersections were collected at this time (see Figure 6.).

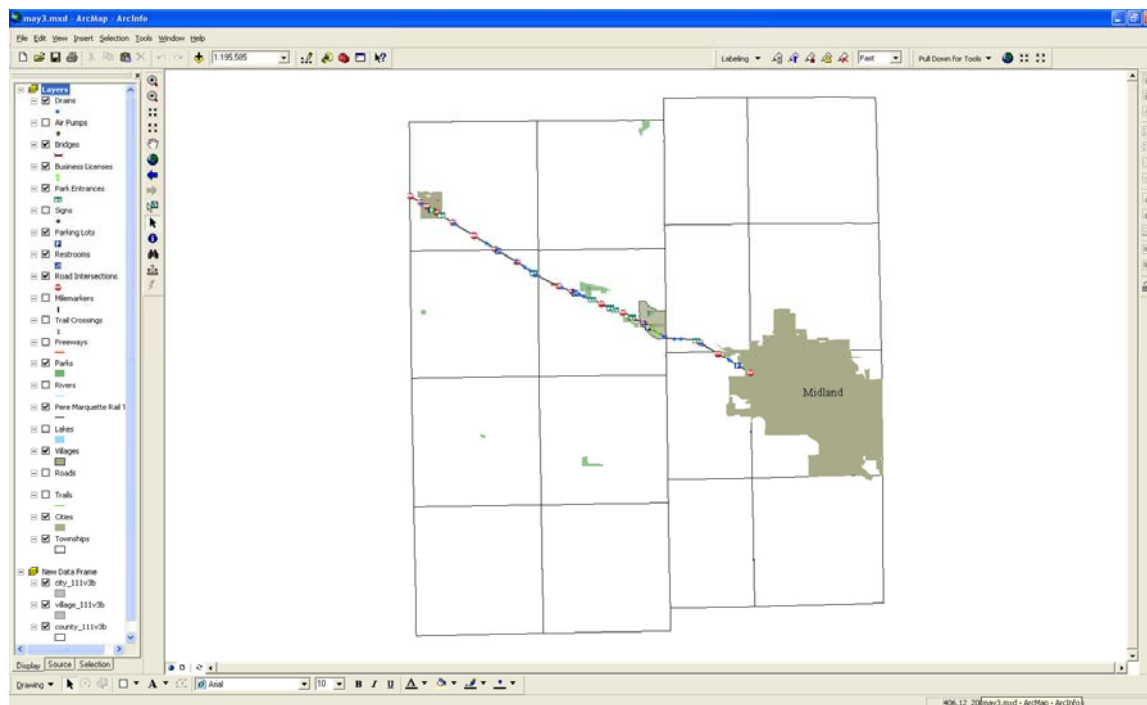


Figure 5. Point data collected in field.

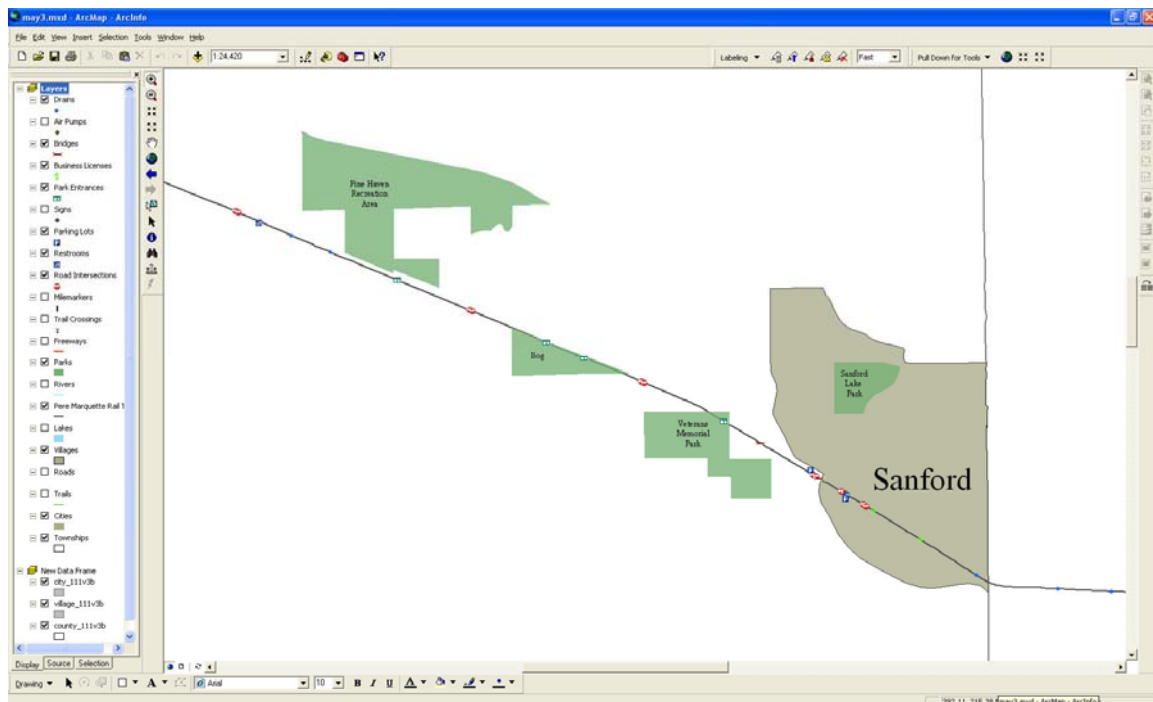


Figure 6. Close-up of point data collected in field.

4.2 Compilation and Standardization

4.2.1 Data Format

It was necessary to find a format in which all data could be stored and disseminated to the Parks and Recreation Department. ESRI's geodatabase was chosen as the format for which all data within the project would be brought in. The only exception would be for both the ArcPad and ArcIMS applications that rely on the shapefile data format.

The geodatabase was chosen because of its functionality and stability. Due to the small amount of data, and lack of ArcSDE, a personal geodatabase was created. The personal geodatabase is built upon Microsoft's Access database platform, making it a reliable replacement for the shapefile (Booth 1999). The personal geodatabase retains many of the functions of the enterprise model, including topology and disconnected editing.

The State of Michigan's data, being in shapefile format, was easily imported into the structure of the Parks and Recreation Department's personal geodatabase. The field collection data had to be converted from its native ASCII format to the shapefile format first, and then processed into the geodatabase. The ASCII data was brought into ArcMap as X/Y data points and then converted to shapefiles. These shapefiles could then be brought into the corresponding feature datasets of the Parks and Recreation Department's personal geodatabase (see Figure 7).

The DOQQ's, in MrSID format, could not be stored within the personal geodatabase. Rather, they were stored in a location that can be overseen by the geodatabase, very similar to that of an image catalogue. The catalogue is beneficial to the Parks and

Recreation Department because it allows for quicker retrieval of the data, due to the geodatabase maintaining the path structures and locations of the images (Booth 1999).

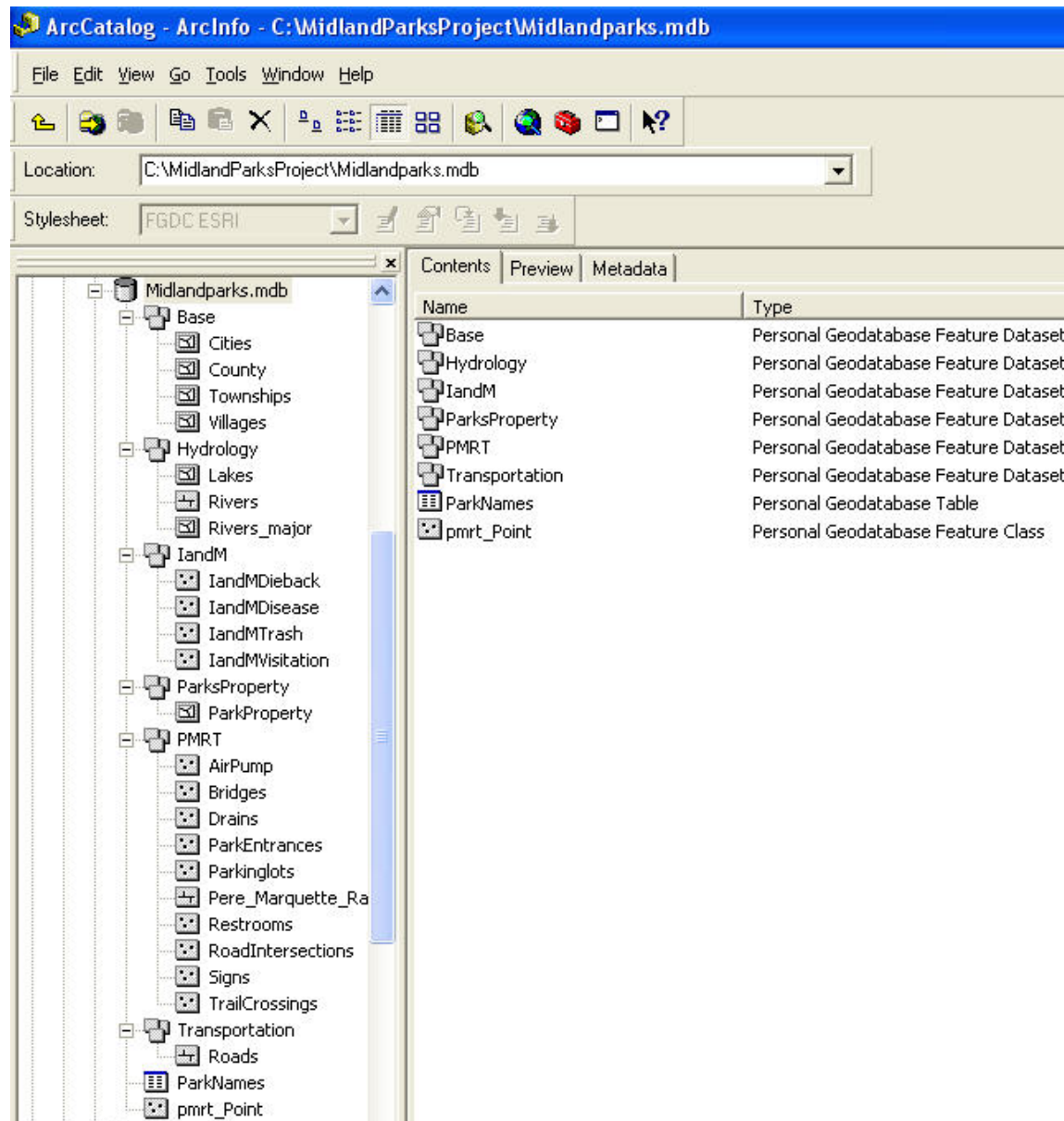


Figure 7. Parks and Recreation Department Personal Geodatabase.

4.2.2 Coordinate System

The Michigan GeoRef Coordinate System was agreed on as the projection and coordinate system for the Trail Management Plan for Midland County's Parks and Recreation Department (see Figure 8). At this stage, with the fledgling GIS program in Midland County and the Parks and Recreation Department, the GeoRef Coordinate System allows for the greatest ease of assimilation of state data. As the state continues to upgrade the Framework network, base information can be updated quickly and with minimal distortion.

Two counties near Midland that have GIS programs are Bay and Saginaw. Both Saginaw and Bay Counties are within the same State Plane Coordinate System (the Southern). Although it would be beneficial to all counties for data transferal among the three, the benefits of the GeoRef Coordinate System outweigh the State Plane System at this time.

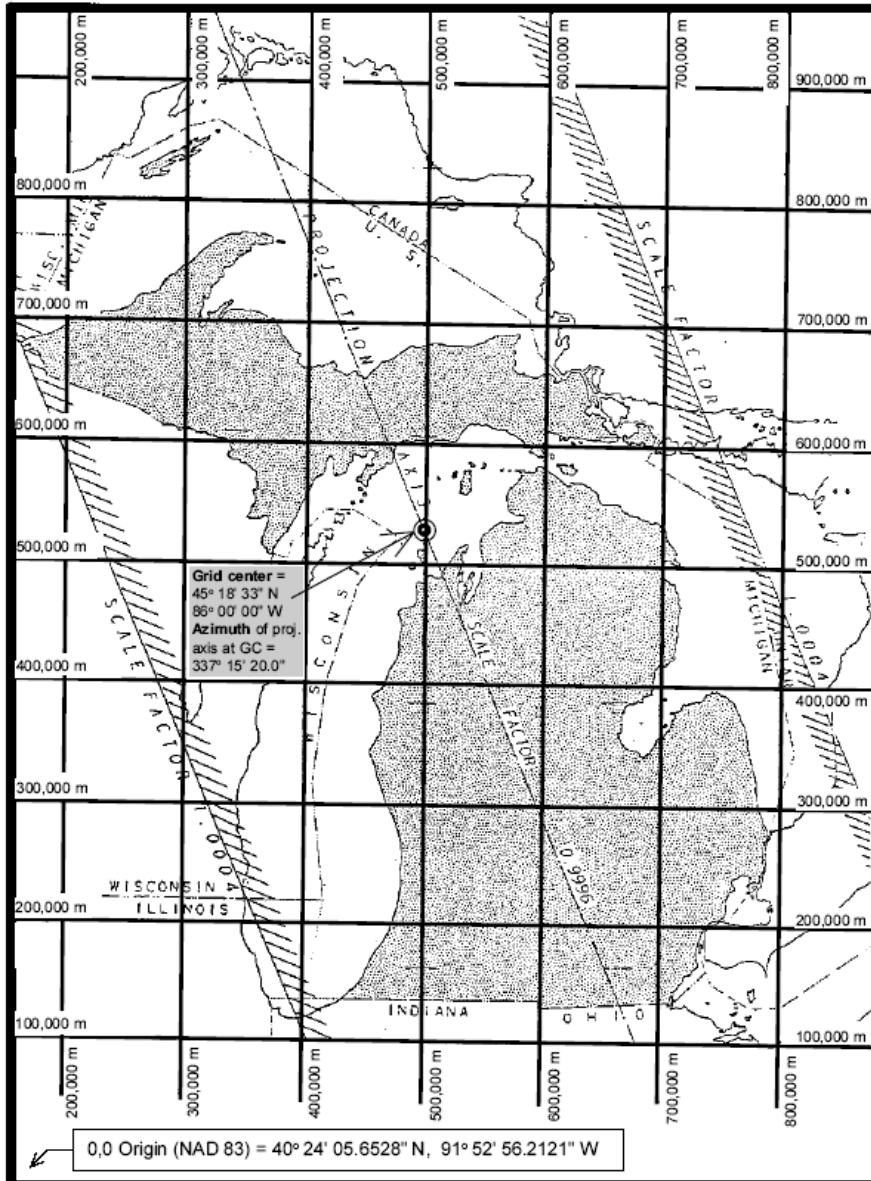


Figure 8. Michigan GeoRef Coordinate System.

4.3 Layers

4.3.1 Trails

The trails data layer was created through collection with a GPS unit by walking along the centerline of all the trails in the Sanford Lake Park and Veteran's Park as well as within Pine Haven Recreation Area. Such trails include hiking, mountain biking and cross-country skiing. With the creation of the trails data, the director and rangers have the

opportunity to make real time, in the field changes to direction and can capture any sort of hindrance, whether it be a sinkhole or a tree.

4.3.2 Bathrooms

The bathroom data layer was created to allow for management and planning for new infrastructure. The bathroom data layer contains information of what types of plumbing, electrical, superstructure and glass are present. The layer also contains information on the last time maintenance was performed and the type of maintenance.

4.3.3 Parking Lots

The parking lots data layer contains information of type of surface and date of last replacement of the asphalt. The data layer also contains information on what type of curbs are found nearby.

4.3.4 Road Intersections

The roads intersection data layer contains information on the signage at every crossing. The signage information consists of the type of signs, last replacement and last mowing in order to create the correct line of sight for patrons along the Pere Marquette Rail-Trail. The data layer also contains information on whether there are benches located at the intersections.

4.3.5 Trail Crossings

The trail crossing data layer represents the areas along the Pere Marquette Rail-Trail where citizens have vehicular access across the trail to their residences. The importance of the trail crossings data layer is that these areas of the trail see more wear due to the vehicles passing over them. By knowing where the residents cross the trail, it allows the director to check these places for damage more frequently.

4.3.6 Signs

The signs data layer represents any sort of memorial or plaque found along the Pere Marquette Rail-Trail. This layer was created to help the director in planning maintenance of the signs and for recording any vandalism of signs.

4.3.7 County Drains

The country drains data layer represents any county drain that passes below the Pere Marquette Rail-Trail. The importance of this data layer is that it allows the director to check specific areas for any subsistence or water leakage around the trail.

4.3.8 Business Licenses

The business licenses data layer represents access to the Pere Marquette Rail-Trail granted by the Parks and Recreation Department. The business license layer allows the director to visualize where access is found along the trail and determine whether too many accesses may be located in any one area. The data layer also captures the date of expiration and name of the business holding the license.

4.3.9 Air Pumps

The air pumps data layer is important mostly to the biking community. Air pumps are located in Sanford and Coleman, available for use by any person, free of charge. It is important for the director to know where the air pumps are located for both maintenance and the possibility of adding more to the Pere Marquette Rail-Trail.

4.3.10 Bridges

There are two bridges located on the Pere Marquette Rail-Trail that were part of the original CSX railway. Besides showing the location of both bridges the data layer also communicates the last time and type of maintenance. With the bridges being refurbished during the conversion of the rail-trail during the mid 1990's, and being part of the original railway, it is important for the safety of the patrons to correctly maintain them.

4.3.11 Mile Markers

The mile markers data layer consists of two different sets of markers, Midland and Saginaw. The Midland mile markers are located on the south side of the rail-trail and display the distance, in miles, from the City of Clare to the end of the trail in the City of Midland. The Saginaw mile markers are located on the north side of the rail-trail and display the distance, in miles, from the City of Midland to the end of the trail in the City of Clare. For management purposes, the data layer communicates the condition, last repaint and last repair dates.

4.3.12 Park Entrances

The park entrances data layer represents an intersection of another county park with the Pere Marquette Rail-Trail. The importance of the park entrances data layer is that there are Parks and Recreation signs at each of these intersections. It is important for the director to know where the sign is located, what kind of material it is made of, and the last time it was replaced.

5 Inventory and Monitoring

5.1 National Park Service Inventory and Monitoring Program

The National Park Service's Inventory and Monitoring Program was developed in 1993 to record and monitor natural resources in the parks to better understand the changes occurring and how they could be managed (Sokup 2003). The program emphasizes the development of a modern database and GIS system to build knowledge for better decision making and protection of the natural resources. The National Park Service partnered with other federal agencies, universities and other organizations to try to make the program succeed.

5.1.1 Background

The Inventory and Monitoring Program is broken into three major divisions Human Activities and Cultural Practices, Physical/Chemical Environment, and Biotic Integrity. Each of the major groups is subdivided further into sub-groups and sometimes into sub-sub groups. The Human Activities and Cultural Practices group can be categorized as any function or interaction that man has with the environment and how it can be monitored, such as park use and activities or land use. The Physical/Chemical Environment can be categorized as soil, water and nutrient dynamics, or landforms and hazards. The last group, Biotic Integrity, can be categorized as terrestrial, freshwater, or marine ecosystems.

The Inventory and Monitoring Program follows this process: The necessary groups have been chosen and the framework for collection and management is established. For each group that is chosen, collection and management must occur once a month, for every month until the project has been completed. The day chosen for collection, say the 15th, is the same day for collection and management every month for the entire project. It is the National Park Service's idea that collecting data on the same day every month for the duration of the project grants stability and rigidity to the science behind it.

5.2 I & M Implemented on the County Level

As of 2003, Inventory and Monitoring had only been implemented on the federal level, in 270 I&M parks, with plans to spread to all national parks. Seeing how the program has grown over the last decade, with major strides in the past five years, the Director of Parks and Recreation determined that Inventory and Monitoring could, and should, be used within Midland County Parks system, with the Pere Marquette Rail-Trail being the pilot park.

There are over twenty-five vital signs that fall under the three major Inventory and Monitoring groups (Sokup 2003). Not all of the vital signs pertain to what Midland County's Parks and Recreation Department have within their parks. For this reason, the director assessed all of the vital signs and the areas of the parks that could benefit from the Inventory and Monitoring program. Only four vital signs were chosen at this time: Refuse Found in Parks, Visitation, Forest Dieback and Disease, and Insect and Disease Infestations. It was the director's plan to start with a minimum number and slowly

progress to all vital signs that apply to Midland County's Parks and Recreation Department parks.

5.2.1 Refuse Found in Parks

The objective for the refuse category is to monitor trash and debris in terrestrial habitats, in or near the high use areas along the Pere Marquette Rail-Trail. The goal for the category is to reduce the level or completely eliminate the debris from the parks. The monitoring questions that arise are: What is the level of litter/debris? and Where are the areas of litter/debris?

The refuse category was developed into a data layer and incorporated into the Parks and Recreation Department's personal geodatabase. The refuse data layer helps the director manage and plan for any new refuse containers and changes in routes the rangers take when traveling through the different parks. The refuse data layer was also developed to be implemented with the ArcPad application for manipulation in the field.

5.2.2 Visitation

The object for the visitation category is to monitor the amounts and types of visitation occurring along the Pere Marquette Rail-Trail. The goals for the category are to minimize the level of human impact and maintain natural conditions, maintain use levels with appropriate impact and intensities, and to establish a baseline for future evaluations of impact and protection of the resources in the park.

The monitoring questions associated with the visitation category are: Are the use levels changing? What are the trends? Are there locations or areas where the intensity is changing? and Are they related to changes in resource levels?

The visitation category was developed into a data layer and incorporated into the Parks and Recreation Department's personal geodatabase. The visitation data layer aids the Director in determining where the high and low levels of use occur along the Pere Marquette Rail-Trail. Along with usage levels, the visitation data layer aids in developing different areas along the trail to attract more patrons. It is important for the Director to have an idea of how many patrons visit and travel along the Pere Marquette Rail-Trail. The visitation data layer was also developed to be incorporated with the ArcPad application for manipulation in the field.

5.2.3 Forest Dieback and Disease

The object for the forest dieback and disease category is to track insect and disease presence during forest dieback. The goals for the category are to distinguish between native and non-native dieback and control the non-native instigators where dieback is not expected. Monitoring questions associated with the forest dieback and disease category are: What population of trees in a population are declining or dying off? What temporal trends associated with dieback? and What proportion of dieback is due to natural versus non-native species influence?

The forest dieback and disease category was developed into a data layer and incorporated in the Parks and Recreation Department's personal geodatabase. The forest dieback and disease data layer will aid the Director in locating areas of both high and low dieback and determine what may be causing it. The data layer can also help locate areas of non-native species and illustrate impact upon native plants. The forest dieback and disease data layer was also developed to be incorporated with the ArcPad application for manipulation in the field.

5.2.4 Insect and Disease Infestations

The object for the insect and disease infestations category is to monitor disease impact and incidence, especially on native species. The goals for the category are to detect and reduce incidence of both disease and pathogens and to prevent disease occurrence or minimize impact within the park.

The monitoring questions associated with the insect and disease infestation category are: What is the incidence and level in populations? What are the diseases or pathogens affecting the populations? What are the trends in disease or pathogens? What are disease locations outside of the parks? What species are they affecting? and What are the rates and directions of spread and identify any existing disease or pathogen incidence, impact and trend?

The insect and disease infestation category was developed into a data layer and incorporated into the Parks and Recreation Department's personal geodatabase. The insect and disease infestation data layer will allow the Director to track and manage infestations in the park. It can also aid in tracking infestations that may be heading towards the park. The insect and disease infestation data layer was also developed to be incorporated with the ArcPad application for manipulation in the field.

6 ArcPad Development

6.1 ArcPad Functional Requirements

6.1.1 Design Constraints

The major constraint when designing anything for use on a Personal Data Assistant (PDA) with ArcPad is the screen size; usually measuring somewhere between 2.5 - 3 inches wide by 3.5 - 4 inches tall (see Figure 9). It was necessary to use the built-in tabs of the form (blue arrows in Figure 9) to insure controls would not overcrowd a form or be too small to see in the field.

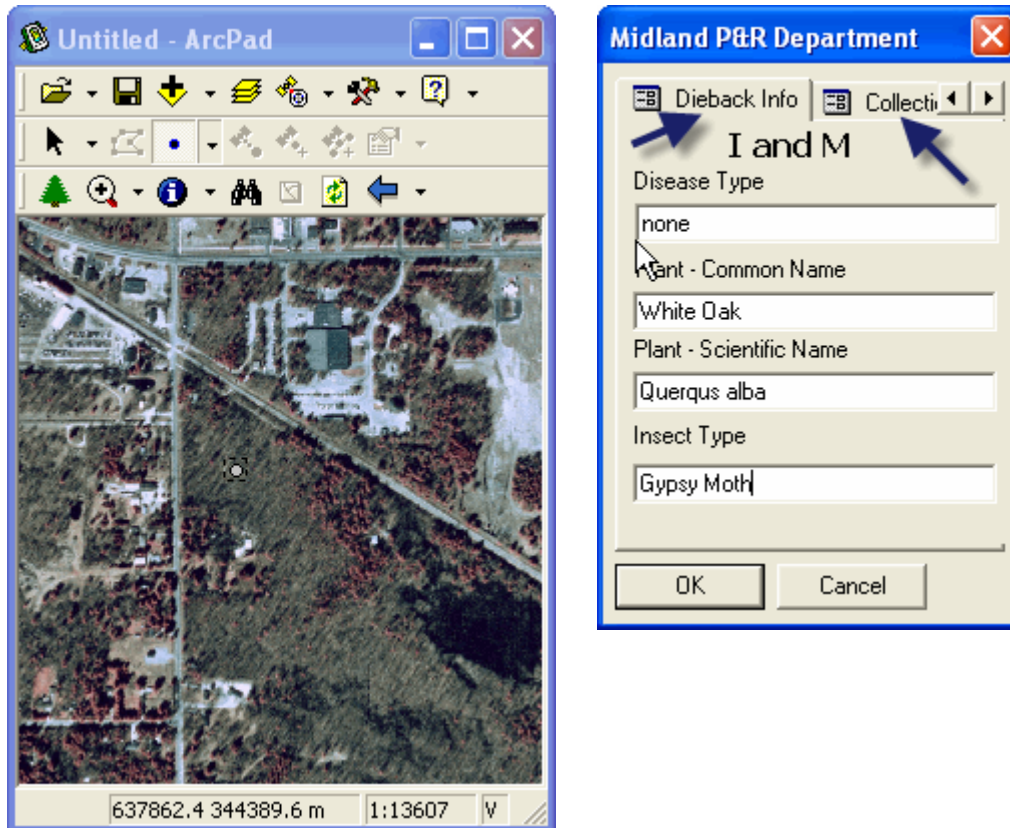


Figure 9. The figures above display the actual sizes of both the application and form.

6.1.2 Performance Requirements

The table below conveys the minimum performance requirements for ArcPad to run on a PDA, or similar equipment.

Table 1. For ArcPad (on any Windows CE platform):

Processor	Hitachi SH3 and SH4, XScale, StrongARM, MIPS, or x86
Memory	32megabytes (MB) of RAM; 64 MB recommended

6.1.3 Software Components

The software required for field data collection and running the Inventory and Monitoring specific forms is ArcPad 6.0.3. The software required for constructing the forms is ArcPad Studio. Table 2 explains the software packages and their different purposes in the construction of the Inventory and Monitoring forms.

Table 2. Software components for ArcPad applet

ArcPad	ArcPad	6.0.3	ESRI	Data collection in the field
ArcPad Builder	ArcPad Studio	6.0.1	ESRI	Writing scripts to create ArcPad application

6.2 ArcPad Specific Functions and Forms

6.2.1 Parks and Recreation Applet

The Parks and Recreation applet is a combination of two of the original ArcPad toolbars. To save screen size only essential tools were migrated from the original toolbars to the Parks and Recreation Department's applet (see Figure 10). These tools are zoom functions, refresh, identify, search, clear, and a parks specific button. The parks specific button allows the user to open a form, choose the shapefile that needs to be edited, and launch the edit toolbar, all with the click of a single button. The button was created to aid the rangers while in the field so they would not have to use the native ArcPad functions for choosing the editable shapefile.

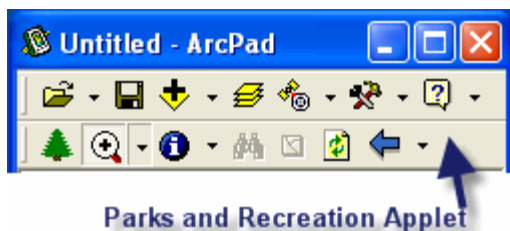


Figure 10. Parks and Recreation's ArcPad applet (lower toolbar), showing park specific button and tools as well as ArcPad's native browser toolbar (upper toolbar).

6.2.2 Parks and Recreation Forms

6.2.2.1 Refuse Monitoring

The refuse monitoring form allows for collection of trash information such as description, name of the park the trash is found in, date collected, and any comments that could be helpful explaining the phenomenon. The figure below (Figure 11) shows the actual form, in its actual size with all of its controls.

Figure 11. Parks and Recreation's ArcPad Inventory and Monitoring Refuse Collection Form.

6.2.2.2 Visitation

The visitation form allows for collection of patron specific information such as the number of visitors, the park they were visiting, type of visitation (biking, hiking, boating, walking, or other recreation), and the date of collection. The figure below (Figure 12) shows the form in actual size with all controls.

Figure 12. Parks and Recreation's ArcPad Inventory and Monitoring Visitation Collection Form.

6.2.2.3 Forest Dieback

The forest dieback form allows for collection of specific forest dieback information such as the type of disease, a plant's common name, a plant's scientific name, type of insect,

park in which the dieback is occurring, and date of collection. The figure below (Figure 13) shows the actual form in its true size. The forest dieback form consists of two sub forms controlled by the tabs at the top and labeled for their appropriate action. It was necessary to utilize the tab sub forms because there is more information being collected than could be fit upon only one form page. If all of the information was expected to fit on one form page, the controls would be too small to see and use in the field.

The figure displays two screenshots of a software form titled "Midland P&R Department".

The left screenshot shows the "Dieback Info" tab. It contains the following fields:

- Disease Type:** A text box containing "none".
- Plant - Common Name:** A text box containing "White Oak".
- Plant - Scientific Name:** A text box containing "Quercus alba".
- Insect Type:** A text box containing "Gypsy Moth".

The right screenshot shows the "Collection Info" tab. It contains the following fields:

- Park Name:** A dropdown menu showing "Sanford Lake".
- Date Collected:** A date picker showing "6/ 2/2004".

Both screenshots have "OK" and "Cancel" buttons at the bottom.

Figure 13. Parks and Recreation's ArcPad Forest Dieback Collection Form.

6.2.2.4 Infestation

The infestation form allows for collection of specific disease infestation information such as disease type, plants common name, plants scientific name, park in which disease was found and date collected. The figure below (Figures 14) shows the form in actual size with all of its controls. Once again, multiple tab forms were necessary to avoid crowding on just one form.

The image displays two screenshots of a software application titled "Midland P&R Department".

The left screenshot shows the "Disease Info" tab. It contains the following fields:

- Disease Type:** Tar Spot
- Plant - Common Name:** Red Maple
- Plant - Scientific Name:** Acer rubrum

The right screenshot shows the "Collection Info" tab. It contains the following fields:

- Park Name:** Sanford Lake
- Date Collected:** 6/ 2/2004

Both screenshots include "OK" and "Cancel" buttons at the bottom.

Figure 14. Parks and Recreation's ArcPad Forest Disease Collection Form.

7 ArcGIS Extension

7.1 Extension Functional Requirements

7.1.1 Constraints

The only constraint for successfully running the extension is the use of ArcGIS version 9.0. The extension does not run on previous versions. The ArcObjects framework, or library of objects, changed somewhat between versions 8.3 and 9.0 making it difficult to run applications that were created in any previous framework.

7.1.2 Performance Requirements

Table 3 explains the performance requirements for ArcGIS to run successfully on Windows NT, and similar NT-based, operating systems.

Table 3. For ArcGIS 9.0 (on Windows NT 4.0 platform):

Processor	Pentium III 800-megahertz (MHz) or higher processor; Pentium IV 1.0 GHz recommended
Memory	256 megabytes (MB) of RAM; 512 MB recommended
Hard disk	4 gigabytes (GB) of available hard-disk space;

7.1.3 Software Components

The software required to run the extension is ArcGIS 9.0. The software required for constructing the extension is Microsoft's Visual Studio 2003 .NET and .NET Framework. Table 4 explains the software packages and their different purposes in the extension.

Table 4. Software Components for ArcGIS extension and System Tray application.

Name	Mnemonic	Version Number	Source	Purpose
ArcGIS – ArcView	ArcGIS	9.0	ESRI	Analyzing and editing data, map production
Visual Basic	VB.NET	.NET	MSN	Build ArcGIS extension and System Tray application
.NET Framework	.NET	1.1	MSN	Coding language for interpreting VB.NET code

7.2 ArcGIS Extension Functions and Forms

7.2.1 Extension Window

The extension window in ArcGIS allows the user to activate or deactivate any extension at any time (see Figure 15). It was necessary to associate the extension with the extension window to be able to show or hide the Parks and Recreation toolbar successfully.

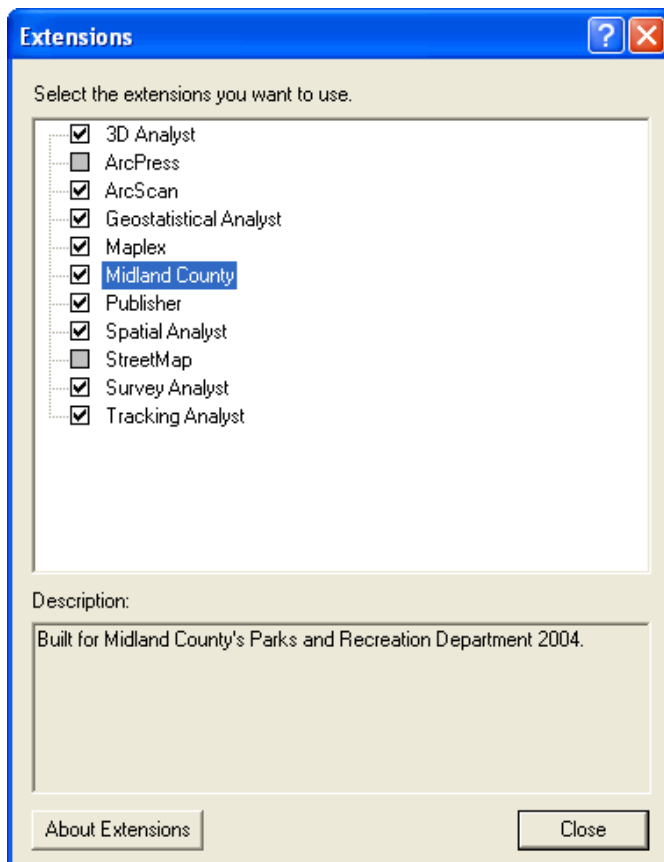


Figure 15. ArcGIS extension window with the Midland County extension highlighted. ArcGIS extension window found under Tools, Extensions.

7.2.2 Report Writing Capability

7.2.2.1 Function

The ArcGIS extension allows the user to create two different types of reports based on the current mxd document. The different report style outputs are either a text file or an HTML document. The user selects whether the report will document only the current data frame or all data frames in the mxd document. The user can also create output images for either the layout or data view or both. The extension also has the capability to add comments to the written report.

Output types were chosen due to both portability and cross-platform functionality. A text file can be opened on either a Windows or Macintosh machine. An HTML document can be opened on any type of operating system with any type of Internet browsing software. Additionally, most PDA's have an Internet browser included in their operating system making it possible to export the report to the handheld unit and transport it anywhere.

7.2.2.2 System Interfaces

The Parks and Recreation toolbar can be docked within the ArcGIS toolbar collection area, or it can be left floating freely. The Create MXD report function is located in a dropdown menu on the left hand side of the toolbar (see Figure 16).

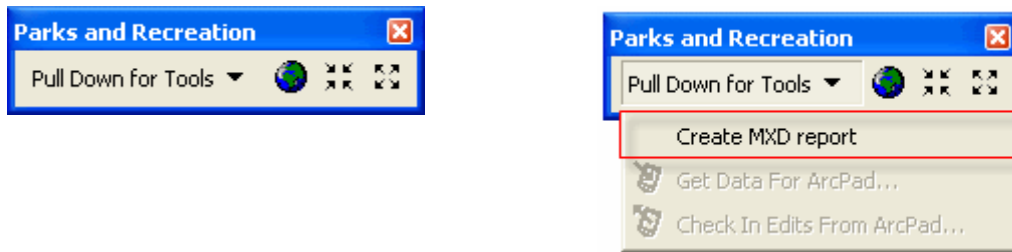


Figure 16. Parks and Recreation toolbar and Create MXD report tool.

The Create MXD report form contains all of the controls available to the user to customize a report (see Figure 17). It allows the user to choose the destination of the report, or output location so it can be found later. If the HTML format is chosen, the user can change the background color of the document being produced. The background color option was included in case any of the reports would be published onto the Parks and Recreation Department's website. Changing the background color during the report creation makes integration with existing web pages much easier.

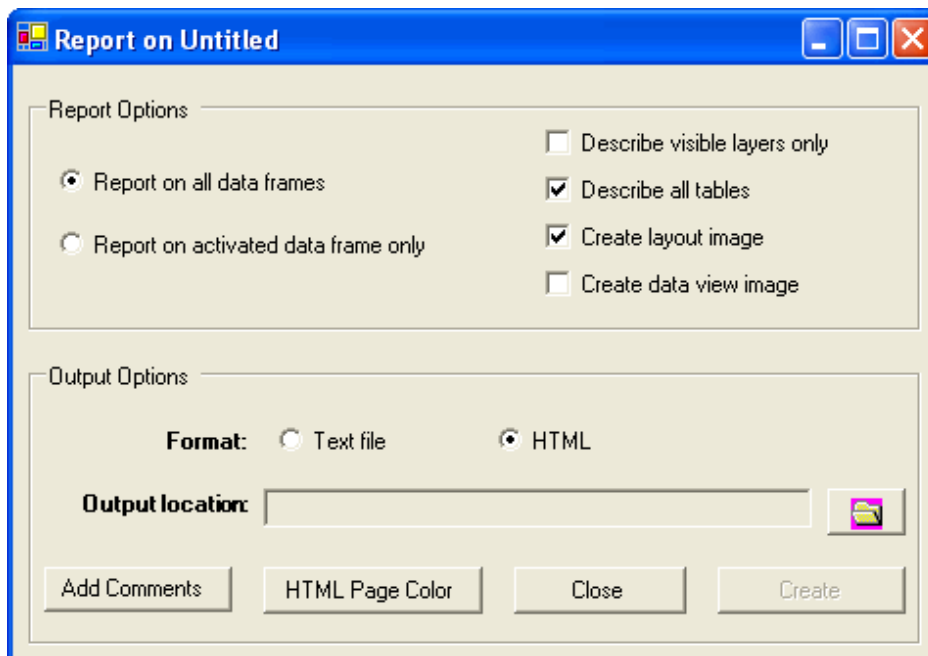


Figure 17. Create MXD report main page.

7.2.3 Inventory and Monitoring Management

7.2.3.1 Function

The Parks and Recreation toolbar has two ArcPad controls incorporated into it. By adding the ArcPad controls and report writing function in one toolbar it would be helpful to the Director and others using the toolbar. The two ArcPad controls are Get Data for ArcPad and Check In Edits From ArcPad. These two controls allow the user to check data in and out from a geodatabase and then transfer the data to a PDA for editing.

7.2.3.2 System Interfaces

The two ArcPad controls are located on the Parks and Recreation toolbar below the Create MXD report in the drop down menu (see Figures 18).

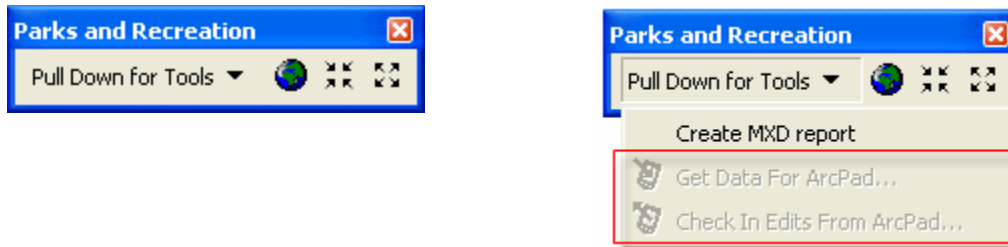


Figure 18. Parks and Recreation toolbar and ArcPad controls.

7.3 Windows System Tray Application and Link to ArcGIS

7.3.1 Monitoring Inventory and Management Timeline

It is important to maintain the Inventory and Monitoring timeline established at the beginning of the program. To aid in timeline management a system tray application was created. The system tray is located on the bottom toolbar of any Windows operating system and allows programs to continue running there, in the background, with the option of expanding them at any time. With the application running in the system tray, it will be out of the way but will appear when the correct time and date has been reached to inform the user that it is time to collect data for the Inventory and Monitoring program.

7.3.2 ArcGIS Connectivity

With the system tray application managing the timeline for the Inventory and Monitoring program, it was thought that connectivity with ArcGIS would be essential. The system tray application makes it possible to associate an mxd document with an event (see Figure 19), recording its location for later use. When the correct time and date have been reached, the application notifies the user and the associated mxd document is opened in ArcGIS.

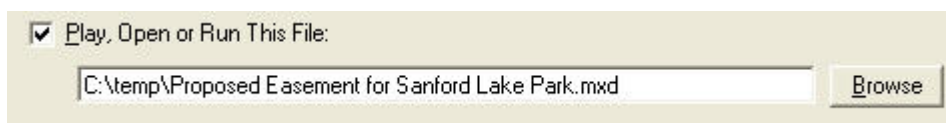


Figure 19. ArcGIS Connectivity.

7.3.3 System Interfaces

7.3.3.1 System Tray Notification

When the application is running, either minimized or maximized, the tree icon will reside in the system tray (see Figure 20). If the application is minimized, it will not appear in the regular taskbar like other programs, but the tree will be present in the system tray. To maximize, or close, the application the tree can be clicked.

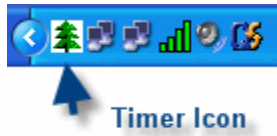


Figure 20. System Tray application notification icon in Windows system tray.

7.3.3.2 Main form

The start up form of the system tray application is where all event controls originate (see Figure 21). It is here where an event can be added or deleted, the application can be minimized to the system tray, a shortcut of the application can be added to the users' startup menu (so it will run every time Windows starts up), and preferences for the application can be manipulated.



Figure 21. System Tray application main form, responsible for managing events and all other functions.

7.3.3.3 Edit Event Form

The edit form allows a user to change the name, date, time and repeat frequency. It also allows the alert window to remain hidden and to delete the event upon completion. It is here, within the edit form, where the ArcGIS connectivity takes place (see Figure 22). It is possible to attach any mxd document to any event, enabling the documents to open when the event has been reached. It is also possible to send an email message notifying someone that the event has been completed and some action should occur.

Parks and Recreation I & M Timer - Edit Event

Event: New Event

When: 11/22/2004 1:17:47 PM Repeat every: Never

Actions

☒ Display Alert Window ☐ Delete Event When Done

☐ Play, Open or Run This File: Browse

☐ Send This E-Mail Message: Refresh

☐ Display This MS Agent Character:

Character: Speak:

Test Cancel Save

Figure 22. System Tray application Edit form, where changes can occur to an event and ArcGIS connectivity is achieved.

7.3.3.4 Preference form

The preference form enables a user to change aspects of the application. It is possible to change the display settings for the time and date and use the current time from the user's machine (see Figure 23). It also has the capability to change the level of opacity of the main form, creating less clutter on the user's screen.

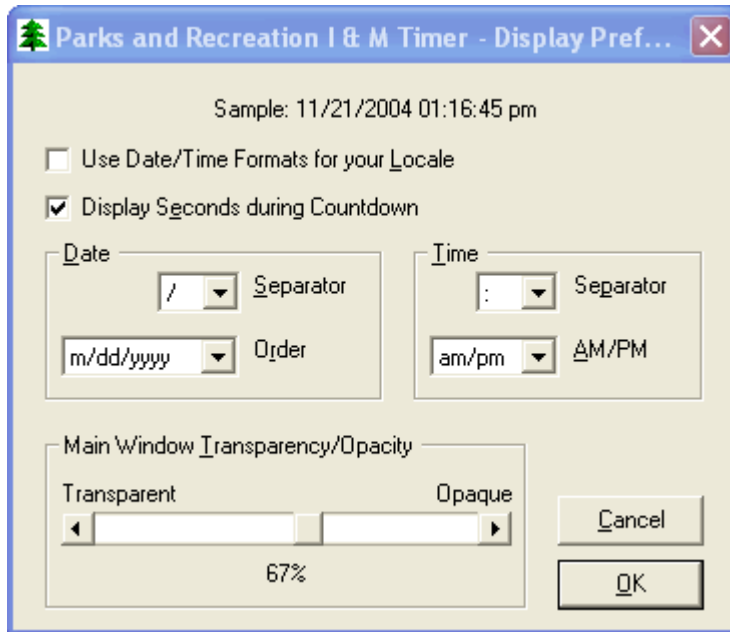


Figure 23. System Tray application Preference form.

7.3.3.5 Create Shortcut Form

The create shortcut form allows the user to create a shortcut of the application in the startup folder of the Windows operating system (see Figure 24). If the shortcut is created, the system tray application will begin running every time Windows is started. It also gives the options of starting in the system tray or starting the main form in regular-or full-screen sizes.

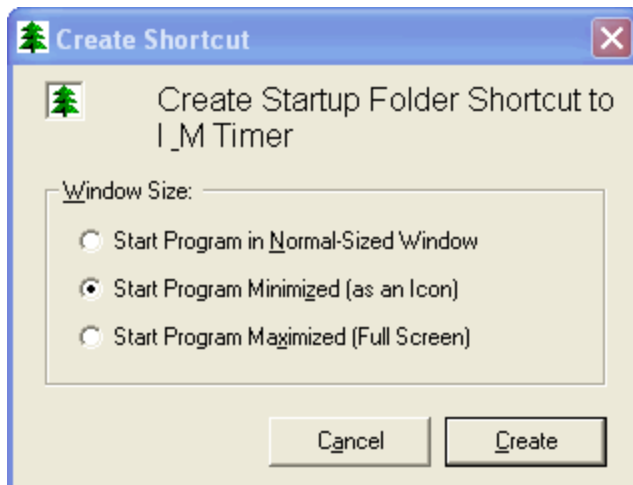


Figure 24. System Tray application Shortcut form.

8 Internet Map Server Customization

8.1 IMS Functional Requirements

8.1.1 Performance Requirements

Tables 5 and 6 explain the performance requirements for running ArcIMS 9.0 on a server and viewing it on a desktop with an Internet browser.

Table 5. For ArcIMS application - Server:

Processor	Pentium II 300-megahertz (MHz) or higher processor; Pentium III 500-MHz recommended
Memory	128 megabytes (MB) of RAM; 256 MB recommended
Hard disk	4 gigabytes (GB) of available hard-disk space; two mirrored 4-GB hard disks recommended

Table 6. For ArcIMS application - Desktop: (minimal requirements) for viewing

Processor	Pentium II 300-megahertz (MHz) or higher processor; Pentium III 500-MHz recommended
Memory	56 megabytes (MB) of RAM; 128 MB recommended
Hard disk	1 gigabytes (GB) of available hard-disk space
Modem	14.4 bps; 56k (recommended)

8.1.2 System Interfaces

The Parks and Recreation Department's ArcIMS Website needed to be created with specific criteria in mind. Criteria were set by the director stating that the viewing audience needed to be able to use the site with what would be deemed as the lowest common denominator at the time for both screen sizes and internet connection speed (800 by 600 pixels and 28.8 kbps modem). Screen size specifications will be discussed further in the next section.

8.1.2.1 Graphic Specifications

The Director of Parks and Recreation decided that three mock up maps of the county, specifically of the ArcIMS service that was being designed for the Parks and Recreation Department, should be created for this assignment to gain an understanding of the interaction and display of the application. One map is an overview of the County, showing the entire county, metropolitan areas, rivers, lakes and parks. The second map shows the area around three parks (Sanford Lake Park, Veteran's Memorial Park and Pine Haven Recreation Area) and a portion of the Pere Marquette Rail-Trail. The last map is a close-up of the City of Coleman and the Pere Marquette Rail-Trail that runs through it. The intended audience for the maps and the ArcIMS service are both the director and the residents of Midland County. The maps and ArcIMS service have been created to allow the Parks and Recreation Department to distribute their geographic data across the Internet to their constituents and among themselves.

An overview map was created for the interface in order to show the entire county, and the relationships between the metropolitan areas and the seven different parks spread throughout the county. To enhance the interface, major rivers, lakes and State Highway 10 were added to give the audience some known landmarks.

When creating the interface it was necessary to make it the same size as the computer screen on which the audience will be viewing it (800 by 600 pixels). It was also important to take into consideration that there would be too much information if all the data for the county was shown (see Figure 25). To cut down on the clutter within the interface, only large landmarks, cities, villages, parks, rivers, lakes, and State Highway 10 were selected.

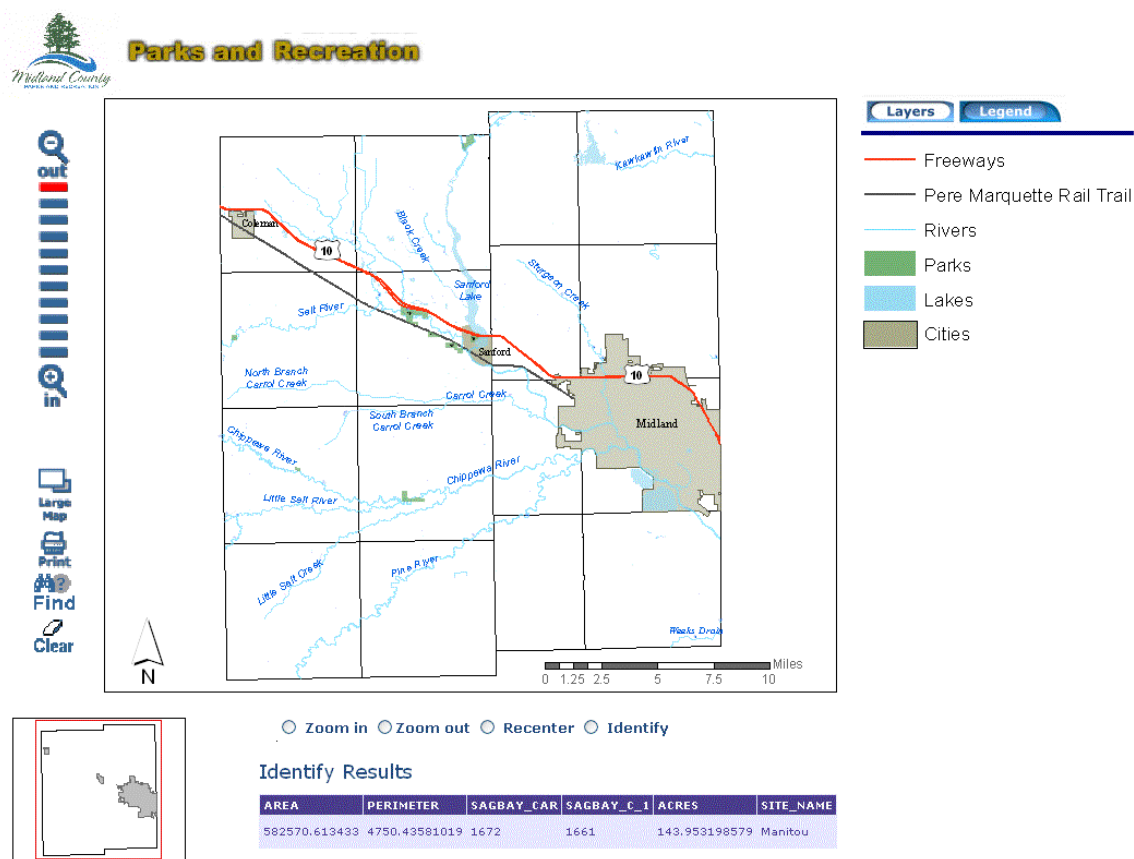


Figure 25. Graphic Specification #1 – ArcIMS application displaying data at smallest scale.

The second interface example, the multiple parks map, was created to show the relationship between the village of Sanford, Sanford Lake Park, Veteran’s Memorial Park, Pine Haven Recreation Area and the Pere Marquette Rail-Trail (see Figure 26). Roads were added, along with labels for the major roads, to serve as references for geographic location.

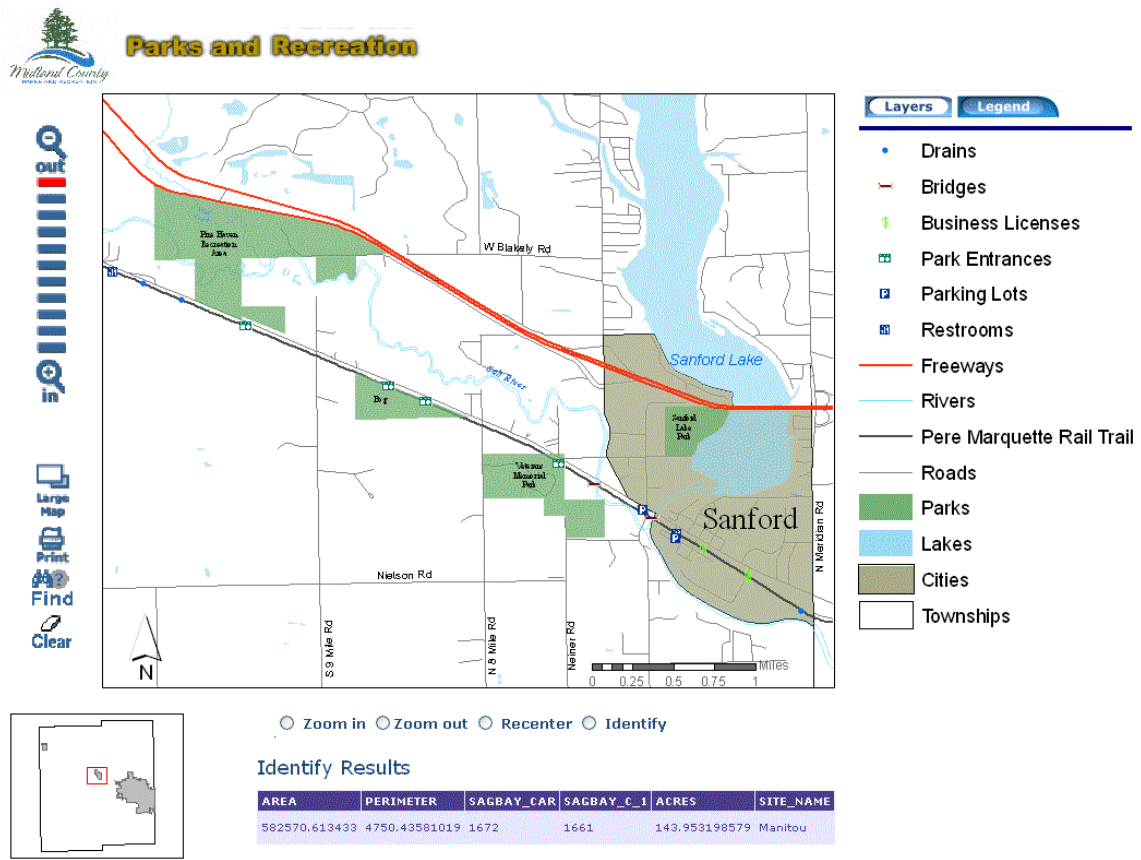


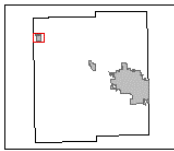
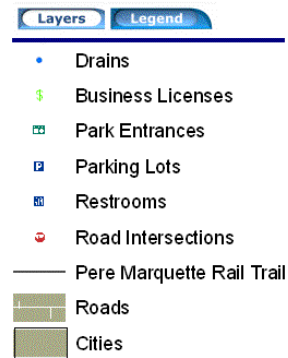
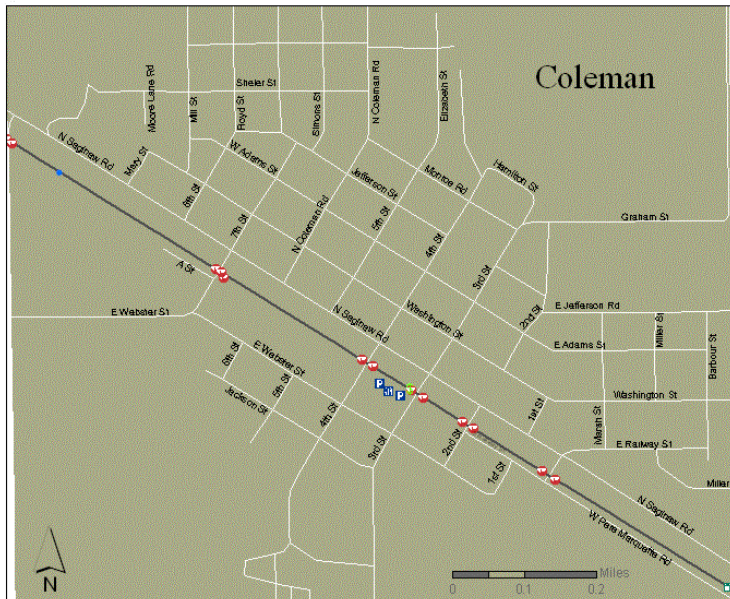
Figure 26. Graphic Specification #1 – ArcIMS application displaying data at medium scale.

Once again, the size of the interface was based upon the viewing size of the audience’s monitors (800 by 600 pixels). The point features found along the Pere Marquette Rail-Trail were symbolized with geometric symbols (symbols that people associate with the features in real life, e.g., a large blue P for parking or a red octagon for a stop sign). Roads were added to the map to aid in geographic reference, but only the larger, major roads were selected.

The third interface example depicts the City of Coleman and was created to show the number of features found along the Pere Marquette Rail-Trail and their relationship to the businesses and the city (see Figure 27). The Pere Marquette Rail-Trail is the most visited park in the county and it is important for the public to understand what can be found along the trail.



Parks and Recreation



Zoom in Zoom out Recenter Identify

Identify Results

AREA	PERIMETER	SAGBAY_CAR	SAGBAY_C_1	ACRES	SITE_NAME
582570.613433	4750.43581019	1672	1661	143.953198579	Manitou

Figure 27. Graphic Specification #1 – ArcIMS application displaying data at largest scale.

The third example was created at the same size of the previous two (800 by 600 pixels). Once again, geometric symbols were used for the points along the Pere Marquette Rail-Trail. Roads were added to the map as geographic reference for the viewing audience. Labels for the roads were added, but only ones that did not conflict with other symbols or did not add clutter to the map.

All three interface examples are considered reference by nature, because they do not have any quantitative features in them. All three maps have an inset (locator) map to aid the viewer in determining where the area being mapped is located within the county. All hydrologic features are symbolized with either blue lines or blue polygons to mimic the real world. Reds and greens were not placed on the map together to help any red-green colorblind viewers effectively determine the different features. Size was an important aspect of map design because it was based upon the lowest common denominator that would allow viewing of the ArcIMS service (800 by 600 pixels). Images were kept small in the interest of keeping download speeds low.

It was important to keep the balance of the Parks and Recreation Department ArcIMS website within the 800 by 600 pixel range to minimize scrolling for any user with a smaller computer monitor. Stereogrammic hierarchical organization, or visual layering,

was used to place the important points found along the trail on top of all the other data. Fonts for the rivers and lakes are Sans Serif (Arial is an example of a Sans Serif font) rather than Serif (a Serif font has “flags” at the ends to help distinguish one letter from another, Times New Roman is an example), which are commonly used for naturally occurring features.

8.1.3 Software Components

The software required to view and edit data is ArcGIS 9.0. The software required to provide geospatial data across the Internet is ArcIMS 9.0. The software required for constructing the ArcIMS application is Microsoft’s Visual Studio 2003 .NET and .NET Framework. Table 7 explains the software packages and their different purposes for the construction of the ArcIMS application (ESRI 2004).

Table 7. Software Components for ArcIMS application.

Name	Mnemonic	Version Number	Source	Purpose
ArcGIS – ArcView	ArcGIS	9.0	ESRI	Analyzing and editing data, map production
ArcIMS (Internet Map Server)	ArcIMS	9.0	ESRI	Providing spatial data over the internet
ASP (Active Server Pages)	ASP.NET	7.1	MSN	Build internet site to host ArcIMS application
.NET Framework	.NET	1.1	MSN	Coding language for interpreting ASP.NET code

8.1.4 .NET Link

The .NET Link is new to ArcIMS 9.0 and allows programmers to develop within Microsoft’s .NET Platform. Upon connection with the ArcIMS Application Server, the .NET Link requires the programmer to write ArcXML requests and responses to accomplish interactions (ESRI 2004). The .NET Link used for the Parks and Recreation Department’s ArcIMS Internet application had been manipulated by Dr. Bryan Baker, of ESRI. His version of the link simulates another connector commonly used (Active X) to enable programmers the luxury of not having to write all ArcXML to complete interactions with the ArcIMS Application Server.

8.2 Thin Client vs. Thick Client

It is necessary to discuss the tiered architecture scheme that corresponds to a distributed GIS, or ArcIMS application. A distributed GIS is comprised of a three tier architecture, consisting of a presentation layer, business logic, and data server (Penn 1998). It is important to understand the relationship between the three tiers, which represent a client/server relationship. In one type of system the presentation layer is the only element using the client’s computing resources, while the other two elements are being run on the server of the system (Plewe 1997). This is commonly referred to as a thin client type of

architecture. In another type of system, referred to as a thick client architecture, the presentation layer and business logic use the client's computing resources while the third element runs on the server. In order to develop a distributed GIS it must be clear whom the users will be and the level of their computing resources (Penn 1998). Within the three tiered architecture, the Internet is not any of the elements, but rather serves as the communication channel between the presentation layer, business logic, and the data server.

A balance between the client/server relationship is crucial when developing a ArcIMS application. It is important to understand the state of the Internet and client needs, which are both bases for a distributed GIS. Using the Internet as a base allows for the sharing of processing between the client and the server, but does not dictate an exact ratio (Plewe 1997). One solution to the client/server balance is to place all of the processing upon the server and almost none on the client, which is referred to as a thin client architecture. The thin client is built upon a type of Internet browser, the presentation layer, which resides upon the client's machine and displays the maps sent back from the server. The other two thirds of the thin client, the business logic and data server, reside upon the server and do not subtract from processing on the clients machine (Peng 2003).

The thin client model has been shown to be successful in displaying geographic data over the Internet, but one drawback is lack of functionality. The thin client is limited to functionality that can be developed into an Internet browser (Harder 1998). On the other side to the spectrum, a thick client model has the ability to add more functionality to the system but requires processing on the client's local computer rather than on the server. In the case of a thick client the presentation layer and business logic are run on the client's machine while the other element, the data server, is found on the server (Peng 2003). In a thick client the server may also be a collection of GIS objects, ready to be transferred via the Internet, to the client's computer for use (Wang 1997).

For the Parks and Recreation Department's Internet application the thin client architecture was utilized. It was decided that the county's servers would be called upon to perform the brunt of the processing. By the director's specifications, taking into consideration that the lowest common denominator may be using a 28.8k modem to connect to the Internet, the thick client architecture would not have been feasible.

8.3 User Interfaces and Functionality

8.3.1 Map Viewer

Since the main element of the Internet application is the map viewer, it is given the largest amount of space within the page (see Figure 28). The map viewer accepts a user's interactions through the use of the different tools, such as Zoom In/Out, Identify, and Recenter (see section 8.2.3). Added navigation for the map viewer can be accomplished through use of the N, S, E and W buttons located directly around the viewer. These buttons allow for the viewer to navigate north, south, east or west without interaction with the map itself.

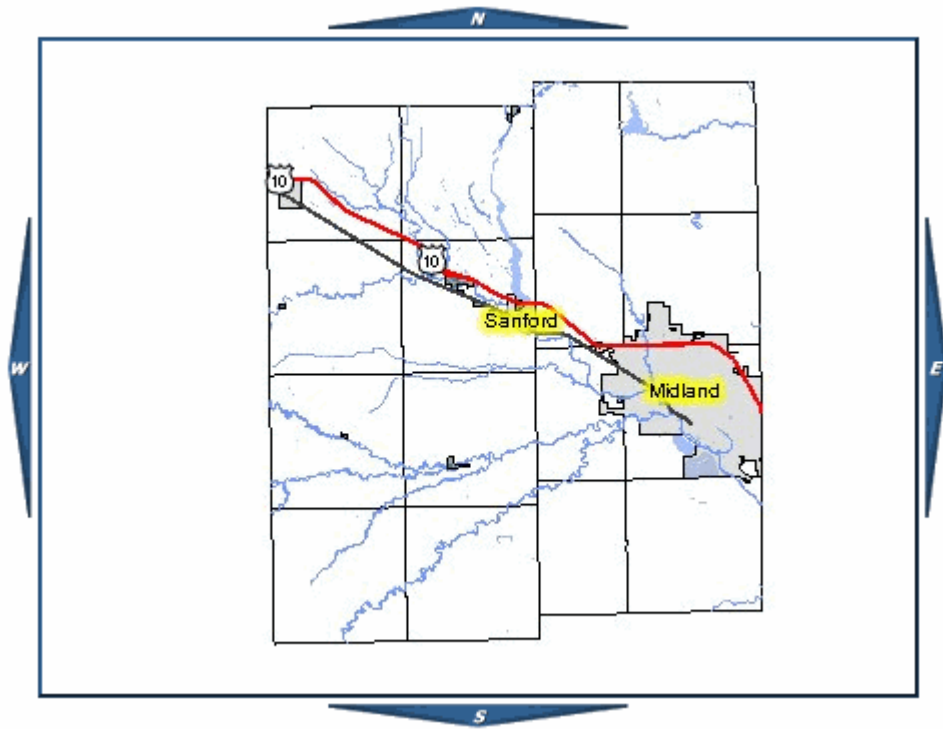


Figure 28. Map Viewer and Navigation for ArcIMS application.

8.3.2 Toolbar – Top



Figure 29. Top toolbar of ArcIMS application.

8.3.2.1 North Arrow

To reduce the amount of clutter within the map viewer the Show North Arrow button was created. The button allows the user to turn on or off the north arrow at any point during the viewing session (see Figure 29). If turned on the north arrow is placed within the lower, left hand corner of the map viewer.

8.3.2.2 Scale Bar

To reduce the amount of clutter with the map viewer the Show Scale Bar button was created (see Figure 29). The button allows the user to show or hide the scale bar at any time during the viewing session. The scale bar will dynamically correct itself (change its scale) during any changes made to the map. If turned on, the scale bar appears in the lower center of the map.

8.3.2.3 Overview Map On/Off

There are distinct buttons for showing and hiding the overview map (see Figure 29). The overview map can be helpful to the viewing audience to determine where in the county they are looking. If the overview map is turned on, it is displayed in the upper left hand corner of the map.

8.3.3 Toolbar – Bottom



Figure 30. Bottom toolbar of ArcIMS application.

8.3.3.1 Zoom In

The zoom in tool allows the user to change the area of interest by clicking or drawing a rectangle on the map. Zoom in allows the user to move in closer to the specific area of interest (see Figure 30).

8.3.3.2 Zoom Out

The zoom out tool is the opposite of the zoom in tool (see Figure 30).

8.3.3.3 Recenter

The recenter tool allows the user to click within the map and then center the map upon that area (see Figure 30). The recenter tool is very similar to that of the navigation tools found around the map viewer, with the major difference being that the recenter tool requires dynamic interaction of the user with the map.

8.3.3.4 Identify

The identify tool allows the user to click upon a feature within the map and learn about the different attributes of that feature. Upon clicking the identify button a drop down box appears under the tool filled with all of the layers of the map in it (see Figure 31). Whatever layer is chosen, from the drop down menu, will be the identifiable feature in the map. Upon clicking on a feature the attributes will appear below the map (see Figure 32).



Figure 31. Bottom toolbar of ArcIMS application with Identify tool selected, showing layer collection drop down below toolbar.

SITE_NAME	ORGANIZATI	ORG_TYP	PROGRAM	CATEGORY	YEAR_	LENGTH	MNGMNT	SOURCE	COUNTY	COMMENTS
Sanford Lake Park	County of Midland	County		Owned			Recreation	OTH	Midland	

Figure 32. Result of Identify tool from ArcIMS application.

8.3.4 Toolbar – Left

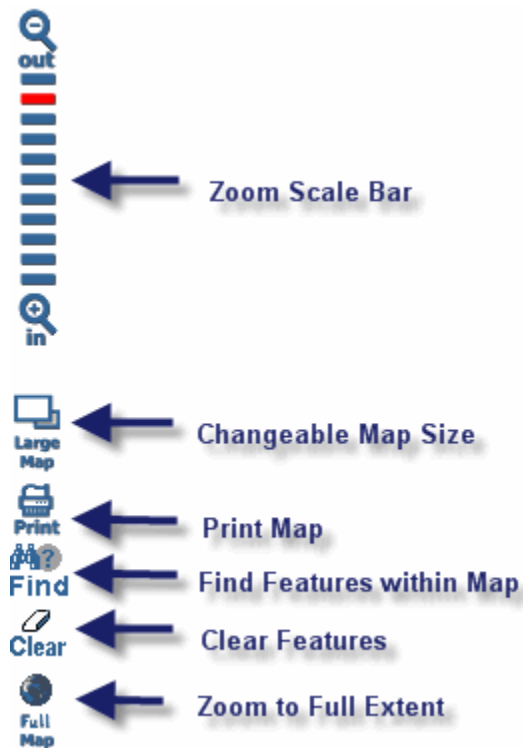


Figure 33. Left toolbar of ArcIMS application.

8.3.4.1 Zoom Scale Bar

The zoom scale bar tool allows the user to zoom in or out at a predefined increment. The increment scale doubles when either zooming in or out to create a uniform extent of the map for the user. The zoom scale bar was patterned after a popular Internet mapping website, MapQuest (see Figure 33). It was determined that most users would be familiar with the MapQuest website interface and would know and understand how the tool worked.

8.3.4.2 Changeable Map Viewer Size

When the Internet map viewer initially displays the size of the map is 440 by 330 pixels, designed for constituent screen sizes of 800 by 600 pixels. Knowing that screen resolution is most often larger than the low 800 by 600 the change map viewer size button was created. The button allows the user to change the map viewer to a larger size, 600 by 450 pixels. Change can occur on the fly without the map extent changing.

8.3.4.3 Print

The print button allows the user to print the current map viewer and add a specific title if needed. The print command allows constituents, the director, and the Midland County Parks Commissioners the ability to have a portable image of the map viewer (see Figure 34).

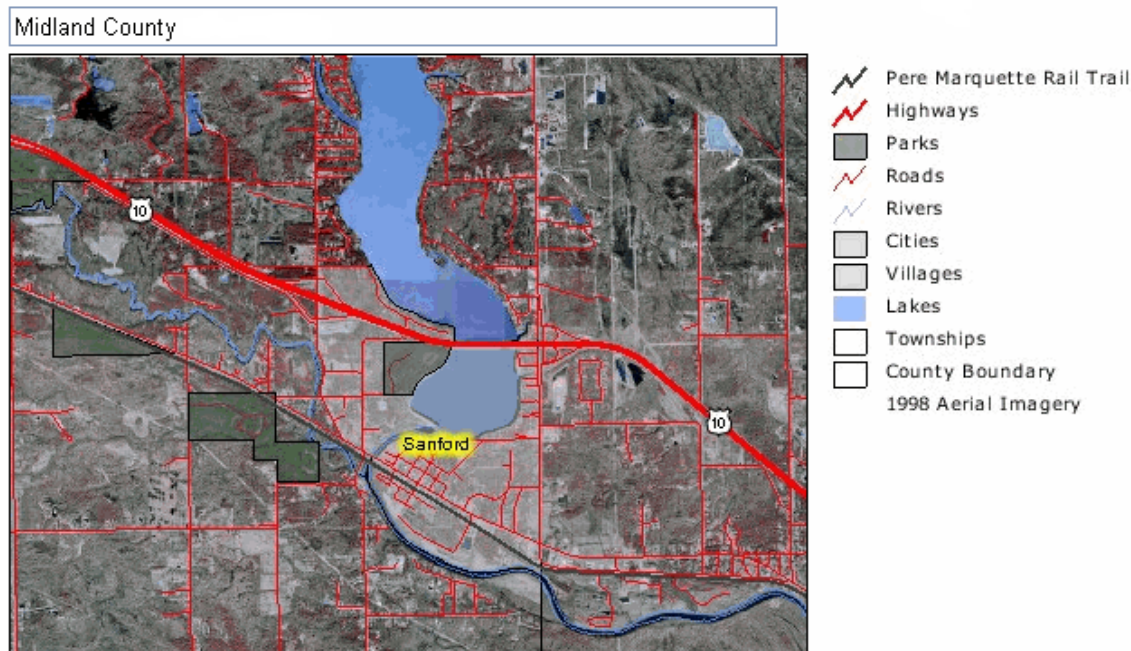


Figure 34. Print tool output for ArcIMS application.

8.3.4.4 Find

The find button allows the user to search layers for a specific feature/place/name/etc. Currently, only the Parks, Roads, and Townships layers are capable of being searched with the find tool (see Figure 35). Per the request of the director, only these three layers are searchable with thoughts of expanding in the future. If a feature is found during a search, the returned value appears below the map viewer. The returned feature appears similar to that of the identify results but with some added functionality. There are zoom to feature and highlight feature tools associated with the returned search result (see Figure 36).

Find: **Find Parks**

[Parks](#)
[Roads](#)
[Townships](#)

Enter value to find:

Enter all or part of the string to search

Figure 35. Initial Find options and Find Parks selection frame of ArcIMS application.

Search Results

Zoom	Hilite	SITE_NAME	AREA	PERIMETER	SAGBAY_CAR	SAGBAY_C_1	ACRES	ORGANIZAT
		Sanford Lake Park	223863.830201	1974.63731993	1363	1347	55.3167524425	County of Midland

Zoom to Feature function Highlight Feature function

Figure 36. Result of Find Parks from ArcIMS application.

8.3.4.5 Clear

The clear button allows the user to clear the map of any selected or highlighted feature.

8.3.4.6 Zoom Out Full

The zoom out full tool allows the user to take the map viewer back to the original map extent when the Internet browser was initiated.

8.3.5 Layers Collection

The layers collection can be found to the right of the map viewer, displaying all layers that can be viewed within the Internet application. In addition to displaying all layers, the collection has the capability to show or hide any individual layer. The collection also gives the user the ability to refresh automatically or after the refresh button is clicked when showing or hiding layers (see Figure 37).

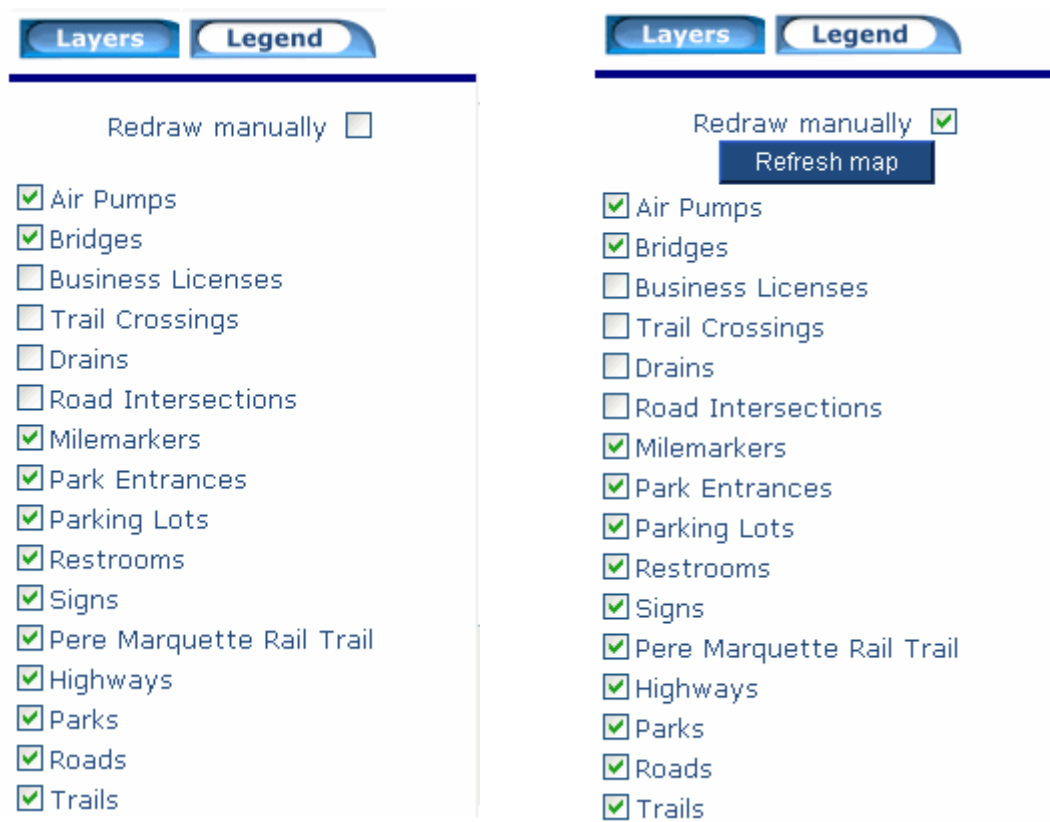


Figure 37. Layers collection with and without redraw manually option selected.

8.3.6 Legend

The legend is very similar to the layers collection in design and form. The difference between the two is that there is no interaction with the legend and it simply displays visible layers and their corresponding symbolization (see Figure 38).

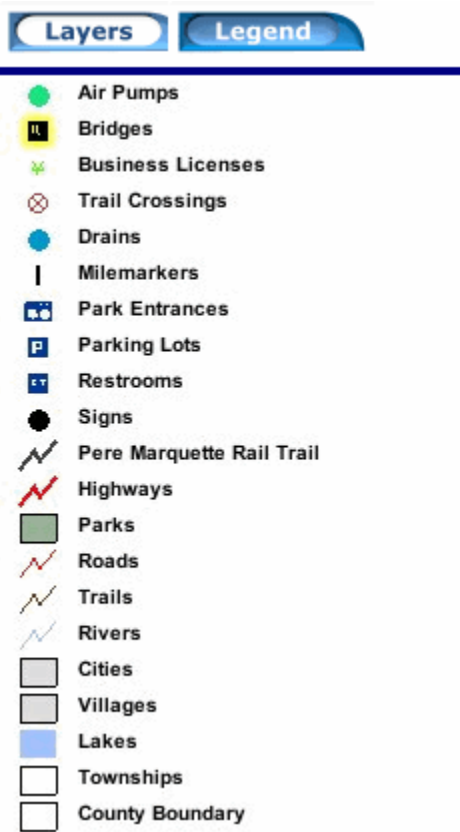


Figure 38. Legend for ArcIMS application, displaying visible layers and associated symbology.

9 Implementation

9.1 Construction and Delivery of Three Applications

Upon completion of the project, the ArcIMS application, ArcGIS extension and ArcPad applet and all necessary data and software will be delivered to the Director of Parks and Recreation Department of Midland County (Michigan).

9.2 Installing ArcIMS and Beginning Parks and Recreation Departments Service

It was agreed, at the onset of the project, that technical support would be provided to both the Parks and Recreation and Information Systems Departments of Midland County when installing ESRI's ArcIMS 9.0 software onto the county's servers. Along with ArcIMS installation, it was agreed that support would be provided to install the new Parks and Recreation Department's Internet application.

9.3 Installing ArcPad on Rangers' Handheld Units

Upon delivery of the ArcPad applet, it was agreed that it would be installed on all PDAs within the Parks and Recreation Department. All information dealing with the installation of the applet will be passed along to the Information Systems Department for documentation. The install documentation will aid the Information Systems Department in dealing with any type of problem that may arise with the PDAs or if the applet would need to be installed on a new machine or reinstalled on the current one.

9.4 Installing Extension on Parks and Recreation Departments ArcGIS Applications

Upon delivery of the ArcGIS extension it was agreed that it would be installed on all desktop machines running the software in the Parks and Recreation Department. All information pertaining to the ArcGIS extension will be passed along to the Information Systems Department for documentation.

9.5 Training in Use of ArcGIS and ArcPad to Parks and Recreation Department Staff

Once the new software and applications have been installed onto the Parks and Recreation Department's desktops and handhelds, training will commence. Training will occur in January, 2005. It was agreed, at the onset of the project, that all application and training material held a warrantee for up to one year. The warrantee enables the Parks and Recreation Department to call for any type of assistance during that year, whether it is for more training or trouble shooting.

10 Conclusions and Future Developments

The project has changed course throughout the year but the overall goal remained unchanged: to create a management tool utilizing GIS for the Parks and Recreation Department of Midland County (Michigan). In the end, three applications were successfully created to aid in management of the parks, specifically the 21-mile long Pere Marquette Rail-Trail: an ArcIMS Internet application, an ArcGIS extension for management of the Inventory and Monitoring program and report writing, and an ArcPad applet designed for field collection of data to enhance the Inventory and Monitoring program.

The ArcIMS Internet applications benefits will be twofold. It will help the Director in allowing him to serve the Parks and Recreation Department data across the Internet for others to use and see, and it will help spread the word about what the department is doing and what they are about. The Internet is a very good forum for mass distribution of information, which was why the ArcIMS application was created.

The ArcGIS extension will allow the Director to manage the Inventory and Monitoring program through use of the ArcPad controls and the report writing function. The ArcPad controls will make the checking in and out of data from the Parks and Recreation Department's personal geodatabase very manageable. The report writing function will allow the director to more accurately depict changes occurring in the park by being able to visualize them and then export the map, with other text, to a very portable format. The report writing function can be very useful at Parks Commission meetings where instead of describing new land purchase or easement granting, the director has the ability to show the commissioners exactly where and what is taking place.

The ArcPad application is essential to the upkeep of the Inventory and Monitoring program. It will also be helpful for other aspects regarding the other parks around the county. Being able to be in the field, collecting accurate real-time data, will help the Director manage the Pere Marquette Rail-Trail more efficiently.

With the core of a GIS system developed for the Parks and Recreation Department it is now possible to think about what can be added and modified. The Pere Marquette Rail-Trail, being a linear feature, would benefit by having dynamic segmentation added to it. Dynamic segmentation is the process of transforming linearly referenced data stored in a table into a feature that can be displayed on a map. Dynamic segmentation would allow the director to link tabular data (like visitation counts) to the Pere Marquette Rail-Trail feature class to determine high or low spots along the trail.

The process in which this project was developed allows it to be incorporated into any other organization working with trails, especially rail-trails, because the applications are not Midland County specific. The ArcPad application is compatible with any version past 6.0.1 and the Inventory and Monitoring forms are transferable to any shapefile sharing similar field structure. The ArcGIS extension and System Tray applications can be installed onto any computer (ArcGIS is required for extension). The ArcIMS application can be placed on any server running IIS 6.0 (data can be interchanged).

11 References

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12 Appendices

12.1 Appendix A – Glossary of Terms

ArcGIS - ArcGIS is a family of software products that forms a complete GIS built on industry standards that provides exceptional, yet easy to use, capabilities right out of the box. ArcGIS is a complete, single, integrated system for geographic data creation, management, integration, and analysis.

ArcSDE – Relational Database Management System gateway.

ArcXML – ESRI XML language for sending request and response actions between Internet browser and ArcIMS Application Server.

Attribute – Information about a geographic feature in a GIS, generally stored in a table and linked to the feature by a unique identifier.

IMS – Internet map server.

Geodatabase - A geodatabase (short for geographic database) is a physical store of geographic information inside a database management system (DBMS).

Geographic Information System – A collection of computer hardware, software and geographic data for capturing, storing, updating, manipulating, analyzing, and displaying all forms of geographic referenced information.

Global Positioning System (GPS) – A constellation of twenty-four satellites, developed by the U.S. Department of Defence, that orbits the earth at an altitude of 20,200 kilometres. These satellites transmit signals that allow a GPS receiver anywhere on earth to calculate its own location.

RDBMS – Relational Database Management System. Stores data in the form of related tables. Relational databases are powerful because they require few assumptions about how data is related or how it will be extracted from the database. As a result, the same database can be viewed in many different ways.

12.2 Appendix B – Sample ArcGIS Extension Report

Parks and Recreation Department



Summary Report for document: Proposed Easement for Sanford Lake Park.mxd

Proposed Easement for Sanford Lake Park.mxd contains 1 data frames ('maps')

Data Frame Summary:

Map Name:Layers

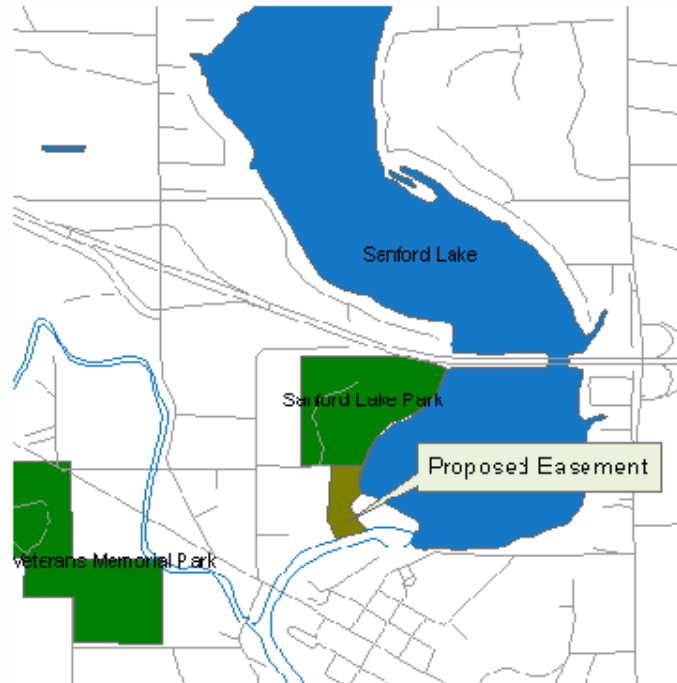
Description:

Distance Units: Meters

Layer Count: 4 Layers -Rivers path: c:\midlandparksprojectriver_111v3b -Roads path:

c:\midlandparksprojectallroads_111v3b -Lakes path: c:\midlandparksprojectlakepoly_111v3b -Park

Property path: C:\MidlandParksProject\Midlandparks.mdb\midcountv



The easement, the brown area to the south of Sanford Lake Park has been granted by Wolverine Power for use. A path connecting the park and a fishing pier at the river will begin construction within the next few months, with completion set for March.

12.3 Appendix C – Sample code – ArcIMS Application

Map Viewer code (Default.aspx)

```
Imports System.Collections
Imports ArcIMS.NETConnector
```

```
*****
```

```
'Part of code developed by Dr. Bryan Baker
```

```
'Part of code developed by Bryan Rayo
```

```
*****
```

```
Public Class MapPage
```

```
    Inherits System.Web.UI.Page
```

```
#Region " Web Form Designer Generated Code "
```

```
    'This call is required by the Web Form Designer.
```

```
    <System.Diagnostics.DebuggerStepThrough()>
```

```
    Private Sub InitializeComponent()
```

```
End Sub
```

```
    Private Sub Page_Init(ByVal sender As System.Object, ByVal e As System.EventArgs)
```

```
Handles MyBase.Init
```

```
        'CODEGEN: This method call is required by the Web Form Designer
```

```
        'Do not modify it using the code editor.
```

```
        InitializeComponent()
```

```
End Sub
```

```
#End Region
```

```
    Private Sub Page_Load(ByVal sender As Object, ByVal e As System.EventArgs)
```

```
Handles
```

```
MyBase.Load
```

```
        If Not IsPostBack Then
```

```
            'Session.Add("VALID_USER", True)
```

```
            hvMapPage.Value = "MakeMap.aspx"
```

```
            ' Initialize map to get layers, visibility and set active layer
```

```
            Dim oConnector As New ArcIMSConnector
```

```
            Dim oMap As New Map
```

```
            Dim sService As String
```

```
            Dim bInitSuccess As Boolean
```

```
            oConnector.ServerName =
```

```
            ConfigurationSettings.AppSettings("MAPSERVER")
```

```
            oConnector.ServerPort =
```

```
            ConfigurationSettings.AppSettings("MAPPORT")
```

```
            sService = ConfigurationSettings.AppSettings("MAPSERVICE")
```

```
            bInitSuccess = oMap.InitMap(oConnector, sService, False, False,
```

```
False)
```

```
            If bInitSuccess Then
```

```
                Dim oLayers As Layers = oMap.Layers
```

```

        Dim i As Integer
        Dim oLayer As Layer
        Dim oActiveItem As ListItem
        Dim sActiveLayer As String =
ConfigurationSettings.AppSettings("ACTIVE_LAYER")
        Dim oCheckBox As CheckBox

        i = 0
        For Each oLayer In oLayers

            ' Add layer to layer list
            oCheckBox = New CheckBox
            oCheckBox.Text = oLayer.Name
            oCheckBox.ID = "layerid_" & i.ToString
            oCheckBox.Checked = oLayer.Visible
            pnlLayers.Controls.AddAt(0, oCheckBox)

            pnlLayers.Controls.AddAt(1, New
LiteralControl("<br>"))

            ' Add layer to active-layer list
            If oLayer.Type = "featureclass" Then
                oActiveItem = New ListItem(oLayer.Name,
oLayer.Id)
                If oLayer.Name = sActiveLayer Then
                    oActiveItem.Selected = True
                    ddlActiveLayer.Items.Insert(0, oActiveItem)
                End If
                i = i + 1
            End If

        Next
        ddlActiveLayer.DataBind()

        ' Generate default legend image
        oMap.DoZoomToFullExtent()
        oMap.MapDraw = False
        oMap.Legend.Display = True
        oMap.Legend.Autoextent = True
        oMap.Legend.Width = 220
        oMap.Legend.Height = 300
        oMap.Refresh()

        imgLegend.ImageUrl = oMap.Legend.Url

        ' Save initial extent
        hvMinX.Value = oMap.Extent.Xmin
        hvMinY.Value = oMap.Extent.Ymin
        hvMaxX.Value = oMap.Extent.Xmax
        hvMaxY.Value = oMap.Extent.Ymax

    Else
        ' (failure will be handled in MapMap.aspx by similar
check)

    End If

End If

```

```

If (Request.QueryString("XMIN") = Nothing Or _
Request.QueryString("YMIN") = Nothing Or _
Request.QueryString("XMAX") = Nothing Or _
Request.QueryString("YMAX") = Nothing) Then

    Dim xmin As String =
ConfigurationSettings.AppSettings("EXTENT_XMIN")
    Dim ymin As String =
ConfigurationSettings.AppSettings("EXTENT_YMIN")
    Dim xmax As String =
ConfigurationSettings.AppSettings("EXTENT_XMAX")
    Dim ymax As String =
ConfigurationSettings.AppSettings("EXTENT_YMAX")

    If xmin <> Nothing And ymin <> Nothing And xmax <> Nothing
And ymax <> Nothing Then

        ' If no initial extent is defined in the incoming QueryString,
default
        ' to the extent defined in web.config.
        hvMinX.Value = xmin
        hvMinY.Value = ymin
        hvMaxX.Value = xmax
        hvMaxY.Value = ymax
    End If
Else
    ' If we have a valid and complete extent defined in the
QueryString,
    ' use these values as the initial extent.
    hvMinX.Value = Request.QueryString("XMIN")
    hvMinY.Value = Request.QueryString("YMIN")
    hvMaxX.Value = Request.QueryString("XMAX")
    hvMaxY.Value = Request.QueryString("YMAX")
End If

    hvTolerance.Value =
ConfigurationSettings.AppSettings("SELECTION_TOLERANCE")

End Sub
End Class

```

12.4 Appendix D – Sample code – ArcGIS Extension

HTML Report writing code

'Part of code developed by Thad Tilton

'Part of code developed by Bryan Rayo

```
Private Sub WriteHTMLReport()
    Dim pDoc As ESRI.ArcGIS.Framework.IDocument
    Dim pMap As ESRI.ArcGIS.Carto.IMap
    Dim pEnumLayer As ESRI.ArcGIS.Carto.IEnumLayer
    Dim pLayer As ESRI.ArcGIS.Carto.ILayer
    Dim pDS As ESRI.ArcGIS.Geodatabase.IDataset
    Dim pDSName As ESRI.ArcGIS.Geodatabase.IDatasetName
    Dim xmlWriter As New Xml.XmlTextWriter(txtTextPath.Text, System.Text.Encoding.ASCII), i As
Integer
    Dim strHTMLBackColor As String = "C0C0C0"
    Dim strMapImagePath As String

    pDoc = m_pMxDoc 'QI

    xmlWriter.Formatting = Xml.Formatting.Indented
    xmlWriter.Indentation = 5

    xmlWriter.WriteStartElement("HTML")
    xmlWriter.WriteStartElement("HEAD")
    xmlWriter.WriteString("TITLE", "Parks and Recreation Department " & CType(Date.Today,
String))
    xmlWriter.WriteEndElement() 'close HEAD tag

    xmlWriter.WriteStartElement("BODY")
    'TODO #6: write code to get the color the user selected for the page color
    '--hint: pass the selected color object to the GetHexColor function to get a string representation
    strHTMLBackColor = GetHexColor(dlgPageColor.Color)
    '***
    xmlWriter.WriteAttributeString("bgcolor", strHTMLBackColor)

    xmlWriter.WriteStartElement("table")
    xmlWriter.WriteStartElement("tr")
    xmlWriter.WriteStartElement("td")
    xmlWriter.WriteAttributeString("width", 200)

    xmlWriter.WriteStartElement("IMG")
    xmlWriter.WriteAttributeString("src", "C:\MidlandParksProject\LOGO.jpg")
    xmlWriter.WriteAttributeString("height", 150)
    xmlWriter.WriteAttributeString("width", 200)
    xmlWriter.WriteEndElement() 'close IMG tag
    xmlWriter.WriteEndElement() 'close td tag

    xmlWriter.WriteStartElement("td")
    xmlWriter.WriteString("H1", "Summary Report for document: " & pDoc.Title)
    'TODO #7: write code here to complete the report (similar to text report above) ...
    xmlWriter.WriteEndElement() 'close td tag
    xmlWriter.WriteEndElement() 'close tr tag
```

```

xmlWriter.WriteEndElement()

' xmlWriter.WriteElementString("H2", "    Summary Report for ArcMap document: " & pDoc.Title)
xmlWriter.WriteString("-----")
' xmlWriter.WriteString(vbNewLine)
xmlWriter.WriteStartElement("br")
xmlWriter.WriteEndElement()
xmlWriter.WriteString(pDoc.Title & " contains " & m_pMxDoc.Maps.Count & " data frames
('maps')")
xmlWriter.WriteString(vbNewLine)
xmlWriter.WriteElementString("H2", "Data Frame Summary:")
xmlWriter.WriteAttributeString()
For i = 0 To m_pMxDoc.Maps.Count - 1
    pMap = m_pMxDoc.Maps.Item(i)
    xmlWriter.WriteElementString("H3", "Map Name:" & pMap.Name)
    ' xmlWriter.WriteString(vbNewLine)
    xmlWriter.WriteStartElement("br")
    xmlWriter.WriteEndElement()
    xmlWriter.WriteString(vbTab & vbTab & "Description: " & pMap.Description)
    ' xmlWriter.WriteString(vbNewLine)
    xmlWriter.WriteStartElement("br")
    xmlWriter.WriteEndElement()
    xmlWriter.WriteString(vbTab & vbTab & "Disatnce Units: " &
GetUnitDescription(pMap.DistanceUnits))
    ' xmlWriter.WriteString(vbNewLine)
    xmlWriter.WriteStartElement("br")
    xmlWriter.WriteEndElement()
    xmlWriter.WriteString(vbTab & vbTab & "Layer Count: " & pMap.LayerCount)
    pEnumLayer = pMap.Layers
    pLayer = pEnumLayer.Next
    xmlWriter.WriteString(vbTab & vbTab & "Layers")
    Do Until pLayer Is Nothing
        pDS = pLayer 'QI
        pDSName = pDS.FullName
        xmlWriter.WriteString(vbTab & vbTab & vbTab & "-" & pLayer.Name)
        xmlWriter.WriteString(vbTab & vbTab & vbTab & "path: " &
pDSName.WorkspaceName.PathName & pDSName.Name)
        pLayer = pEnumLayer.Next
    Loop
    'xmlWriter.WriteElementString(vbNewLine)
Next

'***
xmlWriter.WriteStartElement("BR") 'this writes a line break (carriage return)
xmlWriter.WriteEndElement() 'BR
'TODO #4: write code here that will create a new image for the report (map or layout view)
'--hint: call the CreateMapImage function with the proper parameters to get the image path
strMapImagePath = CreateMapImage("C:\Temp", True)
'***

'TODO #5: write code using the xmlWriter to place the image file (created above) into the HTML
report
'--hint: you will need to write a start element for the "IMG" tag, an attribute string for the "src", then
an end to the "IMG" tag
xmlWriter.WriteStartElement("IMG")
xmlWriter.WriteAttributeString("src", strMapImagePath)
xmlWriter.WriteAttributeString("height", 800)

```

```

xmlWriter.WriteString("width", 800)
xmlWriter.WriteEndElement() 'close IMG tag

xmlWriter.WriteStartElement("br")
xmlWriter.WriteEndElement()

If txtComments.Text = Nothing Then
    txtComments.Text = " "
End If
xmlWriter.WriteString(txtComments.Text)

'***
xmlWriter.WriteEndElement() 'close BODY tag
xmlWriter.WriteEndElement() 'close HTML tag
xmlWriter.Flush()
xmlWriter.Close()
MsgBox("Report was successfully written to " & txtTextPath.Text, MsgBoxStyle.Information, "MXD
Report")

End Sub

```

12.5 Appendix E – Sample code – ArcPad Applet

Option Explicit

```

'*****
'Part of code developed by Craig Greenwald
'Part of code developed by Bryan Rayo
'*****

```

```

Dim m_canEditList()
Dim m_pControls
Dim m_lPtIndex, m_lLIndex, m_lPolyIndex

```

```

Sub DisplayEditableForm
    Dim pLayer, iCount
    iCount = 0
    For Each pLayer in Map.Layers
        If pLayer.CanEdit Then
            ReDim Preserve m_canEditList(iCount)
            Set m_canEditList(iCount) = pLayer
            iCount = iCount + 1
        End If
    Next

    If (iCount > 0) Then
        Applet.Forms(1).Show
    Else
        MsgBox "The current map does not contain any editable layers.", vbExclamation, "No editable
layers"
    End If
End Sub

Sub PopulateCombos
    Dim iCount

```

```

Set m_pControls = ThisEvent.Object.Pages(1).Controls
m_pControls("cboPointLayer").Clear
m_pControls("cboPointLayer").AddItem "<None>", "<None>"
m_pControls("cboLineLayer").Clear
m_pControls("cboLineLayer").AddItem "<None>", "<None>"
m_pControls("cboPolygonLayer").Clear
m_pControls("cboPolygonLayer").AddItem "<None>", "<None>"

m_lPtIndex = 0
m_lLIndex = 0
m_lPolyIndex = 0

For iCount = 0 To UBound(m_canEditList)
    Select Case m_canEditList(iCount).Records.Fields.ShapeType
        Case 1,11,21: 'Point
            m_pControls("cboPointLayer").AddItem m_canEditList(iCount).Name,
m_canEditList(iCount).Name
            If m_canEditList(iCount).Editable Then
                m_lPtIndex = m_pControls("cboPointLayer").ListCount-1
            End If
        Case 3,13,23: 'Line
            m_pControls("cboLineLayer").AddItem m_canEditList(iCount).Name,
m_canEditList(iCount).Name
            If m_canEditList(iCount).Editable Then
                m_lLIndex = m_pControls("cboLineLayer").ListCount-1
            End If
        Case 5,15,25: 'Polygon
            m_pControls("cboPolygonLayer").AddItem m_canEditList(iCount).Name,
m_canEditList(iCount).Name
            If m_canEditList(iCount).Editable Then
                m_lPolyIndex = m_pControls("cboPolygonLayer").ListCount-1
            End If
        End Select
    Next

    m_pControls("cboPointLayer").ListIndex = m_lPtIndex
    m_pControls("cboPointLayer").Enabled = (m_pControls("cboPointLayer").ListCount>1)
    m_pControls("cboLineLayer").ListIndex = m_lLIndex
    m_pControls("cboLineLayer").Enabled = (m_pControls("cboLineLayer").ListCount>1)
    m_pControls("cboPolygonLayer").ListIndex = m_lPolyIndex
    m_pControls("cboPolygonLayer").Enabled = (m_pControls("cboPolygonLayer").ListCount>1)

    m_pControls("chkEditToolbar").Value = Application.Toolbars("draw").Visible
End Sub

Sub SetEditableLayers
    If (m_pControls("cboPointLayer").ListIndex = 0) Then
        If (m_lPtIndex > 0) Then
            m_pControls("cboPointLayer").ListIndex = m_lPtIndex
            Map.Layers(m_pControls("cboPointLayer").Value).Editable = False
        End If
    Else
        Map.Layers(m_pControls("cboPointLayer").Value).Editable = True
    End If

    If (m_pControls("cboLineLayer").ListIndex = 0) Then

```



```

        If (m_ILIndex > 0) Then
            m_pControls("cboLineLayer").ListIndex = m_ILIndex
            Map.Layers(m_pControls("cboLineLayer").Value).Editable = False
        End If
    Else
        Map.Layers(m_pControls("cboLineLayer").Value).Editable = True
    End If

    If (m_pControls("cboPolygonLayer").ListIndex = 0) Then
        If (m_IPolyIndex > 0) Then
            m_pControls("cboPolygonLayer").ListIndex = m_IPolyIndex
            Map.Layers(m_pControls("cboPolygonLayer").Value).Editable = False
        End If
    Else
        Map.Layers(m_pControls("cboPolygonLayer").Value).Editable = True
    End If

    Application.Toolbars("draw").Visible = (m_pControls("chkEditToolbar").Value)
End Sub

Sub Startup
    Application.Toolbars("browse").Visible = False
End Sub

```