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A GIS Connection between Brownfield Sites, Transportation and Infrastructure:
An Economic Redevelopment Tool for Toledo-Lucas County, Ohio

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the
Master of Arts Degree in Geography and Planning

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An Abstract of

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This thesis documents the design and development of a web-based data distribution system for brownfield site redevelopment in Toledo-Lucas County, Ohio. The system is designed to advance smart growth initiatives for economic redevelopment and the sustainable utilization of brownfield sites in the region. As with many Midwestern cities, industrial decline has lead to an abundance of brownfield sites in the area. A lack of data resources is one major barrier to redevelopment of these sites. The system developed here seeks to reduce that barrier by providing a user interface and information delivery system to support the identification and reuse of brownfield sites; in addition it can be replicated for use in other regions. Detailed here is the development and implementation of an interactive web-based geographic information system (GIS) designed as a user-centered decision support tool to augment policymakers’ and stakeholders’ site selection and infrastructure capital investment decisions to support brownfield redevelopment. This system thus provides not only a comprehensive data delivery tool and decision support system but also serves as a template for application in other urban regions.
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Contents

Abstract iii
Acknowledgements iv
Contents vi
List of Figures vii
1 Introduction 1
2 Statement of the Problem 4
   2.1 Objectives .......................................................... 5
3 Literature Review 6
   3.1 Brownfield Redevelopment Through Smart Growth Initiatives ............... 7
   3.2 Barriers to Brownfield Revitalization ........................................ 10
   3.3 Using GIS as a Brownfield Redevelopment Tool .............................. 13
   3.4 GIS Web-Services and Web-Based GIS Distribution Systems ............... 14
4 Study Area and Methodology ..................................................... 18
   4.1 Study Area ........................................................................ 18
   4.2 Methodology ...................................................................... 20
      4.2.1 Discussions with Stakeholders .............................................. 20
         4.2.1.1 Toledo Metropolitan Area Council of Governments .......... 21
         4.2.1.2 City of Toledo – Division of Environmental Services .......... 23
         4.2.1.3 Toledo-Lucas County Port Authority ............................. 23
4.2.1.4 First Energy Corp................................................................. 24
4.2.1.5 Lucas County Improvement Corporation.............................. 24
4.2.2 Data Repository....................................................................... 25
4.2.3 DataViewer Development....................................................... 28
4.2.4 Web-Based Data Delivery System: Development and Implementation 39
   4.2.4.1 Development.................................................................... 39
   4.2.4.2 Implementation............................................................... 41
4.2.5 Future System Developments.................................................. 46

5 Conclusions.................................................................................. 49

References....................................................................................... 52

Appendix A Data.............................................................................. 55
Appendix B Additional Layer and System Capability Figures.............. 66
Appendix C Web Application Development...................................... 70
List of Figures

Figure 3-1   The system architecture of WMS mapping applications………………..     16
Figure 3-2   Web GIS platform server environment…………………………………     17
Figure 4-1   Map of the City of Toledo (red) within Lucas County, Ohio…………..     19
Figure 4-2   Brownfield Impact Area: Toledo, Ohio…………………………………     20
Figure 4-3   Initial GIS view of the desktop system with county jurisdictions and brownfield parcel layers active………………………………………     29
Figure 4-4   HAZMAT routes…………………………………………………………     29
Figure 4-5   HAZMAT routes and Highways…………………………………………     29
Figure 4-6   Zoom in on Toledo………………………………………………………     30
Figure 4-7   Add Michigan heavy weight routes………………………………………     30
Figure 4-8   Activate hyperlinks………………………………………………………     30
Figure 4-9   Click any blue highlighted parcel to jump to site photos and source documents…………………………………………………….     31
Figure 4-10  Results: Site photo from a CORF application PDF document…………     31
Figure 4-11  Results: USEPA Profile Brief…………………………………………………     32
Figure 4-12  Hyperlink site photo from AREIS of 1515 Bancroft……………………     32
Figure 4-13  Proximity model…………………………………………………………..     33
Figure 4-14  Proximity model input feature selection box…………………………..     34
Figure 4-15  User defined distance parameter…………………………………………     34
Figure 4-16  Run the model…………………………………………………………………     35
Figure 4-17  Successful execution................................................................. 35
Figure 4-18  Output display ................................................................. 36
Figure 4-19  New parameters............................................................... 37
Figure 4-20  Successful execution............................................................... 37
Figure 4-21  Output results of new parameters entered in Figure 4-19............. 38
Figure 4-22  Model layer dialog box.......................................................... 38
Figure 4-23  Brownfields web application within the ArcGIS 10 Server Manager..... 40
Figure 4-24  User interface, red arrow pointing to tool bar................................. 42
Figure 4-25  Popup box for search attributes................................................ 43
Figure 4-26  Results................................................................................... 43
Figure 4-27  Identify map object................................................................. 44
Figure 4-28  Additional infrastructure displayed........................................... 45
Figure 4-29  Streets and business establishments (blue dots)................................. 45
Figure 4-30  Traffic counts (red dots) in front of The University of Toledo identified.. 46
Figure 4-31  Select by Location popup dialog box and tip box............................... 47
Figure 4-32  Select by Location popup dialog box and drop-down feature selection list.......................................................... 48
Figure A-1  Rail yards (purple) Port facilities (blue)......................................... 66
Figure A-2  Lucas County with the digital orthophoto layer active.......................... 67
Figure A-3  Zoom in of digital orthophoto layer.................................................. 67
Figure A-4  Lucas County zoning layer active.................................................... 68
Figure A-5  Activate foreign trade zone layer (light green) next to brownfields....... 68
Figure A-6  TARTA service area................................................................. 69
Figure A-7  Publish a map service………………………………………………….. 70
Figure A-8  Set Service Description………………………………………………. 71
Figure A-9  Set service parameters………………………………………………. 72
Figure A-10 Set service capabilities………………………………………………. 72
Figure A-11 Set service pooling – maximum number of users and timeout
guidelines…………………………………………………………………………… 73
Figure A-12 Set service processes…………………………………………………. 73
Figure A-13 New Service Summary………………………………………………. 74
Figure A-14 Set name and description on the ‘General’ tab……………………….. 75
Figure A-15 Layer Properties………………………………………………………. 77
Figure A-16 Specify feature symbol color………………………………………… 78
Figure A-17 Define fields…………………………………………………………….. 78
Figure A-18 Define and format records (Rich Text)………………………………… 79
Figure A-19 Define and format records (HTML)……………………………………. 79
Figure A-20 Add and develop application tasks……………………………………. 81
Figure A-21 Customize query settings……………………………………………… 81
Figure A-22 Define results display………………………………………………….. 82
Figure A-23 Define map elements………………………………………………….. 83
Figure A-24 Set page properties…………………………………………………… 83
Figure A-25 Application summary………………………………………………… 84
Chapter 1

Introduction

A current national trend is devoted to the promotion of smart growth strategies in many cities across the United States. This is part of a wider effort to support economic redevelopment to reduce urban sprawl, reduce congestion, and to utilize public resources with greater efficacy. The project presented here follows this trend with a particular emphasis on the design and development of a web-based geographic information system (GIS) that relates brownfield sites to local infrastructure (particularly the regional transportation system) to area markets, and to land use and zoning patterns. This system is designed for use as a decision-making tool for site selection and capital investments in infrastructure. It is envisioned that local public officials, developers and regional stakeholders will use this system as a first stop resource for potential area brownfield redevelopment projects.

Brownfields are previously developed industrial sites that are now abandoned or contaminated and contribute to blight in the community. Some of these sites contain hazardous environmental contaminants while others are just perceived as contaminated with visible structural obstacles that inhibit redevelopment. Decades of industrial development followed by a subsequent reduction in population have contributed to a significant number of brownfields left in the region. Several factors contribute to the
difficulty in redeveloping these sites. These include: the availability of capital, overcoming perceptions from potential investors, and the availability of adequate data dealing with both physical characteristics of brownfield sites and their locations relative to the regional transportation system. These factors are covered in greater detail below in Chapters two and three within the context of highlighting the main goal of this project – to overcome the lack of freely available data necessary to redevelop regional brownfield sites through a web-based GIS system.

The development of this data delivery resource took place over a number of stages. First, local businessmen and government officials were engaged in a series of discussions to gather information for key design elements and pertinent data components for this project. These meetings led to the design of a comprehensive repository of georeferenced data for brownfield parcel sites that included the following:

- key parcel attributes (e.g., acreage, structures, etc.)
- environmental assessments and remediation efforts for each site;
- regional transportation and infrastructure networks;
- heavyweight truck routes;
- HAZMAT routes;
- intermodal facilities;
- zoning regulations;
- school districts;
- census and other regional population characteristic data; and
- business locations.
This web-based GIS thus allows users to search the repository through selection criteria with a series of menus and query functions to retrieve data results for brownfield parcels, surrounding zoning regulations, network routing for HAZMAT and heavyweight truck loads, and area market characteristics. Search criteria functions are encoded based on parcel size, proximity to selected infrastructure, zoning regulations, and other market characteristics. Output is displayed through a combination of text, maps, and digital orthophotos. This system is thus a comprehensive data delivery tool that can assist policymakers’ and stakeholders’ with capital investment decisions to encourage smart growth within the region through the economic redevelopment of brownfield sites.
Chapter 2

Statement of the Problem

Dating back to the nineteenth century, Toledo-Lucas County once thrived as an industrial, commercial and transportation hub for the Great Lakes region. As with other major Midwest cities, Toledo has experienced a decline in its middle-class population over the last four decades due to a decline in manufacturing. Consequently, areas within the city have experienced property deterioration and abandonment leaving behind an abundance of brownfields particularly in the Downtown and East Toledo areas (USEPA, 2002). Over 65 parcels in Toledo have been identified by the Ohio EPA Division of Emergency and Remedial Response as Brownfield Inventory Projects in Lucas County; these are considered the highest priority sites and have known contaminants. A total of nearly 300 sites have been identified overall due to the decline in manufacturing over the last four decades (USEPA, 2009). These sites were compiled from EPA, the Toledo Metropolitan Area Council of Governments (TMACOG) - the regional MPO, the City of Toledo, and the Lucas County Improvement Corporation (LCIC) – the regional economic development agency, files.

This large number of abandoned and derelict properties produces a number of problems for the community. They contribute to blight that in turn leads to lower
property taxes and less revenue generated for community services. In addition, these unused properties are not being utilized for any other activity, therefore leaving an untapped resource in the center of the urban core that could otherwise be productive space for future industry and job creation or returned to greenfield space for community recreation. Either scenario benefits the community by reusing brownfields.

Several barriers inhibit brownfield site redevelopment. Most commonly discussed in the literature are topics related to developer liability and access to capital. Less frequently discussed is the availability of data linking brownfield parcels to site, situation and infrastructure attributes that are vital components of site selection and capital investment decisions needed for redevelopment. As a result, the work here was performed to help fill the brownfields data gap for this region.

2.1 Objectives

1) Profile and design a prototype system based on results from interviews with area stakeholders.

2) Compile relevant data for parcels, infrastructure, area businesses, markets, zoning, etc. to complete the project.

3) Build an ArcMap 9.3 desktop data viewer for the foundation of the final web-based system.

4) Develop an interactive web-based data resource tool to assist decision-makers with site selection and infrastructure capital investments to promote brownfield redevelopment in Lucas County, Ohio.
Chapter 3

Literature Review

A wide array of literature is devoted to brownfield redevelopment. The review of literature will therefore be divided into several components, beginning with the relationship between brownfield redevelopment and transportation improvements through national smart growth initiatives. This will be followed by a discussion of the benefits and barriers to brownfield redevelopment. One such barrier – not well discussed in the literature – is the lack of data resources available for brownfield redevelopment efforts. As such, this project focuses on the use of GIS and web-based GIS distribution systems as a means to fill the data gap and to assist policy makers and stakeholders with brownfield redevelopment efforts. Few other cities/regions have developed distributed GIS systems for this purpose. Several are critiqued below based on the design, functionality and analytical capabilities offered to users. Finally, the chapter closes with a detailed discussion on brownfields in the Toledo-Lucas County region and their connections to each other, to area businesses and to transportation infrastructure. First, let us discuss smart growth and the importance of brownfield redevelopment.
3.1 Brownfield Redevelopment Through Smart Growth Initiatives

A widely accepted definition initially developed by the USEPA states that “brownfields are vacant, underutilized, or abandoned industrial or commercial sites where either real or perceived environmental contamination is an obstacle to further economic development” (Amakudzi, 1996; Charles, 2001; McCarthy, 2002; Amakudzi, et al, 2003). Alternatively, brownfields are described as “areas which have previously been developed, and have since fallen derelict and may or may not have existing buildings on them; with no assumptions regarding contamination or pollution of any sites” (Boott, et al, N.D.). Neither of these descriptions portrays brownfields in a positive light for the surrounding community. The exact number of brownfields nationwide is unknown but it is commonly accepted that there are approximately 500,000 sites nationwide. Aside from the obvious possible environmental factors and public health risks associated with brownfields, these sites contribute to overall blight in the community that in turn contributes to decreased property values and lower tax revenues along with a variety of other community deterioration factors.

A majority of the literature focuses on the benefits of redeveloping brownfields to improve property values, create jobs, increase tax revenues, remove blight from the community, the reuse of valuable public infrastructure, and as a mechanism to control urban sprawl and to protect greenfields (Amakudzi, 1996; DeSousa, 2005; Hula, 2010). Alternatively, DeSousa (2006) and Siikamaki (2008) discuss the benefits of converting brownfields into greenfields – rather than redevelopment – as part of an effort to improve the community. Some of these factors overlap with the benefits of redevelopment –
removing blight and improving property values – while others are unique with the conversion to greenfields and urban park spaces. These authors address the benefits of public health and fitness given that residents will have new clean areas for exercise and recreation. Accordingly, both redevelopment and brownfield conversion to greenfield efforts enhance the community/neighborhood image.

One major stimulus for brownfield remediation efforts came from smart growth initiatives brought forth by government policy during the 1990s. Brownfield redevelopment has been discussed extensively in the literature as a means to continue development through smart growth initiatives that promote higher land use densities, generate less traffic and congestion in support of alternative transportation modes, and revitalize deteriorating regions and neighborhoods (Amakudzi and Bomunung, 2003; Greenberg, et al, 2001; Amakudzi, et al, 2003; Nexus, 2010). In essence, smart growth is the opposite of urban sprawl. Reusing brownfields is particularly smart land use, as most brownfields are found in centralized locations already on prime transportation infrastructure connections. The most successful reutilization efforts occur where redevelopment and transportation infrastructure improvements are planned in conjunction with each other (Center for Environmental Excellence by AASHTO, 2010; Johnson, et al, 2002). Amekudzi and Bomunung (2003) along with the experts at ICF Consulting cite Alexander Taft to sum this connection as follows:

Reusing brownfields is particularly smart land use because of brownfields’ central location and connection to existing transportation systems. Their reuse has two benefits: Value. Redevelopment cleans up and reuses underused and potentially dangerous land right where it’s most valuable—central to the most people, to the most businesses, and to existing, paid-off infrastructure. In sum, redevelopment turns a liability into an asset. Growth with less traffic. Redevelopment that’s central to people and businesses reduces the traffic from new jobs and housing in two ways:
first, more of these trips can be by foot and by transit, placing less demand on roads. Second, for trips on roads, central location means that the trips are on average shorter, reducing demand for road space. And often these trips are on roads that have been underused since the decline of the industry that used to occupy the brownfield. Putting trips on those roads can be far less costly.

Several papers cited by Hula (2010) expand upon this connection between brownfield redevelopment and improvements to transportation infrastructure by arguing that policy measures should support projects targeting broader community infrastructure. Thus, a greater prospect for brownfield redevelopment can take place around areas where transportation improvements invoke developer investments and create a marketable area. It is also argued that brownfield redevelopment hinges on funding, transportation, and public private partnerships. These factors all contribute to the overall social and economic benefits of reusing brownfields.

Not only is smart growth through brownfield redevelopment strategies beneficial for social reasons (i.e., less congestion, environmental benefits of cleaner land, etc.) it is also beneficial for economic reasons. The cost of revitalizing brownfields is often less than investment into new infrastructure than comparable greenfields – unused agricultural land or untouched green space – development would be (Nexus, 2010). In addition, investments in remediating brownfields are often a precursor to redevelopment, which ultimately leads to job creation and increased tax revenues (Howland, 2007; McCarthy, 2002). All of these trends lend to the overall importance of brownfield redevelopment.

During the 1990s widespread government initiatives were set forth to revitalize urban cores and ignite smart growth initiatives nationwide by relaxing earlier regulations where just about any previous or current owner could be held liable for the cost of any or all contamination cleanup efforts (De Sousa, 2005; Mazur, n.d.; McCarthy, 2002). The
Toledo-Lucas County Port Authority played an essential role in getting standards relaxed in Lucas County by advocating an Urban Setting Designation (USD) through the State of Ohio’s Voluntary Action Program (VAP). With the USD came a significant reduction in regulation barriers. It applies to sites where a community water system is utilized and there is no anticipation of groundwater use at or around the site (McCarthy, 2002).

Toledo is recognized as a region that has put forth great effort in securing funding toward environmental assessments and brownfield cleanup efforts. Thus far, Toledo has received over $14 million dollars in funding for such efforts through the EPA and the Ohio Department of Development (Mazur, n.d.). To put this into perspective, the redevelopment incentives for the newer Chrysler plant on Stickney Avenue in Toledo cost the city and state a combined total of $300 million dollars (McCarthy, 2002).

Toledo’s experience in cleanup and reuse efforts are similar to those in other cities in the Midwest and Northeast. Targeting high profile “success stories” seems to be a common denominator among cities for selecting key redevelopment sites that will initiate a chain reaction for redevelopment investments (McCarthy, 2002). The research project here is thus a direct result of current trends in smart growth initiatives and making the connection between brownfield redevelopment projects and transportation infrastructure investments. In contrast, barriers to brownfield redevelopment are discussed next.

3.2 Barriers to Brownfield Revitalization

Even though the benefits of brownfield revitalization have been clearly documented with respect to improving the urban core and the health and welfare of citizens in post industrialized cities, the fact of the matter remains that several barriers inhibit brownfield revitalization. First, several scholars agree that funding restrictions
and engineering/developer cleanup liabilities are the main obstacles to brownfield revitalization (Charles, 2001; McCarthy, 2002; DeSousa, 2005). McCarthy (2002) also states that other barriers include uncertain cleanup standards, complicated regulatory requirements and a lack of organized data sources – the focus of this effort. Many of these barriers prevent developers from seriously considering investments in brownfield revitalization projects (Hula, 2010).

Consequently, the brownfield stigma was lessened during the mid-1990s when government relaxed regulatory policies that had held developers and engineers involved in site cleanup efforts liable for further state or federal legal action if the site was designated as a Superfund site, even if they were not the site contaminators. McCarthy (2002) sums this problem as follows:

Federal laws, such as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund, and the Resource Conservation and Recovery Act (RCRA), have discouraged brownfield redevelopment because they hold past, current and future owners, developers, operators and lenders potentially liable even if they were not responsible for the contamination. Uncertainty about contamination means that every brownfield may be considered a potential Superfund site even though most of these properties are not polluted enough to warrant federal action.

In the mid-1990s states responded to the cleanup liability issue by creating Voluntary Action Programs (VAPs). These programs allow private parties to investigate and cleanup brownfield properties on a voluntary basis without risk of future state enforcement action. Over 45 states have some type of VAP program (McCarthy, 2002). In relation to this project, Ohio’s VAP is unique with its emphasis on privatization designed to save the Ohio EPA time and money by minimizing or eliminating up-front review of the site investigation and cleanup. Instead, private state certified professionals
(CPs) and laboratories are used for analyzing environmental samples. Program requirements are limited as the OEPA can be notified by the CP of entry into the program and first contact can be as late in the process as the submission of a no further action (NFA) letter on behalf of the owner of a remediated site. The NFA letter simply explains to the OEPA how the site investigation and cleanup activities met standards set forth in the VAP rules (McCarthy, 2002).

Considering the volume of work involved in brownfield redevelopment research, only McCarthy (2002), DeSousa (2005), Boott (n.d.) and Hula (2010) touch upon a lack of cohesive data sources as a further obstacle for brownfield redevelopment. When there is a lack of comprehensive data on the condition, location and management of brownfield sites the equity between “economic demands and social needs [combined] with the capacity of the environment to cope with pollution and to support human and other life” (Boott, n.d. p. 1) is diminished and sustainable development suffers. It is difficult for developers or other community stakeholders to initiate redevelopment efforts if they are unable to locate sites or possible contaminants based on a site’s history. This is an important assertion that provides further rationale for this project. In this regard, the web-based GIS data delivery system developed here can act as the initial “go to” source for the region by providing access to pertinent data and analysis functions to assist developers and stakeholders in key decisions for site selection and investments in infrastructure improvements. Discussed below over the next two sections are the advantages of using GIS and web-based GIS data distribution systems for brownfield redevelopment.
3.3 Using GIS as a Brownfield Redevelopment Tool

The long term success of brownfield redevelopment programs are dependent on government and decision makers’ ability to compile information concerning land use, development incentives, and public goals, interests and incentives (Thomas, 2001). GIS is a comprehensive way to collect, organize, manage, maintain, integrate and analyze multiple data sources and is an important tool for providing textual and visual context to those data sets. Along with interactive mapping, it is known for its toolbox of geoprocessing and analytical capabilities. Thus, common analysis tools allow users to extract, overlay and join spatially related data, create buffers and service areas around features, and perform advanced spatial and network analyses. “One of the most powerful features of any GIS is the capacity to carry out various spatial analyses quickly and easily,” (Boott, n.d.). In this regard, it is a comprehensive tool for use in brownfield remediation efforts. “The ultimate goal is to make brownfield sites competitive with undeveloped sites and return these areas to productive uses, stimulating local economic growth by getting these properties back on the tax rolls, providing new jobs, and attracting other businesses to the vicinity,” (Thomas, 2001, p.9.).

In this manner, a GIS can be used to track and inventory brownfields, for interactive mapping, for site and environmental reviews, and to promote potential sites to prospective businesses (ESRI, 2004). Thus, brownfield redevelopment efforts are assisted in three important ways: through data integration, project management and stakeholder relations (Boott, n.d.; Thomas, 2001; Stasiak, 2002). First, as a full scale data integration tool, GIS can combine historical, social, economic and environmental data sets throughout the life span of the project. Second, as a project management tool it
can be used to relate and display spatial and attribute data associated with brownfield redevelopment projects. Finally, a wide range of stakeholders can use GIS to collect and compare data sets to maintain cohesion within the project and to foster relationships between stakeholders (ESRI, 2004; Stasiak, 2002). These capabilities provide GIS the means to be a full scale decision support system (DSS) for brownfield redevelopment stakeholders.

The Toledo-Lucas County brownfield system was designed as a DSS for regional brownfield redevelopment. The system was designed based on three common DSS factors as described by Thomas (2001). First, a complete user needs analysis was conducted with area stakeholders. Second, a comprehensive database was compiled providing stakeholders with detailed accurate data. Third, success indicators were established based on criteria set forth in meetings with stakeholders thereby qualifying the system as a full scale GIS based DSS for brownfield redevelopment. Finally, GIS as a DSS can be used as an outreach tool by itself or in conjunction with web-services to reach a wider audience. The use of web-services to enhance the distribution of data through a GIS platform is discussed in the next section.

3.4 GIS Web-Services and Web-Based GIS Distribution Systems

GIS web-services are the software components that host spatial data and GIS functionalities that can be accessed and integrated into customized GIS applications. Developers utilize GIS web-services for custom applications that process geographical information without having to maintain a full GIS system or the associated spatial data
(Lu, 2005). Users can tap into web-based GIS distribution systems through their web browsers without having any specialized GIS software on the desktop system.

Two key benefits of web-based GIS distribution systems are the increased interaction with users and connections to a wider audience (Kingston et al, 2000; Rao et al, 2007; Hoar, 2008; Koshak, 2006) and its advanced data integration capabilities (Lu, 2005; Koshak, 2006 Rao et al, 2007; Hoar, 2008). Thus, there is potential for more people over a broader area to be reached through the internet than other forum options and certainly at a lower cost compared to traditional methods – i.e. printing or public forums. In addition, any updates to data can be made on the web server and are immediately available to users with little or no printing costs (Koshak, 2006).

The second key benefit discussed in the literature is the capability of web-based GIS distribution systems to relate a wide range of spatial and non-spatial data sets. The systems discussed are used as public forums and as decision support tools for projects from environmental assessments (Kingston et al, 2000; Rao et al, 2007 ) to transportation infrastructure and mass transit routing (Hoar, 2008; Koshak, 2006). These systems can integrate spatially referenced shapefiles with tabular attribute data, satellite imagery, and aerial photographs. In addition, other photographs, images and documents along with links to additional web resources can be incorporated. Whereas Boott, et.al. (N.D.) created web pages for the project and used hyperlinks to augment their GIS tool but did not develop a true distributed web-based GIS. The other authors – Kingston, Rao, Hoar, Koshak and Lu – developed true web-based GIS distribution systems. As such, the foundations of these systems begin with web map server (WMS) mapping applications and a GIS web platform.
In contrast to the other papers reviewed in this section, Lu (2005) describes the comprehensive technical design for WMS applications and a platform for GIS web services and the interrelated component architecture. See the detailed diagram in Figure 3-1 for the WMS application framework. See Figure 3-2 for a visual depiction of the basic GIS platform server architecture that consists of three layers: the User Interface Layer, the Application Server Layer and the Database Layer. Refer to Lu (2005) for a more detailed technical discussion on the architecture development of a web based GIS distribution system in general. Development of the web-based GIS system for this project is discussed in detail in the methodology section in chapter 4 after a brief discussion of the study area.

Figure 3-1: The system architecture of WMS mapping applications (Lu 2005)
Figure 3-2: Web GIS platform server environment (Lu 2005)
Chapter 4

Study Area and Methodology

This chapter highlights the geographical context of the study area and provides a detailed description of the methodology used to develop this system.

4.1 Study Area

Toledo-Lucas County, Ohio is situated on the southwestern end of the Lake Erie basin (see figure 4-1). The City of Toledo is the major metropolitan urban core of the county. Toledo’s 2009 population was approximately 295,000 within the city limits (USEPA, 2009). From the period of 1970 - 2000 Toledo’s population declined by over 70,000 residents. 94% of this decline occurred in brownfield impact areas (BIA) as defined by U.S. Census Tract demographics (see figure 4-2). Roughly one third of the city’s population resides in the BIA, which houses a large minority population, a 26% poverty rate, and a 10.2% unemployment rate (Webber, n.d.; USEPA, 2009).
Figure 4-1: Map of the City of Toledo (red) within Lucas County, Ohio

Figure 4-2: Brownfield Impact Area: Toledo, Ohio (Weber, n.d.)
4.2 Methodology

A multi-method approach was employed through several distinct phases of this project. The initial phase entailed interviewing key commercial and government officials to gather information and relevant data components for the system. Subsequently, additional data sets were acquired and a comprehensive data repository was assembled and processed. In turn, a data viewer was designed in an ESRI ArcMap 9.3 desktop GIS platform. Finally, the necessary files created from the ArcMap desktop application were used to develop a customized, user-friendly, web-based GIS distribution system in an ArcGIS 10 Server environment. Specific steps to this project are outlined in detail as follows:

1. conduct interviews with area stakeholders to determine a needs assessment;
2. design a prototype system based on results from interviews with area stakeholders;
3. compile relevant data for parcels, infrastructure, area businesses, markets, zoning, etc. to complete the project;
4. build the data viewer and all geoprocessing models in a desktop ArcMap application;
5. carry out system implementation and evaluation of results from discussions with area stakeholders;
6. use the ArcMap desktop data viewer as the basis for developing a web-based data distribution application; and
7. publish the interactive web-based data resource tool on the project web page to assist decision-makers with site selection and capital investments in infrastructure to promote brownfield redevelopment in Toledo-Lucas County, Ohio.

The following sections detail each phase of this project.

4.2.1 Discussions with Stakeholders

Several meetings were conducted with local businessmen and government officials in order to determine the overall viability and usefulness of this system. Results
from initial meetings indicated positive support from both commercial and government officials for the development of a Toledo based Brownfield Data Delivery System. Representatives from the City of Toledo, Division of Environmental Services, the Toledo Area Metropolitan Council of Governments (TMACOG), the Toledo-Lucas County Port Authority, the Lucas County Improvement Corporation (LCIC), and First Energy Corporation provided data and/or feedback for this work. Toledo Growth Partners was also contacted but did not participate. Meetings took place during September and October, 2010.

4.2.1.1 Toledo Metropolitan Area Council of Governments (TMACOG)

TMACOG is a regional metropolitan planning organization (MPO) made up of public and private members throughout Lucas and Wood Counties in Ohio and Monroe County in Michigan. TMACOG is a leader in the area for leveraging our natural and public resources to maintain environmental and economic quality throughout the region. The organization houses a number of environmental and transportation planners. The vision statement for TMACOG is to “be the governmental partner of choice to coordinate regional assets, opportunities, and challenges,” (TMACOG). This was a logical place to begin stakeholder interviews with the group’s clear focus on transportation planning and environmental awareness.

The meeting with TMACOG took place in September, 2010 and was attended by Roger Streiffert a Transportation Planner, David Gedeon the Director of Commuter Services/Transportation Project Manager, and Marc Vondeylen a Transportation Technician III. Two key results came from this meeting. First, the group agreed that users should be able to query for brownfield parcel size by acreage within the system. It
was also suggested that TARTA (Toledo Area Regional Transit Authority) routes and service areas, school systems, and traffic counts be included in the system. It was presumed that including school systems – primary, secondary, advanced – would give potential developers an opportunity to determine a local labor base and wage scales based on levels of training within the community. The inclusion of traffic counts were suggested so prospective retailers would have an idea of volume for potential customers travelling outside their enterprise. Second, TMACOG proved to be a key data source for the delivery system. A vital outcome of this meeting was gaining access to the following data sets for this project:

- Brownfield Inventory List – 2009
- Abandoned Gas Stations List – 2009
- Foreign Trade Zones – 2008
- Hazmat Routes – 2008
- Land Bank Properties – 2009
- Lucas Centerline roads - July 2010
- Michigan Legal Heavy Truck Routes - 2009
- NHS Intermodal Connector routes – 2009
- PCR Pavement Conditions – 2009
- Port Facilities – 2009
- Port Opportunity Districts – 2009
- Rail Yards – 2010
- Traffic Counts - Sept 2010
- Lucas Zoning – 2008
- TARTA data including:
  - routes,
  - TARTA service area,
  - Call-A-Ride service area,
  - Park & Ride lot locations.
- Bridge conditions – 2009

The meeting with TMACOG was an important starting place. It was instrumental in providing design ideas for the data delivery system from a user’s perspective. In addition
to key data sets and component suggestions, it was suggested during this meeting that several other area brownfield stakeholders be consulted for this project. Joel Mazur with the City of Toledo, Ford Webber with the Lucas County Improvement Corporation, and Hans Rosebrock from First Energy were all suggested as points of contact for this project. The following discussion highlights meetings with these stakeholders.

4.2.1.2 City of Toledo – Division of Environmental Services

A meeting with Joel Mazur at the City of Toledo Division of Environmental services took place in September 2010. A list of brownfield sites, compiled by the city, was furnished for use in this project. In addition, Mr. Mazur provided access to source documents for Phase I and Phase II environmental site assessments and results for remediation efforts where available. These source documents are vital pieces of data that have been integrated directly into the desktop system through hyperlinks.

4.2.1.3 Toledo-Lucas County Port Authority

The next meeting took place in October 2010 with Joe Cappel and Brian Perz at the Toledo-Lucas County Port Authority. After a short overview of the project, the group discussed the positive impacts this system would have in revitalizing neighborhoods. In addition, Mr. Cappel and Mr. Perz discussed the use of Clean Ohio Revitalization Fund (CORF) applications obtained through the Ohio EPA or the Ohio Department of Development as an opportunity to link these forms to this system. Furthermore, it was suggested during this meeting that links to any local brownfield site articles in the media and also links to consultants that can assist with CORF applications would be helpful to
users of the system. These are valuable suggestions and are addressed in the Future System Developments section.

4.2.1.4 First Energy Corp

Another October 2010 meeting took place with Hans Rosebrock at First Energy Corp. The most valuable outcome of this meeting was the introduction to the Firstprospector and Ohio InSite websites. These are site selection websites that were valuable resources for designing the Lucas County brownfield data distribution system. In addition, Mr. Rosebrock gave an overview of electrical service levels. There are four basic levels of electrical power service: standard residential and retail power is available throughout Lucas County; the higher three transmission levels of service are required for certain industrial and manufacturing processes. Different industries and processes dictate the service level of power required to perform those processes. System capacity constraints limit transmission levels of service through various parts of the service area. First Energy cannot share the power grid network files due to Homeland Security issues, though they can provide site specific power attributes to interested developers or stakeholders directly.

4.2.1.5 Lucas County Improvement Corporation

A final meeting in October 2010 with Ford Webber, CEO of the Lucas County Improvement Corporation, who provided feedback from the users’ perspective regarding inclusion of important datasets, component design pieces, and initial input for search criteria functions. Moreover, new contacts were obtained for commercial real estate developers, government agencies, and other potential stakeholders.
4.2.2 Data Repository

Data provides the backbone of this project, thus a significant portion of the project’s effort was devoted to compiling and reconciling a wide variety of datasets from public and private sources into a single repository for use in the GIS application. See Table 4.1 below for a complete list of data included in this project.

Table 4.1- Data sets, descriptions and sources incorporated into the Brownfield Data Delivery System

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Description</th>
<th>Source</th>
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<tr>
<td>Brownfields Inventory</td>
<td>Compiled list of all brownfield properties in Toledo - 2009</td>
<td>TMACOG, City of Toledo, Ohio EPA</td>
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<tr>
<td>Ohio EPA Brownfields</td>
<td>Ohio EPA Lucas County Brownfields</td>
<td>Ohio EPA</td>
</tr>
<tr>
<td>Abandoned Gas Stations</td>
<td>Abandoned or suspected abandoned gas stations - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Foreign Trade Zones</td>
<td>Foreign Trade Zones in the Toledo area 2008</td>
<td>TMACOG</td>
</tr>
<tr>
<td>HAZMAT Routes</td>
<td>HAZMAT Routes in and around Lucas County - 2008</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Land Bank Properties</td>
<td>Land Bank Properties - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Center Line Roads</td>
<td>Center line roads in Lucas County - 2010</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Michigan Permit Routes</td>
<td>Michigan legal heavy truck routes - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Intermodal Connector</td>
<td>National Highway System (NHS) Intermodal Connector Routes - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Pavement Conditions</td>
<td>PCR Pavement Conditions - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Port Facilities</td>
<td>Port Facilities - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Port Opportunity Districts</td>
<td>Port Opportunity Districts - 2010</td>
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<td>Rail Yards</td>
<td>Rail Yards in Lucas County - 2010</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Traffic counts</td>
<td>Traffic Counts Lucas County - Sept. 2010</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Lucas Zoning</td>
<td>Zoning in Lucas County - 2008</td>
<td>TMACOG, Lucas County AREIS System</td>
</tr>
<tr>
<td>TARTA System</td>
<td>TARTA routes, service area, call-a-ride service area, park and ride lot locations</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Bridge conditions</td>
<td>Bridge conditions Lucas and Wood Counties - 2009</td>
<td>TMACOG</td>
</tr>
<tr>
<td>Interstate</td>
<td>Lucas County Interstate routes</td>
<td>Lucas County AREIS System</td>
</tr>
<tr>
<td>Ramps</td>
<td>Lucas County Interstate ramps</td>
<td>Lucas County AREIS System</td>
</tr>
<tr>
<td>Highways</td>
<td>Lucas County Highways</td>
<td>Lucas County AREIS System</td>
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<tr>
<td>Highways</td>
<td>Lucas County highway ramps</td>
<td>Lucas County AREIS System</td>
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<td>County Lab</td>
<td>Municipal Jurisdictions in Lucas County</td>
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<td>Lucas County AREIS System</td>
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<tr>
<td>Schools</td>
<td>Lucas County School Districts</td>
<td>Lucas County AREIS System</td>
</tr>
<tr>
<td>Lucas1.sid</td>
<td>Ortho photos for Lucas County</td>
<td>Lucas County AREIS System</td>
</tr>
<tr>
<td>Businesses</td>
<td>Harris InfoSource Dunn and Bradstreet Business Data - 2008</td>
<td>Midwest FreightView</td>
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</table>
Along with the data sets and source documents from TMACOG and the City of Toledo, parcel attribute data and site photographs from the Lucas County Auditor’s AREIS system were collected. Shapefiles of brownfield sites for the study area were also obtained from the Ohio EPA and integrated into the system. These data were combined with brownfield site data from TMACOG and the City of Toledo. In addition, 2008 Dunn and Bradstreet business establishment data were included.

It is important to note here that work for this project did not include a separate investigation to collect primary data regarding which sites were to be included as brownfields in this project. Brownfield sites were obtained from several secondary sources and combined into a single brownfield inventory for the Toledo-Lucas County area. This was a detailed process. Data sets from TMACOG, City of Toledo and the Ohio EPA were combined to include more than 450 brownfield sites—many of which were duplicates. All of the duplicate sites among the three sources were thus removed. Each remaining site was then searched through the Lucas County AREIS system to fill in any data gaps missing from the original list. Sites were found in the system by searching either the parcel number or address whichever was available. For these sites, any missing attribute information was included in the inventory database and site photos were downloaded when available. A total of 291 sites resulted from this process and are now included in the final brownfield inventory shapefile. See Table A.1 in the appendix for the complete list with attributes. Many of the sites from the originally compiled list could not be located due to incomplete or incorrect addresses and parcel numbers. In some cases, no address or parcel number was included in the original data file at all, only a
vague landmark description. In these cases, a further investigation is needed to identify parcel numbers and addresses for these sites.

Another comment on the reliability of data compiled through this effort stems from the accuracy of sites included in the inventory list. Though it is beyond the scope of this project to determine the brownfield sites that should be included, some of the sites included in this inventory may no longer qualify as brownfields and thus should be removed from the inventory. Included in this visual assessment are sites that are currently in commercial or retail use, residences, a cemetery, a school building and even a botanical garden. It is possible that these sites were brownfields at one time and have thus remained on the brownfield list. Two suggestions emerge as an outcome of this data compilation process that could improve the reliability of Toledo-Lucas County brownfield data. These include 1) the questionable sites should be evaluated by an expert in the field to determine if inclusion in the brownfield inventory is appropriate, and 2) a clear method should be defined for removing brownfields from the inventory once the land is in a state of reuse. Again, the main focus of this work is on the design and development of a data distribution decision support tool, the quality and reliability of data are very important though better suited for other experts in the field.

Furthermore, after all datasets were collected, each was verified, georeferenced and processed for inclusion into the Lucas County Brownfield Data Repository. All datasets were systematically organized within the repository by data source and type for optimum data retrieval. As a result, these preprocessed datasets were directly used in the next stage of this effort; building the data viewer.
4.2.3 DataViewer Development

Designing the data viewer in a GIS was the next step toward the final web-based information delivery system. During this stage brownfield data from the repository was combined and integrated into an ArcGIS 9.3 desktop GIS project file. The data sets were georeferenced to the Ohio State Plane (North Zone) coordinate system (NAD83, Lambert Conformal Conic projection, in Feet).

The next series of figures provides an illustration of the viewer. The opening page of the viewer is shown in Figure 4-3. Figures 4-4 and 4-5 show a visual depiction of HAZMAT routes (purple), and then HAZMAT routes and Highways (green) below. Figures 4-6 and 4-7 show how a user can zoom in within the desktop application and then add Michigan heavy weight truck routes. Figure 4-8 below shows blue highlighted parcels when hyperlinks are activated. Then Figure 4-9 below displays a popup box with site source documents listed. Users can click one of the links to activate/view available source documents as shown in Figures 4-10, 4-11, and 4-12.

Other illustrations of the viewer are presented in Appendix II. These include Figure A-1 showing the application with port facilities and rail yard layers active. Figure A-2 is a digital orthophoto layer of Lucas County. Figure A-3 is a close-up on Toledo of the same layer. Figures A-4, A-5 and A-6 show zoning in Lucas County, foreign trade zones and their proximity to brownfields, and TARTA service area coverage.
Figure 4-3: Initial GIS view of the desktop system with county jurisdictions and brownfield parcel layers active

Figure 4-4: HAZMAT routes

Figure 4-5: HAZMAT routes and Highways
Figure 4-6: Zoom in on Toledo

Figure 4-7: Add Michigan heavy weight routes

Figure 4-8: Activate ortho photo layer and hyperlinks
Figure 4-9: Click any blue highlighted parcel to jump to site photos and source documents

Figure 4-10: Results: Site photo from a CORF application PDF document
Figure 4-11: Results: USEPA Profile Brief

Figure 4-12: Hyperlink site photo from AREIS of 1515 Bancroft
In addition to hyperlink tools, several geoprocessing models were developed in the desktop application for integration as geoprocessing tasks in the web-based system. Several buffer tool and selection tools were developed as part of this system. One model developed for this system is the Proximity Model in Figure 4-13 below. It is used to search for desirable brownfield parcels within a certain distance of selected features. Users can select available features from a selection list in the “Input Features” parameter (Figure 4-14). Next users input the distance criteria in the “Search Distance” parameter. In this case the user has input 2500 feet (Figure 4-15). Figures 4-16 and 4-17 illustrate the successful execution of the model.

Figure 4-13: Proximity model
Figure 4-14: Proximity model input feature selection box

Figure 4-15: User defined distance parameter
Figure 4-16: Run the model

Figure 4-17: Successful execution
Figure 4-18 below illustrates the visual output results of parcels (highlighted in aqua) that are less than 2500 feet (approx. ½ mile) from an interstate ramp (dark blue feature). The user enters the distance and selects new parameters from dropdown list (Figure 4-19). This time the user defined parameters are to select brownfield sites within 1200 feet from port facilities. Figures 4-19 through 4-21 demonstrate the ease in which a user can input new selection criteria and the resulting output display.

Figure 4-18: Output display
Figure 4-19: New parameters

Figure 4-20: Successful execution
Figure 4-21: Output results of new parameters entered in Figure 4-19

Figure 4-22: Model layer dialog box
Users can right click on the proximity layer in the desktop application to open the model input dialog box (Figure 4-22). The model has been saved as a layer file and will be used to publish the geoprocessing task in the web application. As a result, this seamlessly integrated data viewer will provide the platform for the final data delivery system application.

4.2.4 Web-Based Data Delivery System: Development and Implementation

Development of the web-based data delivery system architecture and implementation of the system comprised the final stages for this project. The data viewer, completed in the previous phase, provides the foundation for building the web-based data delivery system application. A customized, user-friendly, brownfield data delivery system was developed using ArcGIS Server 10. Complete details of the web-based application development process are available in Appendix III, a summary of the process follows in the next section.

4.2.4.1 Development

Three main steps are required to develop a web-based GIS application in ArcGIS Server 10: 1) publish a map service, 2) publish a geoprocessing tool, and then 3) create the web application. Once a developer has entered the ArcGIS Server 10 Server Manager the first step is to add and publish a new map service (Figure A-7). A wizard tool is used to navigate through the rest of the set-up process (see Figures A-7 through A-13 in Appendix III for screenshots of each step in this process). The .mxd file created from the desktop application is used to publish the map service for the web application. If the web
application is to have geoprocessing capabilities the models developed in the desktop application must also be published. From here the web application development begins.

All of the layers in the application must be defined and formatted with proper symbology. Then tasks are added and customized for the application to perform the required operations. Finally the map elements, or interactive tools, thematic page properties and application settings are defined to complete the development process.

Once completed the application resides in the Arc GIS 10 Server Manager (see Figure 4-23) and can be edited at another time for future updates.

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Figure 4-23: Brownfields web application within the ArcGIS 10 Server Manager
4.2.4.2 Implementation

Users can search the data repository through selected criteria with a series of drop-down menus, query functions and additional analytical tools in order to retrieve data for selected brownfield parcels, surrounding zoning regulations, network routing for HAZMAT and heavyweight truck loads and area market characteristics. Search criteria functions are encoded based on parcel size, proximity to selected infrastructure (under continued development at this time) and other market characteristics. Output is displayed through a combination of text, tables, maps, and digital orthophotos. The data retrieval and analysis tools from this application are intended to assist developers, government officials and other stakeholders through the decision-making process for capital investments in site selection and infrastructure improvements surrounding brownfield redevelopment. User’s can access the system at

http://gisserver.sm.utoledo.edu/LucasCountyBrownfields/default.aspx. The opening user interface (Figure 4-24) is initially displayed on the site. Here users can begin by using any of the tools in the tool bar. These include standard web-based GIS tools such as pan and zoom functions in addition to higher functioning measure; x,y location; and identification tools. In addition, several customized tools were developed specifically for this project. Users can query sites based on any possible attribute. For example, Figure 4-25 shows that “jeep” has been entered in the popup box. Figure 4-26 displays the results from querying “jeep” in the results box in the upper left hand corner and shows how the user can zoom in for a closer view. Notice that two parcels with the same address are displayed in the box while the corresponding feature on the map is
highlighted in green. Users can gather more information about any site by clicking the ‘Map Identify’ tool to display a popup box with that feature’s attributes (Figure 4-27).
Figure 4-25: Popup box for search attributes

Figure 4-26: Results
Users can also select a number of additional features from the data repository through the map contents box on the left of the display. Selected infrastructure is displayed in Figure 4-28 below. Streets and business establishments are shown in Figure 4-29 and traffic counts at a particular location are shown in Figure 4-30 where the “Map Identify” tool is activated to display count values in front of The University of Toledo. Users can query parcels by acreage values with the ‘Query Parcel Acreage’ tool. Results display in the results box similar to the ‘Search Brownfield Attributes’ tool. The ‘Select by Location’ tool will be discussed in greater detail in the next section.
Figure 4-28: Additional infrastructure displayed

Figure 4-29: Streets and business establishments (blue dots)
4.2.5 Future System Developments

Groundwork for the ‘Select by Location’ tool is currently in the development process. Figures 4-31 and 4-32 show the user input dialog box with a tip box and feature drop-down menus. The tool requires some minor input and output data structure reconfiguration in order for it to execute properly in the ArcGIS Server 10 application. This configuration will be restructured and added at a later time. Another area that warrants future work is integrating hyperlinks to source documents into the web-based application. There was also a data configuration with this issue that will need to be worked out and added at a later time.

In addition to the above items, several suggestions were also made during the course of this project that justifies further design integration into this system. Links to
articles and other media files, CORF applications, and professional consultants as suggested by the Toledo-Lucas County Port Authority representatives would add to the site. Further investigation is needed to identify parcel numbers and addresses for brownfield sites that were missing locational information. These items are beyond the scope of this project.

Figure 4-31: Select by Location popup dialog box and tip box
Figure 4-32: Select by Location popup dialog box and drop-down feature selection list
Chapter 5

Conclusions

The work presented here outlined the design and development of a web-based data distribution system for brownfield site redevelopment in Toledo-Lucas County, Ohio. The system is designed to advance smart growth initiatives by creating the link between transportation infrastructure, economic development and the sustainable utilization of brownfield sites in the region. The Lucas County Brownfield system developed here is a comprehensive data delivery tool that can assist policymakers and stakeholders with capital investment decisions to encourage smart growth within the region through the economic redevelopment of brownfield sites. It is envisioned that this web-based system will be a resource for commercial real estate developers, government officials and other regional brownfield redevelopment stakeholders.

This system is designed to fill the data gap concerning brownfield sites in the region. A multi-method approach was used to develop the system. Government and organizational representative stakeholders were consulted for an initial needs assessment. Through these meetings, key data sets, component elements and additional contacts and resources emerged. Next, additional data sets were also obtained and a relational data repository was compiled and preprocessed for use in developing an *ArcView* 9.3 desktop GIS data viewer. Geoprocessing models were developed within the desktop data viewer.
for use in the web-based application to enhance user functionality of the completed system. The desktop application was used as the base for developing the user-centered web-based distributed GIS thus allowing users anywhere with a web browser access to the system.

Furthermore, this user-centered system allows stakeholders to search the repository through selection criteria with a series of menus, check-box selections and query functions to retrieve data results for brownfield parcels, surrounding zoning regulations, network routing for HAZMAT and heavyweight truck loads, and other area market characteristics. Search criteria functions are encoded based on parcel size, proximity to various features and area businesses. Output is displayed through a combination of text, maps, and digital orthophotos. This system is thus a comprehensive data delivery tool that can assist policymakers and stakeholders with infrastructure and site selection capital investment decisions that encourage smart growth within the region through the economic redevelopment of brownfield sites.

Specifically, decision-makers in Toledo-Lucas County now have a comprehensive inventory of spatially referenced brownfield sites to focus attention toward clean-up and redevelopment efforts. The city could choose to offer special incentives for groups interested in reusing these sites in effort to reduce blight, increase the tax base by raising property values and even creating jobs within the city. This system provides a valuable marketing tool for site and situational characteristics of these brownfields packaged within a user-friendly web-based interface. Links to the system have been distributed to city officials and other interested stakeholders.
Finally, the web-based application developed here is not only useful to decision-makers and stakeholders in Lucas County, but also can be used as a DSS template for brownfield redevelopment in other metropolitan areas. The methods used in this application can be replicated for use in other regions thereby further expanding smart growth in metropolitan areas throughout Ohio and the Midwest.
References


Lindquist, P. S. 2010. “A GIS Connection between Brownfield Sites, Transportation and Economic Development.” Research proposal awarded by the University of Toledo University Transportation Center.


Webber, F. N.D. “Excerpts from Toledo Brownfield Presentation – Impact of Central City Brownfields.” Lucas County Improvement Corporation Power Point Presentation, received via email from the author on October 19, 2010.
Appendix A

Data
## Table A.1 – Brownfield Inventory

| Parcel #  | Brownfield | Address                  |_zip| Code | Funding       | Work Completed | Contractor | Previous Owner | Previous Use | Current Owner | Current Use | Contamination | Site Description | Landmarks | Notes |
|----------|------------|--------------------------|----|-----|--------------|----------------|------------|----------------|--------------|---------------|-------------|--------------|----------------|-----------------|-----------|-------|
| 000006   | Toledo Urban Federal Credit Union | 0211317 AMONYX 215 City Park Avenue | 5.56 | Phase I; Asbestos | Commercial; Gas station | Commercial; Gas station; Industrial | Watterson Environmental Group | Brown Claudia Sebree | Toledo | Toledo | Commercial; Gas station | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000009   | Toledo Urban Federal Credit Union | 0305647 Adams St 1311 Adams 43624 | 0.239, 0.042 | USEPA Assessment '03 | Phase I, 2005 | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000012   | Toledo Urban Federal Credit Union | 0327037 SWIP - Gorney | 76 Erin St 43612 | 0.4 | Phase I, additional | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000013   | Toledo Urban Federal Credit Union | 0327047 SWIP - Gorney | 74 Erin St 43612 | 0.175 | Phase I, additional | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000014   | Toledo Urban Federal Credit Union | 0327057 SWIP - Gorney | 64 Erin St 43612 | 0.18 | Phase I, additional | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000015   | Toledo Urban Federal Credit Union | 0327064 SWIP - Gorney | 3730 Lagrange St. 43612 | 0.08 | Phase I | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000016   | Toledo Urban Federal Credit Union | 0327071 SWIP - Gorney | 3722 Lagrange St 43612 | 0.06 | Phase I | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000017   | Toledo Urban Federal Credit Union | 0327077 SWIP - Gorney | 3714 Lagrange St 43612 | 0.03 | Phase I | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |
| 000020   | Toledo Urban Federal Credit Union | 0411813 Hastings 1228 Hastings | 0.79 & 0.83 | N/A | ARIES on-line report | File, Phase I, 2005 | Watterson Environmental Group | Paul, Bishop | Toledo | Toledo | Commercial use, asphalt-paved lot, generally flat. | Soil, Gas, | Toxic waste | Groundwater, | Environmental impact report, 2003; TOX and OFF Survey of active point source effluent to Maumee River. |

Note: All information is subject to change and may be outdated. Please consult the latest reports and documents for the most current information.
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<th>Brownfield</th>
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<td>Abandoned/unknown</td>
<td>Abandoned</td>
<td>None</td>
</tr>
</tbody>
</table>

**Notes:**
- Further investigation necessary. Site appears to be contaminated.
- Must be adjacent to railroad tracks.
- USEPA Assessment '03 Phase I & II Phase I, TTL BDS Acquisition Corp. Toledo Community Development (1.075 sq. ft. structure; 0.033 sq. ft. structure)
<table>
<thead>
<tr>
<th>Brownfield Inventory List</th>
<th>Zip Code</th>
<th>Work Completed</th>
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### Brownfield Inventory List

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### Additional Notes:

- All sites currently for sale and Ann Arbor developer looking to purchase all four and rezone them for a multi-purpose use. (As of 3/30/2015)
- All sites currently for sale and Ann Arbor developer looking to purchase all four and rezone them for a multi-purpose use. (As of 2/9/2016)
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<td>Moving to a condos in June, 2006</td>
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**SITE DESCRIPTIONS:**

- Site consists of the intersection at Manhattan Blvd. and Phillips Ave. and proceeds east on Manhattan Blvd. to Winderer Ave.
- Site consists of the intersection at Manhattan Blvd. and Phillips Ave. and proceeds east on Manhattan Blvd. to Winderer Ave.
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Brownfield Inventory List
Appendix B

Additional Layer and System Capability Figures

Figure A-1: Rail yards (purple) Port facilities (blue)
Figure A-2: Lucas County with the digital orthophoto layer active

Figure A-3: Zoom in of digital orthophoto layer
Figure A-4: Lucas County zoning layer active

Figure A-5: Activate foreign trade zone layer (light green) next to brownfields
Figure A-6: TARTA service area
Appendix C

Web Application Development

Three main steps are required to develop a web-based GIS application in *ArcGIS Server 10*: 1) publish a map service, 2) publish a geoprocessing tool, and then 3) create the web application. Once a developer has entered the *ArcGIS Server 10* Server Manager the first step is to add and publish a new map service (Figure A-7). From here a wizard tool is used to navigate through the rest of the set-up process (see Figures A-7 through A-14 for screenshots of each step in this process).

Figure A-7: Publish a map service
Publish a Map Service

First, the developer can set the tasks and input the service description (Figure A-8). Next, the service parameters are defined (Figure A-9) this is where the .mxd file developed from the desktop application is incorporated into the publishable map service. Then, service capabilities, service pooling, and service processes are set (Figures A-10 – A-12), the default values were used for this application though careful attention was paid in the pooling services section to ensure multiple users would have access at the same time. Finally, a summary of the map service set-up is displayed (Figure A-13) if any changes are necessary the developer can go back at this point and make corrections, otherwise, finish and start the new map service.

Figure A-8: Set Service Description
Figure A-9: Set service parameters

Figure A-10: Set service capabilities
Figure A-11: Set service polling – maximum number of users and timeout

Guidelines

Figure A-12: Set service processes – default used here
Publish a Geoprocessing Task

Describing the process of publishing a geoprocessing task is redundant here; it is very similar to publishing a map service except a .tbx file is incorporated (instead of the map .mxd file) with the tools required for the geoprocessing tasks that are used in the web application. These files came from the geoprocessing models developed in the desktop application. Both the map service and geoprocessing tasks are needed for development of the web-application.
Web Application Development

Development of a web application with geoprocessing capabilities is a bit more complex than publishing either the map service or geoprocessing tasks; it is also not possible without these two components. To begin, the developer navigates to the Web Application Manager within the ArcGIS Server Manager and creates a web application. The name and description are set on the ‘General’ tab (Figure A-14). Next, the layers are set as detailed below.

Figure A-14: Set name and description on the ‘General’ tab
Define Layers

One or more map services can be integrated into a web application. This is done in the ‘Layers’ section. Here the map service generated for Lucas County Brownfields is added as a layer, the multiple shapefiles within it are sublayers and visible in the ‘Layer Properties’ section (Figure A-15). In this context, ‘sublayers’ and ‘shapefiles’ are used interchangeably. LucasCountyBrownfields already contains all the necessary map layers for this application thus it is not necessary to select any additional map services. For other GIS web applications it may be more appropriate to generate multiple map services. A step by step process to define the symbols, fields, and records for each sublayer is explained next.

The symbols, fields, and records must be defined for each sublayer. Depending on what kind of shapefile (point, line, or polygon) the sublayer is composed of determines the symbology defined. The feature color and highlight color is selected from a color palate for line and polygon shapefiles (Figure A-16). Whereas a symbol/color palate is available to define point features. Size of the feature can be defined for line thickness and point symbols. Color transparency can also be defined for all feature types. Next, sublayer fields and records are defined.

Each field for each shapefile is defined in this step (Figure A-17). Though it is not possible to remove a sublayer from a web application, it is possible to suppress an individual field, or multiple fields, from a shapefile and can be done at this time. All field aliases are also set at this time; these are the field names that will be visible to users for each record description in the web application.
Finally, records are defined and formatted in this section. A default format setting is available, though custom formatting options allow the developer to set an appropriate look for the application. Custom formatting can be applied in both ‘Rich Text’ (Figure A-18) and ‘HTML’ (Figure A-19) options. The rich text option is more developer-friendly, it is however sometimes necessary to edit the HTML code directly. Formatting here applies to values in the results box and in the identify map properties pop-up box – these tool features are discussed in greater detail in the ‘tasks’ and ‘map elements’ sections to follow. After this step is completed the look of the results box and pop-up display boxes are set.

![Figure A-15: Layer Properties](image-url)
Figure A-16: Specify feature symbol color

Figure A-17: Define fields
Figure A-18: Define and format records (Rich Text)

Figure A-19: Define and format records (HTML)
Set-up Tasks

Tasks are the customized functionality components for data retrieval. They define what the user is able to do within the application. Some tasks are simple (i.e. the ‘print’ and ‘find’ functions) while others are more complex query and geoprocessing tasks which add greater functionality and analytical capabilities to the application. Tasks are added and developed within the ‘Tasks’ tab in the web application development setting. Figure A-20 is a screen shot of the tasks added in this application. Print, find, query and geoprocessing tasks have been added. After a task is added, the functionality is customized. In Figure A-21 the query task has been added and is customized to enable users to query parcels from the brownfields inventory based on parcel size. Results are displayed based on the defined settings in Figure A-22. Though similar, geoprocessing tasks are more complex and involve integrating the published geoprocessing models described in the previous section. Described below, the remaining components in the development process are straight forward.
Figure A-20: Add and develop application tasks

Figure A-21: Customize query settings
Figure A-22: Define results display

**Map Elements, Page Properties, Application Settings**

Map elements are comprised of all the interactive tools for users to navigate the map. Figure A-23 shows the entire set of map elements included in the toolbar for this application. The functionality of these tools are explained further in the implementation section below. Theme color and help links for the application are set in the Page Properties section (Figure A-24). Application settings are defined here by the default settings. Finally, a summary of the application is displayed (Figure A-25) when the finish button is ‘clicked’ this completes the development process of the web application.
Figure A-23: Define map elements

Figure A-24: Set page properties
Figure A-25: Application summary