# A GIS-BASED DECISION SUPPORT SYSTEM FOR BROWNFIELD REDEVELOPMENT

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**ABSTRACT**

Rapid growth in regions surrounding large metropolitan areas leads to the phenomenon of urban sprawl. In states like Michigan, land is being converted at a rate seven times greater than formerly used (and potentially contaminated) sites are being redeveloped. City governments now see these unused or abandoned areas as important assets in realizing the goal of urban revitalization. New legislation in Michigan provides economic (e.g., tax recapture) and legal (e.g., suspension of retroactive liability) incentives for local governments and prospective developers who are now seeking these brownfields instead of farmland and open space.

To evaluate land use options with respect to brownfields inventory, characterization, and potential for redevelopment, both government and private decision-makers need access to information regarding land capability; development incentives; public goals, interests, and preferences; and environmental concerns such as site contamination and environmental quality. This paper discusses a decision support system that provides access to state, regional, and local geospatial databases, several informational and visualization tools, and assumptions useful in providing a better understanding of issues, options, and alternatives in redeveloping brownfields.

The resultant decision support system is augmented by a unique GIS-based land use modeling application called Smart Places® as an integrated expert system. The decision support system is being tested in a city- and county-level brownfield identification, screening, and marketing effort in Jackson County, Michigan. This project represents a testbed for decision makers and policy analysts at all levels of government to establish urban land use policy and development guidelines that may be applicable to related land use issues in a variety of urban and urbanizing settings. While this project was conducted in Michigan, the tools and procedures used are seen as readily adaptable to other locations.

KEYWORDS: BROWNFIELDS, GIS, DECISION SUPPORT, INFORMATION SYSTEMS, SITING

## INTRODUCTION

Over the past several years, the value of redeveloping brownfields as a potential panacea to urban sprawl has become anecdotal. Popular media at national, regional, and local levels report redevelopment success stories almost on a weekly basis. Brownfield redevelopment is now seen as a sustainable land use strategy.

Brownfields are defined as abandoned, idle, or under-used industrial and commercial properties where expansion or redevelopment is complicated by real or perceived environmental contamination (U.S. Environmental Protection Agency, 1997). Brownfields represent a lucrative, but largely untapped, land resource (Davis and Margolis, 1997; Kirstenberg, 1997; Dennison, 1998; Rafson and Rafson, 1999). The term “land recycling” has gained favor among land use planners, whereas economic development practitioners seek to “turn brownfields into goldfields” (Fleming, et al., 2000). In a recent survey of 150 cities nationwide conducted by the U.S. Conference of Mayors (1998), two-thirds of the cities responding to the survey estimate that redevelopment of known brownfields could bring from $205 to $500 million in additional tax revenues and add as many as 236,000 jobs to local economies.

Estimates suggest that there are over 430,000 brownfields nationwide (Simons, 1998) and from 14,000 to as many as 45,000 sites in Michigan (Consumers Renaissance Development Corporation, 1998). Until recently, these sites were overlooked by developers in favor of greenfields due to high costs to clean properties and upgrade infrastructure, liability concerns, market conditions, and local resistance (U.S. Conference of Mayors, 1998; Consumers Renaissance Development Corporation, 1999). Under state and federal programs like Superfund, past efforts to clean up these sites and attract new development, jobs, and tax recovery have largely been unsuccessful. Because of these uncertainties and the lack of timely information and financial incentives, the identification and selection of brownfields for redevelopment can be a risky business.

## PROJECT OBJECTIVES AND BACKGROUND

The purpose of this project was to build a prototype brownfield decision support system that can be applied statewide in making siting decisions. Such a system would take advantage of cutting-edge information technologies for data access and analysis, in particular, visualization techniques employed by geographic information systems (GIS). However, the system must be accessible and affordable to local units of government and developers. The resultant prototype system takes advantage of existing state, regional, and local geospatial databases; web-based tools that inventory brownfield sites; geographic information system (GIS)-based visualization models and decision criteria; and extensive public interaction, training, and outreach. This information system is then demonstrated using an innovative resource-modeling application called Smart Places®.

Like many states, land in Michigan is being converted to urban use at an alarming rate. In a recent comparison between Michigan and the rest of the U.S., the amount of land used per person was 3 percent nationally versus 13 percent in Michigan (Rusk, 1998). According to this study, urbanized land in the U.S. has grown six times faster than urban population while most central cities are steadily being abandoned. It is estimated that between 1.4 and 2 million acres of land are projected to be converted to urban development between 1990 and 2010 (Michigan Society of Planning Officials, 1995).

In response, the Office of the Governor of Michigan directed state agencies to seek ways of dealing with uncontrolled growth that would provide incentives to local communities to work together on land use and environmental quality issues that crossed jurisdictional boundaries. One of the land use issues targeted by these agencies was formerly used and potentially contaminated industrial and commercial sites typically located in inner-city areas. There were many impediments to fulfilling this objective. Michigan is a strong home-rule state, and the vast majority of land use decisions are made at the local level. Moreover, there were few incentives—financial, legal, social, or environmental—to develop brownfields within urban environments. Even with incentives, it was often far easier for developers to purchase farmlands and open space one more mile down the road than to acquire formerly used properties.

Many of the barriers to brownfields redevelopment are being challenged through changes in Michigan policy and environmental regulations. Public Acts 381 (Brownfields Redevelopment Financing Act) and 382 (Single Business Tax Credit, As Amended) of 1996 work in concert with Part 201 of Public Act 451 of 1994 (Michigan Natural Resources and Environmental Protection Act) to stimulate redevelopment. Resultant state-supported programs have begun to provide incentives toward realizing the goal of urban revitalization instead of rapid conversion of farmland and open space. Michigan provides both economic (e.g., tax recapture and reimbursement of some cleanup costs) and legal (e.g., suspension of retroactive liability) incentives for local governments and prospective developers to seek brownfields. New funding under the Clean Michigan Initiative is also providing significant funding to support these activities..

Unless new approaches to addressing land-use issues can work within this framework for decision making, any relief from sprawl and its associated social, economic, and environmental problems is likely to fail. Innovative approaches that can interest and engage multiple stakeholder groups, while at the same time accommodating private property constraints, would be beneficial in Michigan and applicable elsewhere.

For these programs to be successful in the long run, two factors must come into play. First, government and private decision-makers need more information regarding land capability; development incentives; public goals, interests, and preferences. Second, the information system must be able to address environmental concerns such as site contamination, public health, and environmental quality to (1) evaluate land use options, (2) shorten the time needed to make decisions, and (3) attract federal, state, and private capital to prioritize, revitalize, and sustain development in an urban environment. 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.

**STUDY AREA**

The study area used in this project was Jackson County Brownfield Redevelopment Zone, which includes 19 townships in Jackson County, Michigan. The Jackson study area represents an ideal location for testing the brownfield decision support system. Jackson County is located in south central Michigan at the juncture of Interstate 94 and US-127. The I-94 corridor is the main connection between Chicago and Detroit. Although it is geographically isolated from other major population centers in Michigan, it is being influenced by expansion from Washtenaw County to the east, Ingham County to the north, and Kalamazoo-Battle Creek to the west. After a period of decline in the 1970s and 1980s, the region is experiencing a rapid rate of economic and population growth.

The Jackson County Brownfield Redevelopment Authority (BRA) inventoried candidate sites under the USEPA funded Pilot Program and Community Partnership Grant. This program provides up to $200,000 for two years to test redevelopment models, direct special efforts toward removing regulatory barriers without sacrificing environmental protection, and facilitate community-based and coordinated input (Weiss, 1997). Since many of the brownfield sites are located within the boundary of the City of Jackson, the County and City BRAs established a collaborative relationship.

## METHODS

The use of decision support systems in the business world is well established (Sauter, 1997). The application of such methods to land use in general and brownfields in particular is relatively new. According to Sauter, decision support systems, by definition, should aid in and strengthen the process of choice. For the DSS to be effective, designers must understand the human choice process as well as the needs of the user for information, the abilities of the user to process and understand that information, and the ultimate endpoint of how and why the information will be used. The integration of expert system technologies (e.g., models, visualization tools, etc.) as components of a decision support system is seen as a means of realizing the goal of providing additional support to decision makers.

To be effective, a land use decision support system must provide access to data, the tools or mechanisms to transform data into useful information, and the context from which understanding is derived (Worrest, et al., 1994). For example, geographic information systems have been readily adopted by users seeking to learn more about the physical world through the ability of computers to transform huge databases into thematic maps. With the addition of GIS-based models and other analytical tools, decision makers can begin to manipulate data in a true planning environment (Faber, et al., 1997; Thomas 1994, 1993; Thomas and Roller, 1993).

We worked with selected local units of government (cities, counties, and townships), community and business leaders, and members of the public. This effort was used to (1) determine multi-stakeholder goals for site redevelopment; (2) identify and locate databases held by existing subcontractors; (3) determine a set of environmental indicators to quantify relevant factors and measure project success; and (4) identify specific brownfields sites to demonstrate the decision support application. The team then incorporated project scenario assessment models and indicators into a GIS-based expert system called Smart Places® to evaluate project objectives, compare siting alternatives, and assess the effects of a proposed redevelopment project.

### Information Needs Analysis

To determine information needed to address brownfield redevelopment, the research team reviewed the literature pertinent to urban land use and land renewal issues. General information needs were obtained from national clearinghouses (e.g., Redefining Progress Website (www.rprogress.org/) and RP-CINET list serve; USEPA's Brownfield Pilot Project summary reports at www.epa.gov.brownfields/) and sustainable communities initiatives ((e.g., Sustainable Seattle, 1992; Olympia Sustainable City Program, 1991; and many others), which included aspects of land use planning and management , environmental quality, site restoration and remediation, and community education and involvement. Of particular note was the GIS-based computer model developed by Emeryville, California. Known as the “One-Stop Shop,” it provides provides information on soil and groundwater contamination, assessment findings, planning issues, land use/zoning concerns, and property ownership to potential purchasers and developers. This entire database was made available over the Internet, at www.best.com/~rda/oss.htm.

We reviewed regional information at the Regional Online Brownfield Information Network ROBIN; www.glc.org/robin/). To determine the extent that regional or local needs influence site development, the analysis included a qualitative mail survey of developers actively working with brownfield sites or interested in working on such sites in the future. Based on this survey, critical information needs included (a) the size and location of available sites, (b) infrastructure support services, (c) available financial support, and (d) size of customer base.

In nearly all instances, the end use is the primary consideration, along with economic and environmental concerns (Simons, 1998; Davis and Margolis, 1997; Moyer and Tremarche, 1997). Information requirements for proposed end uses of brownfields have been outlined by Devine (1996). These include (a) an accurate inventory of available sites; (b) environmental compliance status, history of incidents, and any enforcement actions; (c) transportation access; (d) presence of linked industries; (e) availability of development incentives; and (f) labor pool characteristics. While Buchanan (1997) suggests that, in a choice between brownfields and greenfields, the fear of liability of contamination as the most critical factor, Greenwald (1996) lists skill level and cost of labor, proximity to customers, and price of real estate as the principal determining factors. Greenwald also discounts the influence of tax incentives, claiming that communities in their rush to attract business often trade certain services (e.g., education and job training) that may be more essential to sustaining a good business environment.

This search resulted in (1) a set of questions that could be asked by a prospective developer and community decision maker, (2) a set of indicators and metrics — how the success of sustainable development objectives can be measured and quantified, and (3) a list of information requirements to address these questions. An initial set of siting indicators or criteria was prepared for each of four possible end points: industrial, commercial, residential, and open space (Table 1).

**Working Database Development**

A regional-level database was compiled for Jackson County in cooperation with the county Planning and Equalization Department and Region 2 Planning Commission. The principal sources for these databases are government derived (e.g., Michigan Resource Information System, U.S. Bureau of Census, U.S. Geological Service, U.S. Environmental Protection Agency, etc.). Agreements were made with the Michigan Department of Environmental Quality to obtain site-specific data on contaminant levels and locations. Data were also collected in the local area from Consumers Energy Company and the Jackson Public Works Department.

In general, site-specific data requirements include physical data (e.g., current and surrounding land cover, surface and subsurface geology and geohydrology, soils, etc.); land use characteristics (e.g., energy, water, and sewer characteristics; transportation and telecommunication; ownership and property values; zoning and master plans); and demographic and socioeconomic data by neighborhood and block group. Location of contaminants and remediation plans (i.e., results of Basic Environmental Assessment, Phase 1/2, or RI/FS) were used when available. These information requirements were incorporated in Table 1.

**Site Selection Criteria Development**

Site selection criteria were developed as a mechanism to get site- and region-specific information to the developer and community decision-maker. We used a series of facilitated workshops sponsored by the county BRA and attended by representatives of local units of government in Jackson County. Participants felt that a systematic approach would be helpful in identifying sites that fit the developer's requirements, and will also be instrumental in facilitating the process of permit application, financing, and site engineering. Participants agreed that site screening criteria needed to reflect several factors. First, they should consider factors that are generally used in the art and science of locating commercial real estate. Second, the criteria must incorporate local conditions such as infrastructure, site characteristics, and financial incentives. Third, the criteria must take into account local restrictions including zoning ordinances, master plans, and community acceptance.

The resultant criteria are presented in Table 2 in decreasing order of relative importance. Relative importance (assigned weights using an ordinal scale) is suggested by point values assigned to each category heading. Several iterations were required to establish point totals. The values in the figure reflect the relative importance to each criterion to the study area. The highest cumulative point value was 218. Participants determined that industrial sites should fall within an optimal value range of 120 to 220, commercial sites between 140 and 200, residential sites between 90 and 120, and agricultural/open space between 70 and 120. The rest of the ranges are shown on Table 2.

As might be expected, applications of this method in other locations would most likely result in a different point total. The table also indicates which criteria are evaluated at the local level and which are more appropriately evaluated at the county level. Once the criteria categories were established, various sub-criteria or screening factors were identified and ranked within headings. As each site is evaluated, it is then added to the Smart Places® scenario for each township.

**GIS Toolset Implementation**

A basic decision support toolset was assembled and configured for the county. This consisted of a laptop computer running Windows®, ArcView®, and Smart Places® software. The toolset includes site attributes for the inventoried brownfields study areas and selected brownfields site characterization and environmental, social, and economic development indicators (see Table 1). Regional and parcel data were incorporated into ArcView® as they were compiled for each township. Smart Places® scenarios were used to compile the data, integrate siting objectives and constraints, and assess impacts of various land-use options. All sample scenarios used in this paper are from Blackman Charter Township. Information about individual contaminated sites was compared between the MDEQ database and the compiled listing of brownfield sites in the Michigan Site Network (http://www.misitenet.com/). The County BRA provided results from the Phase 1 Environmental Site Assessments (American Society of Testing and Materials Standard E1527-97, as amended), along with information on siting requirements.

Although we investigated several GIS-based expert systems available on the market, the goal of this project was not to compare competing software. We simply selected Smart Places® because it is inexpensive and readily available, adaptable to many applications, and has an established track record as an extremely powerful decision support tool. Smart Places® allows nontechnical users to interactively review land use scenarios, sketch recommended changes, and evaluate these recommendations against local or regional objectives and constraints. Such applications can support land use decision-makers in comparing the impacts, benefits, and risks of alternative land use options or scenarios. As such, it is a tool worth considering in a spatial decision support system. Additional information regarding system requirements and capabilities can be found on-line at (www.epri.com).

Using the Smart Places® Model, editable land use themes (e.g., residential, commercial, industrial, parks and open space, transportation corridors, etc.), analysis categories, and specific measurement and comparison criteria were established. The land use alternatives reflect categories identified in the township master plan (Blackman Charter Township, 1995). Analysis categories and comparison criteria are based on several factors:

- Legal restrictions, zoning ordinances, environmental regulatory requirements;
- Physical restrictions (e.g., presence of wetlands, floodplains, unstable slopes, etc.);
- Models (e.g., ground water transport or air dispersion);
- Community desires, including master plans and community surveys (e.g., Jackson CommUnity Transformation, 1996);
- Brownfield site selection and weighting factors; and
- Professional judgment.

## APPLICATION AND RESULTS: Modeling the Site Selection Process in Smart Places®

To illustrate the process by which site information is compiled in a decision support system and alternative site development options may be evaluated, an example scenario is shown in Figures 1 through 3. Figure 1 is a representation of a proposed industrial development (Figure 1, arrow) using Smart Places® and the site selection criteria described in Table 2.

First, the basic data layers, indicators, and measurement assumptions (described above and listed in Table 1) are built in ArcView® and Smart Places®. The township master plan and the zoning ordinance identified preferred uses for the site regarding type, size, and distribution along with requisite setbacks, minimum square footage, and so on. The options of light and heavy industrial and general and office building commercial uses reflected community preferences for proposed land uses. The site is located on land that is currently zoned industrial (hatched tones); adjacent areas are zoned commercial (darker tones). From the MDEQ contaminated sites database, we learned that the site was previously used for the manufacturing of electronic equipment and components. The site is contaminated with PCE, TCE, benzene, and lead. In addition, there are several physical site limitations, including the presence of poor soils, adjacent municipal water supply wells, and wetlands that may affect use of the site without re-engineering and a wetland permit issued by the state.

This site was ranked relatively high (96 of a possible 118 points) by the township planning department and was nominated to the County BRA for redevelopment incentives (the BRA scored the site as favorable for development, 75 of a possible 100 points). The combined score was 171, which placed the site high on the list for potential industrial redevelopment. Based on the results of this evaluation, sites with a relatively high local score are most likely to be nominated for consideration for either industrial or commercial redevelopment. Local decision makers preferred not to recommend brownfields for residential use and hesitant to recommend them as open space. Sites that did not have industrial or commercial potential were unlikely to score high at the county level.

In the next phase of the siting process, restrictions to the proposed development, including physical limitations, engineering requirements, economics, and so forth. These were evaluated as shown in Figure 2, along with building size; number of employees; water and sewer; heating, ventilation, and air conditioning; road access and parking; and other design criteria. Based on an evaluation of similar proposals and an assessment of environmental effects, a preliminary analysis can then be provided to the developer and to municipal decision-makers. Figure 3 illustrates how several of the selected indicators (e.g., water and energy demand, local power plant emissions, vehicle miles traveled, etc.) can be incorporated in a decision process. This information can then be used to provide specific siting recommendations that would be evaluated against local or regional objectives and constraints as specified in a master plan or zoning ordinance.

Using this method, over 90 individual brownfields in Jackson County were identified, characterized (including a number of Phase 1 environmental site assessments), and ranked for redevelopment. Alternative site plans are tracked in the Smart Places® GIS. To date, approximately 10 percent of these sites have active projects in some phase of redevelopment ranging from remediation to reconstruction.

## DISCUSSION AND LESSONS LEARNED

A geospatial, or land use, decision support system consists of three components: (1) an access mechanism to data and information, (2) appropriate tools and technologies to organize and analyze the data, and (3) training and outreach support for interpretation and implementation of results of the analysis (Worrest, et al., 1994). Results of this investigation focus on the ability of the resultant decision support system to deliver each of these component parts to the end user. Based on the lessons learned, the following observations can be made:

- *User needs analysis is crucial in decisions regarding land use change.* The most time-consuming aspect of decision support system development is determining information requirements; establishing programmatic end points, including indicators, metrics, and analytical assumptions; and assembling a sufficient database. This requires extensive user needs analysis — both active and passive. Active user needs analysis in land use planning and management consists of direct interaction with stakeholder groups in different venues including interviews, public meetings, and surveys. Passive analysis consists primarily of literature review (review of similar programs or materials collected on test programs but not by project staff). A successful land use decision support system needs to include elements of both types of analysis, plus continual training and outreach.

- *Providing detailed, timely, and accurate information remains a major hurdle in brownfield decision making.* For the database to be helpful in an actual siting decision, site-specific data must be obtained, and at the level of detail necessary to differentiate one site from another (or to choose the most appropriate land use from a suite of alternatives) and to provide supporting documentation to meet any engineering, environmental, regulatory, and financial requirements. Such a database is likely to be huge, technically challenging, and costly.

Rather than try to assemble a comprehensive geospatial database, it may make more sense to determine user requirements early in the process and to design a phased system to meet these requirements. This includes both decision-supporting information for general land use applications, as well as specific information required to address some future end point. Although the more users involved, the larger the geographical areas considered, and the types of applications sought tend to argue for a larger, multi-functional information system, the objective of a phased approach is to design systems that can be flexible and upgradable as needed. The goal is to generate data to meet user needs on a project-by-project basis, but not get too far ahead of the tools to handle data and user abilities to assimilate results of analysis.

As demonstrated by the initial phases of this project, however, the time required to establish working relationships with communities considering redevelopment of brownfields is potentially lengthy and complicated. Extensive interactions (phone calls, meetings, presentations, and demonstrations) with city and county representatives over a three- to four-month period are often necessary to establish a working relationship.

Potential developers could experience similar administrative delays. The amount of time required to locate and compare sites, conduct site engineering (including any contaminant remediation), and construct a facility could mean the difference between a decision to purchase or to move elsewhere. This could be complicated in areas with multiple jurisdictions, differing regulatory and incentive programs, scattered data sources among municipal offices or agencies, and numerous stakeholder groups. An additional—and potentially serious—complication is the inability to determine site ownership. In many cases, clear title to the property is difficult to ascertain or the owner is unwilling to admit to having a contaminated site as part of the public record (Consumers Renaissance Development Corporation, 1998). On the other hand, interested and motivated community leaders can significantly shorten the time required to start a redevelopment project if there is a willingness to initiate site remediation and condemnation.

- *Adopting new technologies is challenging at the local level.* Despite the fact that Brownfields Redevelopment Authorities have been established throughout Michigan, the integration of GIS technologies in inventory and comparison of sites is considered somewhat new and innovative (Consumers Renaissance Development Corporation, 1998). The use of GIS in most communities has not progressed beyond basic mapmaking. Incorporation of tools like GIS in local planning will also be dependent on the familiarity factor: unless it has been shown to be effective someplace else, potential users will be reticent to adopt new technologies.

  As more and more communities begin to use GIS in planning and decision making, applications like Smart Places® will become more valuable in establishing urban land use policy and enhancing participatory government; to help address issues of urban sprawl, environmental quality, and environmental justice; and to shorten the time required to return brownfields to productivity. While the prototype decision support system will not make the decisions, it is capable of becoming an essential tool in the decision making process.

- *Using indicators and measurable criteria in siting decisions can help focus the site selection process.* Once community goals and potential end points are established, indicators are then applied which can measure the relative degree of success (Maclaren, 1993). Indicators can also play the role of surrogate since it is impossible to know all physical, environmental, social, and economic constraints and opportunities (including site suitability) which might be present in target areas. Selected indicators must be user-friendly: simple to understand, measurable, achievable, relevant, and timely. An example of this approach has been implemented in Waitakere City, New Zealand's sixth largest city (EarthNews, 1999).

  Indicators can set the boundaries on data collection and manipulation. Initially, we had to rely on secondary sources for this information. For example, we incorporated sustainable development indicators from several programs in progress in communities throughout the U.S. (www.rprogress.org). From there we used county soil surveys to establish a set of physical siting constraints due to soil type, slope, susceptibility to ponding and flooding, etc. We also used data and ratio scales from the U.S. Census Bureau 5% Public Use Microsample to establish socioeconomic conditions at the block group level.

  Once we began working with local groups (e.g., tax assessors, township supervisors, community liaisons, school officials, etc.), we could incorporate indicators that use local data and fine-tune community objectives. Facilitated nominal and focus groups helped determine potential end points. As information about the study area was obtained by working with our community partners, we were able to set siting goals and community desires (e.g., having the local communities develop their own site selection criteria), indicators of success in meeting goals, and how much data needed to be available to evaluate alternatives and measure success.

  We did uncover at least one area where work is needed in establishing local criteria for decision making. Despite the fact that Michigan legislation appears to have addressed the stigma of contaminated sites, local decision makers consistently placed a high ranking on variables such as soil contamination and the status of environmental cleanup in selecting sites for redevelopment. It appears that the learning curve for local government brownfield redevelopment authorities will remain steep until education programs become more widespread and local communities learn of successes achieved by other communities.

## FUTURE DEVELOPMENT AND APPLICATIONS

The project resulted in a prototype hands-on toolset that integrates geospatial information to analyze the environmental and socioeconomic effects of public policy on land planning, use, and management alternatives. This toolset uses commercially available computer applications that are proven, inexpensive, and readily accessible to multiple stakeholder groups—decision makers at all levels of government, business leaders, lending institutions, real estate developers, and the general public. As such, it has value in helping local communities integrate methods and tools to address problems of uncontrolled growth and urban sprawl.

The next steps in the project include continued development of the database for each study area and extensive work with stakeholder groups facilitated by MSU Cooperative Extension representatives in the communities. These community interactions will help build trust and understanding and lead to better land use decisions in which multiple stakeholder groups can participate equally. Project participants within each of the study areas will receive training in the implementation and use of the prototype.

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Table 1.

| Siting Characteristics | Site Decision-Making Questions: Developer/Community | Possible Measurements |
|---|---|---|
| **Land Resource Base** | | |
| Adequate land area | Is the site large enough? | cumulative area |
| Site engineering | Is site ready for development? | time; costs |
| Land use and land cover | What is existing land use/cover? Are there areas sensitive to development? Are there conflicts with surrounding land uses? Can compatible uses be consolidated? | location, areal extent; proximity/distance to incompatible uses |
| Terrain and drainage characteristics | Is there need for site engineering? What are permit requirements? Are there potential natural hazards? | proximity/distance to physical restrictions |
| Soils | Can soils support proposed use? | location and areal extent soil engineering capability |
| Appropriate zoning | Is site zoned for proposed use? Does use violate zoning ordinance? Is use consistent with master plan? | proximity/distance to incompatible uses |
| **Social/Cultural** | | |
| Trained/trainable work force | Is there an adequate local work force possessing needed skills? What is unemployment rate? What is potential for new jobs? | % work force w/in 30 minutes of site |
| Education levels | Does company have to provide job training? Does community have to provide job training? | education levels in vicinity and region |
| Population demographics and economic trends | Does proposed use provide opportunities for a variety of persons at different social and economic characteristics? | demographic and economic statistics in vicinity and region |
| Community education and involvement | Does community need to be educated about proposed use? | *qualitative - yes/no* |
| Social structure and diversity | Will proposed use add to community fabric? | *qualitative - yes/no* |
| Neighborhood cohesiveness | Will neighbors support or oppose development? Will proposed use add to community fabric? Will proposed use lead to decreases in safety and security? | demographic and economic status in vicinity and region |
| Housing | Is housing available for employees? Will additional housing need to be made available? Will residential areas, services need to be upgraded? | demographic and economic status in vicinity and region |
| Environmental justice | Is proposed use being sited in an area inhabited by persons politically, racially, demographically or economically disadvantaged? | demographic and economic status in vicinity and region |
| **Economics/ Finance** | | |
| Land values | What is cost to purchase land or facility? Do land costs attract or repel developers? | valuation per unit area cost per unit area |
| Availability of financial support | Do local lending institutions have adequate financial resources? Are they willing to provide loans for the proposed development? | survey of local financial incentives |
| Incentives | Are there financial/tax incentives to locate development? Are marketing strategies working? What are we willing to do to attract this development? Will development result in additional tax revenues? | contaminated site qualifying for tax recovery |
| Customers | Will customer base support proposed use? Will proposed use be accessible to customers? | demographic and economic status in vicinity and region |
| Willing seller | Can this site be obtained at a fair price? | *qualitative* |
| **Infrastructure: Energy and Resources** | | |
| Proximity to utility services | Are existing services (electric, potable and process water, waste treatment) adequate to meet projected needs? Will services need to be upgraded and at what cost? | kWh; GPM/MGD; age and condition of services; cost/unit |
| Proximity to transportation | Are preferred transportation resources (roads, rail, air, water) adequate to meet projected needs? Will facilities need to be upgraded and at what cost? | distance to nearest point of access |
| Proximity to telecommunications | Are telecommunications (telephone, satellite up-/down-link, Internet/WWW) adequate to meet projected needs? Will services need to be upgraded and at what cost? | Distance, level of technology |
| Proximity to process resources | Are preferred process resources available locally or in region? What is cost of obtaining them? | distance–transportation, recovery costs |
| **Environmental Quality** | | |
| Known levels of contaminants | Are there contaminants present at/near site? Who is responsible? | types; locations movement and dispersion |
| Remediation requirements | Are there remediation costs prior to development? Who pays for remediation? Is remediation compatible with proposed use? | level of cleanup required; time; costs |
| Willing neighbors | Will neighbors support or oppose development? Will development divide community? Will proposed use add to community fabric? | *qualitative - yes/no* |
| Sustainable communities initiatives | Is proposed use within master plan or community desires? | *qualitative - yes/no* |
| Locations for wastes | Are there disposal facilities within region with adequate capacity and lifespan? What are permit requirements? | proximity to disposal facilities transportation routes |

| | | |
|---|---|---|
| Air quality | Is site within, adjacent to incompatible air quality attainment zones? What are baseline conditions? Is there allowable effluent trading? | area in proximity |
| Water quality | Is any additional surface, ground water needed for proposed use? What are baseline conditions? Is there allowable effluent trading? | area in proximity |

Table 2. Brownfield site selection, weighting and ranking criteria and information requirements developed for Jackson County.

| LOCAL GOVERNMENT RANKING CRITERIA | Total Point Value | Rank Value | Information Source |
|---|---|---|---|
| **Site Conditions = 40 points** | | | |
| Environmental Contamination Suspected | 40 | 18.00 | Assumption based on county-supplied data |
| Environmental Problems Unknown | 40 | 10.00 | Assumption based on county-supplied data |
| Environmental Investigation Partially Complete | 40 | 6.00 | Results of Phase 1 ESA/BEA |
| Physical Development Constraints Exist | 40 | 4.00 | MDEQ 201/307/UST database |
| Environmental Investigation Complete | 40 | 2.00 | Phase I/II ESA/BEA results, Admin. Order Release |
| **Utility Infrastructure Capacity = 25 points** | | | |
| Heavy Duty water/sewer, gas, electric | 25 | 12.50 | Utility service specs. |
| Medium Duty | 25 | 7.50 | Utility service specs. |
| Light Duty | 25 | 3.75 | Utility service specs. |
| Incomplete | 25 | 1.25 | Utility service specs. |
| **Telecommunications Infrastructure = 25 points** | | | |
| High-tech fiber optics installed | 25 | 12.50 | Utility service specs. |
| Proposed 1-2 years | 25 | 7.50 | Assumption based on local/county-supplied data |
| Proposed 2-5 years | 25 | 3.75 | Assumption based on local/county-supplied data |
| Basic, upgrades in over 5 years | 25 | 1.25 | Assumption based on local/county-supplied data |
| **Transportation Infrastructure = 25 points** | | | |
| Interstate Access/Rail/Airport | 25 | 12.50 | Local data; type; distance |
| Class A/Primary or State Highway | 25 | 7.50 | Local data; type; distance |
| Secondary or County Road | 25 | 3.75 | type; distance |
| Local Street | 25 | 1.25 | Local data; type; distance |
| **Compatibility with Local Land Use Controls = 40 points** | | | |
| Compliant | 40 | 25.00 | Master plan; zoning ordinance; req'd. setbacks |
| Compliant with Reservations | 40 | 15.00 | Master plan; zoning ordinance |
| Not Compliant | 40 | 5.00 | Master plan; zoning ordinance |
| **Current Use Compatibility with Local Land Use Plans = 30 points** | | | |
| Compliant | 30 | 25.00 | Master plan; zoning ordinance |
| Not Compliant | 30 | 5.00 | Master plan; zoning ordinance |
| **Compatibility with Surrounding Land Uses = 25 points** | | | |
| Compatible, as Proposed | 25 | 12.50 | Master plan; zoning ordinance; req'd. setbacks |
| Compatible, with Reservations | 25 | 10.00 | Master plan; zoning ordinance; req'd. setbacks |
| Not Compatible, as Proposed | 25 | 2.50 | Master plan; zoning ordinance; req'd. setbacks |

Table 2. Brownfield site selection, weighting and ranking criteria and information requirements (continued).

| COUNTY BRA RANKING CRITERIA | Total Point Value | Rank Value | Information Source |
|---|---|---|---|
| **Environmental Risk and Compliance = 40 points** | | | |
| Minor contamination, no risk | 40 | 20.00 | MDEQ 201/307/UST database; BEA results |
| Contamination can be removed, minimum risk | 40 | 12.00 | BEA results |
| Contamination can be contained on site | 40 | 6.00 | BEA results |
| Potential future contamination | 40 | 2.00 | BEA results |
| **Land Re-Use Preferences = 30 points** | | | |
| Industrial | 30 | 15.00 | Master plan; zoning ordinance |
| Commercial/Office | 30 | 9.00 | Master plan; zoning ordinance |
| Open/Agricultural | 30 | 4.50 | Master plan; zoning ordinance |
| Residential | 30 | 1.50 | Master plan; zoning ordinance |
| **Financial Incentives = 50 points** | | | |
| Qualify for BRA TIF Financing | 50 | 22.50 | Assumption based on county-supplied data |
| Qualify for DEQ/EPA Brownfield Grant(s) | 50 | 12.50 | Assumption based on county-supplied data |
| Qualify for Community Development Block Grant | 50 | 7.50 | Assumption based on county-supplied data |
| Qualify for Other Local Financing | 50 | 5.00 | Assumption based on county-supplied data |
| Qualify for Industrial Facilities Tax Exemptions | 50 | 2.50 | Assumption based on county-supplied data |
| **Labor Resources = 45 points** | | | |
| Trained work force available, short response time | 45 | 22.50 | Census; block group labor force/sector |
| Trained work force available, long response time | 45 | 13.50 | Census; block group labor force/sector |
| Job training available | 45 | 6.75 | Assumption based on county-supplied data |
| High unemployment | 45 | 2.25 | MESA stats.; US Census |
| **Market Conditions = 40 points** | | | |
| Customer base located within 50 miles | 40 | 20.00 | Census; block group population |
| Proposed use will attract new markets | 40 | 12.00 | Assumption based on county-supplied data |
| Competitors located within 50 miles | 40 | 6.00 | Census; block group labor force/sector |
| Projections long term | 40 | 2.00 | Requesting firm |
| | | | |
| | | | |
| **Proposed Uses – Ranges of Acceptability** | | | |
| Industrial | High | 120-220 | |
| Industrial | Medium | 70-119 | |
| Industrial | Low | <70 | |
| Commercial/Office | High | 140-200 | |
| Commercial/Office | Medium | 90-139 | |
| Commercial/Office | Low | <90 | |
| Residential | High | 90-120 | |
| Residential | Medium | 60-89 | |
| Residential | Low | <60 | |
| Agriculture/Open Space | High | 70-120 | |
| Agriculture/Open Space | Medium | 50-69 | |
| Agriculture/Open Space | Low | <50 | |
| | | | |

**TABLES & FIGURES/captions**

Figure 1. Example scenario showing a brownfield (arrow) being considered for industrial redevelopment. The database indicates site location, previous use, known contaminants, and remediation status.

Figure 2. A restriction check of the proposed site indicates the presence of environmental contamination and wetlands protected under statute. Other physical, economic, and social constraints would also be checked as part of the decision process.

Figure 3. This figure illustrates how building size; number of employees; water and sewer; heating, ventilation, and air conditioning; road access and parking; and other design criteria can be incorporated in a decision process.

Table 1. A set of siting guidelines and metrics applied in a decision-support framework for Industrial, Commercial, or Service land uses. Additional guidelines can be developed for alternative land uses.

Table 2. Brownfield site selection, weighting and ranking criteria and information requirements developed for Jackson County.