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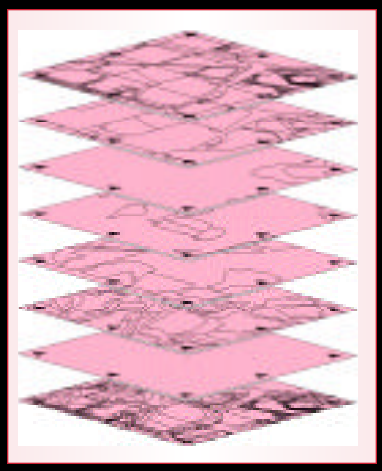


LAND INFORMATION Bulletin
Land Information & Computer Graphics Facility
University of Wisconsin-Madison

LAND-USE PLANNING TOOL KIT

GIS Functionality in a Real-World Setting: A Case Study of Dane County, Wisconsin

How are we growing? Who decides? These two questions are at the heart of land-use planning efforts—in Dane County and in communities nationwide. The recent county land-use initiative (*Design Dane!*— Falk *et al.* 1998) offers a blueprint for *how* our county should grow. But who makes the tough land use choices? We, in Dane County, want to maintain a high quality of life with continued economic prosperity. We also want assurance that growth won't erode our farmland and rural communities. Making wise decisions requires information—not just for a few politicians and select agencies, but also information that is accessible to interested citizens who feel they have a stake in the political process and its outcome.

This publication is part of LICGF's ongoing effort to put the power of information in the hands of *all* the decision-makers: the citizens of Dane County. To accomplish this, we are relying on a spatial information technology—geographic information systems (GIS)—that is a key technology for mapping and addressing land use issues. We are attempting to design a special " tool kit"—that is, to incorporate GIS as a logical, easy-to-use tool that can address an array of specific land-use planning queries. While we are using Dane County as a case study for developing our tool kit, this strategy could be applied to any community that faces land-use planning issues.

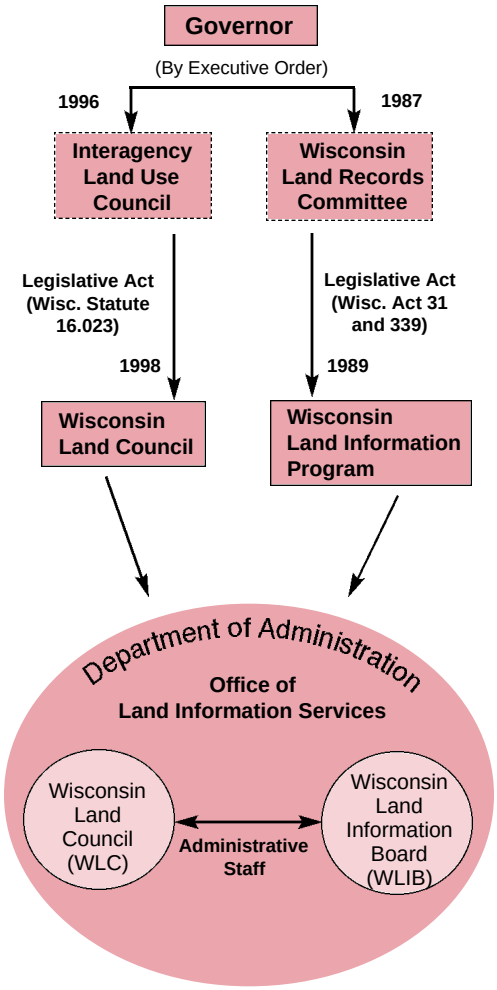
A POLITICAL HISTORY

Although the county's *Design Dane!* initiative adds a level of expediency to growth management locally, broad concern was brewing in Wisconsin in 1996 when the Governor created the state Interagency Land Use Council (ILUC). At that time, the Council concluded it was time to "provide a renewed commitment at all levels of government...to manage land and other resources in the best interest of future generations." It also "encouraged more active citizen involvement in the planning process and the creation of a statewide land information system (WLIS)."

Based on ILUC's newly crafted land-use vision (Bugher 1996), in 1998 the Legislature created the Wisconsin Land Council (WLC) and merged it administratively with the Board that oversees activities of the Wisconsin Land Information Program (WLIP) (see Figure 1). Among WLC's tasks: to create and implement a citizen-based "planning tool

Figure 1

Evolution of Land Information Entities



kit." This tool kit would use land information data created from WLIP foundational elements (five essential areas of land records modernization: soils, wetlands, parcels, geographic frameworks, zoning; Tulloch and Niemann 1996) and from state and federal agencies.

Among the 1996 ILUC report conclusions: "...all levels of government could benefit from new planning tools...(the) strategy should emphasize the use of University of Wisconsin System resources and interagency cooperation...(for) the development of integrated, user-friendly information and data resources for use by local citizens and officials. The goal is to equip counties and municipalities with the tools they need to develop their own land use planning..." (Bugher *et al.* 1996, p.11)

Technology as Political Tool?

Will more timely and reliable information result in better land-use decisions? This assumption, held by the WLC, has been hotly debated. It raises the question of whether land information and new technologies are used to help make decisions, or are they used to justify decisions made for other reasons? (See Niemann 1987 and Zwart 1988 for point/counterpoint debate on this issue)

Another assumption is that the use of land information technologies will result in benefits to society. Some benefits have, in fact, been documented. (see *Land Information Bulletins*, Nos. 1-2, 1998) Other questions have emerged that add fuel to the ongoing discussions: Who has access to the information? At what time does the decision-maker become aware of the information? How does an advocate present the alternatives? (see *GIS and Society*, Tulloch *et al*. 1998)

A third assumption, also widely debated, holds that new land-use information technologies are sufficiently mature and analytically robust to create a practical, user-friendly planning tool kit. The primary technology in question is GIS (geographic information systems)—a subset of a larger community of information technologies. GIS is a spatial technology that has become an invaluable tool for addressing land-use planning questions. Politics aside, and assuming that current land information is relevant, this bulletin outlines our attempt to explore this question: *Does the technology have the capacity to answer a set of basic planning questions?*

SETTING THE STAGE

The ILUC report proposed seven initiatives, and three are pertinent to the task at hand: to define and develop a comprehensive planning tool kit.

1) Develop and Distribute a Planning Tool Kit

"State agencies, the University of Wisconsin System and others should work together to develop flexible tools that utilize new technologies—the heart of this package will be land-use planning software linked to the Wisconsin Land Information System (WLIS) designed for use by all county and municipal governments and add-on modules that will address more specific needs..."

2) Integrate WLIS

"In partnership with the Wisconsin Land Information Board (WLIB) and other federal, state, regional, county and municipal agencies, the Council (now the WLC) will utilize

"The goal is to equip counties and municipalities with the tools they need to develop their own land use planning..."

WLIS to: 1) integrate data... 2) maximize the analytical strengths...of participating organizations... 3) encourage a sense of shared ownership and responsibility, 4) maximize potential efficiencies offered by a computer-based information system; 5) assure that the data used for planning purposes is timely, consistent, reliable and documented; 6) allow the needs of all users to be considered."

3) Make tools usable

"Because access to planning tools is a prerequisite for full participation in the land-use planning process, all tools will be easy to use by non-technicians. This will require the development of "user-friendly" software and widespread access through the Internet..." (Bugher et al., p. 12, 1996)

BUILDING THE TOOL KIT

Given the complexity of preparing a comprehensive land-use plan, how do we define, develop and implement a practical "planning tool kit" to assist citizen participation in the planning process? We began by addressing two tasks:

First, we relied on our experience and an analysis of current GIS literature to determine if current systems and technology are sufficiently robust to address the planning questions that a comprehensive tool kit must be able to answer. In review of the literature, (Maguire 1991; Vonderohe *et al.* 1993; Niemann 1998) we have identified 10 basic planning/analysis questions (see Table 1) a tool kit must be able to answer. These are:

1) How far is it?
2) How large is it?
3) What locations fit specific conditions?
4) Where is it?
5) What is near it?
6) What is adjacent to it?
7) What has changed since?
8) What spatial patterns exist?
9) Which is the best way?
10) What if...?

Second, we analyzed an actual comprehensive land-use plan in the context of these 10 essential analytical questions. *Design Dane*!—an action plan engineered by Dane County Executive Kathleen Falk in 1998 (Falk *et al*. 1998)—served as our model. The plan consists of detailed actions within the context of seven planning areas:

1) Promote healthy, working communities
2) Build strong cities and villages
3) Conserve our lands and waters
4) Plan and govern together
5) Link jobs, housing and transportation
6) Improve the way we do business
7) Recognize we all have something to do

Table 1

A GIS is a subset of a larger community of information technologies. It is a spatial technology that has been defined in various ways. One way is by listing the types of spatial questions a GIS can—or should—be able to answer. For a comprehensive planning application, there are eight distinct queries (framed here as 10 generic questions) that a robust GIS must be able to answer.

Query	Question	Example
Measurement	How far is it?	This spatial question seeks to reveal metric properties of geographic features, e.g., “What is the distance in miles along Highway 12 between Middleton and the Wisconsin Dells?”
	or, How large is it?	“How many acres of farm and rural land would a new four-lane highway alter between Middleton and the Wisconsin Dells?”
Location	Where is it?	What defines a particular location? It can be defined in many ways—place name, street adddress, a post or zip code, or a geographic reference such as latitude, longitude, range, township or section.
Condition	What location fits specific conditions?	This question is the converse of the previous question and requires a more complex spatial analysis. Instead of defining the location spatially, we seek a location where certain conditions are satisfied, e.g., “Find an unforested section of land at least 100 acres in size, within 100 feet of a road, and with soils suitable for supporting buildings.”
Proximity	What is near it?	What are the areas of interest near a selected feature, e.g., “How many school-age children live within one mile of a particular school?” or “How many barnyards are located within 100 feet of a trout stream?”
	What is adjacent to it?	What adjacent feature is next to a selected feature: “Who are the immediate neighbors that must be notified of a proposed zoning variance?”
Trends	What has changed since..?	As with other examples, this question might involve other queries related to change over time, e.g., “How has vegetation changed over time?” or “How much rural land has been converted to residential activity since 1970 in Dane County?”
Patterns	What spatial patterns exist?	This requires sophisticated anlayses for questions such as “Is there a possible relationship between cancer deaths and proximity to a nuclear power plant?” or “Which soil types in Dane County are most susceptible to soil eroison?”
Routing	Which is the best way?	This requires network-anlaysis procedures. Basic analytical functions include four groups: shortest path analysis; optimum tour routing; location/allocation; and transportation/trans-shipment questions (Vonderohe, 1993). Examples include: “Which set of highways offers the fastest route between Madison and the town of Perry?”or “Which highways are the most scenic between the same two points?”
Modeling	What if...?	“What if..?” questions address different planning scenarios. These questions require geographic and descriptive or mathematical models to predict outcomes, given various assumptions and knowledge: “What happens to a highway transportation system if new residences are developed and new roads are not added?” or “If farms are row-cropped, which farm fields would contribute soil to a nearby trout stream?”

The seven areas comprise separate chapters in the *Design Dane!* plan—each of which we examined in terms of:

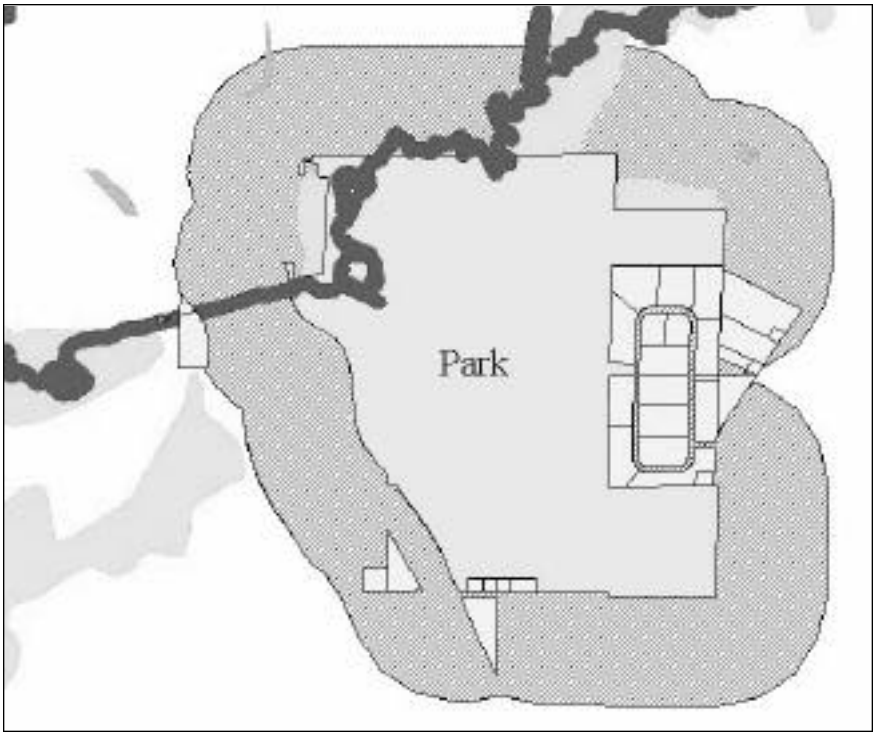
- What planning tasks were identified?
- What GIS task could help assist in resolving the task?
- What GIS query(s) would help address the planning task? (see Appendix A)

DEFINING TASKS

In total, we identified 38 planning tasks—some straightforward, others more complex. (see Appendix A)

Example of a straightforward task

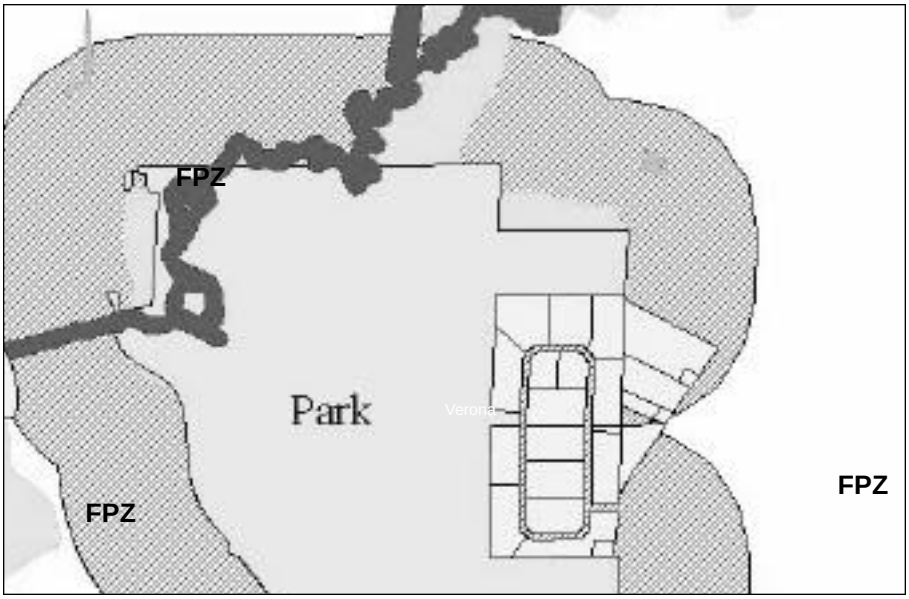
Where possible, establish non-developed "buffer strips" adjacent to all existing parks (Falk *et al*. 1998). The GIS task involved identifies the size and location of the buffering strip of land. The primary GIS query would be "Proximity" (to answer questions: *What is near it?* and, *What is adjacent to it?*).



Example of a complex task

Design Dane! calls for establishing "Farm Priority Zones" (Falk *et al.* 1998, p. 5). These are economically and environmentally sustainable agricultural areas targeted for protection. The aim is to retain viable farmland and preserve traditional ways of life, reduce land conflicts, and maintain rural green space amenities. Here, the GIS task is to identify farm priority zones where critical parcels of farmland can be protected. This involves a complex set of GIS queries that explore patterns and trends in the natural and cultural landscape. For example, soil quality and drainage might be important natural criteria. Proximity to a unique landform or wildlife-viewing area might constitute cultural criteria. The GIS uses your selected model criteria to identify high-priority, threatened, or large continuous areas for possible protection. (For more about determining Farm Priority Zones, see our Technical Bulletin No. 3, forthcoming, Summer 2000)

Identifying Farm Priority Zones
This map shows the cities of Madison and Verona (black) and surrounding areas. Urbanizing areas (pockets of development) appear as light gray. Farm priority zones are in dark gray. Using our model criteria, these zones would likely hold the highest priority for preservation.



ACCESS FOR ALL

Does GIS technology have the capacity to answer a set of basic planning questions? We believe the framework offered in this bulletin builds a strong case for answering "Yes!" The essentials of a "planning tool kit" are, simply stated, a logical inclusion of various analytical queries that can be used to address a set of land-use planning tasks. These analyses could apply to most well-conceived land use plans. The required technology (GIS) is defined by the queries it needs to address.

Because the long-term goal is to involve citizens in land-use decison-making, the planning community will initially have to go the extra mile to help citizens become comfortable with GIS technology and help them frame their questions so that the "tool kit" becomes theirs. Point-and-click, electronic public "interfaces" that hold the latest land information and that conjure up a variety of land-use scenarios at the touch of a button may someday be commonplace.

The explosion of information access via the Internet in conjunction with other readily available technologies, such as hand-held global positioning systems (GPS), are signs that we are dealing with information technologies that may be as systemic as the invention of electricity (Clark 1999). Why would spatial technologies *not* be demanded by those who want access and who want a voice in how land-use decisions are made? ■

Appendix A

Assigning GIS tasks and queries to *Design Dane!*—Dane County's planning framework for land use and population growth.

Planning Task (cited by page in *Design Dane! (DD)*)	GIS Task	GIS Query: (Me) Measurement	(L) Location	(Pr) Proximity	(C) Condition	(T) Trends	(Pa) Patterns	(R) Routing	(MO) Modeling
Design Dane!* *Executive Summary									
• Distinct identity (DD p. ii)	Identify Dane's distinct identities		L		C		Pa		
Chapter 1: Promoting Healthy Working Rural Communities									
• Create farm priority zones (FPZ) (DD p. 5)	Identify "Farm Priority Zones" (FPZ) where critical masses of farmland can be protected.	Me	L	Pr	C	T	Pa		Mo
• Establish buffer strips from other development. (DD p. 5)	Identify the size and location of non-development buffers.		L	Pr			Pa		
• Establish farm priority zones (FPZ)....through official designation in the zoning ordinance.... (DD p. 5)	Provide an official zoning map of FPZ.		L						
• By delineating suitable areas...(where) a threshold number of farmers (would) voluntarily (agree). (DD p. 5)	Identify areas where a threshold of farmers are willing to volunteer.	Me	L	Pr					
• Consolidate town land-use plan maps into a single document (map). (DD p. 6)	Create a seamless county-wide town plan land-use map.						Pa		
• Establish an annual reporting mechanism to monitor (farmland preservation) progress. (DD p. 6)	Create a county-wide farmland preservation map.	Me				T	Pa		
• Provide soil maps, GIS data and related information to towns....to prevent conversion of prime agricultural lands..... and loss of valuable natural resources. (DD p. 8)	Create a comprehensive GIS data set for each town (township).	Me	L	Pr	C	T	Pa	R	Mo
• Establish a uniform system to record the use of the 1/35 split...so that future landowners are informed. (DD p. 8)	Create a parcel-based recording system, and maps, of 1/35 acre splits.	Me			C	T			
• Designate suitable receiving areas...for purchase of development right (PDR) or transfer of development rights (TDR)...as part of the town plan. (DD p. 8)	Create a township-based county-wide parcel map of potential sending and receiving areas.	Me		Pr	C	T			

Planning Task	GIS Task	GIS Query

Chapter 2: *Building Strong Cities and Villages*

Planning Task	GIS Task	(Me) Measurement	(L) Location	(Pr) Proximity	(C) Condition	(T) Trends	(Pa) Patterns	(R) Routing	(Mo) Modeling
• Our villages and cities are diverse and distinct communities. (DD p. 13)	Identify criteria that distinguish communities such as demographic and landscape characteristics.			Pr	C				
• Maintain our separate communities...(so as to maintain) their visual and cultural identities. (DD p. 13)	Develop analyses or procedures which identify visual and cultural values.			Pr			Pa		Mo
• Open space between villages and cities also provides environmental and recreational benefits. (DD p. 13)	Develop analyses that portrays the distribution of various environmental and recreational benefits.		L				Pa		
• Citizens favor policies that focus new job growth and housing in areas where public services, such as roads and schools, already exist. (DD p. 14)	Identify where existing and future services, such as road networks and schools, are located.		L						
• The county can provide technical support and planning assistance (to) municipalities...to help coordinate goals and (growth) strategies that are most effective on a regional basis. (DD p. 14)	Adopt our Growth Allocation Procedure (GAP) to illustrate projected growth by each unit of government.	Me		Pr		T			
• Offer planning grants and other technical assistance to cities and villages to facilitate sensible growth. (DD p. 16)	Develop analyses that predict costs and benefits of...development.	Me			C		Pa		Mo

Chapter 3: *Conserving Our Lands and Waters*

Planning Task	GIS Task	(Me) Measurement	(L) Location	(Pr) Proximity	(C) Condition	(T) Trends	(Pa) Patterns	(R) Routing	(Mo) Modeling
• Dane County residents want to preserve our wonderful land and water resources...and have long recognized the beauty of our steep hillsides, value of our timber, and the susceptibility of those slopes to erosion. (DD p. 21)	Create a comprehensive map showing all of the public lands, trails, etc. (i.e., federal, state, county, municipalities, non-governmental)		L		C				
	Create an overlay of the above, along with the environmental corridor map.						Pa		
• Expand acquisition of parks, recreation, open space, and farmlands. (DD p. 22/23)	Using the county's open space, environmental corridors, and Capitol viewshed maps and other data, create a potential green space analysIs for use by town and municipalities.	Me	L		C		Pa		Mo
• Create buffers around county parks and other publicly owned lands. (DD p. 23)	Create a proximity and adjacency analysis to determine which land owners are adjacent to public lands and are benefiting from access, and which land owners have visual access and are benefiting.			Pr					

Planning Task	GIS Task	GIS Query	(Me) Measurement	(L) Location	(Pr) Proximity	(C) Condition	(T) Trends	(Pa) Patterns	(R) Routing	(Mo) Modeling
• Prepare a county-wide atlas of important natural resources and features...inventory of data (into a) convenient, attractive atlas...to readily identify our important natural resources...such as floodplains, shorelines, wetlands, water basins, environmental corridors, steep slopes, hill tops, groundwater recharge areas, prime agricultural soils, and woodlands. (DD p. 24)	Using a Website, the Internet, and GIS analysis, develop an atlas in a public-access interface and provide hard-copy output. Center in the City/County building.		Me	L	Pr	C	T	Pa	R	Mo
• Set performance standards for slopes of 12% or more and restrict development on slopes in excess of 20%. (DD p. 24/25)	Create an analysis which locates all non-developed slopes of 12% or more and all in excess of 20%.		Me	L		C		Pa		Mo
• Assist the Dane County Drainage Board in mapping drainage districts....to help address stormwater runoff and flooding. (DD p. 26)	Using DEMs and other data, establish stormwater drainage areas.							Pa	R	Mo
• Provide technical assistance to local governments in assessing groundwater impact from development. (DD p. 26)	Access the natural history survey well-head protection model, and overlay with pending development proposals.		Me		Pr		T	Pa	R	Mo
Chapter 4: *Linking Jobs, Housing, Transportation*										
• (Study) the feasibility of commuter rail and adopt a multi-year, multi-modal transportation plan. (DD p. 33)	Using demographic, social economic data, and population growth estimates, evaluate the feasibility of commuter rail.		Me	L	Pr		T	Pa	R	Mo
• Create a “rural scenic byways” designation....in partnership with towns...identify 2-lane, low-volume, scenic, rural highways. Limit access and expansion along these roads and set development standards along the corridor. (DD p. 34)	Create a byways transportation map.			L					R	
Chapter 5: *Planning and Governing Together*										
• Genuinely effective planning must enable local officials and citizens to estimate and measure the cumulative impacts of large and small developments and the effect of one community’s development on its neighbors and region...and assist (in understanding the) “big picture” approach to planning. (DD p. 39)	Develop a model that predicts the transportation and environmental impacts from development.		Me	L	Pr	C	T	Pa	R	Mo

Planning Task	GIS Task	GIS Query	(Me) Measurement	(L) Location	(Pr) Proximity	(C) Condition	(T) Trends	(Pa) Patterns	(R) Routing	(Mo) Modeling
• We operate in a system where each local government has overlapping and sometimes conflicting authority over development decisions. (DD p. 39)	Create a map that locates development authority and the resultant overlaps.			L				Pa		
• Figure out how much different development decisions are going to cost tax-payers before we make them. (DD p. 40)	Develop a predictive model which estimates infrastructure and environmental cost.									Mo
• Work with local communities to adopt a Community Impact Planning Approach (CIPA).... (include components:) projected growth phasing scenarios; assessment of cumulative impacts and the community's ability to serve the proposed development; evaluate the local plan's consistency with the county's adopted plans and adjacent communities'adopted plans, methods, and strategies for natural resource protection, including farmland preservation; procedures for extensive public participation in the planning process. (DD p. 40/41)	Develop an array of analysis methods by which to conduct community-impact planning.		Me	L	Pr	C	T	Pa	R	Mo
• When annexation disputes arise, the problems are further compounded when school district boundaries do not follow municipal boundaries. (DD p. 43)	Conduct an analysis that illustrates the inconsistency between municipal and school district boundaries.			L				Pa		
• One of the most persistently contentious issues...is the siting of quarries...(the county should) consolidate the information and maps to show commercially important deposits of gravel and other minerals...and convene a working group to recommend.... areas in the county where quarrying can be conducted safely, etc. (DD p. 44/45)	Create a map of existing and possible mineral deposits.		Me			C		Pa		
• Explore the potential for expanding the Regional Planning Commission (RPC) to include Dane County and several surrounding counties. (DD p. 46)	Develop an analysis that illustrates growth management factors which cut across county boundaries (e.g. - agriculture, transportation, schools, development).			L	Pr	C		Pa		

Planning Task	GIS Task	GIS Query

Chapter 6: *Improving the Way We Do Business*

Planning Task	GIS Task	GIS Query (Me) Measurement (L) Location (Pr) Proximity (C) Condition (T) Trends (Pa) Patterns (R) Routing (Mo) Modeling
• We should develop new information technologies available up front so that everyone can make more informed growth decisions based upon the long-term costs and benefits to the community. (DD p. 51)	Implement a citizen-based land use planning process using new information technologies.	Me L Pr C T Pa R Mo
• Expand the use of the county's computer technology and existing land information by: publishing and widely disseminating a composite listing and description of Dane County land use information... much useful land use information already exists such as data and/ or maps showing parcel size and ownership, land improvement values, zoning, roads, streams, soil types, agricultural yields, contours, wetlands, woodlands, etc....however, many people are not fully aware of what is available. Increasing access to the county's computerized land use information...can be made more readily available...by greater use of computer technology. (DD p. 52/53)	Implement Internet Website and GIS access to all data sets via public electronic interfaces.	Me L Pr C T Pa R Mo
• Join with the University of Wisconsin-Madison to offer local communities the opportunity to pilot a citizen-based, technology-linked land-use decision-making approach (the "Shaping Dane's Future Demonstration Project") (to) evaluate the impacts of proposed development; visualize alternative developments and combine with county ordinances. (DD p. 53)	Demonstrate how GIS and laptop computing, image technology, and multi-media (visualization) can be used in the land-use decision-making process.	Me L Pr C and Visualization T Pa R Mo

Chapter 7: *We All Have Something To Do*

• Make land use-related information more readily available to the public. (DD p. 58)	See above	
• Provide land use planning, education and technical assistance at the grass roots level. (DD p. 58)	See above	

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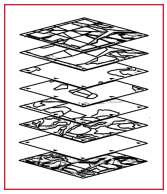

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