Final Report
of the
Wisconsin Land Information System
Project Team

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Executive Summary

The following report provides a blue print for the development of the Wisconsin Land Information System (WLIS). The goal of the report is to provide the next steps in the implementation of WLIS that would leverage and capitalize on the State's investment in land information and maintain our leadership role in this technology. WLIS and the Project Team that prepared this report is a product of Wisconsin Statute16.023 (1) (f). The project team, made up of a cross section of individuals knowledgeable in information systems, volunteered hundreds of hours of collaboration to bring this design forward.

The report is made up of several sections that parallel the team's charge from the report of the Technical Working Group. These sections include requirements, project scope, preliminary conceptual design, system cost, project phase, and action items.

The team recognized that the success of WLIS would hinge upon addressing the needs of the broadest number of stakeholders. The team's first efforts identified who the stakeholders are and what their land information needs are. A list of stakeholders was compiled and interviews were conducted with a representative cross section of interested parties. This information gathering process identified several common themes that lead the project team in the design process. These themes included accessibility, distribution, indexing and retrieval, integration, dynamics, standards, and support of the decision-making process.

The underlying architecture of the proposed WLIS is a web-based distributive system where multiple nodes would support data access and use. The node concept provides for customization of data and the security of replicated data at several sites. While WLIS is primarily a distributive system, implementation and management are centralized for efficiency. The centralized function of WLIS (core node) would house parent databases, stage data replication to distributive nodes, and provide overall systems management.

Other design considerations include incremental development capitalizing on existing investments and standards; service of a wide audience; support of functions enhancing data creation, management, and dissemination; development and maintenance by multiple participants; common interface; and support land information applications. WLIS is designed to provide access to land information held by public as well as private organizations. The design and architecture will be as open as possible to facilitate applications development and economic incentives to participate.

Initial operations of WLIS should accommodate three levels of participation. The first level of participation would be simply providing documentation of existing databases and information (metadata). Metadata can provide a searchable database of who has what information as long as there is a common standard for the metadata. A first step in the development of WLIS is to develop a simple information indexing procedure and metadata entry software,

The second level of participation is providing actual digital data. At this level, the process becomes a bit more complicated because data formats vary from provider to provider. Level 2 participants would have several options available to provide data to the system. The options would allow for multiple levels of technical sophistication and numerous data formats. The system should be built to allow for these scenarios and yet be functional for all participants.

The third level is becoming a WLIS distributive node. At this level, the participant would need to be able to provide hardware, software, facilities, expertise, staff to maintain a node on the system, as well as all of the functions of levels one and two.

It is anticipated that WLIS would be developed in phases and different levels of functionality would be developed over several years. Organizations that routinely use land information systems and have the expertise and equipment would be able to participate in the system sooner than those who do not. It is the intent of WLIS to be open to anyone, however, a system of priorities needs to be established.

There is a vast supply of data available for WLIS. The Wisconsin Land Information Program has invested million of dollars in the development of data on foundational elements. State and federal agencies maintain numerous holdings of data. Private sector organizations also maintain large data resources and will be encouraged to participate through commercial economic development. All WLIS data would conform to a structure and content standard to facilitate integration, exchange, and use. Metadata would be used for indexing and cross-walks table would be developed for data integration. WLIS must be available and easy to use and designed to accommodate all levels of sophistication. The system design will be flexible and extensible to serve a broad spectrum of stakeholders. It must be designed to be dynamic with the ability to grow, evolve, and expand.

The organization of WLIS would require oversight, operational management, and policy direction. The institutional structure of WLIS needs to balance statewide guidance with broad input into applications and operations. Primary authority for the system could be a function of the WLIB and/or WLC. Oversight of the system should be a function of the stakeholders or user. This could be accomplished through existing stakeholder organizations or creation of a new oversight body or users group.

Day-to-day function of the system would require a management team and/or systems manager. The day to day management would deal with efficient use of system resources, ongoing development, technical decisions, technology transfer, interfacing with advisory groups, and reporting to the WLIB and WLC.

The core node of WLIS could be operated within an existing organization with the primary requirement that the organization have the resources and expertise to facilitate the system. The siting of WLIS must be done so as to create a workable financial or staffing situation. Sufficient funding for WLIS must be provided for it to succeed.

It is anticipated that the WLIS project would require from 4 to 10 years to complete. The report outlines a time line for the first two years of WLIS that would take the system from conception to implementing the first data and web-distributed nodes. Development would continue beyond the first two years including applications development such as those that would support comprehensive planning and smart growth. The report also attempts to estimate the financial commitment for WLIS. Although the financial commitment is significant, it represent a fraction of what has been spent on land information in Wisconsin to date. More importantly, financing WLIS would leverage and capitalize on the existing land information investments.

Specific action items intended to move the system from concept to reality include cultivating a support base for WLIS, establishment of standards for data and metadata, policy and governance

structure, and appointment of a systems manager. This report and these action items are the next step in this important project.

The Team identified an extensive array of benefits, to both public and private sector stakeholders, that would emanate from a WLIS.

The direct benefits would include: economic impact, public access to government data, education assistance, and direct government benefit. Economic impact, by assisting with siting of new and expanded business location, facilitating the marketing of Wisconsin, and enhancing Tourism;

Public access to government data, making available to all user groups, the wealth of data possessed at all levels government, the data is now accessible 24 hours per day, 7 days per week;

Education benefits, allowing schools that are now connected to the web, to access directly data for research and school classes, from elementary through college level;

Direct government benefits, by sharing application development costs, duplication is reduced, having common data standards, reduces duplicative development, data is now readily accesible, reducing costs for data discovery related to comprehensive planning and other activities.

Additionally, indirect benefits were also identified, where WLIS will provide the necessary foundation and framework for a wide variety of additional applications to be developed, potentially impacting all users of land information in the state. The project team hopes that the readers will share in our enthusiasm for this project and support the effort to its culmination.

II. Introduction

The WLIS Project Team believes that this report addresses the vision and spirit embodied in the Technical Working Group's Final Report and makes significant progress in the design and realization of the Wisconsin Land Information System (WLIS). This report is intended as a guide for the long-term development of a WLIS, recognizing that with the rapid pace of technological change, many specific recommendations may be modified or eliminated by the time they are ready to be addressed.

Wisconsin Statute 16.023 (1) (f), established "a technical working group that is composed of the State Cartographer, a representative of the University of Wisconsin system who has the expertise in land use issues and any other land use experts designated by the Council's chairperson, to study the development of a computer-based Wisconsin land information system and recommend to the governor legislation to implement such a computer system."

In the fall of 1998 the Wisconsin Land Council appointed the Technical Working Group and its first meeting was held on November 20, 1998. The Technical Working Group was comprised of 26 people knowledgeable in land information systems and technology. The group included representation from federal, state and local government; regional public and private planning organizations; private non-profit and for-profit organizations. Seven all-day meetings culminated with a May 26, 1999 final report. The final report went through a review process by both the Land Council and the Land Information Board and each body adopted a revised report on October 14, 1999 and November 17, 1999 respectively.

The final report of the Technical Working Group contained a vision for the WLIS: "The WLIS will be a computer-based system of land information distributed throughout all levels of government in Wisconsin. It supports land information applications such as comprehensive planning. A common interface will provide access to land information for interested citizens, professionals, and elected officials. The WLIS will be built incrementally, leveraging existing investments and standards for data and technology made by the Wisconsin Land Information Program* and many other public and private initiatives." The Technical Working Group's Final Report also recommended that a WLIS Project Team be created to continue the design and implementation planning of WLIS. The recommendations called for the appointment of the WLIS Project Team by the Land Council and Land Information Board to prepare a more detailed project proposal with costs and time estimates. The Land Council and Land Information Board implemented the recommendation by each appointing five members to the Team.

The chairs of the Land Council and Land Information Board appointed the 10-member WLIS Project Team (Appendix A) during the fall of 2000, and the first meeting was held on January 20, 2000. The WLIS Project Team scheduled 11 meetings to complete its work and report to the Land Council and Land Information Board by July 1, 2000. The Team was given specific tasks via resolutions by the Land Council (Appendix B) and Land Information Board (Appendix C), emanating from the recommendations in the Technical Working Group's Final Report.

The WLIS Project Team also recognized early that:

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* See Wisconsin Statute 16.967

1. It needed someone with experience in designing information systems using internet-based technologies. (Responding to this need, the Department of Administration loaned an experienced Information Technology Project Manager for ¾ time.)
2. It was constrained by the short time allotted to complete the report.
3. No funding was available to test or prototype the systems.

Owing to the lack of available funding and the limited time frame, the assigned tasks were modified by the Team (Appendix D) and submitted to the Land Council and Land Information Board. As modified, the charge of the Team was to:

1. Outline the requirements of shareholders that will participate in the system.
2. Develop and recommend a project scope.
3. Prepare a preliminary conceptual design for the system, including work plan and timeline.
4. Prepare cost estimates.
5. Prepare functional requirements, cost estimates and timeline for the 1st biennial phase of the project.
6. Draft decision item(s) language for WLIS*.

The modifications meant that the Team was not able to:

1. Perform a formalized needs assessment.
2. Design alternatives fully.
3. Develop and test prototypes.

Although unable to perform a formalized needs assessment, the Team did survey representative stakeholders, collecting needs through interviews and other means. The alternatives that were explored during team meetings have been incorporated in the discussions within this report and the best alternative is proposed. Although prototyping was not performed, it is recommended for future implementation phases.

Key Points - Introduction

1. We believe that this report represents the vision and spirit of the efforts of the Technical Working Group.
2. We recommend that this report be used as a guide for the long-term development of the system.
3. We concluded that because of time and money constraints we would not be able to do the needs-assessment, the alternatives, nor the prototyping.
4. We concluded that although there was inadequate resources for a formal needs-assessment, we would survey representative stakeholders for additional perspective.
5. We concluded that alternatives would be constructed within subject context within this report as best as possible.

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* It was later determined by the Team that this last item was not specifically requested by the Land Council and Land Information Board and, therefore, will not be found in this report.

6. We recognize the importance of prototyping and recommend that it be done in future implementation phases.

III. Requirements

Using the Technical Working Group's Final Report (Appendix E) as a springboard for the development of the system's requirements, the Team made a concerted effort to ensure that as many stakeholders as possible had an opportunity for express their needs of a WLIS. From the outset, the Team recognized the significance of addressing the needs the broadest possible selection of stakeholders in the development of the WLIS system requirements. The Team felt strongly that this input would:

1. Ensure the vitality of the system.
2. Generate broad-based support.
3. Encourage additional independent application development and enhancements to a system based on an open architecture.

The Team approached the collecting, creating and validating of system requirements primarily through four principal methods:

1. Summarize the requirements outlined in the Technical Working Group's Final Report.
2. Provide and promote a means of widespread input using a web-based requirements survey form.
3. Create an expansive list of as many potential stakeholders as possible and actively seek the input of as broad a cross-section of them as time allowed.
4. Seek input from members of the Land Council and Land Information Board.

The Team felt that these four methods served in place of a formal needs assessment for this report.

Technical Working Group's Final Report – Requirements Summarization

As the Team began addressing the entire corpus of specific requirements for a WLIS, individual requirements were suggested in the outline of the four architectures from the Technical Working Group's Final Report and were excerpted and incorporated into the list. Eventually, several of these requirements were combined, owing to the fact that the report was created in sections and some requirements were repeated in the different sections.

Web-based Requirements Survey

The web-based requirements survey form was activated and published in early March and is still available on the Team's web site.* Although use of this mechanism was widely-promoted (e.g., a link to this page was posted early on the web site for the Wisconsin Chapter of the American Planning Association and the President of the Wisconsin Land Information Association promoted its use in his column in the May issue of the *Land Records Quarterly*), this method proved to have limited results.

List Of All Stakeholders and Stakeholder Input

Beginning with existing lists of information users and providers, the stakeholders were organized into general groups including the general public, advocacy groups, educational groups and groups

* http://www.doa.state.wi.us/olis/wlis/index.asp

encompassing the various levels of government. The Team filled in the names of known stakeholders and identified their potential roles and relationships to the WLIS. The preliminary stakeholder list was posted to the Team's Internet site to elicit additional feedback from a wider user community. The final list of stakeholders developed by the Team is shown in Appendix F.

After developing this working list of stakeholders, the Team directed the Project Manager to contact and interview specific individuals, comprising a representative cross-section, to collect first-hand information regarding the perceived requirements, needs, constraints and products that a WLIS might provide. These individuals were interviewed by phone, e-mail or, in most cases, by on-site visits. The notes and analysis from this effort are found in Appendices G, H and I.

Input from Land Council and Land Information Board Members

In addition to reporting to and receiving feedback from Land Council and Land Information Board members at each of their general and executive committee meetings, the Team's co-chair actively sought contributions and advice on an informal basis.

Appendix J provides an inventory of the requirements from these efforts.

Requirements Analysis

Using a compilation of individual team member rankings, the resulting requirements list was prioritized. Several common themes emerged, which ultimately define the core functional requirements of the WLIS.

The Team determined that the WLIS will be:

1. A statewide system easily accessible to the public.
2. A web-based, distributed system.
3. A catalogue of external links to spatial and non-spatial Wisconsin land-related data and information through an indexing or retrieval system – i.e., a web gateway linking the user to non-WLIS web sites containing land information specific to Wisconsin.
4. A source for accessing and transferring spatial and non-spatial land information, data and metadata.
5. A platform supporting integrated and aggregated views of state and locally produced data, capitalizing on data already created by state agencies and local governments and other sources such as federal sources.
6. A dynamic system providing an application framework for web-mapping and non-spatial data integration and processing,
7. A means for promoting standards, and standardized data content and structure
8. A means for providing cross-walk functions between non-standard data and a standard WLIS data model.
9. A means of supporting land management decision-making activities, including comprehensive land use planning.

Key Points-Requirements

1. We recognize the importance of understanding stakeholder needs.

2. We used four methods to collect, create, and validate system requirements.
3. We conclude that the system should be a statewide system easily accessible by the public.
4. We conclude that the system should be web-based and distributed.
5. We conclude that the system should be—among other things—a catalogue of spatial and non-spatial links using an indexing retrieval system.
6. We conclude that the system should be a source for accessing and transferring spatial and non-spatial land information, data, and metadata.
7. We conclude that the system should be a platform supporting integrated and aggregated views of state and locally produced data, capitalizing on data already created by state agencies and local governments.
8. We conclude that the system should be dynamic, providing an application framework for web-mapping and non-spatial data integration and processing.
9. We conclude that the system should be a means for promoting standards, and standardized data content and structure.
10. We conclude that the system should be a means for providing cross-walk functions between non-standard data.
11. We conclude that the system should be a means of supporting land management decisions, including comprehensive land use planning.

IV. Project Scope

This section intentionally details a WLIS project scope using the structure common to major Information Systems projects to allow the eventual development of a request for proposal, or similar document, easier. The following sections:

1. Provide a narrative description of the entire project.
2. Enumerate deliverables, which, taken together, describe the project as a whole.
3. Identify specific "measurable" objectives, or critical success factors, to later be able to judge the success of the first phases of the project.
4. List benefits, assumptions and constraints acknowledged by the Team.
5. Discuss specific potential risks that the Team identified, as well as their impact and suggested mitigation strategies that may be employed.
6. Justify the pursuit of the development of a WLIS.

1. Project Narrative

One of the underlying architectural design premises for a WLIS is the distributed approach to data management and distribution. Multiple cooperative nodes will support data retrieval and simple information product development through a common web interface. Although all nodes would contain a standard selection of replicated data sets, these nodes are not simply clones of a central core repository; rather each one maintains additional data appropriate for a local context, as well as the capability to query and retrieve data from other nodes.* Replicating frequently requested data on multiple nodes is offered as an alternative to storing data at only one node in the system. A system supporting replication is less vulnerable to service failure and can be more efficient in serving clients than a single central repository alternative.

Notes are included in the Technical Working Group's Final Report regarding the use of "off-the-shelf software solutions", "industry standards", and tools for converting "commonly-used data formats, datums...". Although these statements allow for the development of a heterogeneous set of WLIS nodes, they do not require it. The Team chose the alternative which allows the support of multiple environments at WLIS nodes. An alternative not proposed is that all nodes be required to have specific hardware in order to participate. That alternative was rejected due to its disregard for existing investments at potential nodes and due to the belief that a standards-based, Internet-resident WLIS could succeed even with a heterogeneous computing environment.

Although fundamentally distributed, some of the implementation and management must be centralized for efficiency and effectiveness. For example, the development of a template for web presence of WLIS nodes, the programming of some core functions, and the subsequent deployment should be provided by a core of technical expertise. Users also expect a single source for commonly-used statewide information, built on the framework of the current WiscLINC clearinghouse.* The need to rely on some measure of core expertise and data management is meant to encourage and leverage the active involvement of a broad community of

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* The term local in the context of WLIS nodes could be any participating organization or unit of government, including state and regional agencies, as described later.

* http://badger.state.wi.us/agencies/wlib/sco/pages/wisclinc.html

land information professionals in the design and implementation of WLIS. Indeed, it is expected that many organizations and individuals will be involved in the development of WLIS components.

Moreover, a physical implementation of a core (for the want of a better term) node will need to exist, although the only characteristics that will distinguish it from any distributed node are that 1) it will house the 'parent' searchable metadata database and 2) it will be the initial staging point for data replication to the distributed nodes. Redistribution of key data and metadata from the WLIS core node to distributed WLIS data and web nodes would provide data to the WLIS core and distributed web applications and independently-developed custom applications. Replication can be implemented as batch or automatic (unattended) processes. The primary rationale for recommending a replication approach is that it would provide for redundant sources of data to optimize performance and availability.

The Team rejected the alternative embodied in the single server/service center approach. In that scenario, all data would be submitted to a central organization for WLIS distribution and publication and tools would be developed to allow data developers/custodians to upload data to the WLIS core. This approach was rejected as being too centralized for the WLIS community of interest and wasteful of the existing capabilities of systems and staff throughout the state.

The design and implementation of WLIS should proceed in phases. Although some organizations will be able to capitalize on the WLIS approach quickly, others will require longer time periods to accommodate the WLIS approach and make the needed investments. In the interim, there will be efforts to facilitate transition and limited use through outreach efforts, extension of technical assistance and the development of core standards for data themes. While it will not be designed for citizen use initially, the system will be publicly accessible and usable. Development of capabilities for the general public in the first phase of the WLIS was felt to be subordinate to the need to focus on the core components, and the use and development by experts and professional users in various organizations.

In summary, the WLIS will be an internet-based network of shared data and information that:

1. Builds incrementally on existing investments and standards in land information.
2. Serves a wide audience, including public agencies, private organizations and individual citizens.
3. Provides web-based access to information and support for functions oriented to "enhancing land-related data creation, management and dissemination".
4. Is developed and maintained by "multiple participants in the land information community" in a phased process.
5. Has a common user interface to local, multi-jurisdictional, and state agency data.
6. Will eventually support land information applications, such as zoning and the new Smart Growth Comprehensive Planning Legislation.

Jurisdictional Scope

WLIS is intended to provide access to land-related data held by all public agencies, as well as participating private organizations, in Wisconsin. Because certain state agencies and counties

are specifically mentioned in the Wisconsin Land Information Program*, these agencies will be one of the initial focuses of design and development efforts. Other state agencies may also be included in WLIS, as well as larger municipalities that already have land information systems. Smaller units of local government and many kinds of special districts may wish to collaborate with counties or regional planning commissions in order to participate in WLIS. Since they are already extensively involved in data collection and dissemination, regional planning commissions would be a likely place to maintain some of the early WLIS nodes. Also, many federal agencies could provide data in forms and formats useful to WLIS in its early stages.

It is also not only possible, but desirable for private organizations to contribute data and applications to WLIS. Although the initial focus of WLIS development will be to support local and state agency applications, this is not intended to deter others from developing additional applications. The design and architecture should be as open as possible to facilitate such additional application development by individuals and private organizations. The Team rejected an alternative approach of having a closed system that precludes the development of third party applications to utilize WLIS data.

Levels of Participation

The WLIS will be designed to accommodate three general levels of optional participation during its development and early operation:

I. Documenting existing databases and information

II. Providing digital land-related data

III. Maintaining a WLIS node

These three levels describe participation in, not use of, WLIS. Use of WLIS includes a much broader set of stakeholders. The designation of three levels is based on the premise that not all units of government or private concerns will have the funding or technical capacity to participate in WLIS in the same way. By providing differing levels of participation, WLIS will be able to incorporate a much broader range of data while minimizing any additional burden on data providers. It also provides a means for all organizations to participate in WLIS at a level they consider appropriate. It is possible for large organizations, such as state agencies, to participate at different levels for different program areas for any reason. Any number of arbitrary "groups" of participants in building the assets of the WLIS could have been identified. The Team chose three to provide for a range of participant capabilities and commitment that broke at logical divides.

The following matrix graphically illustrates the levels of participation and the corresponding levels of participant activity, software support and functional application support. Participants at both level I and II would provide data or documentation to a WLIS node; they would not provide direct support to WLIS users. Level II is subdivided into three sub-levels, based on increasing commitment of effort and resources. At the first sub-level (IIa), organizations would provide data as these are maintained within the agency. At the next two levels, organizations would provide additional services to make the data more useful in the WLIS context. At IIb, the organization would develop cross-walk tables and other parameters necessary to convert data

* See Wisconsin Statute 16.967

into WLIS standard objects, so that this could be done "on-the-fly" as needed to accommodate WLIS data requests. At the third sub-level, the organization would perform all the necessary conversions (e.g., coordinate, classification and terminology, format) and provide data in forms immediately useable within the WLIS framework.

Real time access to replicated data through WLIS can be provided through two mechanisms: 1) request routing and data replication among WLIS distributed nodes or 2) direct access to non-WLIS repositories. The staging of transferred data on WLIS distributed nodes provides better control over data form and availability, and direct access enhances the ability to provide up-to-date data. It eliminates the need for all WLIS participants to maintain local large-volume data storage facilities to store copies of the standard data sets.

Participation Level	Participant Activity	WLIS Software Support Requirements	WLIS Application-level Support
I 	Provide metadata and/or data indexes	Metadata entry and cataloging tools	Simple query processing, data indexing, metadata retrieval, outreach
II-a (path 4 Fig. 2)	Provide "raw" data via ftp and other batch transfer	Internet data tools, data transfer and storage protocols	Data download
II-b (path 1 Fig. 2)	Provide "raw" data with conversion information (e.g., cross-walk table	Database cross-reference tables and procedures	conversion to WLIS-standard formats
II-c  (path 2 & 3 Fig. 2)	Provide data in WLIS-standard forms	Data server and Internet map server capability	On-line data access and integration; support custom developments
III-a 	Support WLIS Web interface	Web-server, WLIS protocols and templates	Advanced query processing, more efficient operation
III-b 	Support interactive WLIS data	Web-server, WLIS protocols (non-WLIS user interface)	Limited query processing, interactive data access

	query		

Figure 1

Level I – Providing Information About Data

One goal of a WLIS is to provide an searchable database containing a minimum set of information about what data exists, where it exists, what it consists of, what format it is in, and how data sets can be obtained (minimal metadata, as described below). Ideally, the data referenced would be available from the source in a standard digital format, but could be in other forms, as well. It is not expected that WLIS will always be able to provide instant retrieval and display of data, but it should at least be able to provide an indication of its existence, location, and availability.

For spatial data, all agencies that receive funding from the Wisconsin Land Information Program are required to provide documentation of data sets generated through program funds. At a minimum, all state agencies and counties should be required to provide minimal WLIS-standard metadata. Non-spatial land related information, such as laws, rulings, procedures, and so forth, should also be documented using the structure of the WLIS-standard metadata and treated the same as spatial data within WLIS.

WLIS requirements for Level I participation would entail creating indices of agency-created or maintained information, and metadata that is minimally-compliant with the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata, and providing this to a WLIS node. This would permit the use of search routines to rapidly query metadata and the indices and to retrieve information on the location, format, and structure of the data and its availability. However, it is not realistic to believe that all jurisdictions will be able to generate such high quality metadata in the short term, particularly organizations that continue to maintain data in analog formats. Therefore, an important first step in developing the WLIS is to develop simple information indexing procedures and metadata entry software that can be used to document both digital and paper records.

Level II – Providing Digital Data

*(Moved to page 13)*Several options are available for data providers at level II, with differing levels of effort on the part of the providers and WLIS technical operations. These are shown as "paths" in Figure 2. In all cases, data would be delivered periodically to WLIS distributed nodes and staged for general availability*. The WLIS distributed node would support processing functions such as indexing, searching, conversion, analysis, mapping and data maintenance. The data node option works very well for organizations that have neither the capacity nor the interest in maintaining Internet accessible data. It does, however, require periodic transfer of data to a WLIS distributed node, potentially necessitating inter-organizational agreements.

This approach also requires the careful selection of additional, frequently used data, since the WLIS node need not duplicate all data generated by a jurisdiction. For example, a regional planning commission could manage a WLIS distributed node that maintains regional coverages

* Specifying the periodicity of data updates to the WLIS was rejected. Identifying appropriate cycles for updating WLIS data was felt to be the charge of individual custodians or constituency groups that better understand their practices and business needs.

and stores parcel data, orthophotography and other foundational elements from counties and other jurisdictions. Some jurisdictions may wish to provide local access to certain replicated data sets from their own databases, particularly commonly requested data, but without the added time and expense of maintaining a WLIS web node. This would allow sites that have already developed a web-delivery of data to participate in WLIS without having to do a complete conversion to the file formats of WLIS.

Inter-organizational agreements might be needed to specify technical linkages, fiscal arrangements (who bears which costs), legal considerations such as liability disclaimers and privacy protection provisions.

(Moved to page 17)

The Team designed a strategy to offer multiple options to participants for providing data to the WLIS, as depicted in the diagram below. This graphic depicts a model for the preparation and distributed deployment of land-related data; spatial and non-spatial, as well as metadata, for use by all WLIS participants. Although the model suggests the batch or automatic reprocessing of data into a WLIS-standard state, it is expected that dynamic cross-walk functionality will be developed for web-based applications, as well.

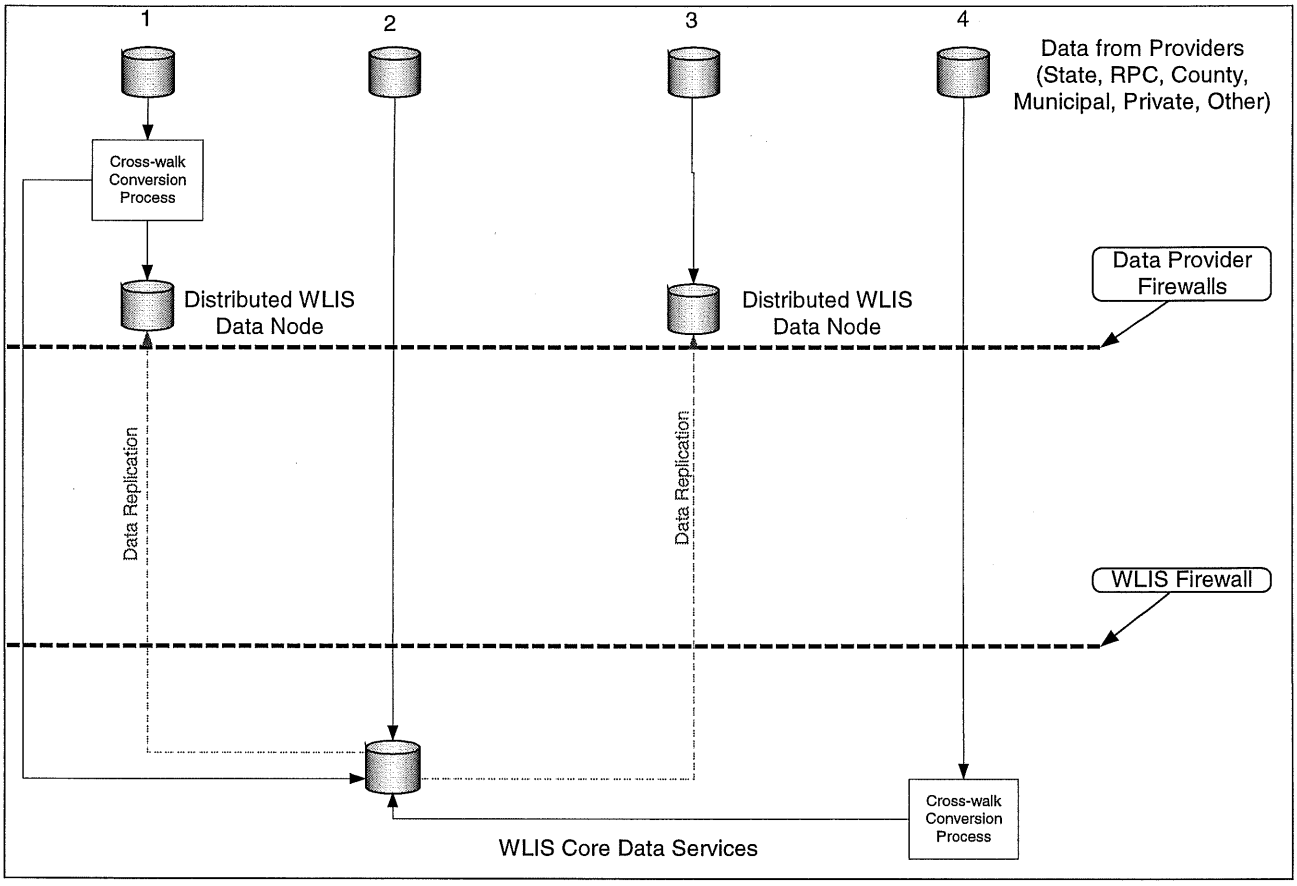


Figure 2

The Team felt that multiple data distribution paths were superior to a single-path approach because it provides flexibility in how an organization chooses to participate in Wisconsin Land

Information System and it avoids potential bottlenecks caused by the movement of large volumes of data through a single point.

The Team's design for data distribution and deployment has two major components: 1) data replication throughout the system and 2) the provision of data by providers into the system. Replication is addressed elsewhere, but the options available to data providers needs further description here.

There are four options available to Level II data providers, intended to offer a selection for the participants commensurate with their technical expertise and level of interest in becoming involved in the process. The design depends on two concepts: 1) a WLIS-standard data model and 2) the development of a software tool to provide a cross-walk, or conversion to this model from the existing format.

Path 1 – This option offers the data providers the ability to convert their data to WLIS standard-compliant format for staging of converted data and metadata to a WLIS distributed data node accessible via the Internet, or on the WLIS core node also accessible via the Internet. This option would require a minimal level of technical expertise and infrastructure and the establishment of a partnership with an organization hosting the distributed node.

Path 2 – This option provides for the staging of WLIS-standard formatted data and metadata directly on core WLIS data node, which is accessible via the Internet. This option requires that the data meet the WLIS standards in its native form.

Path 3 – This option varies from the preceding option only in that it stages the data and metadata on a distributed data node (which is then replicated to the core WLIS data node.)

Path 4 – This option requires the least effort and technical expertise on the part of the data provider and the most effort on the part of the core WLIS service effort. The core staff provides data conversion services for the data provided to the WLIS standard-compliant format and stages the data on core WLIS node for later replication to all nodes. The data submitted must have minimally sufficient metadata to provide the necessary information to allow the conversion.

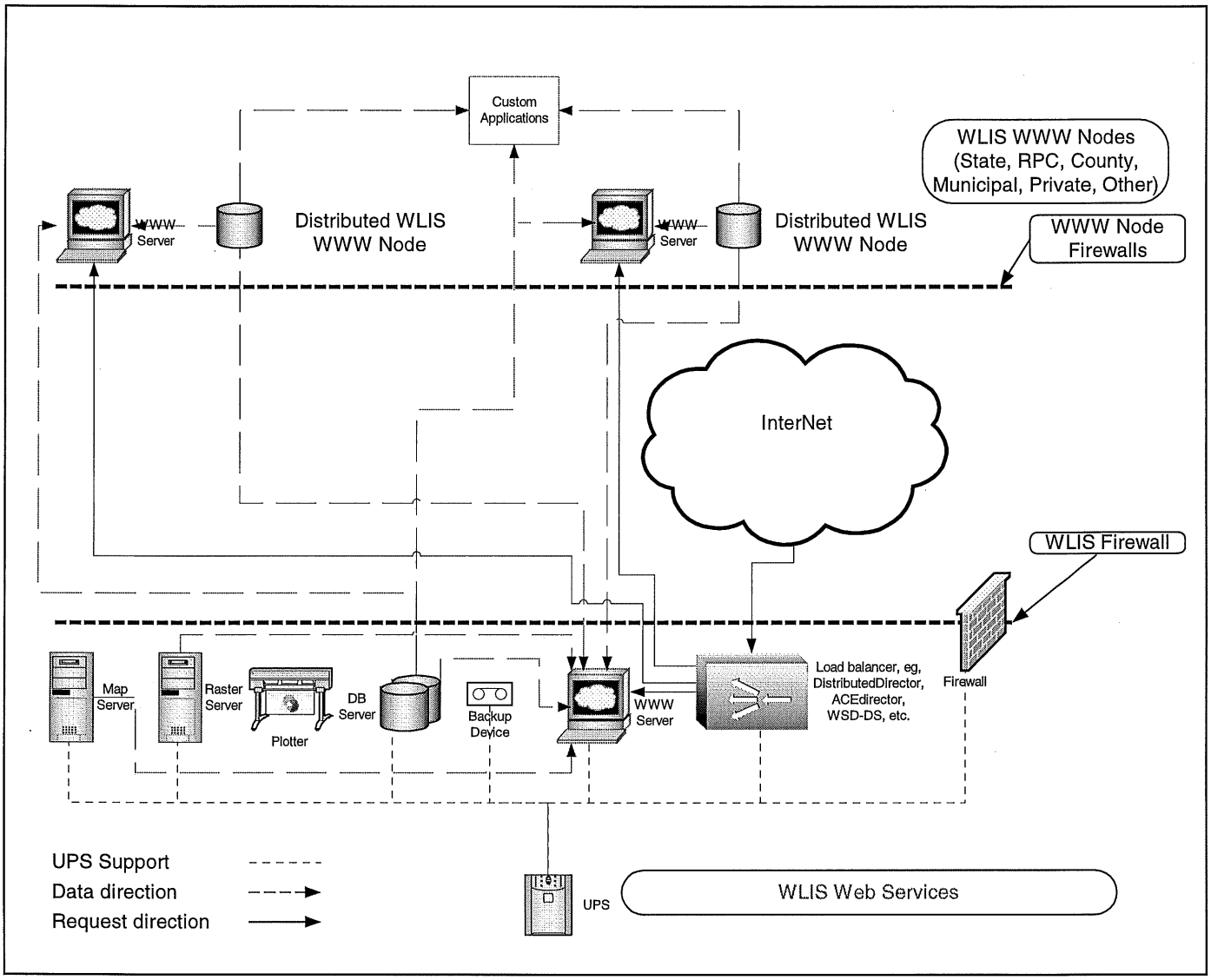
Level III – Maintaining a WLIS Node

User access to WLIS need not emanate from a single web server (though casual users could have a single primary entry point). Instead, multiple nodes maintained at various levels of government and the private sector could provide data and services. The nodes would have a similar look and feel, but could be customized for geographic regions, domain areas, or other preferences. Node support staff would work out agreements for data transfer from Level II participants in their region or area. When a query involved integration with data created and maintained across a more extensive area, the node would seek this information from allied nodes. For example, if the query involved project permitting that required compliance with historic preservation statutes, a county WLIS node could retrieve the necessary information from a node containing data provided by the State Historical Society.

Specifications for maintaining a WLIS node (Level III-a) will depend on functional requirements that emerge from the development of detailed system design specifications. At a minimum, the site will need to maintain a web server and database/file server and all that this implies maintaining software and hardware, performing back-ups, providing a firewall, having sufficient Internet bandwidth and some degree of technical support to users. While all WLIS nodes will not

have identical technical specifications or configurations, minimum levels of operational functionality will need to be maintained. It is desirable to design WLIS to accommodate a broad range of Internet connectivity, hardware and software, given the range of variability that already exists among different organizations.

Standard, customizable WLIS node templates providing basic WLIS functionality and a common look-and-feel should be designed and developed to function 'out-of-the-box' so that distributed



WLIS Project Phasing

The typical information system development lifecycle is comprised of analysis, design (often including prototyping), development, testing, implementation and operations/maintenance. Because WLIS is dealing with such a broad range of functions and participant environments, it should not be assumed that these steps will be linear. Rather, the development cycle might be thought of more as a series of smaller projects, ordered based on logical dependencies. For example, since data indexes and metadata are so crucial to the functioning of WLIS, development of the metadata entry and retrieval tools, training and other outreach activities should be pursued as soon as possible. Other activities, such as application development and development of distributed node models and web templates can only take place after core tools have been developed and documented. The participation levels table above provides initial suggestions for the sequencing of activities, such as metadata development and phasing for other activities. Given the nature of this approach, the Team has made the assumption that the design and implementation of WLIS will take place in phases, over at least two state budget biennium cycles. As a consequence, differing levels of functionality will become accessible to users in a sequence over several years. A "Develop the WLIS in one-shot" approach was rejected by the Team because of the overall system costs, the undetermined extent of the mature system, the need to establish fundamental operational standards and the differing abilities of various stakeholders to commit the necessary time and resources to become full participants. Moreover, a phased approach will permit the development of prototypes and solution testing that is considered necessary for the successful development of the system.

In general terms, as described in the Technical Working Group's final report, the first to benefit from the system will be those organizations and individuals already routinely using automated land information systems. These users have both the expertise and equipment to take advantage of a WLIS right away. It can enhance what they are already doing, and extend their capacity to acquire and integrate data from multiple sources. Another group that will realize early benefits from WLIS are those with applications that can be supported by WLIS, but have been stymied from using automated land information for many reasons, including lack of data access. However, those lacking appropriate tools to manage, analyze, and display the data will not benefit immediately but will need to wait until specific applications are developed within the WLIS framework. For example, local land use planning staff and officials clearly need land information, but may have to wait until a range of applications are developed to help them understand and use the information provided through WLIS. Initial priority of WLIS development is the infrastructure of the system. However, WLIS data and its resources will be available to support individual application development during its early development.**Project Deliverables**

While there can be innumerable functions and products resulting from the phased development of a WLIS, there are several that stand out as deliverables from the first few phases of the project. For ease of consideration, these can be thought of as falling into three broad categories: design, development and operation.

Design

Before any development activity can begin, several fundamental design components must be completed. First, the WLIS metadata standard model must be developed, accepted by the state's land information community and published. Closely following this, a WLIS metadata database

schema, addressing spatial and non-spatial data, needs to be developed. These two steps are prerequisite for the design and development of metadata entry, indexing and querying capabilities, as well as the design of dynamic cross-walk capability. These steps can also be initiated and pursued immediately.

Once the WLIS standard metadata model is established, selected WLIS standard data sets must be identified (see discussion below), and procedures and agreements established for the acquisition and regular updating of these key data sets. These data sets will make up the repository of data common to all nodes on the WLIS network. When the planning begins for the establishment of distributed data nodes, a data replication model will need to be designed to insure that the WLIS standard data sets are synchronized on a timely basis.

Also, with the development of the nodes on the WLIS network, the need for an effective security model to enable dynamic cross-walk capability becomes a critical component. Although the data within the WLIS network is virtually all copies, denial-of-service (DOS) attacks and the surreptitious alteration of data are very real concerns. The development of a distributed security model to permit authorized access to data on distributed nodes for legitimate applications across the open internet is not an insubstantial undertaking. The first central component of this model must be the configuration of the firewall and load balancing mechanisms at the WLIS core to provide data access to WLIS participants, as well as WLIS Web Services applications. This effort must also produce a set of instructions and protocols for access to independent applications development efforts by WLIS participants. The second component must be a model for a similar configuration for the WLIS nodes and the development of instructions for implementing them for the node custodians.

Development

Once the design stage of the project is largely complete, development of individual components of WLIS can proceed. The creation of the core elements would likely begin with the construction of the structure and framework of core user interface (which would become the basis for the templates for the distributed node web templates). These will be followed by the development of the metadata entry and query-retrieval tools.

Before the network begins to add the distributed nodes, several components must be developed. The cross-walk conversion batch process for both the core and distributed nodes must be designed and developed. As already indicated, the process must be designed to be extensible for independent customization, but it must also have the capability to accept non-destructive updates as they are made available by the core technical staff.

Central to the design of WLIS is its distributed nature; this necessitates the planning and design of an intelligent load-balancing or redirection mechanism for both performance and programmatic reasons.

One of the advantages that this network architecture affords is the ability for any participant to develop an application which accesses standard WLIS data, as well as any other data, locally stored, staged on a WLIS distributed or core node or otherwise made accessible on the internet. Therefore, local application protocol will be developed to permit the linking of locally developed applications to any accessible WLIS data source.

Operation

The WLIS core staff will provide for the ongoing maintenance and enhancement of WLIS applications (such as the cross-walk process), the development of standard information products, general data services and the creation and maintenance of the WLIS database schema.

It is assumed that another organizational structure will maintain WLIS data and metadata standards.

2. Critical Success Factors

The Team recognizes that it is critical to be able to establish benchmarks and milestones to measure the development progress and the success of the WLIS. Optimum support from the system stakeholders can be anticipated if they have clearly defined expectations. Ideally, by the end of the first year of operation:

1. There should be direct participation at all levels of government - 4 of the 7 state agencies represented on the Land Council, 1 RPC, 20 counties, as well as cities, towns, and the private sector and some participation by sovereign nations and federal agencies.
2. Data access should be available to local units of government.
3. There should be a metadata entry tool, and an indexing and query tool(s) as part of the system.
4. There should be significant progress on the development of theme core standards, cross-walk functionality and a prototype of an online mapping application.

By the end of the third year of operation, there should be a pilot of a distributed WLIS node with both data and web functionality.

3. Benefits

The Team identified an extensive array of benefits, to public and private sector stakeholders, that would emanate from a WLIS. One of the primary functions of the WLIS is to identify and make available the extensive land related data already in existence. Two existing "barriers" will be largely removed for the large audience; knowing what information already exists and having access to the information by viewing it online or the ability to obtain a copy for application development. As a result, the potential benefits of this system are numerous. The benefits can be grouped as a benefit directly obtainable from the WLIS. Also, WLIS could facilitate the creation of a wide range of applications by varying interest groups.

A list of the direct benefits include:

1. Economic impacts. A WLIS will directly provide the basis for a variety of business- related activities as well as the foundation and platform to build many more. The benefits cited below will benefit both state and local economies. The system will provide economic, demographic, and current business location information. Additionally it will have detailed information available to show the infrastructure of highways, railroads, waterways, and other transportation and infrastructure details. Locally, land available for development, property tax rates, and similar land related information can be provided. This would facilitate:

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   - New business siting and expansions. Providing the base information for market research and analysis necessary for identification of potential sites for new or expanded business locations; additional linkages to local web sites could provide additional information about the communities; some examples include available labor pool, schools and parks and recreation options.

   - Direct marketing of sites. Linking the system to existing sites such as the Brownfields web application at the Department of Commerce [http://comgis1.commerce.state.wi.us] would further enhance the direct marketing of business location throughout the state, reaching a much broader potential audience than would be possible from numerous, independent, and "unconnected' sites if everyone did it on their own.

   - Enhance tourism. Linking to existing web sites, users will find maps of Wisconsin, such as the Ice Age Trail map [http://www.dnr.state.wi.us/org/at/et/geo/iceage/index.htm] which shows amenities available along the trail.

2. Public Access to government data. The list of potential data sets identified for inclusion is extensive, and much of the information would have broad interest. One of the major benefits of web technology is its accessiblity: 24 hours a day, 7 days a week. No longer would access to data be confined to "business hours" or to the time constraints of existing staff. Private citizens, businesses, non-profit organizations, as well as other government entities, could quickly and easily identify data that they need. This information might include: local zoning or assessment information; the size of the deer herds in locations around the state; information about the area where they are thinking of purchasing a summer cottage; viewing a digital orthophoto of their property; or viewing digital raster graphics showing the terrain and other information of their neighborhood, municipality, or county.

3. Educational benefits. The state has taken the lead in ensuring that schools throughout the state are able to connect to the web. All of the information described can thus be accessed by students and their teachers at all levels, from elementary grades through college. Geography classes are a natural for accessing this information, with the ability to access a wide range and significant number of maps and related databases. However, many others will find much to help them as well. Classes will find information on government boundaries, population profiles. The range of planning documents which could be accessed via the WLIS can help them understand how their community plans to change in the coming years. Orthophotos and similar products will provide the students with images of their areas for study and analysis.

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4. Direct Government Benefits. The ***integration*** of state and local data would provide numerous benefits to all participants.

- Having the data on WLIS means that applications developed using WLIS may be available statewide, for everyone; no longer must each unit of government develop the application themselves; rather they can benefit from the work of others.
- With the promotion and support of data and the development of standards, costs can be reduced. Elimination of duplicative development efforts is possible.
- Making data readily available reduces the costs for time and money spent on data discovery, access, and conversion, especially in the area of planning, although all government entities will benefit from the ease of access.
- Increased intergovernmental cooperation is expected. Viewing shared resources and showing how their actions would affect their neighbors is now feasible.
- The WLIS would support the directions outlined by the Kettl Commission, by looking at problems and service delivery from a new, more integrated, cross-boundary perspective.
- The citizenry will be much better informed in a timely manner, especially when it comes to land use issues.
- Less effort and resources spent by public agencies in providing data and information to the public in satisfaction of open records responsibilities.

Indirect benefits are also identified. They are classified as indirect as the ultimate benefit is dependent on another entity taking some action. The types of applications developed are wide-ranging given the variety and extent of the data that is expected to become part of the WLIS. These might include:

- A variety of real estate applications based on parcel maps, related attributes, and local and regional comprehensive plans; comparison of property values; comparison of tax rates, school districts, etc

- Business (re)location applications – Examples could include: Nursing home locations, based on current licensed facilities and population profiles based on age ("Where are elderly undeserved?")

- Research related – Farmland Preservation and related programs - available data could include acreage and location of farmland, over time, Medical research could include incidences of diseases and other medical problems, related to population profiles, business locations, natural environment, etc

- "General public" applications – such as where are good fishing streams near where I am planning to camp? What type of hunting is allowed around our cottage or vacation site? If I moved to this location, what school district would I be in; what would my property taxes be; etc

- Many of these applications can only be built if there is a WLIS, as they may require a combination of both state and local data, private sector data, and potentially federal data as well.

4. Assumptions

It is important in any information systems project to clearly address any and all assumptions made in the design and planning phases. The Team recognized the following assumptions in its work in developing the design of WLIS and would like to ensure that they are recorded.

1. There will be an administrative body, or bodies, to provide guidance, support, operation and decision-making services, as well as management of core assets. While there is not a comprehensive list of decisions to be addressed, initially or on an ongoing basis, a few might be:
   - The determination of the minimum standards for the addition of a new data set to the WLIS environment.
   - The addition of new data sets to the standard set of WLIS core data sets.
   - The technical and organizational requirements for participation as a distributed node.
2. A WLIS administrative body will establish and publish commonly accepted standards for data and metadata that will be used by direct participants in the WLIS and will be used as the target for participants who convert via the cross-walk process.
3. There will be sufficient bandwidth made available to accommodate significant data transfer requirements, both dynamic and automatic.
4. WLIS is a publicly-accessible system. Therefore, data providers and users can be any WLIS participant from any sector.
5. WLIS participants will have the option of selecting the publication path alternative that best suits their needs and interests. In this regard, state agencies are on a par with other data providers - they can provide data using any of the alternative publishing paths.
6. It is expected that there will be a gradual shift by WLIS participants from emphasis initially on data presentation and integration to future improvements in data models, storage and data collection.
7. Data can be passed through intermediaries. (e.g., Regional Planning Commissions can serve counties, municipalities, etc.; counties can serve municipalities, metropolitan multi-jurisdiction districts, etc.; private entities can serve any public and/or private organization)
8. Promotion of desired or preferred paths will probably require differential levels of incentives. (e.g., financial support for hardware, network connectivity, software, grants, etc.) It is expected that there will be a need to provide more incentives to encourage providers to act as a distributed WLIS node.

9. A single, central data services repository is not scalable to meet the potential demand of a fully-developed WLIS; Distributed WLIS nodes, with an intelligent load balancing mechanism, will be required to adequately serve the needs of such a system.

10. Although not to the exclusion of other entities, it seems that organizations with the scale and resources of state agencies, Regional Planning Commissions, and some counties are likely candidates to support a distributed node.

5. Constraints and Risk Analysis

Constraints

The Team recognizes that an endeavor on the scale of developing a statewide system predicated on the cooperation and support of numerous diverse stakeholders is an undertaking that is not without substantial risks. The Team identified a significant, though perhaps not exhaustive, list of potential risks to the successful implementation of WLIS, assessed the impact of each risk and developed some suggested strategies that may be employed to mitigate or avoid the adverse effects. In addition, the Team identified several constraints that will likely be present to some degree, which are not likely to be, or perhaps are unable to be, mitigated.

The constraints identified were:

1. Lack of confidence on the part of potential stakeholders in the ability for WLIS to be successful and beneficial.
2. Lack of local funding available to support participation by organizations with fewer resources.
3. The absence of a cost recovery pass-through for for-profit enterprises or public organizations required to recover the cost of production of information products.
4. Participation constraints (lack of technical staff, infrastructure, spending and staffing limits, etc.).
5. The perception that the existing local investment in land information will be compromised by participating in a system with differing standards and/or technology.

Risk Analysis

The fundamental long-term vision of WLIS can be embodied in the goal of enabling a seamless statewide view of multiple common attributes that can be used in analysis and decision-making. There appear to be a number of potential pitfalls in achieving that vision, but there are also some apparent means of managing the risks they pose.

One class of risks threatens the willingness to provide spatial and non-spatial data which would ultimately defeat attempts at building a statewide land base with the themes identified later. Copyright and redistribution restrictions may translate into holes or gaps in the statewide base, and potentially increase system costs owing to increased data acquisition expense, if the data set is deemed critical. In preparation for this contingency, alternate sources of critical data should be identified and budgeting funds for data that needs to be purchased should be considered. Concerns over liability once a provider's data is released into such a public environment, especially as it may be used with others' data, was a less pressing, but very real question during the requirements gathering. Most, but not all felt that a solid disclaimer associated with their

data would suffice, but it would be prudent to consider *a priori* legal review and participant indemnification. Privacy concerns also ranked as a threat to participation, but the Team felt that clearly defined and published privacy standards, incorporating a provision for shielding or blocking personally identifiable information, where appropriate, would be prudent.

A second category of identified risks is essentially related to finances. It is important to emphasize that the cost of a WLIS is not in just building the pieces, but in the daily operation of a gradually growing system, as well. As a result, the lack of sufficient, continuous operational funding is critical risk. If this is absent or insufficient after initial development, there is a very real possibility of the loss of credibility in the system and a resulting delay in further participation and a potential loss of progress. This is the reason that the Team has differentiated the operational portion of the first phase of the project from the start-up and development costs. A strategy for later justifying the operational costs (as well as new development costs) is to demonstrate the success of the system in delivering value; this led to the Team's decision to establish Critical Success Factors, or benchmarks, as a way of justifying these expenditures.

Another risk identified in this category is the perception that a revenue stream, especially for a public entity, is being displaced by WLIS. The Team generally felt that an analysis of most cost recovery mechanisms would prove that they are not effective in truly providing an added revenue stream and that some effort be considered to provide educational outreach on the benefits to the participants and the cost savings that might result. Closely related to this risk was the threat that WLIS might be perceived as an unfunded mandate, leading to reluctance to participate and potential opposition to the initiative. This consideration led to the Team's approach in designing the system such that participation could be easy and low-cost, at a level commensurate with participant's abilities, resources and interest, and to emphasize that participation is optional. Here, again an early outreach effort on the benefits to the participants, including potential cost savings would help satisfy this concern. This is an area that might benefit from providing incentives – financial and otherwise - for participation.

Another area of risk is technical. The proposed system is employing technologies that have not been long in general use, or used for these purposes. One of the greatest concerns is the impact on user perception and the limitation of functionality arising from the lack of available bandwidth. While limited steps have been made to date in building applications on the web using these kinds of data, nothing has been attempted on this scale in both scope and depth. The contour map base for Milwaukee County, for example, exceeds 20 gigabytes; transferring that data or other data sets like it will require careful network design and potential contingency funds to insure sufficient bandwidth. Similarly, other technical issues (e.g., existing software, hardware, and interoperability) can limit the use of the system and the functionality that can be provided. Therefore, designing the system to maximize the system's capability to accommodate continuous system upgrades and establishing clear minimum technical standards for participation is essential.

Two risks that are potentials for limiting the unqualified success of the system are the lack of buy-in by essential data providers and the failure of data custodians to maintain their contributions to WLIS. The former can threaten the completeness of key data themes, thus impinging on WLIS' credibility. The latter can have the same effect, bringing into question the quality of data available in WLIS. A number of suggestions emanated from the Team regarding ways to address these, including providing incentives, proposing legislation tying participation to

state grants and aids, reinforcing the data sharing requirement in the Land Information Program, and insisting on enforcement minimum data and metadata standards in WLIS.

Finally, the Team focused on the lack of standards and lack of the observance of standards as a key risk. The cost, reduced functionality and lack of interoperability that WLIS is predicated on make this one of the most significant threats. Although the design we propose has cross-walk functionality as a central requirement, this is intended as an expedient to deal with the reality that these conditions exist and must be addressed. For WLIS to be successful in the long run, there must be strong continuous institutional support for the establishment and observance of standards.

6. Project justification

Currently, Wisconsin is experiencing unprecedented economic growth which is affecting all sectors of our economy. An expanding industrial sector, new business startups, business and home construction, low unemployment, a robust stock market and high consumer consumption are all part of the current good times. Continuing to fuel the expanding economy has put a burden on federal, state and local units of government to provide timely services and make educated land use decisions. These decisions have a long-term effect not only on the continued growth of the economy, but also on our environmental resources.

It has been said that "land record information is the currency of the future." Land record information filters through all levels of the economy. Decisions are made daily in both the public and private sectors, based on the most current information available. To keep land record information current and flowing, it must be captured, shared and delivered in a timely and efficient process.

In Wisconsin, dozens of state agencies, over 2000 units of local government, 72 counties, countless private concerns and innumerable multi-jurisdictional organizations make daily land use decisions with the most current information available. These decisions govern the future location of streets, homes, businesses, sewer, water and schools in towns, villages, cities and counties. Vast amounts of land information have been captured at the state and local level since the Wisconsin Land Information Program initiative in 1989. However, the availability of this information for decision making is limited and may not be available in a state or county computer in a format that can be shared. For the first time, a WLIS would make this information widely available, leveraging the investment made in land records modernization for over a decade.

The passage of the "Smart Growth" legislation requires local units of government by the year 2010 to base all land use decisions such as zoning changes, annexations, and subdivision approvals, ect. on an adopted comprehensive plan according to statutory requirements found in s. 66.0295, Wis. Stats. This is a worthy effort which should help guide future growth in Wisconsin's communities. These comprehensive plans are required to be updated at the minimum every ten years. Completion of a comprehensive plan requires a vast array of land record information e.g., existing land uses, soil survey, census information and transportation analysis. For local units of governments to gather or access the necessary land record information to complete a comprehensive plan per state statute, a vehicle such as a WLIS is needed. A WLIS will allow all units of government to access land record information to complete and update their comprehensive plans and to make informed land use decisions.

Beyond its support for Smart Growth, a WLIS will have other significant uses, such as providing the private sector access to land record information making them more competitive and reducing redundant costs and efforts, and providing public access to a wealth of information stimulating citizen involvement and participation in land related issues.

Key points – 1. Project Narrative

1. We recommend that the system be a distributed approach to data management and distribution.
2. We recommend that multiple cooperative nodes should support data retrieval and product development through a common Web interface.
3. We recommend that each node maintains additional data appropriate for a local context, as well as the capability to query and retrieve data from other nodes.
4. We conclude that a system supporting replication is less vulnerable to service failure and can be more efficient in serving clients than a single central repository alternative.
5. We conclude that many organizations and individuals will be involved in the development of the system components.
6. We conclude that some of the implementation and management should be centralized for efficiency and effectiveness.
7. We conclude that the only characteristics that will distinguish the "core" node from any distributed node are that 1) it will house the 'parent' searchable metadata database and 2) it will be the initial staging point for data replication to the distributed nodes.
8. We recommend that the design and implementation of the system should be done in phases based on the availability of data and the state of technology.
9. We recommend that the system build incrementally on existing investments and standards in land information.
10. We recommend that the system target should be to serve a wide audience, including public agencies, private organizations, and individual citizens.
11. We recommend that the system provide Web-based access to information and support for functions oriented to "enhancing land-related data creation, management and dissemination".
12. We recommend that the system be developed and maintained by "multiple participants in he land information community" in a phased process.
13. We recommend that the system have a common user interface to local, multi-jurisdictional, and state agency data.
14. We recommend that the system should support land information applications, such as zoning and the new Smart Growth Comprehensive Planning Legislation.
15. We conclude that the system should provide access to land-related data held by public agencies and private organizations.
16. We recommend that state agencies and counties specifically mentioned in the Wisconsin Land Information Program should be the initial focuses of design and development efforts.

17. We recommend that early nodes should be state agencies and larger municipalities that already have land information systems, smaller units of local government, and special districts who wish to collaborate with counties or regional planning commissions and regional planning commissions themselves.

18. We recommend that Federal agencies could provide data to the system.

19. We recommend that private organizations contribute data to the system, particularly if these data are created using public funds.

20. We recommend that the design and architecture of the system be as open as possible to motivate collateral application development by individuals and private organizations.

21. We recommend a model for the preparation and distributed deployment of land information systems data as show by a graphic in the document text.

22. We recommend that the system accommodate multiple levels of optional (input) participation.

23. We recommend that Level I have a searchable data base containing a minimum set of information about what data exists, where it exists, what it consists of, what format it is in, and how data sets can be obtained.

24. We recommend that at Level 1, for spatial data, all agencies that receive funding from the Wisconsin Land Information Program be required to provide documentation of data sets generated through program funds.

25. We recommend that at Level 1, at a minimum, all state agencies and counties should be required to provide minimal metadata. Non-spatial land related information, such as laws, rulings, and procedures, should also be documented.

26. We recommend that an important Level 1 first step is to create simple information indexing procedures and metadata entry software that can be used to document both digital and paper records.

27. We recommend that at Level II, the system should provide real-time access to data via request routing and via direct access.

28. We recommend that at Level II, data should be delivered periodically to the system nodes for general availability.

29. We recommend that the system nodes would support functions such as indexing, searching, converting, analyzing, mapping, and data maintenance.

30. We conclude that the node concept will allow some jurisdictions to provide local access to certain data sets from their own databases—particularly commonly requested data—without the added time and expense of maintaining their own Web presence.

31. We recommend the Level II carry two basic obligations: (a) to provide info about its capabilities and (b) to maintain a minimum level of query support.

32. We recommend multiple publication paths.

33. We recommend that Level II system design for data distribution and deployment have two major components: 1) data replication throughout the system and 2) the provision of data by providers into the system.

34. We recommend four data distribution and deployment options for Level II data providers.

35. We recommend that Level II, Option One offers the data providers the ability to convert their data to system standard-compliant format for staging of converted data and metadata to a system distributed data node accessible via the Internet, or on the system core node also accessible via the Internet.

36. We recommend that Level II, Option Two provides for the staging of system-standard formatted data and metadata directly on core system data node, which is accessible via the Internet.

37. We recommend that Level II, Option Three varies from the preceding option only in that it stages the data and metadata on a distributed data node (which is then replicated to the core system data node.)

38. We recommend that Level II, Option Four would have the core staff provide data conversion services for the data provided to the WLIS standard-compliant format and stage the data on core system node for later replication to all nodes.

39. We recommend that for Level III, multiple nodes maintained at various levels of government and the private sector to provide data and services.

40. We recommend that for Level III the nodes would be customized for geographic regions, domain areas, or other preferences.

41. We recommend that for Level III, the data archive would include primarily locally generated data and when a query involved integration with data created and maintained across a more extensive area, the node would seek this information from allied nodes.

42. We recommend that for Level III, specifications for maintaining a system will depend on functional requirements that emerge from the development of detailed system design specifications but it will have a minimum standard configuration.

43. We recommend that for Level III, standard, customizable WLIS node templates providing basic WLIS functionality and a common look-and-feel should be designed and developed to function 'out-of-the-box' so that distributed node sites can be implemented without significant effort.

44. We conclude that because the system deals with such a broad range of functions and participant environments, development is likely to occur in a non-linear sequence.

45. We conclude that the development cycle is likely to be a series of smaller projects, ordered based on logical dependencies.

46. We conclude that activities such as application development and development of distributed node models and web templates can only take place after core tools have been developed and documented.

47. We assume that the design and implementation of the system will take place in phases, over at least two state budget biennium cycles.

48. We conclude that a phased approach will permit the development of prototypes and solution testing that is considered necessary for the successful development of the system.

49. We conclude that the first to benefit from the system will be those organizations and individuals already routinely using automated land information systems.

50. We conclude that another group that will realize early benefits of the system are those with applications that can be supported by the system, but have been stymied from using automated land information for many reasons, including lack of data access.

51. We conclude that although the system will be open to anyone, including individual citizens, developing applications to meet specific interests will be a low priority, both because the needs are so disparate and diffuse, and because direct benefits are not compelling.

Key Points – 2. Project Deliverables

52. We conclude that the deliverables from the first two phases of the project fall into three broad categories: design, development and operation.

53. We recommend that a system metadata standard model be developed, accepted by the States' land information community, and published.

54. We recommend that a system metadata database—addressing spatial and non-spatial data—be developed.

55. We recommend that once the system metadata model is established, selected standard data sets should be identified, and procedures and agreements should be established for acquiring and regular updating these key data sets.

56. We recommend that when the planning begins for the establishment of distributed data nodes, a data replication model should be developed.

57. We recommend that the system be designed to insure that the WLIS standard data sets are synchronized on a timely basis.

58. We recommend that security measures should be developed as nodes are created.

59. We conclude that once the design stage of the project is largely complete, development of individual components of the system can proceed.

60. We conclude that the creation of the core elements would likely begin with the construction of the structure and framework of core user interface (which would become the basis for the templates for the distributed node web templates).

61. We conclude that these will be followed by the development of the metadata entry and query-retrieval tools.

62. We conclude that before the network begins to add the distributed nodes, the cross-walk conversion batch process for both the core and distributed nodes must be designed and developed.

63. We recommend that the process be designed to be extensible for independent customization and it must also have the capability to accept non-destructive updates as they are made available by the core technical staff.

64. We recommend that the systems distributed nature necessitates the planning and design of an intelligent load-balancing or redirection mechanism.

65. We conclude that this network architecture provides the ability for any participant to develop an application which accesses standard system data, as well as any other data, locally stored, staged on a WLIS distributed or core node or otherwise made accessible on the internet.

66. We recommend that local application protocol be developed to permit the linking of locally developed applications to any accessible system data source.

67. We conclude that the WLIS core staff will provide for the ongoing maintenance and enhancement of WLIS applications (such as the cross-walk process), the development of standard information products, general data services and the creation and maintenance of the WLIS database schema.

68. We assume that another organizational structure will maintain system data and metadata standards.

Key Points – 3. Critical Success Factors

69. We recommend the adoption of critical system success factors dealing with participation, access, data, prototypes, and participants.

Key Points – 4. Benefits

70. We conclude that access to data for both professional and public stakeholders will keep users better informed, will require fewer resources spent by public agencies in providing data and information to the public in satisfaction of open records responsibilities and will increase accountability of agencies providing data and information.

71. We conclude that participation will be flexible.

72. We conclude that the system will reduce or eliminate redundant costs and efforts in the integration of data and the development of data.

73. We conclude that data will be shared.

74. We conclude that economies-of-scale will occur by pooling of resources.

75. We conclude that there will be better, more informed decision-making.

76. We conclude that data quality will be improved.

77. We conclude that investment will be leveraged in existing land information.

78. We conclude that there will be increased interoperability among participants.

79. We conclude that there will be opportunities to produce new data.

Key Points – 5. Assumptions

80. We assume that there will be an administrative body, or bodies, to provide guidance, support, operation and decision-making services, as well as management of core assets.

81. We assume that a system administrative body will establish and publish commonly-accepted standards for data and metadata that will be used by direct participants in the system, and will be used as the target for participants who convert via the cross-walk process.

82. We assume that there will be sufficient bandwidth made available to accommodate significant data transfer requirements, both dynamic and automatic.

83. We assume that the system is a publicly accessible system. Therefore, data providers and users can be any the system participant from any sector.

84. We assume that the system participants will have the option of selecting the publication path alternative that best suits their needs and interests. In this regard, state agencies are on a par with other data providers - they can provide data using any of the alternative publishing paths.

85. We assume that there will be a gradual migration by the system participants from emphasis on presentation to data storage to data collection. In terms of publication paths, this might mean moving from Path 4 to 1 to 2 to 3.

86. We assume that data can be passed through intermediaries (e.g., Regional Planning Commissions can serve counties, municipalities, etc.; counties can serve municipalities, metropolitan multi-jurisdiction districts, etc.; private entities can serve any public and/or private organization.)

87. We assume that promotion of desired or preferred paths will probably require differential levels of incentives such as financial support for hardware, network connectivity, software, and grants.

88. We assume that a single, central data services repository is not scalable to meet the potential demand of a fully-developed the system; Distributed the system Data Nodes, with an intelligent load balancing mechanism, will be required to adequately serve the needs of such a system.

89. We assume that although not to the exclusion of other entities, it seems that organizations with the scale and resources of state agencies, Regional Planning Commissions, and some counties are likely candidates to support a Distributed Data Node.

Key Points – 6. Constraints & Risk Analysis

90. We conclude that there are constraints on system development that include copyright, liability, lack of vision, lack of local funding, lack of program buy-in, privacy, custodial responsibility, lack of enforcement of existing standards, lack of standards, revenue stream replacement, perception of unfunded mandate, no cost recovery pass-through, participation constraints, lack of participation /cooperation, existing local investment in land information.

91. We conclude that risks facing the system include the willingness to provide information, copyright & redistribution restrictions creating data gaps, liability, privacy, perception of unfunded mandate, ownership, funding limitations, lack of standards, and lack of enforcement.

V. Preliminary Conceptual Design

1. Overview

The WLIS, by Wisconsin Statute 16.023, will be a web-based, distributed system, disseminating all types of land-related data, spatial and non-spatial. This system will serve as a 'Master Portal', or 'Catalog' of Wisconsin land-related information, as well as be the framework and platform for the development of applications employing land-related data.

All WLIS data will conform to general structure and content standards to facilitate integration, exchange, and use. Metadata documentation and indexing will be a prerequisite for the effective use of these data. Cross-walk tables will be developed and integrated into the system to facilitate data integration and application development as an interim measure while data is stored in different formats and using different structures. The WLIS will be a confederation of distributed repositories for all land-related data to support local, regional and statewide analysis, planning and decision-making. In particular, the WLIS will be designed to facilitate activities related to the comprehensive master planning requirements contained within the recently enacted "Smart Growth" legislation.

Toward this end, the WLIS must be available to and easy to use for the broadest range of Wisconsin citizens possible and be designed to accommodate all levels of sophistication. Data producers and custodians should be encouraged to actively participate in the WLIS initiative for this program to be a success. The WLIS system design and functionality should be flexible and extensible to serve the broadest spectrum of stakeholders in this system. User interfaces will require careful design to provide even the casual user with a clear, understandable, and intuitive means to access and use the exploding base of land-related information. The Wisconsin Land Information System must be a dynamic enterprise, which will require a phased implementation and a system flexibility to allow its growth, evolution and expansion.

The various conceptual components of the Wisconsin Land Information System are identified and described below.

2. Physical Design

As with the development of the logical functionality, the physical design – the hardware and network configurations – will develop and evolve from basic foundations. Beginning with the establishment of the basic core node – essentially a web server, a database server and associated support hardware (back-up device, uniterruptible power supply, etc.), the node will add special purpose hardware (e.g., internet map server, raster server, etc.) according to the current stage of development. This basic configuration and expansion model is the same for the distributed nodes that should be piloted in the third year of development. The only physical difference between the core and distributed nodes might be the establishment of a single load-balancing device; detailed network design by consultants will be required to address this issue. The Team is not recommending limiting the number of distributed nodes, but feels that desire and cost-benefit considerations by participants will be determining factors.

While the nodes can be openly accessed from the Internet, the interconnection of the nodes will need to be more dynamic and flexible. Again, this will require detailed network design by consultants to determine minimum capabilities. This may be an area where the State's BadgerNet service, or a private co-location service may be considered.

3. Logical Design

Ultimately, WLIS can be viewed as a framework on which to build applications, such as the mapping and spatial analysis functions of comprehensive planning. This section describes the components of that framework – the foundation and beams that give WLIS overall form. The main components of the WLIS framework include software functions, a database design, a set of standards, and a user interface. The software functions, general characteristics of the database schema and standards are described below; further specifications will emerge as part of the detailed system design process. The Team firmly believes that metadata and data content standards are critical components of WLIS; specific standards will need to be identified before and during the detailed design stages. Since the user interface will be designed in the first phase of the project and will evolve as the system matures, it is not specifically addressed here.

WLIS Software Functions

The general model that the Team used to identify the functionality of the software components relies on producers generating data that is accessed and processed by WLIS, and provided by WLIS to end users in forms that can be used with commonly available analysis and display software. A further discussion of this model is found in Appendix K. Using this model, the Team determined that the key software functions of WLIS are to locate, acquire, convert and disseminate data in forms useable and understandable to end users.

1. Query Processing. For spatial queries, jurisdiction-based bounding may be sufficient, though bounding rectangle support (interactive on-screen or coordinate based) would be more useful to some users. Jurisdiction-based bounding could also be done with text input or pick-lists. Since some level of metadata will exist for any WLIS-retrievable data, selection can be done through key-word searches or through pick lists of available data. Key-word searches using standard Internet search tools would expand the capability of the system to find data and documents, considerably extending the utility of the system for power users and application developers.

2. Searching. WLIS will contain metadata and indexes of documents and spatial data of "Level I" participants which can be searched with standard database management tools to return information to users about the existence of records. Similarly, "Level II" data and accompanying metadata that are stored at a WLIS node can be searched with standard database management tools. An Internet search engine will be needed to find "WLIS-linked" data stored in remote locations and/or accompanying metadata. It will also require ftp and possibly other Internet transfer tools to retrieve data for users.

3. Indexing. Since much of the data useful for WLIS remain relatively stable over time, it will be possible to build indexes of available data (data from all levels of participation). Robust and up-to-date indexes will substantially reduce the need for sophisticated search tools for most user queries. Because indexes will contain at least minimal metadata, they will provide users with enough information to consider whether data (or full metadata descriptions) are worth examining in more detail. Indexes should include location and subject attributes or cross-references.

4. Format Conversion. At least for spatial data, it is expected that WLIS will provide data in standard formats. Even for other kinds of data such as text or image documents, it might be necessary to limit the output to common formats such as .pdf and .jpg. The implication is that at some point it will be necessary to select a limited number of input and output formats supported by WLIS, and to make sure the necessary conversion utilities exist. Limitations on input format put the onus on data creators to write to a standard format; fortunately, input data conversion paths are known for most or all the GIS software in common use in Wisconsin. Output format limits, however, are based on logistic constraints and it may not be possible to support more than a few. The chosen formats should support basic spatial data models – area, line, and raster-based approaches. ArcView Shapefiles, AutoCad .dxf files, and geo-TIFF files would seem to be the likely candidates. Text-based documents could be provided as .pdf or ascii files. Database tables may need to be provided in both text format (e.g., comma-delimited ascii, fixed length) and in one or more common database formats (e.g., Dbase, Access).

5. Datum/projection Conversion. Ideally, the system should be able to convert geographic data between latitude/longitude, county coordinates, Wisconsin Transverse Mercator, Universal Transverse Mercator, and State Plane Coordinates. It should support NAD'27, NAD'83, and NAD'83-91. Based on experiences with *WISCON* and other conversion packages, there may be some limitations in what can be fully supported.

6. Classification Conversion and "Cross-walk Tables". It is not uncommon to map the same data objects with different classification systems. For basic geographic data, starting with the foundational elements, WLIS should have a standard set of geographic objects and accompanying attribute schemas. To the extent possible, these should be based on existing standards and common professional practice. This approach will be used for non-spatial data, as well. Terms and meanings should be described in sufficient detail such that a data producer can "map" their data into the WLIS standard objects. Through collaboration with major data providers, cross-classification tables should be developed to convert data from data creators' schemas to the WLIS-standard objects and attributes. Such cross-classification – or cross-walk - tables could be used in batch processing to convert entire data holdings into WLIS-supported forms, or could be used interactively in data retrievals for small or disparate data holdings. This is discussed in more detail below.

7. Standards Adherence and Compliance Checking Tool. WLIS must rely on standards for metadata, data and reference systems. To effectively promote the use of standards within the data creator community, effective standards education and incentives may be necessary. One component of the standards promotion effort is the development of software to create data in standard forms and help ensure compliance with standards. The software for creating FGDC-compliant metadata is a prime example of this.

8. File Transfer. WLIS may provide whole data sets in a limited number of spatial and non-spatial formats. Entire files of data are transferred and users; software provides the capability to analyze and display these data. Such file transfers can be made

nearly transparent to the end user, mediated by underlying software using file transfer protocol (ftp) based methods. The major design decisions will be choosing appropriate file formats for transfer. The choice is between the official federal standards (Spatial Data Transfer Standard) or any of several commercial packages such as ArcView "Shapefiles." For some kinds of data such as images in .tif format, transfer using .html, the web language, will be sufficient.

9. Mapping. Transfer of pre-formatted images of spatial data (i.e., already created maps in .jpeg or .gif formats) can be handled similar to file transfers with .html and ftp tools. Software for interactive retrieval and display of spatial data as thematic layers, known as WebGIS, will require considerable additional effort however. The software to support WebGIS has only been commercially available for a few years, and is rapidly evolving. It will require additional investigation during the first project phase to determine which packages are most suited to the WLIS environment. It is also likely that adding this capability to WLIS will require additional servers for Internet mapping services and for raster map services.

Database Design

A WLIS database design will organize known sets of data into a set of formats, tables and relations. The WLIS "database" consists of highly dynamic sets of data, developed and maintained in different formats, emanating from different intents, locations and purposes. To the extent that it can be described at this point, the WLIS database design is rooted in the system output side, since WLIS will support a limited set of output formats and objects. With a focus primarily on what comes out of the system, the WLIS database design consists primarily of data lists and indexes of available data, and standards guiding how data are acquired, processed and presented. A database design element necessary for the successful functioning of WLIS is a mapping of the WLIS nodes, including information about hardware, software, and network location; this is needed to access information across the WLIS environment and to support the load balancing needs of a distributed system.

Standards

The institution of a number of standards constitutes a critical element of the WLIS design. Defining the standards serves the same purpose as detailing form and content in traditional database design. Different levels of data standards will correspond to the different "levels of participation" in WLIS. Therefore, the standards needed to pass data into and through WLIS will vary. In general, these will be based on standards already adopted by state and federal agencies, and on commonly accepted professional practices. WLIS should have an on-going initiative for identification, development, promotion, and enforcement of standards.

Documentation of data – spatial and non-spatial - through the mechanism of metadata collection is the lynch-pin of WLIS. Without metadata, the heterogeneous collection of data envisioned as components of WLIS cannot be located, acquired, or manipulated in any meaningful way. In a sense, extensive development of metadata is the engine of WLIS.