

**STATE OF VERMONT
CONCEPTUAL SYSTEM DESIGN**

**Final Report for Phase II of
Vermont's Comprehensive GIS Strategy Study**

Submitted to:

**David Healy
Office of Policy Research and Coordination
Pavilion Office Building
109 State Street, Fifth Floor
Montpelier, Vermont 05602
(802) 828-3326**

Submitted by:

**PlanGraphics, Inc.
202 West Main Street, Suite 200
Frankfort, Kentucky 40601-1806
(502) 223-1501**

**and
The Cavendish Partnership
Main Street
Ludlow, Vermont 05149
(802) 228-5517**

**Contact:
Peter L. Croswell, Vice President
Hugh Archer, Project Manager**

February 27, 1989

**Revised:
March 28, 1989**

EXECUTIVE SUMMARY

This Phase II Report is being submitted to the Vermont GIS Oversight Committee pursuant to a contract for preparation of a comprehensive strategy for development and use of a Geographic Information System for Vermont. This report continues the documentation of information collected by the Oversight Committee, PlanGraphics, and the Cavendish Partnership and contains recommendations, technical analysis, and issue identification necessary for the affordable and timely progress for GIS development in Vermont.

The Vermont Municipal and Regional Planning and Development Act, as amended by the Growth Management Act (Act 200), authorized the establishment of a Vermont Geographic Information System to provide maps and other decision support analytical tools to local and regional government agencies. Land use planning for appropriate development of Vermont's natural resources was defined in terms of legislative goals. The information sharing network anticipated for all units of government in support of these land use planning goals is best suited to a GIS solution, and the considerations presented in these reports provide a framework for that statewide information network.

The Phase I Report focused on the GIS "needs determination," and documented relevant experiences in other states, proposed GIS applications chosen and defined based on interviews with personnel from state agencies, and regional and municipal government that will be the ultimate supporters and users of the Vermont GIS. Initial work on the characterization of users, organizational issues, staffing, system configuration, and data quality standards were also presented in the Phase I Report. Interim support for the software selection process was provided to the Oversight Committee, including development of Guidelines for GIS Software Demonstrations. An interim report examining the issues raised by public access to the Vermont GIS was prepared. This report includes a proposed system for characterizing levels of GIS access, a cost model for establishing prices for commercial products and services that will be available from the Vermont GIS, and an analysis of legal issues that arise from efforts to control access and market government "owned" information processing services.

The Phase II Report covers the remaining tasks specified in the contract for services. It is focused on system design issues in three general areas: Organizational issues are examined and recommendations are made for a phased institutional development to support Act 200 information exchange, and to make the most distributed access to the Vermont GIS possible within budget and schedule limitations of Act 200. Next, database development is examined including discussions of mapping standards, data standards, and conceptual database design requirements for priority applications, data conversion methodologies, and cost estimates. Finally, the Phase II Report provides an analysis of computer hardware needs for the Vermont GIS, conceptual GIS configurations, and cost estimates.

TABLE OF CONTENTS

<u>Title</u>	<u>Page</u>
Section 1: Introduction	1-1
Section 2: Organizational Issues and Institutional Relationships	2-1
Introduction	2-1
GIS Interactions Between State, Regional, Local, and Other Organizations	2-1
GIS Organizational Home	2-2
Consolidated GIS Oversight	2-5
Policy Setting Group	2-5
Technical Subcommittees	2-6
GIS Agreements	2-9
Data Maintenance and User Access Policies	2-10
Data Maintenance	2-10
User Access	2-10
State Agency Roles	2-11
Overview	2-11
Database Updates	2-12
Shared System Funding	2-13
Interagency Organization	2-13
Regional Commission Roles	2-13
Local Government Roles	2-14
University of Vermont Role	2-15
Organization Development Phases	2-15
Interim Phase	2-15
Final Phase	2-16
Next Organizational Steps	2-19
Recommendations for Local, Regional, and State Actions	2-20
Local Level	2-20
Regional Level	2-21
State Level	2-21
Private Sector Roles	2-22
Potential Private Sector Roles	2-22
Status of Geographic Information Use in the Private Sector	2-22
Private Sector Participation in the GIS	2-23
System Access	2-25
Schedule for Private Sector Cost Recovery: Considerations	2-27
Section 3: GIS Database Standards	3-1
Introduction	3-1
Data Standards	3-1
Organizational Overview	3-1
Data Standards in Other States	3-2
Minnesota	3-2
Florida	3-3
Utah	3-4
North Carolina	3-5
Data Standards in Vermont	3-5
Establishing State- and Parcel-Level Databases	3-6
Documenting the Database	3-8
The Next Step	3-9

TABLE OF CONTENTS (continued)

<u>Title</u>	<u>Page</u>
Section 4: Concepts in Database Development and Conceptual Database Design.....	4-1
Introduction	4-1
GIS Database Concepts.....	4-1
Database Layering	4-2
GIS Database Components	4-2
Data Element Relationships.....	4-4
Base Maps	4-5
Geodetic Control.....	4-5
Overview of the GIS Database Development Process	4-6
Vermont's GIS Database	4-7
Local-Level Base Map.....	4-8
State-Level Base Map	4-8
Conceptual Database Design	4-9
State-Level Conceptual Database Design.....	4-11
Local-Level Conceptual Database Design.....	4-20
Database Update Procedures.....	4-28
State-Level Database Update	4-28
Local-Level Database Update.....	4-29
Section 5: Data Conversion Techniques and Database Development Costs and Priorities.....	5-1
Introduction.....	5-1
Data Conversion Techniques.....	5-1
Data Preparation Processes	5-1
Photogrammetric Compilation.....	5-2
Trace Digitizing	5-2
Coordinate Geometry (COGO).....	5-11
Scanning	5-11
Converting Existing Digital Data	5-11
Tabular Data Entry.....	5-12
Image Classification.....	5-13
Data Conversion Cases, Methods, and Issues for Vermont.....	5-13
Specific Data Conversion Cases	5-13
Database Development Cost Estimates and Schedule.....	5-17
Data Conversion Service Alternatives	5-20
Database Development Priorities	5-22
Section 6: Conceptual Geographic Information System Configuration	6-1
Introduction.....	6-1
Hardware and Software Device Needs	6-1
Geographic Distribution of Users.....	6-2
Hardware and Software Needs in Response to Stage I Applications..	6-2
Phased System Acquisition in Response to Phased Application Development	6-3
Conceptual System Configuration.....	6-4
Overview of Stage I Configuration	6-4
Overview of Stage II Configuration	6-4
Stage I Conceptual System Configuration.....	6-4
Stage II Conceptual System Configuration	6-15
Appendix A: UVM - SNR GIS Data Sets	A-1

TABLE OF CONTENTS (continued)

<u>List of Tables</u>	<u>Page</u>
Table 2-1: GIS Interactions Among Vermont Organizations	2-3
Table 4-1: Conceptual Database Design for State-Level Data Layers.....	4-12
Table 4-2: Conceptual Database Design for Local-Level Data Layers.....	4-21
Table 4-3: Suggested Database Update Responsibilities for State-Level Data Layers.....	4-30
Table 5-1a: Suggested Data Conversion Approach for State-Level Data Layers ...	5-3
Table 5-1b: Suggested Data Conversion Approaches for Creating Local-Level Data Layers	5-7
Table 5-2a: Estimated Costs for Local Level Database Layers	5-18
Table 5-2b: Estimated Costs for State Level Database Layers	5-19
Table 5-3: Candidate Data Layers for In-house Data Conversion.....	5-21
Table 6-1a: Stage I Configuration Cost Estimates for State Configuration	6-17
Table 6-1b: Stage I Configuration Cost Estimates for Regional and Local Configuration.....	6-18
Table 6-2a: Stage II Configuration Cost Estimates for State Level	6-26
Table 6-2b: Stage II Configuration Cost Estimates for Regional Level.....	6-27
Table 6-2c: Stage II Configuration Cost Estimates for Local Level.....	6-28

List of Figures

Figure 2-1: Vermont GIS Organizational Structure - Interim Phase	2-17
Figure 2-2: Vermont GIS Organizational Structure - Final Phase.....	2-18
Figure 4-1: Map Database Layering Concept.....	4-3
Figure 4-2: Attribute Data - Map Feature Linkage	4-4
Figure 4-3: Topological Structure.....	4-5
Figure 4-4: 1:24,000 Scale Digital Line Graph Coverage for Vermont	4-10
Figure 6-1: Stage I Configuration Overview	6-5
Figure 6-2: Stage II Configuration Overview	6-6
Figure 6-3: Agency of Administration Stage I Configuration	6-9
Figure 6-4a: Agency of Natural Resources Stage I Configuration	6-10
Figure 6-4b: Agency of Human Services Stage I Configuration	6-10
Figure 6-4c: Agency of Development/Community Affairs Stage I Configuration...	6-11
Figure 6-4d: Agency of Transportation/Planning Department Stage I Configuration.....	6-11
Figure 6-5: University of Vermont Stage I Configuration	6-12
Figure 6-6a: Regional Planning Commissions Example Stage I Configuration	6-16
Figure 6-6b: Vermont Cities/Towns Example Stage I Configuration	6-18
Figure 6-7: Agency of Administration Stage II Configuration	6-21
Figure 6-8: Agency of Transportation Stage II Configuration.....	6-22
Figure 6-9: Agency of Natural Resources Stage II Configuration	6-23
Figure 6-10: University of Vermont School of Natural Resources and Agency of Human Services Stage II Configuration	6-24
Figure 6-11a: Regional Planning Commissions Example Stage II Configuration	6-29

SECTION 1 INTRODUCTION

The Phase II Report (System Design) presents a conceptual design for the Vermont GIS based on system applications defined and grouped into priorities in the Phase I Report (Needs Determination). The Phase II Report includes discussion of three aspects of conceptual design: organizational and institutional development, database design, and hardware configurations. It is to be read in conjunction with the Phase I Report and the interim paper, "Providing Access to the Vermont Geographic Information System: Legal Framework, Functional Access, and Cost-Price Model for Sale of Products and Services," which included examples of interagency contracts and statutory formulations from other states addressing access to government data.

Many decisions remain as to specific choices regarding hardware, staffing, parcel mapping and conversion, investment choices among development of databases to support priority applications, and institutional relations and organization. The considerations presented in these reports do not constitute a final "cookbook" detailing every step to implementation of the Vermont GIS. One of many possible specific recipes could be proposed that meets all the requested applications, but would require inappropriate assumptions of available time and money. These reports provide the Governor, Oversight Committee, and other GIS policy makers a framework for the GIS implementation strategy without attempting to limit the necessary flexibility that funding, schedule, and institutional considerations among the cooperating government agencies still demand at this stage of project development.

The benefits go up as the distributed use of the system expands, spreading the initial investment in data conversion, hardware, and training as more applications are provided to more users. Before this cost effective payoff occurs, limited funds must be stretched to provide basic tools for land use planning at the town level. An interdependent relationship exists between several identified startup tasks. Critical policy decisions are required in the following areas to proceed with implementation:

- Number of users to initially receive on-line, batch, or service bureau access to the Vermont GIS
- Amount and timing of financial investment in cash from the GIS fund and other existing commitments of resources
- Individual agency dedication of staff and facilities supported by existing agency budgets
- Identification of alternative funding sources for parcel mapping, commercial databases, distributed hardware, software, staff, and data conversion
- Development of a GIS service capacity for users where current local or agency resources will not allow direct access to the system
- Schedule for implementation of Act 200 applications
- Schedule for implementation of other cost effective agency applications not directly connected to land use planning.

This report focuses on Vermont GIS implementation options within the known and anticipated constraints of funding, institutional cooperation, and deadlines established by Act 200. The large front end investments, primarily conversion of information into usable GIS data, could well exhaust the current funds allocated for support of Act 200. The current Act 200 time frame for implementation allows little time for further deliberation of alternatives. Initially, Vermont might choose to limit funding of hardware purchases at the regional level, forego certain priority applications in favor of others, or seek a bond issue or other source of funds sufficient to provide more applications for more users quickly. The recommendations in this report provide system design targets for solutions to Vermont GIS implementation goals, but necessarily leave many routes open to interim policy decisions to build a working GIS.

Methods of cost recovery and legal issues impacting proprietary use of the Vermont GIS were examined in an interim report, "Providing Access To the Vermont Geographic Information System." Both Act 200 impact fees and the opportunity to share development and operational costs of the system with private sector users will in time offset certain initial conversion, hardware/software, and staffing costs. Compromises between a more intensive front end investment for establishing the system or an extension of the deadlines for making all Act 200 applications available should be made between now and 1990. Based on the current information collected over the past five months by PlanGraphics and The Cavendish Partnership, this report presents an analysis of the system design issues that will impact necessary GIS implementation choices :

- Obtaining completed parcel mapping for the state (now 50 percent complete)
- Database standards (acceptable minimum levels of accuracy, quality, and format)
- Conceptual database design (for state and local applications)
- Database conversion and maintenance methods and general cost estimates (phased based on need to generate base maps and support of priority applications)
- Hardware configuration and general cost estimates (phased based on near and long term targets capable of meeting Act 200 goals)
- Organizational options and implementation strategies (conditional on interagency agreements and structure of a policy committee).

The initial strategic goal will be to provide base maps for towns and regions adequate to allow a consistent statewide platform for land use planning. Attribute information tied to the maps will come from state sources and be updated and maintained through a state/local partnership. Local planning information will be collected by the towns, and state and regional resources will be devoted to fitting such information into the system allowing spatial analysis that will greatly enhance the quality of planning. Towns with automated parcel maps and support from a Regional Planning Commission with independent GIS capabilities will be able to achieve the benefits of more GIS applications much sooner than towns considering preparation of their first area parcel map. Choices between providing for consistent statewide evolution of this decision support system, and quick results for a limited jurisdiction from the initial investment will be prevalent throughout the implementation of the Vermont GIS.

Along with the natural values of the state's land, air, and water; information about land is one of Vermont's most valuable resources. Accurate and timely information can assist all levels of government in making good decisions to maintain and improve the quality of life

in Vermont. The distributed nature of government's land use decisions mandated in Act 200 demands that high quality data be made accessible to towns through an effective dissemination mechanism at reasonable costs.

The statewide implementation of GIS technology provides Vermont the opportunity to avoid the costs of redundant data collection, to provide for compatibility of information allowing for manipulation, display and analysis, and to provide for automated linkage between databases of different organizations. Vermont's GIS will provide a base for the capture of more useful data than has been practical in the past. It will allow the ability to see organizational impacts of land use decisions historically and to forecast future impacts. The system will allow for better assignment of costs and responsibilities for appropriate development in the state, and provide greater professionalism and efficiency in service delivery to the citizens and land use permit applicants. The requirement for GIS technology to support Act 200 planning will result in making use of Vermont's information resources for an overall improvement in the efficiency of providing government services for a much broader list of current and future programs.