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GIS Management Plan for the Lake Champlain Basin Program

Lake Champlain
Basin Program

Prepared by
Vermont Center for Geographic Information, Inc.
and
Associates in Rural Development

for
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GIS MANAGEMENT PLAN

LAKE CHAMPLAIN BASIN PROGRAM

Final Report

to the Lake Champlain Management Conference

submitted by

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EXECUTIVE SUMMARY

The Lake Champlain Special Designation Legislation charges the Lake Champlain Management Conference (LCMC) with the creation of a pollution prevention, control, and restoration plan

> *"to restore and maintain the chemical, physical, and biological integrity of water quality, a balanced indigenous population of shellfish, fish, and wildlife, recreational and economic activities in and on the lake."*

To help it fulfill its mission, the LCMC will have access to a wide array of data - both historical data and data that result from studies currently sponsored by the LCMC. Much of this data is spatial in nature, that is it refers to some characteristic or phenomenon that varies across the study area, such as locations of point and non-point pollution sources, land use patterns, distribution of wetlands, soil types, etc. Geographic information system (GIS) technology is a powerful analytical tool that can make a tremendous contribution to the integration and understanding of these diverse spatial data sets by allowing them to be "stacked", displayed, and manipulated in a variety of ways.

The Special Designation Legislation specifies that a Lake Champlain GIS be established to facilitate both the writing of The Plan and the long term management of the basin.

Taking advantage of GIS requires planning, funding, and specially trained personnel specifically assigned to the task. Recognizing the need for planning, the LCMC Technical Advisory Committee has created a Data Management Subcommittee and, within that, a GIS Working Group. New York Department of Environmental Conservation (NYDEC) and the Vermont Center for Geographic Information (VCGI) have conducted the GIS planning effort for the LCMC. To date this has consisted of:

- developing QA/QC procedures,
- inventorying GIS resources within the basin,
- inventorying existing spatial data within the basin,
- developing GIS standards and procedures,
- conducting a GIS User Needs Assessment, and
- writing a GIS Management Plan.

This is volume one of the LCBP GIS Management Plan. It is accompanied by two other volumes: the LCBP Handbook of GIS Standards and Procedures and the LCBP Data Inventory.

GIS will aid the LCBP in seven areas:

- Plan writing
- modelling
- research

- monitoring and planning by state agencies
- resource management
- education and outreach
- local planning.

GIS data, products, and services to support these seven areas can most efficiently be provided to the LCBP by a combination of:

- a GIS Service Center to coordinate database development, serve as a data clearinghouse, and oversee GIS product development, and
- the many existing GIS facilities in the region to perform specific data and product development, analytical, and programming tasks.

Via an open bidding procedure, an existing GIS facility in the basin should be selected to serve as the LCBP GIS Service Center. Its activities should be overseen by a GIS Advisory Board, which should be an expanded and more active GIS Working Group.

The LCMC should adopt the GIS mission statement, objectives, standards, policies, and QA/QC procedures proposed in this document. These should be re-assessed on an annual basis, along with the GIS needs of the LCBP.

Despite the wealth of digital data within the basin, there are almost no data sets that provide uniform basin-wide information at a scale and date that are useful for LCBP purposes. Building a useful, creditable LCBP GIS database should begin at once, starting with the base map layers (lake shoreline, basin boundary, political boundaries, surface water, and transportation) and land use/land cover (including wetlands). Other high priority data layers, as indicated by the Needs Assessment, are sub-watersheds, bathymetry, recreation facilities, slope, historic structures and sites, point discharges, population distribution, soils, and fish and wildlife habitat.

Database building activities must be accompanied by development of an efficient data distribution system. In addition to the detailed data documentation called for in the GIS standards, a Summary Data Catalog must be created, maintained, and widely distributed so that potential data users can become aware of the data available to them. Basic GIS software, such as ESRI's ArcView, should be installed at the LCBP office in Grand Isle, at VT ANR, NY DEC, and APA to facilitate data use by LCBP staff and state agency personnel. As the database grows, it will be necessary to reproduce copies of it (probably on CD-ROMs) for distribution to major data users.

With the exception of CD-ROM devices and ArcView, the GIS hardware, software, and expertise existing in the basin today are capable of fulfilling the GIS needs of the LCBP. What is lacking are funds to drive data development and management, and the coordinating mechanism to ensure that GIS activities are carried out in a logical and non-redundant fashion.

ACRONYMS

ANR	Vermont Agency of Natural Resources
APA	Adirondack Park Agency
APES	Albemarle Pamlico Estuarine Study
BPI	Bytes per inch
CAC	Citizens Advisory Committee
CAS	Chemical Abstract Service
CCOGIF	Canadian Council on Geographic Information Format
CCT	Computer Compatible Tape
CD-ROM	Cartridge disk read-only medium
DBA	database administrator
DEC	New York State Department of Environmental Conservation
DEM	Digital Elevation Model
DIMS	Data/information management system
DLG	Digital Line Graph
DOS	Disk Operating System
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute, Inc.
GIS	geographic information system
GPS	Global Positioning System
IJC	International Joint Commission
LCBP	Lake Champlain Basin Program
LCMC	Lake Champlain Management Conference
LCRC	Lake Champlain Research Consortium
NEIWPCC	New England Interstate Water Pollution Control Commission
NEP	National Estuary Program of U.S. EPA
NFLS	Northern Forests Land Study
NODC	National Oceanographic Data Center
NPDES	National Pollution Discharge Elimination System
NWI	U.S. Fish & Wildlife Service's National Wetlands Inventory
ODES	EPA's Ocean Data Evaluation System
PC	personal computer
PFT	Plan Formulation Team of the LCMC
QA/QC	quality assurance/quality control
RFP	request for proposal
RPC	Regional Planning Commission
SCS	USDA Soil Conservation Service
STORET	EPA's Water Quality Storage and Retrieval System
SUNY	State University of New York
TAC	Technical Advisory Committee of the LCMC
TIGER	Topographically Integrated Geographic Encoding and Referencing System (from U.S. Bureau of the Census)
TM	LANDSAT Thematic Mapper Imagery
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator Projection
VCGI	Vermont Center for Geographic Information
VGIS	Vermont Geographic Information System
WAN	Wide Area Network

CHAPTER 1. INTRODUCTION

I. PURPOSE

This plan guides the implementation of geographic information system (GIS) technology within the Lake Champlain Basin Program (LCBP). The LCBP was established by the Lake Champlain Special Designation Act of 1990 as a response to increasing concerns about water quality in the lake and is overseen by the thirty-one member Lake Champlain Management Conference (LCMC). One of its main missions is the development of a pollution prevention, control, and restoration plan for Lake Champlain and its basin.

II. THE STUDY AREA

The Lake Champlain basin is an 8,234 square mile watershed which includes parts of Vermont, New York, and Quebec. Almost half of Vermont, 48% (4611 sq. miles), 6% (3,047 sq. miles) of New York, and .1% (576 sq. miles) of Quebec fall within the basin. Over half (56%) of the basin is in Vermont. More than one third (37%) is in New York. The basin includes all or part of 11 counties and 146 municipalities in Vermont and 5 counties and 61 municipalities in New York. The Lake Champlain shoreline is 587 miles long, 65% of which is in Vermont, 31% in New York, and 4% in Quebec (Lake Champlain Basin Study, 1978).

Table 1-1. The Lake Champlain Basin

	Shoreline	AREA sq. mi.,	%	% of State/ Province
VT	382 (65%)	4611	(56%)	48%
NY	182 (31%)	3047	(37%)	6%
QU	23 (4%)	576	(7%)	0.1%
TOTAL	587 miles	8,234 sq. mi.		

III. THE GIS MANDATE

The 1990 Lake Champlain Special Designation Legislation states that:

> *"... the Management Conference shall publish a pollution prevention, control, and restoration plan for Lake Champlain...*
>
> *The Plan shall*
>
> • *identify corrective actions and compliance schedules addressing point and nonpoint sources of pollution necessary to restore and maintain the chemical, physical, and biological integrity of water quality, a balanced indigenous population of shellfish, fish, and wildlife, recreational and economic activities in and on the lake;*
>
> • *incorporate environmental management concepts and programs established in State and Federal plans and programs...*

> • *clarify the duties of Federal and State agencies in pollution prevention and control activities and — suggest a timetable for adoption by the appropriate agencies to accomplish such duties within a reasonable period of time;*
>
> • *describe the methods and schedules for funding programs, activities, and projects identified in the Plan...; and*
>
> • *include a strategy for pollution prevention and control that includes the promotion of pollution prevention and management practices to reduce the amount of pollution generated in the Lake Champlain basin ...*
>
> *For the purpose of enhancing and expanding basic data collection and monitoring in operation in the Lake champlain basin... USGS shall in cooperation with the appropriate universities and private research institutions, and the appropriate officials of the appropriate departments and agencies of the States of New York and Vermont, develop an integrated geographic information system of the Lake Champlain basin..."*

This GIS Management Plan answers two basic questions:

> **How can GIS assist the LCBP?**
> **How can this assistance best be provided?**

The LCMC has wisely invested in planning before embracing GIS wholeheartedly. Other similar projects have been driven by the technology itself rather than by a concept of an effective management process, with disappointing results. Nevertheless, given the many studies and resource management activities that have been and are being carried out by New York, Vermont, federal and local agencies and the data gathering they have entailed, it is impossible to avoid entirely a situation in which *"information is being created before any plans for its management are in place."* (Zuboff, 1985). The LCMC is far from starting with a blank slate. LCBP data management systems must deal not only with new data created under the sponsorship of the LCMC and other cooperating organizations, but also with the wealth of information generated in the past, and the systems that have been put in place to manage that information.

It should be emphasized that the intent of this study is to develop a GIS management plan which may be only one component of an over all data management plan. The Data Management Subcommittee of the Technical Advisory Committee (TAC) may need to develop additional data management strategies to address any needs not met by a GIS.

IV. ORGANIZATION OF REPORT

In this chapter, GIS definitions and concepts are presented, and the relevance of GIS to the LCBP is discussed. Chapter 2 describes the basin GIS resources: data, software, hardware, personnel, and programs. Chapter 3 describes the User Needs Analysis conducted for the LCBP, and the results. It also includes the Database Development Strategy. Chapter 4 describes a GIS Service Center capable of fulfilling the GIS needs of the LCBP. Other technical, procedural, and policy recommendations are presented in Chapter 5. A time line, costs, and funding for GIS implementation are presented in Chapter 6 along with a summary of recommendations.

The reader is also referred to the appendices and two companion documents: LCBP Handbook of GIS Standards and Procedures and LCBP Data Inventory.

V. WHY GIS?

A. GIS definition and concepts

Geographic Information Systems (GIS) is a computer technology that facilitates the collection, management, manipulation, analysis, and display of spatial features and their associated characteristics.

A *spatial feature* is anything whose location can be defined using a system of earth coordinates such as latitude/longitude. Examples include a sewage treatment plant, a river, a watershed or town boundary. During entry of data into a GIS, the locations of spatial features are very precisely specified based on a well-defined map projection and coordinate system. Because of the precise registration of each feature to a position on the earth's surface, data layers can be registered to one another, or effectively "stacked" within the GIS (Figure 1-1), making possible many types of spatial analyses that were either previously impossible or only accomplished by very cumbersome and labor intensive means (e.g., the stacking of transparent overlays).

A GIS can transform data derived from different map projections to a common map projection, and from different scales to a common scale, thus enabling data sets that previously were incompatible to be displayed and analyzed together.

Each spatial feature in a GIS database has associated with it *attributes* or descriptive information. For example, a road might have attributes such as route number, class, surface type, traffic volume, accident count, etc., all linked to the spatial data - the line segment representing the road - by means of a unique identification code (ID). Attributes can reside within the GIS proper or in a separate database as long as the unique IDs are maintained in both databases to relate attributes to their spatial features.

Because of this linkage of spatial and attribute information, a GIS can turn a static paper map into a dynamic electronic database that can be queried and manipulated. The spatial or geographic relationships between attributes can be displayed, quantitated, and analyzed in various ways. For example, given the availability of appropriate data, we can see such things as where hazardous waste disposal sites are located within the basin, and where they are in relationship to streams, rivers, and public drinking water intakes. We can determine what land uses upstream of a contaminated site that might be the source of contaminants. We can quantitate the amount of the basin devoted to specific land use activities. We can rank candidate sites for a new public access to the lake based on criteria such as size of the parcel, proximity to the shore, proximity to paved roads, current zoning, current land use, etc.

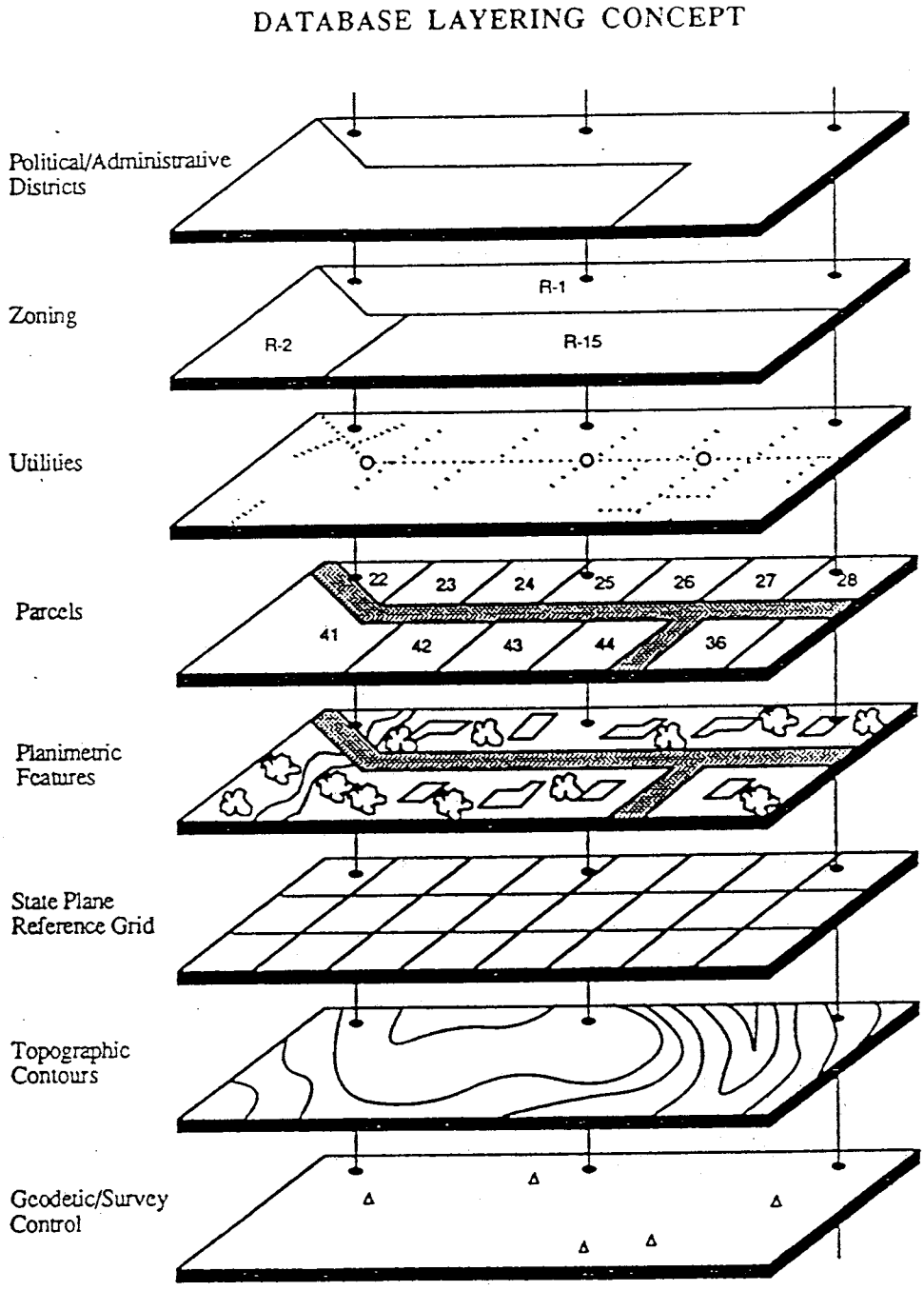

Figure 1-1: Because of the precise registration of each feature to a position on the earth's surface, data layers can be "stacked" within the GIS.

B. Relevance of GIS to LCBP

1. GIS as a Natural Resources Management Tool

Because of the power it provides in visualizing, manipulating, and analyzing spatial information, GIS is being used increasingly throughout the U.S. and the world in the management of natural resources. Some examples that illustrate the diversity of GIS applications include:

- long term monitoring of status and trends of major ecological resources (i.e., U.S. EPA's EMAP),
- developing forest management plans on both national forests and privately owned forest land,
- siting power plants, hazardous waste facilities, sanitary landfills, and other facilities with numerous physical, economic, and political siting criteria,
- developing range management plans based on forage condition, herd size and composition, and needs of indigenous people in Africa,
- prioritizing lands for protection based on a comparison of areas of high biodiversity with existing protected lands (U.S. Fish & Wildlife Service's "Gap Analysis")
- assisting traffic management and deployment of security personnel for both routine conditions and special events, such as the 1992 Summer Olympic Games in Barcelona (Alvaredo and Gomez, 1992).

The LCBP is typical of many resource management GIS applications: the study area is large (8,234 square miles) and the issues (water quality, recreation opportunities, fish and wildlife habitat, economics, etc.) span a wide range of disciplines.

2. EPA Policy

EPA policy requires that positional information (geographic coordinates) be collected and documented with environmental and related data (U.S. EPA, 1991). This means that nearly all descriptive data (e.g. water quality, recreational use, wetland characterizations, etc.) will have to be ascribed to a geographic location. Thus, nearly all data collected under the auspices of the LCBP will have the potential to be included in the LCBP GIS.
EPA policy also indicates ways in which GIS can improve management of EPA programs:

- *"improved access to [EPA], state, and contractor spatial data,*
- *better integration of environmental information for cross-media and cross-program data analysis,*
- *improved ability to determine status and trends of environmental problems in specific geographic areas,*
- *improved risk assessment capabilities,*
- *improved ability to set priorities and target regulatory actions with environmental data,*
- *better communication of environmental data in the form of maps and spatial data overlays."* (EPA OIRM, 1988)

3. Potential Roles for GIS in the LCBP

There are many potential roles for GIS to play in the Lake Champlain Basin both during the life of the LCBP (Phase I) and after the initial five year program is over (Phase II):

- provide spatial analyses and data for writing The Plan,
- support modelling,

- support research,
- support monitoring and planning,
- support of management actions,
- support of public education and outreach, and
- assist local planning.

The main difference between the two phases is the necessity of focusing on writing The Plan in phase I and on implementation in phase II. The emphasis of GIS activities will need to change from that of supporting research and planning to supporting management activities. Both phases will require a GIS database that is accurate, well-designed, well-documented, and well-managed.

a. Writing the Plan

One of the prime uses of GIS should be helping the PFT write The Plan. GIS will serve to integrate the results of the many LCBP participants' research and data gathering efforts. Whether by viewing hardcopy maps or data layers interactively displayed on a computer screen, the PFT will be afforded a view and appreciation of the basin that will be invaluable for understanding problems and envisioning solutions, and even predicting consequences of recommended management actions. GIS-generated maps will also play an important role in communicating the issues and recommendations presented in The Plan to the public.

b. Modelling

GIS data can be used as input to models (e.g. slope and land use data). GIS maps and interactive displays provide an excellent way to view model outputs. A GIS can store and analyze any new data layers that result from running a model. In addition, GIS can be used to help refine models by allowing the comparison of model results to field measurements. For example, the phosphorus loads being measured at the tributary mouths as part of the Diagnostic Feasibility Study can be compared to what is predicted in a phosphorus run-off model that is based on GIS layers such as land use, slope, and soil type. Observed discrepancies may indicate where the model needs to be refined.

c. Research

GIS will facilitate other LCBP research by providing well-documented, quality data that researchers in the basin can have confidence in using. For example, bathymetric data in GIS format can be used an input to hydrodynamic modelling. Maps of land cover, wetlands, population distribution, etc. can aid researchers in selecting sampling sites for field data collection. By showing where particular conditions coexist (e.g., wetlands degradation and a point discharge) GIS may stimulate new research into cause and effect relationships.

d. Monitoring and planning

GIS can help track changing conditions. For example, it can help document impacts to wetlands resulting from changes in surrounding land use. It can aid planning the selection of wetlands for acquisition or other means of protection based on ownership, zoning, adjacent land uses, proximity to the lake, habitat value, recreation potential, and other information in addition to the location, size, and type of wetland.

e. Management

By creating a picture of conditions "before" and "after", the effects of implementing management plans can be evaluated using GIS.

One of the classic uses of GIS is to facilitate site selection. For example, in determining appropriate sites for additional public access to the lake, a GIS could rank candidate sites based on type of road access, slope of site, size of site, vegetation types, zoning, adjacent land uses, etc.

f. Public education and outreach

"GIS is a good data management option. The mapping versatility gains public support and interest." (US EPA, 1990)

Indeed one of the primary products of the New England River Basins Commission's Lake Champlain Basin Study is the Lake Champlain Atlas (1978). Intended to be a resource planning document to be used in conjunction with the Lake Champlain Planning Guide (1976), it consists of a series of maps and accompanying text that serves as an inventory of natural resources in the basin and a summary of results of the two-year study.

GIS products can be an important resource foe LCBP education/outreach staff. Maps can quickly be re-scaled or altered in numerous ways to fit precise format specifications for slides, brochures, newsletters, press releases, etc. in addition to an atlas.

g. Local planning

Elevation data, converted to slope information by a GIS can be used by local planners in the development of zoning districts. Soils, wetlands, surface water, transportation and many other data layers will be of interest to regional and municipal planners.

As will be described in the next section, GIS is proving to be a powerful tool in several EPA programs that are similar to the LCBP.

4. The Experience of GIS in EPA's National Estuary Program

GIS plays a role in many EPA programs around the U.S., including its National Estuary Program (NEP). Collectively and individually the studies that comprise the NEP offer valuable lessons to the LCBP with regard to GIS implementation, because like the LCBP:

- they are administered by EPA,
- they focus on improving water quality,
- they involve large watersheds,
- at least in several cases, they include parts of more than one state, and
- most use GIS as part of their over all information management strategy.

The data management experiences of seven programs (Chesapeake Bay Program, Puget Sound Estuary Program, Albemarle-Pamlico Estuarine Study, Narragansett Bay Project, Long Island Sound Study, Buzzard's Bay Project and the San Francisco Estuary Program) are summarized in EPA's Final Report on NEP's Tier 1 Data Management Systems Summary (1990):

> *"All seven estuary programs... had at least one staff member dedicated to data management activities. Several programs stressed the importance of having one identified person who was responsible for the coordination of all data management activities. Even when data were managed at several locations, a*

central person with data management responsibility increased coordination and enabled data integration. In [one case] where a QA/QC officer was appointed, costs for data integration were significantly reduced.

"...[The programs] differed greatly in their commitment of resources to data/information management systems (DIMS) development or a long-term data management strategy. In the absence of a strategy for managing data, some of the early data gathering efforts were not well coordinated... Implementation of full-scale DIMS...was possible only when the management conferences were given the opportunity to review, comprehend, and modify the DIMS objectives. In other words, DIMS development progress was a function of how well the major proponent of DIMS could enlist adequate multiyear commitments of resources and staff from the management conferences.

"...One feature common to the majority of programs is a GIS. Another is a computerized index of data sets or information sources... All five [of the programs using GIS] use ARC/INFO as the GIS software. Each program uses their GIS for specific needs, which are not necessarily similar between programs. All programs use the GIS for presentation of spatial information, such as simultaneous overlays of ecological resource maps and observed contaminant levels... Spatial analyses should be a major value added to the NEPs by GIS implementation, provided that the underlying data are rigorous enough to support the tests..."

Many of these messages are discussed throughout this report. Specific technical and policy recommendations from individual NEP programs are included in the appropriate sections of this report. Because it has just completed its fifth year and the process of drafting its "Plan" the Albemarle-Pamlico Estuarine Study (APES) provides insight that is particularly relevant to the LCBP. This five-year study of the 12 million acre estuary in North Carolina and Virginia is similar to the LCBP in several ways:

- It was initiated in response to signs of deteriorating water quality.
- The goal of the study is to document what is happening in the waterbody, determine causes and sources, and develop strategies and public policies that will protect the resource.
- The primary output of the study will be a Comprehensive Conservation Management Plan which will "*recommend management solutions to preserve, maintain, and restore the estuary's quality.*" (Siderelis, 1992)

From the outset of the project, "*the program's Policy Committee determined that the ability to assess spatial data was critical to the study's success and that GIS technology should be an integral part of the information management program*" (Ibid). Information management responsibilities were assigned to North Carolina's Center for Geographic Information, an agency of the Office of State Planning, primarily because it is the agency which will assume the responsibility of implementing the strategies that emerge from the five year study including data management responsibility.

According to APES staff, even though GIS technology has become the keystone of data management for APES, GIS was not used as much as it could have been in the Plan writing process. This happened because questions to be addressed in the plan and the data needed to answer them were not sufficiently anticipated in the early phases of the program. As a result, data and analyses that the Plan writers would have liked to have presented to justify their findings and recommendations were not available to them. It was felt that had more emphasis been placed on anticipating data needs and on refining a database development strategy, better use could have been made of the GIS when writing the Plan.

The next chapter describes the GIS resources that exist within the Lake Champlain basin that may provide a foundation for a LCBP GIS program.

Chapter 2. GIS RESOURCES WITHIN THE BASIN

I. DATA INVENTORY

This section of the LCBP GIS Management Plan describes the data inventory of geographic data sets available in the Lake Champlain Study Area. VCGI conducted the data inventory with direct assistance from NYDEC and microDATA. NYDEC provided an independent review of a draft version of the data inventory and microDATA developed the executable database (GENDOC) for constructing the data inventory.

A. Survey Methodology

VCGI distributed a data inventory survey questionnaire and diskette to 95 organizations likely to have geographic-based data or maps that might be useful to the LCBP both in and out of the Lake Champlain Basin . The sources for these organizations came from the membership list of the LCMC TAC, the GIS Work Group of the TAC Data Subcommittee, and VCGI sources. The data inventory also built upon the *VGIS Data Catalog* - a comprehensive documentation of GIS data in Vermont.

A total of 26 questionnaires and diskettes were returned for inclusion in the data inventory database--some of which were team efforts. Follow-up telephone calls were made to the major organizations known to have data that would be useful. MicroDATA developed a CLIPPER-based executable database program called *GENDOC*, both for conducting the survey and for use searching or printing the data inventory.

B. GENDOC

The Lake Champlain Basin Data Inventory resides in a software independent executable database called *GENDOC*. Although paper copies of the inventory are available, they are not highly useful. The paper copy of the inventory would take over 600 pages. The summary version containing ten characteristics of each entry runs over 200 pages.

GENDOC is a comprehensive searchable database that works on any IBM compatible PC. *GENDOC* is expandable and easy to edit. Updates to the current data inventory are simple using this program. *GENDOC* contains up to fifteen (15) data characteristics or fields. The data record structure is illustrated in Table 1. Users can quickly ask to look at or print any information by one of twelve general data categories; organization name; or data location.

C. Summary Results

Currently over 1,000 data sets reside in the Lake Champlain Basin Data Inventory. This section includes general summary information on the subject matter, source organizations, formats, scales, feature types, and coordinate systems of the data sets listed in the database. Complete results of the data inventory are presented in another volume entitled, LCBP Data Inventory.

1. Subject Categories

The data sets cover a wide range of subject matter with specific topics too numerous to list. The following table lists the number of data sets covering each general category:

Cultural	230
Water Resources	201
Land Characteristics	162
Transportation	153
Administrative Boundaries	117
Biological Resources	87
Regulatory	60
Utilities	55
Not Yet Defined	50
Base Maps	34
Other	15
Climatological/Air Resources	13

2. Organizations

There are over 70 organizations listed as source in the inventory. The distribution of these organizations by public, private, and academic sectors is approximately as follows:

Federal Government:	8
State Government:	16
Local Government:	25
Academic Institutions:	5
Private Institutions:	10

3. Data Formats

The inventory contains almost 100 different data formats categories. However, many of these formats can be consolidated into approximately 10 categories. The data format is not listed for 535 of the data sets, with the most common data formats as follows:

Arc/Info:	~380
pcArc/Info:	~ 50
Computer Files:	~ 50
Hardcopy Maps:	~ 50
Computerized Databases:	~ 35

4. Scales

There is map scale information for approximately 170 of the data sets. The most common scales listed are as follows:

1:5,000 (~120)
1:24,000 (~50)
1:100,000 (~20)

The map scales listed range from 1:1,200 to 1:2,000,000.

5. **Map Coordinate Systems**

Map coordinate system information exists for approximately 100 of the items listed in the inventory. Universal Transverse Mercator (UTM) coordinates are listed for ~50 data sets; latitude and longitude are listed for ~20. Although not listed in *GENDOC*, the New York State data sets generally tend to use UTM coordinates while the Vermont data sets tend to use State Plane coordinates.

6. **Feature Types**

GIS data is usually categorized by type of geographic feature--point, line, polygon (area) or some combination of these. The current data inventory contains feature type information for only ~230 of the data sets. Of those listed, the most common feature types are:

Polygon: ~160
Point: ~100
Line: ~70

D. Deficiencies and Improvements

The inventory undertaken in this project has not identified every data source in the basin. This is the nature of conducting surveys. Ongoing follow-up will be necessary to make sure it is as comprehensive as useful. Someone is always creating new data. As soon as this data inventory is published, many other sources of data will become known. The LCBP GIS Service Center should take responsibility for adding new data sets to the inventory.

In addition, the development of a data classification system would help make the information in the database more useful to potential users. The rational for a data classification system comes from the fact these data come from many different sources, deal with a wide-range of subject matter, and are available in a variety of different formats. As a result of this diversity, there are considerable differences in the value of these data sets, both in terms of their application to LCMC activities and the level of effort required to incorporate them into a GIS. To help gauge the relative value of these data, a proposed classification scheme has been developed using criteria of suitability, compatibility, and accessibility.

Suitability can be established based on the extent to which these data are relevant to one or more of the targeted applications of the LCMC GIS, as measured by their subject matter, geographic extent, scale, and vintage. Compatibility can be established based on the degree to which these data conform to the file format used by the selected LCMC GIS, the QA/QC standards of the LCMC GIS, and the coordinate system used. Scale is also an indicator of compatibility between data sets. Accessibility can be established by the level of effort and expense required to acquire these data as indicated by their availability to the LCMC GIS, usage restrictions, available delivery media, and acquisition costs.

Based on these criteria, three classes have been developed that can be used to set priorities for the identified data sets on how well they support the objectives of the LCBP.

Class A Data Sets: Included here are all relevant data sets that can be incorporated into the LCBP GIS with minimal effort and expense.These satisfy all three criteria of suitability, compatibility, and accessibility. These data should be pursued as a high priority as they represent valuable data that can be obtained at low or no cost.

Class B Data Sets: Included here are all relevant data sets that require additional effort and/or expense before they can be incorporated into the LCMC GIS. These satisfy the criteria of suitability but not

those of compatibility and/or accessibility. These data should also be pursued as a high priority, depending on the availability of the resources (e.g. money, personnel, and equipment) needed to accomplish this.

Class C Data Sets: Included here are all remaining identified data sets not directly relevant to the currently defined LCMC GIS needs and/or data sets that cannot be incorporated into the LCMC GIS. These data should be used as a potential "pool" to draw from as additional data needs are identified.

However, because there are insufficient funds to evaluate all 1,000 sets, classifying the data sets according to these criteria will have to occur gradually over time as interest in a particular subject of data (e.g. wetlands) emerges.

II. GIS PROGRAMS

Before making recommendations to the LCMC on how it should proceed with GIS implementation, it was necessary not only to inventory existing data, but also to evaluate existing GIS capabilities within the Lake Champlain basin and in the surrounding region.

A. GIS Capabilities Survey

A questionnaire seeking information on GIS programs, mandates, standards, data access practices, GIS budgets, staff resources, hardware and software was developed. In early January, 1992, 76 questionnaires were mailed to potentially interested parties in the region including federal, state, and local agencies involved in GIS in Vermont, New York, and Quebec, as well as academic institutions and private consultants working in the two states. The mailing list was generated by members of the TAC GIS working group and included anyone who had expressed interest in being involved in, or kept informed of, GIS developments pertaining to Lake Champlain. During tabulation of the results there was follow up via telephone interviews with key individuals to expand on certain responses and to elicit additional information. Results are summarized and discussed below. The questionnaire and detailed results appear in Appendix D.

It is beyond the scope of this report to thoroughly describe each GIS program. Rather the intent is to highlight aspects of the programs that have implications for the LCBP based on the responses provided by the survey. Many of the written answers that were received were brief, and so an incomplete picture may be created of some programs. All respondents had an opportunity to review and comment on a draft report on the GIS Resources Inventory. Their comments are summarized in Appendix A and have been used to modify this final report where appropriate. Readers are encouraged to contact the appropriate respondent for additional information on a specific program.

B. General Results

By mid February, 39 replies had been received, for a response rate of 50%. The organizations responding to the survey are listed in Table 2-2. While not all respondents are located within the basin, they all are involved or have been involved in GIS projects and activities within the basin.

Nearly a third of the responses were from private consultants. Next best represented are state government and local/regional agencies. Most of the local agencies which responded were regional planning commissions in Vermont. They consider themselves not-for-profit organizations rather than local government agencies. One respondent, the Vermont Center for Geographic Information (VCGI) categorized itself as a combination of state agency, academic institution, and not-for-profit organization.

For reasons discussed below, it is grouped with state agencies. There is only one response from a utility and it has been lumped with the private consultants.

The level of respondents' interest in LCBP GIS activities is indicated by their answers to the preliminary question:

"Do you expect to interact in any way with the LCMC or the lake clean-up effort?"

Only one out of the 39 responding said "no". This was the same organization which did not anticipate using any data generated by the LCMC-funded activities. 87% of the respondents expected that digital or mapped data that they had created would be of value to the LCMC database. More than two-thirds of the respondents hoped to analyze data or provide some kind of consulting services to either basin researchers or managers.

Nearly 3/4 of the respondents indicated that, by their own criteria, their GIS facility was fully operational. Six facilities described themselves as being partially operational, two were in the planning stage, and three were undergoing or anticipating a major expansion. One state agency GIS expressed an uncertain future because of funding uncertainties.

To organize the remainder of the discussion of existing GIS resources, the responses have been grouped by sector: private consultants, academic institutions, local/regional agencies, state government, and federal government. Where appropriate, responses will be attributed to specific facilities. However, in the case of certain organizations (mainly the private consultants) much of the information is considered confidential and it would be inappropriate to attribute specific responses to individual organizations

Table 2-2. List of Respondents

academic institutions **6 responses (15%)**
SUNY Plattsburg Remote Sensing Laboratory
SUNY College of Environ. Sci. and Forestry (ESF), Syracuse
Cornell Laboratory for Environmental Applications of Remote Sensing (CLEARS), Ithaca
Middlebury College's Geology Department, and
University of Vermont's School of Natural Resources (UVM), Burlington 2 responses

federal government **6 responses (15%)**
National Geodetic Survey (Montpelier, VT)
US Fish & Wildlife Service (Burlington, VT)
US Geological Survey, Water Resources Div. (Albany, NY)
US Environmental Protection Agency (Boston, MA)
USDA Soil Conservation Service (Syracuse, NY)
USDA Soil Conservation Service (Winooski, VT)

local and regional agencies **7 responses (18%)**
Addison County Regional Planning Commission
Central Vermont Regional Planning Commission
Chittenden County Regional Planning Commission
City of Burlington, Dept. of Planning and Zoning
Clinton County Planning Office
Lamoille County Planning Commission
Rutland Regional Planning Commission

private consultants **12 responses (31%)**

Adirondack Lakes Survey Corporation, Ray Brook, NY
Associates in Rural Development, Inc., Burlington, VT
Applied Geographics, Inc., Boston, MA
DuBois & King, Inc., Randolph, VT
Camp Dresser & McKee, Inc., Cambridge, MA
Fugro McClelland (formerly IEP, Inc.), Portsmouth, NH
Mad River Modeling & Mapping, Warren, VT
Metcalf & Eddy, Inc., Woburn, MA
MicroData, St. Johnsbury, VT
New England Telephone, So. Burlington, VT
North Country Environ. & Forestry Mgmt., Concord, VT
Pinkham Engineering, Inc., Burlington, VT

state government **8 responses (20%)**

NYS Adirondack Park Agency
NYS Dept. of Environmental Conservation 2 responses
NYS Division of Equalization and Assessment
VT Agency of Natural Resources
VT Dept. of Forests, Parks, and Recreation
VT Division of Historic Preservation
VT Center for Geographic Information

C. Mandates, Budgets, Staffing

1. Academic Institutions

The academic institutions responding to the survey are listed in Table 2-2. The major missions reported by these GIS facilities are teaching and research and, secondarily, to perform regional inventories and analyses. All the schools responding do at least some contract or fee-for-services work for municipalities or other clients. None listed data archiving or distribution as a major purpose for the facility. Annual operating budgets were largely unknown or not available but figures of $100 - 125,000 were given by two respondents. Funds largely come from department budgets, but also from grants, federal and state funds, contracts, and user fees.

SUNY Plattsburgh's GIS facility is part of the Center for Earth & Environmental Science's Remote Sensing Laboratory. The staff consists of a manager and a lab technician and is fully operational. Their efforts are equally split between database building and consulting. Funding is provided from the Center's general fund and grants.

The GIS staff of the **SUNY Environmental Science and Forestry (ESF)** in Syracuse, NY consists of 8 individuals who are affiliated with the Northern Forest Lands Inventory (Faculty of Forestry) and the Mapping Sciences Laboratory (Faculty of Forest Engineering). Their GIS is fully functional. For the NFLI there is a principal investigator, a technical director, and three data entry staff. The mapping sciences lab has one assistant professor and two mapping specialists. The NFLI staff devotes 80% of its effort to database building and 20% to administration and project planning. Funding this year is approximately $200,000 and comes from a congressional appropriation through a cooperative agreement with the U.S. Forest Service.

The **Cornell Laboratory for Environmental Applications of Remote Sensing (CLEARS)** GIS staff consists of nine individuals: a GIS program leader, facility manager/database administrator, a student data entry position, and applications specialist, a GIS lecturer, and four to five graduate students. They devote approximately 60% of their time to GIS applications, 20% to database development, and 20% to project consulting. Funding comes from the SUNY system, external grants and contracts, and facility user fees. The mission of the CLEARS's GIS program is to advance the development and use of spatial data for environmental assessment and economic development programs in the New York Sate and the northeastern U.S. The GIS lab is fully operational.

Middlebury College's GIS lab is part of the Geology Department and is funded through the department. It is fully operational and has the twin missions of teaching and research. Its staffing levels and major activities were not indicated.

The **University of Vermont's** (UVM) primary GIS installation is within the School of Natural Resources and Continuing Education. It is fully operational and concentrates on research and development and education and training. Funding is derived from the university's general funds, user fees, and grants. There are three part-time staff: a facility manager, a database administrator/trainer and a PC manager/trainer. They devote 40% of their time to education and training, 40% to course development, and 20% to system management.

It should be noted that there are two other GIS facilities at UVM: VCGI (described below under state government) and the US Fish & Wildlife Service's GAP Initiative (described under federal government). To date no formal cooperative relationship has been established among them.

Compared to the private sector, the academic GIS community devotes more effort to building GIS databases, but still has little responsibility for the routine management and distribution of that data. Database building and analyses are often performed by students. Many different types of GIS applications are undertaken in support of faculty and graduate student research or as outside contracts.

2. **Federal Agencies**

The missions of GIS facilities that are part of federal agencies range from support of implementation and enforcement of environmental legislation (EPA) to providing information for state agencies and performing natural resource inventory and analyses (USGS).

The **Environmental Protection Agency (EPA)** Region I GIS facility in Boston is staffed by six individuals - a mix of EPA employees and contracted staff under EPA's 5 year nationwide support contract with Computer Sciences Corporation. There is an application manager, a technical manager and four GIS analysts. Approximately 60% of their effort is devoted to applications development, 20% to consulting on projects, 10% to database building, and 10% to technical support within the agency.

Their mission was defined broadly as supporting EPA's overall mission: the implementation and enforcement of national environmental legislation (e.g. Clean Air Act, Clean Water Act, etc.). The fully operational GIS center is part of the Information Resources Branch within the Planning and Management Division and has an annual operating budget of about $500,000 which comes from agency funds.

The **US Geological Survey (USGS)** District Office in Albany is part of the Water Resources Division. Its fully operational GIS is run by a staff of four: a GIS specialist, a hydrologist, and two cartographic technicians. Approximately 90% of their efforts are devoted to database building and 10% to policy formulation, administration, etc. Their mission is broadly defined as support for USGS

missions in research and mapping of geological and hydrological resources. Funding levels were not indicated, but major GIS uses within the District are supported by their own project funds. Minor GIS activities are supported by the District GIS section.

The **Vermont Cooperative Fish and Wildlife Research Unit** at UVM has recently acquired GIS capabilities. The system is fully operational and, at least initially, is dedicated primarily to database building (40%), analyses (40%), and data distribution (20%) in support of the Gap Analysis (biodiversity initiative) for northern New England. There is one full-time operator. The annual budget is approximately $50,000. The project is funded under a federal research order between UVM and the U.S. Fish & Wildlife Service.

The **Vermont office of the USDA Soil Conservation Service (SCS)** in Winooski has a partially operational GIS facility with several missions: input of National Resource Inventory Data, automation of conservation master plans for farmers, automation of soil surveys, watershed planning and modeling. Only a little progress is being made on these missions, however, due to staffing constraints. Although there is a staff of three: a resource inventory coordinator/database and facility manager, soil scientist/GIS specialist, and one data entry person, due to Congressional mandate their efforts are largely devoted to other activities. The GIS effort expended goes 100% to database building.

The **New York State Office of the SCS**, located in Syracuse has two GIS systems - one in the Information Resources Management (IRM) Section and the other in the Planning section. The IRM staff administers both systems and both are fully operational. Their missions are to provide GIS data collection, storage, and analysis to serve the needs of SCS in New York. They also provide technical assistance to SCS cooperators, such as the Soil and Water Conservation Districts. The Syracuse SCS GIS has six staff members - three for data entry, a soil scientist, a GIS specialist, and a database administrator who is also the system administrator. Their activities are 20% database building, and 20% hardware maintenance, 35% software support, 15% applications consulting, 5% data distribution, and 5% training. No overall budget figures for SCS's GIS activities in NY were available.

The **National Geodetic Survey's** office in Montpelier, VT, does not have in-house GIS capabilities but is an important resource for the LCMC GIS effort in the areas of mapping, surveying, control networks, and GPS. Its mission is to establish, develop, and maintain the national geodetic reference system (NGRS) which is the framework for many surveying, mapping, and land information systems. There is one staff person in Vermont, funded via federal appropriation.

3. Local/Regional Agencies

Of the local and regional agencies responding to the survey, only Clinton County did not have a GIS. However, a task force will soon be studying the issue of GIS capabilities for the county and it is interested in having the potential to access data generated by the lake clean-up effort.

The **City of Burlington Dept. of Planning and Zoning** was the only municipal respondent. The mission of this facility is to provide support for city planning projects and zoning administration, and to provide information to city council and other city departments. There is one full-time staff person who devotes approximately 30% of this time to database building, 40% to database maintenance and distribution, and 30% to applications and analyses. Funding is made available from the city's general fund by the city council.

The other local/regional agency responses came from the five **regional planning commissions (RPCs)** in Vermont that serve areas located within the Lake Champlain basin - the Rutland Regional Planning Commission, the Addison County RPC, Chittenden County RPC, Lamoille County RPC, and

the Central Vermont RPC. Vermont regional planning commissions received start-up grants from the state to become local VGIS Service Centers. Their mission is to provide GIS data and services to member municipalities. The focus is on providing GIS technical support and database building capability for municipal master plan development and regional planning activities. Four of the centers are fully operational; one is partially operational.

The GIS budgets of the RPCs range from $25,000 to $50,000 per year received from federal, state, and local funds and through grants and contracts. Typical staffing is two individuals but in at least several cases they are not assigned full-time to GIS activities. In one case, one individual is carrying the entire burden; in another only 25% of one person's time is devoted to GIS. Where there are two individuals assigned to GIS, typically one is a more technically trained GIS specialist and the other a cartographer or draftsperson. Several respondents indicated that their level of funding and staffing is inadequate for the successful operation of a GIS service center.

Database building is the primary GIS activity of most of the regional centers, comprising anywhere from 10% to 70% , with an average of 50% Most of the centers reported data distribution comprising 5 - 20% of their efforts and averaging around 10% One center devotes 20% of its time to education and outreach. The project consulting and applications work is done largely for member towns, but increasingly the RPC's are competing for contracts outside their own regions and for clients other than municipalities.

4. **Private Consultants**

Eleven of the private consultants responding to the survey maintain some kind of GIS facility. The budgets, organizational structures, and staffing of the private consultants vary widely because the size of these organizations ranges from one-person private consultants working exclusively in the field of GIS, to large international engineering and consulting firms for which GIS is one of many support functions. However, the private consultants indicated the provision of GIS products and services to paying clients as their major mission. They were reluctant to provide details of staffing and budget. The low annual budget provided was $150,000 and the high $850,000. Total GIS staff ranged from 1 to 8 individuals, although in the larger firms there was usually additional staff with some GIS support functions such as computer programming or system administration. In the cases where there were more than one GIS staff person, there tended to be one manager or administrator, several GIS specialists or analysts, and at least one cartographer or draftsperson.

Of the eleven private respondents, four did not indicate how their staff's efforts were distributed. Of the seven that did, database building ranged anywhere from 10% to 75% of their effort. Only two indicated any effort in data distribution and that averaged under 20% of the GIS effort. Six out of the seven indicated at least some effort expended in applications, analyses, or consulting. Only one consultant reported GIS education and training as an activity. Typically marketing and administration consumed about 50% of the effort.

5. **State Government**

New York and Vermont state agencies that responded to the LCMC GIS survey are listed in Table 3. No response was received from the Province of Quebec.

The two states' GIS facilities expressed a wide range of missions. They include:

- support of other departments and divisions within the agency,
- coordination of information systems for the agency,

- development of maps of entities regulated by the agency for town and regional planning purposes,
- distribution of data to other state and federal agencies,
- maintenance of a database and performing natural resources inventory and analyses for both regional and local planning, and
- revenue generation.

These agencies tend to act more as custodians and distributors of spatial data (both intra- and interagency and to the public) than do the private, academic, or local/regional sectors. State agency GIS annual budgets range from $25,000 to $500,000 with an average figure being around $300,000. Support derives primarily from agency funds or directly from the state general fund, but in some cases it is augmented by federal funds, grants, and contracts. GIS staffing is typically in the range of three to seven people.

On the New York side, the three leading agencies with GIS facilities are the Adirondack Park Agency, NY Dept. of Environmental Conservation (DEC), and NY Dept. of Equalization and Assessment (DEA).

The **Adirondack Park Agency (APA)**, located in Ray Brook, has a fully-operational GIS with a staff of five: 1 full time GIS operator and two part-time operators, two managers who devote a total of 1/10 person year to GIS, and anywhere from 0 - 4 interns assisting with data entry. 30% of their effort is devoted to database building, 50% to analysis, 15% to interagency consulting, and 5% to system maintenance. The APA uses its GIS to maintain property ownership information for use in relationship to APA regulations and the characterization of regional natural and cultural resources and features, and various operational and planning analyses. Funds come from the Agency General Fund Appropriation but the GIS facility itself does not have a separate budget.

At **NY Department of Environmental Conservation (DEC)** there is both a 'departmental' GIS in Albany to support and coordinate the use of GIS within the divisions and the individual GIS installations at the divisional level (e.g. Division of Fish and Wildlife in Latham). The departmental GIS is only partially operational. It provides technical support and guidance on GIS technologies and provides an environment for data sharing and minimizing data redundancies. The departmental GIS staff consists of eleven people - two geologists, a cartographer and 4 cartographic technicians, three management information specialists, and a manager. Approximately 75% of their effort goes to database building, 15% to analyses and system coordination, and 10% for computer programming. Annual GIS funding is roughly $500,000, which comes out of each Division's budget. Indirect funds have been used to support the central GIS.

The missions of the divisional GIS units are specific to the internal objectives of each division. For example, the goal of the Bureau of Wildlife GIS (within the Division of Fish & Wildlife) is to develop, implement, and maintain a comprehensive information management system for the collection, access, and integrated use of fish and wildlife habitat information statewide. This GIS is partially operational and is undergoing a major expansion. Staff time is spent 65% in database building, 5% in data distribution, and 30% in project consulting.

NY DEC has recently been evaluated by an outside contractor who created an agency-wide GIS Implementation Plan for DEC (ESRI, 1991). As of this writing, the agency is just beginning to implement the recommendations that resulted from this study.

At **NY Department of Equalization and Assessment (DEA)** the GIS staff consists of five individuals - a manager, a system administrator, two analysts, and one operator. Only 10% of their

effort is devoted to database building, with 20% going toward data sales and distribution, 20% toward map generation (in support of the agency mission), and 50% to external projects (contracts). The missions of the this fully operational GIS the support of agency operations and revenue generation. Its annual operating budget is approximately $300,000 coming from a combination of general fund and a special revenue fund.

Four Vermont state agencies participated in the LCBP GIS resource survey: the VT Center for Geographic Information (VCGI), the VT Agency of Natural Resources (ANR), the VT Department of Forests, Parks, and Recreation, and the VT Division of Historic Preservation.

The **Vermont Center for Geographic Information (VCGI)** is the successor to the Vermont Office of Geographic Information Services (OGIS). While it is a not-for-profit private corporation, housed at the University of Vermont, it is included here under state agencies because the majority of its trustees are appointed by the governor and because its staffing, database, equipment, and responsibilities are the same as those of the former state agency. In addition to support of education and research, VCGI's mission is the creation of a GIS database, standards, and procedures in support of local and regional planning in Vermont in accordance with VT Act 200, and the distribution of that data for use by municipalities and regional planning commissions. VCGI serves as the distributor for data sets developed by the VT Agency of Natural Resources (see below).

The VCGI staff currently consists of seven: a director, operations administrator, database administrator, database technician, applications specialist, technician, and an administrative assistant. VCGI allocates 30% of its effort to database development, 30% to database management (including data distribution), 30% to institution building, and 10% to applications development. This year's proposed budget is approximately $500,000 with over half to come from the state, about a fifth come from UVM, and the rest from projects and grants.

The **Vermont Agency of Natural Resources (ANR)** GIS provides GIS services for the departments and divisions of the agency. It coordinates information systems for the agency as well as distributes agency data to VCGI and federal agencies. It was established with start-up funds from VT OGIS. It has a GIS staff of two: a manager and a GIS assistant. In addition there are two or three full time equivalents preparing data for automation in other sections of the agency. Database building represents 60% of their effort, applications - 20%, technical support and consulting - 15%, and data distribution - 5%. The annual operating budget is estimated at about $140,000 with the funds coming from the general fund, grants, and fee for service.

The **Vermont Department of Forests, Parks, and Recreation**, within ANR, does not have its own GIS facility but provides many data sets to the ANR GIS and maintains many non-spatial databases of its own.

The **Vermont Division of Historic Preservation** (part of the Agency of Development and Community Affairs) maintains its own PC-based GIS as part of its Survey Program. It is being used to maintain inventories of historic structures and districts, and archaeological sites; to develop maps of archaeologically sensitive lands for town and regional planning, and to map areas that have been archaeologically surveyed. A pilot study is on-going. Two of the survey program managers act as database administrators and they rely on interns, volunteers and temporary employees for data automation. The Survey Program Managers devote 5 - 10% of their time to GIS activities. Funding come from the state general fund and from matching federal funds.

With these Vermont and New York state agencies, more than with the private, academic, and local GIS facilities, we see an emphasis on longterm database building and maintenance at a regional scale, and

on data distribution. A considerable amount of analytical work is done by some of the agencies and/or is contracted out. On the whole, there is a greater depth of staffing than at the regional planning commissions. There is often a great deal of uncertainty over funding levels from year to year because of reliance on the general fund and the appropriations process.

D. Hardware and Software

1. Software

The leading GIS software within the Lake Champlain Basin is Environmental Systems Research Institute's ARC/INFO. Of the thirty-five facilities with GIS capabilities, twenty-two (63%) have PC-ARC/INFO. Seventeen (49%) have host ARC/INFO (either for mainframes or workstations). The only GIS facilities which responded that do not have ARC/INFO are SCS in Winooski and SCS in Syracuse, where GRASS is the GIS software used. The second most widely used GIS software is IDRISI (20%). The other GIS software packages used in the basin are listed in Table 1 of Appendix D. Many of the respondents reported having other spatial data handling software, as well. These are listed in Table 2 of Appendix D.

Every GIS facility reported using at least one non-spatial database management software package (Table 3 of Appendix D). Many facilities use two or three. The most widely used are dBase and INFO, each with 22 users (or 61%). FoxPro is the next most popular with 8 users (23%).

2. Hardware

The predominant hardware type being used for GIS in the basin is the personal computer (PC) - either an IBM: 11 (30%), or an IBM compatible: 19 (53%). Next in popularity are the Sun workstations, including the SPARC stations: 8 (22%). Prime and DEC machines are equally represented at 4 (11%). Table 4 in Appendix D provides the figures for GIS platforms reported in the survey.

Not surprisingly, given the preponderance of PCs being used for GIS in the basin, the primary operating system is MS-DOS, with 24 users (67%). Next most common are the Unix-based systems with 14 (39%). The complete list of operating systems appears in Table 5 in Appendix D.

The peripheral devices associated with GIS work are present in the basin in quantity. Twenty-eight of the facilities have at least one digitizing tablet or table, and twenty-nine have at least one pen plotter. In addition, there are five electrostatic plotters, three scanners, and one film recorder. There are many printers of various types and capabilities.
Given the time constraints and understaffing reported by many of the facilities, particularly the RPCs and the small consulting firms, much of the GIS hardware and software within the basin appears to be under-utilized.

3. Data Formats, Data Storage, Communications

a. Data Storage Formats

Within the basin a variety of media are used for the exchange and long term storage of data. Table 6 in Appendix D summarizes the 38 responses tallied regarding data storage media. Diskettes (both 3 1/2" and 5 1/4") are the only data transfer medium used by all those responding to the question.

The next most widely used medium is the cartridge tape. As might be expected, diskettes and cartridge tape predominates for the private consultants and the local/regional facilities and the more expensive media predominate with the state and federal agencies where data sets are larger and data distribution is a higher priority activity. Many different types of cartridge tape drives are being used including: Helical Scan for Prime and Data General, 1/4" cartridge for Data General, 150 MB for AT&Ts, Sun 150 MB, QIC 40 MB, QIC 150 MB, DEC 4 MM DAT, DEC TK50, Unisys, Everex, Compaq DC-2120, Wangtek, Mountain DC 2000 and DC 4000, Colorado, Sytos, Unix, and Archive DC 600. Many of these brands are compatible with several of the others, some however, have limited ability to communicate with the others.

Reel-to-reel tapes (both 1600 and 6250 BPI) are being used in all five sectors but by relatively few organizations. Bernoulli boxes are relatively rare but are being used by all sectors except the private sector. The use of CD ROM is also relatively rare. Neither the academic facilities or the local/regional facilities are using CD-ROMS, most likely due to the limited functionality (read only).

b. Data Communications

Out of the 36 responding to question #21 regarding electronic communications systems in use, 25% said they currently have no such capability. One third of the respondents had access to a local area network (LAN) and one third used modems with regular dial-up telephone service. Three particular dial-up services were each listed once: Bitnet, Internet, and NYSERnet. The LANs mentioned were Ethernet (4), Novell (2), TCP/IP (2), DOS Pathworks (1), and the IEEE PC interface to the Prime (1). The responses are summarized in Table 7 of Appendix D.

c. Data Formats

When asked what medium is preferred for the exchange of digital data (question # 22), seven gave no response and four expressed no preference. Of those expressing a preference, cartridge tapes were preferred by 35%, diskettes by 19%, a dedicated phone line by 13%, and 9 track reel-to-real tape by 4%. See Table 8 in Appendix D.

Table 9 in Appendix D summarizes the responses regarding a preferred format for data sharing based on current and anticipated in-house capabilities (question #23). Not surprisingly, given the widespread use of ARC/INFO GIS software in the basin, the preferred data exchange format is ARC Export. Data in ARC Export format can be transferred readily among all platforms running ARC/INFO software. Similarly, the preference for ASCII format for the transfer of non-spatial data is logical. ASCII is a generic format that allows sites using different database management software packages to share their data. dBASE format is rapidly achieving the status of an industry standard as well. As more and more good translation routines become available this issue of data format is becoming less critical.

E. Standards and Policy Issues

The construction of a sharable, reliable database requires the establishment of data standards, quality assurance procedures, and thorough documentation. Through the questionnaire, we attempted to determine to what extent the GIS practitioners in the basin are aware of these issues and how they are dealing with them currently.

1. QA/QC Procedures

Question 26 asked about QA/QC procedures and standards utilized at the various facilities.

The most common response (4 out of 11) amongst the **private consultants** was adherence to the data standards and procedures published for the VGIS. Three consultants indicated that data standards and QA/QC procedures vary from project to project depending upon the needs of the client. One replied that standards and procedures are currently under development but that USGS mapping standards are generally relied upon. One consultant simply referred to "standard procedures" without elaborating.

Similarly, the **academic** community responded that standards and procedures are project specific and are largely determined by the granting agency. The Northern Forest Lands Inventory group at SUNY ESF are operating under the standards currently being developed for the Northern Forest Lands Study. Two of the academic facilities did not respond to this question.
All five of the **regional planning commissions** and the City of Burlington indicated that they follow the VGIS data standards and procedures.

Similarly all the Vermont **state agencies** responding indicated that they currently are, or plan to follow the VGIS data standards and procedures. In New York, the Adirondack Park Agency plans to adopt or adapt the GIS data standards and procedures developed for the LCBP. (The proposed LCBP GIS data standards and QA/QC procedures are largely based on the VGIS data standards and procedures. They are presented in Volume II of this LCBP GIS Management Plan)) The situation at NY DEC is more variable with some divisions maintaining their own standard data entry, QA/QC, and documentation procedures. The department as a whole hopes to utilize the LCMC standards and procedures. The NY Dept. of Equalization and Assessment has indicated that if no formal data standards or QA/QC procedures.

The **federal** GIS installations had a variety of responses. The National Geodetic Survey uses very rigorous procedures to determine the accuracy of monuments and other positional information provided to the public. However, at least in the basin, it is not involved in building and maintaining other GIS layers. SCS follows its own project specific digitizing standards. No comment was made about other QA/QC procedures. The Fish & Wildlife Service's Gap Analysis plans to use both USGS and the VGIS standards and procedures. The USGS District Office in Albany adheres to National Mapping Division standards. GIS activities at EPA Region I are guided by the document "IRM Lifecycle Guidance for System Design Level" and by EPA's national locational data accuracy policy of +/- 25 meters. Specific QA/QC procedures for GIS are currently under development.

2. Data Access

The predominant response of the **private consultants** regarding access to, and distribution of data (question #24) was that any data developed belonged to the client and was distributed at cost only with written permission of the client. One consultant simply doesn't distribute data, two had no policy, and two did not respond to the question.

Three of six **academic** facilities did not respond to the question. UVM indicated that data is freely available for the cost of duplication. At SUNY ESF policies are being developed. AT SUNY Plattsburgh there is generally public access to data depending upon the granting agency that funded data development.

Three of the **local/regional agencies** indicated that "public" data is available for the cost of duplication. However, one indicated that regional data is available to anyone but that municipal data is distributed only with the approval of the municipality. This respondent has also instituted a three-tiered pricing scheme for member towns, other non-profits, and the private sector. Two respondents indicated that

clients must provide written permission before their data can be released. One has no policy and one did not respond.

Among the state agencies there was one "no response" and one that simply indicated that it has a policy without stating what it is. The Vermont Division of Historic Preservation has no formal policy yet. However, the location of archeological sites and underwater historical sites is confidential under state law. VCGI has a detailed policy on public access, data distribution, pricing (cost of reproduction), liability, copyright, and priority of services. It publishes and periodically updates a data catalog. VCGI operates as a public corporation subject to Vermont's statutes on 'Access to Public Records,' and makes data available to all.

At NY Department of Equalization and Assessment, nearly all data are available for a fee. At NY DEC and the Adirondack Park Agency data access is governed by the NY Freedom of Information Act.

Among the federal agencies there are a variety of policies regarding data access and pricing. Data collected by the Fish & Wildlife Service Gap Analysis are available for the cost of reproduction. Similarly, at the National Geodetic Survey all data are public domain and a fee is charged for duplication. SCS in Winooski does not distribute data but has a cooperative agreement with VCGI to distribute soils data. At SCS Syracuse, data are free to cooperators but a fee is charged to others. EPA provides free access to data to public agencies except for enforcement sensitive or proprietary information. It charges a nominal fee to businesses requesting data. USGS in Albany does not share second-hand or purchased coverages (e.g. DLGs) or interpreted data without the approval of the director. Working coverages are shared only with cooperators. Control grids are freely shared.

3. Policy-Making Mechanism

In an effort to determine how the GIS facilities deal with policy issues and as a measure of how aware they are of the many legal, political, and organizational issues that attend GIS implementation, we asked each facility whether it had a policy making group or mechanism in place (question 25). Of the five sectors, the private consultants have demonstrated the least need to set up any formal mechanism. Of the nine responding to the question, five said they had no group or mechanism and one indicated that this was the responsibility of the client. Two said that policy matters are worked out informally by the GIS staff and one indicated that all policy is set by the firm's principals and/or board of directors. Most of the GIS consulting contracts in the basin consist of database building and individual analyses. With the scope, purpose, and methodology changing from project to project there is little need for contractors to develop policies. Rather they generally adhere to the standards suggested by the contracting agency and those prevailing in the state.

Only three of the academic institutions responded to this question. The Northern Forest Lands Inventory effort at SUNY ESF is governed by the policy decisions of the state's GIS Technical Committee that has been created to advise the NFLI work. The SUNY Plattsburgh GIS facility relies on the policies of the SUNY system and its Research Foundation. CLEARS, at Cornell, makes its own in-house policy and also participates in a policy committee that governs shared computing facilities on campus.

Of the six local/regional agencies answering this question, only one has no policy making mechanism in place. At two of the regional planning commissions the six-member executive committee makes policy decisions. At two others, policy decisions result from informal discussion of the commission staff.

Six state agencies responded to this question. At the Adirondack Park Agency there is an inter-divisional policy committee that sets guidelines and resolves operational issues regarding GIS. At NY Dept. of Equalization and Assessment there is an executive steering committee to direct policy. At NY DEC a department-wide policy group is planned, in response to recommendations contained in a recent GIS implementation plan commissioned by the department. The Vermont Agency of Natural Resources is also planning an in-house GIS coordinating committee. At the Vermont Div. of Historical Preservation, policy is determined by the two survey program managers and section chiefs. VCGI is guided by a Board of Directors of eleven persons, which is advised by a Technical Advisory Committee of fourteen representatives of major constituent groups (effective 1993).

Four of the federal agency GIS facilities indicated that they did not have any in-house mechanism for making policy. However, one of these - EPA Region I - is clearly governed by agency-wide policies and standards (US EPA, Office of Information Resources Management, 1988). USGS in Albany indicated that all policy originates at USGS headquarters in Reston, VA. SCS in Syracuse has Information Resources Management staff to handle policy issues.

F. Involvement with the Lake Champlain GIS

The results from question #27 indicate that nearly all the GIS practitioners in the basin belong to at least one relevant professional organization, and many belong to two or three. Of the facilities with an operational GIS only one indicated no participation in a professional organization. Nearly all the facilities have at least one staff member who belongs to an ARC/INFO User Group and some belong to several state ARC/INFO User Groups. The Urban and Regional Information Systems Association (URISA) is the second best represented group and the American Society of Photogrammetry and Remote Sensing (ASP & RS) is third. See Table 10 in Appendix D.

G. Participation in Professional Organizations

Twenty-nine of the thirty nine organizations responding to the survey indicated that at least one individual would be interested in the possibility of serving on an advisory board to the LCMC GIS effort. (Table 11 of Appendix D) Some of these individuals are already participating in the TAC Data Management Subcommittee or the GIS Working Group.

When asked what other ways of being involved in the LCMC GIS effort they felt were appropriate for their organizations (question #28) only five out of thirty nine had no response and only one saw no role for their GIS facility.

The private consultants indicated a diversity of strengths that they could bring to bear on LCMC GIS efforts. Both Applied Geographics and DuBois & King expressed their interest in providing a wide range of services related to GIS. Mad River Modeling & Mapping feels that there should be some projects that are suitable for small facilities. New England Telephone's most appropriate area of contribution would be in hardware and communications consulting.

Camp, Dresser, & McKee Inc. could provide on-line data access and maintenance on a host ARC/INFO installation via a 24-hr. VAX network. They are interested in the development and analysis of data related to non-point source pollution, GIS-based water quality models, hydrologic budget analysis, watershed protection plans for basin communities, and the assessment of lake ecology and biological communities.

Metcalf & Eddy Inc.is capable of providing support of resource inventory and field study activities, links to analytical models, planning, watershed protection, support for data collection, and analysis.

Associates in Rural Development, Inc. has expertise in the development of standards, applications, and database layers. Particular areas of interest regarding the Lake Champlain effort are preparation and presentation of maps and other products for public education and participation, input to models, analysis of physical and cultural data to determine viable management alternatives, and wildlife habitat analysis.

Fugro McClelland (formerly IEP, Inc.) indicated it wants to ensure access to data generated by the lake clean up effort (especially land use and soils data) for future projects, particularly aquatic assessment.

The academic GIS facilities have different research emphases and so envisioned themselves contributing to different facets of the lake effort. SUNY Plattsburgh is interested in constructing GIS coverages from multiple data sources, and interpreting airphotos and satellite imagery for basin analyses, particularly wetlands.
The UVM GIS staff (School of Natural Resources/Continuing Ed) feel that they could make the greatest contribution in the areas of research and development and in providing GIS training to individuals involved in other aspects of the project. The SUNY ESF GIS staff would like to be involved in any GIS-related project that is suitable for a small facility. They want to have access to the LCMC data and feel they could contribute to the data archiving and sharing effort. CLEARS expects to have only minimal involvement in the lake clean up effort because of their relatively distant location and because of the GIS talent resident within the basin.

Among local/regional agencies there was a general expression of interest in, and feeling of competence to perform, database building and management, as well as data distribution and analyses within their respective regions. The Lamoille and Addison RPCs are interested in participating in landuse/cover mapping if adequate funding and staffing are made available. The Rutland RPC indicated an ability to provide technical support to basin planners. Because of its extensive, high resolution GIS database, the Burlington Planning and Zoning Department is uniquely qualified to participate in assessments of urban impacts on the Lake Champlain.

Among the state agencies there was a general willingness to contribute the relevant data accumulated by them in the course of carrying out their mandates. For example, the VT Department of Forest, Parks, & Recreation can provide information on recreation, forestry, and state parks and lands to the LCMC database. The VT Agency of Natural Resources maintains a wealth of applicable data. In addition to mapping and analyzing historical/cultural resources data and monitoring the conditions of and threats to sites, the VT Division of Historical Preservation is interested in interacting with resource studies in other disciplines, e.g. toxics and geophysics. Similarly, NY DEC would contribute in-house data as needed for the lake effort. It could also review and comment on proposed data sources, data standards, and analytic models and procedures.

Only three state agencies expressed any interest in being involved in data distribution. The Adirondack Park Agency would like to be one of several centers providing access to the database but does not want to take primary responsibility for QA/QC of the data. The NY Dept. of Equalization & Assessment expressed interest in doing data exchange as well as GIS analyses and production of high quality output products (electrostatic maps). Only VCGI expressed interest in assuming the coordination and management role for the LCMC GIS effort, including data development, management, and distribution, as well as applications development.

None of the federal agencies expressed interest in playing a managerial role for the GIS effort. Because it has received no funding for LCBP GIS work, the USGS District Office in Albany has suggested an

advisory role for itself in support of a "GIS Service Center". It will supply hydrologic coverages and other data layers for modelling efforts.

The EPA Region I Office is prepared to offer technical support, data contributions, and applications development. The National Geodetic Survey Office in Montpelier will coordinate future surveying, mapping, and land information projects in the basin. Both the Syracuse and Winooski SCS offices indicated that they could provide data and expertise on soils, watersheds, and land use management. The Fish & Wildlife Service's Gap Analysis did not suggest a role for itself in the lake restoration effort.

In January 1992 the mission and functions of an LCBP GIS service had not been identified, yet over half of the respondents expressed an interest in assuming, either in part or as a whole, the responsibility for a "GIS service center" (question #3). Those answering "yes" are listed in Table 4.

Table 4. Respondents expressing an interest in assuming, either in part or as a whole, the responsibility for a "GIS service center" for the LCBP.

academic institutions
- SUNY ESF Northern Forest Lands Inventory
- SUNY Plattsburgh Remote Sensing Lab
- UVM School of Natural Resources GIS

federal government agencies
- EPA Boston
- National Geodetic Survey, Montpelier
- USGS Albany

private consultants
- Applied Geographics, Inc.
- Associates in Rural Development, Inc.
- Camp Dresser & McKee, Inc.
- DuBois & King
- Metcalf and Eddy, Inc.
- microDATA, Inc.
- North Country Environmental Forestry Mgmt. & Planning,
- Pinkham Engineering, Inc.

regional/local agencies
- Central Vermont RPC
- Lamoille County Planning Commission
- Rutland Regional Commission

state government agencies
- Adirondack Park Agency
- NY Dept. of Equalization & Assessment
- VT Agency of Natural Resources
- VT Center for Geographic Information
- VT Division of Forest, Parks, and Recreation

H. Respondents' Comments

Many helpful and insightful comments were offered by the respondents to the questionnaire (questions #30 and #31). They are synopsized below and range from recommendations on specific hardware, software, telecommunications devices, and data formats to concerns about database standards, documentation, and access. **The overwhelming sentiment expressed was the need for coordination of the overall GIS effort - whether it be via an existing organization or through a new entity created specially to meet the needs of the LCMC and long term management of the lake:**

- There should be one lead organization to oversee the collection and distribution of data.
- A service center is a must for the LCMC.
- There is a need for major coordination and no duplication of services already provided by VCGI and UVM.
- There should be essentially "one-stop shopping" for LCMC spatial data.

Several stated that such a service center must be located in the basin to adequately serve the LCMC, researchers, and the public. The specific comments were:

- The service center should be centrally located with low user fees to permit easy access to data.
- The clearing house must be located within the basin...
- The GIS service center should be located at an academic institution within the basin. Utilize existing capabilities of VCGI. NY State does not have an equivalent.
- The GIS service center should have a university home, ideally with VT and NY locations. The responsibilities could be split: one specializing in cartographic coverages (QA/QC), the other in image processing.
- The UVM School of Natural Resources should be the home of the GIS service center.
- VCGI should be the data clearing house, and their policies, standards, and procedures should be followed.

Other comments focused on the database:

- We need a uniform, recognized data base.
- Develop data at scale larger than 1:24,000 so it can serve local needs.
- The data should be consistent with VGIS standards and listed in the VGIS Data Catalog.
- Who will maintain and update the many relevant databases that already exist within the state agencies?
- There is a need to insure that there is mechanism in place to steward data for future use after the five years are up and the LCMC is done; or designate a permanent repository from the start. Otherwise data will become fragmented and inaccessible.
- The RPCs can be used to develop municipal databases which can be aggregated for purposes of LCMC.

Others recognized the need for a reliable source of funding for a viable GIS clearing house or service center:

- Design a service center for long-term viability commensurate with long term funding.
- There is a need for guaranteed GIS funding for the entire life of the LCMC.

- It will be difficult to find a qualified individual to perform the database administrator and other functions unless there is a guarantee of multiple-year funding. This role cannot be successfully carried out by a committee of volunteers.

The need for accessible, inexpensive, well-documented data was expressed:

- Have uncomplicated data access.
- The service center should have well-documented data standards, free data access.
- Design a thorough, easy-to-use data catalog.
- Data should be available to the public at minimal cost.
- Data access should have little or no cost to the requestor.
- A small fee should be charged for data access.
- We want access to the [LCMC GIS] data under the current VCGI pricing policy.
- Define data exchange standards for all participants. ARC/INFO is the logical choice.
- Ensure high quality data documentation. Keep the system as simple as possible; archive all data and coverages on optical or compact disks.

Hardware, software, and telecommunications suggestions:

- Use ARC/INFO because there is so much available data in this format.
- The service center should use ARC/INFO software and have workstation level hardware.
- Use RISC-based hardware (Sun).
- Have large disk and ROM capacity, and several high speed data access ports (1.5 - 45 MB).
- I want to be able to use a modem to scan and transfer data to a DOS-based computer for modelling and other analyses.
- There is a need for strong telecommunications.

Other comments and suggestions:

- Establish an accurate geodetic network for data accuracy.
  Encourage the use of new horizontal and vertical datums. Expand the establishment of high accuracy GPS reference sites to the entire basin.
- There is a need for extensive, low cost training programs.
- The LCMC GIS effort needs a vision statement.

III. SUMMARY

Is the GIS capability that has been documented to date adequate for the job? The major challenge facing the LCBP over the past year has been defining what the job of an LCBP GIS service entails. If the mission and objectives suggested in Chapter 4 are adopted, then the answer is "yes" with the notable exception of funding.

There is a great deal of GIS expertise and enthusiasm resident within the basin. Nearly all the GIS facilities in the region are interested in interacting with the LCMC GIS effort - as advisors, data developers, analysts, managers, or simply as data users. All the skills and equipment needed for a LCBP GIS, with the possible exception of mass data storage and transmission devices, exist within the basin. Much of the hardware, software, and peripheral devices existing in the basin are under-utilized. The challenge will be in managing and coordinating the provision of GIS services in such a way so as

to take full advantage of the existing resources for the purposes of the LCBP and thereby leave them strengthened to carry on in their roles after the initial five years of the LCBP have come to an end.

Many of the existing GIS facilities, by their own accounts, are under-staffed and under-funded. Funding levels are often dependent upon legislative appropriations and can change drastically from year to year. A major GIS effort, such as will be required to adequately support the long term management of the Lake Champlain basin, will require a multi-year commitment to at least a minimum level of funding.

ARC/INFO is the logical choice for a GIS software standard for the LCBP. It is the most widely used GIS software in the Lake Champlain basin and it is used throughout the country in EPA activities similar to the Lake Champlain cleanup. The preferred data exchange format within the basin is ARC EXPORT for spatial data and ASCII or dBASE for tabular data.

Because of the portability of GIS data in ARC EXPORT format among computer platforms, there is probably no need to specify certain hardware at this point, however for the centralized management of LCBP GIS data a workstation will be needed. Additionally, workstation and host versions of ARC/INFO have analytical capabilities not available in PC-ARC/INFO.

Existing data transfer capabilities consist of primarily cartridge tapes and diskettes. These may be adequate for the initial LCMC GIS effort. However, the needs analysis is showing that eventually resource managers want to have access to data at their desks. This may necessitate regular updates and bulk transfer of updated data to cooperating agencies.

There is a consensus that there should be one LCMC GIS service center located within the basin to act, as a minimum, as a data clearinghouse. There also is agreement that data should be cheaply and easily accessible to all and be described in a detailed data catalog.

Responses to the survey indicate that the VGIS data standards, documentation, and other procedures and policies are the most comprehensive and widely used in the basin. There is a also a consensus that the role VCGI has played in Vermont comes closest to that of a Lake Champlain GIS service center, although exactly what functions such a center should perform was not always defined by survey participants. It was the only organization responding to the survey to express interest in assuming the management of a Lake Champlain GIS center. VCGI was incorporated in early 1992 as the successor organization to Vermont's Office of GIS (1989-1992). Annual reductions in Vermont's GIS appropriations have created a growing challenge to diversify funding sources to support the statutory and executive mandate given to VCGI. Statutory support for VCGI extends until July 1994, and requires legislative evaluation of a Governor's report and recommendation on the viability of the public corporation / partnership model.

There are no major operational procedures, per se, that would hinder coordinated GIS activity in the basin. Differences in hardware devices, data formats, coding schemes, and data distribution policies are details that can be resolved. More difficult will be reaching compromises on spatial resolution of data, accuracy requirements, updating, and maintenance activities that both meet the objectives of the LCMC and serve the on-going needs of the various resource management agencies. Once specific objectives for the LCBP GIS effort are agreed upon and an efficient mechanism for coordinating and resolving both technical and policy matters is established, these issues can be successfully addressed.

Chapter 3: GIS NEEDS OF THE LAKE CHAMPLAIN BASIN PROGRAM

I. GIS USER NEEDS ASSESSMENT

A. Purpose of a Needs Assessment

A GIS User Needs Assessment is the first step in "mission-based planning" (US EPA, 1988) and is intended to answer the basic question: **Who needs GIS for what?** Usually an organization's GIS needs assessment is based on its mission statement. The mission statement and specific objectives guide a needs analysis in determining what data are to be collected (Antenucci, 1991). However, the LCBP is similar to many programs, such as the Puget Sound Estuary Program, in that goals and objectives emerged and were defined through the user needs assessment process rather than being articulated beforehand (EPA, 1990).

A needs analysis serves several purposes in the implementation of a GIS:

> *The needs analysis establishes a level of internal support for the project .... If an organization cannot organize and complete the needs analysis, then it is unlikely to complete the progressively more complex and demanding phases of ... implementation... Needs analysis provides a process for arriving at inter[agency] understandings about a project's purposes and limits... [It] clarifies the project's specific needs, as well as the specific information and computing resources available to commit to it...Finally, the needs analysis provides a detailed basis for designing the data base, which ensures that the project's original purposes are not forgotten in the myriad technical details of creating data dictionaries and file formats.* (Wells, 1991)

The importance of the needs analysis can be appreciated when it is realized that, on average, more than 70% of the cost of GIS implementation is in building and maintaining the database (Antenucci, 1991). The cost of hardware and software becomes relatively insignificant in the management of a long-term regional database. This is why it is crucial to focus on data needs and database design from the start.

B. Goals of the LCBP GIS User Needs Assessment

The specific goals of LCBP GIS needs analysis were to:

- identify the priority GIS applications (analyses and other products) and the data needed to support them;
- specify data characteristics (scale, resolution, level of accuracy, attributes, etc.) to the extent possible;
- identify overlapping data needs;
- determine which data needs are unmet by existing digital data;
- prioritize data layer development;
- estimate the funds needed and identify the most appropriate mechanism to develop and maintain priority data layers; and

- determine the need for other GIS services such as technical support, education, coordination of data development activities, data management and distribution, production of maps and other products.

C. Methodology

Because the Lake Champlain Special Designation Act states only that a GIS should be developed "... for the purpose of enhancing and expanding basic data collection and monitoring in operation in the Lake Champlain basin...", two additional documents were used to provide a framework for the GIS user needs assessment:

> "Goals and Objectives for the Pollution Prevention, Control, and Restoration Plan" (LCBP Plan Formulation Team, 1992)
>
> "A Research and Monitoring Agenda for Lake Champlain - Proceedings of a Workshop December 17-19, 1991" (Lake Champlain Research Consortium, 1992).

A preliminary identification of spatial data needs was provided in these two documents (Table 3-1, Table 3-2).

As the goals listed above indicate the primary question of the GIS User Needs Assessment was intended to be:

What spatial data will be required to accomplish the goals and objectives established by the PFT?

Input from potential users of an LCBP GIS was sought. Because of time and financial constraints, individual interviews of all the potential users was not possible. Instead, work sessions were scheduled with all the TAC subcommittees, the Plan Formulation Team, and the Education and Outreach Committee with follow-up with the subcommittee chairs. Most of the state, federal, and local resource management agencies who will be involved with Lake Champlain management in the long term are represented on these subcommittees.

In May/June 1992, letters were sent to each TAC subcommittee chair requesting him/her to set up a work session with the entire subcommittee or with a subset of it. Accompanying each letter was information summarizing GIS planning efforts that had gone on up to that date, the goals of the needs assessment, the specific questions to be addressed, and a list of the goals, and objectives and action items from The Plan that pertained to each subcommittee (see Appendix G). The chairs were also asked to assess whether his/her subcommittee would welcome a brief introduction to GIS concepts as background for the work session. (Several groups requested and received an introduction to GIS that ranged anywhere from 15' to one hour depending upon the participants' familiarity with GIS.)

Scheduling these work sessions in a timely manner proved difficult. Several committees were heavily involved in developing RFPs and had no room on their agendas for a GIS needs assessment until late summer. Several met only sporadically or not at all during the summer. Three committees lacked a chair during all or part of the duration of the needs assessment. Despite these difficulties, representatives of all groups participated in the needs assessment (see Appendix F). The level of participation, interest, and preparedness varied considerably among the subcommittees. As needed, follow up phone interviews occurred with appropriate representatives of the subcommittees in an attempt to elicit more specific information.

II. RESULTS - DATA NEEDS

At the time the needs assessment interviews were conducted, most subcommittees were not prepared to fully discuss specific data needs. They were very interested, however, in what GIS services would be available to them through the LCBP and how the data management process would work. This is a common situation in the implementation of new information technologies. Potential GIS users generally know little about GIS capabilities and limitations and, therefore, are at a distinct disadvantage when asked to make suggestions regarding the provisions of GIS services and database structure (Eason, 1988; US EPA, 1989). The newness of the LCBP organization, with its evolving procedures and policies, has also contributed to the difficulty in getting participants to focus on GIS database design issues.

Most of the sessions became general discussions regarding existing spatial data, the desirability of a data clearinghouse, the need for basin wide data standards, whether spatial data collection was intended to support planning, management, or both, how the Plan writing process would work, the fate of a database after the LCBP, etc. These concerns are presented more fully later in this chapter. Clearly the LCBP data needs are at an evolving stage. For this reason, the needs assessment should be an iterative process. The GIS data needs discussed below are preliminary and should be the focus of additional discussion and refinement both within and between the TAC subcommittees and with the GIS Service Center. Despite this uncertainty, several clear recommendations on data development priorities resulted from the Needs Assessment.

Not surprisingly, many of the spatial data layer priorities identified during the Needs Assessment process are the same as those identified by the Plan Formulation Team (Table 2-1) and during the December 1991 Research Conference (Table 2-3). Many of the participants contributed to all three efforts. For this reason "totals" in Table 3-3 should not be imbued with undue quantitative significance but should be used only to identify which data layers stand out as a high priority. The high priority layers (cited anywhere from four to eleven times in Table 3-3) listed in descending order are:

<u>base layers:</u>
basin boundary
lake shoreline
political boundaries
surface water
transportation

land use
sub-watersheds
land cover
wetlands
toxics point sources
historic structures and sites
bathymetry
slope
population distribution
recreation facilities/attractions
public lake access sites
soils
fish & wildlife habitat

Table 3-1. PRIORITY DATA LAYERS articulated in the goals and objectives document drafted by the LCBP Plan Formulation Team.

I. Water Quality
- A. nutrients
  1. point nutrient sources
  2. non-point nutrient sources
  3. watershed and sub-watersheds
  4. hydrography
  5. land use/cover
  6. slope
- B. toxics
  1. point sources of toxics
  2. non-point sources of toxics
- C. lake level
  1. flood levels
  2. areas under floodplain regulations

II. Living Resources
- A. fish and wildlife
  1. fish and wildlife ranges and habitats
  2. Natural Heritage Program inventory
- B. wetlands
  1. wetlands
- C. nuisance aquatics
  1. nuisance aquatic plant distribution
  2. nuisance aquatic animal distribution

III. Human component
- A. recreation resources
  1. recreation attractions, facilities, and services
  2. lake access sites
  3. cultural resources
  4. critical natural resources
- B. cultural heritage
  1. submerged and lake-related cultural sites

Table 3-2. PRIORITY DATA LAYERS suggested by research needs reported in A Research and Monitoring Agenda for Lake Champlain (Lake Champlain Research Consortium, 1992).

I. Recreation
- A. recreational resources

II. Cultural resources
- A. submerged and lake related cultural resources

III. Land and shoreline use
- A. land use
- B. local protection mechanisms
- C. zoning

IV. Nutrients and eutrophication
- A. [P] in lake and basin
- B. hydrography (including tributaries)
- C. land use

V. Toxics
- A. toxics sources and sinks

VI. Health issues
- A. toxics sources

VII. Atmospheric processes
- A. spatial & temporal variation in [pollutants]

VIII. Watershed processes
- A. P sources
- B. sub-basins
- C. land use/cover
- D. soils
- E. slope
- F. hydrography
- G. groundwater sources

IX. Hydrodynamics
- A. temperature profiles
- B. current profiles
- C. extent and duration of ice cover
- D. shoreline
- E. bathymetry
- F. groundwater sources

X. Wetlands
- A. wetlands inventory
- B. biota surveys
- C. elevation (potential flooding of wetlands)

XI. Fish and exotics
- A. lamprey habitat
- B. fish spawning habitat characteristics
- C. zebra mussel distribution

XII. Wildlife
- A. occurrences and distribution of wildlife
- B. land use
- C. habitats
- D. species-habitats associations
- E. beaver habitat

Table 3-3

	PFT Goals & Objectives Doc. (1)	Bi-State Workplan (2)		LC Resource & Monitoring Workshop (3)	TAC Subcommittees (4)								TOTAL
		New York DEC	Vermont ANR		Land Use / Lake Use	Economics	Recreation	Cultural Resources	Fish, Wildlife & Wetlands	Eutrophication/Nonpoint Source Pollution	Toxics	Physical Processes	
PHYSICAL LAYERS													
- Structure													
bathymetry				X			X	X	X			X	5
elevation		X		X						X			3
slope	X	X		X				X		X			5
contours								X					1
subwatersheds	X	X		X	X	X			X	X	X		8
flood plains			X										1
flood levels	X												1
aquifers				X									1
- Materials													
bottom types (sand, clay, etc.)									X				1
soils		X		X	X					X			4
- Processes													
aquifer / main lake exchange												X	1
river mouth flows												X	1
- Lake Water													
current profile				X								X	2
density gradients												X	1
salinity												X	1
phosphorous concentration				X									1
temperature profile				X								X	2
ice cover				X									1
- Sampling													
toxics sampling locations									X				1
stream gauging stations		X	X										2
lake water sampling data		X											1
meteorological data		X										X	2
solar insolation												X	1
atmospheric pollution concentrations				X									1
BIOLOGICAL LAYERS													
land cover	X	X	X	X	X		X			X			7
wetlands	X	X	X	X			X		X		X		7
fish and wildlife habitat	X	X		X			X						4
fish and wildlife ranges	X		X	X									3
beaver habitat				X									1
deer wintering yards									X				1
fish spawning habitat				X							X		2
rare & endangered species distribution									X				1
Natural Heritage Program inventory	X	X											2
exotic species distribution				X					X				2
nuisance aquatic plant distribution	X		X										2
nuisance aquatic animal distribution	X		X	X									3
fish stocking sites			X										1
protected areas			X										1
timber stands			X										1
eutrophication			X										1

Table 3-3

	PFT Goals & Objectives Doc. (1)	Bi-State Workplan (2)		LC Resource & Monitoring Workshop (3)	TAC Subcommittees (4)								TOTAL
		New York DEC	Vermont ANR		Land Use / Lake Use	Economics	Recreation	Cultural Resources	Fish, Wildlife & Wetlands	Eutrophication/Nonpoint Source Pollution	Toxics	Physical Processes	
BASE LAYERS													
land use	X	X			X	X	X	X	X	X	X	X	10
lake shoreline		X		X	X	X	X	X	X	X	X	X	10
surface water	X	X		X	X	X	X	X	X	X	X	X	11
political boundaries		X			X	X	X	X	X	X	X	X	9
transportation		X			X	X	X	X	X	X	X	X	9
CULTURAL LAYERS													
- Administrative													
population distribution		X	X			X	X						4
TIGER files						X							1
parcel ownership							X	X	X				3
zoning				X				X					2
ag districts		X											1
areas with floodplain regulations	X												1
areas w/local shoreline protection				X									1
- Land Use													
land use	X	X	X	X	X	X	X			X	X		9
land use change					X				X				2
hazardous waste sites											X		1
solid waste disposal sites		X	X								X		3
underground storage tanks			X										1
utilities infrastructure					X		X						2
hydropower dams			X										1
private wells			X										1
- Recreation													
recreational lake use			X				X						2
recreational facilities / attractions	X			X			X				X		4
lake access points	X	X	X								X		4
pump-out facilities			X										1
trails							X						1
critical natural resources	X		X										2
open space			X										1
- Cultural Resources													
historic structures and sites	X	X	X	X				X					5
submerged cultural sites	X			X									2
- Pollution and Potential Pollution Sources													
point nutrient sources	X												1
point toxics sources	X	X	X	X			X				X		6
nonpoint nutrient sources	X	X		X									3
nonpoint toxics sources	X	X		X									3
pesticides applications											X		1
agricultural practices											X		1
petroleum problem sites			X										1

Sources: (1) "Goals and Objectives for the Pollution Prevention, Control, and Restoration Plan" drafted by the Plan Formulation Team of the Lake Champlain Management Conference, March 1992. (2) "1991 Status Report on VT-NY Lake Champlain Programs" prepared by VT Agency of Natl. Resources and NY Dept. of Environ. Conservation. (3) "A Research and Monitoring Agenda for Lake Champlain - Proceedings of a workshop Dec. 17-19, 1991." Lake Champlain Research Consortium, 1992. (4) LCBP GIS User Needs Analysis, June - Sept. 1992.

Points for consideration when evaluating these results are:

- Many of the participants in the Needs Assessment were reluctant to state their data needs, feeling that, as a sub-committee, they had insufficient time to reach consensus on their spatial data priorities.

- Within any individual TAC sub-committee, a given data layer may have been identified as important by one or many individuals or programs.

- Table 3-3 indicates which group identified a particular layer as a data need. However, few subcommittees gave priority rankings to the data layers they identified other than the base map layers. For this reason, no meaningful weighting factors could be applied and the expressions of need are simply summed in the last column of Table 3-3. though including such information is considered desirable.

- Some identified layers can be derived from others (e.g. slope and contours can be derived from elevations) and some can be considered subsets of others (e.g. public lake access sites can be considered a subset of recreation facilities.)

- Certain data layers - such as eutrophication - were listed in source documents or mentioned in sub-committee discussions with little or no definition provided. Some - such as land use/land cover - require further definition by the TAC before data development begins because there is no consensus on the level of detail necessary for the applications requiring the information.

These results should be considered only a first step in an on-going process to refine data needs and priorities.

III. DATABASE DEVELOPMENT STRATEGY

All cost estimates are based on known sources of data. It is possible that other data sources may be identified. Existing data sets have not been inspected so actual costs incurred for data layer development may deviate significantly from the estimates provided here.

A. Base Map Layers

It is essential for the LCBP to have an accurate, uniform base map representing the entire study area. A basin-wide map will serve as a frame of reference for discussions on planning and implementation as well as a backdrop for displaying results of data collection efforts and other funded projects. As an aid to the Education/Outreach program it will play a key role in creating an image for the basin.

It is possible to construct a basin-wide map from 1:100,000 scale sources (DLG sources) for display at 1:250,000 scale. However, because several of the base layers are already available at 1:24,000 scale and development of others is underway at this scale, it is recommended that all digital base layer development be done at 1:24,000 scale in New York and Vermont and 1:50,000 scale in Quebec. Users of the GIS base map, particularly the general public, will have more faith in it if the source information is as accurate as the USGS 7 1/2' topo quads with which most people are familiar. The Plan Formulation Team was clear in its preference for 1:24,000 scale base layers. These 1:24,000 scale layers will facilitate further research, monitoring, and management efforts once they are made available in digital format. The automation of field data will be expedited because the digital base layers will reflect what is available on a paper 7 1/2' topo quad taken into the field. While 1:5,000 scale is the standard

scale of data development to support local planning in Vermont, 1:24,000 scale base layers will be extremely useful to state agencies and regional planning. commissions.

1. Quebec

Six topographic map sheets from Canada's 1:50,000 scale series cover the Quebec portion of the basin. In January 1993, digital files capturing all features on these maps (including surface water, roads, political boundaries, and contours) will be available in CCOGIF format for $500 (Canadian) per map from the Canada Center for Geomatics in Sherbrooke, Quebec. These will provide the best and most authoritative representation of all the base map features for the Quebec portion of the basin except for the basin boundary itself, which will need to be interpreted and digitized from the paper map sheets.

2. New York and Vermont

Basin boundary--polygon coverage derived from most recent 1:24,000 scale source (1:50,000 scale in Quebec) to show the limits of the area which drains toward the lake.

status:
APA has a coverage consisting of a 1:24,000 scale coverage from USGS Water Resources Division (Albany) for the NY side, and a 1:24,000 scale coverage from VCGI for the Vermont side. Quebec, N of NY is included, but derived from unknown sources. No digital basin boundary for Quebec, N of VT, has been located.

cost: $600

recommendation:
Delineate and digitize basin boundary from Quebec 1:50,000 scale maps and add to existing APA coverage. Edgematch. Document.

lake shoreline--polygon coverage derived from most recent 1:24,000 scale USGS topos, including all islands.

status:
APA has a 1:24,000 scale coverage of the portions of the shoreline that fall within the Adirondack Park and, on the VT side, portions of the shoreline that appear on topos that include the Adirondack Park. The APA is in the process of completing the U.S. portion of the coverage. VT ANR has created a 1:24,000 scale shoreline for the VT side.
cost: $500

recommendation:
Combine the NY, VT, and Quebec 1:24,000 and 1:50,000 scale digital files into one coverage. Edgematch. Document.

political boundaries--polygon coverage identifying all municipal, county, state, and national boundaries derived from 1:24,000 scale topos (1:50,000 scale in Quebec)

status:
A coverage for NY is complete and available from the APA. A coverage for VT is complete and available from VCGI.

cost: $500

recommendation:
Join the VT, NY, and Quebec coverages. Standardize attribute coding. Edgematch, Document.

surface water-- A combined polygon/line coverage derived from USGS 1:24,000 scale topos (1:50,000 scale in Quebec). This coverage will show all perennial streams, rivers, and connectivity through wetlands, ponds, lakes and large rivers. All lakes and ponds one acre or larger and rivers 100' wide or wider will be represented as polygons.
status:
NY: The APA has created a 1:24,000 scale surface water layer within the Park boundaries. This coverage will require additional coding to be useful for network analysis.

VT: For EPA, VCGI has developed a proposed hydrography coding scheme which allows network analysis as well as the conventional map representation of waterbodies. Surface waters have been digitized from 1:5000 scale orthophotos for Rutland and Addison Counties. Single-line water features have been digitized from 1:20,000 scale orthophotos for Chittenden, Franklin, and Grand Isle Counties but are of limited value and have many known errors.
cost: $33,000

recommendation:
The GIS Service Center should draft proposed work specifications for the creation of a surface water coverage that is as uniform as is practical given the different scale sources.

transportation--Line coverage including centerlines of all public roads and railroads derived from 1:24,000 scale source or larger (1:50,000 scale in Quebec), including attributes of road class and route number (except in urban areas).

status:
NY: APA is currently creating such a coverage for the NY part of the basin. Road class is the only attribute. With some effort, route numbers could be derived from 1:100,000 scale DLGs. The coverage does not include railroads.

VT: VT has completed basin roads and railroads from 1:5000 scale orthophotos.

cost: $2500 - Allows for two weeks of work by a GIS technician, pending completion of the New York portion of the basin.

recommendation: Add railroads and route numbers to NY coverage. Combine three coverages into one coverage, edgematch, standardize attributes, and document.

3. Base Layer Summary

These base layers must be completed as soon as possible to provide a backdrop for data being generated by LCMC-funded projects. The GIS Service Center should inspect the various data sources, write proposed work specifications and refined cost estimates to develop the completed layers, and after TAC approval, but the work out to bid as a package. Except for development of the surface waters layer, the amount of work required to develop the individual base layers is too small to warrant contracting. The development of a final political boundaries layer will require use of the surface water layer to take advantage of coincident features.

B. Other Priority Data Layers

All estimates are based on known data sources. It is possible that other data sources may be identified. Existing data sets have not been inspected so actual costs incurred for data layer development may deviate significantly from the estimates provided here. Potential applications of each data layer are provided in terms of Goals and Objectives for the basin Plan.

Land Use/Land Cover (Land Use Change and Wetlands)

Land use/cover is a database that is expensive and time consuming to develop. The characterization of what is on the ground (*land cover*) is now most frequently accomplished using satellite imagery. Satellite imagery provides approximately 10 - 30 meter resolution. Photo interpretation and "windshield" surveys are still the prevalent method for delineating detailed *land use* maps. Both land use and land cover are polygon coverages.

applications:

Nutrient Management Objective 2: determine the relationship between nutrient loadings and various land uses.
Objective 3: component of whole-lake computer simulation model to predict response of aquatic community to nutrient loadings to the lake.
Objective 5: allocate nutrient load among sources to achieve water quality standards.
Objective 7: prioritize problem areas.
Toxics Objective 2: evaluate sources of toxics contaminants.

Watershed Planning Objective 1: develop a consensus vision for physical character of basin. Objective 3: encourage proactive land use planning at the local level. (Current land use information is a critical component of municipal plans.)

status:
Existing 1978 Landsat-derived land cover GIS data exist for much of the basin. These data are inadequate both in terms of age and aerial extent to meet the modeling and planning requirements for the LCBP. Only eight categories of land cover were derived and there is little documentation on methodology and accuracy.

NY:
New York has been developing a proposal for a new land cover data layer as part of the Northern Forest Lands Study (NFLS). In 1992, a New York consortium purchased Landsat Thematic Mapper (TM) Images that cover all of New York. The scenes also cover 90% of the LC Basin in Vermont. The consortium is currently seeking funds to conduct the interpretation of the images. Discussions have been held among many different organizations in New York to arrive at a consensus on method of land cover classification, number of classes, and where the work should be done. They are looking at a multi-year effort to develop this data layer.

VT:
Vermont has developed a highly detailed land cover/use coding standard. It has produced one technical paper describing the results of a pilot project to determine how best to develop a land cover data layer. There has been considerable interest on the part of Vermont's regional planning commissions for a land cover database. Vermont's Center for Geographic Information (VCGI) has proposed to develop a land cover layer based on the combined methods of New Hampshire's experience working with EPA and its own pilot project. VCGI proposes the development of 26 classes

of land cover using a supervised method of classification. VCGI is currently putting together a funding proposal to carry out the project starting this year.

EPA region I has been conducting a demonstration wetland mapping project that covers 26 towns in the Vermont portion of the basin. They have used one Landsat TM image to derive approximately twenty land cover classes. EPA's experience in this project would be highly useful to the development of a basin land cover data base.

Quebec:
The status of land use/land cover data for the Quebec portion of the basin is unknown. The TAC will need to consider how important it is to gather land use information for the Quebec portion of the basin.

discussion:
Without a good picture of land cover/use in the basin today, it will be difficult to understand the changes that have occurred and will occur. Development of a land cover/use layer would be a significant step toward tracking development and monitoring the impact of change. This should be looked at as the first comprehensive "snapshot" of the basin. Updated landcover should also be planned for. Five year intervals are recommended.

Both New York and Vermont are looking for cost-sharing partners for their projects. The two states seem to perceive their land use/cover needs as different, so a joint LCMC-sponsored project may not result in data development that satisfies either state. It may be, however, that by using the same hierarchical land cover/use coding scheme, similar documentation and quality control, that the data developed by each state can be used together when needed. A TAC meeting devoted to issues involved in land use/cover mapping would clarify where needs differ both between the two states and among the various disciplines, and what course of action to take.

costs:
Based on the experience in New Hampshire, $800 per 7.5 minute quad sheet is the approximate cost to develop a semi-supervised land cover database. This means that to develop a similar basinwide land cover database (for 218 quads) would cost an estimated $180,000.

action:
The TAC should hold a land use/cover work session to identify and resolve, if possible, the differing needs for land use/cover mapping. Based on the results of this session, the TAC, working with the GIS Service Center, should write data specifications and an RFP for development of one land use/cover data layer for the basin that meets the project needs of the LCBP. Use of the most current cloud free images should be specified--both leaf-on and leaf-off. This project should not be undertaken without a quarter-time project manager.

If, the two states find they cannot agree on methodology, categories, resolution, etc., an alternative is for the LCMC to fund two separate land use/cover projects and then have the LCBP GIS Service Center join the two products in the best way possible. A third alternative is to let the two states continue developing their own projects without a funding contribution from the LCMC.

subwatersheds - 11-digit hydrologic units (polygons) developed by SCS and USGS from 1:24,000 scale topographic maps.

applications:
Physical Processes Objective 2: develop a better understanding of watershed hydrology.
Nutrient Management Objective 2: measure water and nutrient inputs from each sub-watershed in the basin.
Objective 3: develop whole-lake computer simulation model. Objective 4: research watershed nutrient transport and transformation processes.
Objective 5: conduct nutrient load allocation among nutrient sources to attain water quality standards.
Objective 8: implement appropriate P non-point source control programs.
Economics Objective 2: identify economic implications of Plan recommendations (Subcommittee has specifically requested this layer as a way to partition and display their other data.). Toxics Objective 2: evaluate sources of toxic contaminants.

status:
NY: Hydrologic units have been digitized but not approved by SCS and USGS.

VT: 1:24,000 scale topos with USGS watersheds delineated, reside at the Bow, NH USGS office.

Quebec: unknown

cost:
USGS Water Resources Division (Albany) estimates a cost of $10,500 to digitize the Vermont portion of the basin. Creating a similar coverage for Quebec, joining, editing, and documenting the three coverages would cost approximately $2000, in addition.
recommendation:
Investigate cost sharing with USGS and SCS to complete this layer. The GIS Service Center should also investigate scanning as a potentially cheaper way to automate this data layer. Secure funds for this layer in FY 93.

wetlands--polygon coverage of all legally defined wetlands in VT, NY, and Quebec. A wetlands layer can be derived from a more general land cover classification effort, or can be obtained as a separate layer such as the National Wetlands Inventory (NWI).

applications:
Wetlands Objective 1: update existing wetlands inventory. Objective 2: evaluate functions and values of inventoried wetlands.
Objective 5: identify wetlands in need of further protection. Objective 6: assess impacts of land use on wetlands functions and values.
Recreation Objective 2: determine where additional public access sites should be located.

status:
NY: A wetlands coverage derived from 1:24,000 scale sources is available from NYDEC for the NY portion of the basin.

VT: For western VT towns, wetlands were digitized from 1:24,000 scale NWI manuscripts. EPA Region I is completing a Landsat TM-derived (1988) land cover classification for 26 towns along the VT shoreline (and some towns in NY) with an emphasis on wetlands (5 wetland classes).

Quebec: Unknown

discussion:

Because NY, VT, and Quebec have different definitions for regulated wetlands, this may be one layer where development methodologies, coding schemes, and attributes may need to differ. Any basin-wide map of wetlands will need to clearly reflect these differences. It will still be important to discuss methodologies and coordinate data layer development as much as possible.

Because of the many known inaccuracies of the NWI, the wetlands layer should be derived from some other source, or the NWI maps should be supplemented with additional information to produce a more accurate data layer. Another possibility is that the wetlands mapping work currently being done by EPA Region I could be expanded to include wetlands in the entire basin. Most cost efficient would be to include wetlands classification as part of the development of a Landsat-TM derived land use/land cover layer described above.

cost: $0 if included as part of general land cover mapping (see above).

recommendation:
Include wetlands delineation as part of the general land use/land cover mapping effort discussed above.

point discharges--point coverage with multiple attributes.

applications:
Toxics Objective 1: identify toxic substances in water, etc.
Objective 2: evaluate sources of toxics.
Objective 3: develop toxics control strategy.
Recreation Objective 2: determine where additional public access sites should be located.
Human Health Objective 5: identify potential human health risks.
Fish & Wildlife Objective 5: coordinate toxic monitoring and issuance of health advisories.

status:
NY: NY DEC maintains a database of permitted discharges by address.

VT: VT ANR maintains a database of permitted discharges by address, with extensive attribute information. There are 22 permitted discharges in the basin.

Quebec: unknown

discussion:
The Federal Water Pollution Control Act requires a permit for every point discharge of waste water into a waterbody. The NY DEC and VT ANR maintain a list of discharges. Additional field/photo work will be needed to determine coordinates for the actual discharge locations.

costs:
VT ANR estimates the costs associated with locating all discharge points using GPS is $200 per point source. Alternatively, for Vermont data entry could be accomplished using on-screen editing with 1:5000 scale roads, 1:100,000 scale surface water, and orthophotos as aids. For New York, the points could be entered interactively using NY DEC's 1:24000 scale scanned image of the 7.5 USGS Quad image as background. The cost for locating these points at this level of accuracy would be on the order of $10/point.

recommendation:

Secure funding for entering coordinate points into NPDES Point Discharge Database using the on-screen editing method. If funding is available, enter coordinate points of all storm water discharge points as well.

historic structures and sites--point coverage derived from 1:24,000 scale sources with extensive attributes.

applications:
Cultural Heritage Objective 1: map historic, archeological, and architectural sites, structures, etc.
Objective 2: develop preservation and management plans for cultural resources.
Recreation Objective 1: prepare and implement a comprehensive recreation management plan (Recreation, Land Use, Economics, and Cultural Heritage subcommittees have expressed a common interest in promoting tourism in the basin based in part on cultural resources.)

status:
NY: awaiting response from NY Bureau of Historic Sites

VT: VT Division of Historic Preservation is completing (1/93) an ARC/INFO coverage of standing historical structures in the Rutland and Addison County portions of the basin. It is derived from a field survey recorded on 1:24,000 scale topos as part of a long-term statewide effort. A similar inventory (UTM coordinates and attributes) exists on paper for the remaining VT basin towns.

Quebec: unknown

cost:
VT: being prepared by VT Division of Historic Preservation
NY: depends upon response from NY Bureau of Historic Sites

recommendation:
Pending the status of the NY inventory, convert the paper inventory for the remaining VT towns to an ARC/INFO coverage, and begin the inventory of the NY portion of the basin on a cost-sharing basis.

bathymetry--a point coverage representing the depth of the lake bottom. From this, using the appropriate software, can be derived slope, contours, aspect, and 3-d views of the lake bottom.

applications:
Physical Processes Objective 1: develop better understanding of hydrodynamics in lake.
Recreation Objective 2: determine where additional public access sites should be located.
Cultural Heritage Objective 1: map submerged cultural resources. Objective 2: develop preservation and management plans for (submerged) cultural resources.
Fish & Wildlife Objective 1: develop a comprehensive fish and wildlife management plan.
Objective 1A: inventory important fish habitats.
Objective 1C: develop protection strategies for rare, threatened, and endangered species, communities, and habitats. Objective 2: maintain or restore populations of key game species.

status:
A partial coverage (broad lake) created from 1:40,000 scale NOAA charts is available from VCGI.

cost: $600 to complete this coverage.

recommendation: The LCBP GIS Service Center should complete this work in-house in FY 93.

elevation, slope, contours--1:24,000 scale digital elevation models (DEMs) consist of a grid of elevation points spaced at 30 meter intervals. From these, with the appropriate software, can be derived slope, contours, aspect, and 3-dimensional views. For 1:250,000 scale DEMS, the elevation points are spaced at intervals of 3 arc-seconds.

applications:
Physical Processes Objective 2: develop better understanding of watershed hydrology.
Objective 3: link whole-lake model to watershed nutrient loading processes.
Nutrient Objective 2: identify factors that determine magnitude of nutrient loadings from a watershed.

Objective 4: research watershed nutrient transport.
Objective 5: use watershed models to help allocate nutrient load among various sources.
Cultural Heritage Objective 1: map historic and archeological sites (slope aids the prediction of archaeologically sensitive sites).
Wetlands Objective 1: update existing wetlands inventories (slope data can improve satellite-image based wetlands classifications).

status:
VT: 1:24,000 scale DEMs are available from USGS for about half the VT quadrangles in the basin. 1:250,000 scale DEMs are available for all of Vermont from VCGI.

NY: DEMS are available for numerous NY quadrangles in the basin. 1:250,000 scale DEMs are available for all of New York from APA.

Quebec: digital contours at 10 meter intervals will be available in 1/93.

discussion:
Many of the research and modelling applications requiring slope and contour information require greater spatial resolution than that provided by the 1:250,000 scale DEMs. However, until the 1:24,000 scale DEMs are available for most of the basin, little is gained by trying to derive basin wide slope or contours at this scale. Where the high resolution DEM data sets are available, they can be processed for use in particular research or sub-watershed planning projects. The coarser resolution DEMs are adequate for regional planning and for creating basin wide slope and 3-d views.

cost: $ 1200 for 3-5 slope classes derived from 1:250,000 scale DEMs for the entire basin
$ 40 per 1:24,000 scale DEM from USGS for existing DEMs. There are considerable price reductions for bulk orders.

USGS has data development cost-sharing programs in which the LCMC could participate to accelerate the creation of the DEMs that are currently unavailable.

Once the 1:24,000 scale DEMs are in-hand the costs to create slope and aspect data are negligible. For example, VCGI can generate five slope classes for the entire basin in two days of processing.

recommendation:
Investigate the cost of new DEMs and cost-sharing with USGS to accelerate the production of the DEMs that are currently unavailable. Generation of slope and aspect data based on the 1:250,000 DEMs should be done at the LCBP GIS Service Center.

population distribution **(1990 census and TIGER files)**--polygon layer that combines the census geography (census tracts and block groups) provided in the TIGER (Topologically Integrated Geographic Encoding and Reference System) database with the population data contained in the Census Bureau's Summary Tape File.

applications:
Economics Objective 1: create an economic database.
Objective 2: identify the economic implications of recommendations of The Plan.
Objective 9: evaluate methods of sharing fiscal burdens and benefits of development.
Rec. Objective 2: determine where additional public access sites should be located.
Human Health Objective 5: identify potential human health risks.

status:
Both New York and Vermont have converted the TIGER line files into ARC/INFO format.
NY: New York's Legislative Reapportionment Commission has not yet released these files for other agencies to use pending the outcome of a lawsuit. If that suit is not resolved shortly, ARC/INFO formatted TIGER files can be obtained from commercial vendors.
VT: Vermont has available TIGER files in ARC/INFO format, but has not attached the population data to it.

Quebec: The 1991 population for the sub-county jurisdictions of Quebec is available from Statistics Canada. The boundaries of these jurisdictions will be included in the digital files to be available in 1/93.

discussion:
Characterization and visualization of the population distribution is helpful for a number of TAC sub-committees. The database would be useful for modeling, planning, and understanding economic and other impacts of implementing various Plan recommendations. An alternative method for displaying population distribution is to plot population by municipality, using the political boundaries base layer.

cost:
The cost for developing this database would vary depending of the availability of New York's TIGER files. If it is available, creating a basin wide population distribution layer would cost approximately $800. If the TIGER boundary files need to be purchased from a commercial vendor, the cost will rise to an estimated $6,000.

recommendation:
Secure funding for developing this layer in FY 93 using the TIGER database. Combining the census data and TIGER files should be done at the LCBP GIS Service Center since the labor involved does not justify contracting the work out.

recreation facilities (including public lake access sites)
point coverage (except for state lands which are polygons) for all publicly and privately owned recreation sites.

applications:
Recreation Objective 1: prepare and implement a Lake Champlain comprehensive recreation management plan.
Objective 2: determine where additional public access sites should be located.
Economics Objective 1: create an economic database to define lake's role in basin's future.
Objective 2: identify economic implications of Plan recommendations.

Objective 7: develop a sustainable economic strategy for the basin.

status:
With National Park Service funding, NY and VT have developed a uniform methodology and list of attributes for a comprehensive recreation inventory.
VT: tabular database will be completed by 1/93. NFLS may pay for some digitizing.
NY: Office of Parks, Recreation, and Historic Preservation is in the process of updating its recreation inventory for basin counties. Additional funds will probably not be needed to create the final coverage.

Quebec: unknown

discussion:
This layer is so close to being completed in the U.S. portion of the basin, that its completion should be a priority for the LCBP. Only a small expenditure of time and money will be needed if data automation is contracted out to one of the many GIS facilities in the basin.

cost:
VT ANR has estimated that $10,000 is required to digitize its inventory, including upgrading department hardware and software for in-house digitizing. Contracting the work out reduces the estimate to $6400. A less expensive method to automate these data is to interactively enter the points in ArcEdit using roads and surface water as "Back coverages."

recommendation:
Explore the possibility of cost-sharing with the NFLS to get the VT inventory automated. Contract this work out in FY 93.

soils--polygon coverage delineating areas of soil with similar properties based (in the U.S.) on field work and photointerpretation by the USDA SCS.

applications:
Nutrients Objective 2: identify factors that determine magnitude of nutrient loadings from a watershed.
Objective 4: research watershed nutrient transport and transformation process.
Watershed Planning Objective 3: encourage proactive local land use planning (Because soils are often a limiting factor for development, soils information is a critical component of local planning.)

status:
NY: Of the five NY counties in the basin, only Warren Co. has an ARC/INFO soils coverage. Field work has been completed for Clinton and Washington Counties. No digitizing has been undertaken for Washington Co. but digitizing for Clinton County is underway with SCS funds. Field work in Essex County is only about 50% done. Only a very small portion of Franklin County, NY is in the basin.
VT: There are ARC/INFO soils coverages for seven of the eleven counties in the basin. However, a number of coding errors have been discovered in the Chittenden, Franklin, and Grand Isle County coverages. Of the four other counties, only Washington makes up a significant portion of the basin. Field mapping has been completed for Washington County but re-compiling and automating the data has not begun.
Quebec: unknown

discussion:
The publication of a county soil survey by SCS is a lengthy and expensive process. However, the soil survey is widely used by agriculturalists, developers, planners, researchers, and resource managers. Soil

characteristics and slope play an important role in determining where and what kind of development is permitted in a community. As these paper maps gradually become available in digital format, the utility of the soils and slope information increases greatly since it can be incorporated into computer assisted site selection, zoning district delineation, and regional characterization and other processes.

Two large areas of the basin - Essex County, NY (728,263 acres) and Washington County, VT (456,960 acres) have field work completed but no digital soils coverages.

On the existing SCS timetable, it would be at least another six years before digital information is available for Essex County and another several years for Washington Co. (VT). To accelerate soils surveys, SCS often enters into cost-sharing arrangements with a local or regional agency. Depending upon the arrangement agreed upon, the time to produce a county digital soils layer can be reduced by a half to two thirds.

costs:
Based on estimates provided by New York's State Soil Scientist, a three year program to complete a digital soils layer for Essex Co. under a typical SCS cost-sharing arrangement would result in the following annual costs to the LCBP (It may be possible to spread the cost among additional sponsors, as well.):

FY 94	$32,500	field mapping
FY 95	$32,500	field mapping
FY 96	$80,108	compilation and automation
	$145,108	TOTAL to sponsor

The NY automation process results in a DLG file that might require additional editing once it is converted to an ARC/INFO format. An additional $1000 should be budgeted for this.

An estimate for completing the Washington County soils layer is not yet available from Vermont's State Soil Scientist. A rough estimate provided by VCGI is $100,000. The LCMC could expect to pay $50,000 of this, probably spread over two years.

The VT automation process results in an ARC/INFO coverage that would require no further manipulation to enter into the LCBP database.

recommendation:
Secure LCBP funds to complete digital soils coverages for Washington County, VT and Essex County, NY over a three year period. The GIS Advisory Board should identify other potential cooperators and secure funding commitments so SCS can begin work in FY 94.

fish & wildlife habitat--polygon layers? point layers? species sightings? range maps? vegetation maps?

status:
US F&WS has a few data sets on various wildlife species' distribution that fall within the basin. GAP analysis will provide some species distribution but because it is based at 1:100,000 scale, the scale may not be appropriate for LCBP.

The Laboratory of Ornithology at Cornell maintains the colonial bird register.

NY: A statewide effort to inventory amphibian and reptile distribution is being conducted by the Wildlife Research Center in Delmar. Occurrences of animals are recorded on 1/4 of a DeLorme atlas sheet.
An inventory of rare and endangered species is being conducted in Franklin & Clinton Counties at 1:24,000 scale. There is no similar inventory for other NY counties.

VT: Deer wintering yards have been digitized from 1:24,000 scale topos for the entire state. Natural Heritage Program sites throughout the site have also been digitized.

Quebec: unknown

applications:
Fish and Wildlife Objective 1: develop a comprehensive fish and wildlife management plan. Objective 1A: inventory fish and wildlife habitats. Rec. Objective 2: determine where additional public access sites should be located.

discussion:
Although it was identified as a priority layer by several subcommittees, it is unclear what kind of fish and wildlife inventory or habitat mapping effort will be most useful in developing a comprehensive fish and wildlife management plan (Objective 1). The 1:100,000 scale habitat information being assembled for the US Fish and Wildlife Service's Gap Analysis may not be suitable for the LCBP, but as yet the Fish and Wildlife Subcommittee has not recommended an alterative. On-going habitat mapping by the two states is inconsistent across the basin. One possible approach is to use (or modify) a satellite-derived land cover layer to indicate various potential habitat types.

recommendation:
With assistance from the LCBP GIS Database Administrator, the Fish and Wildlife Subcommittee should:

- define the term "fish and wildlife" habitat for LCBP inventory and mapping purposes,
- determine what scale and level of resolution are appropriate for LCBP goals,
- develop a methodology for conducting the inventory and developing the data layer, and
- estimate the costs involved.

C. Data Development Summary

Summary recommendations for data development are:

- Begin the development of 1:24,000 scale base map layers immediately. Issue one RFP for all base layers.
- Begin development of a land cover/land use layer immediately. The first step is a TAC work session, facilitated by LCBP GIS Service Center staff, to resolve issues of methodology, scale, resolution, and category definitions.
- Complete development of priority data layers that are nearly done, (recreation facilities, bathymetry), partially done (subwatersheds), and relatively easily done (population distribution and 1:250,000 scale slope), in FY 93.
- In FY 94, develop historic structures and sites layer and point discharge layer.
- Contribute to SCS soils mapping efforts in Essex County, NY and Washington, County, VT starting in FY 94.
- Participate in USGS' cost-sharing program to facilitate the development of missing 1:24,000 scale DEMs.

- In FY 95 develop fish and wildlife habitat layers, continue contributing to soils mapping, and begin development of other layers.

Common features of all these data development efforts must be:

- close coordination among the GIS Service Center, the involved TAC subcommittee(s), and the contracted data developer,
- adherence to data specifications, QA/QC procedures, and documentation requirements,
- capitalizing on data development efforts and funds of other programs and organizations,
- a determination for each data layer as to how important it is to map the Quebec portion of the basin.

Yearly cost estimates for data development are presented in Table 3-4. The data development costs and schedule are also summarized in Chapter 6.

Table 3-4. Data Development Costs

FY 93			
Land use/Cover (.75)	135,000		
Subwatersheds	12,500		
Bathymetry	600		
Rec. Facilities	6,400		
Population w/TIGER	800		
1:250,000 scale slope	1,200		
		TOTAL	$156,500
		TOTAL - 25% match	$116,875
Basin Boundary		600	
Lake Shoreline	500		
Political Boundaries	500		
Surface Water	33,000		
Transportation	2,500		
		Base Layer TOTAL	$37,100
		FY 93 TOTAL	$153,975
FY 94			
Land Use/Cover (.25)	45,000		
Historic Sites	?[1]		
Toxics Points Sources	?[2]		
Soils (begin)	57,500		
		TOTAL	$102,500
		TOTAL - 25% match	$76,875
FY 95			
Soils (continue)	57,500		
Fish & Wildlife Habitat	?[3]		
other layers	?		
		TOTAL	$57,500
		TOTAL - 25% match	$43,125

[1]Awaiting estimates from NY Bureau of Historic Sites and VT Division of Historic Preservation.

[2]Awating estimate from NY DEC.

[3]The Fish, Wildlife and Wetlands subcommittee has not yet defined this data layer(s).

IV. OTHER GIS NEEDS AND CONCERNS

A. Plan Formulation Team

There is a wide range in the level of understanding of GIS and its capabilities among the PFT members. The educational process has been begun but it will still be awhile before the PFT can articulate its preferences regarding the provision of GIS services. Nevertheless, at this point their priorities are:

- to have the ability to do consistent analysis across the basin,
- to ensure that, in situations where GIS is an appropriate tool for managers, researchers, consultants, etc., GIS is available and used consistently across the basin,
- to have maps and data in the Plan to serve as a basis for, and illustrations of recommendations

Specific GIS needs identified by the PFT are:

- base maps for use in The Plan document,
- "one-stop" access to information,
- interactive GIS capabilities (primarily for the PFT in the short term and eventually for others),
- standardized format and method of producing maps
- a hardcopy product similar to the Lake Champlain Atlas.

Members of the PFT feel that maps are an important component of the education/outreach program in that they help people understand the basin and the issues involved in managing the basin. They supplement text by allowing people to visualize information. For this reason, the Lake Champlain Atlas was felt to be a key output of the Lake Champlain Basin Study. An equivalent product from the LCBP would serve as a hardcopy presentation of the database for individuals and organizations who do not have the ability to use data in a computerized format. Such a product should be made available at libraries and other locations. The PFT, itself, would use such a product now if it were available. Developing a new atlas should be done in collaboration with the Education/Outreach Subcommittee.

The PFT feels that 1:24,000 scale is appropriate for basic data collection for the LCBP. It suggested that early GIS efforts should concentrate on one or two specific project applications and that alternative funding mechanisms for data layer development should be explored.

Other questions that the PFT raised were:

- How are GIS application services to be provided?
- What are the data needs and associated costs for the various applications?
- Will there be any data layers complete in time to assist writing the draft of the Plan (scheduled for completion 4/93)?
- What is the cost of an updated Lake Champlain Atlas?
- How should PFT/LCMC respond to the demand from outside the LCBP for applications?

B. Education/Outreach Program

The Education/Outreach Coordinator identified two major contributions GIS can make to the E/O program:

- the production of maps for a wide spectrum of purposes, and
- serving as an interactive classroom tool.

The E/O coordinator would like to use GIS to aid the presentation of spatial (geographic) concepts, such as the concept of a watershed, and the inter-relationships among various resources and activities within the basin. This includes the presentation of results of research and monitoring projects as well as results from modelling and consequences of management measures. As soon as any are available, GIS-generated maps would be incorporated into slide shows, videos, curriculum aids, brochures, the LCBP newsletter, press releases, and reports.

The E/O program will often require maps (and other graphics) in a very specific format (e.g. a certain size, a certain number of colors, legends and other explanations targeted at a certain education level, etc). Three possible mechanisms for producing these graphics are:

- Include detailed specifications for E/O materials in individual LCBP project contracts. In many cases this will not be feasible because, until the research or other activity is completed, the need for, and appropriate format of products for the E/O program will be difficult to determine.

- Include funds in the E/O program budget for the services of a GIS technician or graphic artist to develop the required E/O products from those provided by the funded projects. Labor costs can be estimated using the rate of $12 - 15 for a GIS technician/analyst.

- Grant the E/O Coordinator access to a draw down account at NEIWPCC to allow for work orders to produce the required graphics.

The development of a product equivalent to the Lake Champlain Atlas as an educational resource, is a priority identified by the E/O Committee as well as by the PFT. Creating such an atlas should be coordinated by a work group consisting of PFT staff to provide input on content, a GIS analyst to detail the required GIS process and costs, and E/O staff to handle issues of design, format, and production methods and costs.

Another potential role for GIS identified by the E/O coordinator is as an interactive instructional tool in workshops and classes to illustrate geographic and ecological principles. One exciting possibility is demonstrating techniques of spatial analysis using Lake Champlain data layers and ESRI's ArcView software on a PC at the summer institutes for teachers. This would be possible at a facility such as UVM's Continuing Education computer laboratory in Colchester.

Both for the preparation of graphics and for curriculum development, the E/O coordinator indicated her strong preference to have one GIS organization to deal with rather than having to consult with several organizations to identify and locate appropriate data, identify and locate appropriate cartographic and other services, and develop contract specifications.

C. Physical Processes Subcommittee

This group sees two major roles for GIS:

- as an appropriate means of supplying data for use with models (as input, calibration, and verification of models) and as an effective means of presenting the spatial aspect of model results, and

- as an over all data management mechanism for the LCBP.

They see a need for a mechanism for sharing data and a standard format for receiving data. They prefer to have data physically residing in one location because of the frequent difficulties in locating individual data developers around the basin (due to death, retirement, vacations, field work, etc.). Contractors and researchers are handicapped by the necessity of engaging in lengthy data searches. A central facility will save time and money for researchers and contractors (and thus for the LCMC. This service is needed both during the life of the LCMC and after.

They stressed the need for documentation of data quality and all methodologies involved in data collection. The uniformity of data sets over the basin is not essential, but documentation is.

The periodic recording and distribution of the database on CD-ROMs to subscribers was recommended. CD-ROM recorders and readers are becoming cheaper and more ubiquitous. The database should be widely distributed, including to the two state library systems.

The group also felt that the establishment of a Global Positioning System (GPS) base station in the basin would greatly facilitate field work and improve the accuracy of feature coordinates.

D. Economics Subcommittee

The Economics Subcommittee indicated that it is taking an incremental approach to its data needs. In order, its GIS priorities are:

- appropriate display of economic data by sub-basin,
- access to and display of other projects' data, and
- data needs for a complete economic model.

The committee anticipates using GIS at least for display of economic data. Base map layers should include: hydrography, roads, watersheds, and political boundaries. They want to be able to assign minor civil divisions to sub-basin boundaries (gross watersheds) to display and analyze economic data. Eventually, they would also like to be able to indicate where population is actually located within watersheds and towns, using parcel data, ownership centroid data, and/or census data.

TIGER files and a land use layer will be important to the Committee's work, as well.

E. Toxics Subcommittee

This subcommittee had several questions about how GIS would work in the LCBP:

- Where is GIS in the "data management pipeline" (i.e., when and how will data go to a central database)?
- When and how would data collected with LCMC funds became public information?
- Who will be responsible for maintaining data sets and how will researchers and managers access data?
- What data formats and media will be acceptable for submitting data to a central database?

Several participants wanted a good interactive mechanism for looking at data. Some felt that only a few individuals would need more than few specific layers. Others felt that many people (town and regional planning commissions, for example) would be interested in some aspect of the data, and that demand would increase as soon as a few GIS products based on LCBP data were seen by the public.

It was generally agreed that a site with constant use of data, such as a state agency heavily involved in basin management, will want its own complete set of data and at least some minimal way to manipulate it.

Two researchers indicated that they would like to be able to use GIS for displaying results in reports this service. They would prefer to have capabilities to do it in house rather than pay 20% of their project budget for data processing. In this case, data reporting and display costs need to be included in project budgets. GIS products need to be of publishable quality.

F. Cultural Resources Subcommittee

Cultural resources data need to be treated in The Plan, but perhaps with only extremely generalized locational information. In VT, data on archeological sites are excluded from freedom of information rules.

NY and VT use different methods for determining archaeologically sensitive areas so it would be difficult to assemble a basinwide map that could be interpreted consistently

The Division now uses paper maps in permit review process but it is gradually automating the process.

National Park Service Bulletin 30 guides inventory and management of landscape features and historic patterns of community development. Because so much of VT's landscape would fit the NPS criteria there has been little effort to classify and inventory these landscapes for preservation. However they are important to be aware of for educational and interpretive purposes.

Display and prediction of site locations would greatly be enhanced by slope and contour information (on the land) and bathymetry for submerged resources.

Location of historic lake front camps would help locate sub-standard septic systems and thus sources of lake pollution.

For Objective 6 - interpreting cultural resources for public - GIS could play many roles:

- generation of maps
- interactive display (ArcView) at a site to show locations of and present descriptive information on points of interest
- interactive display basin wide at visitor centers (APA, Burlington waterfront, etc.)
- planning round-the-lake bike and or tourism route.

G. Fish, Wildlife, and Wetlands Subcommittee

This subcommittee expressed three major concerns:

- the appropriate scale and resolution of data collection,
- whether the purpose of data collection is to support regional planning or more local management activities, and
- the need to know what spatial data already exist.

There was a lengthy discussion about scale and resolution. There are various levels of information needs depending upon the purpose varying from regional, planning, and public information to permit

application process and site acquisition. Some felt that there is a need to deal with habitat information hierarchically from regional to site specific levels.

Some agreed that 1:24,000 scale provides the minimum acceptable level of detail for purposes of habitat protection and permit application (relative to wetlands, rare and endangered species, deer wintering areas). 1:24,000 scale provides reasonable resolution for rare species but not for common species. A smaller scale could be used for common species. However, 1:24,000 scale maps are appropriate for deer wintering yards.

Specific site assessments and public information (intentionally imprecise) usually have opposing needs in terms of data resolution.

A major issue was how LCBP database is to be used. Will the application of the data be planning or regulatory? This will influence what is appropriate scale. Mary Watzin, representing the PFT indicated that the priority purpose in amassing data is to meet planning needs (primarily writing The Plan) but the secondary purpose is aiding the state agencies in doing their jobs.

It was recognized that the group needed to come up with a mutually agreeable important set of data which will be carried forward by state agencies after the five year life of the LCMC. However, they were not prepared to build a case for the importance of the various data layers suggested during the session.

It was suggested that once data commonalities are discovered amongst the various TAC subcommittees, representatives from the subcommittees with common data needs should get together to work out specifics of data layer development. (As is discussed in the next chapter, this process should be facilitated by the LCBP GIS database administrator.)

The group felt uncomfortable trying to articulate data priorities on the spot. Rather, the acting chair suggested that each subgroup meet individually to work out data needs (9/15) and then the subgroups will get together to look for commonalities and to agree on priorities (9/28).

There was a universal need to know what spatial data already exist. Distribution of the data inventory done by VCGI would help TAC subcommittees participate in the needs assessment process. Efforts could then be concentrated on partial data layers.

It was noted that NY and VT have different methodologies for collecting data so that creating a basinwide uniform map may be difficult. Aggregation was suggested as a means to solve some of these differences.

Some participants felt that a central agency (preferably an existing facility) where data are collected and made available to users and where data quality is checked would be extremely helpful. But they also wanted a system in each office to view data interactively. (ArcView would probably fill this need.)

The ability to maintain LCBP GIS services beyond life of the LCMC should be one of the criteria for selecting a GIS Service Center.

To be of use, wildlife distribution data has to be updated regularly.

H. Land Use-Lake Use Subcommittee

The RFP under consideration by this subcommittee at the time was not far enough along to know whether any GIS data layers would be required.

The group needed to know what digital (and other) spatial data are available.

It was recognized that the term "land use" is very politically sensitive but land use must be dealt with because of its importance in determining water quality.

There is a need to translate the Plan into visual and easily understood formats, e.g. video simulations, in addition to maps.

It was suggested that a bike path around the lake could serve as an economic stimulus that increases recreational opportunities while taking advantage of both the scenic and historical attractions of the basin. A GIS database could greatly facilitate the siting of such a path.

Most (90%) of the land use change going on in NY is a result of small individual residential and commercial development projects strung out along roads rather than being due to large projects. Because of its low spatial resolution, a satellite-derived land use layer may not be helpful in documenting the land use change that is of concern. Locally useful information is needed, however, because the power to plan and regulate land use resides at the local level. There is a need to empower local groups.

I. Recreation Subcommittee

The subcommittee felt it was important to emphasize to LCMC:

- the overlap between Northern Forest Lands Study and LCBP data collection efforts for VT and NY, and
- there will be a great need to analyze relationships between data sets (e.g. cultural and recreational and transportation) and create a synthesis of results of discipline-specific projects. GIS is one tool to help meet this need.

They also reported that ANR GIS efforts are severely limited by hardware. Databases reside on PCs scattered throughout the agency. Linking of the databases is done via the ANR GIS facility. Over the last year VT state agencies have been meeting to begin coordination of databases. The Recreation Department doesn't have GIS SW and digitizing table but does have a computer that could handle it.

J. Eutrophication and Non-Point Source Pollution Subcommittees

The appropriate scale and resolution of data collection was the primary concern expressed by this group. It was pointed out that the Vermont and New York have been developing GIS databases at two different scales and there may be a problem in reconciling them.

The session focused on land use/land cover, but there was no consensus on a desirable level of spatial resolution for the layer or on what categories were important to map. Some participants were more concerned about a basin-wide picture of land cover, while others placed a higher priority on detailed land use information, such as farming activities, that could have a direct effect on water quality.

K. Summary of GIS (non-data) Needs and Concerns

Many common concerns were expressed by the groups and individuals participating in the GIS Needs Assessment. They are:

- The importance of GIS as a means of integrating data and getting a picture of the basin.
- The need for GIS coordination.
- The need to coordinate LCBP data development efforts with those of other programs (e.g. NFLS and Gap Analysis).
- The difficulty in creating uniform basin-wide data sets and whether there is the need to do so.
- The need to know what data exists already.
- The need for good data documentation.
- Who will store and maintain data and how will participants gain access to it (both during the LCBP and after)?

Recommendations regarding spatial data management and GIS coordination are presented in the next two chapters.

Chapter 4: A GIS SERVICE FOR THE LAKE CHAMPLAIN BASIN PROGRAM

I. MISSION

Both the LCBP Needs Assessment and the experiences of other similar GIS programs around the country indicate that a clear articulation of objectives and priorities is crucial to the success of the LCBP GIS effort. A mission statement and specific objectives are essential to guide decisions on a host of technical and policy questions such as:

Which data should be collected and what are the priorities?
What level of data quality (scale, resolution, accuracy) is necessary to support the decision-making that is to occur?
What QC procedures are needed to meet these data quality requirements?
What are the staffing needs to produce, manage, analyze, and disseminate these data?
What hardware and software is needed to accomplish this?
What level of funding is needed to support these activities?
What type and structure of organization is best able to carry out the GIS mission?

In their Goals and Objectives document (3/13/92) the LCMC Plan Formulation Team suggested a data management and GIS goal:

"Ensure that all data and GIS coverages generated under the auspices of the Lake Champlain Special Designation Act are collected in a credible manner, archived for future access, and readily available to the public."

and three objectives:

"Adopt quality assurance and quality control standards for spatial data and develop requirements to be included in all RFPs.

Establish a data clearinghouse for Lake Champlain data. The Clearinghouse should catalog and organize existing data, provide for data storage and retrieval, and facilitate data coordination and data sharing.

Develop a data information transfer mechanism to make data of all types available to users in machine readable form."

Until it is formally agreed that GIS technology should provide the primary over-all data management mechanism for the LCBP (as is the case in some EPA programs), the GIS mission should be a subset of this overall goal.

II. PROPOSED LCBP GIS MISSION:

to assemble and manage a quality spatial database to facilitate the planning and other activities of the LCBP and ongoing management efforts in the Lake Champlain Basin.

This proposed GIS mission encompasses a number of objectives:

- inventory, evaluate, catalog and facilitate access to existing spatial data sets in accordance with LCBP priorities,

- coordinate data base development and maintenance with other organizations and programs to minimize redundant efforts,
- to the extent possible, for new data collected under the auspices of the LCBP, assure data quality that is commensurate with the intended uses of the data,
- provide for data archiving, security, documentation, and access that is appropriate for LCBP activities and consistent with EPA, NY, and VT policy, and
- as directed by the LCMC, PFT, and TAC, provide GIS products and services.

Once adopted, the mission statement and objectives provide a framework and direction for all subsequent LCBP GIS activities. The mission statement can be modified over time, as needed.

III. ORGANIZATIONAL HOME

The clear consensus of the participants in the Needs Assessment and the GIS Basin Program Survey is that there needs to be a data clearinghouse for the LCBP within the basin. This sentiment is reinforced by the experience of other multi-state water quality programs such as the Chesapeake Bay Program and the Albemarle-Pamlico Estuary Study (U.S. EPA, 1990).

Therefore it is recommended that the LCMC should charge one GIS facility within the basin with the responsibility of providing the GIS services needed by the LCBP. By doing so, one organization will be responsible for GIS data and product quality and will be accountable to the LCMC and EPA. The lines of communications between the LCMC and GIS service will be clear and direct. When a GIS product or service, or technical advice is needed, the PFT, the LCMC, the TAC, the LCBP staff, a researcher, program manager, or other potential data user can contact the LCBP GIS Service Center. A subcommittee or several overlapping organizations cannot efficiently perform the central support functions which other programs similar to the LCBP have demonstrated to be crucial.

IV. ACTIVITIES

The proposed mission and objectives indicate that the LCBP GIS effort will encompass a wide range of activities. These activities can be divided into two groups based on whether they can be carried out effectively by multiple organizations (decentralized) or are integrated tasks that can be most efficiently performed by a single organization (centralized).

A. Centralized Activities

The comment heard most often during the GIS User Needs Assessment was the need for authoritative coordination of LCBP GIS-related activities. Indeed many participants were surprised to learn that no central GIS entity had been established. Activities that are best centralized to avoid redundancy and to maximize efficiency include the coordination of data standards and data development, all aspects of data management and distribution, and the provision of technical support regarding the use of the data.

1. Standards

a. refine standards: Provide leadership in the refinement of the proposed and development of any additional standards.

b. disseminate standards: Publish, distribute, and update standards.

The coordination role includes working with GIS experts from Vermont and New York to establish and revise standards on data, documentation, and procedures.

2. **Data Development**

a. develop data specifications: Provide leadership in the development of technical specifications for data to meet the multiple needs of the LCBP.

b. manage GIS data development contracts: This includes maintaining a vendor list, providing technical assistance in writing RFPs and contracts, and participating in the evaluation of proposals and work products.

c. liaison with other data development programs: coordinate with the appropriate individuals in other data development programs in the region in order to minimize redundancy and to capitalize on capabilities not present within the LCBP.

d. technical assistance: Provide technical assistance to data developers as needed.

e. QA/QC: As described in a later section, provide quality control services during data development, and quality assurance services prior to acceptance of new data.

A high priority is continuing the coordination of data development. The GIS service should assist the TAC with prioritizing data needs, writing technical specifications for data development (RFPs and work plans), and reviewing funding proposals that involve data development. Coordination will also involve liaison between LCBP data needs and state, federal, local, academic, and private data development programs to capitalize as much as possible on data development efforts and funding mechanisms provided by these agencies.

3. **GIS Clearinghouse**

a. data custodian: Maintain secure authoritative copy of data sets created under the auspices of the LCBP and its related documentation. Maintain off-line archives of old data.

b. distribute data and product: Distribute authoritative copies of LCBP-developed data and products for the cost of reproduction on various media and in various data formats.

c. develop data catalog: Develop, maintain, and distribute a summary data catalog of all LCBP GIS data sets and other data sets relevant to LCBP efforts.

d. outreach: Work with the LCBP Education/Outreach Coordinator to maximize the availability and utilization of GIS data and products as directed by the LCMC.

A LCBP GIS service should serve as a data custodian for new data sets created *de novo* or completed under the auspices of the LCBP. This includes receiving data sets as they are created via contracts, work plans, and memoranda of understanding (MOUs) and evaluating them to determine if data quality and documentation meet the LCBP GIS standards. Once data sets meet the standards they will be entered into the LCBP GIS database. The appropriate documentation will be entered into a detailed data catalog (sometimes called a "data dictionary") and in a summary data catalog. As data updates become available they will need to be treated in the same way.

In order to provide the "one-stop shopping" for spatial data that both the survey results and the needs assessment indicate is highly desirable, the GIS Service will also need to distribute data to users. This can be done by direct electronic transfer of data, by periodically issuing a revised copy of the database to a list of subscribers, or by copying and sending individual files in hardcopy or digital format to users when requested, or a combination of these approaches. Crucial to facilitating data access will be the development, maintenance, and distribution of a current summary data catalog (described in more detail later). In accordance with EPA policy, LCBP GIS data sets will also have to be submitted to EPA for inclusion in appropriate agency databases.

4. GIS Products and Services

a. Develop technical specifications: for GIS products and services (standard and custom maps, reports, spatial analyses, applications programming) created as part of the LCBP activities.

b. Manage GIS products and services contracts: this includes maintaining a vendor list, providing technical assistance in writing RFPs and contracts, and participating in the evaluation of proposals and work products.

Users and providers of data will have questions on policy, procedures, standards, and other issues pertaining to interacting with the database. To get consistent, accurate answers in a timely fashion, this technical support should be provided by the organization managing the database.

Assigning responsibility for GIS coordination and data management to one facility helps to avoid duplication of efforts (or the possibility that these functions will not be carried out at all) and has been found to be crucial by several EPA-sponsored water quality management programs (U.S. EPA, 1988). For example, each study within the Chesapeake Bay Program (e.g. point source discharges) has one or two staff dedicated to managing data/results. They interact with state agencies that collect the data and resolve any data submission issues as well as collect data documentation from the state agencies (U.S. EPA, 1990).

B. Decentralized Activities

While there are clear advantages to centralized GIS coordination and data management, there are not as strong arguments for other GIS services to be provided centrally. Activities such as data development and updating, the creation of standard and custom products (e.g. maps, analyses, and reports), and applications programming can be performed in many locations by many individuals as long as they have access to reliable data and their activities are coordinated. These decentralized GIS activities should be managed by, but not necessarily performed by, the GIS center.

1. Data Development

a. primary data: Develop GIS data layers according to contract and workplan specifications.

b. derived data: Derive new data layers from existing data sets according to contract and workplan specifications.

c. update data: As appropriate, update GIS data layers in the LCBP database.

2. Products and Services

a. analyses: Perform spatial analyses according to contract or workplan specifications.

b. products; Create standard and custom GIS products (maps, reports, data extracts, etc.) according to contract or workplan specifications.

c. applications programming: Write GIS applications programs according to contract or workplan specifications.

To take advantage of the specialized GIS expertise and infrastructure which has grown up in the basin, and to encourage widespread participation in and support for its efforts, subcontracts for creation of GIS data and products should be issued by the GIS service center whenever practical.

There are several advantages to distinguishing between centralized and decentralized functions:

- Communication, coordination, and contracting are all simpler if the many participants in the LCBP have to deal with only one organization to obtain the GIS support they need.
- There is one designated source for an authoritative current version of the data.
- By requiring sub-contracting of database development and updating and GIS activities involving use of the data, the LCBP will have access to the many qualified and talented GIS practitioners in the basin through a competitive bidding process.
- This will foster a wider participation in, and support for the LCBP, as well as strengthen existing GIS capabilities within the basin.

The LCBP GIS Service Center should submit an annual work plan and budget, approved by the LCBP GIS Advisory Board, to the LCMC. In addition, the GIS Service Center and the LCMC should agree, in principle, to a multi-year work plan and budget because of the need for continuity in database management. The GIS Service Center should make quarterly progress reports, approved by the GIS Advisory Board to the LCMC and EPA. For reasons discussed above, any agreement between the LCMC and the organization assuming the role of the LCBP GIS Service must contain adequate provisions for ensuring that GIS work that can be efficiently sub-contracted is sub-contracted.

V. AN ALTERNATIVE ARRANGEMENT

An alternative to establishing one GIS service center to carry out the centralized functions described above is to establish two centers - one in each state - whose activities would be coordinated via a GIS Advisory Board and professional GIS staff. This would be similar to the current operating mode of the four-state Northern Forest Lands Inventory. Such an arrangement may better reflect the political realities within the Lake Champlain basin, differences on technical issues and data collection procedures which follow state lines, and the long term use and management of spatial data.

There are several disadvantages of such an arrangement, however.

- To carry out many of the centralized functions (QA/QC, data archiving, documentation, and distribution, etc.) adequate hardware and software are needed. To avoid investing in additional equipment, GIS coordinating staff will need to be housed somewhere where there is already the necessary equipment. This argues for designating one center in one state or the other.

- The many centralized functions are most efficiently carried out by a mix of personnel rather than one individual. Rather than under-utilize highly trained personnel or hire two or three new staff to carry out the centralized functions, it makes sense to designate as a GIS coordinating center, a facility where this mix of expertise already exists.

- Lastly, there will be times when the PFT, the Education/Outreach staff, or others need quick turn around on a GIS product. They will need one organization that has authority to quickly meet their needs rather than merely a coordinator or committee that must negotiate over who is to create a product.

VI. SELECTING A PROVIDER

The LCBP should use an open competitive bidding process to select a provider of the centralized GIS services described above. Widely distributing a Request For Proposal (RFP) will allow the widest range of ideas to be considered including those from state, academic, private institutions, and joint ventures. To avoid bias toward either state, the RFP should be written by representatives of USGS and EPA. Similarly, to avoid bias toward either state, the proposals should be evaluated by representatives of EPA and USGS and reviewers from outside VT and NY.

A. EPA Criteria

EPA has provided four general Criteria for selecting a GIS service center:

- Minimize investment in infrastructure.

In other words, apply as much of the funds as possible to building and use of the database.

- Franchise with existing organizations as appropriate.

Take advantage of equipment and capabilities already present with the study area. For example, APES has found technical and financial benefits by combining data management efforts with the State of NC.

- Follow EPA data and other guidelines and policy, as appropriate.

- Contribute EPA-funded data to the appropriate agency database.

These criteria can be summarized as getting "the biggest bang for the buck." The goal is get the appropriate data to the people who will use it for managing the basin, rather than use scarce resources to buy hardware, hire additional staff, or otherwise build a GIS facility that will duplicate what is already available locally.

Projects funded by EPA are expected to yield data that meet EPA standards so that they have the potential to be useful in other programs. Enforcement of EPA and other LCBP GIS standards will ensure that data sets are compatible and "sharable", thereby increasing their utility ("corporate value") beyond their original context.

B. Other Criteria

Other criteria for evaluating an organization's suitability to provide the centralized GIS services include:

- demonstrated experience in assembling and maintaining a quality database including:
  - design
  - building
  - QA/QC
  - maintenance
  - distribution

- demonstrated ability to successfully manage contracts for the provision of GIS products and services,

- adequate HW, SW, personnel,

- organization history and future that would provide continuity, security, and access to the LCBP GIS database,

- financial soundness,

- appropriate mandate - An organization cannot take on this pivotal managerial role of it is inconsistent with its current mandate and activities,

- cost,

- viable data archiving and distribution plan,

- an approach to spatial data management that is coordinated with and non-duplicative of other agency efforts,

- facility within basin for ease of access and interaction. Build up capabilities within the region and increase the sense of local participation in the LCBP and ownership of the data, and

- in-house capabilities to prepare GIS products for PFT and others when rapid turn around precludes contracting for a particular project.

VII. ALTERNATIVE PROCUREMENT MECHANISMS:

A. State agency workplan

It appears that state agency GIS facilities are in the best position to supply the GIS services needed by the LCBP. It is likely that an agreement with a state agency will result regardless of whether the RFP mechanism or the workplan mechanism is used. However, by issuing an RFP and initiating an open bidding process, the LCMC will give itself the widest possible options. A wide spectrum of capabilities and approaches can be considered, and it is possible that a private contractor or an academic institution could offer an attractive solution.

B. USGS provision of GIS services

USGS was indicated in the Special Designation Legislation as the lead agency for the LCBP GIS. However, there is no precedent for USGS managing a GIS program similar to the LCBP's. This solution is does not meet the criteria of utilizing and strengthening local GIS capabilities or an organizational history of undertaking this kind of responsibility.

C. EPA provision of GIS services

EPA could manage the provision of GIS services needed by the LCBP or contract with another organization (as it has done in the case of the Chesapeake Bay Estuary Program and other EPA programs) to provide these services. This solution does not meet the criterion of utilizing and strengthening local GIS capabilities.

VIII. ADVISORY BOARD

The work of the LCBP GIS Service Center should be overseen by a technically knowledgeable GIS Advisory Board. The existing GIS Working Group provides an excellent nucleus for such an advisory board. Current active members of the GIS Working Group are:

Larry Alber, NY DEC
John Banta/ John Barge, APA
Ivan James, USGS
Grady Moore, USGS
Jim Connolly, NY DEC
Greg Charest, EPA
David Healy, VCGI

To ensure broader participation in an advisory group, the membership should be expanded to include representatives of VT ANR, the regional planning commissions, and the academic and private consulting GIS communities. Because responsibility for the development of GIS for the LCBP was assigned to USGS in the special designation legislation, it would be appropriate for USGS to provide the chairperson for this advisory group. If the GIS program assumes responsibility for all LBP data management, the GIS advisory board should be expanded still further to include a wider range of expertise.

The mission of the GIS Advisory Board members is to be spokespersons for the organizations they represent in advising on data development priorities and technical and policy issues that are within the scope of the GIS service's contract with the LCMC. It would approve the GIS Service Center's annual work plan and budget prior to its submission to EPA. It would receive quarterly progress reports from the GIS Service Center and forward them to LCMC and EPA.

The group should meet at least bi-monthly in open sessions. Agendas should be distributed in advance of all meetings. Minutes of the meetings and recommendations should be forwarded to the Data Management Subcommittee and to the TAC. Members should be specifically appointed by the LCMC so that there is an official roster that can be held accountable for decisions.

Chapter 5: POLICY, PROCEDURAL, AND TECHNICAL RECOMMENDATIONS

Analysis of the results of the needs assessment, the data inventory, the survey of basin GIS resources, a literature review, communication with other GIS programs, and interactions with staff and various activities of the LCBP, have lead to a series of recommendations on organizational, policy, procedural, and technical issues. Organizational recommendations were presented in the previous chapter. In this chapter recommendations on policy, procedures, and technical matters are presented.

I. DATABASE STRUCTURE

Setting up a GIS is sometimes thought of as merely selecting appropriate hardware and software, installing it, and hiring a technician to enter data. Rather,

> "*...it's the data that make a GIS. And the specifications and procedures for data collection and conversion must be developed precisely if a GIS is to fulfill users' expectations. All of an organization's requirements for data .... use translate into data collection specifications.*" (Somers and Singh, 1992)

If GIS technology is to be fully exploited in the management of the Lake Champlain basin, then the process of building a database should never end. Even if all data needs were fully anticipated and the database design perfectly executed, there would still be the need of updating certain data layers (e.g. population distribution, land use, etc.). As a rule of thumb, building and maintaining a GIS database is now estimated to be approximately 80% of the cost of GIS implementation (Antenucci, 1991). That is why so much emphasis is placed on the determination of data needs. The data development strategy proposed in Chapter 3 is based on the goals and objectives of the LCBP and the results of the first round of the needs assessment.

A. Organization of the LCBP Database

The LCBP GIS database design should include both a central database and distributed data and needs to distinguish between existing data and spatial data collected under the auspices of the LCBP.

1. Central database

The central LCBP GIS database is envisioned as the authoritative version of the most widely used data layers - those with the greatest "corporate value." The base layers (lake shoreline, watershed boundary, political boundaries, roads, and surface water) plus the control layers (registration tics, geodetic control, etc.) should reside in the central database. As other priority layers (such as bathymetry, sub-watershed boundaries, elevation, etc.) are completed and documented they should also be entered into the central database. Many individuals, including the PFT, education/outreach staff, researchers, state agency heads, and municipal planning commissions, will want access to these data layers.

The central database should include any spatial data developed under the auspices of the LCMC, such as the sediments toxics data. All such data should meet the LCBP GIS data standards. The most practical way to ensure this is to require that all spatial data development efforts follow the proposed LCBP QA/QC program (described below). A key feature of this program is the submission of completed data sets to a central clearinghouse so that adherence to standards can be verified.

2. **Distributed data base**

Data sets developed without LCMC assistance and which have less corporate value can be maintained at and by the originating agency. Often these are detailed attribute data sets that correspond to particular field sampling locations. These data sets will constitute the distributed database. Examples might include detailed forest stand information or detailed water quality data. Agencies developing and maintaining these data sets would be requested to provide suitable documentation to the LCBP GIS Service Center so that it could be entered into a data catalog.

> *"The distributed approach is useful because it tasks the agency collecting the data with the responsibility for all aspects of data submission and formatting. This ensures better data documentation, and encourages "ownership" and use of the data by the agencies."* (US EPA, 1990)

The Puget Sound Estuary Program data management strategy utilizes a distributed system approach. Raw monitoring data are the responsibility of the agency that collects it. A central database of summary data is maintained on a PC using dBASE IV. No software or database requirements are imposed on the agencies that manage the raw data. However there are *"strict transfer formats for data transmittal to the central system."* (Ibid.)

B. New vs. Existing Data

As the results of the Data Inventory clearly show, there is a wide variety of spatial data already available that is potentially relevant to the LCBP. Because few of these data sets meet the proposed LCBP GIS standards or even have documentation that allows this determination to be made, there is a need to distinguish between new and existing data. For practical reasons, the two will have to be treated very differently. Data collected as a result of programs sponsored by the LCMC and cooperating agencies can be required to meet a set of standards. However, it is unrealistic either to impose these standards on previously collected data or to ignore the existence of these data.

The most practical solution is to create a data catalog (hardcopy and/or electronic) that summarizes what is known about each existing data set. The Chesapeake Bay Program, for example, maintains two separate databases on watershed data sets: one for new data being created by the program and the other for historical data. Similarly, the Albemarle-Pamlico Estuarine Study documents, but makes no effort to correct existing data
(US EPA, 1990).

As the need arises within the LCBP, a particular data set can be more thoroughly examined to determine its suitability as a starting point for a particular investigation. This examination would be carried out by the GIS database administrator and the TAC subcommittee proposing a particular project. For example, if an RFP to study the relationship between zoning and recreational access to the lake is under development, it would be helpful to be able to turn to a current data catalog to learn not only whether there are completed digital data sets on zoning and recreational access, but what partial layers (either digital or hardcopy) could be utilized as a starting point for further data collection efforts. In many cases there will be no data of suitable scale, resolution, or vintage for a particular project, but in many other cases there are either partial digital data sets (e.g. lake bathymetry) or extensive paper originals (e.g. historical buildings) that will need relatively little effort to complete and include in the LCBP GIS.

As existing data sets are used (and improved) with LCMC funds and undergo the proposed QA/QC procedures, they would then reside in central LCBP database, and be subject to maintenance, update,

and distribution procedures established for it. In this way, the central LCBP GIS database will grow incrementally over the years.

C. Database Structure

The central LCBP GIS database will contain four general categories of data, similar to what has been recommended for NY DEC (ESRI, 1991):

- control layers - registration tics, watershed boundary, etc.
- cultural layers - land use, transportation, recreation sites, etc.
- physical layers - bathymetry, surface water, soils, etc.
- biological layers - wetlands, wildlife habitat, etc.

As described in Chapter 3, certain layers will be considered "base map layers" because they constitute a set of map features which are essential to orient map viewers and to provide a background for other spatial data sets. These base layers are: basin boundaries, Lake Champlain shoreline, political boundaries, surface water, and transportation.

USGS 7 1/2' topographic quadrangles should provide the basis for the primary tiling scheme. Additional tiling schemes (such as sub-watersheds and counties) can be developed, as needed, by the GIS Service Center.

II. STANDARDS

A. Purpose

The purpose of standards is to provide guidance and a formalized structure that will insure that independent data development efforts will result in a single compatible database. Compatibility often is not important to the primary data collector but usually is a concern of the agency funding data collection and maintenance which wants to:

- ensure compatibility of independent data development efforts,
- ensure a minimum level of quality, and
- promote confidence and use of database

with the overall objective of making the dollars expended go as far as possible.

> *"The Chesapeake Bay data management staff recommend that first-year data management activities include the establishment of quality guidelines for data submission. This requires negotiation with state agencies, the scientific community, and management... Having different database management software does not preclude programs from supporting consistency of data sets. Proper use of any database management system can afford transfer of data between programs even if the original database structures may be different. Of more importance to data consistency are policies or standards for data encoding... Those programs that had standards... were able to more completely integrate separate data sources than those programs where data compilation was not coordinated by standards..."*
> (US EPA, 1990)

B. Source

The proposed LCBP GIS Standards are modelled largely after The State of Vermont's, because it has among the most comprehensive of any spatial data standards developed in the U.S. to date. These standards are the most widely used GIS standards in the basin, and have been endorsed by the LCMC GIS Working Group. The complete standards are presented in the LCBP GIS Handbook of Standards and Procedures. Highlights of the standards are discussed in the following sections. Other applicable data standards are the Chemical Abstract Service (CAS) Registry Number Data Standard, EPA Data Standards for the Electronic Transmission of Laboratory Measurement Results (US EPA, 1991), EPA's Water Quality Storage and Retrieval System (STORET) data standards, EPA's Ocean Data Evaluation System (ODES) data standards, the National Oceanographic Data Center (NODC) taxonomic standards, and EPA's Order on Minimum Set of Data Elements for Ground Water (Manfredonia and MacDougall, 1992).

C. Documentation

Documentation is the foundation of the proposed standards and their associated QA/QC Procedures.

> *"Proper documentation of how the data standards are applied [QA/QC] should define for the user what source materials were used and what steps were taken to automate the data. This documentation should help avoid misinterpretation or misuse of the data by users. While standards cannot prevent ignorant uses of data, they can require that adequate information necessary to evaluate potential uses of the data be made available."* (Mass GIS, 1990)

Comprehensive LCBP GIS documentation, whether maintained on paper or within a database management system, must fully describe the data layer, its attributes, how it was developed, and any updates over time. It consists of eight tables or files. The primary file, <layer>.DOC, includes the following categories of information:

- data layer summary
- data manager
- geographic area and tile structure
- data source
- data format
- accuracy and tolerances
- data development and automation processes
- detailed narrative descriptions.

The other files are:

- polygon or point attribute documentation
- arc attribute documentation
- tabular data documentation
- annotation documentation
- update file to record changes to features or attributes
- history file to describe data layer development process
- documentation text file.

The LCBP GIS Handbook of Standards and Procedures describes in detail how to complete these files and provides an example of complete documentation for a data layer.

D. Software

1. Rationale for choosing ARC/INFO

ARC/INFO, a product of Environmental Systems Research Institute, Inc. (ESRI) of Redlands, CA, is recommended as the standard GIS software for the LCBP GIS. ARC/INFO is highly suitable for natural resources management and it is used throughout the U.S. in similar EPA water-quality programs. Indeed, it is the agency's software standard (U.S. EPA, OIRM, 1988). ESRI is a stable vendor which provides good support to its users as well as frequent upgrades. ARC/INFO is the most widely used GIS software package in the basin, and there is a considerable ARC/INFO database amassed in the two states. It was the consensus of those responding to the GIS capabilities survey that ARC/INFO is the GIS software of choice.

When base layers development near completion, ArcView, a new limited GIS package created by ESRI, should be installed at the LCBP office in South Hero. After a day of on-site training, LCBP staff will be able to provide interactive GIS capability to the PFT and others. ARC/VIEW should greatly facilitate the use of spatial data in Education/Outreach publications. ArcView's graphics are of publication quality and can be saved as a number of industry standard graphics files which then could be further manipulated, as necessary, to be incorporated into E/O materials.

2. Data Transfer Formats

To help minimize data management costs to the LCMC, spatial data should be provided to the LCBP GIS Service Center in one of four formats:

- ARC/INFO coverage
- ARC/INFO IMPORT/EXPORT interchange file format
- ARC/INFO TAPEWRITE utility (for 1600 BPI CCTs)
- DOS BACKUP utility (for DOS diskettes)

While DXF is a commonly accepted interchange format, the GIS Service Center should not accept data in this format because there is always some data "fixing" required when converting from DXF to ARC/INFO. However, the Center should be able to provide spatial data to users in DXF format whenever it is requested. This policy of requiring a specific data transfer format agrees with that of the Puget Sound Program (US EPA, 1990).

Attribute data alone will rarely be transferred to the GIS Service Center since it will be maintained by the originating organization. However, the Center should be capable of receiving and distributing attribute data in ASCII and a number of commercial database formats.

E. Accuracy

There are two kinds of accuracy to consider within the GIS database: the accuracy of attribute coding and positional accuracy of the features.

1. Attribute Accuracy

The standards call for 100% accuracy in attribute coding and encourage users and developers of data layers to use the same attributes and codes so that data can be more easily exchanged and understood by all users. Codes are provided for land use/land cover and for geographic areas (such as state, county, and municipality), as well as guidelines on how to develop new attributes.

2. Positional Accuracy

Positional accuracy is a function of the accuracy of the map source and the accuracy of the data automation process (e.g. digitizing). The standards document addresses "Digital Data Conversion" (Section A) and "Assessing Feature Accuracy" (Appendix A) to promote the highest quality data conversion process. It is assumed that a suitable source maps exists.

The acceptable level of positional accuracy will vary from layer to layer according to the proposed use of the data and the data source used, but at least must meet EPA requirements of +/- 25 meters (U.S. EPA, 1991). The level of positional accuracy to be achieved should be specified in LCMC contracts involving spatial data development. Thorough data documentation will be crucial in allowing potential data users to assess whether the data are accurate enough for their purposes.

3. Individual Data Layer Specifications

The layer-specific details on attributes and acceptable positional accuracy will have to be worked out over time as individual data layers are developed via contracts and work orders. The Database Administrator will play a critical technical coordinating role in the process. The DBA will need to work with the primary users of the data and those who have technical oversight over data collection in each state to:

- determine the degree of uniformity that is needed and possible to achieve,
- set the acceptable level(s) of positional accuracy,
- define the attributes, and
- agree on data development methodologies.

F. Scale and Resolution

Several participants in the Needs Assessment expressed the need for data at two levels of resolution (spatial detail): one data set at a resolution suitable for basin-wide analysis and planning and another data set for local and site-specific work. Because there is unlikely to be funding to support database building at two levels of resolution, it is recommended that 1:24,000 scale be the primary focus of database building. This will provide an adequate level of resolution (a minimum mapping unit of approximately 2 acres) and positional accuracy (tens of feet) for most applications, and is facilitated by the USGS standard topographic maps at this scale. For synoptic basin-wide views, data collected at 1:24,000 scale can be generalized for mapping or analysis at a smaller scale. A 1:250,000 scale map of the basin will fit on standard 36" x 48" map sheets and can provide resolution of at least 50 acres.

Much of Vermont's recent GIS data has been generated at a scale of 1:5000. Usually these data can be incorporated into 1:24,000 scale databases with little problem, however there are discrepancies in surface water mapping between the 1:24,000 scale source (topos) and 1:5,000 scale sources (orthophotos). A method for resolving these discrepancies will need to be devised if the 1:5000 scale data are to be incorporated into the LCBP surface water layer.

There may be good reasons to collect data from sources at a scale other than 1:24,000. Under the proposed standards, this is perfectly acceptable as long as the map source meets other criteria (Fisher

Associates, 1992). Again, documentation is crucial to allow the data user to evaluate the suitability of each data layer for his/her purposes.

G. Projections, Coordinate Systems, and Datum

The LCBP GIS standard coordinate systems are the New York State Plane Coordinate System, the Vermont State Plane Coordinate System, and the Universal Transverse Mercator System (zone 18). Each of these coordinate system is based on its own projection. Before data sets can be displayed or analyzed together they must be converted to a common map projection. This is easily done within the GIS using the ARC/INFO PROJECT command. Again, documentation of each layer is key.

Either the North American Datum 1927 or 1983 can be used as long as the datum is specified on the data documentation. Although NAD 1927 is out-dated it will generally be more useful because most of the base maps (USGS topographic maps and Vermont orthophotos) are based on NAD 1927. However, any data collected using global positioning system (GPS) technology will be based on NAD 1983. Within the GIS, data can be converted from one datum to the other, as needed.

These issues are discussed in detail in the standards under "Map Coordinate System".

I. Standards for GIS Products (maps)

As maps and other GIS products are produced there will be a need to standardize map formats. This is to promote recognition as LCBP products and facilitate production. For 36" x 48" inch maps, 1:250,000 is an appropriate map scale. UTM Zone 18 should be the map projection. Other map elements to be standardized include the LCBP logo, scale bars, north arrow, disclaimer wording, source information, legend design, text fonts, and symbol sets. The GIS Service Center should develop these standards as plot files and macros and distribute them as needed.

III. QUALITY ASSURANCE/QUALITY CONTROL

A. Rationale

The development of a credible and useful LCBP GIS database requires that all spatial data sets contributed to the database meet certain minimal criteria and are well documented. An important role of a LCBP GIS service center will be to implement a quality assurance/quality control (QA/QC) program to ensure that the spatial data collected using LCMC funds meets EPA standards and the proposed LCBP GIS standards as outlined above and presented in detail in the LCBP Handbook of Standards and Procedures. The goals of GIS QA/QC procedures are to:

- ensure the maximum utility of spatial data collected under the auspices of the LCMC, and
- to minimize redundant data collection efforts.

The QA/QC procedures proposed here are based on a review of relevant EPA policy, literature from similar GIS programs around the United States, and the experience of GIS facilities in Vermont and New York. Most public GIS installations rely on documentation for quality assurance. They tend to accept any data as long as there is adequate accompanying documentation. The documentation must be highly detailed so that data users can evaluate the suitability of data layers for their purposes.

To achieve a valuable, sharable spatial database, the LCMC must have a means of controlling the quality of the data being collected with its funds. Because the LCMC has no regulatory authority, the best means for encouraging compliance with data standards and procedures is through contractual mechanisms. Adherence to GIS data standards, procedures, and documentation described in this and accompanying reports should be implemented through EPA contracting procedures (Objective 1 of the PFT). Specifically:

- **Adherence to GIS standards and protocols must be stipulated in all applicable LCMC requests for proposals and contracts.**
- **All proposals and contracts must include a section detailing how GIS data standards will be met.**
- **Non-adherence to data standards and QA/QC procedures should be considered a breach of contract and result in non-payment.**

These recommendations are similar to policies instituted for the Narragansett Bay Project: all agencies collecting data are required to develop a QA document as part of the funding agreement between the project and the agency (U.S. EPA, 1990).

B. Proposed QA/QC Procedure

The GIS Work Group has reviewed and approved the proposed three-stage QA/QC procedure. It consists of:

- preliminary data compatibility screening,
- spatial data automation planning, and
- final data documentation.

The documents to be included in the proposed QA/QC procedure appear in Appendix E.

1. Preliminary Data Compatibility Screening

A Preliminary Data Compatibility Questionnaire must become part of all RFPs that involve the collection of spatial data. The database administrator would review written answers to these questions in evaluating a proposal for funding. In addition, the DBA should check to see that costs provided in the proposal budget accurately reflect the proposed data sources, data collection methodologies, and necessary documentation.

2. Data Automation Planning

A Data Automation Plan is required from all contractors and agencies proposing to automate spatial data. Each contract will specify when the data automation plan is to be submitted to the database administrator for approval. For most funded projects, it will be part of the contract itself, and is likely to require specific quality checks such as overlaying test plots of data on the source map and correcting any visible discrepancies.

Because of budget constraints, some funded projects may result in mapped, but not automated, data. So that these data can be automated at a later date, contractors and agencies will be required to plot

their data accurately on a suitable hardcopy, planimetric base map and to thoroughly document attribute data.

3. **Final LCBP GIS Data Documentation**

Complete data documentation must be submitted to the database administrator with the digital data. Final payment under each contract should be contingent upon the database administrator certifying that spatial data sets and their documentation meet the LCBP standards and any additional requirements set out in the contract. Required documentation as well as other standards are described in LCBP GIS Handbook of Standards and Procedures.

C. Implementation

The LCBP GIS Service Center will play a critical role in implementing the QA/QC procedures. A qualified individual with access to the necessary hardware and software is needed to assume responsibility for quality assurance for new data. This will be one of the responsibilities of the Database Administrator. He/she will guide the entire data development process, from participating in the initial TAC subcommittee discussions on potential projects, helping to write the RFP, and evaluating proposals, through writing technical contract specifications and evaluating data sets and their documentation submitted to the LCBP GIS database.

As is done at both the Narragansett Bay Project and the Puget Sound Program central databases, the DBA should use automated techniques to check attributes for required fields and value ranges, formats, codes and character frequencies (U.S. EPA, 1990). He/she should also run checks on topology, and visually compare proof plots and source maps before accepting data into the LCBP GIS database.

Contractors and agencies will need to include the costs of data delivery and documentation in their project budgets.

D. Benefits

Why employ a three-stage procedure? Why not just rely on final data documentation and inspection of the data when it is submitted? The state GIS programs in Minnesota and Florida have found numerous benefits in guiding the data development process from its initial stages (Florida Growth Management Data Network Coordinating Council, 1991; Minnesota Land Management Information Center, 1991). A multi-stage QA/QC process

- facilitates review of project proposals,
- minimizes redundant data collection efforts,
- helps avoid problems in data before they are collected and thus minimize expensive "fixing" of data later,
- ensures that any new data collected will be of high quality,
- facilitate final data documentation because much of the required information will already have been assembled and submitted during previous stages, and
- promotes confidence in, and use of, the database by making participants aware that all data in the database have undergone the same acceptance criteria.

IV. POLICIES

In consultation with the GIS Service Center, the GIS Advisory Board will need to establish operating procedures and policies regarding data ownership, access, and maintenance.

A. Data Ownership

Once data sets have met quality and documentation standards and have been accepted into the LCBP GIS database, they become public information governed by the applicable federal and state freedom of information laws. They should be made available in hardcopy or digital format for the cost of reproduction. To limit potential liability arising out of misuse of LCBP data, all maps, data sets, and reports (whether in digital or hardcopy format) must include suitable disclaimers.

B. Data Access

1. Goal

A goal ascribed to the LCBP GIS is to make spatial data sets "*readily available to the public*" (Plan Formulation Team, 1992). Furthermore, the Office of Management and Budget (OMB) Circular A-130 requires federal agencies to "*be sensitive to, integrate, and not duplicate or conflict with*" state and local information resource management practices (U.S. Government Printing Office, 1992). The policy requires active information dissemination programs such as the maintenance of inventories of information products and development of aids for locating information such as catalogs (Tosta, 1992).

2. Role of the GIS Service Center

Copies of LCBP GIS data, either in hardcopy or digital form, should be made available to users for the cost of the materials and labor involved in reproductions. The selected GIS Service Center provider should be able to issue digital data in several formats and on several media, as described in the standards section, above. This approach protects individual data developers from potentially endless requests for data by directing all requests to the GIS Service Center and has worked well for several years now in the State of Vermont. It also saves time and effort for seekers of data by providing them with "one stop shopping".

The LCMC needs to consider carefully the importance of direct electronic transfer of data and/or direct interactive use of data sets residing at the GIS Service Center. These capabilities may require considerable expenditures for communications hardware and software which may not be justified given the main LCBP goals of writing and implementing The Plan for managing basin resources. It is important to decide who will need more direct access to the data than is provided by the requesting, copying, and receiving of a few data sets.

The results of the GIS planning work that has gone on to date suggests that, once some LCBP data sets are amassed, there will probably be three general categories of data users:

1st priority: Those needing frequent access to all or nearly all the LCBP GIS data layers for all of the basin for writing planning documents and overseeing management of the basin. In this category would be the PFT and its staff, and the three major participating state agencies: VT ANR, NY DEC, and NY APA.

2nd priority: Those needing several data layers for sections of the basin from time to time. This category would include managers of individual agency programs, researchers, regional and county planning organizations, EPA, and USGS.

3rd priority: Those needing one or two layers for a section of the basin, usually as a one-time occurrence. Examples would be municipalities, students, private contractors, and the general public.

Priorities 1 and 2 would be best served by entering into a subscription arrangement with the GIS Service Center. On a periodic basis, perhaps quarterly, these organizations would receive a complete copy of the current version of the database on a CD-ROM (or other mass data transfer medium). The two states' state library systems, EPA, and other participating federal agencies should also receive complete database updates. The GIS Service Center would need a CD-ROM recorder and data recipients would need a CD-ROM drive. To display and analyze the spatial data, recipients would want GIS software - probably ARC/INFO or ArcView. The PFT, several researchers, and several managers have specifically said that they will want interactive GIS capability. For those for whom GIS is only a tangential activity, ESRI's ArcView should provide all the capabilities they need - ability to view, manipulate, analyze, and output several layers at a time, but no data entry or editing capability.

The Puget Sound Estuary Program did not develop networked system for multi-user access because of costs. There, only data contributing agencies have direct access to the database and requests from others for data and reports has been minimal (U.S. EPA, 1990). However, if updates to the LCBP GIS database are frequent enough, and demand from the major data users warrant it, use of an electronic network such as EPA's Wide Area Network (WAN) should be investigated.

3. A LCBP GIS Summary Data Catalog

At this point, much more important than establishing an electronic data transfer network is creating, distributing, and maintaining a LCBP GIS Summary Data Catalog.

Within EPA's National Estuary Programs the creation of a data index or catalog was found to be essential to utilizing what is already available. Data or information indices were built by five of the seven programs (US EPA, 1990). Indeed, the need for such a product was a common theme among most of the groups participating in the needs assessment.

NY DEC's LCBP GIS planning contractor suggested using the database created during the basin data inventory as a starting point for a LCBP GIS Summary Data Catalog:

> *"Some means of accessing a description of all [available] data layers must [be provided] such as the GENDOC database created during the LCMC data inventory. Such a reference would need to be updated and maintained by the coordinating agency for the Lake Champlain project.....In order to avoid redundancy and/or duplication of effort, the GENDOC database should be used as a reference when new data sets are being considered for addition to the Lake Champlain GIS. The value of GENDOC in this application alone is an additional justification for improvement and maintenance of the database"* (Fisher Associates, 1992).

Such a catalog must include information on source date and scale, completeness, quality, geographic extent, etc. and should be widely distributed both in paper and electronic format. The Data Catalog Summary published and periodically updated by VCGI provides a suitable model.

4. Data Security

The GIS Service Center should maintain multiple copies of both current and superseded versions of the LCBP GIS database in a secure, fire-proof facility. Only authorized staff would have access to the data for the purposes of making copies, editing, and analysis. Any restrictions to data access placed on data

sets by the data developer (as specified in the data developer's contract with the LCMC) must be honored.

C. Data Maintenance

Certain data layers will not require updating once completed - for example soils, watershed and sub-watershed boundaries, etc. Others, such as land use, transportation, recreation facilities, etc., will require periodic updating in order to continue to be useful. The data developer should perform any updates to a data set already entered into the LCBP GIS database. The GIS Service Center, with the help of the GIS Advisory Board, will need to develop memoranda of understanding with data developing agencies to coordinate the revision and update process. This arrangement has worked well for the Narragansett Bay Program (U.S. EPA, 1990). All updated and revised data should be held to the same data standards and QA/QC process proposed for new data.

V. HARDWARE

A. Hardware needs at the LCBP GIS Service Center

In order to perform its data clearing house and QA/QC roles, the GIS Service Center will need adequate computer hardware. The Chesapeake Bay data management staff, faced with similar tasks, stressed the need for on-site computer resources. This was deemed essential to carry out their mission in a timely way (US EPA, 1990).

The GIS Service Center's hardware requirements are determined largely by the size of the data sets to be handled and the types of manipulations of the data that will be required. Although analytical functions will be largely separated from database management functions under the proposed organizational structure, the GIS Service Center will still need to manipulate large data sets (10 - 20 megabytes each) in the QA/QC procedure, archiving, and copying data sets for distribution. This will require that the GIS Service Center have host ARC/INFO running on at least a workstation.

In order to receive and distribute data, the GIS Service Center will need a variety of data copying devices including diskette drives, tape drives, cartridge tape drives, and Bernoulli drives, each with the appropriate software. The Center will also need the capability to master CD-ROMS for distribution of complete sets of the LCBP GIS data.
The basin resources survey indicated that as of January 1991, there were seven workstation ARC/INFO installations located in the basin and another five at government agencies and academic institutions participating in the LCBP. Assuming that a qualified candidate comes forward to serve as the LCBP GIS Service Center, there is no need for the LCMC to invest in additional hardware for a GIS Service Center.

B. Distributed GIS Hardware

As indicated by the results of the basin GIS programs survey, there is a great deal of GIS hardware and software resident within the Lake Champlain Basin. ARC/INFO is running on every conceivable platform from personal computers (PCs) to mainframe computers. Because ARC/INFO data are easily exchanged between the various hardware platforms, there is little reason to stipulate that a certain type or brand of hardware be used on LCBP projects. For analyses and plots that utilize large quantities of data, such as producing basin-wide analyses or maps, a workstation or better will be needed. However, database building activities, and many analyses and plotting activities can be performed perfectly

satisfactorily on PCs. The GIS Service Center will be able to evaluate whether prospective contractors' facilities suffice to accomplish the database building and analytical tasks to be sub-contracted.

There is no need for the LCMC to invest in additional hardware at this time. Once base map layers are completed, ArcView should be installed at the South Hero LCBP Office for use by Education/Outreach and LCBP staff. This will require hardware capable of running ArcView and a suitable output device.

C. Global Positioning System

Global Positioning Systems (GPS) is a technology that allows the highly accurate determination of geographic position using signals transmitted by orbiting satellites. GPS can facilitate the collection of information regarding the position of features such as boat ramps, water quality sampling stations, or point discharge outfalls. In many cases, the expensive and time consuming step of transforming analog data (mapped data) to digital data (i.e. into an ARC/INFO coverage), can be bypassed altogether when the proper GPS equipment is available. A technician in the field records location information provided by the orbiting satellites and enters attribute information (e.g. the characteristics of a particular public boat launch site). The digital file created in the field is then entered directly into the GIS. The result is more accurate information collected more efficiently.

Several researchers and agency personnel are already using GPS in the basin, and others have expressed interest in doing so. However, their GPS capabilities are limited by the lack of a GPS base station in the area transmitting a signal that allows them to calculate an very accurate position while in the field.

In order for the LCMC to take full advantage of GPS capabilities, a GPS base station, whose signal can be received throughout the basin, is needed. Several organizations are interested in the establishment and management of such a base station: VT AOT, VT ANR, Lyndon State College, the U.S. Coast Guard, the Federal Aviation Administration (FAA), the Federal Highway Administration (FHA), National Oceanic and Atmospheric Administration (NOAA), EPA, and the National Geodetic Survey (NGS).

Milo Robinson, a NGS employee stationed at VT AOT, is eager to work with the LCMC and these other organizations to establish at least one GPS base station in Vermont. A good quality receiver and computer for a base station would cost approximately $50,000. However, there are several technical and managerial issues that need to be worked out in addition to purchase of the equipment, such as the optimal location of a base station and responsibility for base station maintenance and operations.

At this point an expression of need for improved GPS capabilities from the LCMC could be very influential in efforts by VT AOT and members of Congress to secure funding for a base station. Eventually the LCMC might be expected to contribute to the funding of the base station. However by cooperating at this time with NOAA, FHA, NGS, and the Coast Guard, the expenditure of LCMC funds could be minimized.

The TAC should invite Milo Robinson, and perhaps other experts, to make a presentation on GPS in order to help it formulate a recommendation to the LCMC regarding its participation in establishing a GPS base station in the region.

VI. PERSONNEL

A. The Experience of Other Programs

Designing, assembling, and managing a major GIS database requires the services of trained, experienced personnel. The NEP programs indicated that having at least one staff dedicated to data management activities was crucial. For example:

> *"The Chesapeake Bay Program has a full-time data QA/QC officer. The program feels that this is essential, especially with monitoring data...The program was without a QA/AC officer for 4 years and ran into some difficulties with misreported data. Significant time and money was needed to recompile and ensure the quality of retrospective data through examination of laboratory records."* (U.S. EPA, 1990)

For several years the Puget Sound Program had one full-time staff responsible for assessing data management needs and developing a data management approach. Then additional staff were added. On-going data management requires one full-time data manager and one individual for data analyses and report preparation. In addition 3.5 full-time equivalents manage data in the state agencies doing the monitoring. The state agencies participating in the Puget Sound Program are required to produce yearly reports of monitoring results. (Ibid.)

B. Database Administrator

The minimum staffing requirement of a LCBP GIS bureau is a database administrator (DBA). A DBA has been found to be critical in several other EPA water quality programs (U.S. EPA, 1990). This individual would be responsible for:

- refining GIS database design and standards,
- developing data specifications,
- ensuring that data submitted meet established standards,
- documenting and archiving data,
- designing a data catalog, and
- developing technical specifications for GIS products.

GIS database design will encompass a range of activities. It will involve close coordination with TAC subcommittees and others involved in the LCBP as RFPs and work orders are being considered and drafted. In these cases the database administrator will act as a resource to help these groups evaluate existing data sets to determine whether they will meet the needs for the project under consideration or whether new data collection efforts will be required. This activity is basically a continuation of the needs assessment process.

The DBA will assist these groups in writing any technical GIS specifications to be included in RFPs and workorders. The DBA should also be involved in evaluating proposals that involve the collection of spatial data. (Because the involvement of the DBA early on in the planning of data collection will have significant benefits for the QA/QC process and, ultimately, in the quality of the database, these activities were discussed above under "QA/QC".

C. Other Staff

Components of the DBA's responsibilities could be delegated to staff with less training and expertise, but still need to be performed under the supervision of the DBA. For example, once a data catalog is designed, a GIS Technician/Analyst can keep it updated. Similarly, once the procedures for copying and distributing data to users is developed, the mechanics of this task can be turned over to a Technician/Analyst. This Technician/ Analyst would also perform many of the routine tasks of QA/QC under the supervision of the database administrator.

As the PFT gets heavily involved in evaluating the results of scientific studies and in writing The Plan, it may find that the services of a GIS Technician/Analyst are desirable in situations where it needs a product very quickly or the task is too small to warrant setting up a contractual arrangement. The Education/Outreach staff is likely to have similar short-term GIS needs. The Technician/Analyst would also provide technical support to users and providers of the data. This could be as simple as answering questions by phone and/or more formally by offering periodic training sessions.

As the database begins to be populated, products and services (as distinguished from digital data) will be requested. There will be a need for additional GIS staff either to create these products or to manage the contracting with other GIS facilities to create these products. Since contracting out as much work as is practical has been recommended, contract management will require at least the part-time commitment of a **GIS Manager**. Other responsibilities of the GIS manager would include negotiation of data maintenance agreements with participating state agencies, coordination of data development programs with state and federal agencies, the preparation of quarterly progress reports, annual work plans, budgets for submission to the GIS advisory group and EPA, and participating in GIS Advisory Board meetings.

The support services of a **Clerical Position**, at least on a part-time basis would greatly enhance the efficiency of the GIS service. This individual would assist in the distribution of data standards, data, the data catalog, and GIS products and provide word processing and editing assistance for report preparation.

The PFT has expressed an interest in having interactive GIS capabilities. If more than a browse and a limited manipulation capability is envisioned, this would require that an experienced GIS analyst be available to them, in addition to hardware, software, and a copy of the database. If enough data layers have been entered into the LCBP GIS database before Plan drafting is completed, a more practical solution may be to install the ArcView software package at the LCBP office in South Hero and train existing staff in its use.

Table 5 - 1 **Distribution of Responsibility for GIS Service Center Tasks. For a fuller description of each task, please refer to Chapter 4.**

TASK	DBA	TECH ANALYST	MANAGER	CLERICAL
A. Standards				
1. refine standards	X			
2. distribute standards				X
B. Data Development				
1. develop data specs	X			
2. contract management			X	
3. liaison			X	
4. technical assistance		X		
5. QA/QC		X	X	
C. Data Clearinghouse				
1. archive/maintain data	X	X		
2. distribute data and products		X		X
3. maintain data catalog		X		X
4. outreach			X	
D. GIS Products & Services				
1. develop technical specs	X			
2. contract management			X	
3. quick turn-around GIS products		X		

D. Recommendation on Personnel

Several GIS organizations within the basin have personnel capable of fulfilling the DBA, manager, and GIS analyst, and clerical support roles described above. Rather than attempting to hire individuals to fill these roles, the LCBP should select an organization with the appropriate personnel to act as a GIS Service Center. Using personnel who are already in place has the advantage of capitalizing on individuals who are familiar with operating procedures and equipment within their organization and who know, and are known by, the other GIS practitioners in the basin and those involved with the LCBP. Additionally, this would agree with EPA policy to avoid duplication of capabilities within the basin and to strengthen existing organizations.

Chapter 6 - Summary of Implementation

There will be two major phases of GIS implementation for the LCBP:

- Phase I: the remainder of the five years directed by the LCMC, and
- Phase II: the continuation of basin management as determined by the LCMC's Plan.

As the time line in Figure 6-1 indicates, there will be four major categories of GIS activities going on throughout Phase I and Phase II:

- GIS planning,
- organizational activities,
- database building, and
- data use.

Although Phase I consists largely of planning, organization, and database building, and Phase I consists largely of database building and data use, elements of each of the four categories occur in both phases.

I. PHASE I: FY 92 - FY 95

Phase I of LCBP GIS implementation is characterized by planning, organization, and database building activities. The majority of the planning has already been accomplished in FY 92, using LCMC funds from FY 91. Tasks completed include the development of QA/QC procedures, conducting a GIS User Needs Analysis, inventorying existing data, inventorying other GIS resources, developing standards and policies, and writing this GIS Management Plan. Annual re-assessment of GIS needs and planning for the transition from Phase I to Phase II are two planning tasks that remain.

Phase I will also involve database building and data use. The base map layers will be completed during Phase I as will several other priority layers. These will be available for use by the PFT, Education/Outreach staff, researchers, managers, and the general public. A high-visibility demonstration project, combining data development and data use, should be completed during Phase I. Creation of a "New Basin Atlas" could be such a demonstration project. Annual re-assessment of GIS data needs is recommended throughout Phase I and Phase II.

A. Budget

Based on the recommended approach of contracting for a GIS Service Center, costs for Phase I will be largely for personnel and data development. If an existing GIS facility in the basin is selected, expenditures for office space, equipment, and furniture should be minimal.

1. Personnel

Because of the urgent need to start building the LCBP GIS database, a Database Administrator (DBA) should immediately start overseeing base map layer development, land use/land cover development, creation of the summary data catalog, and technical evaluation of funding proposals received by the LCMC. This would require approximately 60% of a full-time equivalent in FY 93 and 80% in succeeding years, depending upon what other assistance is made available to the DBA. A small percentage of a manager's time (10 - 20%) would be used in FY '93 to handle budgets and reporting, to work with the GIS Advisory Board, and to manage contracts. In FY 93 only a small percentage of a GIS Technician/Analyst's time would be needed to assist the DBA and respond to any immediate GIS needs of the PFT and Education/Outreach staff. Clerical assistance would be used for correspondence

and report preparation (the responsibilities of proposed personnel were more fully discussed in Chapter 5).

Table 6-1
GIS Timeline

Tasks	FY 92				FY 93				FY 94				FY 95				FY 96			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A. GIS PLANNING																				
Develop QA/QC Procedures																				
Conduct Needs Analysis																				
Inventory Existing Data																				
Inventory Other GIS Resources																				
Develop Standards																				
Write GIS Management Plan																				
Re-assess LCBP GIS Needs																				
Plan Transition to Post-LCMC																				
B. ORGANIZATIONAL																				
Adopt Proposed GIS Mission Statement																				
Select GIS Service Center Provider																				
Establish LCBP GIS Advisory Board																				
Adopt Proposed Standards and Policies																				
Transition to Post-LCMC																				
C. DATABASE BUILDING																				
Re-assess Data Needs																				
Create Base Map Layers																				
Create Land Use/ Cover Layer (incl. wetlands)																				
Development of other priority Data Layers																				
- subwatersheds																				
- bathymetry																				
- recreation facilities (incl. public access sites)																				
- historic structures and sites																				
- elevation, slope (1:250,000 scale DEMs)																				
- point discharges																				
- population distribution (using TIGER files)																				
- soils																				
- fish and wildlife habitat																				
Development of other Layers																				
D. DATA ACCESS AND USE																				
Evaluate Existing Data Sets																				
Create and Maintain Summary Data Catalog																				
Distribute Data																				
Manage Creation of GIS Products																				
Create a "New Basin Atlas"																				
Initiate a Demonstration Project																				
Install ArcView at LCBP Office																				
Install ArcView at VT ANR, NY DEC, NY APA																				
Purchase CD-ROM recorder																				

Table 6-2. Gross Personnel* Costs for GIS Implementation

Position	FY 93 % FTE	FY 93 $$	FY 94 % FTE	FY 94 $$	FY 95 % FTE	FY 95 $$
DBA	60	27,000	80	36,000	80	36,000
Manager	20	10,000	50	25,000	50	25,000
GIS Tech/Analyst	10	3,500	50	17,500	50	17,500
Clerical	10	2,200	10	2,200	10	2,200
TOTAL		$42,700		80,700		80,700

*Based on annual salary + benefits estimates of:

DBA	$45,000
Manager	$50,000
Technician/Analyst	$35,000
Clerical	$22,000

2. **Hardware and Software**

a. for the GIS Service Center

The facility selected to serve as the GIS Service Center will have adequate hardware and software to meet most of the GIS needs of the LCBP as described in this report. However, if GIS data development proceeds on schedule, by FY 94 some means of producing multiple copies of the complete data set will be needed. This capability does not exist in the basin at the present time.

Although this area of computer technology is changing very rapidly, at this point a CD-ROM recorder seems to be a potential solution. The LCMC should anticipate spending approximately $8,500 on a CD-ROM recorder or similar device, and the distribution media. It may be possible to utilize a data mastering capability made available through a cooperating government agency or through a commercial service, thereby eliminating the need to purchase equipment. However, if there will continue to be updates of the GIS database on into Phase II, the benefits and costs of owning the data mastering capability versus contracting for data mastering services must be considered. Similarly, if the frequency of data updates and the volume of data demand warrant it, the cost of electronic transmission of data such as via EPA's wide area network (WAN) should be investigated.

b. distributed hardware and software

The purchase of ArcView software for use by the LCBP staff in South Hero is recommended by the end of FY93. By the end of FY 94 ArcView should be installed at VT ANR, NY DEC, and NY APA to facilitate use of LCBP GIS data by state agency staff. A suitably equipped 486 computer costs approximately $3000. The ArcView software can be purchased in the basin for $450. By 1994 these agencies may already have purchased ArcView (or a similar software package) for other purposes, and may have a suitable platform in-house, so the necessity of this expenditure should be reviewed.

3. **Indirect Costs**

The LCMC should expect to provide 30% of the personnel costs toward hardware maintenance, software licensing agreements, materials (diskettes, plotter paper and pens, etc.) telephone, and utilities.

4. Training

No GIS training is anticipated except that required for ArcView. One day of on-site training for two LCBP staff members familiar with PCs and Windows would cost approximately $500. This expense would re-occur three times in FY 94 if ArcView is installed at VT ANR, NY DEC, and NY APA.

5. Travel

Travel costs for the Database Administrator and the GIS Manager should be anticipated. Both will be traveling around the basin on a frequent basis to meet with the GIS Advisory Board, TAC subcommittees, and the LCBP staff, and to make presentations to the TAC and the LCMC. An estimate for monthly mileage costs, based on 28 cents/mile is $100.

6. Data Development

Cost estimates for data development were presented in Table 3-4.

Total projected GIS costs, by federal fiscal year, are:

	FY 93	FY 94	FY 95
Personnel	42,700	80,700	80,700
30% Indirect	12,810	24,210	24,210
HW/SW	3,450	18,850	0
Training	500	1,500	0
Travel	1,200	1,200	1,200
SUB-TOTAL	60,660	126,460	106,110
Data Development	153,975	76,875	43,125
TOTAL	$214,635	203,335	149,235

B. Funding

1. Long-term budgetary commitment

The design, construction, and maintenance of a spatial database of the caliber needed to facilitate management of the basin is a large undertaking. A reliable level of funding must be maintained so that the database can be systematically and incrementally assembled and data standards maintained. A qualified organization must be delegated this task over a number of years. Few qualified organizations will take on such a responsibility, unless there is some assurance of funding over several years.

2. Experience of National Estuary Program

The experience of the Chesapeake Bay Program and the Albemarle-Pamlico Estuary Study shows that roughly 20% of the budget for each individual funded project (e.g. water quality monitoring, identification of point and non-point pollution sources) should be allocated to data management activities. In the case of the Chesapeake Bay Program, *"Approximately 21 percent of the individual study budget is allocated to data management activities."* In the case of APES, 20% of program funds ($150,000/yr.) is used for data management activities. This includes salary for the data coordinator. In the case of the Narragansett Bay Project, $180,000/yr. pays the salaries of four full-time data management staff (U.S. EPA, 1990).

3. Funding sources for LCBP GIS activities

a. Support of the LCBP GIS Center

The GIS planning work described in this report funded from FY 91 monies. No FY 92 monies were spent on GIS although $110,000 was set aside by the LCMC for development of a land use/land cover layer and for a GIS clearinghouse.

The FY 93 budget passed by Congress includes $250,000 for USGS to be spent on efforts outlined in the Special Designation Legislation:

- conversion of partial recording sites to continuous flow monitoring stations and the establishment of additional continuous monitoring stations, and
- develop an integrated GIS for the Lake Champlain basin

as directed by the LCMC.

Funds to support the GIS Service Center in FY 93 and to complete the base map layers should be derived from the USGS budget. In succeeding years, if federal funding continues at this level, USGS funds will be needed only to support the GIS Center.

b. Support of database development

The development of base map data layers, something that has been taken for granted by many LCBP participants, and which does not fall under the purview of any one TAC subcommittee, should be accomplished using FY 93 USGS funds, as mentioned above.

Priority data layer development should be paid for from programmatic funds (i.e., TAC subcommittees' project budgets). Several federal agencies involved in data collection and mapping have cooperative and cost-sharing programs that may significantly reduce the LCMC's expenditure of funds for data layer development. Examples are USGS and SCS. The GIS Service Center Manager should investigate all relevant cost-sharing programs that can defray data development costs for the LCBP.

The Lake Champlain Special Designation Legislation requires a 25% non-federal match of EPA funds for all projects, under the auspices of the LCMC.

C. Recommended Roles of Participants

1. Lake Champlain Management Conference

The LCMC should continue to plan, fund, and oversee GIS activities for the LCBP. The LCMC should review the GIS Service Center's annual work plans and progress reports, and approve its budget requests to EPA and USGS. From time to time, the LCMC may need the Service Center to provide a particular GIS product not included in the Center's annual workplan. A draw-down account should be established at NEIWPCC to cover these occasional expenses.

2. **Plan Formulation Team**

As plan writing accelerates, the PFT is likely to need project-specific GIS outputs - a map showing a particular combination of data layers, for example. The PFT, like the Management Conference as a whole, will need access to a draw-down account at NEIWPCC to cover these occasional requests to the GIS Service Center.

3. **Technical Advisory Committee**

The TAC should act as a conduit of GIS needs between the individual TAC subcommittees and the GIS Service Center. The TAC should prioritize the spatial data layer development needs of the subcommittees and forward them to the GIS Advisory Board via the TAC chair. Each TAC subcommittee should work with the DBA to develop appropriate technical specifications for inclusion in RFPs, and will need to forward proposals to the DBA for approval of data collection and documentation protocols as required by the QA/QC procedures. Because of the importance of spatial data management to the success of the LCBP mission, and because a closer working relationship between the TAC and GIS advisors is desirable, the TAC chair should attend GIS Advisory Board meetings.

4. **Lake Champlain Research Consortium**

Via a seat on the GIS Advisory Board, the LCRC will provide valuable input regarding needs and concerns of researchers relative to the GIS operation, such as GIS data development priorities, attribute definitions, and data access.

5. **U.S. EPA**

The appropriate representative of the EPA Office of Information Resources Management should provide oversight for the entire LCBP GIS effort including review of annual work plans, quarterly progress reports, and QA/QC methodology. EPA funding of GIS work plan elements will depend upon prior approval by the LCMC. EPA should staff the GIS Advisory Board to ensure direct communication of pertinent EPA policy and regulations to the GIS Service Center.

6. **USGS**

Based on its designated responsibility for the development of a basin GIS in the Lake Champlain Special Designation Act, USGS is the appropriate agency to chair the GIS Advisory Board. Starting in FY 93, USGS funds will be available for GIS activities as directed by the LCMC. The New York District of the Water Resources Division may be able to facilitate the sharing of spatial data available from USGS and appears willing to participate in specific database building activities, as needed.

7. **VCGI**

The VCGI is one of several organizations that appear potentially capable of serving as the LCBP GIS Center. If it does not assume this role it should be represented on the GIS Advisory Board. As the

major GIS data clearinghouse in Vermont, VCGI should receive a complete copy of the LCBP database as soon as it is available.

8. NY DEC

NY DEC is one of several organizations that appear potentially capable of serving as the LCBP GIS Center. If it does not assume this role it should be represented on the GIS Advisory Board. NY DEC will probably both develop GIS data and be a major developer of GIS applications for the basin. As such, it should receive a complete copy of the LCBP database as soon as it is available.

9. NY APA

NY APA is one of several organizations that appear potentially capable of serving as the LCBP GIS Center. If it does not assume this role it should be represented on the GIS Advisory Board. APA has expressed interest in being a primary LCBP GIS data distribution site in New York and should receive a complete copy of the LCBP database as soon as it is available. It will probably both help develop GIS data and be a major developer of GIS applications for the basin.

10. VT ANR

The VT ANR GIS facility will probably both develop GIS data and be a major developer of GIS applications in the basin. ANR will need a complete copy of the LCBP database as soon as it is available. The appropriate individual from this facility should become an active member of the LCBP GIS Advisory Board.

11. Citizens Advisory Committees

No formal role in the GIS effort is envisioned for the CACs. However, their valuable insights on public participation and education/outreach materials and programs should be transmitted to the GIS Service Center via the LCMC. They are encouraged to provide feedback on the utility of GIS products and services in the education outreach effort, and to suggest additional materials that the GIS should provide.

12. Universities

Several universities in the basin have significant GIS capabilities and are likely to be interested in performing certain GIS analyses as well as having access to the LCBP database. Individual researchers proposing to use LCMC funds to support their projects will be interacting directly with the DBA regarding technical data specifications and QA/QC. A member of the academic GIS community should sit on the GIS Advisory Board.

13. Regional Planning Commissions

The RPCs develop and use a great deal of GIS data in the projects they conduct for the regions and individual municipalities. Whenever possible, their database building efforts and their data needs should be coordinated with those of the LCBP. Looking ahead, the RPCs are likely to be on the front lines of Plan implementation, and so will be looking for suitable spatial data to guide their efforts. The GIS Service Center may also want to take advantage of the considerable analytical capabilities offered by several of the RPCs by contracting with them. The RPCs should be represented on the GIS Advisory Board.

14. **Private consultants**

Private consultants in the basin are eager to provide GIS services to the LCMC, as evidenced by their responses to the GIS Resources Survey. Their expertise and facilities can best be taken advantage of via contracts with the GIS Service Center. The private sector should be represented on the GIS Advisory Board to help ensure that, to the extent practical, GIS work is contracted out.

D. Updating GIS Management Plan

The LCBP GIS Management Plan should be reviewed and, if necessary, updated annually by the GIS Advisory Board. The plan should not be a static document but should be periodically revised to reflect changing priorities, data needs, technology, funding levels and sources, organizational structure, and participants. This will be particularly true during the transition from the LCMC to whatever institutional arrangement is to follow it.

II. PHASE II

Before the end of the five year LCBP, the LCMC must take action regarding the future management of the GIS database. Will it be managed as a separate entity and continually updated, or will it simply be turned over to state agencies as a completed database? This is one of many related institutional issues that the LCMC will be addressing in its Plan. A chief determinant of their recommendations will likely be how useful the GIS database has proven to be during the life of the LCMC. Even if the database is never updated again, it must be widely disseminated in electronic and paper form to ensure its availability throughout the basin. CD-ROM or some other medium containing the entire database should be provided to all organizations requesting it.

A. Continued data development, maintenance, and distribution

Assuming the LCBP GIS database has proven itself useful during the life of the LCMC, it should continue to be developed, maintained, and distributed. If no new successor organization is established, two other bodies that could coordinate the GIS efforts of the two states and the Province of Québec regarding Lake Champlain are the Lake Champlain Steering Committee and the International Joint Commission.

The Lake Champlain Steering Committee was established in 1988 by a Memorandum of Understanding on Environmental Cooperation for Lake Management. Two of its objectives are establishing a process for the regular exchange of information and developing cooperative research and data collection programs. The joint steering committee is co-chaired by the NY DEC Commissioner, VT ANR Secretary, and the Québec Environment Minister.

The International Joint Commission was created by the Treaty of 1909, and has authority over waters which span the borders of the U.S. and Canada. The IJC is not a management agency. Rather, it role is to serve as a mediator in boundary water conflicts (Carlozzi and Prosnitz, 1979). For this reason, the joint Lake Champlain Steering Committee is a more promising candidate for managing the LCBP GIS database than is the IJC.

A third alternative is that GIS data development, maintenance, and distribution by NY DEC, APA, VT ANR, VCGI, and others simply continue on after the life of the LCMC, with no coordination beyond what is desired within the two states. While this will require no additional effort or structure, it is not the most desirable alternative for managing the basin as a single entity.

B. Funding

Depending upon the organizational solution established, there may be follow-on federal funding available for the purposes of maintaining and using the GIS database. Several of the National Estuary Program sites have received additional federal support for follow-on activities. If the LCBP database is to be considered a finished product at the end of FY 1995, it will be a relatively simple matter for the state and federal agencies and the libraries holding copies of the database to simply archive it and make it available upon request.

III. SUMMARY OF RECOMMENDATIONS

A. Organizational

- adopt the proposed GIS mission statement
- select a GIS service center provider
- establish the LCBP GIS Advisory Board
- adopt proposed standards and policies
- re-assess LCBP GIS needs annually
- plan transition to post-LCMC

B. Database building

- re-assess data needs annually
- create base map layers
- create land use/land cover layer (including wetlands)
- coordinate development of other priority data layers; in order:
  - sub-watersheds FY 93
  - bathymetry FY 93
  - recreation facilities (including public access sites) FY 93
  - elevation, slope FY 93
  - historic structures and sites FY 94
  - point discharges FY 94
  - population distribution (using TIGER files) '94
  - soils FY 94, 95, 96
  - fish & wildlife habitat '95
- coordinate development of other layers

C. Data access and use

- evaluate existing data sets
- create summary data catalog
- distribute data
- manage creation of GIS products
- create a "New Basin Atlas"
- initiate a demonstration project
- purchase and install ArcView for LCBP office
- purchase ArcView and install at VT ANR, NY DEC, and NY APA

- develop a database distribution capability that will continue beyond the life of the LCMC.

APPENDIX A: Comments on Previous Components of the LCBP GIS Management Plan Draft Reports

VCGI circulated three draft reports for review and comment:

- "Lake Champlain Basin GIS Resources" -- 17 March 1992
- "Information Management Issues in the Implementation of a GIS for the Lake Champlain Basin Program" -- 30 March 1992
- "Provision of GIS Services for the Lake Champlain Basin Program" -- 29 April 1992

This appendix summarizes these comments and suggestions and -- in some cases -- responses by the report's author.

I. COMMENTS ON "LAKE CHAMPLAIN BASIN GIS RESOURCE" DRAFT DATED 3/17/92

A. From Bruce Wescott (VCGI):

Provided suggestions on presentation and technical points. Many of the suggested changes have been included in this report.

B. From Larry Alber (NY DEC):

1. Suggested that it is important to emphasize that although USGS was charged with the development of a GIS for the basin, it has been given no budget to carry out this charge, as mentioned in the draft.

2. Suggested that EPA OIRM should be involved in the management of the LCBP's non-spatial information.

3. Emphasized the need for long-term funding and the need for a LCBP vision or mission statement

4. Suggested that "support" as in GIS "support of research, public education and outreach, etc., "be defined.

5. Disagreed with many of the comments offered by participants in the basin GIS Programs Survey.

6. Indicated that NY DEC would be interested in participating in a GIS service center of some sort as long as a funding source and level is established and specific functions are agreed upon; and that most of those responding in the affirmative to this survey question would not be able to provide the range of services that probably would be involved.

7. Questioned whether because HW exists in the basin it will be available to LCBP.

C. From Lee Steppacher (EPA Region I):

1. Made a number of helpful format comments.

2. Wondered if GIS should be used as primary data storage and management system for LCBP?

3. Noted that not all survey respondents are in basin.

4. Questioned whether GIS data standards and QA/QC procedures had been presented for approval by LCMC.

5. Wanted to know the thinking behind several comments received from survey participants.

6. Called for needs assessment - why are we using GIS?

7. Noted that a vision statement for the LCBP GIS is a goal of the data management group.

D. From Philip Chernin (Camp Dresser & McKee, Inc.)

1. Why were so many organizations outside of the basin surveyed? All of the organizations surveyed are or have been active in GIS activities in the basin.

2. Felt that the report successfully inventoried the GIS resources, but did not suggest how the LCMC should acquire the services it needs. This topic was addressed in subsequent reports which have been incorporated into the final draft report.

II. COMMENTS ON "INFORMATION MANAGEMENT ISSUES IN THE IMPLEMENTATION OF A GIS FOR THE LAKE CHAMPLAIN BASIN PROGRAM" draft dated 3/30/92

A. From Lee Steppacher (EPA Region I)

1. Tone is negative; describe situation, but be constructive.
2. A needs assessment should be done.
3. Most important role of GIS is support of management actions including monitoring, planning, implementation and evaluation.
4. Don't gather data sets until you know how the data will be used.

B. From Larry Alber (NY DEC)

1. Needs assessment will be beneficial in gaining recognition from EPA.
2. Demonstration project(s) will help gain support of LCMC.
3. How is data collection in support of The Plan balanced with on-going "programmatic data collection" of the states?
4. Concurred with the statement that the Data Management Subcommittee did not have the means to ensure validity of data collected and to disseminate it to public, and with the need to hire qualified staff and charge them with these responsibilities.
5. Concurred with need to begin database design and assembly immediately if data are to help in writing The Plan.
6. Agreed with the need for assured funding over several years if an organization is to be found to assume data management role.

7. Suggested that a needs assessment should be completed in three to six months and concurrently some basic data layers could be assembled.
8. Establishment of an GIS "service center" should wait until a needs assessment is completed. "Interim database development could be done piecemeal by VT, APA, and NYDEC until that time." Some database building is already occurring as the result of investigations already funded by the LCMC.
9. Agreed that DBA is essential staff for the life of the program.
10. USGS should get direct funding via the legislation or receive an EPA grant for GIS data management.

C. from Jim Connolly (NY DEC)

1. was concerned about wording (tone).
2. wants more discussion of VT ANR and its programs.
3. perspective of agency managers should be included via a needs assessment.
4. sees need for committed technical expertise to coordinate GIS activities.

III. COMMENTS ON "PROVISION OF GIS SERVICES FOR THE LAKE CHAMPLAIN BASIN PROGRAM" DRAFT DATED 4/29/92

A. from Bruce Westcott (VCGI)

1. Various helpful formatting comments and wording, particularly for describing functions of a GIS Service Center.
2. Suggested that "GIS service center" be used instead of "service bureau."
3. There will lots of demand for non-ARC data. There should be a capability to provide attribute data in formats such as Lotus, ASCII. etc. Spatial data should be provided in DXF format as well as ARC format.
4. Provide more info on Albemarle-Pamlico, study such as who performs the GIS functions and what lessons were learned.
5. Provide year by year $$ estimates for recommended staff positions.
6. A consortium is not the way to go to provide GIS services to LCBP.

B. from John Dudley (VT ANR)

1. Commented on negative tone of report and a bias to VCGI. There has been attempt to correct these in the final report.
2. Commented that existing government agencies will continue to have the responsibility of developing and maintaining databases and implementing and policies put forward by the LCMC. This should be kept in mind when contracting for a GIS service center. This sentiment is reflected in the criteria for selecting a GIS service provider.
3. Noted lack of emphasis given to ANR-GIS database building activities. These are summarized with other results of the GIS programs inventory.
4. It was suggested to move the list of acronyms from the end of the report to the beginning. This has been done in the final draft.
5. Noted that data development efforts that are already under the purview of a state agency should not be superseded by a contractual relationship between the LCMC and a GIS service center. The author concurs. In its proposed role as a coordinator of GIS data development, the GIS service center would be expected to indicate when a given data need is already being met by a state agency (or other source) or could reasonably be met with the aid of additional funding.

6. Commented that "*unless investments are made in government-operated GIS systems, many of the conclusions of the conference may be useless. State government especially will be charged with a large share of the tasks set forth by LCMC policies.*" Therefore efficient data transfer between state agencies will be desirable as will access to the data and processing power at the desktops of decisions makers. This latter comment has been made by participants in the needs assessment and is reported in Chapter 3. Other specific forms that this investment in government GIS systems could take (e.g. establishing a GPS base station in the basin, funding the development of certain data layers, purchasing a multiple ARC/VIEW license for state agencies, etc.) are also discussed in the final report.
7. Noted that a more thorough discussion of costs is needed. This has been provided in the final draft.
8. Noted that VCGI received a 25% decrease in FY93 funding, while other state GIS organizations were level funded or received increased funding. Also noted that VCGI has a sunset of 1994.
9. Noted that it is impossible to entirely eliminate redundant data collection efforts, citing the fact that some towns are unwilling to share data they have collected with state agencies.
10. Wants to see data made more accessible to ANR decision makers. Establishing a clearinghouse for LCBP sponsored data would be a first step in providing "one-stop" shopping for these data and information on other relevant data sets. An eventual goal for the LCBP GIS service would be to periodically provide copies of the entire LCBP database to cooperating agencies for use at the desktop.
11. Suggested that needs assessment build on those previously performed by VT ANR and NY DEC. This has been done.
12. Suggested that a provider of GIS services to the LCBP be selected via an open-bidding process. Such a process is recommended in Chapter 4.

C. from Lee Steppacher (EPA Region I)

1. Questioned how inclusive the capabilities of a GIS data custodian needed to be. This is addressed in the section on centralized activities of a GIS service for the LCBP.
2. Questioned whether all data need to reside with the data custodian. Only GIS data management was the subject of this report. All GIS coverages developed with LCMC funds should be sent to a central location for purposes of quality assurance, documentation, and distribution. Associated attribute files, such as water quality data, can reside elsewhere, but the services of a DBA will be essential to ensure that data sets can be located and linked appropriately with locational data residing in the GIS proper.
3. Asked about the long term management of the GIS database - whether it will simply be turned over to the state agencies. With no long-term funding mechanism in the offing, the most realistic plan will be to disseminate the data sets as widely as possible and to encourage the two states to enter into a memorandum of understanding or a compact that requires periodic consultation on basin GIS database development and maintenance. The NY-VT Bi-State workplan may be an appropriate vehicle.
4. Wanted to know advantages and disadvantages of a de-centralized approach, i.e. setting standards and protocols, but allowing agencies to continue their GIS activities as they are now. This approach is neither centralized nor decentralized, but a hybrid. To assure quality of the data and usable data documentation and to facilitate access to the data, a LCBP GIS center is crucial. Agencies would continue to develop data layers and update them, but would be relieved of the burden of providing copies to users after having submitted an authoritative copy to the LCBP GIS database. During the course of the needs assessment, it became clear that potential data users wanted a designated

database custodian to provide information on what data sets exist and to get copies of those data sets.

5. Commented that a needs assessment is called for to identify the tasks of a LCBP GIS center.
6. Suggested that an open-bidding process to secure a GIS service provider may be the appropriate way to go. This is called for in Chapter 4.

D. from Jim Connolly (NY DEC)

1. Need to discuss how state and federal resources can be effectively utilized to provide needed services and specific roles of federal and state agencies.

   State agencies are likely to be the long term data custodians. Much of the existing pertinent data and the GIS expertise and equipment in the basin resides with state and regional agencies. What is lacking is funding to harness these capabilities for the purposes of the LCBP. Development of new data layers (such as land cover) or completion of fragmentary layers (such as soils) needs to be funded by federal dollars. In some cases there are cooperative programs and/or cost-sharing programs that can be taken advantage of (such as with SCS). These are discussed in Chapter 6.

2. Commented that it may not be necessary or desirable for "all management services and staff" to be housed in one location. This draft proposal suggests that some LCBP GIS services, and therefore staff, be located centrally. The provision of other services can and should be decentralized as discussed in Chapter 4.

E. from Larry Alber (NY DEC)

1. Commented that the "data clearinghouse is to be an administrative and coordinating activity rather than a GIS service center." Chapter 4 suggests that the role of a GIS Service Center would be largely managerial and coordinating in nature.
2. Noted that when "the final delineation of tasks and responsibilities of this clearinghouse is completed" NYDEC can then "determine its involvement level in the process."
3. Agreed strongly that a DBA be acquired but does not feel that other personnel are warranted if GIS analytical work is to be contracted out. Several sections of this report discuss how the 6 centralized GIS functions are best distributed among several personnel.
4. "Dynamic Data Exchange (DDE) is critical to the data clearinghouse's success." The capability for direct electronic exchange of data may not be warranted in the first year or two of LCBP GIS database building. However, it is a subject that requires further investigation if an on-line need for data emerges.
5. Noted that the priority level given to public access to GIS data has not been agreed upon.
6. Suggested that the GIS capabilities of the various organizations represented by PFT members provide the analytical GIS services that each PFT member needs. This is a possibility, but one that requires knowing where the data are, being confident in their quality, and knowing that one's analytical work is not being duplicated elsewhere. These are functions that a GIS service center could carry out as described in Chapter 4. Not all PFT members have access to staff and GIS facilities.
7. Noted that the GIS working group has discussed CD-ROM as a potential means for distributing copies of the LCBP data set. The author agrees, and suggests that a

"center" is needed to master the CD-ROMs as well as ensure the quality of data sets and their documentation before they are distributed.

8. Indicated that the GIS Working Group should function as the advisory board for a GIS clearinghouse. The author agrees but recommends that membership of the group be expanded and that its procedures become more formal (see section on a GIS advisory board).
9. Suggested that the advisory board ought to determine data development priorities based on the results of the needs assessment. The author would be pleased to have the group's input on data development priorities, particularly with regard to possible funding mechanisms for particular data layers.
10. Indicated that $30,000 would not be sufficient to develop a land use/cover layer. The author agrees.
11. "If the PFT wishes to have GIS capabilities, then it must articulate that requirement and provide additional funding to satisfy that need." As reported in Chapter 3, the PFT has expressed a need for interactive GIS capability without stating precisely what they mean. ArcView is proposed as a possible solution, but until there are at least base layers in the database, there will be nothing for the PFT to view.
12. Noted that the GIS database is not being created solely to serve the needs of the PFT but also to facilitate its use in the basin.
13. Agreed that the process of acquiring a DBA be expedited and that the various organization roles described in the report, with the exception of VCGI serving as a service bureau, reflect the current viewpoints and GIS activities in the basin.

F. from Jay Appleton (Chittenden Co. RPC)

1. Concurred with the idea of having the LCBP GIS effort coordinated by a single organization while subcontracting specific analytical and database building tasks.
2. Felt that the GIS center should have host ARC/INFO to provide as many analytical capabilities as possible.
3. Unless the needs assessment identifies the need for it, funding should not be "wasted" on communication hardware and software.
4. Expressed a willingness to represent regional and local planning and infrastructure management interests on a LCBP GIS advisory board.
5. Expressed confidence in VCGI's capability to serve as a GIS service center for the LCBP: *"The track record of the VCGI on past data development projects such as the parcel mapping and orthophoto road centerline projects, shows the organization maintains the highest standards of quality control and assurance, documentation, and distribution of the data to outside parties in a timely manner."*
6. Would like to see RPCs characterized more as data users and less as data developers. (They have been data developers out of necessity, since there has been little GIS data available.)

APPENDIX B: Mailing List for Basin GIS Programs Survey

Mr. Dean Pierce
Addison Regional Planning Comm.
RR1, Box 275
Middlebury, VT 05753

Mr. John S. Banta
Adirondack Park Agency
Route 86
Ray Brook, NY 12977

Ms. Joan Gardner
Applied Geographics, Inc.
33 Broad Street
Boston, MA 02109", Ms. Gardner

Mr. Peter Ring
BSC
425 Summer Street
Boston, MA 02210

Mr. Phil Chernin
Camp, Dresser, & McKee, Inc.
Ten Cambridge Center
Cambridge, MA 02142

Ms. Pam Shores
Cartographic Associates, Inc.
P.O. Box 267
Littleton, NH 03561

Mr. Johnathan Croft
Central Vermont Regional Planning Comm.
26 State Street
Montpelier, VT 05602

Mr. Bernard Chenette
Chenette Engineering
50 State Street
Montpelier, VT 05602

Mr. Jay Appelton
Chittenden Regional Planning Comm.
P.O. Box 108
Essex Junction, VT 05453

Mr. Kevin Rose
Planning Department
City of Burlington
Burlington, VT 05401

Mr. Steve DeGloria
CLEARS
464 Hollister Hall
Cornell University
Ithaca, NY 14853-3501

Mr. Rodney Brown
Clinton County Planning Office
137 Margaret Street
Plattsburg, NY 12901

Mr. Marty Goldblatt
Division of Equalization and Assessment
Sheridan Plaza
16 Sheridan Avenue
Albany, NY 12210-2714

Ms. Giovanna Peebles
Division of Historic Preservation
58 East State Street
Montpelier, VT 05602

Mr. Dan Stover
Dubois & King
P.O. Box 339
Randolph, VT 05060-0339

Mr. Wilfred Keyser
East Coast Mapping
123 Sheep Davis Road
Concord, NH 03302-0431

Mr. Greg Charest
EPA Region I
Info. Resources Branch
JFK Federal Bldg.
Boston, MA 02203-2211

Mr. Michael MacDougall
EPA Region I
JFK Federal Building
Boston, MA 02203

Mr. Greg Allande
EPA Region II
Office of Policy and Mgmt
26 Federal Plaza
New York, NY 10278

Mr. Chris Conway
Essex County Planning Office
Elizabethton, NY 12932

Mr. Ian Wells
Franklin-Grand Isle RPDC
140 South Main Street
St. Albans, VT 05478

Mr. Gary Smith
Green Mountain Geographics
P.O. Box 2171
South Burlington, VT 05407

Mr. Jim Aylward
Harvard Design & Mapping, Inc.
80 Prospect Street
Cambridge, MA 02139-2503

Mr. Lester Garvin
IEP Corporation
P.O. Box 780
Northboro, MA 01532

Mr. Kevin Behm
Lamoille County Planning Comm.
RR 1 - Box 2265
Morrisville, VT 05661

Mr. Gene Roe
Land Systems, Inc.
P.O. Box 496
Greenland, NH 03840

Mr. Joseph Brent
Mad River Modeling & Mapping
Box 316
Warren, VT 05674

Mr. Mark Tinianou
Metcalf & Eddy
P.O. Box 4043
Woburn, MA 01888

Mr. Bruce Heinrich
microDATA
40 Portland Street
St. Johnsbury, VT 05819

Mr. Bob Churchill
Geography Department
Middlebury College
Middlebury, VT 05753-6151

Mr. Tom Manley
Geology Department
Middlebury College
Middlebury, VT 05753-6151

Mr. Ed Moore
Ed Moore Computer Services
P.O. Box 63
Underhill Center, VT 05490

Mr. Milo Robinson
National Geodetic Survey
133 State Street
Montpelier, VT 05633

Mr. Al Kieslich
New England Telephone
800 Hinesburg Road
South Burlington, VT 05403

Mr. Jim Wood
North Country Environmental &
Forestry Management & Planning
Main Street, P.O. Box 427
Concord, VT 05824

Mr. Larry Alber
NY DEC
50 Wolf Road
Albany, NY 12233-2752

Mr. Jim Beil
NY DEC
Division of Lands and Forests
50 Wolf Road
Albany, NY 12233

Mr. Jim Connolly
NY DEC Region V
Route 86
Ray Brook, NY 12977

Mr. Gerald P. Rasmussen
NY DEC
Habitat Inventory Unit
700 Troy-Schenectady Road
Latham, NY 12110-2400

Mr. Thomas LaRose
NY Division of Equalization & Assessment
16 Sheridan Avenue
Albany, NY 12210-2714

Mr. Robert Reinhardt
NY Office of Parks, Rec. & Historic Pres.
Agency Bldg. #1
Empire State Plaza
Albany, NY 12238

Mr. Larry Young
Pinkham Engineers, Inc.
431 Pine Street
Burlington, VT 05401

Mr. Colin High
Resource Systems Group
Box 1104
Norwich, VT 05055

Mr. Ted Sickley, GIS Specialist
Rutland Regional Comm.
P.O. Box 965
Rutland, VT 05701

Mr. Mark Jadkowski
James W. Sewall Co.
P.O. Box 433
Old Town, ME 04468

Mr. Jeff Nugent
SUNY ES&F
323 Bray Hall
Syracuse, NY 13210

Mr. Jim Dawson
Environmental Sciences Department
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Plattsburg, NY 12901

Mr. Lyn McIlroy
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Plattsburg, NY 12901

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2A Williston Park
P.O. Box 784
Williston, VT 05495

Ms. Caroline Alves
USDA SCS
69 Union Street
Winooski, VT 05404

Mr. Tony Esser
USDA SCS
P.O. Box 7248
Syracuse, NY 13261

Mr. Greg Charest
US EPA Region I
Information Resources Branch
JFK Federal Building
Boston, MA 02203-2211

Mr. Ivan James
USGS
Water Resources Division
10 Causeway Ste. 926
Boston, MA 02114-1040

Mr. L. Grady Moore
USGS - Water Resources Division
P.O. Box 1669 - 445 Broadway
Albany, NY 12201

Mr. Jeff Laible
Dept. of Civil Engineering
Votey Building
University of Vermont
Burlington, VT 05405

Mr. Don Meals
351 Aiken Center
University of Vermont
Burlington, VT 05405

Mr. Tim Sherbatskoy
351 Aiken Center
University of Vermont
Burlington, VT 05405

Mr. Gary Smith
321 Aiken Center
University of Vermont
Burlington, VT 05405

Ms. Mary Watzin
351 Aiken Center
University of Vermont
Burlington, VT 05405

Mr. Ken Williams
351 Aiken Center
University of Vermont
Burlington, VT 05405

Ms. Lisa Borre
Planning Division
VT Agency of Natural Resources
Waterbury State Complex
Waterbury, VT 05676

Ms. Susan Bulmer
Dept. of Forests, Parks & Recreation
VT Agency of Natural Resources
Waterbury State Complex
Waterbury, VT 05676

Ms. Dianne Conrad
State Geologist
VT Agency of Natural Resources
Waterbury State Complex
Waterbury, VT 05676

Mr. John Dudley
GIS Office
VT Agency of Natural Resources
Waterbury State Complex
Waterbury, VT 05676

Mr. Rick Hopkins
Dept. of Environmental Conservation
VT Agency of Natural Resources
Waterbury State Complex
Waterbury, VT 05676

Mr. David Healy
VT Office of Geographic Information Services
120 State Street
Montpelier, VT 05620-4101

Mr. Wayne Lamothe
Warren County Planning Office
Warren County Municipal Center
Lake George, NY 12845

APPENDIX C: GIS Programs Survey Questionnaire

15 January 1992

Dear

The Lake Champlain Management Conference (LCMC) has funded the Vermont Office of Geographic Information Services (OGIS) to develop a GIS implementation plan to help it fulfill its mandate under Title III of the Lake Champlain Special Designation Act. OGIS has hired ARD to assist in developing this plan. The plan will cover issues of database design, data standards, quality, documentation, and sharing, and will identify the leading organizational alternatives for providing GIS services to the LCMC. The GIS services the LCMC will require to carry out its mandate will include data quality control, a data clearinghouse, interaction with basin modelling efforts, performance of analyses needed to write The LCMC Pollution Prevention, Control, and Restoration Plan, and support of public outreach and education efforts.

In meeting the GIS needs of the LCMC we want to be cognizant of all the major GIS activities within the Lake Champlain basin. The enclosed survey will help us evaluate the GIS capabilities, resources, and modes of operation that exist and to identify redundancies and gaps. (OGIS will be doing a separate survey regarding spatial and non-spatial databases at a later date.) **Your responses will be used as background in developing draft recommendations to the LCMC regarding the structure, responsibilities, location, and additional resources needed for a possible "GIS Service Center".** Our goal is to recommend a system design that meets the needs of the LCMC in the context of on-going GIS activities in the basin.

I urge you to fill out the questionnaire as completely as possible and return it to me in the enclosed envelope by January 30, 1992 please. I appreciate your assistance and cooperation and I apologize for the short lead time. If you have any questions or comments please don't hesitate to call me.

Sincerely,

Lenore F. Budd
GIS Specialist

enclosures:
summary of LC Special Designation Act
survey on GIS capabilities

IDENTIFICATION AND ASSESSMENT OF GIS CAPABILITIES WITHIN THE LAKE CHAMPLAIN BASIN

Instructions:

At a minimum, please fill out the first two sections "background information" and "interaction with LCMC GIS" (on page 2).

If your answers to Questions 1 - 3 are "no", stop there and RETURN THE FORM.

If you answer "yes" to any of Questions 1 - 3, please answer the rest of the questions as completely as you can. Some questions may not pertain to your particular GIS operation. Please use additional sheets of paper if necessary.

If you have an up-to-date report that covers much of this information I would appreciate receiving it as additional background for your responses.

If you have questions, please call me at (802)658-3890.

PLEASE RETURN THE FORM, IN THE ENVELOPE PROVIDED, BY JANUARY 30 to:

Lenore F. Budd
Associates in Rural Development, Inc.
PO Box 1397
110 Main Street
Burlington, VT 05402

background information

name of GIS facility:

contact name:

title:

phone: FAX:

address:

interaction with LCMC GIS

1. Do you expect to interact in any way with the Lake Champlain Management Conference (LCMC) or the lake clean up effort?
yes no

a. Do you expect to use spatial or other data generated by LCMC-funded activities?
yes no

b. Do you expect to contribute digital or mapped data to the Lake Champlain database?
yes no

c. Do you expect to analyze data for lake researchers/managers?
yes no

d. Do you expect you'll be providing consulting services to lake researchers/managers?
yes no

2. Would you be interested in having the potential to use spatial or other Lake Champlain data for purposes unrelated to the clean up effort in the future should the need arise?

yes no

3. Is your organization (either by itself or in combination with other organizations) interested in assuming the role of a GIS service center for the LCMC?

yes no

If you answered "yes" to any of the above questions, please complete the rest of this questionnaire. If you answered "no" to

all three, stop here and return the questionnaire in the envelope provided. Thank you.

organizational issues

4. Is your GIS facility a (or part of a):

a. federal agency
b. state agency
c. local government agency
d. academic institution
e. non-profit organization
f. private business
g. utility
h. some combination of the above (please explain)?

5. Briefly outline where your GIS facility resides within the organizational structure. Use a diagram if that is helpful. (e.g. GIS is a section of the Division of Forests. Forests is one of four divisions with the Office of Natural Resources within the state Dept. of Conservation).

6. What month and year was your GIS facility established? _____
Please indicate its current status:

a. in planning stage
b. HW/SW being acquired
c. pilot project in progress
d. partially operational
e. fully operational
f. major expansion in progress
g. uncertain because of government budget
h. other (please explain)

7. If your facility is government sponsored, under what authority or mandate was it established? (e.g. state law, executive order, internal management decision, etc.)

8. What is(are) the facility's major mission(s)?

9. How are managerial decisions (e.g. contracts, hiring, major purchases) made for the GIS facility? By an individual? What is his/her title? By a committee? Please describe briefly.

10. What is the annual operating budget for the GIS facility?

11. What is the source of operating funds? (e.g. general fund, user fees, fee for services, grants, etc.) How is the budget figure established? (e.g. approved by legislative committee, etc.)

in-house capabilities

12. Describe the level of current staffing by job titles and number of individuals. (e.g. 3 data entry staff, 1 database administrator, 1 facility manager) If this level is staffing is likely to change significantly in the next year, please indicate in what way.

13. Please summarize the kinds of GIS activities the staff is engaged in as a percentage of total staff effort for a typical year. (e.g. 50% database building, 20% data distribution, 30% project consulting)

14. What GIS software does your facility have?

ARC/INFO	____	PC-ARC/INFO	____	Atlas GIS	____
GeoSQL	____	System 9	____	MapGraphics	____
Caliper	____	MapInfo	____	IDRISI	____
ERDAS	____	other	_____		
MACGIS	____				

15. What other software for handling spatial data does your facility have?

AutoCad _____ Intergraph _____
other (e.g. PC-Globe) _____

16. What non-spatial database software do you use at your facility?

dBase	_____	FoxPro	_____
INFO	_____	Informex	_____
Oracle	_____	Ingres	_____
Paradox	_____	other	_____

17. On what platforms is your GIS software running?

IBM	_____	IBM PC	_____
DEC	_____	IBM clone	_____
VAX	_____	RISC 6000	_____
Prime	_____	HP Apollo	_____
Sil. Graphics	_____	DG Avion	_____

other _____

18. What operating system version do you use for GIS work?

DOS _____ Unix _____
Primos _____ IBM _____
VMS _____ other _____

19. List any GIS peripheral devices by type and manufacturer:

digitizer _____
scanner _____
pen plotter _____
electrostatic plotter _____
inkjet printer _____
color laser printer _____
thermal printer _____
other _____

data storage and exchange

20. What data storage devices do you currently use? Indicate make, storage capacity, and format as appropriate (e.g Archive DC-2000, 40 MB, Thetamat tape drive).

disk drive _____
cartridge tape drive _____
reel-to-reel tape drive _____
Bernoulli box _____
CD ROM _____
other _____

21. Please describe briefly any electronic communication systems you use to acquire or disseminate files.

direct lines to host _____
dial-up phone lines _____
dedicated phone lines _____
Local Area Network _____
other _____

22. What transfer medium or what telecommunications link would you prefer to use for the exchange of digital files?

23. Based on both your present and future in-house capabilities and mode of operation, what data format(s) would you prefer for sharing Lake Champlain digital data.

a. spatial data (e.g DXF, ARC Export, TIGER, etc.)

b. non-spatial data (ASCII, dBase, etc.)

policy and standards

24. Please summarize your facility's policies on data access and distribution, including fees charged, if any.

25. Is there a policy making group or mechanism in place? If so, please describe briefly.

26. Please summarize the data standards followed at your facility and the types of QA/QC procedures that are in place.

27. What regional, state, or local professional GIS groups do you and your staff participate in? (e.g Vermont ARC/INFO Users Group, etc.)

participation in LC efforts

28. What do you see as the most appropriate involvement in the LC clean-up effort for your GIS facility?

29. Would you or members of your staff be interested in participating in an advisory board for a Lake Champlain GIS Service Center?

30. What suggestions do you have regarding any aspect (HW, SW, standards, management, data access, location, etc.) of a future "GIS Service Center" for the LCMC?

31. Please address any other issues you have regarding the provision of GIS services to the LCMC here.

Thank you very much for your contribution.

APPENDIX D: Detailed tabulation of GIS Programs Survey Results

Please refer to Chapter 2 for discussion of the results.

Table 1. GIS software used in the Lake Champlain Basin. (35 responses)

software	#	%
ARC/INFO	17	49
PC ARC/INFO	21	63
IDRISI	6	20
MapInfo	4	11
ERDAS	4	11
GRASS	2	6
other	7	

Table 2. Other spatial data handling software used by GIS facilities in the Lake Champlain basin. (36 responses)

software	#
AutoCad	7
Atlas PRO	2
Intergraph-CAD	2
VersiCAD	2
Surfer	2
other	6

Table 3. Non-spatial database management software used by GIS facilities in the Lake Champlain basin. (36 responses)

software	#	%
dBase	22	61
INFO	22	61
FoxPro	8	23
Paradox	5	14
R-Base	3	8
Oracle	2	6
Prelude	2	6
other	12	

Table 4. GIS platforms used in the Lake Champlain basin.

(36 responses)

platforms	#	%
IBM compatable PC	19	53
IBM PC	11	30
Sun workstations	8	22
DEC	4	11
Prime	4	11
DG Avion	3	8
AT&T PC	2	5
IBM mainframe	2	5
microVAX	2	5
VAX (VMS)	2	5
other	4	

Table 5. Computer operating systems used for GIS work in the Lake Champlain basin. (36 responses)

operating system	#	%
PC-DOS or MS-DOS	24	67
Unix	14	39
Primos	4	11
VMS	3	8
Mac System 7	1	3
SUNOS	1	3

Table 6. Data storage media (in addition to diskettes) used by GIS facilities in the Lake Champlain basin. (38 responses)

media	Priv(11)	Acad(6)	L/R(7)	State(8)	Fed(6)
cartridge tape	7	3	5	5	5
reel-to-reel tape	1	4	0	3	2
Bernoulli Box	0	3	2	2	1
CD ROM	2	1	0	2	1
other	1	1	0	0	0
diskettes only	2	0	0	0	0
no response	2	0	0	0	0

Table 7. Use of electronic communication systems at GIS facilities within the Lake Champlain basin.

(36 responses)

electronic communications	#	%
local area network (LAN)	13	36
dial-up phone lines	12	33
direct lines to host	8	22
dedicated phone lines	4	11
other	2	6
none	9	25
no response	2	

Table 8. Preferred medium for the exchange of digital data. (48 responses)

preferred medium	#	%
cartridge tape	13	35
diskettes	7	19
dedicated phone line	5	13
9 track reel-to-reel	4	11
CD-ROM	2	5
Internet	2	5
other	4	

Table 9. Preferred formats for sharing spatial and non-spatial Lake Champlain data. (38 responses)

spatial	#	%
ARC Export	28	74
DLG	4	10
DXF	3	8
PC ARC/INFO	2	5
Intergraph SIF	1	3
no response	6	

non-spatial	#	% (40 responses)
ASCII	21	53
dBase	18	45
ORACLE	1	1
no response	5	

Table 10. Professional groups having members from the Lake Champlain GIS community.

ARC/INFO User Group 29

URISA	12
ASP & RS	5
Mass. Geographic Information Comm.	3
Amer. Congress of Survey. & Map.	2
GRASS Users Conference	2
NY State GIS Conference	2
other	9

Table 11. Organizations interested in participating in a LCMC GIS Advisory Board.

private consultants
- Associates in Rural Development, Inc.
- Camp, Dresser, & McKee, Inc.
- DuBois & King, Inc.
- Mad River Modeling & Mapping
- Metcalf & Eddy. Inc.
- MicroData
- New England Telephone
- North County Envir. & Forestry Mgmt.
- Pinkham Engineering, Inc.

academic institutions
- CLEARS
- SUNY ESF (NFLI)
- SUNY Plattsburgh
- UVM Continuing Education

local/regional agencies
- Addison RPC
- Burlington Dept. of Planning & Zoning
- Chittenden RPC
- Clinton Co. NY
- Lamoille RPC
- Rutland RPC

state government
- APA
- NYDEC
- VCGI
- VT ANR
- VT Dept. Forest,Parks, Rec.
- VT Div. Hist. Pres.

federal government
- EPA Boston
- National Geodetic Survey
- SCS, Syracuse
- USGS, Albany

APPENDIX E: QA/QC Procedures Documents

Synopsis of QA/QC Procedures around the U.S.

F. most public GIS installations rely on documentation for quality assurance
   1. they tend to accept any data as long as there is adequate documentation
   2. need exhaustive data dictionary
   3. users evaluate data suitability for their purposes

G. Minnesota relies on data documentation at three stages to insure quality control:
   1. preliminary data integration worksheet - to review nature of data to be collected
   2. data compatibility worksheet - during data collection but before database construction
   3. final data dictionary

H. Florida has similar 2-stage procedure; uses 2 documents
   1.data dictionary - purpose is to identify elements that are to be used in transfer of data (based on federal SDTS)
   2. Quality and Accuracy Report with standard format requiring that each area be addressed (including unknown or N.A.)

I. SUNY ESF
   1. uses VGIS data layer documentation format for their data quality reports (e.g. for NFLS digitizing now in progress)
   2. for digitizing DEC wetlands maps have specific protocol giving specific ARC commands and tolerances, and wetlands codes

J. MassGIS
   1. requires review of all attribute coding before entering any digital data into state DB and recommends that it occur before actual coding commences
   2. requires that contractors supply check plots when submitting digital data
   3. requires 4 types of documentation with each submitted data layer:
      a. hardcopy data layer description memo
      b. cover.DOC file created by DOCUMENT.AML
      c. electronic entry into on-line MassGIS data dictionary to allow browse of entire DB for existence of a given type of data
      d. other required documentation data automation procedure memo

K. Kansas GIS (7/90)
   1. DXF format should be used when exchanging spatial data between different SW systems; best exchange format in terms of
      a. reliability
      b. distortion of info
      c. time elapsed during translation
      d. size of files to be handled
   2. Documentation should include categories called for in draft Spatial Data Transfer Standard
      a. general identification
      b. security
      c. spatial reference system
      d. spatial domain
      e. data dictionary
      f. data quality
         (1) lineage
         (2) positional accuracy
         (3) attribute accuracy
         (4) logical consistency
         (5) completeness

L. USGS topo digitizing contract specs (4/91)
   1. all offerors had to submit Test Sample Operational Capability Demonstration based on manuscript provided by USGS
   2. final product is inspected for compliance with
      a. DLG file format
      b. content and completeness
      c. positional accuracy
      d. attribute accuracy
      e. topologic fidelity
      f. edge alignment
   3. USGS used DLG processing and validation SW (PROSYS) as part of DLG inspection
      a. DLG format
      b. topology
      c. attribute accuracy - must be at least 88%

M. Digital Chart of the World (DMA) has elaborate data quality (DQ) documentation
   1. DQ info, in the form of data quality tables can reside at different levels in the DB with differing levels of specificity (e.g. at database, library, and coverage levels, as in DCW-VPF p. 65)
   2. when DQ info is stored at multiple levels of DB, lower level info takes precedence of higher level (less detailed) info
   3. lineage or coverage history info must be stored in a text file, e.g. LINEAGE.DOC
      a. processing tolerances

b. interpretation rules applied to source materials
c. production and quality control procedures

4. data quality coverages can be included in DB top describe spatial variation in DQ across the project area
5. various coverage components provide opportunity to record DQ information

N. National Spatial Data Transfer Standard (1991) data quality info includes:
1. lineage
2. positional accuracy
3. attribute accuracy
4. logical consistency
5. completeness
a.attribute tables
b. standard data quality tables (see above)
c. optional user-defined relational tables
d. annotations (non-feature-linked text)

O. EPA's 7 estuary programs (NEP)
1. All 7 had at least one staff member dedicated to data management activities
2. Several programs stressed importance of having 1 identified person responsible for coordination of all data management activities even when data were managed at several locations (increased coordination and enabled data integration)
3. 5 of 7 had GIS using ARC/INFO as a component of info management system

P. EPA Information Resource Management Policy Manual (4/91)
1. lat/long coordinates must be collected and documented with environmental and related data
2. 25 meter level of accuracy must be achieved
3. format:
a. latitude +/-DD MM SS.SSSS
b. longitude +/- DDD MM SS.SSSS
c. method used to determine coordinates (source)
d. description of entity to which coordinates refer
e. accuracy estimate

Appendix E. (cont.)

LCBP GIS

PRELIMINARY DATA COMPATIBILITY QUESTIONNAIRE

Background

Many projects funded by the Lake Champlain Management Conference (LCMC) will yield data that are spatial in nature, that is, data than can be mapped or can be assigned to a specific physical location on above, or below the earth's surface. In an effort to ensure that the data collected are compatible and have the potential to be used in combinations not necessarily foreseen at the time of data collection, the Geographic Information (GIS) Subcommittee of the Lake Champlain Technical Advisory Committee (TAC) is instituting a three-stage data quality control process. Issues to be addressed include:

- o the nature and extent of the data,
- o how data are to be collected and updated,
- o accuracy of the data collection procedure,
- o how spatial coordinates will be determined and recorded,
- o what procedures will be used to automate (i.e. computerize) the data,
- o the format used for data archiving and transmission, and
- o how data quality and history will be documented.

The primary goal is to enhance the utility of the spatial database, named "LCBPGIS," for the management of the Lake Champlain Basin by establishing common spatial data standards, procedures, and documentation. Only data meeting the standards established by the LCMC will be accepted into LCBPGIS. A secondary goal is to minimize redundant data collection efforts.

The **LCBP GIS Handbook of Standards and Procedures** is available from the Vermont Center for Geographic Information, Inc. (VCGI).

Instructions

Completion of this form is required as part of the LCBP GIS Data Quality Control Process and is an integral part of the proposal review process of the LCMC TAC. **Please answer all questions as completely as possible.** Reference the question number in your answer. Use as much space as necessary for each answer. If you need assistance contact VCGI. Throughout the questionnaire, examples of appropriate answers are provided in italics.

Failure to respond appropriately to these questions may result in your proposal receiving a poor rating from the TAC.

A. General information

1. Who is the principal investigator/ project manager? Address? Phone number? FAX?

2. What organization will be the prime contractor with EPA? Who has the authority to negotiate the terms of a contract? Address? Phone number? FAX?

3. Will your proposed activities include the collection of spatial data? (Spatial data are data that could be mapped in some way, for example, the locations of public access points to the lake or archeological sites, or the distribution of toxic materials.) If "no", you may disregard the remainder of this questionnaire.

B. Nature of the spatial data

4. If the answer to #2 above is "yes", please briefly summarize the nature of these data and the purpose for which they are intended

> EXAMPLE: depths of the lake bottom as input to hydrologic models

5. What is the areal extent of these data?

> EXAMPLE: the Town of Essex, Addison County, or the entire lake basin

6. How would these data best be represented on a map such as a 1:24,000 scale USGS topo map)? As a point? As a line? As an area?

> EXAMPLE: At a scale of 1:24,000 the location of outfall pipes would be represented as points, local roads as lines, and sub-basins as areas.

7. What attribute information will be collected to describe these features?

EXAMPLE: for an historic site - address, owner, parcel number, date of construction

C. Methods and Accuracy

8. Briefly describe the data collection method(s) to be used.

EXAMPLE: Current land use will be interpreted from 1990 1:40,000 scale stereo black and white airphotos.

9. How will the geographic location of your data be determined?

EXAMPLE: by using a Global Positioning System

EXAMPLE: by estimating positions in the field relative to a 1:24,000 scale USGS topo map

10. What will be the positional accuracy of these data?

EXAMPLE: +/- 3 meters

D. Maps and Data Compilation

11. What sources (including documents, maps, orthophotos, or digital databases) will you use to collect the initial data?

EXAMPLE: Current land use will be manually interpreted from 1990 uncontrolled 1:40,000 scale stereo black and white airphotos.

12. Describe any remotely sensed imagery that will be acquired to carry out your project. Indicate whether imagery will be purchased, and if so, from whom.

EXAMPLE: Most recent leaf-off, low % cloud cover, Landsat Thematic Mapper digital data over the lake - (Bands 1,2,3, and 4) will be purchased from Eosat of Lanham, MD.

13. On what planimetric base will the final data compilation be done?

EXAMPLE: Land use will be hand-transferred to the most recent 1:5000 scale orthophotos available.

14. What is the map projection of the base used for final data compilation?

EXAMPLE: Polyconic

E. Analysis and Final Products

15. Will a geographic information system (GIS) be needed to analyze the data in order to meet the objectives of your project? If "yes," briefly describe the kinds of analyses envisioned and any new data layers or themes that will result. If "no," you may answer some of the following questions with "N.A." as appropriate.

EXAMPLE: Current land use in towns along the Vermont side of the lake will be overlaid with current zoning to identify land uses that are in conflict with zoning.

16. If you answered "yes" to question 15, what hardware and software do you plan to use for conversion of the data to digital form and for the analysis?

EXAMPLE: Information compiled on orthophotos will be manually digitized in-house by a full-time GIS technician using PC ARC/INFO Version 3.4D running on a Dell 386 and a Calcomp 9100 digitizing tablet.

17. What final products will be provided to the LCMC? If you plan to automate your data what will be the final digital format of the data?

EXAMPLE: The LCMC will receive a report recommending potential zoning regulations for protecting water quality in towns adjacent to the Lake. The spatial data that will be developed in conjunction with the report will be delivered in ARC/INFO EXPORT format. Macros for creating maps, etc. will be in ASCII format.

F. Compliance with subsequent QA/QC Procedures

18. If you are going to automate your data, do you agree to submit a copy of the digital data in the proper format and meeting the established LCMC standards (including the required documentation) to the LCMC?

19. If you are going to automate your data, do you agree to submit a Data Automation Plan to the LCBPGIS Database Administrator for approval prior to beginning automation of the

data? A copy of the Data Automation Plan is attached for reference.

G. Storage and Updating of the Data

20. Where will the original hardcopy data (spatial and attribute data) be stored?

EXAMPLE: The orthophotos, worksheets and data entry forms will be stored in metal map cabinets and file cabinets at the Addison Country Regional Planning Commission. The office is locked outside of normal office hours. Climate control consists only of standard heating and air conditioning.

21. Ideally, how frequently should the digital data be updated to be useful for planning and resource management purposes?

EXAMPLE: For maintaining long term water quality in the lake, changes in zoning and land use should be entered into the database every two to three years or, at a minimum, every five years.

22. Ideally, who should manage this update process?

EXAMPLE: In Vermont, changes in land use and zoning could be derived from the required five year update of each municipality's Comprehensive Plan. The GIS service centers at the Regional Planning Commissions could make the changes in the land use and zoning layers as the information becomes available from their constituent towns.

H. Data Security

23. Please describe any concerns you have about sharing digital spatial data with other researchers, state agencies, or the public?

EXAMPLE: Knowledge of the exact point locations of federally or state endangered plant species or animal species must remain within the VT Agency of Natural Resources.

24. What kinds of restrictions on data access and/or what degree of spatial generalization would eliminate the concerns described in #14?

EXAMPLE: For data that are made available to the general public the point locations of endangered

species should be degraded by at least one mile. If a one mile radius or other polygon is generated around the point, the point must not be used as the center.

LCBP GIS SPATIAL DATA AUTOMATION PLAN

Background

To ensure that projects receiving Lake Champlain Management Conference (LCMC) funds yield spatial data in a form that maximizes their potential to be shared with other researchers and agencies, the LCMC Technical Advisory Committee (TAC) is trying to achieve a common methodology, data format, and documentation. In your proposal for funding from the LCMC you indicated the intention to automate spatial data and agreed to complete this Data Automation Plan. Use of this form and the attached checklist prototypes will help you meet the data quality standards specified in your LCMC contract and will expedite entry of data into the LCBP GIS, the common spatial database for the Lake Champlain Basin Program. It will also greatly facilitate completion of the final data documentation that you are required to provide with the final submission of your digital data. LCBP GIS spatial data standards are detailed in the **LCBP GIS Handbook of Standards and Procedures**, available from VCGI.

Instructions

Completion of this form is required as the second step of the LCBP GIS Data Quality Control Process and as part of the fulfillment of your LCMC contract with US EPA. **Please answer all questions as completely as possible.** Reference the question number in each answer. Use as much space as necessary for each answer. A completed Table 1 and Table 2 has been included here as an example of how the tables should be filled out. If you need assistance contact VCGI.

Failure to respond appropriately to these questions may be considered grounds for non-payment under your existing contract with US EPA. Similarly, if the LCBPGIS database administrator determines from a review of this document that your data will be unlikely to meet the LCBP GIS standards, you will be required to revise the plan until it conforms to the standards adopted by the LCMC.

General Information

1. project title

2. EPA contract number

3. name of principal investigator/project manager, address, phone, FAX

4. name of individual responsible for spatial data quality, address, phone, FAX

5. What hardware and software (name and version) will be used for data conversion? What spatial resolution can be achieved with this configuration?

6. Who will perform data automation services?

7. Have the source documents undergone the review steps outlined in the Pre-Automation Checklist (see attached)? Completed copies of this checklist or equivalent log sheets must be included with your final submission of digital data to LCBPGIS.

8.If GPS has been used to determine earth coordinates, provide the device name and model, the datum referenced, the positional accuracy, and a brief description of the methodology.

Table 1. Organization of Spatial Data into Layers (Themes)

Using this table, please provide the following information for each data layer or data theme. (Duplicate this table as necessary.)

a. layer (theme):

b. feature type (point, line, polygon):

c. description (including how and when data were collected):

d. areal extent of layer:

e. method of compilation of analog data:

f. method of data automation:

g. source:

h. date of source:

i. scale of source:

j. source projection:

k. datum:

l. source medium:

m. positional accuracy:

Table 1 example:

a. layer (theme): surface water polys

b. feature type (point, line, polygon): polygons

c. description (including how and when data were collected):

all surface water polygons larger than 1 acre or wider than 10 meters were identified and digitized from VT orthophotos

d. areal extent of layer: all Vermont towns within the LC Basin

e. method of compilation of analog data:

features were traced on mylar taped to orthos, coded, and edgematched to adjoining orthos

f. method of data automation:

features were digitized on a Calcomp 9100 digitizing tablet using PC ARC/INFO 3.4D running on a Dell 386 machine

g. source: VT orthophotos

h. date of source: 1988

i. scale of source: 1:5000

j. source projection: Vermont State Plane

k. datum: NAD 1927

l. source medium: RC paper

m. positional accuracy: 4 meters

Table 2. Organization of Attribute Information

Using this table, list the descriptive information that will be collected for each of the spatial features listed in Table 1. Duplicate this table as needed. Examples are provided.

layer (theme):

item name:

description:

source:

data type (character, numeric, logical, date, memo):

item width:

decimal places:

layer (theme):

item name:

description:

source:

data type (character, numeric, logical, date, memo):

item width:

decimal places:

layer (theme):

item name:

description:

source:

data type (character, numeric, logical, date, memo):

item width:

decimal places:

Table 2 examples:

layer (theme): parcels

item name: PARCELNUM

description: parcel number

source: town tax maps

data type: character

item width: 9

decimal places: 0

layer (theme): parcels

item name: ACRESCALC

description: calculated acres

source: calculated by ARC/INFO during "CLEAN"

data type (character, numeric, logical, date, or memo): numeric

item width: 7

decimal places: 1

APPENDIX F: Participants in LCBP GIS Needs Assessment

Plan Formulation Team
7/28/92 South Hero, VT

phone conversation with Monty Fischer 9/2/92

Education/Outreach Committee
9/15/92 South Hero, VT

Elizabeth Soper

Physical Processes Subcommittee
9/10/92 Middlebury College

Ivan James, USGS
Tom Manley, Middlebury College
Roger Binkerd, Aquatec Inc.
Dave Tolmazin, US EPA Region II

Eutrophication/Non-point Source Pollution Subcommittees
5/27/92 Ticonderoga, NY
Anthony Esser - SCS
Joe DelVecchio - SCS
Terry Faber - EPA Region II
Malcome Henning - EPA Region II
Karen Roy
Jon Anderson - VT ANR
Phil Benedict - VT Dept. of Ag & Farm Markets
Alan Cassell - UVM
Robert Kort
Timothy Beaman - SCS
Richard Croft - SCS
Eric Smeltzer - VT ANR
Scott Quinn
Rob Bonham
Jack Drake - UVM
David Clough - VT DEC
Lisa Borre - LCBP staff
Robin Warrender - NY DEC
Pat Longabucco - NY DEC
Rick Hopkins - VT DEC
Don Meals - UVM
Steven Lanthier - NYSSWCC
Robin Ulmer - BRA
Everett Thomas - Miner Institute
Robert Lucy
Anita Deming - CCES
phone conversation w/chair, Tony Esser 8/27/92

Economics Subcommittee

conversations with the chair, John Banta 6/12/92, 8/13/92, and 9/16/92

Toxics Subcommittee
1 July 1992, UVM Burlington, VT

Doug Burnham - VT DEC - Water Quality Div.
Robert D. Fuller - SUNY Plattsburgh Center for Earth & Env. Sci.
Harold Garabedian - VT ANR - Air Quality
Robert Genter - Johnson State College
Frank Lowenstein - Lake Champlain Committee
Alan McIntosh - UVM Water Resources Center
Lawrence Skinner - NYS DEC
Mary Watzin - UVM School of Natural Resources

Cultural Resources Working
6 August 1992, Montpelier, VT

David Skinas, VT Division of Historic Preservation
Curtis Johnson, VT Div. of Historic Preservation

letter to Philip Lord requesting input from NY, dated 9/23/92

Fish, Wildlife, and Wetlands Subcommittee
7/9/92 Ticonderoga, NY

Carl F. Baren - US Fish & Wildlife Service
David R. Callum - VT Fish & Wildlife Dept.
Brian Chipman - VT Fish & Wildlife Dept.
Bill Crenshaw - VT Fish & Wildlife Dept.
Eric Fried - NYS DEC - Fish & Wildlife
George Haas - US Fish & Wildlife Service
Angelo Incerpi - VT. Fish & Wildlife Dept.
Kenneth L. Kogut - NYS DEC
Chet MacKenzie - VT Fish & Wildlife Dept.
Larry Nashett - NYS DEC
Donna L. Parrish - VT Coop Fish & Wildlife Unit
Gerry Rasmussen
William Sarbello - NYS DEC - Bur. of Envir. Protection
Cathy Schneider-Johnson - NY Natural Heritage Survey
Larry Strait - NYS DEC
Mary Watzin - VT Coop Fish & Wildlife Research Unit

Land Use-Lake Use Working Group
7/15/92 South Hero, VT

John Barge - APA
Rodney Brown - Clinton Co. Planner
Gina Campoli - VT ANR, Planning Division
Kelly Carry - student intern
Jim Cotell - APA
Art Hogan - Chittenden RPC
Bill Johnston - Essex Co. Planner
Sharon Murray - Franklin Grand Isle RPC
Deane Pierce - Rutland RPC
Karyn Richards - NY DEC

Recreation Subcommittee
9/14/92 Waterbury, VT

Sue Bulmer
Maja Smith

phone conversation with Bob Reinhardt on 9/17/92 for NY input

APPENDIX G: Documents used in the GIS User Needs Assessment

3 June 1992

Dear

As you may be aware, over the last six months GIS planning for the Lake Champlain Basin Program has been carried out by the States of Vermont and New York. I have been working with David Healy of the Vermont Center for Geographic Information (VCGI) on Vermont's portion of the project. Accomplishments to date include:

- the development of proposed data standards,
- the development of proposed QA/QC procedures,
- inventory of basin GIS data,
- inventory of technical GIS capabilities within the basin
- draft report: issues surrounding a LCBP GIS,
- draft report: provision of GIS services for the LCBP.

A task that has just recently been added to my contract with VCGI is to perform a GIS user needs assessment for the LCBP. The goals of the GIS user needs assessment are to:

- identify the priority GIS applications (analyses and other products) and the data needed to support them
- specify data characteristics (scale, resolution, level of accuracy, attributes, etc.)
- identify overlapping (commonalities in) data needs
- determine which data layer development
- elicit preferences for methods of funding and developing the data sets (contractor, agency, GIS service center, etc.)
- estimate funding needed and identify the most appropriate mechanism and schedule to develop priority data layers

SUBCOM.LET
(page two)

My plan is to meet with each subcommittee of the TAC (and a few other participating groups) as soon as possible to try to elicit through group discussion specific, detailed information on data needs. To structure this data needs assessment exercise, I plan to use the goals, objectives, and action items described in the March 1992 version of the Plan Formulation Team's Goals and Objectives Document. (With the help of LCMC staff, I have gone through the G & O document and assigned the various goals, objectives, etc. to the various TAC subcommittees. I have also tried to indicate how funded projects fit in with the goals and objectives. Dollar amounts still need to be adjusted to reflect the actual funding levels.)

Enclosed you will find:

- the goals and objectives, etc. that pertain to your subcommittee (SUBCOM.OBS), and

- the questions regarding data we would like to have answered (NEEDS2.ASS).

Questions I have for you are:

1) Is your subcommittee far enough along in its thinking to be able to articulate its data needs for writing its section of The Plan?

2) What is the best way to run through this exercise with your subcommittee? Would they like to work through this exercise on their own before I meet with them? Would meeting with a subset of the subcommittee rather than the whole group be more productive?

3) How knowledgeable is your subcommittee on GIS? Would a brief (15' minute) introduction to GIS concepts be helpful?

4) When could I meet with the subcommittee to run through the GIS user needs assessment?

I will call you in a few days to discuss this with you. As you can appreciate, the sooner we get an understanding of data needs shared by several groups (e.g. land use/cover), the sooner we can begin assembling a useful GIS database. Thank you for your assistance.

Sincerely,

Lenore F. Budd
GIS Specialist

LCBP GIS User Needs Assessment

It is our understanding that the PFT will be looking to each TAC subcommittee for written input to the relevant section of The Plan. The Plan sections that your subcommittee is responsible for are outlined in the accompanying document.

Given the goals and objectives for your subcommittee's section of The Plan, what information will you need, what analyses will you need to have performed so that you can write your section of The Plan? If a particular objective carries over beyond the five year life of the LCBP, still consider what info and analyses will be needed to meet the objectives stated.

For each objective and/or action item the Data Management Subcommittee needs to understand:

1. why it is being done (may be clear from description of objective in PFT document)

2. what data are needed for activity (inputs) *

3. what data will result from activity (outputs) *

4. who will use data (which agencies, researchers)

5. any special data format or structure needed

6. any GIS analyses needed

7. any special display needs (e.g. for public outreach)

8. most appropriate organization/agency or mechanism to develop and maintain data layer

9. how data development can best be funded

10. how soon data layer is needed

11. any particular communication or software needs associated with this activity or data

*** information needed for each cartographic data layer:**

description general definition of data content including feature type (point, line, polygon)

purpose	known or anticipated uses for this data layer in terms of LC basin management (e.g. base layer for display of other spatial data)
user	primary users of this data layer
resolution (or scale)	smallest geographic unit about which information will be needed (e.g. 1 acre parcel, 100 m river segment, etc.)
items	important descriptive information about feature to be maintained either in GIS feature attribute table or external database
geographic coverage	extent of area over which the information is needed (e.g. basin wide, NY State)
status	availability of data as described above (e.g. There is complete digital coverage for Clinton County but only manuscripts for Essex County.)
currency	how recent are data?
source	brief summary of how data were captured (e.g. digitized from 1:24,000 scale topos)
agency	source agency or organization for data
frequency of use	estimate of how frequently data layer is likely to be used (e.g. constant, frequent, average, infrequent)
update frequency	how frequently data should be updated to maintain their usefulness (e.g. every 5 yrs.)
use restrictions	any limitations on access and use imposed by the source agency
other considerations	any data management issues such as the need to tightly integrate layer with other data layers

factors to use for assigning priorities to data layers:

1. relevance to LCBP goals and objectives

2. number of users (& frequency of use)
   develop a matrix of

x = data layers (roads, rivers, counties)
y = LCBP activities or objectives (wetland protection, reducing P run off)

3. cost of data layer development (or completion) and maintenance

4. likelihood of data layer being developed by other agencies or organizations
e.g. inter-agency or cooperative agreements

APPENDIX H: References

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This technical report is the third in a series of reports prepared under the Lake Champlain Basin Program. Those in print are listed below.

Lake Champlain Basin Program Technical Reports

1. *A Research and Monitoring Agenda for Lake Champlain.* Proceedings of a Workshop, December 17-19, 1991, Burlington, VT. Lake Champlain Research Consortium. May, 1992.

2. *Design and Initial Implementation of a Comprehensive Agricultural Monitoring and Evaluation Network for the Lake Champlain Basin.* NY-VT Strategic Core Group. February, 1993.

3. (A) *GIS Management Plan for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc., and Associates in Rural Development. March, 1993.

   (B) *Handbook of GIS Standards and Procedures for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.

   (C) *GIS Data Inventory for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.

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