FY2002 TECHNICAL SUPPORT SERVICES ANMNUAL WORKPLAN:

Information Technologies

The GCMRC has extensive historical data and information collected over many years relating to the condition of resources in the Colorado River ecosystem. This information represents an extremely valuable asset to the Glen Canyon Dam Adaptive Management Program (GCDAMP). Its potential for problem solving, improving management guidelines, modeling relationships, or increasing understanding of the key resources and systems under study requires placing this legacy data into an ecologically integrated database and geographic information system (GIS).

The goal of the Information Technology Program (ITP) is to *satisfy the information needs of the GCDAMP relative to the Colorado River ecosystem* in terms of content and delivery. Key to achieving this goal is the development and maintenance of three core information technologies: 1) a data base management system (DBMS) for tabular information and other electronic non-spatial information, 2) a geographic information system (GIS) for electronic spatial information, and 3) a library for hardcopy information (Figure 3.1). Content of these systems consists of all information gathered as the result of GCMRC investigations, GCES investigations, and additional information relating to the Colorado River ecosystem.

Data in itself is of little use without sufficient information as to its context, quality, and comparability. Therefore, data standards have been be developed which preserve the context under which the data was collected and ensures its quality and comparability from year to year, place to place, researcher to researcher, and discipline to discipline. Data collection efforts supported by the GCMRC incorporate strict data standards and protocols that provide consistency in data collection, storage, and delivery from disparate sources.

Delivery of electronic content will be automated where possible using user-friendly World Wide Web browser interfaces. Library content, while not deliverable across the Internet, has been cataloged and is searchable electronically utilizing similar interfaces.

Warehoused data conforms to the National Information Infrastructure (NII), the National Biological Information Infrastructure (NBII), and the National Spatial Data Infrastructure (NSDI). Guidelines and protocols promulgated by these infrastructures is being incorporated into GCMRC database design and delivery systems whenever possible.

DBMS, GIS, and library operations together form the core information system infrastructure for storing and retrieving information at the GCMRC. Data standards and protocols ensure the quality and compatibility of the information contained within those systems. World Wide Web browsers provide intuitive, consistent interfaces to the information. However, information technology at the GCMRC goes beyond the content and delivery of information. In addition, the ITP also provides:

- Computer support to GCMRC staff
- Survey support to researchers

- Development of remote sensing applications

     These additional services augment the core information infrastructures by providing the support, training, technology transfer, and development necessary to provide a comprehensive ITP.

Information Technology Program Functions

     To accomplish the goal of *satisfying the information needs of GCDAMP relative to the Colorado River ecosystem,* in FY2002, the IT program will focus on 7 functions: 1) database management, 2) GIS operations, 3) library operations, 4) survey operations, 5) systems administration, 6) world wide web services, and 7), aerial photography. Each function of the IT program is described in detail below. Descriptions include general information concerning the role of the function within the GCMRC, proposed objectives to be accomplished in FY2002, and proposed budgets. IT functions are either performed by GCMRC, staff or procured through a contracting process. Non-contracted program budgets include operating costs and salaries that combine to represent the total cost of the function (less the cost of space rental and administrative overhead). Operating costs include equipment, supplies, technical training, and travel relating to program functions. Contracted IT functions represents the total cost of the contracted service or product to GCMRC less the cost of administrating the contract by the appropriate contracting officers technical representative.

     Non-contracted IT program functions have associated with them ongoing objectives that are necessary to organize and manage the various types of scientific data acquired by GCMRC or its contractors. These ongoing objectives may be different depending on the function. They include administration of the function, servicing work request, servicing data request, incorporating new data into developed data systems, and performing annual inventories.

Data Base Management System

     The purpose of the GCMRC DBMS is to store and deliver all tabular and other electronic non-spatial information gathered as the result of GCMRC investigations, and legacy data. Developing the DBMS requires inventorying, organizing, archiving, and developing delivery systems for many years worth of environmental data collection activities representing a vast array of disparate data including physical, biological, cultural, socio-economic, and climatic information. Some data resides on mature DBMS systems but much of it is stored on floppy disks or hard disks on personal computers using PC type spreadsheet and database formats. Although the objective of the information technology program is to provide a centralized database management system (DBMS), it is our policy not to duplicate fully developed and accessible data warehousing already provided by other entities. In these circumstances it is preferable to interrogate the off-site database remotely when possible. However, the GCMRC will act as a clearinghouse of data owned by other entities in the case where remote database interrogation is not possible. The DBMS program is currently working on bringing together years of disparate historical data collected by multiple entities located in databases across the southwest in an organized fashion and then

deliver it transparently to an equally disparate group of stakeholders and researchers for decision making and modeling purposes. In addition, the DBMS program is developing a process that includes adequate documentation and training for users to easily access, query, and obtain data from the information system.

The Oracle data base engine was selected for GCMRC data base development. Oracle is a state-of-the-art data storage and delivery system that can function either as a centralized or distributed data base and incorporates a high degree of information technology integration. Important features of the DBMS are:

1. All data is being ecologically integrated. Meaning that data is being stored in a consistent format relative to time, space, researcher, and discipline. This is essential for comprehensive ecological analysis. Appropriate data standards and protocols have been, or in some cases, will be developed to regulate this feature.

2. Spatial data is being geographically integrated. Although the database does not contain a spatial data analysis engine, the GIS used by the GCMRC will be highly integrated with, and dependent upon, the database for storing attribute data associated with spatial features. Data contained in the database is being spatially referenced within the database where appropriate.

3. Public data will be freely available. Sensitive data will be protected. User accessibility is being configured item by item.

4. The database will be searchable over the Internet using browser interfaces. Intuitive browser interfaces will be the primary method used to interrogate the database.

The GCMRC data base development is occurring over a two-year period ending in December 2002.

Ongoing Activities:
- Administer the database
- Service data requests
- Integrate current year data into data system

FY2002 Activities:
- Complete the design of data entry, analysis and web interfaces–fish, cultural, and water quality components
- Complete the migration of historical fish, cultural, and water quality data from legacy data systems
- Document installation and administration procedures–completed for applications written to date

Complete design and program data entry, analysis and web interfaces

During FY2002, key computer applications will be written that will allow information users to easily enter newly collected data to the Oracle system, and also to retrieve and analyze that information.

Migrate historical data from legacy data systems

In order to make use of data collected in the past, the Oracle database must be populated with historical information. During FY2002 GCMRC will complete this process for physical, biological, and water

quality data. Consistent with the recommendations of the Cultural Program protocol evaluation panel and subsequent guidelines being developed by GCMRC and cooperating organizations, GCMRC will also consolidate cultural data within a GCMRC database. One of the challenges in this process is to protect sensitive information from public access.

Document installation and administration procedures

Accurate and complete documentation is critical not only to the success of maintaining a complex database, but also to making it a success for users of the information it stores. All procedures used in the creation of database tables, loading historical information, and also the creation of user applications will be documented, and will be made available to interested parties.

The cost of these ongoing and three additional activities in FY2002 is:

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002
AMP Funding			
	Data Base Management System		**56,240**
11.0	Salary (includes benefits)		
	Computer Specialist (1-fte) (76%)	73,000	56,240
	Operating Expenses:		**45,000**
21.0	Travel		3,000
25.0	Contracts (Oracle)	160,000	10,000
25.0	Services		3,000
26.0	Supplies and Materials		10,000
31.0	Equipment		19,000
	TOTAL	233,000	101,240

Geographic Information Systems

A GIS is the second of the three core information technologies being used by the GCMRC. Its purpose is to provide spatial analysis capabilities to GCMRC staff and stakeholders and maintain a library of GIS thematic coverages of the study area. GIS is an important analytical tool for change detection of biological, cultural, and physical data.

The GCES program developed up to 20 thematic coverages associated with spatial relationships of biological, cultural and cultural resources at 17 GIS sites (Figure 1.2) within the Colorado River ecosystem (CRE). Tabular attribute data exists as part of these data sets. These data sets are known as "base data". In addition, other GIS data sets which were constructed as part of past GCES-supported investigations and delivered as part of a final product. These data sets are known as "contributor data". Efforts are now underway to catalog, describe, and distribute base and contributor data. The GCMRC is working to increase the GIS coverage of the CRE by using modern light detection and ranging (LIDAR) mapping techniques.

Ongoing GIS activities are:

- Administer GIS data systems
- Service GIS map, data, and analysis request
- Integrate current year data into data systems

FY2002 GIS activities are:

- Complete development of the Internet map server (IMS)
- Complete integration of legacy base data
- Continue to provide GIS support to the remote sensing initiative
- Migrate GIS data from INFO to oracle database

Complete development of the Internet map server (IMS)

The IMS will allow our staff, contributing scientists, AMWG/TWG members and the general public to browse our spatial data holding and produce maps over the internet through their web browsers (Netscape Navigator or Microsoft Internet Explorer). The user will be able to search for data by subject (physical, biological, cultural), temporally (when the data was collected), or spatially (where was the data collected). Multiple data layers can be overlayed on a map and simple spatial analyses will be available through the on-line mapping tool. The results of the search can be printed as a map from the users' local machine. Once data has been identified by the user, he/she can download the data and use a GIS package such as Arc/Info to conduct complicated GIS and statistical analyses.

Complete integration of legacy base data

Legacy base data sets represent considerable time, effort, and expense in their collection. In addition, those data offer snapshots of the past conditions that cannot be derived in any other way. Legacy datasets can be used, in conjunction with current datasets, to produce information regarding change in resource quantity and condition over time in resources areas where legacy data exists (change detection analysis). Integrating these data sets in a usable way presents several challenges including the lack of descriptive information about the data or how it was collected (metadata) making it difficult to assess the accuracy and usefulness of those data for a particular study. The GIS program is currently inventorying all legacy datasets that were collected during the GCES period and before and is attempting to create modern meta data for those data. This is a time consuming and difficult process. Once the inventory and metadata is complete, the legacy data will be stored in its appropriate place in the same databases as current and future data.

Provide GIS support to the remote sensing initiative

The GIS program supports the remote sensing initiative by developing protocols for seamless integration into existing datasets, ensuring that the delivered products meet contract technical specifications and conform to GCMRC data standards, and assisting in program development and execution by recommending sites where remote sensing evaluations would be most useful and cost effective and providing logistical support in data collection.

Migrate GIS data from INFO to Oracle database

GCMRC's selection of the Oracle database engine presents additional challenges to the GIS. Currently GIS data layers are stored in an obsolete database called INFO. Advances in software allow us to migrate this data from INFO to the Oracle relational database system while maintaining all the mapping and analysis capabilities of the GIS. Using a software called Spatial Database Engine, GIS information and tabular data will now be stored in a single Oracle database management system, allowing us to fully integrate tabular

data with spatial layers developed through remote sensing or the GIS program. In addition, the GIS will now be able to take advantage of modern database tools that are available in the Oracle software and not in the INFO software.

Budget:

The cost of these ongoing and three additional activities in FY2002 is:

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002
AMP Funding			
	GIS Services		149,450
11.0	Salary (includes benefits)		91,450
	GIS Specialist (1-fte) (56%)	48,800	33,600
	GIS Assistant (1-fte) (95%)	42,000	40,850
	GIS Student Asst (.5-fte) (100%)		17,000
21.0	Travel		4,000
25.0	Services		8,000
26.0	Supplies and Materials	12,000	11,000
31.0	Equipment		35,000
	TOTAL	102,800	149,450

Library Operations

Library operations provide the last of the three core information technologies being used by the GCMRC ITP. Its purpose is to facilitate research by providing a centralized repository for hard copy information such as books, reports, maps, photography, and videos. The scope and purpose of the library is to collect, archive and deliver those materials that assist the center in its efforts to administer long-term monitoring and research.

Inherent in the administration of long term monitoring and research plans is the delivery of hard copy documents, photographs, slides, videotapes, and ARC/Info coverages. A policy for loaning these materials is developed in a manner that is most parsimonious to all researchers, with underlying GCMRC staffing resources determining the ability to deliver and track loaned materials. Delivery of materials also emphasizes technologies that permit remote multi-user access.

Secondary to providing funded researchers access and use of the library's materials is providing non-funded researchers and the general public access to documents unique to GCMRC's holdings (duplicate documents available at other institutions provide non-funded researchers access to these materials). The singularity of a document requires special policy concerning the borrowing of these materials. Because these unique documents are considered part of the public domain, their availability to the public is required

Collection of materials for the purpose of research and monitoring efforts are coordinated with program managers and information technology managers. Criteria for the accession of materials include:

1. Applicability of materials to specific research efforts and to overall research and management goals; adequacy of the facility and equipment needs of the GCMRC to house materials; Ability of the staff to archive and deliver materials;

2. Availability of funding for materials (e.g., general reference books, government publications, CD ROM's, etc.).

Collection also includes the accessioning of documents that are the product of research funded by GCMRC.

Library holdings included the following:

1. Hard copies and electronic copy of final funded research reports.
2. Reprints of articles resulting from funded research.
3. Books resulting from research efforts associated with GCMRC.
4. Books and articles related to Grand and Glen Canyon.
5. Books and articles related to natural and controlled riverine environments.
6. Photographs and slides developed by GCMRC staff (aerial and field documentation).
7. CD-ROM versions of aerial photographs and slides.
8. Videotapes (overflights, programs related to Glen and Grand Canyon).
9. Maps (topographic, flightline maps, Arc/Info Coverages, Orthophotos).

Archival materials are one of a kind, or hard to replace items (e.g., original aerial photographs, slides, videotapes). Utilizing imaging technology (e.g., CD-ROM's) and electronic media to develop copies of archived materials should always be investigated and promoted so that copies of these materials can be made available to the general collection, and thus reducing the incidence of loss of unique and irreplaceable materials.

Ongoing library activities are:

- Administer library operations
- Service library requests
- Integrate current year data into library
- Annual inventory

FY2002 library activities are:

- Complete cataloging library content
- Continue conversion of catalog
- Continue making content available on-line

Complete cataloging library content

The library cataloging needs to be completed. Presently, books and monographs have been cataloged according to title, author, publisher, and content. This information has been placed into Follett library software and is accessible on-line. The photo and video collection has been cataloged on paper, but this information has not yet been put into the Follett software; this will be completed by FY2002. Subject headings for each item will also be added to each cataloging record for more comprehensive and flexible searching abilities.

Continue conversion of catalog

Currently, all items in the library collection are identified using call numbers based on the Bureau of Reclamation's Record Management System. By the end of FY2002, the library collection will be converted from the Bureau of Reclamation's record management system to a more standardized system such as Dewey Decimal or Library of Congress call numbers. This means that items on the same subject will be grouped together and the collection will be easier to "browse" for information.

Continue making content available on-line

The Follett library catalog is now available on-line through the GCMRC web page. FY2002, items that were previously available only through the library will also be available on-line such as reports and aerial photography.

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002	
AMP Funding				
	Library			
11.0	Salary (includes benefits)			47,500
	Technical Info. Spec (1-fte) (95%)	51,000	47,500	
	Operating Expenses:			18,000
21.0	Travel		1,500	
25.0	Services		1,500	
26.0	Supplies and Materials		10,000	
31.0	Equipment		5,000	
	TOTAL	51,000	65,500	65,500

<u>Survey Operations</u>

The Survey department's mission is to provide survey support for spatial measurement and referencing of scientific data collected in the Colorado River ecosystem by GCMRC programs. This support may be in the form of precise measurement of

geographic coordinates of a sample collected in the Canyon or in the generation of topographic maps used for erosion monitoring of terraces adjacent to the Colorado River. The Survey department is also responsible for establishing and maintaining accurate geographic control in the Canyon that is essential for accurate geo-referencing of remotely sensed data and change detection of resource data using modern image processing and GIS technologies. These technologies are critical to the integration and analysis of the diverse scientific data that have been collected in the Canyon over the past 15 years. Products of the Survey department include precise sample location coordinates, topographic maps, river channel maps and cross sections, digital elevation models, and digital terrain models. This information provides the basis for spatial analysis of data within the ecosystem using GIS software that in turn provides area and volumetric change detection capabilities of resources.

The Survey department is responsible for the development of sound topographic and mapping control required to build accurate spatial data sets that can be used for reliable change detection. David Evan's and Associates and Banner and Associates were hired in 1990 to establish a reliable geodetic control network. In 1991 Joseph Mihalko (NPS surveyor) occupied the Banner ground control points for a soil mapping project by the USGS. He found that the control points did not meet their claimed accuracy and precision. As a result, GCES established a survey department to correct all previously established survey control as well as meet research needs of the future.

The Survey department uses a variety of technology to assist in accomplishing its mission in a timely, cost effective manner that utilizes a minimum amount of personnel. These technologies include global positioning systems, multibeam acoustic technology, and conventional total station survey technology.

Ongoing activities are:
- Administer the survey program
- Service survey work requests

FY2002 activities are:
- Provide survey, control, and GPS support to remote sensing initiative
- Complete organization of legacy data

Provide survey, control, and GPS support to remote sensing initiative

Survey operations provide support to GCMRC remote sensing activities in the form of providing control and GPS base station data. Data provided from these activities is crucial to the geopositioning and rectification of remotely sensed data collected by the initiative and is fundamental to the application of remote sensing technologies in the CRE.

Complete organization of legacy data

As in other IT program functions, there is large amounts of legacy survey data pertaining to CRE resources that is worth keeping. This information will be inventoried, described, and translated into modern data systems. Survey operations will complete this activity in FY2002.

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002	
AMP Funding				
	Survey Services			
11.0	Salary (includes benefits)			35,550
	Surveyor - (1-fte) (5%)	33,200	4,300	
	Surveying Technician (1-fte) (25%)	37,050	14,250	
	Student Asst - Survey (.5-fte) (100%)	20,000	17,000	
	Operating Expenses:			35,000
21.0	Travel	2,000	2,000	
25.0	Services		6,000	
26.0	Supplies and Materials	6,000	27,000	
	TOTAL	98,250	70,550	70,550

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002
Appropriations - Requested Funding			
25.0	Services - Surveying		50,000
	TOTAL		50,000

Systems Administration

The GCMRC computing environment is a complex system of servers, workstations, laptops, printers, plotters, modems, routers, hubs, switches, copy machines, FAX's, and telecommunications equipment networked together using 100baseT networking media. Most of the computers are of the PC type running the Windows NT/2000 operating system. In addition, over 50 applications are utilized by GCMRC scientists and support personnel in carrying out the collective mission of the GCMRC. Applications are primarily off-the-shelf products but in many cases are highly specialized.

Ongoing activities are to:

- Administer GCMRC network, computers, and software
- Troubleshoot day-to-day computer problems
- Upgrade existing computing infrastructure and provide new functionality

Budget:

OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002	
AMP Funding				
	Systems Administration			
11.0	Salary (includes benefits)			61,450
	Res. Info Analyst (Prg Mgr) (1-fte) (5%)		4,450	
	Systems Administrator (1-fte) (95%)	61,000	57,000	
	Operating Expenses:			111,000
21.0	Travel		2,500	
25.0	Services		3,500	
26.0	Supplies and Materials	120,000	25,000	
31.0	Equipment		80,000	
	TOTAL	181,000		172,450

World Wide Web Services

Through the World Wide Web (WWW), general information about the GCMRC, its science programs, and the adaptive management program are provided there. In addition, Web interfaces to GCMRC databases, GIS data, library content, and other information will be provided through this medium. Ongoing activities are:

- Administer the GCMRC website
- Troubleshoot day-to-day web problems

FY2002 objectives will focus on improving the quality of the website by:

- Creating more and better web content
- Making more frequent updates
- Creating more user friendly web interfaces
- Creating more easily navigable web pages
- Creating seamless integration of FTP content

Budget:

OBJECT CLASS	DESCRIPTION		FY-2002
AMP Funding			
	World Wide Web		
25.0		Contracts	60,000
	TOTAL		60,000

Aerial Photography

Aerial photography is a data collection function of the GCMRC ITP. Aerial photography is utilized by multiple researchers conducting scientific investigations in the Colorado River ecosystem. In FY2002 GCMRC will collect digital color infrared aerial photography with a ground resolution less than one foot. GCMRC will collect aerial photography on an annual basis to maintain a continuous photographic record of the Canyon started in 1990 at least until the protocol evaluation panels and remote sensing initiative conclude in 2002. The need for collecting annual aerial photography after 2002 will be reevaluated at that time. After 2002 it may continue, be discontinued, or modified based on the recommendations of the review panels and remote sensing report.

Budget:

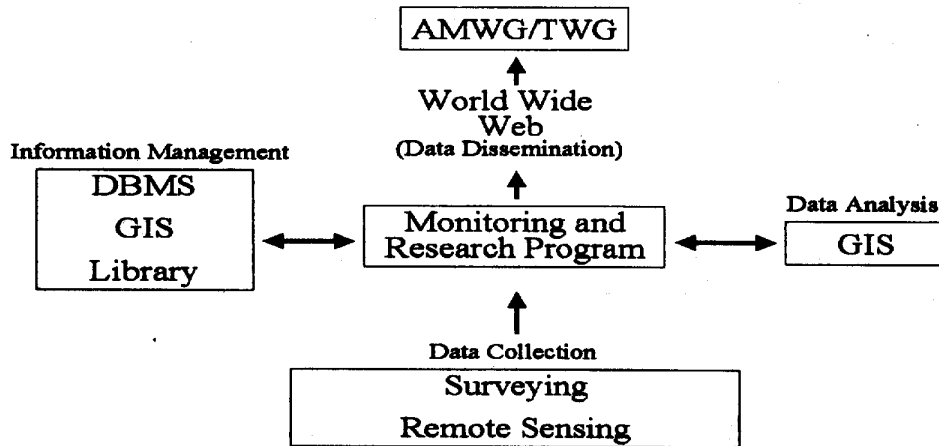| OBJECT CLASS	DESCRIPTION	FY-2001	FY-2002
Appropriations - Requested Funding			
	Aerial Photography		
25.0	Contracts		135,000
	TOTAL		135,000

Information Technology Program

Figure 3.1. – Schematic illustrating the relationship of various Information Technology Program functions to the GCMRC monitoring and research program and the AMWG and TWG.