July 1, 1993

LCMR WORK PROGRAM 1992

I. STREAM AND WATERSHED INFORMATION SYSTEM - Water 6

Program Manager: Susanne Maeder
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Land Management Information Center
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A. M.L. 91 ch. 254, Article 1, Sec. 14, Subd: 4 (a)   Appropriation: $200,000
                                                       Balance: $ -0-

Stream and Watershed Information System: This appropriation is from the Minnesota environment and natural resources trust fund to the commissioner of Administration to develop an integrated system of information relating to streams, watersheds, and retrieval and analysis tools.

B. Compatible Data: During the biennium ending June 30, 1993, the data collected by projects funded under this section that have common value for natural resources planning and management must conform to information architecture as defined in guidelines and standards adopted by the Information Policy Office. In addition, the data must be provided to and integrated with the Minnesota Land Management Information Center's geographic data bases with the integration costs borne by the activity receiving funding under this section.

II. NARRATIVE

The purpose of this project is to develop a computerized information system on Minnesota's streams and their associated watersheds. The system will combine tabular data from various agencies' files with GIS data layers to create a mappable data retrieval system.

Decisions concerning Minnesota's streams and watersheds require data from many state and federal agencies and complex analytical tools. It is often difficult and time consuming to identify, obtain, and analyze needed data from numerous sources. This system is proposed to bridge these numerous sources into one coherent framework. State and local officials involved in water planning and management will be able to dial into the system to obtain information from a variety of sources. The system can help review water appropriation permits, assess drought impacts, assess trends in water quality, and simplify studies requiring both stream and watershed information in areas such as stream flow characterization and nonpoint source pollution assessment.

III. OBJECTIVES

A. **Identification of priority data sets and development of System Design Document.**

A1. Narrative: The first phase of the project will be to develop a System Design Document. The design procedure will identify key applications for the system, graphic and text outputs needed; available data sets; and integration techniques. The SWIM Advisory group will help prioritize data needs and design the system to meet the needs of user agencies.

A2. Procedure: The SWIM Advisory group on surface water issues will be expanded to include all agencies and departments with an interest in system development, including local groups involved in water planning. The group will be surveyed as to specific needs. Data inventories developed under previous SWIM activities, the surface water monitoring site inventory, and the MN GIS/LIS geographic data inventory will be expanded and evaluated. Recommended data and procedures will be developed, using the ARC/INFO and EPPL7 GIS software at LMIC. Potential new GIS techniques needed by the system will be tested. A Design Document will be completed by 12/31/91.

A3. Budget   LCMR Funds
     a. Amount budgeted   15,000
     b. Balance   -0-

A4. Timeline for Products/Tasks

	July 91	Jan 92	June 92	Jan 93	June 93
Expand Committee	|------|				
Inventory Data/Needs		|--------|			
Test Techniques		|--------|			
Complete Design Document	|--------------|				

A5. Status: The GIS/LIS Hydrology Subcommittee, which deals largely with surface water GIS issues, was expanded to include more state and local representatives with an interest in the Stream and Watershed Information System project. This Subcommittee is also in touch with other water-related GIS development projects. Great interest has been expressed in the project by members of local, state, and federal agencies. Over 60 individuals are currently on the Subcommittee mailing list.

A Data Needs Survey and an Analysis Needs Survey were circulated to Subcommittee members, and responses tabulated. Many other agency representatives submitted narratives listing desired capabilities of such a system. Results of these surveys are tabulated in the Design Document submitted 12/31/91.

Wherever possible, data and software capabilities were evaluated, data limitations identified, and procedures outlined.

Data Testing: Available stream trace data sets were compared and evaluated, to identify the best means of improving stream trace files and tagging them with the stream identifiers commonly used in the state. Update procedures were outlined. The stream trace update procedure was not finalized. We are awaiting new test files from the U.S. Environmental Protection Agency. "Reach File 3" designations were required by EPA for MPCA surface water quality reporting, and incorporation of this designation into this Project is crucial to widespread use of the system by MPCA and counties using MPCA information. The first file acquired from EPA was incorrect; EPA promises a replacement file by the end of January. Stream trace file testing will continue once this file is received, and a stream update procedure will be in place by mid-March.

Software Testing: The use of AML (Arc Macro Language) was explored and outlined for graphics and query functions. Software graphics terminal emulators were tested to evaluate the ability to dial in and view graphics from remote locations. PC/Workstation interface software is being tested to enable the integration of GIS data on a workstation with models generally run on PC's.

Some software capabilities needed have not yet been tested because they were not yet available from the vendor. These include several new functions of ARC/INFO which will be available in the next upgrade to ARC 6.0: dynamic segmentation (needed to tag segments of stream traces with different agencies' identifiers); GRID (ARC vector/raster interface - which could be used to convert GIS data layers to grid format for input into commonly-used models); and "one-to-many" RELATE capability (useful for displaying much of the agencies' tabular data sets within a graphics mode). LMIC will be testing these functions when they become available for the Data General workstation.

A Design Document, outlining proposed data layers and capabilities, and describing data options and testing done to date, has been completed and submitted as part of this Project Status Report. Two potential pilot watershed areas have been identified - both watersheds are areas with multi-agency involvement and a high level of interest in watershed planning and GIS.

A6.   Benefits: Needs evaluation and system design is essential as a guideline for system construction.

B.   Improvement/Reconciliation of Major Data Sets.

B1.   Key GIS data layers for the stream and watershed information system include river and lake trace files and watershed boundary files. The stream and lake trace files require clean-up and some tagging with identification codes to make them more usable to the system. Stream and watershed layers need to be better integrated to determine which stream segments are in which watersheds. Since a watershed redelineation and digitization project (DNR) has also been funded, SWIS development will have to be coordinated with that project, and modifications to the Common Stream and Watershed (CSAW) hydrologic ordering system must be tracked. The SWIS will require that stream and watershed delineations be correlated with the Environmental Protection Agency's

"Reach file 3" used by the MN Pollution Control Agency for water quality analysis and reporting. Other agency stream segment designations will have to be transferred to the stream files.

Various point data collections need to be converted. While some collections are already point-located and compatible, other collections relying on location information provided by the regulated party (e.g., water appropriators or owners of underground storage trunks) need further specification.

B2.   Procedure: LMIC, working closely with MPCA and DNR/Waters, will perform data clean-up, tagging, and reconciliation of major GIS data layers using the ARC/INFO software. LMIC will work with other agencies or divisions as necessary to improve other data sets.

B3.   Budget   LCMR Funds
       a.   Amount Budgeted $80,000
       b.   Balance $ -0-

B4.   Timeline for Products/Tasks

	July 91	Jan 92	June 92	Jan 93	Jun 93
Stream/Lake files clean-up			|------------------|		
Stream/Reach Reconciliation				|-----------|	
Watershed/Stream/CSAW				|-------------------|	
Other data sets, (as identified in design)		|--|			

B5.   Status

1. Hydrology Data. The USGS DLG 1:100,000 hydrology data has been tagged with Minnesota lake and stream identifiers for the entire state. DLG Hydrology, RKI, and all available National Wetlands Inventory data have been loaded into the MAP LIBRARY described in C. and D.

The original "Reach File 3" data EPA provided was corrupted. LMIC conducted experiments with the preliminary EPA files which confirm that the Arc/Info 'MATCHCOVER' routine can be used to transfer to LMIC stream files 85% of the Reach Identifier information without manually re-tagging the file. However, the corrected version promised by EPA was not available as of June 15, 1993.

2. Point Data. The Surface Water Monitoring Index (1990) was updated to 1992. The index is a master list of surface water monitoring stations, created by combining files from several agencies. The index identifies point locations, and serves as a tie to the data on water quality, streamflow, etc. Water quality data was added to the system.

B6. Benefits: Reconciliation of these major data layers is necessary for the development of an active Stream and Watershed Information System.

C. Construction of a pilot stream and watershed information system for a major watershed.

C1. Narrative: SWIS Design will be tested on a pilot major watershed or group of major watersheds identified by the SWIM committee. Construction of the system for a pilot area will identify problems and improvements needed to the system, before construction of the entire system is begun. It will also identify further data reconciliations needed.

C2. Procedure: The system will be constructed according to the Design Document using the ARC/INFO software. Access will be through dial-in to the LMIC computer system. The SWIM Advisory group will have access to the system as portions are built, and can comment on usability and additional needs. The pilot system, once operational, will be publicized through Local Water Planning activity and the MN GIS/LIS Consortium, to solicit further comments.

C3. Budget

		LCMR Funds
a.	Amount Budgeted	$40,000
b.	Balance	$ -0-

C4. Timeline for Products/Tasks

	July 91	Jan 92	July 92	Jan 93	Jul 93
Pilot System Construction			|---------------|		
Evaluation				|-------------|	

C5. Status: Point, hydrology, and watershed characteristics data were assembled for 2 pilot watersheds - the Whitewater River in southeastern Minnesota and the Niemackl Lakes watershed in west-central Minnesota. The data includes LMIC data sets, other state agencies' tabular data, and federally and locally-generated data. The menu system was built and tested using the pilot areas.

The Arc/Info (GIS software) module called 'MAP LIBRARIAN' was tested in the pilot area as the means for storing and manipulating the data used by the Stream Information System. The previous status report (12/31/92) reported problems in using the MAP LIBRARIAN which prevented the completion of the pilot project by 12/31/92. These problems were resolved and the pilot work was completed. High-speed communications were also tested. System structure as refined during the pilot stage is outlined in D5.

C6. Benefits: Construction of a pilot system for a small area will allow us to test and refine the concept before full-scale construction. The system will be made available to a wide range of people for evaluation. In our experience, users doing hands-on testing of a system will identify more needs important to them than they could identify in concept only.

D. Construction of the entire Stream and Watershed Information System.

D1. Narrative: During this phase of the project, a full system for the state will be constructed, based on evaluation of the pilot project and the enhanced data available through part B.

D2. Procedure: Using the basic system design constructed in part C, internal evaluations of software techniques used, and external evaluations of the usability and available functions of the system, the statewide system will be constructed. Data layers will be incorporated as they become reconciled or otherwise prepared for integration into the system.

D3. Budget

		LCMR Funds
a.	Amount Budgeted	$65,000
b.	Balance	$ -0-

D4. Timeline

	July 91	Jan 92	Jul 92	Jan 93	Jul 93
System Construction			|----------------------|		

D5. Status

1. Final Design. LMIC is using the Arc/Info 'MAP LIBRARIAN' module to store and manage the large volume of data required by the Stream Information System. MAP LIBRARIAN stores LAYERS of data (such as roads, rivers, wetlands) in 'TILES' or map units of identical format. The map unit or TILE used by the Stream Information System is the USGS 1:100,000 map sheet. This map unit was chosen because the preponderance of new high-resolution GIS data is available by 1:100,000 or 1:24,000 sheet (which fits into the 1:100,000 tile). A map library based on 1:100,000 tiles is also consistent with, and, in fact, contributes to the GIS Data Clearinghouse at LMIC. A Sun Sparc2 workstation and additional storage capacity were delivered in February, 1993, and the STREAM Information System was loaded onto that platform.

Retrieval of information from the system is by watershed or secondarily, by county. However, the watershed unit itself is not used as a map tile boundary because these delineations are expected to change as field-verified information become available, and a map library should not be built using tiles which change their boundaries frequently. Changing tile boundary definitions requires re-loading the library data.

Problems relating to storage by 1:100,000 map sheet and retrieval by watershed and county (which delayed the completion of the pilot project), were resolved.

A menu interface was constructed which allows the user to define the geographic area (a selected watershed or county), display map information on the screen, query the system about particular types of data, create reports from that data, or create hard-copy maps interactively.

The system is flexible in that analysis routines can be added at a later date. These routines can be developed with interested agencies as cooperators as the opportunity arises. Some analysis will involve the extraction of data layers in a certain format to be input into a PC-based model.

2. Data Loading. Primary data layers include base rivers, lakes, wetlands & watersheds; transportation; civil boundary files; point information such as water monitoring stations and water appropriations; map boundaries; census boundaries. These layers are kept online.

Secondary data layers include:

1. data-intensive layers such as land use and soils which cannot be kept online statewide (because of storage requirements) but which can be loaded onto the system on an as-needed basis.

2. specific data layers which are not available statewide (such as drained wetlands and RIM lands/conservation easements) which have been automated by local users for specific areas.

Data not loaded:

- Land Use is one of the most often - requested data layers. Data problems with the land use layer currently retard its use in an ARC/Info vector format. LMIC will continue to work with MPCA, DNR, and other interested users of the data to resolve these problems to facilitate the use of this data.

- RF3 (Reach File 3) Reach file 3 from EPA corresponds to the stream reporting unit used by MPCA for all surface water quality programs. Corrected Reach File 3 data was not available from EPA as of June 15, 1993. Therefore, it was not possible to load it into the system. LMIC will work with MPCA to see what can be done once the data becomes available.

3. System Access and Use. Users of the system will include state and local agencies and local water planning groups. Users are able to view map data, query water data, and create reports and maps.

Rapid outside access to the graphics-based system will be possible via the Internet. LMIC is now connected to the Internet via the router at Intertech in the Department of Administration, as are the MN Dept. of Natural Resources, Minnesota Pollution Control, and the Mn. Dept. of Health Central offices. Most universities in the state are also connected to the Internet System. Graphics terminals or terminal emulators are necessary at the user end to see the graphics. This high-speed link makes it possible to view data in a graphics format which would be tedious or impossible to view under standard phone modem access. The system can currently only be viewed at LMIC. Arrangements for accessing the data system from other sites via the Internet will be made later in 1993.

Use of the system will be promoted through the GIS/LIS Hydrology Subcommittee, the Local Water Planning working group at the Board of Water and Soil Resources, the Environmental Quality Board Water Resources Committee, and the geographic information systems and water planning user community at large. Plans are underway to exhibit the system at the national Geographic Information Systems/Land Information Systems Conference, to be held in the Twin Cities in November, 1993.

D6. Benefits: The full system will provide a workable query system for state and local water managers involved in water quality, water quantity, and land management issues. It will combine a variety of tabular and GIS data layers in map format through a single access point.

IV. EVALUATION

The Stream Information System is a working system, but it is also a framework which has been set up to accommodate future expansion. The MAP LIBRARY data base structure is one which is compatible with the statewide Data Clearinghouse at LMIC.

The map library menu system has been constructed to accommodate future growth, so that LMIC can work with interested agencies as cooperators to add data layers not currently available and associated queries and reports. Analysis and model interfaces can be added on an as-needed basis.

LMIC has tried to design a Stream Information System which can serve as a framework for future application development.

V. CONTEXT

A. Several appropriate GIS data layers have been developed in the past, and many useful state data sets are automated. However, many of the GIS data layers such as streams, watersheds, and EPA Reach files have not been fully integrated, so that the individual data layers are not as useful as they could be. These data layers can be (and have been) combined for a particular application, but since the relevant data sets are scattered among agencies, combining the data can be a tedious and costly process. Links among the GIS layers would allow an analysis of surface water information in light of the watershed characteristics affecting it.

B. The proposed system would add value to the state data collections already developed, by adding the capability for holistic analysis.

C. The groundwork for such a system has been laid through past agency data automation. In particular, the system will build upon the DNR state watershed delineation, the Common Stream and Watershed Numbering System (CSAW), and the River Kilometer Indexing System developed with LCMR funds. Additional improvements have been made to those data bases by LMIC.

The system will also incorporate watershed descriptive information from the MLMIS40 grid cell and vector data bases at LMIC. To the extent possible it will attempt to tap new data layers such as the land use update and National Wetlands Inventory data.

Appropriate tabular information will be incorporated from automated data bases at DNR, MPCA, SPA, USGS, EPA, and elsewhere. These data bases have been developed using a variety of funding sources.

D. Not Applicable.

E. Biennial Budget System Program Title and Budget: Stream and Watershed Information System, APID 16000:58-03, AID #084145

VI. QUALIFICATIONS

1. Program Manager:

Susanne Maeder
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5 yrs. MN Water Planning Board - water policy analysis
6 yrs. MN State Planning Agency/Land Management Information Center -
    water data coordination, data needs analysis, and project management of water-
    related mapping and data base projects at LMIC.

2. Advisory and review committees:

SWIM User Committee
MN Geographic Information Systems/Land Information Systems Consortium -
    Steering Committee and Hydrology Subcommittee
Local Water Planning Project Managers and personnel through the Board of
    Water and Soil Resources.