Cooperative Hydrology Study

Work Plan

By

Technical Coordination Committee

7/10/98

Table of Contents

COOPERATIVE HYDROLOGY STUDY
Work Plan

INTRODUCTION

This document presents a detailed scope of work for completing the Nebraska COoperative HYdrology STudy (COHYST). COHYST was started by state and local agencies (sponsors) and is supported by municipalities, environmental organizations, and water user organizations (partners). The study sponsors have developed and signed an Interagency Cooperative Agreement (ICA) to administer and carry out the financial responsibilities of this Nebraska Environmental Trust (NET) project. Funds were requested and granted from the NET fund to supplement financial support from the sponsors and partners.

A Cooperative Hydrology Coordinating Team (Coordinating Team) has been formed by the study sponsors and partners to direct the study. The team members are listed in Table 1. The Coordinating Team interviewed three firms and hired one to provide a Senior Hydrologist to participate in selecting technologies and reviewing work and work products throughout the study.

March 17-18, 1998 Project Initiation Workshop

A workshop was held March 17th & 18th in Lincoln, NE for the Coordinating Team members and the Senior Hydrologist to develop the scope, content, and format for this **Work Plan**. The agenda for the workshop was divided into five sessions, which addressed a series of questions:

Session 1:	What do we want from the Cooperative Hydrology Study?
Session 2:	What information do we already have to work with?
Session 3:	What are our choices for decision support tools?
Session 4:	What tools and information do we really need?
Session 5:	So how do we get there?

The complete agenda and workshop minutes are available on request. Also available are notes from meetings with USGS, UNL Conservation and Survey Division, Nebraska Game & Parks Commission and Natural Resources Commission.

During the workshop, a **Project Organization** was established and a **Statement of Purpose** and **Study Objectives** were developed. An outline was prepared for the Work Plan, and assignments were made to write portions of this document. The Work Plan presented here was a joint effort of the Hydrology Coordinating Team. In developing the initial Work Plan, a large amount of background information was written that provides additional information on justification for the COHYST. Because this material was not action - based it was not included with the Work Plan, but is available on request as a “working document”.

The Hydrology Coordinating Team continued to work on this Work Plan after the initial workshop through a series of individual efforts, one workshop on May 7, and several conference calls, eventually developing the work breakdown, schedule, and labor estimates included here. This Work Plan is dynamic and will continue to be updated over the three- year project duration.

Table 1. Cooperative Hydrology Study Coordinating Team

Name	Agency
Sponsors	
Rod Horn	South Platte NRD
Ron Cacek	North Platte NRD
Kent Miller	Twin Platte NRD
John Thorburn	Tri-Basin NRD
Ron Bishop	Central Platte NRD
Rich Kern	Nebraska Natural Resources Commission
Mark Brohman	Nebraska Game & Parks Commission
Ann Bleed	Nebraska Department of Water Resources
Don Kraus	CNPPID
Brian Barels	NPPD
Partners	
Dave Sands	Nebraska Audubon Society
Bob Henszey	Platte River Whooping Crane Trust
Jay Rempe	Nebraska Farm Bureau
Jim Lundgren	Nebraska Water Users Inc.
Sara Kay	Nebraska Water Resources Association
Gary Mader	City of Grand Island
Tim Stonge	City of Scottsbluff
Tom Harvat	City of North Platte

Project Organization

After the enactment of the ICA by the sponsors, the following organization was adopted during a meeting of the Coordinating Team: Don Kraus was elected Chairman of the Coordinating Team, Ron Bishop was elected Vice Chair and appointed to handle the administrative duties of the NET Grant & Funding, and a standing Technical Coordination Committee was set up by the Coordinating Team with membership appointed as shown in Table 2.

Table 2. Technical Coordination Committee

Name or Position	Organization
Duane Woodward, Chairman	CPNRD
Ann Bleed	NDWR
Mike Drain	CNPPID
Jeff Lucas	Tri- Basin NRD
Rich Kern	NNRC
Ed Dekleva	NPPD
Larry Hutchinson	NGPC
Bob Henszey	Platte River Trust
Jim Cannia	NPNRD
Senior Hydrologist	Parsons ES & HGE
New Hydrologist / Modelers	
Senior Database Managers	NRC & Parsons ES
New Database Manger	

As soon as possible, the technical coordination committee will identify the ground water modelers who will be working to develop the regional models. Although they probably will not start the actual modeling process until 1999, the modelers and all other identified technicians will be involved in the initial decisions regarding the areas to be modeled and types of data to be included in the database. To the extent that the 1998 budget will allow, efforts will be made to involve the modelers and database technicians in the design and implementation steps shown in the task series described below.

Role of Hydrology Coordinating Team and Technical Coordination Committee

The Hydrology Coordinating Team will direct and administer the study. The Technical Coordination Committee plus new hires and outsource vendors will conduct the majority of the work described in this work plan. Other staff within each sponsor and partner agency may work on various tasks by contributing in-kind services to the overall project effort. Due to the scheduled work and the limited availability of agency staff, portions of the work plan will be accomplished by contracting work from other engineers, geologists, computer scientists, and technicians, primarily members of the staff of various departments in the state university system or by cooperative agreements with other agencies or vendors.

A number of positions onboard or to be hired for the COHYST work included;

1. Senior Database Managers----- Parsons ES,NRC
2. Database Manager ------ New Hire
3. Senior Hydrologist-----Parsons ES and HGE
4. Hydrologists/Modelers---- New Hire/ Existing Staff

Role of Senior Hydrologist

The Senior Hydrologist will function as a study advisor and reviewer. Specifically, the Senior Hydrologist is expected to complete the following tasks:

1. Meet with the cooperators to develop an understanding of the problems we need to address.
2. Working with the cooperators, determine what analyses and models would provide the best tools to address the study objectives and develop a scope of work to implement these studies.
3. Help review the sufficiency of available data and design methods to collect the additional needed data.
4. Make recommendations regarding content and format of the database.
5. Meet with those who will carry out the studies to insure that study methods and objectives are clearly understood.
6. Periodically review work products and provide critical reviews and advice on how to proceed.
7. Be available for periodic consultations and problem solving.
8. Prepare a final review of the models and other study products noting their capabilities and limitations.
9. Provide suggestions for potential additional work and analyses.

Statement of Purpose

The study is a cooperative effort to improve understanding of the hydrological and geological conditions in the Platte Basin in Nebraska upstream of Columbus, Nebraska. A group of Nebraska interests have joined together as sponsors and partners to develop scientifically supportable hydrologic databases, analyses, modeling, and other information which when completed will:

1. Assist Nebraska to meet her obligations under a separate three-state Cooperative Agreement (CA),
2. Assist the Platte River Natural Resources Districts (NRD's) to provide appropriate regulation and management,
3. Provide Nebraskans with a basis to develop policy and procedures related to ground water and surface water,
4. Help Nebraskans analyze proposed activities of the CA and/or other programs in Nebraska.

Study Objectives

In order to accomplish this purpose, a water resources Decision Support System (DSS) will be developed and implemented. Development of the DSS for the Platte River Basin in Nebraska above Columbus will require that the Coordinating Team collect data, develop a database, develop models, contract work from others, and eventually make all the data and models available to any interested user through Web-site access.

The objectives to be met in developing and implementing the DSS include:

1. Collect existing data and models.
2. Place data into an appropriate database.
3. Review existing data and models to identify data gaps.
4. Collect supplemental data as necessary to be added to the database.
5. Develop linked, regional models to cover the Platte basin in Nebraska above Columbus.
6. Establish credibility of the data, database and models.
7. Design and develop a geographical user interface and GIS-based Internet link to the data and models.

8. Put models to use in accomplishing purposes described above.

Relationship of COHYST to Cooperative Agreement (CA)

The relationship between COHYST and the three-state Cooperative Agreement Water Conservation and Supply Study (CA) is indirect. The CA is not required to use any information being developed under COHYST. The CA study is progressing, and may be completed before the completion of COHYST. Nonetheless, information developed as a part of COHYST will be made available to the CA as that information is developed. Providing COHYST information to the CA study will be possible because many of the same individuals are involved in both efforts. Ann Bleed, Duane Woodward, Frank Kwapnioski, and Mike Drain in particular have been involved in both COHYST and the CA Water Committee.

To the extent possible, COHYST will utilize information developed by other entities involved with the CA. This information could be provided by work of the Water Management Committee of the CA, Boyle Engineering or other consultants hired by the CA, or the U. S. Geological Survey, which is doing a separate study of the Platte River basin. Data from these sources will be subject to the same quality control protocol as other data being developed and placed in the DSS.

WORK PLAN FOR DEVELOPING PLATTE RIVER DSS

Much of the workshop discussion and some of the supplemental material developed by the Hydrology Coordinating Team focused on the technical issues surrounding surface and groundwater interactions in the Platte River, goals of the COHYST, a preview of what the DSS will look like, and how the DSS will help decisions makers deal with the technical aspects of the issues. The remainder of this document describes the specific tasks needed to develop the DSS within the time frame of this project, and within the resources available to the sponsors and partners.

After identifying all the tasks needed to develop the DSS, the Technical Coordination Committee developed a schedule, Gantt chart, and labor estimate for completing the tasks, including a plan for meeting the objectives by combining support from available staff, by hiring additional technicians and engineers, by contracting work, and by supplementing the work by preparing applications to other funding programs and seeking other's help. The schedule, Gantt chart, and labor estimate are presented in the Appendix. Finally, costs to accomplish the objectives are assessed and needs are being assessed for supplementing the funds available from the grant and matching support.

The general outline for development of the DSS involves (1) establishment of the study geographical limits and placing other bounds on the size and extent of the database, (2) selection of the tools that will go into the DSS "toolbox," (3) collection of existing models and data, development of a database that matches and meets the needs of the selected tools, (4) development and calibration of models for all the regions selected, (5) integration of the data, database, and models in a user-friendly medium that allows access and interaction by any interested user, and (6) implementation of the DSS in supporting decisions being made by Nebraska water managers.. These six activities are presented as task series, with subtasks that are described briefly in the following paragraphs. The task series and subtasks are not necessarily listed in the order in which they are to be performed. It is anticipated that some of these tasks are complex and will need to be accomplished by outside sources. Detailed scopes of work as appropriate will be developed to supplement this overall Work Plan. The labor requirements, schedule and Gantt chart presented in the Appendix refer to the same task names and numbers.

Task Series 100-- Establish Study Limits and Parameters

Task 101. - Select Groundwater Flow Model Algorithm to be Used - View Task Completion Report

The Technical Coordination Committee and the Senior Hydrologist have completed this task. The MODFLOW algorithm is being recommended as the tool to be used in this study. MODFLOW is a modular, three-dimensional, finite-difference groundwater flow model developed by the USGS in the 1980's. It has had widespread application and has modules which allow the users to develop and account for water movement in a complex groundwater system. Also, a number of commercially-available, user-friendly input and output interfaces have been developed for MODFLOW making it easy to use and effective in modeling most groundwater and surface water systems. Evaluating and selecting a GUI to use in this study is described in Task 208.

Task 102. - Define Overall and Regional Model Boundaries - View Task Completion Report

Members of the Technical Coordination Committee discussed the overall study boundary in light of the upcoming Platte River issues to be evaluated, the sponsor's individual needs, and known boundaries of existing models. Figure 1 in the Appendix shows the area modeled during the Platte Level B Study in the 1970's. Figure 2 shows the boundaries of several other groundwater models completed by various investigators (see list in Task 202). The bounds of the overall study are principally defined by surface water features, groundwater divides, and the Nebraska - Colorado - Wyoming State lines. Figure 3 in the Appendix is a map showing the 1979 water table contours used to set the overall study bounds and footnotes a model boundary condition for each segment of the boundary. The Technical Coordination Committee has recommended that the database cover the highlighted boundary shown on Figure 4. It covers the Platte River Basin above Columbus, NE. In general, the north boundary is the South Loup River, and the south boundary is the Republican River. The regional model boundaries will be delineated as part of Task 401.

Task 103. - Define Database Boundaries and Content - View Task Completion Report

It is felt that the database boundary should be selected to extend beyond the model boundary because the data will be used for innumerable other efforts besides the modeling specified in this study. Also, most data comes in packages that follow non-hydrologic boundaries such as county lines. Consequently, some countywide or other grouped data will be incorporated in the database although the hydrologic study boundaries may include only portions of the zone covered by the data source. The content of the database will include all necessary data to develop the DSS but may include other information if readily available. A boundary map and table listing the possible database contents, plus descriptions of the data resolution and data sources, will be developed in this task. A partial list of data is presented in task 301.

Task 104. - Assess and Select Model Resolution that DSS will support by Regions

For this task the Technical Coordination Committee will evaluate the resolution of data and then consult with the Senior Hydrologist and other experts to assess the smallest appropriate model grid sizes and range of other model parameters that could be developed for each of the regional models. This will be done to help define model construction, model accuracy and study limitations; plus quantify data gaps. This task may include the need to review existing models and previously applied methods to determine their accuracy and limitations. It may require that some models be tested, or some analyses be developed further to complete an assessment of the appropriate level of detail that data of all forms will be incorporated in the database.

Task 105. - Select and Develop Common GIS Coordinate / Projection System for All Models

This task is straightforward and will likely involve selection and development of state plane coordinates or UTM coordinates for the total and regional model boundaries and other control points. The Technical Coordination Committee will assess whether to develop the database and models in the

English or Metric system. Consistent units are needed by the MODFLOW model to perform a basin wide analysis. With English units the common coordinate system likely would be state plane coordinates with distances in feet. These were used, for example, with the groundwater flow model developed for Dawson County at UNL in the 1970's. With Metric units the UTM coordinate system likely would be used.

Task 106. - Establish Streams and Tributaries to be Included - View Task Completion Report

The work effort needed for this task is to determine which streams, tributaries, irrigation canals, laterals, drains, or other surface water bodies receive groundwater inflow or discharge to groundwater in sufficient amounts and over sufficient duration's to warrant inclusion in the stream-aquifer groundwater analyses. Selection will be based on a hydrological review of past USGS low flow investigations, DWR flow records, plus NRD and District knowledge of the areas. A map showing these streams, tributaries and drains would be developed for the database. Selection of the data and information needed for inclusion to these surface water features into a groundwater analyses would be done within Task Series 300.

Task 107. - Establish and Select Methods of Incorporating 1947-97 Pumping, Well Development, Land Uses

For the present, it is felt that land use, well development and pumping amounts will be established using "snapshots in time", and then incremented between times of mass measurements to provide input for each time step in modeling. These will likely be based on data sets developed for previous models, and/or by using land use maps from 1947, 1997, and other sources.

Task 108. - Develop Criteria for Establishing Credibility of Models and Data

For this task the Technical Coordination Committee will draft a set of criteria for selecting and determining the acceptability of data, analyses, and models. Once discussed and approved by the sponsors, the criteria will be applied in deciding the acceptability of each potential item of data, analysis, and models.

Task Series 200-- Evaluate Alternative Tools and Make Selection for DSS

Task 201. - Evaluate Alternative Databases and Make Selection

Requirements for the DSS database system include:

1. The need for security and integrity so the data cannot be deleted or tampered with by unauthorized persons;
2. Easy write-access by those with authorization;
3. Easy, but read-only, access by everyone else;
4. Supporting descriptions of the data in standard "metadata" format; and
5. The ability to create a history of changes to the data or data system.

The assumption throughout the planning process for the development of the DSS has been that the data will reside on the Nebraska Natural Resources Commission's computer system. The NNRC has both UNIX and Windows NT operating systems, and both can be accessed (read/write) by outside users, with certain limitations.

In the UNIX environment, the NRC staff has some experience with Informix and Oracle database programs, but has settled on the "INFO" part of ARC/INFO. For this project, databases created for the UNIX environment will typically be in GIS format which includes mapping features with database

attributes related to the point, line or polygon items. Neither Informix nor Oracle supports this feature. The senior database manger (see Task 304) will assess the options and make recommendations for the database platform and operating system.

Developing databases in the Windows NT environment could be handled by dBase, Paradox, or Access. The NRC uses Microsoft Access as its database program because of the ease of use in developing databases and publishing this information on the Web.

These, and possible other platforms for the DSS database will be assessed and a recommendation made with reasons listed.

Task 202. - Inventory Existing Ground Water Flow Studies

The following is an annotated list of past studies and models that will be reviewed and inventoried to determine for each what data was used, what methodologies were employed, and whether the products can be incorporated in the DSS:

1. Platte River Level B Study - this study developed a1970 level database, estimated Ground Water depletion's, evaluated various projects and generated multiple reports.
2. Upper Platte River Study — performed by USBR, surface and ground water operation hydrology, USGS river hydrologic and geomorphic studies, and USFWS Ecology Study in early 1980's, area studied was Platte River Basin above Grand Island, NE.
3. Missouri River Basin Study - Ground Water depletion estimates made using Jenkins SDF method, 1944 to 1978.
4. CPNRD Ground Water Model - Original USGS model developed in 1983; Revised by HDR; Revised by CH2M HILL 1992; converted to MODFLOW by CH2M HILL; currently supported and maintained by CPNRD.
5. Tri-Basin NRD Area Model - Water Resources Investigation 87-4176; Finite Element Model.
6. Twin Creek Area - Conservation and Survey Division; Open File Report 96-206; MODFLOW Model.
7. Platte/Republican Model - USGS/Conservation and Survey Division studies. Initial study by Conservation and Survey followed by USGS.
8. NPPD/ Harza study - Operations and conservation study.
9. A Digital Model of Conjunctive Use Irrigation in Dawson County by Bob Keasling - UNL master's student thesis.
10. Audubon studies on conservation practices and lining canals.
11. Kearney Kilgore Island Water Supply Ground Water Model developed by Chris Miller and modified by CH2M HILL.
12. Grand Island Well Field Model - 10 square mile Ground Water model; MODFLOW; CPNRD Model
13. Upper Republican Model - South Platte River is northern boundary.
14. Prairie Bend Study by USBR - AQUISIM Ground Water model 1989.
15. Wood River Groundwater Recharge Demonstration 1997.
16. North Platte study for NE v. WY - Similar to Prairie Bend Study.
17. Wyoming Water Research Center Platte River Wetland Hydrology Study in Central Platte.
18. South Central Area Hydrologic Data by USGS & NNRC OFR No. 86-246
19. Other miscellaneous models and analyses developed by various investigators.

Based on a preliminary review of the above reports, ground water analyses have been developed, calibrated and applied over much of the State. A map developed for the Platte River Level B Study showed regions covered by groundwater models at that time. The map is included in the Appendix as Figure 1. The Platte Level B study included coarse-grid models for the Elkhorn, Loup, Middle Platte, Twin Platte, and Lower Platte regions. An Upper Platte model was considered in the study, but the

reliability of the input data was so poor in that area that the development of a model was not considered practical.

The digital models used in the Level B analysis were developed to solve unsteady two-dimensional flow through an unconfined non-homogeneous aquifer and used node sizes of 6.25 square miles. Among other applications, the models were used to estimate stream flow depletion's due to future pumping development.

A study similar to the Platte River Level B ground water depletion work was completed as part of the Upper Platte River Study by DOI agencies. The USBR developed a series of AQUISIM ground water models for the Platte River above Columbus, NE using three-mile node spacing.

The Central Platte NRD has been one area in which significant additional modeling has been developed using the USGS 960-acre node size model which was most recently updated by CH2M HILL to run in MODFLOW. Since it was originally developed it has been used for many purposes (CPNRD Groundwater Management Plan, Prairie Bend Project Planning, Dawson County Conservation Study, etc.)

Figure 2 in the Appendix shows the overlap of models that have been developed along and south of the Platte River (Blues, South Central, Twin Platte/Middle Republican, and Upper Republican) and a model that was developed for the Box Butte County area. All the models have been used for predictive purposes but those south of the Platte River are generally considered more reliable.

Based on viewing the modeled areas shown in Figures 1 and 2 one can see the non-modeled area is basically the Panhandle area of the Platte River system in Nebraska. Information is more reliable in some of the modeled areas than in other areas but there is less model information available in the Panhandle area.

One other modeling project that bears mentioning is the Economic Development Administration (EDA) High Plains study. This was completed in the early 1980s and included models covering much of Nebraska. Where models already existed, they were used in the EDA project. If not, new models were developed. The new models were regional models with cell sizes of 36 square miles. Because of time limitations in the study, the models were not calibrated, so there is no way to assure their accuracy. The models are worth mentioning because quite a bit of data was compiled to develop those models that may be useful in this study. Two of the models from the EDA study that might be useful here are the Upper Niobrara and Republican River models shown on Figure 2.

Task 203 - Contact Other Modelers for Ideas on Tools and Methods

This task is a ongoing task throughout the study which was added to seek out experiences and new developments in applying tools like MODFLOW to estimate groundwater - surface water interactions. Discussing and reviewing ideas with other modelers improves credibility and provides opportunity for avoiding pitfalls. A good example is the ongoing work effort in the Republican River Basin where USGS and Conservation and Survey Division are studying Ground Water - Surface Water interactions.

Task 204 — Inventory and Evaluate Alternative Geologic Parameter Estimating

For this task the Technical Coordination Committee and other geologists and hydrogeologists will be polled to evaluate and select the method or method to be used in the DSS for defining the saturated geologic formations (model layers) that make up the aquifer of the Platte River Basin above Columbus. The method of estimating the associated hydraulic parameters (hydraulic conductivity, specific yield, etc.) for each geologic formation will also be selected. As the methods are selected, they will be described in detail so they can be used and replicated by other technical people performing the work.

Task 205 - Evaluate Alternative Methods of Estimating Hydrologic Parameters

This task is similar in scope to the previous task in that a detailed description of the method to be used in collecting or developing each needed hydrologic parameter will be selected. Hydrologic parameters include items such as riverbed elevation, bed conductivity, streamflows, pumping rates, pan evaporation, lake seepage, and so forth. Identifying the hydrologic parameters will be the first step of this task. Then, a description will be prepared of what needs to be done to estimate or collect each parameter for the entire study area. Algorithms will need to be developed to generate model node, stream node, and boundary node values of these parameters for each time step over the historical baseline.

Task 206. - Evaluate Alternate and Existing Methods of Estimating Net Recharge

A number of methods have been developed into models to simulate the rainfall-runoff-evapotranspiration-recharge processes that provide the vertical component of recharge/discharge needed in groundwater flow models. These existing methods and models will be reviewed and evaluated for use in the COHYST effort. Three methods that will be considered include:

1. USGS Method by Jon Peckenpaugh used in 1983 Central Platte NRD Model
2. UNL Method by Dr. Derrel Martin
3. USBR - BASIN Program to Compute Basin Water Use 1981

Net recharge can be computed by any of these or other existing methods. Many of the existing methods use monthly inputs, which may be a concern when trying to estimate surface water-ground water interaction along the Platte River. Based on precipitation and ground water level data collected along the Platte River, the rate of recharge is very rapid. Thus, the accounting of the soil moisture budget may need to be done on a daily bases to properly account the volume of recharge that is occurring.

Peckenpaugh's method was developed in the mid-to-late 70s. The BASIN method was also developed in the mid-to-late 70's, and Martin's was developed in the mid-to-late 90s so it takes advantage of newer technology and information. Martin's method was developed on a smaller area of western Nebraska and eastern Wyoming and takes advantage of similar latitude conditions and assumptions but could probably be calibrated and applied on a larger area.

It is felt that the development of a net-recharge algorithm needs to be done using a water budget approach on a daily time frame and then summarized into ground model time steps. The method or analyses selected should be similar to the existing Peckenpaugh or BASIN approach so that both crop consumptive use and ground water pumpage are computed. The following tasks will be required to develop net-recharge and other values:

1. Complete a thorough evaluation of existing methods and analyses. This will include conducting a workshop with investigators to establish the preferred method.
2. Determine inputs and computations necessary to provide information (recharge, pumpage, canal water use, etc.) for ground water model inputs.
3. Evaluate the data availability for the preferred method.
4. Develop analyses and model input generator by developing a new, or updating an existing, program (could be assigned to the Senior Hydrologist or contracted with someone else)

Task 207 - Evaluate Alternate Methods and Select Method for Handling Pumping

The Technical Coordination Committee will complete this task by reviewing past methods of computing pumping and then selecting an approach to develop pumpage for use in the database and regional

models. The land use database for several snapshots in time will be used to establish pumping amounts for each time step in the ground water model.

Task 208 - Evaluate Alternate Platforms/GUI's/GIS's, Make Selections - View Task Completion Report

This task will be completed by reviewing the available GIS and MODFLOW processing software plus other viable software to select which option will do the best job for the work that needs to be done. A recommendation will be based on the evaluation by the Senior Database Manager.

Task Series 300 - Develop Water Data for Database

After completing the Task Series 200, most of the analytical methods and platforms will have been selected. Before doing any modeling the data that will be used must be placed in the correct format into the databases. This will be accomplished during Task Series 300.

Task 301 - List Data Needed by DSS

In this task, the Technical Coordination Committee and Senior Hydrologist will define the list of data needed in the database for ground water analyses. The following data is an initial, partial list of the spatial data that will be probably be acquired for the study region shown on Figure 4:

a. Geology (Elevations of Top and Bottom of all Aquifer Layers)
b. Aquifer Properties (Hydraulic Conductivity and Storage Coefficient)
c. Pump Test Data and Results
d. Land Surface Topography
e. Water Table Info (Contour Maps over Time and Depth to Water)
f. River Info (Flow data, Cross Sections, Bed Conductivity, Quality Data, Stage Data)
g. Soils (Classification and Engineering Properties)
h. Land Use by Type for Past and Present, Irrigated — Non-irrigated, Pump Irrigated -- Surface Irrigated
i. Weather (Temperature, Precipitation, Wind, Solar, ---Daily)
j. Consumptive Use (Trees, Grass, Corn, Soybeans, Etc.)
k. Groundwater Recharge -- Surface Water Runoff (Soil Moisture Budget Method, Canals, Reservoirs, and Artificial Recharge)
l. Groundwater Pumping (Past and Present)
m. Estimates of and Measurements of Canal Carriage Losses
n. Estimates and Measurements of River Reach Gains and Losses

The database being developed needs to store both spatial data and time series data. Some of the data will be developed as spatial data with no time element, while some of the spatial data will change with time and will be compiled for a series of years or smaller time steps. The time series data is information collected at a fixed location on an hourly, daily or monthly basis. The following is a partial list of the time series data needed in the database:

a. Stream Flow and Stage Records at all Gaging Stations
b. Reservoir Storage Levels
c. Meteorological Data (Temperature, Precipitation, Wind, Solar Radiation, and Pan Evaporation)
d. Pumping Rates and Volumes
e. Recharge
f. Ground Water Level Data
g. Canal Diversions

h. Gaged Return Flow Records
I. Water Rights and Adjudication's

Task 302 - Apply Data Quality Check from Task 108 (Ongoing)

This task will require the Technical Coordination Committee and Senior Database Manger to apply the data quality-checking process described in Task 108, and then assign this data-checking responsibility to the appropriate individuals. Data not meeting the test will be excluded from the database, and a data collection program will be recommended to fill any gap created by the data screening process.

Task 303 - Assess Availability of Data and Current/Needed Format

This task was started some time ago by the staff hydrologists and the Senior Hydrologists when agency meetings were held in March 1998. The notes and minutes of those meetings are available and contain information on data availability and the general format the data is collected in by those agencies. The USGS attended the last Technical Coordination Committee meeting on May 7th and brought an extensive list of data they had assembled in a database during the NAQA study for the Central Platte. To complete this task, the Senior Database Manger and a staff hydrologist need to make a through review of the available data and make recommendations on the need to acquire it and in what format.

Task 304 - Develop Job Description, Hire Database Manager

This task has been completed. It was implemented to develop a job description for a database manager which would include the following duties and requirements. A staff GIS specialist drafted a job description for presentation to the Coordinating Team for consideration. The approved description of required capabilities is attached in the Appendix. Duties will include:

- Develop Web and GIS application in NT and UNIX environments.
- Process databases using Microsoft Access, MS Visual Basic, and ARC/INFO programming techniques and WWW capabilities.
- Assist and train project sponsors in development of databases.
- Document databases created in "metadata" format.
- Serve as system administrator who manages the project environment.

Two possible descriptions were advertised. One would be for a "guru" who would be able to implement the database and web-site with little supervision. The other would be for a person with similar skills, but one who would work under the supervision of someone else. Minimum requirements for either job is a Bachelor's Degree in Computer Science or related field, and a minimum of one year's experience. Work experience and demonstrated knowledge were required in Microsoft Access, MS Visual Basic, JAVA, HTML and UNIX operations. A Master's Degree in Computer Science or equivalent could be substituted for one year of work experience.

Task 305 - Create Database Framework

This is a major task to be completed by the full time database manager. A conceptual model of the database needs to be developed. From that model, the database structure or framework for the different types of data can be developed to work with the database software. These tasks need to be accomplished before any data can be entered into the database.

Task 306 - Research Existing NRD Ground Water Management Plans for Data & Analyses

In the mid-80's, all of the NRDs developed ground water management plans that contained many types of geologic and hydrologic data. These were updated in the mid-90's to include additional water quality data. A guide was distributed to indicate what data was desired to be included, but there was no requirement that it had to be included. Consequently, some plans were more complete than others. Table 3 that shows some of the data from each NRD that may be useful in modeling the Platte River Basin above Columbus.

Table 3.

Hydrologic Information in NRD Ground Water Management Plans

	CP	**TP**	**SP**	**NP**	**TB**	**MR**	**UR**	**LL**	**UL**	**UNW**
Major Aquifers	M	M	M	M						
Saturated Thickness (Ogallala Aquifer)	M	M	M	M	M	M	M	M	M	M
Depth to Water	SM		M	M		M			M	M
Base of Aquifer	M	M	M	M	M	M	M	M		M
Potentiometric Surface	M	M	M	M	M	M	M	M	M	M
Hydraulic Conductivity	M		M				M			
Transmissivity	M	M	M	M	M	M	SM	M	M	M
Specific Yield	M		M	M		M				M
Precipitation Averages	SM	M	T	M	SM	M	M	M	M	M
General Soils Map	M	M	M	M			M		M	M
Average Expected Crop Water Uses			T			T				T
Root Zones for Some Crops			T							
Water Holding Capacities for General Soils			T							
Crop Acreage by County and Crop			T	T			T			
Irrigation Districts			M	M						

M = Map
T = Table
SM = State-wide Map

Based on the above table showing the information available in the Groundwater Management Plans, the plans will be reviewed to assess what data is available in what format and determine what methods were used to estimate the computed data. This analysis will help in selecting the appropriate level of detail for the database and to identify available data and data gaps.

Task 307 - Evaluate Existing Models and Data for Adequacy, Coverage, Precision, and Gaps

The description for Task 202 gives a short accounting of the existing studies that have incorporated groundwater data and analyses. The goal of this task is to evaluate the existing data for adequacy, coverage, and precision. The process for assembling and analyzing existing data includes:

1. Identify types of data needed (Task 301).
2. List collection sources for each type of data.
3. Review collection methods and protocols used for data gathering.
4. Compare protocol to COHYST task 108 acceptance criteria (adequacy and precision).
5. Identify format of data from various sources and area of coverage.
6. Summarize in table.
7. Decide which data sources to use and select end format of data for database.
8. Convert data if needed and add to Internet database

The various models identified at this time will be reviewed in detail by staff hydrologists to determine types of data available from each model. A table will be prepared for each model showing the original data source and or methods used to develop the data. The geographic extent of the data will be noted along with format of the data. The usability and validity of the data can then be determined, and if appropriate, the data can be assembled and added to Internet database.

Task 308 - Collect and Install Existing Model Data in Database

This task would pull the existing data into the proper format and install it in the database. It is presently felt that both UNIX (ARC/INFO) and Windows NT (MS Access) will be used as the database environments. Regardless, the Database Manager (DM) would be responsible for entering all data in to the "official" DSS. The DM would need to have read/write access to both areas while everyone else would have read access only.

Task 309 - Describe and Recommend Internal and External Work Scopes to Fill Data Gaps

Some data, such as river flows, stream bed conductance, well pumping activity; land use and climate are dynamic and will never be current. What is important is to define which data gaps are critical to the reliability of the model and concentrate efforts to fill those gaps within the constraints of the funding available. If critical data gaps remain after the funding is depleted, more funding should be sought or the weaknesses of the model should be identified to avoid misuse.

Some data gaps will be identified initially by the staff and Senior Hydrologists based upon review of existing data sets. An example would be identifying characteristics of the soil types that affect the quantity and rate of groundwater movement. Some gaps won't be identified until a rough model is developed and used to test whether a perceived data gap is critical. Land use activity and precision of land use data within one mile of the river may be more critical than activity or precision five miles from the river. Changing land use data input at various distances and evaluating the impact will help define what boundaries within which the data and model should be contained. Comparing the impact of using daily flow measurements against monthly may determine which rate or combination is necessary. Monthly time steps may work in some stretches of the river and not in others.

Once the data gaps are identified, there are various ways to fill the gaps. Research of the data pools of various agencies (Conservation and Survey, DWR, NRC., NRD's USGS., CNPPID and NPPD.) should help fill some of the gaps. Interpolation can be used to fill gaps where some information is available but not all that is desired. Actual fieldwork may be necessary to fill some gaps. Stream gaging, metering wells, measuring stream bed properties, or land use surveys may need to be performed to fill in gaps or verify interpolation estimates.

Since funding is a key component to the success of the Cooperative Hydrology Study, it will be important to always be assessing whether a task to be performed should be opened for competitive bids or done in house. This would include entering data into the database or collecting the data. The costs associated with filling data gaps may help to prioritize them.

Task 310 - Compile Historical Streamflow Time Series to be used for Streams, Tribs, Canals

This data is currently available in an acceptable form. This task simply involves the work of downloading the existing data into the COHYST database.

Task 311 - Develop Other Historical Time Series Info (Well Development, Meteorology, Pumping, Flows, Land Uses, Cropping Patterns, Irrigated & Dryland Area, Surface Water Irrigated Areas)

This task also involves putting available time series data into the database. It also includes computing the data in some cases, using the methods established in Task Series 200. This task will be lengthy and was estimated to take at least 9 months to complete.

Task 312 - Contract for Collection of Missing or New Data

Based on the data gaps identified in the above tasks, requests for proposals to collect data can be developed. These proposals can be used to contract the data collection or organize in-house data collection efforts. Depending on the data gaps identified, these collection efforts will take a fair amount of time to organize and accomplish. Some data gaps already identified and budgeted for are testhole log completion and interpolation ,observation well elevations, 1997 land use data, and river surveys for bed elevation, stage, and bed conductivity.

Task 313 - Incorporate Collected Missing Data in Database

Upon completion of a data collection task the collected data will be formatted for database entry. This could mean using the collected data to compute additional data for the database. For example, the observation well data will be used to compute groundwater levels and develop hydrographs for use in model calibration.

Task 314 - Publicize Completed Database

Under this task a brochure explaining the complete database will be written and published for distribution. Notices describing the database will be posted on the state's web site and mailed to potential database users.

Task 315 — Write and Publish Database "Guide"

A detailed database user's guide will be developed and made accessible to guide future users. This will serve as the technical resource for the users and will describe procedures for accessing all parts of the database.

Task 316 - Develop Database Maintenance Plan

To maintain the long term usability of the database, a plan will be developed to accomplish data updates and system upgrades.

Task Series 400-- Develop and Calibrate Models

Once the database design is accepted work in developing and calibrating ground water flow models will begin. This task series describes that work.

Task 401. - Design Layout of All Regional Models

Currently, there are at least eight different groundwater flow models that are either partially or completely covering the COHYST Platte Basin model area and have inputs and outputs of varying quality. Two ways that the future modeling could proceed were evaluated, and the work plan assumes that the second will be implemented.

In the first scenario, the present models could continue to be run separately. The model output in the overlap areas could be compared to make sure they are reasonable and modifications made where necessary. Recalibration and data entry efforts would be minimal. Making sure the inputs are consistent, running all of the models and verifying that the results are consistent would take considerably more work. Two of the models are finite-element and the others are finite - difference models like Trescott-Pender and MODFLOW, adding to the incompatibility.

The second, recommended method would be to develop a new grid system that covers the entire area. All of the original source inputs from the previous models would be reviewed and reentered into a database that accommodates a new standard grid. Data entry efforts would be significant and the regional models would have to be calibrated separately and compared at overlapping areas. In particular, flow in and out of one model area to another would have to be evaluated to maintain a water balance along the entire Platte River Valley. Once developed, new models could be developed for any size area, and sub-models of smaller areas could be developed in areas of special interest.

Figure 3 shows the configuration of the water table in the spring of 1979. Because of ground water flow conditions, models typically use perennial streams and ground water divides as boundaries. This map was used to determine the proposed boundaries for regional models. A standardized coordinate system will be used to develop the grid for the models.

There are many pros and cons of these two methods, but overall the standardized coordinate system for regional models would be the best tool to analyze and manage the ground water resources and to provide the greatest flexibility for future users of the Platte River DSS.

Figure 4 shows the proposed area to be covered by the COHYST data. Model boundaries may be selected for a smaller area. This task will requires staff hydrologist to look at data available and possible boundary conditions to lay out model areas for the regional models. The development of regional models for an area will require that a standard coordinate system (State Plane, UTM, etc.) be selected and a decision made regarding which areas will be covered by regional models with overlapping boundaries.

In the recommended method, any sub region could be selected for modeling. The Technical Coordination Committee will propose and develop a set of overlapping regional models for use by any interested party. These will be laid out on the State Plane or UTM coordinate system, and will allow geographic features to be represented on any maps that might be developed. Features such as canals, laterals, streams, and wells could be geographically located and identified by cell. The important features will be developed in the selected GIS system, which will automatically locate them in the ground water modeling system.

Databases and GIS coverage in the NRC Databank are typically in the UTM projection in either NAD 27 or NAD 83 system. The appropriate data would have to be converted to the State Plane coordinate system for this project if model grids are to be developed in feet.

Other things to be considered in designing the layout of the regional models are:

1. Model boundary conditions along the Platte River and at the outlying boundaries of the model.
2. The number of model layers and aquifers to be modeled.
3. The method of characterizing ET, recharge, and stream and drain flows.
4. How pumping rates and volumes will be developed and modeled.
5. Calibration procedures and acceptance criteria especially in the model overlap areas.
6. Model grid size.
7. Model input and output criteria and format.

Task 402 - Develop and Calibrate Groundwater Flow Models for Two Areas not Previously Modeled

After developing Figure 4, it was determined that two hydrologically separate regions have not yet been modeled in the study area. These occur in the panhandle of Nebraska, with one north of the North Platte River and one south. These were parts of the zones excluded in the Level B models because data were sparse or non-existent. Due to substantial efforts by the NRD's and UNL departments, considerable data has been collected for this region, and models can now be developed. Though this task will involve considerable time and cost, the models will be included to allow complete modeling of stream-aquifer relationships in Nebraska's portions of the Platte River system.

Task 403 - Develop and Run Land Use Algorithm throughout Model Nodes (1947-97)

Alternative methods of integrating time changes and aerial variations of land use will be assessed in Task 205, and the algorithm will be developed in Task 311. Using the algorithm, land-use files for each time step in the historical baseline will be generated, reviewed, and saved in this task.

Task 404 - Develop and Run Daily Net Recharge Generator Everywhere Using Selected Method(s)

As in Task 403, spatial and time-varying values of the net recharge for all model nodes will be developed during this task.

Task 405 - Develop and Run Selected Pumping and Surf. Irrigated. Algorithm(s) Throughout Model Regions

Spatial distributions of pumpage and surface water irrigation use will be generated for each time step in the historical baseline.

Task 406 - Develop and Run Stream Package Parameter Generator for all Streams and Canals in Regional Models

Each stream or canal node will require input of spatial and time-varying parameters. These will be developed for all the regional models in this task.

Task 407 - Develop and Run all Other Geographic and Temporal Parameter "Generators" for all Regional Models Using ArcGRID or Similar

As in Tasks 403 to 406, files of spatially-distributed values of the remaining geographic, geologic, and hydrologic parameters will be developed for each time step in the historical baseline.

Task 408 - Develop and calibrate Linked Regional Ground Water Flow Models for Areas Previously Modeled

From a preliminary analysis of Figure 4, and from discussions of needed regional models, it is felt that as few as three regional groundwater models can be developed and calibrated to cover areas that have previously been modeled. The overlapping boundaries will be established in this task, and the generated data files from Tasks 403 to 407 will be input and run through a series of calibration tests. Once calibrated, the model structure and calibration will be documented and released for use by any interested party.

Task 409 - Apply Model Credibility and Acceptability Criteria (Ongoing)

As an ongoing effort, the criteria for testing and approving model performance developed in Task 108 will be applied by the Senior Hydrologists and others to the work products being developed in Tasks 401 through 408.

Task 410 — Write and Publish "Guide" to Platte River DSS Groundwater Models

After completing the above tasks, a technical guide to the developed groundwater flow models will be written and distributed.

Task 411 -- Develop Job Description, Hire Hydrologist

This task is to write a position description for one or more Hydrologists with groundwater model experience. The Technical Coordination Committee will advertise the job that needs to be done and hire someone for the position.

Task Series 500 - Develop Platte River Decision Support System (DSS)

Task 501 - Develop "Paper" Preview of Possible Screens in the DSS (To Aide Final Design)

The Technical Coordination Committee, the Senior Database Manager and others involved in this task will develop hand-drawn sketches of what the DSS computer screens might look like on the Internet system. These are inexpensive and can be used to promote discussion and to eventually establish a conceptual design of the Web DSS. The concepts could then be given to the web-master for incorporation in the DSS. Input from committee members would be combined with input by potential users to explore ideas and develop the final web-site design. The Database Manager would coordinate efforts in completing this task.

Task 502 - Assess Adequacy of Commercial MODFLOW GUIs

Several vendors have developed (or are developing) excellent interfaces for the "engine" in MODFLOW. Some allow ease of editing data files and others give the user a powerful graphical viewing capability of model results. The staff hydrologists will complete the task of assessing several of these, with input from the sponsors, partners and typical users. MODFLOW software suppliers would be contacted for demo copies, and example runs of the software could be made to test the packages. A decision on an adequate software package could be made based on the review. Some commercial packages may meet practically all the needs of the DSS.

Many companies package MODFLOW with commercial pre- and post-processing software. These commercial products will be analyzed in this task to determine:

1) If and how these programs are able to use GIS-based inputs;
2) How to format the database for easy use with one or more of these commercial products;
3) How the commercial software could serve within the GUI if it were desired to have models within the Internet-accessible GUI (as opposed to stand-alone models); and
4) Whether the commercial software meets all the GUI/GIS/Internet needs of this project.

These evaluations will be based upon discussions with existing users, as well as through contacts with the software developers/distributors. The software to be evaluated would be identified from known products, trade publications, Internet searches, and references from other users or user groups.

Task 503 - Develop Final GUI/GIS

Once the preferred platform for the GUI/GIS is approved, the software needed will be written and tested. In developing the time requirement for this task, it was assumed that the final package will be about 80 percent commercially developed.

Task 504 - Develop Web-Site

The long-term goal is to develop a DSS system similar to Colorado's where the user could download the database, adjust input and rerun the models to output the new results. For this "initial" DSS, the databases to support such a system will be developed and retrievable on the Web, but for now it is assumed that any analyses will be accomplished external to the databases and the Web. Possible external tools to use with the retrieved data might be other spreadsheet or database programs, ARCVIEW or ARC/INFO, surface analysis programs such as Surfer, or various ground water models.

It is envisioned that the database would be Internet accessible by anyone, but that the format would be such that it can be used best by any technician needing data. Some models are also to be constructed as a part of COHYST, but it is envisioned that these models will not be able to be run directly through the GUI (although the input, output, and possibly the model code might be able to be downloaded). The GUI would be for data retrieval and viewing model output's but not necessarily have the capability to run "what if" scenarios. A groundwater modeler would determine the boundaries for his/her model and go to the Internet site to retrieve the data (such as aquifer layers, transmissivity, well locations, ground water level hydrographs, etc.) for his/her model. The Internet site would not necessarily build or run the model. The user could, however click on some location and view the data and examine the model versus historical ground water levels at any point. Other capabilities will be incorporated as need arises.

Either the database manager or the designated web-master will develop the web site needed to access all prepared data, model output, or other technical information prepared for use or viewing by the public. For purposes of developing the time frame and labor requirements of the web site, it was assumed that the site would be informational only at first, and would not necessarily allow the visitor to run models on line or perform other data- or time-intensive operations.

Under UNIX, the NNRC could set up a login account and workspace for the Database Manager (DM) to store and manage the GIS databases. The DM would have direct read/write access in the project workspace. Other project sponsors, cooperators, or users could develop GIS databases but would only pass them on to the DM for inclusion in the DSS.

Under Windows NT, the DM would not have direct access to the project workspace. A directory could be set up to update the information through FTP.

The information would be made available to the public through the Internet on the World Wide Web through their web browser. GIS databases would be in ARC export format and will be downloaded for use on the local PC. The databases on Windows NT would be searchable and addressable so the user could select data for their area of interest.

Task 505 - Develop "Guides" and Training on Uses of DSS (Ongoing)

Probably one of the most important of all, this task will involve the careful preparation of highly-communicative guides for users. The task products will most likely incorporate flyers, manuals, video tapes, news ads, web-site announcements and samples, technical conferences, civic organization lunch presentations, television "shorts," and other forms of communication.

Task 506 - Develop Public Information and Support System for DSS Users

After completing Task 505, a support system will be developed for sufficient duration that interested users will have access to real people for help with implementation of their visits to the web-site. This can include hot-links, volunteer contacts, site visits, user-group workshops, and "advisor" counseling hours posted on the web-site.

Task 507 - Develop Maintenance Plan for Web-site

This task is similar to Task 316, but the maintenance plan here would be for the Web-site itself. The COHYST project should not be concluded until these maintenance plans are prepared and fully implemented.

Task Series 600 -- Implement Cooperative Hydrology Study Products

The end result of the study is a series of usable products that make up the DSS. The Hydrologic and Geologic Database that is GIS oriented is the main product. The use of this database to develop and calibrate Regional Groundwater Models and to determine data adequacy is another product of the study. The last product of this study is making the database and modeling information available on an Internet Web Site for users of these products. Task Series 300, 400, and 500 will develop these products. Task 600 is to explore and assess how these products can be used to accomplish the purposes identified on page 8 as well as other uses such as updating NRD groundwater management plans, evaluating the use of groundwater storage and its connection with surface water, or doing a groundwater flow investigation of a specific site.

SCHEDULE

The Technical Coordination Committee conducted a workshop on May 7 to develop the final work task list and to assign labor and schedule requirements to the tasks. The resources available to perform the work, comprised mostly of in-kind service from sponsor staff members, were also inventoried. The schedule, labor requirement, and resource inventory were reviewed by the Coordinating Team in several subsequent meetings, and the approved versions of all three are provided in the Appendix.

APPENDIX

Figure.1

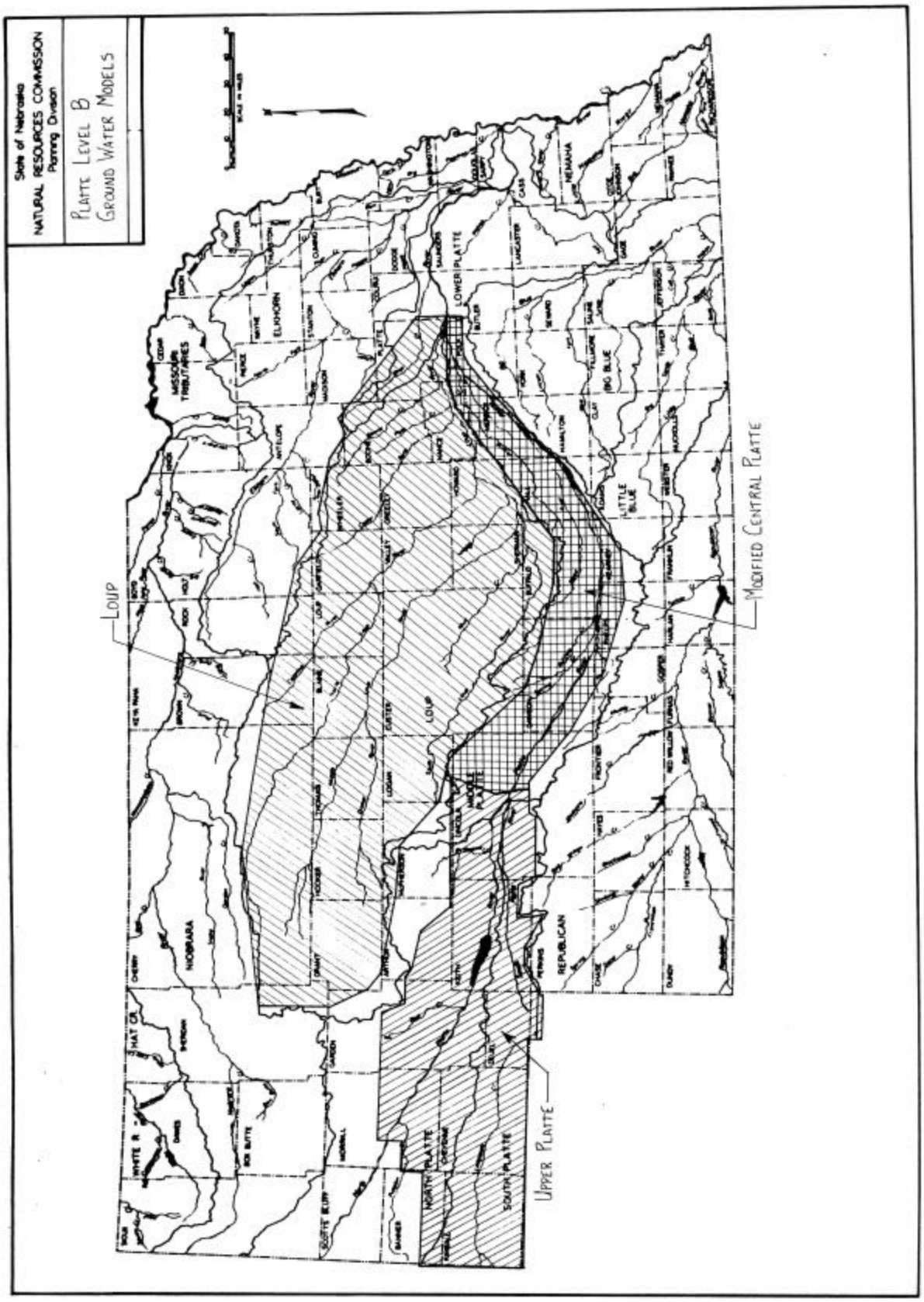

State of Nebraska
NATURAL RESOURCES COMMISSION
Planning Division
PLATTE LEVEL B
GROUND WATER MODELS
LOUP
MODIFIED CENTRAL PLATTE
UPPER PLATTE

Figure 2.

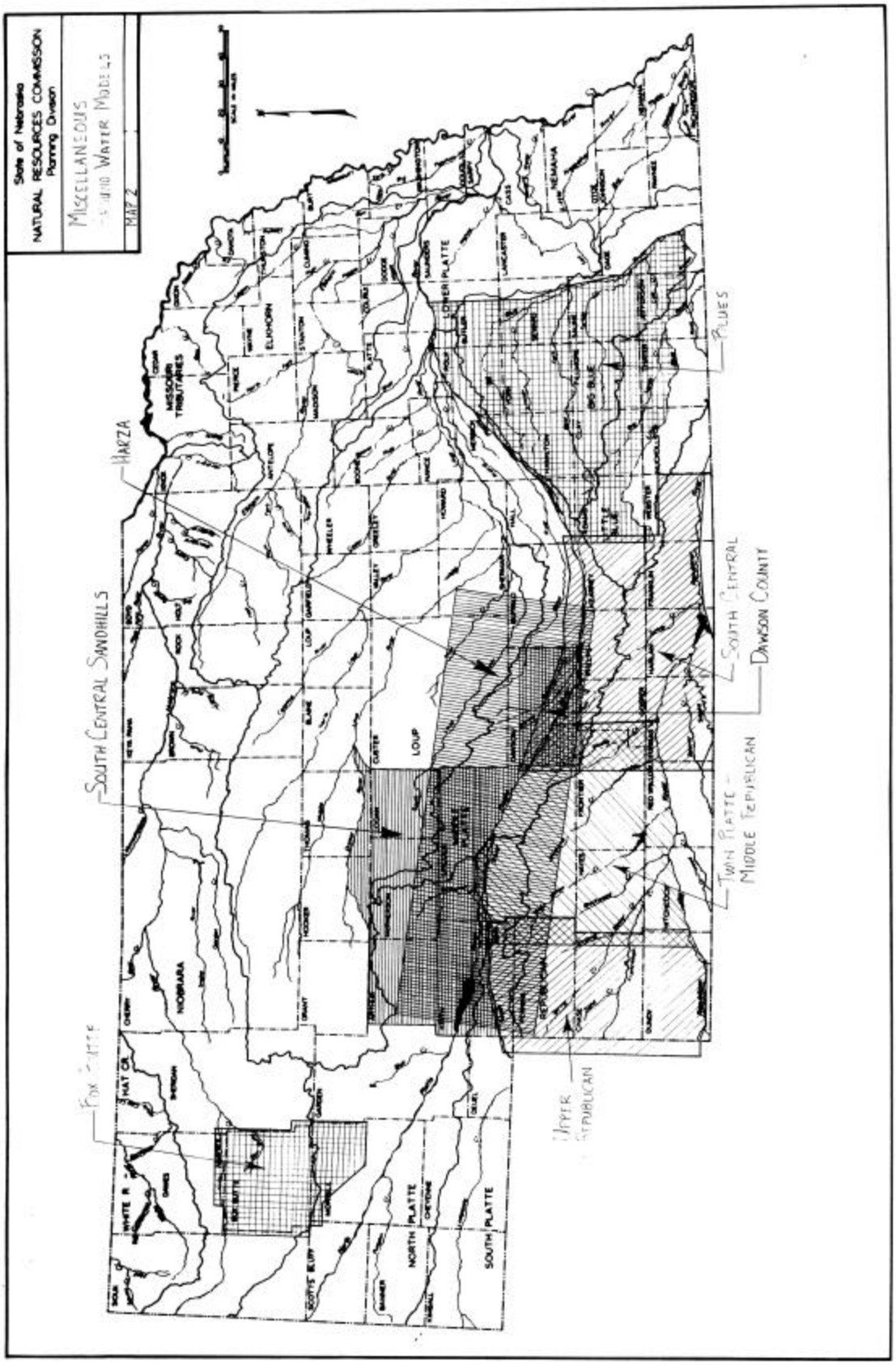

State of Nebraska
NATURAL RESOURCES COMMISSION
Planning Division
MISCELLANEOUS
MAP 2
HASTA
SOUTH CENTRAL SANDHILLS
PLUES
SOUTH CENTRAL
DAWSON COUNTY
TWIN PLATTE -
MIDDLE REPUBLICAN
UPPER
REPUBLICAN
LOUP
NORTH PLATTE
SOUTH PLATTE

Figure3.

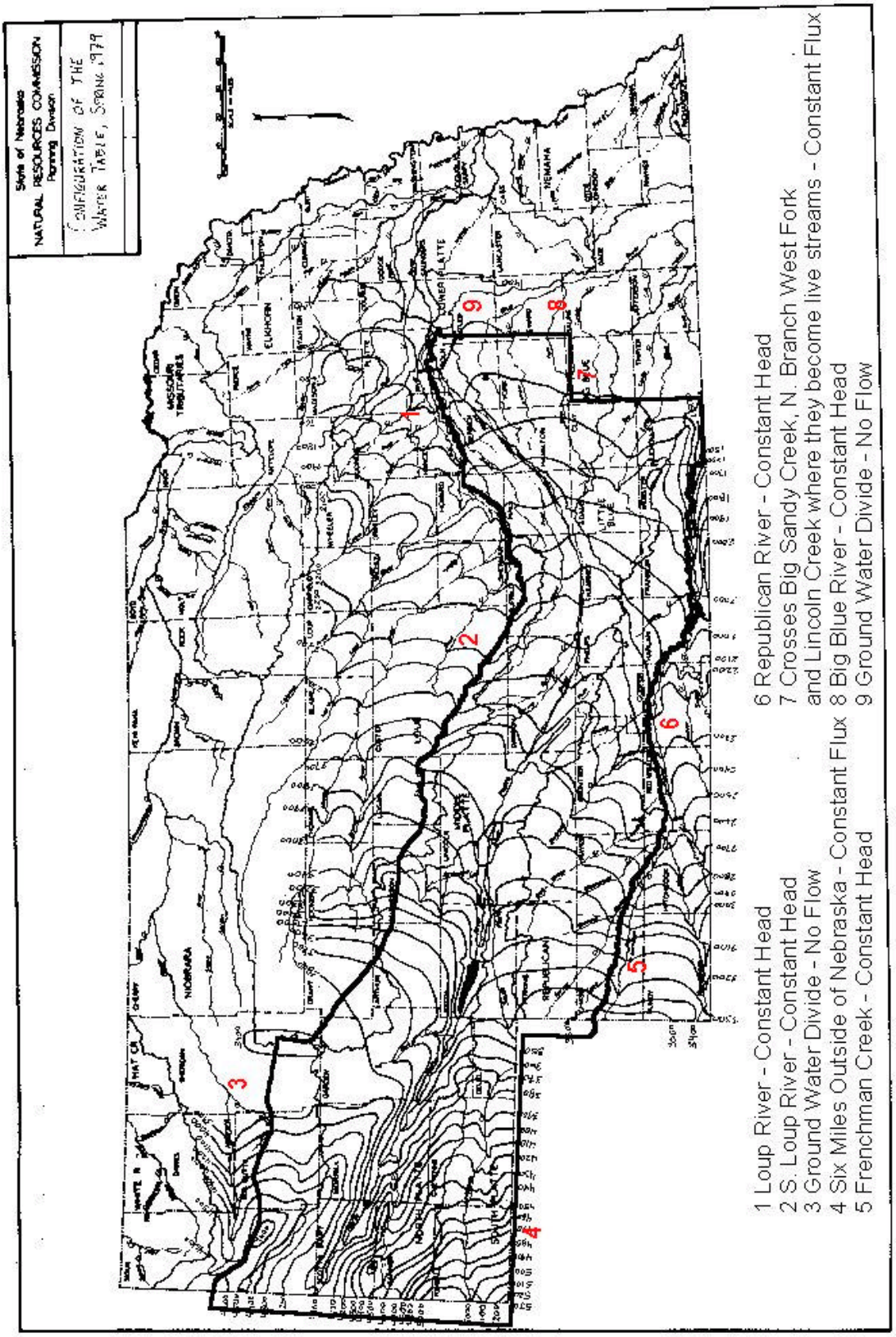

State of Nebraska
NATURAL RESOURCES COMMISSION
Planning Division
CONFIGURATION OF THE
WATER TABLE, SPRING 1979
1 Loup River - Constant Head
2 S. Loup River - Constant Head
3 Ground Water Divide - No Flow
4 Six Miles Outside of Nebraska - Constant Flux
5 Frenchman Creek - Constant Head
6 Republican River - Constant Head
7 Crosses Big Sandy Creek, N. Branch West Fork
and Lincoln Creek where they become live streams - Constant Flux
8 Big Blue River - Constant Head
9 Ground Water Divide - No Flow

Figure4a.

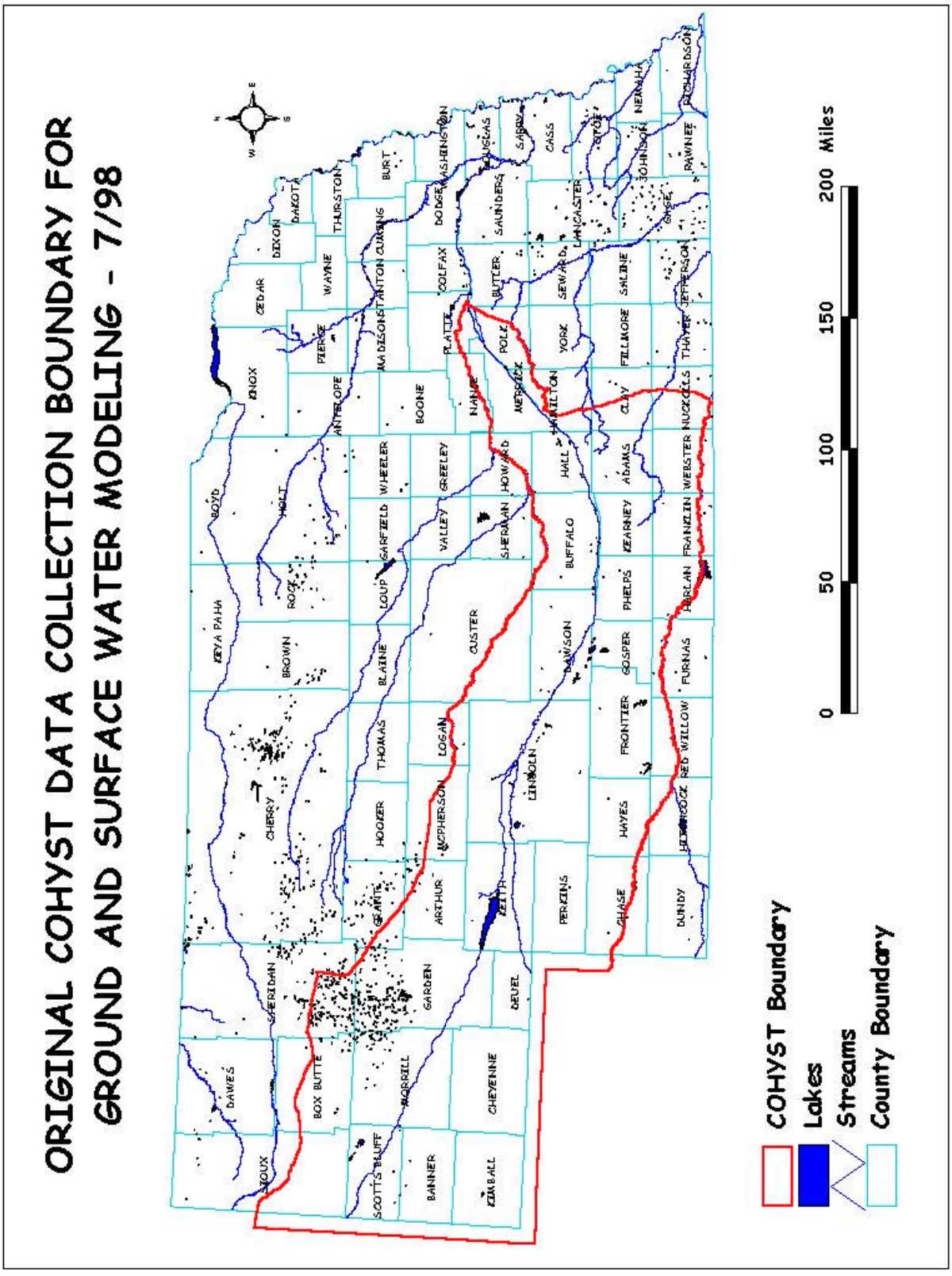
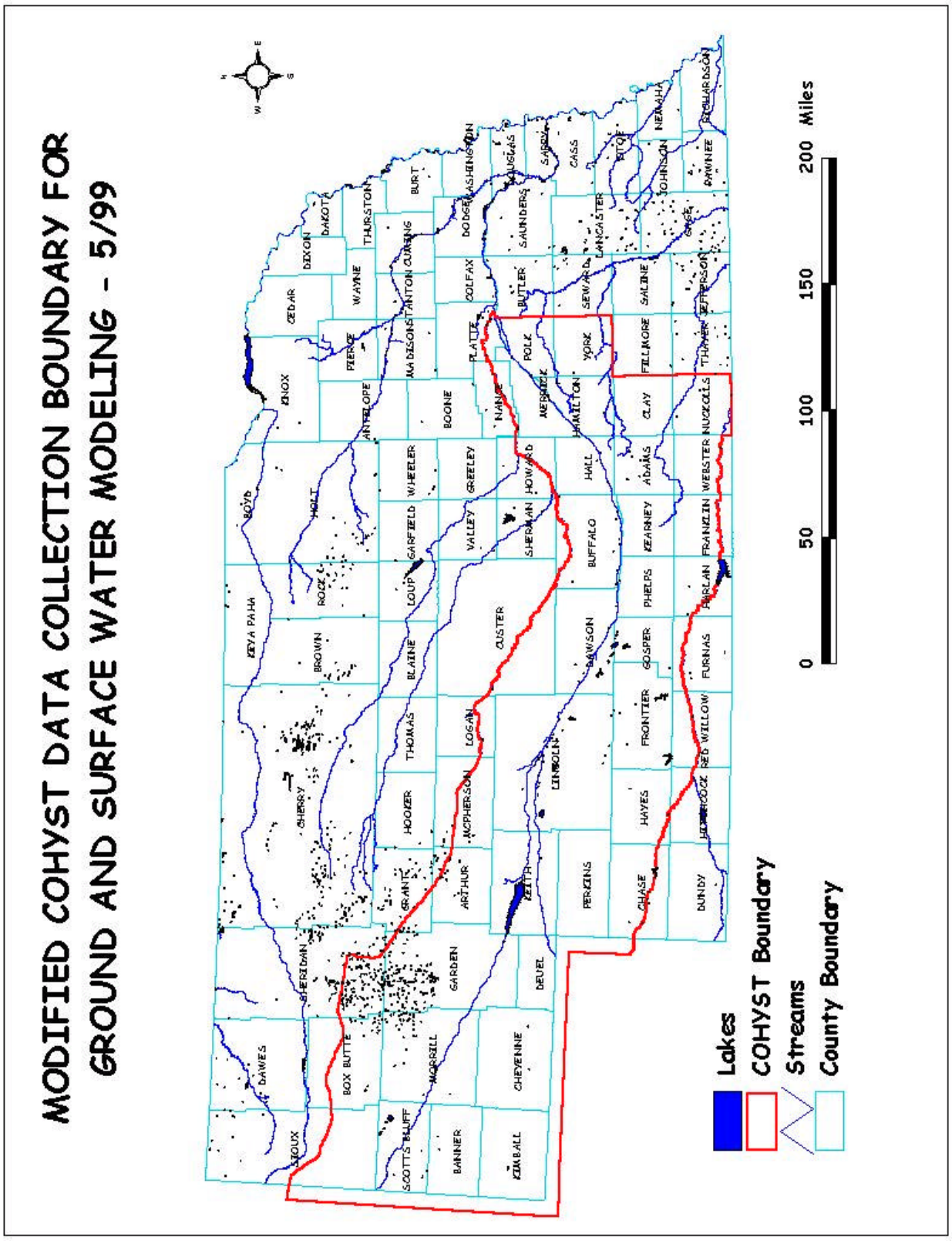
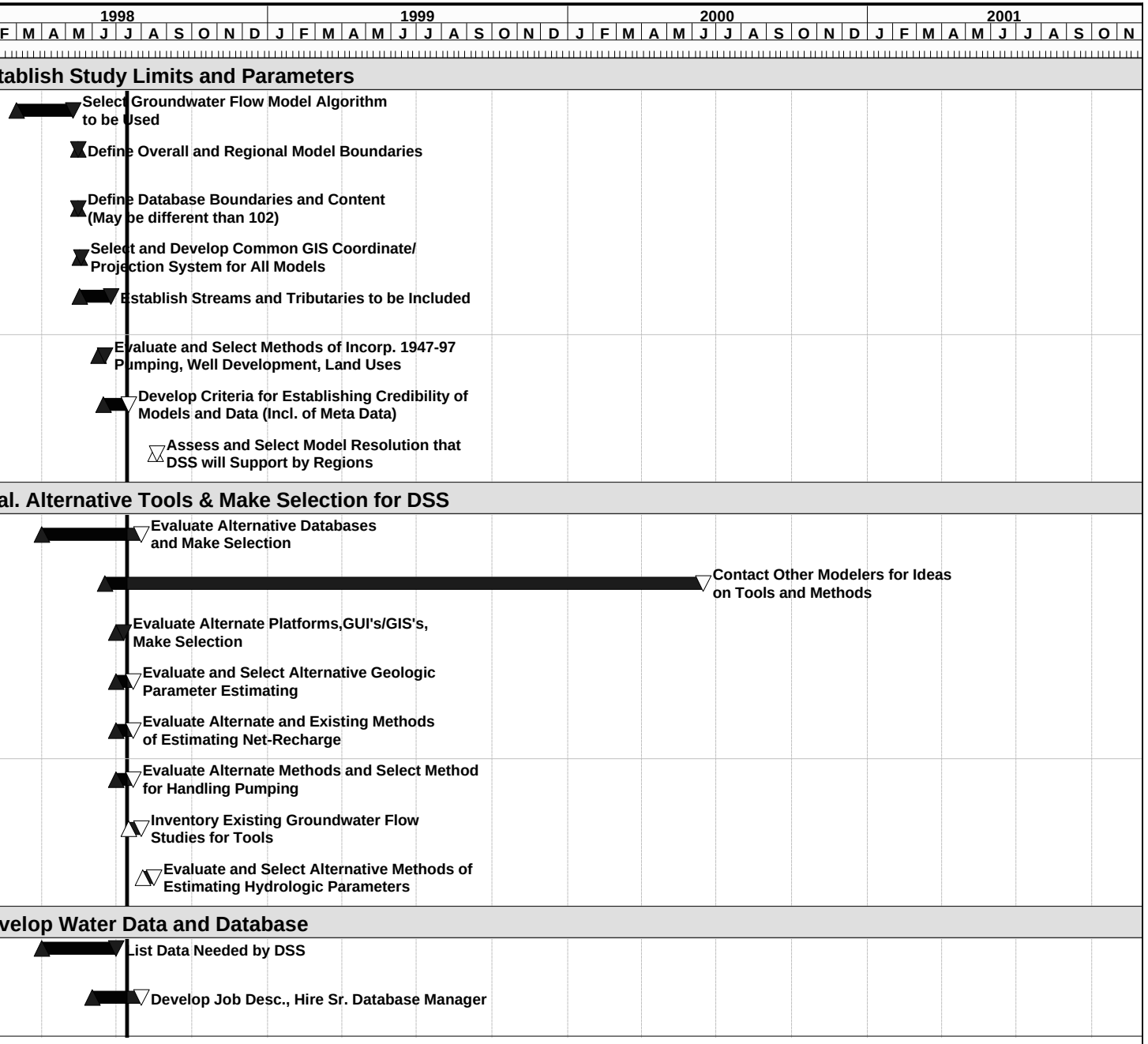

ORIGINAL COHYST DATA COLLECTION BOUNDARY FOR GROUND AND SURFACE WATER MODELING - 7/98
COHYST Boundary
Lakes
Streams
County Boundary
0
50
100
150
200 Miles

Figure4b.


MODIFIED COHYST DATA COLLECTION BOUNDARY FOR
GROUND AND SURFACE WATER MODELING - 5/99
Lakes
COHYST Boundary
Streams
County Boundary
0
50
100
150
200 Miles

Activity ID	Man Weeks	Early Start	Early Finish
100			**Establish Study Limits and Parameters**
101	1	02MAR98A	08MAY98A
102	0.2	15MAY98A	15MAY98A
103	0.2	15MAY98A	15MAY98A
105	1	18MAY98A	19MAY98A
106	1	18MAY98A	24JUN98A
107	1	10JUN98A	16JUN98A
108	2	15JUN98A	15JUL98
104	1	17AUG98*	18AUG98
200			**Eval. Alternative Tools & Make Selection for DSS**
201	1	01APR98A	31JUL98
203	1	17JUN98A	15JUN00
208	1	01JUL98A	10JUL98A
204	1	01JUL98A	20JUL98
206	1	01JUL98A	20JUL98
207	0.6	01JUL98A	20JUL98
202	1	17JUL98*	31JUL98
205	1	03AUG98	14AUG98
300			**Develop Water Data and Database**
301	1	01APR98A	30JUN98A
304	2	01JUN98A	31JUL98



Project Start	01MAR98
Project Finish	02JUL01
Data Date	15JUL98
Run Date	22DEC99

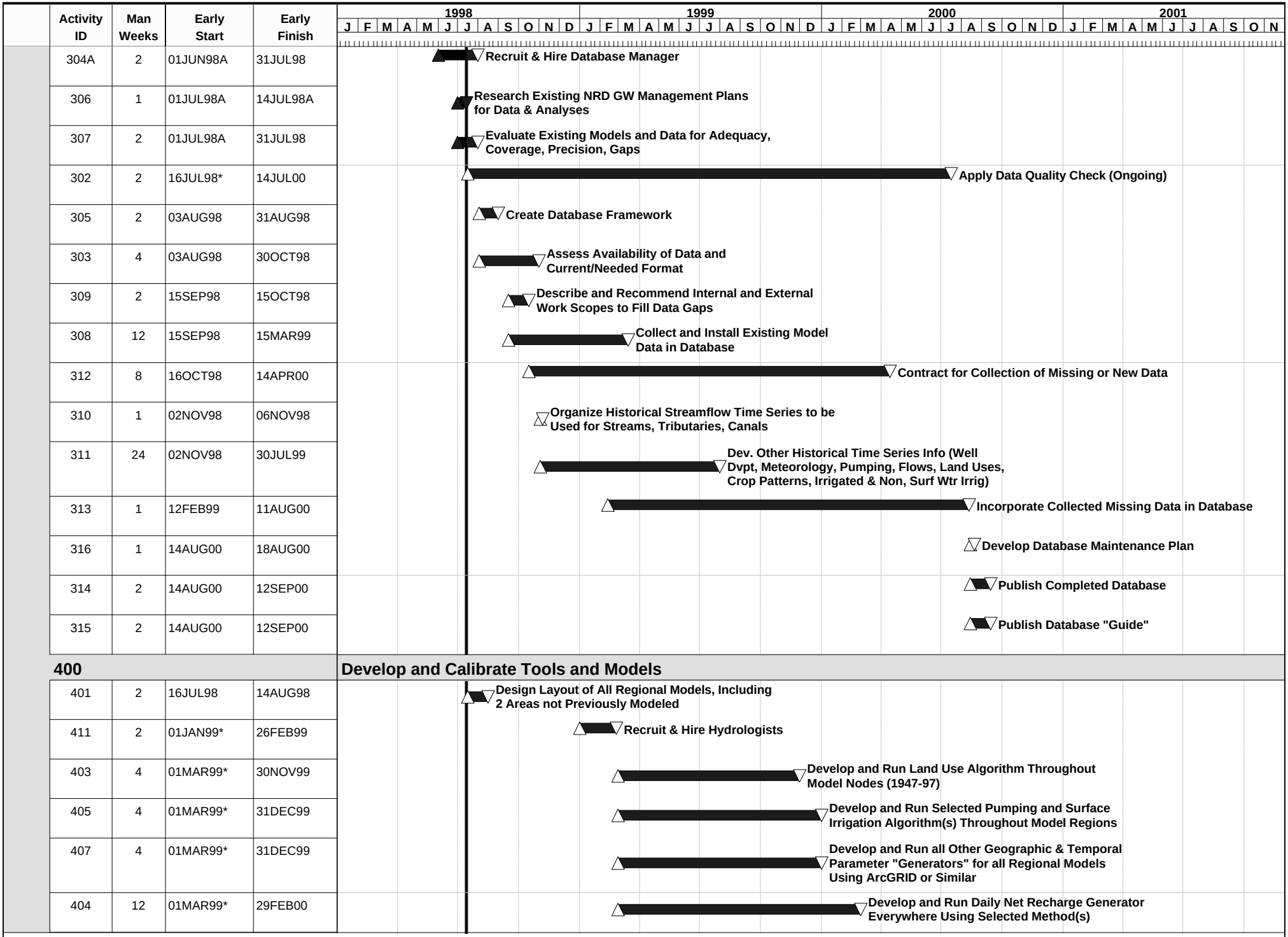
Early Bar
Progress Bar

DSS1

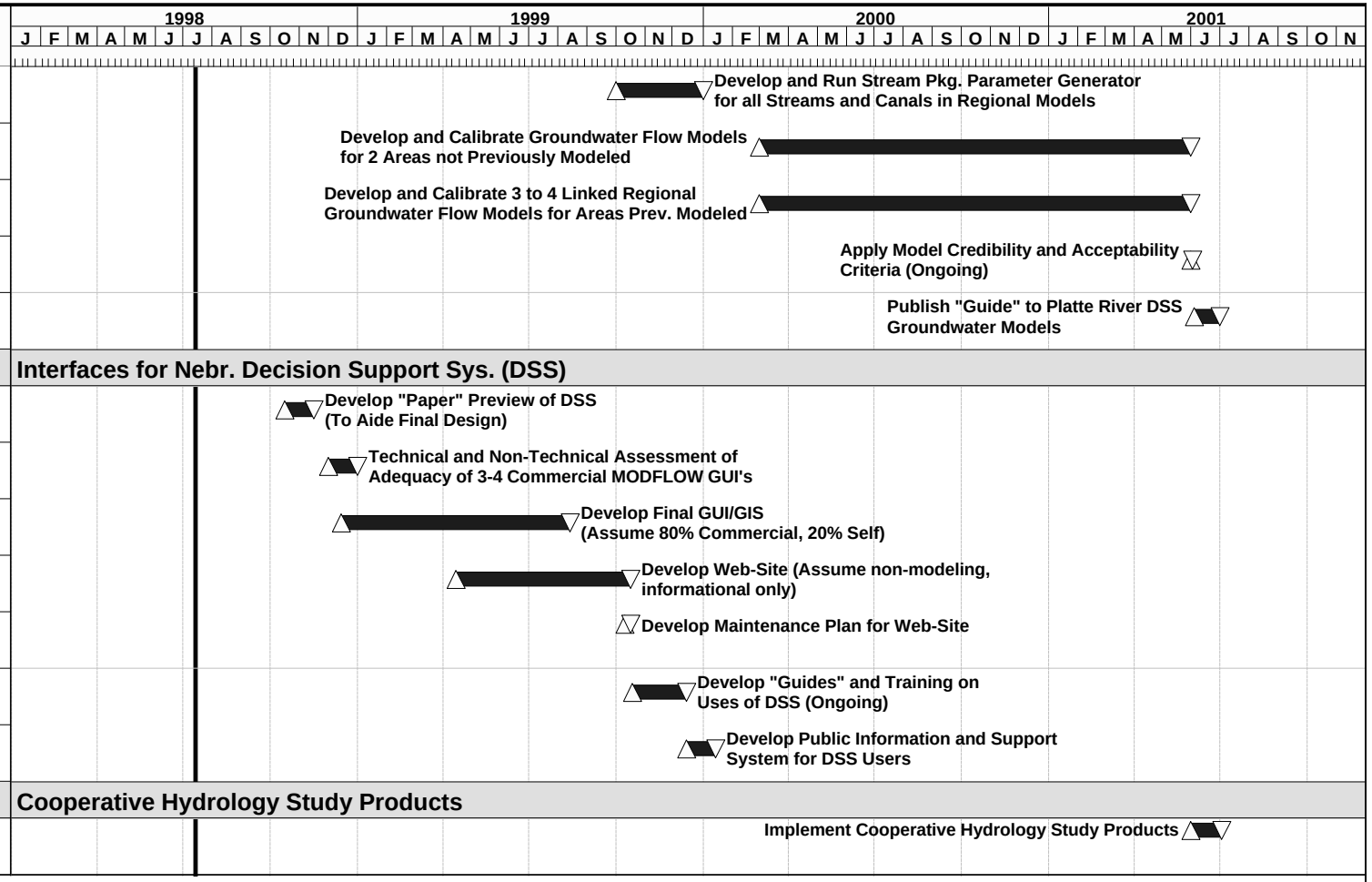
Sheet 1 of 3

Cooperative Hydrology Study
Preliminary Schedule

Primavera PROJECT PLANNER® FOR WINDOWS™


Activity ID
Man Weeks
Early Start
Early Finish
1998
1999
2000
2001
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N
304A 2 01JUN98A 31JUL98 Recruit & Hire Database Manager
306 1 01JUL98A 14JUL98A Research Existing NRD GW Management Plans for Data & Analyses
307 2 01JUL98A 31JUL98 Evaluate Existing Models and Data for Adequacy, Coverage, Precision, Gaps
302 2 16JUL98* 14JUL00 Apply Data Quality Check (Ongoing)
305 2 03AUG98 31AUG98 Create Database Framework
303 4 03AUG98 30OCT98 Assess Availability of Data and Current/Needed Format
309 2 15SEP98 15OCT98 Describe and Recommend Internal and External Work Scopes to Fill Data Gaps
308 12 15SEP98 15MAR99 Collect and Install Existing Model Data in Database
312 8 16OCT98 14APR00 Contract for Collection of Missing or New Data
310 1 02NOV98 06NOV98 Organize Historical Streamflow Time Series to be Used for Streams, Tributaries, Canals
311 24 02NOV98 30JUL99 Dev. Other Historical Time Series Info (Well Dvpt, Meteorology, Pumping, Flows, Land Uses, Crop Patterns, Irrigated & Non, Surf Wtr Irrig)
313 1 12FEB99 11AUG00 Incorporate Collected Missing Data in Database
316 1 14AUG00 18AUG00 Develop Database Maintenance Plan
314 2 14AUG00 12SEP00 Publish Completed Database
315 2 14AUG00 12SEP00 Publish Database "Guide"
400 Develop and Calibrate Tools and Models
401 2 16JUL98 14AUG98 Design Layout of All Regional Models, Including 2 Areas not Previously Modeled
411 2 01JAN99* 26FEB99 Recruit & Hire Hydrologists
403 4 01MAR99* 30NOV99 Develop and Run Land Use Algorithm Throughout Model Nodes (1947-97)
405 4 01MAR99* 31DEC99 Develop and Run Selected Pumping and Surface Irrigation Algorithm(s) Throughout Model Regions
407 4 01MAR99* 31DEC99 Develop and Run all Other Geographic & Temporal Parameter "Generators" for all Regional Models Using ArcGRID or Similar
404 12 01MAR99* 29FEB00 Develop and Run Daily Net Recharge Generator Everywhere Using Selected Method(s)

Activity ID	Man Weeks	Early Start	Early Finish
406	4	01OCT99*	31DEC99
402	96	01MAR00	31MAY01
408	24	01MAR00	31MAY01
409	3	01JUN01	01JUN01
410	4	04JUN01	29JUN01
500			**Interfaces for Nebr. Decision Support Sys. (DSS)**
501	2	16OCT98	16NOV98
502	2	01DEC98	31DEC98
503	8	16DEC98	13AUG99
504	16	15APR99	15OCT99
507	1	11OCT99	15OCT99
505	4	18OCT99	15DEC99
506	4	16DEC99	14JAN00
600			**Cooperative Hydrology Study Products**
601	3	01JUN01*	02JUL01



Job Title: Senior Database Developer/Manager
Field of Work: Hydrology Study of Platte River Basin
Duration: Contract

QUALIFICATIONS

Degree/Major: BS/MS Computer Science or Related Field
Experience: 8 years

Other: Proven experience in GIS (ArcInfo, ArcView, Map Info) and
Database Development
Natural Resource Databases used for Modeling
Familiarity with programming like dBase, AML, Avenue, HTML, JAVA, and Visual Basic
World Wide Web site development and Link establishment
Proven record of Project Management
Knowledge of Water Data a plus
Knowledge in working with Federal, State and Local Gov. and Non Government Organizations (NGO's
Ability to communicate both orally and written

Responsibilities and Duties:

- Train and supervise others in database management
- Provide design, and advise regarding development, and management of multiple databases (tabular and spatial) that can be used to create input data sets for groundwater models.
- Make recommendations on developing GUI's and other customized procedures to incorporate database and model output into interactive GIS and Web browser applications.
- Assist and advise Coordinating Team in developing and publishing database management procedures to assure reliability of data input and updates by multiple technicians.
- Provide strategy for integrating of GIS data and non-spatial data as one database through AML program links.
- Develop and publish database quality control procedures to assure scientific credibility of data sets. Supervise quality control checks on the data.
- Assist and advise Coordinating Team in developing METADATA files for all new data sets to be used in the Hydrology Study.
- Advise and assist Coordinating Team in developing data gathering methods.
- Advise and assist Coordinating Team in groundwater model input development and output application displays.

Interested Persons should contact:

Don Kraus
Central Nebraska Public Power & Irrigation District
P.O. Box 740
Holdrege, NE 68949
(308) 995 8601

or Ron Bishop
Central Platte NRD
215 N. Kaufman Ave.
Grand Island, NE 68803
308-385-6282
cpnrd@nrcdec.nrc.state.ne.us

Job Title: Database Manager
Field of Work: Hydrology Study of Platte River Basin
Duration: 3 years

QUALIFICATIONS

Degree/Major: BS Computer Science or Related Field
Experience: 2 years

Other: Experience with GIS (ArcInfo, ArcView, Map Info) and MS Access 97
Experience with Natural Resource Databases used for Modeling a plus
Knowledge of Water Data a plus
Familiarity with programming like dBase, AML, Avenue, HTML, Visual Basic
Knowledge of Internet Web Site and Links
Proven Record of Project Database experience
Ability to train and supervise others in database operations
Knowledge in working with Federal, State and Local Gov. and Non Government Organizations (NGO's)
Ability to communicate both Orally and Written

Responsibilities and Duties:

- Establish annual budgets, monitor expenditures, supervise technicians, serve with other task managers in accomplishing project goals
- Assist in design, development, and management of multiple databases (tabular and spatial) that can be used to create input data sets for groundwater models.
- Assist in developing GUI's and other customized procedures to incorporate database and model output into interactive GIS and Web browser applications
- Assist in converting outside data for incorporation into new databases. Supervise input of data.
- Assist in developing and publishing database management procedures to assure reliability of data input and updates by multiple technicians.
- Assist in development and supervise quality control procedures to assure scientific credibility of data sets.
- Develop METADATA files for all new data sets, and collect METADATA for all existing data sets, to be used in the Hydrology Study.
- Assist Coordinating Team in developing data collection methods.
- Assist Coordinating Team in groundwater model input development and application.

Interested Persons should contact:

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Task Completion Report
Task 101
Select Groundwater Flow Model Algorithm to be used
07/17/98

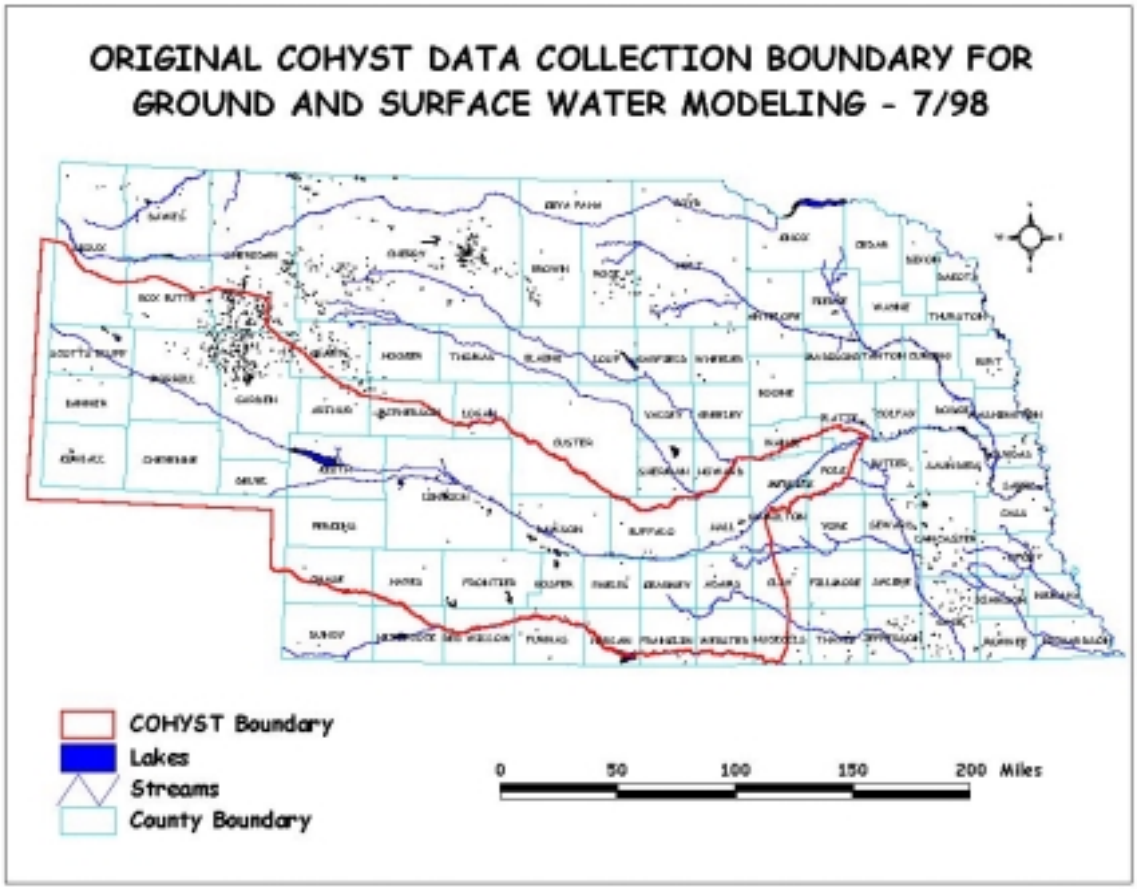
The Technical Coordination Committee (TCC) has selected the MODFLOW algorithm to be used for the groundwater modeling aspects of the Cooperative Hydrology Study (COHYST). MODFLOW is a three-dimensional finite-difference model developed by Michael G McDonald and Arlen W Harbaugh for the United State Geological Survey (USGS) in the 1980's. MODFLOW is widely accepted by water resource experts, has been successfully used in many court cases, and is perhaps the most commonly used groundwater-modeling algorithm available.

Task Completion Report
Task 102
Define Overall and Regional Model Boundaries
07/17/98

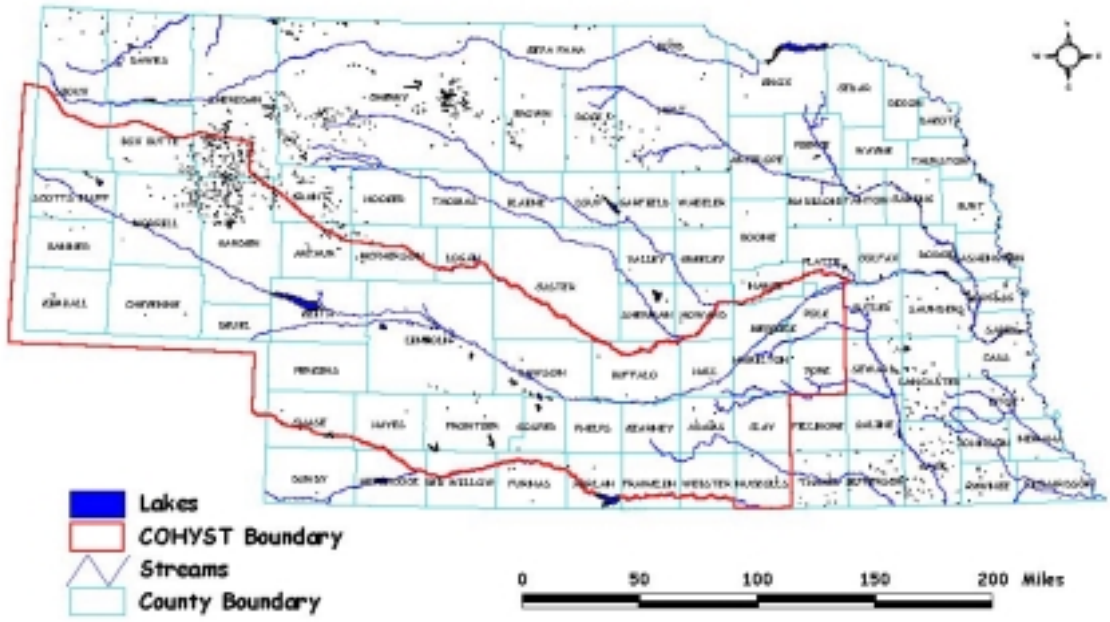
The Technical Coordination Committee (TCC) has selected area outlines on the attached map as the extent of the area to be modeled for the groundwater modeling aspects of the Cooperative Hydrology Study (COHYST). The boundaries of the area are scientifically based, and include constant-head, constant-flux, and no-flow boundaries. Each specific boundary condition is identified on the map by number, and include surface water features and groundwater divides, connected at times by constant-flux boundaries.

The overall area is to be divided into regional areas foor modeling purposes. There will be approximately four regional moodels within the overall area. These model regions can be generally described as coveraing 1) the Morth Platte River and basin in Nebraska, 2) The South Platte River and Basin in Nebraska, 3) The upper Platte River and basin in Nebraska, 4) the central Platte River and basin in Nebraska. The approximate boundaries of the model are shown in the attached map. ***These boundaries are only approximate, and will be left to the individual developing each groundwater model, in consultation with the TCC, to decide the best location for the boundaries.*** Where the regional model extends to the edge of the overall area, then it is expected that the regional model will use the boundaries defined by Task 100. Where two regional models share a common approximate border, the intent is to overlap the models, where possible, to allow for combining results from one model as inputs for another.

These model boundaries were selected by the TCC based upon their understanding of the modeling requirements and their current knowledge of the overall hydrologic system. The TCC recommends that the COHYST retain the ability to modify these boundaries if good reasons exist for doing so.



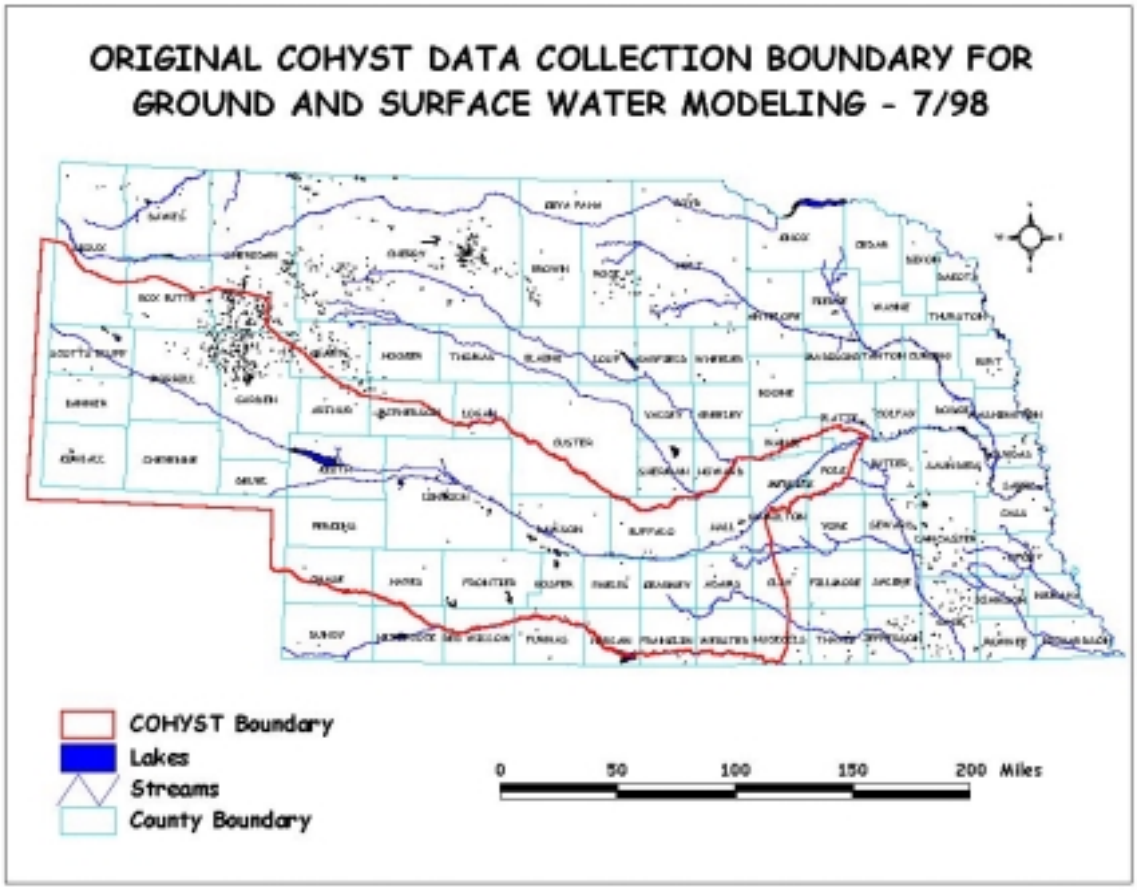
MODIFIED COHYST DATA COLLECTION BOUNDARY FOR GROUND AND SURFACE WATER MODELING - 5/99



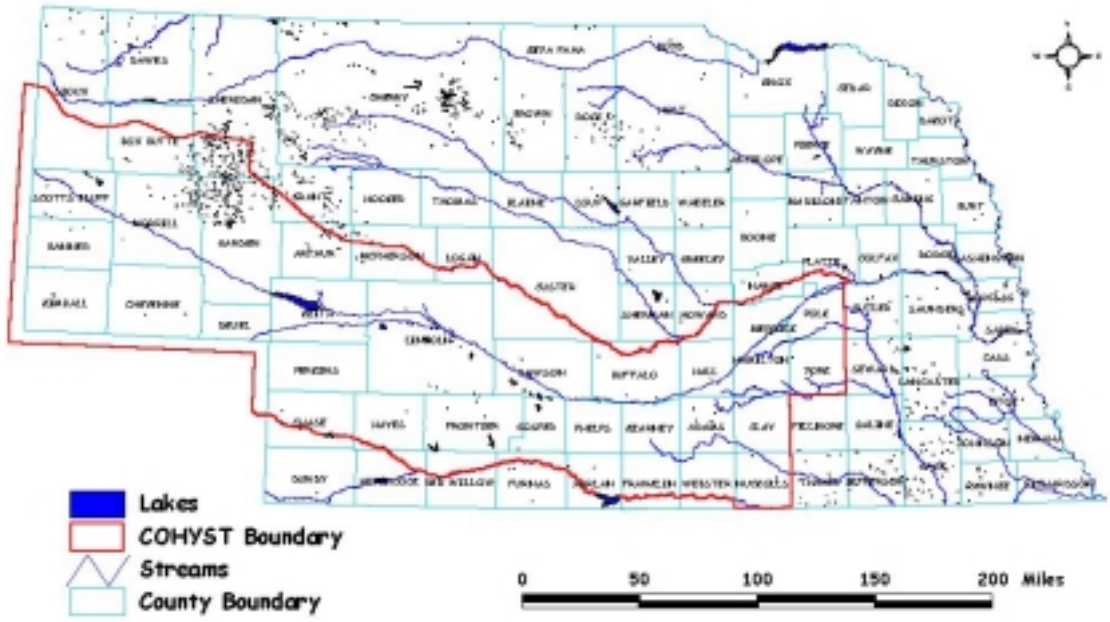
Task Progress Report
Task 103
Define Database Boundaries and Content
07/17/98

The Technical Coordination Committee (TCC) has selected an area outlined on the attached map as the physical extent of the area to be included in the Cooperative Hydrology Study (COHYST) database. The boundaries of the area are scientifically based, and match the boundaries of the overall area to be modeled, which was identified in Task 102. The TCC acknowledges that data collection efforts will not necessarily be uniform throughout the outlined area, but may vary according to existing data availability, distance from the river, importance to the modeling effort, or other considerations.

This database boundary was selected by the TCC based upon their understanding of the modeling requirements and their current knowledge of the overall hydrologic system. The TCC recommends that the COHYST retain the ability to modify this boundary if good reasons exist for doing so.



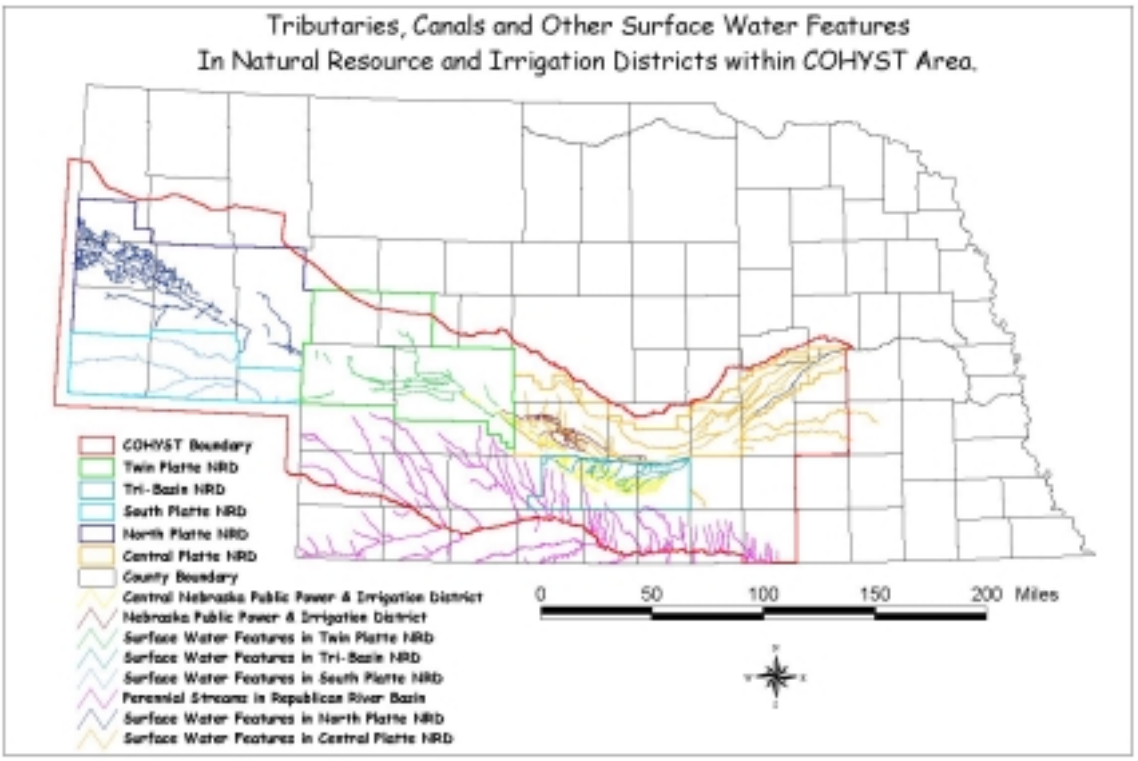
MODIFIED COHYST DATA COLLECTION BOUNDARY FOR GROUND AND SURFACE WATER MODELING - 5/99



Task Completion Report
Task 106
07/98

Task 106 specifies the need to determine which streams, tributaries, irrigation canals, laterals, drains, or other surface water bodies receive groundwater inflow or discharge to groundwater in sufficient amounts and over sufficient duration to warrant inclusion in the stream-aquifer groundwater analyses.

With the cooperation of all COHYST Natural Resources Districts, Central Nebraska Public Power and Irrigation District and Nebraska Public Power District, this task has been completed. The above entities identified the surface water features in their geographic areas, matching the criteria of the task identification on paper maps and sent them to Tri-Basin NRD where these features were compiled into a Geographic Information System (GIS). The compilation of this data into a GIS, is a combination of tasks detailed in the 300 Series of the COHYST Work Plan. Presently, three quarters of the identified surface water features, identified by the COHYST partners, have been compiled into a GIS. Final compilation of all surface water features, identified in Task 106, will take another forty or 50 hours of data input.



Task Progress Report
Task 208
Evaluate Alternate Platforms/GUI's/GIS's, Make Selections

Progress Report on Selecting MODFLOW Interface

The Technical Coordination Committee (TCC) recommends that Visual MODFLOW by Waterloo Hydrogeologic be used as the groundwater modeling software foor the Cooperative Hydrology Study (COHYST). Visual MODFLOW is a pre- and post-processor interface for th MODFLOW algorithm selected in Task 101. Visual MODFLOW was considered along with other commercially available MODFLOW interfaces. Teh selection was also discussed with non-COHYST groundwater professionals (Task 208), and is one of the most used, easiest, and most capable of the commercially available products. Visual MODFLOW can read standard MODFLOW input files, and also can have model inputs in a variety of other formats, including SURFER *.SRF, AutoCAD *.DXF, and ASCII three column format. Visual MODFLOW is easy to use, using windows and pull-down menus, and eliminates much of the hassle of dealing with the original MODFLOW input and output formats. Inputs and results are provided visually, for easy interpretation. Visual MODFLOW contains and runs the MODFLOW algorithm, eliminating the need to exit the program between pre- and post-processing which is inherent to some interfaces. If needed, Visual MODFLOW can provide the user with the appropriate MODFLOW input files for use with the algorithm alone.