Public-Data File 89-19

A Plan for Managing Ground-Water Quality Data in Alaska

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in cooperation with Alaska Department of Environmental Conservation

June 1989

Funding for this report was provided by the Alaska Department of Environmental Conservation through a grant from the U.S. Environmental Protection Agency, Region 10, under section 106 of the Clean Water Act.

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ABSTRACT

Collection of ground-water quality data in Alaska has increased substantially in recent years, creating a demand for efficient methods for managing, storing, and retrieving data. Historic reliance on manual files and recent development and application of diverse types of computer database systems has resulted in difficulty in use of the data by program or project staff and other users. This report presents a plan to computerize ground-water quality data in a cost-effective way according to minimum standards for data completeness. The objective of the plan is to promote industry-wide methods for data collection and storage to improve the usefulness of the data to all present and future users. The plan relies primarily on the National Water Information System (NWIS) of the U.S. Geological Survey (USGS) for hardware and software support with funding from the state under a cooperative program. Statewide data would be entered directly into a Prime minicomputer located at Anchorage. The computer is accessible by a system of modems and telephone lines, or by datasets copied onto paper, diskette, or magnetic tape. Currently, manipulation of the data would be performed via on-line NWIS retrieval capabilities or by user-supplied software. Eventually, data entry and retrieval could be performed anywhere in the state using microcomputers and NWIS-supplied software. Initially and for the long term, the responsibility for verification of data must be shared by the USGS and the source agency for the data. Full interagency participation and discussion is necessary as part of a continuing effort to develop and refine any integrated ground-water data management system.

INTRODUCTION

Ground-water data are collected by a variety of programs within several state, federal, and local agencies in Alaska. These data are collected for many purposes including: compliance monitoring for solid waste landfills, public drinking water systems, wastewater disposal systems and coal mines; investigation of actual or potential ground-water contamination; and baseline ground-water data acquisition. Many of these data are collected for various regulatory programs within the Department of Environmental Conservation (DEC). Also, many data are collected during investigations by the U.S. Geological Survey (USGS), U.S. Army, or U.S. Air Force. With the exception of the USGS, the majority of these data are not stored or generally available for systematic retrieval by agency users or the private sector.

The importance of comprehensive management of ground-water data has recently been recognized at the national level by the U.S. Environmental Protection Agency (1987). U.S. Environmental Protection Agency (EPA) programs typically generate large amounts of data that can not be readily shared with other agencies or programs within EPA. Since many EPA programs in Alaska are delegated to the Alaska Department of Environmental Conservation (ADEC, 1988), the state has become a major collector of water-quality data. Alaska has a well-defined public interest in systematically collecting and managing water data (Alaska Statute 41.08.017(a)):

> Systematic collection, recording, evaluation, and distribution of data on the quantity, location, and quality of water of the state in the ground, on the surface of the ground, or along the coasts, are in the public interest and necessary to the orderly domestic and industrial development of the state.

This report presents an overall plan for managing ground-water data in Alaska. The purposes of the plan are to provide methods to improve the usefulness of data to serve the purposes for which they were originally collected and to make the data useable for other purposes whenever possible. These two functions are highly compatible because of ordinary turnover rates of project or program staff and the requirement for new staff to become familiar with historic data in order to deal with new issues that routinely arise within projects or programs.

Implementation of any statewide ground-water data management system will require the general consensus and cooperation of numerous data gatherers in Alaska. This plan should be considered to be subject to change as the plan is implemented and working knowledge is gained. Agencies affected by suggestions contained in this report should periodically meet to review the suggestions and refine data management practices where appropriate.

A major portion of this report is devoted to developing a conceptual design of a statewide, interagency ground-water quality data management system that will link closely with other existing ground-water databases. This linkage is necessary because: 1) most wells are sources of a variety of types of ground-water data; and 2) an integration of several types of ground-water data are usually necessary to solve ground-water problems or issue permits for several types of facilities.

A ground-water quality data management system is defined as a scheme for collecting data according to core standards of completeness and reliability and for processing data according to criteria for verification, access, retrieval and analysis, within constraints imposed by agency mandates, available funding, and the condition of historic data. The scope of the system includes all historic data, subject to a determination of sufficient completeness and reliability.

ACKNOWLEDGEMENTS

The author thanks Bill Ashton and Douglas Redburn of DEC and Toby Hegdahl of EPA for providing thoughtful reviews of the manuscript and to EPA for approving funding for this project.

REVIEW OF GROUND-WATER DATA MANAGEMENT SYSTEMS

Ground-water data may be classified into eight components. These components may consist of data collected only once at most sites, such as location, altitude, or construction of a well, or may consist of data collected periodically, such as water levels or water-quality data. These eight components are:

1. Site location and use information;
2. Hydrogeologic information;
3. Well construction and development information (including casing, screening, grouting, filter packing, and backfilling information);
4. Periodic and continuous water-level data;
5. Aquifer-test data;
6. Field or laboratory determinations of water-quality parameters;
7. Field or laboratory quality assurance and quality control (QA/QC) information; and
8. Water (including wastewater) extraction or injection information (collectively known as water-use data).

Of these eight types of data, comprehensive computerized data systems currently exist and are routinely used in Alaska for site location and use information, hydrogeologic information, well construction and development information, water-level data, and water-use data. The first three components listed above are commonly referred to as well-log data.

Well-Log, Water-Use, Water-Level, and Aquifer-Test Data Systems

A major source of water data in Alaska is the water rights program of the Alaska Department of Natural Resources (DNR) Division of Land and Water Management (DLWM). Drillers submit well logs directly to DLWM and water users submit well logs with water rights applications. DLWM enters water rights information and cursory well log data into DNR's Land Administration System (LAS). The Division of Geological and Geophysical Surveys (DGGS) within DNR enters water-use data into the LAS and publishes annual summaries. DLWM personnel assign latitudes, longitudes and township, range, section and ¼¼¼¼ section information to water data sites. Well logs are periodically transferred manually from DLWM to DGGS.

DGGS receives most of its well logs from DLWM, drillers, and the Municipality of Anchorage. The well log tracking systems (WELTS) stores cursory information from logs. Well logs are manually filed in numerical order by a unique (up to 5 digit) WELTS index number. The WELTS system is designed to be an intermediate filing system pending comprehensive entry of well log data into the U.S. Geological Survey's Ground-Water Site Inventory (GWSI) system. During water year 1988 (October 1, 1987-September 30, 1988) 860 well logs from the WELTS system were entered into GWSI. The backlog of logs awaiting entry at DGGS on December 31, 1988 was 4,909 logs.

Through the GWSI unit, the USGS checks incoming well logs for duplicates of logs previously in the system, determines and verifies locational information, maintains a location-based manual filing system, and enters virtually all log data into the GWSI. During water-year 1988, the GWSI unit entered 248 logs into the system that were from USGS investigations or other non-DGGS sources in addition to the 860 logs from DGGS (P. Emery, USGS, written commun., 1987; 1988).

Water well or monitoring well logs received by DEC through any of several programs are manually filed in case files, facility files, or archived files at various DEC offices and are not routinely transmitted to DLWM, DGGS, or the USGS. No computerized indexing or tracking system exists for well logs at DEC.

Periodic water-level measurements are made at numerous observation wells in Alaska. Data from most of these wells are stored in the Daily Values file of the USGS with the remainder on file at DGGS. Data from 225 wells monitored during 1984 have been published (Still and Brunett, 1987).

Aquifer-test data are not widely computerized in Alaska. The GWSI system, however, does have the capability of storing a variety of types of information generated from short-term well-yield tests or long-term aquifer tests.

Water-Quality Data Systems

Sources of water-quality data in Alaska were reviewed by Munter (1987) and Maynard (1988) who contacted 39 different data-collecting agencies or programs. Data were found in 228 reports, as well as various computer and manual filing systems. Major sources of data are listed in Table 1. Following is a summary of selected sources of ground-water quality data.

The USGS maintains a database of approximately 1700 sites of ground-water quality data at Anchorage on a Prime minicomputer in a file known as the QWDATA file. The data are periodically updated to the national USGS WATSTORE system at Reston, Virginia, and to the U.S. Environmental Protection Agency's (EPA) STORET system at Research Triangle Park, North Carolina. The USGS has termed its comprehensive centralized nationwide network of well log, water quality, water use, and water level data the National Water Information System (NWIS).

The Drinking Water program of DEC maintains a computerized database (using Revelation software) containing information from 1551 (as of February 1988) public water systems (PWS) using ground water (Maynard, 1988). Locations of points of take for these systems are not computerized. As of December 13, 1988, the STORET system contained water quality data from 673 different stations sampled through the Drinking Water program (Bill Bogue, USEPA, written commun., 1988). These data include an unknown number of treated, surface water, and mixed surface and ground-water samples.

The solid waste program at DEC maintains manual files containing ground-water quality data for approximately 30 solid waste facilities in Alaska. Although these data are not computerized at DEC, data collected by the Municipality of Anchorage (Solid Waste Services) and the USGS (under cooperative programs with facility operators) are computerized.

Table 1. Location of major sources of ground-water quality data in Alaska.

Agency	Program or office	Location(s)	Principle database system(s)[2]
Federal			
US Geological Survey	Water Resources Div. (Alaska Dist.)	Anchorage	NWIS,WATSTORE
US Environmental Protection Agency	Alaska Operations	Anchorage	STORET
US Fish & Wildlife Service	National Wildlife Refuges	Anchorage	STORET
US Department of Defense[1] (Air Force)	Installation Restoration Program	Elmendorf AFB, Anchorage	IRPIMS
State			
Alaska Dept. of Environmental Conservation	Laboratory	Douglas	PCSTORET
"	Oil Pollution Control	Anchorage, Soldotna, Fairbanks, Juneau	NONE
"	Solid Waste	Anchorage, Fairbanks	NONE
"	Public Water Systems	Anchorage, Fairbanks, Juneau	Revelation
"	Wastewater	Anchorage	NONE
"	Underground Storage Tanks	Anchorage, Fairbanks, Juneau	NONE
"	Hazardous Waste	Juneau	NONE
Alaska Dept. of Fish&Game	Fish Hatcheries	various	NONE
Alaska Division of Mining	Surface Mining	Anchorage	NONE
Alaska Div. of Geological & Geophysical Surveys	Water Resources	Eagle River, Fairbanks	NONE
University of Alaska	Water Resource Ctr.	Fairbanks	CONDOR, UofA Comp. Network
Local Governments[1]			
Municipality of Anchorage	Water Quality	Anchorage	Clipper
"	On-site Services	Anchorage	Clipper

[1] Data also available through other listed state or federal programs such as solid waste or public water-supply are not listed here.

[2] See text for explanations for acronyms.

Ambient trend monitoring data are collected by the Municipality of Anchorage (MOA) at 85 shallow wells. Data collected by the USGS at 48 of these wells that were sampled during 1985 and 1986 are stored in the WATSTORE and STORET systems. All monitoring data are anticipated to be stored in an MOA database system currently (December 1988) nearing completion (Marc Little, MOA, oral commun., 1988).

Numerous investigations have been conducted in Alaska at sites of actual or potential ground water contamination. At DEC, only data from the Anchor Point, Sterling, and Peters Creek areas have been computerized. The databases use commercially-available software packages.

Sites of actual or potential ground-water contamination managed by the US Air Force in Alaska utilize the Installation Restoration Program Information Management System (IRPIMS). This database system was developed during 1988 by a contractor for the Air Force and contains ground-water quality data from 1988 field work. The data are not compatible for input into STORET without additional programming (D. Dietzel, USAF/OEHL Brooks AFB, Texas, oral commun., 1988).

A source of ground water quality data not described by Munter (1987) or Maynard (1988) is the Leaking Underground Storage Tank (LUST) program operated by DEC in cooperation with EPA. During 1988, investigations were conducted at 43 sites in Alaska, commonly resulting in the collection of ground-water data (S. Osborn, DEC, oral commun., 1988). These data are not systematically computerized. Also absent from previous inventories is a database developed for ground-water quality data collected in the hills surrounding Fairbanks

(Weber, 1985). This study describes numerous database compilation problems and methodologies potentially applicable to a statewide scale.

Table 2 summarizes the degree to which existing statewide databases include various ground-water data components. The table shows that only the NWIS system operated by the USGS is capable of storing most data types in a thorough manner. Although NWIS stores aquifer test data incompletely, it does a far more thorough job of storing these types of data than any other database. Additional details of the NWIS and STORET databases are discussed in a subsequent section of this report.

Table 2. Summary of existing statewide ground-water databases. Descriptions indicate the degree to which components are included in each database.

T = Thoroughly;
I = Intermittently or Incompletely;
S = Seldom or superficially;
N = Not at all

	GROUND-WATER DATA COMPONENTS							
DATABASE	Site information	Hydrogeologic data	Well construction data	Water level data	Aquifer test data	Water quality parameters	QA/QC	Water use data
LAS (DNR)	T	I	I	N	N	N	N	T
WELTS (DGGS)	I	S	S	N	N	N	N	N
NWIS (USGS)								
GWSI	T	T	T	I	I	I	N	S
QWDATA	T	N	N	N	N	T	T	N
DAILY VALUES	T	N	N	T	N	N	N	N
WATER USE	T	N	N	N	N	N	N	T
STORET (EPA) (including PCSTORET)	I	I	I	N	N	T	T	N
REVELATION (DEC Drinking Water Program)	I	N	N	N	N	I	S	S

A common feature of all ground-water databases discussed in this report is that each one contains some type of site or locational identifier, or both. An understanding of the mechanics of assigning these identifies is critical because: 1) it determines the speed and cost with which data are entered; 2) it determines how data may be retrieved; and 3) it determines how useful the data are to database users.

The WELTS database and most PC-based databases using commercially-available software use arbitrarily-assigned well names or numbers or parcel-based (lot, block and subdivision) locational information. Arbitrarily-assigned identifiers are easily assigned and entered but usually are not very useful for areawide data retrievals because the location of the well is not known without further work. The Revelation Drinking Water database is an example of a database using this type of identifier. Parcel-based locational information is usually fairly easy to enter because it is commonly determined by local governments or DEC field offices for other purposes. Computerized geographic information systems utilizing parcel-based locational data are available.

Disadvantages of using parcel-based locational information for statewide application are that: 1) some subdivisions in different boroughs have the same name; 2) parcel names within a borough can change with time; 3) new subdivisions are constantly being created; 4) parcel names are highly non-uniform in format; 5) well locations within large parcels are vague; 6) multiple wells within a single parcel require separate distinguishing identifiers; and 7) parcel-based base maps can be proprietary.

The LAS and NWIS databases are currently the only ones in which well locations are determined using detailed grid-style map techniques (township-range-section and latitude longitude). This process is relatively laborious and requires some technical training and verification work. By using this method, however, data are easily retrieved using regular or irregular map polygons by any user. Selected data sets can be readily exported to mapping, statistical, or graphics software systems.

Some of the data in the STORET system was copied from the WATSTORE system and contains site identifiers and locational data similar to what is currently contained in the NWIS system. STORET also contains data obtained from the Drinking Water program entered using an arbitrary site identifier and latitude and longitude coordinates that are less precise than the USGS data.

USE OF GROUND-WATER DATA MANAGEMENT SYSTEMS

The key concept underlying a comprehensive ground-water data management system is that it is less expensive and more useful to properly store ground-water data than to search through old and often incomplete records, recollect the data, or make guesses or assumptions about historic conditions that cannot be verified. Without a management system, data can be completely lost or critical auxiliary information such as well location may be lost. Also, data may be archived in obscure locations among volumes of other information, causing effective loss of data for many purposes. Because many sites where ground-water data are collected have regulatory lifespans longer than the tenure of many regulatory staff members, it is particularly important to have information readily available to new staff.

Ready access to data is also important as investigations evolve from an initial assessment stage to area-wide or long-term evaluation stages. For area-wide or long-term evaluations, the process of obtaining and verifying large quantities of data may be prohibitively expensive or only marginally successful.

Common practical applications for ground-water data include aquifer evaluations; facility siting; permitting and permit compliance evaluation; potability determination; spill response, assessment and clean-up; long-term contaminant detection monitoring; responding to public concerns or inquiries; and substantiating enforcement or legal actions.

DESIGN OF AN INTERAGENCY GROUND-WATER QUALITY DATA MANAGEMENT SYSTEM

Criteria

The following criteria were used to develop the conceptual design of a ground-water quality data management system. The system should:

1. Utilize and expand on existing data-handling capabilities wherever possible;
2. Be implementable (at least in selected areas) in a relatively short period of time with modest funding, with a capability for expanding as priorities allow;
3. Ensure that a framework exists for preserving and accessing information that cannot be fully processed immediately;
4. Allow maintenance of permanent and verifiable linkages between computer and manual files that permit easy access to original paper records;
5. Be capable of handling a wide spectrum of ground-water quality data;
6. Be based on minimum standards for data completeness and quality;

7. Be easily accessed by any agency, firm, or the public;
8. Be easily edited and updated by persons directly involved with collecting data;
9. Be subject to appropriate quality assurance procedures;
10. Use, wherever possible, a single unique identification number for each data site; and
11. Allow retrieval in a format suitable for geographic information system (GIS) applications.

Most of the concepts listed above refer to the basic functions of verifying and storing data. Most of these functions are not now occurring on a wide scale in Alaska. Regardless of the structure or type of database ultimately selected, widespread implementation of these functions will require significant increases of effort and cost by some segments of the data collecting, processing, or using community. Selection of an appropriate database and implementation methodologies must be based on maximization of the criteria listed above and minimization of the associated costs.

Review of Database Options

Computer software suitable for using as a ground-water quality database generally falls into two categories: commercially available software such as INFO, Powerbase, dBASE III+, Revelation, RBase, Clipper, CONDOR, or LOTUS 1-2-3, which are purchased and custom-developed to handle whatever data fields the user specifies; or nationally or regionally available software systems that have already been developed.

Commercially available software systems are used in Alaska to manage PWS data, WELTS, two MOA databases, and the Anchor Point, Peters Creek, and Sterling area databases. They are also used for enforcement tracking and project management functions at DEC. Although commercially-available systems are flexible and suitable for local or decentralized applications, they can be complex, expensive and time-consuming to initiate on a statewide scale. Minnesota started planning this type of system more than three years ago and have yet to begin implementation (S. Maeder, Minnesota State Planning Agency, St. Paul, MN, oral commun., 1988).

Primary centralized ground-water data systems are the USGS's NWIS database system and the EPA's STORET system. Although STORET is a centralized database located outside of Alaska, a version capable of operating on a microcomputer (PCSTORET) is in the process of being developed (R. Peterson, EPA, Seattle, WA, oral commun., 1988). PCSTORET provides considerable flexibility for creating a decentralized, data processing network responsive to local needs.

Because STORET does not have parameter fields for handling common well log data elements, Region 10 of EPA (which includes Alaska) has also developed a monitoring well and aquifer characteristics database using dBASE III+ (M. Gubitosa, EPA, written commun., 1988). The database contains many fields from GWSI, along with other non-GWSI fields added by EPA staff. The EPA Region 10 is in the process of entering well log data into the database from up to 6,000 monitoring wells located in Washington, Oregon, and Idaho.

Overview of the STORET System

The STORET system consists of a mainframe computer and support staff located in North Carolina, a Client Services Branch located in Washington D.C., PCSTORET software obtainable from the EPA Region 10 office at Seattle, Washington, a local microcomputer or terminal, a modem and telephone connection, and (optionally) a printer. According to the EPA (Blake-Coleman and Dee, 1987) the agency is recommending the use of the STORET system to manage ground-water quality data because:

- STORET is a well-established system with a proven ability for storing and analyzing environmental monitoring data.
- STORET is widely available, with over 40 states as well as numerous federal agencies, research institutes, local governments, and interstate commissions having direct access to the system. Most users can obtain reports from small portable telecommunication terminals located in their offices.
- STORET is well known by many persons who would be entering ground-water data due to its widespread use in analyzing surface water data. Therefore, any new costs would be related mainly to personnel and software, not to hardware.
- STORET is versatile and has a wide diversity of functions available that will be useful for ground-water data interpretation.
    - STORET has extensive analytical software to aid users in manipulating ground-water data statistically. Specifically, use of STORET will enable you to:
        - Determine short and long term trends in ground-water quality
        - Determine individual facility performance

-- Generalize about hydrological settings, waste treatment, or disposal

- STORET has additional software that enables users to present ground-water data visually via graphics and maps

° STORET routinely loads all water-quality data from the USGS WATSTORE database onto the STORET database. Thus, STORET provides easy access to the USGS water-quality data on one database.

° STORET provides free training and operational aid from EPA's User Assistance Group

For detailed information on data input and retrieval capabilities and methodologies, various manuals are available. One feature of STORET and PCSTORET is that they are not particularly user-friendly, and substantial training is required in order to enter or retrieve data. Some menu-driven software is expected to be available during 1989 (N. Dee, EPA, oral commun., 1988; R. Peterson, EPA, oral commun., 1989).

Overview of the NWIS

During 1987 the USGS decentralized its database from the mainframe Amdahl computer located in Reston, VA, to a nationwide network of Prime minicomputers located at district offices. The Alaska district office's Prime minicomputer is located in Anchorage and is accessible throughout the state via modem and telephone line. Ground-water quality data are entered by project personnel, laboratory staff (in Denver, CO), or a centralized data entry staff in Anchorage. All files are reviewed by the database manager prior to entry into the database. Original water-quality records are manually filed with well logs according to the township, range, section method.

Parameter codes used by NWIS are obtained from the EPA in order to facilitate eventual transfer of data to the STORET system. Also, the USGS assigns unique 15 digit numbers called site ID's to each ground-water data site. The site ID is also used by STORET as a unique site identifier known as the Primary Station Code. Primary characterisitcs of the NWIS are summarized as follows (P.J. Still, USGS, written communication, 1989):

1. NWIS is a well-established system with a proven capability for storage, analysis, and retrieval of water-quality data.
2. NWIS is available in all fifty states, some territories, and is accessible by numerous federal, state, and local agencies, consultants, and the general public. Users may obtain data from telecommunication terminals in their offices or through the many Survey offices located in each state.
3. NWIS is well known by most by federal, state and local agencies, as well as private consultants and the general public involved in water-quality data collection and interpretation activities.
4. NWIS is versatile and has a wide diversity of functions available to use in ground-water quality data interpretation, namely:
   - Water-quality data can be added, modified, or deleted from the database on a real-time basis.
   - Data stored in GWSI, such as well construction, ownership, site usage, water levels, and aquifer descriptions are readily available to the user.
   - Daily water levels are available through the survey's Automated Data Processing System (ADAPS).

- Water-quality data can be retrieved by various formats suitable for inclusion as tables of data for professional reports.
- Water-quality data can be retrieved by individual parameters, groups of parameters, by individual site, multiple sites, by state, by country, by geographic location (polygons based on latitude and longitude), in conjunction with surface-water quality data (streams and lakes), and by hydrologic units.
- Graphic software programs available include:

X,Y plots	Regression plots
Box plots	Flat file output
Stiff diagrams	Summary statistics table
Piper Diagrams	Detection limits table
Time series plots	Statistics plots

A comparison of selected data currently (as of 11/88) stored in the QWDATA file with data stored in STORET revealed several instances where the data did not match. It appears that: 1) modification of site ID's made by the USGS prior to 1988 have not been properly transferred to the EPA; 2) some data were never transferred at all; and 3) some sites contain incorrect county codes. The irregularities are sufficiently numerous that the data currently contained in STORET for Alaska should be considered questionable with regard to completeness and accuracy.

Suggested Minimum Ground-Water Quality Data Elements

In order to justify computerizing ground-water quality data for even the simplest applications, a rudimentary set of data elements is usually collected

(Table 3). In addition to a few other data elements, these form the core of existing databases for the Anchor Point, Sterling, and Peters Creek areas.

The major difficulties with using databases constructed only with rudimentary data elements usually result from inadequate locational information. Table 4, for example, lists locations of sampling sites contained in the database for the Sterling area.

Without personal knowledge of the area, users of the database may not be able to identify sampling locations and use the database for meaningful areawide analyses or responsible environmental permitting or enforcement. Available maps of the area showing sampling locations are incomplete and imprecise. Use of the database in the future could be seriously hampered by changes in property ownership that would make the locational information meaningless.

In order to ensure the useability of data across ground-water related programs, the EPA recently developed a list of 22 minimum data elements (Table 5) that must be collected (EPA, 1988). Subject to the availability of sufficient time and funding, this list is suggested for use in Alaska by all agencies or programs that collect or require the collection of ground-water data. In recognition of time and funding limitations, it is probable that some data will continue to be collected with fewer than these 22 data elements. In order to ensure the preservation of all data for possible use by others, the collection of a core group of data elements is suggested (Table 6). The unifying theme of the core group of data elements is that they should be readily determinable by all ground-water data collecting programs in Alaska.

Table 3. Rudimentary ground-water quality data elements.

Data Element	Data Description
Location	physical description of the well location or site sufficient to allow approximate well site to be found with maps or local inquiries
Source of data	facility owner, data collecting agency, or lab or sample identification
Date sampled	date of sampling
Parameters measured	chemicals for which analyses are made
Concentrations or values	numerical values determined by the parameter measurements, including unit of measure

Table 4. Location codes for data sites listed in the Sterling area database.

Location code	Location	Location code	Location
1	Well # 0	17	Enid Craig residence
2	Well # 1	18	Short Stop Deli
3	Well # 2	19	Ebnet residence
4	Well # 3	20	Hildreth residence
5	Well # 4	21	Johnson residence
6	Well # 5	22	Artesian Sp. at Birch's Hardware
7	Well # 6	23	Pistilli residence
8	Union Chemicals Pit	24	Ellison's rental at Chumley's
9	Sterling Weigh Station	25	Vasilie residence
10	Water Puddle at AEI shop	26	Showalter residence
11	Union's Pond (upper)	27	Gilbertson residence
12	Sterling Elementary School	28	Jensen residence
13	Franzman residence	29	Parrish residence
14	Truck 4	30	Ahlfors residence
15	General Effluent Lead Pond	31	Ellison residence
16	Pedersen residence	32	field or transport blank

Table 5. Proposed minimum set of data elements to ensure useability of data across ground-water related programs (from EPA, 1988).

<u>Latitude</u> - The angular distance north or south from the Earth's equator measured through 90 degrees. The length of a degree varies from 68.074 statute miles at the equator to 69.407 at the poles because of the flattened configuration of the Earth. The length of a second is approximately 100 ft. (USGS)

<u>Longitude</u> - The angular distance, measured in degrees, due east or west from the prime meridian that runs between the north and south poles and passes through Greenwich, England. The length of a degree varies from 69.65 statute miles a the Equator to zero miles at the poles. The length of a second is a little over 100 ft at the equator and about 78 ft at the 40 degree latitudinal parallel which passes through the approximate middle of the United States. (USGS)

<u>Method of Measure for Latitude/Longitude</u> - The method used to determine the latitude/longitude such as surveyed, from a USGS quad sheet, and so forth.

<u>Source Agency for Latitude/Longitude Data</u> - The agency that reported the data.

<u>State Federal Information Processing Standard Code (FIPS)</u> - An established standard that is a two digit number representing the state in which the well or spring is physically located.

<u>County Federal Information Processing Standard Code (FIPS)</u> - An established standard that is a three digit number of the county or county equivalent in which the well or spring is physically located.

<u>Altitude</u> - The altitude of the land surface at the well or spring above or below mean sea level, in feet, National Geodetic Vertical Datum.

<u>Well/Spring and Facility Identification</u> - An identification to be developed for each well or spring, that never changes and is never duplicated. An identification, where applicable, that establishes a tie or linkage between a well or a spring and the facility on which it is located.

<u>Use of well</u> - The principal use of a well or spring or the purpose for which the well was constructed (the former always holds precedence over the latter). (after USGS)

<u>Depth of Well at Completion</u> - The elevation at the completion depth of the well in feet above or below mean sea level (NGVD).

<u>Depth to Top of Open Interval</u> - Depth to the point where the opening begins, in feet below land surface. The first section of the opening always begins at depth 0 (sic). (after USGS)

<u>Depth to Bottom of Open Interval</u> - Depth to the bottom of the open interval, in feet below land surface. (after USGS)

Table 5. (continued)

Location of Well Log - The physical location of the well log, such as the agency name and address where the log is located.

Type of Well Log - Identifies the type of well log: a physical description of the rock cuttings of the different formations penetrated, such as the driller's log; or a continuous recording of the electrical, radioactive, acoustic and/or other properties of the penetrated formations, such as an electric log.

Source Agency for Sample Data - The agency that reported the data.

Sample Date - The date on which the sampling event occurred.

Sample Identification - An identification to be developed to uniquely identify each sample take, it may include several factors, such as sampling purpose, field conditions, field protocol.

Parameter Measured - The specific chemical for which an analysis is made.

Concentration/Value - The numerical value (concentration or quantity) detected by the parameter test (in standard units).

Confidence Factor - An element that can include field and laboratory quality assurance, and other factors that provide the degree of confidence the data source has in the value reported.

Depth to Water - The water level at the well or spring, in feet below land surface. (after USGS)

Measurement Quantification - A method of quantification of a parameter (lab or field methodology).

Table 6. Suggested core group of data elements for ground-water quality data collection in Alaska.

Data element	Description
Sample Source	The source of water at the point of capture (a well, a spring, or surface water, or some mixture of the three) must be known.
Location	Location of the source should be determined to at least the nearest second quarter aliquot portion of a section (40 acres), and to at least the nearest 10 seconds of latitude and longitude. If possible, locations should be determined to at least the nearest fourth order aliquot portion of a section (2.5 acres) and to at least the nearest second of latitude and longitude, and the legal description of the property on which the water source is located should be determined. Sketch maps or narrative descriptions relative to local landmarks can be included.
Method of location determination	The methods used to determine location should be documented. Indicate whether surveyed, or source and scale of map(s).
Owner of well	The owner of the land on which the well is drilled, with any well identifier in common use.
Use of well	The principal use of a well or spring or the purpose for which the well was constructed (the former always holds precedence over the latter). (after USGS)
Source of sample data	The agency or responsible party for data collection, including sample collector's name or initials.
Sample date	Date of sampling.
Parameter measured	A physical or chemical characteristic for which a determination is made.
Analytical method	Method by which a parameter is measured, including field filtering, treating, or storing and preserving methodologies.
Concentration or value	Numerical value determined by the parameter measurement, including units of measure.
Confidence factor	An element that can include field and laboratory quality assurance, and other factors that provide the degree of confidence the data source has in the value reported.
Sample identification number	Unique number assigned to each sample to link field, lab, and database information.

Minimum Standards for Entering Data into Existing Databases

Currently, data entered into WELTS, LAS, NWIS, and STORET are required to meet certain minimum standards. Of these, the least restrictive database is WELTS. Virtually any record relating to ground-water data may be assigned a WELTS index number and entered. Data sites are assigned a status indicator (Table 7) and manually filed in numerical order by WELTS number and status (except status "S" logs, which are filed by the township-range-section method).

Table 7. Summary of WELTS status indicators for ground-water data.

Status	Meaning
S	Data have been Sent to USGS for entry and have returned
U	Data are waiting to be sent to the USGS
G	Data have Gone to the USGS
H	Data are Held at DGGS pending receipt of further well information
X	Data are not suitable for USGS entry
P	Data are temporarily held in a DGGS Project file
V	Data pertain to a Village and lack suitable locational information for entry into GWSI

In order for data to be entered into the water-use data files of the LAS, the water user must be identified, the amount of water and the time period during which it was used must be known, and the location of the source must be known to the nearest second-order aliquot part of a section (40 acres) and the nearest 10 seconds of latitude or longitude.

In order for data to be entered into the Daily Values, GWSI, or QWDATA files of NWIS, header information must first be input. Header information is linked by the computer to the GWSI, QWDATA, and Daily Values data files. Table 8 lists mandatory fields for inputting header information. Although well

Table 8. List of mandatory fields required by the USGS for entering header information into the NWIS.

Field
Latitude
Longitude
Agency Code
State FIPS code
County FIPS code
District Code
Local Number
Site ID
Use of Site
Use of Water
Agency Use
Station Type
Data Reliability
Site Type

locations are assigned fourth-order aliquot locations (2.5 acres), well locations must be known with confidence only to the nearest third-order aliquot portion of a section (10 acres) in order to be entered into the database. In order for automatically-recorded water levels to be included in the Daily Values file, they must be accurate to within ±2% of actual levels as measured from ground surface. In order for data to be entered into the QWDATA file, the contributing agency or lab, analytical method, date of sampling, parameter measured, concentration or value of the parameter, and methods of filtering, treating, storing and preserving the sample must be known.

In order for data to be put into STORET, knowledge of the location of the sampling station must be known to the nearest degree of latitude (one degree of latitude is about 70 miles) and longitude (one degree of longitude is about 34 miles at Anchorage). In addition, the reporting agency, hydrologic unit (obtainable from a USGS hydrologic unit map of Alaska), station type, date sampled, analytical method, parameter measured, and concentration or value of the parameter must be known.

INTEGRATION OF EXISTING GROUND-WATER DATABASES

Existing databases are operated by different agencies generally with different objectives. As a result, it is unrealistic to expect that a single all-purpose database will satisfy all database applications. Rather, data can be collected, analysed and stored using standard techniques to allow sharing of data among agencies. Data may be shared by printouts, floppy diskettes, modem and telephone connections, or hardwire connections.

One of the most useful methods of identifying and using data is through the use of standard locational coordinates such as latitude and longitude. By using a current list of all available ground-water databases an investigator should be able to retrieve all data for any region of interest. Previous sections of this report, Munter (1987), and Maynard (1988) provide descriptions of databases in Alaska and the types of data they include.

A second means of identifying data among different databases is through use of unique well-site identifiers. This method is more useful in some instances because common sites of data collection (water use, well log, and water quality, for example) can be easily identified and closely spaced wells can be easily distinguished. Unfortunately, no single type of site identifier is currently in universal use in Alaska. The two most common types of site identifiers in Alaska are the WELTS index number (about 15,700 sites) and the NWIS site ID (about 15,500 sites). About 10,000 to 11,000 sites have both WELTS and NWIS site identifiers. Substantial numbers of monitoring wells, public water system supply wells, and single family water supply wells have neither type of site identifiers. The NWIS site ID is suggested for use as the primary interagency site identifier in Alaska because locational information as described in Table 6 has not been determined for several thousand WELTS data sites. The primary drawbacks associated with use of the NWIS site ID for this purpose is that assignment of site ID's is a relatively laborious process, considering the statewide volume of data that could potentially be available for site ID assignment. As a practical matter, assignment of site ID's can proceed with relative speed in selected areas of the state where the importance of relating different databases to one another is high.

Development of a Ground-Water Quality Data System

The major functions associated with developing an interagency ground-water database consist of: 1) database software development (programming); and 2) data input and verification. Both STORET and the QWDATA file of the NWIS contain in excess of 3300 parameter fields for nearly every conceivable piece of information related to water-quality data. In addition, GWSI contains about 400 parameter fields for site locational and use, well construction and development, hydrogeologic, and aquifer test information. Both the QWDATA and GWSI systems are modified frequently in order to keep pace with user requirements. The construction of similar databases using commercially-available databases would likely require at least several years of intense work with minimal probabilities of achieving an improved product. For this reason, existing federal software is suggested for use as the primary repository for ground-water data in Alaska.

Database Software

The QWDATA file of the NWIS is suggested for use as the primary ground-water quality database in Alaska. This system is considered superior to the STORET system for most applications for the following reasons:

1) The QWDATA file is closely tied to the GWSI system whereas the STORET system does not adequately handle well and aquifer data. Creation of a database similar to EPA's monitoring well and aquifer characteristics database to use in conjunction with STORET appears to be unnecessarily duplication with GWSI.

2) The QWDATA file currently contains more up-to-date information about USGS data collection sites than does STORET. The existing data in STORET reported to be from the USGS has not been verified.

3) The QWDATA file is managed by experienced Alaskan database managers using established procedures. The STORET system is not widely used in Alaska.

4) The source agency for data entered in the QWDATA file can be designated, as in the STORET system.

5) The USGS in Anchorage is contacted routinely by data users in Alaska, indicating the long-term efficiency of using the USGS for a comprehensive data repository.

6) The USGS maintains an existing location-based manual filing system for ground-water quality records. Use of the STORET system would require creation of a new filing system.

7) The USGS can enter into cooperative programs with any state or local agency, adding federal resources to matching state or local funding and increasing the total size of the data processing effort.

8) The USGS currently has cooperative agreements with numerous agencies that use surface water data, which provides a complementary environment for a ground-water database.

9) STORET should be automatically updated with ground-water data from Alaska through the efforts of the USGS and EPA headquarters offices, making the data available to PCSTORET and STORET users.

10) The NWIS is currently widely accessible via modem and telephone link throughout most of Alaska. Further decentralization of the system to local microcomputer work stations is anticipated. Eventually, most data should be entered into computer files in offices where the original data are generated.

In reality, the quality of data collected by various agencies or private firms may not be up to NWIS standards (e.g. accurate well locations or sample treatment information may not be known). Four options for handling these types of data are:

1) Use the STORET system.

2) Create a separate "cooperators file" within the USGS system. This file would be established with all normal QWDATA parameter fields, but would not be updated to the regular QWDATA database.

3) Use the QWDATA file for data entry but permanently flag the data with an "estimated" designation. This flag denotes the absence of some key piece of information, which could be identified by consulting the manual files.

4) Use commercially-available software and: a) upload data to items 1, 2, or 3 listed above; or b) establish a statewide list of viable ground-water quality databases to direct potential users to database managers.

If data exist for which neither NWIS nor STORET is suitable, yet preservation of information is desired, databases using commonly-available software should be constructed using at least the set of minimum data elements listed in Table

6. Existing databases deficient in parameter fields for one or more of the data elements listed in Table 6 should be revised to include these elements or all ground-water quality data should be transferred to some other database.

Data Input and Verification

The major impediment to implementation of a ground-water quality database is that personnel are not currently available to computerize ground-water quality data. As previously discussed, the function of inputting data can be a significant portion of the cost of implementing a database. Costs can be subdivided into categories for providing training, workspace, supervision, equipment and for actual data entry time. During the first 2000 hours of an employee's time inputting data contained in Tables 6 and 8, it is estimated that 500 hours will be spent in training. Because of this high initial investment in training, it is suggested that data entry tasks be performed by a relatively small number of data entry specialists who are responsible to all projects and programs. Priorities would be established through the funding process. Initially, existing historic or new data would likely be photocopied and sent to USGS offices for entry into NWIS, but eventually data entry should occur where data are collected by using PC-compatible versions of NWIS data-entry software. This system would make effective use of a relatively small number of data management individuals, promote statewide consistency, have a low impact on on-going project or program activities, and allow project or program managers to have primary control and responsibility for the content of databases.

In order to fully utilize NWIS as a comprehensive database, methods for transferring and verifying data from existing computer databases are required.

Logically, this should be accomplished using automated data transferral techniques. This may be impossible, however, because of the diversity of existing databases, the absence of key information in existing databases (e.g., see Table 6 and Table 8), and the requirement for maintaining a system of unique site identifiers in NWIS. Each agency or program with a computer database is encouraged to place a high priority on transferring data to NWIS and confirming the continuing reliability of NWIS data. In order to accomplish this, agency or program staff would be required to expand their databases to include data fields listed in Tables 6 and 8 and exercise appropriate verification of the data or send paper copies of data to DGGS or USGS.

Input of data to the NWIS can be facilitated in Alaska by requiring submittal of a data diskette in a format suitable for NWIS entry as a deliverable for every significant government contract or enforcement action to do ground-water work. This would place primary responsibility for data entry costs with responsible parties and reduce substantial agency costs for data entry. Costs incurred by the private sector to comply with such a clause may be negligible since some contractors already use computer data management systems. The major advantage of such a system would be an industry-wide standard method of reporting ground-water quality data, and over-all efficiency resulting from privatization of the data entry function. Private firms may choose to enter into contractual agreements with DGGS or USGS to provide data entry services.

The state of Washington has selected WATSTORE and STORET for use as a centralized database, and has decentralized data input functions to local governments. The local governments use menu driven software developed by private companies on personal computers to enter data similar to that listed in Tables 6 and 8. The data were intended to be uploaded electronically onto the USGS database, but concerns over data quality have prevented this and caused a re-evaluation of where these data should utlimately reside (M. Blair, Washington Dept. of Ecology, oral commun., 1988).

Quality Assurance and Quality Control

A key feature of the system described in this report is that all sites where ground-water data are collected would have unique identifiers assigned or verified by the USGS. Additionally, the USGS would be responsible for assigning or verifying latitudes and longitudes of sites and checking for duplicate sites. Centralization of the verification functions is essential to ensure data quality. In order to facilitate centralization, efficient routing of information from field offices to the USGS and back is necessary. Methods similar to those currently used by DGGS and USGS to transfer well logs could be used. Transfer of information electronically (via FAX machine or computer files) may be advantageous in the future. No matter what data entry scheme is used, it must be recognized that verification of information contained in the database should be performed both by a database manager and by project or program managers.

As previously noted, PWS data are difficult to use because locations of sources of water are not adequately described. A mechanism for improving this situation is to encourage all PWS owners to file for water rights through education, application assistance, or increased enforcement of Alaska Statute 46.15.180. This statute states that users of significant quantities of water (greater than 500 gallons per day) must obtain a water use permit or be guilty of a class A misdemeanor. Data from water-use permit applications would enter DNR's existing water data management system. Well-log data could be given priority for entry into GWSI, and DEC's water-quality data could be entered into the QWDATA file.

Data Dissemination

The NWIS database is intended to be the primary repository of high-quality water data. Although data can be accessed on a real-time basis by anyone with the necessary communications links with the Prime computer in Anchorage, most user needs are probably best served by data retrievals on printouts, floppy diskettes, or magnetic tapes. Data on diskettes or tapes would be in standard ASCII flat files with field length and type listings. Initially, users would need to provide their own data manipulation software (such as SAS, SPSS, or Autocad) or conduct retrievals using NWIS retrieval software via modem or at the USGS Anchorage office. The USGS will provide customized data retrieval for a nominal fee. NWIS retrieval software is eventually expected to be available in a PC-compatible format. Steps should be taken to ensure the availability of this software to database users in Alaska.

Demonstration Projects

A small-scale demonstration project was conducted to test the viability of using the NWIS system for storing data collected by the state. At the Usibelli Coal Mine near Healy, Alaska, DGGS collected water from 4 wells during 1988. The water analyses were done at the DGGS laboratory in Fairbanks. Well logs were entered into GWSI and the water quality data were entered into the QWDATA file. A sample printout of the data is given in Table 9. Other printout formats could have been obtained. The most time-consuming

Table 9. Sample ground-water quality data retrieval from NWIS.

GROUND-WATER QUALITY DATA

USIBELLI MINE AREA

STATION NUMBER	LOCAL IDENT- I- FIER		DATE	TIME	AGENCY COL- LECTING SAMPLE (CODE NUMBER) (00027)	AGENCY ANA- LYZING SAMPLE (CODE NUMBER) (00028)	TEMPER- ATURE WATER (DEG C) (00010)	SPE- CIFIC CON- DUCT- ANCE (US/CM) (00095)	PH (STAND- ARD UNITS) (00400)
635351148552702	FC01200704DCDA1	002	07-20-88	1605	1/ 9702	9702	4.0	3320	6.70
635427148544201	FC01200703BBDC1	001	05-24-88	1650	9702	9702	2.5	1560	6.40
			07-18-88	1450	9702	9702	4.0	1540	6.70
			09-07-88	1415	9702	9702	1.5	1640	6.00
635427148553401	FC01200704ABDD1	003	05-25-88	1000	9702	9702	1.0	415	6.70
			07-18-88	1700	9702	9702	2.0	504	7.00
			09-07-88	1650	9702	9702	2.0	445	6.40
635419148565701	FC01200705ADAD1	001	05-25-88	1710	9702	9702	5.0	4010	6.30
			07-19-88	1200	9702	9702	3.5	7840	6.20
			09-08-88	1000	9702	9702	2.5	6900	6.40

STATION NUMBER	DATE	ALKA- LINITY WAT WH TOT IT FIELD MG/L AS CACO3 (00419)	ACIDITY (MG/L AS CACO3) (00435)	HARD- NESS TOTAL (MG/L AS CACO3) (00900)	CALCIUM DIS- SOLVED (MG/L AS CA) (00915)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG) (00925)	SODIUM, DIS- SOLVED (MG/L AS NA) (00930)	SODIUM AD- SORP- TION RATIO (00931)	SODIUM PERCENT (00932)	POTAS- SIUM, DIS- SOLVED (MG/L AS K) (00935)
635351148552702	07-20-88	1720	71	360	52	57	660	15	76	64
635427148544201	05-24-88	352	67	310	65	36	160	4	52	19
	07-18-88	356	147	220	56	19	190	6	64	20
	09-07-88	360	278	210	46	22	190	6	63	28
635427148553401	05-25-88	166	32	130	36	9.1	5.6	0.2	6	45
	07-18-88	232	56	160	43	13	8.6	0.3	8	48
	09-07-88	205	83	120	31	9.5	6.7	0.3	7	56
635419148565701	05-25-88	478	129	1000	190	130	790	11	62	10
	07-19-88	666	224	1500	280	190	890	10	56	16
	09-08-88	650	302	1000	250	90	960	14	67	11

STATION NUMBER	DATE	CHLO- RIDE, DIS- SOLVED (MG/L AS CL) (00940)	SULFATE DIS- SOLVED (MG/L AS SO4) (00945)	FLUO- RIDE, DIS- SOLVED (MG/L AS F) (00950)	SILICA, DIS- SOLVED (MG/L AS SIO2) (00955)	ARSENIC DIS- SOLVED (UG/L AS AS) (01000)	BARIUM, DIS- SOLVED (UG/L AS BA) (01005)	BERYL- LIUM, DIS- SOLVED (UG/L AS BE) (01010)	BORON, DIS- SOLVED (UG/L AS B) (01020)	CADMIUM DIS- SOLVED (UG/L AS CD) (01025)
635351148552702	07-20-88	170	24	0.60	6.8	<4	240	<1000	<10	<1
635427148544201	05-24-88	250	85	0.80	9.0	<4	400	<1000	1700	<1
	07-18-88	240	72	0.80	5.3	4	400	<1000	1500	<1
	09-07-88	200	87	0.80	7.9	<4	240	<1000	2800	2
635427148553401	05-25-88	3.8	21	1.0	9.3	9	420	<1000	450	17
	07-18-88	3.8	22	1.4	11	<4	360	<1000	500	<1
	09-07-88	3.5	26	1.2	8.6	20	140	<1000	290	40
635419148565701	05-25-88	1600	62	4.4	10	10	1400	<1000	1500	<1
	07-19-88	1700	72	6.2	12	5	1100	<1000	1400	<1
	09-08-88	1700	63	6.1	10	10	1300	<1000	2900	5

1/ ALASKA

Table 9. (Continued)

GROUND-WATER QUALITY DATA

USIBELLI MINE AREA--Continued

STATION NUMBER	DATE	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COBALT, DIS-SOLVED (UG/L AS CO) (01035)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MOLYB-DENUM, DIS-SOLVED (UG/L AS MO) (01060)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)	ALUM-INUM, DIS-SOLVED (UG/L AS AL) (01106)
635351148552702	07-20-88	2	20	<10	350	50	120	32	<20	300
635427148544201	05-24-88	4	30	130	47000	110	1200	26	210	300
	07-18-88	3	40	150	43000	110	1200	40	230	300
	09-07-88	3	40	<10	36000	110	1300	28	100	300
635427148553401	05-25-88	<1	6	10	13000	<30	660	12	<20	200
	07-18-88	<1	<1	20	12000	<30	760	17	<20	200
	09-07-88	<1	2	610	7700	<30	580	10	<20	200
635419148565701	05-25-88	4	410	130	58000	180	11000	140	300	300
	07-19-88	5	270	20	59000	170	7300	120	340	200
	09-08-88	1	340	<10	43000	210	8300	110	200	300

STATION NUMBER	DATE	ALKA-LINITY WAT.WH. GRAN T. FIELD CACO3 (MG/L) (29813)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS NO3) (71851)	PHOS-PHORUS, DIS-SOLVED (MG/L AS PO4) (71886)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE NGVD) (72000)	DEPTH OF WELL, TOTAL (FEET) (72008)
635351148552702	07-20-88	1700	1040	0.0	1.41	<0.20	5.4	1850	361.50
635427148544201	05-24-88	350	631	0.0	0.85	<0.20	<0.05	1300	33.00
	07-18-88	350	617	0.0	0.83	<0.20	<0.05	1300	33.00
	09-07-88	370	585	0.0	0.79	<0.20	<0.05	1300	33.00
635427148553401	05-25-88	190	133	0.0	0.18	0.06	<0.05	1350	28.80
	07-18-88	230	153	0.0	0.21	0.01	<0.05	1350	28.80
	09-07-88	200	145	0.0	0.19	<0.20	<0.05	1350	28.80
635419148565701	05-25-88	450	2790	0.0	3.77	<0.20	<0.05	1300	85.00
	07-19-88	640	3220	0.0	4.36	<0.20	<0.05	1300	85.00
	09-08-88	640	3080	0.0	4.17	<0.20	<0.05	1300	85.00

task associated with entering the data was the identification of specific laboratory methodologies used for each analysis. These identifications were required so that proper parameter codes could be assigned. This allows users of the data to refer to definitions for parameter codes for each data element and understand how the data were obtained. NWIS was found to perform satisfactorily for the small-scale demonstration project.

The next step for evaluating NWIS is suggested to be a large-scale demonstration project. Such a project should be divided into three phases:

Phase I Establish a QW unit at USGS that is capable of entering and verifying ground-water quality data at a rate of 30 to 100 analyses per month, including associated GWSI data;

Phase II Select a geographic project area and assemble, review and evaluate available historic data for entry into NWIS. Forward data to the USGS that meets minimum criteria for completeness and reliability, such as is listed in Tables 6 and 8;

Phase III Establish standard information collection and routing procedures for all new data that becomes available in the project area so that these data may be computerized or additional information can be collected to allow computerization.

Phase IV Using a relatively complete suite of water-quality and well-log data for an area, produce graphical, statistical, map, or cross-sectional products for use by environmental decision makers. Close cooperation with decision makers is required at the onset of the demonstration project to ensure development of useful products. Phase IV could entail the use of commercially-available software such as SAS, SPSS, or Autocad, or application of existing NWIS data-retrieval software, or both.

SUMMARY AND CONCLUSIONS

A review of current ground-water data management in Alaska reveals the lack of any systematic, statewide, interagency method of dealing with ground-water quality data. The development of a ground-water quality database system consists of two primary components: 1) determining data storage locations and techniques; and 2) determining data retrieval and dissemination techniques. Data storage on a state-wide scale has traditionally been a centralized function using a large computer that has resulted in cumbersome methodologies for retrieving data. Conversely, data storage and retrieval on a project-by-project basis in recent years has been rapid, flexible and responsive to local needs, but has prevented data from being easily and thoroughly accessed by new or different users. Current advancements in decentralizing key functions of the NWIS databases promises to maintain the quality, thoroughness, and breadth of a central repository of information, and yet provide quickness, flexibility and responsiveness for local applications. No matter what database is used, costs will be incurred for establishing trained and equipped data entry and supervisory personnel, for inputting and verifying data, and for developing data retrieval and dissemination techniques and procedures. Because of extensive development of the NWIS system and its widespread use in Alaska for well-log and surface-water data, it is probably the lowest cost alternative for use as a ground-water quality database.

The NWIS system as it is envisioned to function 2-3 years hence is expected to meet the list of 11 criteria presented earlier in this report more readily than systems relying on STORET or commercially-available software packages.

For situations in which other databases are used, the suggested core group of data elements (Table 6) should be entered. Data from these databases may subsequently be transferred to the NWIS system.

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