UNIVERSITY OF MINNESOTA

MINNESOTA GEOLOGICAL SURVEY
Harvey Thorleifson, Director

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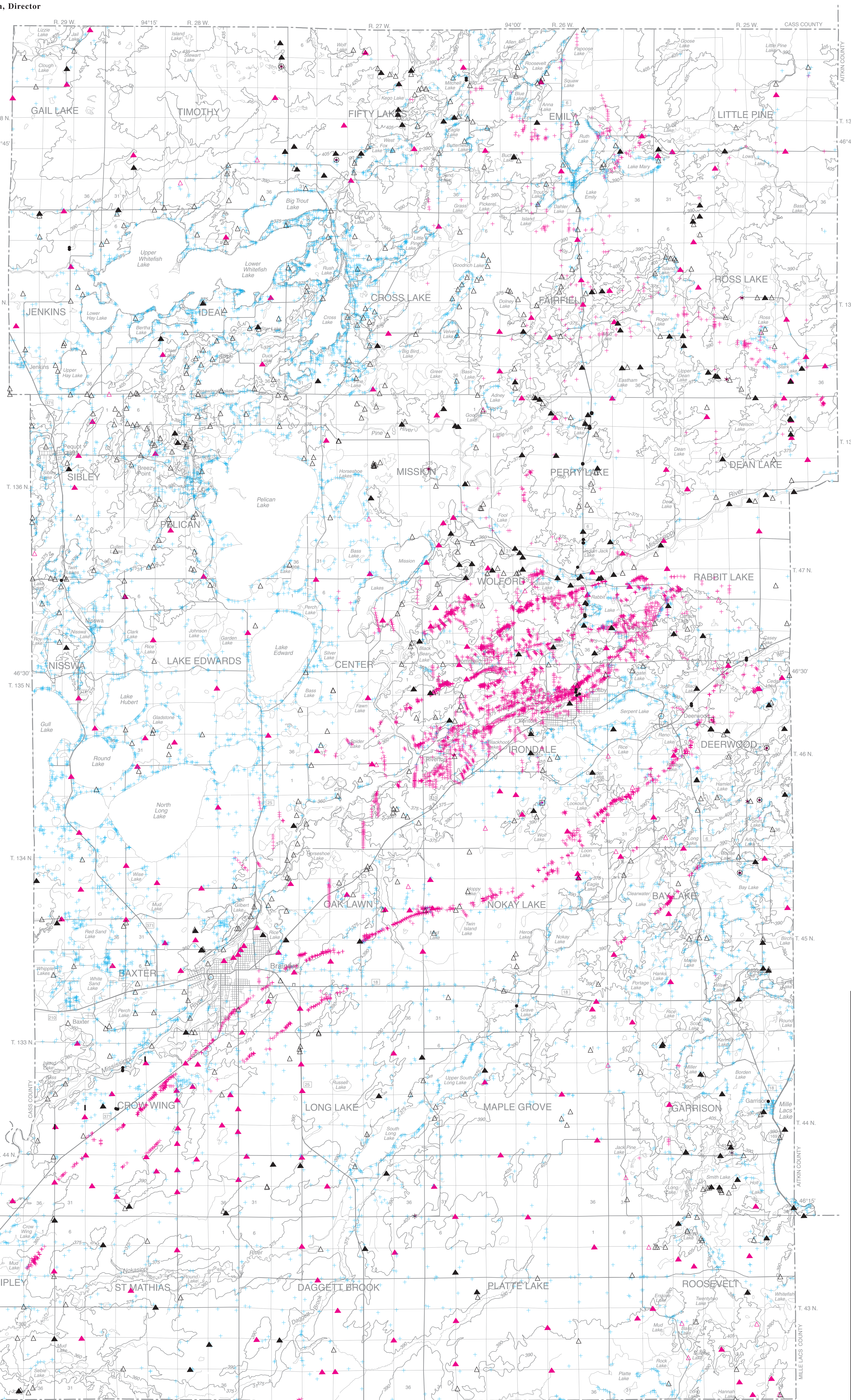
COUNTY ATLAS SERIES
ATLAS C-16, PART A
Plate 1—Data Base

DATA-BASE MAP

By

Emily J. Bauer

2004



Digital base modified from the Minnesota Department of Transportation BaseMap data; digital base annotation by the Minnesota Geological Survey.

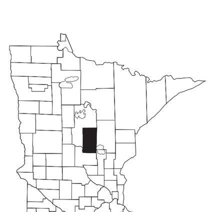
Elevation contours were derived from the U.S. Geological Survey 30-meter Digital Elevation Model (DEM) by the Minnesota Geological Survey.

Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

SCALE 1:100 000

CONTOUR INTERVAL 15 METERS

GIS compilation by Emily Bauer
Edited by Lori Robinson



LOCATION DIAGRAM

THE DATA-BASE MAP

The types, locations, and density of information used to prepare the Crow Wing County atlas are shown on this map. The data are described below to aid the user in assessing what types may be useful for a particular information need. The Data-Base Map serves as a guide to the precision of the other maps in the atlas. It shows where data are sparse or lacking and interpretation and extrapolation were required to prepare the maps.

DRILL-HOLE INFORMATION

A **record of water-well construction (well driller's log)** is a water-well contractor's description of the geologic materials penetrated during drilling and the construction materials used to complete the well. Not all wells extend to bedrock. In areas of thick, unconsolidated Quaternary deposits such as Crow Wing County, drillers usually do not need to drill through the entire thickness of overburden to find sufficient ground water. Hydrologic data, such as the static water level and test-pumping results, are commonly included. Before any driller's log can be used, the location of the well must be verified, and a geologist must interpret the log. Driller's logs are the primary source of subsurface geologic and hydrologic data for Crow Wing County; about 8,100 logs were used for this atlas.

An **exploratory boring (exploration hole)** is an explorationist's description of the geologic materials penetrated during mineral exploration. Exploratory work may include the collection of core samples of the bedrock encountered for descriptive and analytical purposes. In Minnesota, such core is eventually transferred to the Minnesota Department of Natural Resources, Division of Lands and Minerals and is available for public inspection at their offices.

Cutting samples collected during drilling and exploration provide physical evidence of subsurface geologic materials. They are the principal means of establishing the nature of the subsurface materials and are used to interpret and verify driller's logs. They are logged and stored at the Minnesota Geological Survey.

Borehole geophysical logs are created by lowering instruments down a well or drill hole and measuring the physical and chemical properties of the geologic materials through which the hole passes. Different logging techniques measure naturally occurring gamma radiation, spontaneous potential, and resistivity. Gamma logs characterize in graphic form the geologic formations penetrated. Spontaneous potential and resistivity are mainly used to locate water levels in wells and the depth of the well casing. An interpretive log is prepared from the geophysical log and correlated with drilling samples from the same hole, information obtained from nearby outcrops, or a geophysical log from a nearby drill hole. Geophysical logs can provide high-quality subsurface geologic and hydrologic information for wells that have little or no other information available. The information obtained from a geophysical log is added to the County Well Index (CWI) and the paper log is on file at the Minnesota Geological Survey.

Soil borings are test holes drilled to obtain information about the physical properties of subsurface materials for engineering, mapping, or exploration purposes. Most terminate at very shallow depths or where bedrock is encountered. They are logged by an engineer or a geologist using a variety of classification schemes based on particle sizes, penetration rate, moisture content, and color. Soil-boring data are limited in distribution; these data are most useful in determining the composition of unconsolidated deposits.

Extensive **mining data** were collected by various companies during exploration for and excavation of iron ore in the Cuyuna mining district. Data include geologic logs and mineral analyses. Many of the holes drilled had core or cuttings samples collected for analysis that are now available for public examination at the Minnesota Department of Natural Resources, Division of Lands and Minerals offices.

OTHER INFORMATION

Rotary-sonic cores were collected from two sites in the county (T. 46 N., R. 28 W., sec. 10, and T. 46 N., R. 29 W., sec. 27) by the Minnesota Department of Natural Resources, Division of Lands and Minerals to obtain stratigraphic and geochemical data in the area. The coring technique enables recovery of a continuous core, 3.5 inches (8.9 centimeters) in diameter, from glacial deposits and bedrock (if penetrated). It provides excellent subsurface samples for detailed study and comparison with cuttings, geophysical logs, and driller's logs from surrounding sites. The core is available for inspection at the Minnesota Department of Natural Resources, Division of Lands and Minerals offices.

Textural analyses express the proportion of sand-, silt-, and clay-size particles that make up a sample. They are helpful in identifying and mapping unconsolidated materials such as Quaternary glacial deposits. The samples analyzed were taken from natural and artificial exposures, shallow borings, Giddings holes, and the rotary-sonic cores.

Giddings probe holes allow description and sampling of continuous glacial materials in a 2-inch (5.1-centimeter) diameter hole, collected by a truck-mounted hydraulic auger. Samples were generally taken about every 5 feet (1.5 meters), at unit contacts, or where the geologist believed it was important. The average depth of the borings is 18 feet (5.5 meters) and the deepest is 56.5 feet (17 meters).

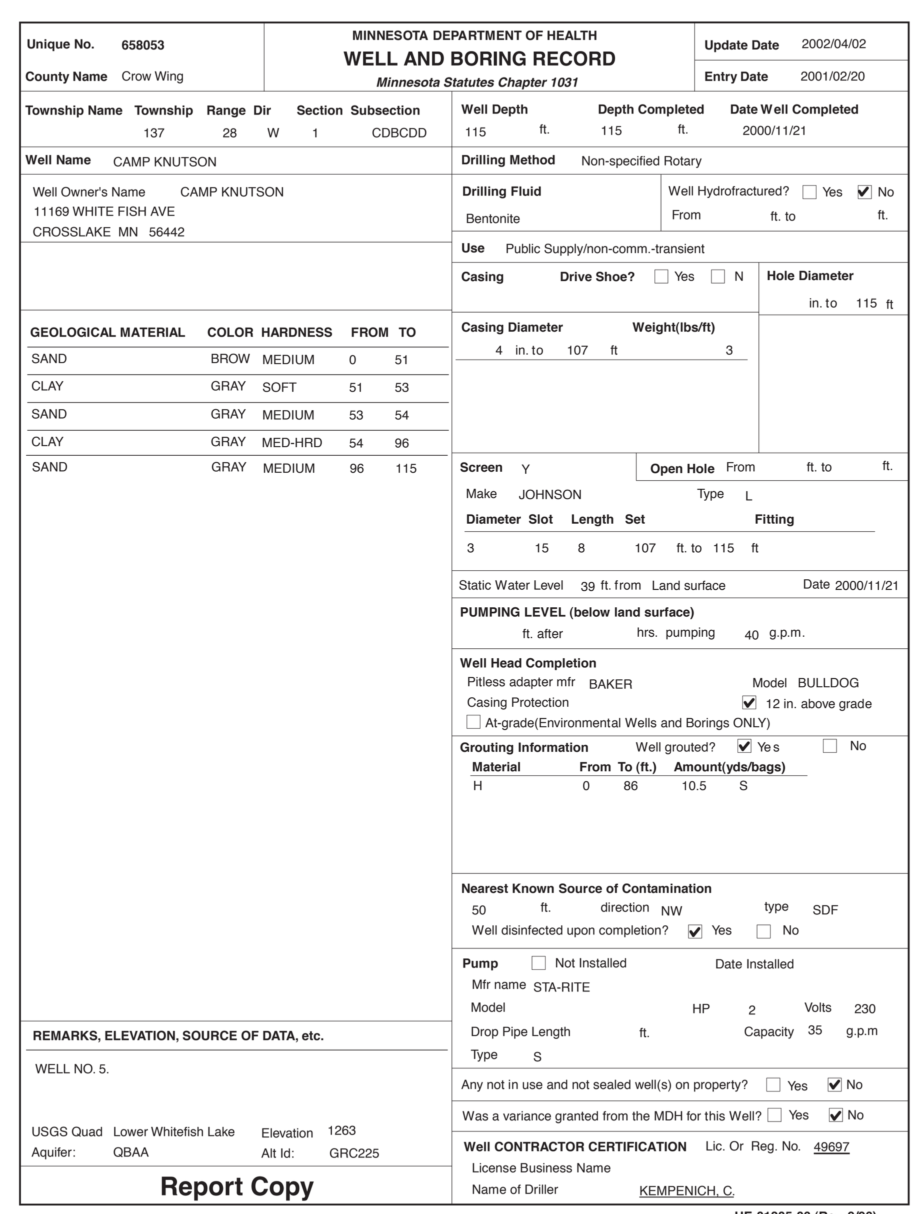
Field sites are natural and artificial exposures of unconsolidated Quaternary deposits that were described in detail; some sites were texturally analyzed. There are no known exposures of bedrock in the county. The water level in former iron-ore mines is higher than the exposed bedrock.

Seismic soundings measure the time required for sound or pressure waves to travel from a source to a receiver. Travel time can be correlated with the density and rigidity of the geologic material. Precambrian rocks exhibit acoustic- or pressure-wave velocities 1.5 to 2.5 times those of unconsolidated Quaternary sediments below the water table. The spacing of the receivers (geophones) and the arrival times (measured in milliseconds) are used to calculate the depth to bedrock. Seismic soundings are labor intensive but can provide high-quality data where no other sources of subsurface information are available. Three seismic lines were collected southwest of Brainerd by Todd Petersen of the Minnesota Department of Natural Resources and were used to confirm the presence of a buried bedrock valley.

MAP SYMBOLS

- + **Record of water-well construction (well driller's log)**
- • **Exploratory boring (exploration hole)**
- ✳ **Cutting sample**
- ○ **Borehole geophysical log**
- ● **Soil boring**
- + **Mining data**
- □ **Rotary-sonic core**
- ▲ **Giddings probe hole with textural analyses**
- △ **Giddings probe hole without textural analyses**
- ▲ **Field site with textural analyses**
- △ **Field site without textural analyses**
- ❙ **Seismic sounding**

Note: More than one symbol can occur at the same location



MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 1031

Unique No. 658053
County Name Crow Wing
Update Date 2002/04/02
Entry Date 2001/02/20

Township Name | Township 137 | Range 28 | Dir W | Section 1 | Subsection CDBCDD
Well Depth 115 ft. | Depth Completed 115 ft. | Date Well Completed 2000/11/21

Well Name CAMP KNUTSON
Drilling Method Non-specified Rotary

Well Owner's Name CAMP KNUTSON
11169 WHITE FISH AVE
CROSSLAKE MN 56442

Drilling Fluid Bentonite
Well Hydrofractured? Yes / No ✓ From ft. to ft.
Use Public Supply/non-comm.-transient

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
SAND	BROW	MEDIUM	0	51
CLAY	GRAY	SOFT	51	53
SAND	GRAY	MEDIUM	53	54
CLAY	GRAY	MED-HRD	54	96
SAND	GRAY	MEDIUM	96	115

Casing | Drive Shoe? Yes / No | Hole Diameter in. to 115 ft.
Casing Diameter 4 in. to 107 ft | Weight(lbs/ft) 3

Screen Y | Open Hole From ft. to ft.
Make JOHNSON | Type L
Diameter 3 | Slot 15 | Length 8 | Set 107 ft. to 115 ft. | Fitting

Static Water Level 39 ft. from Land surface | Date 2000/11/21
PUMPING LEVEL (below land surface) ft. after hrs. pumping 40 g.p.m.

Well Head Completion
Pitless adapter mfr BAKER | Model BULLDOG
Casing Protection ✓ 12 in. above grade
At-grade(Environmental Wells and Borings ONLY)

Grouting Information | Well grouted? ✓ Yes / No
Material H | From 0 | To (ft.) 86 | Amount(yds/bags) 10.5 S

Nearest Known Source of Contamination
50 ft. direction NW type SDF
Well disinfected upon completion? ✓ Yes / No

Pump | Not Installed | Date Installed
Mfr name STA-RITE
Model | HP 2 | Volts 230
Drop Pipe Length ft. | Capacity 35 g.p.m
Type S

REMARKS, ELEVATION, SOURCE OF DATA, etc.
WELL NO. 5.

USGS Quad Lower Whitefish Lake | Elevation 1263
Aquifer: QBAA | Alt Id: GRC225

Any not in use and not sealed well(s) on property? Yes / ✓ No
Was a variance granted from the MDH for this Well? Yes / ✓ No

Well CONTRACTOR CERTIFICATION | Lic. Or Reg. No. 49697
License Business Name
Name of Driller KEMPENICH, C.

Report Copy

HE-01205-06 (Rev. 9/96)

Figure 1. An example of a WELL LOG record, showing all the information about the well as reported by the well driller.

INTRODUCTION

The public health and economic development of Crow Wing County are directly dependent on the wise use and management of its land and water resources. Geologic and hydrologic information are essential before decisions are made that affect natural resources. Although the amount of geologic information required for making specific decisions can vary, the information will not be used if it is unavailable when needed, or if it is available only in a highly technical form, or scattered in many different maps and reports.

County atlases, prepared jointly by the Minnesota Geological Survey and the Minnesota Department of Natural Resources, Division of Waters, present detailed geologic and hydrologic information in an interpretive as well as descriptive form. Maps and texts either summarize basic geologic and hydrologic conditions at a county scale, or interpret these conditions in terms of the impacts of possible land- and water-use decisions. Site-specific information is also available at a greater level of technical detail than shown on the maps of this atlas. The data are too voluminous to present in the atlas, but have been incorporated into readily accessible files housed at the Minnesota Geological Survey.

Several sources commonly provide information about an area or an individual property, but they may use different classification schemes to describe the same geologic materials. As a result, discrepancies in interpreting the data may arise or the different sources may appear to contradict each other. For example, water-well drillers may describe glacial till as "clay," but engineering records will describe it as "clayey sand." Both descriptions are acceptable for their original purpose of describing the physical attributes of the material. "Clay," the term used by well drillers, defines the general inability of the till to yield ground water to a well. "Clayey sand," the term from the engineering record, defines the physical composition of the till relative to particle size and engineering properties. The geologist must take the analysis one step further and define the material in terms of how it formed rather than how it is to be used. In this example, till consists of an unsorted mixture of rock fragments ranging in size from clay to cobbles and boulders, and it is interpreted by the geologist as having been deposited directly by glacial ice.

All of the types of data described on this plate had to be interpreted by geologists or hydrogeologists before they were meaningful for mapping purposes. The 1:100,000- or 1:200,000-scale of the maps in this atlas were chosen because they can show the geologic and topical studies of the county while keeping the physical size of each plate to a manageable level. As a result, some detailed information that was gained by data interpretation and mapping cannot be shown on these maps or discussed in the texts.

Whether to use the atlas alone, or in combination with the data bases, depends on the amount of detail needed. Generally, data-base information must be used to evaluate site-specific conditions.

DATA-BASE MANAGEMENT

All of the data shown on the maps were plotted on 7.5-minute topographic quadrangle maps or highway alignment maps. Inventory numbers were assigned to all data sources except some soil borings. Automated data bases and a few manual files were developed to provide easy access and rapid retrieval of these site-specific data. The data may be obtained from the Minnesota Geological Survey.

Computer storage and retrieval systems are better than manual files for manipulating large amounts of data because automated geologic data bases can be designed to interact with other computer files, such as land-use data. Such interaction permits more efficient assessment of cause-and-effect relationships concerning natural resources than is commonly possible with manual files.

CROW WING COUNTY DATA BASES

Computerized files were developed for point-source data such as wells and borings in Crow Wing County. They use Public Land Survey descriptions, Universal Transverse Mercator (UTM), and latitude-longitude coordinates as location criteria; thus, they are compatible with the natural-resource data bases housed at the Minnesota Land Management Information Center (LMIC). The computerized data bases developed for Crow Wing County by the Minnesota Geological Survey are County Well Index (CWI), Test Borings Data Base (TESTHOLE), and Quaternary Samples Data Base (QBASE).

County Well Index (CWI)—Information from water-well records and exploration holes was entered into this statewide data base. Each well log is assigned a six-digit unique number and each exploration drill hole is assigned either a five- or six-digit unique number. These reference numbers are also used by state agencies and the Water Resources Division of the U.S. Geological Survey. Elevations, expressed in feet above sea level, were determined from topographic maps (see the index to 7.5-minute quadrangles) and are generally accurate to plus or minus five feet. The street address of each well is also included wherever possible to provide data users with a well-location system that is compatible with local regulatory programs. Software at the Minnesota Geological Survey is used to display and tabulate many of the data elements contained on the original well log.

The County Well Index is currently stored in a data base that consists of nine related tables. These tables contain information such as well depths, well construction, addresses, aquifers, dates drilled, static water levels, and pumping test data. They also contain alternate well identifiers such as permit numbers or emergency-service numbers, and the well stratigraphy (the geologic materials encountered during drilling).

CWI application software developed by the Minnesota Department of Health provides two types of reports:

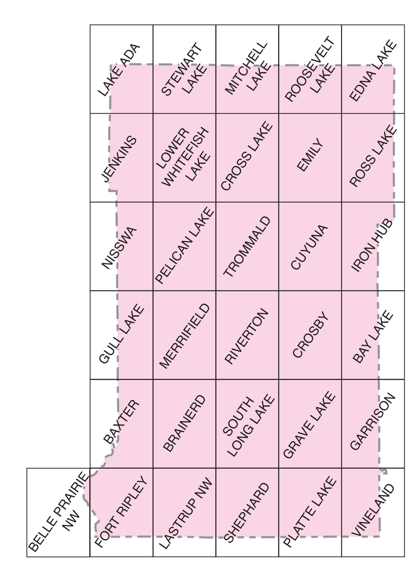
- WELL LOG contains all the information about the well as it was reported by the contractor (Fig. 1). There may also be additional location information, land-surface elevation, aquifer designation, and remarks about the drill holes.
- WELL STRATIGRAPHY contains the geologic log with a geologist's stratigraphic interpretations, which are based on her or his knowledge and understanding of the geology of Crow Wing County (Fig. 2). Only those drill holes with verified locations have stratigraphic interpretations assigned to them.

Test Borings Data Base (TESTHOLE)—Information from soil borings and engineering test holes is stored in this data base. Descriptions of the types of geologic materials penetrated and the soils classification system used are entered together with specific field and laboratory tests. The most common tests are blow counts, liquid and plastic limits, water content, and dry density. The depth to the water table is entered if available. Each test hole receives a unique number, and the location is digitized from the site plan.

Quaternary Samples Data Base (QBASE)—Information from Quaternary samples collected and analyzed is entered into this data base. QBASE contains locations, the name of the sample collector, elevations, depths from where the samples were collected, proportions of sand, silt, and clay, and proportions of crystalline, carbonate, and shale clast types.

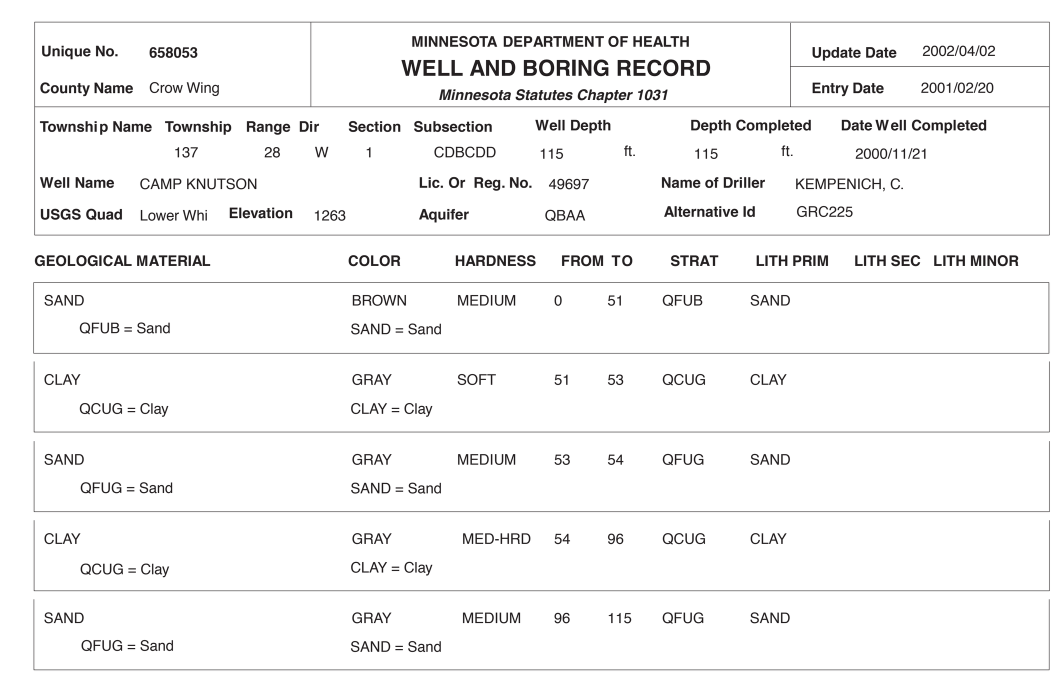
FUTURE DATA COLLECTION

A data-base map is out of date even before it is printed because additional information is continually generated as new water wells are drilled, construction activities expose more bedrock, or additional wells are tested for water quality. The library of geologic information prepared for Crow Wing County is flexible so that old data can be reevaluated in light of new information, and new forms of data can be added if required. The need to manage ground water and other natural resources wisely will never become outdated. Future demands on these resources will require current data to assess the impacts.



INDEX TO 7.5-MINUTE QUADRANGLES

Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.



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Well Name CAMP KNUTSON | Lic. Or Reg. No. 49697 | Name of Driller KEMPENICH, C.
USGS Quad Lower Whi | Elevation 1263 | Aquifer QBAA | Alternative Id GRC225

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO	STRAT	LITH PRIM	LITH SEC	LITH MINOR
SAND	BROWN	MEDIUM	0	51	QFUB	SAND		
QFUB = Sand	SAND = Sand							
CLAY	GRAY	SOFT	51	53	QCUG	CLAY		
QCUG = Clay	CLAY = Clay							
SAND	GRAY	MEDIUM	53	54	QFUG	SAND		
QFUG = Sand	SAND = Sand							
CLAY	GRAY	MED-HRD	54	96	QCUG	CLAY		
QCUG = Clay	CLAY = Clay							
SAND	GRAY	MEDIUM	96	115	QFUG	SAND		
QFUG = Sand	SAND = Sand							

Figure 2. Example of a WELL STRATIGRAPHY record, which contains a geologist's interpretation of the geologic materials listed by the driller in the WELL LOG record (Fig. 1). The headings (such as GEOLOGICAL MATERIAL, COLOR, and HARDNESS) pertain to information in the first line of each entry; the second line contains explanations of most of the four-letter codes used in the first line. The first word (in capital letters) in each entry is the well driller's original description for that interval. All depths are measured in feet. Heading abbreviations: STRAT, stratigraphy (the name of the stratigraphic unit; note, all abbreviations starting with Q are glacial deposits and are not further delineated); LITH PRIM, primary lithology (rock type); LITH SEC, secondary lithology; LITH MINOR, minor lithology.