UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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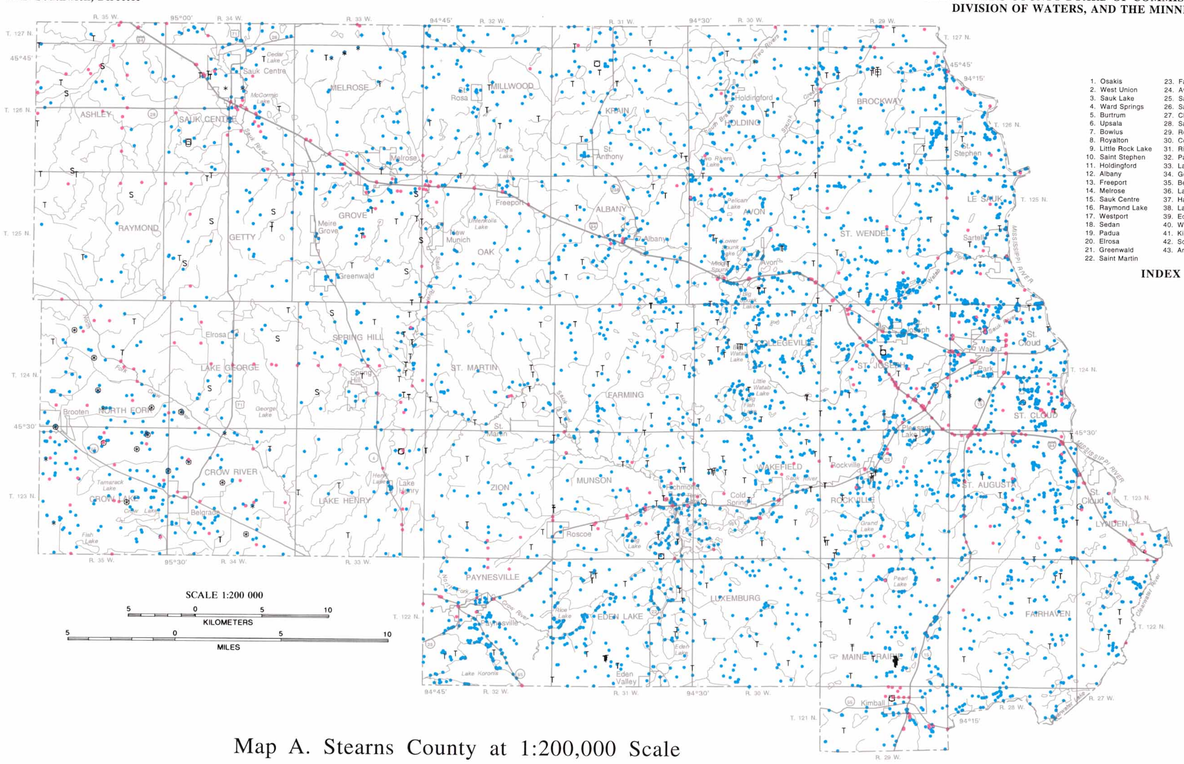

Map A. Stearns County at 1:200,000 Scale

1. Osakis
2. West Union
3. Sauk Lake
4. Ward Springs
5. Burtrum
6. Upsala
7. Bowlus
8. Royalton
9. Little Rock Lake
10. Saint Stephen
11. Holdingford
12. Albany
13. Freeport
14. Melrose
15. Sauk Centre
16. Raymond Lake
17. Westport
18. Sedan
19. Padua
20. Elrosa
21. Greenwald
22. Saint Martin
23. Farming
24. Avon
25. Saint Joseph
26. Saint Cloud
27. Clearwater
28. Saint Augusta
29. Rockville
30. Cold Spring
31. Richmond
32. Paynesville
33. Lake Henry
34. Georgeville
35. Belgrade
36. Lake Johanna
37. Hawick
38. Lake Koronis
39. Eden Valley
40. Watkins
41. Kimball
42. South Haven
43. Annandale

INDEX TO 1:24,000-SCALE TOPOGRAPHIC MAPS

DATA BASE

By

Emily J. Bauer and Kimberly S. Esser

1995

ACKNOWLEDGMENTS

Staff members of the Minnesota Geological Survey who contributed to the development of the data bases include Richard Christopher, Christopher Glassing, John Harris, Michael Olsen, and Dean Schemenauer. Students from the St. Cloud State University, Department of Geography, who contributed include Peter Knutson, Vicki Kramer, Brent Lindstrom, Brian Praske, and Daniel Ross. We thank local water-well contractors and landowners for their valuable assistance.

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EXPLANATION OF MAP SYMBOLS

The size of map symbols differs depending on the map scale. Sources of information used to construct the bedrock geologic map are shown on Plate 2

- Record of water-well construction (well driller's log)
- Cutting sample
- Borehole geophysical log
- Soil boring
- Texture analysis
- Rotasonic core
- Seismic sounding
- Water-quality data

INTRODUCTION

The public health and economic development of Stearns County are directly dependent upon the wise use and management of its land and water resources. Geologic and hydrologic information is 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 at all if it is not available when it is needed, or if it is available only in a highly technical form or scattered in many different maps and reports.

County atlases 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-use and water-use decisions. Digital versions of the maps are available for integration with other digital map products. Site-specific information is also available at a greater level of technical detail than shown on the maps of this atlas. These 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 " a 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 in terms of how it is to be used. In this example, till consists of an unsorted jumble 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 and 1:200,000 scales 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 to use the data bases, depends on the amount of detail needed. Generally, data-base information must be used to evaluate site-specific conditions and test drilling may be necessary. The data bases and GIS products for Stearns County are available on magnetic media.

THE DATA-BASE MAP

The types, locations, and density of information used to prepare this atlas are shown on this plate. The data are described below to aid the user in assessing which types of information may be useful for a particular need. The data-base maps serve as a guide to the precision of the other maps in the atlas. They show where data are sparse or lacking, and interpretation and extrapolation were required to prepare a map.

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, wells usually do not have to drilled 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. Drillers' logs are the primary source of subsurface geologic and hydrologic data for Stearns County; about 4300 logs were reviewed during preparation of this atlas.

Cutting samples collected during drilling 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 drillers' logs. Many of the samples were donated by the United States Geological Survey from test holes drilled for hydrologic studies.

Borehole geophysical logs are made by lowering instruments down the well or drill hole and measuring the physical and chemical properties of the geologic materials that the hole penetrates. Different logging techniques measure naturally occurring gamma radiation, spontaneous potential, and resistivity. Gamma logs, in graphic form, characterize the geologic formations penetrated. Spontaneous potential and resistivity are used mainly 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 another nearby geophysical log. Geophysical logs can provide high-quality subsurface geologic and hydrologic information from wells for which little or no other information is available.

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 size, penetration rate, moisture content, and color. Soil-boring data are limited in distribution; in Stearns County they are concentrated along Interstate Highway 94 and Minnesota Highway 23. These data are most useful in determining the composition of unconsolidated deposits. Some logs include the depth to bedrock and the lithology of the first bedrock encountered.

Rotasonic cores were collected from seven sites in the county to aid the interpretation of Quaternary and Cretaceous deposits. The technique enables recovery of a continuous core, three and a half inches in diameter, from the Quaternary and, where present, the Cretaceous sections and provides excellent subsurface samples for detailed study and comparison with cuttings, geophysical logs, and drillers' logs from surrounding sites.

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 glacial deposits. The samples analyzed were taken from natural and artificial exposures, shallow borings and the Rotasonic cores.

Seismic soundings measure the time required for sound or pressure waves to travel from a source to a receiver. The density and rigidity of the geologic material through which the waves must travel affect their travel time. Granitic rocks exhibit acoustic- or pressure-wave velocities three to four times those of much less dense Quaternary and Cretaceous deposits. 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 when no other sources of subsurface information are available. They were done at selected localities by Denise Kaeter of the Minnesota Department of Natural Resources.

DATA-BASE MANAGEMENT

All of the data shown on the maps were plotted on 7.5-minute topographic quadrangle maps, section maps, or highway alignment maps, and inventory numbers were assigned to all 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. Automated geologic data bases may also 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.

A computerized data base was developed for major point-source data in Stearns County. It uses Public Land Survey descriptions, and Universal Transverse Mercator (UTM) and latitude-longitude coordinates as location criteria and thus it is compatible with the natural-resource data bases housed at the Land Management Information Center (LMIC). The automated data base developed for Stearns County by the Minnesota Geological Survey is the County Well Index (CWI).

County Well Index

The County Well Index (CWI) is a PC-compatible data base of information related to water wells. Each well is assigned a six-digit unique number that is used to reference all data concerning the well. The unique number is used by local, state, and federal agencies, as well as well drillers and consultants, to refer unambiguously to a specific well. The location of each well is digitized from topographic maps. Elevations, expressed in feet above sea level of the surface at well sites are also determined from these maps. These data are included with the well driller's log and any other available information in CWI. The street address of each well is also included to provide data users with a well-location system that is compatible with local programs. The CWI software, which runs on almost any IBM-compatible PC, provides easy access to the data through flexible, interactive browsing and report generation.

The County Well Index has three components: CWI, CWI/WL, and CWI/WC. CWI contains basic data on the well, information on aquifer usage and ground-water quality data, and serves as an index to data that is available in the other two components of the County Well Index (Fig. 1). The Minnesota Department of Health collects data on ground-water quality (mostly nitrate and coliform bacteria counts); some depth and construction data from wells that are sampled are included. This data, though very limited in subsurface information, are stored in CWI, as are historic static water-level measurements. There are approximately 10,500 records in CWI for Stearns County.

CWI/WL, or County Well Index/Well Log, contains well-construction information, such as casing, screen, and pump installation, pumpage-test data, and the driller's log of subsurface materials (Fig. 2). It also contains the geologic interpretation of the materials described in the drillers' logs. The water-quality data from CWI were combined with location and selected depth data from CWI/WL to form a catalog of aquifer usage within the county. Approximately 4300 of the possible 10,500 records in Stearns County have information in CWI/WL.

CWI/WC, or County Well Index/Water Chemistry, contains the results of analyses from water wells. This component is intended for results from more detailed or rigorous sampling than the basic bacteria and nitrate data contained in the CWI component. Basic water-chemistry parameters recorded in CWI/CL include temperature, pH, conductivity, dissolved oxygen, alkalinity, major anions and cations, stable isotopes, and tritium.

DIGITAL MAP DATA

Geographical Information System (GIS) technology played an important role in the development and production of this atlas. Point data from CWI and other sources were incorporated into the Minnesota Geological Survey GIS. Working data maps were produced as aids for geologic and hydrologic interpretation and mapping. The maps and cross sections compiled by the geologists were digitized into the GIS, which was then used to generate the map and cross section components of the final printed plates. The coverages, or digital map layers, in the GIS are included as part of the atlas and may be obtained in digital form from the Minnesota Geological Survey. Details describing the GIS products are included with the digital media.

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 another well is tested for water quality. The library of geologic information prepared for Stearns 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.

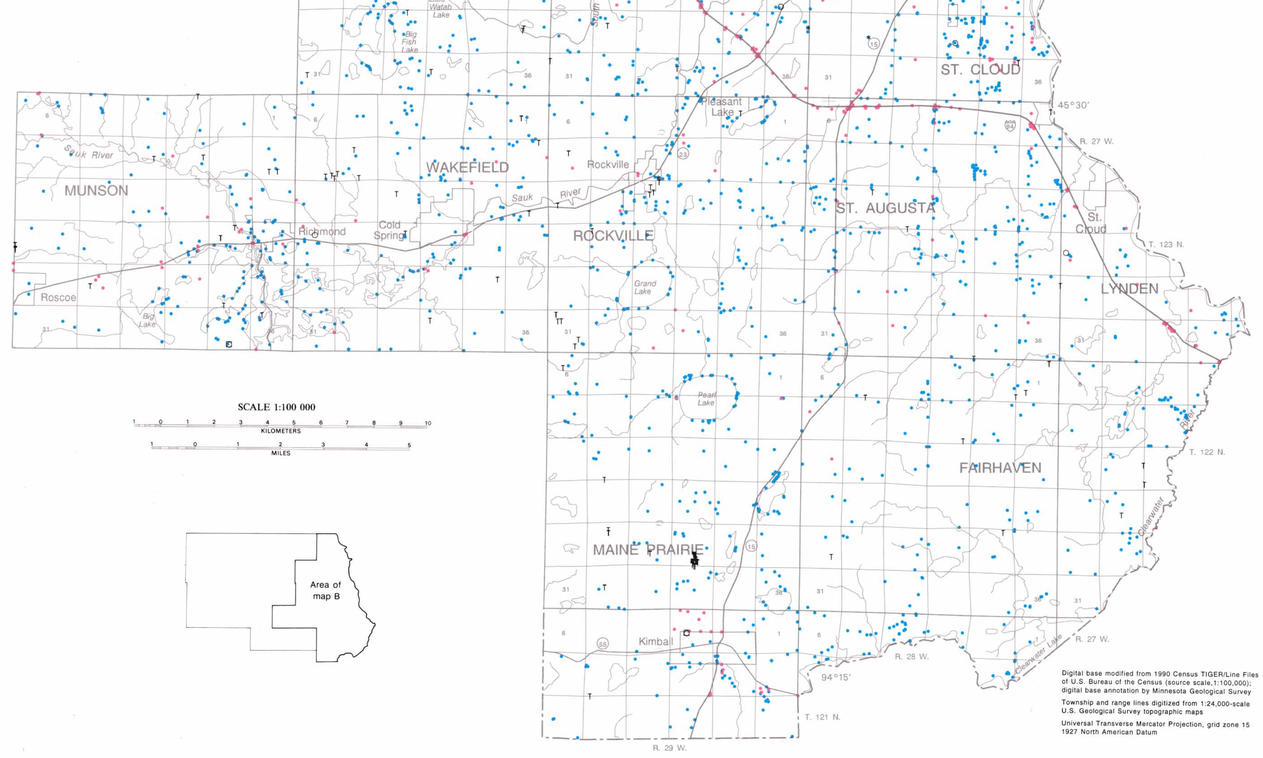
```
MINNESOTA GEOLOGICAL SURVEY
COUNTY WELL INDEX.

UN.NO./CO. : 117907/73                                  ENTERED: 1988/04/17
NAME       : DORSCH, JOE                                UPDATED: 1993/04/26

 COUNTY  : STEARNS          USE    : DOMESTIC   DRILLED: 1975/06/13
 T/R/SEC. : 124/29/ BCCDDDC DEPTH  : 252 FT.     DEPTH D: 252 FT.
 ELEVATION: 1155 FT.(TOPO)  CASED  : 230 FT.     GROUT  : NO
 DIAM.    : 6 IN.           DRL/DS : 73061  :DONABAUER WELL CO.
 LOC.METH.: INPU:OWNER      LOC.RY : MGS        COORDS.:
 STATUS   : ACTIVE          NWPA   :            DNR PA#:

 DPTH BDRK: 299 FT.                 BEDROCK: CRETACEOUS REGOLITH
 OPEN HOLE: CRETACEOUS REGOLITH
 AQUIFER  : CRETACEOUS REGOLITH

 ADDRESS  : RR 2 , ST. JOSEPH , MN 56374
 QUAD(7.5): ST JOSEPH                   CONTACT:
 POTENTIAL POLLUTION SOURCE:  75 FT.  DIR.: NW   TYPE: SEPTIC/DFL
 CWI/WL: YES   CWI/WC: YES   CORE:CTTNGS(GP.)

    DATE    NITRATE  BACTERIA   SOURCE        SWL   ELEV   SOURCE
   ------   -------  --------  ------        ---   ----   ------
 1975/06/13                                   39   1116   73061

   COMMENTS: MUNE NO.602317.
```

FIGURE 1. *Example of output from CWI.*

```
MINNESOTA GEOLOGICAL SURVEY
COUNTY WELL INDEX/WELL LOG.
UN.NO./CO. : 117907/73          NAME  : DORSCH, JOE

 GEO.INTRP: MGS                 GEOLGST: DS    METHOD : GEO.STUDY<1:100K

 WELL CONSTRUCTION.
   DRILLER S NAME: DONABAUER, A.          DRV.SR.: YES
   DRILLING METHOD: ROW-SP. ROT.          FLUID :
   CASING MATERIAL: STEEL                 JOINTING: WELDED      TOP:  1 FT.
                                          [GROUT----------]
                 DIAM(IN)  FROM(FT)  TO(FT)   MATERIAL   ANNT UNITS
                 --------  --------  ------   --------   ---- -----
   CASING 1        6         0        230
   BASEMENT OFFSET:        +/-12" ABOVE GRND: YES    CASING PROTECT:

 SCREEN.
   PRESENT?: NO        OPEN HOLE FROM:  230 FT.  TO:  252 FT.

 PUMP.
   INSTLLD?: YES                  DATE : 1975/09/11
   MAKE    : GOULD                MODEL: 10BJ07412
   SIZE    : 0.75 H.P.      VOLTS: 230       CAPACITY:   10 GPM
   TYPE    : SUBMERSIBLE  DROP PIPE: 168 FT.  MATERIAL: GALVANIZED

 PUMPAGE TEST(S).
   STATIC WATER LEVEL:    39 FT.          DATE: 1975/06/
                 LEVEL(FT)   HOURS    GPM    DRAWDOWN  (FT)
                 ---------   -----    ---    ----------
   TEST 1.:        50         2       50       11.0

                      DRILLER S/GEOLOGIC LOG

 DEPTH
 INTERVAL  DRILLER S DESCRIPTION                 COLOR    HARDNESS
 [EL.TOP ] [INTERPRETED LITHOLOGY   ][CODE][STRATIGRAPHIC UNIT(S)   ] [AGE]
 -------   ---------------------------------------------------------------
   0   26  CLAY                                 YELLOW    HARD
 [  1153] [CLAY                     ][QCUV][CLAY, YELLOW            ] [QUA]
  26    4  CLAY                                 GRAY      HARD
 [  1129] [CLAY                     ][QCUG][CLAY, GRAY              ] [QUA]
  41  209  CLAY                                 BLUE      HARD
 [  1114] [CLAY                     ][QCUG][CLAY, GRAY              ] [QUA]
 209  252  DECOMPOSED ROCK - WATER
 [   946] [REGOLITH                 ][KRRG][CRETACEOUS REGOLITH     ] [KRE]
```

FIGURE 2. *Example of output from CWI/WL (County Well Index/Well Log).*

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.



Map B. Eastern Stearns County at 1:100,000 Scale

Digital base modified from 1990 Census TIGER/Line Files of U.S. Bureau of the Census (source scale,1:100,000); digital base annotation by Minnesota Geological Survey

Township and range lines digitized from 1:24,000-scale U.S. Geological Survey topographic maps

Universal Transverse Mercator Projection, grid zone 15
1927 North American Datum

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GEOLOGIC ATLAS OF STEARNS COUNTY, MINNESOTA