UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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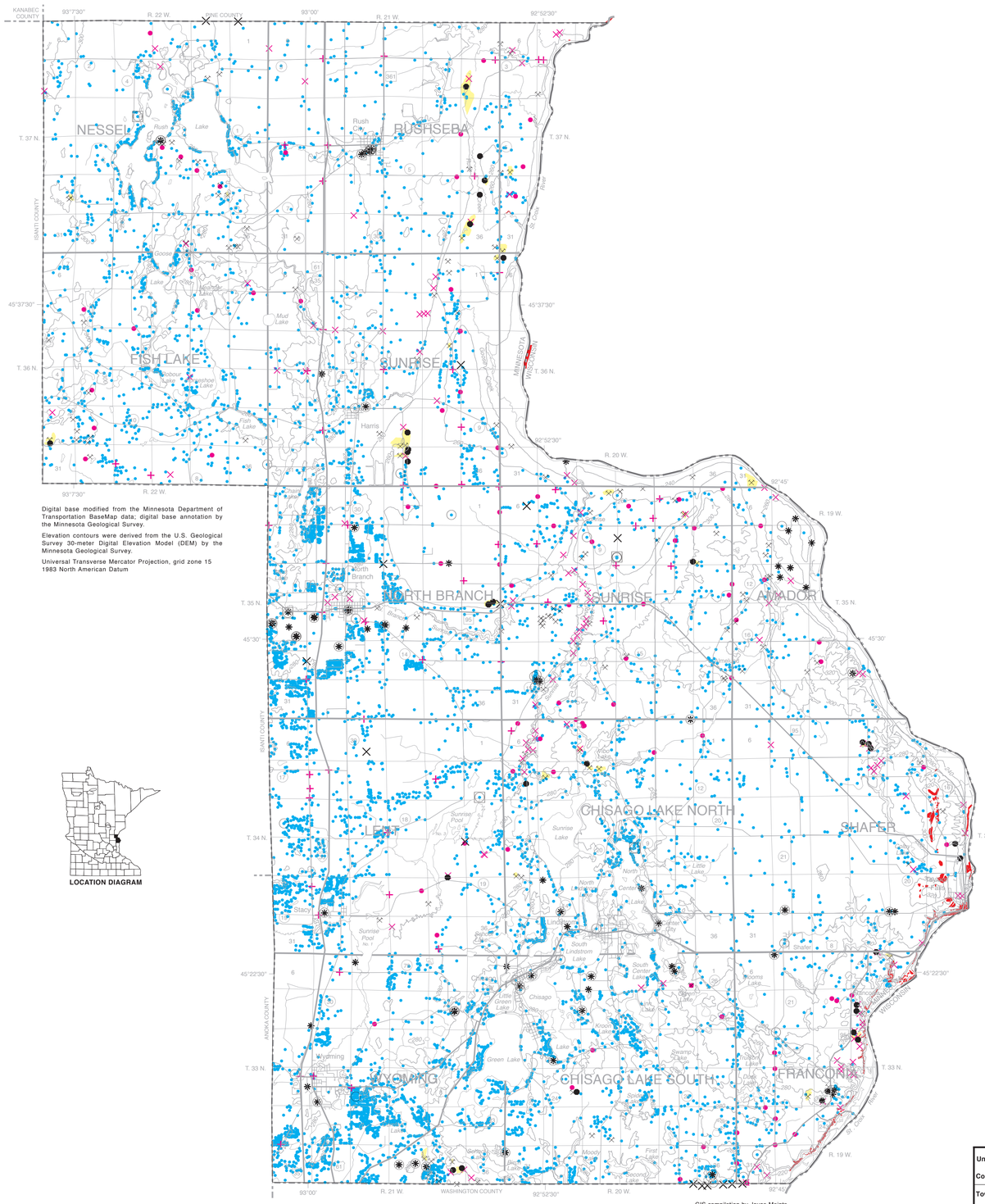
Prepared and Published with the Support of
THE CHISAGO COUNTY BOARD OF COMMISSIONERS AND
THE MINNESOTA ENVIRONMENT AND NATURAL RESOURCES TRUST FUND
AS RECOMMENDED BY THE LEGISLATIVE-CITIZEN COMMISSION ON MINNESOTA RESOURCES



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

LOCATION DIAGRAM

SCALE 1:100 000

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 6 7 8 KILOMETERS

CONTOUR INTERVAL 20 METERS

GIS compilation by Joyce Meints
and E.J. Bauer
Edited by Lori Robinson

DATA-BASE MAP

By

Emily J. Bauer

2010

THE DATA-BASE MAP

The types, locations, and density of information used to prepare the Chisago 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. All data were collected by Minnesota Geological Survey staff unless otherwise specified.

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, 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 Chisago County; about 9,200 logs were used for this atlas.

Rotary-sonic cores were collected at six sites in Chisago County as a means to help establish the nature of the subsurface material. The coring technique enables recovery of a continuous core, 3.5 inches (8.9 centimeters) in diameter, from glacial deposits and bedrock (if present). 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.

Cutting samples collected during drilling provide physical evidence of subsurface geologic materials. Cuttings are the samples generated as the drill bit cuts through the subsurface material and are used to interpret and verify driller's logs. They are logged and stored at the Minnesota Geological Survey or the Minnesota Department of Natural Resources, Division of Lands and Minerals.

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 were collected by the Minnesota Department of Transportation and the U.S. Geological Survey. They are limited in distribution; in Chisago County they are concentrated along the Interstate 35 corridor. These data are most useful in determining the composition of unconsolidated deposits.

OTHER INFORMATION

Giddings probe holes allow description and sampling of continuous glacial materials, 2 inches (5.1 centimeters) in diameter, 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. A description was generated at every site and almost always a sample or samples were taken for textural analyses.

Field sites are natural and artificial exposures of unconsolidated Quaternary deposits that were described in detail; some sites were texturally analyzed.

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 like Quaternary glacial deposits. The samples analyzed were taken from natural and artificial exposures, Giddings holes, and the rotary-sonic cores.

Soil auger holes are shallow borings created with a hand auger to generate a description of the subsurface material. They are generally less than 5 feet (1.5 meters) in depth.

Gravel pit locations were taken from the Minnesota Department of Transportation's Aggregate Source Information System listing of aggregate sources. Test hole logs, sieve, and quality test data are available.

Seismic soundings measure the time required for sound or pressure waves to travel from a source through the subsurface, and be refracted back to a receiver. Travel time can be correlated with the density and rigidity of the geologic material and the depth where these properties change. Most bedrock exhibits 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. In Chisago County and adjacent areas, a total of 16 seismic-refraction lines were used to delineate the depth to bedrock buried beneath Quaternary deposits where greater detail was needed beyond what was available with existing water well data. These consist of seven lines that were acquired by the Minnesota Department of Natural Resources, Division of Waters, as part of this project; and nine historical lines that were acquired by Mooney and others (1970).

Bedrock outcrops are exposures of solid rock at the land surface. Most are natural outcrops; however, some are exposures created during construction. They serve as reference points for mapping and for checking the accuracy of subsurface data. Bedrock at or near the surface must be considered in land-use planning decisions such as pipeline routing, sewage-system design, and excavation.

REFERENCE

Mooney, H.M., Farnham, P.R., Johnson, S.H., Volz, G., and Craddock, C., 1970, Seismic studies over the Midcontinent gravity high in Minnesota and northwestern Wisconsin: Minnesota Geological Survey Report of Investigations 11, 191 p.

INTRODUCTION

The public health and economic development of Chisago County are directly dependent on the wise use and management of its land and water resources. Accurate 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 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 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. 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.

CHISAGO COUNTY DATA BASES

Computerized files were developed for point-source data such as wells and borings in Chisago 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 Chisago County by the Minnesota Geological Survey are County Well Index (CWI) 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 5 feet (1.5 meters). 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 Chisago County (Fig. 2). Only those drill holes with verified locations have stratigraphy assigned to them.

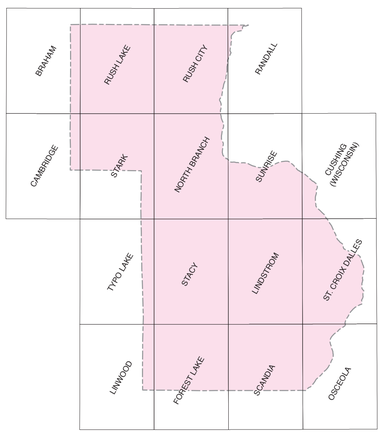
Quaternary Samples Data Base (QBASE)—Information from Quaternary samples collected and analyzed is entered into this data base. QBASE contains locations, the name of the sample collector, elevations, depths from where the samples were collected, proportions of sand, silt, and clay, and proportions of crystalline, carbonate, and shale. Information pertaining to borings obtained from the Minnesota Department of Transportation and the U.S. Geological Survey can also be found in this database.

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 Chisago 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.

- Record of water-well construction (well driller's log)
- Rotary-sonic core
- Cutting sample
- Borehole geophysical log
- Soil boring
- Giddings probe hole
- Field site
- Soil auger hole
- Gravel pit location
- Large gravel pit, or more than one gravel pit
- Seismic sounding
- Bedrock outcrop

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



INDEX TO 7.5-MINUTE QUADRANGLES

Unique No. 00763776	MINNESOTA DEPARTMENT OF HEALTH	Update Date 2009/06/01
County Name Chisago	**WELL AND BORING RECORD** *Minnesota Statutes Chapter 1031*	Entry Date 2008/07/18

Township Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed
	37	22	W	16	ACCDDC	118 ft.	109 ft.	2008/05/23

Well Name CR-2
Drilling Method Vibracore/rotasonic
Contact's Name MNDNR- MIKE MACDONALD
500 LAFAYETTE RD
ST PAUL MN 55155
Drilling Fluid Well Hydrofractured? ☐ Yes ☐ No From ft. to ft.
Use Piezometer
Casing Drive Shoe? ☐ Yes ☐ N
Hole Diameter in. to 110 ft.
Casing Diameter 2 in. to 98 ft. Weight(lbs/ft) 3.65

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
GRAVELLY SAND-FILL	BROW	MEDIUM	0	2
CLAYEY TILL	YEL/BR	MEDIUM	2	13
SILTY CLAYEY TILL	DK. GR	MEDIUM	13	22
SILT TO CLAY BEDS	GRAY	MEDIUM	22	26
SANDY TILL	RED	MEDIUM	26	33
SILTY TILL	RED	MEDIUM	33	40
SAND	RED	MEDIUM	40	71
SILT	GRY/B	MEDIUM	71	75
SANDY TILL	GRY/B	MEDIUM	75	80
GRAVELLY SAND	GRY/B	MEDIUM	80	82
SANDY TILL	GRY/B	MEDIUM	82	97
RED SILT & GRY/BRN LOAM	VARIE	MEDIUM	97	102
SANDY TILL	RED	MEDIUM	102	104
LOAMY SAND & GRAVEL W/	GRY/B	MEDIUM	104	110
SILTY TO SANDY TILL	RED	MEDIUM	110	115
SANDSTONE	TAN	HARD	115	118

Screen Y
Open Hole From ft. to ft.
Make JOHNSON Type L

Diameter	Slot	Length	Set	Fitting
2	10	10	98 ft. to 108 ft.	

Static Water Level -3 ft. from Land surface Date 2008/05/23
PUMPING LEVEL (below land surface) ft. after hrs. pumping g.p.m.
Well Head Completion
Pitless adapter mfr Model
Casing Protection Y ☐ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)
Grouting Information Well grouted? ☑ Yes ☐ No

Material	From	To (ft.)	Amount(yds/bags)
G	93	21	S

Nearest Known Source of Contamination
ft. direction type
Well disinfected upon completion? ☑ Yes ☐ No
Pump ☑ Not Installed Date Installed N
Mfr name
Model HP Volts
Drop Pipe Length ft. Capacity g.p.m
Type
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
REMARKS, ELEVATION, SOURCE OF DATA, etc.
GAMMA LOGGED 5-22-2008. LOGGED FOR CHISAGO CO. ATLAS.
WELL FLOWS.
USGS Quad: Rush Lake Elevation: 924
Aquifer: QBAA Alt Id:
Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 1404
License Business Name
Name of Driller ANDERSON, M.
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.

Unique No. 00763776	MINNESOTA DEPARTMENT OF HEALTH	Update Date 2009/06/01
County Name Chisago	**WELL AND BORING RECORD** *Minnesota Statutes Chapter 1031*	Entry Date 2008/07/18

Township Name	Township	Range	Dir	Section	Subsection	Well Depth	Depth Completed	Date Well Completed
	37	22	W	16	ACCDDC	118 ft.	109 ft.	2008/05/23

Well Name CR-2 Lic. Or Reg. No. 1404 Name of Driller ANDERSON, M.
USGS Quad Rush Lake Elevation 924 Aquifer QBAA Alternative Id

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO	STRAT	LITH PRIM	LITH SEC	LITH MINOR
GRAVELLY SAND-FILL	BROWN	MEDIUM	0	2	RMMF	FILL	SAND	GRVL
RMMF = Man-made fill	FILL = Fill			SAND = Sand			GRVL = Gravel	
CLAYEY TILL	YEL/BRN	MEDIUM	2	13	QTUU	TILL	CLAY	
QTUU = Till	TILL = Till,tillite			CLAY = Clay				
SILTY CLAYEY TILL	DK. GRY	MEDIUM	13	22	QTUG	TILL	CLSN	SILT
QTUG = Till	TILL = Till,tillite			CLSN = Claystone			SILT = Silt	
SILT TO CLAY BEDS	GRAY	MEDIUM	22	26	QJUB	SILT	CLAY	
QJUB = Silt & clay	SILT = Silt			CLAY = Clay				
SANDY TILL	RED	MEDIUM	26	33	QTUR	TILL	SAND	
QTUR = Till	TILL = Till,tillite			SAND = Sand				
SILTY TILL	RED	MEDIUM	33	40	QTUR	TILL	SILT	
QTUR = Till	TILL = Till,tillite			SILT = Silt				
SAND	RED	MEDIUM	40	71	QFUR	SAND		
QFUR = Sand	SAND = Sand							
SILT	GRY/BRN	MEDIUM	71	75	QIUU	SILT		
QIUU = Silt	SILT = Silt							
SANDY TILL	GRY/BRN	MEDIUM	75	80	QTUU	TILL	SAND	
QTUU = Till	TILL = Till,tillite			SAND = Sand				
GRAVELLY SAND	GRY/BRN	MEDIUM	80	82	QHUU	SAND	GRVL	
QHUU = Sand & larger	SAND = Sand			GRVL = Gravel				
SANDY TILL	GRY/BRN	MEDIUM	82	97	QTUU	TILL	SAND	
QTUU = Till	TILL = Till,tillite			SAND = Sand				
RED SILT & GRY/BRN LOAMY GRAVEL	VARIED	MEDIUM	97	102	QPUU	SILT	GRVL	LOAM
QPUU = Pebbly sand/silt/clay	SILT = Silt			GRVL = Gravel			LOAM = Loam	
SANDY TILL	RED	MEDIUM	102	104	QTUR	TILL	SAND	
QTUR = Till	TILL = Till,tillite			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.

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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