UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
Harvey Thorleifson, Director

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COUNTY ATLAS SERIES
ATLAS C-34, PART A
Winona County
Plate 1—Data-Base Map

DATA-BASE MAP

By

Emily J. Bauer and V.W. Chandler

2014

MAP SYMBOLS

- Record of water-well construction (well driller's log)
- Core sample
- Cutting sample
- Borehole geophysical log
- Soil boring
- Giddings probe hole
- Field site
- Passive seismic sounding
- Bedrock outcrop

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

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.

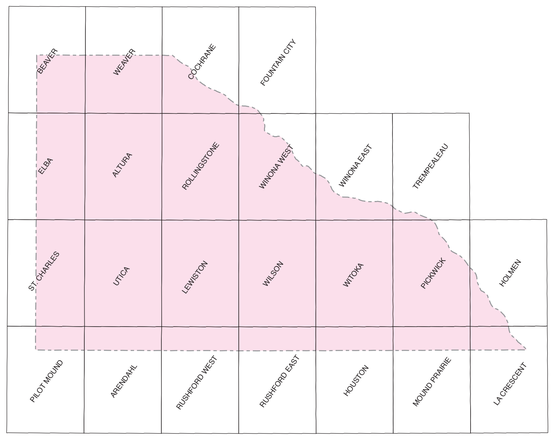
Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

SCALE 1:100 000

1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 8 KILOMETERS

CONTOUR INTERVAL 50 METERS

GIS compilation by E.J. Bauer
Edited by Lori Robinson



INDEX TO 7.5-MINUTE QUADRANGLES

Unique Well Number 110484

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
MINNESOTA STATUTES CHAPTER 1031

County Winona
Quad Winona West
Quad Id 46C

Entry Date 1989/12/19
Update Date 2011/08/10
Received Date

Well Name FROEDTERT MALT CORP.
Township 107 Range 7 W Dir Section 22 Subsection ACCDCB Field Located Elevation MGS 655.00 ft.

Well Depth 418.00 ft | Depth Completed 418.00 ft | Date Well Completed 1985/01/24

Drilling Method Cable Tool
Drilling Fluid | Well Hydrofractured? ☐ YES ☐ NO From ft. to

Use Industrial

Casing Type Steel (black or low) Diameter 20 | Drive Shoe? ☒ YES ☐ NO Depth 251 | Hole Diameter (in.)
24.00 in. from 0.00 to 152.00 ft. lbs/ft
20.00 in. from 0.00 to 251.00 ft. lbs/ft

Screen No | Open Hole(ft.) From 251.0 to 418.0
Make | Type | Diamter | Slot | Length | Set

Description	Color	Hardness	From	To (ft.)
SAND + GRAVEL	BROWN		0	10
SAND FINER + GRAVEL	BROWN	SOFT	10	26
ROCKS + GRAVEL + FINE SAND	BROWN	SOFT	26	46
CLAY + SAND + GRAVEL	BROWN	SOFT	46	64
FINE SAND + TRACE OF CLAY	BROWN	SOFT	64	76
FINE SAND + COURSE GRAVEL	BROWN	SOFT	76	87
CLAY + SAND + ROCK	GRY/BRN	HARD	87	101
GRAVEL + CLAY + SAND	BROWN	HARD	101	115
ROCKS + GRAVEL	BROWN	HARD	115	125
ROCKS + CLAY + GRAVEL	GRY/BRN	HARD	125	135
GRAVEL + ROCKS	GRY/BRN	HARD	135	144
HARD SHALE + TRACE OF SHALE	GRAY	SOFT	144	151
SHALE + ROCK FORMATIONS	PINK	HARD	151	162
LIMEROCK FORMATION	PINK	HARD	162	174
LIMEROCK + LAYERS OF SHALE	PNK/BRN	HARD	174	181
LIMEROCK + LAYERS OF SHALE	PNK/BRN	HARD	181	220
SANDSTONE LAYER OF SHALE	PINK	HARD	220	282
SANDSTONE	YEL/PNK	HARD	282	401
REDDISH SHALE	RED	HARD	401	418

Static Water Level 38.00 ft. Land surface Date measured 1984/10/15

Pumping Level (below land surface) 193.00 ft. after 6.50 hrs. pumping 1050.00 g.p.m.

Wellhead Completion
Pitless adapter manufacturer | Model
☐ Casing Protection ☒ 12 in. above grade
☐ At-grate (Environmental Wells and Borings ONLY) ☐ Basement offset

Grouting Information Well grouted? ☒ YES ☐ NO
Material Neat Cement From 0.0 To 253.0 ft. 18.00 Cubic yards

Nearest Known Source of Contamination
feet | Direction | Type
Well disinfected upon completion? ☒ YES ☐ NO

Pump
☐ Not Installed Date Installed 1985/04/01
Manufacture's name LAYNE+BOWLER
Model number 8RKHC HP 40.00 Volts 400
Length of drop pipe 210 Material S Capacity 500 g.p.m
Type Turbine

Abandoned Wells
Does property have any not in use and not sealed well(s)? ☐ YES ☐ NO

Variance
Was a variance granted from the MDH for this well? ☐ YES ☐ NO

Well Contractor Cerfication
Layne Well Co. 27010

License Business Name | Lic. or Reg No.
HOLLEN, G.

Remarks
M.G.S. NO.2136 GAMMA LOGGED 11-28-84.

First Bedrock CECR | Aquifer Mt.Simon
Last Strat CMTS | Depth to Bedrock 144.00 ft.

County Well Index v.5 REPORT Printed on 3/13/2013 | Name of Driller | Date | HE-01205-07 (Rev. 2/99)

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

Unique Well Number 110484

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
MINNESOTA STATUTES CHAPTER 1031

County Winona
Quad Winona West
Quad Id 46C

Entry Date 1989/12/19
Update Date 2011/08/10
Received Date

Well Name FROEDTERT MALT CORP. | Township 107 | Range 7 | Dir W | Section 22 | Subsection ACCDCB | Depth Drilled 418 ft | Depth Completed 418 ft | Date Completed 1985/01/24 | Lic/Reg. No. 27010 | Driller Name HOLLEN, G.

Elevation 655.00 ft. **Method** 7.5 minute topographic **Aquifer** Mt.Simon **Depth to Bedrock** 144 ft. **Open Hole 251-418** **SWL** 38

Field Located Minnesota Geological Survey | **Location Method** | Universal Transverse Mercator(UTM) - NAD83 - Zone 15 - Meters
Program | **Input Source** | **UTM Easting (X)** 608250 | **UTM Northing (Y)** 4879032
Uni No.Verified Information from owner | **Input Date** 1990/01/01
Geologic Interpretation Bruce Olsen | **Agency** MGS | **Interpretation Method** Inferred from geophysical log

Geological Material	Color	Hardness	DEPTH From	DEPTH To	DEPTH Thick	ELEVATION From	ELEVATION To	Stratigraphy	LITHOLOGY Primary	LITHOLOGY Secondary	LITHOLOGY Minor
SAND + GRAVEL	BROWN		0	10	10	655	645	sand +larger-brown	Sand	Gravel	
SAND FINER + GRAVEL	BROWN	SOFT	10	26	16	645	629	sand +larger-brown	Sand	Gravel	
ROCKS + GRAVEL + FINE SAND	BROWN	SOFT	26	46	20	629	609	sand +larger-brown	Cobble	Gravel	Sand
CLAY + SAND + GRAVEL	BROWN	SOFT	46	64	18	609	591	pebbly sand/silt/clay-brown	Clay	Sand	Gravel
FINE SAND + TRACE OF CLAY	BROWN	SOFT	64	76	12	591	579	clay+sand-brown	Sand	Clay	
FINE SAND + COURSE GRAVEL	BROWN	SOFT	76	87	11	579	568	sand +larger-brown	Sand	Gravel	
CLAY + SAND + ROCK	GRY/BRN	HARD	87	101	14	568	554	pebbly sand/silt/clay	Clay	Sand	Cobble
GRAVEL + CLAY + SAND	BROWN	HARD	101	115	14	554	540	pebbly sand/silt/clay-brown	Gravel	Clay	Sand
ROCKS + GRAVEL	BROWN	HARD	115	125	10	540	530	boulder or boulders-brown	Cobble	Gravel	
ROCKS + CLAY + GRAVEL	GRY/BRN	HARD	125	135	10	530	520	pebbly sand/silt/clay	Cobble	Clay	Gravel
GRAVEL + ROCKS	GRY/BRN	HARD	135	144	9	520	511	boulder or boulders	Gravel	Cobble	
HARD SHALE + TRACE OF SHALE	GRAY	SOFT	144	151	7	511	504	Eau Claire Formation	Shale	Sandstone	
SHALE + ROCK FORMATIONS	PINK	HARD	151	162	11	504	493	Eau Claire Formation	Shale	Sandstone	
LIMEROCK FORMATION	PINK	HARD	162	174	12	493	481	Eau Claire Formation	Shale	Sandstone	
LIMEROCK + LAYERS OF SHALE	PNK/BRN	HARD	174	181	7	481	474	Eau Claire Formation	Shale	Sandstone	
LIMEROCK + LAYERS OF SHALE	PNK/BRN	HARD	181	220	39	474	435	Mt.Simon Sandstone	Sandstone		
SANDSTONE LAYER OF SHALE	PINK	HARD	220	282	62	435	373	Mt.Simon Sandstone	Sandstone		
SANDSTONE	YEL/PNK	HARD	282	401	119	373	254	Mt.Simon Sandstone	Sandstone		
REDDISH SHALE	RED	HARD	401	418	17	254	237	Mt.Simon Sandstone	Sandstone		

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). Additional downhole information for this well (as noted in the Interpretation Method on the record above) controls the geologist's interpretation, which may not match the driller's description of the geologic material penetrated.

INTRODUCTION

The public health and economic development of Winona 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. The data bases described here address this need.

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 summarize basic geologic and hydrologic conditions at a county scale, and interpret these conditions in terms of the impacts of possible land- and water-use decisions. Site-specific information is available in some areas at a greater level of technical detail than shown on the maps of this atlas. The data are too voluminous to present at the scale of this 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. Understanding the process by which the material formed allows geologists to make predictions about what lies between and beyond data points.

All of the types of data described on this plate were interpreted by geologists or hydrogeologists to make them meaningful for mapping purposes. The 1:100,000 scale of the maps in this atlas was chosen because it shows 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. Some of the information is available in digital files that accompany this atlas.

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 and assigned inventory numbers. 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.

WINONA COUNTY DATA BASES

Computerized files were developed for point-source data such as wells and borings in Winona 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 Winona County by the Minnesota Geological Survey are County Well Index (CWI) and Quaternary Data Index (QDI).

County Well Index (CWI)—Information from water-well records and exploration holes is entered into this statewide data base. Each well log is assigned a 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, determined from topographic maps (see the index to 7.5-minute quadrangles) are generally accurate to plus or minus 5 feet (1.5 meters). Elevations determined from lidar (Light Detection And Ranging) datasets are generally accurate to plus or minus 1 foot (0.3 meter). 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 Winona County and augmented in some cases by additional data sources, such as cuttings, borehole geophysical logs, or core (Fig. 2). Only those drill holes with verified locations have stratigraphy assigned to them.

Quaternary Data Index (QDI)—Information from Quaternary samples collected and analyzed and from site descriptions is entered into this data base. QDI 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 fragments. Information pertaining to borings obtained from the Minnesota Department of Transportation can also be found in this database.

FUTURE DATA COLLECTION

Additional geologic information is generated continuously, as new water wells are drilled, construction activities expose more bedrock, or additional wells are tested for water quality. To address this, the library of information prepared for Winona 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.

ACKNOWLEDGEMENTS

The staff from Winona County Environmental Services contributed greatly to the development of the County Well Index (CWI) data base. We thank local water-well contractors and landowners for their valuable assistance.

THE DATA-BASE MAP

The types, locations, and density of information used to prepare the Winona 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 commonly 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 Winona County: about 2,500 logs were used for this atlas; they can be found in the County Well Index (CWI).

Core samples were collected at various sites throughout Winona County as a means to establish the nature of the subsurface material. The core samples were collected by the Minnesota Department of Transportation and the NRRI (Natural Resources Research Institute, University of Minnesota Duluth). Sixty-seven bedrock core samples were collected using diamond core drilling. This method uses a diamond bit rotating at the end of a drill rod. A column of rock moves up the drill pipe and is recovered at the surface for study. 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.

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 by a geologist 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. 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 Minnesota Geological Survey. They are limited in distribution: in Winona County they are concentrated along the U.S. Highway 61 and Interstate 90 corridors. These data are most useful in determining the composition of unconsolidated deposits. Descriptions of the geologic materials penetrated are entered into the Quaternary Data Index (QDI); all other information collected is contained in paper files.

Giddings probe holes are continuous cores of glacial materials, 2 inches (5.1 centimeters) in diameter, collected by a truck-mounted hydraulic auger. A description was generated at every site and samples were taken for textural analyses at most locations. Samples were generally taken about every 5 feet (1.5 meters), at unit contacts, or where the geologist believed it was important.

OTHER INFORMATION

Field sites are natural and artificial exposures of unconsolidated Quaternary deposits that were described in detail; samples from many sites were texturally analyzed. Field sites include stream and river cuts, gravel pits, and road cuts. Data from the field sites can be found in the Quaternary Data Index (QDI).

Textural analyses express the proportion of sand-, silt-, and clay-size particles that make up a sample. The samples analyzed were taken from natural and artificial exposures and the Giddings holes. They are helpful in determining origin, correlation, and hydrologic properties of unconsolidated sediments, and are included in the Quaternary Data Index (QDI).

Passive seismic depth to bedrock soundings provide information based on measurement and analysis of shear and surface wave energy in the ground that allow a calculation of the depth to bedrock beneath that point. The measurements employ a recording geophone system that is implanted into the ground surface and records ambient ground vibrations in 2 horizontal and 1 vertical directions over a 16-minute interval. The method is called passive because no energy is directly input into the ground at the time of measurement; the unit measures background (ambient) vibrations from a variety of natural and artificial sources such as vehicles or wind. Calculations of depth to bedrock are made after the major resonant frequency peak is calculated by taking the combined horizontal components and dividing by the vertical component. This peak frequency is fitted to a calibration curve of frequency (H/V) versus known depth to determine the depth to bedrock at the location of measurement. The calibration curve is constructed experimentally by making at least 30 measurements of H/V frequency at wells with known depths, plotting the results, and fitting a curve to the data. In general, depth to bedrock calculated by this method can have errors up to 15 to 20 percent of the depth; however, in areas with little to no other data, this is still useful information and many soundings can be inexpensively collected over a short period of time with one or two operators.

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. Outcrop data includes rock type and description (formation). Bedrock at or near the surface must be considered in land-use planning decisions such as pipeline routing, sewage-system design, and excavation.