PROGRESS REPORT NUMBER 22

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION
GERALD E. EDDY, DIRECTOR

GEOLOGICAL SURVEY DIVISION
WILLIAM L. DAOUST, STATE GEOLOGIST

RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF SCHOOLCRAFT COUNTY, MICHIGAN

BY

WILLIAM C. SINCLAIR
U. S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
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ABSTRACT

Schoolcraft County is on the north shore of Lake Michigan in the eastern part of Michigan's Northern Peninsula. The County is sparsely inhabited, most of the population being concentrated in the city of Manistique and other communities in the southern part of the county. The northern and central parts of the county are covered by forests and extensive swamps. The forest products and tourist industries are the backbone of the economy of the area.

The county is in the northern part of the Michigan basin, where Paleozoic rocks of Cambrian, Ordovician, and Silurian age form the bedrock surface. During the Pleistocene epoch, glacial ice, streams, and lakes deposited a wide variety of sediments over the bedrock surface. In some areas in the southern part of the county these sediments have been wholly or partly removed by erosion.

The best bedrock aquifers in the county are the sandstones of the Munising (Late Cambrian) and Hermansville (Late Cambrian and Early Ordovician) formations and the Manistique and Burnt Bluff formations of Niagara (Middle Silurian) age. Limestones and dolomites of the Richmond group and the Trenton and Black River limestones of Ordovician age may be sources of fresh water where they form the bedrock surface. These formations and the Cataract formation of Silurian age, however, commonly yield saline water, especially in areas where they are overlain by younger consolidated rocks.

Sand and gravel of glacial origin which mantle much of Schoolcraft County are important or potentially important aquifers. Glacial deposits consisting of silt and clay or sand and gravel containing significant amounts of clay are not important sources of ground water.

Adequate quantities of ground water of good quality are present in most of the county. However, various important aquifers containing water of good quality are covered or underlain by aquifers containing water of objectionable chemical quality. The glacial-drift aquifers generally yield soft or only moderately hard water of the calcium magnesium bicarbonate type. The sandstone aquifers yield water of good quality in the north, but the sodium and chloride content increases to an objectionable degree at the southern edge of the county. The Manistique and the upper member of the Burnt Bluff formation yield hard, but potable, water of the calcium magnesium bicarbonate type. Water in the Manistique and Gulliver areas, however, is subject to bacteriological contamination from surface sources, and the Burnt Bluff is hydraulically connected to the Cataract formation which contains water high in calcium and sulfate.

INTRODUCTION

Purpose and Scope of Study

A ground-water reconnaissance of the eastern part of the Northern Peninsula on a county-unit basis was begun in 1955 as part of the continuing cooperative investigation by the Michigan Department of Conservation and the U. S. Geological Survey. The objective of the reconnaissance is to determine the general occurrence, availability, quantity, and quality of ground water in the study area. This report is the fourth in the series of interim county-reconnaissance reports, and it summarizes the ground-water data obtained in Schoolcraft County during the 1957 field season. The first three reports of this series described the ground-water resources of Chippewa, Mackinac, and Luce Counties (Vanlier and Deutsch, 1958a and b; Vanlier, 1959). Pertinent data from those reports are used freely herein.

This ground-water investigation was directed jointly by A. N. Sayre, former chief, and P. E. LaMoreaux, present chief of the Ground Water Branch, U. S. Geological Survey, and W. L. Daoust, State Geologist, Michigan Department of Conservation, and was under the direct supervision of Morris Deutsch, District Geologist of the Federal Survey, in Lansing.

Previous Investigations

Various phases of the geology and hydrology of Schoolcraft County are described in a number of reports of investigations made in the Northern Peninsula of Michigan. An investigation of flowing-well districts in the eastern end of the Northern Peninsula was made by Frank Leverett in 1906.

A detailed investigation of the glacial features of the county was made by S. G. Bergquist (1936). O. F. Poindexter outlined the geology of the county in an unpublished report prepared about 1933 which contained a number of chemical analyses of ground and surface water samples, and these are included herein. He later (1935, 1936) studied the geology and hydrology of Big Spring and associated features. A reconnaissance study of the probable effects on ground-water levels of a Lake Superior-level canal from Munising to Manistique was made by the U. S. Geological Survey for the Corps of Engineers in 1949. Many of the data used in this report were collected during that survey. Ehlers and Kesling (1957) described in considerable detail the Silurian rocks in Schoolcraft County and in adjacent areas of the Northern Peninsula.

Acknowledgments

Special thanks are given to the well drillers and residents of Schoolcraft County and to the State, county, and municipal agencies whose cooperation made this report possible. Appreciation is expressed also to personnel of the Michigan Geological Survey and to members of the Michigan Basin Geological Society, who furnished much valuable data and assistance.

Well-Numbering System

The well-numbering system used in this report indicates the location of the wells within the rectangular subdivisions of the public lands, with reference to the Michigan meridian and base line. The first two segments of a well number designate the township and range; the third

segment designates the section and the serial number assigned to each well within the section. Thus, well 47N 16W 9-1 is well number 1 in section 9, Township 47 North, Range 16 West. Wells plotted on maps are identified only by serial number where section lines are shown, or by section and serial number where only township and range lines are shown. The locations to 40-acre tracts within the section of wells described in this report are given in table 3.

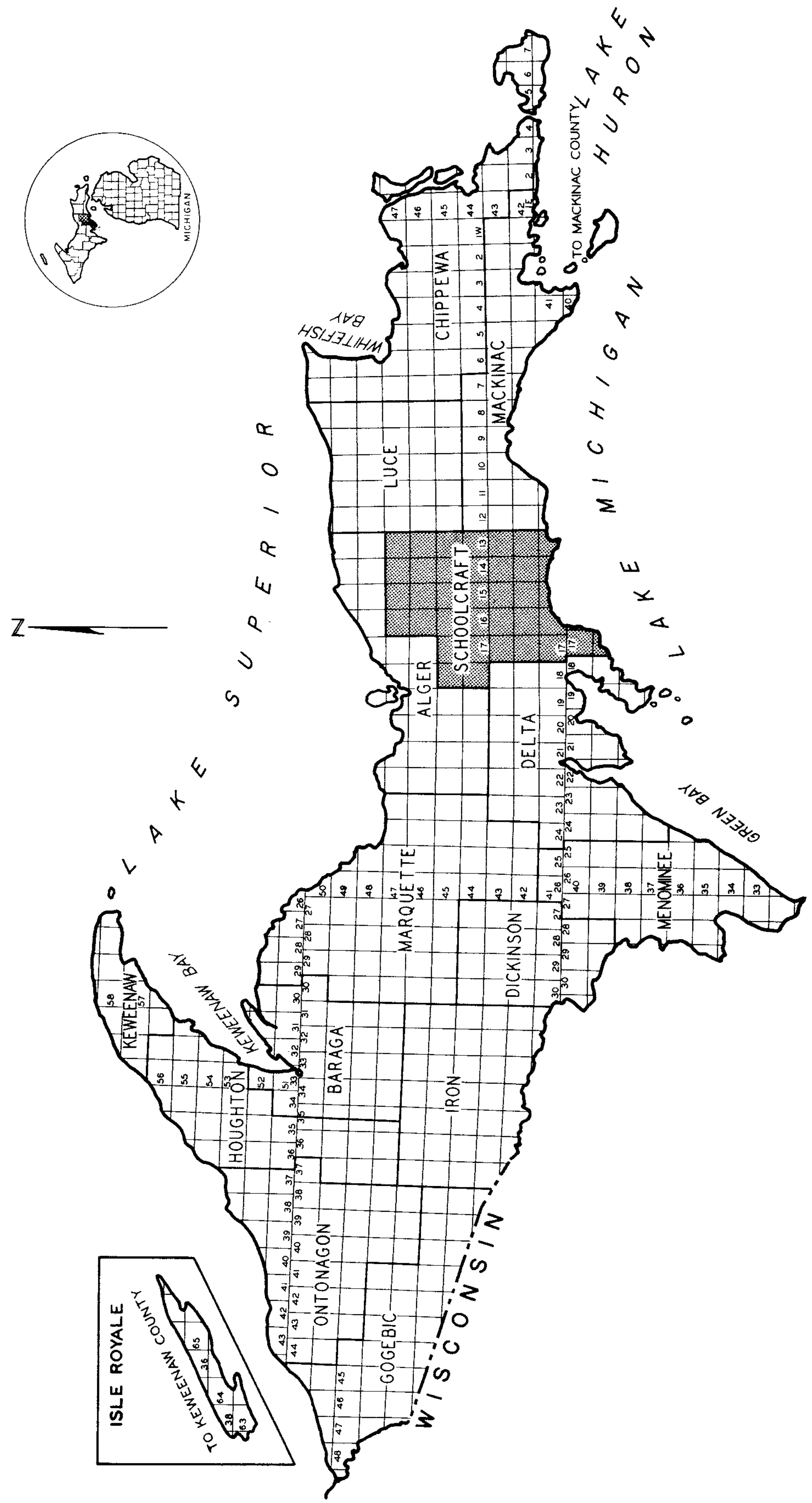

Figure 1. Index map showing location of Schoolcraft County, Mich.

GEOGRAPHY

Schoolcraft County is in the east-central part of the Northern Peninsula along the north shore of Lake Michigan (fig. 1). It is bordered on the west and north by Delta and Alger Counties and on the east by Luce and Mackinac Counties. It has an area of about 1,200 square miles, and a shoreline length along Lake Michigan of about 45 miles. Manistique, at the mouth of the Manistique River (fig. 2), is the county seat.

Population and Economic Development

The Michigan Economic Development Department estimated that the population of Schoolcraft County in 1957 was 8,620. Most of the inhabitants, including 4,780 persons in the city of Manistique, live in the southern part of the county; large areas in the northern part of the county are sparsely populated.

Industry in Schoolcraft County is closely related to the natural resources. Production of lumber, pulpwood, paper, and other forest products constitutes the major industry, which is almost equaled in dollar volume by the tourist business. Although commercial deposits of limestone may be present in Schoolcraft County, all the quarries previously worked have been abandoned in favor of high-quality deposits located in neighboring Mackinac County. Industrial expansion is anticipated as a result of completion of the St. Lawrence Seaway Project and the Mackinac Bridge.

Less than 5 percent of the total land area of the county is farmed, and most of the farmland is used for the production of dairy products. Nearly all the 250 farms are in the southern part of the county.

Transportation

The county is served by three railroads: the Duluth, South Shore & Atlantic; the Manistique & Lake Superior; and the Minneapolis, St. Paul & Sault Ste. Marie (fig. 2).

U. S. Highway 2 links the area with Sault Ste. Marie and with the North-Central and Northwestern States. It also provides easy access to Michigan's Southern Peninsula via the Mackinac Bridge. State Routes M-28, 77, 94, 98, and 149 provide a network of hard-surfaced roads in the county.

The county is served by interstate bus and truck lines. The auto ferry from Frankfort in the Southern Peninsula, which is operated by the Ann Arbor Railroad, stops daily in the harbor at Manistique. Manistique Harbor is unique as the only harbor in the Northern Peninsula that remains open throughout the year; the discharge of the Manistique River prevents the harbor from becoming ice-bound.

Physiography and Relief

Schoolcraft County lies in an area that was glaciated during the Pleistocene epoch, and many of its physiographic features were formed during the period of glaciation (fig. 7). Extensive sandy plains mark areas where sediments were deposited in the glacial Great Lakes which inundated much of the county at the close of the glacial epoch. Highlands and ridges in the vicinity of Hiawatha, Steuben, Cooks, and Blaney Park occupy areas where rock debris (till) was deposited in the form of moraines directly by the glacial ice. These upland areas rise abruptly to elevations of 60 to 90

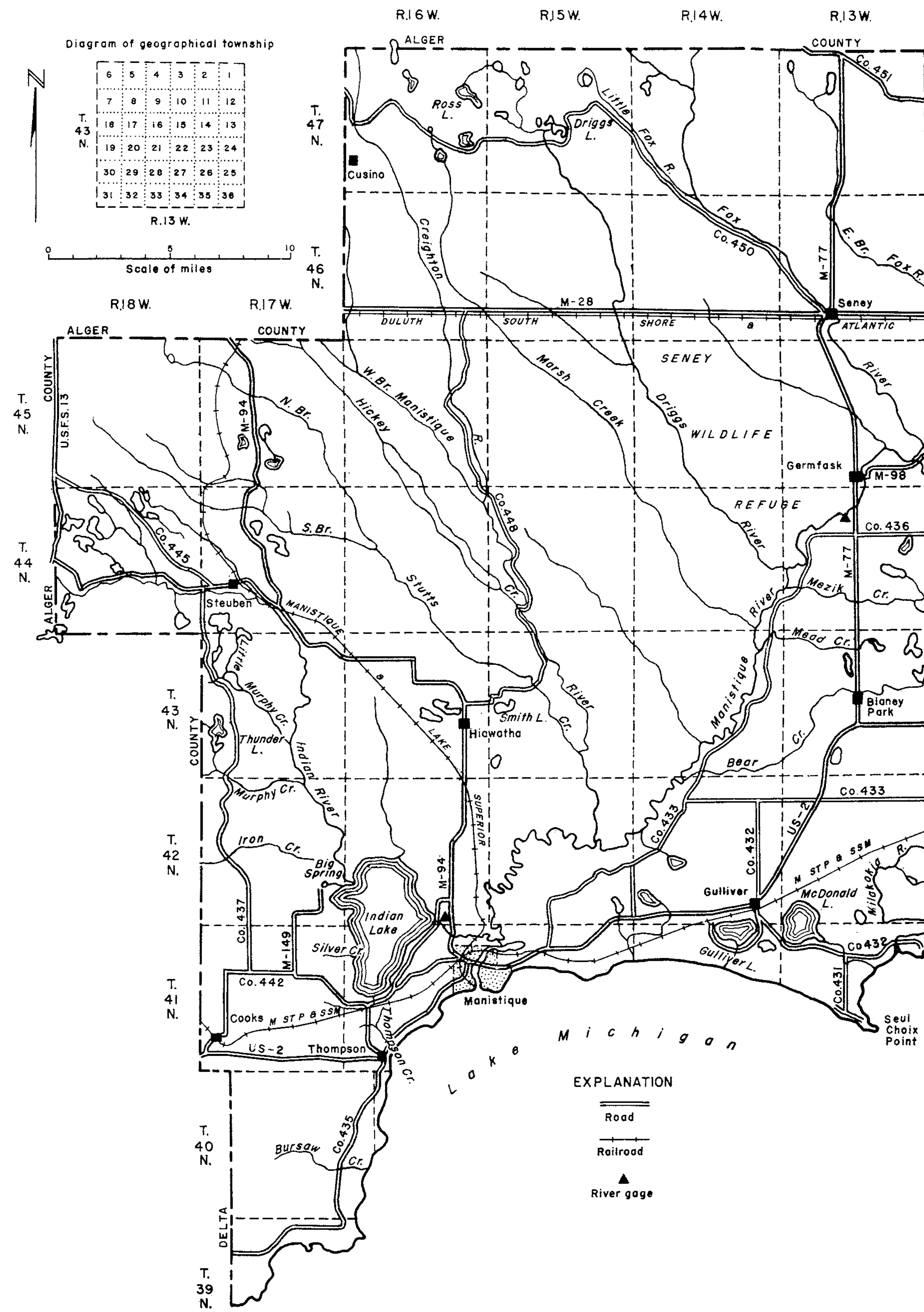

Figure 2. Map of Schoolcraft County

feet above the lake plains. Parts of the Kingston, Wetmore, and Boot Lake Plains in the northern and northwestern parts of the county (Bergquist) reach altitudes of about 1,000 feet above sea level. These plains are underlain by extensive deposits of sand and gravel outwash.

Because much of the drift was deposited in water and subjected to the currents and wave action of the glacial lakes, the relief is somewhat subdued and the distinguishing features of the various types of deposits are not easily recognized.

The lowest areas in the county are along the shoreline of Lake Michigan, which is at an altitude of about 580 feet.

The most prominent physiographic feature in the county, however, is related to the bedrock structure. This feature, the Niagara cuesta, is an asymmetrical ridge of resistant limestone and dolomite having a steep northern face, or scarp (fig. 3). It extends across the county in an arc about 10 miles inland and roughly parallel to the shore of Lake Michigan. In places the crest of the cuesta reaches a height of about 90 feet above the adjacent lake plains. South of the escarpment the topography reflects the bedrock surface, which slopes to the southeast at about 40 feet per mile. The cuesta is breached in the vicinity of Indian Lake along the trace of a preglacial valley. In some areas the topographic expression of the cuesta is obscured by a mantle of glacial drift.

Drainage

Nearly all of Schoolcraft County lies within the Manistique River Basin, which drains a total area of about 1,400 square miles. The Manistique River rises in Manistique Lake in Luce County and flows southwestward across Schoolcraft County from Germfask to Manistique, where it empties into Lake Michigan. Most of the major tributaries of the river flow southeastward across the county in roughly parallel courses until they join the main stream. The largest of these tributaries, the Indian River, flows into Indian Lake, and then to the Manistique River near Manistique (fig. 2).

The Manistique River flows at an average rate of about 1,700 cfs (cubic feet per second) or 760,000 gpm (gallons per minute). The maximum recorded flow was about 15,200 cfs and the minimum about 300 cfs.

South of the Niagara escarpment a total area of about 150 square miles is drained directly into Lake Michigan by the Milakokia River and by Thompson, Bursaw, and several other small creeks. The total length of all of the streams in Schoolcraft County exceeds 700 miles.

The 320 lakes, and the numerous sloughs and marshes in the county are evidence that the drainage is in a very early stage of development.

Climate

Records available from 1937 to the present indicate that Schoolcraft County receives an average precipitation of about 30 inches a year. Monthly precipitation totals at Germfask for the period 1953 through 1957 are shown in figure 11. Recorded temperatures range from a maximum of 97°F to a minimum of -35°F, and show an annual mean temperature of 41.7°F. The estimated average date of the last killing frost in the spring is June 15, and that of the first killing frost in the fall is August 27.

GEOLOGY

Schoolcraft County is underlain by sedimentary rocks of Paleozoic age which are mantled discontinuously by glacial deposits of Pleistocene age. The areal distribution of the Paleozoic rocks is shown in figure 3 and the surficial deposits in figure 7. The lithology and hydrology of the various rock units in the county are outlined in table 1 and are described in the section on Ground Water. Data concerning the depth, surface configuration, and nature of the Precambrian igneous and metamorphic rocks underlying Schoolcraft County are not available.

Summary of Geologic History

The Paleozoic rocks that underlie Schoolcraft County consist of limestone, dolomite, shale, sandstone, and gypsum. These rocks were deposited in the shallow seas which covered the Michigan basin during most of the Paleozoic era. The wide diversity of the sediments deposited is evidence of fluctuating sea levels, oscillating shorelines, and a variety of sediment sources.

During the estimated 200 million years between the Paleozoic era and the Pleistocene epoch, the Paleozoic rocks were uplifted and subjected to erosion, which resulted in the creation of some of the major physiographic features of Michigan. These features, later modified by Pleistocene glaciation, include the Niagara escarpment and the major valleys which are now part of the basins of the Great Lakes.

A period of glaciation (the Pleistocene epoch) followed the long interval of erosion. During this epoch, ice migrated southward from accumulation centers in Canada. The glaciers scoured and abraded the surface and

Table 1.--Lithology and hydrology of the rocks underlying Schoolcraft County

System	Series		NAMES AND SYMBOLS USED IN THIS REPORT LITHOLOGY	THICK-NESS (feet)	HYDROLOGY	NAMES USED BY MICHIGAN GEOLOGICAL SURVEY SYSTEM	SERIES	GROUP	FORMATION
QUATERNARY	Pleistocene	Wisconsin stage	GLACIAL DRIFT UNDIFFERENTIATED (Qgd) SAND (Qs); GRAVEL (Qg) SAND AND GRAVEL (Qsg) Deposits of sand, gravel, and boulder-clay till; well-sorted lake deposited clay, silt, and sand; well-sorted sand and gravel outwash; and well-sorted dune sand.	0 to 200+	In the northern two-thirds of the county the drift is composed primarily of moderately permeable sand which will yield small to moderate supplies of water. Locally, the drift is composed of permeable sand and gravel which may yield large supplies of water. In large areas of the southern part of the county the drift is thin and discontinuous, and generally not a source of water.	QUATERNARY	GLACIAL DRIFT (Wisconsin)		
SILURIAN	Niagara		ENGADINE DOLOMITE (Se) Massive hard bluish-white dolomite.	10±	Not an important source of water because of its limited areal extent and thickness.	SILURIAN	NIAGARAN	LOCKPORT	ENGADINE
			MANISTIQUE DOLOMITE (Sm) Thinly bedded to massive, light-buff to brown and gray siliceous dolomite, with chert nodules; secondary openings enlarged by solution.	150+	Yields fresh water to a number of wells in the southern part of the county. Permeability of these strata is the result of solution openings formed along joints and bedding planes.				MANISTIQUE
			BURNT BLUFF FORMATION (Sb) Thinly bedded to massive, light-gray to buff dolomite and dolomitic limestones.	250±	Important aquifer in the populated southern part of the county. Generally yields small to moderate supplies of water. Locally may yield large supplies. The basal strata of this formation may be hydraulically connected with the underlying Cataract formation which yields water high in calcium and sulfate.			CLINTON	BURNT BLUFF
	Lower Silurian		CATARACT FORMATION (Sc) Buff to gray, dense, shaly dolomite with layers of greenish-gray shale and gypsum.	150 to 200	Generally yields moderate supplies of water containing large amounts of calcium and sulfate.		ALBION	CATARACT	MAYVILLE CABOT HEAD MANITOULIN
ORDOVICIAN	Upper Ordovician	Richmond group	LIMESTONE AND DOLOMITE (Or) Light-brown dolomite and dolomitic limestones with layers of greenish-gray shale and some gypsum.	300+	Generally yields rather mineralized water. Locally these rocks may yield fresh water in the area where they form the bedrock surface.	ORDOVICIAN	CINCINNATIAN	RICHMOND	QUEENSTOWN? BIG HILL STONINGTON BILLS CREEK
		Collingwood formation	SHALE UNIT (Orc) Gray to dark-brown and black bituminous shale interbedded with layers of dolomitic shale.	200+	Not a source of water.				LORRAINE? UTICA? COLLINGWOOD
	Middle Ordovician		TRENTON AND BLACK RIVER LIMESTONES (Otb) Light-brown to gray dolomitic limestone, a few layers of greenish-brown shale.	250 to 300	Where these rocks form the bedrock surface they may be a source of fresh water. Where overlain by consolidated rocks they yield saline water.		MOHAWKIAN	TRENTON BLACK RIVER	TRENTON BLACK RIVER
	Lower Ordovician	OЄhm	HERMANSVILLE FORMATION Dense sandy dolomite with layers of clean, well-sorted sandstone and a few lenses of sandy shale.	20 to 80	These rocks form a single aquifer which will yield moderate to large supplies of water of good quality in most of the county. The water is under considerable artesian pressure and in nearly all the county will flow from wells. Along the southern edge of the county the aquifer may yield water high in sodium and chloride.				HERMANSVILLE
CAMBRIAN	Upper Cambrian		MUNISING SANDSTONE White to gray and some pink sandstone, slightly dolomitic, a few shale lenses.	400+		CAMBRIAN		LAKE SUPERIOR SANDSTONE	MUNISING
PRECAMBRIAN OR CAMBRIAN			JACOBSVILLE SANDSTONE (ЄpЄj) Red and white quartzitic sandstone.		Present in the northern part of the county; its southern extent is unknown. Permeability low. Not important as a source of water because mantled by water-bearing sandstones of the Hermansville and Munising formations.				JACOBSVILLE
PRECAMBRIAN			METAMORPHIC AND IGNEOUS ROCKS		Not a source of water.	PRE-CAMBRIAN			

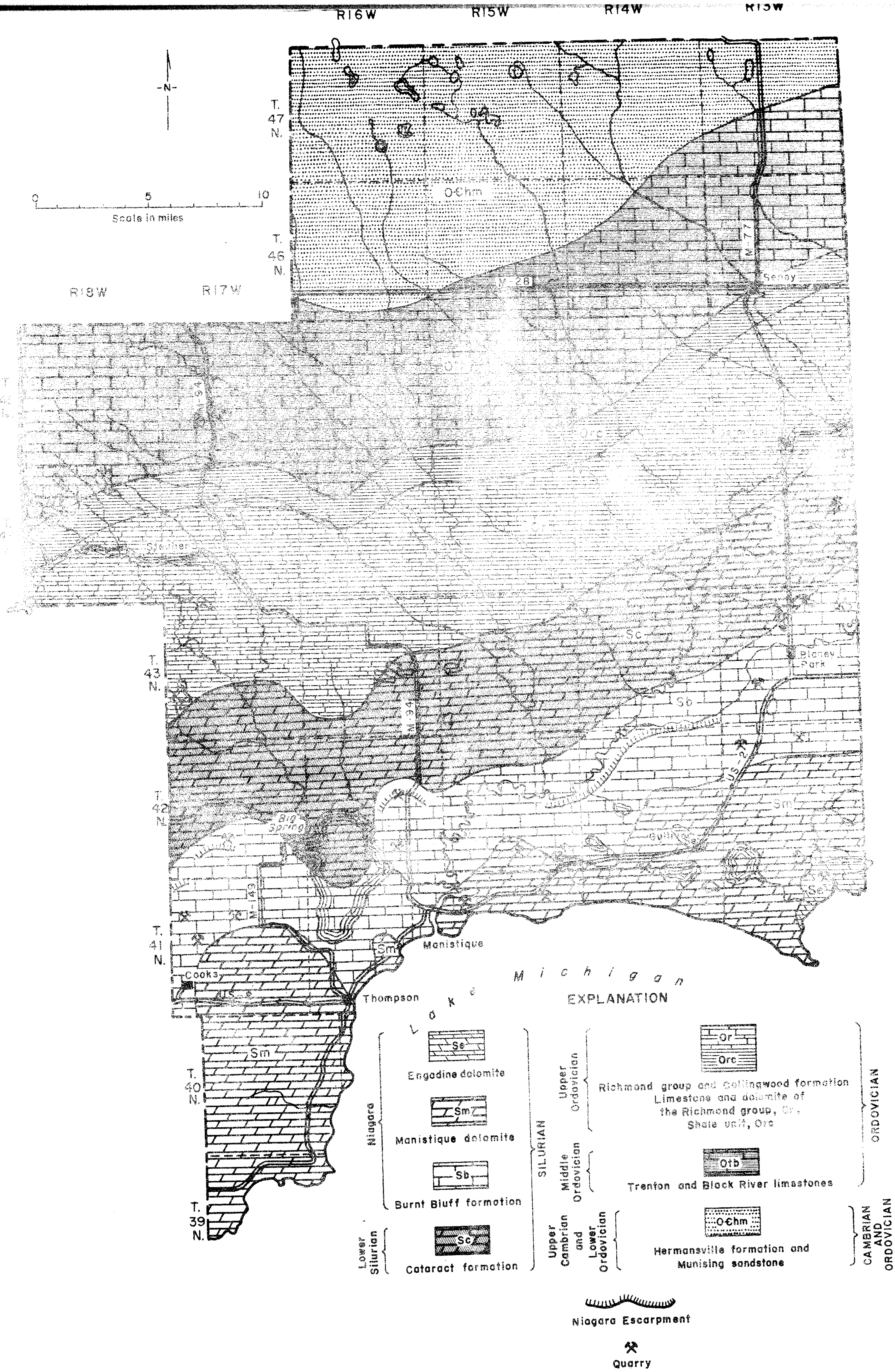

Figure 3. Bedrock geology of Schoolcraft County

transported vast amounts of material torn from it. With melting of the ice sheets, this material was deposited over the eroded Paleozoic rocks (fig. 4).

At the close of the Pleistocene epoch a succession of glacial lakes covered nearly all of Schoolcraft County. Postglacial uplift of the landmass that had been depressed by the ice changed drainage patterns, lake elevations, and shoreline positions (Leverett and Taylor, 1915, chaps. 21-25, and Hough, 1958). The result of these changes was a succession of postclacial upper Great Lakes. Lakes Superior, Huron, and Michigan represent the modern stage of this succession. Bars, beaches, wave-cut terraces, and dunes throughout the county mark the shorelines of this succession of lakes. Another result of the uplift was enlargement of the Manistique River drainage basin and decrease of the size of basins draining to Lake Superior.

Bedrock Structure

The Precambrian surface upon which the sedimentary rocks of Schoolcraft County are deposited generally slopes southeastward toward the center of the Michigan basin. The Paleozoic rocks of the basin were deposited in nearly horizontal layers, but gradual subsidence and compaction of the beds, which was contemporaneous with deposition and greatest in the center of the basin, produced a bowl-shaped structure. The youngest beds are exposed at the surface in the central part of this structure in central Michigan, and the older formations crop out in roughly concentric bands. Schoolcraft County is near the northern edge of the basin, where older sedimentary rocks are exposed. The regional dip of these formations in the county is to the southeast at about 40 feet per mile (fig. 5). The formations tend to become thicker in that direction.

Although details concerning the structure of the Paleozoic rocks throughout the county are not known, at least one deformation in the regional structure has been studied (Ehlers and Kesling, 1957). This local structure is a northwest-southeast-trending fold (anticline) in the vicinity of Seul Choix Point.

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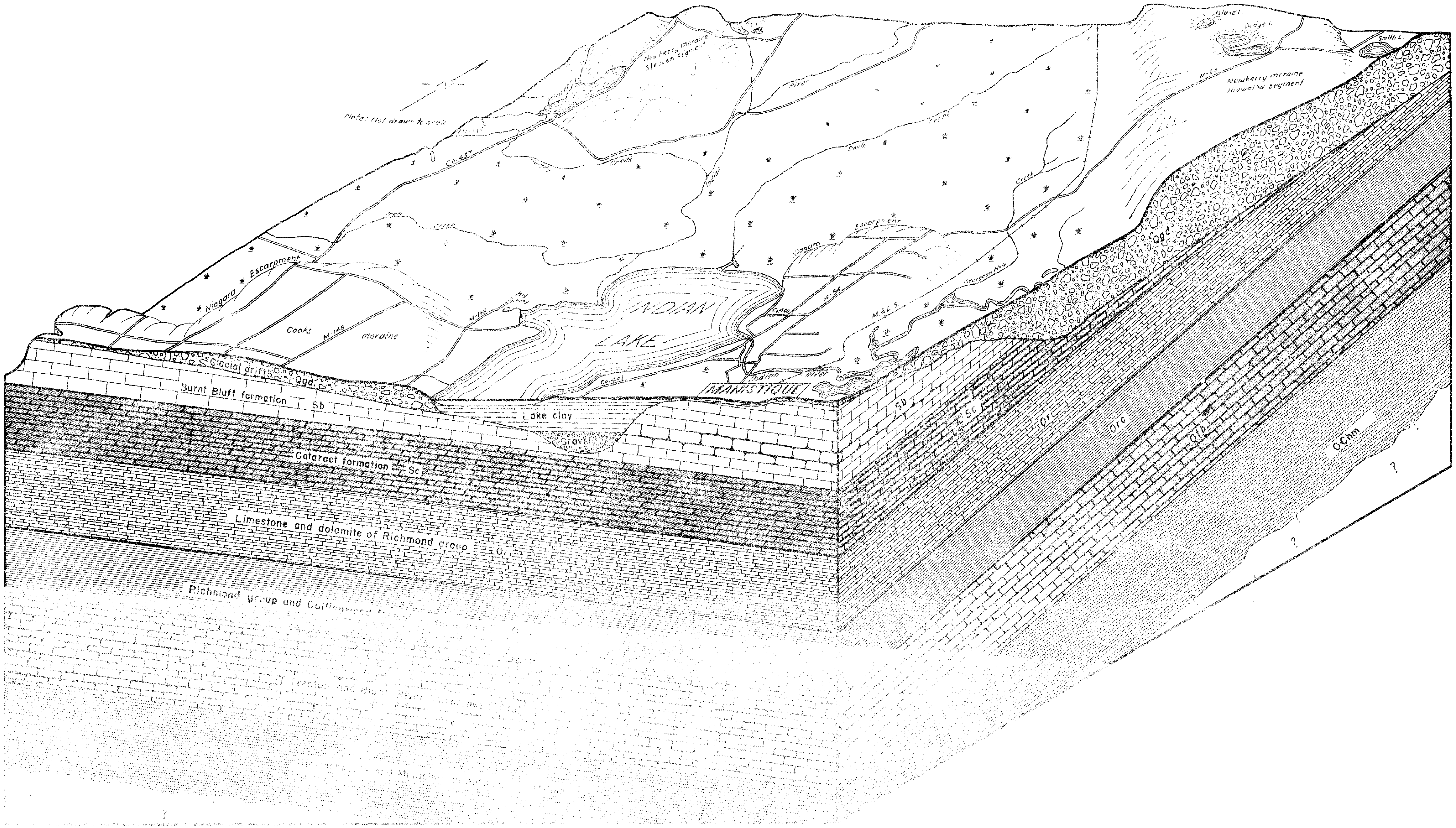

Figure 4. Block diagram [illegible] southwestern Schoolcraft County

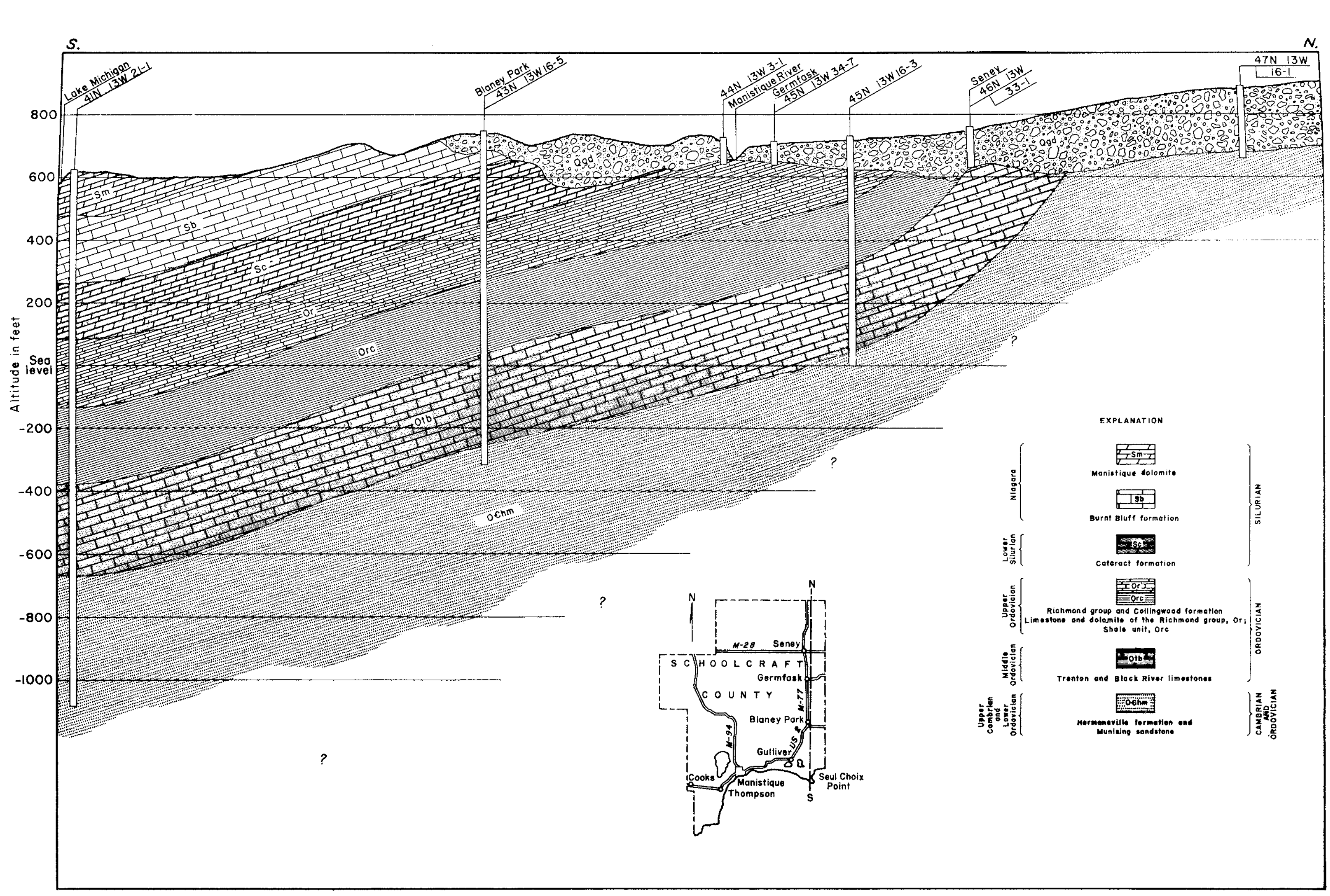

Figure 5. Geologic section through eastern Schoolcraft County

GROUND WATER

Principles of Occurrence and Availability

A rock formation, part of a formation, or group of formations that yields water in usable quantities is called an aquifer. The imaginary surface consisting of all points to which water would rise in wells tapping an aquifer is called the piezometric surface. Aquifers may be classed as water-table or artesian. In a water-table aquifer, ground water is unconfined and the ground-water surface within the aquifer is termed the water table and may be considered the piezometric surface of that aquifer. The zone of saturation is that portion of the formation in which openings are filled with water. In an artesian aquifer, ground water is confined under pressure between relatively impermeable strata (strata through which water does not move readily). Under natural conditions, the water in a well that is finished in an artesian aquifer and tightly cased through the overlying confining bed will rise above the bottom of that bed, and therefore the piezometric surface is above the top of the aquifer. An artesian aquifer is full of water at all times, even when water is being removed from it. In topographically low areas wells tapping artesian aquifers may flow at the surface.

Porosity is the ratio of the volume of open spaces in a rock to the total volume of the rock. Porosity is generally described as primary or secondary. Primary porosity is porosity that is present in the rock when it is first formed. Secondary porosity is porosity that was developed by processes that affected the rocks after they were formed. In unconsolidated deposits the porosity is generally greatest where the deposits are well sorted and least where they are poorly sorted. In consolidated rocks cementation, fractures, and solution and deposition by ground water are generally the most important factors determining porosity.

The capacity of a material to transmit water under pressure is called permeability. The degree of permeability depends on the size and shape of the pores and the extent to which they are interconnected. The coefficient of permeability (P) as used herein is reported in Meinzer and is defined as the number of gallons of water per day that will move through a cross-sectional area of 1 square foot under a hydraulic gradient of 100 percent at a temperature of 60°F. The field coefficient of permeability is the same except that it is measured at the prevailing temperature of the water. But the ability of the aquifer to yield water to a well is related also to the thickness and extent of these materials. A measure of the capacity of an aquifer as a whole to transmit water is called transmissibility. The coefficient of transmissibility (T) is defined as the number of gallons of water per day, at the prevailing temperature, that will move through a vertical strip of the aquifer 1 foot wide and of a height equal to the thickness of the aquifer under a hydraulic gradient of 100 percent, or 1 foot per foot. Hence, the transmissibility of an aquifer is the average field permeability of the rock materials multiplied by the thickness of the aquifer, in feet.

The yield of a well is a function of the transmissibility of the aquifer and the efficiency of the well. It is often expressed in terms of the specific capacity--the yield of water in gallons per minute for each foot of drawdown in water level caused by pumping of the well. Table 2 lists the specific capacities of a number of wells tapping various aquifers in Schoolcraft County.

The aquifers underlying Schoolcraft County consist of a variety of consolidated and unconsolidated rocks. The chief consolidated-rock aquifers are composed primarily of sandstone, limestone, or dolomite. In

Table 2.--Specific capacities of wells in Schoolcraft County

Well No.	Aquifer: Symbol 1/	Aquifer: Lithology	Drawdown (feet)	Rate of discharge (gpm)	Duration of test (hours)	Specific capacity (gpm/ft.)
44N 13W 3-3	Or	Limestone, shaly	3.5	21	.5	6
23-2	Qg	Gravel	20	50	1	2.5
43N 13W 16-5	O€hm	Sandstone	16	35	-	2.2
42N 17W 25-1	Qsg	Sand and gravel	10	15	12	1.5
42N 14W 33-6	Sm	Dolomite	17	20	6	1.2
35-4	Sm	do.	15	10	1	.67
41N 16W 3-4	Sb	do.	8	10	-	1.2
12-21	Sb	do.	3	50	1	17
12-24	O€hm	Sandstone	81	1018	50	13
12-30	Sc	Dolomite	2	33	1	16
41N 15W 9-1	Sb	do.	21	14	1	.67
18-2	Sb	do.	12	100	-	8.3

1/ See table 1.

the sandstone aquifers water moves through primary openings between individual sand grains and through secondary openings along fractures and bedding planes. Water in the limestone and dolomite aquifers of the county moves predominantly through permeable zones which were developed by weathering and solution along such secondary openings.

Shales interbedded with layers of limestone and dolomite are of low permeability and yield very little water to wells. They are important, however, as confining beds in artesian systems.

Aquifers in the glacial drift are the most accessible source of water in much of the county. The water in drift aquifers is contained in the spaces between rock particles, and the permeability varies with the size, shape, and degree of sorting of the particles.

Ground Water in Consolidated Rocks

Precambrian Rocks

Precambrian igneous and metamorphic rocks underlie all of Schoolcraft County. However, neither the depth to the surface of these rocks nor their composition or physical characteristics have been determined at any location in the county. Well 41N 13W 21-1 (table 3) which was drilled to a depth of 1,710 feet, and is the deepest well in Schoolcraft County, did not reach the surface of the Precambrian rocks. (Fig. 14, which precedes tables 3, 4, and 5, is an index of available well records, water-level information, logs, and chemical analyses of ground water in Schoolcraft County, and shows the geographic distribution of these data). Future development of Precambrian rocks in the county as a source of water is very unlikely because of their depth and probable low permeability, and because the Precambrian rocks are overlain by moderately permeable sandstone aquifers.

Jacobsville sandstone of Precambrian or Cambrian age

The Jacobsville sandstone does not crop out in Schoolcraft County. Where it is present at the surface along the shore of Lake Superior in Alger County, it is composed of hard, resistant quartzitic sandstone. The formation extends southward and is presumed to overlie Precambrian rocks in the northern part of Schoolcraft County. Permeability of the formation probably is low, as the voids between grains have been filled with cement and a secondary growth of the quartz crystals that form the sand grains. Joints and other fractures, which are present near the surface, probably are not well developed at depth (Vanlier, 1959). Because of the factors outlined, the formation is considered to have little potential as a source of water in the county.

Munising Sandstone of Late Cambrian Age and Hermansville Formations of Late Cambrian and Early Ordovician Age

The Munising sandstone of Late Cambrian age is the deepest and oldest formation in Schoolcraft County that may be considered a dependable source of ground water. It is composed of medium-grained white to gray sandstone. Locally, shale or slightly dolomitic sandstone layers are present (table 4, log 41N 13W 21-1).

The Munising sandstone is overlain by the Hermansville formation of Late Cambrian and Early Ordovician age. The Hermansville is a rather dense sandy dolomite with layers of clean, well-sorted sandstone. Logs of wells in the Northern Peninsula indicate that the dolomite concentration within the formation increases toward the west. Because of the similar lithologic properties of the sandstones in the Munising and Hermansville it is difficult to distinguish between the formations in drill cuttings and hence they are not differentiated in figures 3, 4, and 5. They are generally similar also in hydrologic characteristics and are treated herein as a single hydrologic unit.

A particle-size analysis of a typical sample of sandstone from an outcrop of the Munising in Alger County (Al 1, fig. 6) shows that about 90 percent of the sample is fine and medium sand. The coefficient of permeability normal to the bedding plane of this sample was 52 gpd per square foot.

Particle-size analysis of a sample of sandstone from the Hermansville formation in Luce County (Lu 9, fig. 6) shows that this formation also is a fine- to medium-grained sandstone. The interstices between sand grains in some of the beds of the Hermansville formation, however, are filled with dolomitic cement, which reduces the permeability of the formation considerably. The permeability normal to the bedding plane of sample Lu 9 was 0.04 gpd per square foot, and the permeability parallel to the bedding plane was 0.07 gpd per square foot. The low permeability of sample Lu 9 is undoubtedly due to the presence of the dolomitic cement. However, the dolomitic beds will probably yield appreciable quantities of water, as most of the water in the well-cemented parts of the formation moves along fractures and bedding planes. Laboratory determinations can indicate permeability along primary but not secondary openings in sandstone samples. Aquifer testing in the field is required to determine the total water-bearing characteristics of fractured sandstone formations.

A sample of the Hermansville formation from an outcrop in Chippewa County (Ch 10, fig. 6) revealed that it too was very similar in particle-size distribution and lithology to the Munising sandstone. This sample, however,

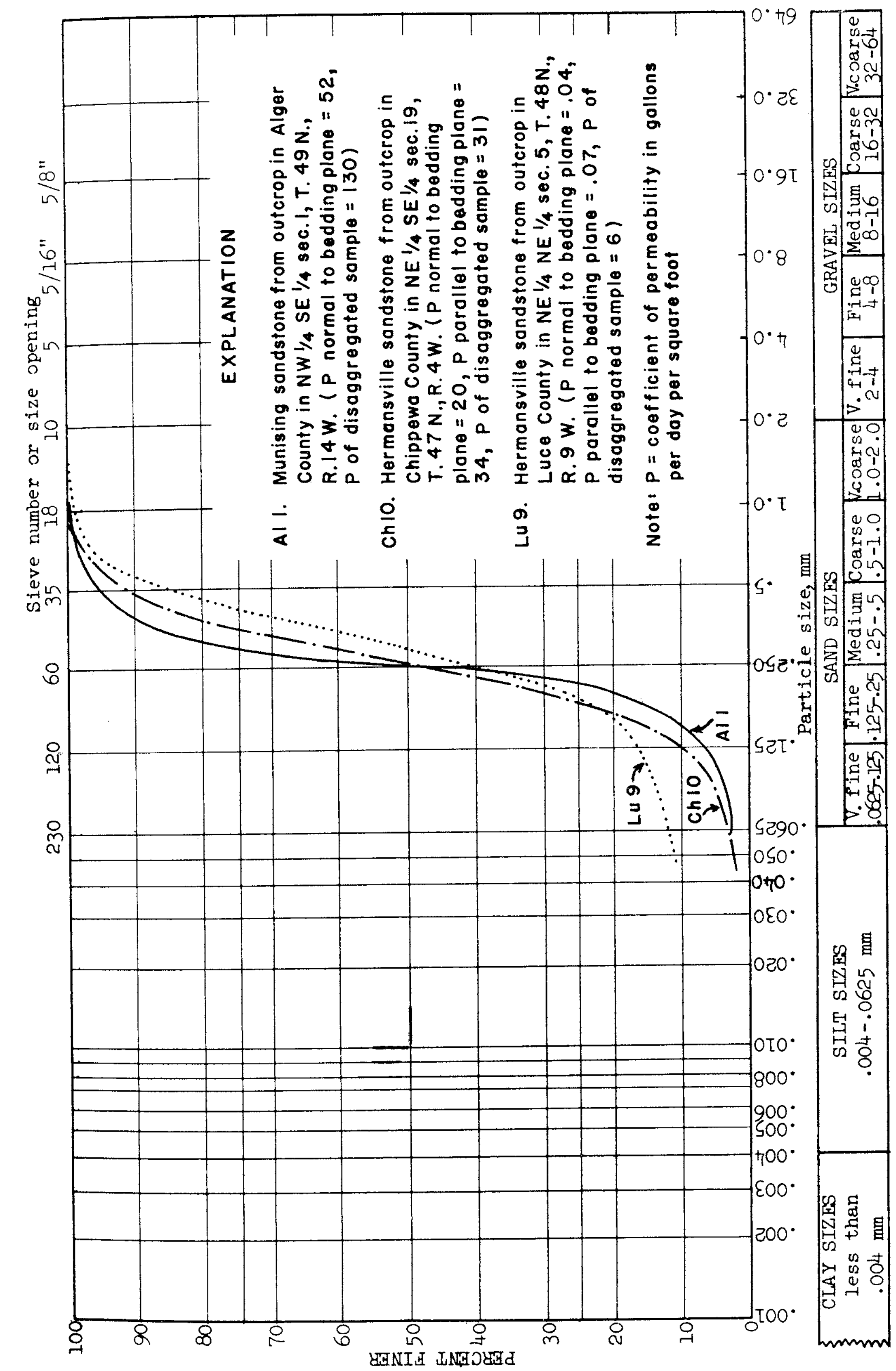

Figure 6. Particle-size-distribution curves of sandstone samples from the Munising and Hermansville formations in Alger, Chippewa, and Luce Counties.

appeared to contain much less cementing material than sample Lu 9. The sample had a permeability of 34 gpd per square foot parallel to the bedding plane.

The Hermansville and Munising formations are a source of fresh water throughout most of the county. In the northern part of the county they form the bedrock surface, but to the south they dip beneath the younger consolidated rocks (figs. 4 and 5). Along Lake Michigan the top of the aquifer is about 1,200 feet below the land surface. The mineral content of the water in the aquifer increases basinward, and may reach objectionable concentrations at the southern edge of the county, although samples analyzed for chemical content (table 5) are believed to be mixtures of water from these sandstones and overlying formations which, in this area, generally yield saline water.

Water in this aquifer is held under artesian pressure by overlying shale beds and, in most parts of the county, will flow at the surface. A water level of 28 feet above land surface was reported for well 41N 16W 12-24 in the city of Manistique in 1942 and 80 feet above land surface for well 41N 13W 21-1 near Seul Choix Point in 1921.

Black River and Trenton Limestones of Middle Ordovician Age

The Black River and Trenton limestones are lithologically similar and no attempt is made herein to differentiate between them. They consist of brown and gray dolomites and limestones with a few layers of soft green, brown, or black shale. Well records indicate that these formations have an aggregate thickness of 250 to 300 feet in Schoolcraft County (table 4).

Where these rocks form the bedrock surface (fig. 3), they are everywhere mantled by glacial drift deposits. Although they may be a source of fresh water in this area, the overlying glacial drift provides a more accessible source of water of good quality. In the southern two-thirds of the county these formations are covered by younger consolidated rocks (figs. 3 and 5). In this area the Black River and Trenton limestones yield moderate supplies of water under artesian pressure, but the water is generally highly mineralized and unsatisfactory for most uses. Artesian pressure in this aquifer sufficient to raise water 9.5 feet above the land surface was reported when well 43N 13W 16-5 was drilled in 1949 (table 3). Mineral-water zones within these rocks should be sealed off in wells drilled through them, to avoid contamination of fresh water both in the underlying sandstones and in the overlying rocks.

Collingwood Formation and Richmond Group of Late Ordovician Age

Shale unit.--A sequence of shale strata of the Collingwood formation and of the basal units of the Richmond group overlies the Trenton rocks. The Collingwood formation, at the bottom of the sequence, is composed of about 20 feet of dark-gray to black bituminous shale. The basal units of the Richmond group are composed primarily of gray shale and include layers of dolomitic shale. The total thickness of the shale unit in the southern part of the county is reported to range from about 200 to 260 feet (table 4). These shales are of low permeability and are not a source of water to wells in Schoolcraft County.

Limestone and dolomite of the Richmond group.--The upper units of the Richmond group consist of about 300 feet of dolomite, limestone, and shaly or sandy dolomite or limestone strata interbedded with shale. The log of well 43N 13W 16-5 (table 4) at Blaney Park also reveals the presence of streaks of gypsum in these strata. These rocks range in color from gray to brown. Rocks of the Richmond group are not known to crop out in Schoolcraft County.

Several wells in the county obtain water from Richmond rocks. The water occurs along fractures and bedding planes, which probably have been enlarged by solutional activity of ground water. Where overlain by the Cataract formation the water is confined under sufficient artesian pressure to cause it to flow at the surface in many places. In these areas the water is generally high in calcium and sulfate. Water of good quality might be obtained from these rocks where they form the bedrock surface (fig. 3). In this area, however, extensive development of the formation is unlikely, as the overlying glacial drift is a more accessible aquifer.

Cataract Formation of Early Silurian Age

The Cataract formation is composed of buff to gray, dense, shaly dolomite with layers of gypsum and greenish-gray shale (Ehlers and Kesling, p. 5-7). This formation ranges in thickness from about 150 to 200 feet. The Cataract is permeable as a result of solution openings which have been formed by leaching of the gypsum beds. This aquifer has been tapped for water at Blaney Park, at Manistique, and in the vicinity of Indian Lake, but in these areas it generally yields saline water (table 5). Generally, fresh

water cannot be obtained from this aquifer anywhere in Schoolcraft County because of the soluble gypsum present in the formation. Where the formation is overlain by fresh-water aquifers, drilling into the Cataract should be avoided in order to insure a supply of fresh water and to prevent contamination of the overlying aquifers.

Niagara Series of Middle Silurian Age

Limestone and dolomite rock strata of the Niagara series which form the bedrock surface along the southern part of Schoolcraft County are an important source of water. In much of this area the glacial drift mantle is thin, and the Niagara rocks are exposed at the surface in numerous places. The Burnt Bluff and Manistique formations are important aquifers because they are present in the area where most of the population of the county is concentrated. The Engadine dolomite, however, is present only in a few square miles in the southeastern corner of the county, along the Lake Michigan shore.

Wells drilled into these rocks obtain water from openings formed largely by solution and weathering when the rocks were exposed at the surface, and from permeable zones developed at depth through solutional activity of percolating ground water. Study of the Niagara rocks in Mackinac County (Vanlier and Deutsch, 1958b) revealed that the permeable zones are areally extensive, and it is probable that such zones are extensive in Schoolcraft County also. Not all of the soluble beds have been made permeable by solutional activity, however, as the development of solution voids in some strata probably was blocked by initial impermeability of the bed, or by restriction of ground-water flow through adjacent strata of low permeability.

Generally, permeable zones in the Niagara rocks are thin and are separated by relatively thick beds of low permeability. Thus, the yield of a well tapping one permeable zone in these formations will not increase significantly until the next permeable zone is reached. By contrast, in a well tapping a formation of uniform permeability, the yield will increase approximately in proportion to the thickness of the formation penetrated.

Burnt Bluff formation.--The Burnt Bluff formation is composed of about 250 feet of thin-bedded to massive light-gray to buff dolomite and dolomitic limestone. Some of the upper strata of the formation are beds of high calcium limestone, which is especially soluble. Caves have been formed by solution of portions of the high-calcium limestone members in adjacent areas in Mackinac County.

Water in the formation is generally confined under sufficient artesian pressure to cause it to rise to within a few feet of the land surface. A number of the wells tapping this formation flow at the land surface (table 3). The Burnt Bluff formation is the most important aquifer in the county, as it is the source of water to most of the wells in the populated areas. Generally, moderate supplies of fresh water can be obtained from it, and locally the formation will yield large water supplies.

Manistique dolomite.--The Manistique dolomite is a thin-bedded to massive light-buff to brown or gray cherty dolomite. Chert nodules are common in the upper layers of the formation. The Manistique has a maximum thickness of about 150 feet in the vicinity of Seul Choix Point where it is overlain by the Engadine dolomite.

The Manistique is an important source of water where it is present in sufficient thickness, principally along the Lake Michigan shore. A number of wells that tap this aquifer in the Gulliver area flow.

Engadine dolomite.--The Engadine dolomite is a massive hard bluish-white dolomite which is an extensive and important aquifer in Mackinac and Chippewa Counties. In Schoolcraft County, however, only a thin remnant of the basal portion of the formation is present in a small area in the southeastern corner of the county along the Lake Michigan shore. No wells in the county are known to tap the Engadine for a water supply, and the formation has little potential for development as an aquifer because of its limited areal extent and thickness.

Ground Water in Unconsolidated Sediments

The mantle of unconsolidated rock material that covers most of Schoolcraft County (fig. 7) was deposited by glacial action during the Pleistocene epoch. This material was plucked from the surface by moving ice and redeposited as till, outwash, lake sediments, and dunes. Glacial deposits are differentiated on the basis of their mode of deposition. Till is generally unstratified material that has been deposited directly from the ice, water playing a minimum part in the process of deposition. Outwash is stratified rock material that has been deposited by meltwater draining from the glacier. Glacial-lake sediments are stratified fine-grained materials laid down in glacial lakes. The general term used to describe all these deposits is glacial drift. Dunes are composed of well-sorted sand deposited by wind.

The physical, and hence hydraulic, characteristics of the drift deposits vary also according to the type of material from which the drift was derived. The sandy drift, which is the predominant type in the county, especially in the northern part, was derived mainly from the Cambrian and

Ordovician sandstone formations, and to a lesser extent from the Precambrian igneous rocks in the Lake Superior region. This is illustrated by comparison of figure 8, in which the particle-size analyses of several samples of till and one sample of dune sand are plotted, with figure 6, in which the particle-size distribution of samples of sandstone from the Hermansville and Munising formations are shown. It is apparent that the till and dune sand were derived almost entirely from the sandstone. The composition of the deposits sampled reflects primarily the source of the rock particles rather than the mode of deposition.

Clayey drift deposits such as the clayey till in the moraines in the southern half of the county were derived from the Ordovician and Silurian limestone, dolomite, and shale formations described above. Figure 9 shows the particle-size analyses of several samples of till from the southern half of the county.

The permeability of the drift deposits varies with the size of individual grains and with the degree of sorting. The most permeable drift sediments are the outwash deposits, which are composed of larger particles of rock and are relatively well sorted. Sandy or gravelly till which contains only minor amounts of clay and silt is generally of moderate permeability. Clayey till, however, is of low permeability. Dune sands and lake-deposited sands, which are well sorted although relatively fine grained, also are of moderate permeability. Lake-deposited silts and clays, or silty, clayey sands, are generally of low permeability.

The drift mantle of Schoolcraft County varies greatly in thickness. Where valleys or channels were cut into the underlying bedrock and subsequently filled with glacial sediments, the drift is known to be as much as 200 feet

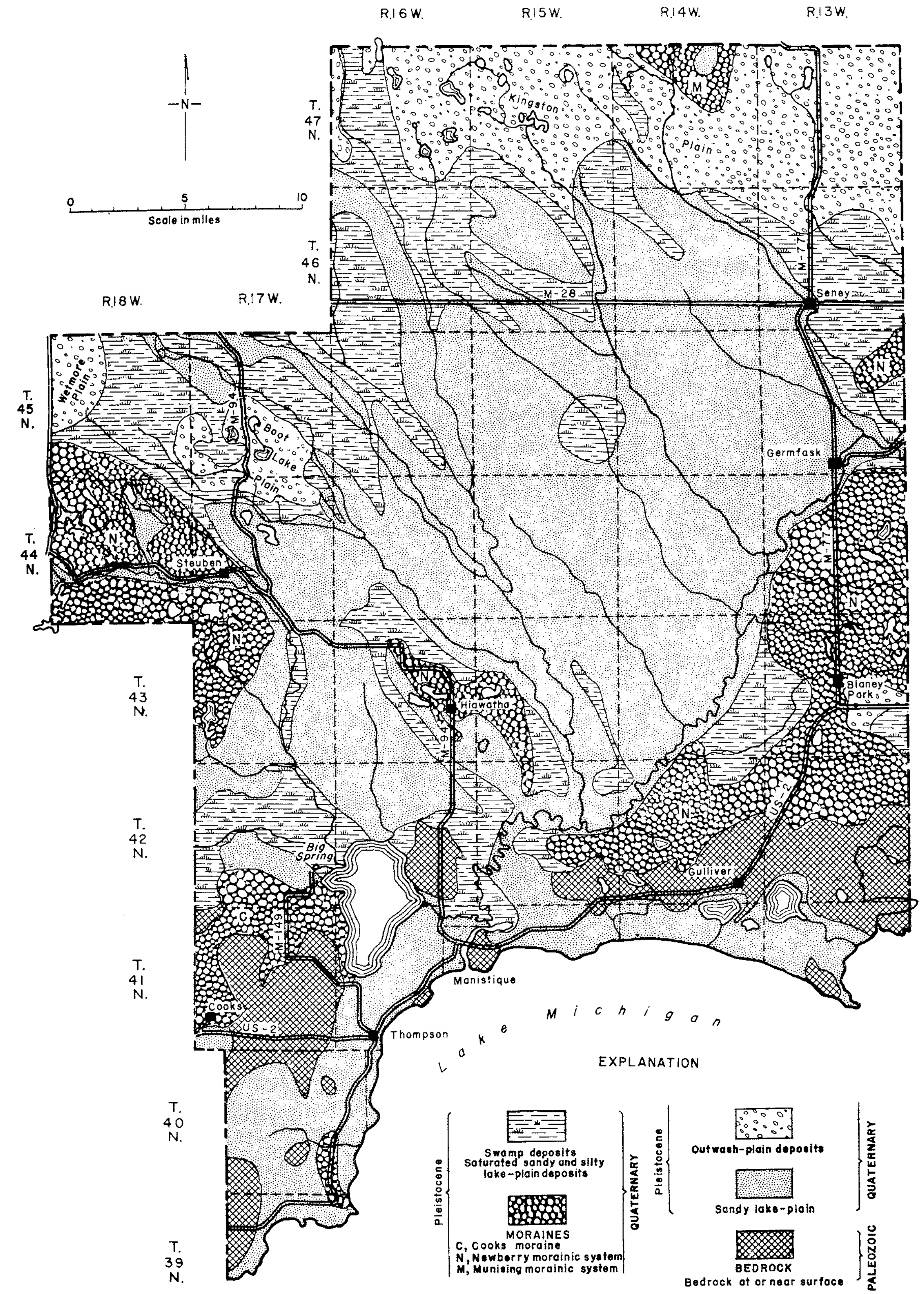

Figure 7. Surface geology of Schoolcraft County
(adapted from Bergquist, 1936)

thick. In the southern part of the county which is underlain by resistant Niagara rocks, the drift is generally thin or discontinuous.

Well records and surface evidence indicate that a pre-Pleistocene valley which connected the Lake Superior and Lake Michigan basins was cut into the bedrock formations underlying Schoolcraft County. This channel is believed to extend northward from the Lake Michigan shore between Thompson and Manistique through Indian Lake (fig. 4). The extent of this channel north of the Indian Lake region is not known, but is believed to be almost due north through T. 47 N., R. 16 W., and into Alger County. The reentrants in the bedrock formations along the trace of this inferred valley that are shown on figure 3 are based largely on surface evidence. The bottom of the valley contains permeable deposits of sand and gravel which are overlain by thick lake-clay deposits. The sand and gravel is the source of water to the many flowing wells near Indian Lake (table 3). Although data concerning this buried channel are incomplete, the channel deposits are believed to have considerable potential as a source of ground water of good quality.

Morainic Deposits

Moraines are ridges composed predominantly of glacial till deposited along the relatively static front of a glacier. The morainal till in Schoolcraft County is composed of unsorted rock particles ranging in size from clay to boulders, but the composition of the till varies with the bedrock sources from which it was derived. Areas in the county that are covered by moraines were mapped by Bergquist (fig. 7) who delineated them into the Cooks moraine and the Newberry and Munising morainic systems.

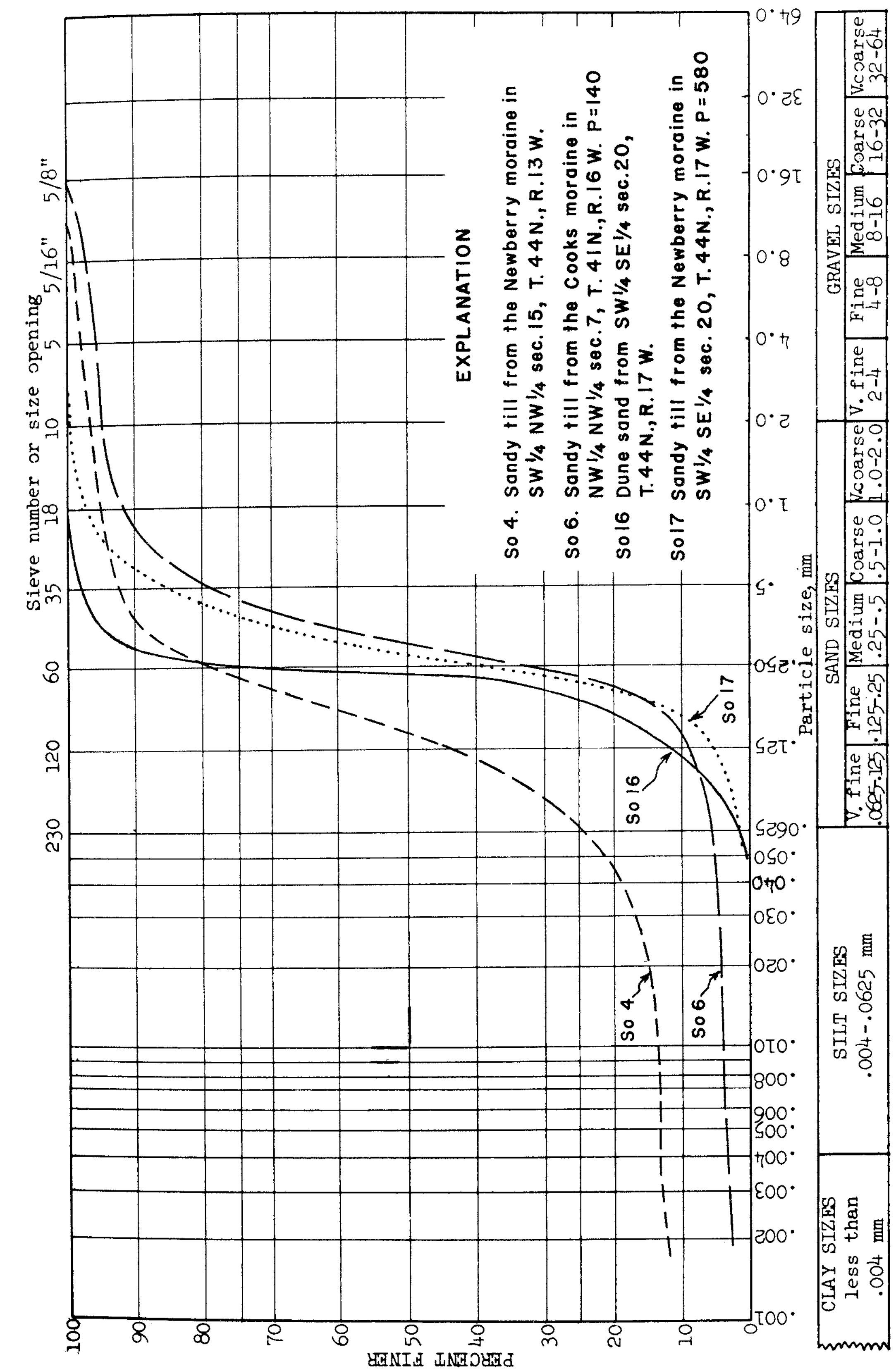

Figure 8. Particle-size-distribution curves of sandy till and dune-sand samples from Schoolcraft County

During periods of rapid recession of the ice the drift material was deposited in undulating sheets known as till plains or ground moraine.

Most of the till of the moraines in the county was deposited in the waters of the glacial Great Lakes. The relief of the moraines has been greatly subdued by the washing action of the glacial lakes, which has also stratified and sorted the till deposits to some extent.

Parts of the moraines and much of the clay and silt originally present in exposed portions of the moraines were subsequently removed by the currents and waves of the various postglacial lakes. This is demonstrated by the virtual absence of clay and silt in samples So 3 and So 19, each taken from a depth of 2 feet (fig. 9). The removal of fine-grained sediments in some places has greatly increased the permeability of the till deposit. Sample So 19, taken from a remnant of a wave-washed moraine, is composed primarily of gravel and has a permeability of 2,600 gpd per square foot (fig. 9). The particle-size-distribution curve of sample So 13, taken from a depth of 4 feet, is similar to that of sample So 19, but the sample contains about 18 percent silt and clay. The permeability of sample So 13 is only 220 gpd per square foot.

Cooks moraine.--The Cooks moraine, the oldest moraine in Schoolcraft County, is a knob of clayey till overlying a bedrock highland northeast of the village of Cooks (fig. 7). The average thickness of this till deposit is about 50 feet. All of the Cooks moraine except the high knob half a mile northeast of Cooks has been subjected to the wave and current action of the highest postglacial lake. Sample So 7 (fig. 9) was taken from a depth of 10 feet from the Cooks moraine at a level above the glacial lakes. The almost complete lack of sorting and the presence of about 40 percent of silt and

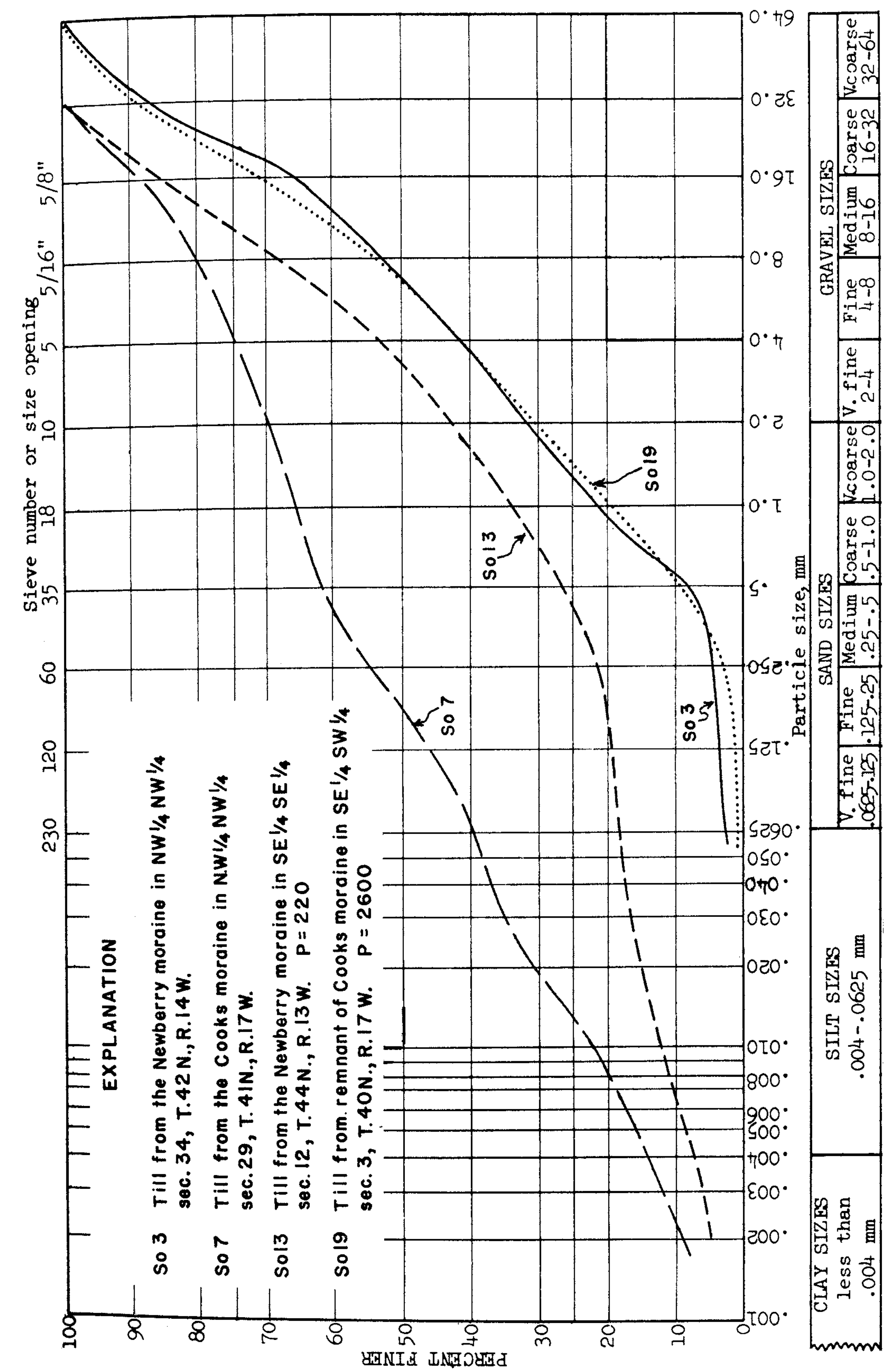

Figure 9. Particle-size-distribution curves of till samples from moraines in Schoolcraft County

clay in the sample indicates that the till has not been washed or reworked by the waters of the lake. The permeability of this material is low, and it would be difficult to develop a water supply from the glacial drift in this area. Low portions of the moraine from which clay and silt have been removed by water are fairly permeable and may yield amounts of water adequate for domestic purposes.

Newberry morainic system.--The Newberry moraine is the most extensive of the till deposits in Schoolcraft County. It extends in an east-west arc across the county (fig. 7), but has been dissected into three distinct segments: the Blaney, Hiawatha, and Steuben segments (Bergquist).

The Blaney segment overlies the Niagara cuesta along the Manistique River south of Germfask. In the Germfask-Blaney Park area north of the cuesta, the till is more than 100 feet thick in places, and locally is an important source of water. Yields are generally small, however, since the Blaney segment is composed primarily of poorly sorted boulder till with a comparatively high content of silt and clay, such as is represented by sample So 13 (fig. 9). In the area north and west of Gulliver, the moraine is thin and discontinuous and is not shown in detail on figure 7. In this area the morainal material generally is not a source of ground water.

The Hiawatha segment of the Newberry moraine forms a highland rising abruptly to an elevation of about 60 feet above the lake plains and separates the Manistique and Indian River basins. The till underlying this segment of the moraine is composed principally of sand, but includes small pockets of boulder clay, and is about 200 feet thick in the vicinity of Hiawatha. A number of wells there obtain water from the sandy till, although some difficulty has been encountered in screening out fine sand.

The Steuben segment has a basin and knob type of topography and reaches an elevation of about 900 feet. It is similar in composition to the Hiawatha segment. Although data concerning the thickness of the drift deposits composing the Steuben segment are not available, the thickness in this area is probably about 200 feet. These deposits presently are tapped by only a few wells of small capacity.

Munising morainic system.--A small part of the Munising morainic system extends from the main body of the moraine in Alger County into the northern part of Schoolcraft County (fig. 7). The moraine is composed largely of sandy till and forms part of the highland area along the northern tier of townships. The morainal deposit is permeable and is a potential source of water, although the area presently is uninhabited and undeveloped.

Outwash

Outwash plains are underlain by stratified sand and gravel which have been deposited by glacial melt-water streams. These deposits commonly are very permeable, and are a good potential source of ground water.

Large deposits of outwash materials occur in the northern part of the county. The Kingston Plain (Bergquist, p. 86) across the northern tier of townships is underlain by outwash carried by melt water from the glacial ice standing on the Munising moraine, as are Wetmore and Boot Lake outwash plains north of Steuben.

The only extensive outwash plain in the southern part of the county is east of Blaney Park. Although other small outwash deposits may be present, they are too small to be shown on figure 7.

The outwash deposits are tapped by only a few wells, as the deposits are located in sparsely inhabited areas.

Glacial-Lake Deposits

Lowlands in about two-thirds of Schoolcraft County are underlain by sand, silt, and clay deposited in the glacial Great Lakes. The surficial lake sediments are composed predominantly of sand, and hence the lake-plain areas shown on figure 7 are mapped as "sandy lake plain".

Figure 10 shows particle-size-distribution curves of three samples taken from the sandy lake plains. Samples So 14 and So 15, taken from depths of 2 and 3 feet, contain very little silt and clay and have permeabilities of 680 and 540 gpd per square foot. The permeability of sample So 5, taken from a depth of 25 feet, is only 170 gpd per square foot. All three samples are predominantly well-sorted sand, but sample So 5 is composed of slightly smaller particles and contains 10 percent more silt and clay, differences which, though scarcely noticeable to the eye, reduces the permeability of sample So 5 to about one-third of that of the other samples. These permeabilities indicate that the sandy lake deposits are potentially good sources of water in areas where they are relatively thick. Little information is available concerning the thickness and nature of the subsurface lake sediments throughout most of Schoolcraft County. In much of the county, however, the lake sands may consist merely of a veneer over the bedrock surface or other glacial deposits.

In some parts of the county, silty or clayey lake sediments underlie the sandy lake deposits. This is illustrated by the log of well 46N 13W 33-1 near Seney (table 4), which shows 60 feet of lake-deposited sand overlying 40 feet of blue lake clay.

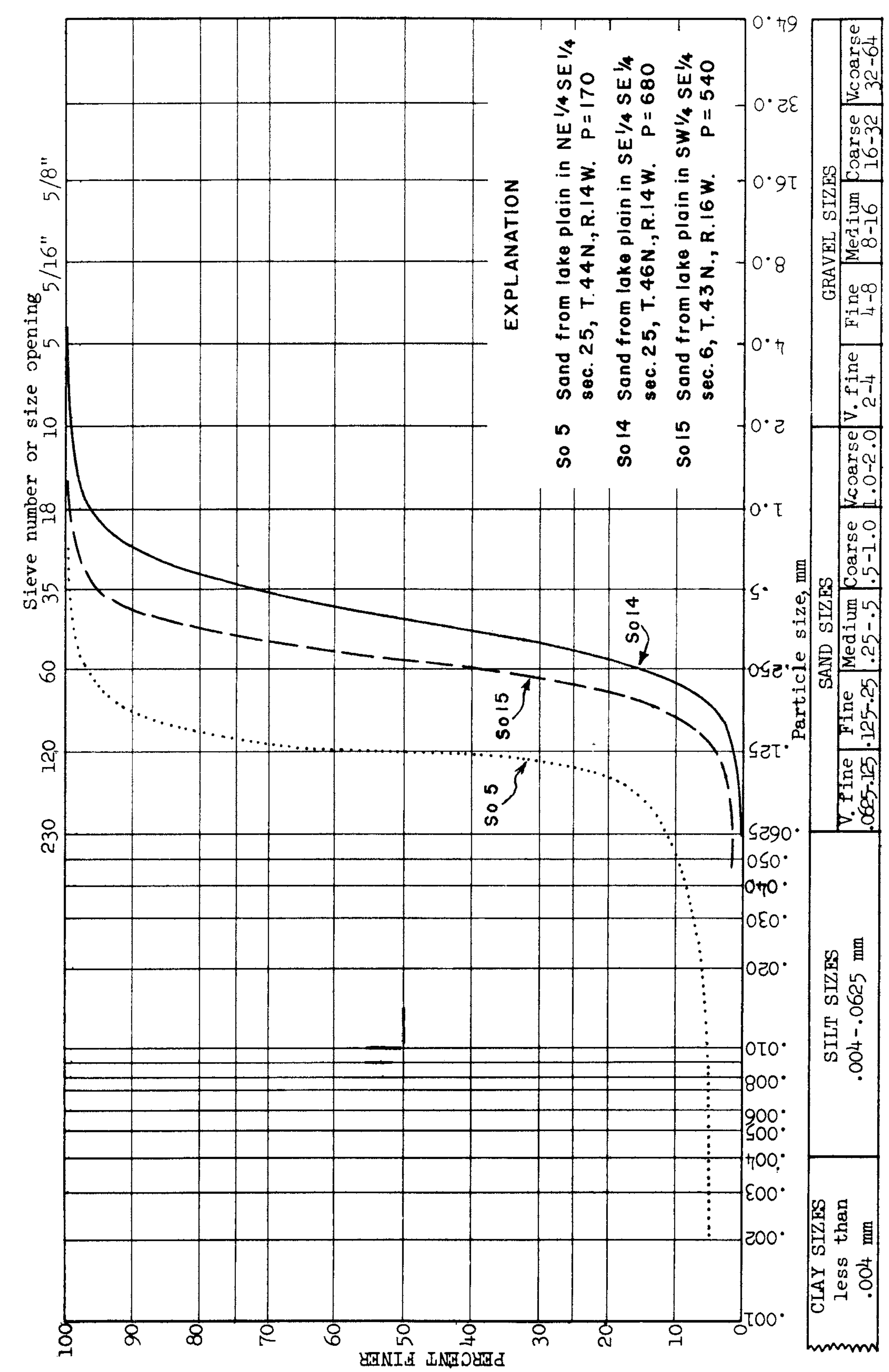

Figure 10. Particle-size-distribution curves of lake-deposited sand samples from Schoolcraft County

Dune Sand

Areas of windblown sand are prevalent in parts of the county. Although very permeable, these deposits are above the water table in most areas and cannot be considered a source of water; however, they are important recharge areas. The individual dunes are relatively small, and hence are not shown on figure 7.

Ground-Water Phase of the Hydrologic Cycle

Source and Recharge Areas

The initial source of all fresh ground water in the aquifers of Schoolcraft County is precipitation, and the average annual precipitation over the county is about 30 inches. Most of the precipitation, however, does not enter the ground-water reservoirs, but is lost by evaporation, transpiration, and direct runoff.

The amount of precipitation that does enter the ground-water reservoirs is influenced by a number of factors including the duration, intensity, and type of precipitation, the density and types of vegetation, the topography, and the porosity and permeability of the soil, subsoil, and underlying rock formations. Also, an aquifer that is already full to overflowing obviously cannot receive additional water.

Conditions for recharge are favorable in the part of the county that is underlain by permeable sandy glacial sediments (fig. 7). In large areas in the southern part of the county, permeable limestones and dolomites at or near the surface have large infiltration capacities. Small areas of the county are underlain by clayey sediments, which impede infiltration of precipitation into the ground-water reservoirs.

Movement

The movement of water underground is similar to movement in surface streams, which is by gravity from high to low levels. Percolation of water through the interstices between rock particles below the surface involves a great amount of friction and hence is much slower than the flow of water upon the surface. Rates of ground-water movement range widely from a few feet per year to many feet per day. Water may travel considerable distances underground from recharge areas to areas down-gradient, where it may once more reach the land surface and appear as a seep or spring, join the flow of streams, enter a lake, or escape to the atmosphere by evaporation and transpiration. Where undisturbed by manmade diversions, the piezometric surface of an aquifer near the surface conforms generally to the configuration of the overlying land surface. In the deeper artesian aquifers, however, the shape of the piezometric surface may differ considerably from that of the land surface. Where more than one aquifer underlies the same area, water will migrate or leak from an aquifer of high head to an overlying or underlying one of lower head.

Discharge

Water is discharged from ground-water reservoirs by evaporation and transpiration and through wells, springs, and drains. Because much of the county is covered by dense growths of forest and swamp vegetation, the amount lost by evapotranspiration is presumed to represent a large percentage of the total discharge. It is likely, also, that large amounts of ground water are discharged at depth directly to Lake Michigan.

The greatest discharge by wells is that from flowing and pumped wells in the Manistique-Indian Lake area. Several flowing wells in the Blaney-Germfask area discharge water from the Cambrian and Ordovician sandstones. A considerable amount of water is discharged also by springs. Several springs are located along the west shore of Indian Lake. Big Spring or Kitchi-ti-ki-pi, which was described in detail by Poindexter (1935 and 1936), is the largest and best known of these. The discharge of Big Spring fluctuates between 20 and 40 cubic feet per second.

Water Level Fluctuations

Effects of Climate

Fluctuations of the water level in well 45N 13W 16-1 (fig. 11), which taps the limestones of the Richmond group near Germfask, have been observed since 1952 (Giroux, 1957). Since the beginning of record, through 1957, the maximum range in water levels has been slightly more than 1 foot. Analysis of the record on this well reveals that the water level fluctuates primarily in response to climatic conditions. This is indicated graphically in figure 11 by correlation of the graphs of monthly precipitation, water levels, and discharge of the Manistique River for the period 1953-57. In 1956 and 1957 precipitation was below the average for the period, and so, therefore, were water levels and streamflow. During the three years prior to 1956, precipitation was above the period average, and this also is illustrated by the curves showing cumulative departures of water levels and streamflow from the monthly averages. The streamflow data were obtained from a gaging station operated by the U. S. Geological Survey on the Manistique River about a mile south of Germfask. The river at this point

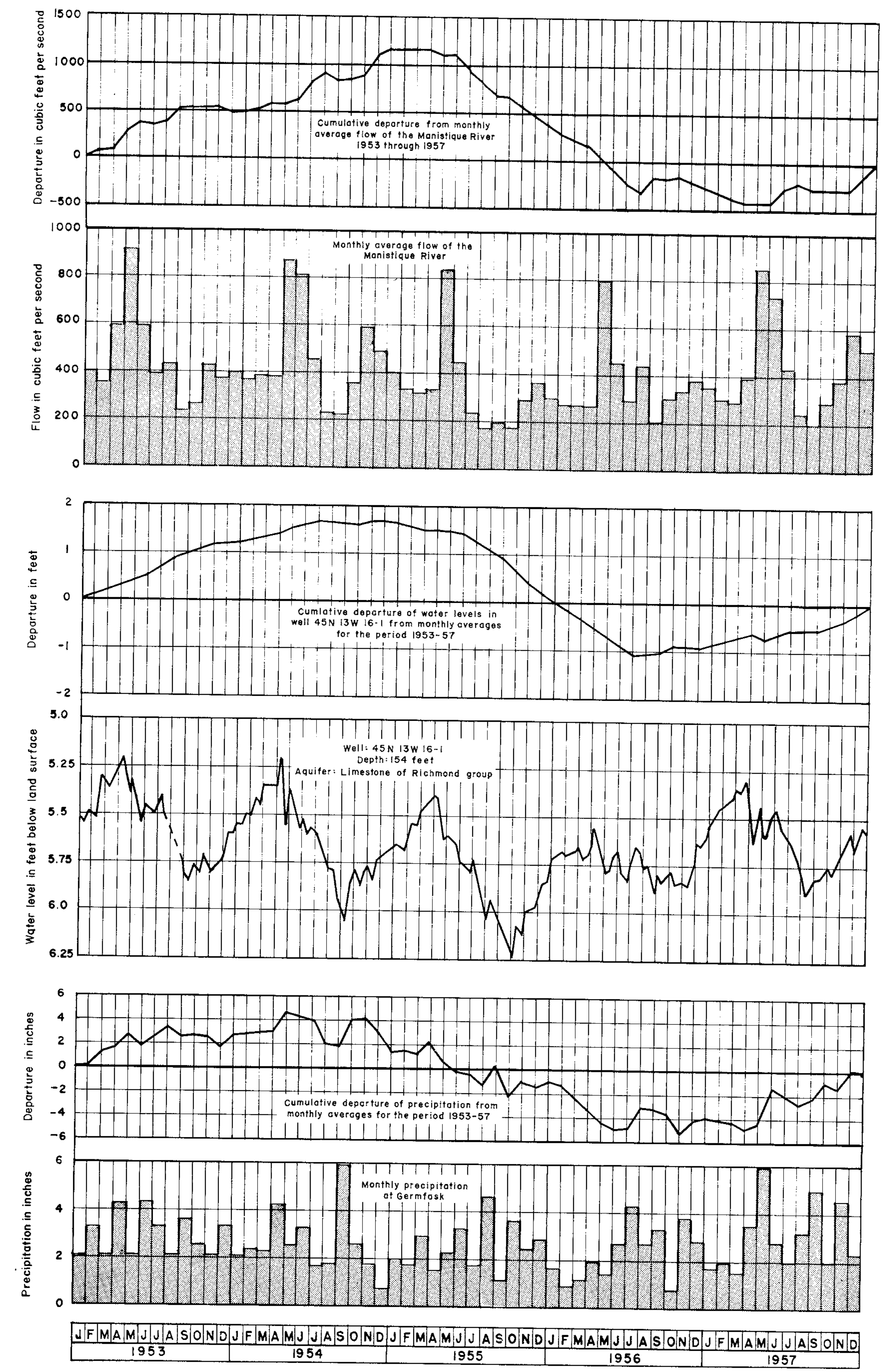

Figure 11. Graphs showing effects of precipitation on water levels in well 45N 13W 16-1 and discharge of the Manistique River near Germfask

drains an area of 341 square miles to the north and east, including the Seney Wildlife Refuge.

Water levels respond also to seasonal changes in climate. Precipitation in the form of snow has little effect on water levels or streamflow until the spring thaw permits runoff and infiltration. As shown in figure 11, the peaks in streamflow and recharge are reached between the spring thaw and the summer growing season. During the growing season, evaporation and transpiration of water by the dense vegetation use most of the available precipitation, thereby causing declines of water levels and stream discharge. Toward autumn, as the temperature falls and vegetation becomes dormant, precipitation is again available for ground-water recharge and surface discharge.

Effects of Discharging Wells

Generally, ground water is a renewable natural resource because it is replenished directly or indirectly by precipitation. Under natural conditions an aquifer is in a state of equilibrium with respect to recharge and discharge. When water is withdrawn from an aquifer by a well, a temporary increase in the total discharge from the aquifer results. This discharge by the well causes a cone-shaped depression in the water table or piezometric surface around the discharging well. Continued discharge expands the cone until the resultant lowering of the piezometric surface causes a decrease in natural discharge from the aquifer or an increase in recharge, which may restore the aquifer to a state of equilibrium. If the discharge from a well, or group of wells, exceeds the total available recharge, the water level will continue to decline as long as the discharge is maintained.

A lowering of the piezometric surface always results from the discharge of water from a well. Where a number of wells are pumped or allowed to flow, a composite cone of depression is formed which may extend over a large area. Water levels in wells within the cone of depression caused by discharge of other wells are thus lowered. A lowering of the piezometric surface is inevitable in the development of an aquifer. This principle was illustrated in the city of Manistique where artesian pressures in several wells were reported to have dropped at the time flowing well 42N 16W 12-24 was installed. Waste of water, however, as from unrestricted flowing wells or by underground leakage from poorly constructed wells or deteriorated well casings results in unnecessary lowering of the piezometric surface, which may cause some wells to cease flowing, decrease yields, and increase the cost of producing water.

Declines in artesian pressure due to pumping have been noticeable only in the vicinity of Indian Lake and in the city of Manistique. In most of Schoolcraft County withdrawals of water have had a negligible effect on water-level fluctuations, as the amount of pumpage is but an insignificant percentage of the available recharge.

Utilization of Ground Water

The city of Manistique has a small number of wells which are used for water supply, but the water of Indian River is its main source of supply. The rest of the county is supplied by privately owned wells or springs.

Stock and domestic use, including the use of water by the tourist industry, accounts for most of the county's use of ground water. Only a small amount of ground water is used by industry in general. The total amount of ground water used in the county is but a small fraction of the total available resource.

QUALITY OF WATER

Ground Water

The minerals present in ground water are acquired primarily by solution of minerals in the rock or soil through which the water percolates. In general, the degree of mineralization of the water is determined by the composition and solubility of the rock or soil; the duration of contact; and other factors such as pressure, temperature, and the amount of mixing, if any, with connate water (water entrapped at the time the sediment was deposited). Water that contains more than 1,000 parts per million (ppm) of dissolved mineral matter is herein considered saline regardless of composition.

Table 5 lists the chemical analyses of ground-water samples collected in Schoolcraft County. Geochemical interpretation of these analyses is aided by the diagrams in figure 12. The diagrams are drawn by plotting in equivalents per million (epm) the concentrations of six important ions and connecting the points plotted according to a technique devised by Stiff (1951). The diagrams are useful in determining the source of the sampled water, the general chemical character of the aquifer, and variations in the chemical quality of water within a given aquifer.

The sandstones of the Hermansville and Munising formations yield water of good quality throughout most of the county. The hardness of water sampled from these formations ranged from 100 to 201 ppm except for the sample taken from well 41N 14W 2-1 near Seul Choix Point, which had a hardness of 351 ppm. The hardness of water (expressed as $CaCO_3$, in parts per million) is classified by the Michigan Department of Health (1948) as follows:

Class of water	Hardness (Parts per million)
Very soft	Less than 50
Soft	50-100
Moderately hard	100-200
Hard	200-300
Very hard	More than 300

The term "grains per gallon" is sometimes used to express hardness. One grain per gallon equals 17.1 ppm.

The sodium and chloride content of water in these formations increases toward the south (table 5), but the content throughout the county has not been determined. It is believed that part of the chloride present in some of the deeper wells tapping these sandstones represents leakage from other formations. Concentrations of chloride in excess of 250 ppm are considered to be objectionable for drinking water. The diagram of the sample from well 41N 16W 12-24 (fig. 12) is different in shape from diagrams of other samples taken from the sandstones. The presence of 360 ppm of sulphate indicates that this sample is a mixture of waters from the Hermansville and Munising formations and the Black River and Trenton limestones. Sulfate concentrations greater than 250 ppm also are considered objectionable for drinking water.

Although only a few wells in the county have produced water from the Black River and Trenton limestones, data from wells in adjacent areas indicate that these formations are generally not a source of fresh water where they are overlain by younger consolidated rocks. They may be a source of fresh water where they form the bedrock surface as in adjacent areas of Alger County. Wells tapping these formations at depth in Delta and Mackinac Counties yielded water containing objectionable amounts of sodium and chloride. The only sample of water taken from the Black River and Trenton limestones in Schoolcraft County contained 1,300 ppm of sulfate.

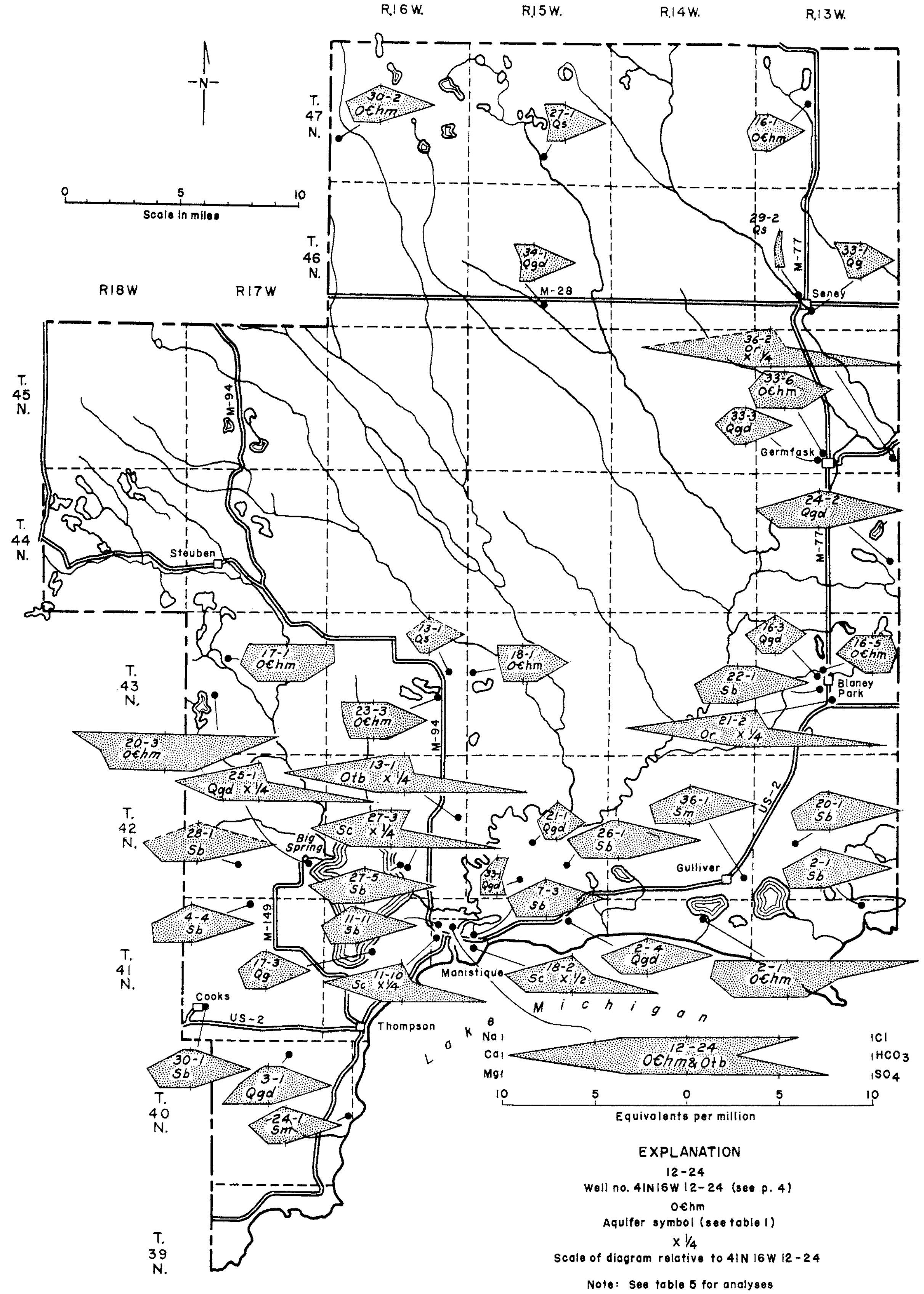

Figure 12. Selected diagrams showing variations in chemical quality of ground water in Schoolcraft County

The limestones and dolomites of the Richmond group generally yield saline water. Water from well 45N 13W 36-2 (table 5) had a hardness of 1,750 ppm. However, these rocks are a source of fresh water in the area where they form the bedrock surface in Luce County. Locally, where they form the bedrock surface in Schoolcraft County, they may also be a source of fresh water.

The Cataract formation is not a source of fresh water in the county. It includes beds of gypsum which are readily dissolved by percolating ground water. Hence, the water contained in this aquifer is high in calcium and sulfate, the sulfate generally amounting to more than 1,000 ppm. The presence of large amounts of calcium in the water makes it very hard, even in places where the sulfate content may be comparatively low (see 42N 16W 27-4, table 5).

Water from the Burnt Bluff formation generally is moderately hard or hard. The hardness results from the presence of calcium and magnesium ions leached from the limestones and dolomites. Most of the wells in the city of Manistique are finished in this aquifer at a depth of about 200 feet (table 3). The water produced from some of these wells, however, contains large quantities of calcium and sulfate which is not characteristic of the Burnt Bluff formation. Apparently the water yielded by these wells is contaminated by upward leakage of calcium sulfate waters from the underlying Cataract formation. Some of the wells may be bottomed in the upper part of the Cataract formation, and derive water from both aquifers. Migration of calcium sulfate water from the Cataract formation apparently has been caused by discharging of water by pumping or by unrestricted flow from wells

tapping the basal part of the Burnt Bluff formation. The water from wells tapping shallower permeable zones in the Burnt Bluff has not been high in calcium and sulfate.

The Manistique dolomite yields water similar in chemical quality to that of the Burnt Bluff (fig. 12). In most areas where the Manistique is present, it is at or near the surface and contamination by organic wastes is a constant hazard due to the free circulation of water through solutionally enlarged fractures at the surface of the formation. Thus, the water contained in this aquifer is generally of good chemical quality but, in many cases, of poor bacteriological quality.

The quality of water from the glacial-drift aquifers of the county varies considerably. The mineral content of the water is determined by the composition of the glacial drift and by the quality of water in aquifers hydraulically connected with the drift aquifers. The glacial drift aquifers, however, generally yield water low in dissolved mineral content. One notable exception is the large concentration of calcium and sulfate in the sample taken from well 42N 17W 25-1 (table 5) near Big Spring. The analysis of this sample indicates that the water has migrated through the gypsiferous Cataract formation or has been mixed with water from that aquifer. Drift aquifers in other areas underlain by gypsiferous rocks may also yield water containing significant amounts of calcium and sulfate.

The temperature of water from most wells in Schoolcraft County ranges from about 44° to 48°F (table 5). That of water from several deep wells tapping the Munising and Hermansville formations ranges from about 46° to 55°F.

Surface Water

Chemical analyses of water from lakes, streams, and springs in Schoolcraft County are listed in table 6 and diagrammed in figure 13. Figure 13 shows the relative uniformity in chemical content of surface water from various sources throughout Schoolcraft County. Water from the Manistique River drainage basin, much of which represents ground-water discharge, is predominantly of the calcium magnesium bicarbonate type. Variations in quality are small as the rapid flow of surface water permits rather thorough mixing of water from different sources. Spring water taken at or near the point of discharge, however, such as at Big Spring and Hoholik's Spring (fig. 13), closely reflects the chemical quality of ground water in the source aquifers.

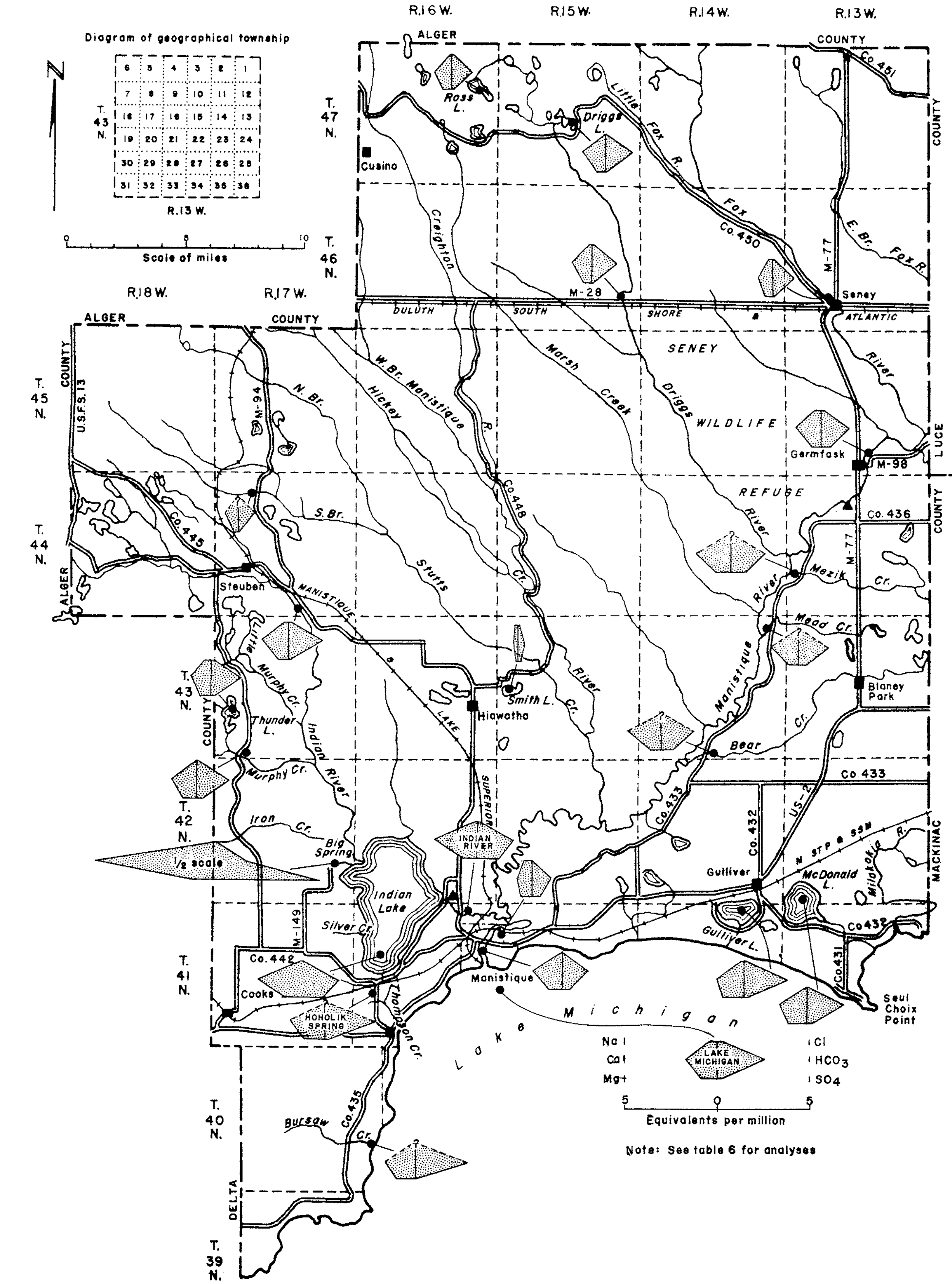

Figure 13. Diagrams showing chemical quality of surface water in Schoolcraft County

CONCLUSIONS

The ground-water resources in Schoolcraft County are adequate for present needs and for considerable future development by municipalities, agriculture, and industry. North of the Niagara escarpment, small to moderate yields of water of good quality can be obtained from relatively shallow wells in the glacial drift or from deeper wells tapping the Hermansville and Munising formations. South of the escarpment, water of good quality can be obtained from the Manistique and Burnt Bluff formations and locally from permeable deposits of glacial drift. The Trenton and Black River limestones and the limestones and dolomites of the upper part of the Richmond group may yield water of good quality in areas where they form the bedrock surface, but for the most part these formations yield water of rather poor chemical quality. The Cataract formation is not a source of good water.

The development of the ground-water resources of Schoolcraft County will involve more problems of quality of water than of locating adequate quantities of water. In much of the county the Munising and Hermansville formations, which are a source of fresh water, are overlain by the Trenton and Black River rocks which yield saline water. Uncased wells drilled to the sandstones will produce a mixture of saline water from the Trenton and Black River and fresh water from the Munising and Hermansville. Thus, the Trenton and Black River must be sealed off in wells tapping the sandstones to prevent contamination by the saline water. In the area where the Cataract formation forms the bedrock surface (fig. 3), water supplies taken from the upper portions of the overlying drift mantle where possible or from the sandstones of the Munising and Hermansville at depth will insure water of good chemical quality. In the Manistique area, fresh water supplies can be obtained from the upper members of the Burnt Bluff formation. Penetration to the basal members of the formation or to the Cataract formation may result in migration of saline water from the Cataract. Restriction of flowing wells tapping the Burnt Bluff formation may be necessary to retain maximum pressure in the aquifer. The lowering of the piezometric surface, which always results from discharge by a well, probably has contributed to the contamination of the water in the basal strata of the Burnt Bluff formation by permitting upward migration of calcium sulfate water from the Cataract formation.

In the Manistique and Gulliver areas, sewage and septic tank effluent that has undergone little or no natural filtration is readily recharged to the creviced and fractured Burnt Bluff and Manistique formations, which are at or within a few feet of the land surface. In these areas a number of wells are reported to yield water of objectionable bacterial quality. To prevent entrance of sanitary wastes, the wells can be drilled to deeper permeable zones and the polluted zones near the surface sealed off to prevent leakage from above. Further contamination of ground water by sanitary wastes should be avoided.

Future ground-water research should include studies of the geochemistry of the aquifers in Schoolcraft County to be used as a guide for development of the fresh-water aquifers in a manner which will result in minimum contamination of those sources from saline-water aquifers. Further study should be made also of the extent, depth, and water-bearing properties of glacial drift in the pre-Pleistocene valleys, as such deposits are potential sources of large quantities of ground water of good quality.

REFERENCES CITED

Bergquist, S. G., 1936, The Pleistocene history of the Tahquamenon and Manistique drainage region of the Northern Peninsula of Michigan: Michigan Geol. Survey Pub. 40, pt. 1, p. 7-148.

Ehlers, G. M., and Kesling, R. M., 1957, Silurian rocks of the Northern Peninsula of Michigan: Michigan Geol. Soc. Ann. Field Trip Guidebook.

Giroux, P. R., 1957, Summary of ground-water conditions in Michigan, 1956: Michigan Geol. Survey Water Supply Rept. no. 1.

Hough, J. L., 1958, Geology of the Great Lakes: Urbana, Univ. of Illinois, Press, 296 p.

Leverett, Frank, 1906, Flowing-well districts in the eastern part of the northern peninsula of Michigan, in Fuller, M. L., and others, Underground-water papers, 1906: U. S. Geol. Survey Water-Supply Paper 160, p. 29-53.

Leverett, Frank, and Taylor, F. B., 1915, The Pleistocene of Indiana and Michigan and the history of the Great Lakes: U. S. Geol. Survey Mon. 53, 529 p.

Michigan Department of Health, 1948, Chemical analyses and their interpretations, in Public water supplies in Michigan: Michigan Dept. Health, Eng. Bull. 4.

Poindexter, O. F., 1933?, Geology of Schoolcraft County: Michigan Geol. Survey unpublished manuscript, 70 p.

__________ 1935, A study of underground waters bearing on the source of Big Spring, Schoolcraft County, Michigan: Michigan Acad. Sci. Papers, v. 20, p. 477-483.

__________ 1936, Sinkholes in the Indian Lake Region, Schoolcraft County, and other Michigan sinks. Michigan Acad. Sci. Papers, v. 21, p. 439-444.

Stiff, H. A., 1951, The interpretation of chemical water analyses by means of patterns: Jour. Petroleum Technology, p. 15-17.

Vanlier, K. E., 1959, Reconnaissance of the ground-water resources of Luce County, Michigan: Michigan Geol. Survey Prog. Rept. 21.

Vanlier, K. E., and Deutsch, Morris, 1958a, Reconnaissance of the ground-water resources of Chippewa County, Michigan: Michigan Geol. Survey Prog. Rept. 17, 78 p.

__________ 1958b, Reconnaissance of the ground-water resources of Mackinac County, Michigan: Michigan Geol. Survey Prog. Rept. 19, 82 p.

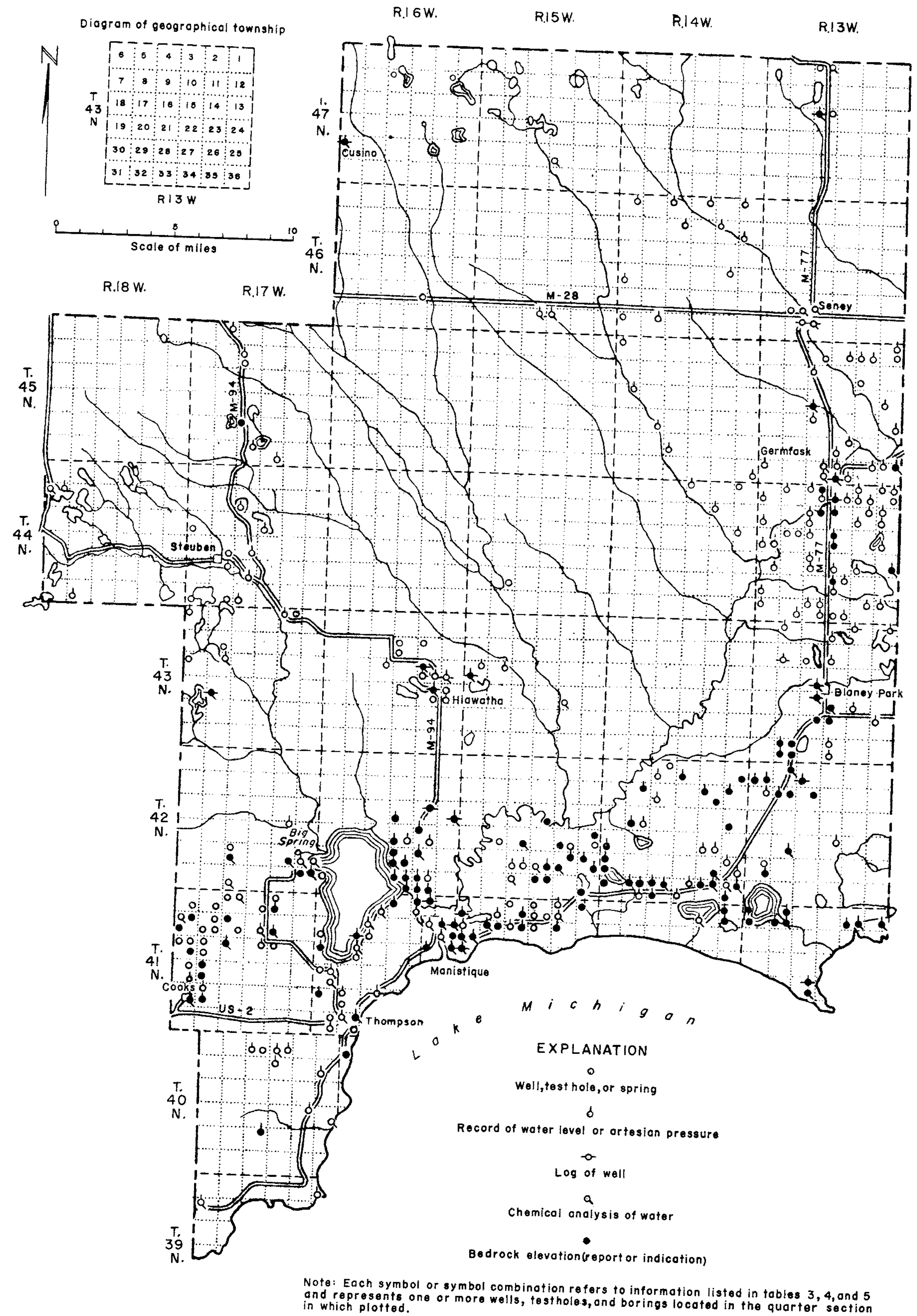

Figure 14. Index map of Schoolcraft County showing availability of hydrologic, geologic, and quality-of-water data

Table 3.--Records of wells and test holes in Schoolcraft County

Well location: See explanation on page 4.

Owner: MDC, Michigan Department of Conservation

Driller: CCC, Civilian Conservation Corps.

Chief aquifer: See table 1.

Use: B, foundation boring; D, domestic; I, industrial; P, public supply; S, stock; Tf, fire-control test well; To, oil test well.

Water level: In feet below or above (+) land-surface datum; M, measured; R, reported.

Altitude: In feet above mean sea level.

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
47N 16W													
9-1	NE NW	MDC	-	-	-	6	Qs	P	-	-	-	-	
11-1	SE NE	MDC	-	-	-	-	Qs	P	-	-	-	-	
30-1	NW NW	MDC	CCC	1941	56	6	O€hm	O	15.4	M	10-22-57	890	
30-2	SE NW	MDC	-	-	57	4	O€hm	P	3.4	M	7-17-57	880	
47N 15W													
27-1	SW SW	Stearns Lumber Co.	-	-	15	2	Qs	P	-	-	-	-	Abandoned.
47N 13W													
4-1	SE NW	-	-	-	30	1¼	Qs	D	-	-	-	-	Do.
4-2	SW NE	R. R. Purple	R. R. Purple	-	19	1½	Qs	D	-	-	-	-	
16-1	SE NW	MDC	CCC	1941	215	3	O€hm	-	-	-	-	875	Flows 30 gpm. Bedrock at 202 ft. Supplies fish hatchery.
16-2	SE NW	MDC	CCC	1940	102	3	Qgd	P	-	-	-	875	Not used.
16-3	NW NE	MDC	CCC	-	-	6	-	P	-	-	-	-	Plugged.
46N 16W													
27-1	SE SE	Pines Motel	-	-	20	1¼	Qgd	P	-	-	-	-	
46N 15W													
33-1	NE NE	Norman Schroeder	Norman Schroeder	1957	21	1½	Qs	I	4	R	11- 6-57	780	
34-1	NW NW	Stearns Lumber Co.	-	1927	184	4	Qgd	P	+1	M	11- 6-57	780	Abandoned.
46N 14W													
1-1	NW NW	MDC	CCC	1934	15	2	Qs	Tf	4.7	R	8- ?-34	-	
3-1	SW NE	MDC	CCC	1934	15	-	Qs	Tf	8.5	R	8- ?-34	-	
4-1	NW NW	MDC	CCC	1934	19	2	Qs	Tf	16.4	R	8- ?-34	-	
6-1	NE NE	MDC	CCC	1934	16	2	Qsg	Tf	2.8	R	8- ?-34	-	
9-1	NE NE	MDC	CCC	1934	14	2	Qs	Tf	8.2	R	8- ?-34	-	
11-1	SW NW	MDC	CCC	1934	19	2	Qs	Tf	13.8	R	8- ?-34	-	
12-1	SE SW	MDC	CCC	1934	14	2	Qs	Tf	6.0	R	8- ?-34	-	
19-1	NW SW	MDC	CCC	1934	15	2	Qs	Tf	2.2	R	9- ?-34	-	
23-1	NW NE	MDC	CCC	1934	15	2	Qs	Tf	.5	R	8- ?-34	-	
31-1	NW NW	MDC	CCC	1934	14	2	Qs	Tf	-	-	-	-	
32-1	NW NE	MDC	CCC	1934	15	2	Qs	Tf	.1	R	8- ?-34	-	
46N 13W													
28-1	SW SW	Seney School	-	-	160	5	Qgd	P	-	-	-	745	
28-2	SW SW	Seney Township	-	-	100	4	Qg	P	-	-	-	-	Supplies several homes in Seney.
29-1	SE SW	Do.	W. J. Rodgers	1948	116	4	Qgd	P	-	-	-	750	Do.
29-2	NW SE	-	-	-	20	1¼	Qs	-	-	-	-	750	
32-4	NE NE	Mich. Highway Dept.	Mich. Highway Dept.	1949	67	-	Qgd	B	-	-	-	734	
33-1	NW NW	Robert Hudson	-	-	101	4	Qg	P	-	-	-	-	
45N 17W													
5-1	SE NE	Everett Long	Everett Long	-	14	1	Qs	D	4	R	9- 3-57	-	
9-1	NW NW	Stanley Coft	Stanley Coft	1954	20	1	Qs	D	8	R	9- 3-57	-	
9-2	NW SW	R. H. Graves	R. H. Graves	1937	25	-	Qs	D	-	-	-	-	
28-1	SE NW	Coe's Boot L. Camp	Inman and McNally	-	135	-	Qs	P	-	-	-	835	
28-2	SE NW	Frank Mullenhour	Frank Mullenhour	-	20	1¼	Qs	P	-	-	-	800	
28-3	SE NW	T. Carey	T. Carey	1948	55	3	Qs	P	-	-	-	-	
28-4	SE NW	Do.	Do.	-	55	3	Qs	P	-	-	-	-	
33-1	NE NE	C. L. Bauman	William Nance	-	152	4	Qgd	D	30	R	1956	795	
34-1	SW SE	U. S. Forest Service	O. P. Degeneffe	1938	100	5	Qsg	P	46.0	M	7-17-57	815	

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
45N 14W													
6-1	SW NW	U.S. Forest Serv.	CCC	1934	15	2	Qs	Tf	6.7	R	8-?-34	-	
18-1	NE NE	Do.	CCC	1934	15	2	Qs	Tf	2.3	R	8-?-34	-	
20-1	SE SE	Do.	CCC	1934	14	2	Qs	Tf	.1	R	11-2-34	-	
28-1	SE SW	Do.	CCC	1934	14	2	Qs	Tf	1.8	R	11-6-34	-	
36-1	SE SE	Do.	CCC	1934	14	2	Qs	Tf	1.6	R	8-?-34	-	
45N 13W													
1-1	NE NE	MDC	CCC	1934	14	2	Qs	Tf	.3	R	11-9-34	-	
1-2	SW SE	MDC	CCC	1934	14	2	-	Tf	Dry	R	11-15-34	-	Drilled in sand.
2-1	SW SW	MDC	CCC	1934	10	2	Qs	Tf	1.1	R	11-9-34	-	
2-2	NE SE	MDC	CCC	1934	14	2	Qs	Tf	10.7	R	11-9-34	-	
3-1	NW SE	MDC	CCC	1934	10	2	Qs	Tf	1.7	R	9-24-34	-	
4-1	NE SE	MDC	CCC	1934	17	2	-	Tf	Dry	R	11-15-34	-	Do.
9-1	NW NW	MDC	CCC	1934	15	2	Qs	Tf	.9	R	11-5-34	-	
11-1	NE SW	MDC	CCC	1934	15	2	-	Tf	Dry	R	8-2-34	-	Do.
13-1	SE SW	MDC	CCC	1934	14	2	Qsg	Tf	7.9	R	11-8-34	-	
13-2	SE SW	MDC	CCC	1934	14	2	Qsg	Tf	11.6	R	11-8-34	-	
16-1	SW SW	U.S. Forest Serv.	-	1935	154	4	Or	O	5.7	M	11-5-57	710	
16-2	SW SW	Do.	Elwin Anderson	1950	702	8	OЄhm	P	+40	R	-	1015	Flows 18 gpm. Bedrock at 142 ft.
16-3	SW SW	Do.	Do.	1954	715	-	OЄhm	P	+65	R	11-18-54	-	Flows 30 gpm. Bedrock at 97 ft.
21-1	SE NW	MDC	CCC	1934	14	2	Qs	Tf	1.4	R	11-5-34	-	
24-1	NE SE	MDC	CCC	1934	15	2	Qs	Tf	+.5	R	9-11-34	-	
27-1	SE NE	MDC	CCC	1934	19	2	Qs	Tf	6.1	R	11-5-34	-	
27-2	NW SW	MDC	CCC	1934	14	2	Qs	Tf	+.8	R	11-8-34	695	
31-1	SE NW	MDC	CCC	1934	14	2	Qs	Tf	4.7	R	11-5-34	695	
33-1	SE NE	Frank Oaken	-	-	-	-	Qs	D	14	R	1946	-	
33-2	SE NE	Frank Brown	-	-	18	1½	Qs	D	8	R	9-9-46	-	
33-3	SE NE	D. Miller	-	-	12	30	Qgd	D	-	-	-	-	Abandoned. High iron content.
33-4	NE SE	Leonard Kubant	Stanley Wilcox	1936	9	14	Qs	D	5	R	1946	695	Low yield.
33-6	NE SE	Germfask School	W. J. Rodgers	1939	780	6	OЄhm	P	-	-	-	695	Flows 200 gpm.
34-1	NW SW	Mrs. A. McDougall	Jack Heath	-	15	-	Qs	D	-	-	-	-	
34-2	NW SW	W. Delaurier	R. Heath	1936	25	1¼	Qgd	D	6	R	1946	-	
34-3	SE SE	Harold Newborn	-	1941	16	6	Qgd	D	10	R	9-12-46	700	
34-4	NE SW	Shamrock Motel	Elwin Anderson	1955	60	6	Qgd	P	-	-	-	-	
34-5	NW SW	Gillman	W. J. Rodgers	1948	777	-	OЄhm	P	-	-	-	695	Flows. Bedrock at 62 ft.
34-6	SW SW	W. N. Caffey	-	1910	75	6	Qgd	D	-	-	-	695	Flows. Bedrock at 65 ft.
34-7	SW SW	Germfask Hotel	G. W. Gray	1905	65	5	Qs	P	5	R	12-17-32	695	
34-8	SW SW	Germfask Twp.	-	-	60	-	Qgd	P	+4	R	8-1-32	695	Flowed. Bedrock at 60 ft.
34-9	SE NW	Joseph Smith	-	1916	50	6	-	D	7	R	1946	-	
34-10	NE SE	F. A. Menerie	-	1940	8	5	Qgd	S	-	-	-	700	
35-1	NE NE	MDC	CCC	1934	10	2	Qs	Tf	33	R	11-8-34	-	
36-1	NW NE	Louis Hartman	Elwin Anderson	1947	789	8	OЄhm	P	+47	M	6-19-57	685	Flows. Bedrock at 60 ft.
36-2	NW NE	Do.	-	-	88	4	Or	P	+3	R	6-26-57	685	Flows. Not used.
36-3	SE NW	MDC	CCC	1934	14	2	Qgd	Tf	2	R	11-8-34	695	
44N 18W													
7-1	NE NE	U.S. Forest Serv.	George Brunner	1941	36	4	Qgd	P	15	R	1949	-	
7-2	NE NE	Do.	Do.	1941	33	4	Qgd	P	11	R	1949	-	
7-3	NE NE	Do.	Do.	1941	31	4	Qgd	P	12	R	1949	-	
7-4	SW NW	Forest Glen Resort	Curtis and Ryan	-	24	1¼	Qgd	P	-	-	-	-	
7-5	SW NW	Do.	Do.	-	25	2	Qs	P	-	-	-	-	
32-1	SW SW	U.S. Forest Serv.	George Brunner	-	28	6	Qs	P	4.1	M	9-17-57	-	
44N 17W													
9-1	SE SW	Do.	-	1940	35	5	Qs	P	8.4	M	6-26-57	750	
15-1	SE SW	Do.	S. Gustafson	1957	15	1¼	Qs	D	15	R	7-1-57	740	
18-1	SW SW	Douglas Salisbury	Elwin Anderson	-	97	6	Qgd	P	-	-	-	800	
18-2	SW SW	Do.	Do.	-	106	4	Qgd	P	-	-	-	800	
20-1	SW SE	V. J. Silk	V. J. Silk	-	39	1½	Qs	P	-	-	-	-	
21-1	SW SE	U.S. Forest Serv.	George Brunner	1938	157	5	Qsg	P	131	M	6-21-57	850	Steuben Fire Tower site.
28-1	NW SE	Do.	Do.	-	43	5	Qs	P	26.9	M	6-20-57	740	Not used
29-1	NW NE	V. J. Silk	Elwin Anderson	1956	69	6	Qsg	D	9	R	6-?-56	-	
31-1	SE SW	Blaze Trail Club	Do.	1923	102	4	Qs	P	-	-	-	-	
32-1	SE SE	U.S. Forest Serv.	George Brunner	1937	66	5	Qs	P	-	-	-	765	
33-1	SW SW	Do.	Do.	1940	21	5	Qs	P	11.	R	1949	750	
44N 15W													
29-1	NW SE	A. T. Mott	A. T. Mott	-	15	2	Qs	D	-	-	-	-	

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
44N 14W													
1-1	SW NW	U.S. Forest Serv.	CCC	1934	14	2	Qs	Tf	-	-	-	-	
3-1	NE NW	do.	CCC	1934	15	2	Qs	Tf	3.0	R	8-?-34	-	
11-1	NE NW	do.	CCC	1934	14	2	Qs	Tf	6.4	R	8-?-34	-	
13-1	SW NW	do.	CCC	1934	14	2	Qs	Tf	3.9	R	8-?-34	-	
44N 13W													
1-1	SW NW	MDC	CCC	1934	14	2	Qs	Tf	.1	R	8-?-34	-	
1-2	SW SE	MDC	CCC	1934	19	2	-	Tf	Dry	R	8-?-34	-	Drilled in sand.
1-3	NE NE	MDC	CCC	1934	14	2	Qgd	Tf	.3	R	9-?-34	-	
2-1	NE NW	MDC	CCC	1934	14	2	Qs	Tf	1.0	R	8-?-34	-	
2-2	NE SE	MDC	CCC	1934	14	2	Qs	Tf	10.7	R	8-?-34	-	
2-3	SW SW	MDC	CCC	1934	10	2	Qs	Tf	1.1	R	9-?-34	-	
3-1	NE SW	Charles Cornell	Charles Cornell	1946	26	1½	Qs	D	21	R	9-10-46	-	
3-2	NW SE	MDC	CCC	1934	10	2	Qsg	Tf	1.8	R	8-?-34	-	
3-3	NW SW	Mich. Highway Dept.	W. J. Rodgers	1957	71	6	Or	P	17.2	M	8-5-57	-	Bedrock at 60 ft.
3-4	NW SE	Ray Heath	Elwin Anderson	-	65	4	Or	D	-	-	-	-	
4-1	NE SE	W. T. Harris	W. T. Harris	1946	12	1¼	Qgd	D	11	R	9-11-46	680	
4-2	NW NW	U.S. Forest Serv.	CCC	1934	14	2	Qs	Tf	6.5	R	8-?-34	-	
4-3	NE SE	Do.		1934	18	2	-	Tf	Dry	R	8-?-34	-	Do.
4-4	NW NE	Leonard Shay	Elwin Anderson	1949	240	6	Otb	D	-	-	-	-	Bedrock at 120 ft.
5-1	NW NW	U.S. Forest Serv.	CCC	1934	14	2	Qs	Tf	1.1	R	8-?-34	-	
6-1	NE SW	Do	CCC	1934	14	2	Qs	Tf	5.8	R	8-?-34		
7-1	SE SW	Do.	CCC	1934	13	2	Qs	Tf	1.0	R	8-?-34	-	
9-1	SE NE	Leo Tavey	W. J. Rodgers	1948	114	-	Or	D	-	-	-	700	Bedrock at 85 ft.
9-2	SE SW	U.S. Forest Serv.	CCC	1934	12	2	Qgd	Tf	.5	R	8-?-34	-	
9-3	NW NW	Do.	CCC	1934	15	2	Qs	Tf	.9	R	8-?-34	-	
10-2	NE NW	-	-	-	55	6	Or	D	23	R	7-8-32	720	Bedrock at 25 ft.
11-2	SW SW	MDC	CCC	1934	13	2	Qs	Tf	.6	R	8-?-34	-	
11-3	NW NE	MDC	CCC	1934	15	2	Qs	Tf	.1	R	8-?-34	-	
11-4	NE NE	MDC	CCC	1934	19	2	Qs	Tf	3.0	R	10-?-34	-	
11-5	NE SW	MDC	CCC	1934	15	2	-	Tf	Dry	R	8-?-34	-	Drilled in clay and sand.
12-1	- NW	E. and J. Stauffer	-	1905	80	-	Qgd	D	45	R	1905	770	
12-2	SE SW	MDC	CCC	1934	14	2	Qs	Tf	1.4	R	8-?-34	-	
13-1	SE SW	MDC	CCC	1934	14	2	Qs	Tf	11.6	R	8-?-34	-	
13-2	SE SW	MDC	CCC	1934	14	2	Qsg	Tf	7.9	R	9-?-34	-	
15-2	SW SW	Chester C. Osborne	-	-	19	48	Qs	D,S	6	R	1946	710	Dug well.
15-3	SW NW	Walter Burns	James Lupton	1920	60	3	Or	D,S	35	R	1946	765	Bedrock at 55 ft.
15-4	SW SW	-	-	-	30	-	Or	D	-	-	-	710	Water from large fissure in limestone.
15-6	NW SW	Bruce Henricks	Elwin Anderson	-	75	5	Or	D	-	-	-	730	Bedrock at 34 ft.
16-1	NE NW	Frank Conlan	-	-	20	3	Qs	D,S	16	R	9-10-46	720	
17-1	NE NE	Mrs. C. Noss	C. Lupton	1910	110	-	Qgd	D,S	-	-	-	-	
17-2	NE NW	MDC	CCC	1934	14	2	-	Tf	Dry	R	10-?-34	-	Drilled in sand.
17-3	NW NW	MDC	CCC	1934	12	2	-	Tf	Dry	R	8-?-34	-	Drilled in clay and gravel.
17-4	SW NE	Telford Burton	Telford Burton	1943	42	1½	Qgd	D	-	-	-	-	
18-1	NE SE	U.S. Forest Serv.	CCC	1934	14	2	Qgd	D	-	-	-	-	
18-2	NW SW	Do.	CCC	1934	16	2	Qgd	Tf	3	R	8-?-34	-	
19-1	NW SE	Do.	CCC	1934	14	2	Qs	Tf	4.1	R	8-?-34	-	
21-1	SW SW	L. Macauky	C. Roate	-	80	3	Qgd	D,S	20	R	-	725	Abandoned.
21-2	SE SW	Otto Wilcox	-	1939	16	2	Qgd	D	9	R	1946	725	
21-3	SE SW	Lyle Wilcox	-	1939	18	-	Qgd	D	8	R	1946	725	
21-7	SE SW	MDC	CCC	1934	10	2	Qgd	Tf	+1	R	8-?-34	-	
21-8	SE NW		CCC	1934	14	2	Qs	Tf	1.3	R	8-?-34	-	
22-1	SW SW	Allen Macoulry	A. Macoulry	1906	26	2	Qgd	D,S	3	R	1946	715	
23-1	SE SW	MDC	CCC	1934	15	2	Qs	Tf	5.4	R	10-?-34	-	
23-2	SW SW	Kornich	Elwin Anderson	1955	75	5	Qg	D,S	27	R	1955	-	
24-1	NE SE	MDC	CCC	1934	15	2	Qgd	Tf	-	-	-	-	Flows
24-2	NW SE	-	-	-	90	-	Qgd	-	-	-	-	-	Bedrock at 88 ft.
27-1	NW NW	Mrs. C. McEachern	W. Bowman	1923	210	6	Or	D,S	-	-	-	725	Bedrock at 64 ft.
27-2	NE NE	G. Burton	-	1911	11	36	Qgd	D,S	7	R	1946	725	Dug well.
27-3	SW NW	MDC	CCC	1934	15	2	Qgd	Tf	.1	R	8-?-34	-	
27-4	SE NE	MDC	CCC	1934	19	2	Qs	Tf	6.1	R	9-?-34	-	
27-5	NW SW	MDC	CCC	1934	14	2	Qs	Tf	.8	R	8-?-34	-	
30-1	NW SW	MDC	CCC	1934	14	2	Qgd	Tf	4.8	R	8-?-34	-	
31-1	SE NW	MDC	CCC	1934	14	2	Qs	Tf	4.7	R	8-?-34	-	
32-1	SE SE	MDC	CCC	1934	14	2	Qs	Tf	3.2	R	8-?-34	-	
33-1	SE SE	H. R. Peters	-	-	-	-	Qs	D	25	R	1946	730	

Table 3 --Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
44N 13W													
33-2	SW SE	MDC	CCC	1934	15	2	-	Tf	Dry	R	8- ?-34	-	Drilled in sand.
33-3	SE NE	MDC	CCC	1934	19	2	Qs	Tf	3.9	R	10- ?-34	-	
33-4	NW NE	MDC	CCC	1934	14	2	Qs	Tf	.3	R	8- ?-34	-	
33-5	SE NW	Orley Losey	-	1936	14	1¼	Qs	D	8	R	1946	-	
34-1	SW SW	Ovid Swisher	-	1934	50	-	Qs	D	-	-	-	730	
34-2	SE SE	MDC	CCC	1934	15	2	Qs	Tf	.3	R	8- ?-34	-	
35-1	NE NE	MDC	CCC	1934	10	2	Qgd	Tf	3.3	R	9- ?-34	-	
36-1	SE NW	MDC	CCC	1934	14	2	Qgd	Tf	2	R	10- ?-34	-	
43N 17W													
2-1	NW NW	U.S. Forest Serv.	George Brunner	1937	56	5	Qs	P	37.1	M	6-20-57	740	
2-2	SE NE	Ernest Miesch	Ernest Miesch	-	25	1½	Qs	P	-	-	-	-	
6-1	NE NW	C. J. Delor	C. J. Delor	1955	30	1½	Qs	D	-	-	-	-	
6-2	NE NW	Dr. Means	Elwin Anderson	-	158	8	Qs	D	58	R	6-21-57	780	
6-3	SE NW	U.S. Forest Serv.	-	-	2	14	Qs	P	.5	M	9- 1-57		
8-1	SW SE	Bunge	Bunge	-	18	1¼	Qs	D	-	-	-	695	
17-1	NW NE	L. W. Clemenson	-	1926	740	-	OЄhm	D	+24.0	M	8-19-57	690	Flows.
18-1	NW NW	G. J. Vatcher	G. J. Vatcher	-	30	-	Qgd	P	-	-	-	-	
20-1	NW SW	Donavan	-	-	25	-	Qs	P	-	-	-	-	
20-2	NW SW	Ramsden	Ramsden	-	28	1½	Qs	P	-	-	-	-	
20-3	NE SW	Henry Peterson	Chet Rice	1948	710	6	OЄhm	P	-	-	-	775	Bedrock at 125 ft.
43N 16W													
10-1	SW NW	William Latsch	-	1937	21	3½	Qgd	D	-	-	-	720	
10-2	NW SW	Cloice Giblin	-	-	65	1¼	Qgd	D	-	-	-	-	
11-1	SE NW	Arnold Hendrickson	Arnold Hendrickson	1904	48	2	Qsg	D	-	-	-	730	
13-1	NW SW	Ollie Schultheist	Toenneson Bros.	1957	171	2	Qs	D	36.2	M	9-23-57	730	
14-1	NW SW	R. A. Hoelzle	R. A. Hoelzle	-	27	2	Qs	D	15	R	1957	715	
14-2	NW NW	Do.	W. J. Rodgers	-	192	4	Qs	D	-	-	-	735	Bedrock at 192 ft.
14-3	SW SE	O. E. Powers	O. E. Powers	-	21	1¼	Qs	P	6	R	7- 3-57	705	
14-4	SE SW	Robert Harris	Robert Harris	1950	28	1½	Qgd	P	-	-	-	730	
14-5	NW SE	John Diegal	-	-	49	1¼	Qs	D	42	R	8-31-57	-	
14-6	SE SE	Weidegardner	W J. Rodgers	-	78	6	Qsg	D	-	-	-	-	
14-7	NE NW	Hiawatha Twp.	Elwin Anderson	1951	78	5	Qs	P	-	-	-	-	
16-1	NE NE	Eugene Hyland	Eugene Hyland	1935	42	2½	Qs	D	10	R	1957	-	
23-2	SE SE	W. Weinert	-	1941	14	48	Qs	D	-	-	-	730	
23-3	SE NE	Frank Schwortz	Chet Rice	1948	820	5	OЄhm	D,S	+15	R	1948	730	Flows. Bedrock at 90 ft.
24-1	SE SW	William Casteel	-	-	45	1½	Qs	D,S	20	R	1946	735	
24-3	NW NW	Dodge School	-	-	60	1¼	Qgd	P	-	-	-	712	
43N 15W													
17-1	SW NE	MDC	CCC	-	?	4	-	P	+2	M	5-23-57	660	Flows. Obstruction at 10 ft.
18-1	SE SW	Frank LeMaire	W. Bowman	1942	875	6	OЄhm	D	+1	R	1957	730	Flows. Bedrock at 200 ft.
18-2	SE NE	Clyde Davis	Elwin Anderson	1957	160	6	Or	D	32	R	8- ?-57	680	
23-1	NW SW	Lauritz B. Hough	Lauritz B. Hough	-	22	1¼	Qs	D	-	-	-	-	
43N 13W													
1-2	NW NE	MDC	CCC	1934	10	2	Qgd	Tf	3.9	R	8- ?-34	-	
2-1	NW NW	MDC	CCC	1934	13	2	Qgd	Tf	+0.8	R	11- 7-34	-	
3-2	SE SW	MDC	CCC	1934	15	2	Qs	Tf	.1	R	8- ?-34	-	
5-1	NE NW	MDC	CCC	1934	14	2	Qs	Tf	5.6	R	8- ?-34	-	
8-1	SE SW	MDC	CCC	1934	8	2	Qgd	Tf	.1	R	8- ?-34	-	
9-1	NE SW	Stewart Earle	W. Bowman	-	180	-	-	I	-	-	-	700	
9-2	SW SW	MDC	CCC	1934	10	2	-	Tf	Dry	R	8- ?-34	-	Drilled in sand and gravel.
10-1	SW SW	MDC	CCC	1934	18	2	Qgd	Tf	.8	R	9- ?-34	-	
16-2	NE SE	Stewart Earle	-	-	17	-	-	P	+1	R	1949	720	Flows.
16-3	SE SE	Do.	-	1927	60	4½	Qgd	P	-	-	-	740	
16-4	SE SE	Do.	-	1902	40	4	Qgd	P	20	R	1928	740	
16-5	NE SE	Do.	W. J. Rodgers	1949	1055	8	OЄhm	P	+27.4	R	1949	740	Flows. Bedrock at 55 ft.
21-1	NE NE	Do.	G. W. Gray	1905	214	-	Sc	P	50	R	1905	740	Bedrock at 113 ft. Not used.
21-2	NW NE	Do.	-	1932	117	6	Sc	P	-	-	-	-	Flows 15-20 gpm. Not used.
21-3	NW NE	MDC	CCC	1934	10	2	Qgd	Tf	.1	R	8- ?-34	-	
22-1	SW SW	Stewart Earle	-	-	70	-	Sb	P	-	-	-	-	Bedrock at 12 ft.
23-1	NE SW	MDC	CCC	1934	11	2	Qsg	Tf	6.5	R	8- ?-34	-	
25-1	NE NW	MDC	CCC	1934	14	2	Qs	Tf	1.8	R	8- ?-34	-	
27-1	NW NW	Stewart Earle	-	-	54	-	Sb	D	-	-	-	714	Bedrock at 6 ft.
28-1	NE NE	Do.	-	-	65	-	Sb	S	-	-	-	714	Bedrock at 14 ft.
28-2	NE NE	Do.	-	-	62	-	Sb	P	-	-	-	715	Bedrock at 6 ft. Abandoned.

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
43N 13W													
32-1	NE NW	John Hunter	William Bowman	1915	100	5	Sb	D	18	R	6-30-32	710	Bedrock at surface.
32-2	NW SE	Otis Freeland	Do.	1919	67	4	Sb	-	-	-	-	710	Bedrock at 14 ft.
32-3	NW NE	-	Elwin Anderson	1910	40	6	Sb	-	-	-	-	710	Bedrock at 6 ft.
32-4	NE SW	E. H. Stites	Do.	1956	114	5	Sb	D	16	R	6-13-56	-	Bedrock at 4 ft.
34-1	NW NW	MDC	CCC	1934	14	2	Qs	Tf	.1	R	9- ?-34	-	
34-2	SW SW	MDC	CCC	1934	10	2	Qs	Tf	.1	R	9- ?-34	-	
42N 17W													
23-1	SE NE	Joseph Richardson	Joseph Richardson	-	22	1½	Qs	D,I	8	R	1957	-	High iron content.
25-1	NE SW	MDC	Richard Kiney	1932	56	3	Qsg	P	7.6	R	1932	624	Destroyed.
25-2	SW SE	Roy Massey	Roy Massey	-	30	-	Qs	P	-	-	-	620	
26-1	SE SE	Munson and Kline	Fred Karridge	-	58	6	Qgd	P	-	-	-	630	Bedrock at 55 ft.
26-2	SE SE	H. C. Rainbow	Elwin Anderson	1956	110	5	Sb	D	-	-	-	680	Bedrock at 78 ft.
28-1	SE SW	Alvin Siddall	Do.	1945	102	6	Sb	D,S	-	-	-	785	Bedrock at 20 ft.
28-2	NW NW	L.J. Tomamichel	Do.	1943	120	-	Qgd	D	-	-	-	745	
33-1	NW SW	Swagart	Chet Rice	-	240	-	Sc	D,S	-	-	-	780	
33-2	NW SW	Do.	Do.	1927	340	-	Sc	D,S	-	-	-	780	
33-3	SW SW	William Strasler	G. W. Gray, Sr.	1930	160	6	Sb	D,S	-	-	-	770	
36-1	NW NE	H. J. Lange	H. J. Lange	-	31	1¼	Qs	P	-	-	-	620	
36-2	NW NE	Do.	Chet Rice	-	200	6	Sc	D	8.2	M	7- 3-57	620	Bedrock at 50 ft.
36-3	NE NW	W. H. Dines	-	-	99	-	Sb	D	-	-	-	640	Bedrock at 45 ft.
42N 16W													
13-1	SW SE	Carl Christenson	Anderson and Rice	-	930	4	Otb	To	+2	M	6-20-57	625	Flows. Bedrock at 155 ft.
14-1	NE NE	Alphonse Verschure	Elwin Anderson	1942	1050	8	OЄhm	To	-	-	-	632	Bedrock at 39 ft. Destroyed.
15-1	SE SW	Russell LaFeur	Do.	-	80	1¼	-	D	15	R	1946	-	
15-2	SE SW	Dawson and Eck	Do.	-	140	6	Sb	-	-	-	-	-	Bedrock at 53 ft.
22-1	SW SW	Robert Michaels	Thomas Rice	1946	100	5	Sb	D	27	R	1946	620	
22-2	SW SE	G. E. Taylor	Elwin Anderson	-	76	5	Sb	D,S	20	R	1946	-	
22-3	NE SW	Maynard Blanford	Do.	-	115	5	Sb	D	40	R	-	-	Bedrock at surface.
23-1	NW NW	Eugene Mathews	Do.	-	120	-	Sb	D	-	-	-	-	
23-2	NE NW	Cliff Christenson	Do.	1915	96	6	Sb	D	20	R	1946	700	Bedrock at 5 ft.
23-3	SW SE	John Tennant	-	1940	180	6	Sb	D	30	R	1946	685	
23-4	NW SE	A. H. Graham	-	1892	109	6	Sb	D,S	46	R	9-10-46	700	
26-1	NE NW	Maple Grove School	-	-	90	6	Sb	P	55.1	M	10-29-57	680	Not used.
26-3	SE NW	Henry Miller	Elwin Anderson	1947	185	6	Sb	D	-	-	-	670	Bedrock at 20 ft.
27-1	NE SE	Frank Beckman	Toenneson Bros.	1957	100	6	Sb	D	-	-	-	645	Bedrock at 35 ft.
27-2	NW SW	C. J. Beckman	Thomas Rice	1933	-	6	Sb	D,S	-	-	-	620	
27-3	SE SW	Howard Leibrock	Elwin Anderson	1900	170	6	Sc	P	25	R	1957	620	
27-4	SE SW	Do.	-	-	150	6	Sc	P	-	-	-	620	
27-5	SE SW	Do.	-	-	108	6	Sb	P	-	-	-	620	
27-6	NW SW	F. D. Heltman	-	-	125	4	Sb	P	16	R	9- ?-32	620	Bedrock at 25 ft.
27-8	SW NW	Elmer Lundstrom	Elwin Anderson	1945	100	6	Sb	D	-	-	-	640	Bedrock at 40 ft.
27-9	NE SW	Everett Cookson	Do.	-	98	5	Sb	D	16	R	1956	650	Bedrock at 14 ft.
27-10	SW SE	August Carlson	Do.	-	85	4	Sb	D	14	R	1957	640	Bedrock at 11 ft.
31-1	NW NW	L. E. Ash	L. E. Ash	-	28	-	Qs	P	-	-	-	655	
31-2	NW NW	Marvin Mercier	Do.	-	30	-	Qgd	D	-	-	-	640	
34-1	NW SE	E. Carlson	-	1950	20	2	Qs	P	-	-	-	620	
34-6	SW NE	County Road Comm.	-	1948	29	-	-	B	-	-	-	622	Bedrock at 28 ft.
34-7	SW NE	Kenneth Seidell	Chet Rice	-	93	6	Sb	P	12	R	1955	620	Bedrock at 1 ft.
34-8	SW SE	William Heltman	Elwin Anderson	-	80	6	Sb	D	6	R	1957	620	Bedrock at 46 ft.
34-9	SE SE	Francis McNamara	Do.	-	145	5	Sb	D	-	R	1957	615	66-in. casing. Flows 5 gpm. Bedrock at 65 ft.
34-10	NE SE	M. L. Hacklemen	Do.	1955	50	5	Sb	D	3	R	1955	615	Bedrock at 39 ft.
34-11	NE SE	Frank Hoholik	Do.	1955	175	5	Sb	D	14	R	1955	615	Bedrock at 12 ft.
34-12	NE NW	E. J. Elliott	Do.	1948	79	6	Sb	D	2	R	9- ?-48	635	Bedrock at 19 ft.
35-1	NW NE	Axel Larson	-	-	180	-	Sb	D	7	R	1946	645	
35-2	NW SE	R. Matchinski	-	1908	110	6	Sb	D,S	24	R	1946	625	
35-3	NW SE	Do.	Elwin Anderson	1950	138	6	Sb	D,S	14	R	1950	625	Bedrock at 25 ft.
35-4	SW SE	Nicholas Frankovich	Toenneson Bros.	1957	87	6	Sb	D	12	R	1957	620	Bedrock at 5 ft.
35-5	SW SW	Col. Stevens	Elwin Anderson	-	120	6	Sb	D	0	R	1957	620	Bedrock at 35 ft.
35-6	NE NW	Hiawatha School	Do.	1954	181	6	Sb	P	26	R	1954	645	Bedrock at surface.
35-7	NE SE	Leo Sikarski	Do.	-	134	6	Sb	D	-	-	-	630	Bedrock at 4 ft.
35-8	SW SW	Rex Morris	Do.	-	63	5	Qsg	D	3	R	1957	615	
42N 15W													
15-1	SE SE	F. W. Walker	Do.	1949	81	5	Sb	D	-	-	-	-	Bedrock at 6 ft.
20-1	SE SE	-	-	-	40	-	Qgd	D	-	-	-	-	
21-1	SE SE	-	-	-	40	-	Qgd	-	-	-	-	-	
21-2	NE SE	Ervic Bosanic	Elwin Anderson	1953	104	5	Sb	D	-	-	-	-	Bedrock at 96 ft.

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
42N 15W													
23-1	SE SW	-	Elwin Anderson	-	55	6	Sb	D	-	-	-	-	Bedrock at 14 ft.
23-2	SW SE	Brick School	-	-	60	2	Sb	P	-	-	-	-	
24-1	NE SE	Neely Schnurer	W. Bowman	1918	80	6	Sb	D,S	-	-	-	-	
24-2	SW NE	Jack Messer	Elwin Anderson	-	90	6	Sb	D	-	-	-	-	Bedrock at surface.
25-1	SE SE	Orlen Schnurer	Do.	1944	55	6	Sb	D	6	R	9-19-46	-	Bedrock near surface.
25-2	NW NW	Vertal Schnurer	Do.	1947	80	4	Sb	D	-	-	-	-	Do.
26-1	SE SW	-	Do.	-	60	6	Sb	D	-	-	-	690	Do.
26-2	NW NE	Clio Brown	Do.	1945	81	6	Sb	D	-	-	-	-	Do.
26-3	NE NE	August Lagman	Do.	-	61	6	Sb	D,S	4	R	1957	-	Bedrock at surface.
27-1	NW SW	Kendall School	-	-	27	1¼	Qgd	P	-	-	-	-	
27-2	NW SW	Jacob Kandall	Jacob Kandall	1924	40	6	Qgd	D,S	-	-	-	-	
27-3	SE SW	Manistique Twp.	Elwin Anderson	1952	300	6	Sb	P	-	-	-	-	
27-4	SE SW	Do	-	-	74	6	Sb	P	-	-	-	-	
27-5	NE SE	Sherwood Temsord	Elwin Anderson	1957	60	5	Sb	D	6	R	1957	-	Do.
28-1	SW SE	Edgar Gerlach	-	-	30	2	Qgd	D,S	6	R	9- 9-46	-	
28-3	NE SW	Arvid Scharatron	-	-	35	-	Qs	D	20	R	9- 9-46	-	
28-4	NW SE	E. Dahlvick	-	-	40	-	Qs	D	20	R	9- ?-46		
33-1	SE NW	-	-	-	-	-	Qgd	-	-	-	-	-	Destroyed.
34-1	NW NE	Matt Clarich	Elwin Anderson	1948	258	6	Sb	D	-	-	-	-	Bedrock near surface.
34-2	SE NW	Orville Winsor	Do.	-	93	5	Sb	D	-	-	-	-	Bedrock at surface.
36-1	SW SW	Otto Johnson	Do.	1942	210	6	Sb	D,S	-	-	-	-	Do.
42N 14W													
1-1	SW SE	-	Do.	1912	80	6	Sb	D	-	-	-	-	Bedrock at 5 ft.
3-1	SW SW	Austin Hayden	-	-	6	18	Sb	D	-	-	-	-	Improved spring. Bedrock at 6 ft.
3-2	SW SW	-	-	-	18	-	Qgd	D	6	R	7- 6-32	-	
4-1	SW SW	Frank Inman	Gilroy and Stephenson	1945	92	6	Sb	D	38	R	1946	-	
4-3	SW NE	Harry Currin	Elwin Anderson	1894	130	6	Sb	D	-	-	-	-	
8-2	SE NE	Dougell McGregor	Dougell McGregor	1882	10	48	Qgd	D	5	R	1949	-	Bedrock at 10 ft.
8-3	SE NE	Wood School	W. J. Rodgers	1947	194	6	Sb	P	-	-	-	670	Bedrock at 25 ft.
8-5	NE NE	Leon Rice	-	1908	110	6	Sb	D	68	R	1946	-	
9-1	NW SW	Albert Letson	-	-	238	6	Sb	D,S	50	R	-	-	
11-1	NW NW	A. J. Davidson	-	1902	60	-	Sb	D	10	R	7- 6-32	670	Bedrock at 10 ft.
11-2	NE SE	-	-	1902	90	6	Sb	D	-	-	-	680	Bedrock at 5 ft.
12-1	NW NW	J. W. Nafgzer	-	1906	35	2	Sb	D	-	-	-	680	Do.
12-4	SW NW	W. Buzzo	-	-	65	5	Sb	D,S	15	R	1946	675	
12-5	NW NW	Glenn McGregor	Elwin Anderson	-	106	6	Sb	D	22	R	1957	-	Bedrock at 3 ft.
13-1	SW SW	-	-	-	8	48	Qgd	D	-	-	-	650	Bedrock at 8 ft.
17-2	NE SE	Curtis Clark	-	1890	65	6	Sb	D	40	R	1949	-	
17-3	NW SW	Ralph Merwin	W. Bowman	1923	50	6	Sb	D	10	R	1932	-	Bedrock at 10 ft.
19-1	SW SW	Keith Schnurer	Elwin Anderson	1955	100	5	Sb	D	8	R	1955	-	Bedrock at 3 ft.
19-2	NW SW	Claude Jewett	Do.	1947	99	6	Sb	D	-	-	-	-	Bedrock near surface.
19-3	SE SW	Andell Burrell	Do.	1956	81	5	Sb	D	18	R	1956	-	Bedrock at 2 ft.
23-1	SE SW	W. Bowman	W. Bowman	-	240	-	Sb	D	-	-	-	-	
23-2	SE SW		Do.	1922	35	6	Sm	D	+3	R	7- 9-32	-	Flows 1¼ gpm.
23-4	SE SE	Furnett	-	-	50	-	Sm	D	3	R	7- 9-32	645	Formerly flowed.
25-1	SE SE	Andrew Michelson	-	1920	125	5	Sb	D	+4	R	7- 9-32	630	Flows 3/4 gpm.
25-2	NW NW	Albert Koksesk	W. Bowman	-	80	6	Sm	D	+3	R	1932	-	Flows.
26-2	SE SE	Orville Klagsted	-	-	300	6	Sb	D	-	-	-	-	Bedrock near surface.
30-2	NW NW	Lawrence Burrell	Elwin Anderson	1957	105	5	Sb	D	11	R	1957	-	Bedrock at 4 ft.
30-3	NW NW	Do.	Do.	1950	95	5	Sb	D	-	-	-	-	Bedrock at surface.
30-4	NW SW	William Anderson	Do.	1947	63	6	Sb	D	-	-	-	-	Bedrock near surface.
31-1	SW NW	Joseph Bubble	-	-	200	-	Sb	D	-	-	-	670	Do.
31-2	SW NW	Alvin Johnson	Elwin Anderson	-	121	6	Sb	S	-	-	-	-	Bedrock at 6 ft.
32-1	SE NW	Walter Duguette	-	-	25	6	Sm	D,S	20	R	1946	625	
32-2	SE NW	Peter Nelson	-	1900	34	6	Sm	D	4	R	1932	630	Bedrock at 14 ft.
32-3	NE SE	Helmer Bjorkman	-	-	40	4	Sm	D,S	-	-	-	-	
32-5	NW SE	Gunnar Carlson	-	1912	50	5	Sm	D,S	-	-	-	630	
32-6	SW NE	J. Anderson	-	-	40	5	Qgd	D,S	30	R	1946	-	
32-7	SE SE	Isaac Pauley	-	1899	150	4	Sb	D,S	10	R	1946	-	
32-8	SW NW	Arvid Carlson	-	1912	36	5	Sm	D,S	10	R	1946	640	
32-9	SE NE	Baptist Church	Elwin Anderson	-	65	6	Sm	P	4	R	1957	-	Bedrock at 3 ft.
33-1	SW NW	Hulda Nelson	W. Bowman	1917	65	6	Sm	D,S	18	R	1946	660	Bedrock at surface.
33-2	NE SW	Fred Peterson	W. J. Rodgers	1946	40	-	Sm	D	-	-	-	660	Bedrock near surface.
33-3	NE SW	Maretz Peterson	Do.	1946	75	-	Sm	D	-	-	-	660	Flows. Crevice at 32 ft.
33-4	SE NE	John Ring	Elwin Anderson	1940	51	6	Sm	D	-	-	-	655	Flows.

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
42N 14W													
33-5	SW NE	Robert E. Rice	W. J. Rodgers	1948	76	6	Sm	P	-	-	-	665	Bedrock at surface.
33-6	SE NW	Viola Smith	Toenneson Bros.	1957	55	6	Sm	D	9.5	M	10-18-57	665	Do.
34-1	NE SW	B. Lockwood	-	-	110	6	Sm	D,S	10	R	1946	-	
34-2	NW NE	J. S. Davis	W. Bowman	-	45	6	Sm	D	35	R	1946	-	
35-1	NE NE	W. E. MacGregor	-	-	73	5	Sm	D,S	-	-	-	635	
35-2	- NW	James Toner	W. J. Rodgers	1947	112	5	Sm	D	-	-	-	620	Bedrock near surface.
35-3	NE NE	Gulliver School	-	-	225	6	Sb	P	-	-	-	635	
35-4	SW NW	Sylvester Leny	W. J. Rodgers	1956	123	6	Sm	D	+.5	R	8- 2-56	-	Flows. Bedrock at 9 ft.
35-5	SW NE	Loyd Klagstad	Elwin Anderson	1950	173	6	Sm	P	8	R	1950	615	Bedrock at 9 ft.
35-6	NW NE	W. Bowman	W. Bowman	1940	375	6	Sb	P	18	R	11- 4-57	-	
35-7	NE NE	J. Rogers	-	-	170	-	Sm	-	-	-	-	-	
36-1	NE NE	Israel Fornea	W. Bowman	1922	88	8	Sm	D	+10	R	7- 9-32	630	Flows 6½ gpm. Bedrock at 10 ft.
36-2	SW NW	McHown	W. J. Rodgers	1939	110	6	Sm	D	-	-	-	615	
36-3	SE SW	Earl Jones	W. Bowman	-	190	5	Sm	D	-	-	-	620	
36-4	SW SW	J. W. Ray	Elwin Anderson	1947	81	6	Sm	D	-	-	-	610	
36-5	SW SW	Lee Chiles	Do.	1946	83	6	Sm	D	-	-	-	610	
36-6	SE SW	Gregg Goudreau	Do.	1951	60	6	Sm	D	10	R	1957	610	Bedrock near surface.
36-7	SW SW	M. M. Bell	Do.	-	99	6	Sm	D	-	-	-	610	Bedrock at 11 ft.
36-8	NW NW	Pawley	-	-	103	-	Sm	D	-	-	-	-	
42N 13W													
4-1	SW SW	Leo Snider	Toenneson Bros.	1957	70	6	Sb	D	30	R	1957	690	Bedrock at surface.
5-1	NW NE	Mich. Highway Dept.	Elwin Anderson	1956	101	6	Sb	P	21	R	1956	690	Bedrock at 6 ft.
6-1	SE SW	Richard Anderson	Do.	1907	125	6	Sb	D	12	R	1932	690	Do.
6-2	SE SE	Mrs. W. E. Baurs	W. J. Rodgers	1938	68	6	Sb	D	-	-	-	690	Crevices at 28 ft., 46 ft., and 55 ft.
6-3	SW SE	Joseph Savanto	Elwin Anderson	-	90	5	Sb	D	-	-	-	-	Flows 6.5 gpm. Bedrock at surface.
7-1	NE NE	William Weber	Do.	-	127	5	Sb	D	15	R	1957	710	
8-1	NW NE	Maple Grove Store	Richard Bros.	1922	70	4	Sb	P	-	-	-	690	Bedrock at surface.
8-2	NW NW	Albert Beckman	Toenneson Bros.	1957	100	6	Sb	D	34	R	1957	700	Bedrock at 15 ft.
8-3	NE NW	Green School	Elwin Anderson	1950	119	6	Sb	P	17	R	2- 7-50	690	Bedrock at 3 ft.
9-1	NE NE	W. E. Tennyson	W. J. Rodgers	1939	125	6	Sb	D	-	-	-	-	Bedrock at 11 ft.
20-1	SE SE	William Vertz	W. Bowman	1922	75	6	Sb	S	+9	M	5-22-57	640	Flows 7.5 gpm. Bedrock near surface.
22-1	NW NE	M.St. P. and S. S. M. RR	-	1902	-	6	-	D	-	-	-	615	Flows 1.5 gpm. Not used.
30-1	SW SE	-	-	-	10	-	Sm	D	+1	R	1949	-	Improved spring. Bedrock at 10 ft. Not used.
30-2	SW NE	John Anderson	W. Bowman	1920	38	-	Sm	D	-	-	-	640	Formerly flowed.
30-3	NW SE	Dave Lancour	Do.	1928	87	6	Sm	D	+6	R	1932	640	Formerly flowed 4 gpm.
41N 17W													
2-1	NW SW	Perry Baxter	Elwin Anderson	1957	77	5	Sb	D	32	R	1957	725	Bedrock at 16 ft.
2-2	- NW	Milton Williams	Do.	1945	115	6	Sb	D	-	-	-	720	
3-1	NE SE	George Keller	Do.	1940	85	4	Sb	D	-	-	-	725	
4-1	NW NW	Albert Huebscher	Laveille	-	90	6	Sb	S	-	-	-	760	
4-2	NE NE	Do.	-	-	130	6	Sb	D,S	-	-	-	775	
4-3	SE NE	Don Benard	Chet Rice	1957	97	6	Sb	D	-	-	-	775	
4-4	SE NE	Chris Peterson	George Gray	-	140	-	Sb	D,S	-	-	-	775	
5-1	SE SE	James E. Kelly	Leveille	1943	86	6	Sb	D,S	-	-	-	770	
5-2	NE SE	John Hartman	-	1917	180	-	Sb	D,S	-	-	-	780	
6-1	SE SE	J. Hardy	-	-	187	4	Sb	D,S	-	-	-	795	
7-1	NW NW	Virgil Fox	-	1900	249	5	Sb	D,S	-	-	-	850	
7-2	NE NE	Henry McGahn	Chet Rice	1956	183	6	Sb	D,S	-	-	-	795	Bedrock at 7 ft.
7-3	NE NE	John McGahn	-	1920	150	5	Sb	D,S	-	-	-	795	Not used.
7-4	SE SW	P. Archambeault	Tom Rice	-	140	6	Sb	D	-	-	-	780	Bedrock at 90 ft.
7-5	SW SW	Donald Blosser	Leveille	1915	120	6	Sb	D,S	-	-	-	750	
8-1	SE NE	Jules Tanguoy	George Gray	1925	130	5	Sb	D,S	-	-	-	780	
8-2	NW SW	Lyle Deuporo	-	1920	185	6	Sb	D,S	-	-	-	790	
8-3	SE SE	Lizzie Middauch	George Gray	-	167	6	Sb	D	-	-	-	790	
9-1	SE SE	Edward Gray	H. J. Gilroy	1956	157	-	Sb	D	-	-	-	755	
9-2	SE SE	Do.	-	-	120	-	Sb	D,S	-	-	-	760	
9-3	SW NW	William Hill	Zenno Leveille	-	136	5	Sb	D,S	-	-	-	780	Bedrock at 20 ft.
10-1	SE SE	Phil Bouchard	-	-	140	-	Sb	D,S	-	-	-	725	

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
41N 17W													
10-2	NE SE	Charles Hancock	-	-	8	72	Qgd	D	2.2	M	7-16-57	720	
11-1	NW SW	Walter Peterson	Chet Rice	1952	80	5	Sb	D	41	R	1952	720	
11-2	NW SW	Do.	-	-	120	6	Sb	P	-	-	-	720	Former school well. Destroyed.
11-3	SW SW	C. Krzyzanski	-	1947	65	6	Sb	P	-	-	-	725	Bedrock at 6 ft.
11-4	SW SW	Joseph Markham	Rice	1952	87	5	Sb	P	-	-	-	720	
14-1	NW NW	L. Savage	H. J. Gilroy	-	85	-	Sb	D	-	-	-	725	
15-1	NE NE	Henry Orschel	-	-	86	-	Sb	D	-	-	-	725	
15-2	NW NE	County Rd. Comm.	-	-	70	6	Sb	D,S	50.35	M	8-18-57	750	Not used.
16-1	NE NW	Ivan Erickson	Rice	1950	143	-	Sb	D	-	-	-	770	Bedrock at 5 ft.
16-2	NW NW	Cooks School	Aenno Leveille	1925	220	6	Sb	P	120	R	1938	800	Destroyed. Bedrock at surface.
16-3	NW NW	Do.	Elwin Anderson	1954	192	6	Sb	P	116		4- 4-56	800	Bedrock at surface.
17-1	NW NW	William Popour	W. Bowman	1930	124	-	Sb	D,S	-	-	-	780	
17-2	NW SW	William Haindl	G. W. Gray	1912	165	6	Sb	D,S	-	-	-	760	
18-1	NW NE	Charles Glosser	Do.	1916	130	5	Sb	D,S	-	-	-	780	
18-2	SE SE	Ernest Knuth	-	1917	140	5	Sb	D,S	-	-	-	760	
18-3	NE SE	Joseph Haindl	G. W. Gray	1917	165	5	Sb	D,S	-	-	-	775	Bedrock at 5 ft.
18-4	NW NW	Albert Huebscher	-	-	166	5	Sc	-	-	-	-	745	
19-1	NE NE	Virgil Wright	G. W. Gray	-	80	6	Sb	D,S	-	-	-	760	
19-2	SE SE	Do.	Do.	1900	130	-	Sb	D,S	110	R	1957	800	
20-1	NW SW	Arthur Demars	Rice	1941	96	4	Sb	D	-	-	-	760	Bedrock at surface.
20-2	NW NW	Herbert Popour	W. Bowman	1937	113	6	Sb	D	-	-	-	760	Bedrock at 9 ft.
29-1	NW NW	Virgil Wright	-	-	8	21	Qgd	D	2.04	M	8-27-57	770	
29-2	NE SW	Cooks Cemetery	-	-	71	6	Sb	P	45.78	M	8-28-57	715	Bedrock near surface.
30-1	NW SE	Village of Cooks	-	-	40	5	Sb	P	-	-	-	700	Bedrock at 30 ft.
30-2	NW SE	Cooks Power Sta.	-	-	100	5	Sb	P	-	-	-	700	Do.
30-3	NW SE	M. St. P. and S. S. M. RR	Elwin Anderson	-	53	5	Sb	P	16	R	1957	700	
30-4	NW SE	G. F. Gray	Do.	-	52	6	Sb	D	10	R	1957	700	
30-5	NW SE	Cooks Lions Club	Do.	1954	52	5	Sb	P	-	-	-	700	
41N 16W													
2-5	SW NE	Mich. Highway Dept.	Mich. Highway Dept.	1948	18	-	-	B	-	-	-	621	Drilled through sand and clay. Bedrock at 18 ft.
2-6	NW NE	-	Elwin Anderson	-	58	5	Sb	D	-	-	-	620	Former school well. Bedrock at 6 ft.
2-7	NW NE	Heights School	-	-	90	1½	Sb	P	-	-	-	620	Not used.
2-8	NW NE	Do.	Elwin Anderson	1900	-	4	-	P	10	R	1946	620	Not used.
2-9	NE SW	Charles Burley	Do.	1946	161	6	Sb	D	6	R	1946	610	
2-10	NE SW	L. P. Headland	Rice	1938	180	2	Sb	D	-	-	-	610	
2-11	NE SW	C. H. Howard	Do.	1936	-	4	-	D	12	R	1946	610	
2-12	- NW	Gerald Muller	Elwin Anderson	1950	162	6	Sb	D	3	R	1950	-	Bedrock at surface.
2-13	NE SW	Gustave Anderson	Do.	1910	65	6	-	D,S	55	R	1946	620	
2-14	NW NW	Chris Johnson	Elwin Anderson	1956	91	5	Sb	D	3	R	5- ?-56	620	Bedrock at 15 ft.
2-15	SE NW	Clark Bashore	Do.	-	265	6	Sb	D	-	-	-	620	Bedrock at 2 ft. Shale at 265 ft.
2-16	SE NW	Walter Whitman	Do.	1949	160	6	Sb	D	10	R	1949	620	Bedrock at 8 ft.
2-17	NE NW	Albert Schubring	Do.	1949	130	6	Sb	D	9	R	10- ?-49	620	
2-18	- NW	Donald Dissenger	Do.	1948	160	5	Sb	D	6	R	1948	620	
3-1	NW NW	-	-	-	127	-	Sb	D	-	-	-	620	Bedrock at 27 ft.
3-2	NE NW	A. C. Fleck	Elwin Anderson	1957	155	5	Sb	P	+1	R	1957	620	Flows.
3-3	SW NW	Oliver Edwards	Do.	-	154	6	Qg	D	-	-	-	620	Flows.
3-4	NE NW	Harry LeFoille	Do.	-	147	6	Sb	D	8	R	3- ?-47	620	
3-5	NE NW	Hazel Anderson	Do	1944	110	6	Qg	D	14	R	11- ?-44	620	
3-6	NE NW	Ed LaLabell	Do.	1957	146	5	Sb	D	2	R	1957	620	Bedrock at 76 ft.
3-7	NE NW	Oscar Edwardsen	Do.	1952	150	6	Sb	D	-	-	-	620	Flows.
3-8	NE NW	Dorothy Mueller	Do.	1956	127	4	Sb	D	11	R	1956	620	Bedrock at 107 ft.
3-9	NE NW	Russell Carlsen	Do.	1956	128	4	Sb	D	11	R	1956	620	Do.
3-10	NW NW	Leland Headland	Do.	1952	110	5	Qg	D	9	R	1952	620	
4-1	NW SE	John Girvin	Do.	1953	158	6	Qg	D	-	-	-	620	
4-2	SW SE	Albert Nigh	Do.	-	154	5	Qg	D	-	-	-	620	Flows 3 gpm.
7-1	SE SW	L. F. Donaldson	Do.	1946	72	6	Sb	D	-	-	-	620	
8-1	SE SE	Dewey Minor	-	1936	80	6	Qg	P	+2	R	1957	620	Flows 12.2 gpm.
8-2	SE SE	Do.	Elwin Anderson	1947	102	6	Sb	D	+2	R	1957	620	Flows 9.4 gpm. Bedrock at 80 ft.
9-1	NE SW	Arthur Young	Do.	-	80	5	Qg	D	-	-	-	620	Flows 6.5 gpm.
9-2	NE SW	George Clem	Do.	1955	78	4	Qg	D	-	-	-	620	Flows 1.5 gpm.

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
41N 16W													
9-3	NE SW	Atmore Schuster	Elwin Anderson	-	65	5	Qg	D	-	-	-	620	Flows 6.6 gpm.
9-4	NW NW	William Stocker	Toenneson Bros.	1957	152	6	Qg	D	+5	M	1957	620	Flows.
9-5	SW NW	Friedolf Danielson	Elwin Anderson	1946	157	6	Qg	D	-	-	-	620	Flows.
9-6	NE NW	Fred Haines	Do.	1953	170	6	Qg	D	-	-	-	620	Flows.
11-9	SW NE	Mich. Highway Dept.	Mich. Highway Dept.	1948	8	-	-	B	-	-	-	607	Drilled in sand.
11-10	SE NE	City of Manistique	-	1892	250	8	Sc	P	-	-	-	610	Flows 5 gpm.
11-11	SE NE	T.B. Sanitarium	-	1890	100+	4	Sb	P	-	-	-	610	
12-1	SE NW	City of Manistique	-	1890	280	-	Sc	P	-	-	-	605	Flows. Not used.
12-20	SE NW	Mich. Highway Dept.	Mich. Highway Dept.	1948	11	-	-	B	-	-	-	603	Drilled in sand.
12-21	SW NW	Hoholik Dairy	Elwin Anderson	1955	189	6	Sb	P,I	9	R	1955	610	Bedrock at 8 ft.
12-22	SW NW	City of Manistique	-	-	220	6	Sc	P	-	-	-	610	Flows 25 gpm.
12-23	SE NW	Hiawatha Hotel	-	1900	800	5	Or	P	+30	R	1905	610	Flowed.
12-24	SW NE	City of Manistique	Layne Northwest	1941	1398	12	OChm	P	+28	R	11- 3-41	610	Flowed 300 gpm. Bedrock at 15 ft.
12-25	NE NE	Old Furnace	-	-	300	-	Sc	I	-	-	-	610	Flows 3 gpm. Not used.
12-26	NE NE	Burrell Chemical Works	-	1903	240	6	Sc	I	+1	R	1949	610	Flows 5 gpm.
12-27	SW NE	Pauley and Pauley Cheese Factory	W. Bowman	1932	241	5	Sc	I	-	-	-	610	Flows 8 gpm. Crevices at 100 ft.
12-28	NW SE	Frank Pavlot	Elwin Anderson	1945	69	6	Sb	D	-	-	-	610	Bedrock near surface.
12-30	SW SW	George Kerr	Do.	1947	245	6	Sc	P	5	R	10- ?-47	595	
13-1	NW NE	City of Manistique	-	-	-	-	-	P	-	-	-	600	Flowed. Bedrock near surface.
14-1	NE NE	Don McPhail	Elwin Anderson	1955	202	6	Sb	D	7	R	9- ?-55	595	Bedrock at 46 ft.
17-1	NW SE	Harry Evans	Do.	1951	87	6	Qg	D	-	-	-	620	Flows 10 gpm.
17-2	SE NE	Dewey Minor	H. J. Gilroy	-	80	6	Qg	D	-	-	-	620	Flows 40 gpm. Not used.
17-3	NE NE	C. L. Stevens	Elwin Anderson	1939	78	6	Qg	P	+10	R	1957	620	Flowed 65 gpm in 1939.
17-4	NW SE	MDC	Do.	1937	145	5	Qgd and Sb	P	-	-	-	625	Flows 12 gpm.
18-1	NE NW	C. J. Forstner	Do.	1947	56	6	Qgd	D	-	-	-	630	
18-2	NE NW	Albrecht	W. Bowman	1926	128	6	Sb	P	11	R	1946	640	Bedrock at 70 ft.
18-3	SE NW	W. L. Sweitzer	H. J. Gilroy	1953	82+	5	Sb	P	8	R	1957	640	Bedrock at 58 ft.
18-4	NE NW	Peterson	Elwin Anderson	1948	56	6	Qgd	D	-	-	-	640	
18-5	NW NW	William Haagenson	Do.	1947	56	6	Qgd	D	-	-	-	640	
19-1	NE NW	M. L. Bloom	Do.	1940	58	5	Qgd	D	-	-	-	660	
19-2	NW NE	Do.	W. Bowman	1926	101	6	Sb	P	-	-	-	655	
19-3	SW NE	August Carlson	August Carlson	1931	42	-	Qsg	D,S	2	R	9-25-46	660	
19-4	SE SE	Ernest Hoholik	Elwin Anderson	-	71	6	Qg	S	-	-	-	640	
28-1	SE NE	Mich. Highway Dept.	Do.	1956	88	5	Qg	P	+8	M	8- ?-57	590	Flows 20 gpm.
29-1	NW SW	Thomas Smith	W. Bowman	1926	200	6	Sb	D,S	-	-	-	645	
29-2	NW NW	Emil Nelson	Do.	1929	205	-	Sb	D,S	-	-	-	650	
29-3	SE NW	MDC	-	-	-	-	Qgd	-	-	-	-	-	Spring. Flows 1400 gpm. Supplies fish hatchery.
30-2	SE NW	John Stoor	Elwin Anderson	1955	157	5	Sb	D	13	R	1955	665	Bedrock at 40 ft.
31-1	NE SE	W. E. Anderson	-	-	45	6	Qg	D	8	R	9-21-46	640	
31-2	NW NE	Oscar Jasmin	Hugo Erickson	1934	30	3	Qgd	D,S	-	-	-	660	
32-1	SW NE	Grants Cabins	W. Bowman	1934	130	6	Sb	P	-	-	-	660	
32-2	NW NW	Noel Hursh	Do.	-	110	4	Sb	D	12	R	9-16-46	640	
32-3	NW SE	Floyd Cox	-	-	330	6	Sc	D	-	-	-	600	Flowed in 1946.
32-5	SE NE	Do.	-	1887	180	6	Sb	P	-	-	-	610	Flows 1 gpm. Bedrock at 20 ft.
32-6	SW NE	Thompson School	Elwin Anderson	1946	115	6	Sb	P	13	R	9-26-46	610	
32-7	NE NW	MDC	-	1936	192	6	Sb	D	-	-	-	620	
32-8	SE NE	Ole Edwardson	Elwin Anderson	1952	70	5	Sm	D	4	R	1952	600	Bedrock at 30 ft.
41N 15W													
1-1	SW NW	Mort. Melligan	-	1922	100	6	Sb	D	-	-	-	630	Bedrock at 25 ft.
2-1	SW NW	James Hubble	James Hubble	-	24	-	Qg	D	15	R	9-13-46	-	
2-2	SW NW	Do.	-	1946	15	1¼	Qsg	D	4	R	1946	-	
2-3	SE SW	Abin Nelson	Abin Nelson	1939	22	1¼	Qs	D,S	12	R	9-12-46	630	
2-4	SE SW	Do.	Do.	-	12	1¼	Qs	D,S	-	-	-	-	
3-1	NE NW	Dan Murphy	-	1931	12	1¼	Qgd	D	-	-	-	-	Not used.
3-2	SW SE	S. Klagstad	-	-	35	1¼	Qgd	D,S	-	-	-	-	
3-3	SW SW	Leonard Maulthaupt	Elwin Anderson	-	44	-	Qgd	P	-	-	-	-	

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
41N 15W													
4-1	NE NW	Redwing School	-	-	28	1¼	Qg	P	-	-	-	-	Destroyed.
4-2	SE SE	George Rasmussen	Elwin Anderson	1956	118	5	Sb	D	28	R	4- ?-56	680	Bedrock at 60 ft.
5-1	SE SE	L. R. Walters	L. R. Walters	-	18	1¼	Qg	D,S	12	R	9-15-46	620	
6-1	NE SW	U. S. Forest Serv.	-	1936	216	5	Sb	P,I	18	R	4-22-36	620	Bedrock at 23 ft.
6-2	NE SW	Do.	-	1938	81	5	Sb	P,I	10	R	1949	620	Bedrock at 28 ft.
7-1	NE SE	Leo McNamara	Elwin Anderson	-	135	5	Sb	P	-	-	-	600	Bedrock at 4 ft.
7-2	SE SE	W. Bowman	W. Bowman	1932	188	6	Sb	P,I	-	-	-	600	Flows. Bedrock at 5 ft.
7-3	SW SW	City of Manistique	-	-	225	6	Sb	P	-	-	-	610	
7-4	SE SW	Nalbert Gerber	Elwin Anderson	1957	57	4	Sb	D	12	R	1957	610	Bedrock at surface.
7-5	- SW	Charles Nelson	Do.	1944	200	6	Sb	D	-	-	-	600	
7-6	SE SW	F. J. Weberg	Do.	-	155	5	Sb	D	-	-	-	600	Flows 1 gpm. Bedrock at 4 ft.
7-7	SE SW	Ernest Edwards	Do.	-	132	6	Sb	D	4	R	1957	610	
7-8	SW SW	Mrs. R. K. Sawyer	Do.	1957	98	5	Sb	D	10	R	1957	600	Bedrock at surface.
7-9	SE SW	R. Ebli and R. Pollman	Do.	1957	52	4	Qs	D	12	R	1957	600	
7-11	SE NW	Daniel Hamill	-	-	30	4	Qs	D,S	15	R	9-17-46	-	
8-1	NW NE	Joseph Lavigne	W. J. Rodgers	1938	300	-	Sb	D	-	-	-	630	Bedrock near surface.
8-3	NW NW	George Babladelius	Elwin Anderson	1955	173	6	Sb	P	12	R	1955	600	Bedrock at 30 ft.
8-4	SE NW	Francis McNamara	Do.	1957	150	5	Sb	P	4	R	1957	590	Bedrock at 17 ft.
8-5	SW NW	Ralph Williams	Do.	1954	160	6	Sb	P	8	R	1954	590	Bedrock at 21 ft.
9-1	NE NW	Thomas Bolitho	Do.	1947	222	6	Sb	D	69	R	9- ?-47	680	
9-2	NE NE	R. B. Schmidt	Do.	-	161	6	Sb	P	28	R	1957	680	Bedrock at 70 ft.
10-1	NE NW	J. S. LeDue	Do.	1953	61	6	Qs	P	-	-	-	680	
10-2	NE NW	Joe Carlson	Do.	-	45	5	Qg	D	-	-	-	680	
11-1	NW NW	Mrs. F.W. Arrowood	-	-	20	-	Qs	D	8	R	9-25-46	680	
11-2	NW NW	Do.	Elwin Anderson	-	74	5	Sb	D	-	-	-	680	Bedrock at 31 ft.
18-1	NW NW	City of Manistique	Kinney and Coleman	1903	240	6	Sb	P	-	-	-	595	Formerly flowed. Bedrock at surface.
18-2	SW NW	Do.	-	1937	242	5	Sb	P	-	-	-	585	Flows. Bedrock at surface.
18-3	SW NW	Harry Secore	Elwin Anderson	1947	102	6	Sb	P	+1	R	8- ?-47	600	Do.
18-4	SW NW	Do.	-	-	227	6	Sb	D	-	-	-	600	Do.
18-5	SW NW	James Ballas	Elwin Anderson	1956	156	5	Sb	P	2	R	1956	600	Bedrock at surface.
41N 14W													
1-1	SW SW	Jack Beaudoin	Do.	1957	136	5	Sm	D	4	R	1957	600	Bedrock at 28 ft.
1-2	SE NW	V. Hellabuyck	Do.	1956	49	5	Sm	D	8	R	1956	-	Bedrock at 4 ft.
2-1	NE SW	Frank Heinz	W. J. Rodgers	1950	1480	8-6	OЄhm	P	-	-	-	620	Flows 63 gpm.
41N 13W													
1-1	SW SE	Inland Lime and Shale Co.	Do.	-	225	6	Sb	I	-	-	-	590	Flows.
1-2	SW SE	Do.	W. Bowman	1928	173	6	Sm	I	+22	R	11-14-32	590	Flows 12 gpm. Bedrock near surface.
2-1	SE SE	Do.	Do.	1928	165	6	Sm	I	+1	R	7- 9-32	590	Flows 3 gpm. Bedrock at 9 ft.
2-2	SW SW	Do.	-	-	115	8	Sm	I	+1	M	11- 7-57	-	Bedrock at surface. Not used.
5-1	NW SW	Harry Brown	Elwin Anderson	-	68	5	Sm	D	4	R	1957	605	Bedrock at 30 ft.
5-2	NE SE	Calib Way	W. J. Rodgers	-	171	6	Sb	D	+7	M	5-22-57	610	Flows 15 gpm. Bedrock at 5 ft.
5-3	SW NE	Leslie Schafer	Do.	-	231	6	Sb	D	-	-	-	610	Flows. Bedrock at surface.
6-1	NW NW	C. Lippert	Elwin Anderson	1946	95	6	Sm	P	-	-	-	605	Bedrock near surface.
6-2	NW SW	Do.	Do.	1948	43	5	Sm	P	-	-	-	605	Do.
21-1	SW NE	Schoolcraft Dev.	W. Bowman	-	1710	-	OЄhm	To	-	-	-	625	Flowed. Bedrock at surface.
21-2	SW NE	Do.	Do.	-	1300	-	OЄhm	To	-	-	-	630	Do.
21-3	SW NE	Vern Goodreau	Elwin Anderson	-	131	5	Sm	D	-	-	-	-	Bedrock at surface.
21-4	NW SE	Seul Choix School	W. Bowman	-	128	-	Sm	-	-	R	1949	600	Do.
40N 17W													
3-1	SW SW	Gunnar Flodin	-	-	20	48	Qg	D	8	R	9-18-46	710	
3-2	NW SE	Willis Yeoman	-	-	12	-	Qs	D,S	7	R	9-13-46	700	
4-1	SW SW	Hugo Gustafson	-	-	20	1¼	Qg	D,S	10	R	9-13-46	710	
4-2	SW SE	E. W. Erickson	-	-	15	-	Qs	D	-	-	-	710	
10-1	NE NW	Bernard Erlandson	-	-	18	-	Qg	D	4	R	9-18-46	705	
12-1	NW SW	Alfred Shenk	H. J. Gilroy	1954	50	4	Qsg	D	30	R	1954	645	
12-2	NW SW	Fred Swan	Fred Swan	1957	47	4	Qs	D	26	R	9- 5-57	635	
23-1	SW NE	Frank Hittle	H. J. Gilroy	1940	55	6	Qg	D	40	R	1940	650	

Table 3.--Records of wells and test holes in Schoolcraft County.--Continued

Well number	Location in section	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Water level	M or R	Date	Altitude	Remarks
40N 17W													
24-1	- SE	Frank Gierke	Elwin Anderson	1957	50	5	Sm	D	-	-	-	590	
28-1	- NE	William Sellman	Do.	1957	60	5	Sm	D	-	-	-	670	Bedrock at 7 ft.
28-2	- NE	Clarence Whalen	Do.	1957	95	5	Sm	D	-	-	-	670	Do.
28-3	- NE	George Karrigan	Do.	1953	50	4	Sm	D	10	R	1953	670	Do.
40N 16W													
6-1	NW SW	William G. Simmons	Do.	1951	72	5	Sm	D	-	-	-	655	Bedrock at 41 ft.
39N 17W													
1-1	NE SW	Julius Ungerer	Do.	1950	89	-	Qgd	P	2	R	1950	620	
7-1	SW NW	John Hoover	Rice	1956	75	5	Sm	D	12	R	10- ?-56	610	

Table 4.--Logs of wells and test holes in Schoolcraft County

Thickness in feet. Depth in feet below land surface.

Altitude in feet above mean sea level.

	Thickness	Depth
47N 16W 30-1 Altitude 890		
Glacial drift:		
Sand	35	35
Clay and sand	4	39
Hermansville-Munising fms:		
Limestone	18	57
47N 13W 16-1 Altitude 875		
Glacial drift:		
Sand, very fine, clayey	202	202
Hermansville fm:		
Limestone, water flow 7 gpm	6	208
Sandstone, water flow 30 gpm	7	215
Shale, traces at	-	215
46N 13W 32-4 Altitude 734		
Glacial drift:		
Sand fill	4	4
Sand, fine, peaty	3	7
Peat, soft	2	9
Sand, fine to medium, occasional peat layers	7	16
Sand, fine, red, compact	39	55
Sand, very fine, red, compact, silty, occasional thin clay lenses	12	67
46N 13W 33-1 Altitude 745		
Glacial drift:		
Sand, yellowish, lake-laid	60	60
Clay, bluish, lake-laid	40	100
Gravel, brownish	1	101
(No bedrock encountered)		
45N 13W 16-2 Altitude 710		
Glacial drift:	142	142
Richmond gr:		
Shale, light-gray, limy, soft	208	350
Shale, dark-gray to black	30	380
Shale, gray, soft	10	390
Collingwood fm:		
Shale, gray, hard	10	400
Shale, black to dark-gray, hard	10	410
Trenton-Black River fms:		
Limestone, light-brown, and gray to black shale	20	430
Limestone, light-brown	30	460
Limestone, light-brown, some black shale	10	470
Limestone, light-gray, fossiliferous	10	480
Dolomite, light- to dark-brown, some black shale	10	490
Limestone, gray, shaly, fossiliferous	30	520
Dolomite, light-to dark-brown, crystalline	20	540
Dolomite, light-brown and gray, crystalline	10	550
45N 13W 16-2 Continued		
Dolomite, white to gray, and light-brown, crystalline	40	590
Dolomite, gray, light-brown, crystalline	20	610
Dolomite, gray, limy	10	620
Limestone, gray, dolomitic	10	630
Limestone, gray, iron stains, dolomitic, fossiliferous	10	640
Limestone, gray to black, dolomitic, fossiliferous, some quartz sand grains and pyrite	20	660
Limestone, dark-gray, quartz sand grains	10	670
Hermansville fm:		
Quartz sand, clean, frosted, pitted, rounded and sub-angular	30	700
45N 13W 16-3 Altitude 710		
Glacial drift:		
Sand, very light-brown, very fine	65	65
Clay, light-red, sandy	32	97
Richmond gr:		
Limestone, dark-gray to buff, fossiliferous	3	100
Sand, light-red, very fine	5	105
Limestone, dark-gray to buff	10	115
Limestone, gray, and sand	5	120
Sand and limestone, gray	10	130
Limestone, gray	30	160
Limestone, gray to white, fossiliferous	25	185
Limestone, gray, and shale	5	190
Dolomite, gray	10	200
Shale, gray, silty	5	205
Shale, gray, and dolomite	5	210
Shale, gray, silty	5	215
Shale, gray, silty, interbedded with limestone	10	225
Shale, gray	15	240
Shale, gray, and limestone	5	245
Shale, gray, silty	20	265
Shale, dark-gray, hard, calcareous	5	270
Shale, gray, silty, calcareous	5	275
Shale, gray, and argillaceous limestone	5	280
No samples	115	395
Shale, gray	5	400
Trenton-Black River fms:		
Limestone, dark-brown, argillaceous and shale	5	405
Limestone, dark-brown, argillaceous and white limestone and shale	35	440
Limestone, very light-gray, with some dark-brown limestone	35	475
Dolomite, buff, and light-gray limestone, little pyrite	20	495
45N 13W 16-3 Continued		
Limestone, gray	10	505
Limestone, gray, and sandstone	5	510
Limestone, gray	5	515
Dolomite, buff and gray, limestone	5	520
Dolomite, buff	35	555
Dolomite, gray	10	565
Dolomite, light-brownish-gray	15	580
Limestone, light-gray, and dolomite	5	585
Dolomite, buff, and gray limestone	5	590
Limestone, gray, and dolomite, little sandy	5	595
Limestone, light-gray, and buff dolomite	5	600
Dolomite, buff	10	610
Limestone, light-gray to buff	10	620
No sample	40	660
Dolomite, buff and gray	5	665
Dolomite, gray, and some sandstone	5	670
Hermansville fm:		
Sandstone, medium, and gray dolomite	10	680
Sandstone, medium, clear, frosted, well-rounded, little pyrite	5	685
No record	30	715
45N 13W 34-7		
Glacial drift:		
Sand	23	23
Clay, blue, pebbly	22	45
Sand, blue	5	50
44N 13W 3-3		
Glacial drift:		
Sand and clay, mixed	40	40
Sand, fine to coarse	20	60
Richmond gr:		
Shale, gray, limy	11	71
43N 17W 20-3 Altitude 770		
Glacial drift:		
Sand and marl, white	125	125
Richmond gr: and Trenton and Black River fms:		
Shale, blue	500	625
Hermansville and Munising fms:		
Sandstone	85	710
43N 16W 13-1 Altitude 730		
Glacial drift:		
Clay	17	17
Sand	18	35
Quicksand	20	55
Sand, fine, and water	99	154
Gravel	1	155
Sand	12	167
No record	3	170

Table 4.--Logs of wells and test holes in Schoolcraft County.--Continued

	Thickness	Depth
43N 16W 14-2 Altitude 735		
Glacial drift:		
Sand and quicksand	160	160
Boulders and quicksand	32	192
Richmond gr:		
Shale at	-	192
43N 16W 23-3 Altitude 730		
Glacial drift:		
Sand and clay	90	90
Cataract fm:		
Dolomite	110	200
Richmond gr: and Trenton-Black River fms:		
Limestone, hard	600	800
Hermansville-Munising fms:		
Sandstone	20	820
43N 15W 18-1 Altitude 730		
Glacial drift:		
Sand	200	200
Cataract fm:		
Dolomite	30	230
Richmond gr. and Trenton-Black River fms:		
Limestone and shale	605	835
Hermansville-Munising fms:		
Sandstone	40	875
43N 13W 1-2		
Glacial drift:		
Sand, fine to coarse	6	6
Clay	4	10
43N 13W 2-1		
Glacial drift:		
Muck	2	2
Clay	10	12
Clay, sandy	1	13
43N 13W 8-1		
Glacial drift:		
Sand, fine	6	6
Clay	2	8
Gravel at	-	8
43N 13W 16-5 Altitude 740		
Glacial drift:		
No record	55	55
Burnt Bluff fm:		
Dolomite, buff to gray, crystalline, and quartz grains, rounded	35	90
Dolomite, gray and light-brown, shaly, dense, and sandy	5	95
Cataract fm:		
Dolomite, gray, sandy, and some impure gypsum	10	105
Dolomite, gray to light-brown, and impure gypsum	15	120
Shale, green, and light-brown dolomite, gypsum, sandy	5	125
Dolomite, light-brown, gray, shale, and gypsum	5	130
Dolomite, gray to light-brown, white gypsum, sandy	15	145
Shale, gray, gray to light-brown, dolomite, and white gypsum	5	150
43N 13W 16-5 Continued		
Dolomite, gray to light-brown, white and colorless gypsum, quartz sand grains, shaly, gray (flow of sulfur water from 164 ft.)	20	170
Dolomite, coarsely crystalline, chert and some gypsum	35	205
Dolomite, light-brown, greenish gray shale, and traces of pyrite gypsum	10	215
Shale, greenish-gray, and white gypsum	5	220
Shale, greenish gray and red, and pink and white gypsum	30	250
Dolomite, light-brown, massive greenish-gray shale, and white and pink gypsum	35	285
Richmond gr:		
Dolomite, light-brown to brown, granular, dark-brown and green, muddy shale	25	310
Shale, and light-brown and gray dolomite	5	315
Dolomite, light-brown, granular, green shale, and white gypsum	15	330
Dolomite, light-brown to brown, crystalline, and green shale	10	340
Shale, gray, muddy, sandy	5	345
Dolomite, gray and light-brown crystalline, tract of gypsum	5	350
Shale, gray, muddy, and gray dolomite, some gypsum	50	400
Dolomite, gray, crystalline, gray to green shale and some gypsum	65	465
Shale, gray, muddy, and dolomite, white, crystalline	20	485
Shale, greenish-gray and brown	200	685
Collingwood fm:		
Shale, gray, dark-brown to black, and gypsum	20	705
Trenton-Black River fms:		
Dolomite, light-brown, crystalline, greenish-gray shale, a little gypsum	5	710
Limestone, light- to dark-brown	75	785
Limestone, gray to light-brown, and greenish-gray shale	20	805
Shale, dark-brown and dark-green, gray limestone, and some carbonaceous sand	10	815
Dolomite, light-brown, crystalline, hard, and some dark-brown and green shale (flow of mineralized water from 819 ft.)	30	845
43N 13W 16-5 Continued		
Dolomite, gray, crystalline, pyrite	15	860
Dolomite, light-brown and gray	20	880
Limestone, light-gray to dark-brown iron stains	95	975
Dolomite, light-brown, crystalline, rounded quartz sand particles, and some dark-brown shale	30	1005
Hermansville-Munising fms:		
Sandstone, rounded grains (fresh water at 1009 ft.)	40	1045
Sandstone, rounded grains with iron stains, traces of limestone and shale	10	1055
43N 13W 21-1 Altitude 740		
Glacial drift:		
Clay loam and sand	15	15
Quicksand	26	41
Gravel, water-bearing	4	45
Clay till with sand streaks	68	113
Cataract fm:		
Shale, some highly mineralized water from near bottom	101	214
42N 16W 13-1 Altitude 625		
Glacial drift:		
Sand	38	38
Clay	100	138
Black rock	12	150
No sample	5	155
Cataract fm:		
Shale	50	205
Dolomite	70	275
Richmond gr:		
Limestone	475	750
Collingwood fm:		
Shale, black	15	765
Total depth		930
42N 16W 14-1 Altitude 632		
No record	39	39
Burnt Bluff fm:		
Dolomite, buff to light-brown, dense to crystalline, some rounded sand grains	48	87
Cataract fm:		
Dolomite, light-gray, dense, shaly	8	95
Shale, green, muddy	5	100
Dolomite, light-gray, dense; some muddy shale and gypsum	15	115
Shale, gray and greenish-gray, flaky, soft, some dolomite	10	125
Dolomite, gray to brownish-gray, dense to finely crystalline, some chert and gypsum	125	250
Richmond gr:		
Dolomite, gray, green, and red, shaly, some gypsum	30	280

Table 4.--Logs of wells and test holes in Schoolcraft County.--Continued

	Thickness	Depth
42N 16W 14-1 Continued		
Shale, gray, flaky and muddy, and dolomite, light-brown, dense	10	290
Gypsum and dense dolomite	5	295
Dolomite, light-brown, dense to finely crystalline	180	475
Dolomite, brown to buff, dense to broken crystalline, some secondary crystallization (show of oil and gas at 490 ft.)	25	500
Dolomite, gray, shaly	40	540
Shale, gray, flaky, some gray dolomite	5	545
Dolomite, gray, shaly	20	565
Shale, gray, muddy, limy (show of gas at 710 ft.)	150	715
Trenton-Black River fms:		
Dolomite, light to dark-brown, dense to crystalline (show of water at 885 ft.)	255	970
Hermansville-Munising fms:		
Dolomite, buff, and very fine-grained sandstone	5	975
Dolomite, dark-brown, dense to crystalline, few sand grains	5	980
Dolomite and sandstone, very fine-grained	5	985
Sandstone, gray, very-fine- to coarse-grained, some dolomite, buff (water from 1002 to 1050 ft. and smell of gas at 1002 ft.)	65	1050
42N 13W 4-1		
Glacial drift:		
Clay till	2	2
Burnt Bluff fm:		
Dolomite, creviced at 20 and 23 ft., water-bearing	68	70
41N 16W 2-5 Altitude 621		
Glacial drift:		
Sand, fine to silty	16	16
Clay, blue, traces of pebbles	2	18
Bedrock or boulders at		18
41N 16W 8-2 Altitude 620		
Glacial drift:		
Sand	30	30
Clay, reddish, lake-laid	50	80
Burnt Bluff fm:		
Limestone	22	102
41N 16W 12-24 Altitude 610		
Glacial drift:		
Clay till	15	15
Burnt Bluff fm:		
Dolomite, buff to light-brown, dense to crystalline	50	65
Limestone, grayish-brown to brown, dense to crystalline	75	140
41N 16W 12-24 Continued		
Dolomite, buff and grayish-brown, dense, traces of glauconite (water flow of 200 gpm from 200 ft.)	75	215
No record	15	230
Dolomite, light-brown crystalline	55	285
Cataract fm:		
Dolomite, gray, shaly, dense	15	300
Shale, gray, flaky to muddy	10	310
Dolomite, gray to light-brown, dense to crystalline, some shale and gypsum	135	445
Richmond gr:		
Shale, dark-gray to brown, some dolomite and gypsum	5	450
Dolomite, gray and brown, some shale and gypsum	50	500
Dolomite, brown and gray, dense	20	520
Dolomite, brown, dense to crystalline, and greenish-gray shale	70	590
Shale, gray, muddy	5	595
Dolomite, brown to buff, crystalline	15	610
Shale, gray, flaky to muddy, some gray dolomite	10	620
Dolomite, grayish-brown, coarsely crystalline	40	660
Dolomite, grayish-brown, dense to crystalline, some shale	60	720
Shale, greenish-gray, flaky to muddy	195	915
Collingwood fm:		
Shale, dark-gray to black, hard	10	925
Trenton-Black River fms:		
Dolomite, light-brown, dense to finely crystalline	110	1035
Limestone, grayish-brown, dense, crystalline, some gray shale	10	1045
Dolomite, buff to gray, crystalline	40	1085
Limestone, brownish-gray, dense, trace of shale	20	1105
Dolomite, gray to brown, crystalline, some limestone	80	1185
Hermansville-Munising fms:		
Dolomite, light-brown, crystalline, some friable, medium-grained, sub-angular sandstone, some greenish-gray shale and pyrite	70	1255
Sandstone, coarse to fine, rounded and frosted, some dolomite	143	1398
41N 16W 28-1 Altitude 590		
Glacial drift:		
Sand	41	41
Clay	46	87
Gravel, medium	1	88
41N 15W 6-1 Altitude 620		
Glacial drift:		
Sand, red, fine	18	18
Clay	5	23
Burnt Bluff fm:		
Limestone, gray to brown, hard	17	40
Limestone, buff to light brown, soft	10	50
Limestone, dark brown	13	63
Limestone, gray	7	70
Limestone, dark-brown	15	85
Limestone, gray	105	190
Limestone, white, soft, creviced at 193 ft.	3	193
Limestone, gray, hard	23	216
41N 15W 18-1 Altitude 595		
Glacial drift:		
Sand	2	2
Manistique fm:		
Dolomite, light-buff, massive	2	4
Limestone, dolomitic	9	13
Dolomite, bluish-white	11	24
Burnt Bluff fm:		
Limestone, brown, and crystalline dolomite	16	40
Limestone, light-blue, dolomitic	12	52
Limestone, buff, crystalline, cherty	11	63
Limestone, white to buff, crystalline, dolomitic (hard drilling from surface to 80 ft.)	17	80
Limestone, white	27	107
Dolomite, buff to mottled gray (soft drilling from 80 to 140 ft.)	29	136
Dolomite, yellow, some limestone	79	215
Dolomite, white, thin banded, fine-grained	25	240
41N 15W 18-2 Altitude 585		
Manistique fm:		
Dolomite, gray, some quartz grains	30	30
Burnt Bluff fm:		
Dolomite, buff and gray, drills to fine powder	40	70
Dolomite, buff and light-brown, dense	50	120
Dolomite, buff to gray, dense	114	234
No record	8	242
41N 13W 21-1 Altitude 625		
Glacial drift:		
No record	10	10
Manistique fm:		
Dolomite, buff, gray, and white, cherty	140	150
Burnt Bluff fm:		
Dolomite, buff and gray, cherty	100	250
Limestone, buff and gray, dolomitic	20	270
Shale, bluish-gray, calcareous	5	275
Limestone, buff and gray, shaly	30	305
Dolomite, buff to cream	55	360

Table 4.--Logs of wells and test holes in Schoolcraft County.--Continued

	Thickness	Depth
41N 13W 21-1 Continued		
Cataract fm:		
Shale, greenish-gray, dolomitic	15	375
Shale, gray, gypsum, and some dolomite	55	430
Shale, greenish-gray	20	450
Dolomite, buff to gray, shaly	50	500
Shale, greenish-gray, and gypsum	45	545
Richmond gr:		
Dolomite, gray and brown, shaly	200	745
Shale, bluish-gray, dolomitic	245	990
41N 13W 21-1 Continued		
Collingwood fm:		
Shale, dark-brown, limy	15	1005
Trenton-Black River fms:		
Limestone, brown to gray, dolomitic	58	1063
Limestone, gray, shaly	42	1105
Dolomite, buff to dark-gray, shaly (water at 1160 ft.)	65	1170
Limestone, brown and gray, (fresh water at 1230 ft.)	105	1275
Dolomite, buff and dark-gray, and quartz sand	18	1293
41N 13W 21-1 Continued		
Hermansville fm:		
Sandstone, slightly dolomitic (fresh water at 1300 ft.)	32	1325
Sandstone, reddish, and greenish slate particles, slightly dolomitic	20	1345
Dolomite, buff to dark reddish-brown (fresh water at 1370 ft.)	25	1370
Munising fm:		
Sandstone, white, slightly dolomitic with dark shale particles	150	1520
Sandstone, gray to pink, slightly dolomitic	190	1710

Table 5.--Chemical analyses of ground water in Schoolcraft County

Aquifer: See table 1.

Analyst: M, Michigan Department of Health; U, U. S. Geological Survey

Potassium: + indicates potassium (K) included in value listed under sodium.

Well number	Aquifer	Analyst	Date collected	Chemical constituents (parts per million)														Specific conductance (micromhos at 25°C)	pH	Temperature (°F)
				Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total solids	Hardness as $CaCO_3$			
47N 16W																				
30-2	OЄhm	U	11- 9-57	7.1	3.3	36	16	1.4	3.0	184	0	13	1.0	0.2	0.2	172	156	301	7.7	46.2
47N 15W																				
27-1	Qs	M	12-17-32	7.2	Tr.	14	11	25	+	149	Tr.	3.6	5.0	-	-	142	78	-	-	-
47N 13W																				
4-2	Qs	M	10-30-57	-	-	4.8	1.7	-	-	-	-	7.0	1.0	-	-	-	19	-	-	46.5
16-1	OЄhm	M	11- -57	-	-	22	8.8	10	1.6	-	-	10	1.0	-	-	-	100	300	-	42
46N 15W																				
33-1	Qs	M	11- 5-57	-	-	14	11	-	-	85	-	5.0	-	-	-	-	80	180	-	46
34-1	Qgd	U	11- 5-57	14	.1	12	9.2	26	3.5	148	0	1.4	2.5	.6	.1	142	68	244	7.8	46
46N 13W																				
28-2	Qg	M	3-12-57	-	-	14	-	23	2.9	129	-	-	-	-	-	-	65	300	-	-
29-2	Qs	M	12-17-32	2.4	Tr.	4.5	2.2	Tr.	+	6	0	8.9	4.0	-	-	28	25	-	-	-
33-1	Qg	M	6-29-32	9.6	.1	16	7.2	32	+	114	17	1.3	11	-	-	156	68	-	-	-
45N 13W																				
16-3	OЄhm	U	3-12-57	6.9	.8	36	17	17	3.4	163	0	45	9.5	.6	0	211	160	387	7.8	-
33-3	Qgd	M	12-17-32	30	5.0	33	7.5	12	+	157	0	4.9	3.0	-	-	186	110	-	-	-
33-6	OЄhm	-	-	8	-	38	19	27	+	157	8	54	23	-	-	256	170	-	-	-
34-5	OЄhm	M	3-12-57	-	-	-	-	22	3.2	-	-	52	10	-	-	-	160	450	-	-
34-7	Qs	M	12-17-32	12	.3	64	16	17	+	215	0	54	20	-	-	304	220	-	-	-
36-1	OЄhm	U	6-26-57	7.6	.9	35	18	43	4.2	166	0	52	51	.9	0	286	162	504	7.6	52.5
36-2	Or	M	6-26-57	-	-	560	-	-	-	195	-	1350	-	-	-	-	1750	2800	7.2	-
44N 18W																				
7-5	Qs	M	10- 7-57	-	-	5.6	.9	-	-	25	-	-	-	-	-	-	18	60	-	-
44N 13W																				
24-2	Qgd	M	6- 4-32	8	0	69	26	Tr.	-	282	0	23	18	-	-	294	275	-	-	-
43N 17W																				
17-1	OЄhm	U	10- 7-57	7.8	.3	51	18	45	4.2	160	0	41	91	.5	.1	383	201	627	7.6	51.8
20-3	OЄhm	M	6-25-57	-	-	70	35	120	-	-	0	73	215	-	-	-	-	1200	7.6	-
43N 16W																				
13-1	Qs	M	10-24-57	-	-	24	5.8	-	-	109	-	0	-	-	-	-	84	180	-	-
14-2	Qs	M	10-24-57	.6	.6	4.4	-	-	-	73	-	6.0	-	-	-	-	58	120	-	46.1
23-3	OЄhm	U	7-12-57	8.6	0	33	16	38	3.7	181	0	40	26	1.0	.1	248	149	446	7.6	51.1
43N 15W																				
18-1	OЄhm	U	11- 9-57	5.8	1.3	28	14	33	3.5	148	0	32	35	1.1	0	227	128	401	7.9	-
23-1	Qs	M	11- 2-57	-	-	3.2	1.7	-	-	24	-	-	-	-	-	-	15	50	-	-
43N 13W																				
16-3	Qgd	M	12-10-32	3.2	0	32	8.8	Tr.	-	109	0	21	40	-	-	128	112	-	-	-
16-5	OЄhm	M	11- -49	2.0	0	39	18	22	+	146	0	46	36	1.3	0	246	170	-	-	-
21-1	Sc	M	4- -32	9.6	1.1	650	149	134	+	131	0	1780	400	-	-	3240	2220	-	-	-
21-2	Sc	M	4- -32	8.8	.1	561	43	5.5	+	173	0	1370	17	-	-	2160	1580	-	-	43.5
22-1	Sb	M	12- 6-32	8.0	.1	46	22	1.4	+	239	0	6.6	3.5	-	-	208	204	-	-	-
42N 17W																				
25-1	Qsg	M	7-14-33	15	.5	366	100	14	+	134	-	1180	11	-	-	1750	1300	-	-	-
25-2	Qs	M	-	-	.1	-	24	-	-	-	-	95	.1	-	-	-	310	-	8.1	-
26-1	Qgd	M	7- 2-57	-	-	-	-	-	-	193	-	9	-	-	-	-	160	320	8.0	-
26-1	Qgd	M	4- -57	-	.1	-	16	-	-	-	-	15	1	-	-	-	145	-	8.1	-
28-1	Sb	M	7- 9-57	-	-	60	23	-	-	255	-	16	-	-	-	-	245	500	8.2	46.4
33-3	Sb	M	7- -57	-	-	-	-	-	-	-	-	-	-	-	-	-	180	325	-	49.7
36-1	Qs	M	-	-	0	-	23	-	-	-	-	460	4	-	-	-	575	-	8.0	-
36-2	Sc	M	-	-	1.7	-	365	-	-	-	-	1250	135	-	-	-	1600	-	7.8	-
42N 16W																				
13-1	Otb	M	6-20-57	49	-	520	73	63	-	130	-	1300	37	-	-	-	1600	2500	7.4	45.4
26-1	Sb	M	11- -57	-	-	88	34	-	-	385	-	22	-	-	-	-	360	700	-	47.5
27-3	Sc	M	-	12	Tr.	352	111	76	+	128	-	1140	150	-	-	1950	1340	-	-	-
27-4	Sc	M	-	10	Tr.	115	41	16	+	263	-	221	34	-	-	573	455	-	-	-
27-5	Sb	M	-	7	Tr.	59	20	0	0	244	-	Tr.	Tr.	-	-	212	250	-	-	-
42N 15W																				
21-1	Qgd	M	11-30-32	4.8	.1	22	8.4	Tr.	-	95	0	7.5	3.5	-	-	98	90	-	-	-

Table 5.--Chemical analyses of ground water in Schoolcraft County

Well number	Aquifer	Analyst	Date collected	Chemical constituents (parts per million)														Specific conductance (micromhos at 25°C)	pH	Temperature (°F)
				Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total solids	Hardness as $CaCO_3$			
42N 15W																				
21-2	Sb	M	11- -57	-	-	74	27	0	0	234	-	-	-	-	-	-	295	560	-	-
26-1	Sb	M	6- 4-32	4.8	0	56	25	8.3	+	269	8.5	17	5.0	-	-	266	240	-	-	-
27-3	Sb	M	6- -52	-	5.4	-	-	-	-	-	-	-	-	-	-	-	290	-	-	-
27-4	Sb	M	1- -50	-	4	-	-	-	-	-	-	-	-	-	-	-	240	-	-	-
33-1	Qgd	M	12- 6-32	4.8	.1	16	11	3	+	15	0	26	21	-	27	270	98	-	-	-
42N 14W																				
26-2	Sb	M	12-29-52	-	-	-	24.4	-	-	-	-	510	144	-	0	-	750	-	-	-
33-5	Sm	M	11- -57	-	-	56		-	-	250	-	-	-	-	-	-	240	480	-	-
35-3	Sb	M	12- -52	-	-	-	-	-	-	-	-	335	94	-	2.6	-	560	-	-	-
35-5	Sm	M	12- -52	-	-	-	-	-	-	-	-	460	82	-	0	-	680	-	-	-
35-6	Sbl	M	11- -57	-	-	170	62	-	-	215	-	-	-	-	-	-	700	1400	-	-
35-6	Sbl	M	12- -52	-	-	-	-	-	-	-	-	460	78	-	0	-	650	-	-	-
35-7	Sm	M	12- -52	-	-	-	-	-	-	-	-	276	68	-	0	-	520	-	-	-
36-1	Sm	M	11-23-32	7.2	1	43	22	Tr.	-	219	0	9.9	4.0	-	27	194	195	-	-	44
36-8	Sm	M	12- -52	-	-	-	-	-	-	-	-	540	140	-	0	-	800	-	-	-
42N 13W																				
5-1	Sb	M	5-22-57	-	-	54	-	-	-	276	-	2.0	-	-	-	-	240	420	-	-
20-1	Sb	M	11-30-32	6.4	0	40	20	9.2	+	235	0	4.6	3.0	-	-	194	182	-	-	44
41N 17W																				
4-4	Sb	M	6- 4-32	8.0	0	42	24	Tr.	-	208	4	14	7.5	-	-	214	200	-	-	-
7-1	Sb	M	7-15-57	-	-	56	29	-	-	280	-	19	-	-	-	-	260	500	8.0	46.3
10-1	Sb	M	11- -57	-	-	60	28	-	-	270	-	20	-	-	-	-	265	600	-	-
11-4	Sb	M	11- -57	-	-	64	24	-	-	230	-	-	-	-	-	-	240	450	-	46.2
16-3	Sb	M	11- -57	-	-	62	32	-	-	295	-	-	-	-	-	-	285	510	-	-
30-1	Sb	M	4- 7-33	5.6	.1	46	20	9.6	+	200	5	17	10	-	11	232	195	-	-	-
41N 16W																				
4-1	Qg	M	3- -53	-	.3	-	-	-	-	-	-	-	3.0	-	-	-	325	-	-	-
9-4	Qg	M	11- -57	-	-	88	32	-	-	173	-	-	-	-	-	-	350	700	-	47.2
11-10	Sc	M	2- -33	9.6	Tr.	340	45	Tr.	-	157	0	870	5.0	-	-	1346	1050	-	-	45.5
11-11	Sb	M	5- -34	13	.5	37	16	6.9	-	203	0	5.6	Tr.	-	-	184	158	-	-	-
12-22	Sc	M	8- -44	-	Tr.	-	-	-	-	-	-	-	12	-	-	-	875	-	-	-
12-24	OЄhm	M	2- -42	13	0	194	45	68	-	163	0	360	220	1	-	1030	671	-	-	-
12-26	Sc	M	8- -44	-	0	-	-	-	-	-	-	-	2	-	-	-	315	-	-	45.5
12-30	Sc	M	-	-	.3	-	-	-	-	-	-	-	130	-	-	-	950	-	7.4	-
13-1	-	M	1932	6.4	0	127	55	20	+	145	0	440	6.0	-	-	726	540	-	-	-
17-2	Qg	M	10-24-57	-	0	31	14	-	-	156	-	10	-	-	-	-	134	260	-	46.9
17-3	Qg	M	8- -44	2.4	0	30	14	5.5	-	151	5	7.6	2.0	1	-	140	125	-	-	-
19-2	Sb	M	6- 4-32	9.6	.1	33	11	7.8	+	127	16	9.5	4.0	-	-	146	130	-	-	-
19-3	Qsg	M	5-21-32	7.2	.1	34	13	4.3	+	136	15	7.2	4.5	-	-	164	138	-	-	-
19-4	Qg	M	5- -52	-	.9	-	-	-	-	-	-	-	-	-	-	-	305	-	-	-
32-5	Sb	M	11- 5-57	-	-	39	20	-	-	220	-	-	-	-	-	-	180	390	-	45.5
32-7	Sb	M	6-28-57	-	-	-	-	-	-	218	-	6.0	-	-	-	-	185	360	8.4	-
41N 15W																				
2-4	Qs	M	11-23-32	4.8	0	53	17	Tr.	-	225	0	13	4.0	-	-	204	200	-	-	-
7-2	Sb	M	12-27-32	11	.3	173	62	47	+	249	0	426	100	-	-	960	680	-	-	45
7-3	Sb	M	8- -44	4.8	Tr.	42	19	2.3	+	189	6	22	3	2	-	204	175	-	-	-
8-3	Sb	M	4- -53	-	1.0	32	15	-	-	-	-	26	Tr.	-	0	-	144	-	-	-
18-2	Sb	M	6- -37	8.8	Tr.	145	59	Tr.	+	167	0	444	3	-	-	899	602	-	-	-
18-4	Sb	M	8- -44	-	0	-	-	-	-	-	-	-	3	-	-	-	425	-	-	-
41N 14W																				
2-1	OЄhm	U	3-13-57	7.5	.8	83	35	87	5.6	162	0	49	255	.5	0	672	351	1150	7.8	55
41N 13W																				
1-2	Sm	M	11-14-32	5.6	Tr.	46	21	2.9	+	235	0	5.2	5.0	-	-	184	200	-	-	46
2-1	Sm	M	11-30-32	7.2	0	43	20	3.9	+	232	0	5.3	3.0	-	-	198	190	-	-	45.5
5-2	Sb	M	5-22-57	-	-	46	-	-	-	201	-	62	-	-	-	-	230	440	-	-
21-4	Sm	M	12-10-32	4	.2	54	30	Tr.	-	293	0	9.9	4	-	-	268	258	-	-	-
40N 17W																				
3-1	Qg	M	5-26-32	9.6	.1	32	30	5.7	+	176	12	15	26	-	-	290	200	-	-	-
24-1	Sm	M	8-13-57	12	.1	40	12	1.8	0.7	182	0	0	1	0	0	186	150	300	8.1	-
39N 17W																				
7-1	Sm	M	11- -57	-	-	76	26	-	-	195	-	-	-	-	-	-	295	600	-	47.8

Table 6.--Chemical analyses of surface water in Schoolcraft County

(Analyses by the Michigan Department of Health)

Source	Location Sec. T. R.	Date collected	Chemical constituents (parts per million): Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) & Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25°C.)
Bear Creek	23 43N 14W	10-24-57	-	-	36	7.3	-	105	32	-	-	120	240
Big Spring	25 42N 17W	10-18-57	8.4	.03	254	23	4.1	212	540	5	942	729	1210
Bursaw Creek	24 40N 17W	10-24-57	-	-	35	13	-	165	-	-	-	140	260
Creighton Creek	26 46N 16W	10-24-57	-	-	22	4.1	-	87	-	-	-	72	140
Driggs Lake	22 47N 15W	1930	2.4	.1	24	5.6	Tr.	90	4.9	4	88	80	-
Driggs Lake	25 46N 15W	1930	5.6	.2	20	5	.5	85	4.9	4	82	70	-
Fox River	29 46N 13W	1930	6.4	.3	17	4.5	4.3	72	7.2	4	78	60	-
Gulliver Lake	35 42N 14W	1930	8.8	-	30	14	3.2	150	11	4	154	130	-
Hoholik's Spring	19 41N 16W	10-24-57	-	-	39	14	-	160	10	-	-	154	300
Indian Lake	17 41N 16W	1930	15.	-	47	10	2.3	122	57	3	214	168	-
Indian River	2 43N 17W	1930	13	-	27	7.1	5.7	114	6.5	4	124	95	-
Indian River	1 41N 16W	3-31-33	7.2	.1	41	8.2	Tr.	107	43	4	162	135	-
Indian River	2 41N 16W	1930	8.8	Tr.	45	9.3	4.1	118	56	3.5	188	150	-
Manistique River	34 45N 13W	1930	8	.1	28	6.6	8.9	94	25	4	134	100	-
Manistique River	12 41N 16W	10- ? -44	3.6	.2	30	7	Tr.	94	25	Tr.	142	104	-
McDonald Lake	6 41N 13W	1930	4.8	.1	29	12	Tr.	123	16	4	132	120	-
Mead Creek	30 44N 13W	10-24-57	-	-	38	8.8	-	110	40	-	-	130	260
Mezik Creek	1 43N 14W	10-24-57	-	-	29	6.5	-	96	20	-	-	100	200
L. Michigan	-	1930	5.6	-	34	11	8	155	15	5	154	130	-
Murphy Creek	32 43N 17W	1930	7.2	-	27	8.2	2.7	108	15	3	116	100	-
Quarry	12 41N 16W	8- ? -44	3.2	-	15	7.2	9.4	68	25	4	106	55	-
Ross Lake	11 47N 16W	1930	4	.1	19	5.2	Tr.	73	4	4	76	68	-
Smith Lake	18 43N 15W	1930	4	.1	5	1.5	4.3	20	6.5	4	36	18	-
S. Br. Stutts Cr.	5 44N 17W	10-24-57	-	-	14	3.5	-	55	-	-	-	50	100
Thompson Spring	29 41N 16W	1930	6.4	-	22	14	9.6	126	5.9	4	133	110	-
Thunder Lake	20 43N 17W	1930	4	-	22	7.3	7.6	99	8.8	4	106	82	-