UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GROUND WATER AND GEOLOGY OF MARQUETTE COUNTY, MICHIGAN

By C. J. Doonan and J. L. VanAlstine

U.S. GEOLOGICAL SURVEY

Open-File Report 82-501

Prepared in cooperation with
the Michigan Department of
Natural Resources

Lansing, Michigan
1982

UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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GLOSSARY

Altitude. The vertical distance of a point or line above or below the National Geodetic Vertical Datum of 1929. The National Geodetic Vertical Datum of 1929 (NGVD of 1929) is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level." In this report, all altitudes are above NGVD of 1929.

Aquifer. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. Also called a ground-water reservoir.

Base flow. Sustained or fair-weather runoff; in most streams it is composed largely of ground-water runoff.

Bedrock. Designates Paleozoic and Precambrian rocks.

Evapotranspiration. Water evaporated from water surfaces and moist soil, and transpired by plants.

Ground water. Water in the saturated zone from which wells, springs, and ground-water runoff are supplied.

Hardness of water. Difficult term to define exactly, but commonly refers to concentration of $CaCo_3$. The classification range for hardness; in milligrams per liter (mg/L) of $CaCo_3$, is as follows:

Very hard -- more than 180
Hard -- 121 to 180
Moderately hard -- 61 to 120
Soft -- 0 to 60

Specific capacity. The rate of discharge of water from a well, in gallons per minute, divided by the drawdown of water level within the well, in feet.

Subcrop. In this report, a bedrock formation or rock unit occurring directly under the glacial deposits and that would be exposed if all glacial deposits were removed.

CONVERSION FACTORS

Factors for converting inch-pound units to metric units are as follows:

Inch-Pound	Multiply by	Metric
acres	0.4047	ha (hectares)
ft (feet)	0.3048	m (meters)
gal (gallons)	3.785	L (liters)
gal/min (gallons per minute)	0.06309	L/s (liters per second)
gal/d (gallons per day)	3.785	L/d (liters per day)
inches	25.40	mm (millimeters)
	2.540	cm (centimeters)
miles	1.609	km (kilometers)
square miles	2.590	km^2 (square kilometers)
	259.9	ha (hectares)
°F (degrees fahrenheit)	(°F-32)/1.8	°C (degrees Celsius)
(gal/min)/ft (gallons per minute per foot)	0.207	(L/s)/m (liters per second per meter)
inches per year	2.54	cm/yr (centimeters per year)

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ABSTRACT

Ground-water resources of Marquette County are about evenly divided between bedrock aquifers and aquifers in glacial deposits. In the northern and the extreme southern parts of the county, most wells are completed in bedrock at depths less than 100 feet. In the central part, most wells are completed in glacial deposits; some of these wells are as deep as 200 feet. Yields, in some places as high as 300 gallons per minute, are generally greatest from wells completed in glacial deposits. Most well water is hard and has iron concentrations ranging from <0.1 mg/L to about 5.0 mg/L. Both ground water and surface water sources are used in municipal water systems.

INTRODUCTION

Geography

Marquette County is in the north-central part of Michigan's Northern Peninsula (fig. 1). Including 1,211,000 acres, Marquette is the largest county in the state. The county's population increased from 47,144 in

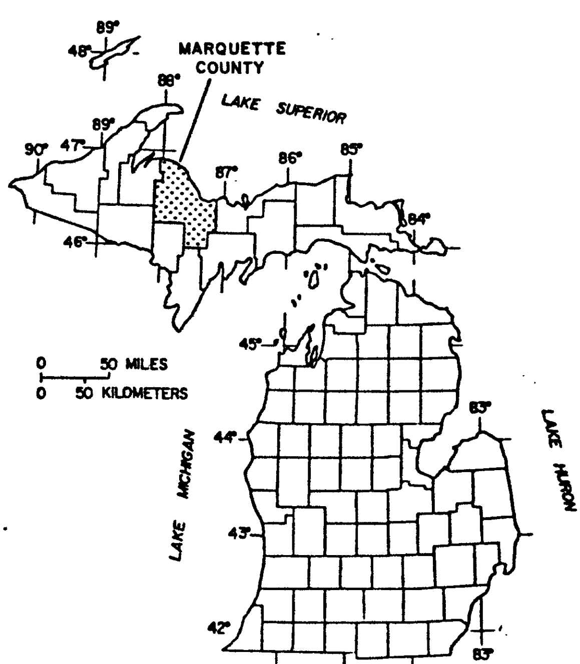

Figure 1.--Location of Marquette County in Michigan's Northern Peninsula.

1940 to 64,686 in 1970 and was about 74,000 in 1980. Much of the population and business activity is located along U.S. Highway 41 between Harvey and Michigamme (fig. 2). Six State and Federal highways and a network of County roads allow access to most parts of the county. Public transportation is provided by bus and air service.

Topography and Drainage

Topography varies considerably from north to south (fig. 3). The northern part of the county is mountainous, and altitudes range from about 600 feet along Lake Superior to more than 1800 feet in the Huron Mountains in the northwestern part of the county. Large, steep rock outcrops are common in the central area, where altitudes in some places reach 1700 feet. The southern part is largely swampy lowland interspersed with low ridges. Altitudes are about 1000 feet. Between the southeast corner of the county and Gwinn, over 20 miles, relief is only 100 feet.

The two major streams, the Escanaba and Michigamme Rivers, flow through adjacent counties to Lake Michigan. The Escanaba River and its numerous tributaries drain a large part of the west and central parts of the county (fig. 2). The Michigamme River system drains a long and relatively narrow area in the western part. The Chocolay, Carp, Dead, and Yellow Dog Rivers drain much of the northern and eastern parts and flow to Lake Superior.

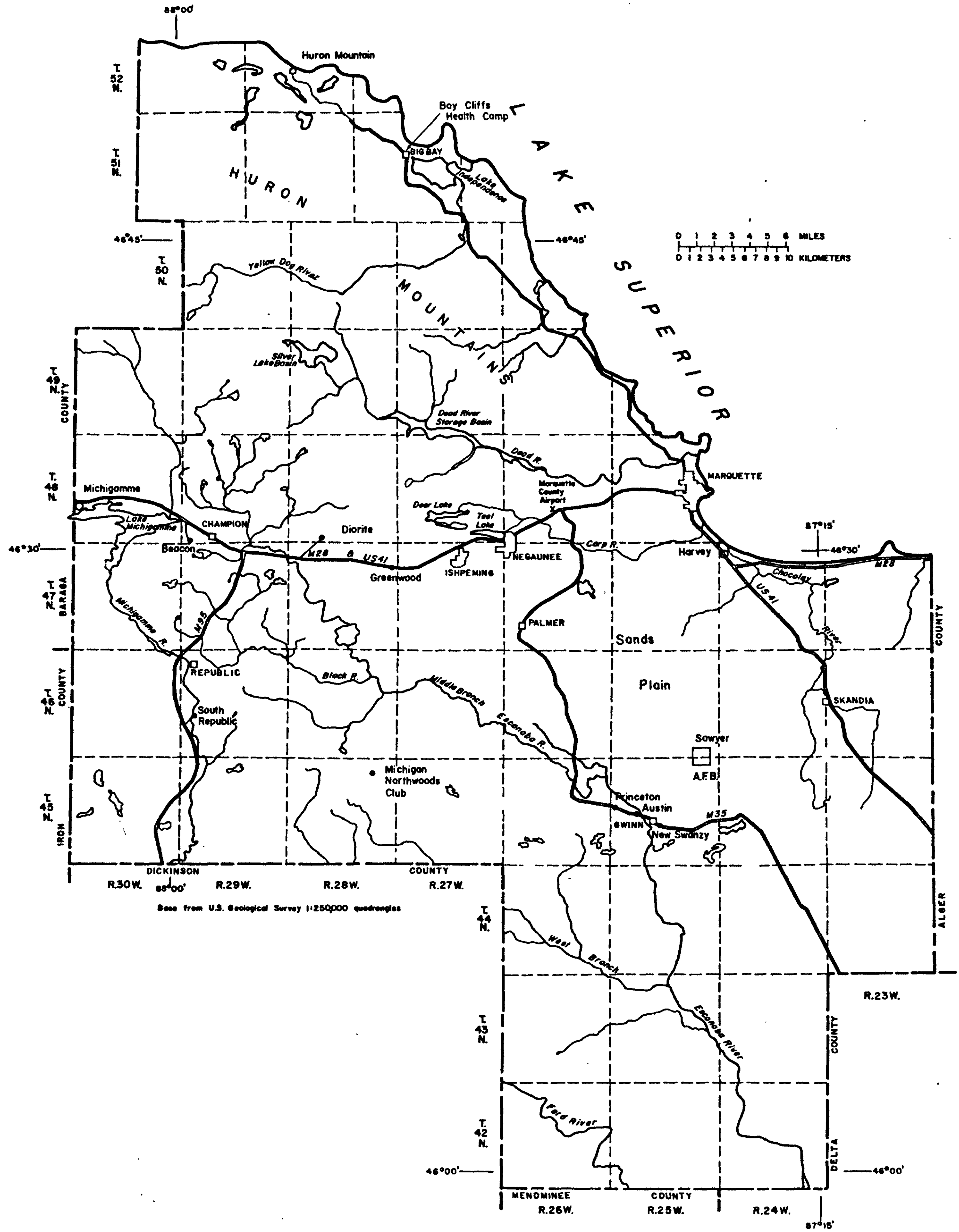

Figure 2.--Physical and cultural features.

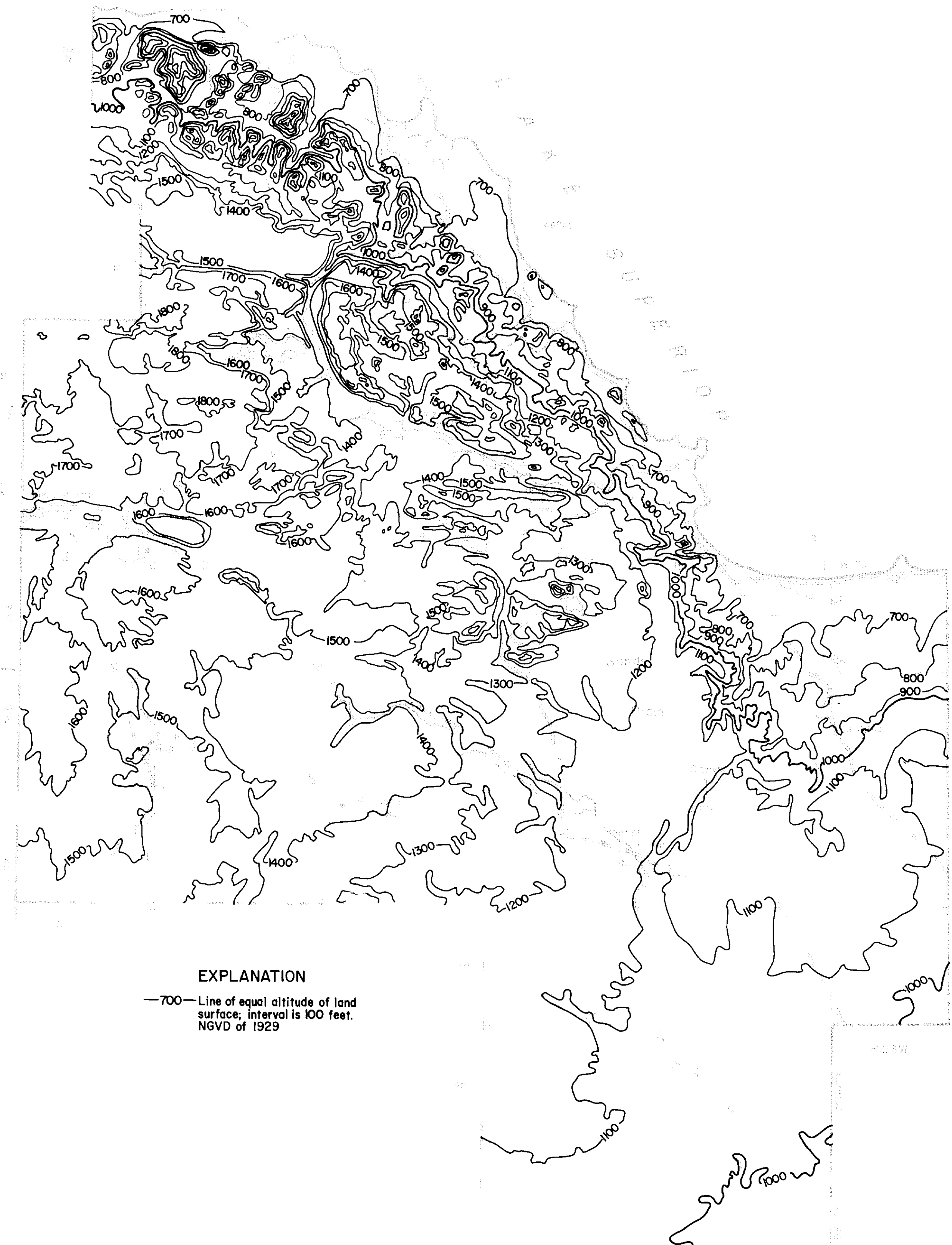

Figure 3.--Altitude of land surface.

Well-Numbering System in This Report

The well-numbering system in this report is that used by the U.S. Geological Survey in Michigan. It indicates the location of wells within a rectangular subdivision of land referenced to the Michigan meridian and base line. The first two segments of the well number designate township and range, the third segment designates the section and the fourth segment, consisting of a possible four-place alpha field A through D, designates successively smaller subdivisions of the section as shown below. Thus, a well designated as 48N 26E 16CCCB is located to the nearest 2.5 acres and within the shaded area in section 16 (fig. 4).

Township	Range	Section	Section ¼ ¼ ¼ ¼	Sequential number
48N	26E	16	C C C B	1

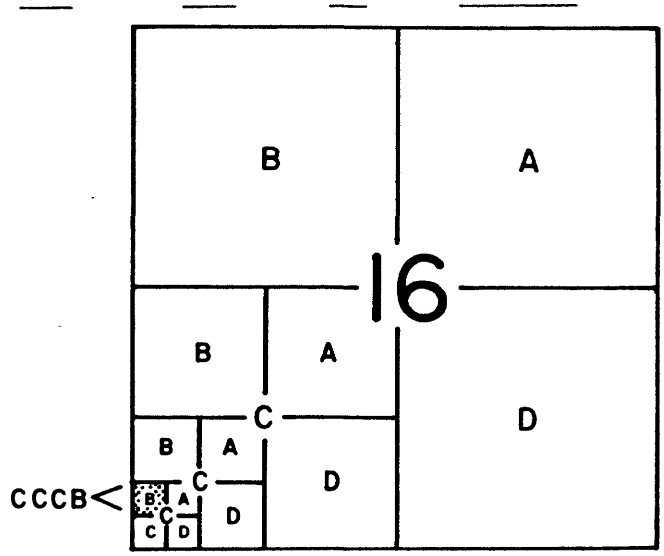

Figure 4.--Well-numbering system used in this report.

For most wells in this report, locations are given only to the nearest 40-acre tract, for example, 16CC. Should two or more wells be located in the same tract, a sequential number designation is added-for example, 26CC1, 26CC2, 26CC3, etc.

GEOLOGY

Rocks in Marquette county are of Precambrian, Paleozoic, and Quaternary age. In much of the central and northern parts, rocks of Precambrian age are at or are near land surface; whereas, in the southern part, the surface and near surface deposits are of Paleozoic and Quaternary age (Plate 1 and fig. 5).

Rocks of Precambrian age are the oldest in Marquette County. These rocks, in places, lie within the Marquette synclinorium (fig. 5) and are among the most widely studied Precambrian rocks in the United States. The synclinorium, a relatively narrow geologic feature, extends westward from near Marquette to Baraga County and shows the effects of intense folding, faulting, and metamorphism. Iron-bearing rocks in the synclinorium are the source of most iron ore produced in the county.

Rocks of Paleozoic age occur primarily in the southern and eastern part of the county. During the Paleozoic Era, much of the county was covered by relatively shallow seas that occupied a large saucer-shaped depression known as the Michigan basin. Subsequent erosion removed all but the older rocks.

Rocks of Quaternary age consist of alluvium, swamp deposits, and glacial deposits and are the youngest rocks. The stratigraphic relationship of the rock units is shown in table 1.

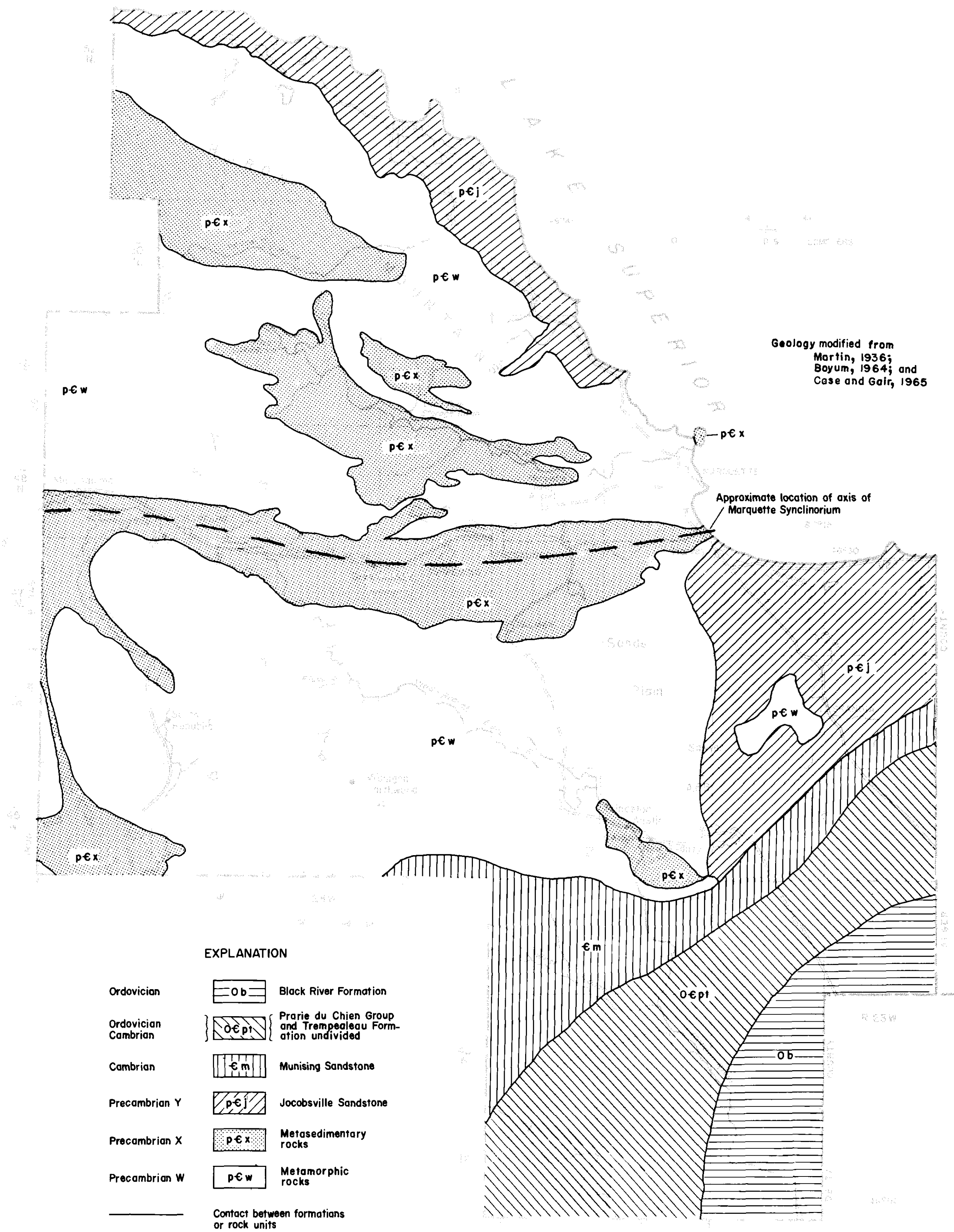

Figure 5.--Distribution of Precambrian and Paleozoic rocks.

Table 1.--Stratigraphic succession of rocks

Erathem	System	Series	Rock stratigraphic unit
Cenozoic	Quaternary	Holocene	Alluvium Swamp deposits
		Pleistocene	Glacial deposits Moraine Outwash Lakebeds
Paleozoic	Ordovician	Middle Ordovician	Black River Formation
	Ordovician and Cambrian	Lower Ordovician and Upper Cambrian	Prairie du Chien Group and Trempealeau Formation undivided
	Cambrian	Upper Cambrian	Munising Sandstone
Precambrian	Precambrian Y	(upper)	Jacobsville Sandstone
	Precambrian X	(middle)	Metasedimentary rocks Iron-bearing unit
	Precambrian W	(lower)	Metamorphic rocks

Rocks of Precambrian Age[1/]

Precambrian W

Precambrian W rocks consist mainly of mafic-volcanic and intruded felsic rocks that have been extensively metamorphosed into schist and gneiss. Precambrian W rocks underlie nearly all the south-central part of the county and about half the north-central part.

1/ Present U.S. Geological Survey usage: Precambrian W = Archean, Precambrian X = Proterozoic X, Precambrian Y = Proterozoic Y.

Precambrian X

Precambrian X rocks consist primarily of metasedimentary rocks--quartzite, gneiss, schist, and present-day iron formations. These rocks were originally sandstone, shale, carbonate rocks, and ferruginous precipitates. Metamorphism and intrusion of basic igneous rocks occurred during periods of intense folding and faulting near the end of the Precambrian. The intrusive rocks have been metamorphosed to metadiabase.

Precambrian Y

Except for the Jacobsville Sandstone[1/], the Precambrian Y does not commonly occur in Marquette County. Some dikes that intrude lower and middle Precambrian rocks are apparently Precambrian Y. Also, a small area of periodotite is probably early Precambrian Y.

Jacobsville Sandstone

The Jacobsville Sandstone is predominantly sandstone, although it contains shale and conglomerate. Some zones are arkosic. The average grain size ranges between 0.01 and 0.02 inches. One of the most striking characteristics of the Jacobsville is it's color. It is generally red to reddish brown and in many places is mottled white. In a few places it has been weathered to a point where the predominant color is white.

The Jacobsville Sandstone crops out and subcrops along Lake Superior in a band a few miles wide from the Baraga County line to Marquette (fig. 5). The formation underlies much of the eastern part of the county.

1/ The age of the Jacobsville Sandstone is uncertain; however, most geologists believe that it is Precambrian Y.

The thickness of the Jacobsville Sandstone is variable, partly because of the irregular surface of the Precambrian bedrock on which it was deposited and partly because the sandstone thickens toward the north. The maximum thickness is not known. In section 9, T. 50 N., R. 27 W., the formation is 601 feet thick. In section 19, T. 47 N., R. 27 W., 347 feet of Jacobsville was penetrated, but the bottom of the formation was not reached. Near the Alger County line, the thickness of the Jacobsville may exceed 600 feet.

Rocks of Paleozoic Age

Cambrian Rocks

Munising Sandstone

The Munising Sandstone is a white-to-gray, friable, fine-to-medium grained sandstone and conglomerate. The Munising occurs only in the southeast part of the County (fig. 5). Although part of the formation has a reddish tint, it can normally be distinguished from the underlying Jacobsville Sandstone of Precambrian age, which is a more distinctive red. The Munising is composed of three distinct members. The lowest and oldest member is conglomerate, the middle member is sandstone having well-developed cross bedding, and the upper member is a poorly cemented sandstone. The Munising Sandstone at most places is covered by glacial deposits, and its areal extent is not well defined. Sandstone in the Munising is lithologically similar to sandstone in the overlying Trempealeau Formation; consequently, in places it is difficult to distinguish between the two formations. Normally, however, sand in Munising is not as well cemented as that in the Trempealeau. The thickness of the Munising is not known, but the maximum is probably about 200 feet.

Cambrian and Ordovician Rocks

Trempealeau Formation and Prairie du Chien Group Undivided

The Trempealeau Formation and Prairie du Chien Group are similar in their lithologic and water-bearing characteristics and, in this report, are called the Prairie du Chien-Trempealeau unit. The unit underlies the southeastern part of the county (fig. 5) and is composed of a sequence of thin-to-medium-bedded dolomite, sandy dolomite, dolomitic sandstone, and lenses of pure quartz sandstone. The Trempealeau Formation is characterized by abundant glauconite; some thin zones are as much as 35 percent glauconite. The Prairie du Chien Group contains numerous thin lenses of sandstone. The maximum thickness of the Prairie du Chien-Trempealeau unit is about 300 feet.

In several places, the unit rests directly on Precambrian rocks. Evidence suggests that, in these places, the Munising Sandstone was removed by erosion before deposition of the uppermost Cambrian rocks.

Ordovician Rocks

Black River Formation

The youngest bedrock is the Black River Formation. This formation, which occurs in the southeast part of the county, is composed of limestone, dolomite, and a zone of thin shaley beds. The shaley zone, 20 to 30 feet thick, lies near the base of the formation.

Most of the Black River Formation is covered by glacial deposits, although it crops out in places in the southeast part of the county. The maximum thickness of the formation is about 100 feet.

Rocks of Quaternary Age

Glacial Deposits

Marquette County was covered by glaciers at least four times during the Pleistocene. Many of the present-day surficial features are the direct result of erosion and deposition by these ice masses. The last glacier moved generally southwestward across the county about 10,000 years ago. As the glacier advanced and receded, it left a series of deposits. The deposits range in thickness from a featheredge to about 450 feet. For this report, the glacial deposits are subdivided into till, outwash, and lakebeds (table 1). The distribution of these deposits is shown on plate 1.

Till

Till is unstratified material deposited directly by glaciers and has little sorting. It consists of clay, silt, sand, gravel, and boulders in a heterogeneous mixture and is generally reddish brown to brown. The two major types of till are end moraines and ground moraines. Location of these moraines is shown on plate 1.

End Moraines.--End moraines are ridges formed when a glacial advance nearly equaled the rate of ice melting for extended periods. Under such conditions, rock material carried by the glacier was deposited with little sorting along the front of the glacier. End moraines in Marquette County trend generally northwest-southeast.

Ground Moraines.--Ground moraines formed when glacial movement stopped and the ice front melted and receded. During this time unsorted rock particles were deposited directly by the ice, forming undulating plains. Relief of the ground-moraine surface is generally 20 to 30 feet. Ground moraines are most extensive in the southeastern part of the county (plate 1). Minor ground moraines occur between major moraine systems and as a veneer in areas where the bedrock is at or near land surface.

Outwash

Outwash deposits are composed mainly of stratified sand and gravel that was deposited by meltwater flowing from the glacier. Variations in grain size, both horizontally and vertically, indicate rapid changes in the volume and velocity of meltwater. Outwash deposits are normally coarser textured near the melting edge of the glacier and finer textured farther downstream.

Maximum thickness of outwash deposits is unknown, but a thickness of as much as 260 feet has been reported. The largest of the numerous outwash areas is in the Sands Plain area south of Marquette.

Lakebeds

As the last major ice sheet retreated, there were periods when glacial meltwaters were ponded. Deposits formed in the ponded water are called lakebeds and consist mainly of stratified layers of fine sand, silt, and clay (such deposits are being formed in present-day lakes). Sand and gravel in the lakebeds are normally delta-type deposits and are confined to relatively small areas.

Glacial lakebed deposits are most numerous in the vicinity of Lake Superior and are sparsely scattered elsewhere (plate 1). Some sand dunes, not easily distinguished from lakebeds, were mapped as lakebeds for this study.

Alluvium and Swamp Deposits

Alluvium and swamp deposits are postglacial. Alluvium is predominantly sand and gravel deposited by streams. It lies along stream channels and underlies the flood plains of the larger streams. Because alluvium is of small areal extent, it is not shown on plate 1. Swamp deposits are composed of muck and peat and are mostly organic in origin, although in some places they contain silt and clay. Swamp deposits are generally thin and in many places are underlain by glacial deposits.

GROUND-WATER RESOURCES

Quality of Water

Springs and wells in Marquette County yield water that is satisfactory for domestic and most other uses (tables 2 and 3). In general, the hardness of water from wells in glacial deposits is less than 180 mg/L; whereas, the hardness of water from bedrock is higher. Iron concentrations may be as high as 5.0 mg/L in both the glacial deposits and bedrock. At some locations the water is high in chloride. Significance of some of the common chemical constituents in water is given in table 4.

Availability

Most attempts to obtain ground water are successful, although in some places, it is necessary to drill 200 or more feet to obtain an adequate supply. Water supplies have been obtained from the glacial deposits and the underlying bedrock. Hydrologic and geologic data from selected wells are shown on figure 6 and in tables 5, 6, and 7. Many parts of the county are so sparsely populated that wells and well data are virtually nonexistent.

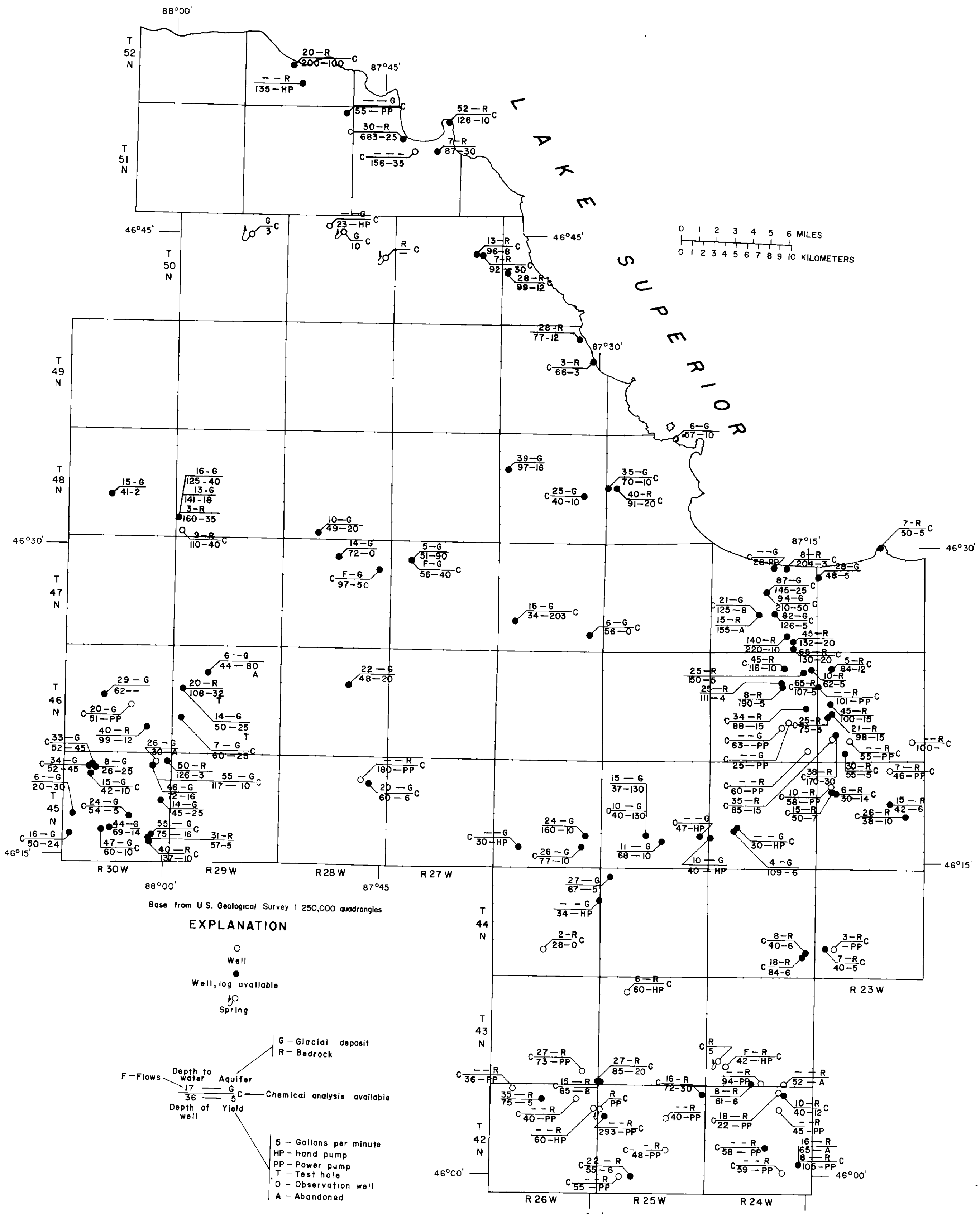

Figure 6.--Hydrologic data for selected wells and springs.

Table 2 — Chemical quality of water from springs

Analyses by U.S. Geological Survey. Results in milligrams per liter except as indicated.
Springs are identified according to their geographic location by the same method used for numbering wells.
Owner: DNR, Michigan Department of Natural Resources
Use: D, domestic; P, public supply; N, none
Altitude: Feet above NGVD of 1929
Discharge: gpm, gallons per minute, estimated; P, power pump

Spring	Owner or name	Altitude (ft)	Use	Date sampled	Discharge (gal/min)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Alkalinity ($CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Calculated dissolved solids	Hardness (as $CaCO_3$)	Noncarbonate hardness	Conductance (µmho/cm at 25°C)	pH (units)	Remarks
42N 25W 7BC1	Holmes	1030	P	9-9-70	P	0.6	57	27	2.8	303	0	248	7.6	1.0	0.0	290	252	4	440	7.6	Concrete cribbing; supplies store and residence
43N 24W 30DA1	DNR	1020	P	9-14-70	5	< .1	44	25	3.0	280	0	230	16	.0	.2	260	240	10	400	7.6	Bubbles up through broken limestone; extensively used by campers and hunters
50N 28W 3CC1	Bittner	1230	D	10-7-70	2	.2	28	4.4	4.8	110	0	90	5.8	1.0	1.5	120	88	0	180	7.9	Piped to point near road; flows about 10 gal/min
50N 28W 13BD1	Gannon Lmbr	1160	N	10-7-70	-	.5	18	7.8	.0	71	0	58	.0	.0	.0	65	76	18	100	7.5	Very thin drift over bedrock; discharge area about 50 feet in diameter
50N 29W 10AA1	Hiwth Lnd Co	1420	P	10-7-70	3	< .1	6.4	1.9	1.8	34	0	28	.0	.0	.0	30	24	0	50	7.1	Pipe from discharge area flows about 3 gal/min

Table 3.--Chemical analyses of water from selected wells

Aquifer: G - glacial deposits; B - bedrock
Chemical analyses by the U.S. Geological Survey (G)
and Michigan Department of Public Health (M)
Dissolved constituents are in milligrams per liter, except as indicated

Well	Aquifer	Date sampled	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (Co_3)	Alkalinity ($CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (calculated)	Hardness ($CaCO_3$)	Noncarbonate hardness	Specific conductance µmho/cm at 25°C	pH (units)	Chemical analysis by
42N 24W 2BC1	B	9-16-70	0.1	72	22	34	298	0	244	86	5.0	7.0	300	270	28	460	7.6	G
2BD1	B	9-16-70	1.4	70	18	9.2	293	0	240	25	1.0	.0	290	250	6	440	7.8	G
22BD1	B	9-11-70	.5	73	19	7.1	317	0	260	8.0	5.0	.0	300	260	0	460	7.6	G
25BC1	B	7-16-70	< .1	81	26	.0	349	0	286	13	2.0	.0	340	310	24	520	7.6	G
26CD1	B	9-14-70	.4	72	16	4.6	298	0	244	12	.0	.0	270	246	2	420	7.8	G
42N 25W 1AD1	B	9-10-70	.4	100	6.8	.0	307	0	252	11	4.0	6.2	310	280	28	480	7.6	G
10DD1	B	9-11-70	.7	78	31	.0	386	0	316	.0	3.0	.0	340	322	6	520	6.9	G
22DA1	B	9-10-70	5.0	93	33	47	525	0	430	15	16	.0	420	366	0	650	7.5	G
32AA1	B	9-10-70	3.7	81	25	6.9	342	0	280	20	14	.0	325	306	26	500	7.6	G
32BA1	B	9-10-70	.2	72	36	.0	332	0	272	44	2.0	4.5	350	326	54	540	7.7	G
42N 26W 2DD1	B	9-09-70	.1	88	33	4.8	393	0	322	8.4	22	1.9	380	352	30	580	7.6	G
5BC1	B	9-09-70	.6	70	16	2.5	293	0	240	6.0	.0	.0	270	240	0	420	8.0	G
43N 24W 29CC1	B	9-14-70	2.0	51	20	6.4	256	0	218	9.8	3.0	.0	250	210	0	380	7.7	G
43N 25W 5CD1	B	9-17-70	.4	62	13	7.1	259	0	212	9.8	1.0	.0	230	210	0	360	7.8	G
31CC1	B	9-10-70	< .1	74	32	2.5	371	0	304	12	4.0	.0	320	320	12	500	7.9	G
43N 26W 27CC1	B	9-09-70	-	45	34	.9	288	0	236	12	3.0	.0	250	250	14	380	7.9	G
36BC1	B	9-09-70	< .1	92	22	21	393	0	322	6.8	8.0	33	420	320	0	650	7.4	G
44N 23W 29BC1	B	9-18-70	< .1	84	36	22	422	0	346	18	27	1.6	490	360	10	750	7.3	G
30AC1	B	9-18-70	1.8	84	24	4.4	349	0	286	14	14	.0	350	310	24	540	7.4	G
44N 24W 25DB1	B	9-16-70	.7	100	18	13	307	0	252	66	22	1.5	390	328	76	600	7.5	G
44N 26W 12DD1	G	10-21-70	>5.0	11	4.4	1.1	49	0	40	6.6	1.0	.0	65	46	6	100	6.7	G
28DA1	B	10-26-70	.4	53	22	3.0	264	0	216	10	3.0	.0	250	220	8	380	7.8	G
45N 23W 7DA1	B	9-28-70	3.7	118	46	51	393	0	322	6.8	187	.0	650	480	160	1000	7.5	G
7AD1	B	10-20-70	.2	53	22	2.3	222	0	182	15	21	.4	210	220	46	320	7.7	G
8CB1	B	9-18-70	2.3	30	12	4.1	149	0	122	6.4	2.0	1.8	160	124	2	240	7.8	G
23AA1	B	9-18-70	.2	42	19	4.1	190	0	156	16	13	3.2	210	180	28	320	7.7	G
45N 24W 20DB1	G	10-19-70	.3	12	2.4	2.3	39	2	36	6.6	1.0	-	40	40	4	60	8.6	G
45N 25W 25AA1	G	10-19-70	>5.0	6.4	2.9	0	27	0	22	0	3	0	<30	28	6	<50	6.3	M
28 1/	-	12-07-73	.0	20	3.5	1.9	60	-	-	5	1	0	80	65	-	120	7.7	M
45N 26W 26DA1	G	10-20-70	.4	27	7.8	.7	124	0	102	.0	.0	.0	80	100	0	120	7.9	G
29CD1	G	10-20-70	.6	27	11	3.2	139	0	114	5.0	.0	.0	120	110	0	180	7.5	G
45N 28W 11AB1	B	10-16-70	.2	27	11	.0	117	0	96	14	.0	.0	140	110	-	220	7.9	G
11AD1	G	10-16-70	.4	22	8.7	15	137	0	112	.0	.0	.0	140	90	0	220	7.6	G
45N 30W 2DA1	G	10-09-70	.7	29	11	2.0	137	0	112	9.0	1.0	.0	140	120	6	220	8.1	G
5CA1	G	10-09-70	.3	31	12	4.4	156	0	128	6.8	.0	.7	160	126	0	240	8.1	G
5CA2	G	10-09-70	< .1	37	16	6.2	198	0	162	5.8	2.0	.4	180	160	0	182	7.9	G
22AC1	G	10-15-70	1.5	38	16	3.4	190	0	156	10	1.0	.0	200	160	4	300	8.0	G
26DD1	B	10-15-70	.2	69	30	150	322	0	264	64	200	1.4	780	300	32	1200	8.2	G
26DA1	G	10-15-70	.2	65	22	.0	266	0	218	8.0	1.0	.8	290	250	34	440	8.1	G
28BC1	G	10-09-70	.4	47	25	1.2	254	0	208	12	1.0	.0	250	220	12	380	7.7	G
30BD1	G	10-09-70	1.2	30	17	-	171	0	140	11	-	.0	170	142	2	260	7.9	G
46N 23W 6DD1	B	9-28-70	.4	31	8.3	27	49	0	40	43	60	1.8	230	112	72	360	6.9	G
7CC2	B	10-02-70	>5.0	69	37	8.7	268	0	220	13	68	15	390	320	100	600	7.0	G
25CD1	B	9-28-70	.7	34	17	.0	168	0	138	10	.0	.0	170	150	14	260	7.9	G
29BC1	B	9-28-70	.5	24	10	2.1	102	0	84	15	4.0	.0	120	100	16	180	7.5	G
29DD1	B	9-30-70	.2	36	15	.0	159	0	130	11	3.0	.0	170	150	20	260	7.9	G
30DA1	B	10-01-70	.5	30	18	.0	155	0	127	10	2.0	.0	140	150	25	220	7.4	G
32DB1	B	9-28-70	.3	51	15	22	178	0	146	16	52	.6	270	190	44	420	7.8	G

Table 3.--Chemical analyses of water from selected wells (Continued)

Well	Aquifer	Date sampled	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Alkalinity ($CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (calculated)	Hardness ($CaCO_3$)	Noncarbonate hardness	Specific conductance µmho/cm at 25°C	pH (units)	Chemical analysis by
46N 24W 2CC1	B	9-30-70	0.2	19	5.8	18	115	0	94	9.0	5.0	0.0	130	70	0	200	8.2	G
23CD1	G	9-30-70	>5.0	18	7.3	.0	46	0	38	8.4	1.5	2.8	220	76	38	340	5.7	G
26BB1	G	9-30-70	.4	24	6.3	7.1	120	0	98	.0	2.0	.0	100	86	0	160	8.1	G
46N 29W 18DB2	G	4-07-66		24	9.0	4.6	107	0	-	14	6.0	.2	130	98	-	195	8.2	M
30AB1	G	11-13-70	.2	28	12	.0	132	0	108	9.0	1.0	.0	140	120	12	220	8.1	G
46N 30W 22AB1	G	10-09-70	< .1	18	9.7	.7	102	0	84	.0	1.0	.5	100	84	0	160	7.9	G
47N 23W 3AB1	B	10-06-70	>5.0	20	6.3	15	98	0	80	.0	21	.0	120	76	0	180	6.7	G
47N 24W 10AC1	G	10-02-70	.2	5.2	1.7	5.1	10	0	8	.0	16	.9	40	20	12	60	6.4	G
11BD1	B	10-02-70	.9	35	6.3	16	171	0	140	.0	5.0	2.9	160	114	0	240	8.3	G
47N 24W 15CB1 2/	G	10-01-70	< .1	46	3.4	.0	137	0	112	10	3.0	12	140	128	16	220	8.0	G
21DD1	G	10-21-70	.2	34	7.3	7.8	149	0	122	7.4	1.0	2.2	160	116	0	240	7.7	G
22DC1	G	10-01-70	2.1	-	-	.0	120	0	98	.0	9.0	4.0	130	130	32	200	7.8	G
35BA1	B	10-01-70	.6	40	12	19	218	0	179	10	2.0	.0	170	150	0	260	7.9	G
35BA2	G	10-01-70	.2	30	12	2.1	149	0	122	.0	4.0	1.0	160	120	2	240	8.1	G
35DC1	B	10-01-70	.7	6.4	3.4	.0	83	0	68	7.2	1.0	.0	100	30	0	160	8.7	G
47N 26W 29BC1	G	11-10-70	.4	34	18	.0	132	0	108	.0	31	.6	200	160	52	300	6.7	G
36BB1	G	10-26-70	3.0	30	7.3	2.5	132	0	108	.0	1.0	.0	130	100	0	210	7.4	G
47N 27W 8BB2	G	6-14-71	.3	44	16	-	190	0	156	13	7.0	1.1	210	174	18	320	7.6	G
47N 28W 12CA2	G	11-12-70	< .1	29	9.7	.0	105	0	86	14	5.0	.0	130	112	26	200	8.0	G
48N 25W 18DC1	G	10-14-70	.2	30	5.8	2.8	112	0	92	6.6	3.0	1.2	130	98	6	200	7.9	G
18CC1	G	10-14-70	< .1	35	6.3	2.8	124	0	102	6.6	6.0	1.2	130	110	10	220	7.8	G
48N 26W 23AC1	G	10-15-70	.3	20	2.9	14	76	0	62	25	3.0	.3	90	62	0	140	8.1	G
48N 28W 32DA1 3/	G	3-20-75	.9	6.4	2.6	2.5	17	0	-	12	27	.2	52	28	-	74	6.2	M
48N 29W 31DB1	G	2- -66	2.6	12	5.0	4.0	50	0	-	10	4.0	2.0	62	50	-	100	7.0	M
49N 26W 12DD1	B	10-13-70	.2	32	11	9.0	171	0	140	.0	4.0	.0	200	126	0	300	7.9	G
50N 26W 19BB1	B	10-13-70	.2	31	6.3	9.0	49	0	40	10	23	50	180	104	64	280	6.2	G
50N 27W 14AB1	B	10-13-70	.2	45	5.8	10	183	0	150	7.6	.0	.0	180	136	0	280	7.5	G
14BA1	B	10-13-70	.2	36	4.9	5.5	137	0	112	9.8	.0	.0	160	110	0	240	6.8	G
50N 28W 4CB1	G	10-08-70	.4	5.6	2.9	16	15	0	12	10	26	1.0	80	26	14	120	6.2	G
51N 27W 1CA1	B	10-14-70	.2	23	10	2.3	117	0	96	7.4	.0	1.7	130	100	4	200	7.1	G
9DA1	B	10-14-70	< .1	26	1.9	9.0	120	0	98	.0	7.0	3.5	160	72	0	240	6.9	G
15BD1	G	10-14-70	1.9	43	7.8	1.6	151	0	124	7.4	9.0	.0	180	140	16	280	7.6	G
52N 28W 21DB1	B	10-08-70	.4	23	4.4	.0	95	0	78	.0	2.0	.0	90	76	0	140	8.2	G

1/ Kidder mine

2/ Composite of wells 47N 24W 15CA1 and 47N 24W 15CB1

3/ Composite of wells 48N 28W 32DA1 and 48N 28W 32DA2 (Diorite)

Table 4.--Significance of chemical constituents found in water

Constituent	Source of Constituent	Significance
Silica (SiO_2)	Dissolved from practically all rocks and soils, usually in small amounts.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of steam turbines.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps and other equipment.	On exposure to air, iron in ground water oxidizes to reddish-brown sediment. More than about 0.3 mg/L stains laundry and utensils reddish-brown. Federal drinking water standards suggest that iron should not exceed 0.3 mg/L.
Calcium (Ca) and magnesium (Mg)	Dissolved from practically all soils and rocks but especially from limestone, dolomite, and gypsum:	Cause most of the hardness and scale-forming properities of water; soap consuming (See hardness).
Sodium (Na) and potassium (K)	Dissolved from practically all rocks and soils.	Large amounts of chlorides give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and limit the use of water for irrigation.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot-water facilities to form scale and release corrosive carbon dioxide gas.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts sulfate in combination with other ions gives bitter taste to water. Federal drinking water standards recommend that the sulfate content should not exceed 250 mg/L.
Chloride (Cl)	Dissolved from rocks and soils.	In large amounts chloride salts give salty taste to water. Federal drinking water standards recommend that the chloride content should not exceed 250 mg/L.
Nitrate (NO_3)	Decaying organic matter, sewage, and nitrates in soil.	Concentrations much greater than the local average may suggest pollution. Nitrate encourages growth of algae and other organisms which produce undesirable tastes and odors. Water of high nitrate content should not be used in baby feeding.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils.	Federal drinking water standards recommend that the dissolved solids should not exceed 500 mg/L. Waters containing more than 1,000 mg/L of dissolved solids are unsuitable for many purposes.
Hardness as $CaCO_3$	In most water nearly all hardness is due to calcium and magnesium.	Hard water consumes soap before a lather will form; deposits soap curd on bathtubs; forms scale in boilers, water heaters, and pipes. Waters of hardness as much as 60 mg/L are considered soft; 61 to 120 mg/L, moderately hard; 121 to 180 mg/L, hard; more than 180 mg/L, very hard.

Table 5.--Yield of wells

Aquifer: G-glacial deposits; B-bedrock
Yield : gal/min-gallons per minute

Well		Aquifer	Yield (gal/min)	Drawdown (feet)	Duration of test (hours)	Specific capacity [(gal/min)/ft drawdown]
42N 24W	2BD1	B	12	15	1	0.8
	25BC2	B	3	24	1	.1
42N 25W	1AD1	B	30	9	2	3.3
	32AA1	B	6	6	1	1.0
42N 26W	4DD1	B	5	25	1	.2
43N 24W	33DC1	B	6	37	1	.2
43N 25W	31CC1	B	8	45	1	.2
	31CC2	B	20	13	2	1.5
44N 23W	30AC1	B	5	3	.5	1.7
44N 24W	25DB1	B	6	10	.5	.6
	25CD1	B	6	57	1	.1
44N 25W	6AC1	G	5	13	1	.4
44N 26W	28DA1	B	10	0.5	1.5	20.0
45N 23W	7DA1	B	7	15	2	.5
	14BB1	B	6	5	.5	1.2
	23AA1	B	10	4	1	2.5
45N 24W	20CD1	G	6	9	3	.7
45N 25W	27BD1	G	10	4	1	2.5
	28AB2	G	130	14	8	9.3
45N 26W	25BB1	G	10	14	1	.7
	26DA1	G	10	12	-	.8
45N 28W	11AD1	G	6	5	1	1.2
45N 30W	1AC1	B	3	65	.5	.1
	2DA1	G	10	47	1	.2
	2DA2	G	16	4	1	4.0
	5CA1	G	45	14	2	3.2
	5CA2	G	45	5	2	9.0
	5DB1	G	25	9	2	2.8
	8BA1	G	10	15	2	.7

Well	Aquifer	Yield (gal/min)	Drawdown (feet)	Duration of test (hours)	Specific capacity [(gal/min)/ft drawdown]
45N 30W 13CA1	G	25	4	1	6.3
22AC1	G	5	25	4	.2
26DD2	B	5	21	1	.3
26DA1	G	16	6	1	2.7
28AB1	G	14	5	1	2.8
28BC1	G	10	3	1	3.3
30BD1	G	24	4	1	6.0
46N 23W 6DD1	B	12	40	2	.3
7CC1	B	5	12	1	.4
18DD1	B	15	10	1	1.5
19AD1	B	15	16	2	.9
29BC1	B	30	3	-	10.0
30DA1	B	15	10	1	1.5
46N 24W 1DC1	B	5	2	1	2.5
2CC1	B	10	20	1	.5
11CC1	B	5	162	1	.0
11CC2	B	4	85	1	.0
12BA1	B	5	75	1	.1
24AB1	B	15	11	1	.7
46N 28W 15AB1	G	20	13	.33	1.5
46N 29W 8DA1	G	80	6	8	13.3
18BD1	B	32	2	8	16.0
18DB1	G	97	16	5	6.0
18DB2	G	25	30	8	.8
18DB3	G	87	36	5.5	2.4
18DB4	G	100	11	7	9.1
30AB1	G	25	15	2	1.7
46N 30W 26CA1	B	12	30	1	.4
47N 23W 3AB1	B	5	36	1	.1
7CC1	G	5	12	1	.4
47N 24W 11BD1	B	3	92	1	.0
15CA1	G	25	30	-	.8
15CB1	G	50	10	6	5.0
21DD1	G	8	9	1	.9
21DD3	G	10	10	3	1.0
22DC1	G	5	8	1	.6
35BA1	B	10	70	1	.1
35DB1	B	20	15	2	1.3
35DC1	B	20	65	1	.3
47N 26W 29BC2	G	203	5	4	40.6
36BB1	G	310	11	14	28.1

Table 5.--Yield of wells (Continued)

Well	Aquifer	Yield (gal/min)	Drawdown (feet)	Duration of test (hours)	Specific capacity [(gal/min)/ft drawdown]
47N 27W 8BB1	G	90	32	48	2.8
47N 28W 12CA2	G	50	52	4	1.0
48N 25W 3AA1	G	10	14	24	.7
18DC1	B	20	35	2	.6
18CC1	G	10	5	1	2.0
48N 26W 7DC1	G	16	6	1	2.7
23AC1	G	10	10	1	1.0
48N 28W 32DA2	G	20	29	4	.7
48N 29W 30CC5	B	35	25	1.5	1.4
31CB1	G	40	1	3	40.0
48N 30W 21CA1	G	2	20	1	.1
49N 26W 2CB1	B	12	17	4	.7
12DD1	B	3	37	1	.1
50N 26W 19BB1	B	12	14	4	.9
50N 27W 14AB1	B	30	33	4	.9
14BA1	B	8	47	4	.2
51N 27W 1CA1	B	10	13	1	.8
14AA1	B	30	9	5	3.3
52N 28W 21DB1	B	100	28	-	3.6

Wells

Most ground-water supplies are obtained from drilled wells that range from 25 to 300 feet deep (table 6) and from 4 to 6 inches in diameter. In several deep wells the static water level is only a few feet below land surface. A few wells flow at land surface. Some homes and hunting camps obtain water from small-diameter drive points. This method is used to tap lakebed deposits in the vicinity of Harvey.

Slightly more than half the wells inventoried are completed in bedrock aquifers. Wells in bedrock are usually cased through the glacial deposits; the remainder of the hole is left open. Wells in the glacial deposits are cased and have screens set in sand and gravel beds. A few wells completed in gravel yield water directly through the bottom of the casing. Some low production bedrock wells have up to 100 feet of additional hole drilled to increase storage capacity.

Springs

Springs are not a common source of water. Only one spring (42N 25W 7BC1) is known to be extensively developed. It has been enlarged, cribbed, equipped with an electric pump and pressure system, and supplies water to a store and residence. Springs inventoried for this study are described in table 2; their locations are shown on figure 6.

Bedrock Aquifers

Yields of bedrock aquifers in Marquette County vary considerably. Some aquifers do not yield sufficient water for modest domestic supplies; others yield as much as 200 gal/min (table 5). Unfortunately, the areas of high density population, generally in or adjacent to the iron-producing areas, are not in the vicinity of the good aquifers in the eastern part of the county.

Precambrian Aquifers

All Precambrian rocks, except the Jacobsville Sandstone, have similar water-bearing characteristics and are discussed as a unit. Water in these rocks fills fractures, joints, and weathered zones at shallow depths. Yields vary but generally range from 1 to 5 gal/min. Low producing wells are common in areas of Precambrian W mafic lava flows and Precambrian X slate, such as in the vicinity of the Marquette County Airport, Lake Michigamme, and the Republic area. Precambrian rocks, where covered by 20 feet or more of glacial deposits, generally yield more water than where the glacial deposits are thin or absent. Also, more water is available from valleys in Precambrian rocks than in highlands.

Jacobsville Sandstone

The Jacobsville Sandstone is a major aquifer in Marquette County. Wells in the formation generally do not yield large quantities of water, but only a few wells fail to yield adequate water for domestic supplies. In places, the Jacobsville is the only source of water. Because much of the pore space in the Jacobsville has been cemented with silica, only the weathered zones and fractures in the upper part of the formation constitute a ground-water reservoir.

The quality of water from the Jacobsville Sandstone is generally good, although iron is common, and chloride concentrations in a few places are as much as 500 mg/L. The high chloride concentrations seem to occur randomly and increase with depth.

Munising Sandstone

The Munising Sandstone probably has the best potential of any other bedrock aquifer for high-capacity wells, although few such wells have been drilled. In Alger County, east of Marquette County, some wells in the Munising yield 200 gal/min. The formation is a fine-to-medium-grained sandstone and has well-developed intergranular porosity. It normally yields water of good chemical quality that is moderately hard. See classification range in table 4. In some places, it is friable and may yield sand to wells pumping at high rates.

Prairie du Chien-Trempealeau Unit

The Prairie du Chien-Trempealeau unit is generally a good aquifer but has not been extensively developed. Two types of porosity are present--the intergranular porosity of the sandstone and the fracture and solution openings in the dolomite and limestone. Although the sandstone is thinly bedded, it is likely to yield as much as 50 gal/min if several beds are tapped by a well. The dolomite and limestone do not yield abundant amounts of water but generally yield sufficient water for domestic needs. Water from both the sandstone and carbonate beds is hard, but otherwise is of good quality. Some carbonate zones are reported to contain sulfur water.

Black River Formation

The Black River Formation yields water from openings along fractures and bedding plains, some of which have been enlarged by solutioning. Most wells in the formation yield from 1 to 10 gal/min, which is adequate for domestic and farm supplies. The water is generally good although moderately hard.

Aquifers in Glacial Deposits

Aquifers in glacial deposits supply water to about half the wells inventoried. Most wells are in areas mapped as moraine (plate 1). Sand and gravel beds in areas where glacial deposits are thick are generally the best aquifer. Areas of thin glacial deposits are generally unfavorable for obtaining even small supplies and, when water is obtained, it generally has a high iron concentration.

End Moraines

Many water wells in areas mapped as end moraines (plate 1) are 50 to 100 feet deep. Small diameter drive point wells generally yield little or no water. All inventoried wells yield at least 5 gal/min and a few as much as 50 gal/min. Some wells are completed in the underlying bedrock. Water from wells in end moraines contains, on the average, 0.3 mg/L of iron (table 3). In the southern half of the county, iron concentrations in excess of 5 mg/L have been reported. Water from 75 percent of the wells samples is moderately hard to very hard.

Ground Moraines

Ground moraines (plate 1) are not a major water source. All wells in ground-moraine areas inventoried were drilled through the thin clayey ground moraines into underlying bedrock, a more dependable and easily developed source of water. Undoubtedly, some wells are completed in the ground moraine material itself, but these are expected to yield only modest supplies. Iron concentrations in excess of 0.3 mg/L, are likely to be present.

Outwash

Except in the central part of the county, well data are not generally available from areas of outwash. Most wells in outwash are less than 50 feet deep, but a few are 150 feet deep or more. Outwash yields from 2 gal/min to 300 gal/min to wells and has a specific capacity as great as 10 gal/min/ft. Properly constructed large diameter wells may yield 500 gal/min or more. Water from most wells has a high iron concentration and is moderately hard.

Lakebeds

Lakebeds are not a major source of water, except in the Harvey area near Marquette. Wells are generally less than 100 ft deep, but depths of about 200 feet have been reported. Well yields range from 3 to 100 gal/min; most wells yield about 10 gal/min. Because lakebed deposits do not always yield sufficient water to meet demands, some wells in areas mapped as lakebeds are drilled to the underlying bedrock to obtain needed supplies. Water from lakebed deposits generally has less than 0.3 mg/L of iron and is moderately hard.

Alluvium and Swamp Deposits as Aquifers

Wells in areas shown as swamp deposits on plate 1, and in areas of alluvium, are generally completed in sand and gravel in the underlying glacial deposits at depths ranging from 45 to 65 feet. In areas where bedrock is relatively impermeable and close to land surface, the alluvium and swamp deposits, where present, may be the most easily developed source of ground water, if small supplies are sufficient. However, the iron content may be high.

WATER SUPPLIES

Municipal Supplies

Most municipal water supplies are obtained from wells. The largest municipalities, however, use surface water; Marquette obtains water from Lake Superior, Ishpeming from Lake Sally, and Negaunee from Teal Lake. One township obtains part of its water supply from an abandoned mine shaft.

Greenwood

Greenwood obtains its water supply from two wells, 47N 28W 12CA1 (Well 1) and 47N 28W 12CA2 (Well 2), completed in glacial deposits (table 6). The wells are owned and operated by Ely Township. Well 47N 28W 12CA1 was drilled in 1930, is 30 feet deep, and is a gravel-pack well. The screen has deteriorated, and sand enters the casing and pump. Because of this, the well is used only for emergencies. Well 47N 28W 12CA2 was drilled in 1967, is 97 feet deep, and is completed with 5 feet of 25-slot stainless steel screen. At the time the well was completed, water flowed from the top of the casing, which was 2 feet above land surface. A 4-hour pumping test indicated a specific capacity of about 1 gal/min/ft. A chemical analysis of water from this well is given in table 3. Water is stored in a 1,500-gallon pneumatic pressure tank buried near the wells. The Greenwood system is a source of water for about 200 families and several businesses.

Diorite

Diorite obtains its water supply from two wells, 48N 28W 32DA1 and 48N 28W 32DA2, completed in glacial deposits. The wells are owned and operated by Ely Township. Well 48N 28W 32DA1 is a dug well constructed in 1935, is 38 feet deep, and is used primarily for a standby supply (table 6). Well 48N 28W 32DA2 is 49 feet deep, is the main production well, and has 6 feet of 10-slot screen set in sand. After pumping 4 hours at 20 gal/min, the drawdown was 29 ft (table 5). The water is soft and contains 0.3 mg/L of iron. Water is stored in a 3,750 gallon pneumatic tank.

Forsyth Township

The main sources of water for Forsyth Township are the abandoned Kidder Mine shaft and 8 and 10-inch wells. The mine shaft is 25 feet in diameter and is equipped with 25-and 40-horsepower pumps. These pumps are used alternately. The pump bowls are set 60 feet below land surface. The wells are about 40 feet deep (table 6) and are completed in gravel. The chief production well, 45N 25W 28AB2, is a 10-inch gravel-pack well. This well is equipped with a 20 horsepower turbine pump, having the bowls set at a depth of 40 feet. Pumpage averages about 260,000 gal/d. The water is stored in a 50,000-gallon elevated tank. Forsyth Township supplies water to 675 customers in the communities of Gwinn, Princeton, Austin, and New Swanzy.

Ishpeming Township

Ishpeming Township has two separate distribution systems. One system supplies North Ishpeming with about 25,000 gal/d. The other supplies the western part of the township with about 180,000 gal/d. Wells 47N 27W 8BB1 and 47N 27W 8BB2 are the sources of most of the water; however, about 28,000 gal/d is purchased from the city of Ishpeming to augment the supply. Well 47N 27W 8BB2 is reported to yield 13 gal/min/ft of drawdown. Water is stored in a 200,000-gallon elevated storage tank. Ishpeming Township supplies water to about 650 customers.

Negaunee Township

Negaunee Township has two 12-inch wells completed in glacial sand and gravel. Both are near Eagle Mills. Township Well No. 1, 48N 26W 35BAB1, is 195 feet deep; Well No. 2, 48N 26W 35BDB1 is 152 feet deep.

Although this water system is new and still being developed, it is expected to serve about 400 customers. Estimated water use will be about 100,000 gal/day. The water will be pumped into a 200,000-gallon overhead storage tank near the Township Hall. The water is metered to customers.

Powell Township

Ford Motor Company drilled well 51N 27W 15BD1 in 1945 and built a water system to supply its mill and the town of Big Bay. The well has 20 ft of 8-inch screen set from 136 to 156 feet and obtains water from glacial deposits. From 8 to 9 hours of pumping are required to obtain from 16,800 to 24,000 gallons. Water quality is good except for the high concentration of iron (table 3). Water is stored in two 10,000-gallon underground pressure tanks.

Republic Township

Republic Township has three closely spaced wells completed in glacial deposits. Well 46N 29W 18DB2 is the principal source of supply. Wells 46N 29W 18DB1 and 46N 29W 18DB4 serve as backup units. Pumpage is about 196,000 gal/d. Water is stored in a 300,000-gallon overhead tank. A nearby well, 46N 29W 8DB1, produced 80 gal/min, but was abandoned because of high iron and tannin concentrations.

Republic Township supplies water to the communities of Republic and South Republic and for domestic use at Republic Mine. About 300 customers pay a flat monthly charge.

Palmer

The community of Palmer obtains its water supply from two wells in glacial deposits. The wells are owned and operated by Richmond Township. Well 47N 26W 29BD2, drilled in 1955 and test pumped at 203 gal/min, is a standby well. Well 47N 26W 29BC2, drilled in 1969, is the main supply. The water is stored in a 135,000-gallon buried storage reservoir. About 220 customers pay a flat monthly rate.

Other Supplies

Several institutions, recreational clubs, and parks have developed their own water systems, using well water. Following are brief descriptions of these systems:

K. I. Sawyer Air Force Base

K. I. Sawyer Air Force Base has a water system supplied by four large capacity wells and several low yield wells. Well 46N 25W 36DAD1 (PW 4), rated at 750 gal/min, and well 46N 25W 36DAD2 (PW 5), rated at 1,000 gal/min, are pumped regularly. In emergencies, well 46N 25W 36BB1 (PW 6), which usually supplies only one building, can contribute 150 gal/min to the main system. Well 46N 25W 36DAD3 (Well 7), used only in summer, produces 180 gal/min. The system supplies about 8,600 people as well as offices, stores, recreational facilities, and shops.

Champion Home Owners Association

Champion Home Owners Association supplies water for industrial and domestic use in the community of Beacon. The water is obtained from a 6-inch well, 48N 29W 31DB1, that has 30 feet of 60-slot screen and yields 40 gal/min. Water is stored in an underground storage reservoir and a 3,000-gallon elevated storage tank.

Bay Cliffs Health Camp

The Bay Cliffs Health Camp obtains water from well 51N 27W 9DA1. The well, completed in bedrock that was blasted several times to improve permeability, yields 25 to 30 gal/min. Water is stored in a 9,000-gallon elevated tank and 6,500-gallon pressure tank. Supplemental water is obtained from Powell Township.

Huron Mountain Club

Water for the Huron Mountain Club's administrative buildings and cottages is obtained from wells 52N 28W 21DB1 and 52N 28W 21DB2, each capable of producing 100 gal/min. The club also has wells at the gage-keepers office and at the club farm. Outlying cottages obtain water from shallow wells in glacial deposits. Chemical analyses of water from some of the club's wells are given in table 3.

Michigan Northwoods Club

At Michigan Northwoods Club, well 45N 28W 11AB1 supplies water for the manager's residence, main lodge, and 12 nearby cottages. Water is stored in a 2,000-gallon pressure tank. Several nearby cottages have individual wells, most of them completed in glacial deposits. Chemical analyses of water from a cottage well and from the well at the main lodge are given in table 3.

Campgrounds and Access Sites

Several campgrounds and public access sites have their own water-supply systems. Generally, the systems are no more than a well and hand pump. The Escanaba River campground well (43N 24W 29CC1) is completed in bedrock. The Horseshoe Lake campground well (45N 30W 22AC1) pumps from glacial deposits. Analyses of water samples from the two campground wells indicate high concentrations of iron. Black River Falls campground well (46N 28W 15AB1) is also completed in glacial deposits. Several cottage owners at Little Lake obtain drinking water from the campground well because it is better quality than water from their wells. Hand pumps have been installed on all the campground wells. Data for these wells are in tables 3, 6, and 7.

Van Riper State Park

Van Riper State Park has modern facilities in the main area on Lake Michigamme, and primitive type camping along the Peshekee River. Water supplies are obtained from three wells in the main area. Production ranges from 16 to 35 gal/min. Two other wells in the primitive area supply adequate amounts of water to hand pumps. The wells, from 48 to 160 feet deep, are completed in glacial deposits and bedrock and yield as much as 35 gal/min.

SUMMARY

Yields from ground-water sources are variable throughout Marquette County. In several places, outwash deposits yield as much as 300 gal/min to wells. Locally, beds of sand and gravel in moraines and lake deposits also yield large supplies. In other places, wells in glacial deposits yield only enough water for domestic supplies.

Bedrock may yield large quantities of water, especially in places where it is covered by relatively thick glacial deposits. Ordovician and Upper Cambrian sandstone, although not extensively developed, are potentially good aquifers--yields of 200 gal/min or more can be expected. The Jacobsville Sandstone in some places yields moderate quantities of water; in other places, it yields little or no water. Precambrian igneous and metamorphic rocks will generally yield only small quantities of water to wells.

The quality of ground-water in Marquette County is generally good--only 2 of 86 analyses show a dissolved solids concentration greater than 500 mg/L. In a few supplies, iron and hardness may be a minor problem.

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APPENDIX

Table 6.--Records of selected wells

Wells are identified according to their geographic location as explained in the section "Well-numbering system".

Aquifer: G, glacial deposits; B, bedrock
Use: D, domestic; S, stock; P, public supply; O, observation; A, abandoned; I, industrial
Water level: Feet below land surface datum; F, flows
Altitude: Feet above NGVD of 1929.
Remarks: PW, production well; L, log in table 7

Well	Owner or name	Date drilled	Diameter of well (in)	Depth of well (ft)	Aquifer	Use	Water level (ft)	Date of water level measured	Altitude of land surface (ft)	Depth to bedrock (ft)	Remarks
42N 24W 2BC1	Harkonen	1914	-	22	B	D	18	1970	990	--	Poor yield, L
2BD1	Larson	1967	5	40	B	D	10	1967	980	23	
11BC1	Ahlgren	1946	5	45	B	D	--	--	960	11	
22BD1	Scheuren	--	5	58	B	D,S	--	--	940	6	Supplies 2 dwellings, L
25BC1	Segar	1950	6	105	B	D,S	8	1970	940	--	
25BC2	Segar	1966	5	65	B	A	16	1966	930	6	L
26CD1	Way	1943	-	59	B	D,S	--	--	920	4	Good yield
42N 25W 1AD1	Van Damme	1969	6	72	B	D,I	16	1969	1040	6	Dwelling, food-processing plant, L
7DA1	Arnold Sch	1958	-	293	B	P	--	--	1020	4	L
10DD1	Usher	1955	6	40	B	D	--	--	1030	--	
22DA1	Jaeger	1910	6	48	B	P	--	--	1000	--	
32AA1	Manninen	1968	5	55	B	D	22	1968	1020	14	Unpleasant taste, L
32BA1	Manninen	--	-	55	B	D	--	--	1020	--	
42N 26W 2DD1	Phillips	1965	6	40	B	D	--	--	1060	2	
4DD1	La Voie	1968	5	75	B	D	35	1968	1120	44	L
5BC1	Paquette	1965	6	38	B	D	--	--	1100	--	Rock outcrop. 200 yards west
12AC1	Wells Twp	1946	5	60	B	P	--	--	1040	12	
43N 24W 29CC1	Campground	1958	4	42	B	P	F	1958	1000	--	
33DC1	Corbisier	1969	5	61	B	D	8	1969	1010	8	L
34CC1	Kamarainen	1943	5	94	B	D	--	--	1030	10	
35CD1	Warnenan	1947	5	52	B	A	--	--	1000	18	
43N 25W 5CD1	DeShambo	1930	6	60	B	D	6	1970	1060	--	
31CC1	Bruce	1967	5	65	B	D	15	1967	1100	27	L
31CC2	DeShambo	1967	5	85	B	D	27	1967	1100	24	L
43N 26W 27CC1	Herbert	--	6	--	B	D	--	--	1140	--	
36BC1	Wyatt	1942	6	73	B	D	27	1970	1100	69	
44N 23W 29BC1	Ontto	--	-	--	B	D,S	3	1970	1070	--	
30AC1	Perkins	1966	5	40	B	D	7	1966	1070	5	L
44N 24W 25DB1	Kivioja	1967	5	40	B	D	8	1967	1090	16	L
25CD1	Guntley	1967	5	84	B	D	18	1967	1080	18	L
44N 25W 6AC1	Niemi	1968	5	67	G	D	27	1968	1120	--	L
44N 26W 12DD1	Campground	1967	2	34	G	P	--	--	1120	--	
28DA1	CCC	--	6	28	B	O	2.4	1970	1120	--	
45N 23W 2CB1	Ecklid	1965	5	46	B	D	7	1965	1100	23	Supplies 2 dwellings
7DA1	Nylund	1970	5	50	B	D	15	1970	1150	22	L
7AD1	Johnson	1964	6	58	B	D	10	1964	1160	--	
8CB1	Evang Ch	1970	5	30	B	P	6	1970	1140	24	L
14BB1	Barnett	1967	5	42	B	D	15	1967	1100	18	L
23AA1	Howard	1969	5	38	B	D	26	1969	1100	28	L
45N 24W 20DB1	Campground	1961	2	30	G	P	--	--	1120	--	
20CD1	Snari	1967	5	109	G	D	4	1967	1115	--	L
30BB1	Kirkwood	1970	1¼	40	G	D	10	1970	1115	--	

Table 6.-- Records of selected wells--Continued

Well	Owner or name	Date drilled	Diameter of well (in)	Depth of well (ft)	Aquifer	Use	Water level (ft)	Date of water level measured	Altitude of sand surface (ft)	Depth to bedrock (ft)	Remarks
45N 25W 25AA1	Girl Sc Camp	1970	1¼	47	G	P	—	—	1120	—	
27BD1	Palmer	1968	5	68	G	D	11	1968	1110	—	L
28AB1	Forsyth Twp	1962	8	37	G	P	15	1962	1100	103	L
28AB2	Forsyth Twp	1967	10	40	G	P	10	1965	1100	—	L
45N 26W 25BB1	Marchand	1970	5	160	G	D	24	1970	1185	—	L
26DA1	Queen	1970	5	77	G	P	28	1970	1200	—	Supplies dwelling, 5 cottages, L
29CD1	Campground	1965	2	30	G	P	—	—	1220	—	L
45N 28W 11AB1	Northwoods	1927	6	180	B	P	—	—	1460	—	Supplies dwelling, 12 cottages, L
11AD1	Keller	1969	6	60	G	D	20	1969	1430	—	
45N 30W 1BC1	Janofski	—	36	30	G	A	26.2	1966	1540	—	Former observation well
1AC1	Baumgartner	1962	6	126	B	D	50	1962	1540	115	L
2DA1	Kerkola	1967	5	117	G	D	54	1967	1560	—	L
2DA2	LaParche	1967	5	72	G	D	48	1967	1560	—	L
5CA1	Adams	1965	6	52	G	D	33	1965	1560	—	L
5CA2	Adams	1965	6	52	G	D	34	1965	1560	—	L
5DB1	Murray	1961	3	26	G	D	8	1961	1530	—	
8BA1	Kestly	1965	6	42	G	D	15	1965	1535	—	On island in Big Chief Lake, L
13CA1	Fst Bpst Ch	1968	6	45	G	D	14	1968	1500	—	High iron reported, L
19BD1	Rigoni	1966	6	20	G	D	6	1966	1470	—	High iron reported, L
22AC1	Campground	1966	4	54	G	P	24	1966	1500	—	L
26DD1	Datema	1969	6	137	B	D	40	1969	1480	40	L
26DD2	Johnson	1969	5	57	G	D	31	1969	1480	57	L
26DA1	Laanenin	1967	5	75	G	D	55	1967	1490	—	L
28AB1	Knipple	1969	5	69	G	D	44	1969	1500	—	L
29BC1	Hill	1969	5	60	G	D	47	1969	1500	—	L
30BD1	Brammer	1969	5	50	G	D	16	1969	1450	—	L
46N 23W 6DD1	Thompson	1968	5	84	B	D	5	1968	780	30	L
7CC1	Bergdahl	1968	6	107	B	D	65	1968	850	25	Very hard water
7CC2	Bergdahl	1930	4	101	B	D	—	—	845	19	
18DD1	Kallio	1968	5	100	B	D	45	1968	960	63	L
19DB1	Wickes Lmbr	1969	5	75	B	P	25	1968	960	50	Maximum yield 3 gal/min, L
19AD1	Johnson	1968	5	98	B	D	21	1968	940	70	L
25CD1	USFS--Duke	1927	6	100	B	D	—	—	1070	8	For dwelling at Dukes Exp Sta.
29BC1	USFS--Duke	1963	6	170	B	P	38	1963	1080	30	For office at Dukes Exp Sta., L
29DD1	Kallio	1961	6	55	B	P	—	—	1100	27	Supplies store, 2 dwellings
30DA1	Luth Ch	1956	5	85	B	P	35	1956	1100	47	
32DB1	Salminen	1970	6	55	B	D	25	1970	1100	25	
46N 24W 1DC1	Maki	1968	6	62	B	D	10	1968	760	34	L
2CC1	Libick	1969	5	116	B	D	45	1969	790	108	L
11CC1	Smith	1969	5	190	B	D	8	1969	820	60	L
11CC2	Culver	1969	5	111	B	D	25	1969	800	80	L
12BA1	Oiens	1968	5	150	B	D	25	1968	780	109	L
23CD1	Matson	1969	-	25	G	D	—	—	880	—	
24AB1	Washburn	1968	5	88	B	D	34	1968	900	40	L
26BB1	Bender	1950	-	63	G	D	—	—	880	—	
36AC1	Coleman	—	6	60	B	D	—	—	980	13	
46N 25W 16DD	Sands Sta	--	1	48	G	O	27	1969	1198	—	
36BB1	AFB	--	10	106	G	-	77	--	1195	--	PW6, L
36DAD1	AFB	--	10	141	G	-	--	--	1100	--	PW4, L
36DAD2	AFB	--	10	145	G	-	--	--	1100	--	PW5
36DAD3	AFB	—	—	—	G	-	--	--	1100	--	Test hole

Table 6.-- Records of selected wells—Continued

Well	Owner or name	Date drilled	Diameter of well (in)	Depth of well (ft)	Aquifer	Use	Water level (ft)	Date of water level measured	Altitude of land surface (ft)	Depth to bedrock (ft)	Remarks
46N 28W 12CB1	Ishpeming		1	19	G	O	3.6	1972	1410	--	
15AB1	Campground	1967	6	48	G	P	22	1967	1460	--	Black River Falls, L
46N 29W 8DA1	Republic Twp	1960	6	44	G	A	6	1960	1520	--	High tannins, L
18BD1	Republic Twp	1968	-	108	B	T	20	1968	1480	108	L
18DB1	Republic Twp	1964	6	56	G	P	13	1964	1480	68	L
18DB2	Republic Twp	1961	6	50	G	P	14	1961	1480	50	Main supply for Republic, L
18DB3	Republic Twp	1964	6	62	G	A	13	1964	1480	62	L
18DB4	Republic Twp	1968	12	46	G	P	15	1968	1480	--	L
30AB1	Dubord	1961	6	60	G	D	7	1961	1480	--	L
46N 30W 16CB1	Merkel Bros	1958	6	62	G	D	29	1958	1640	--	L
22AB1	Grant	1968	5	51	G	D	20	1968	1550	--	
26CA1	Vadnais	1969	5	99	B	D	40	1969	1530	94	L
47N 23W 3AB1	Hicks	1969	6	50	B	D	7	1969	610	3	L
7CC1	Whittaker	1969	5	48	G	D	28	1969	640	--	L
47N 24W 10AC1	Britton	1970	1¼	28	G	D	--	--	615	--	L
11BD1	Rthrfrd & Lewis	1969	5	204	B	D	8	1969	615	197	Poor yield, water muddy at times, L
15CA1	State Mich Corr	1964	6	145	G	P	87	1964	700	--	Standby supply, prison farm, L
15CB1	State Mich Corr	1965	4	210	G	P	94	1965	700	--	Main supply, prison farm, L
21DD1	Berryman	1969	5	125	G	D	21	1969	680	--	L
21DD2	Acre Rlty	1969	7	155	B	A	15	1969	680	153	Water muddy, L
21DD3	Acre Rlty	1969	7	63	G	D	15	1969	680	--	L
22DC1	West	1967	5	126	G	D	82	1967	700	--	L
35BA1	Hillcrest Dy	1968	6	220	B	I	140	1968	820	182	Main supply for creamery, L
35BA2	Hillcrest Dy	1940	5	180	G	I	--	--	820	--	Part of supply for creamery, L
35BA3	Hillcrest Dy	1958	5	188	G	I	--	--	820	--	Part of supply for creamery, L
35DB1	Preibe	1968	5	132	B	D	45	1968	760	129	
35DC1	Zerbel	1967	5	130	B	D	65	1967	740	115	
47N 25W 19CC1	Cascade Jct	1963	1	86	G	O	25	1973	1222	--	
20CC1	E. Cascade Jct	1963	1	103	G	O	78	1973	1230	--	
32CA1	Gentian	1963	1	122	G	O	100	1964	1239	--	
47N 26W 27BC1	Laitala	1966	1	31	G	O	+0.6	1971	1290	--	
29BC1	Richmond Twp	1969	10	38	G	P	--	--	1290	--	Main supply for Palmer
29BC2	Richmond Twp	1955	8	34	G	P	16	1957	1290	--	Standby supply for Palmer, L
36BB1	C.C. - Goose Lake	1964	8	56	G	O	6.5	1970	1210	--	Continuous water-level record, L
47N 27W 8BA1	C.C. - Rock Lake	1966	1	33	G	O	7	1970	1430	--	
8BB1	Ishpeming Twp	1964	12	51	G	P	5	1964	1420	--	PW 1, L
8BB2	Ishpeming Twp	1969	12	56	G	P	+2	1969	1420	--	PW 2, flowed in 1969, L
47N 28W 3CC1	Ely Twp	1955	8	75	G	O	14	1970	1572	--	Low yield; high iron, L
12CA1	Ely Twp	1930	8	30	G	P	--	--	1490	--	Standby unit
12CA2	Ely Twp	1967	5	97	G	P	F	1967	1490	--	Main supply for Greenwood, L
35CB1	Triangle		1	52	G	O	31.8	1973	1481	--	
47N 29W 2AD1	Humboldt	1963	1	19	G	O	1.9	1973	1527	--	
34CB1	Black R. Sch	--	1	23	G	O	7.1	1969	1494	--	
48N 25W 3AA1	Kelly	--	7	57	G	D	6	--	610	--	L
18DC1	Peterson	1968	5	91	G	D	40	1968	1010	90	L
18CC1	Peters	1966	5	70	G	D	35	1968	1010	--	L
48N 26W 7DC1	Theut	1967	5	97	G	D	39	1967	1420	--	L
23AC1	Denn	1968	6	39	G	D	25	1968	1310	40	L
34DA1	Eagle Mills	1963	1	31	G	O	2	1967	1280	--	
35BA1	Negaunee Twp	--	12	195	G	--	--	--	1290	--	PW1
35BD1	Negaunee Twp	--	12	152	G	--	--	--	1285	--	PW2
48N 28W 32DA1	Ely Twp	1935	96	38	G	P	--	--	1561	--	Part of Diorite's supply
32DA2	Ely Twp	1962	6	49	G	P	10	1962	1561	50	Main supply for Diorite, L

Table 6.— Records of selected wells—Continued

Well	Owner or name	Date drilled	Diameter of well (in)	Depth of well (ft)	Aquifer	Use	Water level (ft)	Date of water level measured	Altitude of land surface (ft)	Depth to bedrock (ft)	Remarks
48N 29W 30CC1	Van Riper Park	1957	6	48	G	P	17	1957	1580	—	L
30CC2	Van Riper Park	1968	6	78	G	O	14.7	1970	1560	90	Yield 4 gal/min, L
30CC3	Van Riper Park	1969	7	191	B	A	14	1969	—	162	Yield 0.5 gal/min, L
30CC4	Van Riper Park	1969	6	142	G	P	14	1969	—	162	Yield 18 gal/min; well 4, L
30CC5	Van Riper Park	1972	6	160	B	P	3	1973	—	139	Yield 35 gal/min; well 5, L
31CCD1	DNR	1973	6	195	B	A	—	—	—	130	Yield < 1 gal/min, L
31DB1	Chmpn Hm Owners Assoc	1953	6	110	G	P	9	1953	1690	110	Supplies 22 dwellings, L
48N 30W 21CA1	Mthdst Inst	1968	6	41	G	P	15	1968	1600	—	L
49N 26W 2CB1	Gray	1969	5	77	B	D	28	1969	740	21	L
12DD1	Krieg	1967	5	66	B	D	3	1967	605	15	Water red, silty after prolonged pumping, L
30W 22AC1	WMP 13		1	17	G	O	0.6	1951	1680	—	
50N 26W 19BB1	Fortin	1967	5	99	B	D	28	1967	750	24	L
50N 27W 14AB1	Fraley	1969	5	92	B	D	7	1969	740	18	L
14BA1	Ryerse	1969	5	96	B	D	13	1969	750	20	L
50N 28W 4CB1	Hackel	—	1¼	23	G	D	—	—	1120	—	
51N 27W 1CA1	Pick	1968	5	126	B	D	52	1968	640	11	L
9DA1	Bay Clf Hlth Camp	1968	5	683	B	P	30	1968	700	29	Yields 25 to 30 gal/min, L
14BD1	White	1969	1¼	26	G	D	5	1969	630	—	
14AA1	Thomas	1967	5	87	B	D	7	1967	630	27	High iron content
15BD1	Powell Twp	1945	8	156	G	P	—	—	620	—	Supplies Big Bay, L
51N 28W 1BA1	Huron Mt Clb	—	6	55	G	P	—	—	628	—	High in iron, L
52N 28W 21DB1	Huron Mt Clb	1949	8	200±	B	P	20	1949	620	100±	With 21DB2 is Club's water supply, L
21DB2	Huron Mt Clb	1959	8	200±	B	P	—	—	620	100±	
21DB3	Huron Mt Clb	1968	2	26	G	D	—	—	620	—	Typical of shallow wells in area
27CB1	Huron Mt Clb	1961	6	135	B	A	—	—	630	95	Hand pump, L

Table 7.--Lithologic logs of materials from selected wells
(from drillers records)

Explanation

See table 6 for additional data.
Altitude: Feet above mean sea level.
Thickness and depth to bottom are in feet.

	Thick-ness	Depth to bottom
Twp 42 North, Range 24 West		
Well 42N 24W 2BD1		
Altitude: 980		
Sand and clay	6	6
Clay	12	18
Hardpan	5	23
Limestone, broken	3	26
Limestone, gray	14	40
Well 42N 24W 22BD1		
Altitude: 940		
Clay loam	6	6
Rock	52	58
Well 42N 24W 25BC2		
Altitude: 930		
Hardpan	6	6
Limestone, tan	24	30
Blue rock	35	65
Twp 42 North, Range 25 West		
Well 42N 25W 1AD1		
Altitude: 1040		
Gravel	6	6
Limestone	54	60
Sandstone	12	72
Well 42N 25W 7DA1		
Altitude: 1020		
Glacial deposits	4	4
Limestone	136	140
Sandstone, white	153	293
Well 42N 25W 32AA1		
Altitude: 1020		
Hardpan and stones	12	12
Hardpan	2	14
Limestone, light green	16	30
Limestone, streaks of sandstone	25	55
Twp 42 North, Range 26 West		
Well 42N 26W 4DD1		
Altitude: 1120		
Hardpan and boulders	15	15
Red clay, stones	5	20
Gumbo clay	20	40
Hardpan, red	4	44
Limestone	31	75
Twp 43 North, Range 24 West		
Well 43N 24W 33DC1		
Altitude: 1010		
Clay	8	8
Blue rock	38	46
Limestone, gray	15	61
Twp 43 North, Range 25 West		
Well 43N 25W 31CC1		
Altitude: 1100		
Sand	6	6
Clay and stones	16	22
Hardpan	5	27
Limestone, tan	38	65
Well 43N 25W 31CC2		
Altitude: 1100		
Clay, red	20	20
Clay, white	4	24
Limestone, gray	61	85
Twp 44 North, Range 23 West		
Well 44N 23W 30AC1		
Altitude: 1070		
Hardpan	5	5
Limestone, broken	4	9
Limestone, hard, blue	31	40
Twp 44 North, Range 24 West		
Well 44N 24W 25DB1		
Altitude: 1090		
Sand	2	2
Clay and sand	4	6
Clay	6	12
Hardpan	4	16
Limestone, gray	24	40
Well 44N 24W 25CD1		
Altitude: 1080		
Sand	4	4
Clay	12	16
Hardpan	2	18
Limestone	66	84
Twp 44 North, Range 25 West		
Well 44N 25W 6AC1		
Altitude: 1120		
Topsoil	1	1
Sand, fine to medium	17	18
Sand, fine to medium, and clay	15	33
Sand and clay, hard packed	15	48
Clay	10	58
Sand, fine to medium, clean	9	67
Twp 45 North, Range 23 West		
Well 45N 23W 7DA1		
Altitude: 1150		
Black soil	1	1
Hardpan, red	21	22
Sandstone	5	27
Limestone	23	50
Well 45N 23W 8CB1		
Altitude: 1140		
Topsoil	1	1
Gravel and sand	20	21
Hardpan	3	24
Limestone	6	30
Well 45N 23W 14BB1		
Altitude: 1100		
Sand and stones	12	12
Clay and stones	6	18
Limestone, streaks of sandstone	24	42
Well 45N 23W 23AA1		
Altitude: 1100		
Sand	1	1
Hardpan, red	16	17
Hardpan, white	11	28
Limestone	5	33
Sandstone	5	38
Twp 45 North, Range 24 West		
Well 45N 24W 20CD1		
Altitude: 1115		
Sand, coarse, bad water	38	38
Clay	27	65
Sand mixed with clay and silt	30	95
Sand, fine	5	100
Sand	5	105
Sand, coarse and gravel	4	109
Well 45N 24W 30BB1		
Altitude: 1115		
Sand	30	30
Clay	7	37
Sand	3	40
Twp 45 North, Range 25 West		
Well 45N 25W 27BD1		
Altitude: 1110		
Topsoil	1	1
Sand, fine to medium	24	25
Sand, fine to medium, and clay	20	45
Sand, medium, and clay	16	61
Sand, medium to coarse, some clay	3	64
Sand, clean, coarse	4	68
Well 45N 25W 28AB2 (Log of Testhole No. 7 at site of 28AB2)		
Altitude: 1100		
Sand, coarse, and gravel	10	10
Gravel, medium fine	10	20
Gravel, fine, some sand, medium	15	35
Sand, medium	10	45
Sand, fine	5	50
Sand, silty, fine	5	55
Well 45N 25W 28AB1		
Altitude: 1100		
Topsoil	1	1
Sand	1	2
Gravel, coarse	9	11
Gravel, clay	10	21
Gravel, clean, coarse	16	37
Gravel, clay	1	38
Sand, silty	16	54
Clay, red	3	57
Clay, sandy	6	63
Sand, silty, some clay, red	19	82
Clay, sandy	21	103
Slate, black		103
Twp 45 North, Range 26 West		
Well 45N 26W 25BB1		
Altitude: 1185		
Sand and gravel, silty	15	15
Sand, clay and gravel	35	40
Clay, fine, sandy	30	70
Clay, sandy, packed	50	120
Clay, sandy	30	150
Sand, medium, trace of clay	10	160
Well 45N 26W 26DA1		
Altitude: 1200		
Hardpan; clay, sand, and rock	16	16
Clay, sandy, some pebbles	24	40
Sand and clay	25	65
Sand, medium, some fine gravel, trace of clay	12	77
Well 45N 26W 29CD1		
Altitude: 1220		
Gravel, coarse	14	14
Gravel, fine, layers of hardpan	16	30
Well 45N 28W 11AD1		
Altitude: 1430		
Sand	8	8
Sand, muddy	4	12
Gravel, dirty	2	14
Sand, silty, some boulders	22	36
Gravel and clay	12	48
Sand and gravel, very silty	7	55
Sand, clean, medium, and gravel	5	60

Table 7.--Lithologic logs of materials from selected wells--Continued

	Thickness	Depth to bottom
Twp 45 North, Range 30 West		
Well 45N 30W 1AC1		
Altitude: 1540		
Clay	15	15
Sand	10	25
Silt	71	96
Gravel	10	106
Hardpan	9	115
Granite	11	126
Well 45N 30W 2DA1		
Altitude: 1560		
Surface materials, brown	3	3
Sand, gravel, and boulders, brown	11	14
Sand, coarse, brown	26	40
Gravel, brown	5	45
Sand and silt, brown, gray	17	62
Gravel and sand, brown	3	65
Clay, red	9	74
Sand and silt, gray	30	104
Sand, coarse, brown	13	117
Well 45N 30W 2DA2		
Altitude: 1560		
Clay, gravel and boulders, red, brown	15	15
Hardpan, red, brown	11	26
Gravel, brown	23	49
Sand, brown	11	60
Sand and gravel, brown	12	72
Well 45N 30W 5CA1		
Altitude: 1560		
Humus and clay	2	2
Gravel and boulders	25	27
Sand, fine, silty	10	37
Sand, coarse, silty	3	40
Sand, medium-fine, clean	12	52
Sand, fine, micaceous	10	62
Well 45N 30W 5CA2		
Altitude: 1560		
Gravel and boulders	24	24
Sand and gravel	25	49
Gravel, coarse	3	52
Well 45N 30W 5DB1		
Altitude: 1530		
Sand and clay	3	3
Hardpan and boulders	18	21
Gravel, medium coarse, and sand	5	26
Well 45N 30W 8BA1		
Altitude: 1535		
Boulders, gravel	17	17
Sand, dirty	20	37
Sand, coarse, clean	5	42
Well 45N 30W 13CA1		
Altitude: 1500		
Sand	24	24
Hardpan and boulders	4	28
Silt and sand, heavy clay, gray	4	32
Sand, cleaner than above, gray	8	40
Sand, medium coarse, clean, gray	4	44
Well 45N 30W 19BD1		
Altitude: 1470		
Loam and boulders, sandy	6	6
Sand, coarse, seams of wet puddling clay	8	14
Sand, coarse, and water	6	20
Well 45N 30W 22AC1		
Altitude: 1500		
Loam, sandy, some large boulders	20	20
Sand, clayey, and boulders	5	25
Gravel, fine, and sand	25	50
Sand, coarse, some gravel	5	55
Well 45N 30W 26DA1		
Altitude: 1490		
Clay, red, brown	3	3
Boulders and gravel, brown	15	18
Sand, coarse, brown	8	26
Gravel and boulders, brown	12	38
Gravel, brown	12	50
Sand, coarse, brown	23	73
Sand and gravel, coarse, brown	2	75
Well 45N 30W 26DD1		
Altitude: 1480		
Till, some large boulders	40	40
Michigamme slates	93	133
Granite, gray, high in quartz	4	137
Well 45N 30W 26DD2		
Altitude: 1480		
Clay	2	2
Clay and boulders, sandy	17	19
Clay, sandy, some boulders	37	56
Gravel, coarse, silty	1	57
Bedrock		57
Well 45N 30W 28AB1		
Altitude: 1500		
Sand, gravel and boulders, brown	25	25
Sand, coarse, brown	20	45
Sand, coarse, yellow	17	62
Sand and gravel, coarse, gray	7	69
Well 45N 30W 28BC1		
Altitude: 1500		
Clay, gravel and boulders, dark brown	15	15
Sand and gravel, coarse, light brown	45	50
Well 45N 30W 30BD1		
Altitude: 1450		
Clay, dark brown	4	4
Gravel and boulders, brown	11	15
Sand and gravel, brown	10	25
Sand, coarse, light brown	20	45
Sand and gravel, coarse, gray	5	50
Twp 46 North, Range 23 West		
Well 46N 23W 6DD1		
Altitude: 780		
Clay and large stones, sandy	20	20
Clay, red	10	30
Sandstone, red	54	84
Well 46N 23W 7CC1		
Altitude: 850		
Clay loam	8	8
Clay and rocks, hard	8	16
Clay, sandy, hard	9	25
Sandstone, soft	1	26
Sandstone, medium hard, red	81	107
Well 46N 23W 18DD1		
Altitude: 960		
Sand	12	12
Sand, fine	30	42
Clay, red	11	53
Hardpan, red	10	63
Sandstone, red	37	100
Well 46N 23W 19AD1		
Altitude: 940		
Clay, sandy	20	20
Sand, fine, red	50	70
Sandstone, red	28	98
Well 46N 23W 19DB1		
Altitude: 960		
Clay and rocks, hard	10	10
Clay, sandy, hard	20	30
Clay, hard, red	20	50
Sandstone, reddish	25	75
Well 46N 23W 29BC1		
Altitude: 1080		
Sand, fine to coarse, gravel, silt	10	10
Sand, fine to coarse, very silty	10	20
Sand, fine to coarse, silty, some gravel	5	25
Sand, fine to medium, silty	5	30
Munising sandstone	110	140
Jacobsville sandstone	30	170
Twp 46 North, Range 24 West		
Well 46N 24W 1DC1		
Altitude: 760		
Loam, sandy	6	6
Sand, clay and rocks	9	15
Clay and boulders	5	20
Clay and rocks, hard, red	14	34
Sandstone, medium hard, red	28	62
Well 46N 24W 2CC1		
Altitude: 790		
Sand	15	15
Clay, red	57	72
Hardpan, red	27	99
Sand, coarse	9	108
Sandstone and limestone	2	110
Sandstone, red	6	116
Well 46N 24W 11CC1		
Altitude: 820		
Sand, red	10	10
Clay, red	40	50
Hardpan, red	10	60
Sandstone, red	130	190
Well 46N 24W 11CC2		
Altitude: 800		
Sand, red	11	11
Clay, red	30	41
Hardpan, red	18	59
Hardpan and stones	21	80
Sandstone, red	31	111
Well 46N 24W 12BA1		
Altitude: 780		
Clay, red	86	86
Hardpan and gravel	3	89
Hardpan, red	20	109
Sandstone ledge	41	150
Well 46N 24W 24AB1		
Altitude: 900		
Clay, sandy, red	20	20
Sand, fine, red	20	40
Shale, red, and sandstone	5	45
Sandstone, red, solid	43	88

Table 7.--Lithologic logs of materials from selected wells--Continued

	Thick-ness	Depth to bottom
Twp 46 North, Range 25 West		
Well 46N 25W 36BB1(PW6)		
Altitude: 1195		
Topsoil	1	1
Sand, fine to coarse	24	25
Sand, fine to coarse, thin beds of coarse gravel	5	30
Sand, fine to coarse	5	35
Sand, fine to medium	5	40
Sand, fine to coarse, beds of fine gravel	5	45
Sand, fine to coarse	4	49
Sand, fine to coarse, and coarse gravel	5	54
Sand, fine	5	59
Sand, fine to medium	6	65
Sand, fine to coarse, beds of coarse gravel	20	85
Sand, fine to medium	5	90
Sand, fine	17	107
Hardpan, clay and gravel	2	109
Clay	1	110
Well 46N 25W 36DAD1		
Altitude: 1100		
Sand	20	20
Sand, dirty	10	30
Clay, sandy	20	50
Clay	18	68
Sand and gravel	6	74
Hardpan	5	79
Gravel, clay, boulders	5	84
Boulders, clay	16	100
Gravel and boulders	15	115
Sand, coarse	25	140
Gravel, fine	4	144
Twp 46 North, Range 28 West		
Well 46N 28W 15AB1		
Altitude: 1460		
Sand, fine to medium, brown	5	5
Sand, medium to coarse, brown, little silt	10	15
Sand, very fine to medium, tan, very silty	15	30
Sand, very fine to medium, tan, some silt	18	48
Twp 46 North, Range 29 West		
Well 46N 29W 8DA1		
Altitude: 1520		
Humus and hardpan	5	5
Hardpan, gravel and boulders (at 17 ft. static head 8 ft. below surface, very odorous)	12	17
Gravel, water-bearing	8	25
Rocks, water-bearing, slow producer (at 35 ft. static head 7 ft. below surface, no odor)	10	35
Sand (at 44 ft. static head 6 ft. below surface, no odor)	9	44
Well 46N 29W 18BD1 (Test hole)		
Altitude: 1480		
Clay, red	2	2
Gravel, gray	10	12
Sand, coarse, gravel, gray	10	22
Sand, fine to coarse, and gravel, brown	9	31
Sand, fine, dark brown	10	41
Sand, coarse, silty, and dirty dark brown	8	49
Well 46N 29W 18BD1 (Test hole) (Continued)		
Gravel, dark brown	3	52
Gravel, brown	2	54
Sand, fine, brown	5	59
Sand, fine to medium, brown	11	70
Sand, coarse, brown	16	86
Gravel, large, and sand, brown	7	93
Hardpan, brown	7	100
Sand, coarse, and gravel, dark brown	6	106
Hardpan, brown	2	108
Ledge, hard, red	1	109
Well 46N 29W 18DB1 (Well 1)		
Altitude: 1480		
Loam, yellow	4	4
Sand, gravel, dirty, black	6	10
Gravel, sandy, silty	16	26
Sand and gravel	5	31
Gravel, sandy, silty	4	35
Sand and gravel, fine	5	40
Gravel, fine to medium	10	50
Gravel, sandy, silty	18	68
Bedrock		68
Well 46N 29W 18DB2 (Well 2)		
Altitude: 1480		
Loam, sandy	3	3
Gravel and boulders	7	10
Hardpan, black	5	15
Gravel	5	20
Gravel and clay	10	30
Sand and clay	5	35
Sand, water-bearing	10	45
Sand, clayey	3	48
Hardpan	2	50
Bedrock		50
Well 46N 29W 18DB3 (Well 3)		
Altitude: 1480		
Clay, red, silty, gravelly	3	3
Gravel, fine to coarse, silty, black	10	13
Gravel, fine	5	18
Gravel, clay balls	6	24
Gravel, clayey	2	26
Sand, silty, gravelly, dirty	5	31
Gravel, silty, dirty	5	36
Gravel, sand	9	45
Sand, coarse	5	50
Sand, coarse; gravel, fine, slightly dirty	5	55
Gravel, sandy, silty	7	62
Bedrock		62
Well 46N 29W 18DB4 (Well 4)		
Altitude: 1480		
Clay, red	3	3
Gravel, fine to coarse, gray	10	13
Gravel and boulders, gray	13	26
Gravel, sand, silt, brown	6	32
Gravel, coarse, and sand, brown	14	46
Gravel, tight, black	1	47
Well 46N 29W 30AB1		
Altitude: 1480		
Gravel	30	30
Sand and silt, black	10	40
Hardpan, black	15	55
Hardpan, gray	3	58
Gravel, pea size	2	60
Twp 46 North, Range 30 West		
Well 46N 30W 16CB1		
Altitude: 1640		
Clay	5	5
Gravel	5	10
Gravel, hard	20	30
Gravel	10	40
Gravel, hardpan	10	50
Gravel and clay, water	12	62
Well 46N 30W 26CA1		
Altitude: 1530		
Clay and sand, dark brown	3	3
Gravel, dark brown	37	40
Sand, fine, brown	6	46
Sand, fine and clay, silty, gray	48	94
Granite, red and white	5	99
Twp 47 North, Range 23 West		
Well 47N 23W 3AB1		
Altitude: 610		
Boulders and sandy clay	3	3
Sandstone, soft	6	9
Sandstone	41	50
Well 47N 23W 7CC1		
Altitude: 640		
Sand, fine to medium	15	15
Sand, medium to coarse silty	15	30
Sand, fine to medium, silty	10	40
Sand, medium to coarse, trace of clay	8	48
Twp 47 North, Range 24 West		
Well 47N 24W 10AC1		
Altitude: 615		
Sand	10	10
Clay	2	12
Sand	16	28
Well 47N 24W 11BD1		
Altitude: 615		
Sand, fine, and silt	20	20
Sand, medium, and clay	7	27
Sand, fine to medium, and clay	20	47
Clay, hard, some fine sand, reddish	93	140
Clay, red-brown	13	153
Clay, sandy	31	184
Clay, gravel and sand (hardpan)	13	197
Sandstone, red-brown	7	204
Well 47N 24W 15CA1		
Altitude: 700		
Loam and sandy clay	5	5
Sand, medium	17	22
Sand, coarse, and clay	3	25
Sand, medium fine, and clay	29	54
Sand, fine, and clay	23	77
Sand, medium, and clay	8	85
Sand, medium-coarse, and clay	12	97
Sand, fine, and clay	13	110
Sand, medium	5	115
Clay and sand, fine	10	125
Sand, medium coarse, some silt, water	5	130
Sand, medium, quite clean	16	146
Clay		146

Table 7.--Lithologic logs of materials from selected wells--Continued

	Thick-ness	Depth to bottom
Twp 47 North, Range 24 West (Continued)		
Well 47N 24W 15CB1		
Altitude: 700		
Sand, fine to medium, silty	72	72
Sand, compact, coarse, some silt	14	86
Sand, coarse, quite clean	20	106
Sand, coarse, very silty	6	112
Sand, fine, silty	16	128
Sand, fine, and clay	3	131
Clay	11	142
Sand, red, fine, silty	40	182
Sand, silty, and gravel, brown	10	192
Sand and gravel	18	210
Sand, coarse	2	212
Well 47N 24W 21DD1		
Altitude: 680		
Clay, sandy	2	2
Sand, fine to medium	18	20
Sand, fine to medium, and clay	20	40
Gravel, sand and clay (hardpan)	25	65
Clay, sandy	10	75
Clay, some fine sand	41	116
Clay, sandy, fine to medium sand	3	119
Sand, fine to medium, some fine gravel, trace of clay	6	125
Well 47N 24W 21DD2		
Altitude: 680		
Sand	35	35
Sand and clay	19	54
Gravel and clay	11	65
Sand, fine, heaving	49	114
Sand, coarse, heaving	6	120
Sand, fine, heaving	28	148
Gravel	3	151
Sandstone	2	157
Well 47N 24W 21DD3		
Altitude: 680		
Sand	32	32
Sand and clay	23	55
Gravel and clay	7	62
Gravel	1	63
Well 47N 24W 22DC1		
Altitude: 700		
Sand, fine, and clay	10	10
Clay, sandy, muddy	8	18
Sand, fine, silty	8	26
Sand, fine to medium, and clay	22	48
Sand, fine, and clay	49	97
Sand, medium, and clay	8	105
Sand, medium, some gravel, trace of clay	8	113
Sand, medium, clean	13	126
Well 47N 24W 35BA1		
Altitude: 820		
Sand	80	80
Quicksand	60	140
Clay and sand, red	14	154
Sand and gravel, coarse	16	170
Gravel	5	175
Hardpan and stones	7	182
Soapstone	5	187
Sandstone, red	18	205
Slate rock, black	15	220
Well 47N 24W 35DC1		
Altitude: 740		
Sand, white	12	12
Ssnd, red	31	43
Clay, red	56	99
Hardpan and gravel, red	16	115
Sandstone, red	15	130
Well 47N 24W 35DB1		
Altitude: 760		
Sand	9	9
Clay, red	80	89
Hardpan, red	40	129
Ssndstone	3	132
Twp 47 North, Range 26 West		
Well 47N 26W 29BC2 (Well 2)		
Altitude: 1290		
Sand and rocks, coarse	4	4
Clay, red, sandy	20	24
Grsvel, coarse, and sand, coarse	10	34
Well 47N 26W 36BB1		
Altitude: 1210		
Sand, fine to coarse, tan, some gravel, silty	28	28
Gravel, fine to coarse, sandy	10	38
Sand, medium to coarse, and gravel, fine to pea size	3	41
Gravel, fine to coarse, some sand	9	50
Sand, fine to coarse, some gravel	9	59
Twp 47 North, Range 27 West		
Well 47N 27W 8BB1 (PW 1)		
Altitude: 1420		
Sand, tan, very fine to coarse; and gravel, fine to about ½ inch diameter	5	5
Sand, tan, fine to coarse; gravel, fine to about ½ inch diameter	5	10
Ssnd, tan, fine to medium, clay particles and gravel to ½ inch diameter	5	15
Sand, tan, fine to medium, clay particles; gravel, fine to about ½ inch diameter	5	20
Sand, tan, fine to medium, some coarse sand	7	27
Sand, tan, fine to coarse, and gravel coarse to about 1½ inch diameter with fine to medium	2	29
Gravel, pea size, some gravel, fine to medium, very slight show of sand, fine to coarse	2	31
Sand, tan, fine to medium, some coarse, and gravel, fine to 3/4 inch diameter, with some clay particles	2	33
Sand, tan, fine to coarse, with very fine; gravel fine to about 3/4 inch diameter	1	34
Sand, tan, medium to coarse, with fine; gravel to about 1 inch diameter	3	37
Gravel, fine to about pea size, some sand, very fine to coarse, slight amount of silt	1	38
Well 47N 27W 8BB1 (Continued)		
Gravel, coarse, up to 1 inch diameter, some fine to medium; sand, medium to coarse, with a little fine	4	42
Gravel, coarse, about pea size, some fine to medium, and sand, very fine to coarse	7	49
Well 47N 27W 8BB2 (PW 2)		
Altitude: 1420		
Clay, red	2	2
Sand, medium, and clay	4	6
Clay, sandy	12	18
Ssnd, fine, and clay	18	36
Sand, medium coarse, and gravel	7	43
Sand, coarse, gravel and clay	5	48
Sand, gravel, some clay	10	58
Gravel, medium, trace of clay	8	66
Gravel, packed, muck, and clay	1	67
Twp 47 North, Range 28 West		
Well 47N 28W 3CC1		
Altitude: 1572		
Sand, fine to medium, some coarse gravel	10	10
As above plus pieces of wood	10	20
Sand, medium, brown, some coarse gravel	10	30
Sand, fine, dark brown, some coarse gravel	10	40
Sand, fine to very fine, brown, some coarse gravel	30	70
Sand, fine to very fine, dark brown, some coarse gravel	10	80
Well 47N 28W 12CA2 (Well 2 at Greenwood)		
Altitude: 1490		
Loam, sandy, black	3	3
Sand, fine, and clay	17	20
Clay	55	75
Gravel, fine, and clay, water bearing	10	85
Gravel, coarse, and sand, some clay	5	90
Bedrock, black	3	93
Twp 48 North, Range 25 West		
Well 48N 25W 3AA1		
Altitude: 610		
Topsoil and sand	5	5
Sand, dirty	15	20
Ssnd and clay	32	52
Sand, fine, gravel and clay	4	56
Gravel, pea size, water	1	57
Well 48N 25W 18DC1		
Altitude: 1010		
Sand	14	14
Clay, sandy	18	32
Quicksand	12	44
Clay, red	31	75
Hardpan and stones, red	12	87
Gravel, clean	3	90
Granite	1	91

Table 7.--Lithologic logs of materials from selected wells--Continued

	Thickness	Depth to bottom
Twp 48 North, Range 25 West (Continued)		
Well 48N 25W 18CC1		
Altitude: 1010		
Sand, fine	2	2
Sand, fine to medium	20	22
Clay, fine, sandy, brown	40	62
Sand, fine to coarse, clean	8	70
Twp 48 North, Range 26 West		
Well 48N 26W 7DC1		
Altitude: 1420		
Sand, coarse, brown	25	25
Sand, fine, brown	62	87
Sand, coarse, brown	10	97
Sand, fine, brown	3	100
Well 48N 26W 23AC1		
Altitude: 1310		
Sand	13	13
Sand, grsvel, clay	24	37
Sand and gravel	2	39
Bedrock	1	40
Twp 48 North, Range 28 West		
Well 48N 28W 32DA2 (Diorite)		
Altitude: 1570		
Loam and hardpan	15	15
Sand, fine, silty, and clay	20	35
Sand, medium, some silt	14	49
Bedrock	1	50
Twp 48 North, Range 29 West		
Well 48N 29W 30CC1 (Well 1)		
Altitude: 1580		
Sand, very fine to fine, red, silty and dirty	5	5
Sand, fine to coarse, some very fine gravel, silty	10	15
Sand, very fine to coarse, some fine gravel	5	20
Sand, very fine to medium, some fine and medium gravel, reddish brown	15	35
Sand and sandy clay, sand appears separate from sandy clay as two layers. Sand dirty, and very fine to coarse	5	40
Gravel, clean, sandy	8	48
Sand, clean, some fine gravel	4	52
Sand, very fine to coarse, clean	12	64
Sand, very fine to fine, some clay balls	6	70
Sand, very fine to fine, clean	25	95
Sand, fine to medium, some coarse gravel, clean	5	100
Sand, very fine to fine, clean	2	102
Sand, very fine, some gravel, with clay balls	4	106
Sand, very fine, very clayey	4	110
Sand, fine, dirty, with fine gravel	3	113
Sand, very fine to coarse, with fine gravel, clean	2	115
Sand, very fine to coarse, clean	2	117
Well 48N 29W 30CC1 (Well 1) (Continued)		
Sand, very fine to coarse, dirty	3	120
Sand, very fine to fine, a little very fine gravel	3	123
Sand, very fine to fine, a little clay, dirty	2	125
Well 48N 29W 30CC2 (Well 2)		
Altitude: 1580		
Organic deposits	5	5
Sand, fine to medium, light brown	5	10
Sand, very silty, light brown	10	20
No sample	5	25
Sand, medium to coarse, some silt, light brown	5	30
Sand, medium, some coarse, and gravel, fine, light brown	5	35
Sand, fine to medium, light brown	5	40
Sand, very fine to medium, light brown	5	45
No sample	5	50
Sand, medium, light brown	10	60
Sand, fine to medium, light brown	5	65
Sand, medium to coarse, light brown	5	70
Gravel, high percentage of sand and silt, dark brown	5	75
Gravel, silty, dark brown	5	80
Silt, 25 percent gravel, dark brown	5	85
Silt, some medium to fine sand, dark brown	5	90
Bedrock, slate	2	92
Well 48N 29W 30CC3 (Well 3)		
Altitude: 1560		
Soil	2	2
Sand, medium, high percentage gravel, some silt, light brown	8	10
Sand, medium to coarse, 25 percent gravel, tan	10	20
Sand, medium to coarse, some gravel, light brown	5	25
Sand, medium to coarse, rounded to subrounded, some fine gravel, light brown, some red, black and pink	13	38
Sand, fine to medium, some coarse, trace silt, trace fine gravel, light brown	8	46
Sand, fine to medium, some coarse, light brown	2	48
Sand, very fine to medium, some coarse, a few large (1-3 mm) angular quartzite fragments, light brown	7	55
Sand, fine to medium, light brown	5	60
Sand, fine to medium, some coarse, some fine gravel, light brown	5	65
Well 48N 29W 30CC3 (Well 3) (Continued)		
Sand, very fine to coarse, light brown	5	70
Sand, fine to coarse, light brown	5	75
Sand, very fine to medium, some coarse, light brown	5	80
Sand, very fine to fine, some medium, trace silt, tan	15	95
Sand, very fine to medium, light brown	5	100
Sand, very fine to medium, some coarse, light brown	10	110
Sand, fine to medium, some coarse, light brown	5	115
Sand, very fine to coarse, light brown	5	120
Well 48N 29W 30CC4 (Well 4, 5 feet south of well 3)		
Altitude: 1560		
Samples collected only from zone in which screen was to be set		
Gravel, fine to medium, high percentage of sand and silt, black	2	136
Gravel, fine to medium, high percentage of sand and silt, black	2	138
Gravel, mostly fine, sand is light brown, about 30-40 percent sand, black	2	140
Gravel, fine to medium, sandy, black	2	142
Sand, fine to medium, 20 percent fine to medium gravel, some silt, light brown	2	144
Gravel, high percentage sand and silt, light brown	2	146
Well 48N 29W 30CC5 (Well 5)		
Altitude: 1560		
Sand, medium	5	5
Sand, medium to coarse, and fine gravel	10	15
Sand, medium	15	30
Sand, fine	10	40
Sand, very fine to silty, gray	15	55
Sand, fine	10	65
Sand, fine to medium	15	80
Sand, fine, gray	20	100
Sand, very fine, gray	15	115
Sand, very fine to silty, gray	24	139
Ledge	1	140
Mica schist, gray	20	160

Table 7.--Lithologic logs of materials from selected wells--Continued

	Thick-ness	Depth to bottom
Twp 48 North, Range 29 West (Continued)		
Well 48N 29W 31CCD1 (Well 6)		
Altitude: 1690		
No sample	24	24
Sand, coarse, and gravel, fine	9	33
Sand, very coarse, and gravel, fine	6	39
Sand, very coarse,	22	61
Gravel, fine	8	69
Sand, coarse, and gravel, fine	61	130
Ledge	1	131
Mica schist, gray	14	145
No sample	50	195
Well 48N 29W 31DB1		
Altitude: 1690		
Sand	8	8
Gravel	3	11
Slate, broken	21	32
Mixed sand and gravel	3	35
Slate, broken	28	63
Clay	39	102
Slate, broken	7	109
Slate	1	110
Twp 48 North, Range 30 West		
Well 48N 30W 21CA1		
Altitude: 1600		
Boulders, sand and clay	3	3
Clay and boulders	4	7
Clay, boulders, and gravel	5	12
Clay, boulders and sand	4	16
Gravel, clay and boulders (hardpan)	8	24
Clay, fine sand, and boulders	13	37
Gravel and clay (hardpan)	4	41
Twp 49 North, Range 26 West		
Well 49N 26W 2CB1		
Altitude: 740		
Clay and sand	21	21
Sandstone, red	56	77
Well 49N 26W 12DD1		
Altitude: 605		
Clay, gravel, and rocks	15	15
Sandstone, red	11	26
Clay or soft shale, white	1	27
Sandstone, red	39	66
Twp 50 North, Range 26 West		
Well 50N 26W 19BB1		
Altitude: 750		
Sand and gravel	24	24
Sandstone, red	75	99
Twp 50 North, Range 27 West		
Well 50N 27W 14BA1		
Altitude: 750		
Sand and clay	20	20
Sandstone, red	76	96
Well 50N 27W 14AB1		
Altitude: 740		
Clay and gravel	18	18
Sandstone, red	74	92
Twp 51 North, Range 27 West		
Well 51N 27W 1CA1		
Altitude: 640		
Sand	2	2
Clay and rocks (hardpan)	9	11
Sandstone, brown	15	26
Sandstone, red	100	126
Well 51N 27W 9DA1		
Altitude: 700		
Glacial deposits	29	29
Jacobsville Sandstone, fine grained, well sorted, some clay	601	630
Granite, no fracturing	53	683
Well 51N 27W 15BD1		
Altitude: 620		
Topsoil and sand	8	8
Sand and gravel	21	29
Sand, coarse, and gravel, clean	18	47
Sand, medium fine, and small gravel, clean	12	59
Sand, fine, muddy, streaks of red clay	14	73
Sand, coarse, and coarse gravel, very clean	9	82
Sand, coarse gravel, tight formation	9	91
Sand, coarse gravel, not as tight as above	11	102
Sand, fine, muddy, reddish brown	3	105
Clay, sticky, brown, static water level 14 ft.	9	114
Sand, fine, muddy	19	133
Sand, medium, some gravel, clean, static water level 14 ft.	11	144
Sand, medium, some gravel	12	156
Sand, medium	4	160
Sand, medium, streaks of clay, very muddy	8	168
Sand, fine, muddy, streaks of clay	6	174
Well 51N 27W 14AA2		
Altitude: 630		
Sand	27	27
Sandstone, red	60	87
Twp 51 North, Range 28 West		
Well 51N 28W 1BA1 (Gate)		
Altitude: 628		
Sand	15	15
Muck	5	20
Sand	30	50
Gravel	5	55
Twp 52 North, Range 28 West		
Well 52N 28W 21DB1 (Water System)		
Altitude: 620		
Sand and gravel	100	100
Sandstone	100	200
Well 52N 28W 27CB1 (Club Farm)		
Altitude: 630		
Clay and gravel	65	65
Sand	10	75
Quicksand	20	95
Sandstone	40	135
RECENTLY INSTALLED WELLS		
Well 48N 26W 35BAB1 (Well 1)		
Altitude: 1290		
Sand and gravel, gravel is fine	23	23
Sand, fine to coarse	48	71
Clay, red, some gravel, gravel is fine	101	172
Sand and gravel	2	174
Sand, coarse, some gravel	10	184
Sand, very fine, silty	11	195
Well 48N 26W 35BDB1 (Well 2)		
Altitude: 1285		
Sand and gravel	23	23
Sand, clay streaks	49	72
Clay, red, sand streaks	42	114
Sand, fine	8	122
Sand, coarse, and medium gravel	30	152