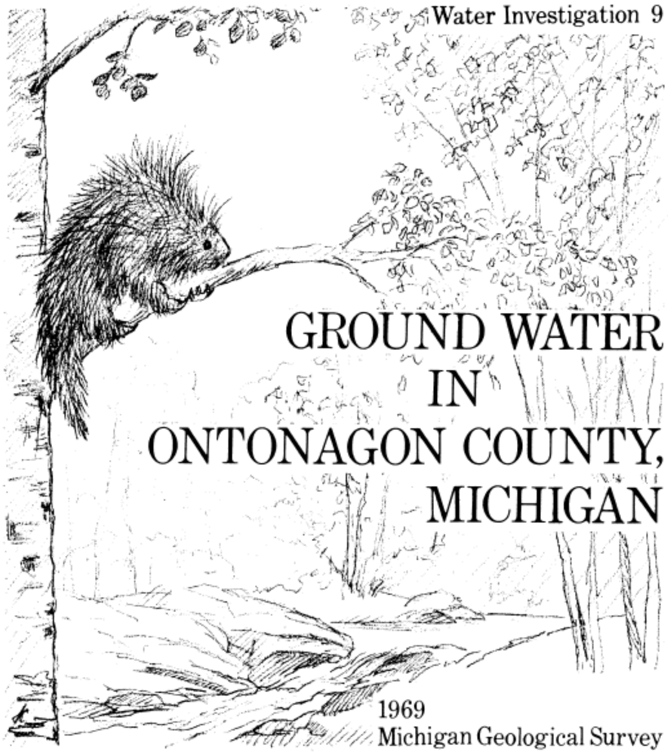

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
Geological Survey

Water Investigation 9
GROUND WATER IN ONTONAGON COUNTY, MICHIGAN

by
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Prepared in cooperation with the Geological Survey
United States Department of the Interior

May 1969

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Figure 1. Ontonagon County, in west end of Michigan's Upper Peninsula.

PREFACE

The purpose of this report is to provide information needed in the search for water supplies from wells or springs in the county.

For many years the state and federal geological surveys have cooperated in producing basic information on water resources in Michigan. This report is one product of that continuing program and was made possible by the assistance of county agencies, municipalities, industrial concerns, well drillers, and many other people in Iron County.

The basic statistics covering well records and chemical analyses are included in the Appendix at the rear of the report.

A. E. Slaughter, of the State Geological Survey, prepared the section on geology and topography. Also, the entire report was reviewed by Mr. Slaughter, and by Mr. Norman Billings, of the State Water Resources Commission.

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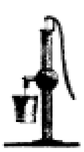
May 1968

ABSTRACT

Most wells in Ontonagon County obtain water1 from glacial lake beds or from bedrock. Deposits of glacial till and out-wash also yield water to domestic wells in a few parts of the county. The lake beds supply enough water for domestic use to many wells, but more than half of the wells in the county are drilled into bedrock to obtain a satisfactory supply. Wells yielding large supplies of several hundred gallons per minute are unknown in this county. Water from most wells is hard to very hard, and many wells yield water that contains objectionable amounts of iron. Water from the deeper wells in bedrock, especially near Lake Superior, is generally too salty for domestic use.

INTRODUCTION



The ground-water resources of Ontonagon County are not abundant, but several townships and most rural residents obtain satisfactory water supplies from wells and springs. In some areas, several wells may be drilled before an adequate supply of good quality is obtained.

This report summarizes data on representative wells and springs and describes the geologic features controlling the quality and quantity of water from wells. Supplementing the text are maps featuring bedrock geology, and glacial geology, topography of ground water based upon geologic interpretations, and, in the rear pocket, hydrologic data for selected wells.

Descriptions of municipal water supplies are included as permanent records needed in evaluating effects of future developments. Data on other wells and springs are included in the Appendix.

Well Numbering System

The well numbering system used in this report relates well location to the rectangular system of land subdivision with reference to the Michigan meridian and base line. The first two parts of a well number designate township and range; the last part designates both the section and well number within the section. Thus 49N 42W 20-2 is well number two in section 20, Township 49 North, Range 42 West.

Geography

Ontonagon County is in the western end of the Upper Peninsula of Michigan. It is the third largest county in the state, having a land area of 1,321 square miles. The county is served by Federal Highway 45 and State Highways 26, 28, 35, 64, and 107. The 1960 census showed a population of 10,584 of which 45 percent reside in the White Pine-Ontonagon area. Most of the remainder live along highway M-28 and in the Mass-Greenland area.

Copper and forest products are the county's principal industries. Since 1845 about 100 mines have produced copper. At present only White Pine mine is operating, and is the largest employer in the county. Hoerner - Waldorf Corporation's paper mill at Ontonagon is the largest wood-user and second largest employer in the county.

About 160 operating farms occupy less than 10 percent of the county's total area. Livestock and dairy products account for most of the farm income.

Tourism and recreation increase in value each year. The chief tourist attraction is the 60,000-acre Porcupine Mountains State Park. In addition to the scenic mountains in the county, there are 21 lakes, 26 trout streams, 9 waterfalls, and 4 named rapids to attract tourists. The area has some of the finest ski hills in the midwest which, coupled with a mean annual snowfall of 105 inches, give this area the potential for an increasingly important winter sports business.

Geology and Topography

About two-thirds of Ontonagon County is underlain by rock formations of Precambrian age (fig. 2). The remaining area, occupying most of the southern part of the county, is underlain by the Jacobsville Sandstone. The age of the Jacobsville has not been clearly identified. It may be late Precambrian or early Paleozoic. The oldest rocks, occurring in the southernmost tier of townships, are largely granite gneiss, undifferentiated metamorphosed sediments, and volcanics. Somewhat younger Precambrian formations, comprising the bedrock of the northern half of the county, are either igneous rocks or unmetamorphosed sandstones and shales.

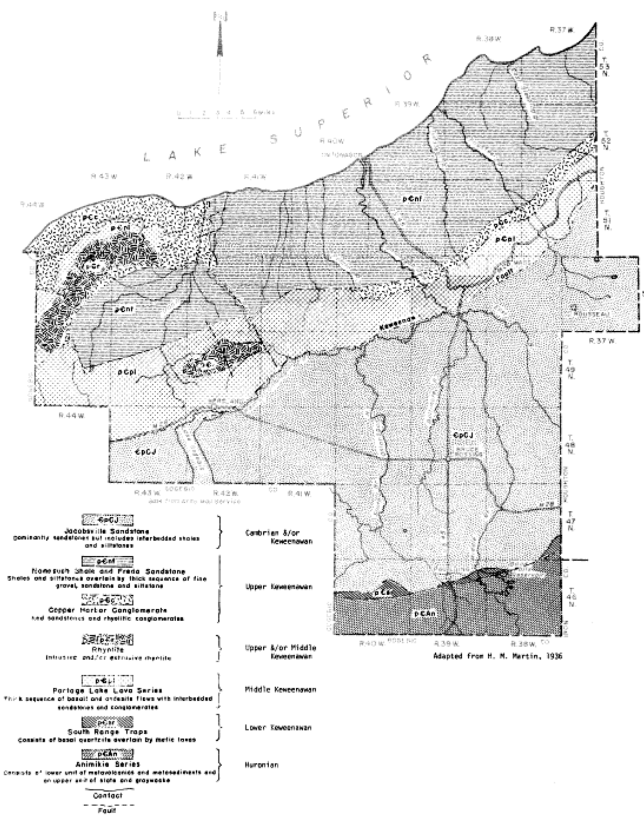


Figure 2. Bedrock geology of Ontonagon County, Michigan.

The bedrock strongly influences the topography of the overlying glacial materials. The prominent topographic features are the Porcupine Mountains in the northwest area and the Trap Range running northeast-southwest across the middle of the county (fig. 4). Both areas contain numerous outcrops. The rock formations of the Trap Range are largely basalt flows. They form a high ridge with steep-sided bluffs in some areas. Interbedded with these lava flows are sandstones, shales, or conglomerate formations, all dipping in a northerly direction. The Keweenaw fault, a major geologic feature, marks the southern boundary of this sequence of rocks. Movements of several thousand feet have occurred along the fault in the geologic past.

The Porcupine Mountains rise sharply from the shore to elevations of as much as 1300 feet above the level of Lake Superior. They are composed of ancient lava flows, sandstone, shale, and conglomerate.

Though generally poor aquifers, the rock formations of Ontonagon County have yielded large tonnages of native copper, particularly in the vicinity of Mass, Greenland, Rockland, and Victoria. Native copper is no longer mined here. Copper is now extracted from a sulfide ore in the Nonesuch Shale at White Pine. Modern production substantially exceeds earlier production.

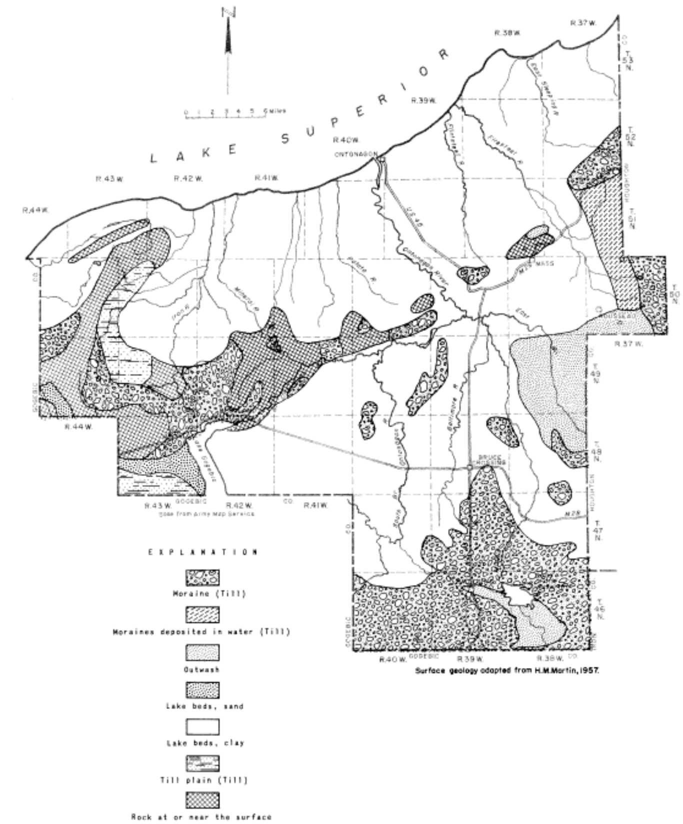


Figure 3. Glacial Geology of Ontonagon County, Michigan.

Unconsolidated glacial materials overlying the bedrock surface vary in thickness up to more than 300 feet. Holes drilled in the vicinity of mines and observations along deeply entrenched streams, indicate that the buried bedrock surface is very irregular. These irregularities, however, are masked by the relatively even surface of the overburden.

The surficial features are mainly abandoned lake plains composed of sediments deposited in the higher ancestral stages of Lake Superior (fig. 3). These old lake sediments, generally red or reddish brown, are mostly clay or sandy clay. Beneath them is glacial till interbedded with still earlier lake deposits. Heavy clayey boulder till occurs in a narrow morainic belt parallel to the Trap Range. A part of the Marenisco Moraine crosses the southernmost part of the county.

Outwash plains and valley trains of stratified sands and gravels constitute only a minor part of the surficial deposits. The largest area of outwash is located along the east boundary south of the Village of Mass and extends into western Houghton County. It is associated with the Keweenawan morainic system. Also, at the north end of Lake Gogebic, a channel, probably containing outwash deposits, extends west into Gogebic County. The outwash is covered by lake beds and swamp deposits. This channel served as a drainageway for Lake Ontonagon, one of the former glacial lakes.

Drainage

Ontonagon County is drained by the Ontonagon River and its tributaries and by several smaller streams, all of which empty into Lake Superior. The Presque Isle River drains a small part of the western edge of the county.

The West Branch of the Ontonagon drains Lake Gogebic, the flow being controlled at the lake outlet. The flow of the South Branch of the Ontonagon is regulated to some extent at Cisco Lake. The Middle Branch is regulated by Bond Falls Reservoir.

The rivers of Ontonagon County are cut into lakebed sediments for the most part, although some of the headwater streams cut into bedrock. The silt from the lake beds causes the rivers to be more turbid than most northern Michigan rivers, even during low flow.

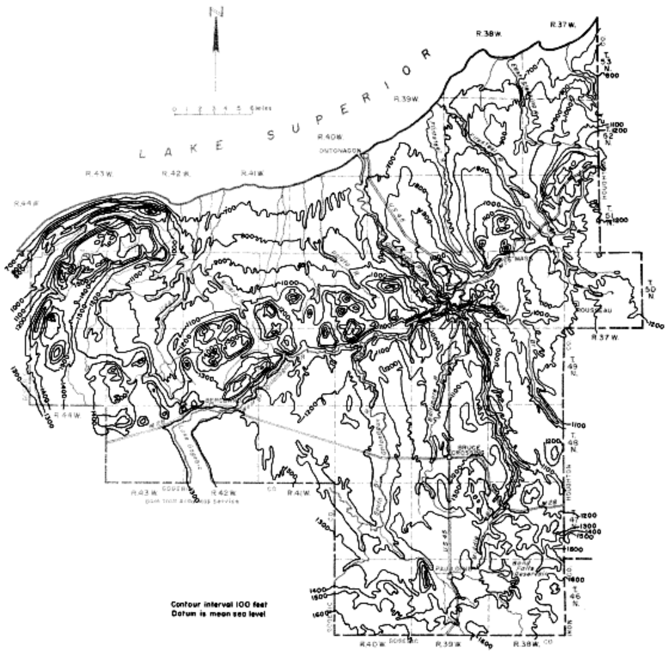
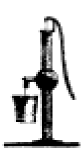


Figure 4. Topography of Ontonagon County, Michigan.

AVAILABILITY OF GROUND WATER

Ground water supplies are by no means abundant in Ontonagon County. Wells yielding large supplies (several hundred gallons per minute) are unknown, and in .some areas it is almost impossible to obtain even the small supply needed for domestic use. Nevertheless, most of the rural residents obtain satisfactory domestic water supply from wells. The quantity, quality, and number of attempts before successfully completing a well, vary from one area to another. Plate I shows the location, depth, water-bearing formation, and yield of most of the wells inventoried for this study. Figure 5 (opposite) shows only the general availability of ground water over broad areas. Yields of wells and quality of water may vary widely over short distances. Tables 1 and 2 summarize information on representative wells and springs; table 3 lists drillers logs of wells; table 4 provides data on well yields, and table 5 lists field analyses of water from wells.



Wells

Most ground-water supplies in Ontonagon County are obtained from drilled wells 4 to 6 inches in diameter and 50 to 300 feet deep (table 1). A few wells are more than 400 feet deep. About 60 percent of the wells visited were completed in bedrock. Small-diameter drive points supply a few homes and hunting camps with small amounts of water. In areas where the glacial drift consists of clay and silt with low permeability many households are supplied by large-diameter dug wells. Most dug wells are between 10 and 20 feet deep; some very shallow dug wells yield water of such poor quality that it is not used for drinking or cooking.

Wells obtaining water from bedrock usually are cased through the drift and a few feet into the underlying rock, with the remainder of the hole left open. Wells obtaining water from glacial drift usually are cased from the top down to the most productive beds -- generally sand or gravel -- and screened through the productive materials. Where earth materials are relatively impermeable silt, clay, or bedrock, dug wells are more successful than drilled wells. The large wall areas of dug wells provide greater area for percolation into the well, and the storage capacity of the dug well makes it possible to utilize a relatively small inflow. Driven wells are little used in Ontonagon County because the glacial drift in most places is not permeable enough to yield adequate water to a well point. Driven wells are impossible in bedrock.

Springs

Most of the springs visited had been developed by enlarging the discharge area and installing a short length of culvert, or building a wood or stone cribbing to prevent collapse of the sides and to provide storage. These springs generally are only 3 or 4 feet deep and yield less than 2 gpm (gallons per minute). One large spring, discharging 10 gallons per minute through the overflow, has a concrete block cribbing protected by a fly and animal-proof concrete block building. A few large springs remain undeveloped. Although many springs are in the county, most ground-water supplies are obtained from wells. Use of springs is restricted because many large tracts contain no springs, and where springs do occur they may not be located conveniently for the intended use.

Aquifers

The aquifers (water-bearing formations) of Ontonagon County are in both glacial drift and bedrock.

Glacial Aquifers

Glacial aquifers supply water to about 40 percent of the wells. Most of the wells in the glacial drift obtain water from beds of sand and gravel, but dug wells may obtain small a-mounts of water from silt or silty clay. Thickness of the glacial drift ranges from a few feet to more than 300 feet.

<u>Lakebeds</u> comprise about two-thirds of the surface of the county (fig. 3). These deposits consist of alternating layers of clay, sandy clay, silt, and some sand. The layers of sand generally are thin and may pinch out in short distances. Most drilled wells in lakebeds obtain water from sand layers, but dug wells may obtain small amounts of water from layers of clay and silt.

Beach sand along the shore of Lake Superior formerly provided the public water supply for the village of Ontonagon, and such deposits may yield moderate supplies in other shore line areas. A deeper deposit of beach sand, buried by younger deposits, is a potential aquifer at Ontonagon and possibly in other areas.

Low permeability of the lakebeds retards movement of ground water so that salty water is not rapidly diluted or flushed out. As a result, some of the deeper wells in lakebeds yield water moderately high in chlorides, but still satisfactory for domestic use. Troublesome amounts of iron are also present in many of the wells.

Drilling a well in lakebeds to obtain a domestic water supply is a gamble at best. To predict the thickness and extent of sand beds is impossible. If beds of sand are penetrated below the water table, the well usually will supply enough water for household use. However, if only silt and clay are penetrated the well probably will yield very little water. If the first hole drilled is a failure, another well at some distance from the first may succeed. In some instances, where the sediments are silt and clay, a dug well has a greater wall area for inflow. Where several attempts to obtain water from lake beds are unsuccessful, wells are generally drilled into the underlying bedrock.

<u>Till</u> areas mapped as moraines and till plains are underlain chiefly by deposits of till. Till varies greatly in composition from place to place. Very sandy till may provide large amounts of water to wells, but silty or clayey till may yield little or no water. The till deposits in the southeast part of the county yield moderate supplies of water to most wells at depths less than 100 feet. The thin mantle of till over bedrock in the highlands areas north and northwest of Bergland probably would yield very little water to drilled wells, although dug wells in stream valleys may obtain enough for domestic supply.

<u>Outwash</u> sand and gravel of adequate thickness is one of the most productive of all aquifers, but outwash areas are few and small in Ontonagon County. The deposits extending southeastward from Paulding yield moderate supplies of water to a few wells, and probably could yield large supplies (more than 600 gmp) to large-diameter wells. Another larger area of outwash south and southeast of Rousseau also yields moderate supplies to a few wells and may be a favorable prospect for future large supplies of ground water.

Bedrock Aquifers

Because the glacial drift is unsatisfactory as a source of water over much of the county, about 60 percent of the wells are drilled into bedrock. Drilling into bedrock, however, does not insure a satisfactory supply. Inadequate supplies or salty water may be obtained in many places. The surface of the bedrock beneath the drift is very irregular. One well may penetrate more than 100 feet of glacial drift before reaching bedrock, whereas another nearby may penetrate bedrock at a depth of only a few feet. Water in bedrock generally occurs in fractures; yields depend on the number and size of fractures penetrated. The first 50 feet of bedrock under the drift are most likely to yield a moderate supply. At greater depths open fractures are rare, yields are smaller, and salty water is more likely to be encountered. Areas of bedrock outcrop usually are not favorable for obtaining water, but shallow wells dug into bedrock in valleys may yield small supplies.

<u>Jacobsville Sandstone</u> underlies the glacial drift in most of the south half of the county (fig. 2), and yields small to moderate supplies of fresh water. Most rock wells in this area are more than 100 feet deep and several are more than 300 feet. The water is generally of satisfactory quality, but many yield water with objectionable quantities of iron.

<u>Freda Sandstone and Nonesuch Shale</u> underlie the glacial drift in most of the northern third of the county. The sandstone beds yield fresh water to many shallow wells, but the deeper wells generally yield water too high in chlorides for domestic use. Near Lake Superior, most wells more than 75 feet deep yield salty water; farther south, most wells less than 150 feet deep yield fresh water. Many of the wells yield water containing objectionable quantities of iron. Most wells yield enough water for a domestic supply, but in some instances drilling more than one hole was necessary for obtaining a satisfactory supply.

<u>Lava flows</u>: The bedrock exposed in the Porcupine Mountains and the Trap Range consists largely of ancient lava flows with interbedded sandstone, shale, and conglomerate. These highland areas generally are unfavorable for obtaining water from wells. However, some deep drilled wells near Mass and a few shallow wells near Bergland yield moderate supplies. The water from some of the deeper wells is salty and very hard, and some is high in iron content.

<u>Other Precambrian Rocks</u>: The oldest rocks in the county, which underlie the southernmost tier of townships, are not generally tapped for water because the overlying glacial drift is generally satisfactory.

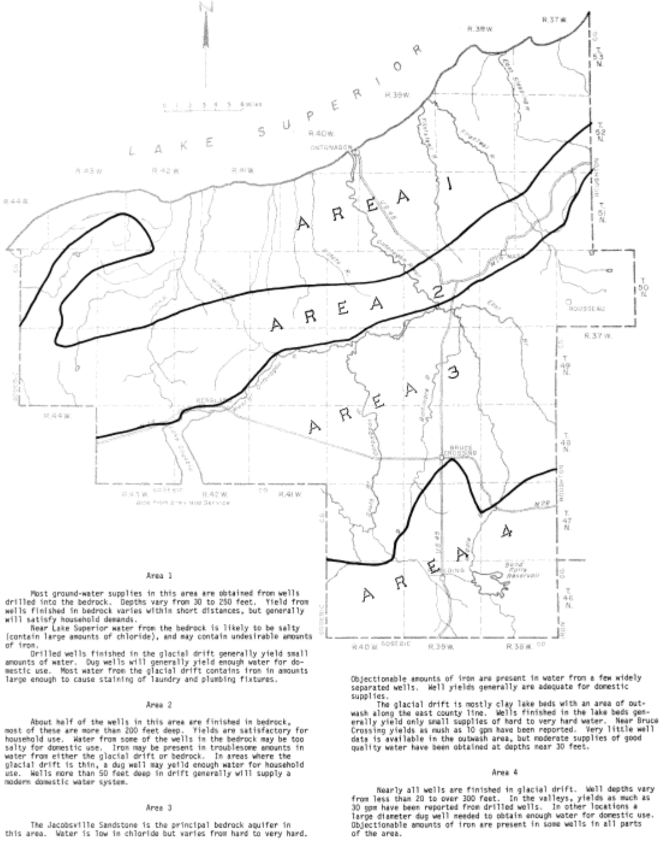
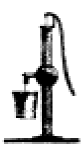


Figure 5. Availability of ground water in Ontonagon County, Michigan.

QUALITY OF WATER



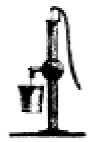
Water obtained from most wells in Ontonagon County is suitable for household use and most other uses (table 5). However, the water is generally hard to .very hard, ranging from 65 to 650 mg/l (milligrams per liter) and many wells yield water too hard for successful treatment by conventional domestic water-softening methods. Salt water (high in chlorides) is a problem in many of the deeper wells in bedrock, especially near Lake Superior.

The quality of water in streams at times of low flow reflects the general quality of ground water in shallow aquifers, because almost all the water in the streams at these times is derived from ground water. Water from streams in Ontonagon County generally is relatively soft (15 to 85 mg/l) and low in dissolved solids, as indicated by specific conductance (table 6). The water in shallow aquifers is much softer and lower in dissolved solids than water in the deeper aquifers -- especially the bedrock aquifers. Iron is not normally a problem in surface waters, but samples from two of the rivers indicated objectionable amounts of iron. The dissolved oxygen content of water from most streams ranged from 8.6 to 11.0 mg/l, which is in the normal range for this area. A sample from Merriweather Creek contained only 614 mg/l.

Water from lakes having surface outlets is similar to streams, although somewhat softer and lower in dissolved solids (table 7). Water from lakes without outlets is extremely soft and low is dissolved solids, suggesting that these lakes have a significant amount of outflow leakage.

WATER DEVELOPMENT

Municipal Supplies



Ground water is not used in any large municipal water supply in Ontonagon County. Several townships supply water from wells to consumers in unincorporated towns and a few privately owned wells supply several household and commercial establishments. Some townships are contemplating additions to their water systems. These public and quasi-public supplies are described below.

Rockland Township

Rockland Township furnishes water to about 100 customers in the town of Rockland. A dug well 14 feet in diameter and 20 feet deep supplies about 37,000 gallons per day. The system includes an electric pump set at 17.5 feet below the pumphouse floor and a stand-by gasoline-powered pump set at 19 feet. Water is pumped to a 147,000 gallon underground storage reservoir on a hill east of town. Altitude of the reservoir is about 180 feet above Rockland's main street. Pressure in the gravity-feed system is 85 to 90 pounds per square inch. Each customer's water consumption is metered. Chlorine is added to the water at the pumping station.

Present production well 50N 39W 9-2, constructed about 1900, recovers from 4 feet of drawdown in 2 hours. In July 1963 test well 50N 39W 9-1 was drilled a short distance north of the existing well, but did not produce enough water to justify further development. Results of chemical analysis of untreated water from well 50N 39W 9-2, and the log of well 50N 39W 9-1 follow:

Driller's Log

50N 39W 9-1, test hole, abandoned
SE¼SE¼
Altitude: 1180
Drilled 1963

	Thickness of Unit	Bottom of Unit
Sand, red-brown, very fine-grained, silty with sand, fine to medium	9	9
Sand, very fine to medium, silty, very slight trace of gravel, medium	6	15
Gravel, medium, trace of coarse,	3	18

silty		
Gravel, pea sized to medium, trace of coarse, silty	3	21
Gravel, medium, silty	10	31
Ledge at 31 ft.		

Chemical Analysis*
(milligrams per liter)

Iron (Fe)	0
Chloride (Cl)	6.0
Hardness ($CaCO_3$)	230
Fluoride (F)	0
pH	7.4

* Michigan Dept. Public Health, 1963

Interior Township

Interior Township supplies water to about 60 customers in the town of Trout Creek. The water system consists of three wells, widely spaced within the town, with pneumatic pressure tanks and about three-fourths of a mile of pipeline. No water treatment is provided. Neither pumpage nor water consumption are metered; consumers pay a flat monthly rate.

Well 47N 38W 12-1 (Twp. well No. 1) located at the Trout Lake School, was drilled in 1915. This is a 6-inch flowing well, 300 feet deep equipped with a 3-horsepower jet pump. Well 47N 38W 14-1 (Twp. well No. 2) supplies the Milltown section of Trout Creek. This is a 6-inch well 215 feet deep drilled in 1953, equipped with a 2-horsepower jet pump. Well 27N 38W 12-2 (Twp. well No. 3) supplies the Redtown area. This is a 6-inch screened well 185 feet deep equipped with a jet pump. Test pumping for 1 hour at 30 gpm (gallons per minute) resulted in 10 feet of drawdown. Wells number one and three have stand-by pumps for emergency use.

Driller's Log

47N 38W 14-1 (twp. well No. 2)
NE¼NE¼
Altitude: 1180
Drilled 1953

	Thickness of Unit	Bottom of Unit
Sand and clay	170	170
Coarse sand	45	215

47N 38W 12-2 (twp. well No. 3)
SW¼SW¼
Altitude: 1170
Drilled 1955

Sand and clay	160	160
Fine sand	25	185

Chemical Analysis*

	Twp. No. 1	Twp. No. 2	Twp. No. 3
(milligrams per liter)			
Total solids	114	112	102
Silica (SiO_2)	14	13	14
Iron (Fe)	0	0	0
Manganese (Mn)	0	0	0
Calcium (Ca)	26	27	23
Magnesium (Mg)	8	7	7
Sodium (Na)	2.1	2.1	2.1
Potassium (K)	0.6	0.6	0.6
Nitrate (NO_3)	2	1.7	4
Chloride (Cl)	3	3	3
Sulfate (SO_4)	0	0	0
Bicarbonate (HCO_3)	122	124	104
Carbonate (CO_3)	0	0	0
Hardness ($CaCO_3$)	96	98	86
Fluoride (F)	0	0	0
pH	8.1	8.0	8.2
(micromhos per centimeter at 25° C.)			
Specific Conductance	180	180	180

* MDPH. Sample collected 11-16-65

Ontonagon

Although the village of Ontonagon now uses water from Lake Superior a brief history of its past problems with ground-water supplies is given here.

In 1895 the village constructed its first municipal water system. A log cistern 30 feet in diameter was built under the Lake Superior beach to collect water seeping through the sand. This intake worked only until the swelling logs sealed off the flow.

In the same year a 12-inch pipe was extended 200 feet into Lake Superior with the intake in about six feet of water. Prevailing west winds moved silt-laden water from the mouth of the Ontonagon River to the intake.

By 1905 the village, concerned about the red silty water, began a search for a more suitable supply. Springs were located within the village and a brick cistern 30 feet in diameter was constructed over them. Chlorine was added to the water from 1922 to 1927 probably as a result of an outbreak of typhoid fever in 1922.

By 1927 water demand exceeded production from the springs and a test drilling program was initiated resulting in two gravel-pack wells 90 feet deep. As years passed water from these wells increased in hardness and a strong odor of hydrogen sulfide developed.

During 1949 an infiltration gallery with 236 feet of 18-inch perforated tile was built under the Lake Superior beach. When the lake was frozen to the bottom far enough off shore to lower the rate of infiltration into the gallery, ground water having a high iron content migrated upward into the gallery. During prolonged periods of extreme freezing, water from the gallery contained as much as 8.0 mg/l of iron.

In mid 1965 a new pumping station and 30-inch pipeline extending 3,000 feet into Lake Superior was put into operation. About 800 customers are served by the system. The filtration plant has a capacity of 750,000 gpd (gallons per day) but daily pumpage averages only 300,000 gallons. Water used by consumers is metered and water bills sent out quarterly.

Hoerner-Waldorf Corporation's paper mill uses 19 to 20 thousand gallons of treated water and 4 to 5 million gallons per day of raw water making them the city's largest water user.

McMillan Township

McMillan Township maintains a water system in the town of Ewen that supplies about 80 customers. The system consists of well 48N 40W 26-1, a 20,000-gallon underground storage reservoir and a 2,000-gallon underground pressure tank.

The well is 473 feet deep with 5-inch casing to 206 feet. When completed in 1960, this well flowed at a pressure of 12 pounds per square inch, it is now equipped with a 3-horsepower submersible pump which discharges into the storage reservoir. Water is repumped into the pressure tank for distribution to water mains. No treatment is provided. Pumpage is not metered; consumers pay a flat monthly rate.

Chemical Analysis*
(milligrams per liter)

Iron (Fe)	0.1
Chloride (Cl)	1.0
Hardness ($CaCO_3$)	100.0
Fluoride (F)	0.4

* Mich. Dept. Public Health, 1961

Driller's Log

<u>48N 40W 26-1</u>
NW¼SW¼
Altitude: 1140
Drilled 1960

	Thickness of Unit	Bottom of Unit
Clay	186	186
Shale	20	206
Sandstone	267	473

Bergland Township

Bergland Township operates a water system in the town of Bergland. Two wells 49N 42W 33-1 and -2, about 30 feet apart, supply water for the 126 customers. Both wells are 8-inch casings 26 feet deep with 10-foot screens set in glacial drift. Centrifugal pumps on both wells discharge into a 5,500-gallon pressure tank. No treatment is provided. Pumpage is not metered; customers pay a flat monthly rate.

Field Chemical Analysis*
(milligrams per liter)

Sulfate (SO_4)	10
Alkalinity (as $CaCO_3$)	32
Bicarbonate (HCO_3)	39
Hardness (as $CaCO_3$)	55
Iron (Fe)	0.1
Chloride (Cl)	40
pH	7.4
(micromhos per centimeter at 25° C.)	
Specific Conductance	235

* U. S. GEOLOGICAL SURVEY, 1967

Driller's Log

<u>49N 42W 33-3</u>
SW¼SW¼
Altitude: 1360
Drilled 1957

	Thickness of Unit	Bottom of Unit
Sand	5	5
Clay and sand	17	22
Clay	4	26
Clay and sand	6	32
Clay, gravel and sand	20	52
Gravel and sand	3	55

White Pine

White Pine Copper Company maintains a 36-inch pipe line 5½ miles long to supply water from Lake Superior to the town of White Pine and the copper mining and processing complex at White Pine mine. Water for use in the town and for domestic use at the mine receives standard filtration treatment plus the addition of fluoride.

Bruce Crossing

Bruce Crossing does not have a municipal water system, although several private wells in town serve more than one household or business. None of the owners measure pumping rates or amount of water pumped. A few of these wells are described here. Chemical quality of water is shown in table 5.

Well 48N 39W 21-1, owned by Vern Hemming, is a flowing well 310 feet deep finished in sandstone. A shallow well jet pump and pressure tank supply water to 12 houses. Maintenance expense is shared by the water users.

Ontonagon Valley Creamery Association owns well 48N 39W 21-2 which supplies water used in the creamery plant and office. A pipeline enables five nearby business places to draw water from the creamery for emergency use. This is an 8-inch well 482 feet deep finished in sandstone. A 3-inch turbine pump is set 165 feet below the plant floor; during non-working hours the well flows 18 gpm into a storage tank.

Well 48N 39W 28-1 is owned by T. A. Nordine and supplies his grocery store and about 25 houses. This is a 4-inch well 325 feet deep finished in sandstone. When completed in 1947 it flowed 15 gpm; in 1967 the rate of flow could not be determined. A one-third horsepower jet pump and pressure tank supply the distribution system.

Upper Peninsula Power Co. at Victoria

The Upper Peninsula Power Company owns the townsite of Victoria near its Victoria Reservoir and generating plant. Three power company employees and their families occupy company-owned houses which receive water from the company's distribution system. This system, as well as the town, was much larger when copper mines in the area were producing.

About 1907 the mining company that owned the mines and townsite developed three closely spaced springs by enlarging and deepening their discharge areas and installing short lengths of 36-inch tile with concrete covers. Water from the springs is piped to a concrete collector 12 feet square by 10 feet deep, then pumped through a mile of 2-inch pipe to an elevated storage tank at the townsite. No treatment is provided.

The three springs were considered as one source and numbered SON 39W 29-1. Chemical quality of water from this system is shown in the following table.

Field Chemical Analysis*
(milligrams per liter)

Hardness ($CaCO_3$)	136
Iron (Fe)	0.2
Chloride (Cl)	5
pH	7.9
(micromhos per centimeter at 25° C.)	
Specific Conductance	340

* U. S. Geological Survey, August, 1967

Parks

Several campgrounds and roadside parks have wells, but some have no water supply because they are located in areas where ground water is difficult to obtain or is of poor quality. Two campgrounds maintained by the U. S. Forest Service have good ground-water supplies.

Paulding Pond Campground and Picnic Area has two wells, 46N 39W 15-1 and 15-2 finished in sand. Both are equipped with handpumps and yield adequate amounts of good quality water (tables 4 and 5).

Well 50N 37W 4-1 supplies good quality water to the Courtney Lake Campground. This well is 316 feet deep finished in sand. A submersible pump and a pressure tank supply water to hydrants in the campground and picnic areas.

Ontonagon County Park, on the west side of Lake Gogebic, receives its water from well 48N 43W 13-1 which is 61 feet deep finished in sandstone. Water from this well is very hard (306 mg/l) but otherwise of good quality.

Well 51N 37W 31-1, which furnished water at a roadside picnic table alongside M-35 near Lake mine, is a diamond drill hole drilled during copper exploration about 1927. It is reported to be about 1500 feet deep. About three-quarters of a gallon of water per minute flows from a pipe extending two feet above land surface. This water is rather poor quality having 279 mg/l of hardness and 500 mg/l of chloride.

Well 53N 37W 13-1, owned by Bohemia Township, is a flowing well at the Misery Bay School site. Water is piped to an outlet at the edge of the road right-of-way. Yield is about 2 gpm from a pipe extending two feet above land surface. Water is of good quality, and many residents of the area use it for drinking and cooking because safe potable water is difficult to obtain in this area.

Porcupine Mountains State Park

Springs supply the water used in that part of the park situated in Ontonagon County. At the main campground a large spring has been developed. A 5-horsepower pump is used to distribute water through 2-inch mains to the various outlets.

Another spring supplies water for the buildings at the ski area.

At the picnic grounds near the abandoned because of the poor quality water.

Driller's Log

51N 42W 15-1
NE¼
Altitude: 615
Drilled 1947

	Thickness of Unit	Bottom of Unit
Clay	18	18
Sandstone	4	22
Clay, seam, very little water	0' 10"	22' 10"
Sandstone	103	125' 10"
Seam in sandstone	4' 2"	130
(Highly mineralized water at 125 feet)		

Household Supplies

In the northern part of the county 4- to 6-inch drilled wells tap Precambrian sandstone for most household water supplies. In some cases two or three attempts were made before water of suitable quality was obtained. Most wells are equipped with electric pumps. Many families have large-diameter dug wells that supply adequate amounts of water from the glacial drift. Some supply enough water to operate a modern home water system. However, water from some dug wells is not suitable for drinking or cooking, and water for these must be obtained from another source. Some small springs have been developed and water piped to the buildings.

Most domestic wells in the central area are drilled in sandstone, but glacial drift is also an important aquifer. In the Trout Creek area deep wells in sand and gravel flow above land surface.

The glacial drift in the southern part of the county contains more sand and gravel than in the north. In the south domestic wells are usually 4- to 6-inch drilled wells finished in sand and gravel, but some householders have driven their own wells using 1 1/4- to 2-inch casing and drive points. Nearly all have electric pumps and pressure systems.

Camps and Cabins

Many hunting and fishing camps are located where electricity is not available. Hand pumps are generally used on drilled or dug wells. Some cabins, especially in the north, do not have wells because the expense of drilling is not justified. A few cabin owners have developed springs on their property.

Motels and Resorts

Throughout most of the county motels and resorts obtain water from drilled wells. However, businesses located along the Lake Superior shore, west of Ontonagon have a variety of water sources, including intakes in Lake Superior, dug wells, drilled wells and drivepoints. Supplies of good quality water large enough to operate a motel or resort are difficult to obtain in this area.

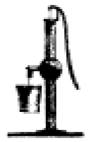
Irrigation

Irrigating with ground water is not known in Ontonagon County. Some strawberry and apple growers use ponds fed by surface runoff during periods of deficient rainfall, and to combat late spring frost.

Water Power

Upper Peninsula Power Company operates a generating plant on the West Branch of the Ontonagon River near Victoria. A dam on the West Branch, where it leaves Lake Gogebic, controls the lake level and regulates the a-mount of water flowing into the reservoir at Victoria. Part of the water which is stored in the Bond Falls Basin is diverted through a flume into tributaries of the South Branch of the Ontonagon River which enters the West Branch above Victoria Reservoir.

SUMMARY



The aquifers of Ontonagon County generally produce only small amounts of water. Glacial aquifers are chiefly beds of sand in glacial lake beds, although sand and gravel in outwash and moraine yield water to wells in a few small areas.

Of the bedrock aquifers, the Jacobsville Sandstone in the southern part of the county generally is a reliable producer of small a-mounts of fresh water. The Freda Sandstone and Nonesuch Shale yield small amounts of fresh water to many shallow wells in the northern part of the county, but deeper wells usually yield salt water. The lava flows and associated rocks of the highlands yield water to a few wells, but water from deeper wells is apt to be salty and very hard.

Ground water is not used for public supplies in any large municipal water supply, but several townships supply water from wells to unincorporated communities.

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