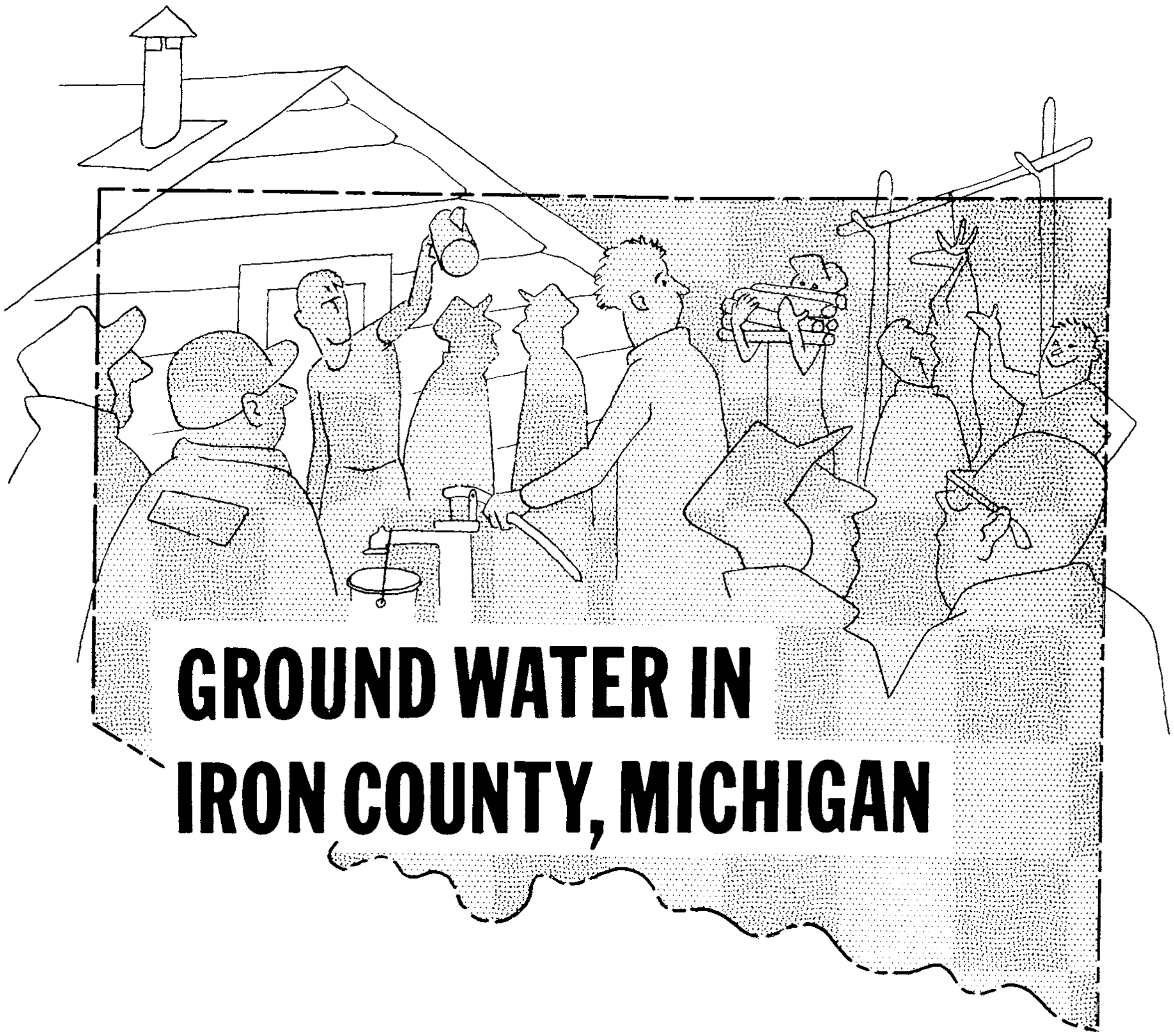
Water Investigation 7



GROUND WATER IN IRON COUNTY, MICHIGAN

Geological Survey, 1967

ABSTRACT

The ground-water resources of Iron County are unevenly distributed but adequate for present needs. Wells yielding several hundred gallons per minute can be developed in glacial outwash areas along streams. On the other hand, in upland areas, a well yielding only a few gallons per minute may be difficult to develop. Most well water in the county is moderately hard to hard, and some areas contain objectionable amounts of iron. All public water supplies are obtained from ground water. Maps showing data-collection sites and glacial deposits are included.

Geological Survey

WATER INVESTIGATION 7

GROUND WATER IN IRON COUNTY, MICHIGAN

by

C. J. Doonan and G. E. Hendrickson

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

Lansing 1967

STATE OF MICHIGAN
George Romney, *Governor*

DEPARTMENT OF CONSERVATION
Ralph A. MacMullan, *Director*

GEOLOGICAL SURVEY DIVISION
Gerald E. Eddy, *State Geologist and Chief*

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PREFACE

This report was prepared as part of a continuing program conducted by the Water Resources Division of the U.S. Geological Survey, in cooperation with the Geological Survey Division of the Michigan Department of Conservation.

The assistance and cooperation of many individuals connected with industry and with federal, state, and county government made this report possible. State Survey geologist A. E. Slaughter, was especially helpful in defining the geology of the county. Harry Kleinman and Wesley Tuomenon furnished data on many wells. Norman Billings, Assistant Executive Secretary of the Water Resources Commission and John Rulison, geologist in charge of the water resources section of the State Geological Survey, reviewed the report. State Survey geologist Robert W. Kelley assisted with editing.

The geologic map was adapted from one prepared by Professor Stanard Bergquist in 1932. Slight modifications were made in extending glacial landforms into municipal areas.

Escanaba and Lansing

June, 1966

Charles J. Doonan and Gerth E. Hendrickson

United States Geological Survey

ILLUSTRATIONS

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In rear pocket:

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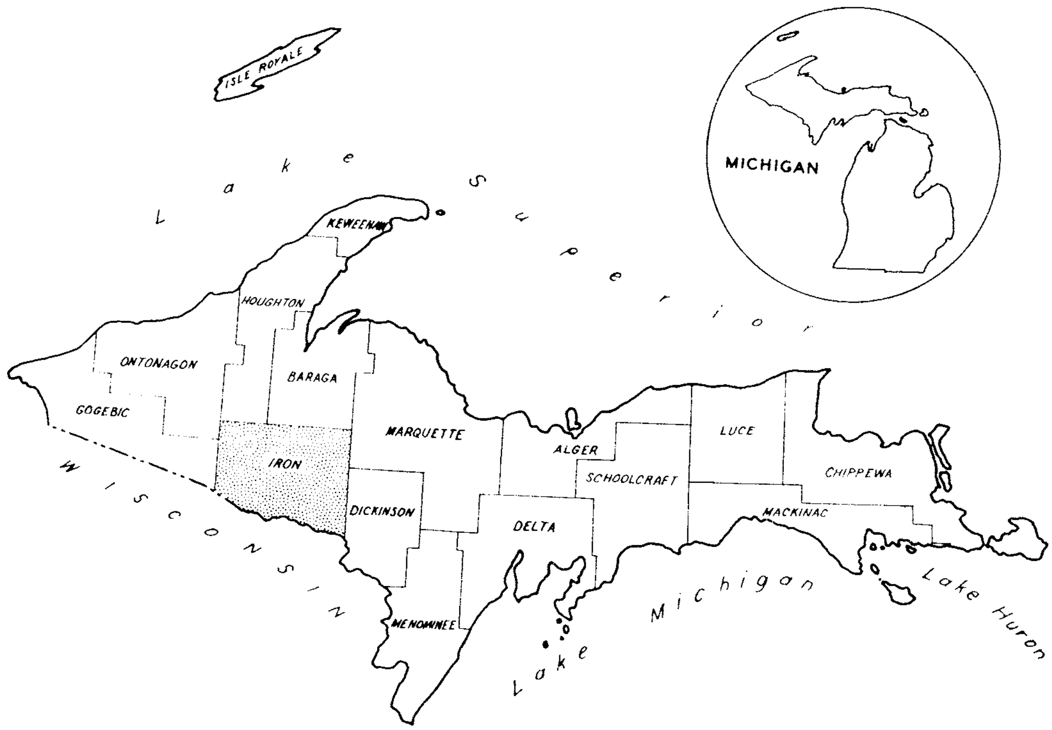
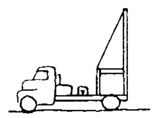


Figure 1. Location map.

GROUND WATER IN IRON COUNTY

by C. J. Doonan and G. E. Hendrickson



INTRODUCTION

The ground-water reservoir that supplies wells and springs and keeps the streams flowing during rainless periods is neither uniform nor continuous. In some areas of Iron County wells may yield several hundred gpm (gallons per minute); in other areas the few gpm needed to supply a family may be difficult or impossible to find. The purpose of this report is to provide information for developing water supplies from wells or springs.

Data on representative wells and springs is summarized, and geologic and hydrologic conditions that cause varying yields are explained. The availability map in the rear pocket should be particularly helpful in the search for a water supply from wells. The map is based on an interpretation of well data and Bergquist's detailed geologic map. The description of municipal water supplies provides a permanent record of the present situation for comparison with future developments. The basic statistical data obtained in this study is included in the Appendix. Sites where basic data was obtained are marked on map 1.

The method of numbering wells in this report is based upon the original federal linear land surveys. Thus, 41N 31W 10-1 is well number 1 in section 10, of Township 41 North and Range 31 West (principal base and meridian for Michigan).

Geography

Iron County is in the western part of the Upper Peninsula of Michigan (fig. 1). Its total area of 780,200 acres includes about 29,000 acres of water and 700,000 acres of forest land.

Most of the people and industries are concentrated in cities and towns along US-2 in the southern part of the county. From 1940 to 1960, the total population declined from 20,243 to 17,184.

The area is served by federal highways 2 and 141, and state highways 69, 73, and 189, as well as a network of secondary roads maintained by the county. Common carrier service is provided by 2 railroads, 10 truck lines and 1 bus line.

- Economy -

Iron ore was discovered in the county in 1851, but the first mine did not begin operations until 1881. By 1929 twenty-three mines were operating; by 1965 only 4 mines were operating with a total employment of about 1,000 men.

Lumbering is an important factor in the economy. The first logging operations began soon after the county was surveyed during the 1850's. Of the 50 manufacturers listed in 1958, 36 were engaged in logging or processing wood products.

Agriculture is confined mostly to the southern part of the county. The 1890 census showed only 32 farms. By 1930 the total had grown to 801. By 1959 the number had dropped to 300 farms occupying only 6.2 percent of the land area of the county.

Recently tourism has become important. Resorts have been developed on many lakes, and on some rivers. According to C. J. D. Brown (1944), the county has about 900 miles of streams and about 500 natural lakes.

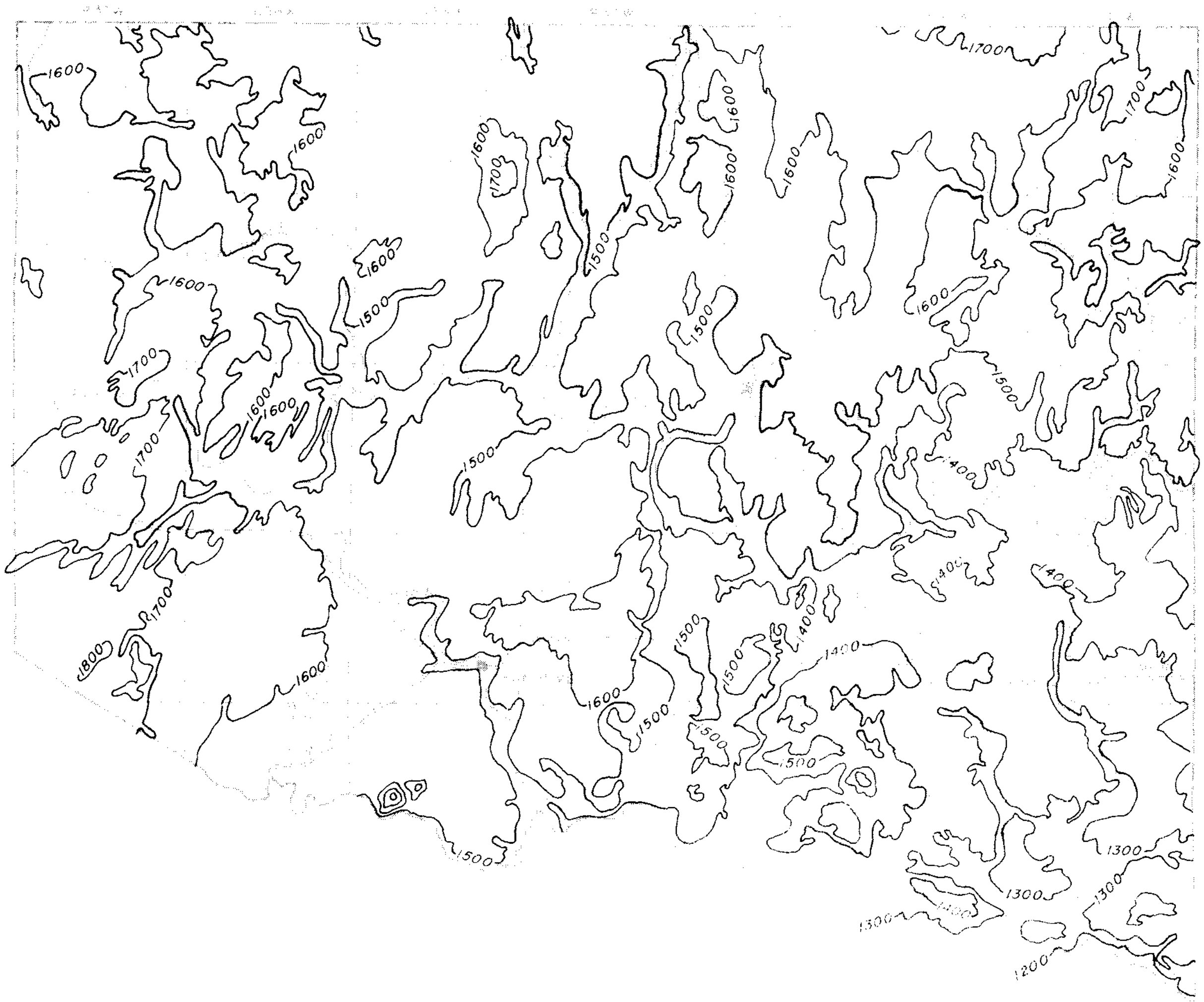


Figure 2. Topographic map.

A number of parks and campgrounds, ranging from primitive to modern, cater to tent and trailer dwellers. Also, the number of winter sports enthusiasts is increasing. Continued expansion of the resort business requires development of additional ground-water supplies as well as the preservation of the water quality of lakes and streams.

- Climate -

Total precipitation in Iron County averages about 31 inches annually. About two thirds, falls during the six months from April through September. Winter precipitation is mostly snow, much of which remains until spring. In an average year about 12 inches of precipitation runs off in streams while the remaining 19 inches is lost by evaporation and transpiration.

The mean January temperature is about 15° F. (Fahrenheit) and the mean July temperature is about 67° F. Mean annual temperature is about 42° F., a few degrees cooler than the temperature of water obtained from most of the wells. April is the first month having a mean temperature above freezing. Greatest snowmelt usually occurs then or in early May.

Geology

The topography of Iron County is directly related to the glacial deposits covering more than 90 percent of the area. Wherever the drift is thin or absent, the topography is controlled by the bedrock. The glacial deposits consist of sand, gravel, silt, clay, cobbles and boulders. The relief and composition of the glacial deposits are controlled by the method of deposition. The greater part of the landscape is characterized by rolling to rugged hills. Low relief is generally limited to alluvial valleys along streams and the outwash plain southeast of Crystal Falls (fig. 2).

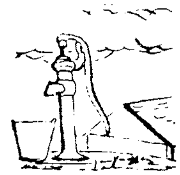
The only extensive outwash plain is a 50-square mile area south and southeast of Crystal Falls (map 2). Most of the other sand and gravel deposits are confined to relatively narrow belts along the major streams, described thus by Bergquist:

> "The valleys of the Paint, Iron, Deer, Fence and Michigamme rivers serve to illustrate the disposition of these features. They were formed, apparently, during the stage when the ice was receding northward by melting. Fast-flowing melt waters draining onto the preglacial valleys served to scour out part of the glacial debris which had been left in the wake of the receding ice-sheet. The coarser materials, such as boulders, erratics and large cobbles, were not carried away by the water, but were concentrated by the removal of the finer till. These remnant boulders may now be observed along the older valley slopes and at the base of the gravel deposits where excavations have been made.
>
> The gravel and sand which make up the bulk of the material in the deposits were no doubt carried in by rapidly flowing, sediment-choked waters issuing from the receding ice border. The preglacial valleys, which received these waters, were partly, but not completely, filled with coarse material, owing to the fact that the ice margin was receding quite rapidly. When the ice-sheet had retreated sufficiently far to the north to diminish the supply of sediments for the valleys, depositional activity was materially diminished and erosional work initiated. During post-glacial times the rivers have continued to scour out the sediment and to sink their channels deeper into the deposits. Till the present, however, the streams have not cut through the material to encounter bedrock, except in very few places where the glacio-fluvial deposits were originally exceedingly thin."

- Bedrock -

Bedrock is exposed in a north-south belt along the Michigamme River east of Crystal Falls and in smaller areas elsewhere (map 2, pocket). The bedrock is entirely of Precambrian age and consists chiefly of hard and dense metamorphic and volcanic rocks. Outcrops occur in steep, rugged hills protruding through the glacial mantle, or, where streams have cut through the drift. Many outcrops have been rounded and polished by glacial abrasion.

GROUND-WATER RESOURCES



Water in the subsurface zone of saturation is called ground water. All water in this zone available for water supply constitutes the total ground-water resources. The upper surface of this saturazed zone is called the water table, unless the water is confined under pressure below impermeable material. Moisture occurs in the soil and rock above the water table, but this water generally cannot be recovered by wells. Beneath the water table, all openings are filled with water. In glacial sediments the openings consist of inter-granular spaces in sand, gravel, silt, and clay. In the Precambrian rock the openings are chiefly fractures. Any formation storing ground water and capable of transmitting it to wells and springs is an aquifer.

Recharge of ground-water reservoirs comes chiefly from percolation of rain and snowmelt into the zone of saturation. Recharge also occurs from streams where the level of the stream is above the water table. In Iron County, this situation probably occurs only where the water table has been lowered by pumping. The amount of recharge depends largely on the topography, soils, and underlying rock. In flat outwash areas recharge may reach ten inches a year or more; in steep bedrock areas, perhaps less than one inch.

Ground water moves slowly from areas of recharge (input) toward areas of discharge (withdrawal). In Iron County most discharge is to streams. Some is discharged to lakes and swamps, and some is used through evapotrans-piration in vegetation.

Storage

The amount of ground water stored in aquifers depends on recharge and discharge. During the spring snowmelt the rate of recharge greatly exceeds the rate of discharge, and water levels in shallow wells rise (fig. 3). In the summer, when growing vegetation uses most of the rainfall, recharge is exceeded by discharge, and water levels decline. Unusually heavy rains may cause a temporary rise before the decline sets in again. In the fall, after much of the vegetation becomes dormant, but before the ground is frozen, water levels may rise again. The fall rise, when it occurs, is much smaller than in the spring. In winter most of the precipitation remains on the ground as snow, and water levels drop until spring thaws. The response of water levels in deep wells to changes in recharge may be delayed several months.

Water levels fluctuate yearly as well as seasonally. In wet years water levels rise, and in dry years decline (fig. 3). However, other factors, such as the time of year when precipitation falls and the rate of snowmelt in the spring also affect the rate of recharge, and consequently, water levels. Summer rains generally are less effective than spring rains in recharging ground-water reservoirs. If the snow melts rapidly in the spring while the ground is still frozen, much of the water runs off, relatively little reaching the water table. A retarded rate of melting on unfrozen ground, on the other hand, is favorable to recharge.

Ground-water records in unpumped areas of Iron County over the past 20 years do not indicate any long-term rise or fall of water levels.

Relation to Surface Water

During dry periods stream flow is derived chiefly from ground-water discharge. Normally movement of water is from aquifer to stream, but water

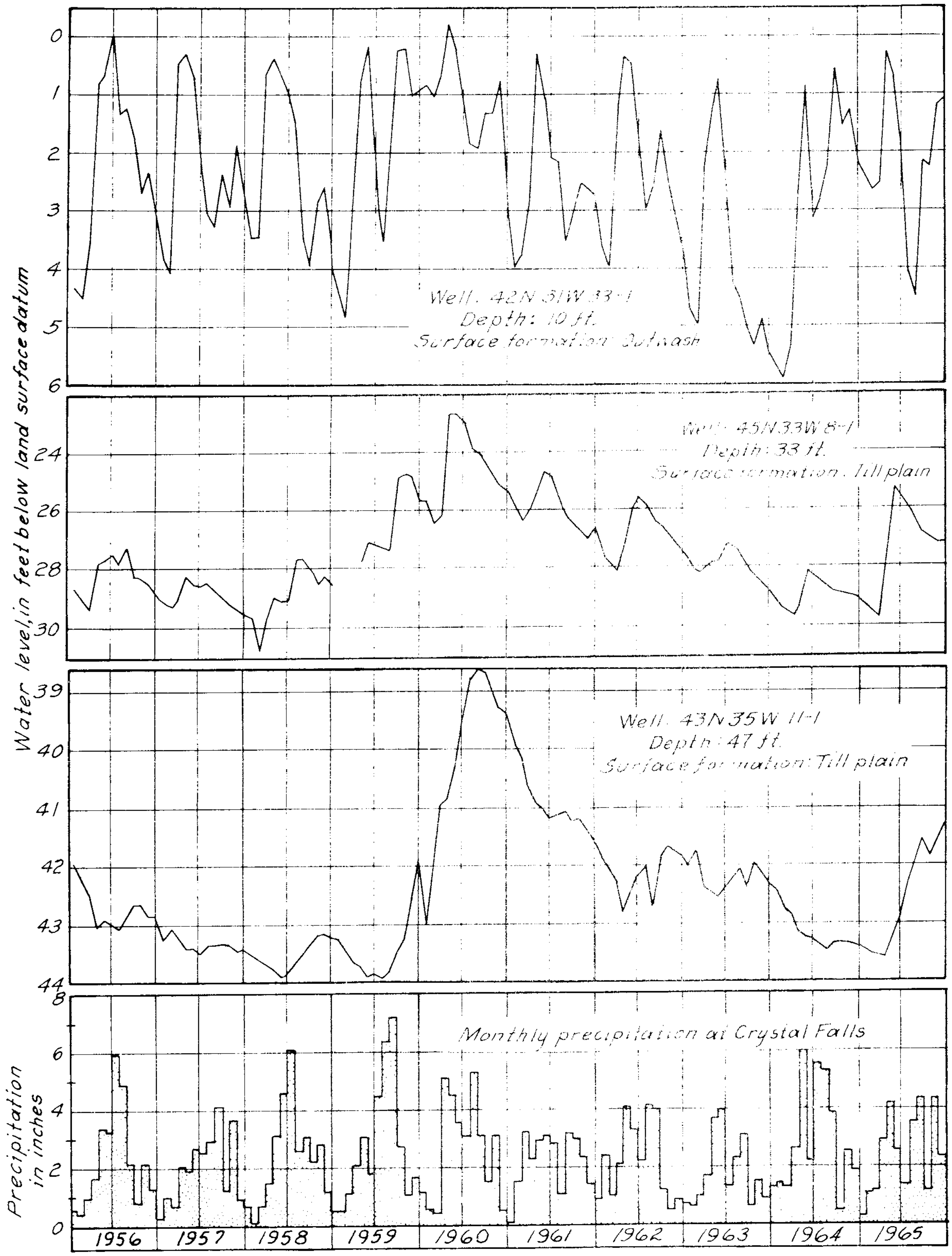


Figure 3. Fluctuations of ground-water levels.

may also move from stream to aquifer, especially where water levels near the stream are lowered by pumping from wells. In such cases large quantities of water may sometimes be obtained from wells with only moderate drawdown because the reservoirs are replenished at the expense of the stream. Most of the high-production wells in Iron County are near major streams. Some of these wells may obtain recharge from the streams. The amount of water moving from stream to aquifer depends upon the permeability of the river bottom and the aquifer, the distance from the well to the stream, and the amount of water pumped. A clay layer between the river bed and the aquifer greatly reduces recharge from the river.

The relationship of ground-water reservoirs to lakes is more complex. Lakes drained by streams generally are replenished to some extent by ground-water inflow. Some lakes without surface outlets have a ground-water inflow on one side and ground water outflow on another. Lakes having lower dissolved solids than nearby wells and streams probably are recharged chiefly by rain and snow. Pumping wells near lakes may induce recharge to underground reservoirs. The amount of water moving from lake to aquifer depends on the same factors as described for a river.

Availability

The Availability of Ground Water Map (in pocket) was prepared by relating well records to Bergquist's geologic map. The records include logs and well-yield data obtained from local drillers, water level data, chemical analyses, and other field observations. The map shows the quantity and quality of water generally available in various areas. Well yields are listed in Table 7 (Appendix). Chemical analyses, well logs, and other well data also are listed in the Appendix.

- Moraines -

Wells in morainic areas generally yield enough water for domestic supplies (at least 1 gpm), but some wells may fail because of thin or impermeable drift.

Most wells are 5 or 6 inches in diameter and less than 100 feet deep. More than half of the logs of wells in moraines indicate boulders at various depths. In three-fourths of the wells, hardpan was encountered. The location of some wells indicates more than one attempt was necessary before completing a successful well. Most wells in moraine are equipped with hand pumps, and very little data on yield is available. The few pumping and drawdown records available indicate most wells yield less than one gpm per foot of drawdown (table 7). Depth to water ranges from 3 feet in wells near streams or lakes to 133 feet in wells on hilltops.

The water from moraine wells often contains enough iron to stain fixtures and laundry (tables 1 and 2). Only one-third of the samples tested contained less than 0.3 ppm of iron; one-third contained more than 4.0 ppm. The water is generally hard; only a few samples contained less than 60 ppm of hardness. More than three-fourths were moderately hard to hard, but none were extremely hard.

- Till Plains -

Wells in till plains have varying small to moderate yields. Some of the township systems obtain adequate supplies from localized pockets of sand and gravel, but some domestic wells break suction after pumping only a few gallons. In some areas hardpan and buried boulders may prevent the use of drive points. Chances of obtaining an adequate domestic supply from a small-diameter well varies from place to place. In the southeast part of the county some wells penetrate the drift and obtain water from bedrock. Several attempts are sometimes required before a successful well is completed. Depth to water ranges from 9 feet in wells in low areas to 103 feet on hilltops. Most wells tested yield more than one gpm per foot of drawdown (table 7). However, the yield varies from 0.1 to 30 gpm per foot of drawdown. Larger yields are obtained from lenses of sand and gravel.

Most water samples tested had a low iron content, less than 0.3 ppm; only one contained as much as 4 ppm (tables 1 and 2). The water generally is quite hard; more than half of the samples were in the moderately hard to hard class, and one-fourth were very hard; a few were considered soft with less than 60 ppm of hardness.

- Outwash -

The outwash plains are the most favorable areas for obtaining large quantities of ground water. Large-diameter wells along stream valleys produce enough water for municipal or industrial purposes. In most places a small-diameter well equipped with a drive point will yield enough water for domestic use.

Specific capacities range from 0.1 to 28 gpm per foot of drawdown. Buried boulders may hamper drilling near the edges of till plains and, to a lesser extent, along the boundaries of moraines. Depth to water in wells along streams generally is less than 20 feet.

Well water is generally low in iron, but a few of the samples tested contained iron in excess of four ppm (tables 1 and 2). Three-fourths of the water samples analyzed for hardness were in the moderately hard to hard range; the remainder were very hard.

- Bedrock -

In the southeast quarter of the county, several wells obtain water from Precambrian bedrock covered by 75 to 200 feet of drift. A few test holes are used as domestic wells; one north of Fortune Lakes is over 500 feet deep. Water in bedrock usually flows to the well through fractures, and yields vary considerably. Fractures play out at depth, and few wells are drilled more than 100 feet into bedrock. Some will yield only one gpm; however, one well at a resort near the Michigamme Reservoir furnishes enough water for eight cottages. Most wells produce less than one gpm per foot of drawdown (table 7).

About two-thirds of the samples tested were low in iron, less than 0.3 ppm (tables 1 and 2). The remainder were mostly in the 0.3 to 2.0 ppm range. More than half the samples were in the moderately hard to hard class; the rest were very hard. None contained less than 60 ppm of hardness.

- Swamps -

In most of the swampy areas, a water supply suitable for a hunting camp or residence is available. Where swamp deposits are underlain by coarse sand and gravel, large municipal or industrial supplies could be developed.

- Springs and Ponds -

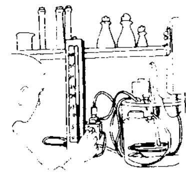
Natural springs are not numerous (Map 1, pocket). Most of those visited were in moraine or till plain and flowed at a rate of about 1 gpm. A sunken barrel or large-diameter tile is usually necessary to concentrate and direct the flow. One spring emerging from an outwash area bordering a small stream flowed about 30 gpm. It had been improved by sinking a 2-foot diameter curbing into the ground. Two 1¼-inch pipes carried the flow from this collector.

The U. S. Soil Conservation Service has assisted in developing several artificial ponds in the county (Map 1). In many of the ponds visited, springs not visible prior to construction were opened up after a few feet of earth had been removed. In some the flow is sufficient to prevent freezing of the pond. Size of ponds vary according to use, the topography of the site, and the amount of water available. Uses include fire suppression, fish raising, and stock watering.

Ponds developed in high water-table areas without springs sometimes become dry or nearly dry when the water table declines during drought periods.

Chemical analyses of water from springs and ponds are listed in tables 8 and 9. Samples ranged from soft to very hard; a few contained objectionable amounts of iron.

QUALITY OF WATER



The quality of water in wells, streams, and lakes influences their use. Public and domestic supplies should be relatively low in dissolved solids, should not be very hard, acid or alkaline, and should not contain objectionable amounts of iron. Concentrations of dissolved solids were not generally measured, but the specific conductance of water can be used as a general indicator of the total dissolved solids. Most waters having a specific conductance less than 800 (micromhos at 25° C.) have dissolved solids less than 500 parts per million (ppm). Waters containing less than 500 ppm dissolved solids generally are considered satisfactory for drinking and most other uses. Waters may be classified as soft (hardness less than 60 ppm), moderately hard (61 to 120 ppm), hard (121 to 200 ppm), and very hard (more than 200 ppm). The pH factor is an indication of acidity or alkalinity. A pH of 7 is neutral; a pH of less than 7 indicates acidity; more than 7, alkalinity. Very high or very low pH is undesirable. Very small concentrations of iron may be troublesome in water used for domestic supplies. As little as 0.3 ppm iron can cause staining of laundry and bathroom fixtures.

Chemical Analyses

Specific conductances of all waters tested in Iron County were less than 800 (tables 1, 2, 3, and 4), therefore concentrations of dissolved solids generally are not a problem.

Most water samples from wells were moderately hard to hard (tables 1 and 2), therefore softening generally is desirable. Water sampled from streams during the period of high flow in May, 1965, was much softer (table 3) than water from most wells. During relatively low stream discharge of summer, river water became moderately hard. Almost all lakes without surface outlets were very soft; whereas most lakes having surface outlets were moderately hard to hard (table 4).

Water from about 80 percent of the wells sampled was slightly alkaline with pH between 7.1 and 8.0. Water from the rest of the wells was slightly acidic, with a pH of 6.0 to 6.9. All but one of the samples from streams had a pH of 7.0 or more. The pH of almost all lakes having outlets also was greater than 7.0, but two-thirds of the lakes without outlets showed slightly acid waters.

About half the samples from wells contained more than 0.3 ppm of iron, so staining of bathroom fixtures and of laundry can be expected unless the water is treated for iron removal. Samples from streams and lakes were not tested for iron, but objectionable quantities of iron in these waters are rare unless the water is quite acid. However, samples of water from near the bottom of deep lakes may contain objectionable amounts of iron.

Dissolved oxygen normally does not occur in water from wells unless it has been absorbed in the pumping process. Dissolved oxygen in most streams and lakes of Iron County ranged from about 7 to 12 ppm (tables 3 and 4). This range is normal for unpolluted surface water in a cool climate. A sample from about 40 to 50 feet below surface at Golden Lake had no dissolved oxygen, and one from about 13 feet deep in Swan Lake had only 3.2 ppm. Dissolved oxygen in streams and near the surface of lakes generally shows a daily cycle during the warmer seasons. The oxygen given off by plant photosynthesis increases the dissolved oxygen during the daylight hours; at night the dissolved oxygen slowly declines.

In summary, the water from most wells, streams, and lakes in Iron County is satisfactory for domestic and most other uses. Standard treatment for softening and iron removal is desirable for most ground-water supplies.

Waste Disposal

At present some contamination is evident in lakes and streams in the southern part of the county. One source is septic tank effluent migrating into lakes and streams. In areas having a high water table ground-water supplies may also be affected.

Analyses of lake water by the Michigan Department of Health showed small amounts of coliform bacteria in shallow water near shore. The samples were all taken in the vicinity of cottages and resorts. As lake shore areas are developed, this problem resulting from inadequate septic tank systems will increase.

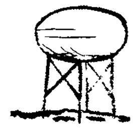
Some septic tanks drain directly into Iron River and Stanley Creek and into roadside ditches. Water samples collected by Iron County Health Department from ditches along U. S. 2 near Iron River contained large amounts of coliform bacteria. Some raw sewage was discharged into Hemlock River in the vicinity of Amasa.

All cities and villages, except Crystal Falls, provide some type of sewage treatment; Crystal Falls discharges untreated sewage into Paint River.

Mine drainage causes some discoloration of the Iron and Brule rivers. Although detracting from the natural beauty of the streams, this condition has not been found to damage fish life. U. S. Public Health Service, Michigan Water Resources Commission and Institute for Fisheries Research report fish, including trout, in these waters. Water pumped from the mine shafts is passed through settling ponds and diluted with ground water before entering streams.

Other industrial wastes are handled by either municipal or private treatment plants or systems.

WATER DEVELOPMENT



Public water systems, individual households, industries, resorts, parks, and camps in Iron County obtain their water supply from the ground. Surface water is used mostly for water power, recreation, and waste disposal. Management of these water resources is directed chiefly toward maintaining and improving well fields, preventing mine flooding, and maintaining adequate streamflow for water power and waste disposal. As water use demands become more urgent, maintaining lake levels, streamflow, and water quality for recreation could become a problem.

Other than a few springs used to supply camps and cabins, nearly all ground-water supplies are obtained from wells (table 5). Municipal wells generally are 8 inches or more in diameter; most domestic wells are 3 to 6 inches; most camp and cabin supply wells are 1¼ inches. Municipal and domestic wells usually are drilled by cable-tools; most camp and cabin wells are driven.

Most wells obtain water from sand and gravel in the glacial drift (table 6). A few wells obtain water from Precambrian bedrock. The most favorable areas for producing large quantities of ground water are areas of outwash deposits along the major streams. Least favorable areas are bedrock outcrops. In general, stream valleys and other low areas are more favorable sites than hilltops or hillsides, because the water table is nearer the surface. High areas underlain by permeable drift, however, are more favorable than low areas underlain by clay or bedrock.

Municipal Systems

A large part of the southern half of the county is supplied by public water systems operated by five cities, one village, and six townships. The main source of ground-water data in this report is derived from these systems, each of which is described next.

- Crystal Falls (city) -

This municipality furnishes water to about 1,000 customers in the city and adjacent areas. Prior to 1929 water was obtained from the Paint River. Water is now obtained from three closely-spaced drift wells, drilled in 1929. Wells No. 1 and No. 2 have 10-inch casings 90 feet deep; well No. 3 has a 10-inch casing 85 feet deep. All three wells are equipped with turbine pumps; well No. 1 has a capacity of 250 gpm, the pumps on wells No. 3 and No. 4 can deliver 400 gpm. A treatment plant has been added to the system to remove the iron. The well field is located on the north edge of town in a marshy area between a water-filled mine cave-in and a natural pond, probably sources of recharge. Water levels in two observation wells, about 200 feet from the pumping wells, fluctuate very little. In 1961 and 1963 several test holes were drilled, but no new production wells have been constructed.

	Total gallons	Maximum Day	Minimum Day
1963	185,796,100	930,000 (summer)	335,000 (winter)
1964	168,475,500		
1965	171,254,100		

Laboratory Analysis by Michigan Department of Health
(collected July 1965)

	Well No. 2	Well No. 3
Silica (SiO_2)	13 ppm	14 ppm
Iron (Fe)	1.0	1.5
Calcium (Ca)	38	35
Magnesium (Mg)	13	9.8
Sodium and Potassium (Na+K)	4.7	3.5
Chloride (Cl)	1.0	0
Sulphate (SO_4)	24	5
Bicarbonate (HCO_3)	161	161
Total Hardness ($CaCO_3$)	150	128
Fluoride (F)	0	0
Total Solids	190	154

A flowing well on the east edge of the business district, known as Crystal Mineral Spring, was drilled many years ago as an iron ore test hole.

Laboratory analysis by U. S. Geological Survey
(collected September 24, 1965)

	Well 43N 32W 29-1
Bicarbonate (HCO_3)	358 ppm
Carbonate (CO_3)	0
Sulphate (SO_4)	108
Chloride (Cl)	30
Nitrate (NO_3)	0.1
Hardness ($CaCO_3$)	416
Hardness (Noncarbonate)	122
Iron (Fe) Field test	0.1
Specific conductance (Micromhos at 25°C)	784
pH	7.5

Driller's logs of wells

Well No.: 43N 32W 21-6
Location: SE¼ SE¼ NW¼ sec. 21
Altitude: 1355 ft. m.s.l.
Drilled: 1963

Test hole 100 feet east of production well No. 3. Observation wells 43N 32W 21-4 and 43N 32W 21-5 were set in this test hole.

	Thickness	Depth
Peat, dark brown	5	5
Sand, tan, fine to medium, and some gravel, fine to pea size	5	10
Sand, tan, coarse, and gravel, fine to coarse	25	35
Sand, tan, medium, and gravel, coarse	5	40
Sand, tan fine, well sorted	25	65
Sand, tan, fine, some coarse grains, slightly silty	15	80
Sand, tan, coarse, with gravel, fine	11	91
Ledge at		91

Well No.: 43N 32W 21-7
Location: SE¼ SE¼ NW¼ sec. 21
Altitude: 1355 ft. m.s.l.
Drilled: 1963

Test hole 200 feet northeast of production well No. 3. Pipe pulled, all the favorable formations were above 43 feet which was considered to be too shallow for the development of a permanent well because of a probable hydraulic connection between the surface water and a well screen placed above 43 feet.

	Thickness	Depth
Muck, black	6	6
Sand, fine to coarse, and gravel, fine	2	8
Sand, very fine to fine, muddy	1	9
Sand, fine, muddy, and gravel streaks	3	12
Sand, fine to very coarse, and gravel, fine	6	18
Gravel, fine to coarse, with streaks of very coarse, and sand	3	21
Sand, gravel, and large boulders	2	23
Sand, fine to medium	5	28
Sand, fine to very coarse	15	43
Sand, very fine to fine	3	46
Sand, very fine, muddy	11	57
Clay, with sand streaks, muddy	20	77
Sand, fine to medium coarse, and streaks of gravel, fine	2	79
Boulders	4	83
Boulders and hardpan	9	92
Ledge at		92

Well No.: 43N 32W 28-1
Location: NE¼ NE¼ sec. 28
Altitude: 1350 ft. m.s.l.
Drilled: 1961

Test hole, pipe pulled.

	Thickness	Depth
Sand, tan, medium to coarse, with coarse gravel	5	5
No sample	5	10
Sand, tan, clean, medium grained	45	55
Sand, tan, coarse, and fine gravel	5	60
Sand, tan, medium grained, and coarse gravel	5	65
Sand, tan, fine grained	25	90
Sand, tan, very fine grained	5	95
Sand, tan, very fine grained, silty	7	102

Well No.: 43N 32W 28-2
Location: NE¼ NE¼ sec. 28
Altitude: 1350 ft. m.s.l.
Drilled: 1961

Test hole, pipe pulled, pumped at 150 gpm.

	Thickness	Depth
Sand, tan, medium grained	5	5
Sand, tan, medium to coarse; gravel, fine to coarse	5	10
Sand, tan, fine grained	5	15
Sand, tan, medium to coarse	5	20
Sand, tan, medium	20	40
Sand, tan, medium; gravel, coarse	5	45
Sand, tan, medium to coarse	15	60
Sand, tan, medium to coarse; gravel	10	70
Sand, tan, medium grained	5	75
Sand, tan, fine grained	15	90

Well No.: 43N 32W 28-3
Location: SE¼ NE¼ NE¼ sec. 28
Altitude: 1340 ft. m.s.l.
Drilled: 1956

Test hole, no water reported, pipe pulled.

	Thickness	Depth
Sand	90	90

- Iron River (city) -

This municipality supplies about 1,200 customers. The well field includes two large-diameter gravel-packed wells drawing water from the glacial drift near the Iron River on the north side of town. Well 43N 35W 26-3 (city well No. 1) drilled in 1952, has a 16-inch casing and is equipped with a turbine pump with a 650-gpm capacity and a 334-foot head. Well 43N 35W 26-2 (city well No. 2) drilled in 1947, has a 20-inch casing and is equipped with a 400-gpm turbine pump. Well No. 2 is used as a stand-by unit and can be operated by a gasoline-powered generator for emergency use in case of power failure. The amount of water pumped varies considerably.

	Total gallons	Maximum day	Minimum day
1963	126,080,000	605,000	344,000
1964	150,900,000	780,000	160,000
1965	139,132,000	705,000	254,000

Laboratory analysis by Michigan Department of Health
(city well No. 1, July 1959)

Silica (SiO_2)	16 ppm
Iron (Fe)	0.2
Calcium (Ca)	106
Magnesium (Mg)	45
Sodium and Potassium (Na+K)	6.5
Chloride (Cl)	8.0
Sulphate (SO_4)	220
Bicarbonate (HCO_3)	285
Total hardness ($CaCO_3$)	451
Fluoride (F)	0.1
Total solids	590

Field test by U. S. Geological Survey
(May 1965)

Specific conductance (Micromhos at 25° C)	700
pH	7.0
Iron (ppm)	0.25
Temperature (°F)	50

Driller's log of well

Well No.: 43N 35W 26-3 city well No. 1
Location: SW¼ NE¼ sec. 26
Altitude: 1480 ft. m.s.l.
Drilled: 1952

Log of test hole at site of city well No. 1. Test hole penetrated to 162 feet. Water clear above 145 feet. Below 145 feet water colored and undesirable.

	Thickness	Depth
Hardpan, boulders, large rock	32	32
Hardpan, boulders, streaks of coarse gravel	7	39
Hardpan and boulder	13	52
Medium coarse gravel, sand, and fine to medium gravel	13	65
Fine to medium sand, streaks of gravel	5	70
Coarse sand and gravel	9	79
Fine to medium sand and gravel, boulders	11	90
Fine to medium sand, streaks of coarse gravel	11	101
Medium sand, some boulders	12	113
Medium sand, coarse sand, fine gravel	17	130

- Stambaugh (city) -

This municipal water system serves 600 customers in and around the city. It consists of two wells drawing water from gravel deposits. City well No. 1 (43N 35W 25-1) drilled in 1938 has a 10-inch casing 81 feet deep and is equipped with an 8-stage pump having a 400-gpm capacity. This is a stand-by unit. Well No. 2 (43N 35W 25-2), drilled in 1962, has a 750-gpm turbine pump on an 8-inch casing 80 feet deep. On May 12, 1965, the water level in well No. 2 was 11.2 feet below land surface. A proposal to add fluoride to the water supply was approved by referendum on November 13, 1962. The chemical constituents of water from a test well drilled at the site of production well No. 2 are shown below.

Laboratory analysis by Michigan Department of Health
(collected October 1961)

Silica (SiO_2)	10 ppm
Iron (Fe)	0.3
Calcium (Ca)	62
Magnesium (Mg)	24
Sodium and Potassium (Na+K)	4.6
Nitrate	2.0
Chloride (Cl)	7
Sulphate (SO_4)	50
Bicarbonate (HCO_3)	244
Total Hardness ($CaCO_3$)	255
Fluoride (F)	0
Total solids	284

Field analysis well No. 2 by U. S. Geological Survey
(May 1965)

Specific conductance (Micromhos at 25° C)	460
pH	7.5
Temperature (°F)	46

Annual pumpage has varied little during the past three years

	Total gallons	Maximum day	Minimum day
1963	67,570,000	278,000	109,000
1964	62,650,000	250,000	100,000
1965	68,451,000	294,000	114,000

Driller's log of well

Well No.: 43N 35W 25-3
Location: SW¼ SE¼ NW¼ sec. 25
Altitude: 1480 ft. m.s.l.
Drilled: 1961

Test hole. City well No. 2 (43N 35W 25-2) was constructed at this site in 1962.

	Thickness	Depth
Sand, tan, fine to medium, show of gravel	5	5
Gravel, some sand, clean	15	20
Sand, tan, gravel, medium, clean	5	25
Gravel, fine to coarse; sand, fine to coarse, clean	10	35
Gravel, some sand, coarse	5	40
Gravel pea sized, with medium to fine, sand	5	45
Gravel, just above pea size, and fine to medium, and sand, clean	10	55
Gravel, larger than pea size, with pea size and medium to fine, and sand	5	60
Gravel, pea size, and above	5	65
Gravel, pea size and above with medium to fine, show of sand	5	70
Gravel, medium to larger than pea size	5	75
Sand, gravel, fine to medium, show of pea size	5	80

- Caspian (city) -

During 1965 this municipality supplied water to about 440 customers. The water comes from two drift wells. Production well No. 1 (42N 35W 1-1) is a dug well 52 feet deep by 30 feet square and was put into operation in 1927. Ten-inch casings were driven eight feet deep in two opposite corners and hooked to a four-piston pump. The unit has been tested at 240 gpm for eight hours. At the present time this well is maintained as a stand-by unit and will probably be abandoned because the concrete walls are crumbling.

Production well No. 2 (42N 35W 1-2), completed in 1957, is gravel-pack construction with a 48-inch outer casing and an 18-inch inner casing. Total depth is 65 feet. The turbine pump has a 400-gpm capacity. The test well at this site was pump-tested in July, 1957. Prior to the test the static water level was 23 feet below land surface. After pumping two and one-half hours at 243 to 480 gpm, the level dropped to 39 feet. After an additional six and

and one-half hours pumping 480 gpm, the level held at 39 feet. Thirty seconds after cessation of pumping the level returned to 25 feet, only two feet below static level. The water is free of iron and moderately hard.

	Total gallons	Maximum day	Minimum day
1963	117,220,000	340,000	210,000
1964	88,910,000	520,000	220,000
1965	108,151,570	445,200	117,800

Laboratory analysis by Michigan Department of Health
(collected July 1959)

Silica (SiO_2)	14 ppm
Iron (Fe)	0
Calcium (Ca)	39
Magnesium (Mg)	15
Sodium and Potassium (Na+K)	3.6
Chloride (Cl)	2
Sulphate (SO_4)	27
Bicarbonate (HCO_3)	171
Total hardness ($CaCO_3$)	160
Fluoride (F)	0
Total solids	182

Field analysis by U. S. Geological Survey
(May 1965)

Specific conductance (Micromhos at 25°C)	310
pH	7.5
Iron	0
Temperature (°F)	44

Driller's log of well

Well No.: 42N 35W 1-2
Location: SW¼ NW¼ sec. 1
Altitude: 1480 ft. m.s.l.
Drilled: 1957

Log of test well No. 3 which is at the site of production well No. 2 (42N 35W 1-2).

	Thickness	Depth
Topsoil	1	1
Clay, rocks, and boulders	4	5
Fine to medium sand and gravel	19	24
Fine to medium sand	14	38
Medium to coarse sand, and gravel	27	65
Sand and dirty gravel	8	73
Dirty sand and gravel, hardpan, broken	4	77

- Gaastra (city) -

This municipality operates one drift well of gravel-pack type construction 150 feet deep, equipped with a 300-gpm turbine pump. A pump test at time of installation shows drawdown of 19 feet after four hours pumping 300 gpm. No stand-by unit is maintained. A second well no longer yields water. Neither pumpage nor consumption is metered. The 125 customers pay a flat monthly rate.

Laboratory analysis by Michigan Department of Health
(collected July 1959)

Silica (SiO_2)	12	ppm
Iron (Fe)	0	
Calcium (Ca)	46	
Magnesium (Mg)	23	
Sodium and Potassium (Na+K)	3.1	
Chloride (Cl)	1	
Sulphate (SO_4)	24	
Bicarbonate (HCO_3)	228	
Total hardness ($CaCO_3$)	210	
Fluoride (F)	0	
Total solids	225	

Field analysis by U. S. Geological Survey
(July 1965)

Specific conductance (Micromhos at 25°C)	400
pH	7.5
Iron	0

Driller's log of well

Well No.: 42N 34W 9-1 (City well No. 1)
Location: SW¼ NW¼ sec. 9
Altitude: 1620 ft. m.s.l.
Drilled: 1945

Log of test hole at site of well No. 1.

	Thickness	Depth
Clay	5	5
Hardpan and boulders	44	49
Medium coarse sand	19	68
Medium coarse sand and gravel	6	74
Muddy fine sand (water level 77 feet)	9	83
Dirty coarse gravel	11	94
Dirty, very coarse gravel	20	114
Clean coarse sand	2	116
Coarse sand and gravel	41	157

- Alpha (village) -

This village supplies water to about 150 customers from two drift wells in an outwash deposit along Alpha Creek near the southeast corner of the village. Both wells, drilled in 1930 are gravel-pack construction with 16-inch inner casings. Logs are not available for either but the log of well 42N 33W 13-2, across the creek from 13-1 (village well No. 2), shows glacial drift at a depth of 90 feet. Well No. 1 (42N 33W 12-1) is 43 feet deep and has a turbine pump of 104-gpm capacity. Well No. 2 is 41 feet deep, is equipped with a 60-gpm turbine pump, and is maintained as a stand-by unit. Pumpage is not metered. Customers pay a flat monthly rate. The water system includes a filtration plant to remove the excessive iron.

Laboratory analysis well No. 1 by Michigan Department of Health (collected February 1961--before treatment)

Silica (SiO_2)	11 ppm
Iron (Fe)	1.4
Calcium (Ca)	20
Magnesium (Mg)	11
Sodium and Potassium (Na+K)	2.5
Chloride (Cl)	0
Sulphate (SO_4)	22
Bicarbonate (HCO_3)	97
Total hardness ($CaCO_3$)	95
Fluoride (F)	0
Total solids	126

Field analysis well No. 1 by U. S. Geological Survey
(July 1965)

Specific conductance (Micromhos at 25°C)	195
pH	7.0
Iron (ppm)	0.7
Temperature (°F)	46

- Crystal Falls Township -

This township operates two wells and 27 miles of water mains. Another well and a 75,000-gallon tower were under construction in May 1965. Water is not metered. The 240 customers pay a flat monthly rate.

Well No. 1 (44N 33W 16-1), drilled in 1950, is gravel-pack construction, 56 feet deep, and pumped at a 100-gpm rate (breaks suction at 135 gpm) and will be placed on stand-by when well No. 3 is completed.

Well No. 2 (43N 33W 14-1), known as the Lind well, was also drilled in 1950. It is gravel-pack construction, has a total depth of 55 feet, and is equipped with a 200-gpm turbine pump. The innter casing is 10 inches in diameter.

Well No. 3 (44N 33W 16-2) will be of gravel-pack construction, 58 feet deep. It will be located about 200 feet southeast of well No. 1. A specific yield of 40 gpm per foot of drawdown has been reported for a test well at this location. Present plans call for pumping rate of 400 gpm.

Laboratory analysis by Michigan Department of Health

	Well No. 1 (July, 1959)		Well No. 2 (July, 1959)		Well No. 3 (June 7, 1965)	
Silica (SiO_2)	13	ppm	11	ppm	--	ppm
Iron (Fe)	0		0.1		0.2	
Calcium (Ca)	40		30		--	
Magnesium (Mg)	20		14		--	
Sodium a. l Potassium (Na+K)	4.8		3.1		--	
Chloride (Cl)	6		0		1	
Sulphate (SO_4)	13		11		--	
Bicarbonate (HCO_3)	200		150		--	
Total hardness ($CaCO_3$)	182		132		160	
Fluoride (F)	0		0		0.1	
Total solids	244		158		--	
Manganese (Mn)	--		--		0	
Nitrates	--		--		0.5	
Nitrates	--		--		.01	
pH	--		--		8.1	

Field analysis by U. S. Geological Survey
(May 1965)

Specific conductance (Micromhos at 25°C)	340	260
pH	7.5	7.5
Iron	0	0
Temperature (°F)	46	--

Driller's logs of wells

Well No.: 44N 33W 16-1 (Township well No. 1)
Location: NW¼ NW¼ sec. 16
Altitude: 1450 ft. m.s.l.
Drilled: 1950

Log of test hole at site of present well. Screen set at 50 feet in test hole, pump tested at 100 gpm for 6 hours with drawdown of 6 feet.

	Thickness	Depth
Surface soil	2	2
Dirty fine sand	4	6
Fine sand, muddy coarse gravel	10	16
Medium fine sand, coarse gravel in hardpan	4	20
Hardpan	5	25
Gravel and coarse sand	16	41
Medium fine sand and gravel	14	55
Sandy hardpan	8	63

Well No.: 43N 33W 14-1 (Township well No. 2)
Location: SW¼ SE¼ sec. 14
Altitude: 1400 ft. m.s.l.
Drilled: 1950

Log of test well drilled November, 1959, at site of present well.

	Thickness	Depth
Surface	1	1
Medium coarse sand	4	5
Fine gravel	2	7
Medium fine sand	11	18
Medium coarse sand	5	23
Coarse sand, gravel and boulders	19	42
Fine sand, gravel and broken rock	13	55

Well No.: 44N 33W 16-2
Location: NW¼ NW¼ sec. 16
Altitude: 1450 ft. m.s.l.
Drilled: 1964

Test hole at site of township well No. 3 which is now under construction.

	Thickness	Depth
Surface soil	2	2
Gravel, coarse, sand, clay	6	8
Sand, dirty, and gravel	4	12
Sand, coarse, and gravel, boulders	7	19
Gravel, coarse	7	26
Sand, dirty, boulders	2	28
Gravel, coarse, boulders	10	38
Boulders, sand, gravel	4	42
Gravel, fine	4	46
Gravel	12	58
Hardpan with gravel	5	63

- Stambaugh Township -

This township operates four wells, each with its own system of water mains.

Well No. 1 (42N 35W 11-1) serves about 185 customers on 22½ miles of water mains in the south central part of the township. This well has a diameter of 12 inches and a reported depth of 58 feet in glacial drift. The turbine pump has a capacity of 125 gpm. Pumpage was 25 percent greater in 1965 than in 1964. The water is moderately hard and contains less than 0.1 ppm of iron.

Well No. 2 (42N 34W 13-1), located between Chicagon and Indian Lakes, is gravel-pack construction. The 12-inch inner casing is 61 feet deep. At the time of installation the turbine pump was tested at 79 gpm; the present normal production rate is 70 gpm. A 3,000 gallon pneumatic storage tank is connected to the pump. About 6 miles of water mains have been built to serve 50 to 55 customers. The water is quite hard, but otherwise of good quality.

Well No. 3 (42N 36W 10-1) is gravel-pack construction 58 feet deep with a capacity of 345 gpm and supplies 65 to 70 customers with 5¼ miles of mains in the southwest part of the township near Hagerman Lake. The water is moderately hard and has very little iron.

The Pentoga Well (42N 34W 25-1) serves the village of Pentoga in the extreme southeast corner of the township. This well has a 6-inch casing. The well is completed in coarse sand and gravel deposits at a depth of 88 feet. The submersible pump has a capacity of 20 gpm. This system, under construction during 1965, will serve about 7 customers along one-fourth mile of water main. Water is quite hard.

Year	Total pumpage
1963	17,590,000 gallons
1964	23,990,000 gallons
1965	25,281,000 gallons

Laboratory analysis by Michigan Department of Health

	Well #1 (July, 1959)	Well #2 (Aug., 1959)	Well #3 (Dec., 1961)	Pentoga Well (May, 1965)
Silica (SiO_2)	15 ppm	14 ppm	-- ppm	15 ppm
Iron (Fe)	0	0.1	0	0
Calcium (Ca)	32	53	--	60
Magnesium (Mg)	16	30	--	29
Sodium and Potassium (Na+K)	3.2	3.3	--	6.5
Chloride (Cl)	0	10	1	12
Sulphate (SO_4)	18	13	--	25
Bicarbonate (HCO_3)	159	290	--	294
Total hardness ($CaCO_3$)	144	254	180	270
Fluoride (F)	0.1	0	--	0.1
Total solids	170	274	--	330

Field analysis by U. S. Geological Survey
(May 1965)

	Well #1	Well #2	Well #3	Pentoga Well
Specific conductance (Micromhos at 25°C)	280	430	190	--
pH	7.5	7.0	7.0	--
Iron (ppm)	0	0.1	--	--
Temperature (°F)	45	45	45	--

Driller's logs of wells

Well No.: 42N 34W 13-1 (Township well No. 2)
Location: SE¼ NW¼ sec. 13
Altitude: 1450 ft. m.s.l.
Drilled: 1956

	Thickness	Depth
Hard clay	5	5
Hardpan and boulders	19	24
Boulders and large rocks	4	28
Large rocks and some medium gravel	6	34
Medium fine sand and coarse gravel	18	52
Medium to coarse gravel	9	61
Medium fine sand	3	64

Well No.: 42N 36W 10-1 (Township well No. 3)
Location: NE¼ NE¼ sec. 10
Altitude: 1485 ft. m.s.l.
Drilled: 1961

	Thickness	Depth
Sand, tan, fine to very fine	5	5
Gravel, coarse, with sand, tan, medium to coarse	20	25
Sand, light tan, medium	15	40
Sand, tan, medium to coarse	5	45
Sand, tan, medium to coarse, and gravel, coarse	5	50
Sand, tan, medium	8	58

Well No.: 42N 34W 25-1 (Pentoga Well)
Location: SE¼ SE¼ sec. 25
Altitude: 1400 ft. m.s.l.
Drilled: 1964

	Thickness	Depth
Topsoil and clay	5	5
Clay and boulders	5	10
Large gravel and boulders	32	42
Fine sand	32	74
Gravel with clay seams (red)	3	77
Coarse sand and gravel	11	88

Well No.: 42N 36W 14-1 (Test hole No. 1)
Location: NW¼ NW¼ sec. 14
Altitude:
Drilled: 1961

Abandoned because of the high iron content of the water.

	Thickness	Depth
Gravel, coarse, with a little medium gravel and coarse sand	5	5
Sand, tan, medium, with gravel, medium to coarse	5	10
Sand, tan, medium to coarse, with gravel	10	20
Gravel, coarse, with some sand, tan, medium	5	25
Sand, tan, medium, and gravel, coarse	5	30
Gravel, some medium sand	5	35
Sand, tan, medium, some gravel, fine	5	40
Sand, medium, and gravel, coarse	5	45
Sand, medium to coarse, gravel, coarse	10	55
Sand, medium to coarse, gravel, fine to coarse	10	65
Sand, tan, fine to medium	28	93

Well No.: 42N 36W 11-2 (Test hole No. 2)
Location: SW¼ SW¼ sec. 11
Altitude: 1580 ft. m.s.l.
Drilled: 1961

Abandoned because of the high iron content of the water.

	Thickness	Depth
Topsoil	1	1
Clay, red, sandy	5	6
Sand, rusty color, fine to medium, gravel, fine	3	9
Sand, muddy, gravel, fine	6	15
Sand, muddy, fine, streaks of gray clay	7	22
Gravel, coarse and clay	2	24
Gravel, fine to coarse, sand, coarse	2	26
Sand, fine to medium, gravel, fine to coarse	1	27
Sand, fine to coarse	1	28
Sand, fine to medium, gravel, clay	1	29
Sand, tight, with dirty coarse gravel	3	32
Sand, tight, dirty gravel with clay streaks and boulders	4	36
Sand, gravel, fine to coarse, boulders and some dirty gravel	9½	45½
Igneous bedrock	½	46

- Hematite Township -

This township furnishes water to about 600 customers, including the town of Amasa. Well No. 1 was abandoned and sealed because of poor yield. Well No. 2 (44N 33W 8-2), drilled in 1937, is gravel-pack construction, 30 feet deep. It is the stand-by unit pumped only once or twice a week. Well No. 3 (44N 33W 8-3), drilled in 1963, is also gravel-pack construction and 30 feet deep. It is pumped daily at 175 gpm.

Water from these wells is not treated. It is quite hard and contains some iron. The wells are acidized about once a year.

Laboratory Analysis of well No. 3 by Michigan Department of Health
(collected July 1965)

Silica (SiO_2)	12 ppm
Iron (Fe)	0.4
Calcium (Ca)	54
Magnesium (Mg)	21
Sodium and Potassium (Na+K)	30.1
Chloride (Cl)	37
Sulphate (SO_4)	37
B carbonate (HCO_3)	222
Total hardness ($CaCO_3$)	222
Fluoride (F)	0
Total solids	322

Log of Well

Well No.: 44N 33W 8-1 (Township No. 1)
Location: NE¼ NE¼ sec. 8
Altitude: 1445 ft. m.s.l.
Drilled: 1947

Log of township well No. 1; logs of No's. 2 and 3 would be similar, as all three wells are in the same building.

	Thickness	Depth
Fill	3	3
Muck, black, and sand, muddy	8	11
Gravel, dirty, hardpan, boulders	11	22
Gravel, coarse, boulders	4	26
Gravel, coarse, dirty	9	35
Hardpan and boulders	9	44

- Bates Township -

This township supplies water to about 450 customers. The system includes 60 miles of water mains, a 50,000-gallon elevated storage tank, and two wells, 43N 34W 28-1 (No. 1) and 43N 34W 28-2 (No. 2). Both are gravel-pack construction 140 feet deep and have six-inch casings. Each has a turbine pump with a 200-gpm capacity. Well No. 1 is maintained as a stand-by unit. No logs are available, but both wells are reported in glacial drift. On July 21, 1965, the temperature of water from both wells was 45°F. Pumpage is not metered, customers paying a flat monthly rate.

Laboratory Analysis by Michigan Department of Health
(collected November 24, 1964)

	Well No. 1	Well No. 2
Silica (SiO_2)	10 ppm	10 ppm
Iron (Fe)	0	0
Manganese (Mn)	0	0
Calcium (Ca)	42	48
Magnesium (Mg)	18	21
Sodium (Na)	2.0	2.3
Potassium (K)	1.0	1.4
Nitrate (NO_3)	1.3	0.6
Chloride (Cl)	0	0
Sulphate (SO_4)	33	37
Bicarbonate (HCO_3)	200	225
Carbonate (CO_3)	0	0
Hardness ($CaCO_3$)	180	205
Fluoride (F)	0	0
Total solids	180	220
pH	7.7	7.5
Specific conductance (Micromhos at 25°C)	390	420

- Iron River Township -

This township operates three wells and 81 miles of water mains. Water is not metered. Charge is based on number of water outlets. During the summer of 1965 the township was supplying water to 481 outlets. The village of Mineral Hills receives its water from Iron River Township.

The Beechwood well (43N 36W 1-3) is 60 feet deep in glacial drift; the turbine pump has a 250 gpm-capacity.

The Ryden well (43N 35W 16-1) has a 10-inch casing with the screen set between 36 and 53 feet in very coarse gravel. The 75 HP-turbine pump has a 550-gpm capacity. Average daily pumpage is about 325,000 gallons.

The Nash well (43N 35W 21-1) has a 10-inch casing and is 60 feet deep, probably in glacial drift. It is equipped with a turbine pump of 250 gpm-capacity. The average pumpage per day is about 195,000 gallons.

Water from these wells is good quality and not treated.

Laboratory analysis by Michigan Department of Health
(collected July 1959)

	Beechwood	Ryden	Nash
Silica (SiO_2)	15 ppm	12 ppm	13 ppm
Iron (Fe)	0	0	0
Calcium (Ca)	24	32	36
Magnesium (Mg)	15	19	22
Sodium and Potassium (Na+K)	3.4	2.5	2.9
Chloride (Cl)	0	0	0
Sulphate (SO_4)	4	5	11
Bicarbonate (HCO_3)	114	154	174
Total hardness ($CaCO_3$)	96	132	158
Fluoride (F)	0	0	0
Total Solids	120	148	172

Field analysis by U. S. Geological Survey
(May 1965)

Specific conductance (Micromhos at 25°C)	180	220	300
pH	7.5	7.5	7.5
Iron	0	--	0
Temperature (°F)	45	46	47

Logs of Wells

Well No.: 43N 35W 16-1 (Ryden Well)
Location: SE¼ NE¼ sec. 16
Altitude: 1530 ft. m.s.l.
Drilled: 1956

	Thickness	Depth
Sand, very fine to medium, some fine gravel, silty	5	5
Gravel, boulders only in sample, no sand boulders of baseball size	5	10
Gravel, coarse, including boulders of base-ball size, with medium to very coarse sand	15	25
No sample	5	30
Gravel, coarse, boulders up to baseball size, very little sand in sample	5	35
Gravel, coarse, boulders up to baseball size with medium to coarse sand (driller reported water at 36 feet)	5	40
No sample	5	45
Gravel, coarse, boulders to baseball size with very little coarse sand	5	50
Gravel, coarse, boulders to baseball size very fine sand (driller reported diminuation of water below 53 feet)	5	55
Gravel, coarse to very fine, with fine to very coarse sand	10	65
Sand, very fine to coarse with some fine gravel	5	70
Gravel, fine to medium, with very fine to medium sand	5	75
No sample	5	80
Ledge, broken greenstone (83-84 into solid ledge)	4	84

Well No.: 43N 35W 15-1
Location: NW¼ NW¼ sec. 15
Drilled: 1956

Log of test hole No. 1, apparently not enough water to develop a production well.

	Thickness	Depth
Gravel, with cobbles, sandy, dirty, red	5	5
Gravel, very coarse, with very fine sand, dirty	5	10
Sand, medium, with cobbles, clean	5	15
Sand, medium, with large cobbles, clean some gravel	5	20
Sand, silty and gravelly	5	25
Sand, very fine to medium, silty and gravelly, gravel to 1 inch size	10	35
Gravel, fine to medium, with silt and sand and some clay, some gravel to 3 inch size	15	50
Sand, with some gravel, very fine to medium, dirty	25	75
Sand, very fine to medium, with some gravel to 3 inch size, dirty	10	85
Sand, very fine to coarse, with some very fine gravel, dirty	5	90
Gravel, fine to medium, red, clayey	5	95
Gravel, fine to coarse, with very fine to medium sand, dirty	6	101
Ledge at 101		

Well No.: 43N 35W 22-1
Location: NW¼ NE¼ sec. 22
Altitude: 1600 ft. m.s.l.
Drilled: 1956

Log of test hole No. 2 reported as a dry hole.

	Thickness	Depth
Gravel, fine to coarse, sandy, red, dirty cobbles to 3 inches	5	5
Gravel, medium to coarse, medium to coarse clean sand, cobbles to 3 inches	20	25
Sand, fine, clean	20	45
Sand, very fine to fine, silty	25	70
Clay, red	10	80
Clay, gray	10	90
Clay, brown	25	115
Sand, very fine to fine, silty	5	120
Gravel, coarse, silty, dirty, cobbles to 3 inch	5	125
Gravel, fine to coarse, cobbles to 3 inch with medium sand, very dirty	5	130
Gravel, fine to coarse, sandy and clayey, reddish color	5	135
Gravel, very clayey, red	5	140
Sand and broken ledge, probably greenstone	5	145
Sand and broken ledge, silty	5	150

- Mastodon Township -

This township operates one well, 42N 33W 1-1, and one-half mile of water main, supplying six water users in the vicinity of the Dunn Location. This is a dug well 8 feet by 12 feet by 20 feet deep. The nine feet of drift is cased off with eight-inch concrete walls set on bedrock which is penetrated for an additional eleven feet. A 5-gpm jet pump and a chlorinator have been installed in the well house. Pumpage is not metered.

Field Analysis by U. S. Geological Survey
(collected July 6, 1965)

Hardness (ppm)	120
Iron (ppm)	0.4
Specific conductance (Micromhos at 25°C)	280
pH	6.0

Motels and Resorts

Most of the motels are located in the southern part of the county in areas served by municipal water systems.

On the other hand many fishing and hunting resorts located on lakes and streams in the less developed areas have a variety of water supply systems.

The Brule Mountain Ski Area has two 6-inch wells in shallow drift. One well, number 42N 35W 20-1, is completed just above bedrock at a depth of 32 feet. A pump test at 50 gpm for 8 hours resulting in a drawdown of 8 feet. This well supplies snow-making equipment and has been pumped at 100 gpm for short periods. The second well, 42N 35W 20-2, encountered bedrock at 25 feet. It provides a 10-gpm domestic supply at the lodge and manager's residence.

Residences

Many individual resident wells in Iron County have been abandoned in favor of public systems. Buying water from a municipality is often easier and cheaper than maintaining a private well. In other instances a domestic well may not provide enough water for added demands as livestock, lawn sprinkling, and modern plumbing appliances.

Most of the domestic wells in the outwash areas are small-diameter and equipped with a drive point. Some are adequate for heavy domestic demands. In till plain and moraine areas, most permanent residences have 5 or 6-inch drilled wells, some of which penetrate bedrock.

Recreation Facilities

Many private hunting and fishing camps are situated in undeveloped areas. Some are equipped with electric generators and modern water systems. However, most of them have a hand pump. A few cabins, especially on till plain in the northeast do not have wells because the expense of drilling is not warranted. In some places more than one attempt is often necessary before a successful well is obtained.

All of the parks and campgrounds in the county have water supplies. Several of the larger parks obtain their water from city or township systems. The remainder have one or more wells, usually equipped with hand pumps.

The golf course at Crystal Falls obtains water from the Crystal Falls municipal system. The golf course at Iron River uses water from Stambaugh Township.

Mine Water

Ground water leaking into working areas of some mines has been a problem. This situation is discussed at length by Stuart, and others (see Selected References).

The Homer-Wauseca mine north of Iron River is handling its drainage problem by lowering the water table in the glacial drift on the surface over the workings, as well as by pumping directly from the shaft. The pumping rates of these wells on October 30, 1965 were as follows:

No. 1	340 gpm
No. 14	560 gpm
No. 16	1,040 gpm
No. 17	1,300 gpm
No. 18	1,770 gpm
Total from surface deposits	5,010 gpm
From shaft	780 gpm

Part of the pumpage from the surface and all of the pumpage from the shaft is diverted to settling ponds before flowing into Sunset Creek or Iron River.

At Hiawatha No. 2 mine in Stambaugh water is pumped only from shafts. The shaft of the nearby abandoned Hiawatha No. 1 mine is also pumped whenever the water level rises high enough to move into the production area of Hiawatha No. 2. During the ten-month period, January-October, 1965, the average pumping rates were 253 gpm for No. 1 and 471 gpm for No. 2. The water is pumped into two settling ponds before flowing into Iron River.

Bristol mine at Crystal Falls and Sherwood mine near Mineral Hills pump between 225 and 250 gpm from their shafts into settling ponds.

Elsewhere abandoned mines are filling with water, with little serious damage to other properties, except in the east side of Caspian where basements in low areas have been flooded.

CONCLUSIONS

Ground-water resources in Iron County generally are adequate to meet present needs. The most important sources of ground water are outwash deposits along the major streams where water supplies of several hundred gallons per minute can be obtained. Large yields are also obtained from localized beds of sand and gravel in till plains. Most wells in till plain areas obtain more than 1 gpm. Most wells in moraines yield at least 1 gpm. Areas where bedrock is exposed or is covered by a thin layer of glacial drift are the least favorable for obtaining ground water. However, some wells in bedrock yield enough water for a domestic supply.

Ground water is generally hard and may contain objectionable amounts of iron, but is otherwise suitable for domestic and most industrial uses.

All municipal supplies and all industrial systems other than power generators use water from wells. Lakes and streams may be considered a potential source of water if future population growth and industrial development occurs in the areas of low ground-water yield.

SELECTED REFERENCES

Bergquist, S. G., 1932, Glacial geology of Iron County, Michigan: Mich. Acad. Sci. Papers, vol. 16.

Brown, C. J. D., Michigan lakes and streams: in Michigan Conservation Magazine, June, 1943, vol. 12, No. 5, and June, 1944, vol. 13, No. 5.

Foster, Z. C., Veatch, J. O., and Schoenmann, L. R., 1937, Soil survey of Iron County, Michigan: U. S. Dept. of Agriculture.

Giroux, P. R., and Huffman, G. C., 1965, Summary of ground-water conditions in Michigan, 1964: U. S. Geol. Survey open-file report.

Humphrys, C. R., and Green, R. F., 1965, Michigan lake inventory bulletin number 36: Dept. of Resource Development, Mich. State University.

Michigan Department of Health, 1961, Data on public water supplies in Michigan: Engineering bulletin No. 4.

Stuart, W. T., Theis, C. V., and Stanley, G. M., 1948, Ground-water problems of the Iron River district, Michigan: Michigan Geol. Survey tech. report.

APPENDIX

Tables 1 through 9

Table 1.--Laboratory Analysis of Ground Water - Iron County

Water-bearing aquifer: Pcr - Precambrian rocks
Pa - Paleozoic rocks
Gd - Glacial drift

Well Number	Aquifer	Date sampled	Temperature °F	Specific conductance (Micromhos @ 25°C)	pH	in parts per million							
						Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Hardness ($CaCO_3$)	Hardness (Non-carbonate)	Iron (Fe) Field Analysis
43N 32W 29-1	Pcr	9-24-65	46	784	7.5	358	0	108	30	0.1	416	122	0.1
43N 33W 31-1	Gd	9-23-65	--	338	7.3	210	0	7.2	1.0	1.6	182	10	4.0
44N 37W 26-1	Gd	9-21-65	--	176	7.5	102	0	6.8	1.0	0.5	89	6	0
45N 32W 5-2 (Spring)	Gd	9-30-65	45	208	7.8	114	0	28	2.0	0.1	106	12	0
46N 35W 7-2	Gd	9-15-65	49	122	6.9	70	0	2.4	1.0	0.5	59	2	2.5

Table 2.--Field Analyses of Ground Water from Iron County

Aquifer: Pcr - Precambrian rocks; Pa - Paleozoic rocks;
Gd - Glacial drift.

Well Number	Aquifer	Date Sampled	In parts per million		Specific conductance (Micromohs at 25°C)	pH	Temperature °F
			Hardness	Iron			
41N 31W 14-1	Pcr	7-29-65	170	>4.0	385	7.5	46
41N 32W 11-1	Gd	8-26-65	150	0	240	7.2	48
42N 31W 6-1	Gd	7-29-65	170	0.3	285	7.5	44
6-2	Gd	8-12-65	90	0.15	290	6.5	48
42N 32W 26-1	Gd	7-30-65	90	0.2	180	7.7	--
42N 33W 15-1	Pcr	8-11-65	170	0	290	7.5	--
42N 3							
42N 35W 20-2	Gd	9-27-65	50	0	80	6.0	45
42N 36W 18-1	Gd	9-22-65	90	3.5	155	6.5	44
43N 31W 4-1	Pcr	8-10-65	140	1.2	220	7.5	45
16-1	Pcr	8-11-65	310	0	480	7.0	--
33-1	Gd	7-16-65	170	0.6	295	7.0	46
36-2	Pcr	8-11-65	290	1.5	440	7.7	--
43N 32W 1-1	Gd	8-17-65	190	0.7	310	7.2	44
4-2	Gd	8-17-65	190	>4.0	310	7.5	45
43N 33W 21-1	Gd	5-11-65	170	0	280	7.5	--
27-2	Pcr	9- 9-65	290	0	520	7.0	--
27-3	Pcr	9- 9-65	240	0.7	400	7.2	--
43N 34W 24-1	Gd	8-11-65	150	0.4	245	7.5	--
43N 36W 12-1	Gd	7-22-65	120	0.1	200	7.2	47
36-1	Gd	9-22-65	150	0	250	7.5	--
43N 37W 33-1	Gd	9-22-65	220	0.1	420	6.9	--
33-3	Gd	9-22-65	30	1.5	<50	6.0	--
44N 31W 26-1	Gd	8-12-65	170	0.2	220	7.5	47
34-1	Pcr	8-10-65	220	<0.1	380	7.2	--
44N 32W 16-1	Gd	8-17-65	150	2.0	275	7.1	52
17-1	---	8-18-65	140	0	280	7.8	47
44N 33W 6-1	---	8-19-65	150	<0.1	235	7.7	--
7-1	Gd	8-18-65	150	1.0	170	7.8	46
7-2	Pcr	8-18-65	120	0	225	7.7	--
17-1	Gd	8-18-65	170	0	310	7.7	--
35-1	Gd	8-12-65	150	0	270	7.7	--
44N 35W 4-1	Gd	8-20-65	50	----	150	9.0	44
44N 36W 19-1	Gd	10- 1-65	90	0	170	7.1	--
44N 37W 6-1	Gd	9-22-65	100	0	180	8.0	46
10-1	Gd	8-24-65	100	2.0	180	7.9	--
13-1	Gd	8-24-65	90	2.0	160	7.9	46
36-1	Gd?	7-20-65	<17	3.5	60	6.5	46

Table 2.--Field Analyses of Ground Water from Iron County.--Continued

Well Number	Aquifer	Date Sampled	In parts per million: Hardness	Iron	Specific conductance (Micromohs at 25°C)	pH	Temperature °F
45N 31W 7-1	Gd	8-25-65	100	0	205	7.1	52
24-1	Gd	8-25-65	200	0	360	7.5	--
25-1	Gd	8-25-65	120	0.5	225	7.0	--
26-1	Pcr	8-25-65	120	<0.1	220	8.0	--
45N 32W 5-1	Gd	8-13-65	70	>4.0	125	6.5	46
29-1	Gd	8-13-65	90	<0.1	165	7.0	45
45N 33W 8-2	Gd	8-19-65	100	2.0	175	7.9	46
45N 37W 18-1	Gd	5- 6-65	100	----	190	---	44
46N 31W 30-1	Gd	11-11-65	20	1.0	50	6.0	45
46N 33W 6-1	Pcr	8-19-65	140	0	290	7.5	--
46N 35W 4-1	Gd	9-15-65	70	0.5	120	7.1	45
4-2	Gd	9-15-65	30	>4.0	100	6.0	44
7-1	Gd	9-15-65	90	>4.0	155	6.8	49
22-1	Gd?	8-23-65	100	>4.0	200	6.8	45
29-1	Gd?	8-20-65	140	0.2	270	7.8	44
29-2	Gd	8-20-65	70	1.0	120	6.8	44
46N 36W 4-1	Gd	9-29-65	50	>4.0	110	7.1	45
17-1	Gd	5- 6-65	100	----	145	---	44
35-1	Gd	9-15-65	90	0.2	140	7.1	45
46N 37W 13-1	Gd	9-16-65	90	3.5	150	7.1	46
13-2	Gd	5- 5-65	80	----	145	---	45
27-1	Gd	5- 6-65	50	----	135	---	46
27-2	Gd?	9-16-65	70	0.6	125	7.2	49

Table 3.--Field analysis of chemical constituents of water from streams

Weather: BrS - Bright Sun
C - Cloudy
PC - Partly cloudy

Stream	Location	Date sampled	Hour	Weather	Air Temp °F	Water Temp °F	Specific conductance (micromhos at 25°C)	pH	Hardness in ppm	Dissolved oxygen in ppm	Remarks
Brule River	NE¼ SW¼ sec 9 T41N R32W	5- 4-65	3:40	---	--	52	140	7.4	90	----	
Bush Creek	NW¼ NE¼ sec 35 T45N R36W	8-24-65	11:30a	BrS	70	62	150	7.4	85	8.0	
Fence River	SE¼ SE¼ sec 7 T45N R31W	8-25-65	11:15	C	65	--	160	7.5	85	8.0	
West Branch Hemlock River	SW¼ NE¼ sec 10 T45N R33W	5- 5-65	9:45	---	56	44	50	---	---	----	
Little Hemlock River	SE¼ SW¼ sec 17 T45N R33W	5- 5-65	9:20	---	55	44	60	---	---	----	
Michigammee River	SE¼ NE¼ sec 31 T43N R31W	7-16-65	12:15	C	72	69	90	7.2	51	9.0	Slight yellow tint
Michigammee River (Peavy Pond)	NW¼ SE¼ sec 32 T42N R31W	5-12-65	-----	---	--	59	60	7.0	34	----	Slight yellow tint
Morrison Creek	SW¼ NW¼ sec 24 T44N R35W	8-20-65	9:45	BrS	62	59	215	7.5	120	8.0	Est. discharge 4 cfs @ bridge
Net River	NW¼ SW¼ sec 21 T45N R34W	8-19-65	10:00	PC	64	67	120	7.3	68	8.0	Sampled wide pool below small rapids
East Branch Net River	NW¼ NW¼ sec 8 T46N R33W	8-19-65	3:30	BrS	67	68	105	7.3	69	9.0	Sampled deep pool below small rapids
East Branch Net River	NW¼ SW¼ sec 20 T46N R33W	5- 5-65	11:00	---	53	48	50	---	---	----	
West Branch Net River	SE¼ NW¼ sec 13 T46N R34W	5- 5-65	11:40	---	55	47	50	---	---	----	
Paint River	NW¼ NW¼ sec 7 T43N R32W	5- 4-65	5:00	---	57	52	50	---	60	----	
Paint River	NE¼ SW¼ sec 24 T42N R32W	5-12-65	-----	---	70	58	60	6.5	34	----	Sampled above dam
North Branch Paint River	SW¼ NE¼ sec 13 T45N R37W	7-22-65	3:15	BrS	85	68	140	7.3	68	10	

Table 4.--Field analysis of chemical constituents of water from lakes

Lake	Location	Date sampled	Hour	Weather	Air Temp °F	Water Temp °F	Specific conductance (micromhos at 25° C)	pH	Hardness in ppm	Dissolved oxygen in ppm	Remarks
				Lakes having outlets							
Cable Lake	SW¼ NE¼ sec 29 T46N R34W	5- 5-65	12:30	-------------	64	48	70	---	---	----	
Dawson Lake	NE¼ SE¼ sec 33 T43N R31W	7-16-65	1:30	Partly cloudy	76	75	240	8.0	137	10.0	Heavy weed cover on lake bottom
Deer Lake	NE¼ SE¼ sec 5 T45N R32W	8-13-65	11:00	Bright sun	77	74	130	7.7	69	9.0	Sand bottom, sparse vegetation
Lake Emily	SW¼ NE¼ sec 24 T43N R34W	8-11-65	3:20	Bright sun	82	73	250	8.0	120	9.0	Sand & gravel bottom, sparse vegetation
Lake Mary	NE¼ SW¼ sec 5 T42N R31W	5-12-65	-----	-------------	70	64	100	7.5	51	----	Water clear
Perch Lake (at surface)	SW¼ SW¼ sec 22 T46N R35W	8-23-65	5:30	Bright sun	--	69	70	6.9	34	----	Slight yellow tint
Perch Lake (at 12' depth)	SW¼ SW¼ sec 22 T46N R35W	8-23-65	5:30	Bright sun	--	--	110	6.8	51	----	Silt bottom
Shank Lake	SE¼ sec 7 T46N R32W	8-18-65	-----	-------------	--	70	95	7.7	51	9.6	Some vegetation, sediment in sample
Stanley Lake	SE¼ SE¼ sec 5 T42N R35W	7-21-65	2:10	Cloudy	69	71	200	8.0	120	10.0	Bottom very stony
Swan Lake (near shore)	SW¼ NE¼ sec 35 T44N R33W	8-18-65	7:PM	Sunny	59	73	165	8.7	165	10.0	Heavy bottom growth. Sun nearly set
Swan Lake (at surface)	SW¼ NE¼ sec 35 T44N R33W	8-24-65	8:45 PM	Dark	64	71	170	8.0	85	10.6	Day had been bright sun
Swan Lake (at 13' depth)	SW¼ NE¼ sec 35 T44N R33W	8-24-65	8:45 PM	Dark	64	71	165	8.0	85	3.2	
Tepee Lake	NE¼ NW¼ sec 13 T46N R37W	5- 5-65	4:20	-------------	59	46	<50	---	---	----	
				Lakes not having outlets							
Lake Ellen	NE¼ SE¼ sec 26 T44N R31W	8-12-65	11:30	Bright sun	76	72	70	7.7	51	9.0	Sand bottom, no vegetation near site
Glidden Lake	NW¼ NW¼ sec 6 T42N R31W	8-12-65	9:20	Cloudy	72	69	<50	6.2	17	9.0	Yellow tint, sparse vegetation, muddy bottom
Golden Lake (near shore)	SW¼ NW¼ sec 36 T44N R37W	7-20-65	5:20	Bright sun	74	69	<50	6.75	---	10.0	Clear
Golden Lake (at surface)	About ¼ mi. N of park	8-24-65	4:00	Bright sun	71	69	<50	7.5	12	7.0	
Golden Lake (at 40-50' depth)	About ¼ mi. N of park	8-24-65	4:00	Bright sun	71	58	<50	6.0	12	0	Lake quite rough
Hagerman Lake	NW¼ SW¼ sec 11 T42N R36W	7-21-65	3:00	Partly cloudy	74	71	110	8.0	68	12.0	Sandy bottom, clear
Hannah Webb Lake	NW¼ SW¼ sec 29 T46N R35W	8-20-65	3:30	Sunny	69	71	<50	6.4	<17	9.0	
Holmes Lake	NW¼ SE¼ sec 24 T43N R31W	8-10-65	12:00	Bright sun	68	72	<50	6.7	17	8.0	Muddy bottom, water cloudy
James Lake	SE¼ NW¼ sec 25 T44N R37W	8-24-65	10:15	Bright sun	69	69	<50	6.0	<17	8.0	Silty bottom, heavy weed growth

Table 5.--Records of Wells

Aquifer: Pcr - Precambrian rocks; Pa - Paleozoic rocks; Gd - Glacial drift

Use: D - Domestic; S - Stock; P - Public Supply; I - Industrial; O - Observation; T - Test Hole

WMP - Wisconsin-Michigan Power Company

Water level is in feet below land surface.

Well number	Location in section	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
41N 31W 10-1	SW NE	Iron Co. Rd. Comm.	WMP	----	1¼	17	Gd	O	14.53	11-1-65	----	---	WMP obs. well
14-1	SE NW	Dick Abraham	Kleiman	1961	3	106	Pcr	D	78	1961	1300	104	Water very cloudy
14-2	SW NE	C.J. Carlson	Rommetti	1959	6	103	Gd	D	68	1959	1300	103	Will supply comm. nursery by 1966
41N 32W 11-1	SE SE	George Gruell	Kleiman	1963	6	42	Gd	D	22	1963	1240	---	
42N 31W 6-1	SW SE	Leonard Olsen	Tuominen	1964	5	40	Gd	D	25	1964	1320	---	
6-2	NW NW	Mich. Dept. Cons.	Owner	1965	2	32	Gd	P	26	1965	1360	---	Glidden L. Campground
33-1	NW SE	Iron Co. Rd. Comm.	WMP	1954	1¼	10	Gd	O	2.39	11-1-65	----	---	WMP obs. well
33-2	NW SE	J. Giachino	---	----	15	12	Gd	D	9.55	11-1-65	----	---	WMP obs. well
42N 32W 15-1	NW SE	E. Brauer	Tuominen	1965	5	86	Gd	D	22	1965	1310	---	
26-1	SE NW	Iron Co. Airport	Kleiman	1960	6	110	Gd	P	40	1960	1340	---	
29-1	NW NW	Mrs. Gursky	Tuominen	1961	5	90	Pcr	D	21.19	7-30-65	1400	52	Open casing, never used
42N 33W 1-1	NW NE	Mastadon Twp.	Owner	1958	8'X 12'	20	Pcr	P	7.76	7-16-65	1485	9	Equipped with chlorinator
1-2	SW NE	Mastadon Twp.	Wilcox	1954	6	100	Pcr	P	30	1954	----	5	Abandoned, replaced by 1-1
12-1	SE SE	Village of Alpha	Layne N.W.	1930	16	43	Gd	P	-----	----	1400	---	Gravel pack
13-1	NE NE	Village of Alpha	Layne N.W.	1930	16	41	Gd	P	-----	----	1390	---	Gravel pack, stand by unit
13-2	NE NE	E. Kascielski	Tuominen	1960	5	90	Gd	P	3.09	8-11-65	1400	---	
15-1	SE NW	Wm. Jutila	Tuominen	1964	5	200	Pcr	D	43	1964	1435	156	
15-2	NE SE	J. Romanowski	Tuominen	----	5	43	Gd	D	29	----	1380	---	
28-1	SE SW	J. A. Gondek	Kleimen	1959	6	68	Gd	D	28	1959	1330	---	Dynamited boulders at 18'
42N 34W 9-1	SW NW	Village of Gaastra	Layne N.W.	1945	---	150	Gd	P	86.88	7-21-65	1620	---	Gravel pack
13-1	SE NW	Stambaugh Twp.	Layne N.W.	1956	12	61	Gd	P	35.98	5-13-65	1450	---	Gravel pack
25-1	SE SE	Stambaugh Twp.	Tuominen	1964	6	88	Gd	P	41	1964	1400	---	
25-2	SE SE	R. Mathison	Tuominen	1961	5	99	Gd	D	30	1961	1395	---	
42N 35W 1-1	SW NW	City of Caspian	---	1927	10	60	Gd	P	-----	----	1480	---	Dug well 30'x 30' to 52' deep; two 10" casings to 60'. Used as standby unit.
1-2	SW NW	City of Caspian	Layne N.W.	1957	18	65	Gd	P	21.71	5-12-65	1480	---	Gravel pack
11-1	NW SE	Stambaugh Twp.	Layne N.W.	----	12	58	Gd	P	17.01	5-13-65	1615	---	
20-1	NE NE	Brule Mtn. Ski Area	Kleiman	1964	6	32	Gd	I	12	1964	1540	32?	Used for snow machine. Has been pumped @ 100 gpm.
20-2	NE NE	Brule Mtn. Ski Area	Wilcox & Audio	----	6	25	Gd	P	-----	----	1540	25?	During ski season pump runs constantly.
42N 36W 10-1	NE NE	Stambaugh Twp.	Layne N.W.	1961	12	58	Gd	P	28.92	5-13-65	1485	---	Gravel pack
11-1	SW SW	U.S. Forest Service	---	1954	6	34	Gd	P	4.90	9-15-65	1560	34	Abandoned
11-2	SW SW	Stambaugh Twp.	Layne N.W.	1961	---	46	Gd	T	-----	----	----	46	High Fe, no well developed
15-1	NE SW	Mich. Hwy. Dept.	WMP	----	1¼	6	Gd	O	3.42	11-1-65	1544	---	WMP obs. well
15-2	NE SW	Mich. Hwy. Dept.	WMP	----	1¼	6	Gd	O	1.97	11-1-65	1545	---	WMP obs. well
15-3	NW SW	Wm. Young Est.	WMP	----	1¼	14	Gd	O	7.36	11-1-65	1554	---	WMP obs. well
15-4	SE SE	Stambaugh Twp.	Layne N.W.	1961	---	93	Gd	T	-----	----	----	---	High Fe, no well developed
18-1	NE NE	U.S. Forest Service	---	1964	5	60	Gd?	P	12.22	9-22-65	1560	---	Black sediment in water

Table 5.--Records of Wells.--Continued

Well number	Location in section	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
43N 31W 4-1	SE SW	Jack Sophie	Kleiman	1963	6	51	Pcr	P	14	1963	1390	15	Cased to 29'
16-1	SW NE	Ray Peterson	Kleiman	1963	6	95	Pcr	D	23	1963	1420	---	Cased to 20'
24-1	NW NE	P. Mitchell	Kleiman	1963	4	59	Pcr	D	9	1963	----	39	
26-1	SE NE	Francis Drake	Kleiman	1963	4	30	Gd	D	18	1963	1400	---	Screen plugs with silt
33-1	NE SE	Mansfield Twp.	Kleiman	1963	3	31	Gd	P	5	1963	1320	---	Dawson L. Park
35-1	NE NW	Mansfield Twp.	Kleiman	1961	5	50	Gd	P	15	1961	1380	---	Twp. hall
36-1	SE NW	Robt. Magray	Tuominen	1961	5	70	Pcr	D	12	1961	1420	38	
36-2	NW NW	Alex Mac Leod	Tuominen	1964	5	75	Pcr	D	21	1964	1405	71	1.5 ppm Fe
43N 32W 1-1	NW SW	Stock	---	----	4	---	Gd?	D	-----	----	1375	---	Hunting camp
4-1	NW SE	Minarcik & Janov	---	----	1¼	51	Gd	D	41.26	8-17-65	1490	---	
4-2	NE SW	Paros	---	----	6	37?	Gd?	D	23.69	8-17-65	1490	---	More than 4 ppm iron
6-1	NW SW	James Whittock	Tuominen	----	5	68	Gd	D	13	----	1380	---	
21-1	SE NW	City of Crystal Falls	Odgers	1929	10	90	Gd	P	22.87	5-10-65	1355	---	City well #1
21-2	SE NW	City of Crystal Falls	Odgers	1929	10	90	Gd	P	-----	----	1355	---	City well #2
21-3	SE NW	City of Crystal Falls	Odgers	1929	10	85	Gd	P	-----	----	1355	---	City well #3
21-4	SE NW	City of Crystal Falls	Layne N.W.	1961	2	50	Gd	O	1.14	5-10-65	1355	---	Test hole
21-5	SE NW	City of Crystal Falls	Layne N.W.	1961	2	69	Gd	O	8.07	5-10-65	1355	---	Test hole
21-7	SE NW	City of Crystal Falls	Layne N.W.	1963	10	91	Gd	T	1	1963	----	92	Insufficient water, pipe pulled
28-1	NE NE	City of Crystal Falls	Layne N.W.	1961	--	102	Gd	T	-----	----	----	---	TH -pipe pulled
28-2	NE NE	City of Crystal Falls	Layne N.W.	1961	--	90	Gd	T	-----	----	----	---	TH -pipe pulled
28-3	NE NE	City of Crystal Falls	Layne N.W.	1956	8	90	Gd	T	-----	----	----	---	Insufficient H_2O; pipe pulled
29-1	SE NE	City of Crystal Falls	---	----	--	---	Pcr	P	+4.0	9-24-65	1360	---	Old diamond drill hole, has flowed many years
43N 33W 14-1	SW SE	Crystal Falls Twp.	Layne N.W.	1950	10	55	Gd	P	21.22	5-10-65	1400	---	Lind well, gravel pack
21-1	SE SW	Wm. Honkala	Kleiman	1961	6	145	Gd	D	125	1961	1540	---	
27-2	SW NW	E. Reiman	Pickands-Mather	1950	3	53	Pcr	P	20	1950	1400	20	Drilled as iron ore Test hole
27-3	SW NW	E. Reiman	Pickands-Mather	1950	3	500+	Pcr	D	20	1950	1400	20	Do.
31-1	SE SW	F. G. Pardee	Layne N.W.	1957	8	143	Gd	D	114	1957	1500	---	More than 4 ppm iron
43N 34W 19-1	NW SW	Johnson	---	----	3	---	Gd?	O	67.44	11-18-65	1590	197	Ore expl. hole
19-2	NE SW	Johnson	---	----	3	---	Gd?	O	73.92	11-18-65	1620	---	Ore expl. hole
24-1	NW SE	Edw. Schlasser	Tuominen	1964	5	36	Gd	D	2	1964	1420	---	
24-2	NW SE	J. Strazer	Tuominen	1964	5	32	Pcr	D	2	1964	1420	27	
24-3	NW SE	W. J. Phillips	Kleiman	1964	6	38	Gd	D	4	1965	1420	---	
28-1	NE NE	Bates Twp.	Layne N.W.	----	6	140	Gd	P	-----	----	1630	---	Twp. #1, stand-by unit
28-2	NE NE	Bates Twp.	Layne N.W.	----	6	140	Gd	P	-----	----	1630	---	Twp. #2
29-1	SW NE	Rogers Mine	---	----	48	---	Gd	O	16.75	11-18-65	1567	---	Mine drainage well
43N 35W 11-1	SE NE	J. J. Javerski	---	----	36	47	Gd	D	41.83	11-1-65	1565	---	WMP obs. well
13-1	SW SE	F. Gendzwill	---	----	3	576	Pcr	O	54.99	11-18-65	1635	64	Ore expl. hole
16-1	SE NE	Iron River Twp.	Layne N.W.	1956	10	84	Gd	P	19	1956	1530	83	Rodine well
20-1	SW SE	Mrs. B. Henrickson	---	----	1¼	48	Gd	O	43.77	11-1-65	1560	---	WMP obs. well
21-1	SW SE	Iron River Twp.	Layne N.W.	----	10	60	Gd	P	22.20	5-13-65	1540	---	Nash well
22-1	NW NE	Iron River Twp.	Layne N.W.	1956	10	150	Gd	T	-----	----	1600	---	Test hole, dry
23-1	NW NE	M. A. Hanna Co.	Layne N.W.	1963	48	80	Gd	I	36	1963	----	103	Mine drainage well
24-1	NE SE	Johnson	E. J. Long-year Co.	1945	3	113	Gd	O	69.71	11-18-65	1600	113	Ore expl. hole

Table 5.--Records of Wells.--Continued

Well number	Location in section	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
43N 35W 25-1	SE NW	City of Stambaugh	---	1938	18	81	Gd	P	18	1946	1480	---	City #1; stand-by unit
25-2	SE NW	City of Stambaugh	Layne N.W.	1962	8	80	Gd	P	11.20	5-12-65	1480	---	City #2
26-1	SW NE	City of Iron River	Layne N.W.	----	2	130	Gd	O	25.64	11-18-65	1480	---	Test hole
26-2	SW NE	City of Iron River	---	1947?	20	170	Gd	P	-----	----	1480	---	City #2; stand-by unit
26-3	SW NE	City of Iron River	Layne N.W.	1952	16	130	Gd	P	34	1952	1480	---	City #1
28-1	SE SW	Lewis Gregg	---	----	36	20	Gd	D	15.90	9-12-45	1540	---	Destroyed
33-1	SE NW	Mich. Hwy. Dept.	WMP	----	1½	12	Gd	O	5.25	11-1-65	1525	---	WMP obs. well
43N 36W 1-1	SW NE	Iron Co. Rd. Comm.	WMP	----	1½	9	Gd	O	7.84	6-1-63	1540	---	WMP obs. well; destroyed 6-63
1-3	SE NW	Iron River Twp.	Layne N.W.	----	---	60	Gd	P	49.01	5-13-65	1540	---	Beechwood well
36-1	NW SW	U. S. Forest Service	---	----	5	86	Gd	P	46	1947	1580	---	Ottawa Lake Campground
43N 37W 33-1	SE NE	Gordon Kinner	---	----	2	40	Gd	D	-----	----	1700	---	
33-3	NE NW	Charles Zenas	Owner	----	1½	28	Gd	D	-----	----	1720	---	
44N 31W 26-1	NE SE	T. J. Bailey	Kleiman	1964	4	39	Gd	D	21	1964	1395	---	
26-2	NE SE	T. J. Bailey	Kleiman	1961	3	43	Gd	D	15	1961	1395	---	On lot next to 26-1
26-3	NW SE	W. Hosking	Kleiman	1961	3	57	Gd	D	29	1961	1400	---	
26-4	NE SW	A. Peterson	Kleiman	1961	3	54	Gd	D	29	1961	1400	---	
26-5	SE SE	V. Ball	Kleiman	1961	3	41	Gd	D	3	1961	1390	---	
34-1	SE NW	F. Phelan	Kleiman	1957	6	100	Pcr	P	30	1957	1400	50	Supplies 8 cottages
44N 32W 16-1	SW NE	E. Bicigo	Owner	----	1½	20	Gd	P	10±	1965	1385	---	
17-1	NW SE	M. Smith	Tuominen	----	6	170	---	P	-----	----	1390	---	Supplies 4 cottages
44N 33W 6-1	NW SW	M. Vireen	---	----	6	125	---	D	-----	----	1555	---	
7-1	SE NW	Robert Jacabson	Tuominen	1965	5	33	Gd	D	20	1965	1500	---	
7-2	NE SE	V. Hanttula	Tuominen	1963	5	146	Pcr	D	-----	----	1490	---	Ledge nr. surface
7-3	NE NW	Henry Rajala	Tuominen	----	4	132	Pcr	D	-----	----	1515	103	
8-1	NE NE	Hematite Twp.	---	1947	21	44	Gd	P	5	1963	1445	---	Yield dropped, well abandoned
8-2	NE NE	Hematite Twp.	Layne N.W.	1937	8	30	Gd	P	4.95	5-5-65	1445	---	Twp. well #2, stand-by unit
8-3	NE NE	Hematite Twp.	Layne N.W.	1963	12	30	Gd	P	-----	----	1445	---	Gravel pack
10-1	SW SW	Iron Co. Rd. Comm.	WMP	----	1½	9	Gd	O	6.65	11-1-65	1540	---	WMP obs. well
16-1	NW NW	Crystal Falls Twp.	Layne N.W.	1950	8	56	Gd	P	8	1965	1450	---	Twp. well #1, gravel pack
16-2	NW NW	Crystal Falls Twp.	Layne N.W.	1965	16	58	Gd	P	7	1965	1450	---	Twp. well #3, gravel pack
17-1	SW SW	Stuart Dickinson	Tuominen	1962	5	29	Gd	D	10	1962	1395	---	
35-1	NW SE	A. Anderson	Tuominen	1961	5	31	Gd	D	-----	----	1410	---	
35-2	NW SE	Rev. C. Peterson	Tuominen	1965	5	17	Gd	D	4	1965	1410	---	
44N 35W 4-1	NW NW	Tellio Ponozzo	Johnson	1942	---	165	Gd	D	-----	----	1615	---	
6-1	SW SW	U. S. Forest Service	WMP	----	1½	6	Gd	O	1.91	11-1-65	1468	---	WMP obs. well
6-2	SW SW	U. S. Forest Service	WMP	----	1½	14	Gd	O	8.60	11-1-65	1475	---	WMP obs. well
6-3	NW SW	U. S. Forest Service	WMP	----	1½	12	Gd	O	8.94	11-1-65	1478	---	WMP obs. well
7-1	NW NW	U. S. Forest Service	WMP	----	1½	7	Gd	O	3.04	11-1-65	1472	---	WMP obs. well
7-2	NW NW	U. S. Forest Service	WMP	----	1½	13	Gd	O	5.04	11-1-65	1471	---	WMP obs. well
7-3	NW NW	U. S. Forest Service	WMP	----	1½	17	Gd	O	12.50	11-1-65	1480	---	WMP obs. well
20-1	NE NE	State of Michigan	---	----	6	100+	Gd?	P	50±	1965	1560	---	Camp Gibbs; stand-by unit
29-1	SE SW	Ralph Tepel	---	----	6	103	Gd	D	96.15	9-23-65	1650	101±	Abandoned, poor yield
44N 36W 19-1	SW SW	Elmer Virkler	---	----	3	65	Gd	D	21	1964	1600	---	Supplies 2 houses, large barn
44N 37W 6-1	SE NW	C. Swanson	Owner	1959	1½	13	Gd	D	-----	----	1640	---	
10-1	SE NW	U. S. Forest Service	---	----	5	46	Gd?	P	35.89	8-24-65	1660	---	Elmwood Guard Sta.
13-1	NW NW	F. Penkevich	---	----	6	---	Gd	D	-----	----	1710	---	
14-1	NW NW	U. S. Forest Service	---	----	6	102	---	O	95.82	9-27-65	1730	---	USGS obs. well
25-1	SE SW	U. S. Forest Service	---	----	8	124	---	O	103.04	9-27-65	1690	---	Former Golden L. Tower site
26-1	NE SE	Univ. of Michigan	Layne N.W.	1945	8	106	Gd	P	-----	----	1660	---	Camp Filbert Roth
36-1	SW NW	U. S. Forest Service	---	----	6	---	Gd?	P	29.11	8-23-65	1620	---	Golden L. Campground

Table 5.--Records of Wells.--Continued

Well number	Location in section	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
45N 31W 7-1	SE SE	Harry Patrick	---	----	1¼	---	Gd	P	-----	----	1490	---	
24-1	SE SE	K. Mattila	Owner	----	1¼	20	Gd	D	-----	----	1460	---	
25-1	NE NW	Chas. Blaim	Owner	----	1¼	25	Gd	D	-----	----	1450	---	Occasionally has musty smell
26-1	NW NE	J. Albrecht	Anderson	1961	5	99	Pcr	P	17	1961	1445	---	
45N 32W 5-1	SE SE	A. Rogers	Owner	1957	1¼	24	Gd	D	-----	----	1560	---	
29-1	SW SW	A.&L. Aeschliman	Former owner	----	1¼	30	Gd	D	-----	----	1540	---	Dry awhile in '63
45N 33W 8-1	SW SW	Basilio Prandi	WMP	1959	1¼	33	Gd	O	27.11	11-1-65	----	---	WMP obs. well
8-2	SW SW	Basilio Prandi	Tuominen	----	6	91	Gd	D	-----	----	1570	---	
10-2	SE NW	Ervin Evans	---	----	1¼	32	Gd	D	9.04	5-5-65	1540	---	
18-1	NW NW	F. Columbino	---	----	6	41	Gd	D	18.71	8-19-65	1545	---	
45N 36W 23-1	NE NE	U. S. Forest Service	---	----	48	22	Gd	O	6.15	3-1-57	1580	---	WMP obs. well; destroyed 1957
45N 37W 18-1	SE NW	U. S. Forest Service	---	----	5	187	Gd	P	132.69	9-21-65	1770	---	Mallard L. Tower
23-1	SW NE	U. S. Forest Service	WMP	----	1¼	9	Gd	O	3.34	7-22-65	1600	---	WMP obs. well
46N 31W 30-1	NE SW	USGS	USGS	1965	1¼	8	Gd	O	0	11-11-65	1560	---	Casing removed
46N 33W 6-1	NE SW	Joseph Lang	---	1945	---	125	Pcr	D	-----	----	1520	40	
18-1	SW NW	Mich. Hwy. Dept.	WMP	----	1¼	13	Gd	O	8.25	11-1-65	1550	---	WMP obs. well
46N 34W 13-1	SW NW	J. Poulos	---	----	6	---	Gd	D	31.78	5-5-65	1520	---	
14-1	NE NW	Oliver Iron Mining Co.	WMP	----	1¼	12	Gd	O	7.30	11-1-65	1520	---	WMP obs. well
46N 35W 4-1	NE NE	U. S. Forest Service	---	----	6	25?	Gd	P	19.62	9-15-65	1535	---	Norway L. Picnic area
4-2	SE NE	U. S. Forest Service	---	----	6	20?	Gd	P	4.80	9-15-65	1530	---	Norway L. Camping area
7-1	SE SE	U. S. Forest Service	---	----	6	---	Gd	P	-----	----	1560	---	Kidney L. Campground
7-2	SE SE	U. S. Forest Service	---	----	6	54?	Gd	P	35.74	9-15-65	1560	---	Kidney L. Boat landing
22-1	SW SW	U. S. Forest Service	---	----	6	31?	Gd?	P	13.80	8-23-65	1540	---	Perch L. campground
29-1	NW SW	Ivan Heminiger	Wilcox & Audio	1958	---	35	Gd?	P	30	1958	1580	---	Supplies 4 cottages
31-1	SW SW	M. Dettling	Tuominen	----	5	52	Gd	D	42	----	1500	---	
46N 36W 4-1	NW SE	J. J. Gendzwill	Johnson	1951	5	68	Gd	D	28	1951	1540	---	
7-1	SE SW	U. S. Forest Service	---	----	6	120	Gd	P	-----	----	1725	---	Tepee Tower
35-1	NW SE	F. Good	---	----	2	30	Gd	P	-----	----	1560	---	
46N 37W 13-1	NE NW	U. S. Forest Service	Anderson	1963	6	103	Gd	P	52.38	9-16-65	1580	---	Tepee L. campground
13-2	NE NW	U. S. Forest Service	Anderson	1963	6	93	Gd	P	38.29	9-16-65	1580	---	Tepee L. Picnic area
27-1	NW SE	I. M. Hougham	---	----	1¼	48	Gd	D	-----	----	1620	---	
27-2	NE NE	John Kern	Johnson	1940	6	125?	Gd?	D	-----	----	1620	---	
27-3	NE NE	John Kern	---	----	4	70	Gd?	D	40.89	10-9-45	1620	---	No longer used; poor yield

Table 6.--Logs of wells in Iron County

Thickness in feet. Depth in feet below land surface.
Altitude in feet above mean sea level.

	Thick-ness	Depth
TOWNSHIP 41 NORTH; RANGE 31 WEST		
41N 31W 14-1 R. Abraham SE¼ NW¼ Section 14 Altitude: 1300		
Sandy loam	3	3
Boulders and clay	12	15
Sand	5	20
Gravel	1	21
Intermittent formations of clayey sand and hard red shale	69	90
Ledge (soft, heavily laden with mica)	16	106
TOWNSHIP 41 NORTH; RANGE 32 WEST		
41N 32W 11-1 George Gruell SE¼ SE¼ Section 11 Altitude: 1240		
Sand and gravel	20	20
Hardpan	15	35
Sand and gravel	7	42
TOWNSHIP 42 NORTH; RANGE 31 WEST		
42N 31W 6-1 Leonard Olson SW¼ SE¼ Section 6 Altitude: 1320		
Sand	4	4
Sand and gravel	16	20
Sand, gravel and silt	12	32
Coarse sand	8	40
TOWNSHIP 42 NORTH; RANGE 32 WEST		
42N 32W 26-1 Iron Co. Airport SE¼ NW¼ Section 26 Altitude: 1340		
Sand	50	50
Silt	10	60
Sand	5	65
Clay	20	85
Hardpan	15	100
Gravel	10	110
42N 32W 29-1 Mrs. Gursky NW¼ NW¼ Section 29 Altitude: 1400		
Hardpan (red)	30	30
Hardpan (black and gray)	8	38
Hardpan (red)	14	52
Ledge (gray)	18	70
Ledge (red)	20	90
TOWNSHIP 42 NORTH; RANGE 33 WEST		
42N 33W 13-2 Edwin Kascielski NE¼ NE¼ Section 13 Altitude: 1400		
Fine sand	30	30
Clay	2	32
Fine sand	11	43
Clay	43	86
Gravel	4	90
42N 33W 15-1 William Jutila SE¼ NW¼ Section 15 Altitude: 1435		
Open well	42	42
Hardpan (red)	20	62
Gravel (red)	1	63
Hardpan (red)	7	70
Gravel and silt	5	75
Hardpan (red)	8	83
Sand and silt (gray)	9	92
Sand (brown)	7	99
Hardpan (red)	57	156
Ledge (red and brown)	44	200
42N 33W 15-2 John Romanowski NE¼ SE¼ Section 15 Altitude: 1380		
Coarse sand	43	43
42N 33W 28-1 J. A. Gondek SE¼ SW¼ Section 28 Altitude: 1330		
Surface soil	5	5
Gravel 18 and 19½ ft. blast boulders	30	35
Black silt	5	40
Fine gray sand	10	50
Fine red sand	10	60
Fine sand and clay mixed	2	62
Sharp, clean gray sand	6	68
TOWNSHIP 42 NORTH; RANGE 34 WEST		
42N 34W 25-1 Ralph Mathison SE¼ SE¼ Section 25 Altitude: 1395		
Hardpan and boulders	32	32
Sand and clay	58	90
Fine sand	5	95
Sand and gravel	4	99
TOWNSHIP 42 NORTH; RANGE 35 WEST		
42N 35W 20-1 Brule Mt. Ski Area NE¼ NE¼ Section 20 Altitude: 1540		
Surface water, muck and boulders	4	4
Brown clay	14	18
Silty and clayey sand and water	3	21
Hardpan, gravel and boulders	3	24
Clean hard gravel and water	4	28
Less consolidated gravel, very coarse chips	4	32
Boulder or ledge		32
TOWNSHIP 43 NORTH; RANGE 31 WEST		
43N 31W 4-1 Jack Sophie SE¼ SW¼ Section 4 Altitude: 1390		
Humus	5	5
Red clay	10	15
Paint Rock	5	20
Hematite	30	50
43N 31W 24-1 Peter Mitchell NW¼ NE¼ Section 24 Altitude: 1400		
Clay loam	15	15
Hardpan	10	25
L. S. floater	9	34
Clay (red)	5	39
Slate	20	59
43N 31W 26-1 Fransis Drake SE¼ NE¼ Section 26 Altitude: 1400		
Sand	6	6
Gravel and boulders	19	25
Coarse sand	5	30
43N 31W 33-1 Mansfield Twp. Park NE¼ SE¼ Section 33 Altitude: 1320		
Sand	15	15
Mica sand, fine	15	30
Mica sand, dirty, silty	1	31

Table 6.--Logs of wells in Iron County.--Continued

	Thick-ness	Depth
43N 31W 35-1		
Mansfield Twp. Hall		
NE¼ NW¼ Section 35		
Altitude: 1380		
Pit	8	8
Sand, a little clay	22	30
Fine sand	7	37
Sharp sand	13	50
43N 31W 36-1		
Robert Magray		
SE¼ NW¼ Section 36		
Altitude: 1420		
Clay hardpan (red)	38	38
Ledge (gray)	32	70
43N 31W 36-2		
Alex MacLeod		
NW¼ NW¼ Section 36		
Altitude: 1405		
Topsoil	6	6
Hardpan (brown)	16	22
Coarse sand	6	28
Sand, silt, and clay	27	55
Clay (red)	6	61
Hardpan (red)	7	68
Clay (red)	3	71
Broken ledge (red)	4	75
TOWNSHIP 43 NORTH; RANGE 32 WEST		
43N 32W 6-1		
James Wittock		
NW¼ SW¼ Section 6		
Altitude: 1380		
Sand (red)	10	10
Clay and sand (gray)	32	42
Sand (brown)	12	54
Quicksand (gray)	12	66
Gravel (gray)	2	68
TOWNSHIP 43 NORTH; RANGE 33 WEST		
43N 33W 21-1		
William Honkola		
SE¼ SW¼ Section 21		
Altitude: 1540		
Gravel	18	18
Gravel and boulders	42	60
Hardpan	3	63
Gravel	7	70
Hardpan and gravel	40	110
Gravel	5	115
Hardpan	20	135
Sand	13	148
43N 33W 31-1		
F. G. Pardee		
SE¼ SW¼ Section 31		
Altitude: 1500		
Hardpan and boulders (very dry)	71	71
Streaks of sand (sandy hardpan)	3	74
Tight dirty sand and gravel	3	77
Coarse gravel	8	85
Sand and gravel	5	90
Coarse gravel	3	93
Boulders and very coarse gravel	7	100
(Note--all of above formation was completely dry)		
Dirty sand and gravel	4	104
Sandy hardpan	4	108
Dirty sand and gravel	7	115
Red sandy clay	10	125
(Note--all of the above formation was dry)		
Muddy fine sand - wet	8	133
Coarse sand and gravel	9	142
Dark sand may contain maganese causing hard water	1	143
TOWNSHIP 43 NORTH; RANGE 34 WEST		
43N 34W 24-1		
Edward Schlasser		
NW¼ SE¼ Section 24		
Altitude: 1420		
Surface	2	2
Black muck	5	7
Hardpan and boulders	19	26
Hardpan and gravel	2	28
Gravel and coarse sand	4	32
43N 34W 24-2		
John Strazer		
NW¼ SE¼ Section 24		
Altitude: 1420		
Sand fill	2	2
Black muck	5	7
Hardpan	13	20
Sand	4	24
Hardpan (blue)	3	27
Ledge (blue)	5	32
43N 34W 24-3		
W. J. Phillips		
NW¼ SE¼ Section 24		
Altitude: 1420		
Clayey sand and gravel	3	3
Sand	12	15
Hardpan and boulders	10	25
Gravel (dirty)	10	35
Dirty coarse sand	3	38
Gravel and water	½	38½
TOWNSHIP 43 NORTH; RANGE 35 WEST		
43N 35W 23-1		
M. A. Hanna (Homer-Wauseca Mine)		
NW¼ NE¼ Section 23		
Altitude:		
No sample	2	2
Gravel with a little sand	23	25
Sand, medium to coarse with coarse gravel	18	43
Gravel coarse, boulders	7	50
Clay	10	60
Gravel, coarse, small amount of sand	2	62
No sample	5	67
Sand, tan, medium to coarse, clean	7	74
Sand, iron stained, fine to medium, jospilite	29	103
Ledge, precambrian	2	105
43N 35W 24-1 (test hole)		
Johnson		
NE¼ SE¼ Section 24		
Altitude: 1600		
Sand, gravel and clay	22	22
Coarse gravel	14	36
Coarse gravel and boulders	4	40
Coarse gravel	15	55
Gravel	5	60
Sand	2	62
Gravel	48	110
Broken ledge	3	113
Ledge at		113
TOWNSHIP 44 NORTH; RANGE 31 WEST		
44N 31W 26-1		
T. J. Bailey		
NE¼ SE¼ Section 26		
Altitude: 1395		
Sandy loam	10	10
Hardpan	10	20
Hardpan and gravel	10	30
Gravel hardpan	6	36
Sand and water	4	40
44N 31W 26-2		
T. J. Bailey		
NE¼ SE¼ Section 26		
(200' West of 26-1)		
Altitude: 1395		
Sandy loam	5	5
Sandy hardpan	15	20
Gravel, hardpan, clay stringers	10	30
Clayey sand	10	40
Medium coarse sand, water	4	44

	Thick-ness	Depth
44N 31W 26-3		
Welton Hosking		
NW¼ SE¼ Section 26		
Altitude: 1400		
Topsoil	8	8
Sand, silty	40	48
Sand, clean	2	50
Fine sand and water	6	56
44N 31W 26-4		
Art Peterson		
NE¼ SW¼ Section 26		
Altitude: 1400		
Hardpan and boulders	20	20
Red clayey sand	15	35
Fine sand and water	5	40
Intermittant layers sand and clay	2	42
Medium coarse sand and water	12	54
44N 31W 26-5		
Vince Ball		
SE¼ SE¼ Section 26		
Altitude: 1390		
Sandy loam	5	5
Brown, wet clay	13	18
Coarse gravel with clay seams	17	35
Coarse sand and water	7	42
44N 31W 34-1		
Frank Phelan (Phelan's Resort)		
SE¼ NW¼ Section 34		
Altitude: 1400		
Sand	23	23
Hardpan	7	30
Clay	10	40
Hardpan, with gravel	10	50
Slate	2	52
Soapstone	10	62
Clay and rock	3	65
Slate	35	100
TOWNSHIP 44 NORTH; RANGE 33 WEST		
44N 33W 7-1		
Robert Jackson		
SE¼ NW¼ Section 7		
Altitude: 1500		
Hardpan and boulders	27	27
Gravel and sand	6	33
44N 33W 7-3		
Henry Rajala		
NE¼ NW¼ Section 7		
Altitude: 1515		
Existing well	36	36
Hardpan (brown)	60	96
Sand and gravel	2	98
Hardpan (brown)	5	103
Ledge	29	132
44N 33W 17-1		
Stuart Dickinson		
SW¼ SW¼ Section 17		
Altitude: 1395		
Topsoil	2	2
Hardpan (gray)	20	22
Fine sand and gravel (brown)	4	26
Gravel (gray)	3	29
44N 33W 35-1		
Albert Anderson		
NW¼ SE¼ Section 35		
Altitude: 1410		
Coarse gravel	17	17
Coarse sand	4	21
Gravel	8	29
Gravel, water	2	31
44N 33W 35-2		
Rev. C. Petronek		
NW¼ SE¼ Section 35 (300' SW of 35-1)		
Altitude: 1410		
Gravel and boulders	12	12
Fine sand and gravel	5	17
TOWNSHIP 46 NORTH; RANGE 31 WEST		
46N 31W 30-1 (Test well)		
U. S. Geological Survey		
NE¼ SW¼ Section 30		
Altitude: 1560		
Muck	3	3
Clay, gravel and sand	2	5
Sand and gravel	3	8
TOWNSHIP 46 NORTH; RANGE 35 WEST		
46N 35W 29-2		
D. O. Wigle		
NW¼ SW¼ Section 29		
Altitude: 1590		
Topsoil	2	2
Hardpan	6	8
Gravel	8	16
Hardpan and boulders	17	33
Sand and gravel	3	36
Gravel	10	46
Coarse gravel	2	48
46N 35W 31-1		
Maurice Dettling		
SW¼ SW¼ Section 31		
Altitude: 1500		
Sand and clay	4	4
Sand and gravel	16	20
Boulders	8	28
Sand	24	52
TOWNSHIP 46 NORTH; RANGE 37 WEST		
46N 37W 13-1		
U. S. Forest Service		
NE¼ NW¼ Section 13		
Altitude: 1580		
Glacial drift	103	103
46N 37W 13-2		
U. S. Forest Service		
NE¼ NW¼ Section 13		
Altitude: 1580		
Glacial drift	93	93

TABLE 7.--WELL YIELDS

Well Number	Aquifer Pcr - Precambrian rocks Gd - Glacial drift	Yield (gal/min)	Drawdown (feet)	Duration of test (hours)	Specific capacity (gal/min/ft/ drawdown	Surface formation
41N 31W 14-1	Pcr	17	7	4	2.4	Moraine
41N 32W 11-1	Gd	30	5	2	6.0	Outwash
42N 31W 6-1	Gd	5	4	----	1.2	Outwash
42N 32W 15-1	Gd	480	43	----	11.0	Outwash
26-1	Gd	20	6	2	3.3	Outwash
29-1	Pcr	1	--	----	----	Till plain
42N 33W 1-1	Pcr	5	--	----	----	Till plain
1-2	Pcr	8	55	8	0.1	Till plain
13-1	Gd	60	--	----	----	Outwash
13-2	Gd	8	--	----	----	Outwash
15-2	Gd	5	--	----	----	Till plain
28-1	Gd	20	--	----	----	Outwash
42N 34W 9-1	Gd	300	19	4	15.7	Till plain
13-1	Gd	79	21	11	3.8	Till plain
25-1	Gd	20	4	6	5.0	Outwash
25-2	Gd	8	30	----	0.3	Outwash
42N 35W 1-1	Gd	240	--	8	----	Till plain (?)
1-2	Gd	480	16	9.5	30.0	Till plain (?)
11-1	Gd	125	--	----	----	Swamp deposit
20-1	Gd	15	5	2	3.0	Bedrock at or near surface
20-2	Gd	10	--	----	----	Bedrock at or near surface
42N 36W 10-1	Gd	345	--	----	----	Outwash
11-1	Gd	8	--	----	----	Outwash
11-2	Gd	150	--	----	----	Outwash
18-1	Gd	10	--	----	----	Outwash
43N 31W 4-1	Pcr	40	20	1	2.0	Outwash
16-1	Pcr	10	50	2	0.2	Till plain
24-1	Pcr	3	28	3	0.1	Outwash
26-1	Gd	10	4	2	2.5	Outwash
33-1	Gd	10	6	2	1.7	Outwash
35-1	Gd	30	6	1.5	5.0	Outwash
36-1	Pcr	6	14	----	0.4	Outwash
36-2	Pcr	16	2	----	8.0	Outwash
43N 32W 6-1	Gd	8	17	----	0.5	Moraine
21-1	Gd	250	--	----	----	Swamp deposit
21-2	Gd	400	--	----	----	Swamp deposit
21-3	Gd	400	--	----	----	Swamp deposit
21-6	Gd	30	--	----	----	Swamp deposit
28-2	Gd	150	--	----	----	Outwash
43N 33W 21-1	Gd	30	5	3	6.0	Till plain
31-1	Gd	50	--	2	----	Moraine
43N 34W 24-1	Gd	8	9	----	0.9	Moraine
24-2	Pcr	8	16	----	0.5	Moraine
24-3	Gd	30	10	2	3.0	Swamp deposit
28-1	Gd	200	--	----	----	Till plain
43N 35W 16-1	Gd	85	3	1	28.0	Outwash
21-1	Gd	250	--	----	----	Till plain
23-1	Gd	1,770	--	----	----	Till plain
26-2	Gd	400	--	----	----	?
43N 36W 1-3	Gd	250	--	----	----	Outwash
36-1	Gd	15	--	----	----	Till plain
44N 31W 26-1	Gd	10	--	----	----	Moraine
26-2	Gd	5	20	4	0.3	Moraine
26-3	Gd	35	5	4	7.0	Moraine
26-4	Gd	25	15	3	1.7	Moraine
26-5	Gd	30	10	2	3.0	Moraine
44N 33W 7-1	Gd	6	8	----	0.8	Till plain
8-3	Gd	200	--	6	----	Outwash
16-1	Gd	100	6	6	17.0	Till plain
16-2	Gd	400	--	11	----	Till plain
17-1	Gd	8	4	----	2.0	Till plain
35-1	Gd	3	10	----	0.3	Moraine
35-2	Gd	7	6	----	1.0	Moraine
45N 31W 26-1	Pcr	14	70	5	0.2	Outwash
46N 35W 29-2	Gd	2.5	4	----	0.6	Moraine
46N 37W 13-1	Gd	10	12	----	0.8	Moraine
13-2	Gd	5	18	----	0.3	Moraine

Table 8.--Chemical constituents of water from spring-fed ponds

Weather: S - Bright sun; C - Cloudy; R - Rain.
Altitude estimated from U. S. G. S. topographic maps.

Number	Location in sec. ¼ ¼	Owner	Date sampled	Weather	Air Temp. °F	Water Temp. °F	Specific conductance (micromhos @25°C)	Hardness (ppm)	Iron (ppm)	Dissolved oxygen (ppm)	pH	Altitude	Remarks
42N 33W 24-1	SE SW	Louis Kurtz	9/ 9/65	S	74	64	120	51	0.2	15	> 10	1480	Spring uncovered in one end of pond, bedrock exposed at opposite end. Water has green tint.
43N 33W 20-1	NE NW	Bernard Pringle	9/ 9/65	C,R	65	60	240	136	0	9.4	7.9	1420	2 bubbling springs near West end. Est. discharge at pond overflow 10 gpm, water clear, does not freeze.
43N 33W 27-1	SW NW	Earnest Reiman	9/ 9/65	C,R	65	62	400	238	0	8.0	7.9	1400	2 bubbling springs, water level in pond very stable, pond does not freeze in vicinity of springs.
44N 36W 19-2	SW SW	Elmer Virkler	10/ 1/65	S	59	52	70	17	1.0	13.8	8.0	1590	Pond 200'x75' spring near center, water level very stable, water has slight green tint.

Table 9.--Chemical constituents of water from springs

Altitude estimated from U. S. G. S. topographic maps.

Number	Location in sec. ¼ ¼	Owner	Date Sampled	Estimated yield gpm	Water Temp. °F	Specific conductance (micromhos @25°C)	Hardness (ppm)	Iron (ppm)	Dissolved oxygen (ppm)	pH	Altitude	Remarks
43N 34W 1-1	NW NW	Joseph Gendzwill	8/18/65	1	47	245	120	0	----	7.0	1440	Wooden barrel buried in hillside.
44N 33W 8-4	NW SW	Arne Maki	9/14/65	1	57	80	34	0.4	----	6.7	1470	Spring in boggy area on hillside, surrounding area is heavy clay soil. Water piped to stock tank.
45N 32W 5-2	NE NE	Sherwin Glass	9/30/65	30	45	190	102	0	----	7.9	1560	Crib 2 ft. in dia. 2-1¼ inch pipe outlets in hillside just above stream valley.
45N 34W 29-1	SE SW	Mich. Dept. Cons.	8/19/65	1	47	90	51	3.0	4.6	6.1	1430	Sampled at source, seeps out of bank above river.
45N 34W 29-1	SE SW	Mich. Dept. Cons.	8/19/65	--	--	---	---	4.0	8.4	6.5	----	Sampled 50 ft. downgrade from source.