U.S. Department of the Interior

Geological Survey

WATER

AND THE

MINNESOTA IRON RANGE

By

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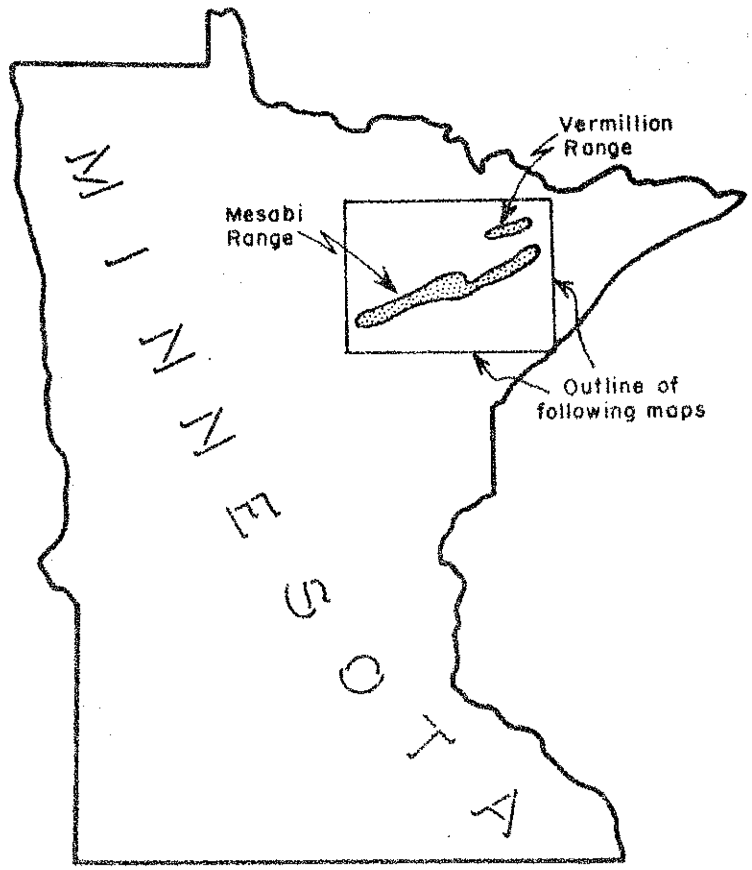
Prepared in cooperation with the

Department of Iron Range Resources and Rehabilitation

1963



Economically important parts of Mesabi and Vermillion Iron Ranges

The economy of the Iron Range areas in Minnesota is currently severely depressed. Prosperity on the Range will come only with full utilization of the area's major raw materials:

TACONITE

WOOD

PEAT

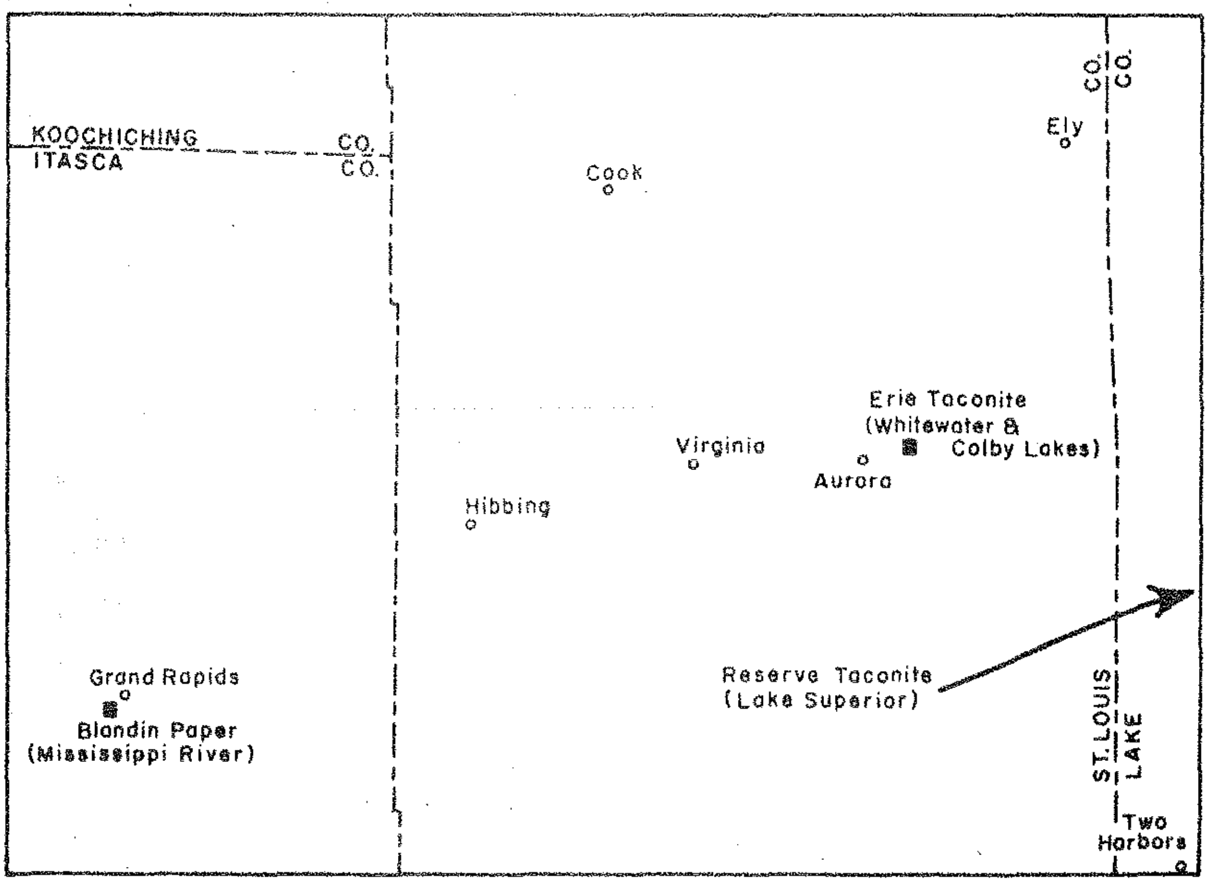
Water is needed for utilization of these raw materials.

One ton of finished Taconite pellets requires more than 10,000 gallons of water.

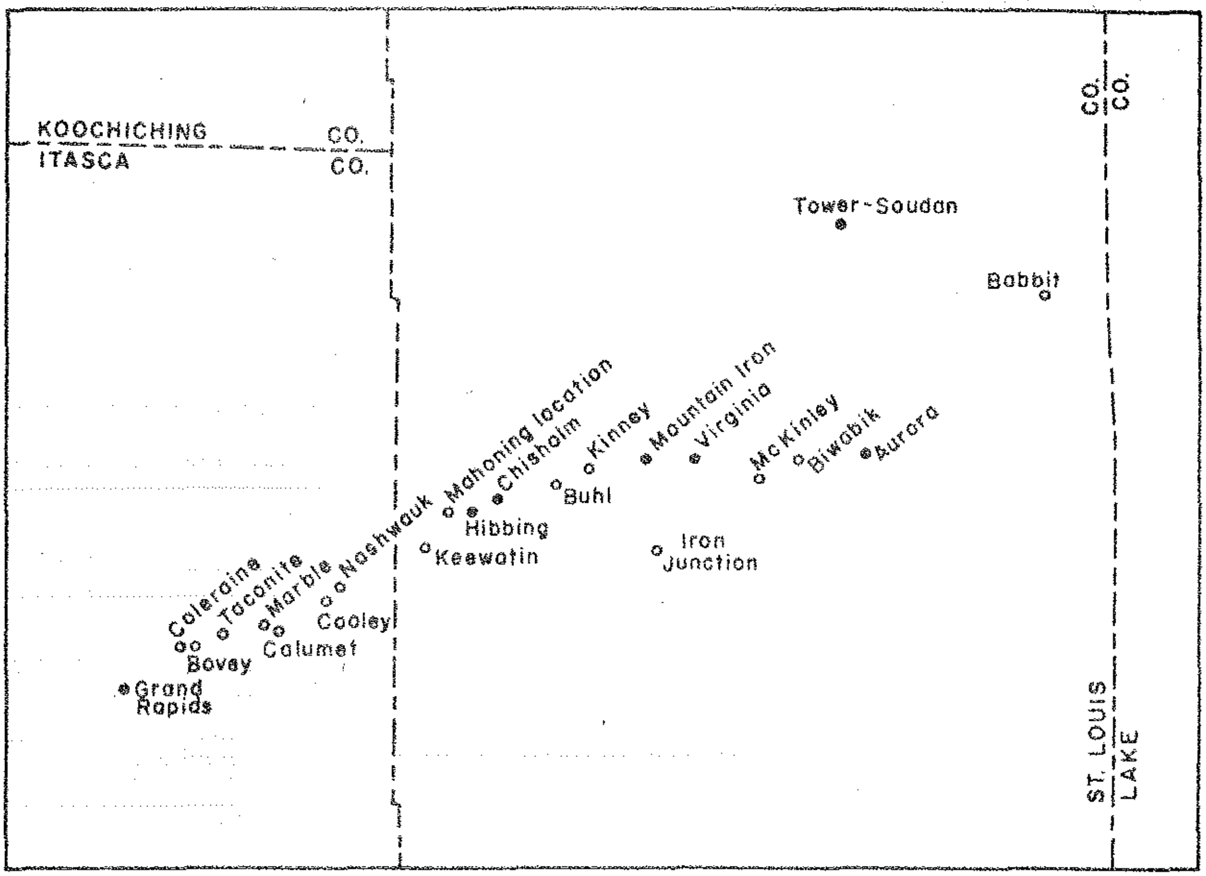
One ton of fine paper requires 184,000 gallons of water.

Production of chemicals from peat requires large quantities of water.

The location of adequate supplies of good quality water is the major factor in the selection of sites for the industrial plants that process these raw materials.



Location of large industrial water users and their source of water.



Municipalities having ground-water supplies

Water is needed for municipal supplies.

Because ground water is available all year, because it can be obtained close to the area of demand, and because it requires relatively little treatment, it is the major source of supply for Range towns. Extension of mines and increasing municipal water demands require frequent relocation and expansion of water systems. Data collected and interpreted by the U.S. Geological Survey is used extensively in locating sites where adequate water is available.

The Water Resources Division of the U.S. Geological Survey, in cooperation with State and local agencies, evaluates the water resources of the nation. In the Iron Range, studies are made in cooperation with the Department of Iron Range Resources and Rehabilitation. The investigation includes ground water (well water), surface water (lakes and streams), and the chemical quality of these waters. The goal is to <u>know</u>:

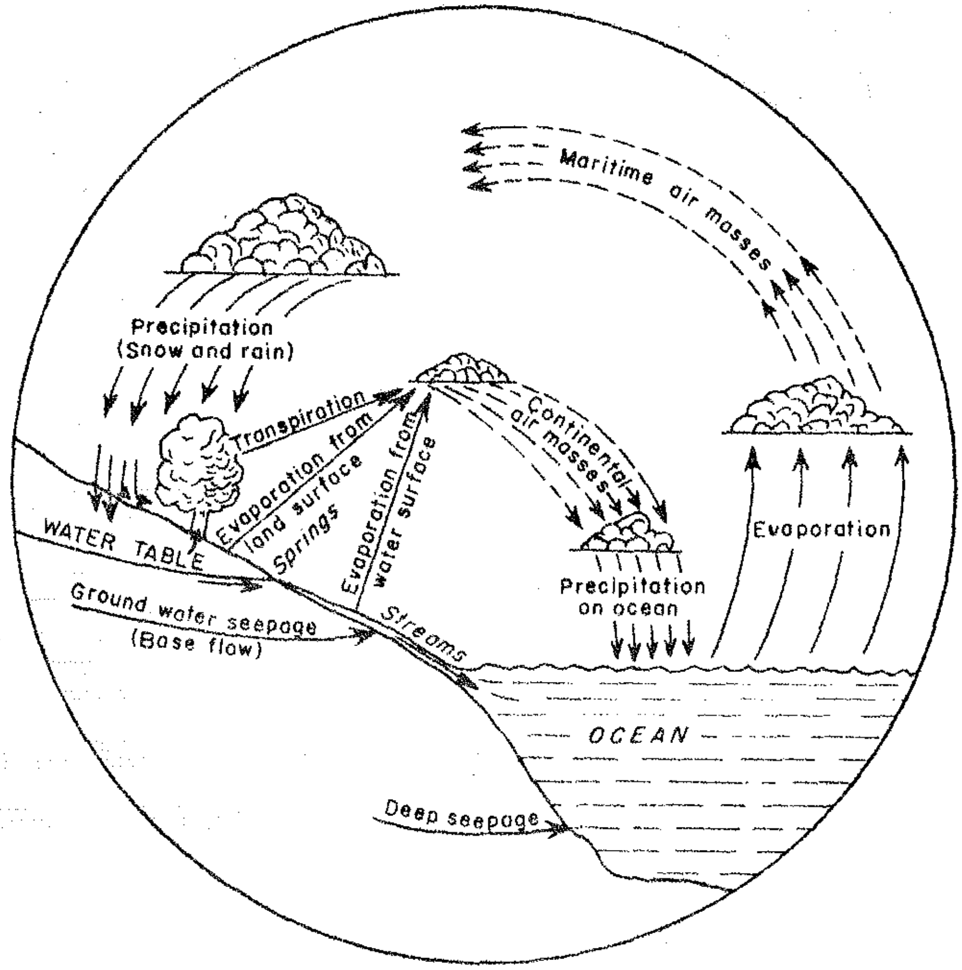
HOW WATER OCCURS

WHERE TO GET WATER

HOW MUCH WATER IS AVAILABLE

IS THE QUALITY GOOD

To know, we need water facts and interpretation.



Hydrologic cycle
(From Parker and others, 1955, fig. 2.)

HOW WATER OCCURS

Some of the water falling as precipitation runs off into streams and lakes; some enters the ground and becomes ground water; some evaporates and returns to the atmosphere. Surface water can be pumped directly from lakes and streams. Large quantities of ground water can be pumped from beneath the ground when wells are finished in permeable rock deposits or aquifers.

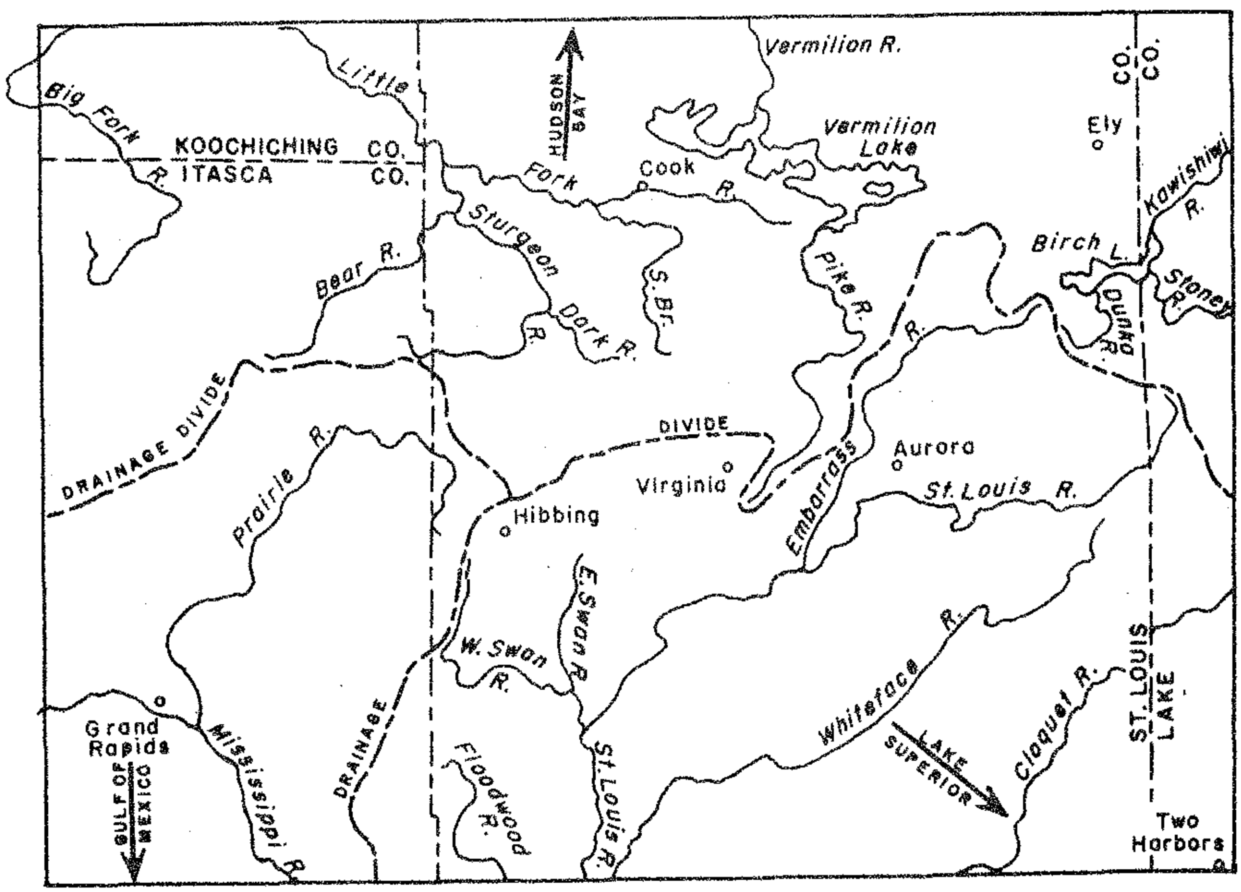
WHERE TO GET WATER

Water for industries and municipalities must come from sources that are adequate. The location of sources of water and the determination of the quantity of water available are the products of the Survey's investigation.

Surface Water

Large quantities of water are available from streams in the Range area. Where to get the best supply is the problem. The flow of selected streams must be gaged to know the quantity of water available at each site. Flow duration curves must be made to determine the percent of the time flow is adequate for needs. Flood frequency must be determined to design intake and storage structures properly. The water must be analyzed to determine whether the chemical quality is acceptable at all stages of flow. The source of supply should be close to the point of use.

Records of the flow of many of the streams in the Range have been published in U. S. Geological Survey Water-Supply Papers. Flood frequency curves are also available for some of the streams.

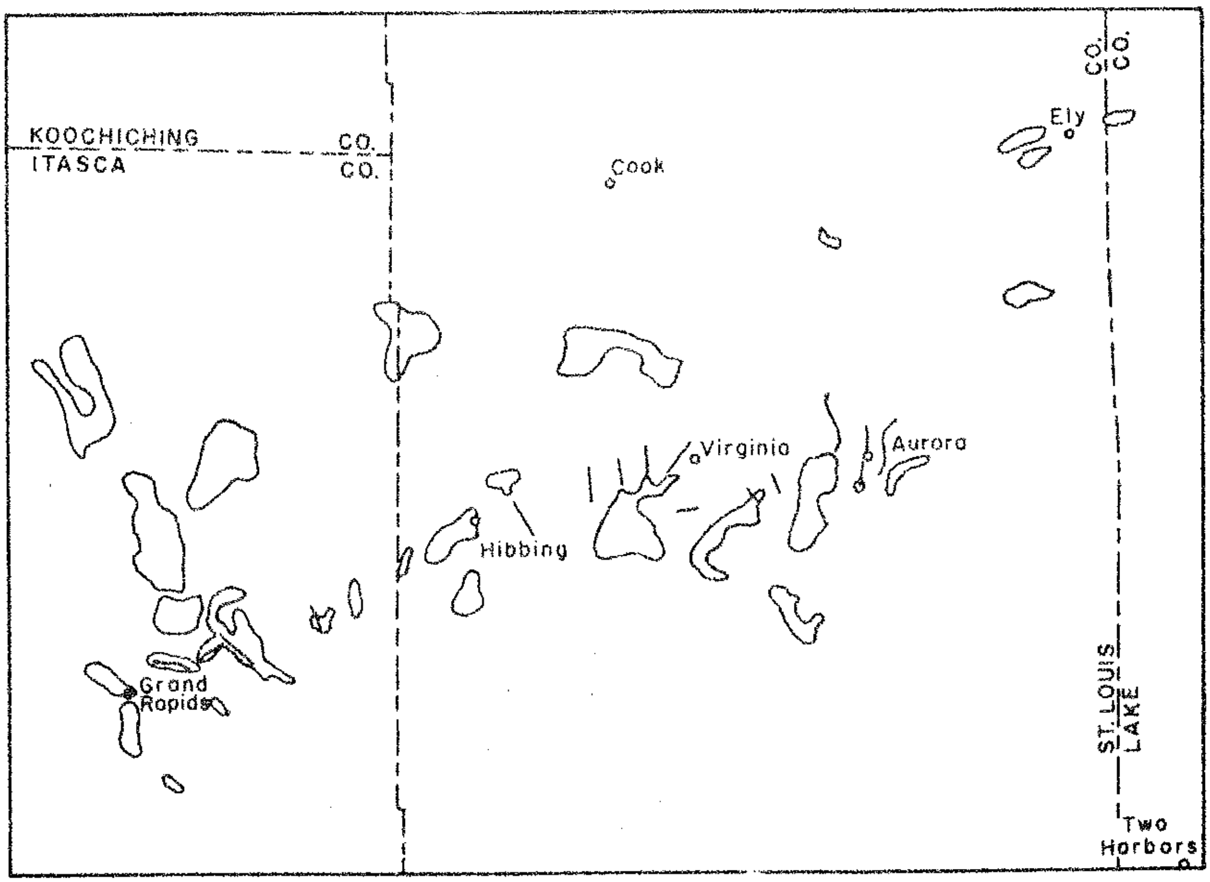


Major drainage divides and rivers

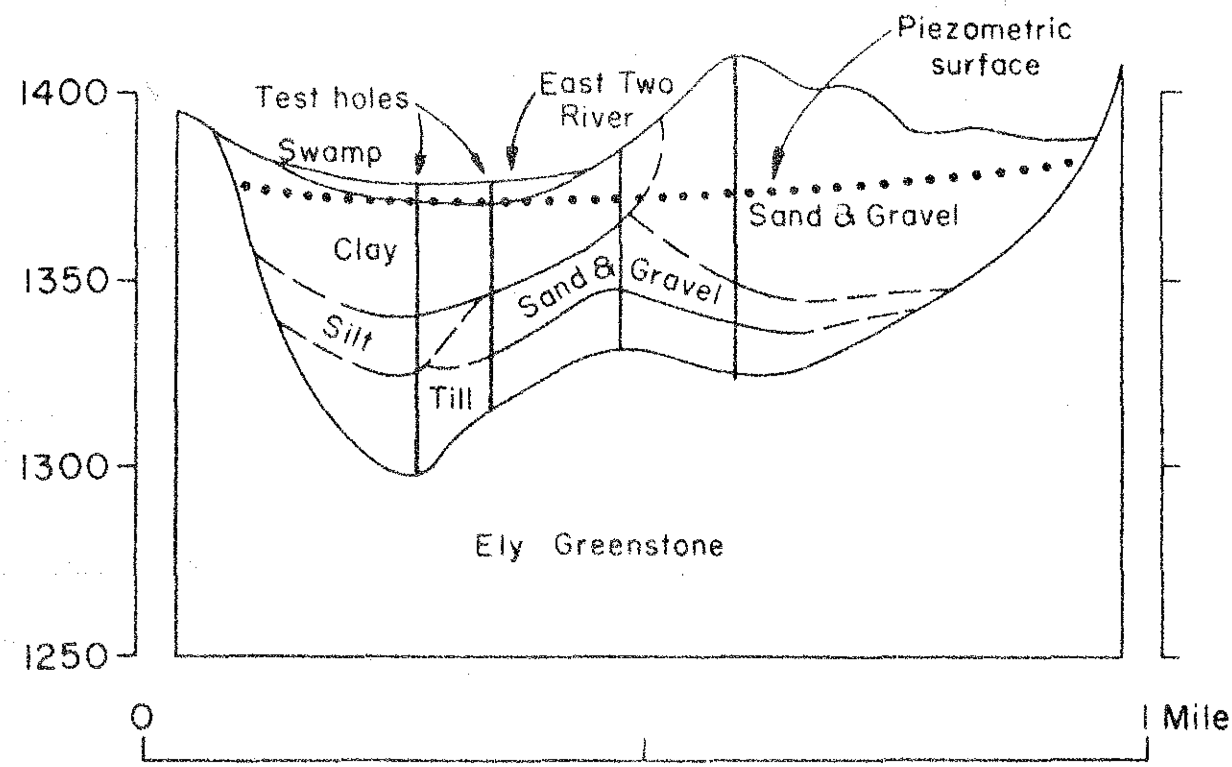
Ground Water

Ground water is locally the largest source of available water, but efficient use requires knowledge of its occurrence. For industry's needs, ground water reservoirs must be mapped and the quantity of water available from these reservoirs determined. The rate at which water can be withdrawn must also be determined. Many ground water reservoirs in the Range have been mapped by the U.S. Geological Survey in cooperation with the Department of Iron Range Resources and Rehabilitation. Data on each of the areas are available. Interpretive reports have been released to the public for areas near Mountain Iron, Virginia, and Chisholm, as well as for the Range as a unit.

Most of the available ground water is in sorted sand and gravel deposited by glaciers.



Major bedrock channels (/), and known and suspected areas of glacial sand and gravel aquifers (⬭).

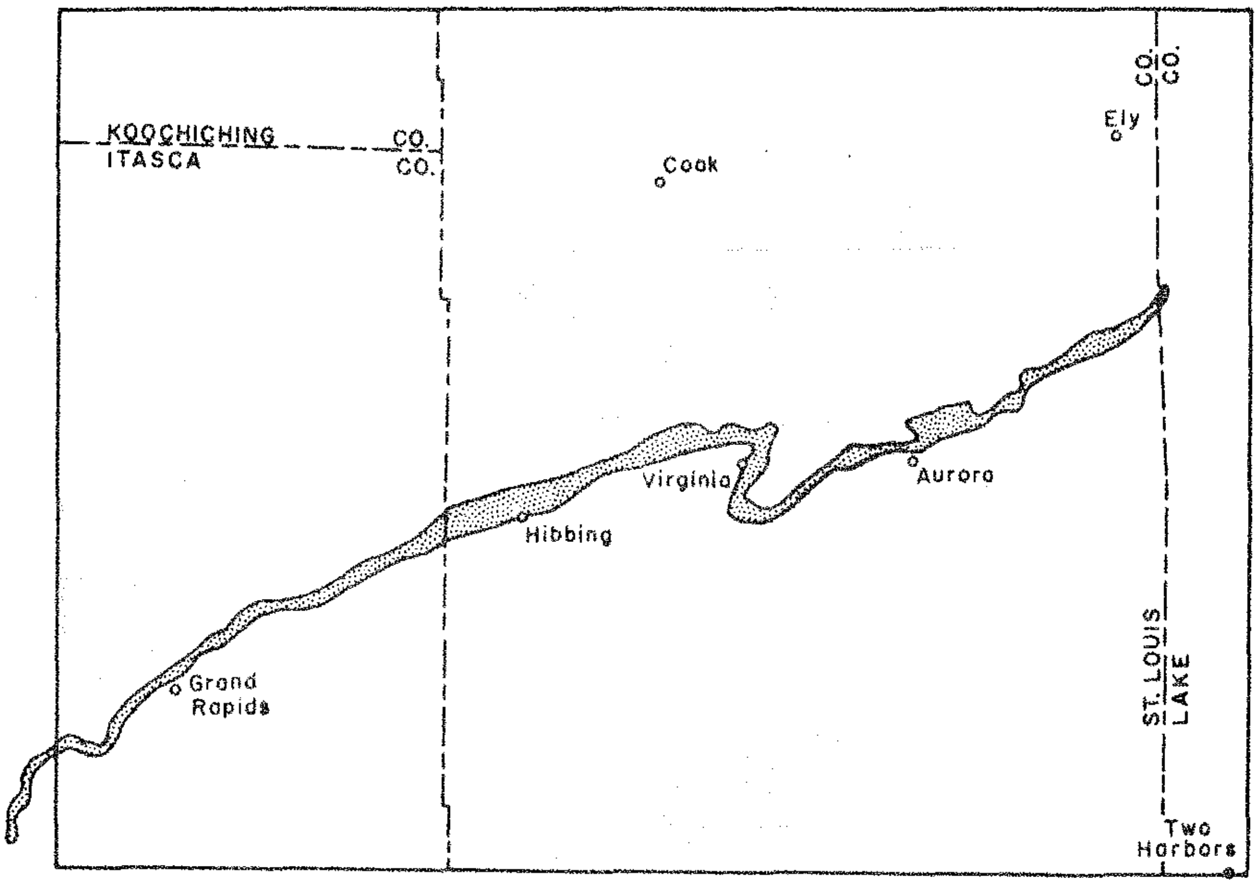


Cross section of rock types near Tower, Minn.

The glacial deposits in the Iron Range are multi-layered. In many sections the glacial deposits are all clay and yield no water to wells. Permeable deposits can be found by test drilling in areas that surface mapping indicates are favorable. Geologists use the logs of wells and test holes to construct cross sections that predict the type of deposits that lie between the test holes.

Cross sections help in determining the saturated area of channels, the percentage of permeable material in an area, and the volume of water in storage in a ground-water reservoir.

Large amounts also can be obtained from the Biwabik Iron-Formation. The amount available from this unit varies and is dependent upon the degree of fracturing and alteration of rocks at selected places.

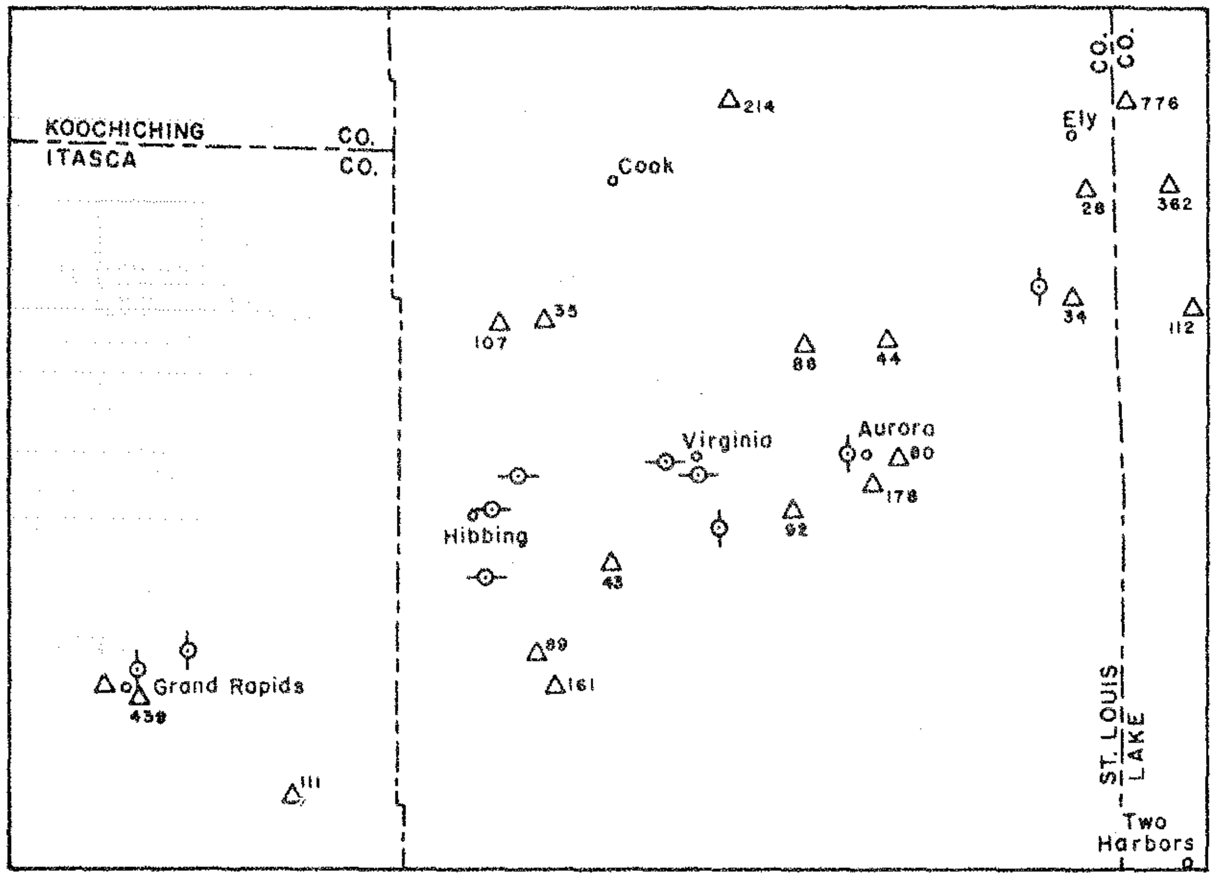


Preglacial outcrop area of the Biwabik Iron-Formation

(Now covered by glacial deposits)

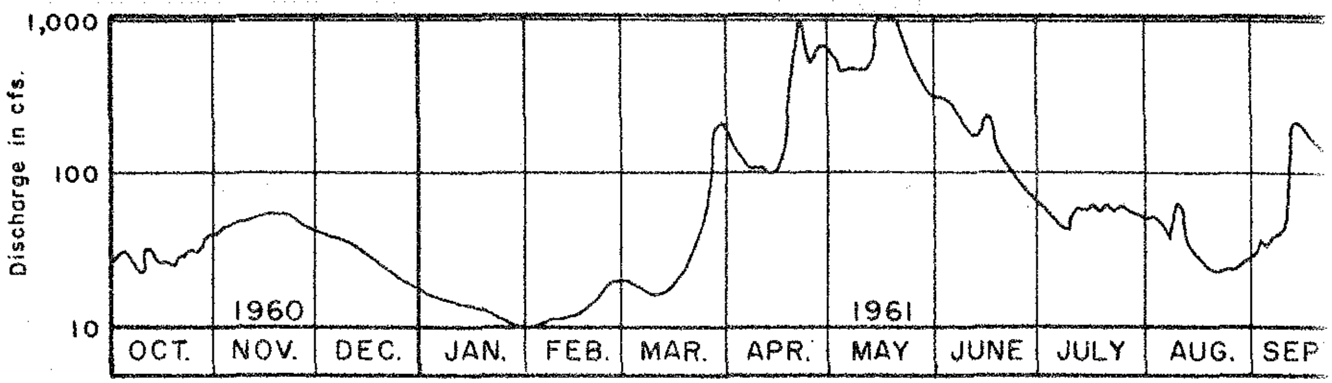
HOW MUCH IS AVAILABLE

Careful measurements of many kinds are needed to know how much water can be pumped from a ground-water reservoir or a surface-water body, and what the effect of withdrawal will be on the water resources of the area.



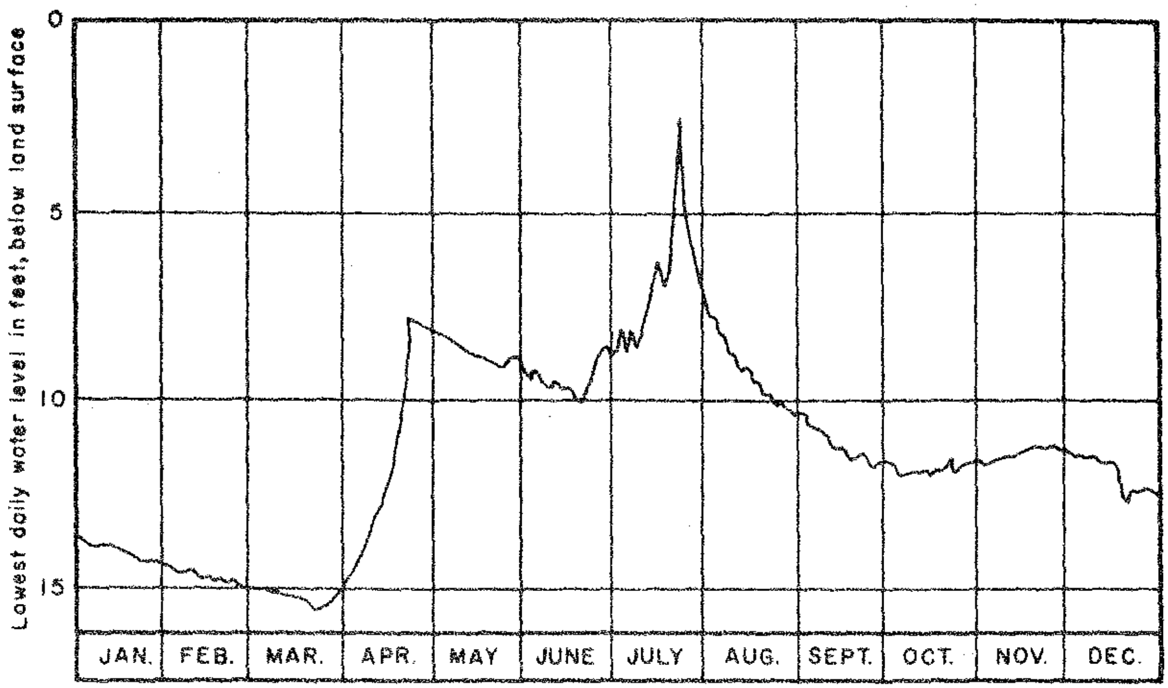
**Location of surface-water gaging stations (△) and ground-water observation wells (-⊙- operating; ⌽ undeveloped).
Surface-water stations show annual mean discharge in cubic feet per second for water year 1959.**

Gaging stations on streams are used to measure the amount of the stream at any given time. Observation wells are used to help measure the ground water in an area, just as stream gages are used to measure surface flow. Maximum value from these records comes where the geology and hydrology are understood. Observations of water levels are continued for long periods on some wells, short periods on others.



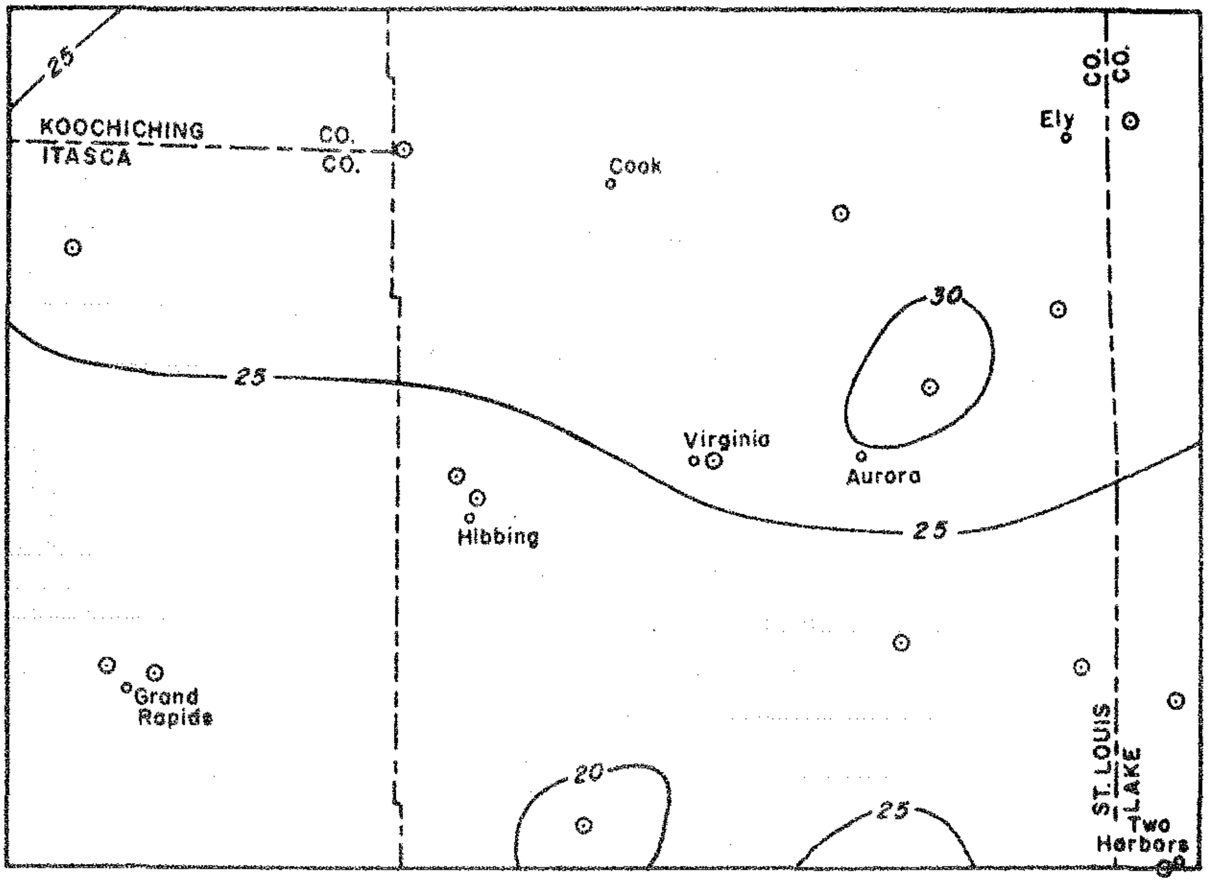
Hydrograph of St. Louis River near Aurora Minn., 1960-61.

Hydrographs of stream flow at gaging stations show distribution of run-off throughout the year. With the information, economical methods of use and storage can be developed. Long-term records are needed in order to know how to utilize fully the water available. For instance, stream flow records indicated that the water supply for the Hoyt Lakes taconite plant was adequate.



Hydrograph of observation well near Chisholm, Minn., for 1957.

Hydrographs of water levels in wells help us understand the relationship of ground water to the rest of the hydrologic cycle. This hydrograph shows the gradual decline of the water table during the winter of 1956-57; then the abrupt rise following the spring thaw; a peak in July resulting from heavy precipitation, followed by a gradual decline into the winter of 1957-58. Hydrographs of water levels in wells also indicate changes in the quantity of water stored in the ground, effects of drainage or floods, and the rate at which water moves underground.



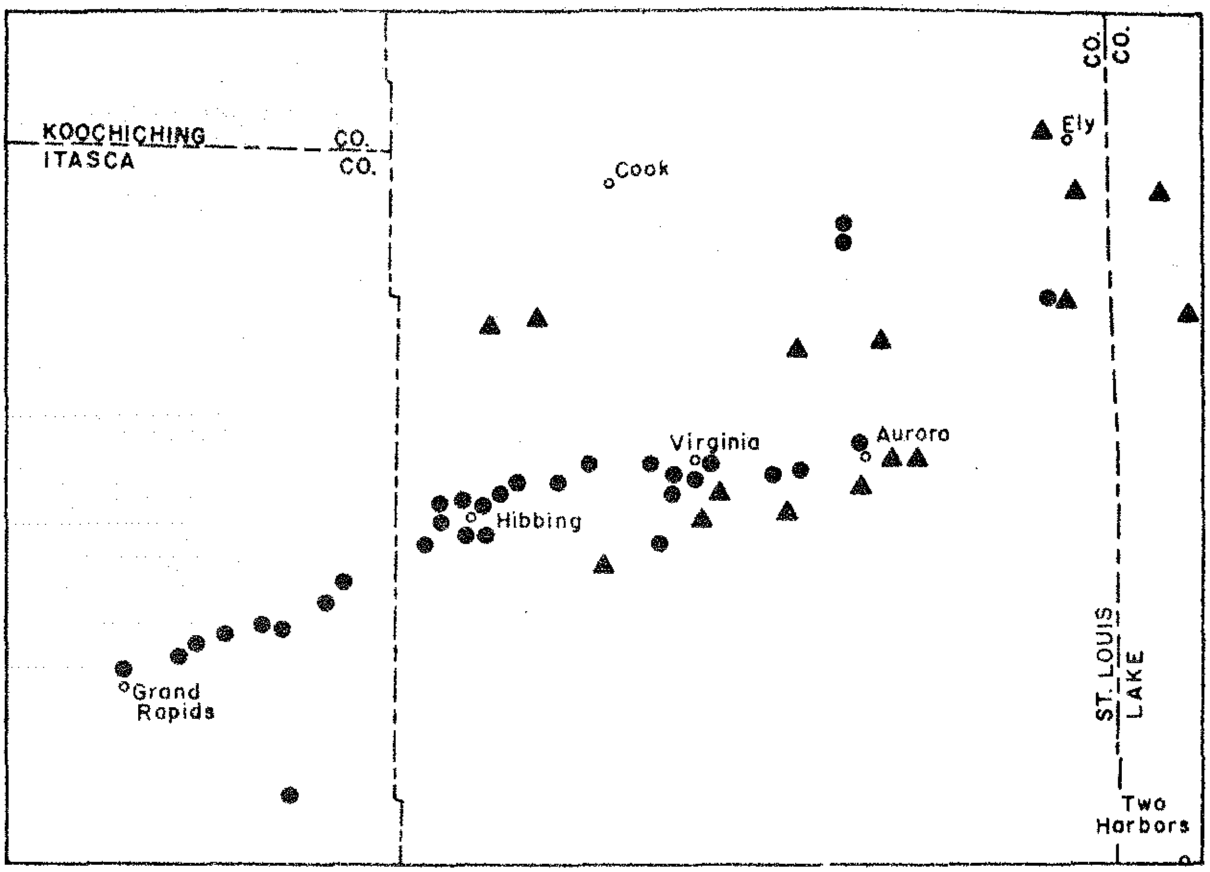
Total precipitation in inches for typical year
(⊙ Reporting stations)

Mean annual precipitation ranges from about 25 to 30 inches in the area, but three-fourths falls between April and September. Stream runoff is low during the winter and water requirements in excess of low flow must be supplied by ground water or by surface-water impoundment in reservoirs.

Using available surface water records and precipitation data for the water year 1959 (October 1958 - September 1959), estimates have been made of the amount of water available within the area shown on the above figure. Parts of 3 major drainage basins lie within the area. However, surface water entering the area has been subtracted from the total precipitation. Ground water entering the area has been disregarded.

Using an average annual precipitation of 27 inches, it is estimated from Geological Survey records that 850 billion gallons a year constitute the surface water runoff. This is about 26% of the average annual precipitation. The remaining 74% of the average annual precipitation is evaporated or enters the ground-water reservoir.

A part of the flow of surface streams is from ground water that discharges to the streams as seeps and springs. During periods of little precipitation almost all of the surface flow of a stream is from ground water discharge. At least 254 billion gallons a year, or about one-third of the surface water flow, is contributed from ground water discharge. This is equal to a flow of nearly 500,000 gallons per minute.



Points at which quality of water analyses are available for ground water (●) and surface water (▲)

IS THE QUALITY GOOD?

Water used for different purposes sometimes must meet different standards of chemical purity. Some waters must be treated. Before selecting a source of water, its chemical quality must be known.

Towns and industries must dispose of water that contains noxious waste. Where waste water goes when it is discharged, how fast it gets there, and what changes take place in the water and the waste, must be determined. Significant quantities of waste limit the usefulness of the water to downstream users and may produce unwanted growth of plants in recreational water bodies.

STUDIES NEEDED

Reports that show the configuration of the bedrock surfaces in the eastern part of the Mesabi Range, and the position of permeable deposits in the Mesabi and Vermilion Ranges are available. Published reports on surface-water flows at selected gaging stations are also available. Reports in preparation will further define the limits of the water-yielding deposits by relating the deposits in each area to the region as a whole.

Scheduled for the future are studies to determine:

Quantities of ground water than can be obtained from the major ground-water reservoirs

Rate of movement of ground water through major aquifers

Relation of ground-water levels to stream flow

Effect on stream flow of pumping large quantities of water from the ground

Effect on ground-water levels of large surface impoundments

Effect on the water resources of an area of diverting large quantities of water from one watershed to another

Effect on the water resources of an area of disposal of noxious wastes

Changes in the chemical quality of the water resources of an area caused by heavy pumping from the area