GEOLOGIC STUDIES AS AN AID TO GROUND-WATER MANAGEMENT

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A preliminary geologic evaluation of an area where management of ground-water resources is contemplated can be made from existing maps, water well logs, and engineering borings relating to the region.

Based on criteria established by the Illinois State Water Survey, geologic studies have been made in northeastern Illinois of the possibilities for natural and artificial ground-water recharge in the Chicago region. Similar studies can be made elsewhere with such criteria where there is available geologic control.

INTRODUCTION

Increased ground-water pumpage in the Chicago region, which has more than doubled since 1940, has resulted in a growing interest in the management of ground-water resources. Consequently, geologic studies of areas suitable for natural and artificial ground-water recharge have been conducted both on a regional scale, involving several counties, and on a local scale, covering several square miles. These studies were made by the Illinois State Geological Survey in response to requests by the Illinois State Water Survey, and subsequently by other groups, for geologic data applicable to the problem.

The existence of a suitable geologic environment is a prime prerequisite for artificial recharge of aquifers. The geologic environment may
be assessed by examination of existing maps, well records, and engineering borings available for the area in question. For the Chicago area, this information is on file in the Urbana and Naperville offices of the Illinois State Geological Survey. From interpretation of these data, the presence, distribution, thickness, and character of the aquifer deposits and their overburden can be delineated.

The most commonly used methods for artificial recharge were considered in the studies of northeastern Illinois. Recharge may be effected by (1) a spreading basin, which involves scraping and other minor surface improvements for shallow ponding of the recharge water, a method that can be used when the aquifer is at the surface; (2) a channel, which requires a shallow excavation, to reach an aquifer 5 to 10 feet below the surface; (3) a pit, used when overburden must be excavated as much as 25 feet to reach the aquifer; and (4) a recharge well, which must be drilled to the aquifer through thick overburden. These criteria were set by the State Water Survey (McDonald and Sasman, 1966, p. 17).

Recharge is but one land use, however, that can be evaluated from existing data and criteria. Evaluation for other land uses, such as mineral resource development, waste disposal, reservoir construction, other large scale construction projects, and multipurpose land-use projects can also be made from such data.

GENERAL GEOLOGY OF NORTHEASTERN ILLINOIS

Throughout the greater part of northeastern Illinois, unconsolidated glacial deposits overlie dolomite bedrock of Silurian age. The glacial deposits generally consist of silts and clays of low permeability and sands and gravels of moderate to high permeability. The sand and gravel deposits and dolomite bedrock were the principal aquifers considered for recharging.
In many areas, the sand and gravel deposits are at or near land surface and coincide with stream or river valleys. Recharge operations can be conducted with a minimal amount of excavation and re-working of the natural deposits if the movement of water is into the deposits. Where sand and gravel aquifers are overlain by a cover of silts and clays with low permeability, the cover must be removed, but such excavation is easily accomplished by earth-moving equipment. In many areas sand and gravel present at shallow depth immediately overlies permeable bedrock. In such environments the sand and gravel deposits act as a filter bed for water recharged to the underlying bedrock aquifers.

REGIONAL GEOLOGIC STUDIES

Anderson (1960) mapped surficial glacial aquifers along selected streams in northeastern Illinois. The streams were selected by the State Water Survey on the basis of their adequacy of flow and water quality and included the Fox River and its tributaries, the DuPage River system, and the DesPlaines River north of Libertyville. The aquifers located and delineated met the following criteria stipulated by the State Water Survey: (1) minimum aquifer thickness of 20 feet, with 15 feet of aquifer below the stream surface; (2) median grain size of 0.3 mm, or a medium sand having a permeability in excess of 500 gallons per day per square foot (gpd/ft²); and (3) a minimum surface area of 370 acres, with a minimum width of a quarter of a mile.

A map showing the location of the aquifers was prepared, based on descriptions of surface exposures, topographic interpretation, and examination of available water well logs. The aquifers were then divided into four categories—most favorable, generally favorable, possibly favorable, and unfavorable for recharge—on the basis of the Water Survey criteria.
During 1962 and 1963, the Illinois Geological Survey mapped the surficial and buried sand and gravel aquifers throughout northeastern Illinois as part of a water-resources management study conducted by the Northeastern Illinois Planning Commission. No sand and gravel deposits less than 15 feet thick were mapped as aquifers. Sand and gravel deposits overlain by less than 10 feet of cover material were called surficial aquifers, and those with less than 10 feet of fine-textured deposits between the sand and gravel and the underlying bedrock were called basal aquifers. The basal aquifers generally lie directly on bedrock and are, therefore, in direct hydrologic connection with the bedrock.

Maps showing the aquifers were used by the Northeastern Illinois Planning Commission to show the prime natural recharge areas in northeastern Illinois (Sheaffer and Zeizel, 1966, p. 100, fig. 40) and to indicate the most feasible artificial recharge methods in those areas of heavy groundwater pumpage from the shallow aquifers (Sheaffer and Zeizel, 1966, p. 105, fig. 41).

An evaluation of the geology of the unconsolidated deposits in DuPage County was made by Landon, Hackett, and Hughes (1965) for possible uses of open space, one of which was artificial recharge. They divided the county into eight geologic environments, primarily on the basis of the relative permeability of the glacial deposits and the thickness of cover material overlying sand and gravel or bedrock aquifers. Each environment was then rated for its adaptability for artificial recharge by spreading-basin and pit methods.

PARK FOREST—CHICAGO HEIGHTS STUDY

An example of a localized study for which geologic information was used to evaluate the possibilities for and methods of artificial recharge is
that made in the Park Forest—Chicago Heights area (Landon, 1966). Preliminary geologic evaluation was limited to the area of the cone of depression that results from heavy ground-water pumpage at Chicago Heights.

The principal aquifer considered for artificial recharge was the dolomite bedrock. A basal sand and gravel deposit was present in direct hydrologic connection with the underlying bedrock—that is, that water would be free to move from the sand and gravel into the bedrock. That being the case, water pumped from one or more of the three streams in the area into the sand and gravel aquifer would filter through into the bedrock to recharge that aquifer.

The State Water Survey criteria for the pit, channel, and spreading-basin recharge methods were considered in this study. Recharge by wells was not considered because of economic and water quality limitations.

Surficial geologic maps (scale, 1:24,000) (Bretz, 1943) and water well logs of the Park Forest—Chicago Heights area were used to delineate the cover material overlying a basal sand and gravel deposit or bedrock within the cone area. The overburden, predominantly a silty clay till (a heterogeneous mixture of clay, silt, sand, and boulders), was contoured at a 25-foot thickness interval (fig. 1) and proved to be thinnest in the northeastern portion of the area. It thickens rapidly to the southwest.

Only the northeastern portion of the cone area had geologic conditions that met the criteria specified for possible recharge methods. Evaluation of the geologic environment for artificial recharge was limited, therefore, to that portion of the cone area. The sequence of deposits present in this area is shown along a line of cross section (fig. 2), which best illustrates the geologic conditions at depth.
Fig. 1—Thickness of cover material over shallow aquifers in Park Forest-Chicago Heights area.
Fig. 2—Cross section of cover conditions in the Park Forest—Chicago Heights area.

The criteria for pit recharge are best met in the Thorn Creek valley north of Sauk Trail Lake, the Butterfield Creek valley, and, in general, the northeastern part of the area shown in figure 1. The area where bedrock is either exposed or present at shallow depth (fig. 1) may limit pit excavation.

Recharge by channeling could be considered in the Butterfield Creek valley, in the Thorn Creek valley north of the spillway, and in the area of exposed or near-surface bedrock. In the last location, depth of excavation should again be considered as a limiting factor.

Recharge by the spreading-basin method was eliminated from consideration for the Forest Park—Chicago Heights region as there are no sizable areas in which surface sand and gravel is in direct hydrologic connection with the dolomite aquifer.

It was recommended in the report that test drilling be conducted prior to the final selection of any specific site for artificial recharge operations if preliminary evaluations of water quantity and quality were also favorable. Drilling would provide detailed information as to the nature, thickness, and extent of the deposits at the site. Drilling should
continue to bedrock to insure that the sand and gravel encountered is continuous to bedrock and not merely a lens within finer textured deposits. Such a drilling program would be both necessary and applicable in the Thorn Creek valley north of the Sauk Trail Lake spillway.

CONCLUSIONS

Preliminary geologic studies to determine whether artificial recharge of ground-water aquifers can be conducted in northeastern Illinois have been made, based on maps and other data available in the files of the Illinois State Geological Survey. The usefulness and ease of application of the Survey's geologic information is greatly increased by establishing criteria similar to those set forth by the State Water Survey in the studies mentioned.

The advantages of making a preliminary evaluation of the geologic data already available are (1) it can eliminate from consideration areas where further investigation would be unprofitable, and (2) it can indicate where more detailed studies, such as drilling programs, are needed.
REFERENCES


