# PROGRESS OF THE INVESTIGATION

# OF THE

# GROUND-WATER RESOURCES OF THE LOWER DELAWARE RIVER BASIN

By

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U. S. Geological Survey

September 1952

55-4

United States Geological Survey

in cooperation with

the States of Delaware, New Jersey, and Pennsylvania

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# PROGRESS OF THE INVESTIGATION OF THE GROUND-WATER RESOURCES OF THE LOWER DELAWARE RIVER BASIN

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## DESCRIPTION OF PROJECT

Ground water is a resource vital to the industrial development and high standard of living of the people of this Nation. Its use has more than doubled in the last 15 years and the demand continues to increase. The availability of ground water may become one of the most critical factors in the continuing development of many areas, especially in centers of rapid industrial expansion such as the lower Delaware River valley.

The Interstate Commission on the Delaware River Basin, "Incodel" for short, was among the first to sense the impending development of the lower part of the basin and to recognize the importance of ground water to the progress of the area. The valley of the Delaware River from Trenton to Wilmington and below seemed ripe for industrial growth, for land was available, markets and transportation were nearby, and the resources needed to support industries--such as labor, electric power, and water--all appeared promising. In 1948 the Commission sponsored a coordinated joint investigation of the ground-water resources of the lower part of the basin by the States of New Jersey and Pennsylvania. Each of the two States allotted funds to the work and the State offerings were matched by the United States Geological Survey. The interest in the Incodel ground-water program was thus a four-sided one. Work on the coordinated program was begun in July 1949. Recent developments in steel, oil, and related industries, with their vast requirements for fresh water and their attendant

problems of new housing and expansion of public services, have justified the interest of the parties in the investigation and have indicated that it came none too soon.

Fortunately, the area was not without a hydrologic background on which to base water-using projects. For many years the United States Geological Survey, in cooperation with the States of New Jersey and Pennsylvania, has been making general studies in the lower Delaware River area as a part of broader ground-water investigations throughout the two States. By 1948, however, it became apparent to the agencies investigating water resources, and to Incodel, that additional emphasis must be given to a study of the lower Delaware area to provide a satisfactory basis for the effective development of the water resources in the area in the next few years.

Consequently, by arrangement between the New Jersey Department of Conservation and Economic Development, the Pennsylvania Department of Internal Affairs, and the U. S. Geological Survey, a program was set up to provide for the preparation and publication of a report on the ground-water resources of the area believed to have the greatest industrial potential. This area included Bucks, Montgomery, Philadelphia, Delaware, and Chester Counties in Pennsylvania, and Mercer, Burlington, Camden, Gloucester, and Salem Counties in New Jersey. The plan further called for the publication of detailed reports on the ground-water conditions in the individual counties to follow the first report for the area as a whole. It has since been found desirable to include New Castle County, Del., as a part of the area. This was made possible by a cooperative agreement between the Delaware Geological Survey and the U. S. Geological Survey.

As a modification of the usual approach to the study of ground-water resources in an area, it was believed necessary in this case to make an

especially detailed study of the chemical quality of the water in the Delaware River between Trenton, N. J., and Marcus Hook, Pa., because of the interrelationship between the water in the Delaware River and that in the ground-water reservoirs along that section of the stream. To satisfy this need, in August 1949 the Quality of Water Branch of the U. S. Geological Survey and the City of Philadelphia began a cooperative survey of the quality of the river water, having as its objective the analysis of the flow-quality relationship and the determination of the long-term chemical characteristics of the Delaware River throughout that part of the basin.

## GROUND-WATER HYDROLOGY OF AREA

### Geology

The area of study is divided almost in half by the so-called Fall Line, a line--or, rather, a zone of varying width-- of geologic contact between the unconsolidated clay, sand, and gravel of the Atlantic Coastal Plain and the hard, massive rocks (gneiss, quartzite, granite, sandstone, limestone, etc.) of the Appalachian Piedmont. This line of contact extends in a southwesterly direction through Trenton, N. J., and continues almost as a straight line to Wilmington, Del. It follows the Delaware River for much of the distance between Trenton and Wilmington, leaving only small areas of the Atlantic Coastal Plain on the Pennsylvania side of the river. From the standpoint of ground-water resources the position of this line is of the utmost importance, for it marks not only a major change in the type of rocks but, with few exceptions, it separates highly productive water-bearing formations from those that are generally not suitable for development of large ground-water supplies.

Although it can be said that ground water is generally abundant in

the Coastal Plain and only relatively small supplies are available in the Piedmont area northwest of the Fall Line, many variations in yield can be found throughout the area because numerous different geologic formations occur in each of these broad regions (fig. 1). The quantity and chemical character of ground water available at a selected locality are closely related to the type of rock that contains the water. Therefore, an important phase of ground-water study has been the investigation and evaluation of each geologic formation to determine its water-bearing characteristics, and its extent and location where exposed at the surface or where buried beneath other rocks at depths within economic reach of drilling. Fortunately, much basic geologic work in the area had been done prior to the beginning of the ground-water studies, so that it was possible to concentrate largely upon the refinements in the geology that are essential to the ground-water hydrology.

Within the lower Delaware area there are more than a dozen important water-bearing formations, or aquifers, which supply large quantities of ground water to municipalities or industries. Each formation has a characteristic ability to store and transmit ground water, and each imparts a characteristic chemical quality to the water. There are a considerable number of formations that normally yield little or no ground water. The potential ground-water yield at any given site is therefore intimately related to the geology.

## Ground-Water Resources

In appraising the ground-water resources of an area or of individual formations, two considerations are of paramount importance--(1) the determination of the quantity of water that may be expected from individual wells and (2) the dependability of the yield of the aquifer in terms of

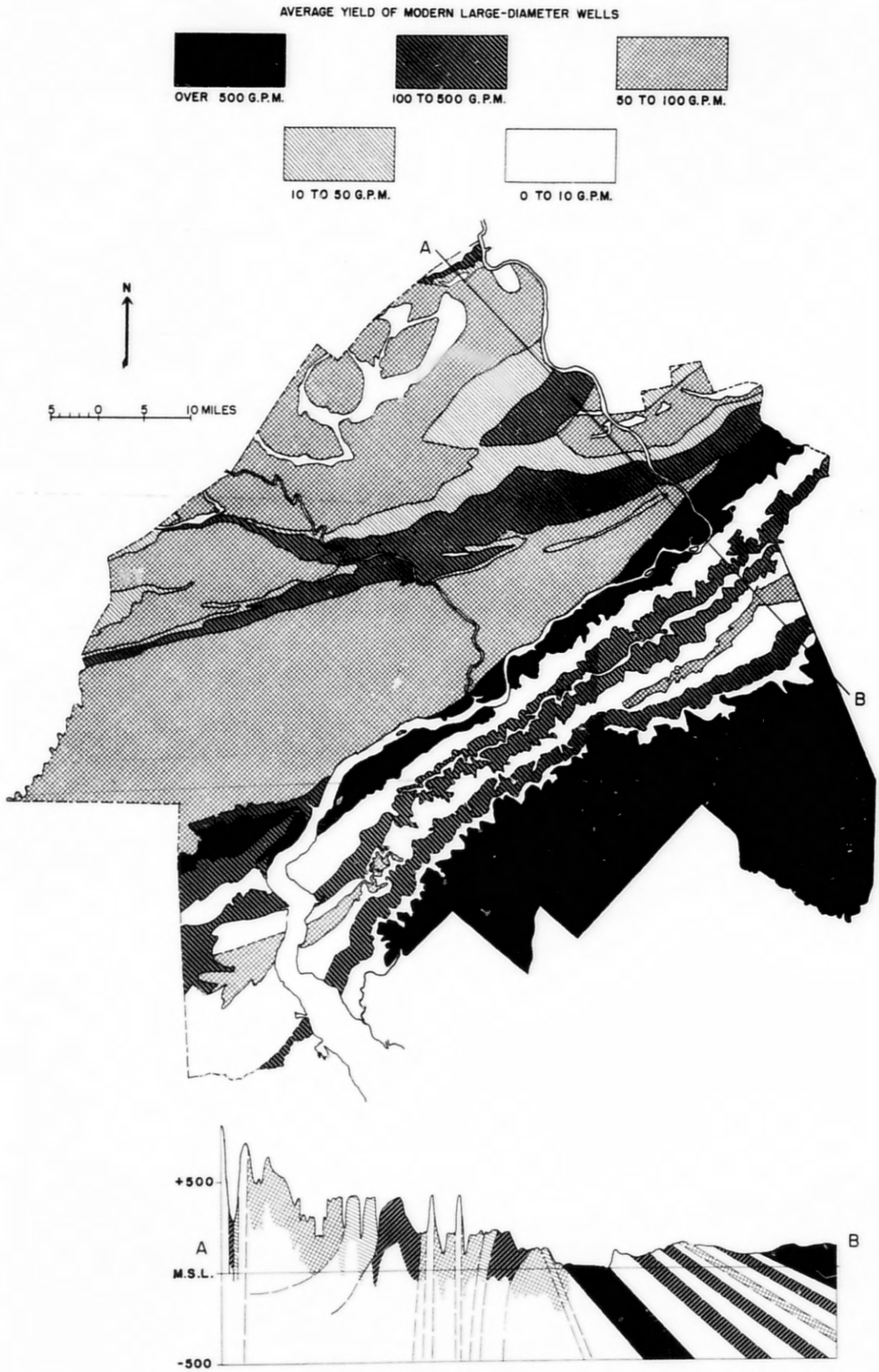


Figure 1.—Water-yielding capacities of important aquifers in the lower Delaware River region.

long-continued use. The first depends upon the local water-bearing properties of the aquifer, whereas the second may involve the geologic and other conditions covering broad areas and long periods of time. Particularly under artesian conditions, the area of intake that must support continued withdrawal from an aquifer may be some distance away and be affected by conditions not apparent at the point of withdrawal.

The regular withdrawal from an aquifer of more water than its perennial safe yield may ruin the water supplies of many or all those who use water from it. It is important, therefore, that further developments of an aquifer or any part of it proceed with caution when danger signals such as changes in the chemical character of the water or serious declines of water levels are observed. The only safe course in such cases is to analyze carefully all the factors that may affect the safe yield of the aquifer before proceeding with large and continuing additional withdrawals of water.

In the 11-county area covered by this report it is probable that nearly all the available ground water comes from precipitation within the area or from recharge from surface-water bodies within the area, such as the Delaware River. There is no basis for the supposition that any of the ground water in the lower part of the basin comes through underground channels from the Pocono Mountains or from any other remote source. Fortunately, rainfall is relatively abundant in the area and opportunities for infiltration of part of this rainfall into the ground are good, especially in the Coastal Plain.

The coarse sediments of the valley alluvium and the sand and gravel members of the Raritan formation, the lowermost Coastal Plain formation in this area, are in hydraulic connection with the bed of the Delaware

River in many places between Trenton and Wilmington. This condition provides an excellent opportunity for large-scale infiltration of surface water. Because of the high potential for recharge wherever the water-bearing sediments are in hydraulic connection with the river, the opportunity for large-scale ground-water development along the Delaware River is probably the best that can be found within the area. The water undergoes the natural filtering action of the sands and gravels between the river and the wells. Where the chemical character of the river water is satisfactory and where favorable geologic and hydrologic conditions prevail, large quantities of satisfactory water can be and are being obtained from wells near the river.

However, the aquifers along the river are also being drawn upon more heavily than any others in the area because they are found where conditions are most favorable to industrial developments. Their continued use and further development will depend to a large degree upon the maintenance of a satisfactory chemical quality of water in the river. Dissolved mineral salts are generally not removed by the filtering action of the sands. In some places the draft upon these aquifers appears to be approximately as large as can safely be maintained without excessive lowering of water levels or deterioration of the quality of the water. In other places they are capable of yielding substantial additional quantities of water.

The next most favorable areas for large-scale withdrawals are those underlain by sand and gravel formations of the Coastal Plain in New Jersey and Delaware, where infiltration from precipitation occurs at a maximum rate and over wide areas. Only a relatively small portion of the Coastal Plain extends into the Pennsylvania part of the area. Existing or planned installations by Bristol, Morrisville, Levittown, and the U. S. Steel Co.

point toward maximum ground-water use in southeastern Bucks County. The existing large pumpage of ground water in south Philadelphia leaves southwest Philadelphia and perhaps the southeasternmost part of Delaware County as about the only Coastal Plain areas in Pennsylvania available for potential large-scale developments. Except in Camden and several other communities located on or near the Delaware River, the pumpage of ground water in the large Coastal Plain region in New Jersey and Delaware is small in comparison to the quantities of ground water potentially available. In most places these potential supplies are on the order of half a million to a million or more gallons a day from a single well, and they aggregate many millions of gallons daily.

In the Piedmont area of Pennsylvania, of Mercer County, N. J., and of New Castle County, Del., available ground-water supplies are much smaller. Yields of most wells do not exceed 100 gallons a minute and in many they are considerably less than that quantity. However, there are a few water-bearing formations from which yields of more than 100 gallons a minute are obtained, including the sandstones and shales of the Stockton formation of south-central Bucks and Montgomery Counties, Pa., and Mercer County, N. J., and the Cambrian and Ordovician limestones of central Chester County and southern Montgomery County, Pa. These formations are at present used by a number of municipalities and industries, and further large-scale development is possible only at sites not immediately adjacent to existing installations.

## Ground-Water Use

Among the advantages of ground water are its availability in many localities, its low turbidity, and its relatively constant temperature and chemical characteristics. These factors have played an important part in

the choice of a ground-water source by many industries and numerous small communities throughout the area. The supply of Camden, N. J., is the largest municipal supply within the area that is obtained exclusively from the ground and averages more than 20 million gallons a day.

It is not surprising to find that the location of present large users of ground water is fairly well defined by the regional division between the Coastal Plain to the southeast and the less productive hard rocks to the northwest. In New Jersey nearly all municipalities and most of the industrial plants (except the largest users located along the Delaware River) use ground water; whereas in Pennsylvania most of the municipalities have surface-water sources and in general only the smaller industries have been able to obtain a ground-water supply sufficient for their needs. In the southern part of Philadelphia and in lower Bucks County, where there are Coastal Plain formations on the Pennsylvania side of the Delaware River, much greater use of ground water has been made than would have been possible from the underlying hard rock at these locations.

In 1950, it was estimated that the average daily withdrawal of ground water in the Philadelphia-Camden area (then considered as 10 counties only) was on the order of 125 million gallons. For the somewhat larger area now being studied (with the addition of New Castle County, Del.), and making allowance for the increase in use since 1950, it is probable that the present withdrawal exceeds 175 million gallons a day (fig. 2). The largest part of this water is pumped in three centers of withdrawal: the Camden metropolitan area, the Philadelphia metropolitan area, and southern Bucks County. These areas use approximately 70, 25, and 15 million gallons a day, respectively. Table 1 gives the present estimate of ground-water use by counties for the entire 11-county area.

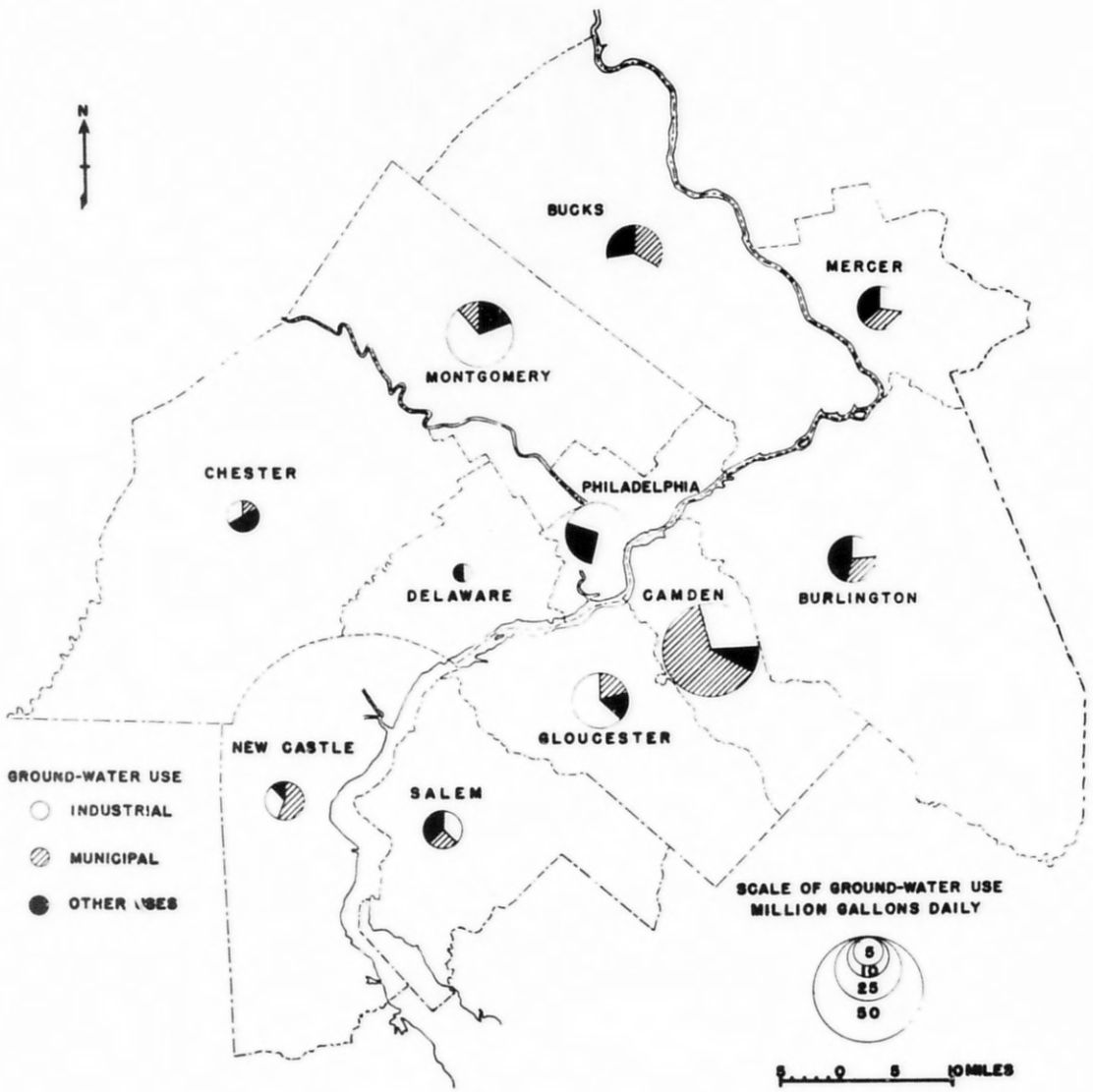


Figure 2. Present use of ground water in the lower Delaware River region.

Table 1.--Estimated ground-water use in the 11-county area in million gallons daily

| STATE AND COUNTY | Municipal | Industrial | Other | Total |
|---|---|---|---|---|
| DELAWARE | | | | |
| New Castle | 5 | 3 | 1 | 9 |
| Total | 5 | 3 | 1 | 9 |
| NEW JERSEY | | | | |
| Burlington | 4 | 3 | 6 | 13 |
| Camden | 34 | 15 | 5 | 54 |
| Gloucester | 4 | 12 | 3 | 19 |
| Mercer | 4 | 3 | 4 | 11 |
| Salem | 2 | 3 | 3 | 8 |
| Total | 48 | 36 | 21 | 105 |
| PENNSYLVANIA | | | | |
| Bucks | 6 | 8 | 4 | 18 |
| Chester | 1 | 2 | 3 | 6 |
| Delaware | 0 | 1 | 1 | 2 |
| Montgomery | 3 | 18 | 5 | 26 |
| Philadelphia | 0 | 16 | 6 | 22 |
| Total | 10 | 45 | 19 | 74 |
| GRAND TOTAL | 63 | 84 | 41 | 188 |

It is difficult to assign a monetary value to such a resource as water because it is so essential for so many purposes. Where necessity might dictate, other sources than those now used might be found and their cost would be one measure of the value of the present supply. Conservation measures such as more intensive re-use of water and mechanical refrigeration can be employed, at a cost, to make the existing supply go farther--another indirect measure of its value. In an emergency, such uses as air conditioning for comfort and lawn sprinkling could be curtailed without a direct loss of production or profit. In any event, there is no doubt that the present use of ground water is of vital importance to the area. The advantage of ground water for cooling alone is such that conversion to the warmer surface-water supplies of the summer months would greatly increase costs for equipment and pumping operations. Furthermore, the surface-water supplies of the area, almost without exception, require filtration for uses other than some types of industrial cooling, so that many new filtration plants would be required if adequate ground water were not available.

Among the many users of large quantities of ground water in the area, exclusive of municipalities, are the Philadelphia Naval Base, Publicker Industries, the Texas Co., Rohm & Haas Chemical Co., E. I. du Pont de Nemours Co., the Socony Vacuum Oil Co., and the Public Service Electric Co.

## RESULTS OF STUDY

Although detailed studies have been made in this area only within the past few years, a considerably longer background of basic data is available for the evaluation of the ground-water resources of the region, as a result of the cooperative State-wide programs. Work was begun in the area by the U. S. Geological Survey in New Jersey in 1923, and in Pennsylvania in 1925.

The scope of this work was necessarily limited by the need for work in other parts of the two States, and it was not until the inception of the Incodel program that it was possible to apply anything approaching adequate effort to the area. In general, the over-all water-bearing properties of the several aquifers are now known, and some knowledge is available as to their recharge characteristics and present stage of development, and also of the chemical quality of the waters they yield. Areas favorable for greater development, as well as localities where serious ground-water problems now exist or soon may appear, have been tentatively identified and scheduled for further study.

A number of brief reports have appeared in technical journals relating to ground-water conditions in the area. Two U. S. Geological Survey reports have been issued: Circular 104, Water resources of southeastern Bucks County, Pa., and Circular 190, Index of water-resources records in the Delaware River basin to September 30, 1951. A detailed report on the ground-water resources of the Philadelphia Naval Base was prepared at the request of the Navy Department. A report on the ground-water supplies of the Camden area, N. J., was published in 1932 as Bulletin 39 of the N. J. State Department of Conservation and Development. A preliminary report for the 11-county area is now approaching completion and, it is hoped, will be available by the end of this fiscal year. Following this over-all appraisal report, detailed county ground-water reports will be issued for each of the counties as State reports by the cooperating agencies in Pennsylvania, New Jersey, and Delaware.

## PROBLEMS

Among the objectives of the ground-water program for the 11-county

area are the delineation and evaluation of additional sources of ground water within the area and the identification of conditions that now exist or may develop that would seriously interfere with the continued use of the resource. Each of these objectives has many ramifications and, once determined for a given set of conditions, cannot be considered final, for the factors that affect them are continually changing.

Although, as has already been stated, the area is in a generally favorable position with respect to ground-water supplies at the present rate of use, there are some serious problems that must be recognized in the proper planning of expanded ground-water facilities for new developments. Among the most important of these are those that relate to the geology of the area, those that relate to the chemical quality of its ground waters, and those that relate to the regional or local decline of head or storage in important aquifers.

## Problems Relating to Geology

The water user who has little knowledge of geologic problems is prone to apply his knowledge of conditions in one area to a new area without making adequate allowance for differences in geologic conditions. In an area as wide and as varied as the lower Delaware River basin, it must be recognized that the hydrology varies widely with the geology from place to place. The hard rocks that occur in the Piedmont area throughout most of Bucks, Montgomery, Philadelphia, Delaware, and Chester Counties and parts of Mercer and New Castle Counties differ greatly in their water-bearing characteristics from the Coastal Plain sediments of the remainder of the area. Furthermore, the ground water in the hard rocks occurs for the most part in cracks formed by earth movements, and these openings are much more

prominent in some places than in others. Consequently, wells only a few feet apart may differ greatly in yield, and prior to drilling there can be no assurance of the quantity of the supply the well will yield when finished. It is true that when the records of a great number of wells are available for study a certain average expectancy can be derived, but the yield of individual wells cannot be predicted with confidence. Again, the depth of wells in the hard rock may show little relation to yield, some shallow wells having much greater production than nearby wells drilled to depths of a thousand feet or more. In general the yield of hard-rock wells is not proportional to depth because the number and size of openings tend to decrease at greater depths. Thus, not only is the supply of ground water in the hard rocks of the region generally less than that in the Coastal Plain sediments, but the yield of individual wells is a great deal more erratic.

In sharp contrast are the relatively uniform and prolific sand and gravel layers to be found in the Coastal Plain sediments. Some Coastal Plain aquifers extend more or less uniformly over large areas, but they dip gently toward the southeast and thus are encountered at different depths in different places. Even in the Coastal Plain area, however, widespread uniform aquifers are the exception rather than the rule. Many are of limited extent and variable in character. On the Coastal Plain, as elsewhere in the area, one essential to a successful development is a thorough knowledge of the geology.

## Problems Relating to Chemical Quality of Water

It is reasonable to assume that when ground water was first withdrawn from wells in the area it was all potable and of acceptable chemical character,

except for occasional instances of high iron concentration and perhaps of brackish water from wells along that reach of the river where salt water from the bay moved upstream during low flow. As industries and communities developed and as wastes were discharged into the streams, or spread on the ground, or disposed of down wells; as city dumps swelled in size and number; and as sewers were built and not repaired when leaky or broken, these wastes began to be added to the natural recharge from rainfall to such an extent that in some areas the ground-water supply is now trending slowly toward uselessness because of contamination.

For nearly 10 years the Geological Survey has been making periodic analyses of well waters at several sites in south Philadelphia and has noted with concern the constantly increasing concentration of dissolved chemicals in the water. The U. S. Naval Base, which a few years ago used well water with no treatment other than chlorination, now has found it necessary to install expensive treatment equipment for its entire supply. It is believed that most of the water obtained from wells in south Philadelphia, including the Naval Base area, is recharged by water moving from the Delaware and Schuylkill Rivers through sand and gravel layers cut by the rivers 2 or 3 miles upstream from the Naval Base. However, this water has been seriously polluted by waste waters from sewers and abandoned wells, and by recharge from precipitation which becomes contaminated as it moves downward through extensive dump areas. Some of this contaminated water appears to have been drawn through common aquifers beneath the Delaware River into centers of heavy pumping in Camden. Contamination of this nature cannot be corrected quickly, if at all, for the upper layers of the ground have been saturated with chemically inferior water for many years and there is no effective means of flushing them free of their polluted

water. It appears that ground-water users in the locality must look forward to increasing treatment costs as the contamination increases. Perhaps some level may be reached, after which the degree of treatment required will remain constant. There is also a possibility that the contamination may rise to levels that will render the water unfit for some uses even after treatment.

New industries and growing communities in the lower Delaware basin will increase the threat of waste-disposal contamination of both surface and ground-water supplies, no matter whether accidental or intentional. State and interstate agencies such as Incodel have been waging a campaign to reduce this threat by requiring the construction of new or improved waste-treatment plants and discouraging the discharge of wastes into wells. This campaign has had a gratifying measure of success in recent years. However, it will probably be quite a number of years, if ever, before the corrective measures can come abreast of the load of contamination which will be produced by all the present and proposed industrial and residential expansion in the area. Constant and everlasting vigilance will be required to keep our present and potential water supplies in a usable condition and as free from contamination as possible.

## Problems Relating to Lowered Water Levels

When water is withdrawn from a well (or a well field) the water levels in the surrounding parts of the aquifer are lowered by the creation of a slope toward the well sufficient to induce water to flow to it from an area of recharge. Thus with any pumping from any aquifer there will be some lowering of water levels. The lowering per unit of water withdrawn will depend upon the characteristics of the aquifer. The greater the rate of

withdrawal, the greater will be the lowering. In itself, therefore, the lowering of water levels is not a cause for concern except as it is persistent year after year, or as it is related to other factors.

Each additional well that draws from an aquifer will lower the water level in adjacent wells. The proper spacing of wells is therefore important in order to reduce the cost of pumping as much as may be compatible with obtaining the full yield of the aquifer. As an example of the interference of wells, it was estimated that the regular operation of the Texas Co.'s wells at Eagle Point, N. J., at a rate of 6 million gallons daily would lower the water levels at the Philadelphia Naval Base about 10 feet if everything else remained constant. Subsequent observations have indicated that the estimate was of the right order of magnitude.

Progressive lowering of water levels without increased pumping or disproportionally great lowering for an increase in pumping may be an indication that the capacity of the aquifer is being exceeded. It is important, therefore, to maintain adequate and accurate records of pumpage and water levels and to study their relation periodically.

Records of water levels are also important where an aquifer is exposed to recharge from bodies of surface water that are of unsatisfactory chemical quality, because they will indicate whether such recharge is likely to occur. The safe yield of an aquifer may be sharply limited by the danger of the intrusion of unsuitable surface water. Such conditions probably exist in some places along the lower Delaware River where salt or brackish water moves upstream from the Bay, especially at times of low stream flow.

## CONCLUSION

Let us now review briefly the situation in the 11-county area and see what conclusions may be drawn as to the future of the ground-water supplies in it. More than 175 million gallons of water is being withdrawn every day from underground sources in the area. These supplies appear to be dwindling in some localities, and additional water for such places will have to be drawn from a distance, either from underground sources or from surface sources, depending upon the quantity and quality required. For the area as a whole there is no evidence of a regional decline in storage and there is a reserve of unused ground water that is ample to support substantial growth.

The area's largest single reserve of ground water, that in the central part of New Jersey, is essentially untapped and is capable of yielding very large quantities of excellent ground water. This reserve lies largely outside the Delaware River basin but partly, at least, within the 11-county area. Its use in the industrialized lower Delaware basin will require extensive well fields and long pipelines. This resource should be carefully developed and jealously protected. Its proper development will require a great deal of additional basic information.

In many places along the Delaware River, conditions are favorable for induced recharge from the river. Where this is so, the quantity of ground water may be substantially increased by water drawn from the river. However, the quality of the water tends to approach that of the river water, and the permanency of a local supply of good ground water in these places therefore will depend upon the quality of the adjacent river water.

Much more detailed work is needed to determine the safe yield of the important aquifers in the area. The aquifers in the Magothy and Raritan

formations now yield the largest part of the ground water withdrawn in the area and are capable of yielding still more. Their further development should proceed cautiously and in the light of accurate and up-to-date information. Other good aquifers in the area are not so heavily developed but the conditions affecting them are less thoroughly understood. Even the less productive aquifers will warrant further study as the demand for small supplies for residential and minor industrial use increases.

Probably the most serious and urgent ground-water problem in the area relates to the maintenance of the chemical quality of the ground water at a satisfactory level. If ground water were used only as a coolant this would not be so important, but many of its uses, including human consumption, are limited by the nature and concentration of the mineral salts that it contains. Conditions such as those in south Philadelphia emphasize the importance of careful study of all the factors that may affect the quality of the ground-water resources of the area. Areas of actual or potential recharge from the Delaware River should be defined in order that the effects of changes in the quality of the river water may be evaluated.

As the pressure of industrial growth increases in the area surrounding Philadelphia, the demands for ground-water supplies will be felt in parts of the Delaware River basin that have not yet been much affected. The ground-water potentials of that part of the basin downstream from the 11-county area will become increasingly important. Investigations currently being made by the Geological Survey in cooperation with the States of Delaware and New Jersey, in Kent and Sussex Counties, Del., and Cumberland and Cape May Counties, N. J., should be intensified and integrated into the regional picture.

In a region of such dynamic growth and widespread development as the

11-county area the conditions that affect the quantity and quality of its ground-water supplies are constantly and sometimes rapidly changing. The dredging of a 40-foot channel in the Delaware River would greatly increase the opportunity for ground-water recharge from the river. The decisions of a court, of Congress or of a State legislature may have far-reaching effects upon the flow and/or quality of the water in the river and hence upon the ground waters recharged from it. Increasing industrial and municipal developments with their attendant waste-disposal problems and the regulatory actions of the State and Federal governments may have both a direct and an indirect effect on our ground-water resources. Certain activities, such as improper disposal of wastes in the intake areas of those aquifers that have not yet been extensively developed, would reduce the potential supply of usable ground water. Suitable observations should be maintained or started and constantly analyzed in order to predict significant changes or at least to detect them as they occur and determine their causes.

Only through such observations and analysis can those who are responsible for the planning of the developments within the Delaware River basin be provided adequate and current data on our ground-water resources. The wisdom of Incodel in sponsoring coordinated ground-water investigations in the lower part of the basin and the farsightedness of the State and Federal governments in supplying funds for studies well in advance of the present accelerated industrial development have been justified by the availability and usefulness of the data during the initial stages of development. Continued effort and vigilance will lead to even greater benefits as the development of the area proceeds to still greater heights.