GEOLOGICAL SURVEY CIRCULAR 257

THE USE OF WATER IN PENNSYLVANIA, 1951

Based on data collected in cooperation with the Pennsylvania Departments of Internal Affairs and Forests and Waters

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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INTRODUCTION

Pennsylvania is endowed with abundant supplies of fresh water. Indeed, water has been one of the key factors in the development of the Commonwealth into one of the great centers of commerce and industry of the world. Only recently, however, has there been any attempt to inventory accurately the uses of water in Pennsylvania; it being generally assumed in the past that the supplies were unlimited for practical purposes.

It is now apparent that careful, periodic analyses of the utilization of water, even in areas of plentiful supply, are required in view of the present trend in water use to double or triple within a generation, particularly in industrial areas. Water shortages, due largely to inadequate facilities, have been experienced in only a few places in Pennsylvania; however, anticipated growth of industry may be expected to result in many new problems in water supply. The successful solution to the water problems of the future will depend in large measure on a reliable background of hydrologic data, including a knowledge of water requirements and use.

During 1951, almost 11,000 million gallons of water were withdrawn on an average each day to satisfy the water demands of Pennsylvania. It would take a railroad train composed entirely of tank cars, about 9,000 miles in length (equivalent to the distance from New York to New Zealand), to hold the amount of water withdrawn in Pennsylvania in only one day.

The water used was taken from more than 10,000 miles of streams, from many lakes and ponds, and from the underground reservoirs found in the State. Assuming that the total water used could be evenly distributed among Pennsylvania's 10,500,000 inhabitants, it would amount to slightly more than 1,000 gallons per person per day. As is to be expected, the highly industrialized areas used most of the water. Sixty-one percent of all water withdrawn was used in five counties, namely: Allegheny, Philadelphia, Delaware, Westmoreland, and Beaver.

Few States have undertaken water-use inventories, so precise comparisons are not possible. On the basis of water-use estimates for the United States in 1950, as published by the Geological Survey, 1/ Pennsylvania ranked fourth among the States in the withdrawal uses of water exclusive of irrigation. The present study in Pennsylvania constitutes a far more accurate appraisal than previously available and it is probable that, disregarding irrigation, only New York State exceeds Pennsylvania in the use of water and, on the basis of fresh-water withdrawal, Pennsylvania may lead all States. This report represents the combined efforts of the United States Geological Survey and the Pennsylvania Departments of Internal Affairs and Forests and Waters to obtain an inventory of water use in Pennsylvania. It is the first comprehensive survey of the utilization of water from all sources ever made in Pennsylvania.

The municipal and industrial records presented in this report give quantities delivered into public and private supply systems. Public systems are those that supply water for purchase, whether publicly or privately owned. Private supply systems are those that serve private needs and supply only the private owner.

The records as a whole are reliable but in some places it has been difficult to divide water use between counties. Some water-supply agencies operate in two or more counties and have little information on the apportionment between counties. Studies were made to apportion this water but the lack of data upon which to base the apportionment makes questionable the totals for some counties.

The records of quantities as presented in this report are in units of million gallons per day (mgd).

The information on water used by industry was obtained by the Pennsylvania Department of Internal Affairs from questionnaires sent to 21,000 productive enterprises engaged in 322 kinds of industry. Public and private supply agencies, public utilities, agricultural agencies, and individuals have all cooperated by furnishing data for other phases of the inventory.

The report was prepared by John W. Mangan, district engineer, Surface Water Branch, and Jack B. Graham, chief, Water Utilization Section, Technical Coordination Branch, under the general direction of Carl G. Paulsen, chief, Water Resources Division, U. S. Geological Survey. The Ground Water Branch of the Geological Survey (Paul H. Jones, district geologist) and the Pennsylvania Department of Forests and Waters (T. H. Mathews, chief engineer) were responsible for the compilation of a part of the statistical data contained in the report.

1/ MacKichan, K. A., 1951, Estimated use of water in the U. S.-1950, U. S. Geol. Survey Circ. 115.

TYPES OF WATER USE

For the purposes of this report, uses of water are classified as withdrawal and nonwithdrawal. The principal withdrawal uses in Pennsylvania are (1) municipal, which includes water obtained from public supplies to satisfy the needs of the urban population, (2) industrial, from both public and private sources, and (3) rural, for the rural domestic population and livestock.

Nonwithdrawal uses of water are those which do not involve withdrawal from sources of supply, such as hydroelectric power generation, navigation, waste disposal, and recreation. Except for hydroelectric power generation, nonwithdrawal usage cannot be evaluated in terms of quantities used.

WITHDRAWAL USES

Municipal use

In 1951, public water-supply systems furnished an average of 1,319 mgd, of which 879 mgd served the urban needs of 8,600,000 people, 82 percent of the population of Pennsylvania (table 1). Urban needs include water for residential use, fire protection, office buildings, commercial establishments, churches, schools, and street flushing. Pennsylvania has 12 urbanized areas having a population in excess of 50,000. These are:

Urbanized Areas in Pennsylvania, 1950

[Key cities of 50,000 or more population including urbanized fringe areas]

Urbanized areas	Population
Allentown-Bethlehem	225,962
Altoona	86,614
Erie	151,710
Harrisburg	169,646
Johnstown	93,354
Lancaster	76,280
Philadelphia	2,922,470
Pittsburgh	1,532,953
Reading	154,931
Scranton	236,076
Wilkes-Barre	271,589
York	78,796

The urban use in Pennsylvania averaged 102 gpd per person. On the average, residential use may account for about half the total.

Table 1.--Summary of withdrawal use of water in Pennsylvania, 1951
(million gallons per day)

Use	Public supply			Private supply			Grand total
	Surface water	Ground water	Total	Surface water	Ground water	Total	
Municipal a/	797.3	81.2	878.5	--		--	878.5
Industrial	409.5	30.8	440.3	8,995.5	288.7	9,284.2	9,724.5
Rural	--	--	--	b/ 16.5	c/ 109.1	125.6	125.6
Total	1,206.8	112.0	1,318.8	9,012.0	397.8	9,409.8	10,728.6

a/ Residential, fire protection, commercial establishments, office buildings, schools, and street flushing.
b/ Livestock.
c/ Rural domestic and livestock.

In addition to handling the urban needs, public-supply systems furnished 440 mgd to industry.

Of the total of 1,319 mgd delivered into public-supply systems, 1,207 mgd or 92 percent was obtained from streams, lakes, and ponds, and 112 mgd was taken from underground sources.

Philadelphia County is the largest user of water from public supplies, followed by Allegheny and Cambria Counties. (See table 2.) Cambria County, although more sparsely populated than several other counties, uses more water from public supplies for industrial uses than any other county.

Industrial use

Water for industrial purposes includes water taken from both publicly and privately owned supply systems. (See table 1.) It also includes the water used by public utilities in the generation of steam to produce electrical energy, for central steam heating, and in the manufacture of artificial gas. It does not include a record of the water used for flooding in the extraction of oil in the oil fields, roughly estimated to be in excess of 10 mgd. Industries using less than 10,000 gpd (0.01 mgd) were inventoried but not included in this report.

Of water withdrawn for all purposes in Pennsylvania, more than 90 percent is used by industry. Industry used an average of 9,724 mgd during 1951. Of the total, 97 percent was obtained from surface-water sources and more than 95 percent was obtained from industries' private sources of supply.

Industrial plants use water for a variety of purposes, including processing (water used in contact with the products manufactured), cooling, boiler feed, and sanitation and service purposes. Large plants often require water having certain quality characteristics and unless municipal water is used, private treatment is usually necessary. Of all industrial water used probably more than three-fourths is used in cooling and in processing.

Allegheny County leads in the industrial use of water and requires 2,888 mgd to support its great industrialization. This is 30 percent of all water used in Pennsylvania for industrial purposes.

Rural domestic and livestock use

The rural population of Pennsylvania in 1951 was about 1,900,000. An estimated average of 92 mgd of ground water, taken from private sources of supply, was used daily for rural domestic purposes. This is an average of 48 gpd per capita.

Livestock use for 1951 was estimated to average 33 mgd. The amount of water used by livestock was estimated from the livestock population, as taken from the 1950 agricultural census, by applying a generally accepted per capita livestock water-use factor.

All domestic water used by the rural population was assumed to be ground water. There is little information as to the sources of the supply used by livestock but the amount was assumed to be divided equally between surface and ground water.

Air-conditioning use

Air-conditioning is a relatively new but important use of water. There has been a steady increase in commercial air-conditioning installations since this practice was initiated a little over a quarter of a century ago. In both large and small communities, many theaters, commercial establishments, and office and industrial buildings are now air-conditioned for comfort during summer. Some industries also use air-conditioning in their processing.

The records given in this report probably include most of the water used for air-conditioning purposes except where establishments other than those classified as industries use a private source of supply. Except in Allegheny County, little information is available as to the amount of water withdrawn from private supply by these nonindustrial establishments for air-conditioning. Studies made by the Geological Survey in 1950 indicate that about 500 million gallons of ground water was used annually in the Pittsburgh area by these establishments during the 100- to 120-day air-conditioning season. 2/ In general, ground water is preferred to surface water for air-conditioning use, owing to the relatively uniform temperature of ground water, which in summer is cooler than surface water.

2/ Van Tuyl, D. W., 1951, Ground water for air-conditioning in Pittsburgh, Pennsylvania; Pennsylvania Topog. and Geol. Survey Bull. W-10.

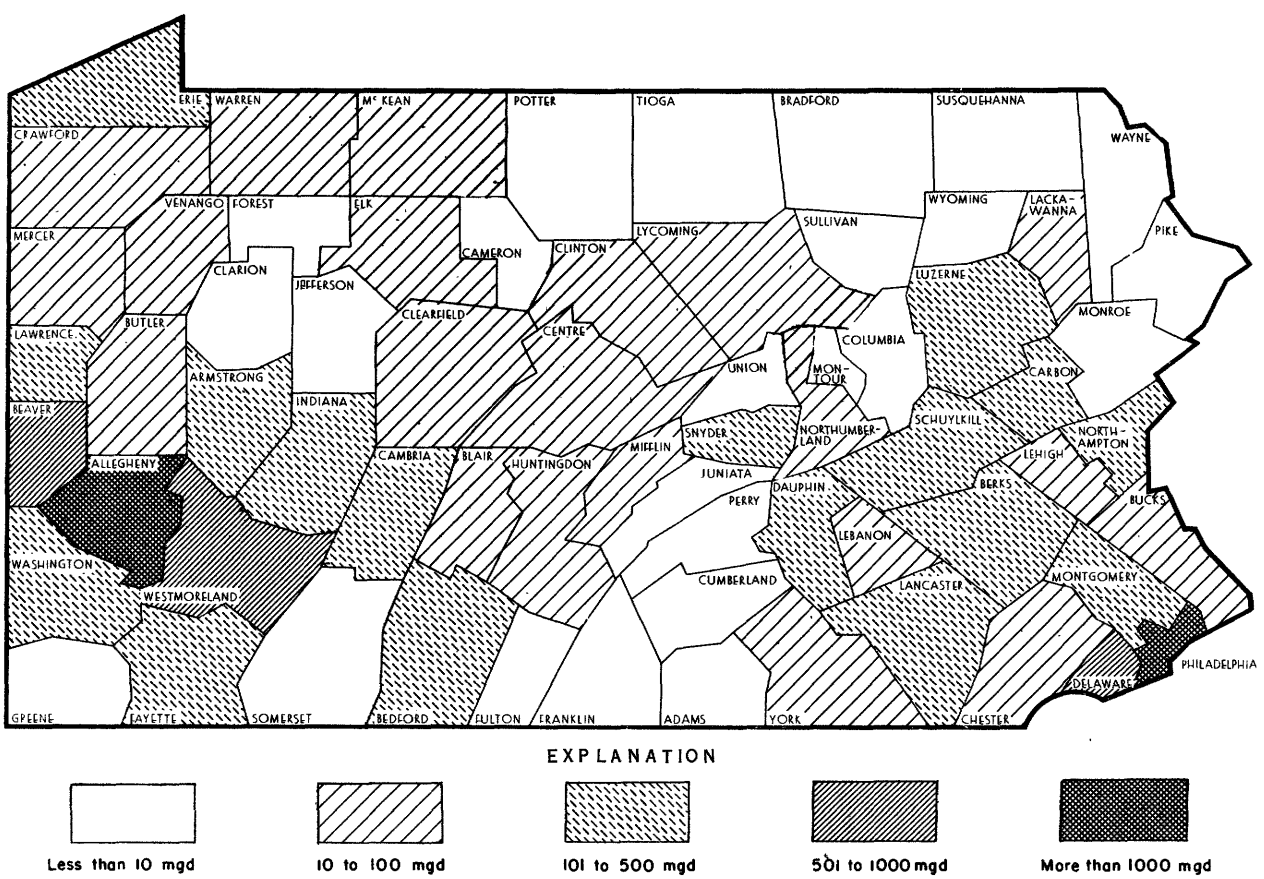

Figure 1.--Withdrawal use of water in Pennsylvania, by counties, 1951.

Table 2. —Average daily withdrawal use of water by counties in Pennsylvania, 1951
(million gallons per day)

Counties	Population (1950 census)	Public supply						Private supply						Grand total
		Municipal use a/		Industrial use b/		Total		Industrial use		Rural use		Total		
		Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface c/	Ground d/	Surface	Ground	
Adams	44,197	0.5	0.5	0.1	(e)	0.6	0.5	0.2	5.9	0.3	1.6	0.5	7.5	9.1
Allegheny	1,515,237	134.2	12.5	39.1	3.0	173.3	15.5	2,799.4	46.4	.1	1.3	2,799.5	47.7	3,036.0
Armstrong	80,842	3.3	.4	.2	.1	3.5	.5	97.6	1.5	.2	2.6	97.8	4.1	105.9
Beaver	175,192	4.6	2.8	3.8	3.5	8.4	6.3	504.3	17.6	.1	1.0	504.4	18.6	537.7
Bedford	40,775	.2	1.2	(e)	(e)	.2	1.2	97.7	.1	.4	1.6	98.1	1.7	101.2
Berks	255,740	12.3	3.6	6.3	.4	18.6	4.0	156.4	5.3	.5	2.9	156.9	8.2	187.7
Blair	139,514	6.9	1.6	2.6	(e)	9.5	1.6	65.3	18.8	.2	2.3	65.5	21.1	97.7
Bradford	51,722	.8	.7	.3	.1	1.1	.8	.9	.2	.7	1.8	1.6	2.0	5.5
Bucks	144,620	2.6	3.5	.8	2.3	3.4	5.8	58.2	3.9	.4	4.5	58.6	8.4	76.2
Butler	97,320	2.6	.7	1.6	(e)	4.2	.7	4.0	3.3	.3	2.6	4.3	5.9	15.1
Cambria	209,541	20.1	.6	124.6	(e)	144.7	.6	23.1	.4	.1	3.0	23.2	3.4	171.9
Cameron	7,023	(e)	.4	0	(e)	(e)	.4	.4	(e)	(e)	.1	.4	.1	.9
Carbon	57,558	2.2	1.3	1.5	0	3.7	1.3	123.2	5.0	(e)	.8	123.2	5.8	134.0
Centre	65,922	1.8	2.8	.1	.2	1.9	3.0	46.1	4.3	.3	1.3	46.4	5.6	56.9
Chester	159,141	7.8	1.1	1.2	(e)	9.0	1.1	34.6	1.8	.7	4.2	35.3	6.0	51.4
Clarion	38,344	.2	.5	0	.1	.2	.6	.6	(e)	.2	1.3	.8	1.3	2.9
Clearfield	85,957	3.7	(e)	1.2	0	4.9	(e)	1.1	25.4	.1	1.5	1.2	26.9	33.0
Clinton	36,532	1.1	(e)	1.2	.1	2.3	.1	61.0	.6	(c)	.6	61.0	1.2	64.6
Columbia	53,460	2.0	.2	2.0	0	4.0	.2	.4	.3	.2	1.0	.6	1.3	6.1
Crawford	78,948	(e)	4.1	(e)	.9	(e)	5.0	.5	6.2	.6	2.3	1.1	8.5	14.6
Cumberland	94,457	5.6	1.0	.1	(e)	5.7	1.0	.2	.1	.3	1.3	.5	1.4	8.6
Duphin	197,784	18.8	1.1	6.4	(e)	25.2	1.1	211.9	21.2	.2	1.2	212.1	22.4	260.8
Delaware	414,234	28.8	0	5.2	0	34.0	0	591.4	.1	(e)	.9	591.4	1.0	626.4
Elk	34,503	1.3	1.6	.2	.7	1.5	2.3	26.9	.7	(e)	.5	26.9	1.2	31.9
Erie	219,388	20.7	.6	18.1	1.8	38.8	2.4	121.2	.3	.4	2.2	121.6	2.5	165.3
Fayette	189,899	10.6	(e)	8.5	0	19.1	(e)	91.7	(e)	.2	1.1	91.9	1.1	112.1
Forest	4,944	0	(e)	0	0	0	(e)	(e)	.3	(e)	.2	(e)	.5	.5
Franklin	75,927	1.6	.5	2.2	(e)	3.8	.5	1.4	.4	.5	2.0	1.9	2.4	8.6
Fulton	10,387	0	.1	0	0	0	.1	(e)	(e)	.1	.4	.1	.4	.6
Greene	45,394	.6	0	(e)	0	.6	0	2.0	.1	.4	1.8	2.4	1.9	4.9
Huntingdon	40,872	2.0	.2	.8	7.3	2.8	7.5	14.6	.1	.2	1.0	14.8	1.1	26.2
Indiana	77,106	5.0	.5	1.2	(e)	6.2	.5	168.5	.9	.3	1.9	168.8	2.8	178.3
Jefferson	49,147	1.1	.1	.9	0	2.0	.1	.1	.1	.2	1.5	.3	1.6	4.0
Juniata	15,243	0	.3	0	(e)	0	.3	.7	(e)	.1	.5	.8	.5	1.6
Lackawanna	257,396	25.4	.4	11.5	0	36.9	.4	12.8	3.0	.2	1.5	13.0	4.5	54.8
Lancaster	234,717	8.8	1.8	4.6	.3	13.4	2.1	152.0	2.2	1.2	4.8	153.2	7.0	175.7
Lawrence	105,120	6.4	.3	3.0	(e)	9.4	.3	146.3	1.0	.2	.9	146.5	1.9	158.1
Lebanon	81,683	3.0	.6	3.5	.1	6.5	.7	28.7	3.5	.3	.7	29.0	4.2	40.4
Lehigh	198,207	3.6	8.4	2.7	6.1	6.3	14.5	14.1	3.7	.1	3.4	14.2	7.1	42.1
Luzerne	392,241	39.2	1.0	16.5	0	55.7	1.0	188.5	6.8	.1	2.0	188.6	8.8	254.1
Lycoming	101,249	5.5	2.0	1.8	.2	7.3	2.2	6.1	.5	.2	1.3	6.3	1.8	17.6
McKean	56,607	2.6	1.0	1.9	(e)	4.5	1.0	10.6	1.0	(e)	.9	10.6	1.9	18.0
Mercer	111,954	5.8	1.1	2.2	.1	8.0	1.2	3.3	2.1	.4	1.4	3.7	3.5	16.4
Mifflin	43,691	2.3	(e)	2.3	0	4.6	(e)	32.4	.2	.2	1.2	32.6	1.4	38.6

Monroe	33,773	2.4	.4	.3	(e)	2.7	.4	4.2	(e)	(e)	.5	4.2	.5	7.8
Montgomery	353,068	18.0	3.8	3.2	.5	21.2	4.3	157.5	18.3	.3	1.9	157.8	20.2	203.5
Montour	16,001	1.0	0	.5	0.	1.5	0	8.0	.1	(e)	.3	8.0	.4	9.9
Northampton	185,243	12.5	2.1	14.7	.9	27.2	3.0	226.0	11.7	.2	.6	226.2	12.3	268.7
Northumberland	117,115	2.4	.9	8.4	.3	10.8	1.2	5.2	3.3	.2	4.0	5.4	7.3	24.7
Perry	24,782	.2	.3	0	(e)	.2	.3	(e)	.2	.2	.8	.2	1.0	1.7
Philadelphia	2,071,605	312.4	0	66.4	0	378.8	0	1,379.5	20.5	0	0	1,379.5	20.5	1,778.8
Pike	8,425	(e)	.3	0	0	(e)	.3	(e)	(e)	(e)	.2	(e)	.2	.5
Potter	16,810	.1	.4	(e)	(e)	.1	.4	(e)	(e)	.2	.6	.2	.6	1.3
Schuylkill	200,577	12.2	2.9	4.7	0	16.9	2.9	139.1	21.5	.1	2.6	139.2	24.1	183.1
Snyder	22,912	.2	.5	(e)	0	.2	.5	205.1	(e)	.2	.7	205.3	.7	206.7
Somerset	81,813	.8	.9	.3	(e)	1.1	.9	.1	.8	.4	3.0	.5	3.8	6.3
Sullivan	6,745	.1	(e)	(e)	0	.1	(e)	1.0	.1	(e)	.2	1.0	.3	1.4
Susquehanna	31,970	1.0	.2	(e)	0	1.0	.2	1.2	.6	.5	1.5	1.7	2.1	5.0
Tioga	35,474	(e)	1.7	0	.4	(e)	2.1	2.8	.6	.4	1.5	3.2	2.1	7.4
Union	23,150	.6	(e)	.7	(e)	1.3	(e)	(e)	.3	.1	.6	.1	.9	2.3
Venango	65,328	1.2	3.2	.2	.5	1.4	3.7	44.4	.7	.1	1.2	44.5	1.9	51.5
Warren	42,698	.4	1.2	.1	.2	.5	1.4	81.8	8.8	.2	1.0	82.0	9.8	93.7
Washington	209,628	8.5	.1	6.3	0	14.8	.1	310.3	.4	.6	1.9	310.9	2.3	328.1
Wayne	28,478	.6	.2	.2	0	.8	.2	(e)	(e)	.4	1.2	.4	1.2	2.6
Westmoreland	313,179	10.8	.5	12.0	.5	22.8	1.0	509.6	3.5	.4	7.7	510.0	11.2	545.0
Wyoming	16,766	.3	.2	0	0	.3	.2	1.0	.3	.2	.7	1.2	1.0	2.7
York	202,737	6.0	.3	11.3	.2	17.3	.5	18.3	1.7	.6	3.5	18.9	5.2	41.9
Total	10,498,012	797.3	81.2	409.5	30.8	1,206.8	112.0	8,995.5	288.7	16.5	109.1	9,012.0	397.8	10,728.6

a/ Includes water for residential purposes, business establishments, office buildings, schools, street flushing, and fire protection.
b/ Includes water used by public utilities for steam-power generation, steam heating, and gas manufacture.
c/ Livestock.
d/ Rural domestic and livestock.
e/ Less than 0.1 mgd.

Summary of withdrawal uses

Quantity. —A comparison of the quantity of water withdrawn in each county in Pennsylvania during 1951 is presented in figure 1. The areas of greatest water use correspond closely to the industrial areas. Development of water supplies has not reached the stage where the water-use pattern reflects the availability of water. Counties bordering the Susquehanna River, the largest stream in Pennsylvania, are, for the most part, small water users. Some of the largest ground-water reservoirs, those in the glaciated areas of northwest and northeast Pennsylvania, and in the central and eastern limestone valleys, have undergone little development.

The five counties having the largest withdrawal uses (fig. 2) contain a large proportion of Pennsylvania's manufacturing industries. A single manufacturing plant using water as a coolant, as in the making of steel, may have a larger water withdrawal than most of the individual county totals. Water serving such industrial use is generally pumped untreated through heat-exchange systems and discharged immediately to the streams without change except for an increase in temperature and without significant losses. Water used by the rural and urban population, although generally polluted during use, is mostly returned to water sources, and becomes available for use again. Therefore, the quantities given in this report for withdrawal uses are not indicative of consumptive use, that is, water that becomes unavailable for re-use. Of the nearly 11 billion gallons of water withdrawn daily in Pennsylvania, probably less than one billion gallons is consumed by evaporation or incorporated in manufactured products.

A part of the water withdrawn may be lost before being used. The larger part of this loss no doubt could be prevented. Water is wasted through leakage from old or poorly constructed supply lines. When supplies are unmetered, consumers are prone to use water excessively. Industries which have developed their own private source of supply are often indifferent to water economy unless it is known that the supply is limited. This may be true of that part of the rural population having modern plumbing and using water electrically pumped into individual homes and farm buildings. Evaporation from the surface of storage reservoirs is a water loss that probably can never be economically controlled.

Source. —In an industrial area, such as Pennsylvania, the larger cities and great manufacturing plants depend almost entirely upon surface-water supplies wherever available. Generally, requirements of several million gallons a day or more can be more economically obtained from streams and lakes than from well fields,

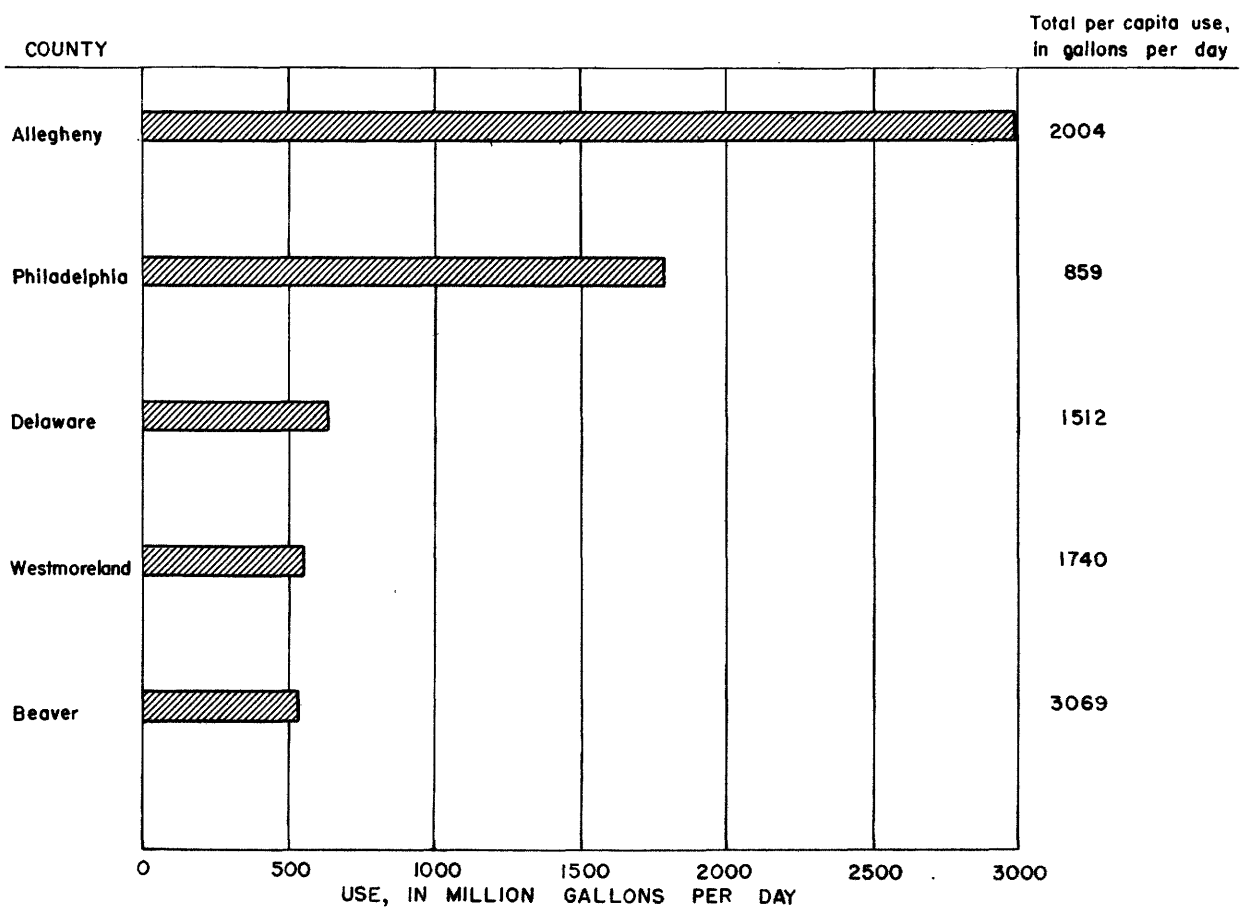

Figure 2. —Quantities of water withdrawn in five largest water-using counties, 1951.

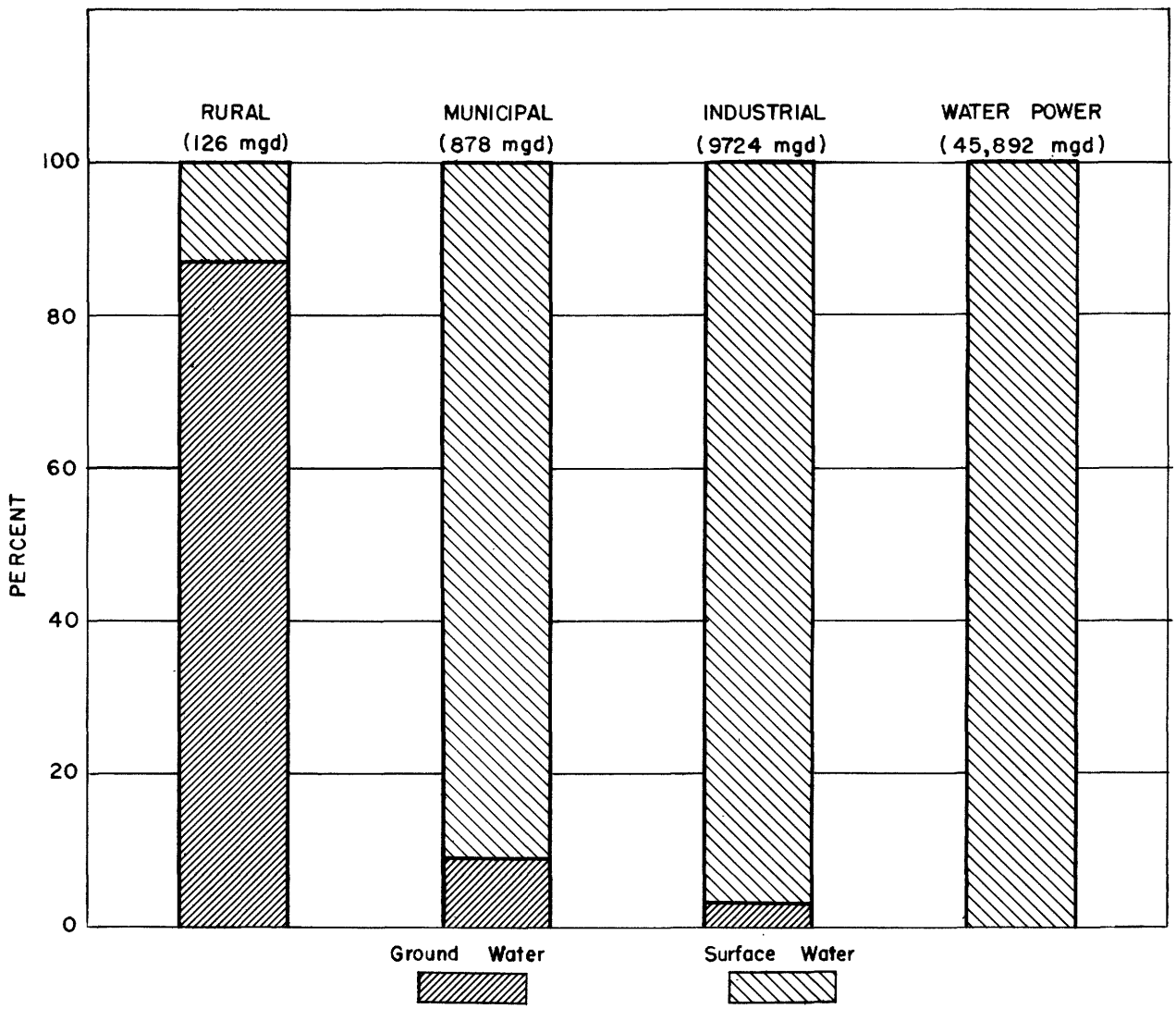

Figure 3. --Source of water used.

unless expensive pipelines or reservoirs are required. In Pennsylvania, most communities and the larger industries are near surface-water sources.

The smaller communities and industries rely on ground water to a much greater degree, where small supplies are sufficient and the ground-water reservoirs can yield a dependable supply, because the cost of surface-water intakes, filter plants, and other necessary facilities is often greater than that of wells. Thus, most of the smaller communities in Pennsylvania utilize ground water, or a combination of ground and surface water, but although these communities outnumber those using surface-water supplies, they furnish less than 10 percent of the total public water supply in the State.

Adequate water for farm and rural residential use can be obtained almost without fail from wells and springs, and there has been little need for rural users to resort to development of more costly surface-water supplies for their needs. Many stock ponds have been developed recently in rural areas, but more as a part of broad conservation programs than for water supply.

The relative use of surface water and ground water as sources for municipal, industrial and rural needs is shown in figure 3.

NONWITHDRAWAL USES

Water power

Water required for water power to generate electricity averaged 45,892 mgd during 1951, more than four times the combined requirements for all other uses (fig. 4). Of the total, 43,063 mgd was used at hydroelectric plants along the lower Susquehanna River.

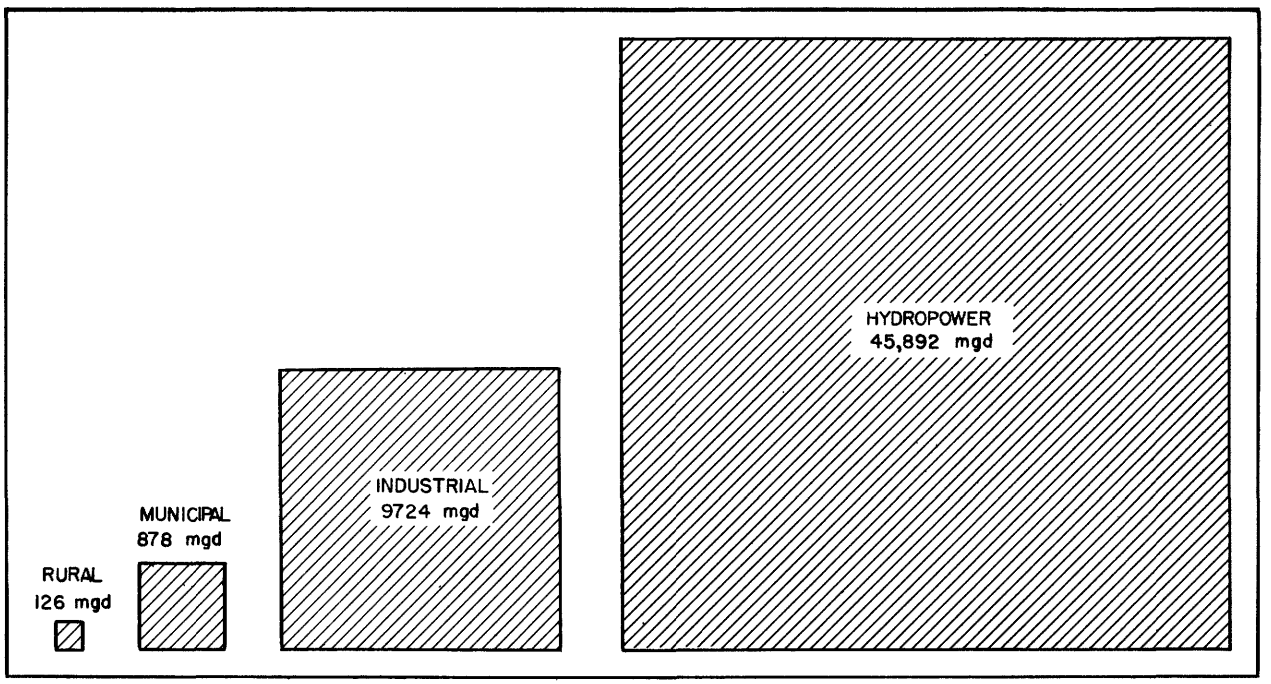

Figure 4.--Rural, municipal, industrial and water-power use of water in Pennsylvania, 1951.

The water was used by hydroelectric plants in only ten counties; the county named is the county in which the plant is located.

County	Million gallons per day
Berks	23
Clarion	1,145
Cumberland	28
Huntingdon	287
Lancaster	35,770
Monroe	381
Northampton	571
Pike	306
Snyder	89
York	7,292
Total	45,892

There are a few small hydroelectric plants that do not keep records of water used and accordingly they are not included in the above table. No records are available as to the water used to develop mechanical power to turn machinery in small factories or at grist mills along many of Pennsylvania's smaller streams.

Navigation

Water transportation at Philadelphia and through inland waterways continues to be an important factor in the prosperity of Pennsylvania. The port of Philadelphia ranked second in importance only to New York in 1950, handling 68,358,388 tons. Pittsburgh Harbor is the most important inland river port in the United States. The total shipping handled on the Allegheny, the Monongahela, and the Ohio Rivers in the Pittsburgh area in 1950 was 38,188,192 tons. Erie is noted principally for its Great Lakes commerce. Erie Harbor handled 6,390,612 tons of lake shipping during 1949.

Waste disposal

Streams have long been used for the disposal of wastes. For many years, the volume of waste discharged was so small that there were few pollution problems. Most streams had sufficient flow and water quality to assimilate sewage and processing wastes discharged into their waterways, generally without treatment. This condition no longer is true for the quantities of sewage and processing wastes discharged into streams have become too large to be assimilated adequately. Water pollution, both surface and underground, is now a major problem which in some areas is increasing in seriousness.

The Commonwealth of Pennsylvania now requires that all communities and industries provide some degree of treatment of all wastes before returning the effluent to the waterways. The clean up of the waterways in Pennsylvania is being pursued actively by the Commonwealth at the present time (1953). However, the streams will remain important for the dilution of wastes.

Recreation

Pennsylvania's rivers, lakes, and ponds provide water recreational facilities to an increasing number of people in Pennsylvania each year. The 672,466 licenses issued in Pennsylvania in 1951 indicate the popularity of fishing as a sport. Although no estimate can be made of the total number who participate in swimming and boating, records at the Pennsylvania Department of Forests and Waters show that in 1951 almost

4 million persons visited its State parks where water-sport facilities were available.

Water is needed by the wildlife that furnishes sport for 855,000 people who hunt on Pennsylvania's lands each year.

Commercial fisheries

Although fishing is very closely related to sports and recreation in Pennsylvania, it is also of importance to industry. The commercial fisheries (including shellfish) in Pennsylvania in 1947 obtained 1,357,000 pounds valued at $354,780.

FUTURE DEMANDS FOR WATER

The industrial production of Pennsylvania's industries reached the remarkable total of $23,097,663,200 in 1951, according to the Pennsylvania Department of Internal Affairs. This was three times the value of the products of industry in 1941. Although no complete statistics on water use prior to 1951 are available, studies made elsewhere in industrial areas indicate that recent increases in water use have been generally proportional to industrial growth. It is not unlikely that there has been at least a twofold increase in total water use in Pennsylvania during the last decade, and that most of this increase has been due to industry, notwithstanding an increase in population of 600,000 during the same period. There is no question, of course, that present-day trends in greater use of such automatic home appliances as dishwashers, washing machines, and garbage-disposal units will increase the domestic per-capita rate in the future.

Figure 5 is a graph showing the increase in population in Pennsylvania since 1860, the population for 1960 having been estimated by the Pennsylvania State Planning Board. The municipal use of water will undoubtedly keep pace with the population trend, but will probably not be commensurate with industrial increases in water use.

At the present time, Pennsylvania is a highly industrialized State supporting heavy industry which requires tremendous amounts of water. Even a small expansion in industrial activities on a state-wide scale will reflect greatly upon water usage. Nowhere can the immediate need for increased water supply be anticipated more clearly than in southeastern Pennsylvania centering in southeastern Bucks County. The Fairless Works of the United States Steel Corp. is now under construction near Morrisville, Pa. When completed it will be the largest integrated steel plant in the world. Several large companies making derivative products are also building industrial plants in the same area. The population of Bucks County is expected to double within the next 2 years. Although little information is available as to the industrial water needs of the affiliated companies, it is anticipated that the Fairless Works alone will draw 15 mgd from its own wells and 235 mgd from the Delaware River. In the future interests of nagivation in this region, consideration is being given to the widening and deepening of the channel of the Delaware River to permit ocean-going vessels to reach as far as Trenton Falls.

At present, the use of water for irrigation appears relatively unimportant in Pennsylvania. According to the U. S. Department of Agriculture 1950 census, only 7,302 acres of farm land was under supplemental irrigation. Of this total, 4,570 acres was in Bucks County where only about 2,000 gallons a day was used during the growing season. Although Pennsylvania with its irregular topography and humid climate cannot be expected to irrigate on as large a scale as is done in Western States, it is believed that, within only a few years, Pennsylvania and other Eastern States will adopt supplementary irrigation on an increasing scale. Droughts causing heavy crop losses have been experienced in Eastern States at all-too-frequent intervals in the past.

OUTLOOK FOR THE FUTURE

With proper planning, Pennsylvania appears to be adequately supplied with water to take care of its future needs. Its average rainfall of 42 inches is the equivalent of 90,230 mgd. Pennsylvania's rainfall exceeds the average for the United States by 13 inches or more than 40 percent. And, although approximately half the water that falls on Pennsylvania is lost through evaporation or use by vegetation, the remainder is many times the estimated consumption of water by man and his activities in Pennsylvania.

Although the total amount of water available appears adequate to meet the water needs of Pennsylvania for many years to come, there are many problems of unequal distribution, abuses in use, and unwise development practices that face present users. These problems will become more acute as water use increases. One of the most serious problems is that of adequately planning and constructing facilities for water supplies during drought.

In 1930, Pennsylvania experienced its most devastating drought in history when 29 inches of precipitation fell on Pennsylvania as compared with a normal of 42 inches. This water deficiency caused tremendous losses and inconveniences to population, agriculture, and industry. Another drought of like proportions occurring today would be far more seriously felt in most parts of Pennsylvania that it was in 1930.

As the result of the water shortages experienced in 1930, some municipal water systems have increased their storage facilities. Low-water conditions in the Pittsburgh area have been improved with the completion of eight flood-control and navigation reservoirs on the Allegheny and the Monongahela Rivers. The release of water from these reservoirs during low flow will be of great aid in maintaining municipal and industrial water supplies in case of another drought. They will also provide low-water regulation for water supply in the interests of pollution abatement and navigation. In 1933, the State-owned Pymatuning Dam and Reservoir were placed in operation. This reservoir, with a usable capacity of 51,000 million gallons, provides flood protection for the lower Shenango River basin. It is also regulated so as to insure a flow of not less than 130 mgd in the Shenango River during low-flow periods in summer and fall. The large Sharon and Newcastle industrial areas no longer worry about the shortages of water supply that retarded their growth

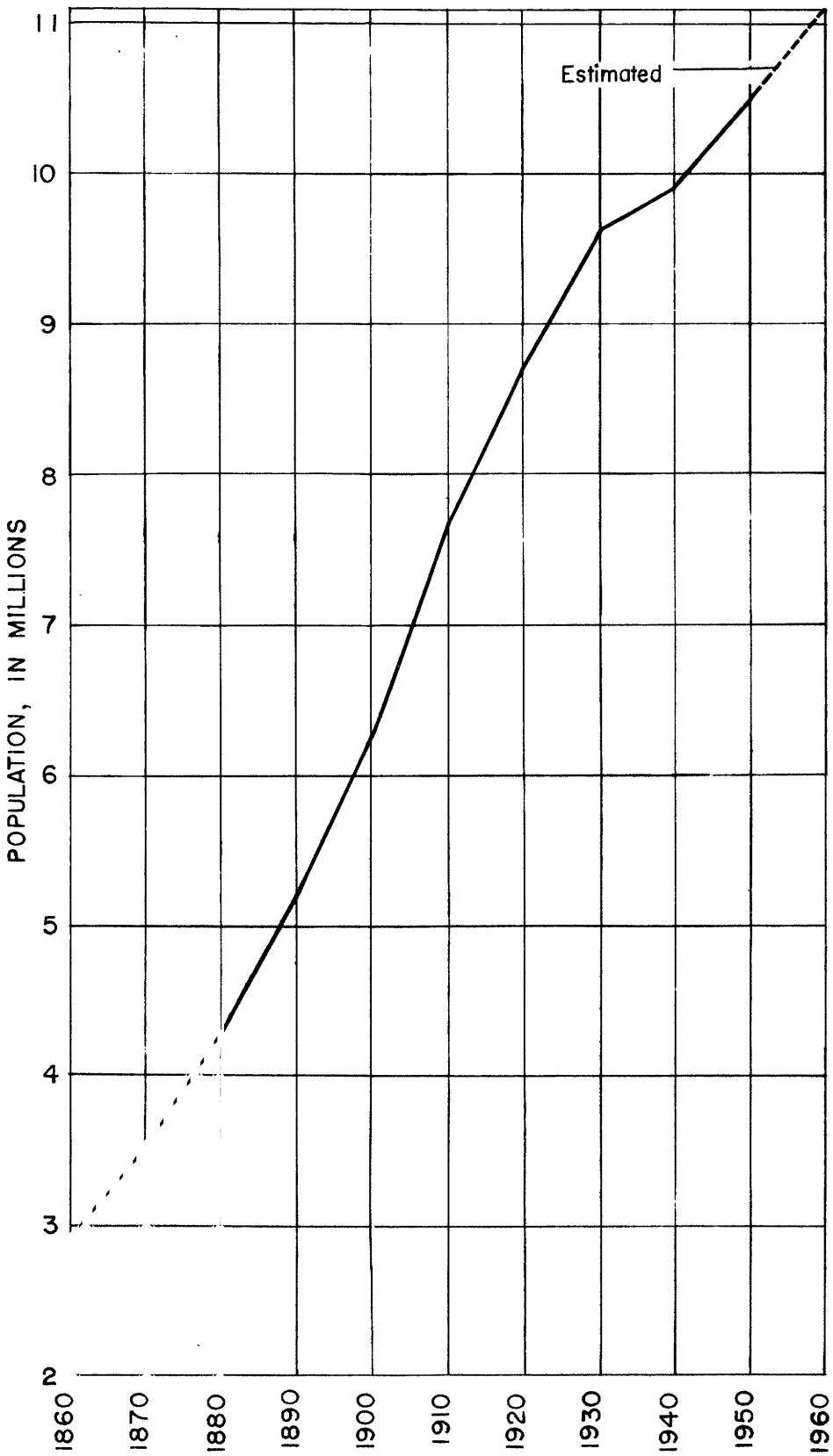

Figure 5.—Population of Pennsylvania, 1860-1950 with estimate for 1960.

for many years. There are other places where storage facilities have been increased in recent years but they are far too few.

It has not yet been demonstrated that precipitation can be increased or controlled effectively by man, but the topography of Pennsylvania affords abundant opportunities to construct impounding reservoirs which will permit the storage of water in times of plenty in order that it may be available to meet water demands during prolonged periods of deficiency.

Another serious problem facing the future is the pollution of water supplies. However, great progress has been made in the reduction of stream pollution, and the quality of surface water is improving in many areas throughout Pennsylvania. Some streams heretofore unsuitable for use or usable only after exorbitant treatment costs are again becoming available as economic sources of supply. However, acid mine waste is still a serious pollution problem in some areas and probably can never be economically controlled. Because mine waste pollution of streams limits the use of that water it will continue to retard growth in some sections of the State.

The pollution of Pennsylvania's ground-water resources is a no less serious threat, particularly since the degree of pollution and its causes are not readily apparent nor easily controlled.

Much remains to be done in effectively regulating the development and use of ground water in Pennsylvania so as to insure that it will be continuously available and of satisfactory quality. During the past few years, the use of ground water has been increasing at a rapid rate in Pennsylvania. Ground water has certain advantages over surface water and it is often preferred where the supply is adequate to suit the demand and where economical treatment is a factor. Its greatest advantage is its widespread availability, at least in moderate supply. Ground water is generally free from disease-producing bacteria and suspended matter; it has more uniform chemical composition, and a more uniform temperature making it more desirable for cooling purposes than surface water. The added impetus given to the use of ground water in recent years is due in part to the improvement of well-construction methods and the development of better pumping equipment.

There is a widespread opinion that ground-water levels are progressively decreasing and that soon the supply may be exhausted. There is nothing to substantiate such a claim. There are a few areas in Pennsylvania where ground-water levels are declining, and probably are reaching the critical condition of overdevelopment, but these are the result of heavy localized pumpage.

In downtown Pittsburgh, the large withdrawals of ground water, particularly for air-conditioning purposes, cause a marked seasonal decline in water levels, and little additional development in this area can be anticipated. However, large undeveloped supplies are available in nearby valley sediments along the Allegheny and the Ohio Rivers.

Ground-water problems are present in the Philadelphia area. Heavy ground-water pumping in south Philadelphia has induced movement of waters of inferior quality into the principal aquifers in the area. This contamination has increased rapidly in recent years and is of grave concern to the many industries in south Philadelphia that are using this source of supply.

The quantity of ground water used will always be far less than surface water because the large supplies required by the larger cities and industries generally cannot be obtained locally. Nevertheless, Pennsylvania's over-all supply of ground water is large and if proper measures are taken for its conservation it should satisfy Pennsylvania's needs for many years to come. Far too little is known at present as to the availability of unexploited ground water, but it is likely that supplies in quantities and of a quality attractive to industries are available in many parts of the State. At present there are no legal controls to protect aquifers against overdevelopment nor safeguards against contamination. No doubt, legislation will be enacted in the near future so that there will be assurance that this important resource can be more effectively utilized.

Pennsylvania's water resources are abundant and, with few exceptions, they should be ample to care for future needs. All that is required is that they be conserved for use at the proper time, that they be properly and fairly allocated and distributed, in accordance with sound State laws and interstate compacts, and that they be protected against misuse and abuse. As the use of water increases to keep pace with Pennsylvania's progress in ever-greater industrialization, hydrologic data—not the least of which is the continuing appraisal of all uses of water—are becoming more and more essential for sound planning.

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