GEOLOGICAL SURVEY CIRCULAR 339

PUBLIC AND INDUSTRIAL WATER SUPPLIES OF THE WESTERN COAL REGION, KENTUCKY

Prepared in cooperation with the
Agricultural and Industrial
Development Board of Kentucky

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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CONTENTS

ILLUSTRATIONS

TABLES

PUBLIC AND INDUSTRIAL WATER SUPPLIES OF THE WESTERN COAL REGION, KENTUCKY

By B. W. Maxwell

ABSTRACT

Data on the source, pumpage, treatment, and storage of water for 88 public and industrial water supplies in the 10 counties of the Western Coal Field region of Kentucky are presented.

The total daily pumpage of water in the region is about 50,000,000 gallons. Seventy-two percent of this is obtained from wells and 28 percent is obtained from surface supplies. The Quaternary alluvium provides about 91 percent of the ground water used in the region. Of the total pumpage 24 percent is used for all purposes from public supplies. The daily consumption of water per person from public supplies ranges from 21 to 197 gallons and averages 110 gallons. The chief industrial consumption of water is for coal washing, production of chemicals, distilling, and secondary recovery of petroleum.

The region is the southern part of a large basin of shales and sandstones of Pennsylvanian age which are overlain in places by alluvial sands and gravels, and silts of Quaternary and Recent age. The chief aquifers are the Pennsylvanian sandstones and the sands and gravels of the alluvium. The waters in the Pennsylvanian sandstones are fresh in the outcrop areas and become progressively more mineralized toward the center of the basin. Yields from the Pennsylvanian sandstones range from a few gallons per minute up to 500 gpm. Water in the alluvium ranges from hard to very hard and may be pumped from vertical wells at rates up to at least 1,000 gpm.

INTRODUCTION

Purpose and Scope of Report

In order to provide data for planning intelligently the use and conservation of the water resources of the State of Kentucky, a statewide program of ground-water investigations is being conducted by the Ground Water Branch of the United States Geological Survey in cooperation with the Agricultural and Industrial Development Board of Kentucky. For convenience in making ground-water investigations the State has been divided into five regions: Eastern Coal Field, Blue Grass, Mississippian Plateau, Western Coal Field, and Jackson Purchase. The boundaries of these regions (shown on fig. 1) are drawn on county lines, and do not coincide exactly with physiographic or geologic limits. This report on the public and industrial water supplies of the Western Coal Field region is one of a series of five which describe the public and industrial water supplies of the entire State. The reports on the Jackson Purchase (Circular 287) and Blue Grass (Circular 299) regions have already been published.

The Western Coal Field region, as defined in this report, includes 10 counties in the western part of the State: Butler, Daviess, Hancock, Henderson, Hopkins, McLean, Muhlenberg, Ohio, Union, and Webster. It is bounded on the north by the Ohio River and on the east, south, and west by the Mississippian Plateau region. The 10 counties of the Western Coal Field have a combined area of about 4,680 square miles and a population of about 238,000. This report contains basic data on the water supplies of 27 cities and towns, 60 large industries, and 1 State park. Water supplies of less than 10,000 gpd have not been included in this report. Data given are source, pumpage, treatment, storage facilities, and quality of water as shown in analyses.

The information compiled here should be useful in planning the future development of water resources in this area. The industrialization of parts of this region will increase the demand for knowledge of its water resources, because the availability of water may be the limiting factor in development.

Previous Investigations and Acknowledgments

The general geologic information included in this report is based largely on the work of L. C. Glenn, H. R. Wanless, and C. V. Theis. (See "Selected bibliography.") Additional geologic information was obtained by study of well logs and well cuttings and from well drillers, miners, and oil men. The Kentucky Geological Survey made available its files of well logs and cuttings.

Information on pumpage and quality of water used at Henderson, Owensboro, and Madisonville are included in a report by E. W. Lohr and others (1952).

The data on water supplies presented in this report were furnished by the owners and operators of the public and industrial supplies. The report could not have been prepared without the full cooperation of these officials.

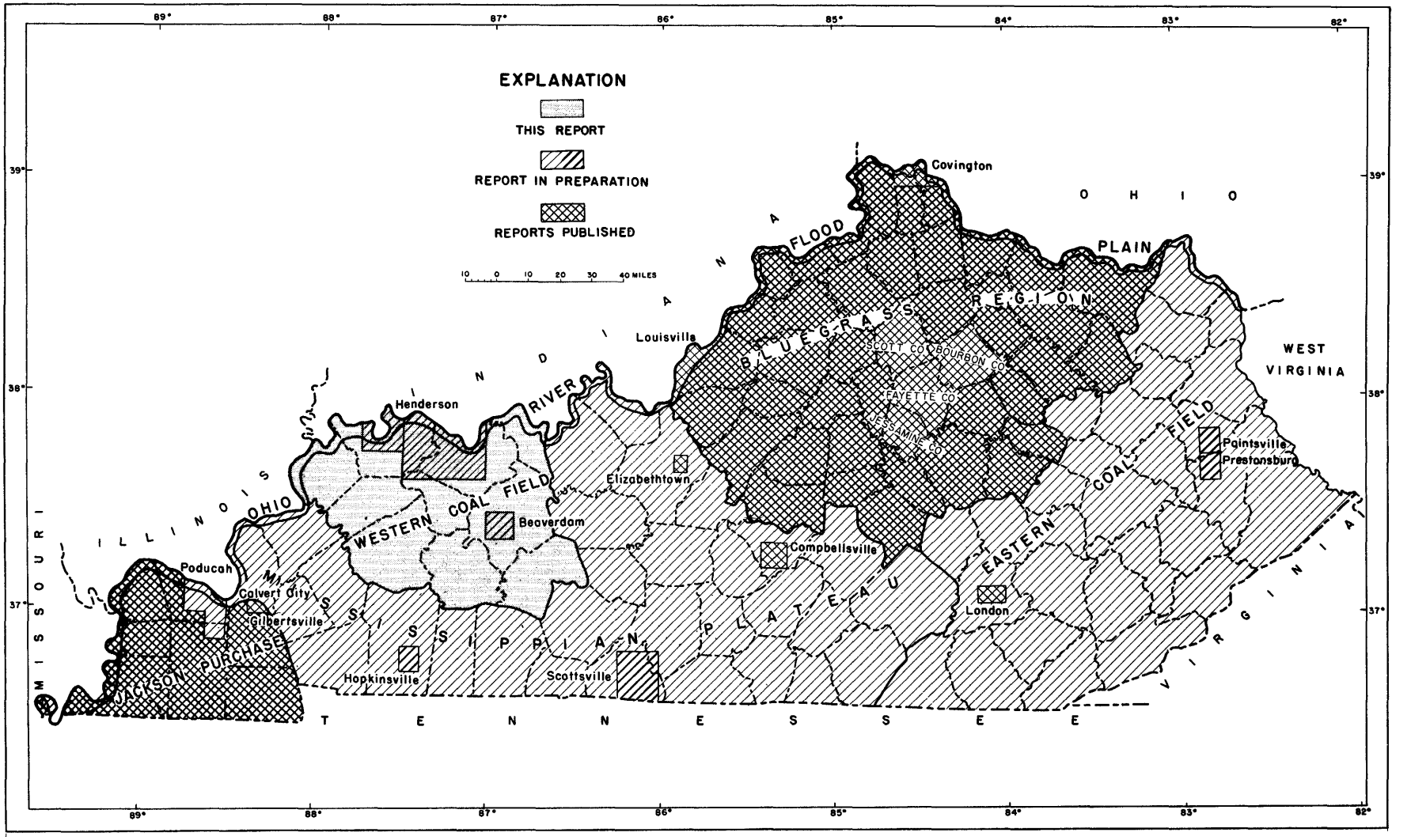

Figure 1. —Index map of Kentucky showing progress of ground-water investigations.

Methods of Investigation and Presentation of Data

The public and industrial water supplies for which data are given were visited in 1951 and 1952 by B. W. Maxwell, E. J. Harvey, and R. W. Devaul, of the U. S. Geological Survey. Information was obtained directly from waterworks officials, plant engineers, and operators. Samples of ground-water supplies were collected and sent for analysis to the Columbus, Ohio, regional laboratories of the U. S. Geological Survey.

The data obtained in this investigation are tabulated under the heading "Descriptions and analyses." This information is presented graphically in plates 1 and 2. Plate 1 shows location, source, and pumpage in gallons per day of 87 public and industrial supplies and 1 State park. Plate 2 shows the quality of the water of 35 of these supplies. The general geology of the region is illustrated in the cross section and map, plate 3.

Table 1 is a generalized section of the geologic formations exposed or penetrated by wells. Table 2 shows elements and substances commonly found in ground water and their significance. Table 3 shows the cities, towns, and industries in the region served by ground water, the population served, the water-bearing formations, and the pumpage. Table 4 shows similar information for cities and industries using surface water. Table 5 shows the per-capita and total consumption of water from the public water supplies in the Western Coal Field.

The water supplies described in this report are numbered to conform to the numbering system used by the Ground Water Branch throughout Kentucky. Under this system the State has been subdivided into rectangles bounded by 5-minute meridians of longitude and 5-minute parallels of latitude. Each well in a 5-minute rectangle has been assigned a number based on the longitude and latitude of the southeast corner. Well 8735-3745-10, for example, at Henderson, is the tenth well numbered in the rectangle bounded on the east by longitude 87°35' and on the south by latitude 37°45'. Surface-water supplies are designated by town names or, when in the country, by capital letters. For example, the surface-water supply of the W. G. Duncan mine at Graham, the first to be inventoried in rectangle 8715-3710, is designated by the letter A.

Ground-water investigations are under the general direction of A. N. Sayre, chief, Ground Water Branch, and in Kentucky under the direction of M. I. Rorabaugh, district engineer, U. S. Geological Survey. This report was prepared under the direction of G. E. Hendrickson. All analyses, except where otherwise noted, were made in the U. S. Geological Survey regional laboratory at Columbus, Ohio, under the direction of W. L. Lamar, district chemist.

GEOGRAPHY

Topography and Drainage

Most of the region is rolling upland, with altitudes ranging from 400 to 550 feet, underlain chiefly by shales and sandstones of Pennsylvanian age. Near the east, south, and west boundaries of the region is a belt of rugged hills, ranging up to 800 feet in altitude, which generally coincide with the belt of outcrop of the Caseyville sandstone and lower part of the Tradewater formation. Another belt of hills lies along the Shawneetown-Rough Creek fault which extends east and west across the central part of the region. Extensive flood plains and alluvial terraces of low relief, ranging in altitude from 320 to 415 feet, border the Ohio and Green Rivers and their tributaries.

The Green River, draining the east and central parts of the region, and the Tradewater River, draining the western part, flow north and northwest, respectively, into the Ohio River. Minor tributaries flowing into the Ohio drain small areas in the northern part of the region.

Climate and Vegetation

The climate of this region is the humid continental type. Records of the United States Weather Bureau station at Evansville, Ind., from 1897 to 1951 show an average annual precipitation of about 41 inches. A minimum of 25 inches was recorded in 1930 and a maximum of 63 inches in 1950. The heaviest rainfall usually occurs during the spring and winter, the lightest during the fall. The average annual temperature is about 57°F. Temperatures below 0°F occur occasionally during the winter, and temperatures above 100°F are common during the summer. The growing season varies from 169 to 250 days and averages 210 days.

The native vegetation includes various grasses and trees. Small stands of second-growth hardwoods are scattered throughout the area, and more extensive wooded areas occur in the lowlands along streams and in the rugged hilly areas.

Population

The population of the region at the time of the 1950 United States Census was 237,899, or one-twelfth of the population of the State. Owensboro, Madisonville, and Henderson are the only cities in the area that have populations of more than 10,000. Since 1950 there has been a slight increase in population because of industrial expansion.

Rural Land Use

Most of the large and prosperous farms are on the alluvial terraces along the rivers. Corn, soybeans, tobacco, and cattle are the chief products here; potatoes and truck crops are of lesser importance.

The rolling upland is not so easily worked as the alluvial terrace. The land is fertile, but the farms are generally smaller. Corn and tobacco are raised here, but fruit farming, grazing, and dairying are more important.

The belt of hills near the east, south, and west boundaries of the area and the dissected areas bordering the rivers are too rugged for large-scale farming. The cultivated areas here are small, and most of the crops are used for subsistence. There is some production of timber, mostly for local use, from this area.

Mineral Resources and Industries

All 10 counties of the region produce coal, although most of the present production is in Hopkins and Muhlenberg Counties. In 1951 western Kentucky produced 23,547,524 tons of bituminous coal from 216 mines employing 7,254 men. Coal reserves are ample to meet the present demand or any likely increased demand for many years.

The exploitation of the oil and gas is more recent than that of the coal. All the counties produce some oil, but until recently exploration and development have been concentrated in the area north of the Shawneetown-Rough Creek fault. At the present time the area south of the fault is being more thoroughly explored and developed. During 1951 the region produced 8,173,193 barrels of crude oil, 72 percent of the total production of Kentucky for that year.

Several firms produce brick and tile from local clay deposits. Sand and gravel are obtained by dredging in the Ohio River to supply the northern part of the region. Pliocene(?) gravels are used locally farther south. Limestone is not generally abundant as there are no thick limestones in the section of Pennsylvanian rocks. (See table 1.) However, limestones of Pennsylvanian age are quarried in places for local use. The Mississippian limestones crop out near the east, south, and west borders of the area and in places along the Shawneetown-Rough Creek fault and are also quarried for local use.

Manufacturing and Processing Industries

The economy of the region is chiefly dependent on farming, mining, and petroleum production, which are discussed above. Other industries include production of distilled beverages, food processing, production of chemicals, and manufacture of furniture, clothing, electrical equipment, and plastic products. At the time this report is written (1952) a plant to process scrap into steel is under construction near Owensboro.

Six steam plants supply the region with electricity. Two of these serve Henderson and Owensboro; one at South Carrollton serves the remainder of the area; three are standby plants — at Nortonville, Earlington, and Graham — that operate only in emergencies or at time of peak loads.

GEOLOGY

Structure

The Western Coal Field is the southern part of a large basin. In general the rocks dip gently inward from the east, south, and west borders. Minor folds and normal faults with displacements up to several hundred feet occur over much of the region. This simple pattern is interrupted by two major structural features. The Moorman syncline extends from Union County through Butler County and includes the deepest part of the Western Coal Field. The Shawneetown-Rough Creek fault extends across the region north of the Moorman syncline. The displacement along this fault exceeds 1,000 feet, in places bringing limestones of the Chester group of Mississippian age in contact with shales of the Lisman formation of Pennsylvanian age.

The south side is upthrown in relation to the north side. Locally, however, the movement apparently has been reversed. These structural features are shown on the cross section and map, plate 3. The cross section was constructed from electric logs of oil tests, from the Webster County geologic map by Glenn (1923), and from the Muhlenberg County geologic map by Woodruff (1930).

Stratigraphy

This section on stratigraphy is based on earlier geologic investigations in the region and on observation of well logs and cuttings, and outcrops. This geologic information is summarized and presented graphically in table 1 and on plate 3.

The Chester group of late Mississippian age crops out in a semicircle west, south, and east around the coal field and at several locations along the Shawneetown-Rough Creek fault zone. The group consists predominantly of marine shales, limestones, and several sandstones. The Chester group does not furnish any large fresh water supplies in the Western Coal Field, but does furnish brine for secondary recovery operations.

The Caseyville sandstone is the lowest Pennsylvanian formation in the Western Coal Field. Although it wedges out in places, it is as much as 600 feet thick in other places. Where fully developed the Caseyville sandstone consists of three members. The lowermost member is a conglomerate composed of quartz sand, and rounded quartz pebbles. In the northwest part of the region this has been called the Battery Rock and in the southeast where it is locally impregnated with asphalt, the Kyrock conglomerate (McFarlan, 1950). The middle member is a shale which in places contains the Battery Rock coal. The uppermost member is a medium to coarse sandstone known as the Bee Spring sandstone (of Bryant, 1914). The Caseyville sandstone is the source of six public and industrial water supplies in the region. (See table 3.)

The Tradewater formation overlies the Caseyville sandstone and is generally marked by a transition from massive sandstones below to a shaly sequence above. In most places the 1A coal occurs in the Tradewater formation a few feet above the contact with the underlying Caseyville sandstone. According to Glenn (1922), the thickness of the Tradewater ranges from 175 feet to 700 feet. The formation contains, from bottom to top, coals 1A to 7, inclusive. Prominent sandstone members in the lower part of the formation furnish water for 10 public and industrial supplies. (See table 3.)

Unconformably overlying the Tradewater formation is the Carbondale formation consisting mainly of shales and a few shaly sandstones and coals 8 to 11 inclusive. Thickness ranges from 230 to 650 feet, according to Glenn (1922). This formation yields water to old mine workings connected with the Norco mine at Nortonville but does not furnish water to any other large supply. Only a little of the water pumped from the Norco mine is used for washing coal. (See p. 30.)

Table 1.—Generalized section of the geologic formations exposed or penetrated in the Western Coal Field region, Kentucky

System		Series	Group	Formation	Range in thickness (feet)	Lithology	Water-bearing characteristics
Quaternary		Recent and Pleistocene		Loess	0-50 ?	Silt.	Yields no large supplies.
				Alluvium	0-136	Sand, gravel, clay, and silt.	Yields up to 1,100 gpm from sand and gravel. Hard to very hard.
Tertiary		Pliocene(?)		Lafayette(?) gravel	0-10	Sands and gravels.	Yields no large supplies.
Carboniferous	Pennsylvanian		McLeansboro	Henshaw	>400	Shales and sandstones.	Yields up to 20 gpm.
				Lisman	900-1,000	Shales, sandstones, thin limestones, and coals.	Yields up to 200 gpm. Reported soft to hard water.
				Carbondale	250-650	Shales, sandstones, coals, and thin limestones.	Yields up to 20 gpm in the Henderson area.
			Pottsville	Tradewater	175-700	Shales, sandstones, and coals.	Yields up to 100 gpm of fresh water in some places, brines in others.
				Caseyville	0-600	Conglomerate, sandstone, and shale.	Yields up to 500 gpm of fresh water in some places, brines in others.
	Mississippian		Chester			Marine limestones, shales, and sandstones.	Yields brines in this region.

The Lisman formation overlies the Carbondale formation and ranges in thickness from 900 to 1,000 feet. Near the base of this formation is the Anvil Rock sandstone member, a coarse, loosely cemented, ferruginous, crossbedded, and locally conglomeratic sandstone. The remainder of the formation is predominantly shale. The Anvil Rock sandstone member furnishes four and part of a fifth public and industrial water supplies. (See table 3.) No public or industrial water supplies are obtained from the shaly beds of the Lisman formation above the Anvil Rock sandstone member.

The Henshaw formation, commonly referred to as the Dixon formation (of Glenn, 1912) by local geologists, is the uppermost Pennsylvanian formation recognized in the Western Coal Field. Unconformably overlying the Lisman formation, it consists of more than 400 feet of shales and sandstones. The sandstone member at the base of the formation furnishes the town of Dixon with water.

Scattered patches of high-level gravels, composed of chert fragments and ferruginous sands, have been correlated with the so-called Lafayette gravels of Pliocene(?) age. These gravels generally lie above the water table and are the source of no large public or industrial water supplies.

The valley alluvium of Quaternary (Pleistocene and Recent) age is the youngest and most productive aquifer in the coal field. During Pleistocene and Recent times, sand, gravel, silt, and clay were deposited in the stream valleys. The maximum known thickness of alluvium in this area is 136 feet along the Ohio River. The alluvium is characterized by rapid lateral variation in material. Generally the deeper deposits are coarser than those near the surface. All the large water supplies obtained from the alluvium are in the Ohio River terraces. The alluvium of tributaries of the Ohio in the Western Coal Field region is generally fine grained and does not yield large supplies of water. However, gravel is reported in several localities along the Green and Rough Rivers, and it is possible that fairly large supplies may be obtained in some of these places. The river alluvium furnishes water for 19 public and industrial supplies. (See table 3.)

The loess of Pleistocene age is a wind-laid deposit of fine-grained calcareous sand and silt ranging up to about 50 feet in thickness near the Ohio River. No large supplies are derived from this formation because water does not readily pass through it.

WATER RESOURCES

Quality of Water

This report includes chemical analyses by the U. S. Geological Survey of 41 ground-water samples. These are given under the heading "Descriptions and analyses." The results of analyses of the dissolved substances in these samples are given in parts per million by weight. These figures can be converted to grains per gallon by multiplying by 0.0584.

The dominant ionic constituents in most natural waters are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, and chloride. Small quantities of nitrate and fluoride are also present in most ground water. The ions of calcium, magnesium, sodium, and potassium are called cations or metallic ions and sometimes are referred to as bases or basic ions. The ions of bicarbonate — and carbonate, when present — sulfate, chloride, nitrate, and fluoride are called anions and are sometimes referred to as acid ions.

The cations and anions will combine to form chemical compounds such as sodium chloride, which is common salt. However, this combination does not take place unit for unit by weight because 22.997 ppm of sodium will combine exactly with 35.457 ppm of chloride. In order to express chemical combinations, as well as to show water analyses graphically, as on plate 2, the quantities may be expressed in equivalents per million. Parts per million may be converted to equivalents per million by dividing the parts per million by the combining weight of the constituent. Thus, for example, a unit equivalent of the cation sodium will combine exactly with a unit equivalent of the anion chloride to form the compound sodium chloride.

Plate 2 shows the quality of water in graphic form. The analyses shown are plotted as equivalents per million. When parts per million are converted to equivalents per million, the sum of all the cations (bases) should equal the sum of all the anions within limits of practical analytical accuracy, inasmuch as these ions are in equilibrium. In the graphic plots on plate 2, the left-hand column of cations and the right-hand column of anions are of the same height. Slight adjustment was usually necessary to compensate for slight differences in the totals for cations and anions. In these diagrams, the cations are shown in the following order, from the bottom to the top: calcium, magnesium, and sodium and potassium. The anions, in ascending order, are: bicarbonate (including carbonate), sulfate, and chloride (including fluoride and nitrate, if the nitrate content is less than 10 ppm). If the nitrate content is more than 10 ppm it is shown separately, in solid black, at the top of the column. The hardness of a water as calcium carbonate, in parts per million, is shown by a figure at the top of the magnesium block because the hardness of water in this region is due mainly to the calcium and magnesium content.

The hydrogen-ion concentration, expressed as the pH (log of the reciprocal of the hydrogen-ion concentration), is useful in determining the scale-forming or corrosive tendencies of the water. The pH of neutral water is 7.0. Decreasing values of pH denote increasing hydrogen-ion concentration; increasing values of pH denote decreasing hydrogen-ion concentration. Thus, on the pH scale when the pH is lower than 7.0 the water is acid; when the pH is higher than 7.0 the water is alkaline.

The specific conductance of a water is a measure of the ability of the water to conduct an electric current. The conductivity test is important as a general indication of the amount of dissolved solids in the water. It provides a convenient means of indicating changes in concentration, but is not considered a reliable check on the accuracy of the analyses.

The dissolved-solids content represents the quantity of substances in solution, although the value reported may include some organic matter and water of crystallization. The United States Public Health Service recommends that the total solids of a potable water supply be limited to 500 ppm, but 1,000 ppm is permitted where necessary.

Hard water is usually recognized by the large amount of soap required to produce lather and by the scale of insoluble salts formed when the water is heated. Hardness is due chiefly to the salts of calcium and magnesium, although aluminum, iron, manganese, and free acid can contribute to it. The hardness equivalent to the bicarbonate or carbonate or both in a water is called carbonate hardness; the hardness caused by other compounds of hardness-forming cations is called noncarbonate hardness. In this report, waters having a hardness from 0 to 60 ppm are considered soft; those between 61 and 120 ppm are moderately hard; those between 121 and 200 ppm are hard; and those above 200 ppm are very hard.

The significance of the various mineral constituents in solution is indicated in table 2.

Utilization

The consumption of water for public and industrial supplies is summarized in tables 3 and 4 and shown

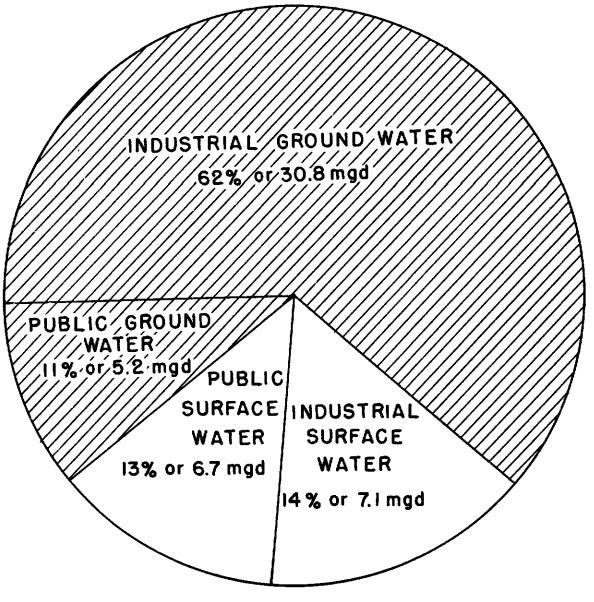

Figure 2.--Water utilization and source in the Western Coal Field region, Kentucky.

Table 2.—Elements and substances commonly found in ground water

Constituent	Source	Significance
Silica (SiO_2)	Siliceous minerals present in essentially all formations.	Forms hard scale in pipes and boilers. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	The common iron-bearing minerals present in most formations.	Oxidizes to a reddish-brown sediment. More than about 0.3 ppm stains laundry and utensils reddish brown, is objectionable for food processing and beverages. Larger quantities impart taste and favor the growth of iron bacteria.
Manganese (Mn)	Manganese-bearing minerals.	Rarer than iron; in general has same objectionable features; brown to black stain.
Calcium (Ca) and magnesium (Mg)	Minerals that form limestone and dolomite and occur in some amount in almost all formations. Gypsum also a common source of calcium.	Cause most of the hardness and scale-forming properties of water, soap consuming.
Sodium (Na) and potassium (K)	Feldspars and other common minerals; ancient brines, sea water; industrial brines and sewage.	In large amounts cause foaming in boilers and other difficulties in certain specialized industrial water uses.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate minerals.	In combination with calcium and magnesium forms carbonate hardness which decomposes on application of heat with attendant formation of scale and release of corrosive carbon dioxide gas.
Sulfate (SO_4)	Gypsum, iron sulfides, and other rarer minerals; common in waters from coal-mining operations and many industrial wastes.	Sulfates of calcium and magnesium form hard scale.
Chloride (Cl)	Found in small to large amounts in all soils and rocks; natural and artificial brines, sea water, sewage.	In large enough amounts may give salty taste, objectionable for various specialized industrial uses of water.
Fluoride (F)	Various minerals of widespread occurrence, in minute amounts.	In water consumed by children, about 1.5 ppm and more may cause mottling of the enamel of teeth and up to about 1.0 ppm appears to reduce incidence of tooth decay.
Nitrate (NO_3)	Decayed organic matter, sewage, nitrate fertilizers, nitrates in soil.	Values higher than the local average may suggest pollution. There is evidence that more than about 45 ppm NO_3 may cause methemoglobinemia (infant cyanosis), sometimes fatal. Waters of high nitrate content should not be used for baby feeding. 1/

1/ Maxey, K. F., 1950, Report on the relation of nitrate concentrations in well waters to the occurrence of methemoglobinemia: Nat. Research Council, Bull. Sanitary Eng. p. 265, App. D.

graphically by block diagrams on plate 1. These blocks are so constructed that they are proportional to the pumpages in volume. The basic unit of these block diagrams is the cube representing 10,000 gallons of water used daily. These are assembled in piles 10 cubes high, or in the very large blocks in piles 25 cubes high. Ground water is distinguished from surface water by shading on the front of the blocks. Pumpage of water by the six steam plants is not shown in the block diagrams, nor is it included in the figures given below.

The average daily pumpage of water for public and industrial supplies in this region is about 50,000,000 gallons. Public supplies use 24 percent of this total and industrial supplies use 76 percent. Wells furnish 72 percent of the water used and lakes and rivers furnish 28 percent. This is shown graphically in figure 2.

Public Supplies

The 27 public water supplies in the region serve 109,734 people (46 percent of the population of the region) with about 12,000,000 gallons of water per day, or about 110 gpd per person. Surface water is used for 15 supplies and ground water for 12 supplies. The uses of public water supplies include domestic, industrial, air conditioning, and smaller amounts for schools, fire fighting, public buildings, and small businesses.

The average daily per-capita consumption from public supplies in this region ranges from a minimum of 21 gallons to a maximum of 197 gallons. Table 5 shows the daily per-capita consumption of public water supplies in the Western Coal Field. Generally in the smaller towns most of this water is used for

Table 3.—Pumpage and source of ground water for public and industrial supplies in the Western Coal Field region, Kentucky

[Water-bearing formation and pumpage in gallons per year: a, plus 936,000,000 gal. from the Ohio River shown on table 4, total of tables 3 and 4 is metered; m, metered; e, estimated on basis of part of year; g, geologic formation not definitely known]

County	Location	Owner	Water-bearing formations and pumpage in gallons per year					
			Alluvium	Henshaw	Lisman and Carbondale	Tradewater	Caseyville	Chester group
Daviess	Andersonville, Red Hill oil pool.	Simon LeBow.....	-	-	-	g,m5,570,000	-	-
Do.	Birk City, Birk City oil pool.	Sohio Petroleum Co...	-	-	-	m5,060,000	-	-
Do.	Boston, Cane Run oil pool.	J. C. Ellis.....	-	-	-	g,m4,600,000	-	-
Do.	Griffith, Griffith oil pool.	Roy Pledger.....	e5,360,000	-	-	-	-	-
Do.	Habit, Habit oil pool.	J. C. Ellis.....	-	-	-	g,m4,200,000	-	-
Do.	Knottsville, Pellville oil pool.	Great Lakes Carbon Corp.	-	-	-	m17,600,000	-	-
Do.	do.....	C. Leeper and Cox Drilling Co.	-	-	-	m6,132,000	-	-
Do.	Masonville, Cane Run oil pool.	Cumberland and Kemrow Petroleum Cos.	-	-	-	m5,520,000	-	-
Do.	Owensboro.....	City of Owensboro....	m1,600,000,000	-	-	-	-	-
Do.	do.....	Field Packing Co., Inc.	368,000,000	-	-	-	-	-
Do.	do.....	Fleishmann Distilling Corp.	480,000,000	-	-	-	-	-
Do.	do.....	Glenmore Distilleries Co.	612,000,000	-	-	-	-	-
Do.	do.....	Ideal Pure Milk Co...	55,700,000	-	-	-	-	-
Do.	do.....	Medley Distilling Co.	156,000,000	-	-	-	-	-
Do.	do.....	Owensboro Canning Co.	20,000,000	-	-	-	-	-
Do.	do.....	Owensboro Country Club.	10,000,000	-	-	-	-	-
Do.	do.....	Owensboro Grain Co...	75,000,000	-	-	-	-	-
Do.	Whitesville.....	City of Whitesville..	-	-	-	12,000,000	-	-
Hancock	Hawesville.....	K. T. Water and Electric Co.	13,500,000	-	-	-	-	-
Do.	Lewisport.....	City of Lewisport....	3,960,000	-	-	-	-	-
Henderson	Corydon.....	City of Corydon.....	-	-	5,516,000	-	-	-
Do.	Dixie, Dixie oil pool.	Sun Oil Co. and Carter Oil Co.	-	-	-	-	-	36,500,000
Do.	Green River Island, Dade Park.	J. C. Ellis.....	2,850,000	-	-	-	-	-
Do.	Green River Island, Trocadero, Inc.	Clarence Wood.....	8,100,000	-	-	-	-	-
Do.	Henderson, Audubon State Park.	State of Kentucky....	2,640,000	-	-	-	-	-
Do.	Henderson.....	Farmers Tankage Co...	112,320,000	-	-	-	-	-
Do.	do.....	Spencer Chemical Co..	a8,424,000,000	-	-	-	-	-
Hopkins	Dawson Springs.....	City of Dawson Springs.	-	-	-	-	144,000,000	-
Do.	Nortonville.....	City of Nortonville..	-	-	-	-	g40,000,000	-
Do.	Nortonville, Norco mine.	Norco Coal Corp.....	-	-	680,000,000	-	-	-
Do.	Nortonville, Williams Number 4 mine.	Williams Coal Co.....	-	-	-	-	63,400,000	-
Muhlenberg	Drakesboro.....	City of Drakesboro...	-	-	17,280,000	-	-	-
Ohio	Beaver Dam.....	City of Beaver Dam...	-	-	-	g,m29,458,000	-	-
Do.	Dundee, Dundee oil pool.	Sohio Petroleum Co...	m7,670,000	-	-	-	-	-
Do.	Haynesville, Herbert oil pool.	F. M. Ashby.....	-	-	-	m4,390,000	-	-
Do.	Horse Branch.....	Illinois Central System.	-	-	-	-	5,800,000	-
Do.	Sunnydale, Sunnydale oil pool.	Sohio Petroleum Co...	m23,000,000	-	-	-	-	-
Union	Uniontown, Uniontown oil pool.	Sun Oil Co.....	-	-	-	-	m12,300,000	-
Do.	do.....	Sun Oil Co., Ashland Oil and Refining Co., and Carter Oil Co.	-	-	-	-	-	6,130,000
Do.	Waverly, Saint Vincent oil pool.	Sohio Petroleum Co...	-	-	6,440,000	-	-	-
Webster	Clay.....	City of Clay.....	-	-	22,500,000	-	-	-
Do.	Dixon.....	City of Dixon.....	-	5,400,000	-	-	-	-
Do.	Sebree.....	City of Sebree.....	-	-	-	-	g11,400,000	-
Total.....			11,980,100,000	5,400,000	731,736,000	94,530,000	276,900,000	42,630,000

Table 4.—Pumpage and source of surface water for public and industrial supplies in the Western Coal Field region, Kentucky

[Source of water and pumpage in gallons per year: a, plus 8,424,000,000 gal. from alluvium shown on table 3, total of tables 3 and 4 is metered; m, metered]

County	Location	Owner	Source of water and pumpage in gallons per year				
			Impounded supplies and small streams	Green River	Ohio River	Rough River	Tradewater River
Butler	Morgantown	City of Morgantown	-	21,600,000	-	-	-
Henderson	Henderson	City of Henderson	-	-	m1,314,000,000	-	-
Do.	do	Spencer Chemical Co.	-	-	a936,000,000	-	-
Hopkins	Beulah, Colonial mine	Colonial Coal Mining Co.	43,300,000	-	-	-	-
Do.	Beulah, Meadows mine	Meadows Coal Co	13,000,000	-	-	-	-
Do.	Beulah, Stony Point mine	Stony Point Coal Co., Inc.	35,100,000	-	-	-	-
Do.	Charleston, Daylight Number 6 mine.	Dawson Daylight Coal Co.	168,000,000	-	-	-	-
Do.	Dawson Springs, Dawson Number 6 mine.	Dawson Collieries, Inc.	94,500,000	-	-	-	-
Do.	Earlington	Kentucky Utilities Co. and City of Earlington.	142,380,000	-	-	-	-
Do.	Madisonville	City of Madisonville	304,160,000	-	-	-	-
Do.	Madisonville, East Diamond mine.	West Kentucky Coal Co.	90,000,000	-	-	-	-
Do.	Madisonville, Fies mine	Miners Coal Co	136,660,000	-	-	-	-
Do.	Madisonville, Magnolia mine.	Magnolia Mining Co.	98,250,000	-	-	-	-
Do.	Madisonville, Oriole mine.	Bell and Zoller Coal and Mining Co.	102,000,000	-	-	-	-
Do.	Madisonville, Pleasant View mine.	West Kentucky Coal Co.	90,000,000	-	-	-	-
Do.	Madisonville, Pond River mine.	Terteling Bros., Inc.	98,000,000	-	-	-	-
Do.	Mortons Gap	City of Mortons Gap	9,140,000	-	-	-	-
Do.	Saint Charles, Buffalo Creek mine.	United Electric Coal Co.	43,600,000	-	-	-	-
Do.	Saint Charles, Homestead mine.	Homestead Coal Co	131,000,000	-	-	-	-
McLean	Calhoun	City of Calhoun	-	18,000,000	-	-	-
Do.	Livermore	City of Livermore	-	27,600,000	-	-	-
Muhlenberg	Central City	City of Central City	-	m240,000,000	-	-	-
Do.	Drakesboro, Kirks mine	Kirk Coal Mining Co.	12,800,000	-	-	-	-
Do.	Earles, Briar Creek mine	Crescent Coal Co	59,000,000	-	-	-	-
Do.	Earles, Vogue mine	Terteling Bros., Inc.	14,000,000	-	-	-	-
Do.	Graham, Graham mine	W. G. Duncan Coal Co.	43,000,000	-	-	-	-
Do.	Greenville	Kentucky Water Service Co.	80,000,000	-	-	-	-
Do.	Greenville, Caney Creek mine.	Kirkpatrick Mining Co.	52,500,000	-	-	-	-
Do.	Luzerne, Skibo mine	W. G. Duncan Coal Co.	129,000,000	-	-	-	-
Ohio	Centertown, Alston mine	Alston Coal Co	11,650,000	-	-	5,000,000	-
Do.	Hartford	City of Hartford	-	-	-	m33,934,000	-
Do.	Hartford, Weller oil pool.	Felmont Oil Corp	-	-	-	m92,000,000	-
Do.	do	Sohio Petroleum Co.	-	-	-	m38,400,000	-
Do.	Haynesville, Haynesville oil pool.	Cumberland and Kemrow Petroleum Cos.	m7,670,000	-	-	-	-
Do.	Oaks, Oaks oil pool	Cumberland Petroleum Co.	m7,660,000	-	-	-	-
Do.	do	Felmont Oil Corp	m13,000,000	-	-	-	-
Do.	Rockport	City of Rockport	-	8,400,000	-	-	-
Do.	Rockport, Ken mine	Ken Coal Co	30,000,000	-	-	-	-
Union	Morganfield	City of Morganfield	-	-	84,000,000	-	-
Do.	Sturgis	City of Sturgis	-	-	-	-	m51,600,000
Do.	Uniontown	City of Uniontown	-	-	20,000,000	-	-
Webster	Providence	City of Providence	-	-	-	-	100,000,000
Do.	Providence, Precision mine.	Hart and Hart Coal Co.	5,000,000	-	-	-	-
Total			2,064,370,000	315,600,000	2,354,000,000	169,334,000	151,600,000

Table 5.—Per-capita use of water from public supplies in the Western Coal Field region, Kentucky, 1951

City	Population	Daily use of water per person (gal)	Remarks
Ground-water supplies			
Beaver Dam....	2,000	40	No large industrial use.
Clay.....	1,600	40	Do.
Corydon.....	368	41	Do.
Dawson Springs	3,860	102	Railroad uses large amount.
Dixon.....	600	25	No large industrial use.
Drakesboro....	1,010	47	Do.
Hawesville....	715	51	Do.
Lewisport.....	475	23	Do.
Nortonville...	1,000	109	Railroad and utility company use large amounts.
Owensboro.....	34,028	129	Large amount of industrial use.
Sebree.....	1,100	28	No large industrial use.
Whitesville...	472	70	Do.
Weighted average...		110	
Surface-water supplies			
Calhoun.....	950	52	No large industrial use.
Central City..	4,300	153	Railroad uses large amount.
Earlington....	3,000	135	Large amount of industrial use.
Greenville....	4,000	55	No large industrial use.
Hartford.....	2,200	42	Do.
Henderson.....	18,264	197	Large amount of industrial use.
Livermore.....	1,650	46	No large industrial use.
Madisonville..	14,000	56	Do.
Morgantown....	860	69	Do.
Morganfield...	4,500	51	Do.
Mortons Gap...	1,200	21	Do.
Providence....	3,934	71	Do.
Rockport.....	385	60	Do.
Sturgis.....	2,500	57	Do.
Uniontown.....	763	69	Do.
Weighted average...		108	

domestic purposes, but in some of the larger cities more than half of the water is used for industrial purposes. The amount of water lost by leakage in mains may be as much as 25 percent of the total pumpage in some places. The daily consumption of water from public supplies for domestic purposes ranges from about 20 gallons per person to about 60 gallons per person.

The quality of water used for public supplies should meet the minimum requirements for drinking water recommended by the U. S. Public Health Service. The quality of water should also meet the requirements of the industries which are dependent on the public supply.

Future growth of industry will govern to a large extent the growth and development of public water supplies. The city of Owensboro has grown rapidly in the recent past because it has attracted new industry. As a result of municipal growth the city recently found it necessary to expand its water-treatment plant. On the other hand, lack of an adequate water supply, potential or developed, may limit commercial and industrial development in the region. Other communities will probably follow suit in attracting industries and will find that present facilities are not adequate for an increased demand. These communities should plan their expansion only after competent evaluation of the hydrologic and economic conditions.

Chemical Industry

The only large chemical manufacturing plant in the Western Coal Field is an ammonia plant at Henderson. Water is taken from three collector wells, passed through a cooling system, and discharged into the river. An average of 25,545,000 gpd is used in the plant. The main requirements are an abundant supply and a temperature that is more nearly constant than that of surface water, and lower during the summer.

It is possible that other producers of chemicals will locate in the coal field in the future because of the coal, oil, and water resources of the region.

Power Production

Water is used for cooling and for boiler feed by several plants making steam to generate electric power. Because only a small portion of the water needed by these plants is used for boiler feed, the most important requirements for the water supply are a sufficiently low temperature and large quantities. Water is taken from a lake or river, passed through a cooling system, and discharged. The only change in the water during this process is the increase in temperature.

There are six steam plants in the coal field. The plant at Henderson uses water from the municipal water system. Three plants use impounded surface water and two use "run of river" water. The three plants using impounded supplies are on a standby basis and do not operate all of the time.

Coal Washing

The object of washing coal is to separate the coal from such useless material as shale, pyrite, and sulfur balls. There is no special requirement for water used in a coal-washing plant except that an adequate amount must be available. Data in table 6 show that the water consumed per ton of coal washed varies widely. The water consumed is the amount of water actually used in the washing process. It does not include the water recirculated through the plant. The consumption of water does not in any way indicate the quality of the washed coal. The consumption of water per ton of coal depends on availability of water, sizes of coal washed, age and repair of the washing plant, method of washing, and quality of coal to be washed. In most washing plants most of the water is reused after the waste is settled out. The water consumed ranges from 6 to 25 percent of the water circulated through the washing plant.

Table 6.—Water consumed by coal-washing plants and amount of coal washed in the Western Coal Field region, Kentucky

[Water withdrawn from source; does not include water which is reused]

County	Mine	Coal produced 1951 (tons)	Water consumed 1951 (gal)	Water consumed per ton of coal (gal)	Remarks
Hopkins....	Buffalo Creek	337,815	43,600,000	129	Water is reused.
Do.....	Colonial.....	662,956	43,500,000	66	Do.
Do.....	Dawson Number 6...	261,415	94,500,000	362	Do.
Do.....	Daylight Number 6.	157,695	168,000,000	1,065	Water is not reused.
Do.....	East Diamond.....	1,181,622	90,000,000	760	Water is reused.
Do.....	Fies.....	1,225,476	136,660,000	109	Do.
Do.....	Homestead.....	1,659,108	131,000,000	79	Do.
Do.....	Magnolia.....	699,697	98,250,000	141	Water is reused. Figures for 1950.
Do.....	Meadows.....	82,347	13,000,000	158	Water is reused.
Do.....	Norco.....	248,854	39,300,000	158	Water is not reused.
Do.....	Oriole.....	653,080	102,000,000	156	Water is reused.
Do.....	Pleasant View.....	1,218,685	90,000,000	880	Do.
Do.....	Pond River.....	381,425	98,000,000	257	Do.
Do.....	Stony Point.....	969,000	35,100,000	36	Only part of this coal is washed. Water is reused.
Do.....	Williams Number 4.	365,070	63,400,000	174	Water is reused.
Muhlenberg.	Brier Creek.....	776,214	59,000,000	82	Do.
Do.....	Caney Creek.....	232,108	52,500,000	214	Do.
Do.....	Graham.....	709,128	17,000,000	24	Do.
Do.....	Kirks.....	434,955	12,800,000	29	Do.
Do.....	Skibo.....	559,214	129,000,000	230	Do.
Do.....	Vogue.....	589,628	14,000,000	24	Do.
Ohio.....	Alston.....	294,242	16,650,000	57	Do.
Do.....	Ken.....	1,177,712	30,000,000	25	Do.
Webster....	Precision.....	136,085	5,000,000	37	Do.
All mines.....		14,044,531	1,546,960,000	110	Does not include Stony Point mine.

Twenty-four washing plants use surface water and two use ground water. The coal-mining industry consumes 4,241,000 gpd. Of this, 3,960,000 gallons is surface water and 281,000 gallons is ground water.

It is probable that more coal-washing plants will be installed in the future, inasmuch as the market for washed coal is somewhat better than that for unwashed coal. Two large new mines are being developed, both of which will have washing plants.

Water Flooding for Secondary Oil Recovery

Secondary-recovery operations, including water flooding, increase the production of the wells in an oil pool. This is done by injecting water or gas under pressure into the producing formation in order to restore the volume and pressure lost through natural production and to drive the oil in the formation toward the producing wells. A high percentage of the oil in a formation may be recovered by this process.

All secondary-recovery operations in this region use water rather than gas. For this purpose the water must be of such chemical quality that precipitates will not form either in the injection system or on mixture with the formation fluids. This requirement is met by using a brine similar to that in the producing formation, soft water of low mineral content, or water that can be treated to eliminate or stabilize those compounds that precipitate easily. The water should also be free from organic growths that will hinder or stop the injection of water. Brines are usually free from these harmful growths and require no treatment, but fresh water usually must be chlorinated and may require softening and filtration. The advantages of using brine are somewhat offset by the greater corrosiveness. Uniformity of quality is desirable so that treatment plants may be made automatic. For this reason ground water is preferred to surface water. The quantity of water should be sufficient for operation at all times, for temporary shutdowns will cause the subsequent rate of injection to decline.

By the end of 1952 approximately 848,000 gallons of water per day was being used for water flooding. Five operations required 435,000 gpd of surface water and 15 operations required 413,000 gpd of ground water. In addition to these, several pilot and small operations used less than 10,000 gpd each. The use of water for secondary recovery of petroleum is rapidly expanding in the region. About 20 new projects were planned or put in operation in 1951 and 1952.

Distilling Industry

In the production of whisky water is used for cooling, for mashing, and for boiler water. The amount used for boiler water is small, and the requirements are the same as that for any other boiler water. The water used for mashing is mixed with grain so that the mixture can ferment and produce alcohol. This process is kept at a constant temperature by circulating water through coils in the vats or tubs in which the mash is fermenting. Alcohol is separated from water by distillation. The condensing of the alcohol

is accomplished in water-cooled condensers. To meet the requirements of the process the supply of water must be large, have a temperature of 60°F or less, and (for mashing) be moderately hard.

At present three distilleries are in operation and use about 3,421,000 gpd although there were several others before prohibition. All three are in Owensboro.

Food Processing

The packing and canning plants, located chiefly in Henderson and Owensboro, obtain their water from wells and municipal supplies. Part of the consumption of water for food processing is seasonal, with the peak season in the summer and early fall. Water used for food processing should generally be of the same quality as that used for domestic purposes.

Air Conditioning

Air-conditioning units clean and cool air for use in buildings and industrial processes. A common method of air conditioning is to circulate air through a series of sprays. This washes the dust from the air at the same time that it cools it. This method is cheap, but is not as efficient as the use of heat exchangers designed to take heat from the air and add it to the water circulated through them.

Water of 60°F or colder is desired. If the source of water is warmer or the quantity inadequate, mechanical refrigeration may be used. Corrosive water or water which forms precipitates in the system is undesirable. Both may require the frequent replacement of equipment, and the formation of precipitates will hinder the exchange of heat necessary in the cooling process. The quantity of water required is dependent on several variables: the amount of air to be cooled, the temperature change in the air, the temperature of the water, the efficiency of the equipment, and whether or not the water is recirculated. In areas where the pumping costs are excessive or where sufficient quantities of water are not available, cooling towers may be installed and the water reused.

At the present time the greatest concentration of air conditioning in this region is in the downtown Owensboro area. Some of the air-conditioning units use city water but most use water from privately-owned wells in the alluvium. None of the water from the wells is metered, but it is estimated that the downtown area of Owensboro uses about 1,000,000 gpd from private wells for air conditioning during the summer.

With the increasing size and number of businesses in the population centers it seems probable that more and larger supplies of water will be used for air conditioning.

Irrigation

Although more than 40 inches of water fall on the region during a year, the distribution is such that minor droughts are frequent during the summer. During these periods irrigation can supplement the precipitation and prevent damage to crops from lack of moisture. Less than 200 acres were irrigated in the coal field during 1952. Most of this acreage was in tobacco, although some corn and pasture was irrigated also. As no accurate data on water used for irrigation were available, this usage is not included in the tables or in the "Descriptions and analyses."

Water was applied by spraying through rotating nozzles similar to those used for sprinkling lawns. These can supply water at rates ranging from 3 to 400 gpm per sprinkler, but the type usually selected in this region supplies about 12 gpm. Both ground water and surface water are used to supply the irrigation systems. Surface water has been taken from streams and sloughs, and several farmers plan to irrigate from ponds. All the ground water used for irrigation in this region has been pumped from shallow drive points in the valley alluvium. Several of these are connected together and pumped with a single centrifugal pump. The amount of water that should be supplied by irrigation has not been determined. Up to 5 inches per month applied in 2 1/2-inch applications has been used on tobacco with good results.

Sufficient data are not available to evaluate accurately the effects of irrigation in this region. The effect on corn and pasture is not known at the present time, but fragmentary data available on tobacco indicates that irrigation during 1952 increased the yields by about 500 pounds per acre and increased the value of the tobacco by about 5 cents per pound.

It seems probable that in the future more land will be irrigated. Up to the present time the possibility of using drilled screened wells for irrigation has not been investigated. It is probable that many areas of the alluvial plain could be irrigated from this type of well. Further study of the hydrology and economics of this problem, including the chemical suitability of the water for continued use on the soils found in the region, should be made before extensive development is undertaken.

Parks

Water is needed in the public parks to supply the needs of the visitors and the park staff. Thus, the water should meet the requirements of water intended for domestic use. The only large public park in the Western Coal Field is the Audubon State Park near Henderson. The park obtains its supply from the alluvium and uses an average of 12,000 gpd during the summer.

Ground Water

Ground water provides 44 percent of the water for public supplies and 81 percent of the water for industrial supplies in this region. Most of the water is produced from the alluvium of Quaternary (Pleistocene and Recent) age and the sandstones of Pennsylvanian age. A few supplies come from the Chester group of Mississippian age.

Most wells in Pennsylvanian rocks yield 5 to 50 gpm; a few wells yield more than 100 gpm, and one well is reported to yield 500 gpm. Wells in the alluvium, especially those in the Ohio River alluvium,

generally yield more water than those in the consolidated Pennsylvanian rocks. Yields of 200 to 500 gpm from the alluvium are common and a few wells yield more than 1,000 gpm. Owing to lateral changes in materials in both the alluvium and the rocks of Pennsylvanian age and to faults in the Pennsylvanian rocks, it is not always possible to predict the yield of an area on the basis of information obtained for another some distance away. Careful planning and exploration should precede the development of any large supply.

The record of past water levels observed and reported to the author does not indicate any continuous decline in the water level. The years 1945-51 were wetter than average, probably resulting in some slightly higher water levels than normal. These levels declined somewhat in 1952. As part of a continuing investigation, water-level records are being collected from 54 wells in the region.

As stated earlier, the Pennsylvanian rocks dip gently inward from the east, south, and west. Shallow wells which penetrate aquifers in or near their recharge area generally yield fresh water of a calcium, magnesium bicarbonate type. Wells farther from the recharge areas of the producing aquifers generally yield sodium bicarbonate waters which may contain undesirable amounts of sulfate. Brines are known to occur at depth throughout the area, but the upper limit at which these occur has not been determined. Waters in the alluvium are generally of the calcium, magnesium bicarbonate type and are harder than those in the Pennsylvanian sandstones.

Chester Group

The Chester group crops out near the east, south, and west boundaries of the region and locally along the Shawneetown-Rough Creek fault. In the rest of the region it is overlain by younger rocks. The Chester group does not furnish fresh water to any public or industrial supplies in the Western Coal Field but it does furnish 42,630,000 gallons per year of brine for two water-flooding projects. Much of this is produced water (water that is produced with oil and then separated from it). Several small springs and wells in or near the outcrop area have been reported to yield fresh water from this group. Forty analyses examined by the author (not included in this report) show that most waters of the Chester group in this area are brines. They range from 7,170 to 113,000 ppm in dissolved-solids content.

Caseyville Sandstone

The Caseyville sandstone crops out around the rim of the Western Coal Field and along the Shawneetown-Rough Creek fault. The Caseyville sandstone provides 276,900,000 gallons of water per year for six public and industrial supplies. Yields are as great as 500 gpm, but are usually between 100 and 250 gpm.

In the area of outcrop and for some distance downdip fresh water may be obtained from the formation. Analyses of water from five wells in the Caseyville sandstone in or near the outcrop area showed sodium bicarbonate and calcium bicarbonate waters ranging in total hardness from 3 to 175 ppm and dissolved solids from 112 to 662 ppm. One of these, well 8730-3705-1, at the Williams No. 4 mine at Mannington, is 840 feet deep and yields a sodium bicarbonate water with only 34 ppm of chloride and 662 ppm of dissolved solids. This is the deepest of the wells inventoried that produces fresh water in this region.

With increasing distance from the outcrop the waters are more highly mineralized, and brines are encountered in this formation in the deeper parts of the basin. Five samples of brine (analyzed by private companies) from oil tests in the central part of the basin contained as much as 33,300 ppm of dissolved solids.

Tradewater Formation

The Tradewater formation crops out in a belt inside the outcrop area of the Caseyville sandstone. Several of the sandstone members of the formation are moderately good aquifers and supply 94,530,000 gallons per year to 8 secondary-recovery projects and 2 towns. Yields range from 8 gpm to more than 100 gpm per well.

As in the Caseyville sandstone, the total mineralization of the water probably increases with distance from the recharge area. Of 8 water samples from wells in the Tradewater formation in or near the outcrop area, 7 were fresh water of the sodium bicarbonate type, with hardness ranging from 10 to 298 ppm and dissolved solids from 89 to 850 ppm. One water sample from a well in the Tradewater formation near the outcrop area and another from a well several miles from the outcrop area were brines with 9,080 ppm and 17,300 ppm of dissolved solids, respectively. In the central part of the basin brines are usually obtained in oil tests penetrating the Tradewater formation.

Carbondale Formation

The Carbondale formation crops out in a belt inside the outcrop area of the Tradewater formation. The Carbondale formation is not the source of water for any large supplies other than the 680,000,000 gallons per year pumped from the Norco mine for coal washing at Nortonville. Water seeps into the mine from both the Carbondale formation and the overlying Lisman formation. A large number of stock and domestic supplies of small size obtain water from the formation in and near its outcrop area. Little is known of the quality of water in the Carbondale formation, but it is known to yield fresh water in and near its outcrop area.

Lisman Formation

The Lisman formation crops out in the Moorman syncline and in Henderson, Union, and Daviess Counties north of the Shawneetown-Rough Creek fault. This formation provides 51,736,000 gallons of water per year to four public and industrial supplies. In addition, 680,000,000 gallons of water per year is pumped from both the Lisman and Carbondale formations to supply the washing plant at the Norco mine at Nortonville. (See p. 30.) In the event of

future increased production of oil in the Moorman syncline the Anvil Rock sandstone member near the base of the formation may be prospected as a source of water for secondary recovery projects. Reported yields range from a few gallons per minute in some domestic supplies to 200 gpm at Drakesboro.

The quality of water in the Lisman formation is similar to that of other Pennsylvanian rocks in the region in that mineralization increases with distance from the outcrop area. Five samples of water from the Lisman formation were analyzed for this study. Most of these waters were hard to very hard, and dissolved solids ranged from 419 to 2,990 ppm. The more highly mineralized waters are of the sodium sulfate-bicarbonate type.

Henshaw Formation

The Henshaw formation crops out in the trough of the Moorman syncline in Union, Webster, Hopkins, Muhlenberg, and McLean Counties.

The town of Dixon is the only supply inventoried for this report which derives its water from the formation. The yield at Dixon is approximately 21 gpm per well from what is probably the Dixon sandstone of Glenn (1912) at the base of the Henshaw formation. The total annual pumpage is only 5,400,000 gallons. The water is a calcium-magnesium bicarbonate-sulfate type.

Alluvium

Alluvium occurs along all the major streams and most of the minor streams of the region and furnishes 19 public and industrial supplies with 11,980,100,000 gallons per year, which is 91 percent of the ground water used in this region.

The yields of vertical wells in the alluvium are as great as 1,000 gpm, and the yield of collector wells is as great as 9,000 gpm. Wells capable of yielding 200 gpm to 500 gpm are common. In a few areas the alluvium is composed of silts and clays with no gravel and little or no sand, and no large water supplies can be developed. This condition is not common except in the smaller valleys. In general the deeper gravels along the Ohio River may be relied upon for the highest yields. The material in the tributary valleys is generally finer grained and less likely to yield large supplies to wells. Five wells along the Rough River have reported yields of 14 to 20 gpm.

Analyses of water from 18 wells in the alluvium show hard to very hard waters of the calcium, magnesium bicarbonate type with hardness as calcium carbonate ranging from 136 to 458 ppm. Only 4 of the 18 wells produced water with hardness of less than 200 ppm. Dissolved solids ranged from 136 to 648 ppm. Silica content ranged from 3.7 to 22 ppm; most samples contained 16 to 20 ppm. Iron ranged from 0.10 to 26 ppm and only five samples contained less than 2 ppm; thus, the iron content of the water constitutes a troublesome problem in this area. Sulfate ranged from 1.3 to 155 ppm, 8 of the samples showing less than 30 ppm. Chloride ranged from 2.5 to 84 ppm with 14 samples less than 20 ppm. Fluoride ranged up to 0.5 ppm. Nitrate ranged from 0.1 to 7.6 ppm. Temperatures ranged from 56° to 60°F except where infiltration from the river raised the temperature.

Surface Water

Surface water is used in many places where ground water of satisfactory quality is not available in sufficient quantity. Ground water is often preferred because surface water varies in chemical quality and temperature, generally has considerable suspended sediment, and is more often contaminated.

Surface water is filtered and chlorinated for most uses. In places it is necessary to add lime and soda ash to coagulate solids and soften the water. Thus, the cost of developing a surface-water supply is generally higher than that of developing a ground-water supply, and ground water commonly is preferred for most uses where enough is available at or near the desired location.

No samples of surface-water supplies were collected for analysis in this investigation. Water samples are collected periodically at several points on the streams of the region and analyses of these samples are on file with the Surface Water Branch of the U. S. Geological Survey, Louisville, Ky. The hardness and organic contamination are usually at a maximum during the summer and fall when the flow of water is at a minimum. During this period the sediment load is less than during the rainy winter and spring. Contamination, whether by industrial wastes, sewage, or mine drainage, is more troublesome at low water because there is less dilution of the contaminant during low-flow periods.

In the Western Coal Field 60 percent of the surface water is taken from the major streams and 40 percent from small impounded streams. There are 14 public and 29 industrial supplies using surface water. The majority of the industrial supplies are coal-washing plants in Hopkins and Muhlenberg Counties that use water from small impounded streams. The largest users of water are the steam plants at South Carrollton and Owensboro. These, however, do not consume the water but only raise its temperature. Surface water provides more than 13,800,000 gpd in the Western Coal Field. This is 28 percent of all the water used in public and industrial supplies. Considerable data on surface water are available at the Surface Water Branch, U. S. Geological Survey, Louisville, Ky., and the Corps of Engineers, Louisville, Ky. The Surface Water Branch, U. S. Geological Survey, has records on discharge and gage height for the major streams as well as data on temperature. The U. S. Geological Survey, Quality of Water Branch, has records on chemical and physical quality. These records are available at the Survey Office at Louisville.

DESCRIPTIONS AND ANALYSES

The following descriptions and analyses include the detailed information gathered on the water supply of each city, town, or industry, arranged alphabetically by county and alphabetically by city or town within

each county. Complete information was gathered if available, but not all communities and industries have kept records of the amount of water pumped, the static (nonpumping) water levels in wells, and the drawdowns during pumping. The material is listed according to the following plan:

1. Name of county.

2. Name of city or town.

3. Population served. In some towns this is an estimate based on an average of 3.5 people per meter or house.

4. Ownership of waterworks, whether private or public.

5. Source of supply, whether ground water or surface water, location number and location of supply; for ground-water supplies, brief descriptions of wells, including depth, diameter, date drilled, water-bearing formation, static (nonpumping) water level, and yield, are given.

6. Description of treatment, including the reason for each phase of treatment, and location of treatment plant.

7. Rated capacity of treatment plant.

8. Location and capacity of storage reservoirs, elevated tanks, and standpipes.

9. Total distribution of water for year, usually 1951. For some of the towns and industries this is an estimated quantity.

10. Average pumpage, in gallons per day.

11. Breakdown of annual distribution as domestic, industrial and commercial, and other public use, and as leakage and waste.

12. Drillers' logs of wells.

13. Chemical analyses of the water. Except where otherwise noted, analyses were made by the U. S. Geological Survey.

BUTLER COUNTY

Morgantown

Population served: 860 (approximate).
Ownership: Municipal.
Source: Green River at ferry in Morgantown, Ky.
Treatment: Lime added for pH adjustment and softening; alum added to coagulate solids; filtered through sand to remove solids; chlorine added to control bacteria.
Storage: 25,000 gal in elevated tank at treatment plant.
Total distribution of water for 1951: 21,600,000 gal.
Average daily pumpage, 1951: 59,000 gal.
Remarks: Maximum daily pumpage is 75,000 gal.

DAVIESS COUNTY

Andersonville, Red Hill Oil Pool

Ownership: Simon LeBow.
Source: Two wells, approximately 0.5 mile south of Andersonville, Ky.
Well 8700-3735-1. Depth, 550 feet; diameter, 8 inches; water-bearing formation, Tradewater (?); yield (reported), 13 gpm.
Well 8700-3735-2. Depth, 550 feet; diameter, 8 inches; date drilled 1952; water-bearing formation, Tradewater (?); pumping level (estimated), about 320 feet below land surface, December 3, 1952; yield (reported), 13 gpm.
Treatment: Filtration to remove solids; chlorination to control bacteria.
Storage: 10,500-gal tank on hill at well 8700-3735-2.
Total distribution of water for 1951: 5,570,000 gal (metered).
Average daily pumpage, 1951: 15,256 gal.
Remarks: All the water is used for the secondary recovery of petroleum. Plans have been made to expand this project.

Analysis, in parts per million, well 8700-3735-2

(Collected Dec. 3, 1952)

Silica (SiO_2)	7.9
Iron (Fe)	2.7
Manganese (Mn)	-
Calcium (Ca)	28
Magnesium (Mg)	28
Sodium (Na)	3,374
Potassium (K)	23
Bicarbonate (HCO_3)	776
Carbonate (CO_3)	0
Sulfate (SO_4)	1,086
Chloride (Cl)	4,108
Fluoride (F)	-
Bromide (Br)	1.5
Iodide (I)	0.0
Dissolved solids	9,078
Hardness as $CaCO_3$	
Total	185
Noncarbonate	0
Temperature (°F)	59
pH	7.6
Specific conductance at 25°C (micromhos)	13,810

Birk City, Birk City Oil Pool

Ownership: Sohio Petroleum Co.
Source: One well, 0.2 mile west of the road intersection at Birk City, Ky.
Well 8715-3745-14. Depth, 314 feet; diameter, 6 inches; water-bearing formation, "Curlew" sandstone of Owen, of the Tradewater formation; static water level (reported), 33 feet below land surface, September 12, 1952; yield, 27 gpm.
Treatment: None.
Total distribution of water for 1951: 5,060,000 gal (metered).
Average daily pumpage, 1951: 13,900 gal.
Remarks: This water is used for the secondary recovery of petroleum. In September 1952 the rate of use increased to 27 gpm. The pumping level at this rate is 105 feet below land surface.

Analysis, in parts per million, well 8715-3745-14

(Collected July 24, 1952)

Silica (SiO_2)	7.7
Iron (Fe)	.09
Manganese (Mn)	-
Calcium (Ca)	87
Magnesium (Mg)	100
Strontium (Sr)	.0
Barium (Ba)	-
Sodium (Na)	6,350
Potassium (K)	64
Bicarbonate (HCO_3)	345
Sulfate (SO_4)	1,738
Chloride (Cl)	8,675
Fluoride (F)	-
Bromide (Br)	27
Iodide (I)	5.2
Nitrate (NO_3)	-
Boron (B)	-
Phosphate (PO_4)	-
Dissolved solids	17,300
Hardness as $CaCO_3$	
Total	-
Noncarbonate	-
Temperature (°F)	61
pH	7.7
Specific conductance at 25°C (micromhos)	24,700
Density at 28°C	1.0088

Boston, Cane Run Oil Pool

Ownership: J. C. Ellis.
Source: Twelve wells, 3.2 miles southwest of Boston, Ky.
Wells 8655-3735-2 through 13. Each of these wells is reported to be about 160 feet deep; diameter, 8 inches; yield, about 2 gpm from the Tradewater formation.
Treatment: Chlorination to control bacteria; filtration to remove solids.
Total distribution of water for 1951: 4,600,000 gal (metered).
Average daily pumpage, 1951: 12,600 gal.
Remarks: This water is used for secondary recovery of petroleum by water-flooding. Four to six wells are pumped at one time.

Analysis, in parts per million, well 8655-3735-5

(Collected Dec. 3, 1952)

Silica (SiO_2)	5.3
Iron (Fe)	16
Manganese (Mn)	.00
Calcium (Ca)	2.4
Magnesium (Mg)	1.0
Sodium (Na)	227
Potassium (K)	1.4
Bicarbonate (HCO_3)	386
Sulfate (SO_4)	1.1
Chloride (Cl)	127
Fluoride (F)	.5
Nitrate (NO_3)	.5
Dissolved solids	550
Hardness as $CaCO_3$	
Total	10
Noncarbonate	0
Temperature (°F)	57
pH	8.3
Specific conductance at 25°C (micromhos)	980

Griffith, Griffith Oil Pool

Ownership: Roy Pledger.
Source: One well 600 feet southeast of the intersection of Kentucky Highway 279 and U. S. Highway 60.
Well 8710-3745-24. Depth, 52 feet; diameter, 6 inches; date drilled, 1952; water-bearing formation, alluvium; static water level, 15.86 feet below land surface, June 4, 1952; yield (reported) 15 gpm.
Treatment: Filtration to remove solids.
Total distribution of water for year (estimated on basis of three months operation): 5,360,000 gal.
Average daily pumpage, 1952: 14,700 gal (metered).
Remarks: This water is used for the secondary recovery of petroleum. The well described above has been abandoned because of the high iron content of the water, and a driven well about 10 feet away is now in use. This well is reported to be 28 feet deep.

Analysis, in parts per million, well 8710-3745-24

(Collected July 24, 1952)

Silica (SiO_2)	18
Iron (Fe)	26
Manganese (Mn)	.55
Calcium (Ca)	33
Magnesium (Mg)	13
Sodium (Na)	7.6
Potassium (K)	2.3
Bicarbonate (HCO_3)	158
Carbonate (CO_3)	0
Sulfate (SO_4)	4.1
Chloride (Cl)	18
Fluoride (F)	.1
Nitrate (NO_3)	.1
Dissolved solids	179
Hardness as $CaCO_3$	
Total	136
Noncarbonate	6
Temperature (°F)	59
pH	7.3
Specific conductance at 25°C (micromhos)	345

Habit, Habit Oil Pool

Ownership: J. C. Ellis.
Source: One well, 0.8 mile west of Habit, Ky., at road intersection.
Well 8700-3740-1. Depth, 550 feet; diameter, 6 inches; water-bearing formation, Tradewater (?); yield, 8 gpm.
Treatment: Calgon and alum added; chlorine added to control bacteria.
Storage: 10,500-gal tank at well.
Total distribution of water for 1952: 4,200,000 gal (metered).
Average daily pumpage, 1952: 11,500 gal.
Remarks: All water is used for the secondary recovery of petroleum in the Habit oil pool. The aquifer is reported to be sandstone.

Analysis, in parts per million, well 8700-3740-1

(Collected Dec. 5, 1952)

Silica (SiO_2)	14
Iron (Fe)	2.1
Manganese (Mn)	.00
Calcium (Ca)	10
Magnesium (Mg)	4.1
Sodium (Na)	335
Potassium (K)	1.5
Bicarbonate (HCO_3)	848
Carbonate (CO_3)	0
Sulfate (SO_4)	12
Chloride (Cl)	32
Fluoride (F)	2.8
Nitrate (NO_3)	.0
Dissolved solids	836
Hardness as $CaCO_3$	
Total	43
Noncarbonate	0
Temperature (°F)	59
pH	7.6
Specific conductance at 25°C (micromhos)	1,340

Knottsville, Pellville Oil Pool

Ownership: Great Lakes Carbon Corp.
Source: Seven wells on the lease 3.5 miles east of Knottsville. Most of these wells are producing water from the annulus between the first and second strings of casing set in the oil wells. Thus, the water comes from sandstones to depths as great as 500 feet. One well has been drilled as a supply well to a depth of 190 feet; the log of this well is given below. Also given is a partial log of another well that is producing water from the annulus. The Tradewater formation and possibly the Caseyville sandstone are the sources of water in these wells.
Wells 8650-3745-1 through 7.
Treatment: Filtration to remove solids.
Storage: 500 gal.
Total distribution of water for 1952: 17,600,000 gal (metered).
Average daily pumpage, 1952: 48,300 gal.
Remarks: The water is used for the secondary recovery of petroleum by water-flooding.

Log of well 8650-3745-1

Material	Thickness (feet)	Depth (feet)
Mud	20	20
Sand	2	22
Mud, blue	28	50
Shale, gray	10	60
Sandstone	5	65
Sand, hole full of water	5	70
Shale	4	74
Sandstone, gray	11	65
Sandstone, white, hard	11	96
Shale, black	1	97
Sandstone, gray	18	115
Sandstone	45	160
Sandstone and a small break with a little coal	5	165
Sandstone	5	170
Shale, white	10	180
Shale, dark	17	197
Lime, hard, sandy shells	4	201
Shale, dark	26	227
Lime shells, sandy	5	232
Shale, gray	4	236
Sandy shells, hard	7	243
Coal	1	244
Shale and limestone	16	260

Log of well 8650-3745-7

Material	Thickness (feet)	Depth (feet)
Soil	20	20
Sandstone	50	70
Shale	25	95
Sandstone, white	20	115
Shale, sandy	3	118
Sandstone	17	135
Shale, sandy	10	145
Sandstone, water; can't bail water	25	170
Sandstone	20	190

Analysis, in parts per million, well 8650-3745-1

(Collected Sept. 5, 1952)

Silica (SiO_2)	36
Iron (Fe)	5.1
Manganese (Mn)	.60
Calcium (Ca)	7.2
Magnesium (Mg)	3.9
Sodium (Na)	7.3
Potassium (K)	.7
Bicarbonate (HCO_3)	44
Sulfate (SO_4)	3.5
Chloride (Cl)	7.2
Fluoride (F)	.3
Nitrate (NO_3)	.0
Dissolved solids	89
Hardness as $CaCO_3$	
Total	34
Noncarbonate	0
Temperature (°F)	58
pH	6.2
Specific conductance at 25°C (micromhos)	108

Knottsville, Pellville Oil Pool

Ownership: C. Leeper and Cox Drilling Co.
Source: One well, 1,200 feet south of Kentucky Highway 144, 3.5 miles east of Knottsville, Ky.
Well 8650-3740-4. Depth, 90 feet; diameter, 12 inches; water-bearing formation, Tradewater; static water level (reported), 20 feet below land surface, December 5, 1952; yield (estimated), 37 gpm.
Treatment: Filtration to remove solids; chlorination to control bacteria.
Storage: 21,000-gal tank for raw water at treatment plant.
Total distribution of water for 1952: 6,132,000 gal (metered).
Average daily pumpage, 1952: 16,800 gal.
Remarks: Water is used for the secondary recovery of petroleum. The supply for the day is pumped during 7 or 8 hours.

Analysis, in parts per million, well 8650-3740-4

(Collected Dec. 5, 1952)

Silica (SiO_2)	34
Iron (Fe)	1.6
Manganese (Mn)	.25
Calcium (Ca)	17
Magnesium (Mg)	4.6
Sodium (Na)	46
Potassium (K)	1.0
Bicarbonate (HCO_3)	161
Sulfate (SO_4)	12
Chloride (Cl)	10
Fluoride (F)	.1
Nitrate (NO_3)	.2
Dissolved solids	198
Hardness as $CaCO_3$	
Total	62
Noncarbonate	0
Temperature (°F)	59
pH	7.5
Specific conductance at 25°C (micromhos)	298

Masonville, Cane Run Oil Pool

Ownership: Cumberland and Kemrow Petroleum Cos.
Source: Three wells, 2.5 miles southeast of Masonville, Ky., on the Sid Easton lease.
Well 8700-3735-3. Depth, 140 feet; diameter, 7 inches; water-bearing formation, Tradewater.
Well 8700-3735-4. Depth, 300 feet; diameter, 7 inches; water-bearing formation, Tradewater.
Well 8700-3735-5. Depth, 400 feet; diameter, 7 inches; water-bearing formation, Tradewater.
Treatment: None.
Total distribution of water for 1952: 5,520,000 gal (metered).
Average daily pumpage, 1952: 15,100 gal.
Remarks: This water is used for the secondary recovery of petroleum in the Cane Run oil pool.

Owensboro

Population served: 34,028.
Ownership: Municipal.
Source: Drilled gravel-packed wells located in a well field at the power and water plant. Twenty-three wells have been constructed. Of these wells, there are now 17 in use. From four to seven wells are pumped at one time, depending on the demand.
Well 8705-3745-2 (owner's number 18). Depth, 128 feet; diameter, 12 inches; date drilled, May 1950; water-bearing formation, alluvium; yield, 360 gpm.
Well 8705-3745-13 (owner's number 5). Depth, 128 feet; diameter, 10 inches; date drilled, 1930; water-bearing formation, alluvium; yield (reported), 100 gpm.
Well 8705-3745-14 (owner's number 6). Depth, 128 feet; diameter, 10 inches; date drilled, 1930; water-bearing formation, alluvium; yield (reported), 100 gpm.
Well 8705-3745-16 (owner's number 8). Depth, 118.5 feet; diameter, 12 inches; water-bearing formation, alluvium; static water level, 32 feet below land surface, January 18, 1952; yield, 681 gpm.
Well 8705-3745-17 (owner's number 9). Depth, about 120 feet; water-bearing formation, alluvium.
Well 8705-3745-18 (owner's number 10). Depth, about 120 feet; water-bearing formation, alluvium.
Well 8705-3745-19 (owner's number 11). Depth, about 120 feet; water-bearing formation, alluvium.
Well 8705-3745-20 (owner's number 12). Depth, 126.75 feet; diameter, 12 inches; date drilled, 1947; water-bearing formation, alluvium; static water level, 34.7 feet below land surface, February 12, 1952; yield, 1,007 gpm.
Well 8705-3745-21 (owner's number 13). Depth, 124.75 feet; diameter, 12 inches; date drilled, 1947; water-bearing formation, alluvium; static water level, 45 feet below land surface, April 1, 1952; yield, 869 gpm.
Well 8705-3745-22 (owner's number 14). Depth, 148.8 feet; diameter, 12 inches; date drilled, 1947; water-bearing formation, alluvium; yield, 760 gpm.
Well 8705-3745-23 (owner's number 15). Water-bearing formation, alluvium.
Well 8705-3745-25 (owner's number 17). Water-bearing formation, alluvium.
Well 8705-3745-26 (owner's number 19). Depth, 131.2 feet; diameter, 12 inches; date drilled, 1950; water-bearing formation, alluvium; static water level, 59.6 feet, April 15, 1952; yield, 805 gpm.
Well 8705-3745-27 (owner's number 20). Water-bearing formation, alluvium.
Well 8705-3745-28 (owner's number 21). Depth, 132 feet; diameter, 12 inches; date drilled, 1950; water-bearing formation, alluvium.
Well 8705-3745-74 (owner's number 22). Depth, 129 feet; diameter, 12 inches; date drilled, August, 1951; water-bearing formation, alluvium.
Well 8705-3745-75 (owner's number 23). Depth, 126 feet; diameter, 12 inches; date drilled, September 1951; water-bearing formation, alluvium; yield, 1,000 gpm.

Treatment: Lime and soda ash for softening; filtration to remove solids; chlorination to control bacteria; aeration to precipitate iron.
Rated capacity of treatment plant: 10,000,000 gpd.
Storage: Finished water, 4,000,000-gal underground storage at treatment plant and 1,000,000-gal elevated tank at Fifth and Harper Streets.
Total distribution of water for 1951: 1,600,000,000 gal (metered).
Average daily pumpage, 1951: 4,380,000 gal.
Breakdown of annual distribution as to use (estimated):

Domestic	832,000,000 gal
Industrial and commercial	448,000,000 gal
Other public use, leakage, and waste	320,000,000 gal

Remarks: One of the owner's abandoned wells is being used as an observation well by the U. S. Geological Survey.

Analysis, in parts per million, well 8705-3745-2

(Collected July 31, 1950)

Silica (SiO_2)	19
Iron (Fe)	3.7
Manganese (Mn)	-
Calcium (Ca)	95
Magnesium (Mg)	37
Sodium (Na) } Potassium (K)	5.3
Bicarbonate (HCO_3)	354
Sulfate (SO_4)	87
Chloride (Cl)	14
Fluoride (F)	.0
Nitrate (NO_3)	.5
Dissolved solids	441
Hardness as $CaCO_3$	
Total	389
Noncarbonate	99
Temperature (°F)	58
pH	7.8
Specific conductance at 25°C (micromhos)	383

Owensboro, Owensboro Municipal Utilities

Ownership: Municipal.
Source: Ohio River at municipal well field.
Treatment: None.
Remarks: This water is used for cooling and condensing in the Owensboro Municipal Utilities power plant. The water is circulated through the plant and discharged to the river.

Owensboro, Field Packing Co., Inc.

Ownership: Field Packing Co., Inc.
Source: Four wells, at the plant on Dublin Lane and Lock Avenue.
Well 8705-3745-41 (owner's number 3). Depth, 113.8 feet; diameter, 12 inches; date drilled, June 6, 1939; water-bearing formation, alluvium; static water level (reported), 36 feet below land surface, May 22, 1947; yield, 592 gpm.
Well 8705-3745-42 (owner's number 4). Depth, 121.2 feet; diameter, 12 inches; date drilled, September 15, 1944; water-bearing formation, alluvium.
Well 8705-3745-43 (owner's number 5). Depth, 121 feet; diameter, 12 inches; date drilled, March 28, 1950; water-bearing formation, alluvium; static water level (reported), 30 feet below land surface, March 30, 1950; yield, 500 gpm.
Well 8705-3745-89 (owner's number 2). Depth, 108 feet; diameter, 12 inches; date drilled, October 1, 1950; water-bearing formation, alluvium; static water level (reported), 50 feet below land surface, October 16, 1950; yield, 488 gpm.
Treatment: Commercial boiler water treatment.
Storage: 500 gal raw water.
Total distribution of water for 1951: 368,000,000 gal.
Average daily pumpage, 1951: 1,000,000 gal.
Remarks: The water is used for steam and condensing and for watering stock.

Log of well 8705-3745-43

Material	Thickness (feet)	Depth (feet)
Clay	30	30
Sand, dark, and mud	12	42
Clay, blue	6	48
Mud and sand	9	57
Water sand	10	67
Gravel, good	19	86
Water sand, fine, some coarse	34	120

Analysis, in parts per million, well 8705-3745-43

(Collected Aug. 13, 1952)

Silica (SiO_2)	19
Iron (Fe)	4.2
Manganese (Mn)	.15
Calcium (Ca)	92
Magnesium (Mg)	34
Sodium (Na)	8.1
Potassium (K)	1.3
Bicarbonate (HCO_3)	411
Sulfate (SO_4)	54
Chloride (Cl)	7.0
Fluoride (F)	.1
Nitrate (NO_3)	1.1
Dissolved solids	429
Hardness as $CaCO_3$	
Total	370
Noncarbonate	33
Temperature (°F)	58
pH	7.4
Specific conductance at 25°C (micromhos)	711

Owensboro, The Fleischmann Distilling Corp.

Ownership: The Fleischmann Distilling Corp.
Source: Three wells at the distillery.
Well 8705-3745-1 (owner's number 4). Depth, 118 feet; diameter, 12 inches; date drilled, 1949; water-bearing formation, alluvium; static water level (reported), 53 feet below land surface; yield, 630 gpm.
Well 8705-3745-6 (owner's number 3). Depth, 114 feet; diameter, 12 inches; water-bearing formation, alluvium; yield, 550 gpm.
Well 8705-3745-7 (owner's number 5). Depth, 115 feet; diameter, 12 inches; date drilled, Fall 1950; water-bearing formation, alluvium; yield, 500 gpm.
Treatment: Reported demineralization to less than 10 ppm silica (SiO_2) to prevent boiler scale.
Storage: Finished water, 15,000-gal elevated tank at plant.
Total distribution of water for 1951: 480,000,000 gal.
Average daily pumpage, 1951: 1,315,000 gal.
Remarks: The water is used for distilling and boiler water. All three wells are finished with screens. Two other wells have been abandoned and are now being used as observation wells by the U. S. Geological Survey.

Log of well 8705-3745-7

Material	Thickness (feet)	Depth (feet)
Sand, yellow	26	26
Mud, blue	22	48
Sand, brown, fine	23	71
Sand, coarse, some gravel	7	78
Sand, good	17	95
Sand, fine	19	114

Analysis, in parts per million, well 8705-3745-1

(Collected July 31, 1950)

Iron (Fe)	3.1
Bicarbonate (HCO_3)	338
Sulfate (SO_4)	17
Chloride (Cl)	6
Fluoride (F)	.1
Nitrate (NO_3)	1.0
Hardness as $CaCO_3$	
Total	304
Noncarbonate	-
Temperature (°F)	58
Specific conductance at 25°C (micromhos)	580

Analysis, in parts per million, well 8705-3745-6

(Collected Aug. 13, 1952)

Silica (SiO_2)	18
Iron (Fe)*	4.1
Manganese (Mn)	.58
Calcium (Ca)	61
Magnesium (Mg)	21
Sodium (Na)	5.1
Potassium (K)	1.0
Bicarbonate (HCO_3)	293

Analysis, well 8705-3745-6—Continued

Sulfate (SO_4)	7.1
Chloride (Cl)	2.5
Fluoride (F)	.1
Nitrate (NO_3)	1.8
Dissolved solids	261
Hardness as $CaCO_3$	
Total	239
Noncarbonate	0
Temperature (°F)	57
pH	6.9
Specific conductance at 25°C (micromhos)	466

*Iron in sediment and solution.

Owensboro, Glenmore Distilleries Co.

Ownership: Glenmore Distilleries Co.
Source: Three wells, at the plant.
Well 8705-3745-3 (owner's number 2). Depth, 129 feet; diameter, 10 inches; water-bearing formation, alluvium; yield, 600 gpm.
Well 8705-3745-30 (owner's number 1). Depth, 129 feet; diameter, 10 inches; water-bearing formation, alluvium; static water level, 48.3 feet below land surface, January 1, 1952; yield, 690 gpm.
Well 8705-3745-31 (owner's number 3). Diameter, 10 inches; water-bearing formation, alluvium; yield, 600 gpm.
Treatment: None.
Storage: 18,000-gal elevated tank at the distillery.
Total distribution of water for 1952: 612,000,000 gal.
Average daily pumpage, 1951: 1,677,000 gal.
Remarks: The water is used for cooling and condensing in the manufacture of alcohol and whisky. Maximum pumpage is 2,000,000 gpd. Two other wells have been abandoned by the company. One of these is being used as an observation well by the U. S. Geological Survey.

Log of well 8705-3745-3

Material	Thickness (feet)	Depth (feet)
Topsoil	20	20
Gravel	8	28
Clay, sandy	12	40
Sand and clay	21	61
Sand and gravel	43	104
Sand	22	126
Gravel	2	128

Log of well 8705-3745-30

Material	Thickness (feet)	Depth (feet)
Sand and clay	25	25
Sand	37	62
Sand, coarse	20	82
Sand and gravel	24	106
Rock	1	107
Sand	25	132

Log of well 8705-3745-31

Material	Thickness (feet)	Depth (feet)
Clay, sandy	50	50
Sand and gravel	51	101
Sand	27	128
Rock	-	-

Analysis, in parts per million, well 8705-3745-3

(Collected July 31, 1950)

Silica (SiO_2)	16
Iron (Fe)	3.1
Manganese (Mn)	-
Calcium (Ca)	67
Magnesium (Mg)	27
Sodium (Na) } Potassium (K)	5.1
Bicarbonate (HCO_3)	300
Sulfate (SO_4)	31
Chloride (Cl)	7.2
Fluoride (F)	.1
Nitrate (NO_3)	.9
Dissolved solids	302
Hardness as $CaCO_3$	
Total	278
Noncarbonate	32
Temperature (°F)	58
pH	7.6
Specific conductance at 25°C (micromhos)	520

Owensboro, Ideal Pure Milk Co.

Ownership: Ideal Pure Milk Co.
Source: One well at Tenth and Locust Streets.
Well 8705-3745-50. Depth, 104.5 feet; diameter, 8 inches; date drilled, June 28, 1948; water-bearing formation, alluvium; static water level, 37.5 feet below land surface, June 28, 1948; yield, 277 gpm.
Treatment: None.
Total distribution of water for 1951: 55,700,000 gal.
Average daily pumpage, 1951: 152,000 gal.
Remarks: The water is used 15 hours per day year round for cooling and refrigeration in food processing.

Log of well 8705-3745-50

Material	Thickness (feet)	Depth (feet)
Clay	11	11
Sand, yellow	15	26
Mud, black, sandy	5	31
Clay, black	12	43
Gravel and sand	44	87
Sand	11	98
Sand and a little gravel	6.5	104.5

Analysis, in parts per million, well 8705-3745-50

(Collected Dec. 13, 1951)

Silica (SiO_2)	19
Iron (Fe)	4.5
Manganese (Mn)	.22
Calcium (Ca)	73
Magnesium (Mg)	50
Sodium (Na)	7.8
Potassium (K)	.7
Bicarbonate (HCO_3)	418
Sulfate (SO_4)	55
Chloride (Cl)	6.0
Fluoride (F)	.1
Nitrate (NO_3)	.8
Dissolved solids	422
Hardness as $CaCO_3$	
Total	386
Noncarbonate	45
Temperature (°F)	58
pH	7.7
Specific conductance at 25°C (micromhos)	383

Owensboro, Medley Distilling Co.

Ownership: Medley Distilling Co.
Source: Three wells, at the plant.
Well 8705-3745-34. Depth, 95 feet; diameter, 10 inches; date drilled, July 17, 1948; water-bearing formation, alluvium; static water level (reported), 47.5 feet below land surface, July 17, 1948.
Well 8705-3745-47. Depth, 110 feet; diameter, 10 inches; date drilled, 1945; water-bearing formation, alluvium; static water level (reported), 60 feet below land surface, 1945 (?); yield, 700 gpm.
Well 8705-3745-48. Depth, 110 feet; diameter, 10 inches; water-bearing formation, alluvium; static water level (reported), 60 feet below land surface, February 1951; yield, 700 gpm.
Treatment: Boiler-feed water is softened with lime.
Storage: 40,000-gal elevated tank at the plant.
Total distribution of water for 1951: 156,000,000 gal.
Average daily pumpage, 1951: 429,000 gal.
Remarks: The water is used for cooling and condensing and for boiler water in the manufacture of alcohol and whisky.

Log of well 8705-3745-34

Material	Thickness (feet)	Depth (feet)
Clay	12	12
Mud, black, sandy	43	55
Sand, coarse, and gravel	30	85
Sand, fine-grained	10	95

Analysis, in parts per million, well 8705-3745-47

(Collected Aug. 13, 1952)

Silica (SiO_2)	19
Iron (Fe)	3.4
Manganese (Mn)	.11
Calcium (Ca)	62
Magnesium (Mg)	29
Sodium (Na)	3.8
Potassium (K)	1.0
Bicarbonate (HCO_3)	322
Sulfate (SO_4)	18
Chloride (Cl)	3.5
Fluoride (F)	.1
Nitrate (NO_3)	.5
Dissolved solids	296
Hardness as $CaCO_3$	
Total	274
Noncarbonate	10
Temperature (°F)	57
pH	7.1
Specific conductance at 25°C (micromhos)	527

Owensboro, Owensboro Canning Co.

Ownership: Owensboro Canning Co.
Source: One well at the plant at Seventh and George Streets.
Well 8705-3745-39. Depth, 85+ feet; date drilled, April 4, 1940; water-bearing formation, alluvium; static water level (reported), 44.3 feet below land surface, April 4, 1940; yield (reported), 180 gpm.
Treatment: None.
Total distribution of water for 1951: 20,000,000 gal.
Remarks: Some city water is used. During the summer and fall for a period of about 6 months, the daily usage is 108,000 gpd pumped during a 10-hour period. During the remainder of the year little or no water is used.

Owensboro, Owensboro Country Club

Ownership: Owensboro Country Club.
Source: Two wells.
Well 8705-3740-1 (owner's number 1), at the club house. Depth, 96 feet; diameter, 8 inches; date drilled, May 20, 1948; water-bearing formation, alluvium; yield (estimated), 125 gpm.
Well 8705-3740-2 (owner's number 2), on the golf course approximately 1,300 feet southeast of well 8705-3740-1. Depth, 123 feet; diameter, 8 inches; date drilled, July 1949; water-bearing formation, alluvium; static water level (reported), 20 feet below land surface, July 1949; yield (estimated), 125 gpm.
Treatment: None.
Total distribution of water for 1951: 10,000,000 gal.
Average daily pumpage, 1951: During the summer about 37,500 gpd is used for watering greens from well 8705-3740-2. Well 8705-3740-1 is used for domestic purposes in the club, for the swimming pool, and for watering some greens. Maximum pumpage from this well probably is about 30,000 gpd.
Remarks: In 1952 a system of circulating and purifying the water in the swimming pool was installed resulting in a reduction of water taken from well 8705-3740-1.

Log of well 8705-3740-2

Material	Thickness (feet)	Depth (feet)
Clay	20	20
Mud, blue	4	24
Mud, gray	34	58
Mud, green	14	72
Mud, gray	20	92
Gravel, lots of water	2	94
Sand, fine	2	96
Sand and gravel	15	111
Sand	12	123

Analysis, in parts per million, well 8705-3740-2

(Collected Aug. 13, 1952)

Silica (SiO_2)	17
Iron (Fe)	2.5
Manganese (Mn)	.19
Calcium (Ca)	74
Magnesium (Mg)	32
Sodium (Na)	16
Potassium (K)	.5
Bicarbonate (HCO_3)	420
Sulfate (SO_4)	1.3
Chloride (Cl)	2.5
Fluoride (F)	.0
Nitrate (NO_3)	3.4
Dissolved solids	361
Hardness as $CaCO_3$	
Total	314
Noncarbonate	0
Temperature (°F)	58
pH	7.5
Specific conductance at 25°C (micromhos)	643

Owensboro, Owensboro Grain Co.

Ownership: Owensboro Grain Co.
Source: Two wells, at the soybean plant at Leitchfield Road and Second Street.
Well 8705-3745-40 (owner's number 1). Depth, 102 feet; diameter, 10 inches; date drilled, September 1948; water-bearing formation, alluvium; static water level (reported), 45 feet below land surface, September 1948; yield, 288 gpm.
Well 8705-3745-51 (owner's number 2). Depth, 118 feet; diameter, 10 inches; date drilled, August 1951; water-bearing formation, alluvium; yield, 409 gpm.
Treatment: None.
Storage: 5,000-gal elevated tank at the plant.
Total distribution of water for 1951: 75,000,000 gal.
Average daily pumpage, 1951: 205,000 gal.
Remarks: When the plant is operating, it uses approximately 400,000 gpd and operates continuously. The water is used mainly for condensing.

Log of well 8705-3745-40

Material	Thickness (feet)	Depth (feet)
Clay	18	18
Sand, yellow	12	30
Clay, blue	5	35
Clay, yellow	8	43
Sand, yellow	4	47
Water sand and gravel	48	95
Water sand, finer	7	102

Log of well 8705-3745-51

Material	Thickness (feet)	Depth (feet)
Filled in	6	6
Mud, yellow	15	21
Mud and sand, yellow	11	32
Mud, blue, and little sand	9	41
Mud and sand, yellow	5	46
Water sand, yellow muddy, and gravel	14	60
Sand, coarse, and fine gray gravel	7	67
Sand, coarse, and much gravel	11	78
Sand, medium, and gravel, fine sand	10	88
Sand, fine to medium	2	90
Sand, medium to coarse, some fine gravel	2	92
Sand, medium	15	107
Sand, medium, black pebbles	16	123

Analysis, in parts per million, well 8705-3745-51

(Collected Aug. 13, 1952)

Silica (SiO_2)	11
Iron (Fe)	.27
Manganese (Mn)	.09
Calcium (Ca)	57
Magnesium (Mg)	16
Sodium (Na)	13
Potassium (K)	1
Bicarbonate (HCO_3)	190
Sulfate (SO_4)	59
Chloride (Cl)	16
Fluoride (F)	.2
Nitrate (NO_3)	.6
Dissolved solids	282
Hardness as $CaCO_3$	
Total	207
Noncarbonate	52
Temperature (°F)	60
pH	7.2
Specific conductance at 25°C (micromhos)	473

Whitesville

Population served: 472 (approximate).
Ownership: Municipal.
Source: Three wells, 1.5 miles west of town on Kentucky Highway 54.
Well 8650-3740-1. Depth, 158 feet; diameter, 8 inches; date drilled, 1939; water-bearing formation, Tradewater; static water level (reported), 20 feet below land surface, August 20, 1951.
Well 8650-3740-2. Depth, 169 feet; diameter, 8 inches; date drilled, 1939; water-bearing formation, Tradewater; static water level (reported), 20 feet below land surface August 20, 1951.
Well 8650-3740-3. Depth, 175 feet; diameter 16 inches; date drilled, November 1950; water-bearing formation, Tradewater; yield (estimated), 70 gpm.
Treatment: Chlorination to control bacteria.
Storage: 25,000-gal elevated tank at the southwest corner of the city limits.
Total distribution of water for 1951: 12,000,000 gal.
Average daily pumpage, 1951: 33,300 gal.
Remarks: There is no industry in the town; all of the water is utilized for domestic purposes except for a small percentage used by the school and by small businesses.

Analysis, in parts per million, well 8650-3740-1 and 2

(Collected Oct. 5, 1951)

Silica (SiO_2)	35
Iron (Fe)	.46
Calcium (Ca)	78
Magnesium (Mg)	25
Sodium (Na)	34
Potassium (K)	1.0
Bicarbonate (HCO_3)	332
Sulfate (SO_4)	93
Chloride (Cl)	7.0
Fluoride (F)	.1
Nitrate (NO_3)	.8
Dissolved solids	434
Hardness as $CaCO_3$	
Total	298
Noncarbonate	25
Temperature (°F)	60
pH	7.4
Specific conductance at 25°C (micromhos)	657

Note.--This sample was a composite of raw water from wells 8650-3740-1 and 2.

HANCOCK COUNTY

Hawesville

Population served: 715 (approximate).
Ownership: K. T. Water and Electric Co.
Source: Two wells, at the railroad depot.
Well 8645-3750-2. Depth, 110 feet; diameter, 10 inches; water-bearing formation, alluvium; yield (reported), 250 gpm.
Well 8645-3750-3. Depth, 110 feet; diameter, 10 inches; date drilled, December 1951; water-bearing formation, alluvium; yield (reported), 250 gpm.
Treatment: Chlorination to control bacteria.
Storage: 118,000-gal tank on ridge in northeast corner of town.
Total distribution of water for 1951: 13,500,000 gal.
Average daily pumpage, 1951: 37,000 gal.
Remarks: Wells are located about 15 feet apart, and only one is pumped at a time.

Analysis, in parts per million, well 8645-3750-2

(Collected Oct. 5, 1951)

Silica (SiO_2)	22
Iron (Fe)	5.4
Manganese (Mn)	.72
Calcium (Ca)	114
Magnesium (Mg)	42
Sodium (Na)	40
Potassium (K)	1.8
Bicarbonate (HCO_3)	382
Sulfate (SO_4)	155
Chloride (Cl)	48
Fluoride (F)	.3
Nitrate (NO_3)	7.6
Dissolved solids	648
Hardness as $CaCO_3$	
Total	458
Noncarbonate	144
Temperature (°F)	56
pH	7.5
Specific conductance at 25°C (micromhos)	976

Lewisport

Population served: 475 (approximate).
Ownership: Municipal.
Source: Two wells, 1,200 feet south of the Ohio River and 600 feet east of U. S. Highway 60.
Well 8650-3755-1. Depth, 80 feet; diameter, 12 inches; date drilled, 1935; water-bearing formation, alluvium; yield (reported), 260 gpm.
Well 8650-3755-2. Depth, 80 feet; diameter, 12 inches; date drilled, 1935; water-bearing formation, alluvium; yield (reported), 290 gpm.
Treatment: Chlorination to control bacteria.
Storage: 5,000-gal elevated tank at Fourth and Market Streets.
Total distribution of water for 1951: 3,960,000 gal.
Average daily pumpage, 1951: 10,800 gal.
Remarks: The low per-capita consumption in this town may be attributed to the lack of a sewer system. None of the water is metered.

Analysis, in parts per million, well 8650-3755-2

(Collected Oct. 5, 1951)

Silica (SiO_2)	16
Iron (Fe)	.10
Manganese (Mn)	.00
Calcium (Ca)	94
Magnesium (Mg)	32
Sodium (Na)	13
Potassium (K)	5.7
Bicarbonate (HCO_3)	392
Sulfate (SO_4)	46
Chloride (Cl)	12
Fluoride (F)	.2
Nitrate (NO_3)	4.9
Dissolved solids	410
Hardness as $CaCO_3$	
Total	366
Noncarbonate	45
Temperature (°F)	59
pH	7.5
Specific conductance at 25°C (micromhos)	660

HENDERSON COUNTY

Corydon

Population served: 368 (approximate).
Ownership: Municipal.
Source: Three wells.
Well 8740-3740-2, east of U. S. Highway 60 at the north edge of town. Depth, 160 feet; diameter, 8 inches; date drilled, 1939; water-bearing formation, Anvil Rock sandstone member of the Lisman formation; static water level (reported), 130 feet below land surface, June 1949; yield, (reported), 4 gpm, 1951.
Well 8740-3740-3, 200 feet south of well 8740-3740-2. Depth, 160 feet; diameter, 8 inches; date drilled, 1939; water-bearing formation, Anvil Rock sandstone member of the Lisman formation; static water level (reported), 130 feet below land surface, 1951; yield (reported), 4 gpm, 1951.
Well 8740-3740-50, on the west side of U. S. Highway 60 south of its intersection with Kentucky Highway 145. Owned by W. S. Abell. Depth, 185 feet; diameter, 6 inches; date drilled, 1947; water-bearing formation, Anvil Rock sandstone member of the Lisman formation; static water level (reported), 30 feet below land surface, 1952; yield (reported), 13 gpm, 1952.
Treatment: Chlorination to control bacteria.
Storage: 50,000-gal elevated tank at the south city limits east of U. S. Highway 60.
Total distribution of water for 1951: 5,516,000 gal.
Average daily pumpage, 1951: 15,000 gal.
Remarks: Two of four city wells have been abandoned. The school well 8740-3740-4, several hundred feet north of well 8740-3740-50 was used for some time until the school burned. After the school burned well 8740-3740-50 was connected to the city supply. Prior to this time, the supply was not sufficient to meet the demands made on it. A steep depression cone has been created in the municipal well field at the north end of town. The static water levels of these wells when drilled is not known; however, the static levels of wells in the vicinity would indicate that there has been about 100 feet of drawdown in the municipal well field.

Analysis, in parts per million, well 8740-3740-3

(Collected Nov. 14, 1951)

Silica (SiO_2)	13
Iron (Fe)*	.48
Manganese (Mn)	.00
Calcium (Ca)	128
Magnesium (Mg)	46
Sodium (Na)	800
Potassium (K)	33
Bicarbonate (HCO_3)	832
Sulfate (SO_4)	1,446
Chloride (Cl)	82
Fluoride (F)	1.5
Nitrate (NO_3)	7.2
Dissolved solids	2,986
Hardness as $CaCO_3$	
Total	510
Noncarbonate	.0
Temperature (°F)	58
pH	7.0
Specific conductance at 25°C (micromhos)	3,810

*Iron in sediment and solution.

Analysis, in parts per million, well 8740-3740-4

(Collected July 28, 1950)

Silica (SiO_2)	8.5
Iron (Fe)	.25
Manganese (Mn)	-
Calcium (Ca)	15
Magnesium (Mg)	8.7
Sodium (Na) + Potassium (K)	370
Bicarbonate (HCO_3)*	624
Sulfate (SO_4)	237
Chloride (Cl)	79
Fluoride (F)	1.2
Nitrate (NO_3)	6.4
Dissolved solids	1,040
Hardness as $CaCO_3$	
Total	73
Noncarbonate	0
Temperature (°F)	62
pH	8.2
Specific conductance at 25°C (micromhos)	1,630

*Includes equivalent of 18 ppm of carbonate (CO_3).

Analysis, in parts per million, well 8740-3740-50

(Collected May 19, 1952)

Silica (SiO_2)	14
Iron (Fe)	.20
Manganese (Mn)	.26
Calcium (Ca)	44
Magnesium (Mg)	18
Sodium (Na)	175
Potassium (K)	1.5
Bicarbonate (HCO_3)	331
Sulfate (SO_4)	126
Chloride (Cl)	64
Fluoride (F)	.5
Nitrate (NO_3)	88
Dissolved solids	702
Hardness as $CaCO_3$	
Total	185
Noncarbonate	0
Temperature (°F)	58
pH	7.5
Specific conductance at 25°C (micromhos)	1,120

Dixie, Dixie Oil Pool

Ownership: Sun Oil Co. and Carter Oil Co.
Source: Produced water from the Chester group.
Treatment: None.
Total distribution of water for 1952: 36,500,000 gal (metered).
Average daily pumpage, 1952: 100,000 gal.
Remarks: The water is produced with the oil from the Cypress sandstone of the Chester group and is returned to the Cypress and Tar Springs sandstones to recover oil.

Green River Island, Dade Park

Ownership: J. C. Ellis.
Source: Three driven wells, at the northwest corner of the race track.
- Well 8730-3755-12. Depth, 45 feet; diameter, 2.5 inches; water-bearing formation, alluvium; static water level (reported), 15 feet below land surface; yield (reported), 29 gpm.
- Well 8730-3755-13. Depth, 45 feet; diameter, 3 inches; water-bearing formation, alluvium; static water level (reported), 15 feet below land surface; yield (reported), 29 gpm.
- Well 8730-3755-14. Depth, 45 feet; diameter, 3 inches; water-bearing formation, alluvium; static water level (reported), 15 feet below land surface; yield (reported), 44 gpm.

Treatment: None.
Storage: 60,000-gal elevated tank at wells.
Total distribution of water for 1951: 2,850,000 gal.
Remarks: Use is seasonal. During the month of racing at the track, 81,300 gpd is used, but during the rest of the year, a total of only 330,000 gal is used.

Green River Island, Trocadero, Inc.

Ownership: Clarence Wood.
Source: Two wells, at the club on Green River Island.
Well 8730-3750-210. Depth, 78 feet; diameter, 10 inches; date drilled, July 2, 1949; water-bearing formation, alluvium; static water level (reported), 37.5 feet below land surface, July 2, 1949; yield (reported), 325 gpm.
Well 8750-3750-236. Depth, 60 feet; diameter, 3 inches; water-bearing formation, alluvium.
Treatment: Oakite to stabilize salts.
Total distribution for 1951: 8,100,000 gal.
Remarks: Well 8730-3750-210 furnishes the air conditioning system, and well 8730-3750-236 supplies water for domestic purposes. Air conditioning usage is about 52,000 gpd during the summer.

Analysis, in parts per million, well 8730-3750-236

(Collected Mar. 30, 1950)

Silica (SiO_2)	14
Iron (Fe)	.32
Manganese (Mn)	-
Calcium (Ca)	94
Magnesium (Mg)	34
Sodium (Na) + Potassium (K)	6.0
Bicarbonate (HCO_3)	332
Sulfate (SO_4)	84
Chloride (Cl)	18
Fluoride (F)	.1
Nitrate (NO_3)	4
Dissolved solids	434
Hardness as $CaCO_3$	
Total	374
Noncarbonate	102
Temperature (°F)	59
pH	7.4
Specific conductance at 25°C (micromhos)	697

Henderson

Population served: 18,264.
Ownership: Municipal.
Source: Ohio River at Atkinson Park in Henderson, Ky.
Treatment: Coagulation with lime and alum in a settling basin; rapid sand filtration to remove solids; chlorine and ammonia added to control bacteria.
Rated capacity of treatment plant: 5,200,000 gpd.
Storage: 4,000,000 gal in tanks at Atkinson Park.
Total distribution of water for 1950: 1,314,000,000 gal (metered).
Average daily pumpage, 1950: 3,600,000 gal.
Remarks: No breakdown as to type of use is available because much of the city is on flat rates and is not metered. The city plans to develop a supply of 10,000,000 gpd.

Henderson, Audubon State Park

Ownership: State of Kentucky.
Source: One well, 2 miles north of Henderson west of U. S. Highway 41 at the park entrance.
Well 8730-3750-125. Depth, 65.5 feet; diameter, 6 inches; date drilled, July 1938; water-bearing formation, alluvium; static water level (reported), 16 feet below land surface, July 6, 1938; yield (reported), 50 gpm.
Treatment: None.
Storage: 30,000-gal elevated tank.
Total distribution of water for 1950: 2,640,000 gal.
Remarks: Maximum use is during the months of July and August when about 12,000 gpd is used. During 1950, this park served 45,000 people.

Analysis, in parts per million, well 8730-3750-125

(Collected Mar. 30, 1950)

Silica (SiO_2)	17
Iron (Fe)	.22
Manganese (Mn)	-
Calcium (Ca)	102
Magnesium (Mg)	38
Sodium (Na) + Potassium (K)	12
Bicarbonate (HCO_3)	416
Sulfate (SO_4)	73
Chloride (Cl)	10
Fluoride (F)	.2
Nitrate (NO_3)	7.6
Dissolved solids	462
Hardness as $CaCO_3$	
Total	411
Noncarbonate	70
Temperature (°F)	-
pH	7.6
Specific conductance at 25°C (micromhos)	759

Henderson, Farmers Tankage Co.

Ownership: Farmers Tankage Co.
Source: Two wells, at the plant.
Well 8735-3745-6. Depth, 110 feet; diameter, 13 inches; date drilled, December 31, 1946; water-bearing formation, alluvium; static water level (reported), 61 feet below land surface, December 31, 1946; yield (reported), 250 gpm.
Well 8735-3745-7. Depth, 110 feet; diameter, 13 inches; date drilled, December 1946; water-bearing formation, alluvium; static water level (reported), 61 feet below land surface, December 31, 1946; yield (reported), 215 gpm.
Treatment: A small amount of water receives commercial boiler water treatment.
Storage: 500-gal elevated tank.
Total distribution of water for 1951: 112,320,000 gal.
Average daily pumpage, 1951: 308,000 gal.
Remarks: The water is used in the processing of tankage. It is used for washing, for boiler feed, and for vacuum cookers.

Log of wells 8745-3745-6 and 7

Material	Thickness (feet)	Depth (feet)
Sand, fine	106	106
Gravel	4	110

Analysis, in parts per million, well 8735-3745-6

(Collected Dec. 29, 1949)

Silica (SiO_2)	12
Iron (Fe)	4.5
Calcium (Ca)	92
Magnesium (Mg)	31
Sodium (Na) } Potassium (K)	11
Bicarbonate (HCO_3)	414
Sulfate (SO_4)	27
Chloride (Cl)	8.5
Fluoride (F)	.1
Nitrate (NO_3)	2.1
Dissolved solids	390
Hardness as $CaCO_3$	
Total	357
Noncarbonate	18
Temperature (°F)	56
pH	8.0
Specific conductance at 25°C (micromhos)	680

Henderson, Spencer Chemical Co.

Ownership: Spencer Chemical Co.
Source: Three collector wells, on the south bank of the Ohio River near the mouth of Canoe Creek. Gravity feeds from the Ohio River supply about 10 percent of the total pumpage.
Well 8735-3745-8 (owner's number 1). Depth, 65 feet; laterals 8 inches in diameter; date constructed, 1942; water-bearing formation, alluvium; static water level, approximately the same as that of the river; yield (reported), 9,000 gpm.
Well 8735-3745-9 (owner's number 2). Depth, 74 feet; laterals 8 inches in diameter; date constructed, 1942; water-bearing formation, alluvium; static water level, approximately the same as that of the river; yield (reported), 3,500 gpm.
Well 8735-3745-10 (owner's number 3). Depth, 71 feet; laterals 8 inches in diameter; date constructed, 1942; water-bearing formation, alluvium; static water level, approximately the same as that of the river; yield (reported), 5,000 gpm.
Treatment: None.
Storage: 500,000 gal.
Total distribution of water for 1951: 9,360,000,000 gal (metered). About 10 percent of this is estimated to come from the river through gravity feeds.
Average daily pumpage, 1951: 25,545,000 gal.
Remarks: The water is used for cooling in the manufacture of ammonia from atmospheric nitrogen. In 1952 a cooling tower was installed reducing the consumption of water. Prior to this, the supply had to be augmented by gravity feeds open to the river. Since the cooling tower has been placed in operation the gravity feeds are rarly open.

Analysis, in parts per million, well 8735-3745-10

(Collected Sept. 5, 1952)

Silica (SiO_2)	3.7
Iron (Fe)	.17
Manganese (Mn)	.07
Calcium (Ca)	52
Magnesium (Mg)	12
Sodium (Na)	22
Potassium (K)	2.0
Bicarbonate (HCO_3)	113
Sulfate (SO_4)	94
Chloride (Cl)	31
Fluoride (F)	.2
Nitrate (NO_3)	1.5
Dissolved solids	287
Hardness as $CaCO_3$	
Total	181
Noncarbonate	86
Temperature (°F)	76
pH	6.8
Specific conductance at 25°C (micromhos)	478

HOPKINS COUNTY

Beulah, Colonial Mine

Ownership: Colonial Coal Mining Co., Inc.
Source: Lake at the mine connected to Clear Creek by a ditch, 8735-3715-A. An emergency supply is a lake south of Kentucky Highway 70, 2 miles east of Beulah, Ky.
Treatment: None.
Total distribution of water for 1951: 43,300,000 gal.
Average daily pumpage, 1951: 119,000 gal.
Remarks: The water is recirculated, about 25 percent being added each cycle. The figures given above represent the amount of water consumed and not the total amount pumped.

Beulah, Meadows Mine

Ownership: Meadows Coal Co.
Source: Impounded stream at Meadows mine, Beulah, Ky., 8740-3715-A.
Treatment: None.
Total distribution of water for 1951: 13,000,000 gal.
Average daily pumpage, 1951: 35,600 gal.
Remarks: This water is used for washing coal. Part of the supply is derived from an impounded stream and part from strip pits.

Beulah, Stony Point Mine

Ownership: Stony Point Coal Co., Inc.
Source: Impounded stream and strip pits at mine, 8740-3715-B, 3 miles northwest of Beulah, Ky.
Treatment: None.
Total distribution of water for 1951: 35,100,000 gal.
Average daily pumpage, 1951: 96,000 gal.
Remarks: All of the water is used for washing coal and is recirculated. The figure given above is the amount of water added to the system during the year. The average daily consumption when operating is 135,000 gal.

Charleston, Daylight Number 6 Mine

Ownership: Dawson Daylight Coal Co.
Source: Two impounded streams at the mine, 8735-3710-A, at Charleston, Ky.
Treatment: None.
Total distribution of water for 1951: 168,000,000 gal.
Average daily pumpage, 1951: 460,000 gal.
Remarks: The water is used for washing coal. The water is not recirculated. It is discharged to the natural drainage after it passes through a settling basin and loses its suspended load. This plant ceased operation in 1952 and another has been constructed which will recirculate its water.

Dawson Springs

Population served: 3,860.
Ownership: Municipal.
Source: Three wells, in the southeast part of town.
Well 8740-3705-1 (owner's number 1). Depth, 188 feet; diameter, 12 inches; date drilled, 1930; water-bearing formation, Caseyville sandstone; yield (reported), 250 gpm.
Well 8740-3705-2 (owner's number 2). Depth, 188 feet; diameter, 12 inches; date drilled, 1930; water-bearing formation, Caseyville sandstone; yield (reported), 250 gpm.
Well 8740-3705-3 (owner's number 3). Depth, 249 feet; diameter, 12 inches; date drilled, 1948; water-bearing formation, Caseyville sandstone; static water level (reported), 165 feet below land surface; yield (reported), 115 gpm.
Treatment: Aeration on coke to precipitate iron; settling to remove solids; chlorination to control bacteria.
Storage: 234,000-gal reservoir on hilltop near treatment plant.
Total distribution of water for 1950: 144,000,000 gal.
Average daily pumpage, 1950: 395,000 gal.
Remarks: The daily pumpage remains nearly constant throughout the year because in the summer the townspeople use more water than in the winter and the railroad uses more water in the winter due to the increased haulage of coal. Industrial use is estimated to be about 40 percent of the total use.

Log of well 8740-3705-3

Material	Thickness (feet)	Depth (feet)
Soil	4	4
Gravel, red	1	5
Clay, yellow	6	11
Mud, blue	7	18
Sandstone, red	9	27
Soapstone, sandy brown	7	34
Sandstone, gray	8	42
Shale, sandy	5	47
Sandstone, gray	4	51
Shale, sandy	10	61
Sandstone, gray	11	72
Shale, sandy	9	81
Sandstone, white	168	249

Analysis, in parts per million, well 8740-3705-3

(Collected Nov. 14, 1953)

Silica (SiO_2)	11
Iron (Fe)	4.4
Manganese (Mn)	.00
Calcium (Ca)	16
Magnesium (Mg)	7.3
Sodium (Na)	14
Potassium (K)	2.2
Bicarbonate (HCO_3)	92
Sulfate (SO_4)	18
Chloride (Cl)	5.0
Fluoride (F)	.2
Nitrate (NO_3)	.1
Dissolved solids	112
Hardness as $CaCO_3$	
Total	70
Noncarbonate	0
Temperature (°F)	59
pH	6.5
Specific conductance at 25°C (micromhos)	200

Dawson Springs, Dawson Number 6 Mine

Ownership: Dawson Collieries, Inc.
Source: Mine water and impounded stream at mine, 8740-3710-A, 0.5 mile northeast of Dawson Springs, Ky.
Treatment: None.
Total distribution of water for 1951: 94,500,000 gal.
Average daily pumpage, 1951: 259,000 gal.
Remarks: The water is used for washing coal. Part of the supply is derived from an artificial lake and part from the mine. No figures are available to indicate the percentage from each source. The water is not recirculated.

Earlington

Population served: 3,000.
Ownership: Kentucky Utilities Co. owns the supply; the city of Earlington owns the distribution system.
Source: Impounded stream (Loch Mary) at southwest city limits of Earlington, Ky.
Treatment: Water consumed by the Kentucky Utilities Co. power plant is untreated except for the water consumed by the boilers. Water purchased by the city is chlorinated to control bacteria.
Storage: 150,000-gal tank at Highland and Farren Avenues.
Total distribution of water for 1951: 142,380,000 gal.
Breakdown of annual distribution as to use:
Domestic ..... 49,200,000 gal
Industrial and commercial ..... 96,900,000 gal
Other public use, leakage, and waste ..... 1,280,000 gal
Average daily pumpage, 1951: 390,000 gal.
Remarks: This lake at Earlington has served as an emergency supply for Madisonville for several years.

Madisonville

Population served: 14,000.
Ownership: Municipal.
Source: Three impounded streams in and near Madisonville, Ky., at southeast and northwest city limits.
Treatment: Prechlorination to control algae and slime; coagulation with lime and alum; sedimentation and rapid sand filtration to remove solids; postchlorination to control bacteria and corrosion control with polyphosphate.
Rated capacity of treatment plant: 2,000,000 gal.
Storage: 550,000 gal in elevated tanks at Hall and Daves Streets and at South Seminary and West Lake Streets.
Total distribution of water for 1951: 304,160,000 gal.
Average daily pumpage, 1951: 835,000 gal.
Remarks: No breakdown of consumption as to use is available. The municipal system can obtain water from Earlington in emergencies. At this time (1953) another lake is being constructed which is expected to alleviate or eliminate the summer shortages and the dependence on Earlington.

Madisonville, East Diamond Mine

Ownership: West Kentucky Coal Co.
Source: Impounded stream at mine, 8725-3715-A, 1 mile east of Madisonville, Ky.
Treatment: None.
Total distribution of water for 1951: 90,000,000 gal.
Average daily pumpage, 1951: 250,000 gal.
Remarks: The water is used for washing coal. The water is recirculated in the washing plant. The consumption figure given above is the amount of water added to the system during the year.

Madisonville, Fies Mine

Ownership: Miners Coal Co.
Source: Impounded stream at tipple, 8720-3715-A, 5.5 miles east of Madisonville, Ky., on Kentucky Highway 70.
Treatment: Water consumed by the camp is chlorinated to control bacteria.
Storage: 25,000-gal elevated tank for the camp.
Total distribution for 1951: 136,660,000 gal.
Breakdown of annual distribution as to use:
Domestic ..... 1,550,000 gal
Industrial (coal washer) ..... 135,100,000 gal
Average daily pumpage, 1951: 374,000 gal.
Remarks: A small camp is supplied from the same lake as the washer. Water in the washing plant is recirculated. The consumption figures given above show water actually added to the system during the year. The daily consumption during operation is approximately 490,000 gal.

Madisonville, Magnolia Mine

Ownership: Magnolia Mining Co.
Source: Impounded stream and strip pits at mine, 8735-3715-B, 4.5 miles west of Madisonville, Ky.
Treatment: None.
Total distribution of water for 1951: 98,250,000 gal.
Average daily pumpage, 1951: 269,000 gal.
Remarks: All the water is used for washing coal and is recirculated. The figures given above represent the water added to the system during the year. Average daily pumpage when operating is 491,000 gal.

Madisonville, Oriole Mine

Ownership: Bell and Zoller Coal and Mining Co.
Source: Impounded streams at mine and Pond Creek, 8735-3720-A, 6 miles west of Madisonville, Ky.
Treatment: None.
Total distribution of water for 1951: 102,000,000 gal.
Average daily pumpage, 1951: 280,000 gal.
Remarks: The water is used in washing coal. The figure given above is the amount of water added to the system during the year. The average daily consumption when operating is 505,000 gal.

Madisonville, Pleasant View Mine

Ownership: West Kentucky Coal Co.
Source: Impounded stream at mine, 8730-3715-A, 3 miles west of Madisonville, Ky.
Treatment: None.
Total distribution of water for 1951: 90,000,000 gal.
Average daily pumpage, 1951: 246,000 gal.
Remarks: Water is used for washing coal and is recirculated. The figure given above is the amount of water added to the system during the year. Average daily pumpage when operating is 395,000 gal.

Madisonville, Pond River Mine

Ownership: Terteling Bros., Inc.
Source: Impounded stream at mine and Pond River, 8720-3715-B, 4 miles east of Madisonville, Ky.
Treatment: None.
Total distribution of water for 1951: 98,000,000 gal.
Average daily pumpage, 1951: 270,000 gal.
Remarks: Water is used for the washing of coal. During about 5 months in the summer, water is pumped from the Pond River to the mine. The water is recirculated; the figure given above represents the amount of water added to the system.

Mortons Gap

Population served: 1,200.
Ownership: Municipal.
Source: Impounded stream west of U. S. Highway 41 at Mortons Gap, Ky.
Treatment: Coagulation with lime and alum; rapid sand filtration to remove solids; chlorination to control bacteria.
Storage: 25,000-gal elevated tank on hill in southeast part of town.
Total distribution of water for 1951: 9,140,000 gal.
Average daily pumpage, 1951: 25,000 gal.
Remarks: A well is being constructed (in 1954) to supplement the supply.

Nortonville

Population served: 1,000.
Ownership: Municipal.
Source: One well, 0.2 mile south of the city limits on the west side of the Louisville & Nashville Railroad Co. tracks.
Well 8725-3710-1. Depth, 600 feet; diameter, 8.5 inches; water-bearing formation, Caseyville sandstone; static water level (reported), 40 feet below land surface; yield (reported), 500 gpm.
Treatment: Chlorination to control bacteria.
Storage: 25,000-gal elevated tank on hill in southwest corner of town.
Total distribution of water for 1951: 40,000,000 gal.
Average daily pumpage, 1951: 110,000 gal.
Remarks: There are no figures available giving the breakdown as to use because some of the consumers are on flat rates. The industries probably consume about 30 percent of the water used from the supply.

Log of well 8725-3710-1

Material	Thickness (feet)	Depth (feet)
Clay	18	18
Limestone	18	36
Slate, black	4	40
Limestone	4	44
Shale	62	106
Coal, No. 6, coal rider	3	109
Shale, sandy	6	115
Shale, gray	8	123
Coal, No. 6	4	127
Shale, gray	33	160
Sandstone	8	168
Shale	3	171
Sandstone	24	195
Limestone, brown	10	205
Shale, shelly	20	225
Shale, sandy	65	290
Shale	20	310
Slate, black	72	382
Sandstone	51	433
Sandy	32	465
Slate, black	25	490
Shale, gray	5	495
Slate, black casing set at 512	17	512
Sand	88	600

Analysis, in parts per million, well 8725-3710-1

(Collected Nov. 14, 1951)

Silica (SiO_2)	12
Iron (Fe)	.23
Manganese (Mn)	.00
Calcium (Ca)	3.2
Magnesium (Mg)	1.5
Sodium (Na)	107
Potassium (K)	1.7
Bicarbonate (HCO_3)	292
Sulfate (SO_4)	.3
Chloride (Cl)	3.5
Fluoride (F)	.2
Nitrate (NO_3)	.0
Dissolved solids	283
Hardness as $CaCO_3$	
Total	14
Noncarbonate	0
Temperature (°F)	64
pH	8.4
Specific conductance at 25°C (micromhos)	447

Nortonville, Kentucky Utilities Co.

Ownership: Kentucky Utilities Co.
Source: Impounded stream.
Treatment: Commercial boiler water treatment.
Remarks: Most of the water used is for cooling purposes. A smaller amount is used for boiler water. Since operation is on a standby basis only, the consumption will vary widely.

Nortonville, Norco Mine

Ownership: Norton Coal Corp.
Source: Mine water, 8725-3710-6 at Nortonville.
Treatment: None.
Total distribution of water for 1951: 680,000,000 gal.
Average daily pumpage, 1951: 1,863,000 gal.
Remarks: The figures given above represent the amount of water actually pumped from the mine. Only 39,300,000 gal annually were used for the washing of coal. The water was not recirculated. Much of the water was derived from old mine workings. The water is coming from the Carbondale and Lisman formations. The mine was closed in 1952 because of the excess amounts of water which had to be pumped to keep the mine dewatered.

Analysis, in parts per million, mine 8725-3710-6

(Collected Sept. 5, 1952)

Silica (SiO_2)	
Iron (Fe)	258
Manganese (Mn)	32
Calcium (Ca)	429
Magnesium (Mg)	141
Sodium (Na)	98
Potassium (K)	3.4
Bicarbonate (HCO_3)	0
Sulfate (SO_4)	2,469
Chloride (Cl)	50
Fluoride (F)	-
Nitrate (NO_3)	-
Dissolved solids	3,532
Hardness as $CaCO_3$	
Total	1,650
Noncarbonate	1,650
Temperature (°F)	70
Total acidity as H_2SO_4	492
pH	3.00
Specific conductance at 25°C (micromhos)	4,070

Nortonville, Williams Number 4 Mine

Ownership: Williams Coal Co.
Source: One well, at the mine, 4 miles southwest of Nortonville.
Well 8730-3705-1. Depth, 840 feet; diameter; 8 inches; date drilled, 1945; water-bearing formation, Caseyville sandstone; static water level (reported), 30 feet below land surface; yield (reported), 119 gpm.
Treatment: Hydrated lime is added to the water that is recirculated to adjust the pH.
Storage: 25,000-gal elevated tank and a settling pond holding an estimated 15 acre feet.
Total distribution of water for 1951: 63,400,000 gal.
Average daily pumpage, 1951: 174,000 gal.
Remarks: The water is used for coal washing and is recirculated; a small additional amount is used for drinking and bathing. The figures given are estimates of the amount of water added to the washing system during the year.

Log of well 8730-3705-1

Material	Thickness (feet)	Depth (feet)
Soil	26	26
Shale	4	30
Sandstone	20	50
Shale, black	18	68
Limestone	3	71
Shale, gray	46	117
Coal, No. 6	3.5	120.5
Fire clay	2.5	123
Shale, gray, casing set at 128	27	150
Shale, sandy	10	160
Shale, gray	10	170
Sand	25	195
Coal	2	197
Fire clay	3	200
Shale, dark	16	216
Limestone	2	218
Shale, gray	17	235
Coal	2	237
Shale, dark sandy	26	263
Shale, dark gray	4	267
No record	1	268
Shale, black	12	280
Coal	3	283
Fire clay	2	285
Shale, dark sandy	13	298
Sand	22	320
Shale	5	325
Sand	40	365
Shale, dark	35	400
Shale, sandy	25	425
Shale, gray	25	450
Sand	20	470
Shale, dark gray	20	490
Shale, dark	30	520
Water sand	32	552
Shale, gray	8	560
Shale, sandy	12	572
Shale	78	650
Sand	8	658
Shale, sandy	32	690
Sand	150	840

Analysis, in parts per million, well 8730-3705-1

(Collected Dec. 12, 1951)

Silica (SiO_2)	13
Iron (Fe)	.36
Manganese (Mn)	.00
Calcium (Ca)	13
Magnesium (Mg)	7.8
Sodium (Na)	240
Potassium (K)	1.2
Bicarbonate (HCO_3)*	576
Sulfate (SO_4)	58
Chloride (Cl)	34
Fluoride (F)	1.5
Nitrate (NO_3)	.9
Dissolved solids	662
Hardness as $CaCO_3$	
Total	64
Noncarbonate	0
Temperature (°F)	64
pH	8.3
Specific conductance at 25°C (micromhos)	1,080

*Includes equivalent of 14 ppm of carbonate (CO_3).

Saint Charles, Buffalo Creek Mine

Ownership: United Electric Coal Co.
Source: Impounded stream, 8730-3710-B, 1 mile west of Saint Charles, Ky.
Treatment: None.
Total distribution of water for 1951: 43,600,000 gal.
Average daily pumpage, 1951: 119,000 gal.
Remarks: The water is used for washing coal and is recirculated. The figures given above represent water added to the system during the year. Average daily pumpage when operating is 218,000 gpd.

Saint Charles, Homestead Mine

Ownership: Homestead Coal Co.
Source: Two impounded streams, one 2-acre lake at mine and one 11-acre lake at Saint Charles, 8730-3710-A, 2.5 miles northeast of Saint Charles, Ky.
Treatment: None.
Total distribution of water for 1951: 131,000,000 gal.
Average daily pumpage, 1951: 358,000 gal.
Remarks: The water is used for washing coal and is recirculated. The figures given above represent water added to the system during the year. The average daily consumption when operating is 648,000 gal.

McLEAN COUNTY

Calhoun

Population served: 950.
Ownership: Municipal.
Source: Green River at foot of Branch Street.
Treatment: Coagulation with lime and alum; sedimentation and filtration to remove solids; chlorination to control bacteria. When required the water is passed over charcoal to remove objectionable odors and copper sulfate is added to control algae.
Storage: 40,000-gal elevated tank at Third and Poplar Streets.
Total distribution of water for 1951: 18,000,000 gal.
Average daily pumpage, 1951: 49,400 gal.
Remarks: Normal operation of this system entails pumping for 4 hours per day at 250 gpm. There are no large industrial users of water in the town.

Livermore

Population served: 1,650.
Ownership: Municipal.
Source: Green River at mouth of the Rough River.
Treatment: Coagulation with lime and alum; settling and filtration to remove solids; chlorination to control bacteria.
Storage: 116,000-gal elevated tank on hill in southwest part of town.
Total distribution of water for 1951: 27,600,000 gal.
Average daily pumpage, 1951: 76,000 gal.
Remarks: At the present time there are no large industrial consumers of water in the town.

MUHLENBERG COUNTY

Central City

Population served: 4,300.
Ownership: Municipal.
Source: Green River north of Central City, Ky.
Treatment: Coagulation with lime and alum; settling and filtration to remove solids; chlorination to control bacteria.
Rated capacity of treatment plant: 864,000 gpd.
Storage: 180,000-gal reservoir on Reservoir Hill.
Total distribution for 1951: 240,000,000 gal (metered).
Average daily pumpage, 1951: 658,000 gal.
Breakdown of annual distribution as to use:
Domestic ..... 120,000,000 to 140,000,000 gal
Industrial and commercial ..... 100,000,000 to 140,000,000 gal
Remarks: The largest consumer is the railroad which accounts for the greatest part of the industrial consumption. Figures are not exact because some of the consumers are on flat rates.

Drakesboro

Population served: 1,010.
Ownership: Municipal.
Source: Two wells, 0.7 mile southwest of the city limits at the foot of cemetery hill.
Well 8700-3710-1. Depth, 150 feet; diameter, 6 inches; date drilled, 1948; water-bearing formation, Lisman; static water level (reported), 10 feet below land surface; yield (reported), 250 gpm.
Well 8700-3710-2. Depth, 150 feet; diameter, 6 inches; date drilled, 1948; water-bearing formation, Lisman; static water level (reported), 10 feet below land surface; yield (reported), 250 gpm.
Treatment: Chlorination to control bacteria.
Storage: 55,000-gal elevated tank on west side of Kentucky Highway 75 at the south city limits.
Total distribution of water for 1951: 17,280,000 gal.
Average daily pumpage, 1951: 47,000 gal.
Remarks: Each of the wells was reported pumped at 200 gpm for a period of 1 week.

Analysis, in parts per million, well 8700-3710-1

(Collected Dec. 12, 1951)

Silica (SiO_2)	23
Iron (Fe)	.25
Manganese (Mn)	.04
Calcium (Ca)	48
Magnesium (Mg)	28
Sodium (Na)	69
Potassium (K)	2.2
Bicarbonate (HCO_3)	318
Sulfate (SO_4)	111
Chloride (Cl)	3.0
Fluoride (F)	.2
Nitrate (NO_3)	3.0
Dissolved solids	438
Hardness as $CaCO_3$	
Total	236
Noncarbonate	0
Temperature (°F)	57
pH	7.5
Specific conductance at 25°C (micromhos)	695

Drakesboro, Kirks Mine

Ownership: Kirk Coal Mining Co.
Source: Impounded stream at mine, 8700-3715-A, 3 miles northeast of Drakesboro, Ky.
Treatment: None.
Total distribution of water for 1951: 12,800,000 gal.
Average daily pumpage, 1951: 35,000 gal.
Remarks: This water is used for washing coal and is recirculated. The figure above represents water consumed during the year.

Earles, Brier Creek Mine

Ownership: Crescent Coal Co.
Source: Impounded stream at mine, 8715-3715-A, 2 miles northeast of Earles, Ky.
Treatment: None.
Total distribution of water for 1951: 59,000,000 gal (estimated on the basis of pump capacities and operating time).
Average daily pumpage, 1951: 162,000 gal.
Remarks: This water is used for washing coal and is recirculated. The figures given above represent water added to the system during the year.

Earles, Vogue Mine

Ownership: Terteling Bros., Inc.
Source: Impounded stream at mine, 8720-3715-C, 3.5 miles west of Earles, Ky.
Treatment: None.
Total distribution of water for 1951: 14,000,000 gal.
Average daily pumpage, 1951: 38,400 gal.
Remarks: This water is used for washing coal and is recirculated. The figure above represents the amount of water consumed annually.

Graham

Population served: 420 (approximate).
Ownership: W. G. Duncan Coal Co.
Source: Impounded stream, one lake at Graham and another at Luzerne, Ky., 8715-3710-A.
Treatment: Aeration to cool; chlorination to control bacteria.
Storage: 80,000 gal.
Total distribution of water for 1951: 43,000,000 gal.
Average daily pumpage, 1951: 118,000 gal.
Breakdown of annual distribution as to use:
Domestic ..... 26,000,000 gal
Industrial and commercial ..... 17,000,000 gal
Remarks: The coal washer consumes 17,000,000 gal annually and the water is recirculated.

Greenville

Population served: 4,000.
Ownership: Kentucky Water Service Co.
Source: Three lakes (impounded streams) at Greenville and an emergency line to the Duncan Coal Co. in Luzerne, Ky.
Treatment: Chlorination to control bacteria.
Rated capacity of treatment plant: 400,000 gpd.
Storage: 80,000-gal elevated tank at Campbell and Cherry Streets.
Total distribution of water for 1951: 80,000,000 gal.
Average daily pumpage, 1951: 219,000 gal.
Remarks: During the summer of 1952 the supply was not adequate.

Greenville, Caney Creek Mine

Ownership: Kirkpatrick Mining Co.
Source: Impounded stream at mine, 8705-3710-A, 4 miles east of Greenville, Ky.
Treatment: None.
Total distribution of water for 1951: 52,500,000 gal.
Average daily pumpage, 1951: 144,000 gal.
Remarks: This water is used for washing coal and is recirculated. Figures above represent water added to the system during the year.

Luzerne, Skibo Mine

Ownership: W. G. Duncan Coal Co.
Source: Impounded stream at Luzerne, Ky, 8710-3710-A.
Treatment: None.
Total distribution of water for 1951: 129,000,000 gal.
Average daily pumpage, 1951: 353,000 gal.
Remarks: This water is used for washing coal and is recirculated. The figure above represents water consumed.

South Carrollton, Kentucky Utilities Co.

Ownership: Kentucky Utilities Co.
Source: Green River near Moorman, Ky.
Treatment: Water used for boiler and drinking. Coagulation with lime and alum; filtration to remove solids; chlorination to control bacteria. The water used for cooling is untreated.
Remarks: This water is used in the production of electric power from coal.

OHIO COUNTY

Beaver Dam

Population served: 2,000.
Ownership: Municipal.
Source: Five wells, in and near town.
Well 8650-3720-7 (owner's number 4), on the north side of East Third Street between Main Street and Broadway. Depth, 255 feet; diameter, 6 inches; date drilled, March 1948; water-bearing formation, Tradewater (?); static water level, 120 feet below land surface, April 1948; yield (reported), 27 gpm.
Well 8650-3720-9 (owner's number 1) 80 feet west of Main Street between First and Second Streets. Depth, 238 feet; diameter, 6 inches; date drilled, 1925; water-bearing formation, Tradewater (?); static water level, 82 feet below land surface, June 1945; yield (reported), 30 gpm.
Well 8650-3720-10 (owner's number 2), about 35 feet northwest of well 8650-3720-9. Depth,526 feet; diameter, 8.25 inches to 6.25 inches; water-bearing formation, Tradewater (?); static water level, 82 feet below land surface, June 1945; yield (reported), 20 gpm, 1936.
Well 8650-3720-13 (owner's number 3), about 500 feet southeast of the corner of South Third and Main Streets. Depth, 325 feet; diameter, 8.25 inches; water-bearing formation, Tradewater (?); static water level, 80 feet below land surface, June 1945; yield (reported), 50 gpm.
Well 8650-3720-20 (owner's number 7), about 3,000 feet east of city limits and 100 feet north of railroad tracks. Depth, 230 feet; diameter, 5.6 inches; date drilled, April 1952; water-bearing formation, Tradewater (?); static water level, 80 feet below land surface, April 1952; yield (reported), 20 gpm.
Treatment: Chlorination to control bacteria.
Storage: 75,000-gal elevated tank on west side of U. S. Highway 231 at its intersection with Kentucky Highway 273.
Total distribution of water for 1950: 29,458,000 gal (metered).
Average daily pumpage, 1950: 81,000 gal.
Remarks: There has been some trouble with declining water levels in this area. Additional data in files of the U. S. Geological Survey.

Log of well 8650-3720-10

Material	Thickness (feet)	Depth (feet)
Soil	27	27
Shale, black	18	45
Coal	1	46
Shale, black	3	49
Lime	1	50
Shale, lime	44	94
Lime	3	97
Shale, gray	15	112
Lime, black	5	117
Shale, black	3	120
Shale, gray	30	150
Shale, blue	30	180
Sand, water	60	240
Shale, reddish, 4 in. of coal at 245	12	252
Sand	4	256
Shale and sand	33	289
Lime	7	296
Shale	59	355
Shale, blue	10	365
Shale, black	19	384
Shale	56	440
Lime	3	443
Shale, black	25	468
Lime	8	476
Sand, white, broken	50	526

Log of well 8650-3720-20

Material	Thickness (feet)	Depth (feet)
Earth	35	35
Soapstone	16	51
Lime, black	2	53
Soapstone	1	54
Lime, gray	3	57
Shale, sandy	2	59
Soapstone	9	68
Lime, gray	3	71
Soapstone	15	86
Lime, sandy	3	89
Soapstone	1	90
Lime, sandy	7	97
Soapstone	25	122
Shale, black	9	131
Soapstone	17	148
Sand, white	40	188
Lime, coarse	6	194
Sand, white	36	230

Analysis, in parts per million, well 8650-3720-7

(Collected Dec. 12, 1951)

Silica (SiO_2)	17
Iron (Fe)	.09
Manganese (Mn)	.00
Calcium (Ca)	23
Magnesium (Mg)	16
Sodium (Na)	271
Potassium (K)	1.5
Bicarbonate (HCO_3)*	526
Sulfate (SO_4)	191
Chloride (Cl)	59
Fluoride (F)	1.5
Nitrate (NO_3)	.3
Dissolved solids	845
Hardness as $CaCO_3$	
Total	122
Noncarbonate	0
Temperature (°F)	58
pH	8.3
Specific conductance at 25°C (micromhos)	1,330

*Includes equivalent of 6 ppm of carbonate (CO_3).

Centertown, Alston Mine

Ownership: Alston Coal Co.
Source: Impounded stream at mine 70 percent, Rough River 30 percent near mine, 8655-3725-A, 1 mile north of Centertown, Ky.
Treatment: None.
Total distribution of water for 1951: 16,650,000 gal.
Average daily pumpage, 1951: 46,000 gal.
Remarks: The water is used for washing coal and is recirculated. The figure given above represents water added to the system during the year.

Dundee, Dundee Oil Pool

Ownership: Sohio Petroleum Co.
Source: One well, in the Dundee oil pool on north bank of Rough River, 600 feet east of Kentucky Highway 69.
Well 8645-3730-1. Depth, 60 feet; diameter, 8 inches; water-bearing formation, alluvium; yield, 20 gpm
Treatment: None.
Total distribution of water for 1952: 7,670,000 gal (metered).
Average daily pumpage, 1952: 21,000 gal.
Remarks: This water is used for the secondary recovery of petroleum by water flooding.

Analysis, in parts per million, well 8645-3730-1

(Collected Sept. 5, 1952)

Silica (SiO_2)	13
Iron (Fe)	7.3
Manganese (Mn)	.13
Calcium (Ca)	52
Magnesium (Mg)	11
Sodium (Na)	64
Potassium (K)	1.8
Bicarbonate (HCO_3)	232
Sulfate (SO_4)	1.5
Chloride (Cl)	84
Fluoride (F)	.5
Nitrate (NO_3)	.2
Dissolved solids	350
Hardness as $CaCO_3$	
Total	174
Noncarbonate	0
Temperature (°F)	58
pH	6.4
Specific conductance at 25°C (micromhos)	654

Hartford

Population served: 2,200.
Ownership: Municipal.
Source: Rough River about 100 feet downstream from U. S. Highway 231.
Treatment: Coagulation and softening with lime and alum; filtration to remove solids; chlorination to control bacteria. Copper sulfate is added during part of the year to control algae.
Rated capacity of treatment plant: 504,000 gal.
Storage: 75,000-gal elevated tank on west side of Frederica Street between Griffin and Clay Streets, and 15,000-gal clear well at treatment plant.
Total distribution of water for 1951: 33,934,000 gal (metered).
Breakdown of annual distribution as to use:

Domestic	22,835,000 gal
Industrial and commercial	8,244,000 gal
Other public use, leakage, and waste	2,855,000 gal

Average daily pumpage, 1951: 93,000 gal.
Remarks: It is reported that a well was drilled in the town of Hartford, Ky., before the present surface supply was developed. The well did not furnish enough water to supply the town and was abandoned.

Hartford, Weller Oil Pool

Ownership: Felmont Oil Corp.
Source: Rough River 6.5 miles northeast of Hartford, Ky., in the Weller oil pool, 8650-3730-B.
Treatment: Alum and Calgon added; filtration to remove solids; chlorination to control bacteria.
Total distribution of water for 1952: 92,000,000 gal (metered).
Average daily pumpage, 1952: 252,000 gal.
Remarks: The water is used for the secondary recovery of petroleum by water flooding. On the consumption map, this supply has been combined with that of the Sohio Petroleum Co. in the same pool.

Hartford, Weller Oil Pool

Ownership: Sohio Petroleum Co.
Source: Rough River 6.5 miles northeast of Hartford, Ky., in Weller oil pool, 8650-3730-A.
Treatment: None.
Total distribution of water for 1952: 38,400,000 gal (metered).
Average daily pumpage, 1952: 105,000 gal.
Remarks: This water is used for the secondary recovery of petroleum by water flooding. On the consumption map this supply is combined with that of the Felmont Oil Corp. in the same pool.

Haynesville, Haynesville Oil Pool

Ownership: Cumberland and Kemrow Petroleum Cos.
Source: Impounded stream, 8645-3740-A.
Treatment: Coagulation with lime and alum; filtration to remove solids.
Total distribution of water for 1951: 7,670,000 gal (metered).
Average daily pumpage, 1951: 21,000 gal.
Remarks: This water is used for the secondary recovery of oil by water flooding. During the summer of 1952, the supply of water failed and injection ceased during the drought.

Haynesville, Herbert Oil Pool

Ownership: F. M. Ashby.
Source: Five wells, 3.5 miles northeast of Haynesville, Ky.
Wells 8645-3740-2 through 6. Depth (reported), 185 feet; diameter, 6 inches; date drilled, 1950; water-bearing formation, Tradewater (?). No detailed data are available for these wells.
Treatment: Tetraphosphate, Calgon, and copper chloride.
Total distribution of water for 1951: 4,390,000 gal (metered).
Average daily pumpage, 1951: 12,000 gal.
Remarks: The water is used for the secondary recovery of petroleum by water flooding.

Horse Branch

Ownership: Illinois Central System.
Source: Two wells, at the railroad intersection in Horse Branch, Ky.
Well 8640-3725-1. Depth, 360 feet; diameter, 6 inches; date drilled, 1951; water-bearing formation, Caseyville sandstone; static water level, flowing 1951.
Well 8640-3725-2. Depth, 360 feet; diameter, 6 inches; date drilled, 1951; water-bearing formation, Caseyville sandstone; static water level, flowing January 18, 1952.
Treatment: The water is hardened for locomotive use.
Storage: 100,000-gal elevated tank at the wells.
Total distribution of water for 1951: 5,800,000 gal.
Average daily pumpage, 1951: 16,000 gal.
Remarks: The water is used for boiler feed for the railroad. Well 8640-3725-1 is reported to have flowed at the rate of 55 gpm. When one well is pumped, the other stops flowing. Maximum yields are reported to be about 200 gpm.

Log of well 8640-3725-1

Material	Thickness (feet)	Depth (feet)
Earth	30	30
Slate, blue	28	58
Sandstone, yellow	152	210
Limestone, gray	25	235
Soapstone	10	245
Sandstone, white, water	20	265

Analysis, in parts per million, well 8640-3725-2

(Collected Jan. 18, 1952)

Silica (SiO_2)	10
Iron (Fe)	.11
Manganese (Mn)	.00
Calcium (Ca)	.8
Magnesium (Mg)	.2
Sodium (Na)	245
Potassium (K)	1.0
Bicarbonate (HCO_3)*	606
Sulfate (SO_4)	2.7
Chloride (Cl)	30
Fluoride (F)	1.2
Nitrate (NO_3)	1.1
Dissolved solids	590
Hardness as $CaCO_3$	
Total	3
Noncarbonate	0
Temperature (°F)	58
pH	8.7
Specific conductance at 25°C (micromhos)	973

*Includes equivalent of 18 ppm carbonate (CO_3).

Oaks, Oaks Oil Pool

Ownership: Cumberland Petroleum Co.
Source: Impounded stream, 8640-3735-B, 2 miles east of Fordsville, Ky.
Treatment: Lime, alum, and Calgon added; filtration to remove solids; chlorination to control bacteria.
Total distribution of water for 1952: 7,660,000 gal (metered).
Average daily pumpage, 1952: 21,000 gal.
Remarks: The rate of use is expected to increase to 30,640,000 gal per year. On the consumption map this secondary recovery project is combined with that of the Felmont Oil Corp. in the same pool.

Oaks, Oaks Oil Pool

Ownership: Felmont Oil Corp.
Source: Impounded stream, 8640-3735-A, 2 miles east of Fordsville, Ky.
Treatment: Lime, alum, and Calgon added; filtration to remove solids.
Total distribution of water for 1952: 13,000,000 gal (metered).
Average daily pumpage, 1952: 35,600 gal.
Remarks: This water is used for the secondary recovery of petroleum. On the consumption map this supply is combined with the Cumberland Petroleum Co. project in the same pool.

Rockport

Population served: 385 (approximate).
Ownership: Municipal.
Source: Green River at Rockport, Ky., between the railroad and highway bridges.
Treatment: Coagulation with alum and lime; sedimentation and filtration to remove solids; chlorination to control bacteria.
Storage: 50,000-gal standpipe on hill in center of town.
Total distribution of water for 1951: 8,400,000 gal.
Average daily pumpage, 1951: 23,000 gal.
Remarks: There is no large industrial consumer of water in this town so most of the water is used for domestic purposes.

Rockport, Ken Mine

Ownership: Ken Coal Co.
Source: Impounded stream at mine, 8655-3715-A, 4 miles southeast of Rockport, Ky.
Treatment: None.
Total distribution of water for 1951: 30,000,000 gal.
Average daily pumpage, 1951: 82,000 gal.
Remarks: The water is used for washing coal and is recirculated. Figures given above represent water added to the system during the year.

Sunnydale, Sunnydale Oil Pool

Ownership: Sohio Petroleum Co.
Source: Three wells, about 1 mile north of Sunnydale, Ky., on west side of road on J. C. Smith lease, and one well on east side of road on Mark Renfro lease.
Well 8645-3730-2 (owner's number 1). Depth, 100 feet; diameter, 6 inches; water-bearing formation, alluvium; yield,(reported), 14 gpm.
Well 8645-3730-3 (owner's number 2). Depth, 90 feet; diameter, 6 inches; water-bearing formation, alluvium; yield (reported), 14 gpm.
Well 8645-3730-4 (owner's number 3). Depth, 90 feet; diameter, 6 inches; water-bearing formation, alluvium; yield (reported), 14 gpm.
Well 8645-3730-7 (owner's number S7), Depth, 100 feet; diameter, 8 inches; date drilled, 1952; water-bearing formation, alluvium; static water level (reported), 20 feet below land surface.
Treatment: Filtered as a precautionary measure.
Total distribution of water for 1952: 23,000,000 gal (metered).
Average daily pumpage, 1952: 63,000 gal.
Remarks: This water is used for the secondary recovery of petroleum by water flooding, The water supply is not as great as is desired. Several wells have been drilled into the consolidated Pennsylvanian rocks, but none of these have produced the desired amounts of water.

Analysis, in parts per million, well 8645-3730-2

(Collected Sept. 5, 1952)

Silica (SiO_2)	17
Iron (Fe)	21
Manganese (Mn)	.26
Calcium (Ca)	58
Magnesium (Mg)	13
Sodium (Na)	63
Potassium (K)	1.5
Bicarbonate (HCO_3)	346
Sulfate (SO_4)	3.1
Chloride (Cl)	36
Fluoride (F)	.3
Nitrate (NO_3)	.1
Dissolved solids	365
Hardness as $CaCO_3$	
Total	196
Noncarbonate	0
Temperature (°F)	60
pH	6.4
Specific conductance at 25°C (micromhos)	671

UNION COUNTY

Morganfield

Population served: 4,500.
Ownership: Municipal.
Source: Ohio River north of Uniontown, Ky.
Treatment: Coagulation with lime and alum; softening with soda ash; filtration to remove solids; chlorination to control bacteria; carbon added when needed to remove objectionable odors and tastes.
Storage: 500,000-gal clear well and 50,000-gal standpipe at West Spaulding and South Townsend Streets.
Total distribution of water for 1951: 84,000,000 gal.
Average daily pumpage, 1951: 230,000 gal.
Remarks: There are no large industrial consumers of water in this town.

Sturgis

Population served: 2,500 (approximate).
Ownership: Municipal.
Source: Tradewater River about 1 mile below the confluence of Cypress Creek.
Treatment: Coagulation with lime and alum; softening with soda ash; sedimentation and filtration to remove solids; chlorination to control bacteria. Carbon and copper sulfate are added when needed to combat tastes, odors, and algae.
Rated capacity of treatment plant: 1,008,000 gpd.
Storage: 75,000-gal standpipe at Fourth and Main Streets, and 40,000-gal standpipe at extension of 13th and Johnson Streets.
Total distribution of water for 1951: 51,600,000 gal (metered).
Average daily pumpage, 1951: 142,000 gal.
Breakdown of annual distribution as to use:

Domestic	36,800,000 gal
Industrial and commercial	7,200,000 gal
Other public use, leakage, and waste	7,600,000 gal

Remarks: Iron from coal mine wastes is excessive when the Ohio is at pool stage.

Uniontown

Population served: 763 (approximate).
Ownership: Municipal.
Source: Ohio River.
Treatment: Coagulation with lime and alum; sedimentation and filtration to remove solids; chlorination to control bacteria; addition of charcoal when needed to remove offensive tastes and odors.
Rated capacity of treatment plant: 60,000 gpd.
Storage: 100,000-gal elevated tank at railroad and Kentucky Highway 130.
Total distribution of water for 1951: 20,000,000 gal.
Average daily pumpage, 1951: 55,000 gal.
Remarks: Total pumpage is not known and is not metered. There is no industry which consumes large amounts of water, thus the consumption is almost completely domestic.

Uniontown, Uniontown Oil Pool

Ownership: Sun Oil Co.
Source: One well, 8755-3745-2. Depth, 1,550 feet; diameter, 7 inches; date drilled, 1951; water-bearing formation, Caseyville sandstone; static water level, 30 feet below land surface; yield, 24 gpm.
Treatment: None.
Total distribution of water for 1952: 12,300,000 gal (metered).
Average daily pumpage, 1952: 33,600 gal.
Remarks: This water is a brine and is used for the secondary recovery of petroleum. Pumping level is 550 feet below land surface.

Analysis, in parts per million, well 8755-3745-2

(Collected Sept. 4, 1951)

Silica (SiO_2)	14
Iron (Fe)	16
Manganese (Mn)	.3
Calcium (Ca)	1,360
Magnesium (Mg)	60
Bicarbonate (HCO_3)	176
Sulfate (SO_4)	2,740
Chloride (Cl)	15,350
Temperature (°F)	76

Analyzed by Bradford Laboratories, Evansville, Ind., for Sun Oil Co.

Uniontown, Uniontown Oil Pool

Ownership: Sun Oil Co., Ashland Oil and Refining Co., and Carter Oil Co.
Source: Produced water.
Treatment: None.
Total distribution of water for 1952: 6,130,000 gal (metered).
Average daily pumpage, 1952: 16,800 gal.
Remarks: The water is produced with oil from the Tar Springs sandstone and injected into the Waltersburg sandstone for the secondary recovery of oil.

Waverly, Saint Vincent Oil Pool

Ownership: Sohio Petroleum Co.
Source: One well, on the C. M. Hancock lease, 2.5 miles north of Waverly, Ky.
Well 8750-3740-11. Depth, 230 feet; diameter, 7 inches; water-bearing formation, Lisman; yield (reported), 13 gpm.
Treatment: None.
Total distribution of water for 1952: 6,440,000 gal (metered).
Average daily pumpage, 1952: 17,600 gal.
Remarks: This water is used for the secondary recovery of petroleum.

WEBSTER COUNTY

Clay

Population served: 1,600.
Ownership: Municipal.
Source: Three wells, two near the intersection of the Louisville & Nashville Railroad Co., and the Illinois Central System railroad tracks and one at the south city limits and the Louisville & Nashville Railroad Co. tracks.
Well 8745-3725-1 (owner's number 2), at the railroad intersection. Depth, 102 feet; diameter, 8 inches; date drilled, 1931; water-bearing formation, Lisman; yield (reported), 35 to 40 gpm.
Well 8745-3725-2 (owner's second number 4), at the railroad intersection. Depth, 150 feet; diameter, 8 inches; date drilled, 1948; water-bearing formation, Lisman; static water level (reported), 6 feet below land surface, 1948; yield (reported), 50 gpm.
Well 8745-3725-3 (owner's number 5), at the city limits. Depth, 112 feet; diameter, 8 inches; date drilled, 1950; water-bearing formation, Lisman; static water level (reported), 7 feet below land surface; yield (reported), 75 gpm.
Treatment: Chlorination to control bacteria; filtration to remove solids; zeolite softening.
Rated capacity of treatment plant: 150,000 gpd.
Storage: 40,000-gal clear well at treatment plant, and 55,000-gal elevated tank at the intersection of Kentucky Highway 85 and Illinois Central System railroad tracks.
Total distribution of water for 1951: 22,500,000 gal.
Average daily pumpage, 1951: 62,000 gal.
Remarks: Two dry holes have been drilled and three other wells have been abandoned. Three are still in use. These wells are reported to lie in or near a faulted zone.

Analysis, in parts per million, well 8745-3725-1

(Collected Dec. 3, 1952)

Iron (Fe)	2.0
Bicarbonate (HCO_3)	358
Sulfate (SO_4)	124
Chloride (Cl)	39
Fluoride (F)	.1
Nitrate (NO_3)	.8
Phosphate (PO_4)	.00
Hardness as $CaCO_3$	
Total	398
Noncarbonate	-
Temperature (°F)	58
Specific conductance at 25°C (micromhos)	906

Analysis, in parts per million, well 8745-3725-3

(Collected Nov. 14, 1951)

Silica (SiO_2)	29
Iron (Fe)	.42
Manganese (Mn)	.00
Calcium (Ca)	38
Magnesium (Mg)	15
Sodium (Na)	99
Potassium (K)	1.8
Bicarbonate (HCO_3)	370
Sulfate (SO_4)	22
Chloride (Cl)	42
Fluoride (F)	.2
Nitrate (NO_3)	.1
Dissolved solids	419
Hardness as $CaCO_3$	
Total	156
Noncarbonate	0
Temperature (°F)	58
pH	7.3
Specific conductance at 25°C (micromhos)	705

Analysis, in parts per million, well 8745-3725-3

(Collected Dec. 3, 1952)

Iron (Fe)	0.51
Bicarbonate (HCO_3)	386
Sulfate (SO_4)	30
Chloride (Cl)	44
Fluoride (F)	.2
Nitrate (NO_3)	.0
Phosphate (PO_4)	.00
Hardness as $CaCO_3$	
Total	186
Noncarbonate	-
Temperature (°F)	58
Specific conductance at 25°C (micromhos)	796

Dixon

Population served: 600.
Ownership: Municipal.
Source: Three wells, 0.2 mile west of city limits on Free Union Road.
Well 8740-3730-1. Depth, 45 feet; diameter, 6 inches; date drilled, 1938; water-bearing formation, Henshaw; yield 20 gpm.
Well 8740-3730-2. Depth, 55 feet; diameter, 6 inches; date drilled, 1928; water-bearing formation, Henshaw; yield, 21 gpm.
Well 8730-3730-15. Depth, 75 feet; diameter, 8 inches; date drilled, August 1951; water-bearing formation, Henshaw; static water level, 24 feet below land surface (reported), August 1951; yield, 13 gpm.
Treatment: Chlorination to control bacteria; filtration to remove solids.
Capacity of treatment plant: 24,000 gpd.
Storage: 50,000-gal elevated tank across street from courthouse square on southeast side.
Total distribution of water for 1951: 5,400,000 gal.
Average daily pumpage, 1951: 14,700 gal.
Remarks: During the summer of 1951, there was a shortage of water. This was relieved in the month of August when a third well was placed in use. The pump was set at 57 feet. After 6 weeks of pumping the water level had lowered to 57 feet, and the pump was reset at 68 feet.

Analysis, in parts per million, wells 8740-3730-1 and 2

(Collected Nov. 14, 1951)

Silica (SiO_2)	31
Iron (Fe)	2.0
Manganese (Mn)	.00
Calcium (Ca)	115
Magnesium (Mg)	67
Sodium (Na)	47
Potassium (K)	9.0
Bicarbonate (HCO_3)	442
Sulfate (SO_4)	272
Chloride (Cl)	16
Fluoride (F)	.1
Nitrate (NO_3)	1.3
Dissolved solids	790
Hardness as $CaCO_3$	
Total	564
Noncarbonate	200
Temperature (°F)	57
pH	6.9
Specific conductance at 25°C (micromhos)	1,060

Providence

Population served: 3,934.
Ownership: Municipal.
Source: Tradewater River, 8745-3720-B.
Treatment: Chlorination to control bacteria; sedimentation and filtration to remove solids; addition of lime and soda ash for softening and carbon to remove odors and tastes; postchlorination to control bacteria.
Rated capacity of treatment plant: 1,500,000 gpd.
Storage: 535,000-gal tank at head of Cemetary Street in northeast part of town.
Total distribution of water for 1951: 100,000,000 gal.
Breakdown of annual distribution as to use:

Domestic	95,000,000 gal
Industrial and commercial	4,700,000 gal
Other public uses	150,000 gal
Leakage and waste	150,000 gal

Average daily pumpage, 1951: 274,000 gal.

Providence, Precision Mine

Ownership: Hart and Hart Coal Co.
Source: Two impounded streams with a combined size of 5 1/2 acres, 8745-3720-A.
Treatment: None.
Total distribution of water for 1951: 5,000,000 gal.
Average daily pumpage, 1951: 13,700 gal.
Remarks: This water is used for washing coal and is recirculated in a heavy media plant. The consumption figures given above represent water added to the system during the year.

Sebree

Population served: 1,100.
Ownership: Municipal.
Source: Two wells, 1,000 feet south of the city limits on west side of Louisville & Nashville Railroad tracks.
Well 8730-3735-1. Depth, 325 feet; diameter, 10 inches; date drilled, 1935; water bearing formation, Caseyville sandstone (?); static water level (reported), 20 feet below land surface; yield (reported), 125 gpm.
Well 8730-3735-2. Depth, 325 feet; diameter, 10 inches; date drilled, 1935; water-bearing formation, Caseyville sandstone (?); yield (reported), 125 gpm.
Treatment: Chlorination to control bacteria.
Storage: 100,000-gal elevated tank on hill in west part of town.
Total distribution of water for 1951: 11,400,000 gal.
Average daily pumpage, 1951: 31,400 gal.
Remarks: These wells are in or very close to a fault zone. In the past several years there has been reported an increase in iron content of the water.

Analysis, in parts per million, well 8730-3735-1

(Collected July 31, 1950)

Silica (SiO_2)	36
Iron (Fe)	5.0
Manganese (Mn)	-
Calcium (Ca)	52
Magnesium (Mg)	11
Sodium (Na) + Potassium (K)	17
Bicarbonate (HCO_3)	182
Sulfate (SO_4)	43
Chloride (Cl)	12
Fluoride (F)	.0
Nitrate (NO_3)	.3
Dissolved solids	264
Hardness as $CaCO_3$	
Total	175
Noncarbonate	26
Temperature (°F)	60
pH	7.1
Specific conductance at 25°C (micromhos)	395

Analysis, in parts per million, well 8730-3735-2

(Collected Dec. 3, 1952)

Iron (Fe)	7.2
Bicarbonate (HCO_3)	196
Sulfate (SO_4)	36
Chloride (Cl)	19
Fluoride (F)	.0
Nitrate (NO_3)	.0
Phosphate (PO_4)	.00
Hardness as $CaCO_3$	
Total	186
Noncarbonate	-
Temperature (°F)	53
Specific conductance at 25°C (micromhos)	470

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