Water Resource Report 39

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SUMMARY GROUND-WATER RESOURCES OF BEAVER COUNTY, PENNSYLVANIA

Charles W. Poth

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF
TOPOGRAPHIC AND GEOLOGIC SURVEY
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SUMMARY GROUND-WATER RESOURCES OF BEAVER COUNTY, PENNSYLVANIA

by Charles W. Poth
U. S. Geological Survey

Prepared by the United States Geological Survey, Water Resources Division, in cooperation with the Pennsylvania Geological Survey

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PREFACE

This report is presented as a comprehensive description and inventory of the ground-water resources available in Beaver County. With the continuing growth of our population and the expansion of our industries, there is an ever increasing rise in demand for quality water resources. Ground water, or subsurface water, constitutes one of the largest reserves of quality water remaining to be developed.

This report can be of assistance to anyone who is planning for future water needs. It will help to evaluate the quantity and quality of ground water available in any part of the county, and it will aid in choosing the locations, depths and conditions most favorable for the desired ground-water yield.

While this publication has attempted to include all available ground-water data for the county, the Pennsylvania Topographic and Geologic Survey will continue to collect ground-water and water-well data for the area; such data will be kept on open file at the Survey offices in Harrisburg, available to anyone who desires the very latest information.

We hope that this report will aid users of water in Beaver County to develop and manage their water resources so as to accommodate their water needs.

ARTHUR A. SOCOLOW

CONTENTS

ILLUSTRATIONS

FIGURES

PLATE

TABLES

SUMMARY GROUND-WATER RESOURCES OF BEAVER COUNTY, PENNSYLVANIA

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ABSTRACT

The geologic units in Beaver County include the Pennsylvanian Monongahela, Conemaugh, Allegheny and Pottsville Groups and unconsolidated Quaternary deposits. Ground water occurs largely in the unconsolidated Quaternary alluvial deposits that are present as terraces and modern flood plains along the major streams of the county. Yields of over 1000 gpm have been reported from wells drilled in these alluvial deposits.

Small supplies of water are also available in the bedrock, but the water is generally of poor quality. The Monongahela Group is not important as a water-bearing unit, but the Conemaugh Group is present throughout the county, and has yields of less than 1 to 100 gpm. About half of the wells in the Conemaugh Group yield 5 gpm or more. The Allegheny Group crops out in the stream valleys in the northern half of the county and along the major stream valleys in the rest of the county. The Allegheny Group is capable of supplying moderate amounts of water; about half of the wells in the group yield more than 15 gpm. The Pottsville Group crops out only in the northern part of the valleys of the Beaver River and Connoquenessing Creek. Reported yields of wells in the Pottsville range from 6 to 60 and average about 30 gpm.

Chemical analyses of 32 samples of well water showed that most of the samples were of acceptable quality. The water is generally high in iron, and much of the bedrock below several hundred feet may contain salt water.

There is no known overdraft of ground water anywhere in the county, except in the vicinity of active mines, where the water table is being lowered to facilitate mining.

The locations of sources of pollution, such as sanitary landfills and septic tanks, are a major factor in the selection of well sites. The discharge from abandoned strip and deep mines is a major source of pollution. The hundreds of oil and gas wells that were abandoned and not properly plugged are another source of pollution. In many of these wells, salt water has moved up the boreholes and contaminated shallow freshwater aquifers.

INTRODUCTION

PURPOSE AND SCOPE

This report is part of a program to summarize the ground-water resources of Pennsylvania in a series of county reports that will be easy to read and suitable for widespread distribution. It contains a general description of the aquifers in the county, a geologic and well location map, and data on the depth and yield of wells and the chemical quality of ground water.

LOCATION AND GENERAL GEOGRAPHIC FEATURES

Beaver County encompasses an area of 441 square miles in west-central Pennsylvania (Figure 1). The county is bordered on the north by Lawrence County, on the east by Allegheny and Butler Counties, on the south by Washington County, and on the west by the State of Ohio. The city of Beaver, the county seat, is 35 miles northwest of Pittsburgh, and 237 miles west of Harrisburg.

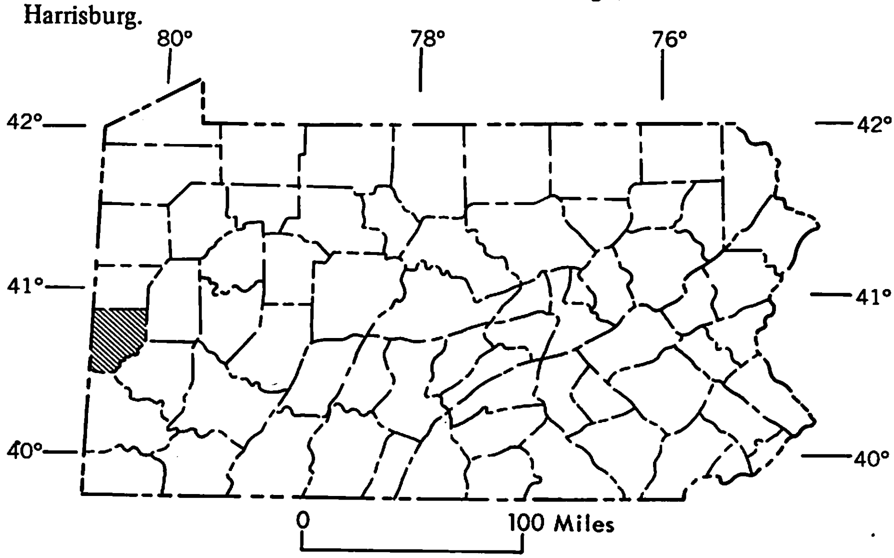


Figure 1. Location of Beaver County.

POPULATION TRENDS

The population of Beaver County has increased about 87 percent during the past 50 years. In the past decade the population increased by 0.7 percent. Table 1 shows the results of the decennial census from 1920 to 1970. The 1970 population density in the county was 473 persons per square mile.

Table 1. *Population of Beaver County, 1920-1970*

Year	Population
1920	111,620
1930	149,062
1940	156,754
1950	175,192
1960	206,948
1970	208,418

LANDFORMS

Beaver County is in the western part of the Appalachian Plateaus province. Its surface is characterized by rounded hills and steep-sided valleys. Flat upland surfaces are small and decrease in size and number southward. Flood plains are present along some of the rivers and streams, especially the Beaver and Ohio Rivers and Connoquenessing and Raccoon Creeks.

The highest land in the county is at an altitude of more than 1380 feet above mean sea level along the Ohio border, about 2¾ miles south of the lowest point in the county, which is on the Ohio River at an altitude of 680 feet. Much of the upland area lies between 1100 and 1200 feet above sea level.

LAND USE IN THE 1960'S

Data from the Beaver County Planning Commission show that about one-fourth of the land in the county is classified as developed land; that is, land used for residential, commercial, industrial, public and semipublic, and general services purposes. Slightly less than one-fourth is used for agriculture; about 2 percent for strip mining; the remaining land, slightly more than half, is classified as unused. Raccoon State Park is in the southwestern part of the county.

WHERE THE WATER COMES FROM

HYDROLOGIC CYCLE

Water is one of our most important resources, and it constitutes the major part of most living things. Man's existence depends upon it, yet water supplies are taken for granted by most individuals. As shown in Figure 2, water evaporates from the oceans and is carried as vapor until it condenses and falls. Most of the precipitation on the land is either used by vegetation, evaporates back to the atmosphere, or runs overland as streamflow. Part enters the soil and

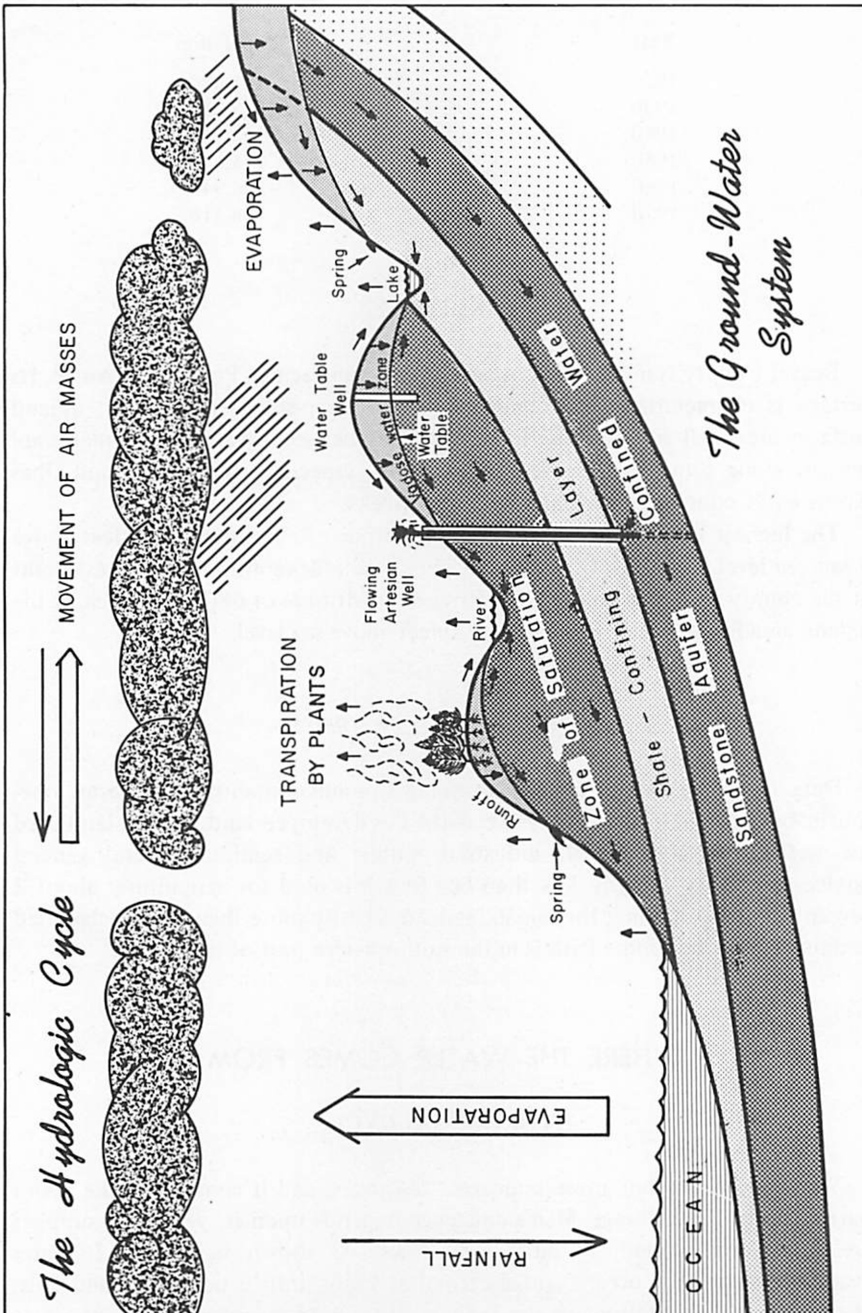


Figure 2. The hydrologic cycle.

bedrock to recharge water-bearing formations, called aquifers. The water moves at a varying pace, depending on its environment, but it eventually returns to the oceans.

If man interrupts or changes the hydrologic cycle, he may cause effects that last for many years.

PRECIPITATION

Precipitation is the source of all fresh water in the county. The average yearly precipitation from 1961 to 1970 was 34.14 inches at Beaver Falls and 33.94 inches at the Montgomery Lock and Dam (U.S. Department of Commerce, 1970). Not all the water in the streams is from precipitation on the county, as some streams carry runoff from areas outside the political boundaries.

Precipitation is distributed evenly throughout the year. The summer has a little more rainfall than the other seasons. Much of the summer rain falls during intense thunderstorms of short duration. About one-tenth of the total precipitation is snow.

WHERE THE WATER GOES

EVAPOTRANSPIRATION

Evapotranspiration is a collective term describing the return of water to the atmosphere as vapor. In the process of transpiration, soil moisture returns to the atmosphere as a by-product of plant growth. In the evaporation process, water changes directly from a liquid to a vapor. The total annual water loss from Beaver County by both evaporation and transpiration is about 20 inches.

Measurements of evaporation from a free water surface by the U.S. Weather Bureau at their station at Ford City, Armstrong County – the nearest station to Beaver County where such measurements have been made – show an average annual evaporation of 28 inches. The evaporation rate from a free water surface, however, is greater than the combined evapotranspiration rate from other surfaces. Direct measurements of transpiration have not been made.

STREAMFLOW

Most of the water not lost through evapotranspiration leaves the county as discharge from streams. This discharge accounts for about 14 inches of the annual precipitation on the area. The larger streams and the locations of gaging stations that measure streamflow in Beaver County are shown in Plate 1. Identification numbers are those assigned by the U.S. Geological Survey. A summary of discharge data for the gaging stations is given in Table 2. More detailed information on streamflow can be obtained from *Surface Water Records for Pennsylvania* published annually by the U.S. Geological Survey (1970).

GROUND WATER

Much of the precipitation on the land surface returns to the atmosphere or reaches the streams as overland runoff. Part infiltrates the soil and moves through fractures and other void spaces in the underlying rock. Its downward movement continues until it reaches the water table, below which all the interconnected voids are filled with water. This is illustrated in Figure 3. After reaching the saturated zone, the water moves downward and laterally toward lower altitudes and eventually returns to land surface, either from springs or from wells.

Ground water occurs under both water-table and artesian conditions. Water-table conditions are those in which ground water is unconfined and the upper surface of the water, or water table, is free to rise or fall. Artesian conditions exist where the ground water is confined in a permeable rock (having interconnected openings) that is overlain by a relatively impermeable rock. The upper surface is not free to rise or fall, but the water is under enough pressure to rise above the containing aquifer in wells that penetrate the aquifer. The imaginary surface to which water will rise in wells tapping an artesian aquifer is called the artesian or confined potentiometric surface.

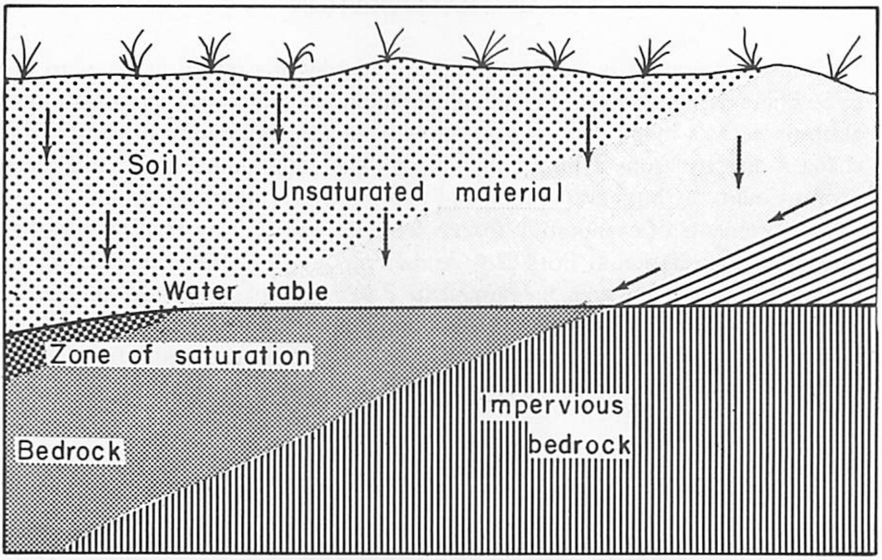
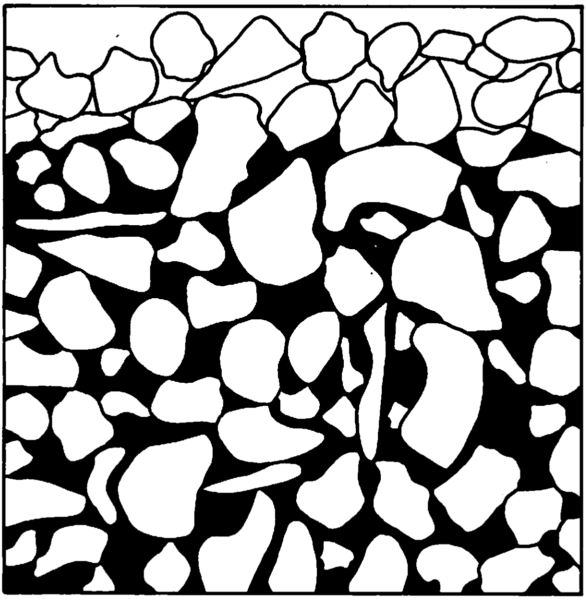


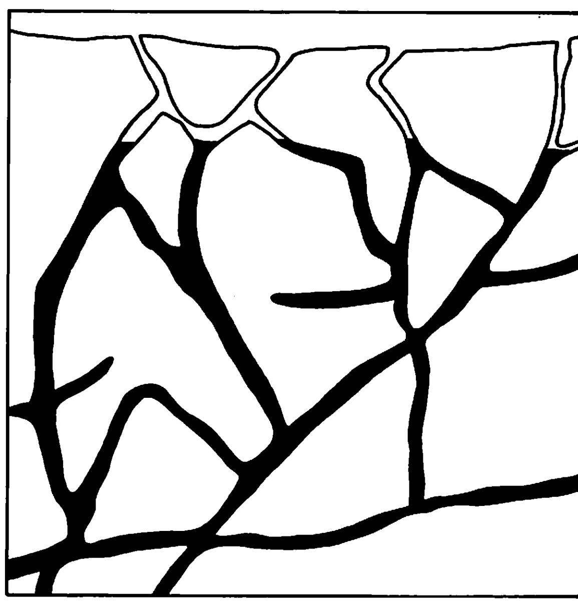
Figure 3. Downward movement of water through soil and rock to the water table.

Table 2. *Discharge Data for Gaged Streams*

Station number	Location	Period of record (years)	Average discharge (cfs)	Maximum discharge (cfs)	Date of maximum discharge	Minimum discharge (cfs)	Date of minimum discharge
3-1060	Connoquenessing Creek	1919 to present	458	23,000	June 29, 1924	6	July 21-23, 1936
3-1075	Beaver River	1956 to present	3188	69,900	Jan. 22, 1959	Not determined	---
3-1080	Raccoon Creek	1941 to present	182	8,590	Jan. 27, 1952	4.5	Aug. 24-25, 1965



Primary openings in unconsolidated material



Secondary openings in consolidated rock

Figure 4. How water occurs in the rocks.

The water table fluctuates according to the relative amounts of recharge (additions to the aquifer) and discharge (losses through springs and wells). Because large evapotranspiration losses occur during the growing season (April to October), very little recharge reaches the saturated zone during that period, and water levels decline. Water levels generally rise throughout the rest of the year.

Water levels in the county are at or near the land surface in the valleys and rise under the hilltops and ridges. The rate of water-level rise, however, is less than that of the land surface, so depths to water at the higher altitudes are greater than those in the valleys. The water table, therefore, is a subdued replica of the land surface. Because wells drilled in valleys generally contain water at shallower depths than wells drilled on hills, they have more available drawdown than wells of the same depth drilled on the hills and are less likely to go dry during droughts.

Ground water occurs in and moves through interconnected openings (Figure 4) of either primary or secondary origin. Primary openings are the spaces between individual grains (chiefly in unconsolidated material). Secondary openings are those formed after the consolidation and cementation of the sediments and generally result from the fracture or solution of the rock as the result of external forces. Solution cavities are formed by the solution and removal by water of parts of rocks such as limestone.

Ground-Water Quality

As precipitation enters the ground, it dissolves parts of the soil and rock and, thus, picks up various mineral constituents. The changes that occur in the chemical quality of the water in the bedrock are discussed more thoroughly in a later section. Ground water generally contains more dissolved mineral matter than surface water and occasionally may contain so much dissolved matter that it is not fit to drink. Water containing more than 500 mg/l (milligrams per liter) dissolved solids is not considered desirable for domestic supplies, though more highly mineralized water is used where better water is not available. The soil and rocks through which the ground water percolates tend to filter solid suspended materials and bacteria so that the ground water is generally clear and has fewer bacteria than surface water. The temperature of ground water is fairly uniform throughout the year.

Analyses of 32 samples of well water are listed in Table 3. Seventeen of the samples are from wells in river alluvium, eight are from wells in glacial outwash, six are from wells in the Conemaugh Group, and one is from a well in the Allegheny Group.

Most of the water sampled is of acceptable quality. However, iron concentrations in eight samples and dissolved-solids content in ten samples exceed the maximum values (0.3 mg/l and 500 mg/l) recommended by the U.S. Public Health Service (1962). Only two of the samples are high in both iron and dissolved-solids concentrations.

Table 3. *Chemical Analyses of Ground Water*

(Results in milligrams per liter except where indicated.)

Aquifer: Qal, alluvium; Qgo, glacial outwash; IPc, Conemaugh Group, IPa, Allegheny Group.

Well number	Aquifer	Date of sampling	Silica (SiO_3)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mn)	Sodium (Na)	Sodium and potassium[1]	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids: Residue at 180°C	Dissolved solids: Sum	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Non-carbonate
Bv- 5	IPc	1-19-43	11	--	-	82	14	-	330	--	325	-	200	360	--	-	1160	260	-
6	Qal	1-19-43	12	--	-	96	33	-	57	--	96	-	320	59	--	-	630	380	-
7	Qal	1-19-43	13	--	-	65	29	-	23	--	63	-	190	60	--	-	409	280	-
10	Qal	9-30-45	-	Trace	.10	73	12	-	15	--	268	-	25	17	--	260	275	230	-
11	Qal	8-27-45	-	do.	.00	86	9.8	-	11	--	215	-	72	19	--	330	303	260	-
12	Qal	8-9-45	-	do.	.00	90	12	-	19	--	201	-	95	37	--	410	352	270	-
13	Qal	7-27-45	-	do.	.00	110	13	-	10	--	249	-	110	19	--	440	379	320	-
14	Qal	6-28-45	-	.00	.00	120	10	-	12	--	246	-	140	19	--	480	422	350	-
36	Qal	5-16-47	14	.10	-	36	8.0	-	27	--	81	-	75	27	--	--	227	120	-
37	Qal	5-16-47	9.0	.70	-	32	7.0	-	17	--	92	-	50	14	--	--	175	110	-
38	Qal	7-22-47	6.0	1.30	-	24	8.0	-	20	--	81	-	50	14	--	--	163	93	-
39	Qal	5-16-47	7.0	2.20	-	34	7.0	-	18	--	79	-	65	17	--	--	189	110	-
40	Qal	5-16-47	9.0	5.00	-	43	10	-	21	--	92	-	80	32	--	--	246	150	-
41	Qal	5-16-47	13	0.90	-	40	9.0	-	57	--	81	-	50	100	--	--	313	140	-
54	Qgo	10-10-41	-	.10	-	130		-	16	--	283	-	65	49	--	--	403	330	-
156	IPc	1-29-69	7.8	19.00	0.14	3.0	1.4	236	-	3.8	445	24	23	110	0.5	714	622	13	0
157	IPc	6-3-71	-	.05	.00	14		-	280	--	368	104	8	110	.1	1070	695	36	-
170	Qal	7-30-29	-	--	-	30	20	-	89	--	88	-	70	140	4.3	408	401	160	-
171	Qgo	7-30-29	-	--	-	36	20	-	110	--	199	-	120	61	50	491	496	170	-

172	Qgo	7-30-29	–	--	–	64	35	–	66	--	252	–	110	63	42	526	506	300	–
173	Qgo	7-30-29	–	--	–	64	19	–	36	--	164	–	120	34	12	376	366	240	–
174	Qgo	7-30-29	–	--	–	88	5.6	–	78	--	108	–	250	36	12	516	525	240	–
175	Qgo	7-30-29	–	--	–	56	15	–	73	--	222	–	96	46	17	417	412	200	–
176	Qgo	7-30-29	–	--	–	42	18	–	6	--	121	–	55	17	.4	206	198	180	–
181	Qal	11-19-28	14	.07	–	110	21	56	–	3.2	262	–	95	100	33	579	366	360	–
188	₽a	10-6-28	10	11.0	–	40	12	1400	–	23	862	–	3.3	1900	1.5	3830	3810	150	–
193	Qal	10-6-28	13	4.03	–	44	9.3	24	–	3.5	92	–	81	30	0.5	256	255	150	–
195	Qal	1926	–	--	–	110	8.1	–	16	--	222	–	150	1.5	1.4	484	395	350	–
201	Qgo	10-6-28	18	.17	–	86	19	19	–	3.5	198	–	76	38	49	425	406	290	–
212	₽c	5-26-71	–	.03	.00		7.2	–	–	230.0	368	76	10	62	.04	876	571	18	–
213	₽c	6-9-71	–	.20	.00		2.4	–	–	220.0	386	48	8	62	.8	828	538	6	–
214	₽c	5-27-71	–	--	–		7.2	–	–	270.0	332	80	7	140	.04	884	669	18	–

[1] Combined sodium and potassium weights were determined by subtracting the combined equivalence of all other metallic constituents from the total equivalence of the non-metallic constituents and then converting the difference to milligrams per liter.

Table 4. *Record of Wells in Beaver County*

Well number: Identification number that relates record in this table to well's location on map. The letter "S" following number indicates the record was obtained from the Pennsylvania Geological Survey.
Location: The number is the coordinates in degrees and minutes of the southeast corner of a 1-minute quadrangle within which the well is located.
Use: C, commercial; F, fire; H, domestic; N, industrial; P, public supply; R, recreation; T, institution; U, unused.
Topographic setting: H, hilltop; S, slope; T, terrace; V, valley; W, hillside drainageway.
Aquifer: Qal, alluvium; Qgo, glacial outwash; ₽c, Conemaugh Group; ₽cg, Glenshaw Formation; ₽a, Allegheny Group; ₽af, Freeport Formation; ₽ak, Kittanning Formation; ₽av, Vanport Limestone; ₽ac, Clarion Formation; ₽ph, Homewood Formation; ₽pc, Connoquenessing Formation.
Lithology: gv, gravel; sd, sand; sdgv, sand and gravel; ls, limestone; ss, sandstone; sh, shale; shss, shaly sandstone.
Static water level: F, flowing; +, above land surface.
Pumping data: gpm, gallons per minute; dd, drawdown; ft, feet; hr, hours.
Hardness: gpg, grains per gallon.

Well	Location	Owner	Driller	Date Completed	Use	Altitude of Land Surface (feet)	Topographic Setting	Aquifer/ Lithology	Total Depth Below Land Surface (feet)	Casing		Depth(s) to Water-Bearing Zone(s) (feet)	Static Water Level		Pumping Data			Hardness	pH
										Depth (feet)	Diameter (inches)		Depth Below Land Surface (feet)	Date Measured	Yield (gpm)	dd (feet)	Time (hour)		
Bv- 1	4034-8013	American Bridge Co.	The Ohio Drilling Co.	1939	N	711	V	Qal/sdgv	64	44	18		29	Oct. 1939	1500	15	8	22	7.4
2	4034-8013	American Bridge Co.	The Ohio Drilling Co.	1939	N	711	V	Qal/sdgv	65	45	18		28	Nov. 1939	900	23	8	12	
3	4034-8013	American Bridge Co.	The Ohio Drilling Co.	1939	N	711	V	Qal/sdgv	60	44	18		24	Dec. 1939	1200	13	8		
4	4034-8013	American Bridge Co.	The Ohio Drilling Co.	1942	N	711	V	Qal/sdgv	66	51	8		31	Feb. 1942	100	9	8	12	
5	4035-8013	National Electric Prod. Corp.			N	757	S	₽c	147		10		70					15	7.6
6	4035-8013	National Electric Prod. Corp.	Poe Drilling Co.	1923	N	755	V	Qal	100	80	10		74	1943	275	12	48	22	6.2
7	4035-8013	National Electric Prod. Corp.	Poe Drilling Co.	1943	N	755	V	Qal/gv	104		12		74	1943	375	16	48	16	6.1
8	4035-8013	National Electric Prod. Corp.	Ralph L. Dunbar	1948	N	755	V	Qal/sdgv	106	86	20		72	July 1948	450	28	18		
10	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	691	V	Qal/sdgv	43	29	13		2	Sept. 1945	518	18	24	14	7.6
11	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	695	V	Qal/sdgv	51	38	13		12	Aug. 1945	465	22	23	15	7.3
12	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	692	V	Qal/sdgv	44	32	13		8	Aug. 1945	440	16	14	16	7.2
12S	4040-8018	Mancini, Americo	Ellsworth Brown	1968	H	1140	S	₽c/ss	121			29, 80	68	Sept. 1968	28		2		
13	4035-8014	Ambridge Borouth	Pennsylvania Drilling Co.	1945	P	692	V	Qal/gv	46	33	13		8	July 1945	500	18	14	19	7.3
13S	4038-8017	Girata, Paul	Miles T. Rogish, Jr.	1966	H	990	S	₽c/sh	51	22	6	27, 37	23	June 1966	12		8		
14	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	692	V	Qal/sd	44	30	13		6	June 1945	500	16	14	20	7.2
14S	4038-8017	Girata, Paul	Miles T. Rogish, Jr.	1966	H	1000	S	₽c/sh	100	22	6	62, 80	72	June 1966	5				
15	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	696	V	Qal/sdgv	52	39	13		14	June 1945	500				
16	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	698	V	Qal/gv	57	44	13		16	Oct. 1945	400	17		27	7.2
17	4035-8014	Ambridge Borough	Pennsylvania Drilling Co.	1945	P	701	V	Qal/gv	58	45	13		19	Nov. 1945	400			31	7.2
17S	4038-8019	Betters, John	Miles T. Rogish, Jr.	1966	H	1090	S	₽c/sh	115	21	6	49, 92	67	July 1966	3		48		
18	4036-8013	Spang Chalfant Co.	James Kinney, Jr.	1916	N	748	V	₽a	210		10								
18S	4036-8018	Goss, Frank	Eugene Thomas	1965	H	820	S	₽a	45	30	6		25	June 1965	5				
19	4036-8013	Spang Chalfant Co.	James Kinney, Jr.	1916	H	748	V	₽a	210		10			1916	150				
20	4036-8013	Spang Chalfant Co.	Charles Springer	1916	H	748	V	Qal/gv	94		5				36				
21	4036-8013	Spang Chalfant Co.	Charles Springer	1917	C	748	V	Qal/gv	107		5				36				
22	4036-8013	Spang Chalfant Co.	Layne-New York Co., Inc.	1942	C	758	V	Qal/sdgv	108	93	12		74	Aug. 1942	350	21	8		

23	4036-8013	Spang Chalfant Co.	Layne-New York Co., Inc.	1943	C	758	V	Qal/gv	109	94	12		79	Jan. 1944	260	28	12		
24	4036-8013	Spang Chalfant Co.	Layne-New York Co., Inc.	1944	H	718	V	Qal/sdgv	74	57	8		40	Aug. 1944	175	16			
25	4038-8014	Baden Borough	Layne-New York Co., Inc.		P	700	V	Qal/gv	40		8				325				
27	4029-8021	Young, J. M., Dr.	James H. Walters	1925	H	1050	S	ℙcg/sh	155		6		40						
28	4035-8016	Figley, J. H.	Bell & Goss		H		S	ℙc	185		6								
35	4040-8015	Conway Borough	Layne-New York Co., Inc.	1939	P	707	V	Qgo/gv	69	47	10		24	July 1939	304	12			
36	4041-8015	Freedom-Valvoline Oil Co.	J. P. Leaf		N	700	V	Qal/gv	61		16		26	1938	350			7	7.3
37	4041-8015	Freedom-Valvoline Oil Co.	D. L. Gilkey	1938	N	700	V	Qal/gv	67		16		26	Apr. 1938	250			6	7.3
38	4041-8015	Freedom-Valvoline Oil Co.	Guaranteed Drilling Co.	1940	N	700	V	Qal	63		18		26	1940				5	7.3
39	4041-8015	Freedom-Valvoline Oil Co.	Guaranteed Drilling Co.		N	700	V	Qal/sd	64		16		26		750		8	7	7.0
39S	4039-8010	Spolan, Richard	Paul E. Boehm	1968	H	1120	S	ℙc/clay	115	30	7	40, 100	25	Nov. 1968	10	35			
40	4041-8015	Freedom-Valvoline Oil Co.	Freedom-Valvoline Oil Co.	1943	N	700	V	Qal/gv	66		16		23	Jan. 1949	500	4		9	7.2
40S	4039-8010	Perry, Wm. T.	Paul E. Boehm	1968	H	1070	S	ℙc/ss	202	32	7	53, 70	38	Sept. 1968	9				
41	4041-8015	Freedom-Valvoline Oil Co.	Freedom Valvoline Oil Co.	1943	N	700	V	Qal/gv	68		16		26	1943	750			8	7.3
42	4041-8017	Beaver Borough	McCormick Drilling Co.	1923	P	700	V	Qal/gv	40	22	10				1600			21	
43	4041-8017	Beaver Borough	Elmer L. Book	1923	P	680	V	Qal/gv	40		6				1600				
43S	4040-8011	Rehoboth Church	Paul E. Boehm		H	1260	S	ℙc	90				40						
44	4041-8017	Beaver Borough	D. L. Gilkey	1947	P	692	V	Qal/sdgv	67		12		12		910	16	8		
45	4041-8017	Beaver Borough	D. L. Gilkey	1947	P	692	V	Qal/sdgv	61		12		12	1947	960	18	8		
46	4041-8017	Beaver Borough	D. L. Gilkey	1947	P	692	V	Qal/sdgv	62		12		12	July 1947	960	19	8		
46S	4040-8011	Barto, Lewis	Paul E. Boehm	1967	H	1200	S	ℙc/clay	190			160	102	Aug. 1967	3				
47	4041-8018	Beaver Ice Co.	Elmer L. Book	1928	N	780	V	Qgo/gv	150		10		60	July 1947	50				
48	4041-8018	Beaver Ice Co.	McCormick Drilling Co.	1928	N	780	V	Qgo/gv	150		10		60	1928	50				
49	4041-8019	Vanport Boro. Twp. Auth.	Tom Gilkey	1941	P	755	V	Qgo/gv	119	102	12		72	1941	610	16	24		
50	4041-8019	Vanport Boro. Twp. Auth.	Tom Gilkey	1941	P	755	V	Qgo/sdgv	119	102	12		72	1941	720	5	24	15	7.8
50S	4039-8010	Papantonio, George	Paul E. Boehm	1967	H	1100	S	ℙc/sh	62	35	7	55	42	Apr. 1967	10		3		
51	4041-8019	Vanport Boro. Twp. Auth.	Tom Gilkey	1941	P	755	V	Qgo/gv	118	101	12	101	72		640	12	16		
52	4039-8023	Monongahela Land Co.		1929	P	770	V	ℙa	166		4		90		15				
53	4039-8023	Monongahela Land Co.	J. C. Boyd	1943	P	750	V	Qgo/gv	126		8		91	June 1943	100			13	7.8
53S	4039-8011	Wigton, Kenneth	Paul E. Boehm	1966	H	1140	S	ℙc	225		6		147	Dec. 1966	0.2		1		
54	4037-8027	Treadwell Construction Co.	D. L. Gilkey	1941	N	698	V	Qgo/gv	60	60	10		35	Dec. 1966	195	5	24	19	7.4
55S	4039-8011	Rehoboth Church	Paul E. Boehm	1966	U	1180	S	ℙc	280	48	6								
56	4037-8027	Macintosh Hemphill Co.	Orin K. Gilkey	1941	U	775	V	Qgo/gv	62		10		45	1948	20				
56S	4039-8011	Rehoboth Church	Paul E. Boehm	1966	P	1180	S	ℙc/sh	110	48	6	58	50	July 1966	2		1		
57	4038-8028	Midland Slag Co.	Arthur Evans	1945	N	750	V	Qgo/gv	126		10		60		150	4			
58	4039-8021	Koppers Co., Kobuta Plant	Pennsylvania Drilling Co.	1942	N	754	V	Qgo/sdgv	114	93	16		70	July 1942					
58S	4045-8012	Holmes, Dores	Ellsworth Brown	1967	H	1020	S	ℙc/sh	300	42	8	150	150	Mar. 1967	0.1	150	72		
59	4039-8021	Koppers Co., Kobuta Plant	The Ohio Drilling Co.	1942	U	759	V	Qgo/sdgv	121	106	16		78	Oct. 1942	835	4	78		
60	4039-8021	Koppers Co., Kobuta Plant	The Ohio Drilling Co.	1942	U	753	V	Qgo/sdgv	111	92	16		65	Dec. 1942	800	2	55		
60S	4048-8012	Nesbitt, Don	Ellsworth Brown	1967	H	950	S	ℙa	304		6	30, 157	130	July 1967	3		1		
61	4039-8020	Koppers Co., Kobuta Plant	Pennsylvania Drilling Co.	1942	N	740	V	Qgo	103		12		48		500				
62	4039-8020	Koppers Co., Kobuta Plant	The Ohio Drilling Co.	1944	U	740	V	Qgo/sdgv	107	78	12		58	Aug. 1944	410	27	48		
63	4040-8020	Beaver County Home		1920	T	760	V	Qgo/sdgv	165		6		70		50				
63S	4034-8028	Ewing, Henry	Smith Drilling Contractors	1969	H	1080	S	ℙc/ss	152	42	6	142	95	May 1969	20		2		
64	4040-8020	Beaver County Home	Tom Gilkey	1931	T	760	V	Qgo/sdgv	140		6		70	1948	50				
65	4040-8019	St. Josephs Lead Co.		1930	N	672	V	Qal/sdgv	30	30	12								
66	4040-8019	St. Josephs Lead Co.	Tom Gilkey	1941	N	678	V	Qal/sdgv	52	40	12								

Table 4. *(Continued)*

Well	Location	Owner	Driller	Date Completed	Use	Altitude of Land Surface (feet)	Topographic Setting	Aquifer/ Lithology	Total Depth Below Land Surface (feet)	Casing		Depth(s) to Water-Bearing Zone(s) (feet)	Static Water Level		Pumping Data			Hardness	pH
										Depth (feet)	Diameter (inches)		Depth Below Land Surface (feet)	Date Measured	Yield (gpm)	dd (feet)	Time (hour)		
67	4040-8020	St. Josephs Lead Co.	D. L. Gilkey	1947	N	788	V	Qgo/sdgv	152	138	12		107	Feb. 1947	1380	22	8		
68	4040-8020	St. Josephs Lead Co.	D. L. Gilkey	1947	N	788	V	Qgo/sdgv	153	138	13		107	Feb. 1947	1000				
68S	4037-8025	Johnston, Jerry	Ross Swogger	1968	H	800	V	Pa	85	87	7	78	75		20				
69	4041-8017	Monaca Borough			P	680	V	Qgo/gv	45		10		5		75				
69S	4035-8028	McGaffic, Charles	Smith Drilling Contractors	1966	H	1140	S	Pc/sh	110	22	6	78	78	Nov. 1966	1	32	2		
70	4041-8017	Monaca Borough			P	680	V	Qgo&gv	45		10		5		75				
71	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	47	45	10		5		105	18	24	19	7.15
72	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	45	45	10		5		250	8	24		
73	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	49	45	10		5		225	6	24		
74	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	50	45	10		5		175	4	24		
75	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	45	45	10		5		200	14	24		
76	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	45	45	10		5		150	8	24		
77	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	46	46	10		5		135	9	24		
77S	4035-8028	Beal, Eugene	McCoy Brothers Drilling	1966	H	990	S	Pc/ss	72	27	6	60	50	July 1966					
78	4041-8017	Monaca Borough	Tom Gilkey	1933	P	680	V	Qgo/gv	43	43	10		5		142	8	24		
79	4041-8016	Phoenix Glass Co.		1910	N	740	V	Qgo/gv	103		12		59	Oct. 1943	200	26	12		
80	4041-8016	Richmond Radiator Co.	T. M. Flocker	1920	N	730	V	Qal/gv	96	93	8		57	Dec. 1938	125	7	36		
81	4041-8015	Pittsburgh Tube Co.	The Ohio Drilling Co.	1942	N	740	V	Qgo/sdgv	105	109	16		60	1942	575	8	24		
81S	4034-8026	South Beaver City School	Smith Drilling Contractors	1967	P	1300	S	Pc/sh	350	35	8	84	84	Feb. 1967	6		8		
82	4041-8015	Pittsburgh & Lake Erie R.R.	Pittsburgh & Lake Erie R.R.	1932	C	702	V	Qal/sdgv	76	76	8		26	Nov. 1932	150			20	
83	4040-8015	Vanadium-Alloys Steel Co.		1921	N	754	V	Qgo/sdgv	105		6		78		14				
83S	4036-8028	Ross, Kenneth	Smith Drilling Contractors	1968	H	1000	S	Pc	76	25	6	68	68	June 1968	5		1		
84	4040-8015	Vanadium-Alloys Steel Co.		1900	N	755	V	Qgo/gv	100				78		14				
86	4038-8014	Vulcan Crucible Steel Co.			U	740	V	Qal/gv	93		6		59	Nov. 1944	3				
87	4038-8014	West Aliquippa Borough	The Ohio Drilling Co.	1945	P	741	V	Qal/sdgv	98	83	16		60	Sept. 1945	820	15	24	27	
88	4038-8014	West Aliquippa Borough	The Ohio Drilling Co.	1945	P	743	V	Qal/gv	102	87	16		58	July 1945	860	24	24		
89	4034-8014	South Heights Water Co.	Lester McCartney	1924	P	742	V	Qgo	97	97	8		59	Aug. 1924	67			20	7.3
90	4034-8014	South Heights Water Co.	Chester Bell	1935	P	742	V	Qgo	97		8		60	1948	67				
91	4037-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1939	P	728	V	Qgo/sdgv	85	65	16		44	Apr. 1939	575	14	24	14	7.6
92	4036-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1939	P	731	V	Qal/sdgv	87	67	16		48	1939	615	14	24	12	7.3
93	4036-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1939	P	732	V	Qal/sdgv	88	68	16		50	Sept. 1939	590	13	24	14	7.4
94	4037-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1940	U	726	V	Qal/sdgv	83	63	16		46		575	20	24	14	7.6
95	4037-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1942	P	728	V	Qal/sdgv	80	65	12		47	Mar. 1942	600	15	24		

95S	4034-8026	South Beaver City School	Smith Drilling Contractors	1968	P	1300	S	Pc/ss	150	38	6	98, 119	100	Feb. 1968	2	50	1
96	4037-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1942	U	733	V	Qal/sdgv	80	65	16						
97	4037-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1942	U	733	V	Qal/sdgv	80	60	16						
97S	4036-8028	Wright, Charles	Smith Drilling Contractors	1968	P	1030	S	Pa/ss	98	24	8	60, 90	60	Apr. 1968	6	38	2
98	4036-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1945	P	732	V	Qal/sdgv	89	69	16		52	Oct. 1944	745	12	24
98S	4034-8026	South Beaver City School	Smith Drilling Contractors	1968	P	1280	S	Pc/sh	135	91	6	45, 98	76	Apr. 1968			
99	4036-8014	Woodlawn Water Co.	The Ohio Drilling Co.	1949	P	733	V	Qal/sdgv	91	71	16		54	May 1949	1000		
100	4043-8018	Standard Specialty & Tube Co.			N	730	V	Qal/sdgv	74		6		59		25		
101	4044-8018	Rochester Pipe Products Co.		1900	N	745	V	Qal/sdgv	70		6		50		20		
102	4044-8019	Union Drawn Steel Co.			U	730	V	Qal/sdgv	90		8		60		10		
103	4044-8019	Fame Laundries Inc.		1908	U	740	V	Qal/sdgv	100		5		12		85		
104	4044-8019	Andalusia Dairy Co.	McCormick Drilling Co.	1935	N	740	V	Qal/sdgv	95		8		F		40		
105	4040-8020	Petroleum Solvents Co.	D. L. Gilkey	1946	N	705	V	P ph/ss	75	38	8				50	15	
106	4038-8024	Industry School	D. L. Gilkey	1940	T	750	V	P ak/ss	66	26	8						
107	4038-8027	Midland Ice Co.		1920	U	830	S	P a/ls	175		6						
107S	4033-8027	Smalley, James	Miles T. Rogish, Jr.	1966	H	1120	S	P c/sh	70	29	6	41, 47	41	Oct. 1966	4	45	48
108	4038-8014	Kidd Drawn Steel Co.		1917	H	740	V	P ak/ss	150		8		60		3		
109	4038-8018	Center Township Fire Dept.	Orin K. Gilkey	1944	H	1130	S	P c/ss	110		6		50	1944	0.3		
110	4037-8015	Aliquippa Ice Co.	John Bell	1933	U	840	S	P a/ss	100		8				50		
111	4036-8016	Sutherland Dairy Co.	Chester Bell	1940	N	900	S	P a/ss	190		8				40		
112	4036-8016	Sutherland Dairy Co.	Chester Bell	1949	N	900	S	P a/ss	210		8				45		
113	4036-8017	Aliquippa Golf Club	D. L. Gilkey	1940	H	820	S	P a/ss	65		10		22	1940	45		
114	4042-8017	Pettibon Dairy Co.	Russell M. Cable	1947	U	860	S	P a/ss	135		12		25	Aug. 1947	10		
115	4042-8017	Pittsburgh Bridge & Iron Works		1919	H	920	S	P a/ss	105	28	8		45		15		
116	4043-8018	William Leard Co.		1900	H	745	S	P ph/ss	150		8				40		
117	4044-8018	Sterling Borax Co.		1900	U	780	S	P ph/ss	180		6				20		
118	4044-8018	Brighton Fire Brick Co.		1900	U	800	S	P ph/ss	175		4				10		
119	4044-8019	Mayer China Co.	D. L. Gilkey	1946	N	740	V	P ph/ss	50	10	12		45	1946	15		
120	4044-8019	Mayer China Co.	Orin K. Gilkey	1946	N	740	V	P ph/ss	50	11	12		45	1946	20		
121	4044-8019	Mayer China Co.	D. L. Gilkey	1946	N	740	V	P ph/ss	50	11	12		45		20		
122	4044-8019	Mayer China Co.	Orin K. Gilkey	1947	N	740	V	P ph/ss	35	11	8		45		20		
123	4044-8019	Mayer China Co.	D. L. Gilkey	1948	N	740	V	P ph/ss	51	10	12		45		20		
124	4045-8019	Brodhead Hotel		1926	C	810	H	P ph/ss	125		6		80	May 1948	30		
125	4045-8019	Brodhead Hotel		1926	C	810	H	P ph/ss	125		6		80	May 1948	30		
126	4047-8021	Frumen's Dairy	George Dillan	1941	N	920	V	P ph/ss	105	20	8		70		50		
127	4047-8021	Frumen's Dairy	George Dillan	1944	N	920	V	P ph/ss	105	20	8		70		50		
129	4050-8019	Koppel Borough	Bradshaw & Modro Drilling	1943	P	960	S	P a	60		8		12				
130	4050-8019	Ellwood Stone Co.	Bradshaw & Modro Drilling	1945	C	860	S	P pc/ss	50		6		20		50		
130S	4032-8016	Sickelsmith		1967	H	1200	S	P c/sh	100	27	7	38, 45	20	Apr. 1967	5	72	
131	4048-8013	Camp Kon-O-Kwee	D. L. Gilkey	1941	P	925	S	P av/ls	102	32	8	45, 68, 98	35	May 1941	30	10	
132	4049-8023	New Castle Refractories Co.	Tom Gilkey	1920	N	970	V	P a	180		6		80	1947	10		
133	4047-8029	Malvern Fireproofing Corp.	George Dillan	1949	N	830	V	Qal/sdgv	35		8		15				
137	4046-8023	Open Air Theater	D. L. Gilkey	1948	P	1200	H	P a/ss	80	14	8				10		
138S	4034-8019	Zelaski, Steve	Miles T. Rogish, Jr.	1969	H	950	S	P c/sh	92	13	8	20, 45	16	Apr. 1969	1		

Table 4. *(Continued)*

Well	Location	Owner	Driller	Date Completed	Use	Altitude of Land Surface (feet)	Topographic Setting	Aquifer/ Lithology	Total Depth Below Land Surface (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Depth(s) to Water-Bearing Zone(s) (feet)	Static Water Level: Depth Below Land Surface (feet)	Static Water Level: Date Measured	Pumping Data: Yield (gpm)	Pumping Data: dd (feet)	Pumping Data: Time (hour)	Hardness	pH
139S	4030-8019	Ankron, Wilford	Eugene Thomas	1969	H	1140	S	P c/ss	108	17	6	80	38	Apr. 1969	5				
149	4047-8029	Watt	D. L. Gilkey	1926	H	860	V	Qal/gv	60		4		12						
152	4048-8025	Duff, F. E., Mrs.			U	915	V	Qal/sdgv	45		6								
153	4035-8013	Ambridge Borough	Pennsylvania Drilling Co.	1949	U	755	V	Qal/sdgv	97		3		60	Apr. 1950					
154	4037-8026	Mackintosh-Hemphill Co.	D. L. Gilkey	1941	U	775	V	Qgo/gv	62		10		45	1948	20				
155	4044-8011	Gulf Oil Corp.	Western Reserve Dr. Co.		H	1070	V	P ak/ss	196	161	8	31, 51, 127	38	June 1956	106	20	25		
156	4030-8025	U.S. Geological Survey	Ellsworth Brown	1967	U	930	V	P c/sh	101	25	6	30, 52, 67	11	Nov. 1967	7	67	1	1	
157	4030-8025	Raccoon State Park	William J. Glunt, Inc.	1965	R	930	V	P c/sh	100	85	6	35	21	Jan. 1969	13	24	24		
158	4048-8027	Francis Coal & Clay Co.	The Ohio Drilling Co.	1922	N	900	S	P a	50		4		30						
159	4047-8024	Higher	D. L. Gilkey		H	1100	H	P af	52		4		8						
160	4050-8019	Koppel Water Co.	Elmer L. Book		P	920	T	P ph/ss	76		8		33		60				
161	4050-8019	Koppel Water Co.	The Ohio Drilling Co.		P	920	T	P ph/ss	72				33		60				
163	4049-8018	Tuba, Mike	J. K. Gilkey	1927	H	920	T	P ph	71		4		40						
164	4046-8021	Holton, William	J. K. Gilkey	1927	H	1200	S	P af	48				26						
165	4044-8019	Valley Ice Co.		1925	N	750	V	Qgo/gv	92	75	12	10, 75	+2		1000	18			
166	4042-8019	Barrett, J. M.	T. M. Flocker	1919	H	1160	S	P c/ss	65	10	6		2						
167	4042-8018	Scroggs, Dr.	T. M. Flocker		H	1020	S	P a/sh	300	30	6		270						
168	4042-8018	Eckart, Charles	T. M. Flocker		H	1020	S	P cg/ss	65	10	6		25						
169	4042-8017	Rochester Bridge Works	T. M. Flocker	1919	N	920	T	P a/ss	106	28	8		45						
170	4041-8016	Polar Water Co.			N	680	V	Qal/gv	50										
171	4041-8017	Sowash, Charles			H	720	T	Qgo	86		4								
172	4041-8016	Runzo, Joseph		1928	H	720	T	Qgo	85		4		75						
173	4041-8016	Phoenix Glass Co.			N	740	T	Qgo/gv	115	115	8				200				
174	4041-8016	Phoenix Glass Co.			N	740	T	Qgo/gv	98	98					50				
175	4041-8016	Fronko, M. K.			H	720	T	Qgo/gv	96		5								
176	4041-8016	U.S. Sanitary Manufacturing Co.		1928	N	720	T	Qgo/gv	110	110	4		50		36				
176S	4041-8011	Zamba, Fred	Paul E. Boehm	1968	H	1110	S	P c/ss	61	30	7	50	5	Sept. 1968	30	12	1		
177	4040-8015	Colonial Steel Mills	T. M. Flocker	1906	N	760	T	Qgo/gv	135	135			80						
178	4040-8015	Allaire Water Co.			P	754	T	Qgo/gv	110	106			78						
179	4040-8015	Allaire Water Co.			P	754	T	Qgo/gv	110	106			78						
180	4040-8015	Allaire Water Co.			P	754	T	Qgo/gv	110	106			78						
181	4041-8018	Beaver Borough	L. MacCormack	1925	P	680	T	Qal/gv	20	20	6		F						
182	4041-8018	Beaver Borough	L. MacCormack	1908	P	680	T	Qal/gv	40	40	6		F						

183	4041-8020	Russel, Abe	T. M. Flocker	1904	H	740	S	₱ ac/sh	97	18	6		67					
184	4040-8020	Beaver County Home	T. M. Flocker	1916	H	780	T	Qgo/sdgv	167	167	8		117					
184S	4042-8011	Sidler, Jack	Paul E. Boehm	1967	H	1140		sh				130	69					
185	4039-8021	Halsteter	T. M. Flocker		H	760	T	Qgo/sdgv	135	135	6		85					
186	4040-8022	Flocker, T. M.	T. M. Flocker	1910	H	1060	W	₱ c/ss	54		6		35					
187	4039-8022	Williams, A.	T. M. Flocker		H	760	T	Qgo/gv	135		6		100					
188	4039-8023	Hogue, John G.	T. M. Flocker	1920	H	760	T	₱ a/ss	200		6		150					
189	4038-8022	Carpenter, W. H.	T. M. Flocker	1904	H	740	T	₱ a/ss	125	50	6		90					
190	4041-8029	Davis, Dr.	T. M. Flocker		H	740	T	Qgo/sdgv	150	150	6		100					
192	4038-8014	Baden Borough		1923	P	680	T	Qal/gv	25	25	4				45	18	6	
193	4038-8014	Baden Borough		1906	P	680	T	Qal/gv	20	20	8							
194	4038-8014		T. M. Flocker	1919	H	920	S	₱ a	150	20	6		112					
195	4038-8014	Aliquippa Borough		1926	P	680	T	Qal/sdgv	41	41	12				1200	25	24	
197	4037-8014	Woodlawn Water Co.		1927	P	700	T	Qal/sdgv	82	82	18		48		1320	7	1	
201	4034-8014	Crescent Beach Water Co.	R. A. Jackson	1912	P	740	T	Qgo/sdgv	124	94	8	75	59					17
204	4050-8019	Borough of Koppel			P	910	T	₱ ph/ss	34				150		6			
205	4050-8019	Borough of Koppel			P	910	T	₱ ph/ss	34						20			
207	4050-8019	Borough of Koppel			P	910	T	₱ ac	31						20			
208	4050-8019	Borough of Koppel			P	910	T	₱ ph/ss	47						6			
209	4050-8019	Borough of Koppel			U	910	T	₱ ph/ss	48									
210	4050-8019	Borough of Koppel			P	910	T	₱ ph/ss	76						60			
211	4050-8019	Borough of Koppel			P	910	T	₱ ph/ss	75						60			
212	4030-8026	Raccoon State Park			R	940	V	₱ c	238				9	May 1971	70	40	24	
213	4030-8026	Raccoon State Park			R	940	V	₱ c	143				28	June 1971	40	74	22	
214	4030-8024	Raccoon State Park			R	920	V	₱ c	143				14	May 1971	100	52	24	
221S	4037-8023	Shaffer, C. W.	McCoy Brothers Drilling	1968	H	1130	S	₱ c/sh	148	30	6	65	65	Sept. 1968	0.6			
227S	4036-8021	Gormen, James	Miles T. Rogish, Jr.	1966	H	1100	S	₱ c/ss	96	76	5	34, 62	35	June 1966	1	61		
232S	4036-8021	Mikalich, Andrew	Miles T. Rogish, Jr.	1966	H	1100	S	₱ c/sh	110	21	6	59, 73	73	Sept. 1966	3	41	48	
237S	4037-8021	Staub, Irwin	Miles T. Rogish, Jr.	1966	H	1060	S	₱ c/ls	208			149, 162, 175	165	Oct. 1966	0.5	43		
238S	4037-8022	Stickles, Stan	Eugene Thomas	1966	H	1140	S	₱ c/sh	89	19	6	70	55	Oct. 1966	1			
242S	4037-8021	Nadzam, Alan	Miles T. Rogish, Jr.	1967	H	1080	S	₱ c/sh	85	26	6	17, 45	30	Apr. 1967	6			
243S	4036-8023	Ayoob, John	Eugene Thomas	1967	H	1135	S	₱ c/sh	100	26	6	40	20	May 1967	0.5			
250S	4036-8021	Vidovich, John	Miles T. Rogish, Jr.	1967	H	1200	S	₱ c/ss	101	80	5	73	66	Aug. 1967	2		72	
284S	4033-8025	Fanala, George	Ross Swogger	1970	H	1260	S	₱ c/ss	135	28	7	107		Sept. 1970	22			
287S	4033-8025	Gosztonyi, Sylva	Ross Swogger	1969	H	1260	S	₱ c/ss	123	29	7	75		Oct. 1969	8	43		
290S	4029-8022	Hughes, Detmer	Ross Swogger	1970	H	1120	S	₱ c/shss	100	23	7	66		Sept. 1970	5			
297S	4029-8026	Church, W. B.	Smith Drilling Contractors	1969	H	1190	S	₱ c	210	63	6	34, 58, 196	160	Oct. 1969				
298S	4029-8026	Cortwright, Jim	Smith Drilling Contractors	1969	H	1200	S	₱ c/sh	197	80	6	50, 175	110	Oct. 1969	7		2	
328S	4036-8022	Fire Dept.	Miles T. Rogish, Jr.	1970	F	1110	S	₱ c	114		8	65		June 1970	1			
332S	4038-8023	Macs Superette	Miles T. Rogish, Jr.	1969	H	1125	S	₱ c	216		6			Mar. 1969	0.1			

HOW AND WHERE GROUND WATER IS FOUND

Ground water in Beaver County occurs under both artesian and water-table conditions. Reported well yields range from less than 1 to 1600 gpm (gallons per minute). Data on about 220 wells drilled in the several geologic formations that underlie the county are listed in Table 4. Plate 1 shows the locations of the wells and the areas where the geologic units are at the surface or beneath the unconsolidated deposits.

A summary of the water-bearing characteristics of the geologic units in Beaver County is given in Table 5. Sample logs of several wells are given in Table 6. These sample logs are representative of the variety of rocks penetrated when drilling in this county.

UNCONSOLIDATED DEPOSITS

Origin and Lithology

The unconsolidated deposits in Beaver County are present chiefly along the valleys and in the extreme northwest corner of the county. Most of these deposits owe their origin, either directly or indirectly, to glaciers that covered the northern part of North America during early Quaternary time.

Glaciers moved into northwestern Beaver County at least twice during the Quaternary Period and deposited a heterogeneous veneer of clay, silt, sand, and boulders (Plate 1). The earlier glaciation is called Illinoian, after the state where it was first studied, and the later glaciation is part of the Wisconsinan glaciation called the Kent Stade (both named in the same fashion as the Illinoian).

The Illinoian drift in Beaver County is represented now chiefly by scattered, severely weathered erratics – that is, rocks that are not native to the area in which they are found. The Kent drift in Beaver County covers a smaller area than that covered by the Illinoian drift. It is thin, probably less than 25 feet thick, and lacks the hummocky topography that it displays along its border to the northeast.

As the glaciers melted, much of the rock debris that the glaciers had picked up was carried away by the meltwater streams and deposited in the stream valleys miles beyond the ice border. The deposits consist chiefly of sand and gravel, most of the silt and clay having been carried far downstream. Subsequent erosion has removed most of these outwash deposits, leaving only remnants as terraces scattered along the valley walls. The erosion also deepened the valleys and removed most of the outwash deposits, so that the high terraces are correlated with the earlier (Illinoian) glaciation and the low terraces with the later (Wisconsinan) glaciation.

Terraces occur also in Beaver County along the valleys of some streams that did not flow from the ice and which contain only locally derived material. These deposits are called the Carmichaels Formation; they consist dominantly of sand but also contain minor amounts of both coarser and finer material. The altitude

Table 5. *Composite Stratigraphic Section for Beaver County*

System	Group	Thickness (feet)	Character of strata	Water-bearing characteristics
Quaternary		0-160+	Unconsolidated material, ranging in size from clay to boulders; deposited by glacial ice, by streams flowing off the ice, and by modern streams.	Yields of wells differ widely, depending on sorting and thickness of deposits. Reported yields are as much as 1600 gpm. Dissolved-solids (chiefly calcium magnesium bicarbonate) concentrations are high, though chloride and sulfate are also abundant. Water is moderately hard to very hard. Iron concentration is high in many samples.
Pennsylvanian	Monongahela	60	Sandstone, shale, and two coal beds.	Not important as a source of water.
	Conemaugh	520	Sandstone, shale, limestone, thin coal beds, and red beds.	Reported yields of wells range from less than 1 to 100 gpm. About half the wells yield 5 gpm or more. Dissolved-solids (chiefly sodium bicarbonate) concentrations of water are high; the average iron content is 0.12 mg/l; the water is soft.
	Allegheny	300	Sandstone (in thick channels in places), shale, limestone and several commercial-grade coal beds.	Reported yields of wells range from 3 to 150 gpm. About half the wells yield 17 gpm or more. Only a single analysis of water from these rocks is available. The water is saline and high in iron concentration.
	Pottsville	200	Sandstone, shale, and several thin coal beds.	Reported yields of wells range from 6 to 60 gpm and average about 30 gpm. No analyses of water are available.

Table 6. *Drillers' Logs of Wells*

Well Bv-22

Description	Thickness (feet)	Depth (feet)
Soil	1	1
Sand, brown	5	6
Sand, brown; gravel	8	14
Sand and gravel	54	68
Sand and clay	2	70
Sand and gravel	36	106
Sand, gray	4	110
Slate rock	1	111

Well Bv-49

Description	Thickness (feet)	Depth (feet)
Sandy loam and clay	6	6
Sand and coarse gravel	60	66
Sand, brown; gravel	33	99
Sand and coarse gravel	20	119
Sand and fine gravel	3	122
Sand and coarse gravel	3	125

Well Bv-58

Description	Thickness (feet)	Depth (feet)
Loam	1	1
Sand, gravel, and clay	21	22
Clay, gravel, and some sand	3	25
Sand and gravel	16	41
Hard pan	6	47
Sand and gravel	19	66
Sand, some gravel	16	82
Sand, gravel, and some clay	18	100
Sand, coarse, and fine gravel	10	110
Clay, gravel, and some sand	2	112
Sand and gravel	18	130

Table 6. *(Continued)*

Well Bv-155

Description	Thickness (feet)	Depth (feet)
Clay, yellow	8	8
Clay, gray, and gravel	6	14
Clay, gray	3	17
Sand and gravel	5	22
Shale, brown, soft	9	31
Sandstone, gray to brown	51	82
Shale, gray	7	89
Shale, black	6	95
Coal (Middle Kittanning?)	1½	96½
Clay	1½	98
Sandstone, gray	54	152
Shale, blue and gray	28	180
Shale, black	6	186
Coal (Lower Kittanning?)	4	190
Underclay	1	191
Shale, white	3	194
Sandstone	2	196

Well Bv-156

Description	Thickness (feet)	Depth (feet)
Fill, tan	19	19
Shale, tan and gray	16	35
Mudstone	3	38
Shale, gray, becomes red downward	9	47
Shale, red	10	57
Mudstone, red	10	67
Siltstone, gray	15	82
Shale, gray	19	101

of these terraces is about the same as that of the higher glacial terraces, so they are considered to be of Illinoian age.

The maximum thickness of the glacial terrace deposits is not known, but one well (Bv-184) drilled to a depth of 167 feet failed to reach bedrock. As casing is used to prevent the unconsolidated material from collapsing into the well, the amount of casing in a well is often a good index of the thickness of the deposit at that point. Half of the 34 wells on which data are available use more than 97 feet of casing. The terraces formed by the Carmichaels Formation are considerably thinner. Thickness estimates range from 5 to 10 feet in the Sewickley quadrangle (Munn, 1911, p. 7) to "20 or 30 feet" in the adjoining Beaver quadrangle (Woolsey, 1905, p. 7).

The last type of unconsolidated deposit is the alluvium, which forms the flood plains of the present streams. The alluvium ranges in particle size from clay to gravel and is locally stratified. Based on the depth of casing of 38 wells drilled on flood plains, the average thickness is about 50 feet. One well penetrated 109 feet of alluvium without reaching bedrock (well Bv-23).

Water-Bearing Characteristics

The drift or sediment laid down by the ice is generally poorly permeable and capable of yielding only enough water to wells for a domestic supply.

The outwash deposits, which are present today as terraces, are highly permeable, and excellent yields have been reported for wells penetrating these materials. Half of the 40 wells on which data are available yielded more than 162 gpm, and three of the wells yield 1000 gpm or more.

The alluvial deposits along the modern flood plains are also excellent sources of water. About half of the 49 wells on which data are available yield 500 gpm or more, and seven yield more than 1000 gpm.

Well Construction, Location, and Spacing

Yields of wells in the unconsolidated material are greatest if the wells are drilled to the underlying bedrock and if screens are installed opposite any zones of coarse-grained, water-saturated material. Wells aligned parallel to a nearby stream minimize interference between wells. A parallel alignment to the streams can also increase the amount of recharge to the alluvium from the stream when the wells are pumped. Distances between wells and between the stream and wells can be determined after the areal extent, saturated thickness, and permeability of the alluvium are known.

Water Quality

Chemical analyses are available of the water from eight wells drilled in glacial outwash deposits and 17 wells drilled in recent alluvial deposits.

The water from the glacial material has an average dissolved-solids content of about 425 mg/l and ranges from hard to very hard. In four samples, calcium and magnesium are much more abundant than sodium and potassium; in three, the two sets of ions are about equal; and in one sample, sodium and potassium predominate. Bicarbonate is the dominant anion in all but one sample, where sulfate is the most abundant. Sulfate and chloride, however, are prominent in all samples. Nitrate concentration exceeds Public Health Service drinking water standards (45 mg/l) in two samples and nearly exceeds them in a third. Concentration of iron, determined on only two of the samples, amounts of 0.1 and 0.17 mg/l.

The water from the alluvium has an average dissolved-solids content of about 410 mg/l and ranges from moderately hard to very hard. Most waters are dominantly of the calcium magnesium bicarbonate type. Sulfate, however, is the dominant anion in two samples, and chloride is dominant in two other samples. Concentration of iron was determined on 13 samples and ranges from zero to 5.0 mg/l; about half the samples contain more than the 0.3 mg/l limit recommended by the Public Health Service.

BEDROCK

General Features

Origin and Lithology

The sediments forming the bedrock in Beaver County were deposited on or a short distance seaward of a large delta that grew generally westward during the time of Pennsylvania's great coal swamps. The youngest of these rocks is the Monongahela Group, which is present only on the tops of a few hills along the southern border of the county (Plate 1). The next older and most extensively exposed group of rocks in the county is the Conemaugh. Along the Ohio and Beaver Rivers and some of the smaller streams in the northern part of the county, erosion has removed the Conemaugh and exposed some of the underlying rocks. The rocks immediately underlying the Conemaugh are the Allegheny Group. Along the northern part of the Beaver River and its tributary, Connoquenessing Creek, erosion has deepened the valleys sufficiently to expose the Pottsville Group beneath the Allegheny Group.

Each of the four groups is composed of sandstone, shale, and coal, but certain rock types predominate over others in the different groups and locally some may be absent. In the Conemaugh and Pottsville Groups, sandstone is prominent and coal is poorly developed; however, in the Monongahela and Allegheny, coal and shale are prominent and sandstone beds are generally thin and shaly.

Each of the groups contain sandstone, which occupies long narrow bodies that seem to have been deposited in a stream channel. The channels are eroded into the underlying beds, and some of the major ones may have been eroded entirely through the beds of one group of rocks. The major channel sandstones commonly overlie one another, so that the entire stratigraphic sequence at a given point may be sandstone. A few miles on either side of the channel the beds may be predominantly shale.

Structure

The stresses that formed the Appalachian Mountains to the east of Beaver County were much weaker in Beaver County but still made their presence known. To determine the effect of these stresses, the altitude of a single rock layer is measured at many different places throughout the county, and a structure contour map is prepared from the data. The layer or marker bed should be one that is widely distributed and easily recognized. Only some of the limestones and coal beds qualify as marker beds here.

Previous geologists have used several beds to construct structure maps of parts of the county. The Upper Freeport coal is used in this report because it is exposed over a large area in the central part of the county and also is intermediate in altitude among the beds used. The interval between each of these beds and the Upper Freeport coal was assumed to be constant throughout the bed's areal extent and was added or subtracted, as appropriate, to obtain the altitude of the Upper Freeport coal.

Plate 1 shows how the rocks have been warped into folds or structural ridges (anticlines) and structural troughs (synclines). These folds have been superposed on a broader regional structure that causes the rocks to dip generally southward. The total relief, or range of altitude, on the top of the Upper Freeport coal is more than 550 feet in the county.

A structure map is important in the study of ground water because it makes possible the determination of the altitude of the rocks. Thus, a rock may be an important water-bearer in one area but may lie too deep to be worth drilling in another area.

Water-Bearing Characteristics

Water occurs in consolidated rocks chiefly in fractures. Where the rock is shale, the fractures are small and close readily because shale is weak and crumbles easily. Sandstone is generally well cemented, but when fractured it tends to develop clean breaks that remain open and serve as excellent conduits for water. The fractures are irregularly distributed in the rock, however, and make up a relatively small amount of the total volume of the rock; thus, they are unable to store the large quantities of water that the spaces between grains of the unconsolidated material are capable of storing.

Well Location and Spacing

Wells of good yield in consolidated rocks must intercept fractures in which water occurs, though the locations of such fractures are difficult to determine. In recent years it has been discovered that fractures or concentrations of fractures are, in places, detectable on aerial photographs as linear features, called fracture traces, which result from topographic (including straight stream segments), vegetational, or soil-tonal alignments. Care must be taken to ensure that the features are not man-made.

If aerial photographs are not available, or if fracture traces cannot be identified on the photographs, good results may often be obtained by drilling in stream valleys, especially straight reaches. The drilling of wells in valleys is justified theoretically because fractures are zones of weakness in the rocks and, therefore, more erodible and apt to become valleys than adjacent areas. Also, there is more available drawdown in the valley wells, because water occurs at shallower depths beneath the surface in valleys than on hills.

The location and spacing of wells in a well field is a major factor controlling their interference with one another during pumping. When a well that obtains its water from a fracture is pumped, the water level draws down in the shape of a cone whose horizontal dimensions are distorted into an elongate shape, with the longest axis along the fracture in both directions from the well. If two or more fractures supply the well, a part of the cone will extend along each of the fractures.

Fractures are not randomly oriented, but are generally arranged in two or three major directions. In a small area, two fractures may be parallel and only poorly interconnected, so that a well on each of the fractures interferes with the other only slightly or not at all. In contrast, if the fractures are well connected or if the wells tap the same fracture, the pumping of one of the wells produces nearly as much drawdown in the unpumped well as in the one that is pumped.

In summary, wells located on fracture traces tend to yield more water than wells not so located; wells located on different fractures, or as far apart as practicable, interfere with one another to a minimum extent.

Water Quality

The chemical character of the water in the rocks of the Appalachian Plateaus is diverse. Geologic conditions here give rise to three distinct types of water and, of course, mixtures of these types.

First, as precipitation percolates through the soil and underlying rock it dissolves small amounts of mineral matter, chiefly calcium and magnesium carbonates, which become bicarbonate in solution, and minor amounts of silica, iron, manganese, sodium, potassium, sulfate, chloride, nitrate, and fluoride. The resultant solution is called a calcium magnesium bicarbonate water. It generally contains about 200 mg/l dissolved solids and is the type of water that is usually referred to when good quality ground water is mentioned.

Second, ancient environments that favored the accumulation of plant material, which later was transformed into coal, also favored the deposition of iron sulfides, chief of which is pyrite. Many coal beds, therefore, have pyrite associated with them, either in masses interbedded with the coal or finely disseminated in the overlying strata. The pyrite dissolves in the ground water and contributes iron and sulfuric acid to form a second type of water, called a sulfate water. More commonly it is known as acid-mine water, though it may not be connected with any mining operations, and the acid may have been neutralized by reaction with limestone. However, mining will accelerate the solution of pyrite by breaking up the rock and exposing more surface area of pyrite to water and air.

The presence of sulfuric acid enables the water to attack the rocks more strongly, which may increase the dissolved-solids content of the water to more than 2000 mg/l.

Third, when the sediments that form the consolidated rocks were laid down, sea water, which contains chiefly sodium and chloride, was trapped in the pore spaces. Subsequently, changes have concentrated the dissolved-solids content of this trapped water so that today the concentration of dissolved material may exceed 200,000 mg/l. Such water occurs below the zone of fresh water and is commonly found during the drilling of deep oil and gas wells. Sometimes the salt water invades the freshwater aquifers through damaged or poorly plugged deep wells.

Precipitation has flushed the salt water from the upper several hundred feet of rock. However, all the constituents are not flushed with equal ease. Some sodium is held by the clay in the rocks and is removed very slowly, but the chloride is readily flushed. The flushing may be summarized as taking place in the following steps: (1) the dissolved-solids content is decreased, yielding a dilute sodium chloride water; (2) almost all the chloride is removed, leaving a sodium bicarbonate water; (3) the sodium concentration is still further reduced, and the water in the rocks becomes the type 1, or calcium magnesium bicarbonate type.

In the absence of poorly permeable, difficult-to-flush rocks or contamination from leaky wells, the upper 100 to 300 feet of rocks of the county contain fresh ground water. Near the base of this zone the partly flushed water discussed above is present.

Monongahela Group

Distribution and Lithology

The rocks of the Monongahela Group are present only on the upper parts of a few hills in the southern part of the county. At its maximum thickness in the county (about 60 feet), the group is represented in ascending order, by the Pittsburgh coal bed and its underclay, an unnamed shale, the Pittsburgh rider coal bed, and an unnamed shale that contains a coarse 5-foot-thick sandstone bed.

Water-Bearing Properties

The Monongahela is not important as a water-bearing unit because of its small areal extent, topographic position, and lithologic character.

Conemaugh Group

Distribution and Lithology

The Conemaugh Group has been divided into the Casselman and Glenshaw Formations. It is present throughout the county except in the valleys of some of the streams, where it has been eroded. Only in the southern part of the county, however, is the entire group present. Each formation contains a massive sandstone member that has locally formed topographic benches.

The following is a generalized geologic section of the Conemaugh Group in Beaver County.

	Average thickness (feet)
Casselman Formation	
Shale, several limestones (Pittsburgh limestone beds), and coal beds	40
Connellsville Sandstone Member – sandstone, shaly; shale; locally coal and limestone	75
Morgantown Sandstone Member – sandstone, coarse- to fine-grained, massive to thin-bedded; sandy shale; most persistent sandstone in region	65
Shale, red and green; shaly limestone; thin discontinuous coal beds	40
Glenshaw Formation	
Ames Limestone Member – greenish-gray, breaks along a rough surface that resembles coarse-grained sandstone	5
Red beds – shale, red to green; locally coal and limestone near top	30
Saltsburg Sandstone Member – sandstone, clayey; shale	65
Buffalo Sandstone Member – shale, sandy, and laminated sandstone; coal near top	100
Shale, yellow to red at bottom, dark-gray to brown at top; coal and limestone	60
Mahoning Sandstone Member – sandstone, coarse-grained, locally conglomeratic, yellowish-brown, may be massive; thin lenses of coal and limestone; shale	40

The lithology of the formations is extremely variable, so that sandstone is superseded by shale both laterally and vertically within short distances, and the coal and limestone beds are thin and not persistent. The Ames is more widely distributed than the other limestones in the Conemaugh and is used as a marker bed in places. The Conemaugh is about 520 feet thick.

Well Depths and Yields

Data are available for 52 wells in the Conemaugh in Beaver County. The wells range in depth from 51 to 350 feet, and the average depth is about 112 feet.

Yields were reported for 41 of the wells. Eight yield less than 1 gpm and nine yield more than 10 gpm. Only one well yielded as much as 100 gpm. About half the wells yield 5 gpm or less.

Water Quality

Analyses of six samples of water are available from the Conemaugh. Five are from a small area in the southern part of the county and may not be representative of the Conemaugh throughout the county. The wells are in valleys, and although not excessively deep (they range in depth from 100 to 238 feet), they contain water that shows that these rocks have not been completely flushed of the sea water trapped in the pore spaces when the rocks were deposited. The dissolved-solids content of the well water, more than 500 mg/l, exceeds the recommended limit of the U.S. Public Health Service (1962), and the water is of the sodium bicarbonate type. Three samples also contain more than 100 mg/l chloride.

The sixth sample is from an unused well (Bv-5) drilled for industrial use at Ambridge. It contains 1160 mg/l dissolved solids and is high in concentration of sodium and potassium, chloride, bicarbonate, and sulfate.

Allegheny Group

Distribution and Lithology

The Allegheny Group crops out in stream valleys in the northern half of the county and along the major stream valleys across most of the county. It includes all the rock between the top of the Upper Freeport coal and the base of the Brookville coal or its underclay and is about 300 feet thick. The Allegheny has been divided into the Freeport Formation (youngest), Kittanning Formation, Vanport Limestone, and Clarion Formation (oldest).

The following is a generalized section of the Allegheny Group:

	Average thickness (feet)
Freeport Formation	
Upper Freeport coal	3
Clay; limestone; sandstone, fine- to medium-grained, micaceous, thin-bedded to massive; shale	60
Lower Freeport coal, canneloid and shaly in places	2
Clay; limestone; sandstone, fine- to medium-grained, quartzose, micaceous	56
Kittanning Formation	
Upper Kittanning coal, canneloid and shaly	1
Shale; siltstone; sandstone, fine- to medium-grained	26
Middle Kittanning coal	2
Shale; sandstone, fine-grained	40
Lower Kittanning coal, discontinuous	1
Clay; shale; sandstone, very fine- to medium-grained, thin-bedded to massive, quartzose, lenticular	53
Vanport Limestone	16
Clarion Formation	
Shale; sandstone, fine-grained; coal, thin, at top (Scrubgrass coal), middle (Clarion coal), and bottom of the formation (Brookville coal)	40

Well Depths and Yields

The Allegheny Group is capable of supplying moderate amounts of water to wells. About half the 18 wells on which data are available yield more than 15 gpm. Two wells yield less than 5 gpm, and two yield more than 100 gpm. Measurements of depth of 31 wells are available. About half the wells are more than 105 feet deep, three are less than 50 feet deep, and only two are more than 210 feet deep.

Water Quality

Only a single analysis is available for water from a well tapping the Allegheny Group. The well is near the Ohio River, about 4 miles east of Midland. It is only 200 feet deep, but its water contains more than 3800 mg/l dissolved solids, most of which are sodium chloride. The water is typical of that obtained from rocks that have been incompletely flushed of their original water. The chemical analysis of water from this well illustrates the dangers of drilling too deep in some areas.

Pottsville Group

Distribution and Lithology

The Pottsville Group crops out only in the northern part of the valleys of the Beaver River and Connoquenessing Creek. It is about 200 feet thick and typically consists of alternating sequences of massive sandstone and shale. However, the sandstones grade laterally into sandy shale or shale and are then difficult to distinguish from the overlying or underlying units. The Homewood and the upper and lower members of the Connoquenessing are the sandstone units. The Mercer, the middle member of the Connoquenessing, and the Sharon constitute the shale units.[1]

The sandstones of the Pottsville are sometimes misidentified because of their similar appearance and the common practice of identifying them by their relation to a nearby coal bed. Thus, the Homewood is considered to lie immediately beneath the Brookville coal or its underclay (Allegheny Group). However, the Brookville was misidentified in some of the older reports, and the name was applied to a coal bed in the Mercer. This usage is sometimes applied today, so that the Homewood then becomes a bed in the Clarion, the Connoquenessing is called the Homewood, and the sandstone in an underlying formation becomes the Connoquenessing.

The base of the Pottsville is also difficult to define in places. The underlying (Mississippian) surface has been truncated by erosion, so that the upper shale

[1] These formation names do not conform to the nomenclature used by the Pennsylvania Geological Survey. For a discussion of the stratigraphy of the Pottsville Group in western Pennsylvania, see Edmunds, W. E. (1969), *Revised lithostratigraphic nomenclature of the Pottsville and Allegheny Groups (Pennsylvanian), Clearfield County, Pennsylvania,* Pa. Geol. Survey, 4th ser., Inf. Circ. 61, 36 p.; Ashley, G. H. (1945), *The Pittsburgh-Pottsville boundary,* Jour. Geology, v. 53, p. 374-389; and Renick, B. C. (1924), *The correlation of the Allegheny-Pottsville section in western Pennsylvania,* Jour. Geology, v. 32, p. 64-80.

units may be missing, and the Pottsville then rests directly on sandstone. Both the Pottsville and the Mississippian sandstones are typically gray to white, well-cemented quartzites.

A conventional, generalized section through the Pottsville Group is as follows:

	Average thickness (feet)
Homewood Formation	
Shale to massive sandstone; thin coals	40
Mercer Formation	
Sandy shale; shale; coal (one to three beds); clay; limestone	30
Connoquenessing Formation	
Sandstone, massive to shaly	40
Shale; sandy shale; coal	30
Sandstone, massive to shaly	40
Sharon Formation	
Shale and coal	20

Well Depths and Yields

Data for the Pottsville are available from 23 wells whose average depth is about 70 feet and whose average yield is about 30 gpm. Where the group is not buried too deeply, it should be an excellent source of water, as it is farther north.

Water Quality

No analyses of water from wells drilled in the Pottsville in Beaver County are available. However, where the sandstones are well developed, they usually contain large, easily flushed fractures. Therefore, where the Pottsville is not too deeply buried beneath poorly permeable rocks, it should contain water of satisfactory quality.

DEVELOPMENT OF GROUND-WATER SUPPLIES

During the early settlement of the area, water needs of the people were easily satisfied by shallow dug wells. The shallower of these wells failed during the late summer and fall and especially during draught years, so that the wells had to be deepened. Even so, the yield of a dug well was severely limited because it could be dug only a short distance below the water table. Dug wells were also easily contaminated because their sides were loosely lined with stone, permitting ready access of water without the benefit of slow filtration; also, burrowing animals sometimes tumbled into dug wells and drowned.

As advancing technology made possible the drilling of wells, this type of construction supplanted the digging of wells. Drilled wells overcame both disadvantages of dug wells cited above. They could be drilled to nearly any depth, thus ensuring a perennial supply of water. Surface pollutants, discrete zones of undesirable water, and burrowing animals could be kept out by steel casing.

As more people settled close to one another, and as mines were activated, the drilled well next to an owner's home could no longer be counted on to supply adequate amounts of pure water. In some places the close proximity of many families discharging wastes into cesspools exceeded the ground's capacity to filter the water, and some or all of the wells were contaminated.

Mining can adversely affect the quality of water by accelerating the oxidation of iron sulfide minerals and also can permanently lower the water table, so that the water becomes brackish.

The latest step in the development of ground-water supplies is the construction of community-supply wells. These wells are drilled in favorable locations, where large supplies may be obtained and where the sites can be protected from contamination.

PUBLIC WATER SUPPLIES

Approximately 70 percent of the population of Beaver County uses water from a public supply. The water is supplied to 38 communities by 15 water authorities or water companies in the county. Seven of the suppliers use wells, four use surface-water sources, and four purchase water from three of the other suppliers (Table 7).

WATER PROBLEMS RESULTING FROM THE ACTIVITIES OF MAN

The activities of man have caused an acceleration of some natural processes, resulting in a marked worsening of the chemical quality of the water.

Chief among these activities is coal mining. As noted earlier, mining breaks up the rock and exposes more surface area of iron sulfide minerals to air and water. The consequent oxidation and solution of iron sulfide minerals result in water high in sulfate, iron, and acid content. The acid in the water attacks calcium carbonate minerals and increases the water's hardness. The water continues to move through the rocks, so that it is associated not only with the iron sulfide minerals but also with underlying rocks or in rocks down the hydraulic gradient;

Table 7. *Public Water Supplies*[1]

Water authority or company and community supplied	Source	Number of customers
Municipal Authority of Aliquippa Aliquippa Borough Hopewell Township (parts)	Wells	6,500
Borough of Ambridge Water Authority Ambridge Borough, Economy Borough Baden Borough, Harmony Borough	Impoundment	5,600
Water Authority of the Borough of Beaver Beaver Borough	Wells	2,200
Beaver Falls Water Authority Beaver Falls City, New Brighton Borough Big Beaver Borough, New Sewickley Township Bridgewater Borough, Patterson Heights Borough Chippewa Township, Patterson Township Conway Borough, Pulaski Township Daugherty Township, Rochester Borough E. Rochester Borough, Rochester Township Eastvale Borough, W. Mayfield Borough Fallston Borough, White Township Freedom Borough	Beaver River	15,460
Water Authority of Borough Township Borough Township	Wells	[a] 600
Water Authority of Brighton Township Brighton Township	Purchase from the Water Authority of Borough Township	1,512
Water Authority of Center Township Center Township	Wells	2,050

Cresswell Heights Water Authority Crescent Township (Allegheny County) Hopewell Township South Heights Borough	Wells	2,500
Ellwood Consolidated Water Company North Sewickley Township	Slippery Rock Creek	5,651
Borough of Industry Water Authority Industry Borough	Wells	484
Borough of Koppel Koppel Borough	Purchase from Ellwood Consolidated Water Company	370
Water Authority of the Borough of Midland Midland Borough	Ohio River	[b] 1,400
Water Authority of the Borough of Monaca Monaca Borough	Wells	2,500
Water Authority of North Sewickley Township North Sewickley Township	Purchase from Ellwood Consolidated Water Company	585
Municipal Authority of Ohioville Ohioville Borough	Purchase from Midland Borough	577

[1] From Beaver County Planning Commission
[a] Housing projects (2) considered as individual customers.
[b] Ohioville Borough considered as one customer.

that is, in the direction the water moves naturally. This water eventually is discharged to streams, where, in sufficient quantities, it kills fish and plant life and leaves an orange scum of oxidized iron on the stream bottom.

Mining may result in a permanent lowering of water levels. This lowering, plus land subsidence, may reduce the value of land above the mine.

Oil and gas operations constitute another source of contamination of water supplies. Hundreds of wells have been drilled in the county in the search for oil and gas. When a well proved nonproductive it was abandoned. Not always in the past, however, was the well properly plugged before abandonment. In some places wells were left open or only capped, so that salt water and oil were able to rise in the borehole. When the casing became corroded or was removed, saline water and oil moved into freshwater aquifers and into streams.

WELL CONSTRUCTION

DRILLING METHODS

Dug wells are being replaced gradually by drilled wells. Two methods are used to drill most of the wells: the cable-tool percussion method and the rotary-drilling method.

In the cable-tool percussion method, wells are drilled by alternately lifting and dropping a heavy drill bit in the borehole. The drill bit breaks or crushes the rock into small fragments, which are then removed from the hole by bailing. In the rotary-drilling method, wells are drilled by a rotating bit, and the rock chips are removed by circulating water, drilling mud, or air under pressure in the borehole. Well diameters for drilled wells are smaller than those of dug wells, but depths and yields of drilled wells generally are much greater.

Steel casing is emplaced in the drilled wells to the bottom of the weathered rock, and a slurry of rock cuttings (in most domestic wells) or concrete (in public supply and industrial wells) is then poured in the annular space between the casing and the wall of the well to seal the space tightly and to prevent contaminants from entering the well.

WELL DEVELOPMENT

The method commonly used to increase well yields consists of heavy pumping of the well for a short period of time to remove drill cuttings and fine material. Other less common techniques used to increase yields are mechanical surging and the addition of detergents.

Mechanical surging is similar to operating a piston in a cylinder, with the casing or well bore acting as the cylinder and the surge block as the piston. Alternately raising and lowering the block in the well forces water in and out of openings in the aquifer. Rock chips or fine sand grains are loosened and drawn into the well bore, from which they may be pumped after surging. This method is most successful in sandstone, conglomerate, and unconsolidated aquifers.

Detergents can be used in wells where clay and silty materials are plugging small fractures and other openings in the aquifer. The detergent helps break up these plugs into small particles, so that they may be pumped out, leaving the aquifer openings clear to transmit more water to the borehole.

MANAGEMENT OF WATER SUPPLIES

PROTECTION FROM OVERDRAFT

Except in the vicinity of active mines, where the water table is deliberately being lowered to facilitate mining, there is no known overdraft of ground water anywhere in the county. Overdraft is possible wherever well fields are established or expanded to supply large amounts of ground water. Determining interference between wells before drilling final production wells is a safeguard against possible overdraft, as are periodic water-level measurements to determine the long-term trend of water-table fluctuations and the effect of pumping.

PROTECTION FROM POLLUTION

Pollutants are carried downward from the land surface by infiltrating water or are moved laterally from adjacent areas. Because ground-water movement is relatively slow, such pollutants are slow to accumulate and just as slow to disperse after the polluting source is removed. The locations of sources of pollution, such as sanitary landfills and septic tanks, are a major factor in the selection of well sites.

Government agencies are becoming increasingly active in the field of pollution prevention. For example, the Pennsylvania Department of Environmental Resources has set standards for length and cementing of casing in wells. The Division of Oil and Gas has regulations concerning the abandonment of oil and gas wells, and the Bureau of Land Protection and Reclamation supervises the backfilling of strip mines to reduce the formation of acid water in the stripped areas.

WHERE TO GET INFORMATION ABOUT WATER

A variety of information on water supplies is available from the several government agencies listed below. When requesting information it is important to give an accurate location of the site for which you wish information.

The Pennsylvania Topographic and Geologic Survey has information on the geology of Beaver County and has published reports that describe in detail the rocks that underlie the county. Well drillers' logs and reports on new wells that have been drilled in the county are also available at their office.

The Division of Water Quality, Bureau of Water Quality Management, Pennsylvania Department of Environmental Resources, can supply information on well-construction requirements, biological reports on well water, and the chemical quality of ground water. The Division, through various regional offices, tests water samples for bacterial pollution. They also can advise effective corrective measures when pollution is reported.

The Division of Natural Resources and Technical Services, Bureau of Engineering, Pennsylvania Department of Environmental Resources, has information on stream discharges, flood data, reservoir requirements, and power-plant discharges.

The Public Utility Commission, Bureau of Rates and Research, has information on some municipal water supplies, including source, average daily use, total annual use, and estimated future needs.

The U.S. Geological Survey has data on wells, springs, and streams and on the chemical quality of water.

Local well drillers and pump installers can provide prices and suggest the type of equipment needed to develop a water supply. They can also suggest the proper well diameter for the necessary pumping equipment. Pump installers can supply information concerning the size of the pump, depth of the pump setting, and the pressure-tank capacity.

If the chemical analysis of the well water indicates treatment is necessary, any of the commercial water-treatment companies can provide the necessary information and equipment. Equipment for water treatment can be purchased or rented, and it will generally be serviced by the supplier if desired.

GLOSSARY

Aquifer: A formation, group of formations, or a part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Artesian conditions: The occurrence of ground water under sufficient hydrostatic head to rise above the upper surface of the aquifer.

Base flow: Discharge entering stream channels as effluent from the ground-water reservoir; the fair-weather flow of streams.

Cubic feet per second: The discharge of a stream of rectangular cross section, 1 foot wide and 1 foot deep, whose velocity is 1 foot per second; equivalent to 448.8 gallons per minute.

Cone of depression: A conical depression, on a water table or other potentiometric surface, produced by a pumping well.

Direct runoff: The water that moves over the land surface directly to streams promptly after rainfall or snowmelt.

Dip of beds: The angle at which the formation or bed in inclined from the horizontal measured at a right angle to the strike.

Discharge, ground water: The process by which water is removed from the saturated zone; also the quantity of water removed.

Drawdown: The lowering of the water table or potentiometric surface caused by pumping (or artesian flow).

Evapotranspiration: Water withdrawn from a land area by direct evaporation from water surfaces and moist soil and by plant transpiration.

Fault: A fracture or fracture zone along which there has been displacement of the two sides relative to each other parallel to the fracture. The displacement may be a few inches or many miles.

Formation: A fundamental unit in rock stratigraphic classification. It is a body of rock characterized by lithologic homogeneity; it is prevailingly but not necessarily tabular and is mappable at the earth's surface or traceable in the subsurface.

Fracture: A break in rocks.

Generalized geologic section: The description of the prominent features in a sequence of rocks. Minor features are neglected.

Ground-water reservoir: An aquifer or a group of related aquifers.

Head, static head: The height of a vertical column of water, the weight of which, in a unit cross section, is equal to the hydrostatic pressure at a point.

Homocline: A structure in which the beds dip uniformly in one direction.

Hydraulic gradient: Change in static head per unit of distance in a given direction.

Overdraft: An excessive lowering of the water level or artesian head in an aquifer caused by excessive withdrawal.

Perched ground water: Ground water separated from an underlying body of ground water by unsaturated deposits.

Permeability: The capacity of a material to transmit a fluid.

Porosity: The ratio of the aggregate volume of interstices in a rock or deposit to its total volume, expressed as a percentage.

Potentiometric surface: The surface that represents the static ground-water head; defined by the levels to which water will rise in tightly cased wells.

Primary openings: Openings or voids existing when the rock was formed. In sedimentary rocks, openings result from the arrangement and nature of the original sediment.

Recharge, ground water: The process by which water is added to the saturated zone; also the quantity of water added.

Runoff: That part of the precipitation that appears in streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on the stream channels.

Saturated zone: The zone in which interconnected interstices are saturated with water under pressure equal to or greater than atmospheric.

Secondary openings: Voids produced in rocks subsequent to their formation by solution, weathering, or movement.

Soil tonal alignments: The arrangement of similar tones or shades of color in a particular direction on an aerial photograph believed to be due to a similarity in the properties of the soil.

Specific capacity: The yield of a well, in gallons per minute, divided by the drawdown of water level in the well, in feet.

Stream-gaging station: A gaging station where a record of discharge of a stream is obtained. Within the Geological Survey this term is used only for those gaging stations where a continuous record of discharge is obtained.

Surface water: Water on the surface of the earth.

Transpiration: The process by which vapor escapes from the living plant, principally the leaves, and enters the atmosphere.

Unconformity: A surface of erosion that separates younger strata from older rocks.

Vadose water: Water in the zone of aeration.

Water table: The potentiometric surface of an unconfined water body where the pressure is equal to that of one atmosphere.

Water-table conditions: The condition under which water occurs in an aquifer that has a water table and is not overlain by an impermeable body.

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