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GROUND WATER

IN

NORTHEASTERN PENNSYLVANIA

By
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QUATERNARY SYSTEM

RECENT ALLUVIUM

Recent deposits of silt, sand, and gravel are found along all the streams in this area, but they are thin and unimportant as sources of ground water. A part of this material is derived from the disintegration of the bedrock by rain, frost, and stream erosion, and a part is derived from the reworking of glacial drift, which fills the valleys north of the drift borders.

Another type of material being deposited in the stream beds of northeastern Pennsylvania is very fine coal, or culm, which is discharged into the streams in enormous quantities from the numerous coal washeries.[12] Wherever it is turned into a small stream that does not carry enough water to transport the culm, the stream bed soon becomes filled, and in some streams no channel is left, the water running at will over the adjoining flat lands. The Lackawanna and Schuylkill Rivers and numerous smaller streams, like Shamokin Creek, deposit large amounts of culm. This transported coal is dredged at numerous places along the Susquehanna River as far south as Holtwood, Lancaster County.

PLEISTOCENE GLACIAL DRIFT[13]

More than half of the area described in this report was covered by ice during some of the glacial stages of the Pleistocene epoch. Glacial deposits of at least three ages—from oldest to youngest the Jerseyan, Illinoian, and Wisconsin—are preserved in northeastern Pennsylvania. The drift borders or southern limits of these deposits are shown on plate 1.

As the ice advanced, the soil and decomposed rock were scraped off and shoved along. Masses of bedrock were plucked out by the ice and, held firmly, formed tools with which the glacier scoured the bedrock. Many grooves and striae produced in this manner are still preserved on smooth rock surfaces and show that the general direction of ice movement was about S. 30° W. Except for a few high peaks, which were probably "islands in the sea of ice," the glacier covered the entire northern part of the area, traversing mountains as well as valleys. When the ice sheets reached their southern limits and warmer climatic conditions forced them to retreat by melting back slowly, they left terminal moraines, consisting of a heterogeneous accumulation of unstratified clay, sand, gravel, and boulders.

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[12] A coal washery is a plant erected for the purpose of working over the old waste or culm piles, to recover coal which in earlier times under cruder methods of handling passed out as waste.

[13] See Leverett, Frank, Glacial deposits outside the terminal moraine in Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. G-7, 123 pp. 38 figs., 2 pls. (incl. map), 1934.

The oldest glacial drift in the area is called the "Jerseyan drift." This is no longer marked by a well-defined terminal moraine, and the Jerseyan drift border shown on plate 1 simply indicates the southernmost limit where glacial deposits have been found and includes some areas of questionable glaciation. No extensive deposits of Jerseyan drift were observed, and it is unimportant as a source of ground water.

The Illinoian drift border is generally not far south of the Wisconsin drift border, except along Lehigh River and the North and West Branches of the Susquehanna River, where long, narrow lobes of ice extended farther south. In most places the Illinoian drift border is not marked by a well-defined terminal moraine, the absence of which is due to subsequent erosion. The noteworthy deposits of Illinoian drift are described in the sections on Carbon, Columbia, Montour, and Northumberland Counties. Illinoian drift is unimportant as a source of ground water in northeastern Pennsylvania except in Carbon County and to some extent in Columbia, Montour, and Northumberland Counties. It yields large supplies of potable water in the valley of Aquashicola Creek, in Carbon County. It probably supplies a few dug wells in Columbia, Montour, and Northumberland Counties, but no attempts have been made to recover large quantities of water from it.

The Wisconsin drift, resulting from the most recent glaciation, covers the north half of the area and is marked by a well-defined terminal moraine crossing the area as a series of low hills, hummocks, knobs, and ridges interspersed with depressions, called "kettles," many of which are filled with water. These depressions are due to slumping caused when a block of ice contained in the drift melted. This terminal moraine enters the area in southern Monroe County, traverses it in an irregular, sinuous line, and leaves it in northern Columbia County.[14] Its course through the area is set forth in more detail in the county descriptions. As the Wisconsin ice cap retreated it left drift of two different types in till and outwash.

Till is an unstratified deposit of material that has been dropped directly by the melting ice and has not been sorted by running water. It usually consists of fine, impure clay containing stones of all sizes and shapes, without sorting. Many of the pebbles show one or more facets, or flat sides, which may be grooved or striated. The facets indicate that the pebble was once frozen in the ice and ground flat against the bedrock. Deposits of stratified drift, usually clay, sand, and gravel, which have been sorted by running water are in many places associated with the till. Many of the transported boulders, or "erratics," dropped by the ice consist of rock whose source is known to be hundreds of miles north of the area.

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[14] Lewis, H. C., Report on the terminal moraine in Pennsylvania and western New York: Pennsylvania Geol. Survey, 2d ser., Rept. Z, pp. 1-125, 1884.

A. Terraces of glacial outwash along Tunkhannock Creek ⅛ mile east of Nicholson, Wyoming County (looking northeast from a point on top of the highest terrace)

B. Morainic topography one mile east of Oakland, Susquehanna County

Glacial drift consisting of till and stratified material covers the area north of the Wisconsin drift border and ranges in thickness from a few feet to several hundred feet, except in places where subsequent erosion has removed it. Many valleys were filled up and the streams forced to find new channels over or around the buried valleys. Many of the streams were dammed up by thick deposits of drift, forming lakes, and other streams were diverted from their preglacial courses by heaps of drift, which caused them to flow over cliffs, forming waterfalls. Lakes and waterfalls of glacial origin are numerous north of the Wisconsin drift border. Much of the drift-covered terrane presents a hummocky topography, with odd-shaped hills or mounds of drift and undrained depressions (pl. 6-B). The water-bearing properties of glacial till are described on pages 28-30.

The swollen streams that issued from the melting of the ice sheet transported an immense quantity of material. Whenever the quantity of material exceeded the transporting power of the streams, the material was dropped, and when the streams carried lighter burdens they cut through the outwash material, leaving terraces (pls. 2-B and 6-A). Deposits of glacial outwash fill the larger valleys north of the Wisconsin drift border (pl. 3-A) and extend as "outwash trains" beyond the border. The outwash material consists of clay, sand, "quicksand," and gravel (pl. 7-B).

Many of the valleys were excavated by preglacial erosion much deeper than they are at present, and these deep channels were later filled with clay, sand, and gravel, so that the present streams flow over deeply buried valleys in many places. Locally the depth of the sediments filling these old channels is more than 300 feet, but generally the depth ranges from 50 to 150 feet. The Wyoming Valley of the North Branch of the Susquehanna River is one of the most notable examples of such filling, for from Pittston to Nanticoke it is underlain by a deposit of sand, gravel, and clay which attains a thickness of 309 feet at one locality and is more than 100 feet thick under an area of nearly 20 square miles.[15] A cross section of the Wyoming Valley is shown in figure 4.

The occurrence of water in the glacial outwash is described on page 30. The thickness and character of the glacial drift varies in the different counties, and the deposits are therefore described separately for each county.

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[15] Darton, N. H., Sand available for filling mine workings in the Northern Anthracite Basin of Pennsylvania; U. S. Bur. Mines Bull. 45, p. 6, 1913.

LUZERNE COUNTY

GENERAL FEATURES

[Area 892 square miles, population 444,409]

Luzerne County is about in the center of the area described in this report and is bordered by Sullivan County at the northwest corner. It is by far the largest county in the area and has a greater population than any other county in the area. With 498 inhabitants to the square mile Luzerne County is second in density of population only to Lackawanna County. Of the 20 largest municipalities in the area described in this report 6 are in Luzerne County—Wilkes-Barre, 86,626; Hazleton, 36,765; Nanticoke, 26,043; Kingston, 21,600; Pittston, 18,246; and Plymouth, 16,543. The centers of population and industrial development are the anthracite fields, foremost of which are the Northern field in the Wyoming Valley and the Eastern Middle field at Hazleton. In 1929 there were in the county 411 manufacturing establishments with products valued at $5,000 or more each, and in 1930 there were 102 anthracite mines and 2,385 farms. The farms are scattered in the higher regions on both sides of the Wyoming Valley.

SURFACE FEATURES

The highest point in Luzerne County is on the western border of Fairmount Township, at the corner of Luzerne, Sullivan and Columbia Counties where North Mountain reaches a maximum altitude of 2,450 feet. Southeast of Susquehanna River Penobscot Knob and Bald Mountain are each 2,140 feet above sea level. The Susquehanna at Berwick is 480 feet above sea level and therefore, the maximum relief in the county is 1,970 feet. The greatest local relief is around North Mountain, which rises 1,000 to 1,200 feet above the surrounding country.

A portion of the eastern and southeastern part of Luzerne County is drained by the headwaters of Lehigh River. The remainder and by far the greater part of the county is drained by the North Branch of Susquehanna River, which flows southwestward through about the center of the county. In flowing 42 miles from Ransom to Berwick the North Branch drops 40 feet—a gradient of 1.05 feet to the mile.

GEOLOGY AND GROUND WATER

GENERAL SECTION

The rock formations exposed in Luzerne County range from the post-Pottsville formations, of Pennsylvanian age, down to the Onondaga formation, of Middle Devonian age. Outcrops of the Helderberg limestone reach the southwestern boundary of the county but do not extend beyond it. The Wisconsin terminal moraine crosses the southern part of the county (see pl. 1), and the greater part of the county is covered by glacial drift. Extensive deposits of glacial outwash occur along Susquehanna River and less extensive deposits along the smaller streams.

Generalized section for Luzerne County

Geologic formation	Maximum thickness (feet)	Character of rocks	Ground-water conditions
Glacial drift (Wisconsin)	300±	Till consisting of clay and boulders, with sand lenses, outwash consisting of stratified clay, sand, and gravel.	Till yields small supplies to shallow wells. Outwash yields moderate to very large supplies. Yields water of excellent quality to numerous small springs. Outwash in Susquehanna Valley yields water of less desirable quality.
Post-Pottsville formations (of Pennsylvanian age)	1,800±	Sandstone, conglomerate, shale, fireclay, carbonaceous "slate" and coal, a few beds of limestone.	Unimportant as water bearer; head lowered and water polluted by mining operations.
Pottsville formation	500±	Chiefly hard coarse quartz conglomerate, with gray, red brown, and green sandstones, "slate", and a few thin seams of coal.	Yields moderate to large supplies of water of good quality. Many flowing wells.
Mauch Chunk shale	2,000±	Chiefly red shale, with red and green sandstone and green shale.	Yields adequate supplies of water to shallow domestic wells, and moderate to large supplies to deep drilled wells, especially in the Hazleton region. Some flowing wells. Water is of good quality.
Pocono sandstone	600±	Coarse and in places pebbly gray and yellowish-gray sandstone, flaggy sandstone, and greenish-gray sandstone; thin seams of coal may be found locally.	Yields moderate supplies of water to wells of moderate depth, some of which are flowing wells. With one exception, water is of good quality.
Catskill group	1,700±	Red shale, red and gray cross-bedded sandstone, gray, green, and white sandstone, gray shale and sandstone in lower part.	Yields moderate supplies of water to wells of moderate depth. Few flowing wells. Water is of good quality.
Chemung formation and Portage group	3,100±	Alternating gray and olive-green shale and sandstone, dark shale at base; fossiliferous; marine.	Yields small supplies of water. Deeper wells likely to obtain salty or brackish water. Water generally hard and may give off hydrogen sulphide.
Hamilton formation	1,000±	Brown, gray, and bluish-gray sandy shales; fossiliferous; marine.	Yield small supplies of potable water. Water usually hard, likely to be high in dissolved mineral matter, chiefly sulphate, and likely to give off hydrogen sulphide.
Marcellus shale	410	Black and dark-blue fissile shales; fossiliferous; marine.	
Onondaga formation	10–15	Limestone.	Unimportant.

STRUCTURE

Nearly all of Luzerne County lies in the Valley and Ridge province, in which the rocks have been strongly folded. In going from north to south across the county, five major folds are encountered, all of which trend northeast. The first of these is a shallow syncline on the crest of North Mountain, forming the Mehoopany coal basin. The second is the Milton anticline, which exposes the Portage group in the northwestern part of the county and gradually flattens out toward the norheast. The third and most pronounced is the Lackawanna syncline, which has preserved the post-Pottsville formations throughout the Wyoming Valley. The maximum depth of this syncline is reached in the vicinity of Wilkes-Barre and Plymouth. The double rim of this syncline is formed by the resistant Pottsville formation and Pocono sandstone, separated by the less resistant Mauch Chunk shale. The fourth fold is the Berwick (Montour) anticline, which exposes a few feet of the Onondaga formation in the vicinity of Beach Haven. This fold reaches its maximum development farther west, and only the eastern portion reaches Luzerne County. The fifth major fold comprises a series of anticlines

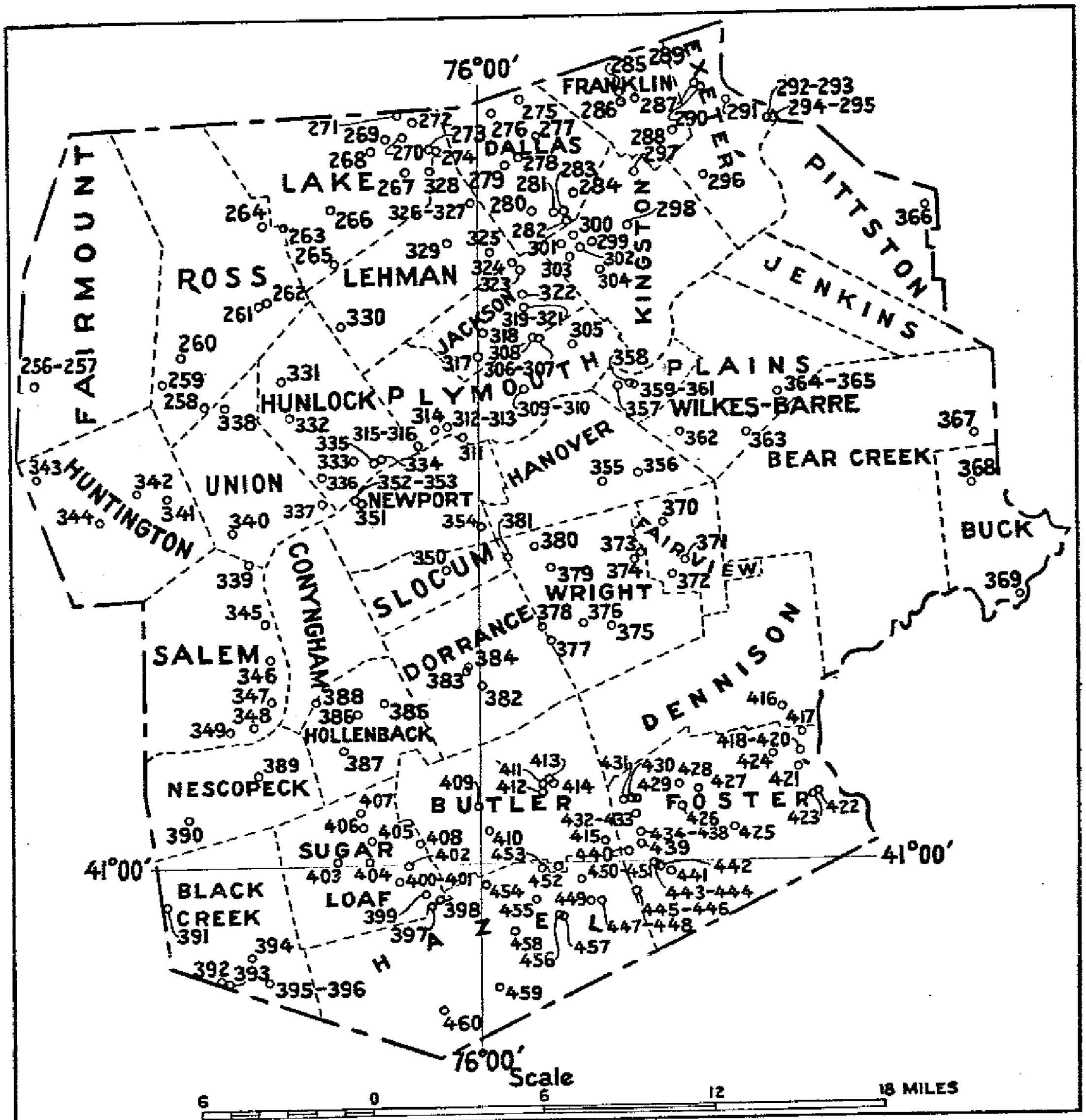

Figure 11. Map of Luzerne County showing location of water wells

Laurel Run Twp. name omitted (wells 362-3). South boundary of Plains Twp. runs from L in Plains to B in Barre. Well 339 is in Union Twp.

and synclines forming the Eastern Middle anthracite field in the vicinity of Hazleton. The synclinal basins in this region are relatively shallow, and there are large areas from which all the coal beds have been eroded.

The general dips of the region are 0° to 40°, and the maximum dips are found on the rims and within the synclinal coal basins. Although these synclines are relatively simple canoe-shaped folds as viewed in a general way, the relatively soft post-Pottsville beds in their cores are severely folded and contorted, with numerous minor faults. The northern and the easternmost parts of the county border the Appalachian Plateaus province and are characterized by horizontal or nearly horizontal strata.

WATER-BEARING FORMATIONS

[See pp. 41-59 for further description]

Glacial drift.—The terminal moraine left at the end of the Wisconsin glaciation crosses the southern part of the county from a point west of Beach Haven to the southeast corner on Lehigh River. North of this line the county is covered by glacial drift except where erosion has exposed the underlying bedrock.

On both sides of Susquehanna River the unsorted till and the stratified outwash material yield small to moderate supplies of potable water to shallow dug wells, and where lenses of gravel occur stronger supplies are obtainable. In the smaller rural communities dug wells and springs in the glacial drift are the chief sources of domestic water supply, and many of these springs are used for small public supplies. The drift waters are exceptionally low in dissolved mineral matter. (See analyses on p. 165.)

Very few drilled wells end in the glacial drift in Luzerne County, but many of them penetrate 20 to 200 feet of drift before reaching the underlying bedrock. In many of these drilled wells lenses of water-bearing sand and gravel are cased off. In some places the glacial drift is composed largely of clay or "hardpan" and may yield little or no water.

Along Susquehanna River, particularly in the Wyoming Valley, there are thick deposits of glacial outwash consisting of irregular lenses of stratified clay, sand, and gravel. The river flows over a buried valley in many places, and buried channels are encountered in mining operations. Near Beach Haven, where the terminal moraine crosses Susquehanna River, there are at least three terraces, two of which are visible in plate 2-B. The buried valley of the Susquehanna in the Wyoming Valley has been studied by Darton[93], who found that the glacial outwash deposits reached a maximum depth of 309 feet near Plymouth. (See fig. 4.)

Moderate supplies of water are obtained by dug and driven wells in the glacial outwash deposits, and exceptionally large supplies are obtained in a few places by means of drilled wells equipped with well screens or strainers. An excellent example of proper well construction is furnished by the three gravel-walled and screened wells of the Stanton Operating Co., of Pittston, which are by far the strongest wells noted in northeastern Pennsylvania. (See well 294). A cross section of well 1 is shown in figure 5, and the wells are described on pages 33-35. Each well was tested at 1,280 gallons a minute with a draw-down of only 9 or 10 feet after 8 hours continuous pumping. (See also wells 295, 353). Doubtless many more wells of this type could be developed in the county. The Horn Dairy Co., of Wilkes-Barre, obtains an adequate supply of water from outwash sand by means of a driven well only 45 feet deep (well 358). An analysis of water from this well shows that the water is high in nitrate, and this would probably be true of other wells obtaining water from outwash deposits within the coal basin.

Post-Pottsville formations.—The post-Pottsville formations, including the Allegheny and part of the Conemaugh, crop out in the Wyoming

[93] Darton, N. H., Sand available for filling mine workings in the northern anthracite basin of Pennsylvania. U. S. Bur. Mines Bull. 45, p. 6. 1913.

Valley, where their combined thickness is about 1,800 feet. All of the Conemaugh formation has been swept away by erosion in the Hazleton region, and only about 700 feet of the Allegheny formation remains in the deepest (Hazleton) basin.

The coal and sandstone beds are well fractured and in most places contain considerable water. However, in the coal basins mine drainage has lowered the water level considerably, and the oxidation products resulting from the exposure of the coal to air in the mines have rendered the water unfit for ordinary use in most places. According to Mr. Paul Sterling, engineer of the Lehigh Valley Coal Co., Wilkes-Barre, most of the ground water occurs within about 450 feet of the surface, and the lower beds are usually dry. Individual collieries in the Wyoming Valley pump from 1,500 to 2,500 gallons a minute on a yearly average, and those in the Hazleton basin pump from 500 to 8,000 gallons a minute. According to Mr. Sterling, 17 to 20 tons of water is pumped for every ton of coal mined. Mine drainage water is used only for washing coal.

Despite the drainage and pollution several wells obtain satisfactory supplies of potable water from sandstone beds in the Wyoming Valley. (See wells 357, 361.) Well 361 yields water containing hydrogen sulphide.

Pottsville formation.—The Pottsville formation crops out as a high strike ridge surrounding the Wyoming Valley coal basin and is also exposed around and between the small coal basins in the Hazleton region. Its thickness around the Wyoming Valley averages about 220 feet and varies between 150 and 300 feet. In the Hazleton region the Pottsville formation is about 500 feet thick, and the conglomerate is considerably coarser than it is in the Wyoming Valley. Thin beds of coal occur in the Pottsville in both regions, but few of them are of workable thickness.

The six wells believed to penetrate the Pottsville around the Wyoming Valley are reported to yield large supplies of potable water, and all the wells for which data are available are said to be flowing wells. The water occurs in open fractures and crevices in the hard conglomerate and sandstone, and the artesian head is probably due to the presence of thin shale beds above the fractured conglomerate. Most of these wells were formerly used for municipal supply but have been abandoned in favor of larger surface-water supplies.

In the Hazleton region numerous drilled wells (chiefly for municipal supply) penetrate the Pottsville, though many of these wells extend down into the underlying Mauch Chunk shale. In many wells it is not certain whether the water comes from the Pottsville or from sandstone beds in the Mauch Chunk, and in some the water probably comes from beds of both formations. These wells range in depth from 150 to more than 800 feet, and most of them yield from 50 to 150 gallons a minute, although a few yield as little as 10 gallons a minute. The wells in the Hazleton region show great variation in water level. Many of the wells flow during wet seasons, and during dry seasons the water level drops far below the surface. (See pp. 160-163.)

On the basis of three analyses the water from the Pottsville formation appears to be of good quality. It is very soft and contains a relatively small amount of dissolved mineral matter.

Mauch Chunk shale.—The Mauch Chunk shale has two areas of outcrop in Luzerne County. It crops out in a long, narrow valley between ridges of the Pottsville formation and the Pocono sandstone around the Wyoming Valley, and in the large valley area drained by Nescopeck Creek and Lehigh River. In the western part of the Wyoming Valley the Mauch Chunk is about 400 feet thick, but it thins rapidly to the northeast, and the red beds gradually disappear, giving way to about 150 feet of greenish shale and thin-bedded sandstones. In the southern part of the county the Mauch Chunk is about 2,000 feet thick.

The Mauch Chunk yields adequate supplies of potable water to numerous shallow farm wells 50 to 250 feet deep in the southern part of the county. Large suppplies are obtained from the Mauch Chunk in the Hazleton region by wells that reach it after penetrating the overlying rocks. Some of these wells that encounter sandstone beds yield more than 100 gallons a minute, and many of them flow during the winter. Like the water in the other non-marine formations, that in the Mauch Chunk contains very small amounts of dissolved mineral matter and is rather soft.

Pocono sandstone.—The Pocono sandstone is the principal mountain maker of the county. Its horizontal strata cap the high North Mountain and its tilted strata form the outer and highest ridge surrounding the Lackawanna syncline and the highest ridge (Nescopeck Mountain) north of the Hazleton coal basin.

Most of the wells that obtain water from the Pocono sandstone in Luzerne County are along the north rim of Wyoming Valley. In the vicinity of West Nanticoke there are several shallow flowing wells in the Pocono, some of which supply water for bottling. The highest reported yield for any of these wells is 20 gallons a minute, but it is probable that greater yields are obtainable. The water from the Pocono is as a rule noticeably low in dissolved mineral matter, but the water from well 334, at Hunlock Creek, contains 393 parts per million of total dissolved solids, principally sodium chloride and sodium bicarbonate.

Catskill continental group.—The Catskill continental group underlies most of the county north and southeast of the Wyoming Valley and crops out in two strips about 1½ miles wide around the Berwick (Montour) anticline.

Because of its great areal extent the Catskill supplies more drilled wells than any other formation in the county, generally with an adequate supply of good water. The water is generally of good quality but salty or brackish water such as was obtained in well 256, is likely to be encountered by deep wells in the western part of the county north of the river.

Chemung formation and Portage group.—In Luzerne County the Portage group is deeply buried in most places and crops out only along the Milton anticline and around the Berwick (Montour) anticline, and a few feet of marine Chemung are present near Beach Haven.

The Portage is a rather poor water-bearing formation in this county. Domestic wells in the Portage yield from 2 to 10 gallons a minute. The water is generally hard, and some of it gives off an odor of hydrogen sulphide. An analysis of water from well 342 showed 224 parts per million of total dissolved solids, chiefly calcium bicarbonate and sodium chloride, and a hardness of 110 parts per million. However, most of the shallow drilled wells in the Portage yield water that is satisfactory for domestic purposes.

Hamilton formation, Marcellus shale and Onondaga formation.—The Hamilton formation and Marcellus shale have a very small area of outcrop in Luzerne County, being exposed only along the core of the Berwick (Montour) anticline between Nescopeck and Dorrance, and the Onondaga formation is present only near Beach Haven.

This group of formations is much like the Portage group both in lithology and in water-bearing properties. Most of the wells end in shale or "slate" and have small yields. A few wells obtain somewhat more water from beds of fractured sandstone. No water samples were collected from this group of formations within the county, but samples taken in other counties and reports within the county indicate that the water is likely to contain a large amount of dissolved mineral matter, is generally high in sulphate, is generally hard, and in many places gives off hydrogen sulphide.

ARTESIAN CONDITIONS

In many of the wells penetrating the hard-rock formations the water stands somewhat above the level at which it was first encountered. In some wells the artesian head is sufficient to produce a flow. The deep synclinal coal basins are the structural features that produce nearly all the flowing wells in Luzerne County. Several flowing wells occur around the Wyoming Valley, but not every well adjacent to the valley is a flowing well, for locally the confining beds may allow the water to escape into overlying formations. The wells in the small synclinal coal basins in the Hazleton region are noteworthy for their great seasonal variations in artesian head. Many of the wells flow during the winter, but during the summer the water level may drop to a point several hundred feet below the surface of the ground. This is probably due to the fact that all the wells are relatively close to the catchment areas of the formations from which they draw water. Thus the wells continue to flow only as long as the catchment areas continue to be supplied by rainfall.

QUALITY OF WATER

Eighteen samples of water were collected from Luzerne County, 12 from drilled wells and 6 from springs, the analyses of which are tabulated on page 165. The waters from drilled wells contain moderate or small quantities of dissolved mineral matter and are generally soft. The sample from a well in Hunlock Creek in the Pocono sandstone (well 334) was soft but contained 393 parts per million of total dissolved solids, most of which was sodium chloride and sodium bicarbonate. The other analyses of water from the Pocono sandstone show negligible amounts of these constituents and but small amounts of dissolved mineral matter.

The samples from springs, all of which are in glacial drift, contained very little dissolved material and were very soft.

No analyses were made of drainage waters from coal mines, but it is reported that such waters may be very acid, presumably from the pyrite rather than from the sulphur contained in the coal[34]. With the exception of the post-Pottsville formations all the rock formations above the Portage yield water of good quality. The water from the Portage and older formations is satisfactory for most purposes but is likely to contain more dissolved mineral matter and to have greater hardness than water from

[34] Leitch, R. D., Acidity of drainage from high pyritic coal areas in Pennsylvania. U.S. Bur. Mines Rept. Inv. 3146, p. 9, Jan. 1932.

the overlying formations. Deep wells may encounter brackish or salty water in the region north of Wyoming Valley (see well 256), but no brackish or salty water has been reported south of the valley. In many places water from the Portage and underlying formations contains a small quantity of hydrogen sulphide but nowhere in amounts large enough to be objectionable.

A driven well in Wilkes-Barre (well 358) obtains water from the glacial outwash that has a hardness of 198 parts per million and contains considerable chloride and nitrate. This is not characteristic of water in the glacial drift of the higher and more sparsely populated regions and may be due to the large amounts of mine drainage and sewage which are discharged into Susquehanna River above Wilkes-Barre, chiefly from Lackawanna River[95].

PUBLIC SUPPLIES

The larger cities in Luzerne County depend entirely on surface water, Wilkes-Barre and surrounding towns in the Wyoming Valley being supplied by the Wilkes-Barre division of the Scranton Spring Brook Water Co. The water is obtained from numerous small streams impounded on both sides of the valley. The Wyoming Valley Water Co. supplies Hazleton and the nearby Hudsondale, Bear Creek, Wolffs Run, Barnes Run, Mount Pleasant, and a small part of Harleigh. This company also obtains its water from numerous small streams fed by springs.

The communities supplied by ground water are tabulated below. The water from supplies for which analyses are available is low in dissolved mineral matter, soft, and satisfactory for domestic and industrial use. Of the 22 ground-water supplies tabulated, only one is treated for sanitary reasons. The water from spring supplies is noticeably low in dissolved mineral matter and is comparable in this respect to the surface water used for public supply.

INDUSTRIAL SUPPLIES

Ground water is used by a variety of industries in Luzerne County. Perhaps the largest industrial use is in coal washing, in which a large quantity of mine drainage water is used. At times, particularly during dry seasons, the water pumped from the mines is insufficient to supply this need, and additional water is pumped from wells. Both surface water and ground water are used to supply the boilers in the collieries. A large quantity of ground water derived from glacial outwash is used for cooling in the generation of electric power. Ground water is also used for bottling, for swimming pools, and for washing bottles and cooling in dairies.

DOMESTIC SUPPLIES

Domestic supplies in the more thickly settled parts of Luzerne County lying outside of the coal basins are derived largely from drilled wells. In the rural communities the proportion of drilled wells to dug wells is steadily increasing, because many of the dug wells are reported to be unreliable during dry seasons and subject to contamination.

[95] See Leighton, M. O., Quality of water in the Susquehanna River drainage basin: U.S. Geol. Survey Water-Supply Paper 108, pp 23-31, 1904.

Public water supplies in Luzerne County using ground water