

## CHAPTER 16

### GEOLOGY AND AQUIFER YIELDS

#### INTRODUCTION

A Geology and Aquifer Yield by Formation Map of the Region depicts the boundaries of the geologic formations in the area as well as the average aquifer yield in gallons per minute (gpm) for each formation. The map provides aquifer yields in order to determine where, in general, the most productive aquifers in the area can be found.

In the description of each formation, porosity and permeability will be indicated. Below are the definitions of each term as it relates to groundwater supplies.

**Porosity** – the quality of being porous, full or abounding in pores. The porosity of rocks, i.e., the ratio or percentage of the total volume of the pore spaces (minute interstices through which liquids or gases can pass) in relation to the total volume of the rock. Sand, gravel, sandstones, with open textures and coarse grains, are typical porous rocks. Porosity is quite different from perviousness. Dry clay, for example, is highly porous and will hold much water in its pores, but when saturated the small spaces between the grains become blocked with water held by surface tension, preventing the passage of water. To be an aquifer or source of water a rock must be both porous and pervious. Porosity may be increased by leaching or decreased by compaction.

**Permeability** - is capable of being wholly penetrated by a fluid, of allowing the passage of a fluid, of being saturated. The opposite condition is termed "impermeable".

**Permeable Rock** – a rock that allows the free passage of water through it owing to its porosity, e.g., sandstone. Some geologists also include rock with joints, bedding plans, cracks, fissures, etc. that allow the free passage of water, defining the porous rock as being of primary permeability and the rock with joints, etc. of secondary permeability. Other geologists distinguish the secondary group as being pervious.



## **INFLUENCE OF GEOLOGY**

For planning purposes, we are concerned about the way that geologic formations determine soils types and potential groundwater supplies. It is desirable to identify the areas with the most potential for groundwater yields to determine where a particular effort should be made to protect groundwater supplies. The following are the major geological formations found in the region and their groundwater yields.

### **Brunswick Formation**

This formation is located throughout most of Exeter and Amity Townships. It is predominately found in the eastern cutoff, a line west of the Schuylkill River, and consists of fine red sandstone, siltstone, and shale; maximum thickness is about 500 feet. It is moderately well bedded; fissile to thin, sandstone units are mostly flaggy to thick. Only slightly resistant to weathering; highly weathered to moderate depth; irregularly shaped, very small fragments result; overlying mantle is thin. The topography is usually rolling hills of medium relief; natural slopes are fairly steep and stable. The surface drainage is good. Joint-, fault- and bedding-plane openings provide a secondary porosity of low to moderate magnitude; moderate permeability.

This formation has median yield of 60 gpm. It is also moderately easy to excavate with a relatively fast drilling rate. Because this formation is weathered relatively easily, the cut-slope stability is poor to fair. It is a good source of road material and fill; possible source of raw material for common brick.

### **Limestone Fanoglomerate**

This sequence is located in the northern portion of Amity Township, just below the Township line. It consists of transported rocks; black to white, silty and siliceous in many places; crystalline and is well bedded. It is moderately resistant; moderately weathered to a shallow depth; small, flat, rectangular fragments result. It can be found at a depth of up to 500 feet and the topography is usually rolling valley of medium relief; natural slopes are moderate and stable. Surface drainage is good.

Joints and bedding plane openings provide a secondary porosity of moderate magnitude; locally solution openings in limestone produce a very high porosity and permeability.

Groundwater yields may yield in excess of 200 gpm; best location for high-yielding well is upland stream valley; water-bearing openings decrease in number and size with increased depth; most wells receive water from yielding zones less than 200 feet deep.

The ease of excavation is moderately to difficult with a fast drilling rate. The cut-slope stability is fair, due to disintegration when exposed to moisture for a relatively short amount of time. It is known to be a good source of road material and fill.

### **Diabase**

This formation is located in the central portions of both Exeter and Amity Townships. It consists of light to dark gray, fine to very coarse-grained sandstone and conglomerate containing thin shale interbeds; crossbedded; tightly cemented. Includes four members, in descending order: Tammany Member - conglomerate and sandstone; Lizard Creek Member - sandstone and red and green shale; Minsi Member - sandstone and conglomerate; and Weiders Member - conglomerate. Maximum thickness is 1,000 feet.

It is highly resistant and can be slightly weathered to a shallow depth and weathers irregularly in medium to large blocks. In many places it can form large boulder fields downslope from outcrop. The overlying mantle is very thin. The topography is usually high mountains and ridges; very high relief in rough terrain; natural slopes are stable and steep. It has good surface drainage as well with intergranular porosity in conglomerate with joint openings, which provide a small to moderate secondary porosity; low permeability.

The median yield is 5 gpm and may be a poor aquifer because of topographic position; often of excellent quality. Excavation is difficult due to boulder fields on lower slopes beneath outcrop areas, which are special problems. The drilling rate is very slow; however the cut-slope stability is good and can stand in vertical cuts if bedding is not steeply dipping toward cut. It is usually a good source of road material, riprap, concrete aggregate, embankment facing, building stone, and silica for refractory brick.

### **Allentown Formation**

A small area is found in northcentral Amity Township. Medium-gray dolomite and impure limestone; dark-gray chert stringers and nodules; laminated; some oolite and sharpstone. Joints have a blocky pattern; well developed; moderate to highly abundant; regularly spaced, having a moderate distance between fractures; open and steeply dipping. Moderately resistant to weathering, slightly weathered to a shallow depth; decomposition results in medium-sized, blocky fragments; overlying mantle is thin in most areas; interface between bedrock and mantle is characterized by pinnacles. Undulating valley of low relief; natural slopes are gentle and stable. Good subsurface drainage; little surface drainage. Solution channels produce a secondary porosity of moderate to high magnitude; low permeability.

Median groundwater yields from specific study areas range from 60 to 210 gal/min; many wells are capable of yielding 1,000 gal/min or more; aquifer can be easily contaminated; turbidity is a common water-quality problem.

Difficult excavation. Bedrock pinnacles are a special problem; moderate to slow drilling rate; numerous sandstone beds containing chert lenses slow the drilling rate. Good cut-slope stability, stable in vertical cuts where fractures are at a minimum. Good foundation stability, a thorough sinkhole investigation should be undertaken.

### **Beekmantown Group**

Found in the vicinity of Oley Turnpike Road in Exeter Township and along the northernmost portion of Amity Township. Where these rocks have not been subdivided into separate formations, they are interbedded, finely laminated, light-gray limestone containing dark-gray dolomite beds; dolomite is fractured, and the fractures are recemented by white calcite; limestone weathers to a pale-gray surface contrasting with the yellowish-gray-weathering dolomite; maximum thickness is about 2,300 feet. Well bedded; thick. Joints have a blocky pattern; moderately to well developed; moderately abundant; regularly spaced, having a moderate distance between fractures; both a steeply dipping set and a gently dipping set are present; most are open, but some are filled with calcite. Moderately resistant to weathering, slightly weathered to a shallow depth; small to large, blocky fragments result; overlying mantle is variable in thickness, in most places greater than 5 feet; bedrock pinnacles are characteristic. Flat to rolling valleys of low relief; gentle and stable natural slopes. Good subsurface drainage; minor surface drainage. Joint and solution-channel openings provide a secondary porosity of low to moderate magnitude; low permeability.

High groundwater yields from fractures and solution cavities; median yield is 50 gal/min in southeastern Pennsylvania; industrial and public supplies are available in most areas.

Difficult excavation; bedrock pinnacles are a special problem; moderate drilling rate; chert beds, lenses, and quartz sand slow the drilling rate. Good cut-slope stability, intersection of joint and bedding surfaces may create a problem if the depth of cut is extreme. Good foundation stability, should be investigated thoroughly for solution openings.

### **Granitic Gneiss**

Found in much of the northern portion of Exeter Township. Light buff to light pink; fine to medium grained; most mineral grains are about 1 mm in diameter; primary minerals are quartz, microcline, hornblende (5 to 10 percent), and occasional biotite. Banding is poorly developed; massive. Joints have an irregular pattern; moderately to poorly

formed; moderately abundant; widely to moderately spaced; irregular and steeply dipping to vertical; open.

Highly resistant to weathering; slight weathering to a shallow depth; loose material consists of large rectangular blocks; mantle is thin. Hills of medium to high relief; natural slopes are steep and stable. Good surface drainage. Joints provide a very low secondary porosity; low permeability.

Median groundwater yield is less than 20 gal./min.; yields of 35 gal./min. or more may be obtainable from wells properly sited and developed; wells should be at least 100 feet deep, but probably not over 200 feet for maximum yield.

Difficult excavation; slow drilling rate. Good cut-slope stability. Good foundation stability; should be excavated to sound rock.

### **Hardyston Formation**

Found in the vicinity of the St. Lawrence watershed and Neversink Mountain, and in a portion of St. Lawrence. Light-gray quartzite; weathers yellow brown; porous and limonitic in many places; quartz-pebble conglomerate occurs at base; maximum thickness is 800 feet; moderately well bedded to well bedded; thick. Joint and cleavage planes display a blocky pattern; moderately well developed; moderately abundant; widely spaced and fairly regular; steeply dipping and open. Highly resistant to weathering; usually slightly to moderately weathered to a shallow depth; hackly, large, irregularly shaped fragments result from weathering; locally, may be highly weathered to loose sand; overlying mantle is thin. Rough mountains of medium to high relief; natural slopes are steep and stable. Good surface drainage. Joint- and cleavage-plane openings produce a secondary porosity of low magnitude; low permeability. Median groundwater yield of 20 gal./min.; water-yielding fractures are seldom found below 200 feet; water is usually soft and of good quality; iron may be a problem.

Difficult excavation; slow drilling rate, in part due to many quartz veins that exceed 12 inches in width; large boulders may be a special problem; locally highly fractured, highly weathered, and moderately easy to excavate. Good cut-slope stability, locally, where highly fractured, cut-slope stability is fair. Good foundation stability; should be excavated to sound material.

### **Hornblende Gneiss**

A few small areas scattered in northern Exeter Township. Dark-gray to black; most grains are about 1 to 2 mm in diameter; hornblende makes up about 50 percent of the rock; the other 50 percent is labradorite (feldspar); rock is extremely resistant to abrasion and very resistant to rupture, but may be susceptible to crumbling. Banding is common; most bands are flaggy, but some are thick. Joints have a platy or blocky pattern; moderately to poorly formed; moderate to high in abundance; moderately to closely spaced; irregular; steeply dipping and open.

Moderately resistant to weathering; highly and deeply weathered in many places, resulting in a rubble that contains small- to medium-sized rectangular fragments; overlying mantle is thin. Undulating hills of medium relief; natural slopes are moderately steep and stable. Good surface drainage. Extremely low primary porosity; joint openings provide a low secondary porosity; highly weathered near-surface rock may have high porosity; low permeability.

Median groundwater yield of reported wells is 10 gal./min.; yields of 35 gal./min. or more may be obtained from wells properly sited and developed.

Highly weathered portion of rock mass has moderately easy excavation; unweathered rock is difficult; fast to moderate drilling rate. Poor cut-slope stability due to partial disintegration when exposed to moisture for a relatively short time; drainage maintenance is required. Good foundation stability; should be excavated to sound material.

### **Leithsville Formation**

Found throughout St. Lawrence and surrounding areas of Exeter Township. Dark-gray to medium-gray dolomite; some calcareous shale and sandy dolomite; cherty; 1,500 feet thick; moderately well bedded; massive. Joints have a blocky pattern and are moderately to well developed; moderately abundant; irregularly spaced, having a wide distance between fractures; open and steeply dipping. Undulating valley of low to medium relief; natural slopes are gentle to moderately steep and stable. Good surface drainage; little subsurface drainage. Joint openings and solution channels provide a secondary porosity of high magnitude; moderate to high permeability.

Median groundwater yield is 100 gal./min.; large yields may be obtained from solution openings; aquifer can be easily contaminated; turbidity is a common water-quality problem; water is relatively hard.

Difficult excavation; bedrock pinnacles may be a special problem; fast drilling rate. Good cut-slope stability. Good foundation stability; solution openings and bedrock pinnacles should be thoroughly investigated.

### **Martinsburg Formation**

A very small area is found along Route 562 in northern Amity Township. Buff-weathering, dark-gray shale, and thin interbeds of siltstone, metabentonite, and fine-grained sandstone; brown-weathering, medium-grained sandstone containing shale and siltstone interbeds occurs in the middle of the formation; basal part grades into limy shale and platy-weathering, silty limestone; may be 12,800 feet thick. Well bedded; sandstone is thick to massive; limestone and shale are thin to fissile. Cleavage is dominant and highly developed; joints are also present, and are irregularly spaced, open, and nearly vertical. Moderately weathered to a moderate depth; small to large platy fragments results; mantle is thick. Dissected valley of low relief; natural slopes along streams are steep and often unstable. Good surface drainage. Cleavage- and joint-plane openings provide a secondary porosity of generally low magnitude; low permeability.

A median sustained groundwater yield of 32 gal./min. has been calculated and a maximum well yield of 200 gal./min. is reported; yielding zones are commonly less than 150 feet in depth but occur as deep as 400 feet below land surface; the natural quality of the water is often poor due to hydrogen sulfide and high concentrations of iron.

Moderately easy excavation in shale; moderately difficult in limestone; difficult in sandstone; fast drilling rate. Fair cut-slope stability in shale and limestone; good in sandstone. Good foundation stability; should be excavated to sound rock; limestone should be investigated for solution openings.

### **New Oxford Formation**

Found in central Exeter Township. Light-colored sandstone, arkosic sandstone, and conglomeratic sandstone; includes red to purplish-red sandstone, shale, and mudstone; total thickness is approximately 4,000 feet and represents the upper half of the formation. Well bedded; thin to flaggy. Joints have a seamy to platy pattern; moderately developed; highly fractured; very close spacing; vertical and open. Only slightly resistant to weathering; exposures are quickly weathered to a moderate depth; very small, pencil-like, platy fragments result from rapid disintegration; overlying mantle is thin. Gently rolling plain; broad shallow valleys and low, flat-topped ridges; stable. Good surface drainage. Primary porosity occurs in weathered portion; joint- and bedding-plane openings provide a secondary porosity in unweathered rock; high to moderate total effective porosity; moderate permeability.

Median groundwater yield is 66 gal./min.; hardness and total dissolved solids are frequently high.



Moderately easy excavation, relatively fast drilling rate may be expected. Poor to fair cut-slope stability, due to rapid disintegration when exposed to moisture for a relatively short time. Good foundation stability; should be excavated to sound material; underdrainage may possibly be required.

