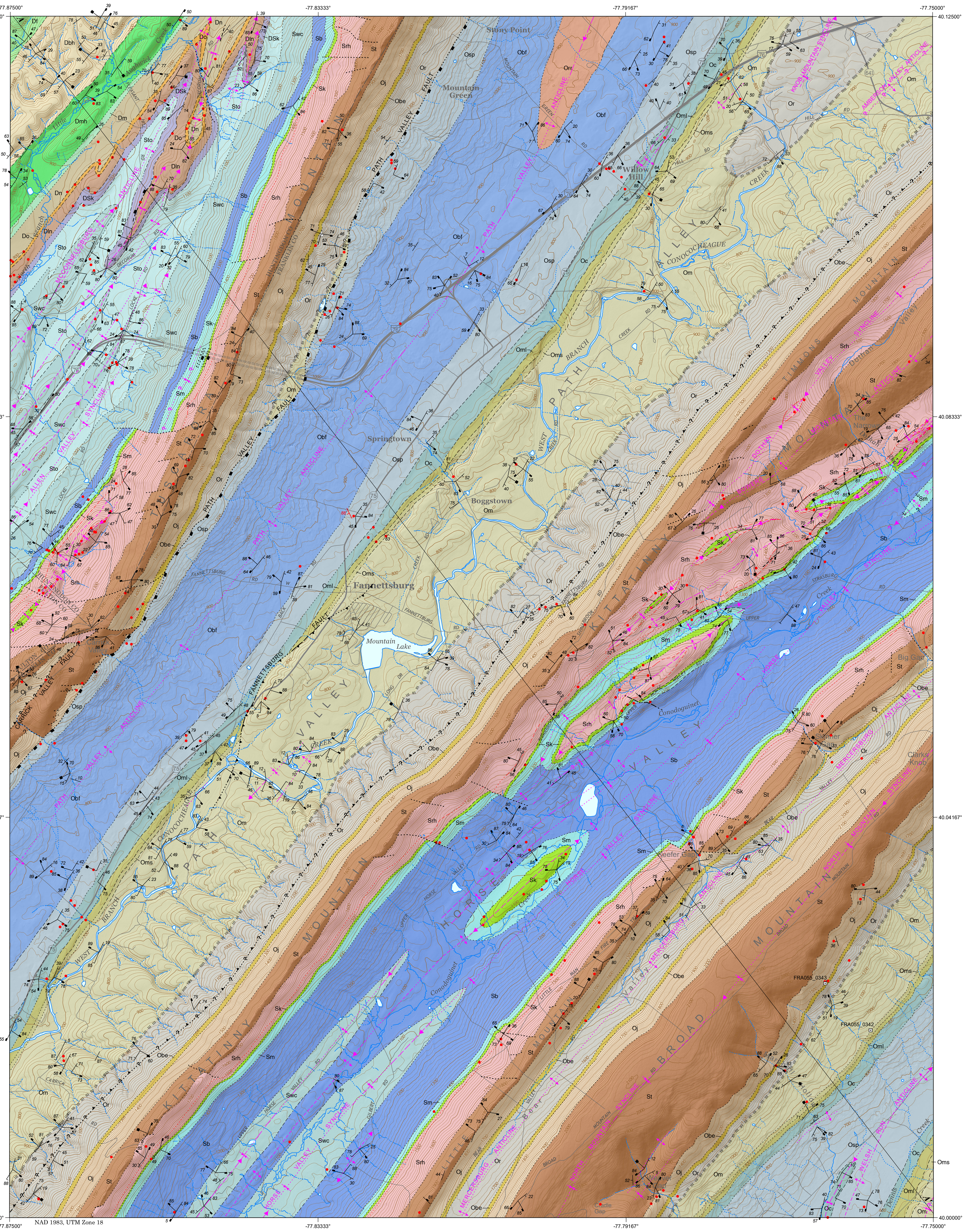


Geology based on field mapping by Aaron D. Bierly, 2013–15 and 2020. Mapping was aided by the following resources: descriptions of the geology inside the turnpike tunnel and in its vicinity by Cleaves and Stephenson (1949), discussion of the Carrick Valley fault in Nickelsen (1996), and the map showing the Path Valley and Fannettsburg faults by Okuma (1970).

Most fold names based on Faill (2011). New fold names were assigned by Bierly.

Water bodies and flowpaths from preliminary data created by Ellen Fehrs of the Pennsylvania Geological Survey in 2022 for the Pennsylvania Hydrography Dataset (PAHD) using QL2 lidar elevation data collected for the U.S. Geological Survey in 2019 and distributed through PASDA at http://www.pasda.psu.edu/.

SCALE 1:24 000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

NORTH AMERICAN VERTICAL DATUM OF 1988

$10\frac{1}{2}°$ MAGNETIC NORTH TRUE NORTH APPROXIMATE MEAN DECLINATION, 2023

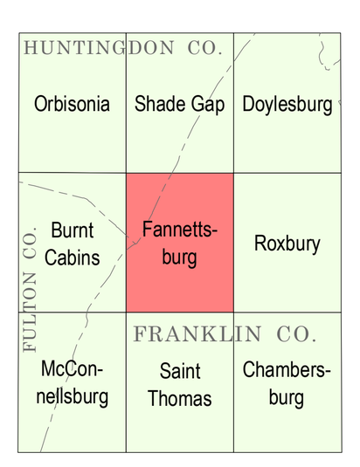
Base map modified from *USGS Topo Map Vector Data (Vector) 14979 Fannettsburg, Pennsylvania 20190920 for 7.5 x 7.5 minute FileGDB 10.1*, which was published by the U.S. Geological Survey, National Geospatial Technical Operations Center, on September 20, 2019.

Hillshade created from DEMs derived from lidar elevation data collected for the Pennsylvania Geological Survey PAMAP program in 2007 and distributed through PASDA at http://www.pasda.psu.edu/.

Digital map production by Caron E. Pawlicki and Aaron D. Bierly, Pennsylvania Geological Survey, 2022–23.

BEDROCK GEOLOGIC MAP OF THE FANNETTSBURG 7.5-MINUTE QUADRANGLE, FRANKLIN, FULTON, AND HUNTINGDON COUNTIES, PENNSYLVANIA

BY
AARON D. BIERLY
PENNSYLVANIA GEOLOGICAL SURVEY
2023



ADJOINING 7.5-MINUTE QUADRANGLES

MAP LOCATION IN PENNSYLVANIA

EXPLANATION

SYSTEM	GEOLOGIC DESCRIPTION	UNIT	ENVIRONMENTAL CHARACTERISTICS[1,2,3]
DEVONIAN	Grayish-red, brownish-gray, light-olive-gray, yellowish-gray, and dusky-yellow shales, siltstones, and very fine grained to fine-grained sandstones and medium-dark-gray to light-gray coarser grained sandstones and conglomerates. Conglomerates are composed of rounded, quartz granules and small pebbles. Basal contact defined at base of lowest medium-grained to very coarse grained sandstone or conglomerate. Only the lowest 650 ft of the Foreknobs Formation is present in the quadrangle.	FOREKNOBS FORMATION Df	Record for one water well reported. Water well depth is 260 ft. Casing depth is 52 ft. Water yield is 6 gal/min. Cut-slope stability is good in siltstone, sandstone, and conglomerate; fair in shale due to rapid disintegration. Foundation stability is good where excavated to sound bedrock; foundation should be kept water free. Weathered shale can be excavated easily; excavation is generally difficult in other strata. Good surface drainage. Good source of random fill and may be a source of brick raw material.
DEVONIAN	Upper 695 to 765 ft consists of pale-red, grayish-red, light-olive-gray, medium-dark-gray, yellowish-gray, and dusky-yellow shales, siltstones, and very fine grained to fine-grained sandstones. Sandstone beds are 0.1 to 1.4 ft thick with intervals up to 20+ ft thick and may contain crossbeds or laminations. Shale and claystone intervals range from less than a foot to several of tens of feet thick. Sparse crinoids, brachiopods, bivalves, and plant fossils. Lower 1,070 to 1,175 ft consists of light-olive-gray, yellowish-gray, and medium-dark-gray shales, siltstones, and very fine grained sandstones. Shales may be laminated and silty, and rarely contain poorly preserved marine invertebrate fossils. Beds are up to 0.4 ft thick. Siltstones and sandstones may be laminated; beds range in thickness from less than 0.01 to 1.0 ft. The formations are topographically characterized by deeply incised headwater ravines and gullies. Neither the basal black shale of the Harrell Formation nor the basal contact was observed. Total thickness is calculated to be between 1,765 and 1,940 ft.	BRAILLIER AND HARRELL FORMATIONS, UNDIVIDED Dbh	Records for six water wells reported. Water wells range from 154 to 654 ft deep; median depth, 229 ft. Casing depths range from 63 to 105 ft; median depth, 84 ft. Water yields range from 2 to 30 gal/min; median yield, 12.5 gal/min. Cut-slope stability is fair to good; steep cuts can be maintained except in weathered shales. Foundation stability is good where excavated to sound bedrock. Easy to moderately difficult to excavate. Good surface drainage. Good source of road material and random fill.
DEVONIAN	Dominantly light-olive-gray to yellowish-gray shales, siltstones, and sandstones. Shale beds are less than or equal to 0.25 in. thick and can occur in packages up to 3.0 ft thick. Individual sandstone beds range from 0.1 to 1.5 ft thick. Rare, coarse-grained sandstone lenses observed approximately 150 to 200 ft below the top of the formation. Fossils include brachiopods, crinoids, and tentaculites. Two resistant ridges were observed: approximately 200 ft below the top, approximately 25 ft of very fine grained sandstone grading into several feet of siltstone; and approximately 665 ft below the top, 35 to 50 ft of very fine grained sandstone. The basal contact was not observed in the quadrangle. Total formation thickness is calculated to be between 1,020 and 1,200 ft.	MAHANTANGO FORMATION Dmh	Records for three water wells reported. Water wells range from 204 to 398 ft deep; median depth, 284 ft. Casing depths range from 46 to 84 ft; median depth, 59 ft. Water yields range from 4 to 15 gal/min; median yield, 10 gal/min. Water is moderately hard. Water is potentially high in iron, manganese, and hydrogen sulfide. Cut-slope stability is fair due to disintegration when exposed to moisture and due to rapid weathering along fractures. Foundation stability is good where excavated to sound bedrock. Moderately easy to moderately difficult to excavate. Good surface drainage. Good source of road material and fill where sulfide minerals are lacking or will not impact surrounding area. Potential source of lightweight aggregate.
DEVONIAN	Dark-gray to olive-black shales. Individual shale beds in the Marcellus are less than 0.5 in. thick. Formation is not exposed in the quadrangle. Limited exposure and float observed just west of the quadrangle. Basal contact is placed below the lowest dark-gray to black carbonaceous shale. Estimated thickness is between 105 and 190 ft.	MARCELLUS FORMATION Dm	No water well data available. Water yields are estimated to be less than 20 gal/min. Water is commonly high in iron and hydrogen sulfide. Cut-slope stability is fair due to disintegration when exposed to moisture. Foundation stability is good where excavated to sound bedrock. Moderately easy to excavate. Fast drilling rate. Good surface drainage. Good source of road material and fill where sulfide minerals are lacking or will not impact surrounding area.
DEVONIAN	Light-olive-gray to medium-dark-gray calcareous shales and argillaceous limestones. Rare brachiopods. Beds range from less than 0.1 to 0.5 ft thick. Basal contact is at the top of the highest sandstone of the Oriskany Formation. Thickness is calculated to be between 400 and 525 ft.	NEEDMORE FORMATION Dn	Record for one water well reported: water well depth, 354 ft; casing depth, 61 ft; water yield, 75 gal/min. Reported yield is likely close to a maximum value. Low yields are more characteristic of the formation. Target lower contact with Oriskany Formation for better yields. Water is potentially high in iron. Water is moderately hard. Cut-slope stability is fair to good. Foundation stability is good where excavated to sound bedrock. Moderately difficult to excavate. Good surface drainage. Good source of road material and fill. Shale pits are located within the quadrangle.
DEVONIAN	Grayish-orange, poorly sorted, fine-grained to very coarse grained sandstones with scattered granules and small pebbles; bed thickness ranges from 0.15 to 1.5 ft. Local chert inclusions with relict peloidal structures. Local iron mineralization filling in pore and fracture voids. Basal contact is at the base of the lowest sandstone. Thickness is estimated at 50 ft.	ORISKANY FORMATION Do	Records for two water wells reported. Both wells start in the Needmore Formation and intersect the Oriskany in the subsurface. When the Oriskany Formation is at the surface, expect to drill and case off the entire interval due to deeply weathered rock. Where sandstones are poorly cemented, there is a potential for the borehole to cave in. Formation should be targeted from the overlying Needmore Formation. Reported yields were 2 gal/min and 10 gal/min. Expect higher yields in valley bottoms. Water quality is generally good. Cut-slope stability is good in resistant, fresh bedrock but poor where jointing is parallel to cut. Foundation stability is excellent to good where excavated to sound bedrock. Moderately difficult to difficult to excavate in fresh bedrock; easy to moderate to excavate in weathered zones. Good surface drainage. Formation is commonly deeply weathered near the surface in the quadrangle. Good source of sand and fill. Potential source of refractory sand and glass sand.
DEVONIAN	Within the study area, the upper part of the Helderberg Group is thought to be composed of five formations. From youngest to oldest, these are the interfingering Licking Creek Limestone and Shriver Chert, the Mandata Shale, the Corriganville Limestone, and the New Creek Limestone. Only the Licking Creek-Shriver and New Creek intervals were observed. **Licking Creek–Shriver:** Medium-dark-gray to medium-gray, sparitic limestones interbedded with up to 3-in.-thick, bedding-parallel, cherty layers that appear as either nodular or extended lenses. Fresh chert is dark gray, and weathered chert is light olive gray. Limestone beds range from less than 0.3 to 1.3 ft thick. **New Creek:** Medium-gray to medium-dark-gray, fine- to coarse-grained, biosparitic limestones. Fossils include crinoids and several genera of brachiopods. Individual beds range from 0.1 to 6.6 ft thick, with beds being thicker towards the base of the formation. Basal contact is with the top of the laminated limestones of the Keyser Formation. Thickness of the Licking Creek through New Creek Formations is 215 to 280 ft.	HELDERBERG GROUP: LICKING CREEK FORMATION THROUGH NEW CREEK FORMATION, UNDIVIDED Dln	Records for two water wells reported. Water wells are 229 and 379 ft deep. Casing depths are 105 and 126 ft. Water yields range from 0 to 12 gal/min. Water is potentially high in iron. Water is moderately hard. Cut-slope stability is fair to good. Foundation stability is excellent to good where excavated to sound bedrock. Moderately difficult to difficult to excavate. Good surface drainage. Good source of fill. Potential soure for riprap and road aggregate. Historically targeted for agricultural lime.
DEVONIAN / SILURIAN	Medium-gray to medium-light-gray limestones. At one locality near the contact with the New Creek Formation, limestones are very fine to finely crystalline, bryozoan-bearing sparite or biosparite. Knobbly limestones up to 20 ft thick were observed in the basal section; the knobs are finely crystalline biosparite surrounded by argillaceous micrite. Individual knob layers are 0.1 to 0.25 ft thick. Basal contact is at the base of the lowest knobbly limestone. Formation thickness is calculated to be between 80 and 135 ft.	HELDERBERG GROUP: KEYSER FORMATION DSk	Record for two water wells reported. One well drilled from the Keyser Formation into the Tonoloway Formation. Other well started in the Oriskany Formation and intersects the Keyser Formation in the subsurface. Water well depths are 229 ft and 528 ft. Casing depths are 81 ft and 126 ft. Water yields are 1 gal/min and 25 gal/min. Water is commonly hard. Cut-slope stability is good; where rock is intensely fractured it is fair. Foundation stability is good where excavated to sound material. Keyser limestones are known elsewhere to contain solution channels; a thorough investigation should be conducted. Difficult to excavate, particularly if there are pinnacles. Good surface drainage and minor subsurface drainage. Good source of road material, riprap, aggregate, embankment facing, and fill. Has been quarried in the quadrangle for agricultural lime.
SILURIAN	Dark-gray to medium-dark-gray, argillaceous, cleaved limestones that weather medium light gray to light gray. Rare calcareous, very fine grained to fine-grained sandstone beds were observed. Most fossils are small, shelly fragments that are only readily seen by hand lens or microscope; brachiopods were observed in hand sample. The basal contact is gradational to Wills Creek calcareous shales. Formation thickness is calculated to be between 440 and 580 ft.	TONOLOWAY FORMATION Sto	Records for eight water wells reported. Water wells range from 178 to 379 ft deep; median depth, 291 ft. Casing depths range from 84 to 147 ft; median depth, 126 ft. Water yields range from 6 to 75 gal/min; median yield, 25 gal/min. Water is very hard. Cut-slope stability is good; where rock is intensely fractured it is fair. Foundation stability is good where excavated to sound material. Tonoloway limestones are known elsewhere to contain solution channels; a thorough investigation should be conducted. Difficult to excavate, particularly if there are pinnacles. Good surface drainage, and minor subsurface drainage. Good source of road material, riprap, aggregate, embankment facing, and fill. Has been quarried in the quadrangle for agricultural lime.
SILURIAN	Diverse color range of red, brown, yellow, and olive-green shales, silty shales, and sandy shales with subordinate yellowish-gray to light-olive-brown, very fine grained to medium-grained sandstones. Gray argillaceous limestones and calcareous shales observed at the top of the section are likely transitional beds from the overlying Tonoloway Formation. Shale horizons range from less than 1 to greater than 10 ft thick, and commonly contain mud cracks. Sandstone horizons are up to 4 ft thick with beds ranging from 0.1 to 0.25 ft thick. The basal contact with the Bloomsburg Formation was not observed. Formation thickness is estimated to be between 630 and 750 ft.	WILLS CREEK FORMATION Swc	Records for 14 water wells reported. Water wells range from 65 to 340 ft deep; median depth, 190 ft. Casing depths range from 31 to 80 ft; median depth, 56 ft. Water yields range from 7 to 75 gal/min; median yield, 13 gal/min. Iron is a potential problem. Water is hard to very hard. Cut-slope stability is fair due to rapid disintegration when exposed to moisture. Foundation stability is good where excavated to sound bedrock. Moderately easy to excavate. Good surface drainage. Good source of road material and fill. Potential source for common brick material.
SILURIAN	Pale-red to grayish-red sandstones, siltstones, and claystones, with subordinate quantities of dusky-yellow shales. Shale horizons range from 0.3 to greater than 10.0 ft thick. Siltstone and sandstone horizons are generally less than 3.0 ft thick, although siltstone intervals greater than 12.0 ft thick were observed. Individual beds range from 0.05 to 1.0 ft thick. Portions of the formation are calcareous, and ostracods were observed. The basal contact is gradational with several feet of interbedded, grayish-red shale and medium-dark-gray shale; contact is placed at the base of the lowest red bed. Formation thickness is estimated at 235 ft.	BLOOMSBURG FORMATION Sb	Records for 16 water wells reported. Water wells range from 120 to 420 ft deep; median depth, 220 ft. Casing depths range from 20 to 240 ft; median depth, 118 ft. Water yields range from 4 to 100 gal/min; median yield, 20 gal/min. Water is moderately hard. Cut-slope stability is poor to fair due to rapid disintegration when exposed to moisture. Foundation stability is good when excavated to sound material. Good surface drainage. Good source of road material and fill. Possible source of raw material for common brick. One inactive borrow pit observed in the quadrangle.
SILURIAN	Very thin to thin, interbedded, dark-gray to medium-dark-gray shales and medium-gray to medium-light-gray, ostracodal limestones. Styolites common in limestone beds. Limestones compose between 20 to 25 percent of the formation. Shales are commonly calcareous in the subsurface but lose calcite in weathered outcrop exposures. Calcite veining and healed fractures are common. Cleaved shales and argillaceous limestones observed in faulted shear zones. Sharp basal contact at top of highest occurring Keefer sandstone. Formation thickness in Horse Valley is between 175 and 180 ft and may be as thin as 125 ft west of Tuscarora Mountain.	MIFFLINTOWN FORMATION Sm	Records for seven water wells reported. Water wells range from 178 to 240 ft deep; median depth, 209 ft. Casing depths range from 79 to 126 ft; median depth, 102 ft. Water yields range from 2 to 100 gal/min; median yield, 30 gal/min. Water is moderately hard. Cut-slope stability is fair; shale portion is susceptible to moisture, causing short-term stability. Foundation stability is good when excavated to sound material. Good surface drainage. Good source of road material, fill, and possible brick and expanded aggregate.
SILURIAN	Very pale orange, light-gray, and very light gray sandstones, orthoquartzites, and rare siltstones. In the subsurface, some sandstones darken to a medium dark gray. Sandstones are commonly soft and friable, whereas quartzites are extremely hard and weather into blocks. Grain size in both lithologies is very fine to medium. One 1.4-ft interval in the bottom third of the formation is coarse to very coarse grained. *Skolithos* is abundant throughout most of the section. Individual beds range from less than 0.1 to 2.0 ft thick. Basal contact is at the base of the lowest sandstone. Formation thickness was measured at 49.6 ft.	KEEFER FORMATION Sk	No water well data available. Yield estimated at 5 to 10 gal/min. Cut-slope stability is good except where cuts are made parallel to bedding. Rockfalls on steep cuts should be expected due to blocky fracturing. Foundation stability is good after removal of weathered material and boulders. Moderately difficult to difficult to excavate. Good surface drainage. Good source of fill and riprap.

EXPLANATION (CONT.)

SYSTEM	GEOLOGIC DESCRIPTION	UNIT	ENVIRONMENTAL CHARACTERISTICS[1,2,3]
SILURIAN	Light-olive-gray, olive-brown, and dusky-yellow shales, siltstones, and very fine grained sandstones; interbedded, brownish-gray, grayish-red, and reddish-purple hematitic sandstones. Shales commonly display a rosy-pink sheen. Shale horizons range from 0.25 to 5.2 ft thick. Brown brachiopod coquinites at the top of the formation form along distinct horizons as small, channel-shaped lenses that are up to 1.25 ft thick. The Centre Sandstone Member is a hematitic sandstone horizon, estimated to be 35 ft thick, that makes a distinct topographic rise in the formation. These sandstones are generally moderately well sorted but can be poorly sorted, generally very fine to fine grained but can range up to very coarse grained, commonly bear pale-red claystone clasts, and may contain fossilized burrows or feeding traces. Individual beds in the Centre Sandstone range from less than 0.1 ft to 2.5 ft thick. Basal contact is at the top of the highest sandstone in the Tuscarora Formation. Total formation thickness is calculated to be between 585 and 730 ft.	CENTRE SANDSTONE MEMBER; ROSE HILL FORMATION Srh	No water well data available. Yields estimated at 5 to 30 gal/min. Water is potentially high in iron and manganese. Water is moderately hard. Cut-slope stability is good to fair with some rockfall and shale-chip rubble accumulation at toes of slope. Steep cuts can be maintained. Potential for rockfalls if steep cuts are made in the Centre Sandstone or other thick sandstone sequences. Foundation stability is good where excavated to sound bedrock. Good surface drainage. Good source of fill, fair source for expanded light-weight aggregate and structural clay products; hematitic sandstone beds have been mined in other parts of the state. Inactive borrow pits within the study area.
SILURIAN	Light-gray to white sandstones and quartzites, locally stained grayish-red to reddish-purple. Generally planar bedded, may have ripple marks and crossbeds. Sandstones are fine to coarse grained and can carry scattered, very coarse sand and granules. Scattered conglomeratic horizons and lenses are generally a few inches thick but can be up to 1.2 ft thick. Small, pebble-sized claystone clasts observed at one locality. Rare bedding-parallel burrows or feeding traces and vertical burrows *(Skolithos?)* were observed. Bed thickness ranges from 0.1 to 6.1 ft, with most beds between 0.75 and 1.5 ft thick. The basal contact was not observed in the quadrangle. Thickness calculations for the formation average between 400 and 650 ft, but the formation may be as little as 350 ft or as thick as 800 ft in places.	TUSCARORA FORMATION St	Records for one water well reported. Water well is 500 ft deep. Casing depth is 80 ft. Water yield is 12 gal/min. Its high topographic position makes the Tuscarora Formation unfavorable for high yields. Water quality is usually good. Water is soft. Cut-slope stability is generally good; stability is fair where bedding is steeply dipping towards the cut. Foundation stability is good where excavated to sound bedrock. Excavation is difficult; boulder fields add to difficulty. Good surface drainage. Good source of road material, riprap, aggregate, embankment facing, building stone, and silica for refractory brick. Blocks used in foundations of older buildings in the area. Two abandoned dimension-stone quarries were observed in the study area.
ORDOVICIAN	Grayish-red to reddish-brown sandstones and conglomeratic sandstones with rare pale-red shale beds. Sandstones are fine to coarse grained, rarely with scattered very coarse sand and granules. Clasts in conglomeratic zones are vein quartz and pale-red claystone up to large-pebble size. Sandstones are generally moderately to poorly to moderately well sorted. Conglomeratic zones are moderately to poorly sorted. Abundant crossbedding and some planar bedding. Rare *Skolithos* burrows up to 1.0 ft long observed. Shale beds are less than 1.0 ft thick, and sandstone beds range from 0.3 to 2.8 ft thick. The basal contact is at the base of the lowest "red" sandstone. Formation thickness is calculated to be between 400 and 700 ft.	JUNIATA FORMATION Oj	No water well data available. Yield estimated to be less than 15 gal/min. Its high topographic position makes the Juniata Formation unfavorable for high yields. Water quality is generally good. Water is probably soft. Cut-slope stability is good. Minor rockfall is to be expected in steep cuts. Foundation stability is good when excavated to sound material. Ease of excavation is difficult; slow drilling rate. Good surface drainage. Good source of road material, riprap, and building stone.
ORDOVICIAN	Light-gray to dusky-yellow, very fine grained to medium-grained, well-sorted to moderately well sorted sandstones, locally with crossbeds. Brachiopods were observed. Grayish-yellow to medium-dark-gray shales are rare in the upper part of the formation, but they are more common near the base where they are found interbedded with sandstones. The transitional basal contact is at the top of the first encountered very fine grained to fine-grained, marine-fossil-bearing sandstone or at the top of the highest significant shale interval of the Reedsville Formation. Formation thickness is calculated between 90 and 180 ft.	BALD EAGLE FORMATION Obe	No water well data available. Yield estimated to be less than 15 gal/min. Its high topographic position makes the Bald Eagle Formation unfavorable for high yields. Water quality is generally good. Water is probably soft. Cut-slope stability is good. Foundation stability is good when excavated to sound material. Excavation is difficult; slow drilling rate. Good surface drainage. Good source of road material, riprap, embankment facing, and fill.
ORDOVICIAN	Upper 40 ft is very fine grained to fine-grained sandstones, commonly bearing marine fossils, with subordinate cycles of claystones and siltstones. This upper sequence grades downward into cycles of shales and siltstones bearing thin interbeds of very fine grained sandstones. These cycles are usually a few tenths of a foot thick. Crinoidal debris zones are observed in some of these cycles, generally at the base of a sandstone or siltstone bed. Bryozoans, brachiopods, and trilobites are also present. Fossil zones are commonly less than 0.25 in. thick but may be up to 0.5 ft thick. Nonfossiliferous sandstones and siltstones are commonly laminated or cross-laminated. The basal contact of the Reedsville Formation is gradational and is defined by the lowest shelly marine fossil horizon. It is likely that the Reedsville and Martinsburg Formations interfinger. The Reedsville Formation is estimated to be at least 375 to 475 ft thick but could be up to greater than 800 ft thick.	REEDSVILLE FORMATION Or	Records for 14 water wells reported. Water wells range from 75 to 253 ft deep; median depth, 200 ft. Casing depths range from 32 to 123 ft; median depth, 44 ft. Water yields range from 10 to 75 gal/min; median yield, 20 gal/min. Yields are likely greater near faults. Iron and hydrogen sulfide are potential problems. Cut-slope stability is fair, as shale easily weathers when exposed. Foundation stability is good when excavated to sound bedrock. Good surface drainage. Good source of road material and fill. Excavation is moderately easy. Widely used on dirt roads, driveways, and logging trails. One shale quarry and numerous abandoned, inactive, and active borrow pits observed in the study area.
ORDOVICIAN	The Martinsburg Formation (Om) is predominantly repetitious sequences of dark-gray and medium-dark gray shales and siltstones with rare interbeds of very fine grained sandstones; locally contains graptolites. The lower approximately 20 percent of the formation has been subdivided into two informal members, an upper mostly shale (Oms) unit and a lower mostly limestone (Oml) unit, collectively referred to as the "basal Martinsburg." The total thickness of the Martinsburg Formation is estimated to be between 1,130 and 1,760 ft. **Oms:** The upper member of the basal Martinsburg is 90 to 120 ft of dark-gray to black, carbonaceous shales, commonly containing graptolites. Surface exposures tend to be noncalcareous, whereas fresh rock in cores is at least in part calcareous. Beds are generally less than 0.25 in. thick, although beds up to 0.5 in. thick have been observed. **Oml:** The lower member of the basal Martinsburg is interbedded, medium-dark-gray to dark-gray, micritic to fine-crystalline limestones and dark-gray to grayish-black, calcareous shales, transitioning downward to crystalline limestones interbedded with highly cleaved argillaceous limestones. Beds range from less than 0.1 to 1.4 ft thick. Crystalline limestones generally become thicker and more abundant towards the base of the formation. Laminations and very sparse graptolites were observed in the shales and argillaceous limestones. Rare crinoids and other marine invertebrate fossil fragments were observed in the crystalline limestones. At least four light-olive-gray bentonite beds, ranging from 0.05 to 2.1 ft thick, were identified. Bentonites commonly contain slickensided calcite shards, and some have a very thin bed of dark-gray shale overlying them. The lower member of the basal Martinsburg ranges from approximately 105 to 275 ft thick. Mapping on State Game Lands 235, just south of the southeast corner of the quadrangle, suggests that the limestone could be as much as 490 to 560 ft thick. The basal contact is at the base of the lowest argillaceous limestone or calcareous shale.	MARTINSBURG FORMATION Om; Oms; Oml	Records for 78 water wells reported. Water wells range from 50 to 529 ft deep; median depth, 145 ft. Median depth of water wells in basal member is 166 ft. Casing depths range from 18 to 112 ft; median depth, 42 ft. Water yields range from 2 to 165 gal/min; median yield, 20 gal/min. The lower contact of the Martinsburg Formation with the Chambersburg Formation has potential for being a water-bearing horizon. Springs and spring houses are observed along the basal contact. Cut-slope stability is fair, as shale easily weathers when exposed. Foundation stability is good when excavated to sound bedrock. Excavation is generally moderately easy, but difficult in the limestones. Good surface drainage in the shales, and poor surface drainage and good subsurface drainage in the limestones. In the basal Martinsburg, rockfalls are a concern in steep cuts. Road construction workers should avoid cutting into rock exposures that are dipping moderately or steeply toward the road, as competent limestone beds may slip on limy shale or bentonites. Good source of road material and fill where sulfide minerals are lacking or will not impact surrounding area. Shales are widely used on dirt roads, driveways, and logging trails. Two active shale quarries observed in the quadrangle.
ORDOVICIAN	Medium-dark-gray to dark-gray micritic or biomicritic limestones. In upper portions of the formation, the micritic limestones are riddled with undulatory beds and inclusions of argillaceous limestones. This gives weathered surfaces a "knobby" texture and leaves limestone "cobbles" in agricultural fields. Fossils are commonly disarticulated and fragmented crinoids and brachiopods. Sparite and biosparite beds are rare. Light-olive-gray, dismicrite (birdseye vaughanite) are rare. Bentonites similar to those described in the basal Martinsburg are present. Beds range from 0.6 to 6.0 ft thick and are dominantly 1.0 to 3.5 ft thick. Basal contact is at the top of the highest dolostone. Formation thickness was calculated to be between 325 and 510 ft.	CHAMBERSBURG FORMATION Oc	Records for 27 water wells reported. Water wells range from 50 to 400 ft deep; median depth, 174 ft. Casing depths range from 19 to 80 ft; median depth, 42 ft. Water yields range from 2 to 60 gal/min; median yield, 21 gal/min. Springs are common within the Chambersburg Formation and at its upper contact, with measured yields of 180 to greater than 1,700 gal/min. Water is very hard. Cut-slope stability is fair to good. Road construction workers should avoid cutting into moderate and steeply dipping rock exposures that are dipping into the road, as competent limestone beds may slip on thin bentonite horizons. Excavation is moderate to difficult. Good source of aggregate, anti-skid, riprap, and fill. There is one active commercial quarry north of the study area.
ORDOVICIAN	Interbedded light-gray to medium-gray dolostones and medium-light-gray to medium-dark-gray limestones; contains chert nodules. Chert nodules commonly concentrate in soils formed over the St. Paul Group, providing a good marker in areas without outcrops. Dolostones are aphanocrystalline to very finely crystalline and potentially laminated. Limestones are micritic or very finely crystalline and may contain mottling, laminations, fossil fragments, fossilized gastropods, clayey drapes, and intraclasts. Light-olive-gray dismicrites (birdseye vaughanites) are present. Beds range from 0.1 to 3.0 ft thick. Basal contact is at the base of the lowest limestone bed. Formation thickness was calculated to range from 425 to 1,010 ft.	ST. PAUL GROUP Osp	Records for 45 water wells reported. Water wells range from 80 to 620 ft deep; median depth, 214 ft. Casing depths range from 18 to 130 ft; median depth, 59 ft. Water yields range from 1 to 100 gal/min; median yield, 18 gal/min. Cut-slope stability is good. Steeply dipping beds inclined toward the road require moderate to gentle cuts. Excavation is difficult, particularly if pinnacles are present. Poor surface drainage and good subsurface drainage. Formation is prone to sinkholes, particularly on the north side of Path Valley and the eastern flank of Broad Mountain. Good source of road materials and fill. Certain beds may be high in calcium and suitable for fluxstone.
ORDOVICIAN	Very light gray to medium-gray, very finely crystalline to medium-crystalline, commonly laminated dolostones rarely containing fossilized algal domes and convoluted laminations. Very rare thin, dark-gray shale beds observed along the Willow Hill exit of the Pa. Turnpike. Milky quartz, cauliflower-head nodules ranging from 0.1 to 0.7 ft in diameter are found along some bedding horizons. Secondary gray and black cherts are commonly found as nodules and bedding-parallel stringers. Beds range from 0.2 to 3.1 ft thick, with most being 1.0 to 2.0 ft thick. Basal contact at the top of the highest limestone of the Rockdale Run Formation. Formation thickness is calculated between 955 and 1,310 ft.	BELLEFONTE FORMATION Obf	Records for 37 water wells reported. Water wells range from 90 to 1,200 ft deep; median depth, 262 ft. Casing depths range from 21 to 222 ft; median depth, 76 ft. Water yields range from 0 to 60 gal/min; median yield, 10 gal/min. Cut-slope stability is good. Minor surface drainage and good subsurface drainage. Formation is prone to sinkhole development, particularly on the north side of Path Valley. Good source of road material, riprap, building stone, embankment facing, and fill.
ORDOVICIAN	Dominantly medium-gray to dark-gray limestones with interbeds of medium-gray to medium-dark-gray dolostones. Limestone is micritic or very finely to finely crystalline. Laminations and fossil fragments are fairly common. Dolostone is aphanocrystalline to finely crystalline. Abundant chert observed in agricultural fields on Rockdale Run Formation bedrock but not observed in exposure. Beds range from 0.1 to 1.5 ft thick. Basal contact was not observed. Formation thickness is estimated to be between 540 and 600 ft.	ROCKDALE RUN FORMATION Orr	Records for five water wells reported. Water wells range from 125 to 420 ft deep; median depth, 280 ft. Casing depths range from 40 to 210 ft; median depth, 60 ft. Water yields range from 2 to 20 gal/min; median yield 7 gal/min. Water is very hard. Cut-slope stability is good. Should be investigated for solution openings and intense pinnacle development. Excavation is difficult, particularly if there are pinnacles. Minor surface drainage and good subsurface drainage. Good source of coarse aggregate, agricultural lime, and building stone.

[1]Blue type refers to groundwater characteristics, red type to engineering characteristics, and black type to mineral resources.

[2]Groundwater information from Becher and Taylor (1982, Plate 1), Pennsylvania Geological Survey (2021), and Taylor and others (1982, Plate 1).

[3]Engineering characteristics and mineral resources information from Geyer and Wilshusen (1982) and field observations.

SYMBOLS

Location approximate — Location inferred — Location concealed
Geologic contacts
Queried where existence is questionable.

Location inferred — Location concealed
Gradational geologic contacts
Queried where existence is questionable.

Location approximate — Location inferred — Location concealed
High-angle faults

Location approximate — Location inferred — Location concealed
Thrust faults
Sawteeth on upper plate. Queried where existence or identity is questionable.

Location concealed
Reverse fault
Rectangles on upper plate.

Location approximate — Location inferred — Location concealed
Rose Hill Formation, Centre Sandstone Member

Perennial — Intermittent — Ephemeral
Streams
Assigned stream types associated with shown flowpaths.

Location approximate — Location inferred — Location concealed
Anticlines
Showing axial trace. Large arrowhead indicates direction of plunge. Queried where existence is questionable.

Location approximate — Location inferred — Location concealed
Synclines
Showing axial trace. Large arrowhead indicates direction of plunge. Queried where existence is questionable.

A — A′ **Line of geologic cross section**

Field station
Where structures or fossils are not shown.

Invertebrate fossil
Found in Reedsville and Bald Eagle Formations.

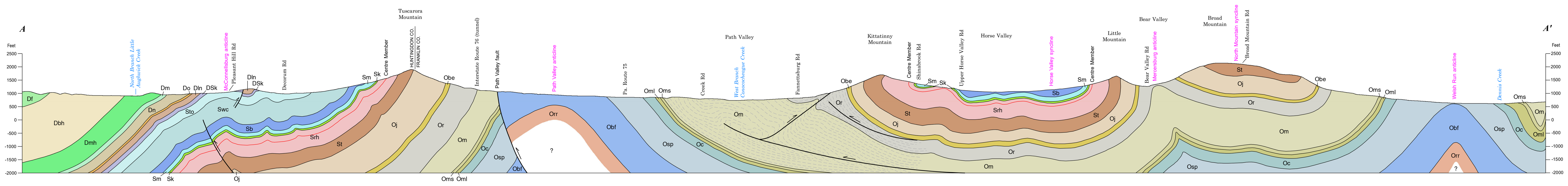
FRA055_0343
Core borehole and identifier
Drilled for the Pennsylvania Geological Survey.

Inclined bed (single) — Inclined bed (multiple) — Vertical bed (multiple) — Overturned bed (multiple) — Inclined joint (single) — Vertical joint (single) — Inclined joint (multiple) — Vertical joint (multiple) — Inclined cleavage (single) — Inclined cleavage (multiple) — Vertical cleavage (multiple) — Inclined extension vein (single)

Strike and dip of planar structures
Single strike-and-dip symbols are placed so the mid-point of the strike line is at the point of observation; multiple symbols at one locality are joined at the tail ends of their strike lines, and the junction point is at the point of observation.

CROSS SECTION

(Horizontal scale same as map scale; no vertical exaggeration)



This plate is part of Map 23–05.0, a publication of the Pennsylvania Geological Survey. In addition to being reviewed by staff at the Survey, it received two external peer reviews. The publication includes a PDF file of the map plate and a GIS file geodatabase containing the geologic data used to create the map. A surficial geologic map and a karst map of the Fannettsburg quadrangle have also been published (Map 23–06.0 and Map 23–07.0, respectively). Links to download these reports are in the Survey's list of publications, which is available at https://www.dcnr.pa.gov/Geology/PublicationsAndData/Pages/default.aspx.

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