An Overview of the Geology At Greenwoods Conservancy

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June 12, 2012

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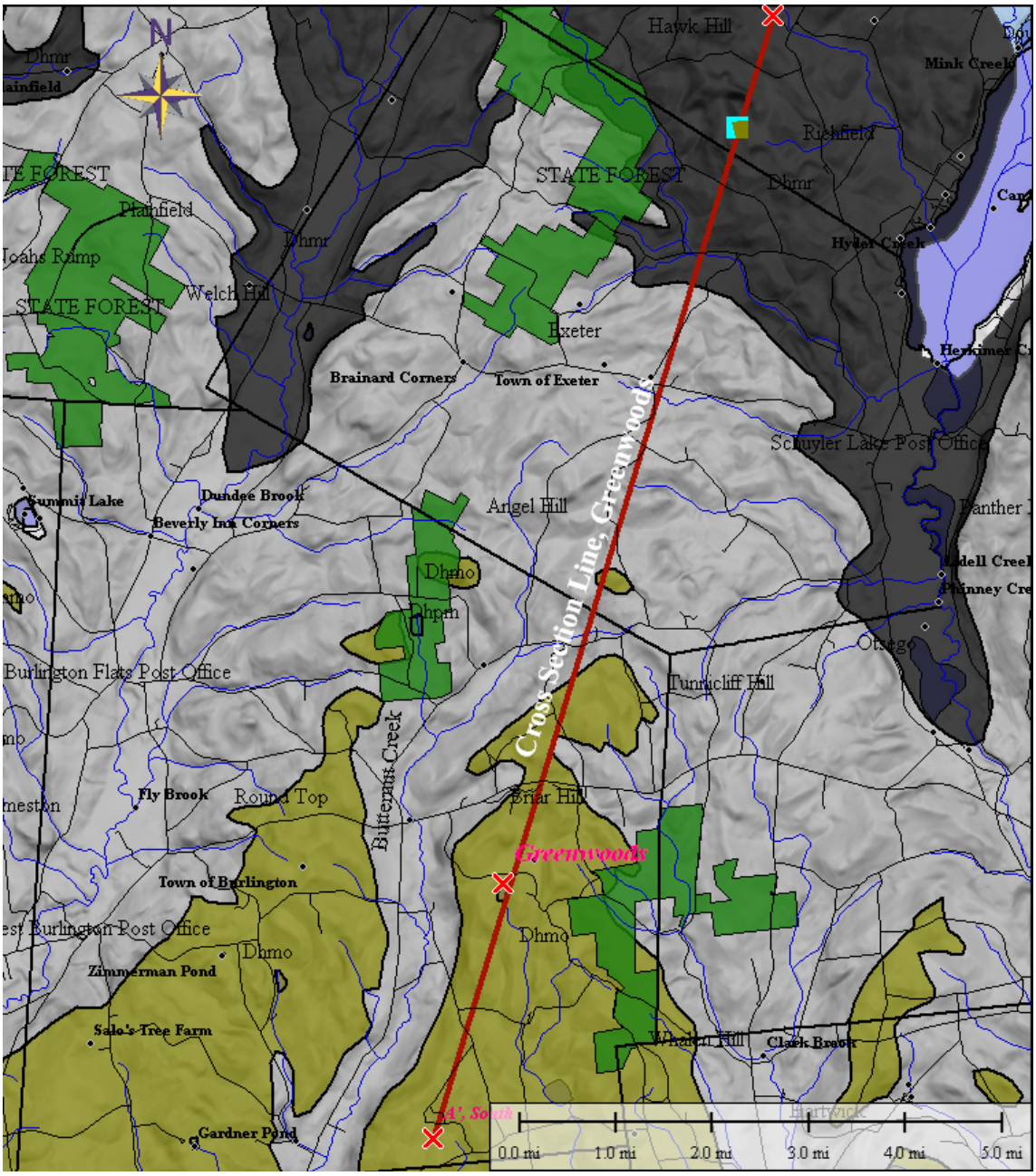
Geologic Overview of Greenwoods Conservancy

Greenwoods rests on the northern edge of the Appalachian plateau in central New York. The plateau is gently etched with rivers which drain south to the Susquehanna River, and ultimately to Chesapeake Bay. Devonian age sedimentary rocks, (407 to 385 million years old) underlie the area around Greenwoods Conservancy. These sediments were deposited into a marine setting, which started off as a shallow warm sea (Onondaga limestone was deposited), then experienced a large influx of terrestrial muds from erosion of mountains that lay to the east (Marcellus, Panther Mountain, and Moscow formations), and sediments from this event are known as the Catskill delta. The seas gradually waned, and retreated. A long period of time elapsed, when these sediments were buried and lithified into sandstone and shale, then uplifted and eroded by streams. During this time period, a series of mountain building events occurred farther east, but those events are not recorded in the sediments under Greenwoods, except, perhaps, by the presence of regionally extensive fractures, which likely formed as a consequence of compressive stresses from continental collisions south of the region. In Pennsylvania, younger sedimentary rocks than those underlying Greenwoods are strongly folded and overthrust, documenting the continental collision. Some modern stream locations follow those fractures. The linear ridge and trough which holds Cranberry Bog follows one of these fractures. 180 million years ago, North America began to separate from Africa, and the Atlantic Ocean formed. About 2 million years ago, glaciers advanced repeatedly over the area from Canada, and further sculpted the valleys, and buried much of the lower valley floors during the last glacial retreat, about 13-14,000 years ago. The glaciers scoured depressions into some of the uplands, and these basins were later filled with lakes and bogs.

A bedrock geologic map and a glacial deposit map of Greenwoods Conservancy are provided on the following pages. A geologic cross section which shows the approximate depth of significant sedimentary formations beneath Greenwoods is also provided. A summary of the depositional environment and general character of sedimentary rock beneath Greenwoods appears below, and a more detailed description of the bedrock geology appears in the Appendix.



LEGEND

- DEC Lands
- Geol-1: Dhmo Moscow
- Geol-2: Dhpm Panther Mtn Fm
- Geol-3: Dhmr Marcellus
- Geol-4: Dou Onondaga Ls
- Cross Section Line
- Road

Bedrock Geologic Map for Greenwoods Conservancy

Geologic Data from NYS Museum
Elevation Data from US Geological Survey
UTM Zone 18 Projection
Map compiled by L. Hasbargen, June 2012

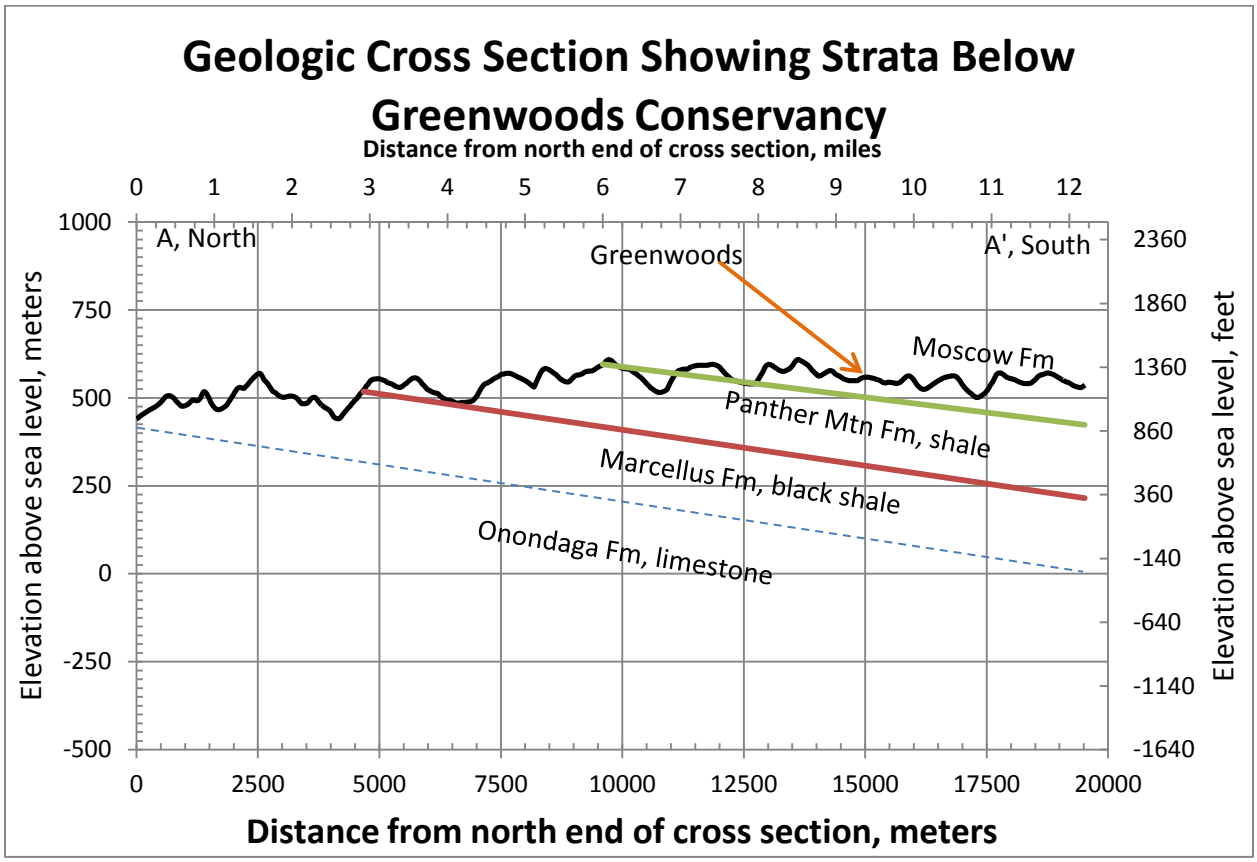
Geologic Descriptions, modified from the New York State Geologic Map

Moscow Formation represents a marine environment, ranging from deeper water where black shale accumulated, to shallower depths where thin ripple-marked sandstone beds and occasional marine fossils were deposited. The upper portion of the Moscow Formation grades into terrestrial deposits. It underlies the Unadilla Formation. 392-385 million years old.

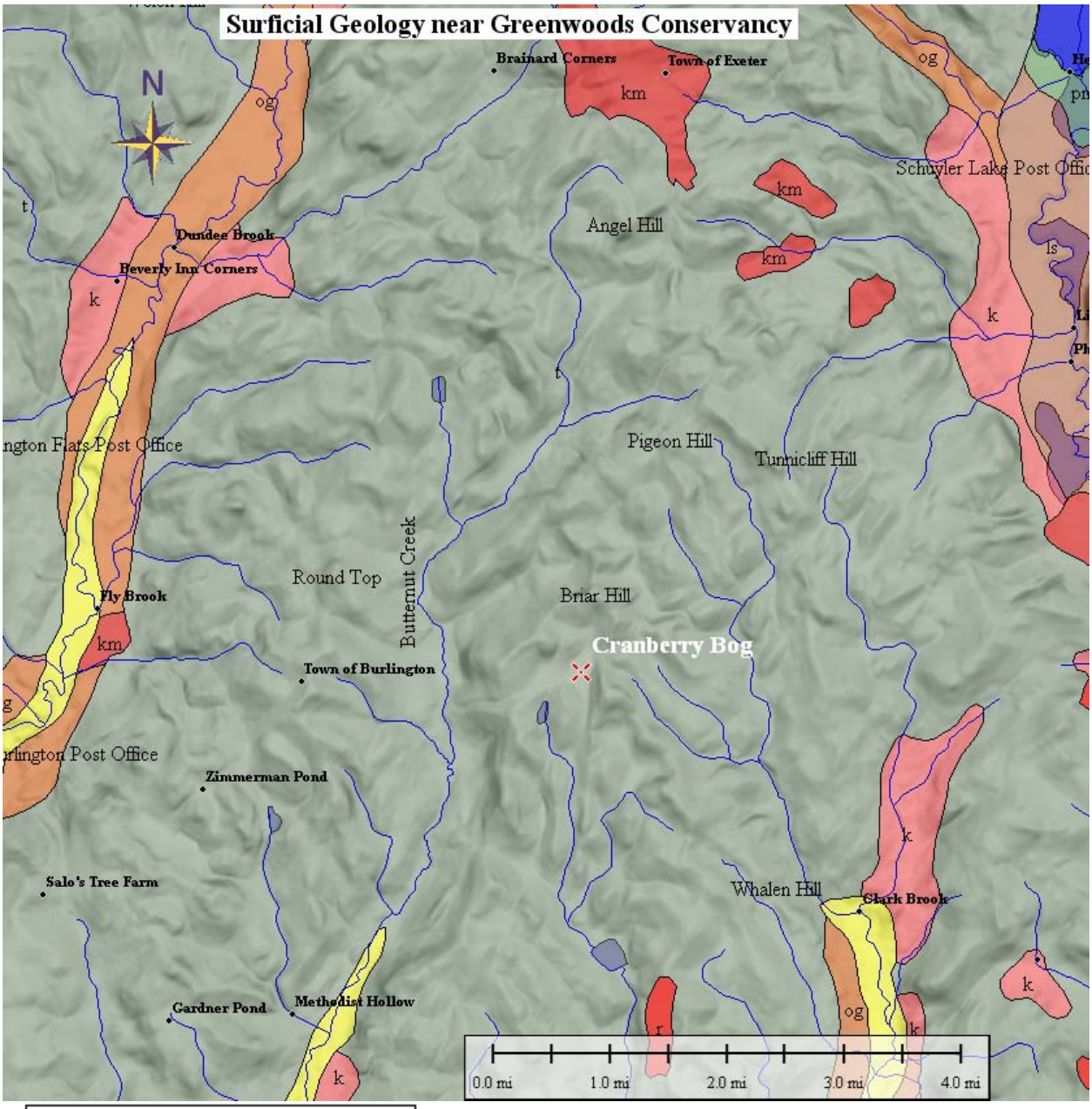
Panther Mountain Formation consists mostly of shale layers, with lesser amounts of siltstone and sandstone beds. It underlies the Moscow Formation. 397-385 million years old.

Marcellus Formation covers a wide region, from New York to Ohio, West Virginia, Pennsylvania and Maryland. It consists for the most part of black shale and occasional beds of medium-gray shale and limestone nodules or beds of dark gray to black limestone. Deposition of the Marcellus marks the rise of mountains to the east, which shed terrigenous sediment in to a marine basin. It underlies the Panther Mountain Formation. 397-392 million years old.

Onondaga Formation consists of limestone, dolostone, and shale beds. The Onondaga represents a shallow warm tropical sea, with very minor terrigenous input from continental erosion. It underlies the Marcellus Formation. 407-392 million years old.



Geologic Cross Section for Greenwoods. Line of section corresponds to the red line on the Bedrock Geology under Greenwoods Conservancy, page 2. Vertical exaggeration is x7. Regional dip of bedrock formations is ~1 degree south.



LEGEND

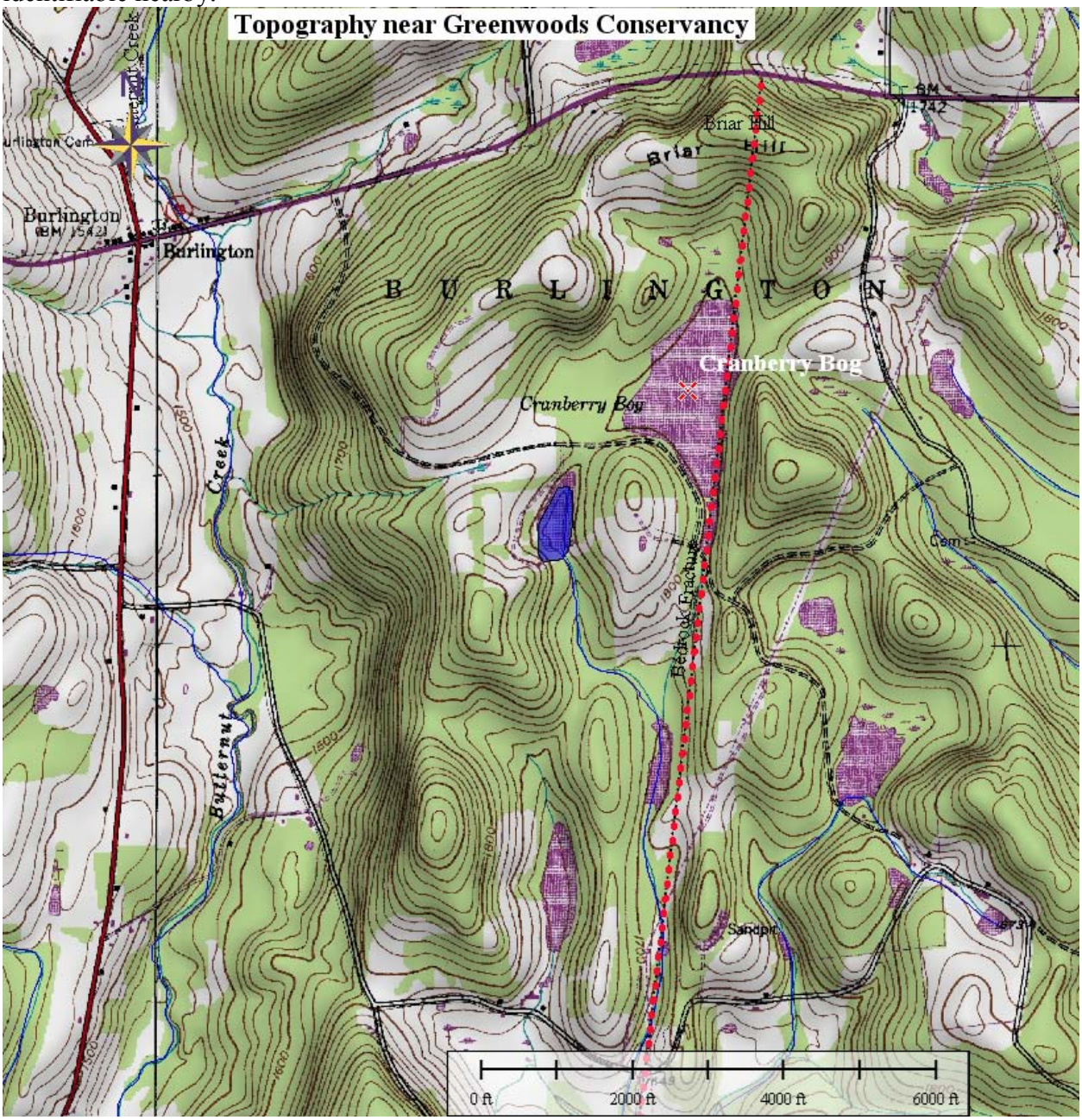
- Geol: Bedrock exposed (<1 m), r
- Geol: Qal Alluvium
- Geol: Swamp/peat, pm
- Glacial Kame moraine, km
- Glacial Kame, k
- Glacial Lacustrine sand, ls
- Glacial Outwash, og
- Glacial Till, t

Surficial Geology near Greenwoods Conservancy

Geologic Data from NYS Museum
Elevation Data from US Geological Survey
UTM Zone 18 Projection
Map compiled by L. Hasbargen, June 2012

The surficial geology of the area shows a rough line of kame moraines about 5 miles north of Greenwoods. This line marks a temporary halt to the retreat of the ice sheet 13-14,000 years ago. The surficial geology in the area is rather poorly detailed. For instance, several kames and kame terraces have not been adequately mapped in the Butternut Valley just west of Greenwoods.

The topographic map below reveals the linear fracture in relation to Cranberry Bog. Cranberry Bog rests in a rock basin, scoured by glacial activity. Several other basins are easily identifiable nearby.



Topography of Greenwoods Conservancy. Red dotted line designates a regional fracture in the bedrock. Several marshes highlight rock basins in the uplands, formed by glacial activity. Elevation data from USGS. Contour interval = 20 feet. Topographic map supplied by Terraserver.

Appendix

Descriptions below are from the New York State Museum's Geologic Map. Formations are arranged from youngest on top to oldest on bottom.

Moscow Formation is "part of Hamilton Group 1700-2800 ft. (520-850 m), and extends from western NY to western PA and in subsurface to northern WV and western MD (de Witt and others, 1993). The Moscow is the uppermost of five major formations in the Hamilton Group. In western NY, consists of gray to black shales, calcareous mudstones and thin limestone. Can be interpreted as a single major depositional sequence, representing 1.5 to 2.0 m.y. of geologic time and bounded above and below by angular unconformities. Lower portion according to authors "might be termed Portland Point subformation" and consists of the Tichenor, Deep Run, Menteth and Kashong Members. In the Cayuga Lake region and in Erie Co., members thin abruptly and merge into a thin limestone-rich interval previously termed the Portland Point Member. The upper, thicker portion of the Moscow consists of the Windom Shale Member in western NY and the Cooperstown Siltstone Member in central NY. In the Finger Lakes region another thin, silty, fossil-rich interval intervenes between the Kashong and the Windom and is here informally termed the "unnamed member." The unnamed member consists primarily of shales and thin concretionary limestone in western areas, but eastward can be subdivided into coarsening-upward mudstone to siltstone packages. The unnamed member extends from Hamilton in the Chenango Valley to just west of Bristol Valley where it is absent due to erosional truncation. It includes the informally named Barnes Gully bed at its base, MEGASTROPHIA beds, Curtice Road bed, and Geer Road bed. Between the Curtice Road and Geer Road beds is a 3-m-thick interval referred to as LONGISPINA-MUCROSPIRIFER shales. Age of the Moscow is Middle Devonian (Givetian) (Brett and Baird, 1994). Lowermost 50 m of the Moscow Formation in the Schoharie Creek and Valenti Road Sections is composed of gray mudstone interbedded with sandstone sets that vary in thickness from 1 cm to 1 m and contain small and medium-scale cross-strata and ripple marks. All strata is burrowed. The lowest 20 m is mudstone dominated and contains marine shelly fossils and quartz pebbles. The middle Moscow is composed of two 35-m-thick sandstone-dominated sequences, parts of which are exposed in this area. A mudstone-rich interval splits the two sandstone sequences. The upper Moscow is predominantly red and gray-green mudstone. The 130-m-thick lower to middle Moscow represents a regressive shoreline sequence on which three smaller-scale regressive sequences are superposed. In this area, the Moscow includes the lower Portland Point Member and the overlying Cooperstown Member. Overlies the Panther Mountain Formation and underlies the Gilboa Formation. Grades eastward into the Manorkill Formation. Age is Middle Devonian. Emphasis of article is on depositional environment. (Bridge and Willis, 1994).

Panther Mountain Formation consists of shale, siltstone, sandstone, and is part of the Hamilton Group 1700-2800 ft. (520-850 m).

Marcellus Formation is "part of Hamilton Group 1700-2800 ft. (520-850 m). Marcellus Shale of the Hamilton Group is the oldest of the extensive black gas shales. Unit crops out in the Valley and Ridge from southeastern NY to northern WV. The Marcellus or its partial equivalent the Millboro Shale, is present in the subsurface in NY, PA, OH, western MD, VA, WV, and northeastern TN. Consists for the most part of sooty black shale and a few beds of medium-gray shale and limestone nodules or beds of dark gray to black limestone. Marcellus is approximately

1,000 ft thick in central PA, but thins to the north, west, and south. Feathers out in eastern OH, western WV, and southwestern VA. The Cherry Valley Limestone Member is an extensive unit in the subsurface of NY, PA, and WV (deWittand others, 1993). Marcellus Formation will be formally raised to subgroup status within the Hamilton Group and be divided into a lower Union Springs Formation and an upper Mount Marion Formation (in eastern NY) and an upper Oatka Creek Formation (in central and western NY) in a publication by Ver Straeten and others (in prep). Union Springs Formation will incorporate three members across NY: The Bakoven Member (geographically extended across the State of NY), the Stony Hollow Member (restricted), and the Hurley Member (new). The Hurley underlies the Cherry Valley Member at the base of the laterally equivalent Mount Marion and Oatka Creek Formations. By extending the Cherry Valley across the State, it now includes strata formerly assigned to the upper part of the Stony Hollow Member. The revised Cherry Valley is composed of two lithosomes; an eastern sand-dominated facies and a central to western carbonate-dominated facies. Strata above the Cherry Valley in the Oatka Creek remain unnamed, though they bear some resemblance to the Chittenango Shale Member of the Mount Marion Formation of west-central NY (Ver Straeten and others, 1994). Otsego - Mount Marion Formation of Hamilton Group is divided into Berne and overlying Otsego Members. The boundary between the two members is revised in this report. The base of the Otsego is placed at the base of a coral-brachiopod biostrome, the lowest rugose coral in a massive sandstone or the top of the massive sandstone (in the absence of corals). In the absence of both, the base is placed at the lowest shell-bed-rich shales that overlie an 8.0-m-thick package of thin sandstones and shales. The base is somewhat diachronous due to local erosive beveling. Formal names are proposed here for four key beds within the Formation: the Dave Elliott occurs in the upper part of the Berne Member; the Halihan Hill Bed marks the base of the Otsego; and the Katsbaan and Timmerman Hill Beds occur in the lower part of the Otsego (Ver Straeten, 1994).

Onondaga Limestone and Ulster Group 100-500 ft. (30-150 m) Second part of description from USGS Lexicon website (ref. NY046) and reference NY017: Middle Devonian Onondaga of NY represents broad, carbonate platform facies deposited during early to middle Eifelian time. Carbonates are characterized by calcarenitic to cherty to argillaceous limestones and minor shales deposited in a shallow epicontinental sea. The Selinsgrove Limestone Member of the Needmore Formation of central PA is the direct equivalent of the Onondaga Limestone in NY. The Onondaga is generally subdivided into four members across NY: Edgecliff, Nedrow, Moorehouse, and Seneca. These four members are directly equivalent to those of the Buttermilk Falls Limestone of eastern PA. The Clarence Member has been recognized only in western NY and is here designated a local informal facies of the Edgecliff. The informal Jamesville Quarry facies of the Edgecliff is also named in this report for the chert-poor, crinoidal pack- and grainstone that occurs at the Edgecliff type locality. Several marker beds within the Nedrow Member are recognized and the upper boundary with the Moorehouse Member is redefined. The Moorehouse contains several fossil horizons and the Seneca contains several bentonite beds, including the Tioga B or Onondaga Indian Nation Bentonite, which defines its base. The Lower-Middle Devonian (Emsian-Eifelian) boundary, long placed at the base of the Onondaga in NY, could lie as high as the base of the Nedrow Member according to Kirchgasser and Oliver (1993), as there are no age diagnostic fossils in the Edgecliff (Brett and Ver Straeten, 1994). Named the Onondaga limestone in PA, NY, western MD, VA, and WV for Onondaga Co., PA. Also called gray crinoidal limestone. Consists of gray or grayish-blue compact crystalline limestone.

Overlies the Oriskany sandstone and underlies the Seneca limestone. Named the Schoharie grit for Schoharie, Schoharie Co., eastern NY. Consists of calcareous fine-grained sandstone that is readily recognized by peculiar mineral characters and fossils. Overlies the CAUDA-GALLI grit (Esopus grit) and underlies the Onondaga limestone. Carlisle Center formation is buff to brown, sandy shale with top 6 in. being a greenish, glauconitic, sandy shale. Base of unit marked by local glauconite bed. Thickness is 5 to 45 ft. Overlies Esopus formation; underlies Springfield Center Member (new) of Onondaga formation. Age is Early or Middle Devonian. Named the Esopus shales for Esopus, Ulster Co., eastern NY. Unit also occurs in northern NJ and northeastern PA. Term Esopus shales replaces CAUDA-GALLI grit. Consists mainly of fine-grained, dark gray arenaceous rock with well developed slaty cleavage. West of Schoharie, unit is moderately hard, dark gray or buff to light olive sandy shale. Unit thickness to east and south; thickness in Albany Co. is 110 feet and in Ulster Co., 200 to 300 feet. The Esopus is of Early Devonian age.

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