3.1 SOILS AND GEOLOGY

Close scrutiny of the Rondout Creek Watershed reveals a complex story of the inter-relationships of bedroll control of drainage from millions of years of sedimentary rock deposition, episodic processes of tectonic uplift and deformation by folding and faulting, eons of erosion of ancient mountains, and more recent glacial action and soil development.

3.1.1 Historical Geology: The topography of the watershed has developed over millions of years. Four main periods of bedrock deposition are recorded in the rock record:

- Late Ordovician Flysch (Austin Glen, Normanskill) marine trough
- Silurian Shawangunk Conglomerate beach
- Late Silurian and Early Devonian Carbonates in warm shallow seas
- Devonian Catskill Delta

Late Ordovician Flysch (Austin Glen, Normanskill) marine trough: The oldest sedimentary bedrock units in the basin are the Late Middle Ordovician gray fine-grain thin-bedded siltstone, shale and sandstone deposits named Austin Glen and Normanskill Formations. Approximately 8000 feet of sediments were deposited in a sinking north-south trough as the backbone of the Appalachian Mountain chain. In Ulster County the sediments were derived by erosion of bedrock within the older precursors to the Taconic Mountains of eastern New York. The rock particles were transported westward and downslope and deposited in the marine trench. Many of the sedimentary layers were “turbidites” formed on the sloping sea floor disturbed by local earthquakes causing the sediment to shake, become suspended in the water, flow down slope, and come to rest with a gradation in grain size. A “turbidite” bed is a deposition from one slide event with sediment sorted from coarse grain (gravel or sand) on the bottom to fine grain (silt or mud) on top. After deposition of these fine-grain gray marine sediments were consolidated into rock by heat and pressure. Later, at least two tectonic events of mountain building such as upheaval and deformation occurred resulting in folded and faulted bedrock rising above sea level and subjected to periods of erosion.

Silurian Shawangunk Conglomerate beach: The Shawangunk Mountains are a ridge composed of huge slabs of quartzite conglomerate interleaved with thrust slabs of Ordovician Martinsburg (Hudson River Beds of Austin Glen and Normanskill Formations). The Shawangunk Conglomerate was deposited at the beginning of the Upper Silurian Period (423 to 421 million years ago) in geologic time. The conglomerate consists of beds of sandstone and quartz pebbles, which were deposited on a beach. The beach developed on an eroded surface of the Ordovician Martinsburg bedrock, which had already been folded and faulted. The deposition of nearly horizontal beds of sediments on a beach overlying the folded and faulted beds below is called an angular unconformity. The contact zone represents a period of time when deposition was not occurring while sediments were lithified into rock, the rock was deformed by earth’s compressional forces, and the older Martinsburg marine rocks were brought to rest at a beach level with upland to the east and a salt-water sea to the west.

The beach zone was oriented north to south and a marine sea was located to the west. Transport of the sand and pebbles came from erosion of crystalline rocks in the vicinity of the present day

Taconic Mountains on the border of New York with Massachusetts and Connecticut. The coarse-grained sand and gravel size pieces of quartz were rounded and polished as they were carried westward by streams and floods to a littoral or beach zone in the area of eastern Ulster and Orange Counties. Smaller size sediments (fine sand, silt, clay) were transported across the beach and into the sea. The Shawangunk conglomerate correlates with sandstones to the west such as the Herkimer sandstone of central New York. The littoral zone slowly sank or sea level rose maintaining the beach in approximately in the same geographic location for approximately 1800 feet of sediment to accumulate. Interbedded red shale and coatings of red iron oxide on grains indicate that the sediments were in a subaerial environment in contrast to other deposits under water. The sediments were lithified by heat and pressure and eventually the beach zone was uplifted by earth forces and the brittle rock was fractured along lines running north 30 degrees east. The broken slabs of the Shawangunk Conglomerate were thrust to the northwest and deformed into a heap of slabs forming the Shawangunk Ridge. The edges of the slabs are the cliff faces. Made of Silurian Shawangunk conglomerate, a white, quartz-pebble, well-indurated rock with an inward dip of the bedding, the escarpment is ideal for rock climbing and attracts and challenges climbers from around the globe. (Van Diver 1985: 92)

<u>Late Silurian and Early Devonian Carbonates in warm shallow seas:</u> The folded carbonate belt of Eastern New York includes the Upper Silurian Rondout Formation and the overlying Lower Devonian Helderberg Group. Carbonate rocks are those made up of limestone and dolostone. The chief mineral of limestone is calcite (calcium carbonate) and of dolostone is dolomite (magnesium-calcium carbonate). Carbonate sediments are is deposited in warm tropical marine waters. The particles of calcium carbonate are formed in green algae and corals in oxidizing conditions. Various species of green and blue-green algae extract the calcium from seawater and form a carbonate skeleton under a green chlorophyll skin. Other marine creatures have carbonate spines, shells, exo- and endo-skeletons, and multi-dwelling units or colonies such as corals. Carbonate rocks are classified by function and shape of floral and faunal debris, which is discarded on the sea flow and the matrix holding the particles together. The grains may be biological pieces and parts, excreted pellets, oolites (pearl-like spheres), and broken pieces of limestone. The two types of matrix cementing the particles together include lime mud known as micrite and crystalline calcite known as spar. The classification name is composed of the particle name and matrix name. Hence, in a bed of Thallassia algae growing in lime mud in the Florida Keys, the modern day marine processes are making a carbonate rock known as a “bio-micrite.” “Bio” is for the origin of the algae parts and “micrite” is for the fine grain mud matrix.

One can go to the Florida Keys and Florida Bay and witness the deposition of modern day carbonate sediments in the shallow warm marine coastal waters. One can also travel to Florida and witness accidents related to collapse of karst features which houses, cars, and all manner of things that have fallen into expanding sinkholes. Karst features are described below.

Between Rosendale and Kingston and from Kingston north to Coeymans, the Helderberg Group is folded and faulted into a complicated three-dimensional puzzle of duplex structures. Also the mining of some strata for cement has removed significant volumes of bedrock both in surface and underground mines. Since the majority of these units are composed of limestone and dolostone, they are somewhat soluble in water, and more soluble in acid rain water. The solution of such carbonate bedrock leads to development of streams, which disappear into the ground and emerge as springs some distance away. Caves, sinkholes, conduits, and a myriad of various shapes and sizes of solution cavities form karst landscape. The unique characteristic of karst areas versus regular competent bedrock areas is that large volumes of groundwater can flow very rapidly from the surface into and through underground karst conduits.

KARST AQUIFER REGION: For that reason, the 2009 NYS Open Space Conservation Plan defines the as follows and has designated this area as a regional priority for conservation (p. 71):

> "The Karst Aquifers are situated in a narrow band of carbonate rocks that extend throughout Ulster County, generally parallel with the Hudson River and tending south-southwest through portions of Saugerties, Kingston, Esopus, Marbletown, Rosendale, Rochester, and Ellenville continuously outcropping just northwest and along the flank of the Shawangunk Mountain Ridge. This region is characterized by such features as caves, sinkholes, mines, springs, lakes and sinking streams. The area is rich in biological, geological and historical resources, provides diverse outdoor recreational opportunities and critical water reserves."

In addition to recreational and water supply uses, the very same karst features can transport spilled or released contaminants into groundwater supplies very rapidly with no filtration by soils or other natural mitigation. Such potentially hazardous conditions require special protection for the groundwater within these carbonate units.

Because the Rondout flows over these bedrock units and also is hydraulically connected with the groundwater within these carbonate rock, protection of the groundwater resources is a natural topic for inclusion in a discussion of management of the Rondout Creek.

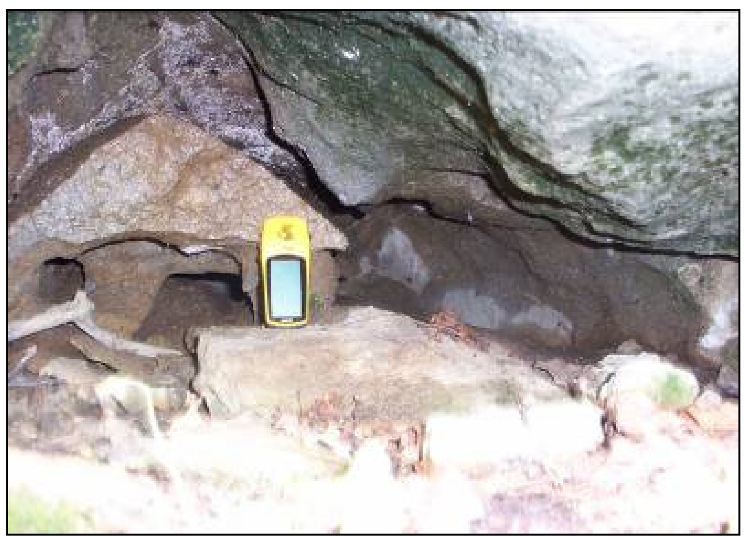
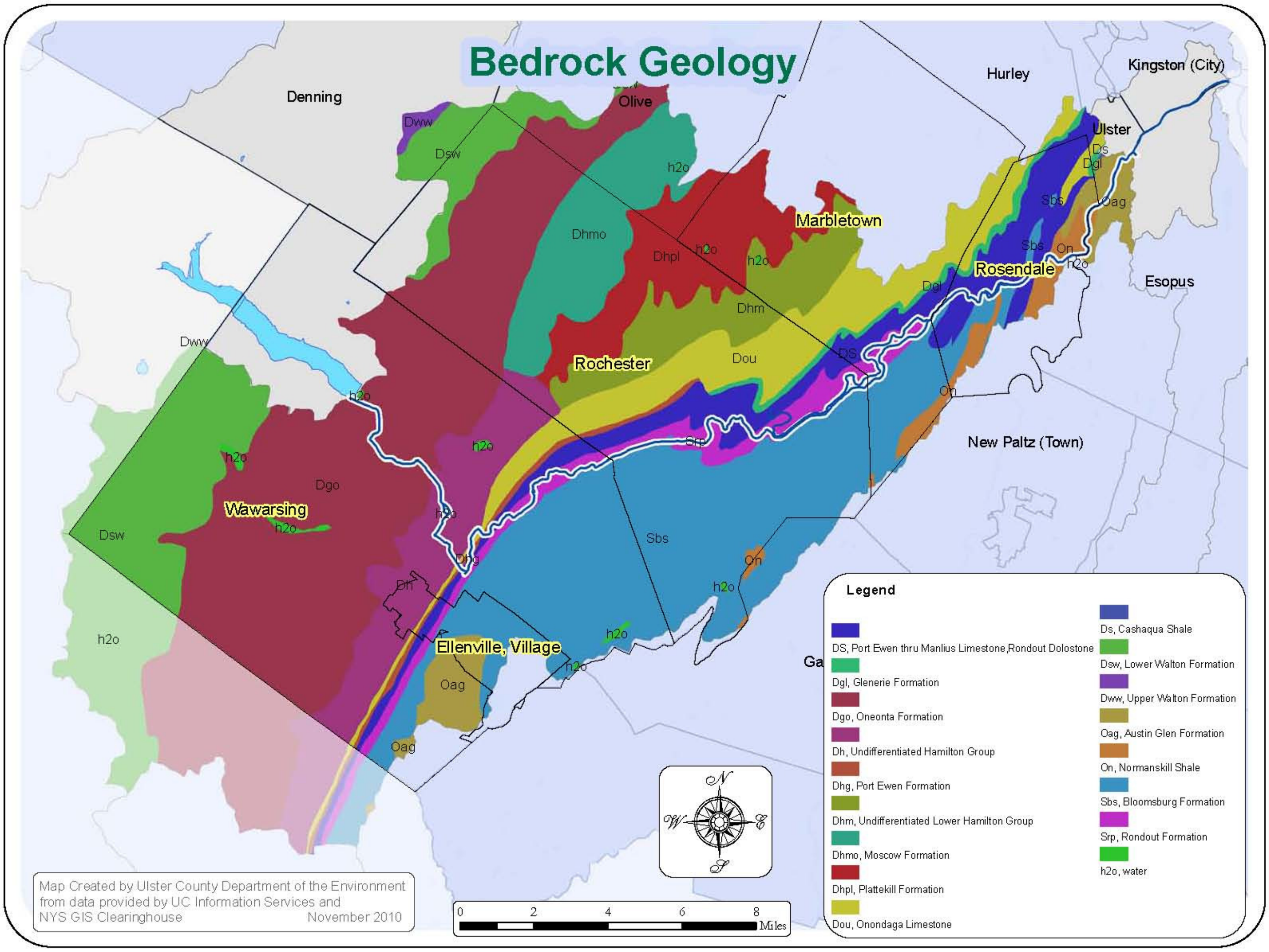


Photo 3.1.1 Karst dissolution: Note the fissures and openings created by rainwater and snowmelt dissolving limestone rock. Small hand-held GPS unit indicates scale of the erosion. With features like this, development over karst should either be avoided or done very careful to protect underlying aquifers and to ensure structural stability.

<u>3.1.1.4 Devonian Catskill Delta</u>: Estimates indicate that the 7000 to 9000 feet of sediment were deposited as the Catskill Delta on the edge of a sinking shallow sea. The sediments were eroded from the ancient Taconic Mountains and transported westward to the shallow marine environment. The youngest bedrock was deposition as a coarse grain layer of the Slide Mountain Formation on top of the Catskill Delta 550 million years ago.



Map 3.1.1 Bedrock Geology. Courtesy of Ulster County Department of the Environment, November 2010.

3.1.2 Course of the Rondout Creek from Reservoir to Eddyville Dam: The lower non-tidal Rondout Creek is a major drainageway capturing water flowing down the southeast front of the Catskill Plateau and from the northwestern side of the Shawangunk Ridge. These two drainage areas converge in the southwest-northeast trending Silurian-Devonian carbonate belt and the stream flows northeast from Ellenville toward High Falls, Rosendale, and Eddyville.

The lower Rondout Creek flows southeast from the NYC Rondout Reservoir down the slopes of the near horizontal sedimentary deltaic deposits of the Catskill Plateau. At Napanoch the Rondout Creek is joined by Sandburg Creek flowing northeast from Ellenville. At that point the Rondout makes a right angle turn and flow s northeast within the Silurian-Devonian carbonate belt. The solubility and softness of calcite and dolomite minerals allow the bedrock to be easily eroded and the carbonate belt forms the natural lowland to conduct the stream flow to the northeast.

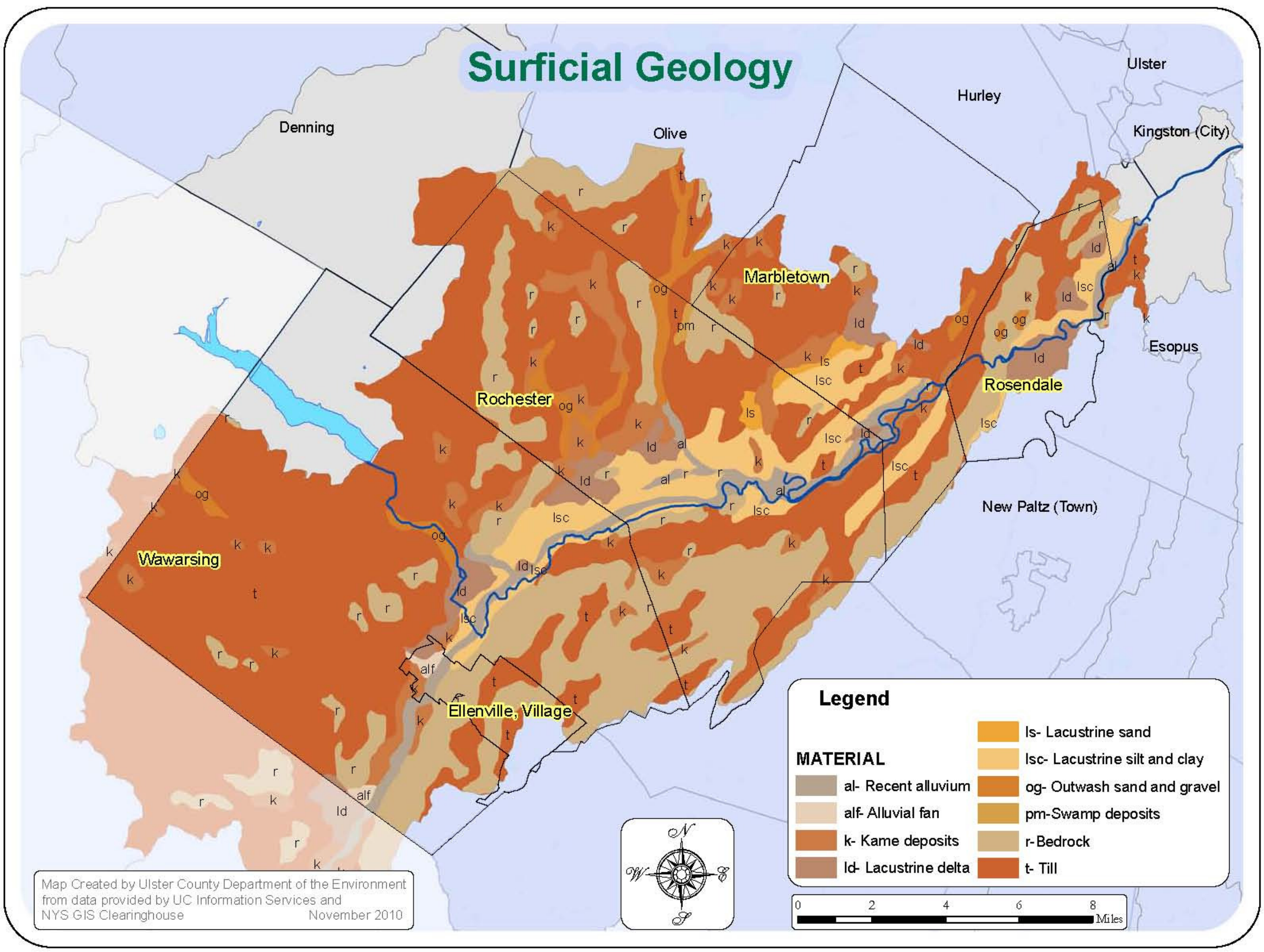
From Napanoch to Kerhonkson the Rondout Creek follows a meandering pathway on a floodplain (about 2000 feet wide). From Kerhonkson to within one mile of Accord, the stream flows in a wide nearly straight arc changing direction from northeast to nearly east always hugging the southeast limit of the floodplain.

With respect to stream flow, a constricting point is located directly south of Mill Hook and about 1500 feet north of the intersection of Berme Road and Granite Road. Immediately after the constriction, the Rondout Creek resumes a meander pattern from Accord to High Falls. At High Falls, a dam confines the stream flow and periodically the water is diverted through a sluice and tunnel system to drive electric generating turbines. Before the dam, the last 2000 feet of stream bed is confined by Berme Road on the southeast and Lucas Avenue on the northwest up to the bridge where Route 213 crosses the stream on the west side of High Falls.

After the power plant, the Rondout follows a relatively straight course from Bruceville to Lawrenceville because the stream is confined on both sides by a v-shaped bedrock valley. At Lawrenceville the stream follows a course of incised meanders through Rosendale to LeFevre Falls. About 2,000 feet below the Falls, the Wallkill River spillway from Sturgeon Pool enters the Rondout from the south. At the confluence the Rondout changes course and flows north-northeast in a v-shape valley with very gentle arcs (in contrast to curly meanders) to Eddyville.

3.1.3 Surficial Geology

Map 3.1.2 Surficial Geology. Courtesy of Ulster County Department of the Environment, 2010.



Rondout Surficial Geology: Overburden is the general term for unconsolidated sediments deposited above bedrock and consists of surficial geologic sediments with developing soil on top. Surficial geology includes the study of sediments placed on the bedrock surface as a result of geologic processes of erosion, transport, and deposition by glaciers, wind, streams, and glacial meltwaters above, within, under and away from the ice. Other processes include lacustrine environments such as ponds and lakes as well as delta formation where streams transport sediments into such still bodies of water and drop the sediments upon entrance. The surficial geologic units mapped by the New York Geological Survey on the Lower Hudson sheet (map scale 1:250,000) include the following:

Till (map symbol "t") consists of sediments deposited directly by a glacier without reworking by melt water and is comprised of a mixture of clay, silt, sand, gravel, and boulders. Such materials originate from the pressure and grinding of glacial ice eroding underlying sediments and bedrock. There were four ice ages and detailed mapping has shown that much of the New York State shows evidence of advance and retreat of more than one glacial episode.

Stratified drift may be glaciofluvial, glaciolacustrine, or glacialmarine in nature depending on the water body interacting with the glacier such as streams, lakes or salt water. In moving water such as a stream flow or tidal oscillation, the sediments tend to be sorted and beds are formed by size related to intensity of action. Greater velocity or amplitude can move larger size particles and when the energy is dissipated strata of like size are deposited. In still water such as ponds and lakes or wetlands, sediments can be deposited by settling from suspension. Often the source of water is glacial melting on top, within, under or on the sides of glaciers. Stratified drift deposits are a broad category of many distinct types such as lacustrine, kame, outwash deposits, and swamps.

Glaciofluvial deposits include kame and outwash deposits.

Kame (map symbol "k") deposits are mounds, knobs, or short irregular ridges, composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier or by a superglacial stream in a low place or hole on the surface of a glacier or as a deposit on the surface of or at the margin of stagnant ice.

Outwash deposits (map symbol "og") consists of sand and gravel strata left by melt water streams in front of an end moraine of the margin of an active glacier.

Lacustrine deposits include deltas, silt, and silt and clay deposits.

Lacustrine deltas (map symbol "ld") are formed where glacial or other flowing water enters a lake or pond. The sediment is dropped because energy of stream movement or momentum diminishes upon reaching the base level or surface elevation of the lake or pond. The sediment grain size in the delta is the largest grain sizes transported by the moving water. The smaller sediments such as clay and silt can be carried by suspension farther out into the body of still water.

Lacustrine silt (map symbol "ls") is material, which may be at the toe of the delta or lake bottom sediments depending on stream carrying capacity when entering a still body of water. Other silt deposits, formed by wind blowing over the glacier and exposed sediments, are known as "loess".

Such wind-blown silt deposits are lumped in with lake silt deposits on the surficial maps included in this report.

Lacustrine silt and clay deposits (map symbol “lsc”) are lake bottom deposits from fine grain silt and clay material dropping from suspension in still waters. Such deposits are often seasonal with alternating fine light and dark strata.

Swamp sediments (map symbol “pm”) consist of organic and fine grain sediments deposited under saturated reducing conditions in slow moving wetland waters.

Alluvial deposits (map symbol “al”) are composed of alluvium that is deposited by streams or running water as a stream channel. In contrast to fluvial deposits associated with actual streams, alluvial features are related to episodic heavy rains associated with erosion, transport, and deposition of material, which is normally dry on sloped landscapes.

Alluvial fans (map symbol “af”) are outspreading, gently sloping sediment masses deposited by an intermittent stream on generally dry lands as a result of episodes of heavy rains. Viewed from above, the shape of deposits is in the shape of an open fan with the apex at the upgradient point of dispersal, similar to the dispersion of a delta where a stream enters still waters.

Once the surficial deposits are in place, the slow process of development of a soil profile takes places over thousands of years driven by mechanical and chemical reactions driven by periods of rainfall, leaching, drying out, and natural mixing such as worm borrowing. Each soil is characterized of the type surficial deposit upon which it develops as well as topography and nearby agents of change.

In some areas, surficial deposits have never formed or have been eroded away leaving bare bedrock exposed (map symbol = “r”).

Distribution of Surficial Deposits and Bedrock Knobs and Planes: On the northwestern side of the Rondout Creek drainage basin, till is widely distributed by the action of glaciers at elevations above those listed for each sub-basin.

580 feet	Sandburg Creek
490 feet	Beerkill Creek
611 feet	Direct Discharge below Rondout Reservoir
895 feet	Vernooy Kill

Within the till area, several hill tops are shown as rock areas as well as medial drainage divide areas between Vernooy Kill sub-basin and Sagebush--Mombaccus drainage and on the west side of the Beaverdam and Rochester Creek drainage. A large bedrock exposure area is shown near the intersection of the boundaries of the Towns of Rochester, Marbletown and Olive in the headwaters of Vly Creek. Also another bedrock area is mapped on the northern edge of the Rondout Basin around the peaks of Little Rocky, Mombaccus, and High Point in southeastern Olive. These bedrock high points often show glacial striations indicating that while a glacier was moving over the bare bedrock, rock chips in the muddy frozen base of the glacier have scratched grooves. Sometimes two directions of striations are superimposed showing movement of two glaciers or ice lobes moving in different directions.

The Sandburg Creek to Wallkill River Sub-Basin shows is the area on the western side of the Shawangunk Ridge where drainage flows westward down to the Rondout Creek. On the surficial geology map distinct linear patterns of till and bedrock exposure are shown. Obviously the bedrock areas are the open steep spans of the Shawangunk Conglomerate slabs dipping west toward the Rondout. The till is found in depressions and valleys in areas which may have been former ice caves formed by erosion and mass wasting of open linear fractures between large slabs of the conglomerate bedrock. The path of the Rondout Creek was described as a nearly straight arc from Kerhonkson to within one mile of Accord. From inspection of the surficial geology map (Map 3.1.4), it is evident that resistant bedrock on the east side of the creek controls the direction of flow.

Several kame areas are shown in the Beaverdam and Rochester Creek drainage basin indicating significant meltwater activity as glaciers were waning. Comparing the stream flow patterns and the kame deposits in that area, disrupted drainage patterns are caused by kames acting as dams to flow. Many streams flow south and are diverted to the east by kame deposits and bedrock outcrops.

The lowland drainage-way from Spring Glen to Rosendale within the Silurian-Devonian carbonate belt has many types of surficial units, such as lacustrine, fluvial and alluvial deposits. Because the carbonate belt encompasses convergence of stream waters on lowlands, there are more sites for lakes and ponds to occur after glacial retreat. Outwash and subsequent freshwater erosion, transport and deposition are the dominant post-glacial geologic processes forming the modern landscape.

From Napanoch to High Falls, broad linear bands of lacustrine silt and clay are shown covering the valley floor on the northwest side of the Rondout Creek, while the southeast side is confined by bedrock and till deposits. From the confluence with the Wallkill flow east of the New York Thruway to the dam at Eddyville, a similar, somewhat thinner band of lacustrine silt and clay lies on the northwestern side of the Rondout and bedrock on the southeastern side. Although the surficial map shows areas of till in the segment from High Falls to the Wallkill confluence, the till is a thin veneer and the Rondout stream flows over and between bedrock walls.

3.1.4 Soils: A soil profile is made up of different horizons defined by the physical, chemical and hydraulic characteristics as the soil changes from the surface downward toward bedrock. The soil profile develops in the surficial sediments from the time they are exposed to the atmosphere and weather. In the Rondout Valley most soil profiles have been developing foe about 10,000 years after the end of the lat ice age until now. Each soil type is a product of a surficial deposit consisting of a grain-size distribution from clay-size particles though boulder-size. Rainfall and snowmelt play a significant role in the vertical change in the profile due to the interaction of water infiltrating through the loose sediments interacting with some sediments, which are soluble in water and even more soluble in acid rain. Some minerals are dissolved and transported downward in the water. Other minerals undergo chemical alteration depending on conditions of temperature, pH, and oxidation-reduction potential. The annual freeze-thaw cycle and mixing of sediments and formation of worm-castings also alter the sediments as the soil develops.

As mentioned previously, soils develop on surficial deposits. There are more soil classifications than types of surficial deposits because soil types are classified by more factors including parent material, climate, plant and animal life, topographic relief (elevation and slope), time, and hydrologic conditions.

Ulster County Department of the Environment is preparing a simplified version from the Soil Survey of Ulster County, NY (published by USDA, June 1979). Many soils have the same locality name and are further subdivided by slope and association with other soil types and bedrock and boulders. For instance the following four soils are grouped together because they all developed in reddish glacial till above sandstone, siltstone, and shale bedrock.

OgB	Oquaga Channery silt loam, 3 to 8 percent slopes
OlC	Oquaga & Lordstown Channery silt loams, 8-15 percent slopes
ORC	Oquaga-Arnot-Rock Outcrop Complex, sloping
ORD	Oquaga-Arnot-Rock Outcrop Complex, moderately steep

All of these soils are related in that they formed on reddish till derived from red sandstone bedrock by scraping and gouging by the base a moving glacier. A similar consolidation of soils into groups is presented in Table 18 in the Soil Survey of Ulster County, NY (pages 271 and 272) based on the parent material, depth and grain-size (texture) of the soil as well as degree of soil drainage and saturation (excessively drained to very poorly drained).

Sandburg Creek to Wallkill River Sub-Basin (Shawangunk Mountain). Although much of the Shawangunk ridge consists of barren conglomerate slabs with no soil development, soils can be found derived from till, lacustrine, and swamp deposits. Well-drained Lordstown and Arnot soils are found in the low areas where the Ordovician shale, siltstone, and sandstone are exposed in windows between the conglomerate slabs. Where water was confined in depressions, lacustrine environments provided the parent material for the poorly drained Madelin soils. Palms muck soil developed in a few isolated swamps.

Sandburg Creek, Beerkill, Rondout Reservoir direct drainage, and Vernooy Sub-Basins. The upland till areas identified above in the surficial till discussion extend across these four sub-basins. The soils developed on till encompass the full range of drainage capacities from Menlo, Morris, Wellsboro, Lackawanna, Lordstown, Oquaga, and Arnot soils. The soils formed on glacial outwash deposits include Walpole and Lamson soils on the “poor” end of the drainage scale. Wayland and Palms muck soils are also on the “poor” end of the scale. The Wayland soil develops along flat stream segments where the valley is wide enough to accommodate a floodplain and the Palms muck forms in swamps confined isolated depressions. The Vernooy drainage area has more Arnot soils and associated rock outcrop than the other sub-basins.

Vernooy Kill to Rochester Creek to Cobbeskill Brook Sub-Basins. These areas have similar soils and till to the sub-basins to the southwest, except for a broader range of till parent materials. All of the till soils are on the well drained half of the drainage scale. Those soils include Bath, Mardin, Wellsboro, Valois, Lordstown, Oquaga, Arnot, and Nassau. The Arnot-Lordsville soils have the greatest distribution. The Hoosick soil is found in former stream terrace, outwash terrace, and outwash fan locations, providing many good sources of stratified sand and gravel for building materials.

From Rondout Reservoir to Honk Lake, the Rondout Creek traverses a sloped course with the Swartswood and Lackawanna well drained soils representing the only soils developing on tills of that area. The dominant soils are developed as stream terraces. The Raynham, Red Hook, and Scio soil types are mid-range on the drainage scale. Hoosic soils are extremely well drained sand and gravel deposits, which are valuable mining resources.

From Honk Lake to the stream valley in the Route 209 corridor, the well drained Lordstown and Arnot soils are developed on till deposits. The extremely well-drained Plainfield and Suncock soils develop on deltaic and floodplains associated with the stream and its valley.

Along the Sandburg Creek flowing from Sullivan County to the point of confluence with the Rondout northeast of Ellenville, the floodplain soils represent the full range of drainage from very poorly drained to excessively drained including Wayland, Middlebury, Tioga, and Suncock. Stream terrace deposits of Unadilla and Raynham are found along this segment. The Unadilla, a well-drained soil is probably the most common soil along the full length of the Rondout Valley along the Route 209 corridor. Stratified Haven alluvium and the Plainfield delta sands are also common along the Sandburg Creek segment.

From the Sandburg and Rondout Confluence to Kerhonkson the same suit of soils are found along the lowlands within the floodplain.

From Kerhonkson to St. Josen, two stream terrace groups of soils are found, the silty Unadilla, Scio, and Raynham soils differing by drainage capacity and the stratified sand and gravel Haven, Pompton, and Walpole soils also differing by drainage capacity. Poorly drained Wayland soils are found on the floodplain.

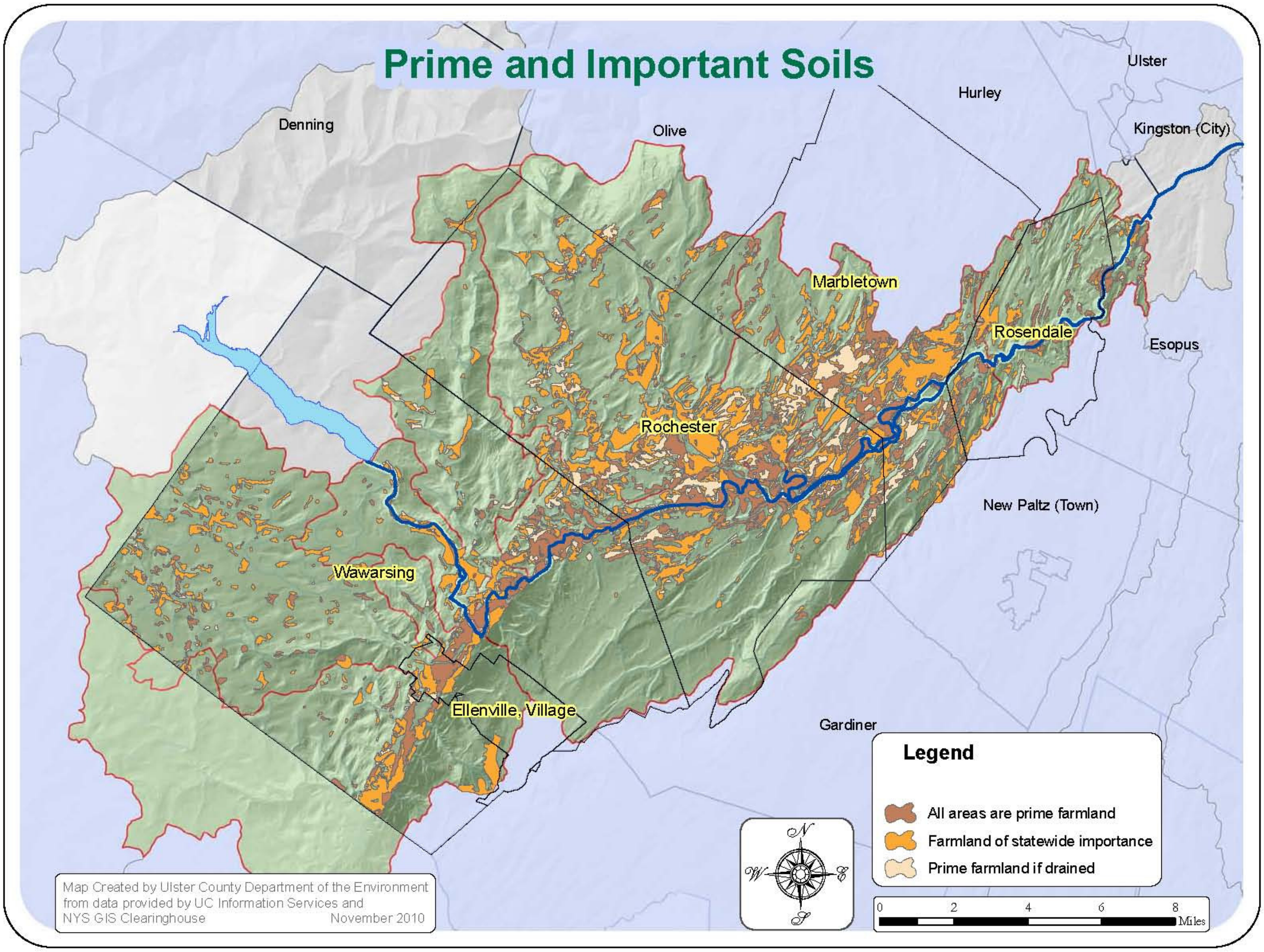
From St. Josen to Alligerville, the soils are different from those upstream and downstream. Till-derived soils such as the well drained Bath and Mardin developed in an area where a moraine was probably left behind with the retreat of glacier ice. The Rondout breeched the moraine and has probably been eroding it ever since. In this segment other soils associated with outwash terraces and lake plains include Hudson-Schoharie, Odessa, Raynham, Red Hook, and Hoosic.

From Alligerville to High Falls Cemetery, these soils are predominantly stream terrace soils such as Unadilla, Scio, Canandaigua, Haven, and Walpole. Tioga floodplain soils are also included. Unadilla is the dominant soil type.

From High Falls Cemetery to the High Falls Dam, the soil have greater diversity of grain size, drainage capability, and origin since soils are found to develop on tills, terraces, and floodplains. The till-derived soils include Stockbridge and Farmington, both of which indicate the presence of limestone bedrock. Stream terrace soil types include Hudson, Schoharie, Scio, Hoosic, Riverhead, Plainfield, and Lamson. Floodplains are represented by Suncock soil.

From High Falls Dam to Rosendale; till, stream terrace, and floodplain soils are found along the stream although the stream has steep bedrock valley walls and thin floodplain areas. The till soils include Lordstown, Arnot, and Farmington, all associated with rock outcrops. Farmington is specifically associated with limestone bedrock. The limited stream terrace development is represented by stratified Red Hook and Hoosic soil types and coarse textured Plainfield soil. The floodplain soil is Wayland, poorly drained compared to all of the other soils in this area.

Rosendale to Bloomington has a large array of soil types. Soils derived from thin tills include the Menlo, Stockbridge, and Farmington. The soils associated with lakes and stream terraces include Hudson, Schoharie, Unadilla, Riverhead, and Plainfield. The Middlebury, Hamlin, and Wayland soils developed on floodplains.



<u>Map 3.1.3</u> Prime and Important Soils. Courtesy of Ulster County Department of the Environment, 2010.