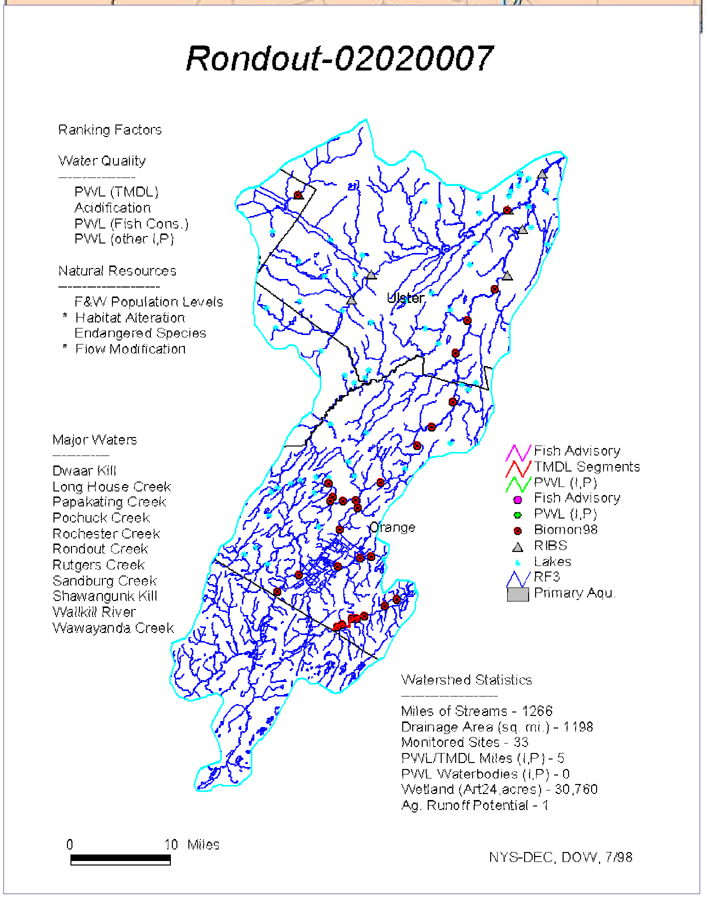
## 2.1 The Rondout-Wallkill Watershed:

The Rondout Creek is among the largest tidal tributaries to the Hudson River. The headwaters of the Rondout Creek begin in the Town of Shandaken at an elevation of 3,837 feet (DEP, 2008). The creek flows southwesterly through the Peekamoose area in the Town of Denning and into the Rondout Reservoir. The Creek is impounded by the Merriman Dam in the Town of Wawarsing to form the Rondout Reservoir, which stretches, into Sullivan County. The Rondout Creek picks up again below the dam with a State-mandated release of 10-15 million gallons per day from the reservoir, then travels southeast through Napanoch, where it bends northeast through the agricultural floodplains of Wawarsing, Rochester, and Marbletown where it plunges over the falls in High Falls. Beyond the hamlet of Rosendale, the Rondout Creek is joined by the Wallkill River beyond the Central Hudson-owned hydroelectric plant at Sturgeon Pool in Rifton.

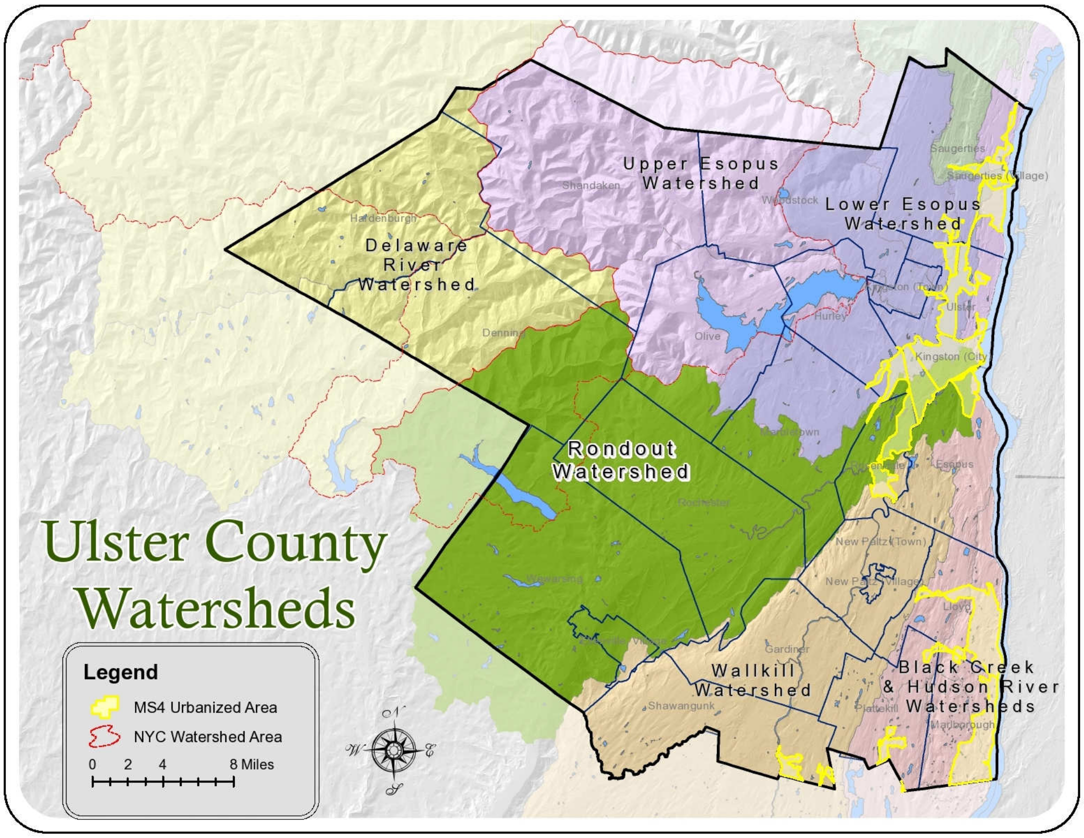
Map 2.1.1: Rondout – Wallkill Combined Watershed


The Wallkill River system and Rondout Creek system form the approximately 3,082-km$^2$ (1,190 sq. mi.) Rondout-Wallkill watershed, the largest tributary basin entering the Hudson River south of the head of tide at Troy. The Rondout then continues to flow north over the Eddyville dam, where it is tidal for a 4-mile stretch until it empties into the Hudson River in downtown Kingston at an elevation of 190 feet. The Rondout enters the Hudson River Estuary at River Mile 91 (148 km), far enough north of the limit of saltwater intrusion so that the Rondout is characterized as a tidal freshwater system.

**Delineation:** Delineating the Rondout Creek watershed was challenging because it overlaps with the Catskill Park and the New York City Water Supply System for the Catskill and Delaware. In addition, the Hydrologic

Unit Code (HUC # 02020007 – Map 2.1.2) is called Rondout, but includes the Wallkill Creek, which flows north from New Jersey through Orange County. A *Wallkill River Watershed Conservation and Management Plan* has already been created for the Wallkill watershed. The Rondout Creek Interim Watershed Management Plan for the lower, non-tidal section has been designed to interface easily with this and other watershed planning and protection efforts in the adjacent watersheds -- the Upper Rondout, under the guidance of NYC DEP, and the Upper and Lower Esopus, with the leadership of the Lower Esopus Watershed Partnership (LEWP).



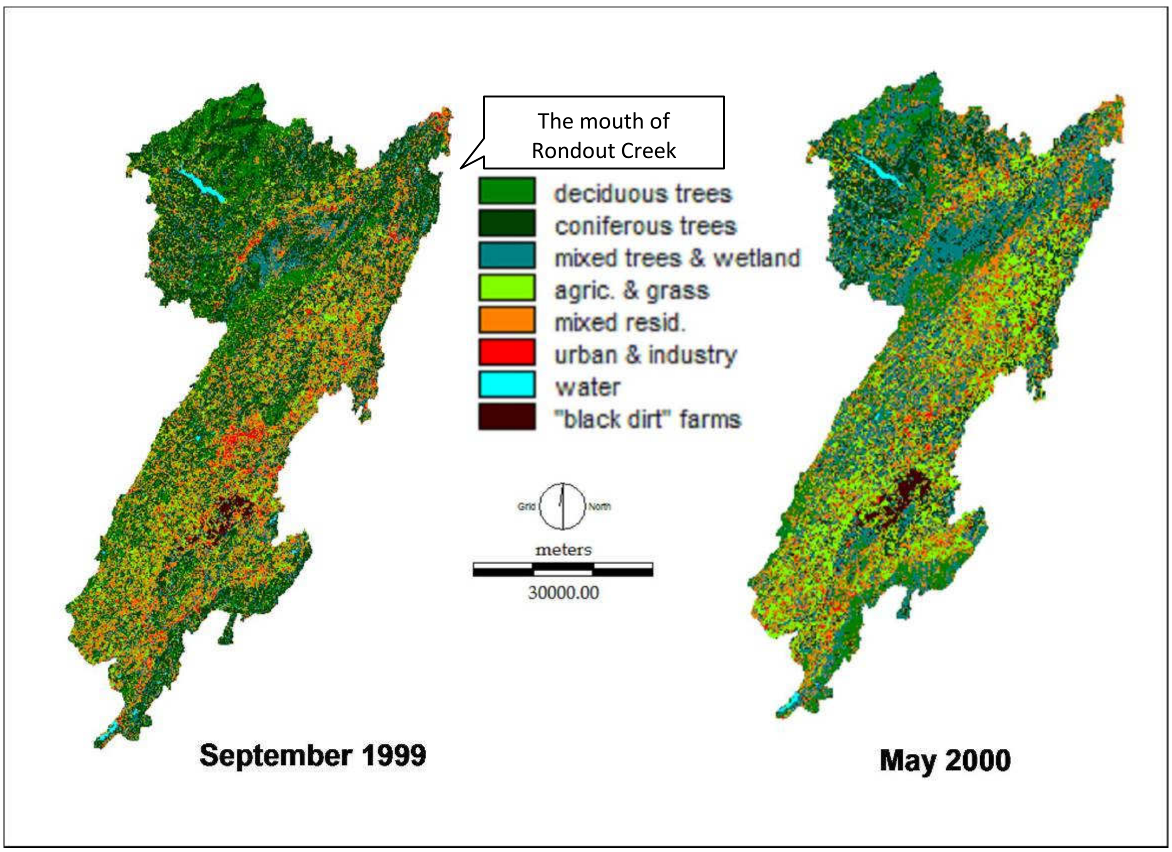

Map 2.1.3: The full Rondout Creek Watershed covers most of the southwest portion of Ulster County with the Delaware Watershed in Delaware and Sullivan Counties to the west, the Upper and Lower Esopus to the north and the Wallkill and Black Creek to the east.

**Impervious Surface in the Rondout-Wallkill Watershed**: This section has been adapted from *Using a Shoreline Inventory for Conservation and Planning: the Rondout Creek Case Study*, original research by Chris Bowser (*Appendix E*).

Because it contains a high diversity of shoreline type in a relatively short stretch, it was used extensively and historically used as an early site for sampling, inventory and collection classification for many studies. Finally, the Rondout Creek contains, within a relatively small area, many of the same issues and challenges found along the greater mainstem estuary, including competing needs of economy and ecology as well as management across municipal borders. The design and implementation of a Watershed Management Plan that takes into consideration the Rondout Watershed's ecological assets and cultural highlights will establish the context of conservation needs and could best be applied to the larger whole (connectivity of all the watersheds) in the future.

**Land Cover of the Rondout Watershed and Creek** (Winter 1999, Spring 2000)**:** Percentage of impervious land cover within a watershed can be used as a general indicator of watershed health and non-point source pollutant loading. Impervious cover refers to roads, roofs, and parking lots that do not allow rainwater to penetrate soils, thus increasing the likelihood of erosion and non-point source pollutants to rapidly enter local waterways. Urban areas typically have a high percentage of impervious cover, agricultural areas less so, and forested areas have the least (For more information about impervious surfaces see Section 4.2).

Thirty-meter resolution Landsat imagery (bands 4, 3, and 2) of the Wallkill-Rondout watershed from both September 1999 (a month when deciduous trees are in full leaf) and May 2000 (a time before deciduous leaves have fully formed) were classified for land use cover using the IDRISI software package. Two seasons were used to examine the effect of multi-seasonal differences, such as deciduous leaf cover, on classification.

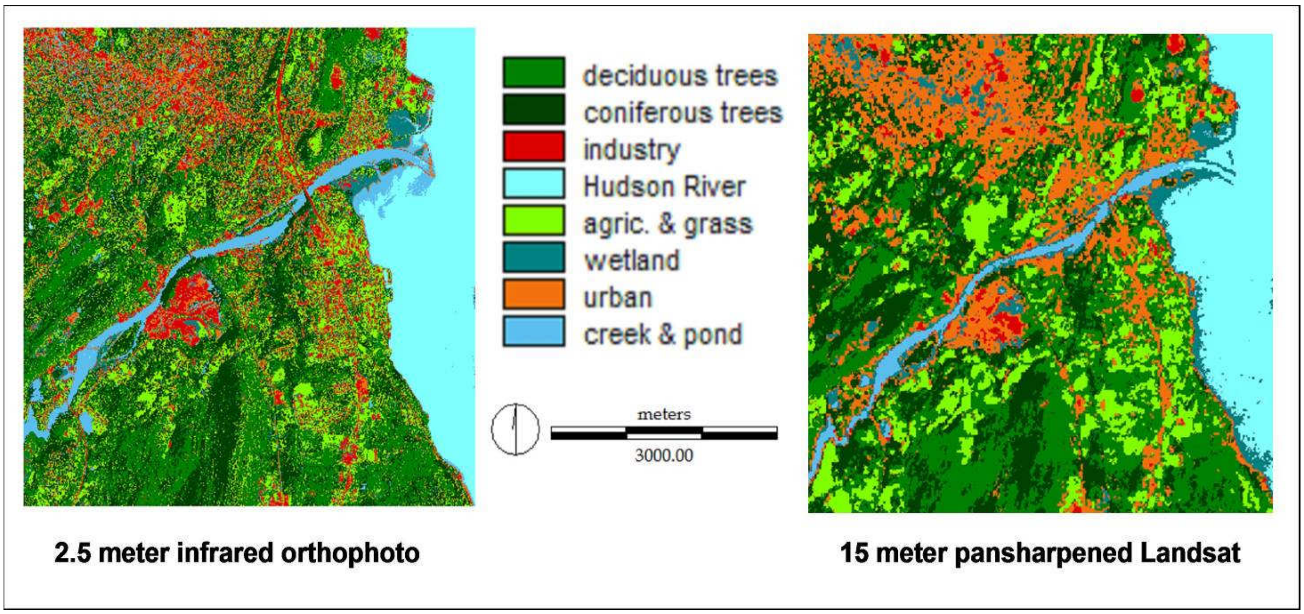



**Map 2.1.4:** Land use in the Rondout-Wallkill watershed *(Source of Landsat image: University of Maryland website: glcfapp.umiacs.umd.edu).* Note: This HUC map includes both Rondout and Wallkill watersheds.

For the September and May images, impervious surface was calculated at 9.2% and 9.6%, respectively. The presence of leaves on the trees did not greatly affect the impervious cover calculations in this analysis. According to the Center for Watershed Protection, watershed imperviousness of 10% to 25% indicates an impacted stream or estuary tributary likely to exhibit a decline in water quality, loss of biodiversity, greater storm flows and altered stream geometry. Imperviousness beyond 25% indicates severe degradation, no longer able to support a diverse stream biota and likely having poor water quality. Similar thresholds have been linked to other indicators. Wang et al., (1997) found habitat quality and biotic integrity, based on an array of fish and invertebrate community metrics, with an impact range of 10% to 20% similar to that of Zielinski's land use thresholds of 10% to 25%.

The 1999-2000 average calculation of 9.4% impervious cover for the Wallkill- Rondout Watershed indicates a watershed that is on the borderline of experiencing negative water quality impacts from runoff and non-point sources associated with impervious cover.

A similar analysis of the area around the tidal Rondout Creek, located in the northeast corner of the watershed, reveals a smaller region of greater imperviousness. An impervious cover of 14.7% to 18.5% is higher than the overall imperviousness of the entire watershed (9.4%), and indicates the tidal Rondout Creek may be an impacted estuary tributary that is experiencing negative water quality impacts from runoff and non-point sources associated with urbanization at the local scale of land use immediately adjacent to the tidal Rondout Creek.




Map 2.1.5. Land use along the tidal Rondout Creek. (L) Derived from 2.5 meter orthophotos, April 2001. (R) Derived from 15-meter pan-sharpened Landsat, May 2000. *(Source: Ulster County Information Services, Kingston, NY).*

The Rondout-Wallkill watershed, specifically the area around the tidal Rondout Creek, exhibits a percentage of impervious cover (14.7% to 18.5%) that may lead to negative water impacts. In the case of the Rondout Creek, the effects of watershed-scale water quality is especially relevant since the lower portion of the creek is the "bottleneck" of the drainage basin before entering the Hudson estuary. The Creek's tidal nature at this point also means it has a more variable flushing rate and considerable re-suspension of sediments. Shoreline hardening and the reduction of riparian vegetation can lead to reduced filtration and greater inputs of pollutants and sediment into streams. Furthermore, urban waterfronts are usually associated with impervious parking lots and rooftops as well as hardened shorelines. It is typical that imperviousness will increase as development pressures in the watershed continue.

## Section 2.2 Lower Non-Tidal (LNT) Rondout Creek Watershed

**Watershed General Description:** The Rondout Creek is a tributary of the Hudson River in Ulster and Sullivan counties of New York State. It arises on Rocky Mountain in the eastern Catskills, flows south into New York City's Rondout Reservoir, then into the valley between the Catskills and the Shawangunk Ridge, where it goes over the spectacular High Falls and finally empties out into the Hudson at Kingston, receiving the Wallkill River along the way.

The lower, non-tidal portion of the Rondout, which is the focus of this management plan, begins below the Rondout Reservoir and includes the confluence with the Wallkill River in Creek Locks upstream of the Eddyville Dam. The mainstem of the LNT Rondout Creek is part of a 383 sq. mi. drainage basin. This includes major portions of the towns of Wawarsing, Rochester, Marbletown, and Rosendale. Thirty-eight tributaries flow into the lower non-tidal portions of the creek *(Appendix F: Table 3.1 Tributaries to Rondout Creek).*

The name of the Rondout Creek comes from the fort, or redoubt, that was erected near its mouth. The Dutch equivalent of the English word redoubt (meaning a fort or stronghold), is reduyt. In the Dutch records of Wildwyck, however, the spelling used to designate this same fort is invariably Ronduyt during the earliest period, with the present form Rondout appearing as early as November 22, 1666.

The Rondout Creek became economically important in the 19th century when the Delaware and Hudson Canal followed closely alongside it from Napanoch to the village of Rondout, now part of the City of Kingston, which grew rapidly as the canal's northern port. Today it is important not only for the Rondout Reservoir, which provides drinking water to nine million people in the greater New York City metropolitan area, but also for its scenic beauty, agricultural resources and the fishing and other recreational opportunities it provides.

Including the contribution from the Wallkill, the Rondout drains a vast area stretching over 1,100 square miles (2,850 $km^2$) from Sussex County, New Jersey to its mouth in Kingston. The high mountains around its upper course and the reservoir, which collects water from three others, also add to its flow.

The Rondout goes through several different stages due to the changes in surrounding geography and past development, such as the canal and reservoir that has drawn on its waters. Its headwaters, above the reservoir, are typical of a mountain stream. Below the reservoir, the streambed remains fairly rocky but widens into the floor of a narrow valley. At Napanoch, where it turns northeast and receives its first significant tributary, the Ver Nooy Kill, it becomes wider, as does the valley it drains, and deeper.

North of the Shawangunks, where the Wallkill trickles down from Sturgeon Pool, it is wide enough to be referred to as the Rondout River. At Creek Locks, the former northern outlet of the Delaware-Hudson Canal, it becomes wide and deep enough to be navigable, and several marinas line the banks of the tidal Rondout, now more than a hundred feet (30 m) wide, at Kingston just before its mouth.

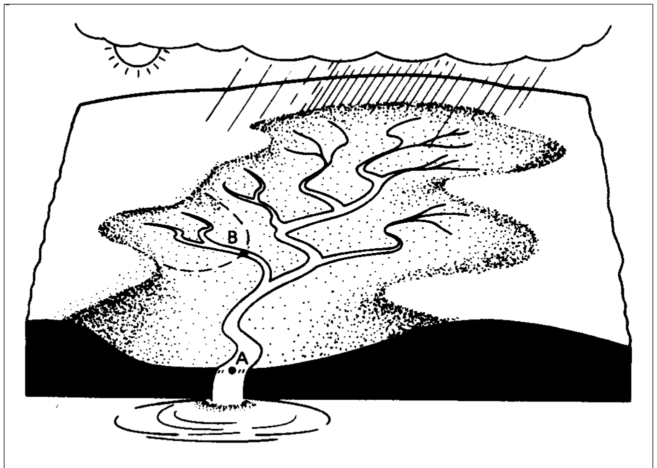
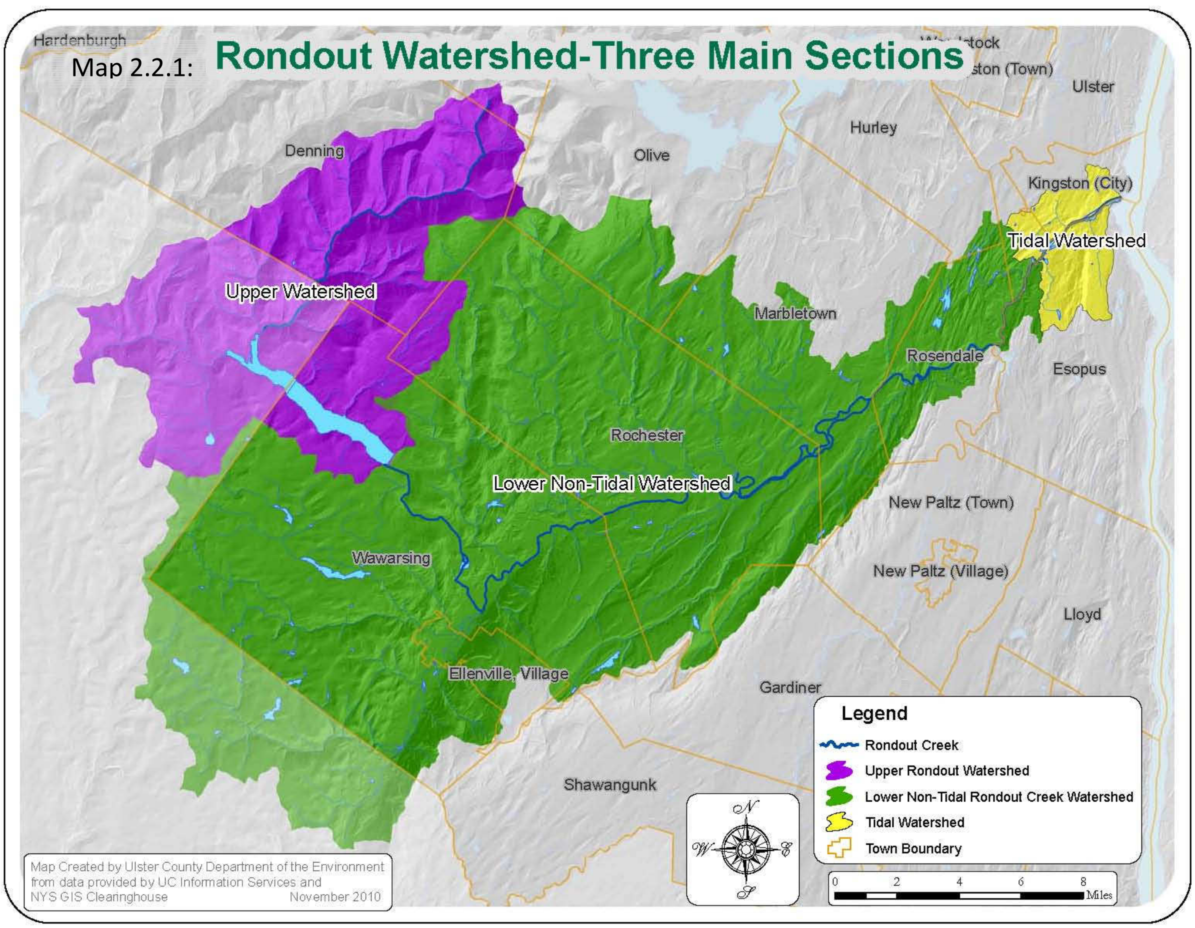
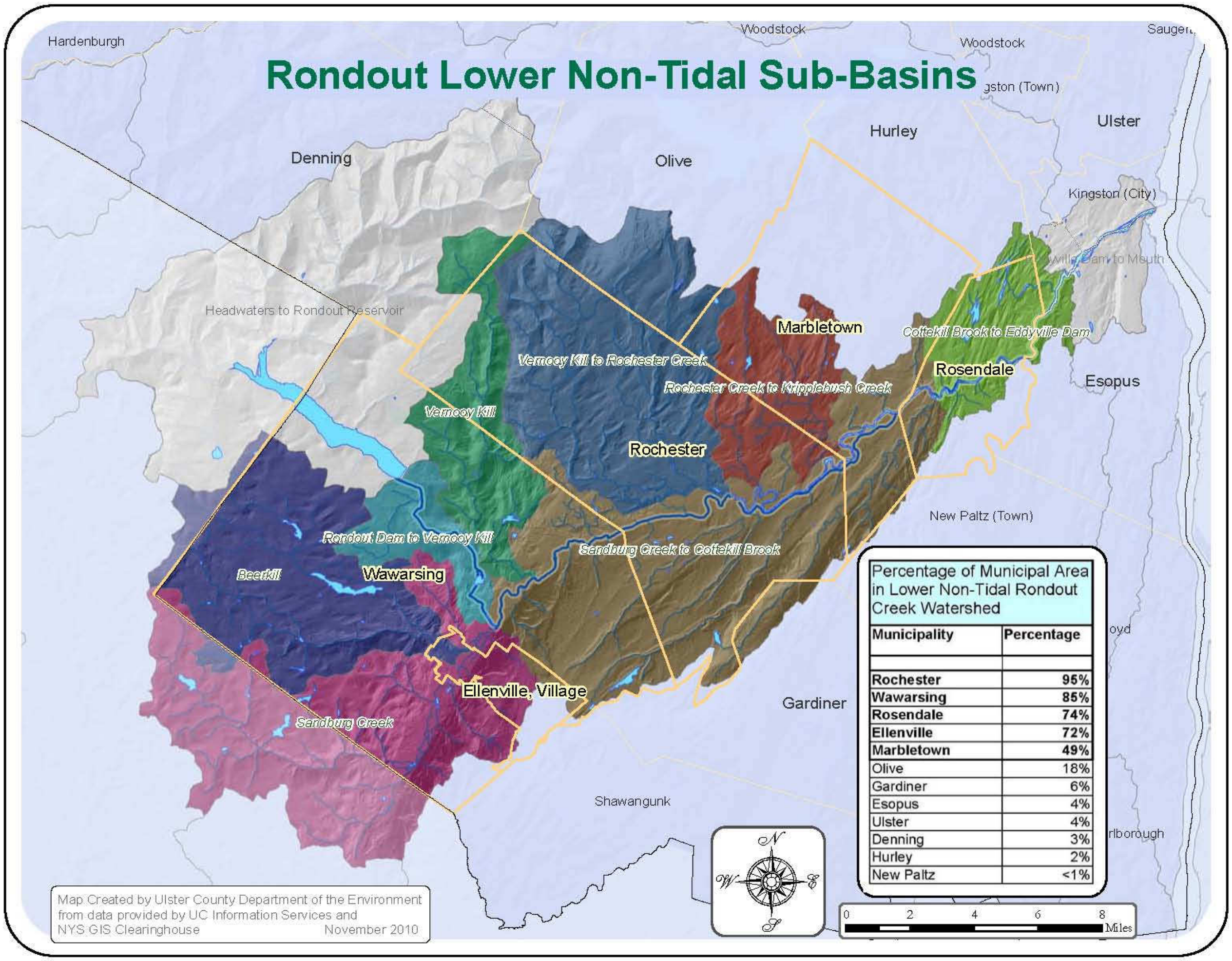



**Figure 2.2.1:** Delineation of a watershed boundary.

### Delineation of the LNT Rondout Creek

The concept of a watershed is basic to all hydrologic designs. Since large watersheds are made up of many smaller watersheds, it is necessary to define the watershed in terms of a point, which is referred to as the watershed "outlet". With respect to the outlet, the watershed consists of all land area that "sheds" water to the outlet during a rainstorm. Using the concept that "water runs downhill," a watershed is defined by all points enclosed within an area from which rain falling on these points will contribute water to the outlet.
The Lower Non-Tidal Rondout, which is the focus of this document, is located between the Upper Rondout, for which a management plan has been developed by New York City Department of Environmental Protection *(Appendix G – Upper Rondout Watershed Management Plan Summary)*, and the Tidal portion which includes about half of the City of Kingston and portions of the Town of Esopus and the Town of Ulster.



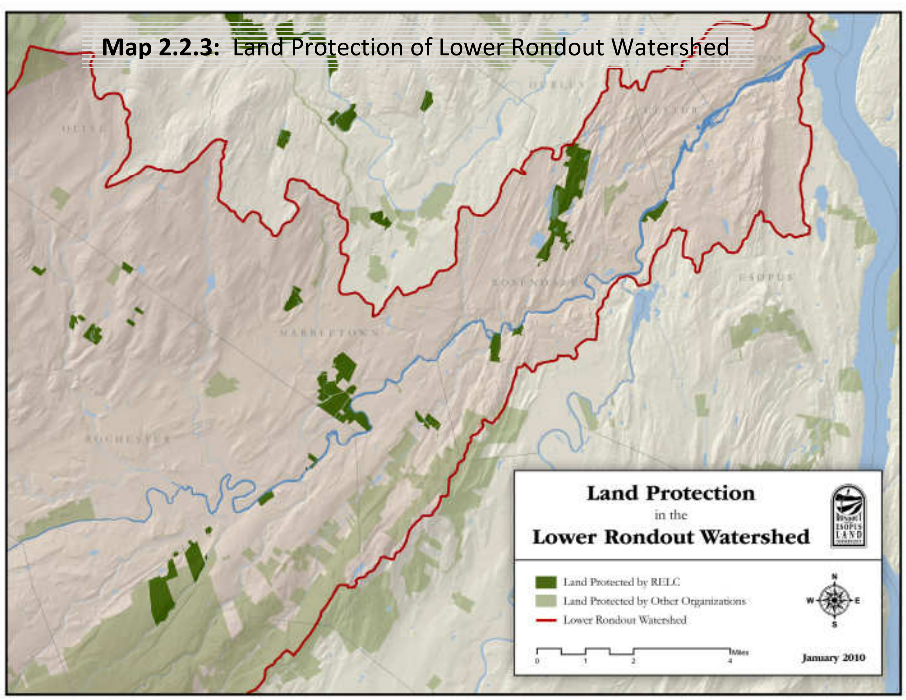



Percentage of Municipal Area in Lower Non-Tidal Rondout Creek Watershed

| Municipality | Percentage |
|---|---|
| Rochester | 95% |
| Wawarsing | 85% |
| Rosendale | 74% |
| Ellenville | 72% |
| Marbletown | 49% |
| Olive | 18% |
| Gardiner | 6% |
| Esopus | 4% |
| Ulster | 4% |
| Denning | 3% |
| Hurley | 2% |
| New Paltz | <1% |

**Map 2.2.2:** Smaller Sub-Basins of Lower Non-Tidal Rondout Creek Watershed

Approximately 95% of the Town of Rochester is in the LNT Rondout Creek Watershed, 85% of Wawarsing (including 72% of Ellenville), 74% of Rosendale and 49% of Marbletown; in addition to smaller parts of Olive (18%), Gardiner (8%), Esopus (4%), Denning (3%), Hurley (2%) and <1% of New Paltz. In addition, the LNT section of the Rondout includes parts of Fallsburg and Mamakating in Sullivan County.




**Map 2.2.3:** Land Protection of Lower Rondout Watershed

### Land Use in the LNT Rondout Creek

Open space preservation is often the first line of defense and the most effective strategy for protecting water resources. The responsibility for protecting large or significant portions of the watershed is often assumed by or designated to area land trusts, of which the Rondout Esopus Land Trust (RELT) is an important organization in this watershed. Map 2.3.3 shows the lands protected by RELT (in dark green), and those protected by other organizations (in lighter green), extending all the way out to the Hudson River and includes the tidal portion of the Rondout Creek Watershed. Note the large amount of protected lands along the Shawangunk Ridge, much of which is protected by Mohonk Preserve and the Nature Conservancy.

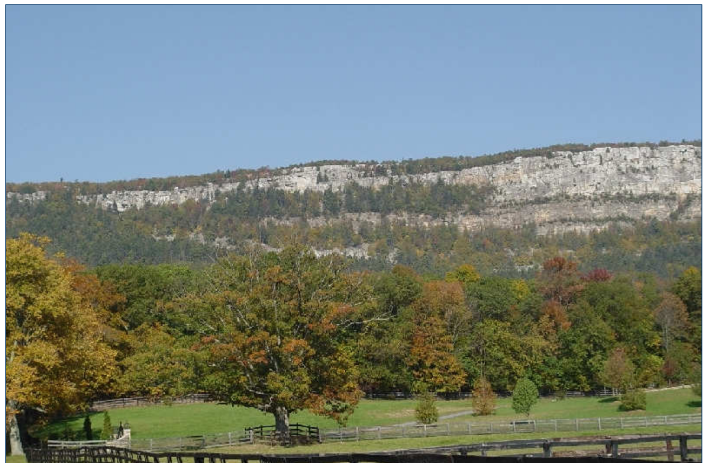


**Photo 2.2.2:** Scenic view of Shawangunk Ridge from the Wallkill Valley.

This area, along with the farms in and along the Route 209 corridor, creates a very scenic byway. Area land trusts and related organizations have partnered with local municipalities to form the Shawangunk Mountains Scenic Byway Regional Partnership (www.mtnscenicbyway.org) to help preserve the region's beauty and resources.

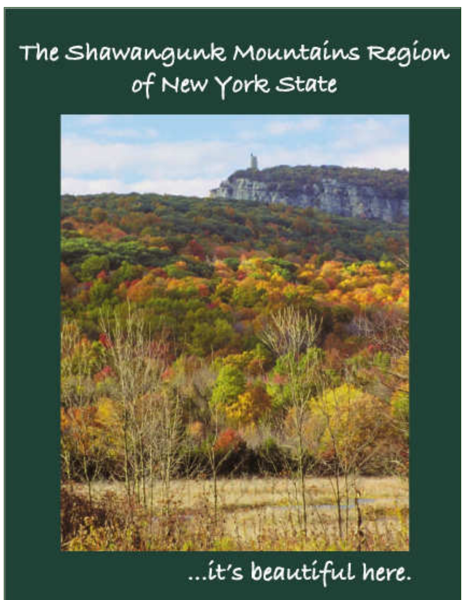



**Photo 2.2.3:** Shawangunk Mountains Scenic Byway

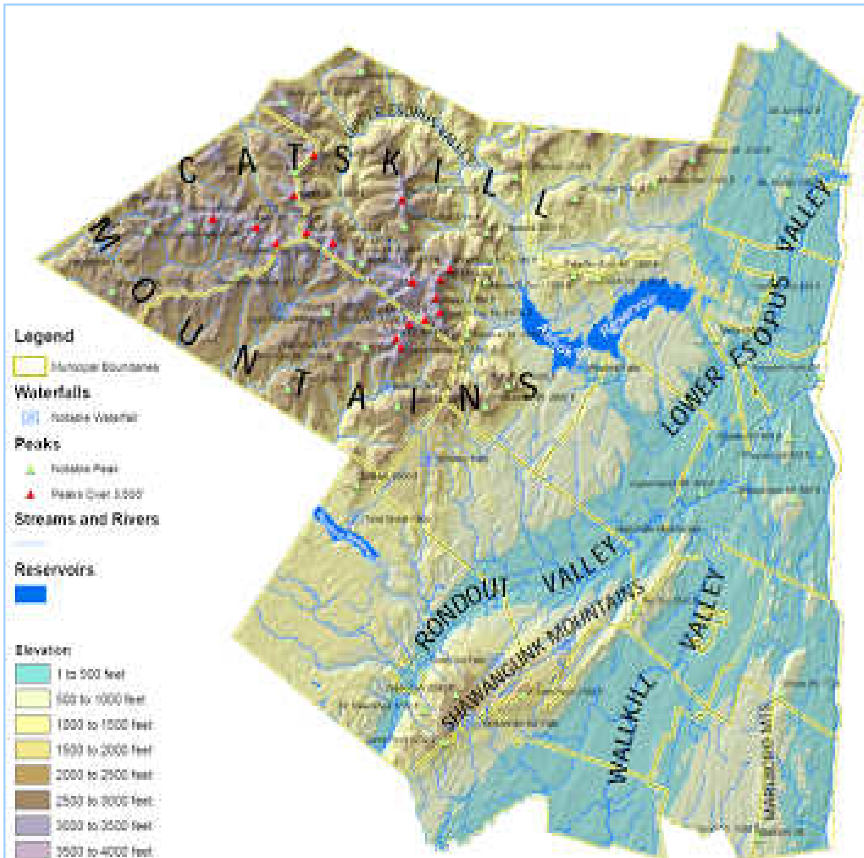
During the six years of planning the byway, nine towns and two villages came to realize that they have a lot in common and to appreciate the synergy that can be achieved by working together so they formed an intermunicipal partnership to implement a corridor management plan, to help improve transportation systems, and to advance their mutual goals of advancing economic growth through tourism, while helping to preserve the important resources of this region. The Shawangunk Mountains Regional Partnership includes the towns of Crawford, Gardiner, Marbletown, Montgomery, New Paltz, Rochester, Rosendale, Shawangunk, Wawarsing and the villages of Ellenville and New Paltz and is the management organization for the Shawangunk Mountain Scenic Byway with Al Wegener as its Executive Director.

By joining this partnership the towns participated in an intermunicipal agreement (IMA), forerunner to the one signed by the four central Rondout municipalities for watershed protection.

## Section 2.3 Adjacent Watersheds

The Rondout Creek watershed in the Rondout Valley roughly parallels the Lower Esopus Valley, which is to the northeast, as they both flow northward towards the Hudson River, passing through many of the same towns.

The Rondout Creek flows along the eastern and southern portions of Marbletown, through of Rosendale), and the Town of Ulster, and the City of Kingston.



Map 2.3.1: Source: Ulster County Planning Dept.

The Esopus Creek flows to the west and north of the elevated limestone ridge that shaped the Esopus Valley and gave many of the early settlements a high place to grow and expand. (A full description of both the Upper and Lower Esopus watersheds and the Ashokan Reservoir, which separates them -- as the Rondout Reservoir does the Upper and Lower Rondout -- is attached as *Appendix H*.) The Wallkill Valley and its watershed are to the southeast of the Rondout and flow into it at Creek Locks. Glacial activity in these adjoining watersheds repeatedly covered and melted, scraped and deposited the land forms and soils and outwash that defined the valley forms and their composition.

**New York City Water Supply System:**

Another major adjacent watershed is the Catskill/Delaware Watershed, which is New York City's West-of-Hudson water supply. A smaller source in Westchester and Putnam counties is the East-of-Hudson Croton Watershed. The Catskill system was completed in 1927 while the Delaware portion of the system was completed in 1967, and the Croton system in 1842. East of the Hudson River, the "Cat-Del" system as it has come to be called is comprised of a series of reservoirs. The Ashokan Reservoir is the terminal reservoir of the Catskill system. The Delaware system, consisting of the Cannonsville, Pepacton and Neversink reservoirs, is connected to the Rondout Reservoir in the Hudson watershed by aqueducts, which represent a major inter-basin transfer of water across watershed boundaries. This transfer is under the jurisdiction of the Delaware River Basin Commission. The Cat-Del system has 580 billion gallon storage capacity. Both the


Photo 2.3.1

Catskill/Delaware and the Croton systems are connected by aqueducts to the greater New York City metropolitan area. Together theses systems deliver approximately 1.4 billion gallons of high-quality water each day to nearly nine million people in New York City and Westchester, Orange, Putnam and Ulster counties.

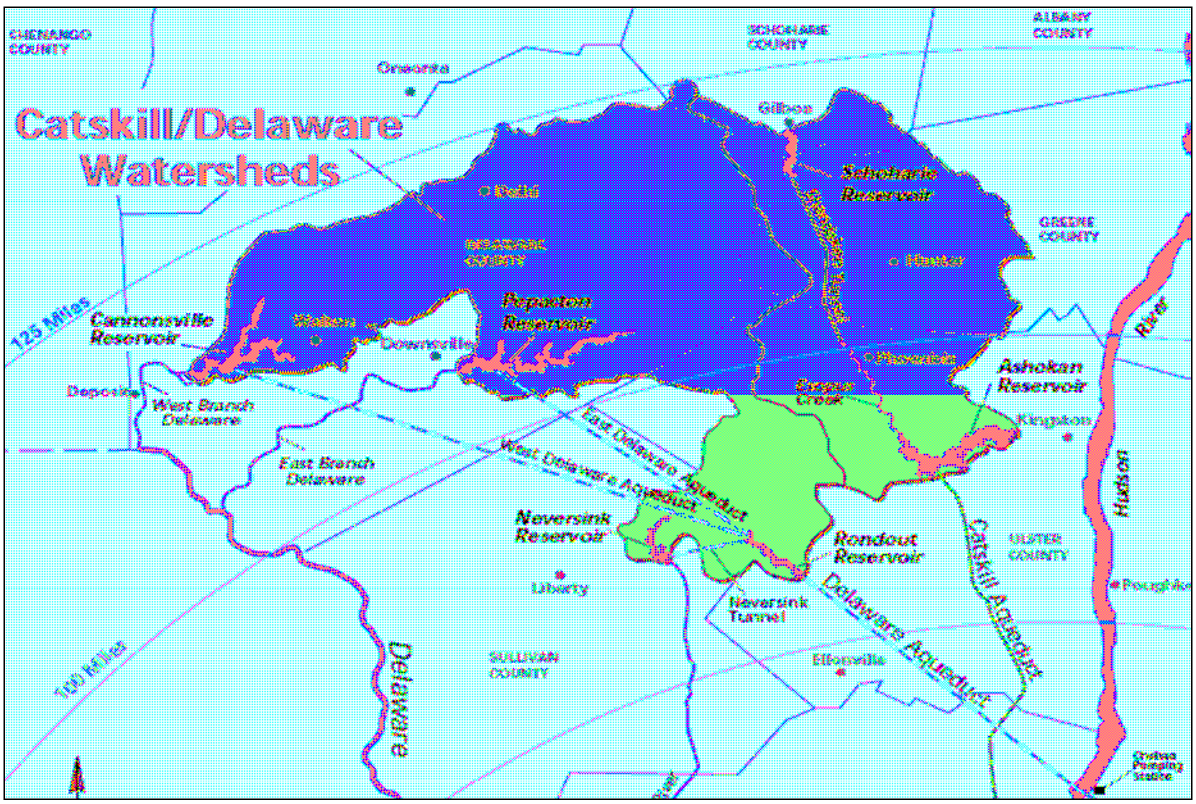

In addition to assuring water quality these areas provide important fish and wildlife habitat, open space preservation, and recreational opportunities, the New York City Department of Environmental Protection has carefully protected these major drinking water supplies by promulgating strict regulations and entering into related Memoranda of Understanding (MOUs) with municipalities which are located in these drainage basin and those through which the aqueducts run. To assure watershed protection in agricultural areas of these watersheds, the NYC DEP has worked with the Watershed Agricultural Council to implement Whole Farm Planning projects in which farmers participate in the design, installation and management of a variety of systems on their own farms that protect water resources, especially these critical reservoirs. Technical assistance and funding is provided by New York City, NY State and related agencies.

## Ecosystems Protection Pays Off

In the 1990's as development pressures increased in the area, the Catskill-Delaware System was threatened with increasing pollution due to construction, agricultural runoff and other activities. The City was faced with an important decision: whether to build an artificial filtering system at a cost of approximately $6-$8 billion or to invest $1 billion in sustainable development practices which would restore the Catskills' natural filtering purification capacity. Choosing to protect ecosystems and the services they provide, they convened a multi-stakeholder process to encourage Whole Farm Planning, upgraded sewage treatment plants to tertiary treatment and implemented other watershed protection measures. In 1997, EPA issued a five-year Filtration Avoidance Determination, which ultimately saved City taxpayers $5 to $7 billion in construction costs and actually increased property values in these rural areas. (Penn State College of Ag Sciences, Coop Extension & Center for Biodiversity Research, Environmental Resources Research Inst., *Biodiversity: Our Living World: Your Life Depends On It!,* Penn State U: University Park, PA 2001, p. 7.) Under the Surface Water

Treatment Rule, New York City is required to filter water from the Croton system, which provides 10 to 15 percent of the City's water; however, many of the protections developed for the Cat-Del system also apply in the Croton watershed *(EPA).*

**Role of the Rondout Reservoir:** The Rondout Reservoir (see Photo 2.3.2) is the terminal reservoir in New York City's Delaware System, which was the subject of a 1931 Supreme Court decision (amended in 1954) that apportioned water rights between New York, Pennsylvania, and New Jersey. The Delaware System comprises the Neversink, Pepacton, and Cannonsville reservoirs, which all deliver water to the Rondout Reservoir in Ulster County via separate tunnels. At each of these outlets are hydroelectric facilities. The Rondout Reservoir impounds the Rondout Creek with the Merriman Dam, an earthen-covered concrete cut-off wall structure with a masonry spillway. The reservoir has a storage capacity of 50 billion gallons of water and sends water to the Rondout-West Branch Tunnel (a section of the Delaware Aqueduct) at a maximum of 825 million gallons per day (MGD). The Rondout Reservoir also releases water into the lower Rondout Creek at a rate of 10-15 MGD as per DEC regulations.




Map 2.3.3: The Delaware System: Cannonsville, Pepacton, Neversink, and Rondout reservoirs

The importance of the Rondout Reservoir to the city's water supply system cannot be understated. It provides, on average, 50% or more of the city's supply. The operational objectives for this reservoir are as follows:

- Avoid spilling water into the downstream Rondout Creek.

- Keep the elevation of the reservoir high enough to maximize delivery through the Rondout-West Branch Tunnel.
- Manage diversions into the reservoir from Neversink, Pepacton, and Cannonsville reservoirs to achieve operational objectives.
- Meet the needs of hydroelectric energy generation agreements.
- Comply with all federal, state, and consent decree requirements.

The operating objectives of the Rondout Reservoir and upstream contributing reservoirs also reflect an arrangement with the Delaware River Basin Commission and downstream consent decree parties through the Flexible Flow Management Program (FFMP). The FFMP release levels from Cannonsville, Pepacton and Neversink reservoirs are based on reservoir storage levels. Storage levels will indicate which FFMP zone the reservoir is in, which in turn correlates to a determined release level. The higher the storage, the higher the downstream release rate.

While Rondout Reservoir is not subject to the FFMP, it is affected by the operation of the upstream reservoirs under this program. Fifty percent of snow water equivalent of the snowpack, which is measured biweekly, may require manipulation of the current and long-term reservoir level outside of normal operations, depending upon the analysis of short and long term meteorological and hydrological conditions. Targeting an appropriate elevation to account for the potential runoff as a result of snowpack within the watershed may be accomplished within a reasonable period, but is also dependent upon the conditions within the East-of-Hudson system and the Delaware System reservoirs.

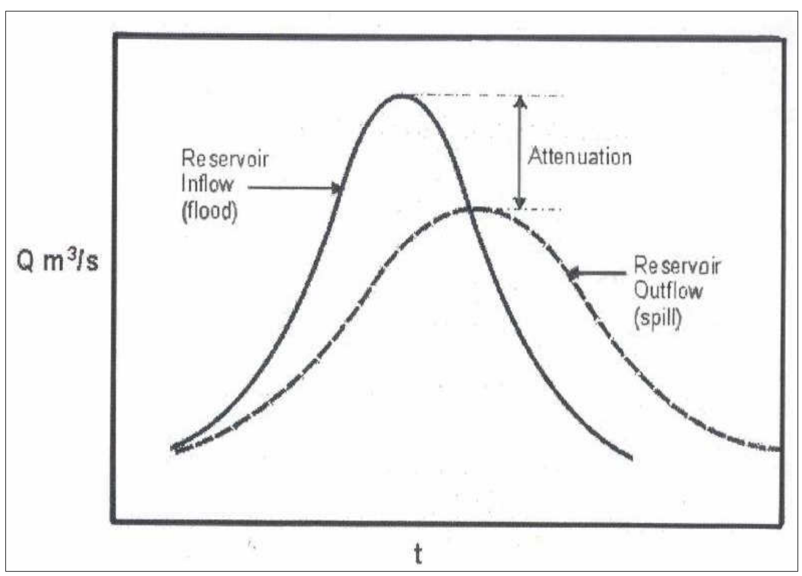



Figure 2.3.1: Source: "A *Review of the Role of Dams in Flood Mitigation*", a paper submitted to the World Commission on Dams (www.dams.org) in March 2000 by Peter Hawker

DEP manages the Rondout Reservoir in a way that has a significant impact on flood prevention in the Rondout Valley. The reservoir is managed with a primary goal of not spilling and the operators take into account snowpack, meteorological forecasting and modeling, careful management of inflows (upstream reservoirs and local runoff), and to allow for ample water to be released to the lower Delaware River and Rondout Creek. While the reservoir is not operated for flood control (nor was it designed for this purpose), the operating objectives of DEP provide benefits for flood mitigation and reduction. Reservoirs provide flood attenuation even when full.

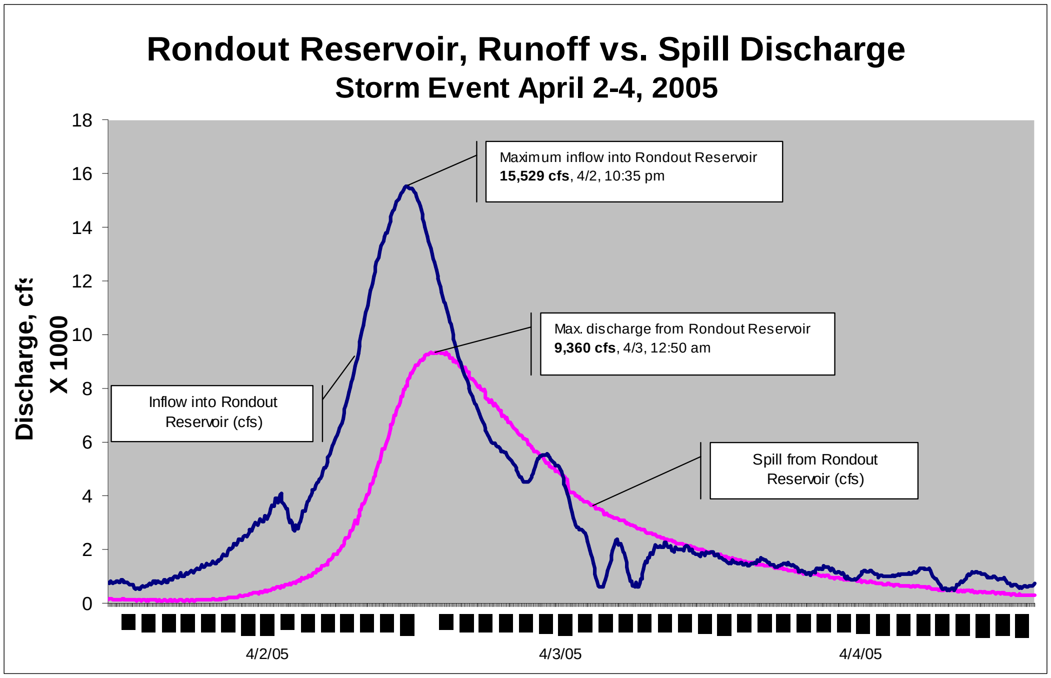



Fig. 2.3.2: Attenuating floodwaters means slowing down and/or reducing flow to the reservoir compared to outflow from the reservoir. *(Source NYC DEP)*

Even when the Rondout Reservoir spills, attenuation can occur. For example, during a storm on April 2-4, 2005, the maximum inflow to the reservoir was 15,529 cubic feet per second (cfs) on April 2 at 10:35 pm. The maximum outflow was 9,360 cfs on April 3 at 12:50 pm. In this case, the reservoir, even when full, attenuated 40% of the water that entered it. This has a benefit downstream by holding back floodwaters and delaying downstream flows.