zone (see Habitat section), and upland areas. There is no simple solution for protecting and repairing watersheds. Watershed management actions include regulations on stormwater discharge and developing steep slope, restoration projects of riparian zone and steep slope, land acquisitions, monitoring, education, and research. Successful watershed programs are comprehensive efforts that incorporate science, planning, policy, and politics.

Floodplains

Summary: Floodplains in Marbletown are found on 7% of the land and are located along the Esopus Creek, the Kripplebush Creek, the Rondout Creek, and the Coxing Kill. Floodplains perform important functions for biodiversity and society. Buildings in floodplains are subject to devastating damage.

Floodplains occur in the lowlands along rivers and streams. Due to their periodically changing water levels, floodplains can flush stale water in wetlands and recharge aquifers by soaking the surrounding lands. During floods, they allow a rich exchange of nutrients and organisms from the various habitats of the river channel, backwaters, floodplain lakes, forests, and wetlands. This rich exchange of nutrients and organisms contributes greatly to biodiversity. The exchange of nutrients replenishes depleted resources that organisms need for survival, and the exchange of organisms from similar but otherwise non-contiguous habitats allows more variation in the gene pool, which permits greater possibility for adaptation and survival.

Plant and animal life is promoted by flooding. The moisture helps seeds to germinate, and the exchange of nutrients contributes to healthy plant life, which, in turn, helps to stabilize banks and to prevent erosion of valuable soils. Animal life is supported by floodplains as well. Some fish feed in flooded areas, and the eggs of some invertebrates, which lie dormant in dry situations, are stimulated by flooding. When flooding is more extended, it allows waterfowl to nest and raise fledglings.

Floodplains perform important functions for society. Extended flooding replenishes soils and stimulates vegetation and provides society with highly productive sites for agriculture and forestry as well as food for domestic and native animals. The plant life in floodplains helps prevent erosion and retain floodwaters during heavy rains or snowmelts. In so doing, it protects lands and structures outside the floodplain.

The floodplains mapped for Marbletown all fall within the area of a 100-year flood as designated by the Federal Emergency Management Agency (FEMA). This designation is often misunderstood due to its confusing name. A 100-year flood has a 1 % chance of occurring in any given year. A structure in a 100-year floodplain has a 26 % chance of suffering flood damage over a thirty year period. This is five times the chance of a structure suffering a severe fire during the same period. Therefore, structures in a floodplain and purchased with federally backed mortgages or assistance are required to have flood insurance (FEMA, National Flood Insurance Program website).

Recommendations: Landowners in the floodplains of Marbletown should be discouraged from building structures that not only are at risk of sustaining damage, but also take away from rich agricultural, forested, and wild lands that perform essential ecological and societal functions.

Wetlands

Summary: Protected Wetlands make up approximately 8% of the land cover in Marbletown. These wetlands are strictly protected by state and federal law, because they perform vital ecological services for nature and society. Buffers exist only around wetlands registered with the state. The town has a large number of unique and sensitive wetlands. Due to mapping practices, there may be wetlands in Marbletown that are not currently mapped.

State and federal registered wetlands constitute 8% of the land cover in Marbletown. Once considered wasteland, these wetlands are protected by law because they perform ecological processes now understood to be vital to human and environmental health. These processes are explained in the first part of this section and include flood control, the purification of surface water, groundwater discharge and recharge. Wetlands also provide fisheries habitat, wildlife habitat, and habitat for rare, threatened, and endangered species. To be registered as a wetland, three elements are required: wetland hydrology, hydric soils, and hydrophytic vegetation. These elements are explained in the second part of this section. In the third part of this section, the classification of registered wetlands by state and federal agencies is explained.

Ecological Processes

Wetlands have the capacity to hold large amounts of water. For this reason, wetlands, particularly those that are found in the floodplains of rivers and the basins of restricted streams, can lessen the damage of flood events by retaining stormwater and releasing it slowly back into the waterways or allowing it to seep into the ground. The protective capacity of the wetlands is determined by their size and number; the types of soils and vegetation present; and the location of the wetlands. In general, the greater their size and number, the more the wetlands can attenuate flood flows. They also stabilize river banks and deter erosion.

The purification of surface water occurs in wetlands as the speed of water flowing into them is slowed or stopped. This allows hazardous wastes, sediments from erosion, and nutrients to settle in the wetland. In many cases, wetland plants are able to take up and process the wastes and nutrients and thus release cleaner water into the waterways or ground.

Besides forming where water flows on the surface, some wetlands form where groundwater seeps to the surface. Groundwater generally comes to the surface at a constant temperature of 47º F. In the summer, groundwater seeps into rivers, cools the water, and provides important habitat for fish and other creatures. Many fish, including sport fish like trout and salmon, require cold water for habitat. The groundwater discharge found in wetlands near water bodies and waterways supplies such a cold water supply. These wetlands are necessary for the successful spawning of many species.

Wetlands formed around seeps are also a reliable source of water for other animals during droughts; in the winter, the seeps do not freeze over and provide needed fresh water for animals.

While some wetlands discharge groundwater, others recharge it by capturing surface water and allowing it to percolate back into the ground. Such wetlands have relatively porous bottoms and allow purified water to seep back into the ground and thereby provide a safe water supply.

Besides being a source of drinking water, wetlands provide wildlife with a variety of foods that can be foraged from the plants found there. Wetlands provide viable habitat as well as forage for a number of birds, amphibians, reptiles, and mammals. They are also habitat for a large number of dragonflies, moths, butterflies, beetles, and other insects.

Among the many plants, animals, and insects found in wetlands or relying on them for forage and habitat are some that are rare, threatened, or endangered. While some are thought to be present (See Biodiversity and Threatened Wildlife Habitat), a field survey is required to establish which ones are found in Marbletown. Such a survey is recommended.

Physical Environment

It is generally accepted that wetlands are characterized by three elements: wetland hydrology, hydric soils, and hydrophytic vegetation. To be a wetland, the area must be inundated or saturated by water for some part of the growing season. This constitutes the hydrological element. Hydric soils are those that develop in saturated conditions. Hydrophytic plants are plants that are well adapted to saturated conditions. Precise definitions of these elements are used by regulatory agencies for determining the type, location, and extent of a wetland area.

Regulations

The scientific classifications for wetlands are complex. They depend on the degree of saturation, the kinds of soil, the types of plants, and the functional process (e.g., association with water discharge or recharge). For the purposes of planning, regulatory jurisdiction comes into play. Both federal and state governments regulate wetlands; New York State law also allows municipalities to regulate them. The location and extent of regulated wetlands on the National Wetlands Inventory have been determined through remote sensing and the use of aerial photographs. Due to seasonal fluctuations of water levels and plant growth, not all wetlands in an area may be mapped, and those that are mapped may, in fact, be larger than the area shown on the map. It is therefore essential that when any activity is proposed in or near a wetland area, a wetland ecologist be consulted to determine the exact location and extent of the wetland. Although the National Wetlands Inventory does classify wetlands for scientific purposes, for regulatory purposes it does not distinguish among wetlands. Federal regulations do not allow wetlands to be disturbed, but they do not mandate a buffer around the wetlands. In Marbletown, there are 688 federally regulated wetlands, totaling 2048 acres.

The state classifies wetlands according to extent and rarity. At this time, the state regulates only wetlands of 12.4 acres or more unless they are of particular local interest. New York State Regulated Wetlands have been mapped on the ground by qualified ecologists. Each wetland is classified as one of four types. Class I Wetlands are the most sensitive; Class IV Wetlands are the least sensitive. Any proposed development in a New York State Wetland or its buffer must be permitted by the state's Department of Environmental Conservation. It is easier to obtain a permit for development in or near a Class IV Wetland, but any wetland loss must be mitigated. In other words, if a permit is granted, an equal or greater amount of wetland will need to be created elsewhere.

The 1,674 acres of New York State Regulated Wetlands in Marbletown are classified as follows:

Class	Number of Parcels	Total Number of Acres
I	3	137
II	26	1163
III	17	360
IV	1	14

Both in number and size, Marbletown has more of the sensitive Class I and Class II wetlands. These wetlands are unique natural features whose importance will be of interest to the citizens of Marbletown.

All New York Regulated Wetlands have a hundred-foot buffer around them to protect the wetland. Waterways also have a hundred-foot buffer. The purpose of the buffer is to catch pollutants and warm water from runoff. Riparian buffers (streamside buffers) are divided into three zones. Zone A, the first twenty-five feet from the stream, is highly restricted. Zone B, the next fifty feet, allows for some passive recreation, such as hiking trails and some stormwater management practices. Zone C, the final twenty-five feet, acts as a buffer to the buffer. Turf is allowed in this area, although native shrubs and trees are more effective at removing pollutants from stormwater runoff.

Many of the state and federal wetlands overlap, but due to differing methods of mapping, they do not line up exactly. State wetlands are mapped by qualified ecologists on the ground; federal wetlands are mapped using remote sensing. Therefore, when state and federal wetlands do not line up exactly, it may be assumed that the state's delineation is likely to be more accurate. Due to the differences in mapping methods, it is not possible to determine exactly how much of Marbletown is covered by wetlands. Wetland cover can be estimated at approximately 8%.

Some wetlands appear on the National Wetlands Inventory, but do not overlap with the New York State Regulated Wetlands. These wetlands are not surrounded by a buffer zone. The U.S. Army Corps of Engineers is the overseeing body of national wetlands, and when development is proposed, it guides the possibility or extent of development according to its designation of the purpose of a particular wetland. It does not, however, review development adjacent to the wetland. Therefore, the town needs to consider a buffer for nationally designated wetlands in order to protect them from nearby disturbances that could imbalance in their sensitive ecology.

Due to current methods of mapping and regulation, smaller wetlands may not appear on current maps. Many municipalities, however, choose to regulate wetlands that do not fall under state or federal jurisdiction. Wetlands of particular concern are vernal pools. These pools appear in the spring and sometimes in the fall when runoff from rain and snow is heavier. They provide critical breeding areas for many amphibians, some of which are endangered or threatened. Although vernal pools are not fully understood, they are essential to biodiversity.

Recommendations: Current regulations must be respected. No regulated wetland can be disturbed. The twenty-five-foot outer buffer around New York State Regulated Wetlands allows minimal disturbance. Since not all wetlands, particularly smaller and seasonal wetlands and those on the National Wetlands Inventory, may be mapped or mapped accurately, the town needs to consider an audit of wetlands and further wetland regulation, such as creating buffers around wetlands that are part of the National Wetlands Inventory. Before development near a wetland is approved, a qualified ecologist should be consulted to delineate the actual location and extent of the wetland.

Aquifers

Summary: Marbletown's two types of aquifer, unconsolidated and bedrock, offer constraints and opportunities for the town. The unconsolidated aquifers, particularly the one beneath the Route 209 corridor, have proven unreliable in recent years and are quite vulnerable to contamination. The School Aquifer is more productive, but also subject to rapid contamination. Two bedrock

aquifers, the Vly and Rondout Creek Aquifers, are more productive. These three aquifers, the School, the Vly, and Rondout Creek, offer the possibility of a municipal water supply in the future. Areas above all aquifers need to be carefully managed to meet Marbletown's present and future needs.

This section summarizes the findings of Marbletown's *Aquifer Protection Study,* conducted by Katherine Beinkafner, PhD. of Mid-Hudson Geosciences and submitted to the town in January 2005. Her report should be consulted for more detailed information and recommendations. The map of unconsolidated aquifers accompanying the present summary was prepared using generalized data on New York State's unconsolidated aquifers from the New York State Museum. Data that is more specific to Marbletown can be found in Dr. Beinkafner's report.

According to Dr. Beinkafner, an aquifer is "groundwater that is used for some purpose." Aquifers are distinguished from water-bearing zones in that water-bearing zones may be sampled or monitored, "but may not produce appreciable volumes of water for use" (p. 12). Two types of aquifer, unconsolidated and bedrock, are described in the report.

An unconsolidated aquifer is located in unconsolidated material, which is material such as sand, gravel, or sediment that was deposited by glaciers as they melted at the end of the ice age and formed what is known as "overburden." The aquifer lies within the overburden, and both the aquifer and the overburden lie upon bedrock. With the exception of clay and some silt deposits, unconsolidated materials are relatively permeable. Permeability, which is also affected by soil type above the overburden, determines the ability of the unconsolidated aquifer to recharge. Thus, there is a direct relationship between the recharge and purity of an unconsolidated aquifer and the amount of precipitation, surface flows, and bodies of water. Where the overburden and soils are shallow, well yields tend to be low and less reliable.

By far, the larger part of unconsolidated aquifer in Marbletown is shallow and unreliable, particularly along the Route 209 corridor. Anecdotal evidence suggests that older, shallower wells in this area have either failed or produced lower yields in recent years due to new buildings with competing wells and additional surface sealing as well as increased societal demands on the aquifer over time, demands such as "dishwashers, clothes washers, pressure washers, swimming pools, hot tubs, and modern sanitary habits" (p. 26). New wells have had to be drilled deeper in order to tap underlying bedrock aquifers. Thicker overburden, however, is to be found beneath the area near the Marbletown Elementary School. Drillers' logs from this area indicate higher and more reliable yields. This aquifer could be tapped as a municipal water supply, although it is vulnerable to rapid contamination from surface activities.

Due to their general permeability and proximity to the surface, unconsolidated aquifers are vulnerable to rapid contamination from a wide variety of sources: car exhaust, tire wear, petrochemicals, and road salt; bacteria from failed septic systems; fertilizers and pesticides; and toxic spills. Particular care must be taken in the areas above an unconsolidated aquifer to minimize these threats. Although bedrock aquifers are not as vulnerable, they, too, require a certain amount of protection from contamination.

Bedrock aquifers are water deposits found in the openings in the underlying bedrock. Their exact location is harder to determine than unconsolidated aquifers, and their source of recharge may be more distant than the surface immediately above them, although many in Marbletown are thought to be recharged locally. Using drillers' logs, Dr. Beinkafner has calculated the approximate location of eight bedrock aquifers.

She has expressed concern that some of these aquifers may be vulnerable due to the mineral makeup of the carbonate bedrock surrounding them. She identifies three vulnerabilities: First, improper drilling practices may cause the borehole to cement up and go dry after drilling. Second, moving subsurface water easily dissolves carbonate bedrock and could create sinkholes that break to the land's surface. This, in turn, would make the aquifer easily contaminated by surface activities. Third, the high degree of acidity in rain dissolves the carbonate bedrock and makes the water particularly hard. The pumped water would then need to be treated to make it acceptable for human use (p. 22).

Two aquifers in other types of bedrock have been identified as highly productive and less vulnerable. They lie in the areas beneath the Rondout Creek and the Vly. Because they recharge from the land directly above them, Dr. Beinkafner recommends that these areas be protected so that they are preserved as potential sources of municipal water.

The town may or may not wish to commit to a municipal water supply. As long as a municipal water supply is not available, proposals for new construction must be able to demonstrate an acceptable well yield before construction is approved. Such yield should fall within generally accepted guidelines, and the new well should not substantially affect the yields of established neighboring properties.

Recommendations: Dr. Beinkafner recommends that the following actions be considered by the town: "public education relative to living with a well, creation of critical environmental areas, [further study and protection of potential] municipal water supplies, and policies to demonstrate adequate well yield for future construction" (p. 26).