Topography

Topography, the mix of slopes, ridges and valleys, has been a significant influence on the patterns of settlement throughout the County. The ridges and valleys in the County trend northeast/southwest. (See **Map 18, Slope Categories in Sussex County**) This has led to most road patterns following the line of least resistance, with relatively few crossing the ridges west to east. In addition to determining the primary road network, the soils located on relatively steep (25% or greater) slopes are typically thin and highly erodable. To that instability is added the increased force of storm water flows moving at high velocities in steep areas. The net result of these cumulative conditions is a general desire that they not be disturbed. In this way, we avoid loss of vegetation, soil and increased downstream impact from storm water flows.

As indicated earlier, Sussex County lies in two of the four physiographic provinces in the State, the Highlands and the Ridge and Valley. The highly accessible broad valleys are the least susceptible to environmental damage through disturbance and are also the most highly productive agricultural lands. They contain the valley fill sand and gravel deposits which are the County's most productive aquifers. The ridges are highly visible, vulnerable to erosion when disturbed and steeply sloping. The Highlands are resistant, poor aquifers, generally steeply sloping, mantled with soils of modest productivity. (**Map 1, Physiographic Provinces and Ridgelines**). In New Jersey, the Highlands are more conventionally designated pursuant to legislation adopted in 2004.

Slopes reduce the ability of land adjacent to streams to filter sediments and act as a sink for nutrients. In developing stream protection mechanisms, the degree of engineering necessary to achieve a particular standard increases with slope where the slope runs to the stream. Access to steeply sloping land requires the disturbance of substantially more area than is needed in gentler terrain.

Water Availability as Determinant of Development Density

Where there are waste treatment plants, the waste dilution capacity limitation on an individual site is removed. In the event a Sewage Treatment Plant (STP) offsets the waste load impact, available water supply becomes the environmentally limiting factor.

Safe sustained yield in drought conditions is the appropriate standard to use in estimating water use effects. Under this standard, aquifers in Sussex generally receive between eight and twenty inches of recharge per year. Recharge, over and above its use for human consumption, is critical to the health of streams, lakes, ponds, etc. Of the total recharge, no more than 20% is available for consumption, according to the New Jersey Geologic Survey.

Water supply is calculated on the basis of gallons per square mile rather than per acre. Under these circumstances, the most productive areas in the County may be expected to safely yield, on average, no more than 300 gallons of water per acre per day. Depending on the specific aquifer, a 100,000 square foot commercial facility would require thirty two to eighty acres to

support its consumption. Although a particular aquifer may produce substantial quantities of water from some wells, much of the availability is based upon recharge from remote sites.

From the above, we may calculate the amount of water which may be taken from any given aquifer without a substantial adverse effect. **Maps 2, 3 and 8,** depict bedrock and surficial geology and aquifer recharge. These, taken together, form a picture of the capacity of the County to support existing and future development. This has wide ranging implications. Existing development, other than that in the Town of Newton (served by Morris Lake), or Sussex Borough (served by Lake Rutherford) depends entirely on ground water resources. When the existing demand is allocated, the remainder becomes the available supply for all future growth. In some instances, the supply is impressively small. For example, the County of Burlington is in the process of carefully controlling the remaining six percent of water supply it calculates is available for future development.

For a general idea of the water yielding capacity of the County, turn to **Map 8**, Groundwater Recharge. The County is divided into two major areas, corresponding generally to the Highlands and the Ridge and Valley Province. The former includes approximately one-third of the County. For purposes of calculation, an annual average of ten inches of recharge is assigned to the Highlands and eighteen inches to the Valley and Ridge. Not only are the soils in the Highlands less able to accept recharge, but the severe topography limits the recharge of that which would be available.

Individual waste water discharges, if overly concentrated in an area, tend to generate a septic "plume". This concentration of effluent may reach the ground water Figure before infiltrating precipitation dilutes it to an appropriate standard, degrading the resource and creating a potential hazard to public health.

Water supplies, on the other hand, are not parcel specific, being calculated in gallons per day per square mile. The calculations are not confined to the square mile in all aquifers as many, such as cavernous limestone and some of the glacial deposits, draw from a larger region. Here the watershed is the appropriate area of delineation.

Using the non-residential criterion of 0.125 gallons per square foot, a 100,000 square foot facility would require 12,500 gallons per day. This amounts to 4,562,500 gallons per year. This would require 168 acres at one inch of recharge or 52 acres at an overall rate of sixteen inches per year (yielding 3.2 inches per acre per year for consumption). This information will be of interest in the review of the build-out calculations by municipality found farther along in this report.

Water Quality

Recent work undertaken by the NJDEP in addressing pristine streams has yielded another, more stringent standard. In such a Category 1 watershed, nitrate concentrations are to be consistent with naturally occurring "background" levels. In this case, the level used for

regulatory purposes is two milligrams per liter of nitrate. This change in input value reduces the resultant density substantially. Depending on the soil, the area required to adequately serve a residential lot or small non-residential facility could increase to between four and ten acres. The rationale for the two milligram value is that, at background levels, no other pollutants contributed by human activities are expected. The water thus reached is pristine. All this ties directly into the carrying capacity and build-out analysis. From a zoning perspective, the overall zoned density required to achieve these densities runs between 2.8 and 7.0 acres per unit.

With the 300 foot Category 1 stream buffer, some of the additional negative economic effects could be avoided by allowing density calculations to include land within that buffer, as with transition areas and transferring those densities in a cluster development. By the same token, these credits could be transferred to a receiving area. If the buffer is located in a developed or designated center, a waiver of the width, predicated on alternative means to accomplish the objectives, would be appropriate.

Highlands Water Quality

Maintaining the high quality of Highlands' water is tremendously important, both for protecting New Jersey's drinking water supply and for preserving the fragile ecosystems that depend on the water.

Recent U.S. Geological Survey studies have concluded that some parameters of surface water quality concern in the area are improving while others are worsening. While the trend for ammonia, phosphorus and nitrogen is toward improvement, nitrate concentrations have increased. Degraded water quality trends were also noted for dissolved solids, sodium and chloride.

The DEP conducts sampling of aquatic communities in the region as part of its Ambient Biomonitoring Network (AMNET). The 1999 round of sampling found that 67 percent of the region's sites were not impaired, while 33 percent exhibited some impairment (although only one percent rated as severe). This is nearly the opposite of the remainder of the state where 67 percent show some degree of impairment. The impaired rivers in the region include the Whippany, Rockaway, Wallkill, Musconetcong, the upper reaches of the Pequannock, and the Pohatcong Creek.

It is likely that the degradation is the result of a variety of factors that modify habitat or other environmental factors such as land use, point and nonpoint sources of pollution, and changes in stream flow – both higher and lower. Other studies have shown statistically that the percentage of urban land within a watershed in conjunction with the amount of upstream wastewater discharges correlates to the rate of impaired rivers in a watershed.

The Highlands' water quality helps improve the quality of degraded downstream surface waters as well. For example, a major fraction of the main stem of the Passaic River is comprised of treated wastewater during drought. If not for less affected Highlands Region water, the main

stem of the Passaic River would be comprised of an even larger overall percentage of treated wastewater during drought.

As for ground water, the natural water quality of the Highlands region's aquifers is generally good. Some wells exceed drinking water standards for naturally occurring substances such as manganese and iron. The one drinking water standard that is consistently a problem in Highlands' ground water is radon, which is a naturally occurring element in much of the rock formations. Ninety percent of the 565 samples taken during one study in the Highlands exceeded the proposed standard for radon-222.

Over time new development in the Highlands could affect the amount of water being withdrawn from reservoirs and aquifers, while at the same time reducing the flow of water in streams and rivers that is vital to aquatic ecosystems. New pavement and impervious surface cover will also decrease recharge of aquifers and increase runoff into surface water, leading to poor ground water quality and increased incidents of flooding.

Degradation of the drinking water supply due to new development may eventually lead to a dramatic increase in water costs for residents throughout northern New Jersey, not just those living in the Highlands region. The North Jersey District Water Supply Commission estimates that the Highlands water purveyors currently spend an estimated $14.3 million to treat 550 million gallons of water per day. Degradation of water quality will require the water purveyors to upgrade existing plants and purchase additional chemicals. The Commission estimates that if development continues without a change in policy, treatment costs will reach $30.3 billion by 2054. Moreover, costly investments for additional water sources and treatment plants will be necessary to supply increased demand. Implementation of a regional plan may offer the resident ratepayers a substantial savings in treatment costs, may eliminate the need for new water sources and treatment plants.

Forests

More than half of the Highlands region contains rich and diverse forests occupying 370,000 acres of land. Much of these forests remain in large, unfragmented pieces, some exceeding 5,000 acres in size. Most of the forestland is dominated by oak-hickory forest with northern hardwoods, hemlock, and swamp hardwoods. These forests contribute to the region's clean water and air, wildlife habitat, recreational resources, and serve as an excellent timber resource.

The most current data from the USDA Forest Service in New York and New Jersey estimates that there are between 50,000 and 75,000 private forestland ownerships in the Highlands region. A majority of the forest is owned by private citizens and organizations with the remainder owned by public agencies. Most forestland ownerships are small with more than 50% of them smaller than 10 acres, and more than 90% smaller than 50 acres in size. Much of the private ownership is simply because it is part of an individual's property for enjoyment of green space and wildlife. However, a significant amount is owned as a real estate investment. The publicly owned forestlands are predominately owned to provide the general public with