3.1 Water Quality

The West Kill is one of the three major sub-basins of the Schoharie Watershed, located in Greene County, New York. Comprising 10% of the total Schoharie basin, the West Kill sub-basin is comparable in aerial extent to the East Kill sub-basin, which is about 12% of the Schoharie basin. The other major Schoharie sub-basin is the Batavia Kill, which accounts for just over 23% of the total basin. The mouth of the East Kill is approximately 3.75 stream miles upstream of the West Kill and the mouth of the West Kill is about 6.10 stream miles above the Batavia Kill.

West Kill is designated as a New York State DEC Class C (TS) stream along its entire 11 mile length from headwaters to its confluence with Schoharie Creek. Tributaries of the West Kill are Class C, C (T), and C (TS). Classification C refers to waters that support fisheries and are suitable for non-contact activities. Additionally the TS designates the West Kill as possibly supporting trout spawning and as such is subject to the stream protection provisions of the NYS DEC Protection of Waters regulations.

It is useful to place the water quality of the West Kill in context with that of the other major sub-basins of the Schoharie Watershed. Since 1994, NYCDEP has routinely monitored West Kill water quality at a site located 0.125 miles upstream from its confluence with Schoharie Creek. Stream discharge has been monitored by the USGS since 1997 at two locations, the first about 1.5 miles upstream from the initial DEP water quality site, and another upstream in the basin headwaters area. In 2002, NYCDEP began water quality monitoring at the USGS headwaters location.

Water quality monitoring of the West Kill and East Kill began in 1993 for most constituents, with Total Suspended Solids (TSS) starting in 1994. Most of the Batavia Kill data gathering began in 1987, with TSS being added in 1989, DO in 1990 and Sulfate in 1994. The time period chosen for comparison, 1993-2004, was the period for which DEP has final approved data available.

Parameters of interest to surface WQ for drinking water supplies include Turbidity, Total Suspended Solids, Conductivity, Fecal Coliform, DO, Total Phosphorus, Sulfate, Chloride, and Temperature. Data reported here shows annual medians for selected water quality variables, plotted against time for the major sub-basins of the Schoharie Watershed. The median is a statistic that expresses the "typical" condition of something. The median is simply the value in the center of a data set, i.e. half of the samples are higher, and half lower. One drawback of the median is that does not show data from extreme events. However, the median is a useful yardstick with which to compare data from different streams.

In comparing the Schoharie sub-basins, it is useful to note that each sub-basin is not geographically very far from the other, and as such, they are all subject to similar rainfall characteristics as well as sharing similar underlying geology and overall climate. The differences in water quality data therefore may be attributed in large part to the historical and present-day impacts wrought by land use development that is unique to each basin.

Routine monitoring on the West Kill by DEP indicates good water quality overall, with no chronic water quality problems including biological monitoring in which was found no impacts to aquatic life. However, the West Kill has been identified as a principal contributor of sediment and turbidity to the Schoharie Reservoir.

Turbidity is an optical measurement of the light-scattering and adsorption properties of molecules and particles suspended in water. Turbidity is measured in "nephelometric turbidity units" (NTUs) by a "nephelometer". Turbidity can be influenced not only by the amount of particles in suspension, but also the shape, size and color of the particles. There is no fixed relationship between turbidity and total suspended solids. Total suspended solids are a measure of suspended sediment concentration, expressed as a weight per volume (mg/L) obtained by physically separating the liquid and solid phases by filtration.

Annual median turbidity values show that although the West Kill headwaters sites indicate good water quality with NTUs around 2, median values measured downstream place the West Kill on par with the larger and more developed Batavia Kill stream. Elevated turbidity in the stream water is the end result of an imbalance in stream stability in relationship to the surrounding landscape. A stable stream will adopt a form that can pass the water and sediment bedload associated with the yearly spectrum of flood events. Some reaches of the West Kill stream display obvious symptoms of instability. Causes of the instability are likely a combination of historical and modern day anthropogenic alterations in the stream basin landscape. Reduction in riparian cover reduces the critical network of tree and shrub roots that provide streambank soil stability as well as water temperature moderation.

Changes in stream slope will affect the potential force the water has to move its sediment. The processes of aggradation and degradation are the result of a decrease and increase in stream slope, respectively. Aggradation, while visibly less of an issue in the West Kill than degradation, occurs in several places along its reach. Aggradation is an indication that the stream is not capable of moving sufficient bedload and resultant deposition raises the flood surface elevation and can create a stream channel subject to flooding, increased meandering and excessive stream bank erosion.

In other reaches of the West Kill, the stream has experienced severe impacts from the process of incision, or degradation. Typical to many streams of the Catskill region, the West Kill generally has a shallow cobble or gravel streambed pavement, underlain by highly erosive deep glacial lake clays. During a high flow storm event, the streambed armoring can be ripped away, causing the clays to be exposed and consequently severely eroded. The end result is that the stream channel is cut deeper into the landform. As the streambed deepens, adjoining stream banks become destabilized and this often leads to massive failures of not only the stream banks but also slumping of adjacent high slopes sometimes hundreds of feet away from the stream. This is evident in several areas along the lower reaches of the West Kill where the stream runs parallel to NYS Rt. 42.

Specific conductivity describes the ability of water to conduct an electric current, and is a measure of the concentration of chemical ions in solution. Sp. conductivity is often used to compare different streams because it is a cheap and easy measurement that can indicate when and where a site is being influenced from a source of contamination. A plot of conductivity indicates that the more developed Batavia Kill basin exhibits higher conductance than both the East Kill and the West Kill, with the headwaters of those streams having the lowest value. It should be noted however, that even the Batavia Kill values are low compared to more heavily developed areas, which may have conductivities in the hundreds or thousands of micromhos/cm. One source of elevated conductivity values is the use of salt for road de-icing and consequent runoff. As is typical to most of the Catskill Mountain region, the roadways in the Schoharie Basin tend to have been constructed along the stream valleys. In a small valley like the West Kill, the road closely follows the stream, crossing the water many times on small, unprotected bridges. Lending support to this idea is the plot of chloride concentrations showing good agreement with the plot of conductivity. Chloride values are still very low when compared to more developed areas.

Fecal coliform bacteria are a health hazard whose source can be traced back to either human or animal wastes, are measured to determine to what degree a stream may be contaminated by fecal matter. The New York State regulatory limit states: "The monthly geometric mean, from a minimum of five examinations, shall not exceed 200 CFU/100 mL". A review of median values from DEP's twice-monthly sampling of the West Kill stream for the period of record show that fecal coliforms have not exceed 10 CFU/100 mL and have shown a continuing downward trend since 1998. These values are similar to that of the East Kill stream with not much difference noted from headwater sites to downstream sites.

Another water quality parameter of concern is dissolved oxygen (DO). Dissolved oxygen is vital for aquatic life. The content of DO in surface water varies slightly with atmospheric pressure and significantly with temperature. The highest possible value occurs when the water temperature is at 0 degree C and is at zero at 100 degree C. The New York State regulations regarding DO and a stream designated as trout spawning is that the DO should not be less than 7.0 mg/L from other than natural conditions. The annual medians for the West Kill stream as well as that of the Schoharie Creek and other sub-basins, all measured over 10 mg/L and show favorable agreement in trends.

Phosphorus is a common biological nutrient found in natural waters. Major features of phosphorus chemistry that govern its behavior include the low solubility of most of its inorganic components and its use as a biological nutrient. Phosphorous is a constituent of potential concern in stream waters as an over abundance can lead to excessive growth of algae. Although there is no legal standard for phosphorus, it has been suggested that a value of 50 micrograms/L is the limit under which there should be no problems with algal growth. The median annual values of total P show that for the West Kill stream, although slightly elevated above the East Kill, are well below the 50 microgram/L threshold. Because phosphorus is fairly abundant in sediments, soil erosion may add considerable amounts of suspended phosphorus to a stream. This can be seen in a comparison of the plots of turbidity and total phosphorus where the highest values of TP correlate to the highest turbidity values.

Sulfur in natural waters is essential in the life processes of plants and animals. Although the largest Earth fraction of sulfur occurs in reduced form in igneous and metamorphic rock, there is significant sulfur in sedimentary rock as well. When sulfide minerals undergo weathering in contact with oxygenated water, the sulfur is oxidized to yield stable sulfate ions that become mobile in solution. Another major source of sulfate in the environment is the combustion of coal, petroleum and other industrial processes such as smelting of sulfide ores. Atmospheric deposition both as dry particulates and entrained in precipitation can cause rain of low pH that can alter stream chemistry. The annual median values found in the West Kill stream for the period of record show relatively low values consistent with that of the region. The slightly higher values for the Batavia Kill are likely from increased development. It is interesting to note that overall, for the entire Schoharie basin, the annual median Sulfate values have declined since the beginning of the record in 1994.

Knowing the hydrogen ion activity (pH) of water can give some idea as to the extent of chemical reactions in the liquid involving not only the dissolution of water, but also the myriad of other solute, solid and gaseous reactions involving hydrogen ions. This is because the activity (concentration) of the H+ ion in water is the end result of those equilibrium and non-equilibrium reactions. The pH of pure water at 25 C is 7.00. Natural waters on Earth may have pH values ranging from the low extremes approaching 0 to above 12 in certain conditions. Annual median pH values for the period of record for the West Kill stream ranging from 6.6 to 7.9 indicate stream water in near neutral balance and are similar to those in the rest of the Schoharie basin. The slightly lower values found in the headwaters sites is likely due to groundwater leaching through acidic soils, and also their position upstream from potential sources of buffering. High and low values can be correlated to periods of greater and lesser rainfall, respectively.

Water temperature is one of the most important variables in the aquatic biosphere. Temperature affects movement of molecules, fluid dynamics, and metabolic rates of organisms as well as a host of other processes. Typically, the greatest source of heat in a watershed is solar radiation from the sun. In a densely wooded area, where the majority of a streambed is shaded, heat transferred from the air and from groundwater can dominate temperature dynamics. Annual fluctuation of temperature in a stream may drive many biological processes, for example, the emergence of aquatic insects and spawning of fishes. Even at a given air temperature, stream temperature may be highly variable over short distances depending on plant cover, stream flow dynamics, stream depth and groundwater inflow.

Annual median values of West Kill water temperature vary from just under 6 degree C to 10 degree C, indicating a fair amount of shading and consequent moderation of incoming solar radiation. Lowest median temperature values indicate very wet years and highest values dry ones. The lower temperature of headwater sites reflect lower air temperatures at higher elevations as well as the predominance of shading.