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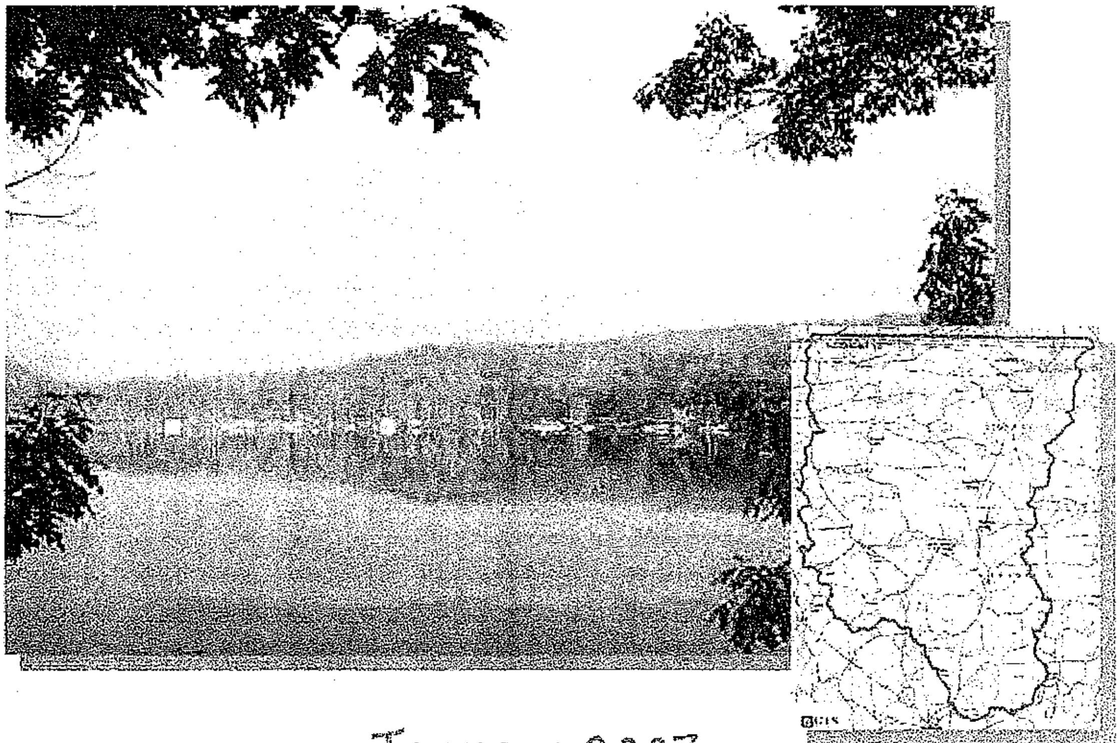
# Snake Creeks
## Watershed Assessment Report



January 2003

*Prepared by:*

GTS TECHNOLOGIES

*In Association with:*

**HAWK Engineering, PC**

*Prepared for:*

**The Snake Creeks Watershed Assn.**

## D. Field Data Collection

Following a review of secondary source information, stream sampling points were chosen at various points along Snake Creek and its tributaries. The approach was to collect data from different areas of the watershed that could be impacted by various impairments, including: agricultural activities, unpaved roads, and intensive land development. Fourteen lakes and ponds were also chosen to be sampled depending on their location, size, and potential for impairment from non-point source discharges. Unimpaired water features were included in the data collection effort to verify and validate secondary source data collection results.

Letters identifying the goals and methodology of the watershed assessment were sent to members of several lake associations within the Snake Creeks Watershed, township officials, and other interested residents. Various planning documents and information regarding impairments or problems within their specific area were requested. In addition, their concerns and input were noted. From this information, areas of severe erosion, impact by agriculture and mining, and unpaved roads were located and mapped. In addition, several areas of impairment were identified from field observations while familiarizing ourselves with the study area. These areas were also added to the GIS mapping and tabulation system.

### 1. Stream Sampling and Analysis

An assessment of the physical, chemical and biotic conditions of selected streams within the watershed was performed. The physical, chemical, and biotic conditions of a stream are interdependent upon each other. Together, they determine the health of a stream. Visual recognition of the physical characteristics of a stream can indicate stream stability and determine the presence of habitat for aquatic life. The type and diversity of aquatic life found in a stream is often dependent on its chemical makeup. The type of macroinvertebrates (biotic conditions) within a stream is a good indicator of its water quality.

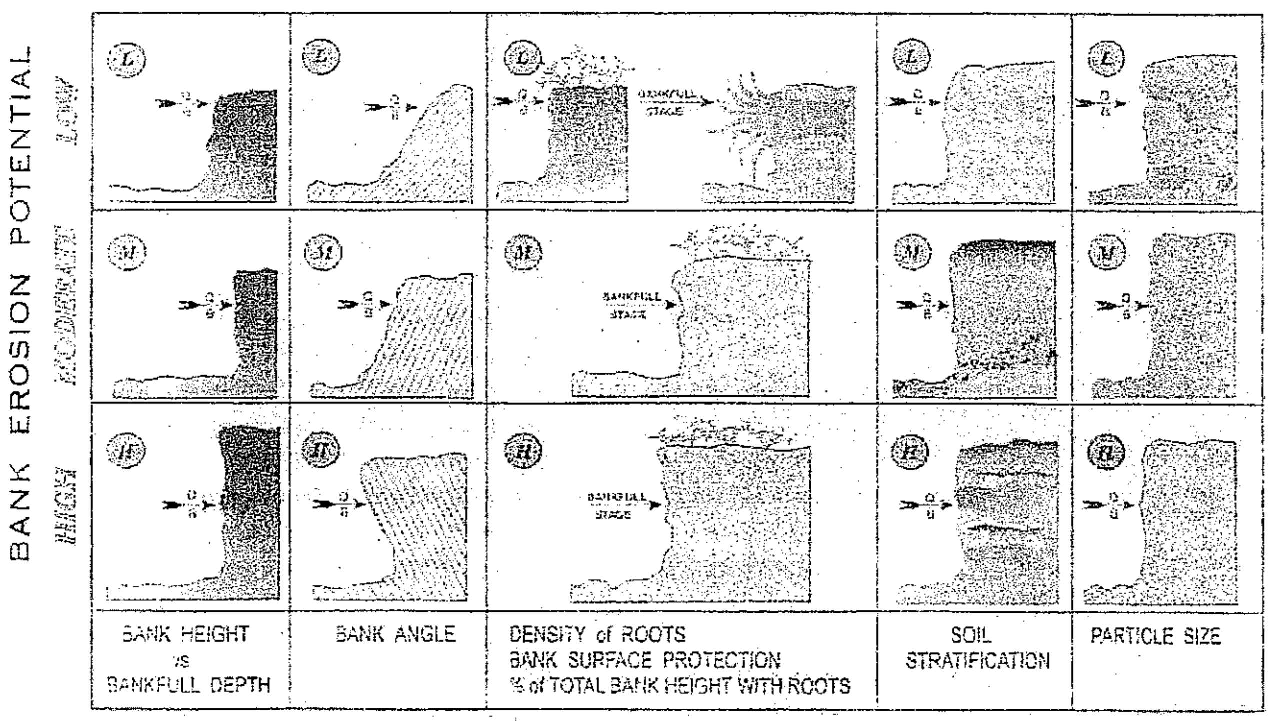
A detailed analysis of each stream is beyond the scope of this study. Testing was performed along Snake Creek and at the mouth of the tributaries flowing into Snake Creek. Additional testing was later completed higher in the watershed in those headwater tributaries that had moderate or poor testing results in an attempt to determine the source of impairment.

#### a. Physical Conditions

The physical conditions of the streams within the various subwatersheds were assessed and recorded at each sample location. The physical conditions of a stream channel can help determine channel stability and aquatic habitat. Channel stability was determined by estimating the width/depth ratio, the amount of erosion, bank erosion potential, and aggradation or degradation of the stream channel for comparison to a stable reference reach.

Width/depth ratio is the ratio of the bankfull surface width to the mean depth of the channel. Bankfull is defined as the "incipient elevation on the bank where flooding begins." In many stream systems, the bankfull stage is associated with the flow that just fills the channel to the top of its banks and at a point where the water begins to overflow onto a floodplain. The width/depth ratio is the most sensitive and positive indicator of trends in channel stability. Determination of the width/depth ratio provides a rapid, visual assessment of channel stability" (Rosgen, 1996). Bankfull width and depth were estimated and not field measured. A low width/depth ratio (narrow and deep) indicates a stream that is degrading, causing erosion and siltation within the stream channel. A high width/depth ratio (shallow and wide) indicates that the stream may be aggrading, causing sediment to drop in the stream channel.

Visible bank erosion at each sample site was noted. The slope of the stream banks was rated from gradual to steep. Bank erosion potential was determined utilizing a chart developed by Rosgen (1996) comparing stream bank characteristics such as bank height versus bankful depth, bank angle, root density, soil stratification, and particle size.



Aquatic habitat within a stream is dependant on several factors including water temperature, streamside cover, pool to riffle ratio, cover within the stream, and stream substrate. Water temperature was measured with a pH/temperature/conductivity meter suspended in a riffle and was recorded in degrees Celsius. A temperature below 19 degrees Celsius can support fish that are indigenous to a Cold Water Habitat, while any temperature up to 31 degrees Celsius can support fish indigenous to a Warm Water Fishery. Dominant vegetation types along the stream were described as trees, shrubs, or herbaceous. Trees and shrubs not only shade a stream to keep the water temperature cooler, but help in reducing water temperature fluctuations. In addition, streamside cover of shrubs and trees typically has a better root mass and reduces the erosion potential of the stream bank. The pool to riffle ratio indicates the general flow characteristics of the stream. A 1:1 pool to riffle ratio is desirable. The stream banks were assessed for any signs of possible fish habitat or cover in the form of root systems, undercut banks, and large rocks. Streambed composition was listed in terms of percent of substrate types. A streambed of cobble and gravel provides the best aquatic habitat. Sand and silt fill in the nooks and crannies that fish and macroinvertebrates need to hide, and large boulders have less area to hide. The overall physical condition of the stream sampling point was ranked on a scale of 0 to 20, based on the various sampled parameters.

**b. Chemical Conditions**

Chemical characteristics vital to determining stream health were also measured. As previously stated, a pH/temperature/conductivity meter was suspended in a riffle in each stream. Conductivity was recorded in µS/cm. In addition, a dissolved oxygen meter measured the oxygen at the water surface in parts per million (ppm) while the probe was agitated within a riffle. Readings from riffles are generally more accurate because the water is flowing and not stagnating. Turbidity was measured using a LaMotte test kit that involved adding drops of a turbidity solution into distilled water in an attempt to match the turbidity of the stream sample. The units of the turbidity measurements were recorded in Jackson Turbidity Units (JTU). Iron, phosphate ($PO_4$), and Nitrate ($NO_3$) concentrations in the sampled streams were measured using LaMotte colormetric test kits, and the units were recorded in parts per million (ppm). A 20-point scale was used to rate the overall chemical health of the stream. The Pennsylvania Lake Management Association provided standards used to rate the chemical health of streams.

Conductivity is the measurement of a solution's ability to conduct an electrical current. Absolutely pure water is actually a poor electrical conductor. The substances (or salts) dissolved in the water in the form of ions determine how conductive the solution will be. Therefore, conductivity can be an excellent indicator of water quality. The higher the conductivity, the more ions or salts (i.e. calcium, sodium etc.) that are dissolved in the water. Possible sources of ions to a water body include wastewater from sewage treatment plants and septic systems, runoff from roads (particularly road salt), and agricultural runoff. Environmental conditions such as drought, changing seasons, and heavy rainfall or snowmelt can cause the concentration of dissolved salts in water to vary significantly.

The hydrogen ion concentration within a solution determines the pH. The more hydrogen ions in a solution, the more acidic the solution and the lower the pH. A higher number of hydrogen ions raises the pH, making the solution more basic. The more acidic or basic a stream is, the less biologically diverse it becomes. The pH scale ranges from 0 to 14 with 7 as the neutral or desirable number. For aquatic life in stream channels a measurement of 6.5 to 8.2 is optimal.

Turbidity measures the amount of suspended solids and dissolved substances, including organics, in a stream. A stream that has high rates of siltation will be high in turbidity. A turbid stream measures 50 JTU, while a severely impaired stream measures 100 JTU. High turbidity in a stream is not conducive to good aquatic habitat.

Dissolved oxygen is a measure of how much oxygen is available in the water for aquatic species. A measurement of 6 to 8 ppm is good, while a measurement of 3 to 4 ppm is stressful for aquatic life.

The amount of iron, phosphates, and nitrates in a stream were also measured. These parameters were chosen due to former and current land uses within the watershed. Iron was tested because of former mining and gravel quarrying operations within the watershed. Iron precipitates out in water as ferric hydroxide, clogging gills and filling nooks and crannies, which are good for aquatic life. Iron can also occur naturally in streams. Therefore, a reading of 0.1 to 0.5 ppm is acceptable. Iron levels should not exceed 1.5 ppm.

Sources of nitrates in a stream include wastewater and agricultural non-point source pollution. Streams with good water quality have a nitrate ($NO_3$) level of less than 1.1 ppm. Sources of phosphates in a stream include fertilizers, sewage, and detergent. Phosphates stimulate plant production within a stream. In streams where water quality is excellent, phosphates measure less than 1.0 ppm; a good phosphate level is between 1.1 and 4 ppm; a fair level is between 4.1 and 9.9 ppm; and a reading over 10 ppm is poor.

#### c. Biotic Communities

The diversity of macroinvertebrates in a stream channel is a good indication of the health of the stream. The greater the number and diversity of species, particularly pollution sensitive species, the better the quality of water.

The macroinvertebrate population was sampled within the selected streams through a kick-net sample. Twenty kicks at the stream substrate within 1 square meter were conducted per sample site, and the macroinvertebrates were rinsed from the gauze net and collected in a plastic pan. Using a macroinvertebrate key, sampled individuals were identified and tallied. The number of pollution tolerant, pollution sensitive, and facultative species was totaled. The tally of pollution sensitive and facultative macroinvertebrate species were multiplied by three and two, respectively, and the values of the three categories were added to obtain a total ranking number. The water quality of the stream was then rated using a 27-point value scale: for a total less than 11, the stream was poor; between 11 and 16, fair; from 17 to 21, good; between 22 and 26, very good; and 27 or higher, excellent. Additionally, sightings of other organisms, including amphibians, fish, reptiles, and waterfowl, were noted.

Details of the stream survey results are listed in the Stream Survey Forms located in Appendix B. A summary of the stream survey data is in Tables 1 and 2 in Appendix B.

### 2. Lake Sampling and Analysis

As with streams, the physical, chemical, and biotic characteristics of a lake are also interdependent, and collectively determine the health of a lake. Many lakes exist within the Snake Creek watershed; however, 14 were chosen for detailed study, representing a cross-section of expected impaired and unimpaired systems. The lakes that were studied in detail were those that had a varying amount and type of development around each.

### a. Physical Conditions

Physical conditions of the sampled lakes were assessed through a number of parameters. Several aspects of the lake appearance were noted, including the color of the water and whether or not the shoreline exhibited a bottom coating of any type. These characteristics are a general indicator of overall health and may help in determining what, if any, nutrients, metals, or types of algae would be anticipated. In addition, the bottom substrate and plant covering in the littoral and shoreline zones were described. Waterfowl in the vicinity of the lake were counted. Water temperature was measured with any reading over 30 degrees Celsius considered as stressful to aquatic life. The physical parameters were then ranked on a scale of 0 to 20.

### b. Chemical Conditions

Many of the procedures performed in the stream sampling were replicated in the testing of the selected lakes. All measurements were taken from the approximate center of the lake by the use of a canoe. Battery operated meters were used to measure conductivity (in µS/cm), pH, and dissolved oxygen (in ppm). Each of these measurements was taken at approximately 3.2 meters (10.5 feet) of depth. Iron, Phosphate ($PO_4$), and Nitrate ($NO_3$) in the water were measured using LaMotte test kits and were recorded in ppm. Iron combines with phosphate, precipitates out, and is stored in the sediment of a thermally stratified lake. This reaction is reversed during overturning of lakes and the phosphate becomes available to algae, which can cause taste and odor problems. Turbidity was measured in JTU's using the LaMotte test kit and in feet utilizing the Secchi Disk. A secchi disk on a cord with increments marked in feet was lowered from the side of the boat to a point at which the disk was no longer visible. The disk was then raised until it was visible again. The point at which the disk disappeared and reappeared was measured in feet along the cord. A total measure of the chemical health of the lake or pond was given as a value between 0 and 20. Standards provided by the Pennsylvania Lake Management Association were again used to rate the chemical health of the lakes and ponds.

A pH measurement between 6.0 and 9.0 is optimal for aquatic lake organisms. Dissolved Oxygen in a lake should be similar to that of flowing water, using 4 to 5 ppm as a minimum.

The water quality parameters of iron, nitrate, and phosphate in lakes are similar to that of streams. Therefore, a reading of 0.1 to 0.5 ppm for iron is acceptable. Iron levels should not exceed 1.5 ppm. Iron levels will be higher near the lake bottom in summer. Lakes with good water quality have a nitrate ($NO_3$) level of less than 1.1 ppm. In summer, the top layers of a eutrophic lake have lower levels of nitrate due to the uptake by plants, and the bottom layers will be higher in nitrate due to decay. In lakes where water quality is excellent, phosphates measure less than 1.0 ppm; a good phosphate level is between 1.1 and 4 ppm; a fair level is between 4.1 and 9.9 ppm; a reading over 10 ppm is poor.

In addition to tests and observations performed in the field, an analysis of the impact of the nutrient loads to the sampled lakes and ponds within the Snake Creek Watershed was done. The Vollenweider Relationship predicts the degree of a lake's eutrophication as a function of the areal phosphorus loading. The Vollenweider-OECD eutrophication study, completed from 200 water bodies in 22 countries in Western Europe, North America, Japan, and Australia in the 1970s, is considered "the most comprehensive and reliable approach" to correlate nutrient loads to planktonic algal growth in bodies of water (Lee, 2002). The basis of the developed relationship is that the effect of nutrients on lakes is dependent on the mean depth and hydraulic residence time associated with the lakes in addition to the nutrient loads of the water bodies. The method compares the collected lake and pond secchi disk depth to normalized relationships developed from the Vollenweider-OECD eutrophication study and thereby determines the approximate mean Chlorophyll a and the hypolimnetic oxygen depletion rate for the respective water body (Rast et al., 1978). Chlorophyll a and hypolimnetic oxygen depletion rate values were estimated from secchi disk readings in micrograms per liter (µg/L) and grams of Oxygen per square meter per day ($g\ O_2/m^2/d$), respectively. The Vollenweider-OECD study can be useful in eutrophication management efforts, as the results of this application may offer an explanation for observed algal blooms. For example, a low secchi disk reading would result in a high Chlorophyll a reading and a high hypolimnetic oxygen depletion rate. In addition, a low secchi disk reading may be caused by high nutrient input, combined with a high hydraulic residence time or a low mean depth. Results of the Vollenweider-OECD eutrophication application are contained below in Table 11.

## TABLE 11. VOLLENWEIDER-OECD EUTROPHICATION RESULTS

| Lake | Mean Secchi Depth (m) | Mean Chlorophyll a (ug/L) | Hypolimnetic Oxygen Depletion Rate (g $O_2/m^2/d$) |
|---|---|---|---|
| Bel Aire | 1.8 | 5.50 | 0.19 |
| Cranberry | N/A | N/A | N/A |
| Dora Pond | 2.7 | 4.40 | 0.24 |
| Lake Montrose | 1.5 | 5.80 | 0.18 |
| Lake Raylean | 1.5 | 5.80 | 0.18 |
| Lake Roy | 1.5 | 5.80 | 0.18 |
| Lower Laurel | 1.7 | 5.70 | 0.18 |
| Meeker/Arrowhead | 4.2 | 3.25 | 0.31 |
| Quaker | 3.0 | 3.80 | 0.27 |
| Pop's Hobby | 1.0 | 7.00 | 0.14 |
| Silver | 5.2 | 2.70 | 0.36 |
| Tripp | 4.8 | 3.00 | 0.33 |
| Upper Laurel | 1.3 | 6.50 | 0.16 |
| Williams Pond | 0.9 | 7.70 | 0.13 |

### c. Biotic Communities

The biotic health of the lakes and ponds of the watershed was assessed in several ways. The health of a lake is indicated by its fish population, which was a key component of our investigation. Available cover and habitat for fish, such as root systems and undercut banks, was described. Algae blooms and the presence of other aquatic plant species within the lakes were mapped. Finally, other organisms spotted near the lake were recorded, including amphibians, fish, and reptiles. An overall ranking of the biotic communities was determined based on a scale of 0 to 20.

Lake survey details are contained in the Lake Survey Forms in Appendix C. The lake survey data is summarized in Table 1 in Appendix C.

## 3. Coordination with Affected Parties and Local Officials

Members of lake associations, township officials, and other interested residents within the Snake Creek Watershed were sent letters identifying the goals and methodology of the watershed assessment. Information regarding sources of impairments or land uses and activities leading to degraded water quality within their specific areas was requested. Various planning documents, such as comprehensive plans, zoning, stormwater, subdivision and land development ordinances, and Act 537 sewage facility plans were requested.

Personal interviews were conducted with township supervisors and members of lake associations. Township officials were asked to identify any easements, Agricultural Security Areas, quarries, unpaved roads, farms, confined feed operations, and eroded or impaired areas of streams or lakes. In addition, information about any problems regarding sewage and other issues were requested. Lake Association members were asked general questions regarding the number of residences around the lake, maintenance practices, physical features of the lake, recreational uses, and other watershed problems experienced by the lake community. From these interviews, areas of severe erosion, impact by agriculture and mining, and unpaved roads were located and mapped.

A meeting with the Snake Creek Watershed Association, Township officials, lake associations, and other interested parties was held on November 19, 2001. The existing conditions of the watershed that had been collected during the previous month were presented to the audience, focusing on specific impaired areas of streams and lakes located within the Snake Creek Watershed. In addition, possible sources of these impairments and land uses identified within the impairments were also discussed. Additional issues of concern and needs for further data collection were requested from participants.

### 1. Stream Survey Results

Six stream samples were conducted within the Silver Creek Subwatershed. The outlet stream from Silver Lake was surveyed at sample point SIL1. This stream was rated a 7 for its physical characteristics, because of its severe sedimentation, silt and clay substrate, inadequate streamside cover, and stagnant flow. Chemically, the outlet stream ranked a 17, as its conductivity was relatively high and dissolved oxygen was low. The aquatic biota were not sampled since there was no water movement or riffles, and the stream therefore received a value of 0 for this category. The composite rating for the outlet stream from Silver Lake was fair (8).

Silver Creek was sampled in four different areas, as its surrounding watershed contained many potential water quality impairments. The first sample point, SIC1, was conducted along Silver Creek at the intersection of S.R. 167 and S.R. 4020, within a cow pasture. Physically, this section of Silver Creek was ranked at a value of 5, because the banks were severely eroded, had silty substrate and sedimentation, the stream was barely flowing, and had inadequate streamside cover. The chemical characteristics of the stream were given a value of 16 because conductivity and turbidity were slightly high and Iron showed up with a value of 0.5 ppm. Aquatic biota received a value of 12, because most of the macroinvertebrate species identified were pollution tolerant and facultative species, and one banded killifish was encountered. The composite rating for this stream was good (10).

The second sample site along Silver Creek, SIC2, was located upstream of site SIC1. The physical characteristics of the channel were rated a 10, as the streamside cover was primarily herbaceous, with severe bank erosion potential, and sedimentation. Chemically, the stream was given a value of 15 because the conductivity and turbidity measurements were high, and Iron was tested to be 1.0 ppm. The aquatic biota ranked a value of 25, as most of the species identified were pollution sensitive species. Therefore, the composite rating of this section of Silver Creek was very good (14.5).

The third station along Silver Creek, SIC3, was located immediately upstream of the confluence with Laurel Lake Creek, within a cow pasture. The physical characteristics of the stream were ranked an 18, as the substrate was mostly cobble, streamside cover was trees and herbaceous, and the bank erosion potential was slight. The chemical characteristics were rated a 19, because all values were good, although the conductivity was relatively high. The aquatic biota exceeded the maximum value of 27, as an abundance of pollution sensitive and facultative species were identified. The composite rating for this section of Silver Creek was excellent (19).

The final sampling point on Silver Creek, SIC4, was surveyed near the mouth of the stream, immediately west of Rt. 29. The physical characteristics of this section of the stream were rated an 8, as the streamside cover was inadequate, the bank erosion potential was severe, and sedimentation was moderate. The chemical aspects were ranked a value of 17, as conductivity was relatively high, and Iron measured at 0.5 ppm. Because most of the macroinvertebrates identified were pollution sensitive species, the aquatic biota exceeded the maximum value of 27. Therefore, the composite rating for this section of Silver Creek was very good (15).

In addition, an unnamed tributary to Silver Creek was sampled at point SICT1. The physical characteristics of this stream were rated a 14 for its deposited point bars along the stream edge, undercut banks, and severe erosion potential to the east. Chemically, the stream performed well in all tests and received a value of 20. The aquatic biota were rated a 27, as most of the species identified were pollution sensitive. The composite rating for this stream was excellent (18).

## TABLE 27. SUMMARY OF STREAM SURVEY DATA FOR SILVER CREEK SUBWATERSHED

| Stream | Outlet Stream-Silver Lake | Silver Creek | Silver Creek | Silver Creek | Silver Creek | Unnamed Tributary to Silver Creek |
|---|---|---|---|---|---|---|
| Sample point | SIL1 | SIC1 | SIC2 | SIC3 | SIC4 | SICT1 |
| Bankfull Width:Depth Ratio | 6 | 6.7 | 4.3 | 11.9 | 10.4 | 7.5 |
| Pool:Riffle Ratio | 1:0 | 1:0 | 1:2 | 2:3 | 2:1 | 1:1 |
| Erosion | Slight | Severe | Moderate | Slight to S, none to N | Slight to S, moderate to N | Slight to W, Moderate to E |
| Water Temperature (°C) | 5.0 | 11.8 | 10.2 | 6.5 | 8.2 | 8.0 |
| Fish Cover/Habitat | None | None | Medium cobbles | Root systems, undercut banks, medium-large boulders | Boulders | Undercut banks, boulders |
| Sedimentation | Severe sedimentation, especially near spillway of lake | Silt deposits | Reddish-brown silt deposits | Many vegetated gravel beds | Moderate | Point bars along edge of stream |
| Side Slopes | Gradual | Gradual | Gradual to N, steep to S | Gradual to N, vertical to S | Moderate | Gradual to W, moderate to E |
| Bank Erosion Potential | Moderate | Severe | Severe | Slight | Severe | Severe to E, moderate to W |
| Streamside Cover | Trees, herbaceous, lawn | Herbaceous, shrubs | Herbaceous, forested | Trees, herbaceous | Herbaceous and soil/rock | Trees, shrubs, herbaceous |
| Substrate | 40% silt, 40% clay, 10% gravel, 10% cobble | 80% silt, 20% cobble | 60% cobble, 30% silt, 10% gravel | 50% cobble, 25% silt, 25% gravel | 25% sand, 25% gravel, 20% cobble, 30% boulder | 50% cobble, 20% sand, 20% gravel, 10% boulder |
| Conductivity (µS/cm) | 105.0 | 121.8 | 155.5 | 141.6 | 139.0 | 108.3 |
| Dissolved Oxygen (ppm) | 5.0 | 9.0 | 9.92 | 11.5 | 11.3 | 11.4 |
| pH | 7.06 | 7.02 | 7.03 | 7.38 | 7.41 | 7.27 |
| Turbidity (JTU) | 2 | 5 | 10 | 3 | 3 | 1 |
| Iron (ppm) | <0.5 | 0.5 | 1.0 | <0.5 | 0.5 | <0.5 |
| Phosphate ($PO_4$) (ppm) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Nitrate ($NO_3$) (ppm) | <1.1 | <1.1 | <1.1 | <1.1 | <1.1 | <1.1 |
| Number of Pollution Tolerant Macroinvertebrate Species Present | 0 | 3 | 3 | 1 | 3 | 1 |
| Number of Pollution Facultative Macroinvertebrate Species Present | 0 | 3 | 2 | 6 | 4 | 4 |
| Number of Pollution Sensitive Macroinvertebrate Species Present | 0 | 1 | 6 | 6 | 6 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Physical Characteristics Ranking | 7 | 5 | 10 | 18 | 8 | 14 |
| Chemical Characteristics Ranking | 17 | 16 | 15 | 19 | 17 | 20 |
| Aquatic Biota Ranking | 0 | 12 | 25 | 27 | 27 | 27 |
| Composite Ranking | 8 | 10 | 14.5 | 19 | 15 | 18 |

## 2. Lake Survey Results

Two lakes within the Silver Creek Subwatershed were sampled: Cranberry Lake and Silver Lake. Cranberry Lake received a physical value of 17 for its clear appearance and plant cover in the littoral zone and shoreline area. Chemically, the lake ranked at 12 for its low pH and dissolved oxygen measurements, and its high turbidity and iron values. In addition, a rainbow sheen was observed in the shallow area where the testing occurred. The aquatic biota was rated a 14, as the lake contained many root systems for fish habitat, and the small amount of algae located near the outlet of the lake. Therefore, the composite rating for Cranberry Lake was very good (14.3). Mean secchi depth was not measured for this water body, so the approximate mean Chlorophyll a and hypolimnetic oxygen depletion rate were not determined.

The physical characteristics of Silver Lake were clear blue water appearance, less than 30% plant cover in the littoral zone, and 90% trees along the shoreline, giving a ranking of 17. The chemical aspects of Silver Lake were rated 18, as the pH was slightly low, but the other results were good. Root systems were available for fish habitat, no algae blooms were observed, and a snake was encountered, giving the aquatic biota a value of 19. The composite rating for Silver Lake was excellent (18). Because the mean secchi depth was measured at 5.2 meters (17.2 feet), the approximate mean Chlorophyll a and hypolimnetic oxygen depletion rate were determined to be approximately 2.70 µg/L and 0.36 g $O_2/m^2/d$, respectively.

Snake Creek Watershed Assessment
Susquehanna County, Pennsylvania
November 19, 2001

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***REAM NAME:*** | Silver Creek | ***DATE OF FIELD VIEW:*** | 10-16-01 |
| ***LATITUDE:*** | 41° 54' 42.8" | ***LONGITUDE:*** | 75° 55' 27.7" |
| ***STATION:*** | SIC1 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 9.5°C, cloudy, windy |
| ***APPROXIMATE FLOW:*** | 0 ft/sec | ***DESCRIPTION OF SITE:*** | Pasture used for cow grazing located adjacent to Rt 167 and steep forested area. |

*Channel Physical Characteristics Range 0 to 20: Value 5*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 20 | Average bankfull depth (ft): | 3 |
| Pool to riffle ratio: | 1:0 | Erosion: | severe |
| Water Temperature (°C): | 11.8 | Fish cover/habitat: | none |
| Sedimentation: | silt deposits | Side slopes: | gradual |
| Bank erosion potential: | severe | Streamside cover: | herbaceous, shrubs |
| Substrate: | 80% silt, 20% cobble | | |

*Chemical Characteristics Range 0 to 20: Value 16*

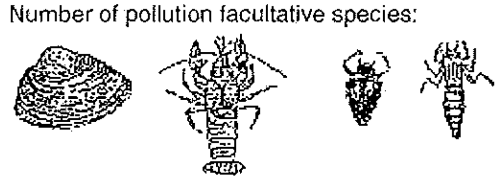
| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 121.8 | Dissolved Oxygen (ppm): | 9.0 |
| pH: | 7.02 | Turbidity (JTU): | 5 |
| Iron (ppm): | 0.5 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

*Aquatic Biota Range 0 to 27: Value 12*

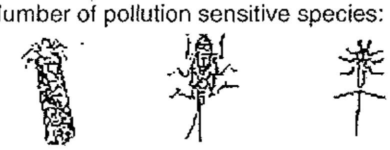
Macroinvertebrate species present:

Number of pollution tolerant species: 3

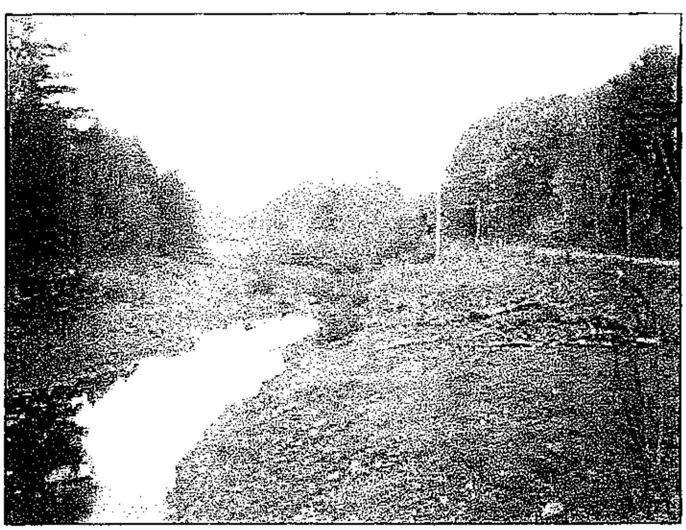
Number of pollution facultative species: 3



Number of pollution sensitive species: 1

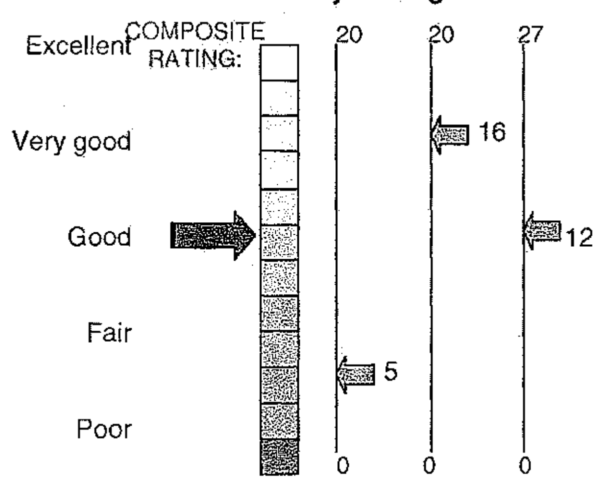


Others (fish, amphibians): 1 banded killifish



Facing west and looking upstream at Silver Creek from bridge.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**

GTS TECHNOLOGIES

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***STREAM NAME:*** | Silver Creek | ***DATE OF FIELD VIEW:*** | 10-17-01 |
| ***LATITUDE:*** | 41° 54' 17.9" | ***LONGITUDE:*** | 75° 56' 14.0" |
| ***STATION:*** | SIC2 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 5.5°C, drizzling, windy, cloudy |
| ***APPROXIMATE FLOW:*** | 2 ft/sec (riffle) | ***DESCRIPTION OF SITE:*** | Pasture used for cow grazing adjacent to dirt road and low density residential. |

*Channel Physical Characteristics Range 0 to 20: Value 10*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 3 | Average bankfull depth (ft): | 0.7 |
| Pool to riffle ratio: | 1:2 | Erosion: | moderate |
| Water Temperature (°C): | 10.2 | Fish cover/habitat: | medium cobbles |
| Sedimentation: | reddish-brown silt deposits | Side slopes: | gradual to N, steep to S |
| Bank erosion potential: | severe | Streamside cover: | herbaceous, forested |
| Substrate: | 60% cobble, 30% silt, 10% gravel | | |

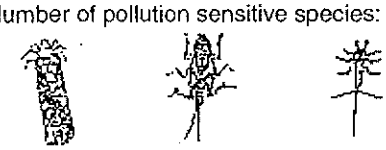
*Chemical Characteristics Range 0 to 20: Value 15*

| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 155.5 | Dissolved Oxygen (ppm): | 9.92 |
| pH: | 7.03 | Turbidity (JTU): | 10 |
| Iron (ppm): | 1.0 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

*Aquatic Biota Range 0 to 27: Value 25*

Macroinvertebrate species present:
Number of pollution tolerant species: 3 Number of pollution facultative species: 2

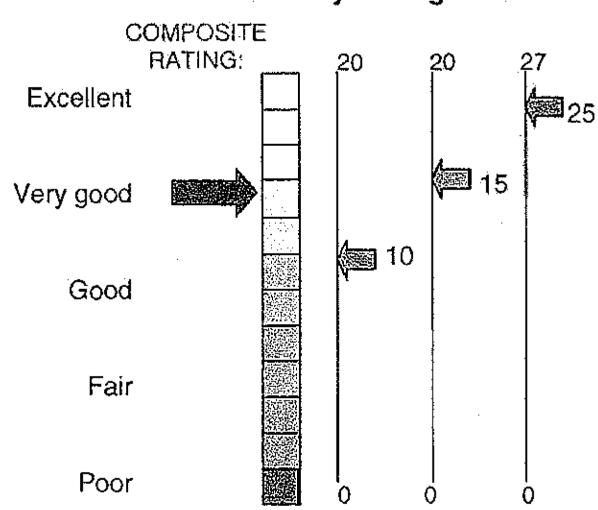
Number of pollution sensitive species: 6



Others (fish, amphibians): none

Facing northeast, looking downstream at sample site along Silver Creek.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**

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GTS TECHNOLOGIES

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***STREAM NAME:*** | Silver Creek | ***DATE OF FIELD VIEW:*** | 10-18-01 |
| ***LATITUDE:*** | 41° 54' 54.0" | ***LONGITUDE:*** | 75° 53' 20.4" |
| ***STATION:*** | SIC3 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 1.9°C, sunny |
| ***APPROXIMATE FLOW:*** | 1 ft/sec (riffle) | ***DESCRIPTION OF SITE:*** | Cows use stream in pasture, runs at base of mountain, residences adjacent. |

*Channel Physical Characteristics Range 0 to 20: Value 18*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 25 | Average bankfull depth (ft): | 2.1 |
| Pool to riffle ratio: | 2:3 | Erosion: | slight to S, none to N |
| Water Temperature (°C): | 6.5 | Fish cover/habitat: | root systems, undercut banks, medium-large boulders |
| Sedimentation: | many vegetated gravel beds | Side slopes: | gradual to N, vertical to S |
| Bank erosion potential: | slight | Streamside cover: | trees, herbaceous |
| Substrate: | 50% cobble, 25% silt, 25% gravel | | |

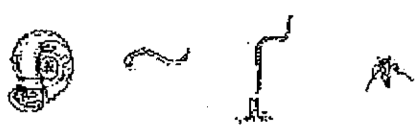
*Chemical Characteristics Range 0 to 20: Value 19*

| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 141.6 | Dissolved Oxygen (ppm): | 11.5 |
| pH: | 7.38 | Turbidity (JTU): | 3 |
| Iron (ppm): | <0.5 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

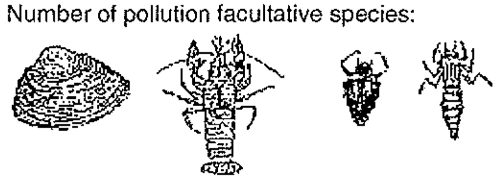
*Aquatic Biota Range 0 to 27: Value 27*

Macroinvertebrate species present:

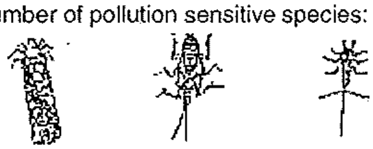
Number of pollution tolerant species: 1



Number of pollution facultative species: 6



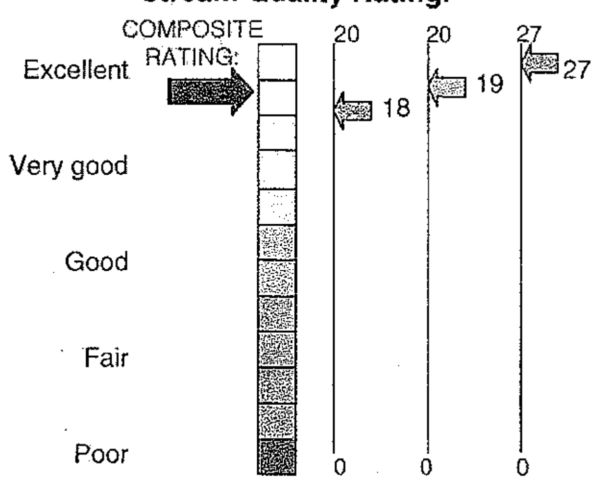
Number of pollution sensitive species: 6



Others (fish, amphibians): none

Facing east and looking downstream along Silver Creek.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**

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GTS TECHNOLOGIES

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***STREAM NAME:*** | Silver Creek | ***DATE OF FIELD VIEW:*** | 10-18-01 |
| ***LATITUDE:*** | 41° 55' 4.1" | ***LONGITUDE:*** | 75° 50' 52.9" |
| ***STATION:*** | SIC4 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 11.7°C, sunny |
| ***APPROXIMATE FLOW:*** | 1.9 ft/sec (pool) | ***DESCRIPTION OF SITE:*** | Adjacent to Rt. 29 and S.R. 4008 within Franklin Forks, in residential area, partially forested. |

*Channel Physical Characteristics Range 0 to 20: Value 8*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 26 | Average bankfull depth (ft): | 2.5 |
| Pool to riffle ratio: | 2:1 | Erosion: | slight to S, moderate to N |
| Water Temperature (°C): | 8.2 | Fish cover/habitat: | boulders |
| Sedimentation: | moderate | Side slopes: | moderate |
| Bank erosion potential: | severe | Streamside cover: | herbaceous & soil/rock |
| Substrate: | 25% sand, 25% gravel, 20% cobble, 30% boulder | | |

*Chemical Characteristics Range 0 to 20: Value 17*

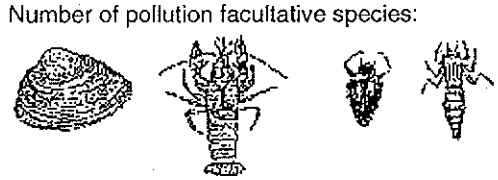
| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 139.0 | Dissolved Oxygen (ppm): | 11.3 |
| pH: | 7.41 | Turbidity (JTU): | 3 |
| Iron (ppm): | 0.5 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

*Aquatic Biota Range 0 to 27: Value 27*

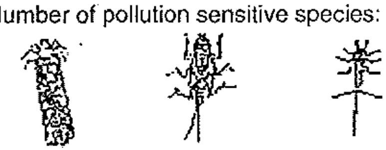
Macroinvertebrate species present:

Number of pollution tolerant species: 3

Number of pollution facultative species: 4



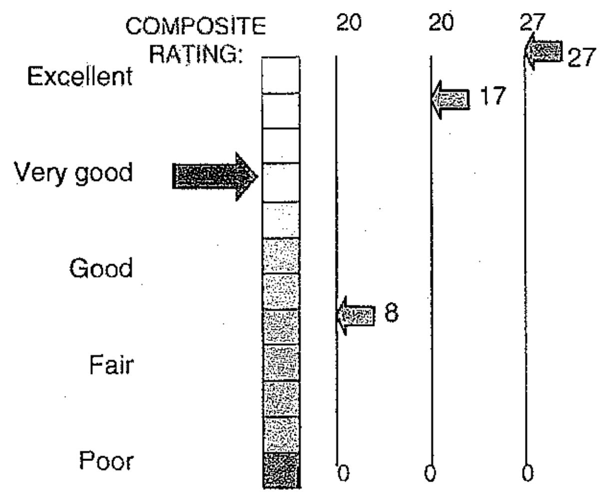
Number of pollution sensitive species: 6



Others (fish, amphibians): small fish

Facing downstream and looking east at the sample location.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***STREAM NAME:*** | Unnamed tributary to Silver Creek | ***DATE OF FIELD VIEW:*** | 10-18-01 |
| ***LATITUDE:*** | 41° 55' 4.0" | ***LONGITUDE:*** | 75° 51' 5.0" |
| ***STATION:*** | SICT1 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 6.5°C, sunny |
| ***APPROXIMATE FLOW:*** | 0.6 ft/sec | ***DESCRIPTION OF SITE:*** | Adjacent to road within residential area of Franklin Forks, forest. |

*Channel Physical Characteristics Range 0 to 20: Value 14*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 15 | Average bankfull depth (ft): | 2 |
| Pool to riffle ratio: | 1:1 | Erosion: | slight to W, moderate to E |
| Water Temperature (°C): | 8.0 | Fish cover/habitat: | undercut banks, boulders |
| Sedimentation: | point bars along edge of stream | Side slopes: | gradual to W, moderate to E |
| Bank erosion potential: | severe to E, moderate to W | Streamside cover: | trees, shrubs, herbaceous |
| Substrate: | 50% cobble, 20% sand, 20% gravel, 10% boulder | | |

*Chemical Characteristics Range 0 to 20: Value 20*

| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 108.3 | Dissolved Oxygen (ppm): | 11.4 |
| pH: | 7.27 | Turbidity (JTU): | 1 |
| Iron (ppm): | <0.5 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

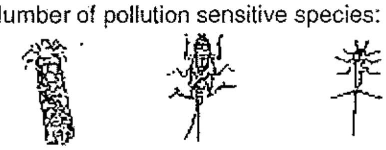
*Aquatic Biota Range 0 to 27: Value 27*

Macroinvertebrate species present:

Number of pollution tolerant species: 1

Number of pollution facultative species: 4

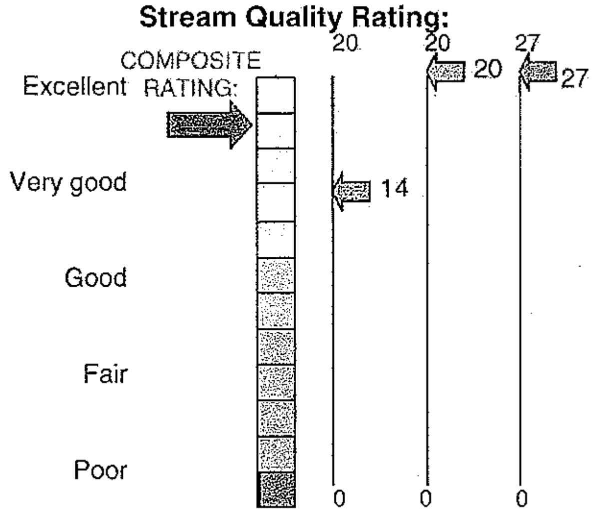
Number of pollution sensitive species: 6



Others (fish, amphibians): none

Looking south and downstream at the unnamed tributary to Silver Creek from the sample location, which was approximately 150 feet upstream of the S.R. 4008 bridge.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**

# STREAM SURVEY SUMMARY

| | | | |
|---|---|---|---|
| ***STREAM NAME:*** | Outlet stream of Silver Lake | ***DATE OF FIELD VIEW:*** | 10-18-01 |
| ***LATITUDE:*** | 41° 55' 55.9" | ***LONGITUDE:*** | 75° 56' 49.2" |
| ***STATION:*** | SIL1 | ***SUBWATERSHED LAND USE:*** | Forested, agriculture |
| ***DRAINAGE AREA:*** | | ***WEATHER CONDITIONS:*** | 2.0°C, sunny |
| ***APPROXIMATE FLOW:*** | 0 ft/sec | ***DESCRIPTION OF SITE:*** | Downstream of Silver Lake, near Rt. 167 and residences, horse pasture downstream. |

*Channel Physical Characteristics Range 0 to 20: Value 7*

| | | | |
|---|---|---|---|
| Average bankfull width (ft): | 12 | Average bankfull depth (ft): | 2 |
| Pool to riffle ratio: | 1:0 | Erosion: | slight |
| Water Temperature (°C): | 5.0 | Fish cover/habitat: | none |
| Sedimentation: | severe sedimentation, especially near spillway of lake | Side slopes: | gradual |
| Bank erosion potential: | moderate | Streamside cover: | trees, herbaceous, lawn |
| Substrate: | 40% silt, 40% clay, 10% gravel, 10% cobble | | |

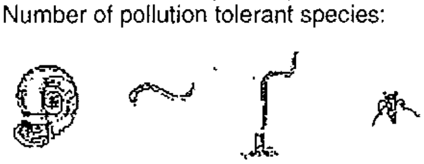
*Chemical Characteristics Range 0 to 20: Value 17*

| | | | |
|---|---|---|---|
| Conductivity (µS/cm): | 105.0 | Dissolved Oxygen (ppm): | 5.0 |
| pH: | 7.06 | Turbidity (JTU): | 2 |
| Iron (ppm): | <0.5 | Phosphate ($PO_4$) (ppm): | <1.0 |
| Nitrate ($NO_3$) (ppm): | <1.1 | Ammonia ($NH_4$) (ppm): | Not tested |

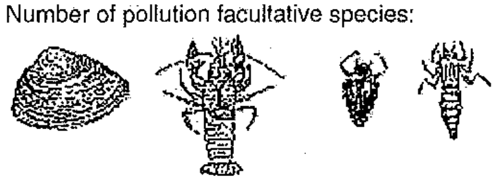
*Aquatic Biota Range 0 to 27: Value 0*

Macroinvertebrate species present:

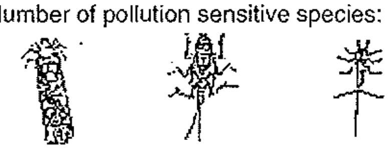
Number of pollution tolerant species: 0



Number of pollution facultative species: 0



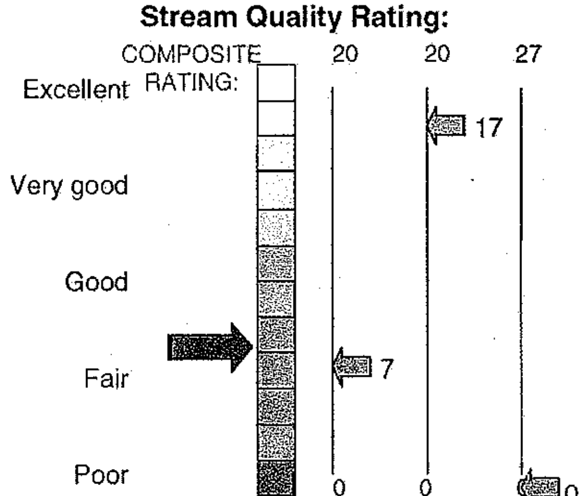
Number of pollution sensitive species: 0



Others (fish, amphibians): none

Facing north from bridge, looking upstream at Silver Lake outlet. Spillway is visible in background.

**Stream Quality Rating:**




***Color of arrow reflects color of corresponding parameter**