NORTHEAST OHIO FOUR COUNTY REGIONAL PLANNING AND DEVELOPMENT ORGANIZATION

Upper Wolf Creek

Comprehensive Watershed Management Plan (CWMP) Phase II - Watershed Monitoring

Report with Results of Twelve Months of Data

Final Report
July 1999

The preparation of this report was financed through a contract with the City of Barberton.

This report is submitted in fulfillment of twelve months of sampling and sharing test results at a local meeting for watershed residents for the Comprehensive Watershed Management Plan.

The scope calls for NEFCO to develop a report to summarize the results and discuss the findings from twelve months of data. Monitoring will include eight sites during the first six months of sampling, and ten sites during the last three months of sampling in the Upper Wolf Creek Watershed. These sites will include Wolf Creek and its tributaries. Parameters to be monitored include phosphorus, ammonia, total suspended solids, iron, nitrate + nitrite, biochemical oxygen demand, fecal coliform, *E. coli*, pH, and stream temperature. NEFCO staff will collect samples from the monitoring sites, monthly for twelve months. Samples will be analyzed for all parameters, with the exception of pH and stream temperature, by a commercial laboratory. Four sites will also be surveyed for macroinvertebrates using the Scenic River Methodology.

The scope also requires NEFCO to hold a public meeting for local citizens to discuss the importance of healthy water resources, impacts of pollution, and to gain insight into citizen priorities.

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Introduction

NEFCO, through a contractual agreement with the City of Barberton, has conducted chemical, bacterial and macroinvertebrate sampling in the Upper Wolf Creek Watershed. Chemical and bacterial sampling can offer clues as to possible sources of pollution and their severity. The type, abundance, and diversity of macroinvertebrates can be used to reveal the overall ecological quality of the water.

The purpose of this watershed monitoring study is to assess stream health and characterize nutrient and sediment concentrations originating in the watershed. This study begins the process of forming baseline data, which will be useful for comparison during future water quality testing in the watershed. Information gathered from this study will serve to identify any critical areas, offer guidance for implementation, and provide a basis for evaluation of remedial efforts to reduce pollution of streams and lakes. Data can also serve as a defensible basis for future management decisions and best management practices (BMPs). This study is part of the Comprehensive Watershed Management Plan (CWMP) Phase II.

NEFCO initially selected eight monitoring stations for water quality monitoring. The City of Barberton and NEFCO later added two additional sites for testing each month, for a total of ten monitoring stations tested every month. The sampling areas are located throughout the Upper Wolf Creek Watershed (Figure 1). Table 1 lists each monitoring station and a description of its location. There are a total of eleven stations for chemical and bacterial testing. Station 5a was used during the first three months of sampling; however, an alternate station (5b) was chosen for the second three months of monitoring due to insufficient flow at station 5a. The monitoring locations were chosen to reveal impacts from a variety of land uses, to provide representation of the entire watershed.

Table 1 Monitoring Stations Selected for Sampling in the Upper Wolf Creek Watershed					
Station No.	*Stream Name	River Mile (approximately)	Access Point/Location	USGS 7.5 min. Quad.	**Type of sampling
1	Stimson Creek	0.52	Minor Road	Wadsworth	C
2	Koontz Creek	0.58	Fixler Road	Wadsworth	C
3	Little Lakes Creek	0.63	Fixler Road	Wadsworth	C
4	Big Lake Creek	0.60	Ridge Road	Wadsworth	C
5a	Unknown	--	Sharon-Copley Road	Wadsworth	C
5b	Wolf Creek	4.36	Ridge Road	Wadsworth	C
6	Wolf Creek	5.84	Beach Road	Seville	C,M
7	Ridge Creek	0.96	State Road	Wadsworth	C,M
8	Spruce Run	0.01	Medina-Line Road	Wadsworth	C
9	Wolf Creek	7.40	Ridgewood Road	Seville	C
10	Wolf Creek	0.00	State Route 21	Wadsworth	C
11	Ridge Creek	2.42	Ridge Road	Wadsworth	M
12	Wolf Creek	6.53	Thoroughbred Drive	Seville	M

* Stream names were assigned by NEFCO from a previous study, with the exception of Wolf Creek (NEFCO, 1997).
** C = Chemical and bacterial, M = Macroinvertebrate

Summary and Conclusions

This report presents water quality data of samples taken from selected sites, which include the mainstem and tributaries of Wolf Creek. Chemical and bacterial samples were collected monthly for twelve months at eight to ten monitoring stations. All of the samples were analyzed for phosphorus, ammonia, suspended solids, iron, nitrate + nitrite, biochemical oxygen demand (BOD), fecal coliform, and *E. coli*. Stream temperature and pH were also tested during the last nine months of monitoring.

Field and laboratory results did not indicate any unusually high levels for any of the parameters tested during the twelve months. In fact, levels appear to be relatively low in comparison to other watersheds in the region (Ohio EPA-NEDO, pers. com., March, 1999). Phosphorus, ammonia and nitrate + nitrite levels were all within reasonable levels, indicating that nutrients do not appear to be impairing water quality at the stations tested throughout the watershed. Suspended solids levels were generally low, with a few levels recorded above 31 mg/l (milligrams per liter), which was not surprising, since these higher results coincided with a rain event. Recorded values for BOD were primarily below the detectable limit at the selected stream areas. Iron levels were elevated, (above 1,000 micrograms per liter), mainly during the warmer months. This is possibly the result of runoff events which transported iron-bearing particulates from natural deposits in rocks and soils, or other sources. Due to the geology of the region, elevated levels of iron are not unusual (Ohio EPA-NEDO, pers. com., March, 1999). Fecal coliform and *E. coli* counts were elevated during the warmer months (May-September). The highest results were recorded just after or during a rain event in June. Numbers of *E. coli* were higher than those of fecal coliform during the same sampling location and date for nearly 30 percent of the samples analyzed, which indicates that the source of *E. coli* is most likely of human origin (Ohio EPA, per. com., March, 1999). Failing home sewage disposal systems upstream of sampling areas are probable sources of human-related bacterial contamination. All pH and stream temperature measurements were within or below expected levels for the watershed.

Macroinvertebrate surveys were conducted at four sites using methodology from the Scenic River Monitoring Program. The Ohio Department of Natural Resources developed this methodology for examining the macroinvertebrate community and scoring stream segments accordingly. The results of the macroinvertebrate sampling revealed excellent water quality at three of the four stations surveyed. The lowest scoring stream area indicated fair water quality. The average cumulative index value for the four stations was 22.25, which indicates excellent water quality.

Recommendations

This study is the initial step in the process of gathering baseline data to be used for comparison in future monitoring studies involving the watershed. Therefore, it is strongly recommended that stream monitoring for chemical and bacterial parameters continue once a month or more, particularly after storm events. Unfortunately, only one sampling for this study occurred during or immediately after a rain event (June 15, 1998). Limitations, pertaining to laboratory schedules, prevented NEFCO from sampling during certain days and times of the week. This made it difficult to sample on short notice to monitor after or during storm events. Chemical and bacterial sampling should continue at the stream areas selected for this study, in addition to other monitoring stations as resources allow.

It is also recommended that an assessment of stream water quality through the evaluation of macroinvertebrate communities continue. Re-sampling for macroinvertebrates at the four selected areas can serve to identify water quality improvements or degradation. In addition to the four stations already sampled, three other sites have been identified as suitable candidates for macroinvetebrate surveying. These areas are Station 4, upstream of Station 5b, and downstream of Station 9. Sampling additional stations will further the understanding of stream water quality within the watershed. Other stream areas should also be identified for this type of testing throughout the watershed.

The protection of the water quality for the Upper Wolf Creek Watershed relies on an understanding of contaminants in the streams and tributaries. Continuation of stream monitoring will assist in providing sufficient information to facilitate management decisions. This study initiates the effort toward that understanding.

Methods, Results and Discussions

A. Chemical and Bacterial Sampling

This portion of the report discusses the results of twelve months of chemical and bacterial sampling performed in the watershed. Eight sites were selected for the first six months of sampling. Two additional sites were added during the last three months of monitoring. The dates of the grab samples were April 28, May 26, June 15, July 20, August 19, September 15, October 28, November 18, December 14, 1998 and January 12, January 27 (Station 10 only), February 10, and March 8, 1999. Sampling occurred between the hours of 8 a.m. to 12 p.m. and were delivered to an analytical lab for testing each month. The numerical laboratory results and sample dates and times are presented in Appendix A.

The parameters were selected from previous stream monitoring reports. Those which yielded the most information and maximized available resources were chosen. Water samples were collected and analyzed for phosphorus, ammonia, suspended solids, iron, nitrate + nitrite, BOD, fecal coliform and *E. coli*. Stream temperature and pH were also measured during the last nine months of monitoring.

When analyzing concentrations of pollutants in a waterway, it is important to take into consideration storm events during and preceding the sampling period. Table 2 contains precipitation levels for three days prior to and on the sampling date. Most sampling dates were partly to mostly sunny. Only one rain event occurred during a sample date, which was on June 15, 1998.

Table 2
Total precipitation recorded for three days prior to and on the sampling date at the Akron-Canton Regional Airport

First two quarters of sampling			Second two quarters of sampling		
Month	Day	Total Precipitation (in inches)	Month	Day	Total Precipitation (in inches)
April	25	0.10	October	25	0.00
	26	0.97		16	0.00
	27	0.00		27	*trace
	28	0.00		28	0.04
May	23	0.00	November	15	0.00
	24	0.50		16	0.00
	25	*trace		17	0.01
	26	0.00		18	0.00
June	12	1.41	December	11	0.00
	13	0.24		12	0.00
	14	*trace		13	0.00
	15	0.49		14	0.00
July	17	0.00	January	9	0.16
	18	0.00		10	0.01
	19	0.21		11	0.02
	20	0.00		12	0.14
August	16	0.00	February	7	0.56
	17	0.00		8	*trace
	18	0.00		9	0.00
	19	0.00		10	0.00
September	12	0.00	March	5	0.00
	13	0.00		6	0.62
	14	0.00		7	*trace
	15	0.00		8	0.00
*Trace amounts are less than 0.01 inches. Source: National Weather Service, 1998-1999.					

The Wolf Creek and its tributaries within the Upper Wolf Creek Watershed are located in the Muskingum River Basin which is part of the Ohio River Drainage Basin. The Ohio Environmental Protection Agency (Ohio EPA) Division of Surface Water has developed water quality standards for the state of Ohio, according to drainage basin and designated uses, under Chapter 3745-1 of the Administrative Code. The purpose of these water quality standards is: “to establish minimum water quality requirements for all surface waters of the state, thereby protecting public health and welfare; and to enhance, improve and maintain water quality as provided under the laws of the state of

Ohio, section 6111.041 of the Revised Code, the federal Clean Water Act, 33 U.S.C. section 1251 et seq., and rules adopted thereunder".

Water quality standards contain two distinct elements: designated uses; and numerical or narrative criteria designed to protect and measure attainment of the uses. The Ohio EPA designated uses for streams within the Upper Wolf Creek Watershed are as follows:

Aquatic life habitat:

"Warmwater" - These are identified by the Ohio EPA as waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified referenced sites within specific ecoregions.

Water supply:

"Agricultural" - These are waters suitable for irrigation and livestock watering without treatment.

"Industrial" - These are waters suitable for commercial and industrial uses, with or without treatment. Criteria for the support of the industrial water supply use designation will vary with the type of industry involved.

____**Recreation:**

"Primary Contact" - These are waters that, during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as a result of water quality. In addition to those water body segments designated in rules 3745-1-08 to 3745-1-32 of the Administrative Code, all lakes and reservoirs, except underground storage reservoirs and those lakes and reservoirs meeting the definition of bathing waters, are designated as primary contact recreation.

Whenever two or more use designation apply to the same surface water, the more stringent criteria of each use designation is applied by the Ohio EPA. If numerical or narrative criteria from the State of Ohio water quality standards is available, the Outside Mixing Zone (OMZ) criteria will be reported for the parameters below. The OMZ refers to the water after any effluent and the receiving water are reasonably well mixed. Water quality standards do not apply to water bodies when the flow is less than the critical low-flow values determined in rule 3745-2-05 of the Administrative Code.

The following table presents each parameter tested in addition to possible sources and adverse effects.

Table 3 Chemical and Bacterial Parameters Tested During Stream Monitoring		
Parameter	**Possible Sources**	**Possible Adverse Effects**
Phosphorus	• Human and animal waste • Decomposing organic matter • Fertilizer runoff • Industrial effluent • Detergent wastewater • Natural deposits	• Increasing rates of eutrophication - High levels of algae - Oxygen depletion - Fish kills • Taste and odor problems
Nitrogen - Ammonia - Nitrates + Nitrites	• Human and animal waste • Decomposing organic matter • Fertilizer runoff • Industrial effluent	• Increasing rates of eutrophication High levels of algae - Oxygen depletion - Fish kills
Suspended solids	• Runoff from: - Agriculture - Construction - Mining - Forestry - Natural erosion processes • microscopic plankton	• Reducing light available - Decreasing photosynthesis • Smothering of aquatic habitat • Decreasing visibility • Binding to other contaminants and transporting them into the waterway
Iron	• Industrial wastes • Acid mine drainage • Natural deposits	• Toxic at higher levels • Taste problems
Biochemical Oxygen Demand	• Decomposing organic matter • Chemical oxidation of ammonia, sulfides and ferrous iron	• Decreasing oxygen available
Fecal coliform	• Human or animal waste • Plants and soils	• Raising risk of illness and disease
E. coli	• Human or animal waste • Soils	• Raising risk of illness and disease
Stream Temperature	• Increases may be due to discharges of water used for cooling purposes, runoff from impervious areas, and loss of shading • Decreases may be the result of underground water sources, snow melt, and shade	• Interfering with natural chemical and biological processes
pH	• Increases in pH may be due to rapidly growing algae or underwater aquatic vegetation • Decreases may be due to acid mine drainage	• Interfering with natural chemical and biological processes

The paragraphs below give a brief description of each parameter tested including possible sources, significant levels and impacts associated with high levels. Figures 2-11 contain box and whisker plots using statistical calculations to illustrate levels recorded for each parameter tested. Due to the limited sampling at Station 5a, statistical calculations were not possible; therefore, they are not included in Figures 2-11.

Please Note: *Values recorded below the detectable limits, i.e., <4, were changed to half the detectable limit for the statistical calculations required for Figures 2-11.*

Appendix B contains two bar graphs for each parameter tested. The first bar graph is useful to examine various concentrations of parameters for each station during the study. The second bar graph effectively illustrates monthly concentrations of each parameter for the sampling stations.

Phosphorus

Chemical analysis to determine phosphorus concentration is important to assess stream health. Phosphorous can enter the water from human and animal waste, decomposing organic matter and fertilizer runoff. Industrial effluent and detergent wastewater also contribute phosphates, in addition to leaching from natural deposits. Figure 2 depicts phosphorus concentrations for the monitoring stations.

Total phosphorus levels higher than 0.03 mg/l contribute to increased eutrophication and levels above 0.1 mg/l may stimulate plant growth sufficiently to surpass normal eutrophication rates (Campbell and Wildberger, 1992, p. 42). Elevated levels of phosphorus may stimulate plant growth beyond natural limits causing excessive algal production, fish kills, and taste and odor problems. The OEPA's water quality standards limits phosphorous to the extent necessary to prevent nuisance growths of algae, weeds and slimes that result in violation of water quality criteria or, for public water supplies, results in taste or odor problems (3745-1-07, 1997, p. 20).

Nearly 37 percent of samples analyzed had phosphorus levels above 0.03 mg/l, with 16 percent over 0.1 mg/l. The median value for all sampling stations was below 0.1 mg/l and only two stations had median values above 0.03 mg/l. No excessive rates of eutrophication were observed at the sampling areas.

Ammonia

Ammonia is a naturally occurring compound of nitrogen and hydrogen highly soluble in water. It can reach waterways through discharge of industrial wastes containing ammonia as a byproduct or wastes from industrial processes using "ammonia water". It is a normal product of biological degradation of nitrogenous organic material. Sources of nitrogen can enter water from human and animal waste, decomposing organic matter and fertilizer runoff. The toxicity of aqueous solutions of ammonia is attributed to the NH_3 species. Factors which affect the concentration of NH_3 in water solutions include pH and water temperature (U.S. EPA, 1976, pp. 10-11).

Ammonia concentrations are displayed on Figure 3. Since water temperature and pH relate to ammonia concentrations, the Ohio EPA has developed tables to determine acceptable maximum and 30-day average levels of ammonia based on stream temperature and pH. Refer to Appendix C for copies of these tables. There are no levels in excess of the maximum or 30-day average total ammonia-nitrogen criteria during the sampling dates.

Many laboratory experiments of relatively short duration have demonstrated that the lethal concentrations for a variety of fish species are in the range of 0.2 to 2.0 mg/l NH_3, with trout being the most sensitive and carp the most resistant (U.S. EPA, 1976, p.11). Less than 3% of the stream samples contained more than 0.2 mg/l of ammonia, and only one sample measured over 2.0 mg/l (2.01 mg/l). All of these samples were located at Station 3, which is a narrow stream with typically low flow conditions. Lack of dilution, due to low flow at this station, is a reasonable cause for elevated levels at this site.

Suspended Solids

Sources of elevated levels of suspended solids and low water clarity include sedimentation from agricultural and construction site runoff, mining, forestry, natural erosion processes and increased growth of microscopic plankton.

There are no formal water quality criteria for suspended solids relating to either human health or aquatic life (U.S. EPA, 1983, p.6). Moderately low levels of turbidity may indicate a healthy, well functioning ecosystem without excessive plankton growth. High levels of turbidity may be an indication of runoff or blooms of microscopic organisms as a result of high nutrient inputs (Campbell and Wildberger, 1992, p. 32). A document referred to as the Ohio Reference site data (Brown, 1988) has developed a water quality scale based on total suspended solids values:

Table 4
Water Quality Based on Total Suspended Solids Values

Total Suspended Solids (mg/l)	Water Quality
Less than 10	Excellent water quality
10 to 30	Normal
31 to 133	Impaired stream
More than 133	Severely impaired stream

Figure 4 presents suspended solids concentrations during the sampling periods. All stations had a median value of less than 10 mg/l with the exception of Station 10. Cumulative impacts from upstream land uses and/or re-suspension of sediment by carp or other fish could be an explanation for these slightly higher levels of suspended solids. Over 70 percent of the samples taken had less than 10 mg/l of suspended solids, approximately 22 percent were between 10 and 30 mg/l, and roughly 6 percent of the samples contained between 31 and 133 mg/l. Four percent of the samples with suspended solids levels between 31 to 133 mg/l were taken in the month of June, during or just after a rain event. Additions of particulates and mixing of bottom sediments from stormwater runoff is a probable reason for higher levels in June.

Suspended materials reduce light penetration, therefore limiting the amount of photosynthetic organisms which decompose organic matter and are an important link in the food chain (Miller, 1998, pp. 348-9). Some examples of how fish populations are adversely affected by suspended solids include: preventing successful development of eggs and larvae, modifying natural movements and migration, and reducing food sources (U.S. EPA, 1976, p. 211). Soil particles can also bind to contaminants such as heavy metals and nutrients, thus transporting them into the waterway (Mayer et. al. 1995).

During the last six months of monitoring, total suspended solids measurements were also taken with the Ohio Sediment Stick. This tool has been recently developed by the Lake County Soil & Water Conservation District. For information about this tool, refer to Appendix D. A comparison of turbidity results using laboratory analysis and the sediment stick is located in Appendix E.

Iron

Figure 5 illustrates iron concentrations in µg/l (micrograms per liter) for the twelve months of sampling. Iron is common in many rocks and soils, especially clay soils where it is often a major component. Iron may be present in water in varying quantities, dependent upon the geology of the area and the remaining chemical composition of the waterway. Both plants and animals require iron, making it an essential trace element.

Prime iron pollution sources include industrial wastes, acid mine drainage and iron-bearing groundwaters. In the presence of dissolved oxygen, iron in water from mine drainage is precipitated as a hydroxide, $Fe(OH)_3$. These yellowish precipitates produce "yellow boy" deposits.

Levels of iron above 1.0 mg/l or 1000 µg/l can be toxic to aquatic life. Iron at exceedingly high concentrations has been reported to be toxic to livestock and to interfere with the metabolism of phosphorus (U.S. EPA, 1976, pp. 79-80). Ohio EPA water quality criteria for the protection of agricultural uses is 5,000 µg/l or below (Ohio EPA, 1997, 3745-1-07 p. 21).

Approximately 10 percent of the samples analyzed had iron levels above 1000 µg/l, with 5 percent of these taken during the month of June, during or proceeding a rain event. No stations had a median value greater than or equal to 1,000 µg/l. The highest iron level recorded was 4100 µg/l at Station 6. "Yellow boy" deposits were consistently found during sampling at Station 3, which was the only station to have a value over 1,000 µg/l for the 75 percent quartile.

Nitrate + Nitrite

Nitrate + Nitrite concentrations are shown on Figure 6 for the monitoring stations in the watershed. Nitrate is a natural form of nitrogen found in water. Nitrite occurs as an intermediate stage in the biological decomposition of compounds containing nitrogen.

Since nitrites readily oxidize to nitrates, they are not often found in surface water (HACH Co.).

Nitrogen is similar to Phosphorus, in that it can also enter water from human and animal waste, decomposing organic matter and fertilizer runoff.

State water quality criteria for the protection of agricultural uses limits total nitrates + nitrites to levels of 100 mg/l or less. The limit of nitrates for drinking water is 10 mg/l or less (Ohio EPA, 1997, 3745-1-07, pp. 19- 21).The highest level recorded was 2.27 mg/l, which was a sample taken during February at station 2.

Nitrogen is an essential nutrient for plant growth. Excessive amounts of nitrates and nitrites may result in plant growth past normal eutrophication rates, leading to high levels of algae, oxygen depletion, and fish kills (Campbell and Wildberger, 1992, pp. 46-7).

Biochemical Oxygen Demand

Decomposition of organic material is performed by oxygen consuming microorganisms. The chemical oxidation of ammonia, sulfides, and ferrous iron also consume oxygen in the water. Biochemical Oxygen Demand (BOD) is determined by measuring the dissolved oxygen level in a freshly collected sample and comparing it to the dissolved oxygen level in a sample collected at the same time but incubated at a specific temperature and length of time. The difference between the two oxygen levels indicates the amount of oxygen required to break down organic material and the oxidation of chemicals in the water during the storage period.

Figure 7 depicts levels of BOD for the monitoring stations during the sampling dates. Unpolluted, natural waters should have a BOD of 5 mg/l or less. Wastewater treatment plants must reduce BOD to levels specified in their discharge permits, which is usually between 8 and 150 mg/l (Campbell and Wildberger, 1992, p.40). The majority of BOD levels measured 5 mg/l or less ; however, a few were between 6 and 10 (approximately 12 percent). The highest level of BOD occurred at Station 2, with a reading of 55 mg/l. All median values for BOD were below 5 mg/l.

Fecal Coliform and E. coli

Fecal coliform are a type of bacteria naturally abundant in the lower intestine of humans and other warm blooded animals but are rare or absent in unpolluted waters. Because of this, their presence is a reliable indication of sewage or fecal contamination in water. Other coliform bacteria are also present in human and animal feces, but the fecal coliform measurement is more specific, by indicating coliform strains of which 95 percent have a fecal origin (Campbell and Wildberger, 1992 p. 49).

Escherichia coli (*E. coli*) is defined as a specific bacterial species included in the fecal coliform bacteria group, the presence of which in surface waters has been correlated with gastrointestinal illness in swimmers (Ohio EPA, 1997, p. 02-02).

Figures 8 and 9 illustrate fecal coliform and *E. coli* levels recorded at the monitoring locations.

Fecal coliform counts of less than 200 per 100 ml of water is desirable for primary contact waters (swimming) and less than 1,000 per 100 ml for secondary contact waters (boating and fishing). Generally, less than 1,000 colony forming units per 100 ml is permissible for primary contact waters and less than 5,000 per 100 ml for secondary contact waters (Campbell and Wildberger, 1992, p. 10).

The Ohio EPA has developed specific acceptable levels of bacteria for surface waters within Ohio. Statewide criteria for recreational use designations are included below. For each designation at least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met.

Primary Contact

Fecal Coliform - geometric mean fecal coliform content, either most probable number (MPN) or membrane filter (MF), based on not less than five samples within a 30-day period, shall not exceed 1,000 per 100 ml and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 ml in more than 10 percent of the samples taken during any 30-day period.

E. coli - geometric mean *E. coli* content (either MPN or MF), based on not less than five samples within a 30-day period, shall not exceed 126 per 100 ml and *E. coli* content (either MPN or MF) shall not exceed 298 per 100 ml in more than 10 percent of the samples taken during any 30-day period.

High levels (above 1,000/100 ml) of fecal coliform were present in approximately 4 percent of the samples tested. These samples were taken from Stations 1, 2, 3 and 6 during the June monitoring. It is interesting to note that these four samples were taken during or just after a rain event. Elevated levels (between 200 and 1,000 per 100 ml) of fecal coliform were recorded for approximately 11 percent of the samples taken. All of these were taken during warmer months (May - September). Median values for fecal coliform were below 200/100 ml for all of the stations included. Seventy-five percent quartiles were less than 1,000 for all of the stations.

High levels (greater than 298/100 ml) of e. coli bacteria were detected in approximately 12 percent of the samples tested. Elevated levels (between 126 and 298/100 ml) of *E. coli* were present in nearly 5 percent of the samples analyzed. The majority of the samples with high or elevated levels of bacteria, were taken during warmer months (May - September). Median and 75 percent quartile values were below 298/100 ml for all the stations shown.

Fecal coliform and *E. coli* counts are typically higher during the summer months and are during or immediately after storm events (USEPA, 1983, p. 5). Numbers of *E. coli* were higher than those of fecal coliform during the same sampling location and date for nearly 30 percent of the samples analyzed, which could indicate that the source of *E. coli* is most likely of human origin (Ohio EPA, per. com., March, 1999). Human-related bacterial contamination is probably the result of failing home sewage disposal systems upstream of sampling areas.

pH

Figure 10 illustrates pH for the monitoring stations tested in the watershed. The Ohio EPA defines pH as “the negative logarithm of the hydrogen ion activity concentrations when expressed as moles per liter or pH = -log (H+)” (1997, pp. 2-4). The pH test is one of the most common analyses in water testing. Rapidly growing algae remove carbon dioxide from the water during photosynthesis, which can elevate pH levels (Campbell and Wildberger, 1992, p. 33).

A range of pH 6.5 to 8.2 is optimal for most organisms. Rapidly growing algae or submerged aquatic vegetation (SAV) remove CO_2 from the water during photosynthesis and can result in significant increases in pH levels. Ohio EPA statewide water quality criteria for the protection of aquatic life in warmwater habitats lists pH levels between 6.5 - 9.0 as acceptable. All pH measurements taken during the twelve months of sampling were within the Ohio EPA’s limit. There was one occurance over 8.2, which was 8.73 at Station 4 during the month of July. This station is located downstream of a lake which is situated on the outskirts of a golf course. It is possible that rapidly growing algae or SAV in the lake removed CO_2 sufficiently enough to cause a rise in pH.

Changes in the water’s pH can affect aquatic life indirectly by changing other aspects of the water chemistry. For example, toxic metals trapped in sediment are released into the water at lower pH levels and the toxicity of ammonia to fish varies with changes in pH.

Stream Temperature

Water temperature may be increased as a result of discharges of water used for cooling by industrial or utility plants, runoff from impervious surfaces, and loss of riparian cover. Increased stream temperature enhances oxygen retention in the water and facilitates the streams assimilative capacity. Underground water sources, snow melt and shade can lower water temperature (Campbell and Wildberger, 1992, p. 30). Stream temperatures measured during the last nine months of sampling and are shown on Figure 11.

The Ohio EPA has developed temperature criteria for all waters of the state within the Ohio river basin. They list average and daily maximum levels for different months and times of the year. No sampling sites had temperatures above the average or maximum temperature levels as designated by the Ohio EPA. Refer to Appendix F for these temperature criteria.

Stream temperature affects feeding, reproduction and the metabolism of aquatic animals. Temperature preferences among species vary, but all species can tolerate slow, seasonal changes better than rapid changes.

B. Macroinvertebrate Sampling

This portion of the report presents water quality data based on the results of macroinvertebrate sampling within the Upper Wolf Creek Watershed. Areas were surveyed for macroinvetebrates using the Scenic River Methodology, which was developed by ODNR. Stations 6 and 7 were sampled on June 16, 1998 and stations 11 and 12 were surveyed on October 15, 1998. Figure 1 indicates the locations of the sampling stations. The stations were selected based on their convenient access point, adequate riffle area, and stream depth and width. For further details on the procedure for macroinvertebrate sampling, please refer to the NEFCO Citizen Stream Monitoring Program Final Report, June 1994.

Examination of the benthic macroinvertebrate community is commonly used to determine the environmental quality of a stream. Since these organisms are rather restricted to their immediate habitat, they cannot escape changes in water quality. If pollutants impact a stream, a considerable period of time may be required for the macroinvertebrate community to fully recover. Therefore, macroinvertebrate surveys can provide information regarding the overall quality of a stream at any given moment. Generally, unpolluted waters support a greater variety of aquatic life and polluted waters support larger numbers of more pollution tolerant organisms. This type of stream assessment takes into consideration all of the factors which can pose threats to aquatic life, such as channelization, climatic change and nutrient enrichment.

The results of the macroinvetebrate surveys at each of the selected stations ranged from fair water quality, at one station, to excellent water quality at the remaining three sampling stations. Figure 12 illustrates the type and abundance of macroinvertebrates recorded at each of the four stations. Caddisfly larvae, which are classified as group one taxa, were present at every site, and were the most abundant organism in three of the four stations evaluated. Adult riffle beetles (group one taxa) and crayfish (group two taxa) were also present at all four stations. Stations 11 and 12 contained the greatest diversity of macroinvertebrates, with eleven different types of organisms per station. Station 7 was comprised of ten types of different organisms and Station 6 had seven.

Table 5 presents the cumulative index values and stream quality assessments for each site surveyed. Station 6 revealed fair stream quality, with a cumulative index value of 16, based on the composition of organisms found in the sampling. The results of the remaining three stations (7, 11, and 12) indicated excellent stream quality, with values ranging from 23 to 26. Several species were represented at these three stream areas.

Refer to Appendix G for the completed Stream Quality Assessment forms and Stream Inventory forms used in this study.

Table 5 Cumulative index values and stream segment conditions based on macroinvertebrate surveys at selected sites				
Station Number	Sample Date	Stream	Cumulative Index Value*	Stream Segment Condition**
6	6/16/98	Wolf Creek	16	Fair
7	6/16/98	Ridge Creek	23	Excellent
11	10/16/98	Ridge Creek	26	Excellent
12	10/16/98	Wolf Creek	24	Excellent

*Stream Quality Assessment (Source: ODNR, Stream Quality Monitoring Manual)
**Excellent: >22, Good: 17-22, Fair: 11-16; Poor: <11.

The results of the macroinvetebrate sampling conducted at the four stream areas indicates relatively excellent water quality with an average cumulative index value of 22.25. Station 6 was the only station to rate below excellent water quality, with a score of 16. Identified potential threats to water quality at Station 6 include agricultural runoff, sedimentation and poor shading due to lack of an adequate riparian corridor. Potential threats were identified at the other three stations, and are mentioned in the Stream Inventory forms, but Station 6 has the most recognizable threats to surface water quality.

II. Public Meeting

Summary

This report briefly summarizes the results of a public meeting held in the Upper Wolf Creek Watershed. The purpose of this meeting was to inform local residents about the value of the watershed, the impacts of nonpoint source pollution and to gain insight into citizen priorities. The results from twelve months of stream monitoring were also presented, in addition to upcoming activities through a nutrient and sediment pollution reduction program in the watershed.

Meeting participants identified chemicals from industries, sediment from construction sites, and nutrients from lawn fertilizers and herbicides as critical issues with the highest priorities in efforts to protect and/or restore water resources. The most important watershed uses identified included a place for wildlife to live, a source of drinking water and a source of water to irrigate fields and plants. Questions were raised during the meeting regarding the adverse effects of uncontrolled development and loss of open space on water quality and whether efforts to protect water quality will create more stringent regulations pertaining to farm practices such as fertilizer and pesticide application.

Introduction

Education and cooperation of the local residents which are most likely to be affected by change in the watershed is essential to a watershed project's success. The goal of this meeting is to raise awareness of watershed citizens regarding the benefits of their water resources and threats to its quality. As watershed residents become more informed about issues facing the watershed, a more integrated and proactive approach to cleaning up and/or preventing problems should be realized.

The education of agencies and local governments, responsible for environmental management, regarding the perception and priorities of watershed residents is equally important to effective pollution reduction programs. Resources utilized for problems with little or no public priority could be perceived as a waste of taxpayers dollars. Issues which are considered as major problems and seem logical to remedy by agencies and local governments, will have little remediation success, without local support.

While NEFCO has been fairly effective in raising the awareness of local agencies about the Upper Wolf Creek Watershed, it was felt that the time has come to approach the general public. One effort to raise citizen awareness has been accomplished through the use of this public meeting. Future efforts could include development of brochures, watershed field trips, and workshops.

The meeting was held at a central location on Sharon Circle. The meeting included a review of watershed conditions, results from twelve months of stream monitoring, and an introduction to the partners and activities involved in a current nutrient and sediment pollution reduction program in the watershed.

Discussion

An evening meeting was held on Tuesday April 20, 1999 at the Sharon Township Administration Building, which is located on Sharon Circle in Medina County. Appendix A contains a copy of the meeting announcements and sign-in sheet. Meeting announcements included a news release, which was sent out to local newspapers and radio stations. Many of the participants learned about the meeting through a newspaper article in the Akron Beacon Journal, which is included in Appendix H.

The meeting was organized so that opportunities were available for questions and discussion. The first portion of the meeting described the watershed approach to planning and results from the Upper Wolf Creek Comprehensive Watershed Management Plan, which was completed in April 1997 by NEFCO under a contract with the City of Barberton.

The second part of the meeting summarized the results from one year of monthly stream monitoring throughout the watershed and plans to continue sampling by the City of Barberton. (Refer toTable 3 for a list of the parameters analyzed during the stream monitoring and possible sources and adverse effects.)

The last segment of the meeting included a summary of activities involved in a program to reduce nutrient and sediment pollution in the Upper Wolf Creek Watershed. This Nutrient and Sediment Pollution and Reduction Program was made possible, in part, through federal funding from the U.S. Environmental Protection Agency and the Ohio Environmental Protection Agency through Section 319 of the Clean Water Act. The program will last three years and has several partners involved.

Table 6 presents the organizations participating in this program, in addition to activities, contact names and phone numbers for each of them.

Table 6
Organizations Involved in the Nutrient and Sediment Pollution Reduction Program

Name	Activities	Contact
Medina County Health Department	• Producing and distributing educational outreach materials (pamphlets and videos) and holding educational seminars • Evaluating sites for HSDS repair or replacement • Assisting interested homeowners with the cost to repair or replace failing or malfunctioning HSDSs	Janet Gammell: (330) 723-9523
Medina SWCD	• Producing and distributing educational materials (information packet) • Implementing BMPs for landowners to demonstrate manure management	Chris Hartman or Jim Dieter: (330) 722-2628 ext. 3
Medina County Land Conservancy	• Assisting with development of slide show • Providing cost share assistance to landowners to cover the costs to establish conservation easements	Jeff Holland: (330) 239-4480
City of Barberton	• Stream monitoring throughout the watershed	Terry Palmer: (330) 848-6744
NEFCO	• Producing educational outreach materials such as: fact sheets, brochures and a slide show • Organizing Technical Advisory Committee meetings, tracking project expenses and preparing project progress reports	Claude Custer or Jo Ann Keiser: (330) 836-5731

Two questionnaires were also completed during the last part of the meeting. These questionnaires asked meeting participants to prioritize potential pollution sources and watershed uses.

Table 7 contains the results of meeting participant responses regarding the importance of various watershed uses.

Table 7
Ranking of Watershed Uses

Priority	Watershed Use
1	A place for wildlife to live
2	A source of drinking water
3	A place to relax beside
3	A place to hold back floodwater
3	A source of water to irrigate fields and plants
4	A place for recreation
4	A source of water for livestock
5	A place to wade in
6	Makes my property look good
7	To drain water from my property
8	A place to raise fish for food
9	A place to discharge from wastewater treatment plants
9	A method to carry wastes from septic tanks

Please Note: If two or more watershed uses ranked equally, the same ranking number was used.

Table 8 contains the results from meeting participant responses regarding the level of importance for several critical issues, which have the potential to degrade water quality.

Table 8 Ranking of Critical Issues Facing the Watershed	
Priority	**Critical Issue**
1	Chemicals from industries
2	Nutrients from lawn fertilizers and herbicides
2	Sediment from construction sites
3	Nutrients and bacteria loads from septic tanks
3	Nutrients loads from wastewater treatment plants
3	Brine from oil and gas drilling
3	Fertilizers and herbicides from agricultural operations
4	Runoff from landfills and dumps
4	Nutrient loads from agricultural operations
4	Gas and oil from roadways
4	Storm water runoff from impervious areas
5	Sediment from agricultural operations
5	Metals from roadways
6	Concentrated storm water flows
6	Trash and litter from urban and recreational areas
7	Sediment from mines
8	Soil runoff from salt storage
8	Acid mine drainage
Please Note: If two or more critical issues ranked equally, the same ranking number was used.	

The meeting was thought to be very informative and useful to gain perspective into citizen priorities and concerns. The educational fact sheet developed for the meeting was also considered to be successful. A copy of the fact sheet produced for the meeting is included in Appendix I.

Concerns were raised during the meeting pertaining to future water quality. Several meeting participants questioned how water quality would be affected by the changing land use in the area, from open space and agricultural to commercial and residential development. Local residents realized the need for preventative measures to protect water quality from future degradation. Local farmers raised concerns as to whether efforts to protect water resources would spawn more stringent regulations pertaining to farm practices such as fertilizer and pesticide application.

Conclusion

Lessons drawn from the meeting suggest that more public meetings need to be held throughout the watershed to continue raising awareness about potential pollution sources. Outreach efforts should focus on opportunities to avoid costly clean-ups and promote preventative measures to protect healthy water quality. It is important to relay a sense of urgency to implement such measures, since this may help to raise interest and involvement to avoid a crisis from occurring.

The resulting newspaper articles from the meeting reinforced the importance and value of local newspapers on educating the public about watershed issues. These articles are included in Appendix H, and summarize the contents of the public meeting for those who were unable to attend.

There is a need to identify local community groups that are interested in doing something, and then inform them about resources, tools, and opportunities to accomplish the desired change(s). Public outreach should be an ongoing effort with several different approaches. Well planned efforts need to be innovative and persistent to generate the local support to effectively protect water resources.

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APPENDIX A

Numerical Results for Twelve Months of Chemical and Bacterial Testing

Appendix B

Graphs Depicting Concentrations of Selected Parameters

Appendix C

Ohio EPA Statewide Ammonia Water Quality Criteria for the Protection of Aquatic Life in Warmwater Habitats

Appendix D

Ohio Sediment Stick Field Sheet

Appendix E

Comparison of Turbidity Results Using Two Different Methods of Analysis

Appendix F

Ohio EPA Temperature Criteria for the Protection of Aquatic Life

Appendix G

ODNR Stream Quality Assessment and Stream Inventory Forms for Analysis of Stations 6, 7, 11 and 12

Appendix H

Meeting Announcement Materials and Sign-in Sheet

Appendix I

Fact Sheet