Summary

The information contained in this report directly reflects the steps involved in formulating a watershed action plan. In order to create an effective and meaningful plan, an inventory of the various land uses, pollutants and valuable natural resources was needed.

The Upper Tuscarawas (Portage Lakes) River Watershed is an area of mixed development with increasing conversion of agricultural and open space to single family and commercial development. As land use changes, greater demands are placed upon the water resources, which are a vital component to the quality of life for many who live and/or work in the area.

Various potential pollution sources were identified in the watershed, and reflect the many types of land use taking place. Each of these sources was evaluated to assess their ability to impair surface and/or ground water quality. On-lot home and semi-public sewage disposal systems (HSDSs) and (SPSDSs), landfills and dumps, and construction sites appear to have the greatest potential impact from nonpoint source pollution (NPS) in the watershed as a whole, although individual subwatersheds may vary. The evaluation revealed that the greatest potential water quality threat from point sources of pollution is linked to off-lot HSDSs and SPSDSs. Other point sources of pollution include municipal wastewater treatment plants, several smaller semi-public sewage treatment plants (package plants) and industrial direct dischargers.

Critical resources, such as state resource waters, ground water resources, headwaters and biologically significant wetlands have been located within the watershed. While the watershed does not contain any streams designated as “state resource waters,” there are thirteen publicly-owned lakes and/or reservoirs that are designated as such. Perennial and intermittent streams (headwaters), which are tributaries to the Tuscarawas River, are present throughout the watershed and flow through mostly residential and agricultural areas. Groundwater yields of 100 gallons per minute and greater were mapped for the watershed. The highest yielding areas (500-1,000 gallons per minute) were found in Summit County along the Tuscarawas River. Biologically significant wetlands are present throughout the watershed, however; the location with the greatest species diversity is the wetland area surrounding Singer Lake (Subwatershed 5).

Six waterways were evaluated for riparian habitat quality, for a total of 42.61 river miles, which included the following: Tuscarawas River, Myersville Creek, Graybill Creek, Cottage Grove Creek, Wonder Lake Creek, and Nimisila Creek. The riparian evaluation revealed that 34.5 percent, of the six waterways assessed, consisted of high quality riparian habitat (i.e. forest, swamp, shrub, or old field). Myersville Creek contained the greatest percentage of high quality habitat (39.50 percent), and Graybill Creek had the lowest percentage, with only 19.01 percent.

To assist in remediation efforts to improve or preserve water quality, a watershed action plan has been developed. This action plan directly reflects the information gathered from other components of this report, especially the ranking of potential pollution sources. The action plan has identified goals, objectives, priority areas and activities to address water quality concerns. Each activity is associated with suggested responsible parties, possible funding sources, estimated time frames, expected improvements and evaluation procedures. This plan will serve as a "road map" to lead future implementation efforts.

Introduction

The intent of the Upper Tuscarawas River Watershed Action Plan is to protect and/or restore the water quality of the Upper Tuscarawas River Watershed. Prior to the implementation of an action plan, characterization of the interacting components within the watershed is required. This will enable key stakeholders to locally identify the most appropriate mechanism(s) not only for preservation/protection efforts, but also for maintaining the integrity of the natural resources and their habitats necessary for a healthy watershed, while at the same time promoting economic growth.

It is also the intent of this study to raise public awareness, especially among the watershed's residents, of the valuable natural resource areas in the Upper Tuscarawas River Watershed. This awareness will enhance the effort to develop and implement watershed stewardship projects through volunteer citizen groups or local landowners within the watershed, and to encourage their participation in the use of Best Management Practices (BMPs) included in the action plan for the protection of the water quality within the watershed.

<u>Study Area</u>

The study area is located in the Upper Tuscarawas River Major Subwatershed, which is a subset of the Muskingum River Watershed of the Ohio River Drainage Basin. The Upper Tuscarawas River drains nearly 79 square miles in Summit County with portions in Stark County and Portage County (Figure 1). The headwaters arise in a suburban area of Stark County near Hartville. The river flows west through a series of small impoundments and eventually into the Portage Lakes.

The location and controlled drainage flow of the northern portion of the study area, which is located on a Mid-Continental Divide of the Lake Erie and Ohio River Basin, makes this study area rather unique because of the intricate nature of the Portage Lakes drainage system.

The Portage Lakes Drainage Area (Figure 2) is a very complex hydrologic system that is controlled by the Department of Natural Resources, Division of Water. The system consists of natural lakes and man-made reservoirs originally intended to maintain an adequate supply of water to serve the Ohio & Erie Canal and the growing industries in

Akron. The Portage Lakes hydrologic system includes the following water bodies: Nimisila Reservoir, Turkeyfoot Lake, Rex Lake, Mud Lake, West Reservoir, East Reservoir, Miller Lake, Hower Lake, North Reservoir, Long Lake, Tuscarawas Diversion Dam, Lake Nesmith, Summit Lake, Tuscarawas River and the Ohio & Erie Canal.

The Portage Lakes hydrologic system, from south to north, consists of Nimisila Reservoir, which normally discharges excess water through an uncontrolled spillway draining south into the Tuscarawas River via Nimisila Creek. Nimisila Reservoir was built in 1936-37 to augment the water supply to the Portage Lakes during low flow periods when the lakes are used primarily for recreational purposes. However, water may be released north into Turkeyfoot Lake through two 36 inch gated outlets. Turkeyfoot Lake is connected to Rex Lake to the west, Mud Lake to the east and West Reservoir to the north. The East Reservoir is connected to the West Reservoir by a channel from which the West Reservoir discharges receiving waters from East Reservoir, Miller Lake, Nimisila Reservoir, Turkeyfoot Lake, Rex Lake and Mud Lake into the North Reservoir. However, the East Reservoir and Miller Lake are also connected to Long Lake, consequently, water from East Reservoir and Miller Lake also flows into Long Lake. Water from Long Lake normally flows into the Tuscarawas River as discharges are controlled by two outlet works. The first outlet consists of an adjustable flood gate permitting normal flow into the Tuscarawas river. The second outlet consists of a 50 foot concrete weir having the same elevation as the lower flood gate. There are two 3 foot square gated conduits located near the second outlet which are being used to release water into the Ohio & Erie Canal. (ODNR, 1997, p. 1).

Another element of the Portage Lakes hydrologic system begins at the Tuscarawas Diversion Dam where two outlet works either discharge the water into the Tuscarawas River flowing into Long Lake, or divert water into the Feeder Race Canal through two 3 foot square gates where it discharges into the East Reservoir where, again, water may discharge directly into Long Lake or flow through West and North Reservoirs, eventually discharging into Long Lake.

As previously mentioned, water normally flows back into the Tuscarawas River from Long Lake, although water is also released into the Ohio & Erie Canal for aesthetic purposes and as a water supply for the canal in order to prevent stagnation. Water entering the Ohio & Erie Canal from Long Lake is controlled by two outlet works, one of which is located at Lock No. 1 in the City of Akron, with the other located just north of the confluence of the Canal and Wolf Creek located in the City of Barberton. Lake Nesmith and Summit Lake, located along the Ohio & Erie Canal, share the same water elevation.

Summit Lake and a portion of the Ohio and Erie Canal, located in subwatershed 28 of the Cuyahoga River Basin, have been included in this study as they are a component of the Portage Lakes Drainage System. For purposes of this study, the study area will be referred to as the Upper Tuscarawas River Watershed, which will permit this study to remain consistent with previous NEFCO work. Located within the Upper Tuscarawas

River Watershed are, in whole or in part, the following government jurisdictions: Suffield Township in Portage County, the Village of Hartville, Lake Township and Jackson Township in Stark County, and the Village of Lakemore, the Village of New Franklin, the City of Green, the City of Akron, Springfield Township, Franklin Township, and Coventry Township in Summit County (Figure 3).

Data Sources

The following information was obtained in consultation with a number of state and county agencies including the Ohio Environmental Protection Agency (Ohio EPA) Northeast District Office (NEDO), Division of Surface Water, Division of Drinking and Ground Waters, Division of Solid and Infectious Waste Management, and Division of Emergency and Remedial Response. Other data sources include: AMATS, the Summit County Auditor's office, the Akron City Health Department, the Stark County Regional Planning Commission, Summit, Stark, and Portage County Health Departments, the Summit and Stark County Engineer, the Summit Soil and Water Conservation District (SWCD) and Stark and Portage SWCDs. The Ohio Department of Natural Resources (ODNR) provided information from its Division of Water, Division of Ground Water Resources, Division of Soil and Water, Division of Geological Survey, Division of Oil and Gas, Division of Natural Areas and Preserves, Natural Heritage Data Services, Division of Real Estate and Land Management, and Division of Mines and Reclamation. The United States Geological Survey and the United States Department of the Interior also provided valuable information. Additional data was obtained from the State Fire Marshall's Bureau of Underground Storage Tank Regulations. The digital data received from these sources was then imported into NEFCO's Geographic Information System (GIS), thereby permitting NEFCO to conduct a more complex and comprehensive evaluation of the study area. Furthermore, the GIS permits NEFCO to conduct complicated spatial analyses, modeling of map features, data storage and retrieval, data manipulation and display of geographically-referenced information.

I. Land Use/Land Cover

Summary

Characterization of a watershed's land use/land cover can lend a better understanding of potential threats to water quality. A study of the Upper Tuscarawas River Watershed's land use/land cover was achieved by combining and enhancing existing digital information with newly digitized data from orthophotos. Results of the study revealed that the watershed is comprised of several types of land use/land cover. The most substantial form of land use in the watershed is residential. Residential areas have the potential to be sources of nutrients, bacteria and other pollutants. Significant portions of undeveloped land remains, in the form of wooded/wetland and open area. These areas may help alleviate the impacts from stormwater runoff from urbanized areas. Agricultural land still remains, however; these lands are under tremendous pressure from development as urban sprawl continues.

Introduction

An effective watershed action plan should take into consideration the various forms of land use taking place. Understanding land uses within the watershed can offer clues as to the types of nonpoint source pollutants, subwatersheds at high risk of NPS, and appropriate BMPs to address the problems. Land use in the Upper Tuscarawas Watershed was derived from existing digital data and orthophotos. The orthophotos were digitized for incorporation into a GIS. Land use/land cover categories for the Summit County and Portage County portions of the study area include: residential, commercial/industrial/public/semi-public, transportation, agricultural, wooded/wetland, open area/urban park, and water. Land use/land cover for the Stark County portion of the study area include: residential, institutional and governmental, communications, industrial, general retail and service, parks and recreation, and open area. The land use/land cover for the watershed is illustrated in Figure 4. Tables 1 and 2 present the acreage and percentage of land use/land cover in the watershed.

Source Materials

The source materials include the following:

1. Summit County - 1997 orthophotos produced from 1994 aerial photos by the Summit County Auditor's Office and digitized through the University of Akron's Cartography Laboratory.

2. Portage County - 1995 Ohio Capability Analysis Program (OCAP) data and enhanced via 1995 aerial photos.

3. Stark County - 1977 OCAP data

Discussion

The watershed constitutes a total area of approximately 52,131 acres (Table 1). The majority of the watershed is located in Summit County (78.29 percent), with smaller portions in Stark (19.17 percent) and Portage (2.54 percent) Counties.

Due to insufficient data and resources, the Stark County land use information used in this report dates back to 1977. Because of this, many land use/land cover categories for Stark County are different than the categories chosen for Summit and Portage Counties.

The land use/land cover categories for Summit and Portage County include: 1) Residential (high, medium and low density); 2) Commercial/Industrial/Public/Semi-Public: shopping centers, office buildings, warehouses, parking lots, heavy and light industrial operations, educational, religious, health care, and correctional facilities; 3) Transportation: airports, railways and highways; 4) Agricultural: cropland, pasture and orchards; 5) Wooded/Wetland: deciduous and evergreen forest land, forested and non forested wetlands; 6) Open Area/Urban Park: undeveloped areas, golf courses, cemeteries, parks and landfills and dumps; 7) Water: lakes, ponds and streams.

Land use/land cover categories for Stark County include: 1) Residential (high, medium and low density); 2) Institutional and Governmental, which can include educational, health, religious and other public use facilities; 3) Communications indicate areas used for airwave communications, such as telephone, radio, radar or television antennas; 4) Industrial (heavy and light industry); 5) General Retail and Service; 6) Parks and Recreation (golf courses, camp grounds and parks); 7) Open Area: undeveloped areas, cemeteries and landfills and dumps.

Table 2 reveals that the predominate land use in the watershed is residential (36.01 percent). Other significant forms of land use/land cover consist of wooded/wetland (17.73 percent), open area (13.29 percent) and open area/urban park (10.72 percent). Comparison of Stark County 1977 OCAP data and 1997 aerial photos reveals that a substantial amount of undeveloped land has been converted to residential or commercial use since the late 1970s. Therefore; actual percentages of residential and/or commercial-related land use for Stark County would be significantly greater than the percentages listed in Table 1, and the percentage of open area would be lower.

As residential development continues, the demand for clean and safe water is on the rise. Residential areas have the potential to be sources of nutrients and bacteria, particularly if located on poor soils for HSDSs and if sewers are unavailable. Nutrients and bacteria can originate from failed HSDSs, while other pollutants can arise as the result of lawn fertilizers, pesticides and general household wastes. As development proceeds, the level of imperviousness and storm water drainage increases. The impacts of storm water runoff from urbanized areas can destabilize streams and ditches. Streams respond to increased flows by eroding (usually along stream banks), transporting and depositing sediment downstream. Increased sediment and attached nutrients may well exacerbate other pollutant impacts, i.e. reducing a stream's ability to assimilate pollution.

Significant portions of wooded/wetland and open areas are located throughout the watershed (Tables 1 and 2). For example, vast tracts of wooded/wetland areas are located along the Tuscarawas mainstem in Subwatershed 2, around Nimisila Reservoir and north of Long Lake in Subwatershed 3, and around Singer Lake in Subwatershed 5. These areas may have remained intact due to their natural limitations for certain types of development. The presence of these natural areas probably moderates the impact of runoff from many of the land uses throughout the watershed. These natural areas act as buffers and filters to moderate water flow and reduce erosion and the transport of pollutants downstream.

Conclusion

Because of the diversity of land use/land cover present in the watershed, a wide variety of preventative and restorative measures are needed to ensure healthy water quality. The increasing pressure of development should be taken into consideration when designing activities to protect the Upper Tuscarawas River Watershed. Efforts to promote environmentally-sound and sustainable development should be encouraged. Riparian, wetland, and shoreline protection and restoration activities and storm water management are essential to protecting water quality.

II. Potential Pollution Sources

Summary

Potential pollution sources in the Upper Tuscarawas River Watershed vary widely, but generally are typical of a watershed of mixed development. Limited sampling by the Ohio EPA performed in April 1992 indicated that East Reservoir receives most of the material flowing into the lakes. Phosphorous and nitrate-nitrite contributions to the lakes are in amounts expected for an urban area with various forms of land use. Bacteriological data suggest a trend toward pollution of streams by human waste. Overall, the watershed is characterized by eutrophic conditions (high biological productivity). Activity along the shorelines of the Portage Lakes and in the adjacent subwatersheds does seem to be providing a source of sediment that is substantial enough to impair biological productivity. Instream lakes, such as Tritts Mill Pond and Pine Lake, apparently have reduced the sediment load in the Tuscarawas River; however, it has resulted in volume loss to these upstream lakes (NEFCO, 1996, p.14, 37, and 69).

Sources of pollution can include home sewage disposal systems (HSDSs), public and semi-public sewage treatment plants (package plants), agricultural runoff, construction sites, petroleum production activity, landfills and dumps, industrial land use areas, and leaking underground storage tanks.

The following pages examine the potential pollution sources in the watershed as they exist today. Wastewater treatment plants were the primary point sources of pollution. Self-monitoring requirements were reviewed for domestic wastewater dischargers. Nonpoint sources of pollution in the watershed were identified by focusing on studying land use (human activity) within the watershed.

Unsewered areas, older residential areas, and soil characteristics were used to estimate the potential for septic systems or Home Sewage Disposal Systems (HSDSs) in the watershed to fail. The distribution of these areas, and all other sources of NPS pollution in the watershed, was evaluated at a subwatershed level for prioritization purposes.

Introduction

Understanding the problem areas that adversely affect or impair the water quality of the Upper Tuscarawas River Watershed requires a knowledge of the condition of the watershed (NEFCO, 1997d, p. 11). Insight can be gained by looking at the contributions from point sources, nonpoint sources and land use. This section of the report examines the present potential pollution sources in the watershed, and attempts to prioritize the subwatersheds that appear to be the most impaired. Potential point sources of pollution will be discussed and particular emphasis will be given to potential nonpoint source (NPS) pollution within each subwatershed. It is intended that the results of this study help guide land use decisions made by key stakeholders in order to protect/maintain the integrity of the Upper Tuscarawas River Watershed. Such an analysis can help these stakeholders identify and prioritize subwatersheds that are in need of remediation efforts or that are adversely affected by certain land uses.

It is also the intent of this study to raise public awareness, especially with the watershed's residents, of the pollution sources in the Upper Tuscarawas River Watershed. It is hoped that information in this report will stimulate watershed stewardships, through government organization, volunteer citizen groups, or land owners within the watershed, to help develop and implement best management practices (BMPs), which can ameliorate water quality problems associated with (NPS) pollution in the watershed.

Relevant Data

Aquatic Life Use Designations

The ultimate goal of many watershed action plans is the restoration or preservation of aquatic life use designations and beneficial uses within the watershed. According to the Ohio Environmental Protection Agency (Ohio EPA) the aquatic life use designation within the watershed is warmwater habitat. The water supply designations are agricultural and industrial, and the recreational use designation is primary contact. Beneficial uses include unrestricted consumption of fish and wildlife and drinking water, restoration of aquatic and terrestrial biotic communities and their habitats, and unrestricted recreational and commercial uses. Currently, three of the five stream segments monitored by the Ohio EPA are not attaining their aquatic life use designation in at least part of the stream miles monitored within the segment. Reasons for this vary, and include flow and other habitat alterations, siltation, organic enrichment, and unknown toxicity. Appendix A contains the use attainment status and causes and sources of impairment for stream segments monitored within the watershed.

Fecal Coliform Testing

NEFCO assisted the Ohio EPA-Northeast District Office (NEDO) in selecting monitoring stations, for fecal coliform, in the Upper Tuscarawas River Watershed. Sixteen stations were chosen, and two of these stations had insufficient flow for monitoring. Five of the sixteen stations chosen were monitored for several parameters by NEFCO in 1992. Five of the sixteen stations were also located within sewered areas. Table 3 presents the results from the July 28, 1998 monitoring by the Ohio EPA.

Table 3 Fecal Coliform Counts From Samples Taken on July 28, 1998 in the Upper Tuscarawas River Watershed			
Station	**Stream**	**Road**	**Fecal Coliform (per 100 mL)**
*1	Ohio Canal	Wilbeth Rd.	600
*2	Tuscarawas River	South Main St.	300
3	Long Lake Canal	Carmany Rd.	1,300
4	Wonder Lake Creek	Cottage Grove Rd.	240
5	Tributary	Killinger Rd.	130
6	Cottage Grove Creek	South Main St.	Dry
***7**	Turkeyfoot Tributary	Roble Rd.	3,300
***8**	Tuscarawas River	Pickle Rd.	400
9	Tuscarawas River	Myersville Rd.	160
10	Tuscarawas River	Portage Line Rd.	Dry
11	Tuscarawas River	Mogadore Ave.	720
12	Tributary to Nimisila Creek	Koons Rd.	1,200
13	Myersville Creek	Heckman	230
*14	Myersville Creek	Raber Rd.	270
15	Nimisila Creek	Arlington Rd.	600
16	West Reservoir Tributary	Baypath Dr.	<20

*Refer to monitoring stations within sewered areas.
**Information received from Ohio EPA-NEDO, 1998.
Bold numbers correspond to NEFCO monitoring stations in 1992, which included fecal coliform.

Fecal coliform counts of less than 200 per 100 ml (milliliters) 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 counts 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 primary contact waters is 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% 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% of the samples taken during any 30-day period.

Potential Point Source Pollution Inventory

A point source is defined as a source that discharges pollutants, or any effluent, from a known discharge point, such as a pipe, ditch, or sewer and into a waterbody after treatment (Miller, 1988, p. 348). Point sources can be traced back to the discharger, i.e., the owner/operator of a factory, sewage treatment plant or even an off-lot home sewage disposal system (HSDS). Treatment generally consists of removal of solids and disinfection. The discharge often contains a high proportion of dissolved nutrients and chemicals. Municipal point sources were identified as a major source of impairment to assessed stream segments of Metzger's Ditch, which is located in Subwatershed 4. Municipal point sources with smaller flows were considered a minor source of impairment to stream segments studied along the Tuscarawas River (Appendix A).

Approximately seventy-nine point sources were identified discharging domestic wastewater into the watershed. These include wastewater treatment plants (WWTPs) which encompass both public and semi-public sewage treatment plants (package plants). Industrial direct dischargers (process and stormwater) were also identified in the watershed, these are noted in Table 13 under Active Industrial Operations. Table 4 shows the distribution of domestic wastewater dischargers by subwatershed and design flow in millions of gallons per day (mgd). Most of the information in Table 4 is from a 1984 inventory of package wastewater treatment plants, however; plants listed with design flows greater than or equal to 0.1 mgd were verified and updated as needed.

Table 4 Distribution and Design Flow for Domestic Wastewater Treatment Plants by Subwatershed						
Subwatershed	**Design Flow (Q) in Millions of Gallons Per Day (mgd)**					
	10.0>Q>1.0	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.025**	**Q<0.0251**	**Total Maximum Designed Discharge**
1						0.0000
2	1			1	18	4.1390
3			1		44	0.2129
4					7	0.0400
5					7	0.0345
Total	1	0	1	1	76	4.4264
Source: NEFCO,1984, Inventory of “Package Wastewater Treatment Plants”, Summit County Department of Environmental Services and Stark County Engineer, Pers. Com., August, 1998.						

Self-Monitoring

The Ohio EPA has the authority to regulate all wastewater treatment plants, enforce water quality regulations, and review plans or permits-to-install for any new plants (Ohio EPA and Local Health Department Work Group, 1996). However, under the provisions of House Bill 110, the Ohio EPA allows contracts with local health departments to inspect, and collect fees for, package plants with design flows of 25,000 gpd or less. To protect surface and ground waters from pollutants associated with WWTPs, the Ohio EPA requires that all sanitary dischargers monitor their effluent stream for certain parameters with a frequency based on design flow, and report the results to its agency once a month.

Table 5 lists the final effluent self-monitoring requirements for WWTP owners/operators. There is one plant with a design flow greater than 1.01, but less than 10.0 mgd: Summit County Plant #91-Upper Tuscarawas (4.0 mgd) discharges to Subwatershed 2. This plant is monitored for fifteen out of sixteen parameters listed on the table, as seen in the column on the extreme left hand side. There is one WWTP with a design flow greater than 0.1 mgd and less than 0.249 mgd: Summit County Plant #48-Zelray Park (0.123 mgd) discharges into Subwatershed 3. This plant corresponds to the middle column on the table, and is monitored for all parameters except nitrates, nitrites, and turbity/odor/color. The remaining seventy-seven package plants correspond to the two columns on the right hand side of the table. These are monitored for eleven parameters, but do not include nitrates, nitrites, phosphorous, oil and grease, metals, and free cyanide (Ohio EPA, 1994a., p. 2).

Table 5 Final Effluent Self-Monitoring Requirements					
Parameter	**Design Flow (Q) in Millions of Gallons Per Day (mgd)**				
	10.0>Q>1.0	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.025**	**Q<0.0251**
Flow	Daily	Daily	Daily	Daily	Daily
Temperature	Daily	Daily	Daily	Daily	1/week
Residual Chlorine	Daily	Daily	Daily	Daily	1/2 weeks
Dissolved Oxygen	Daily	Daily	Daily	1/week	1/ week
pH	Daily	Daily	Daily	1/week	1/month
Suspended Solids	3/week	2/week	2/week	1/week	1/month
Biological Oxygen Demand (BOD)	3/week	2/week	2/week	1/week	1/month
Carbonaceous BOD	3/week	2/week	2/week	1/week	1/month
Ammonia (NH_3)	1/month	2/week	1/2 weeks	1/2 weeks	1/month
Nitrites (NO_2)	1/month	1/month	Not monitored*	Not monitored*	Not monitored*
Nitrates (NO_3)	1/month	1/month	Not monitored*	Not monitored*	Not monitored*
Phosphorous (P)	1/week	1/month	1/quarter	Not monitored*	Not monitored*
Oil and Grease	1/2 weeks	1/month	1/month	Not monitored*	Not monitored*
Bacteria	3/week	2/week	1/week	1/month	1/month
Metals, Free Cyanide	1/month	1/quarter	2/year	Not monitored*	Not monitored*
Turbidity/Odor/Color	Not monitored*	Not monitored*	Not monitored*	Daily	Daily
*Effluent is not monitored for the corresponding listed parameter as of 1997. Source: Ohio EPA, 1994a., p.2					

Table 6 lists the Ohio EPA's influent self-monitoring requirements. It indicates that the influent for 98 percent of the domestic wastewater dischargers (corresponding to the two columns on the right hand side) is not monitored. However, the influent of larger plants with a discharge greater than 0.25 mgd, is monitored for suspended solids, carbonaceous BOD, pH, metals and total cyanide, as shown in the two columns on the left hand side of the table. Plants discharging between 0.249 mgd and 0.1 mgd are required to monitor suspended solids and carbonaceous BOD (Ohio EPA, 1994a., p. 3).

Table 6 Influent Self-Monitoring Requirements					
Parameter	Design Flow (Q) in Millions of Gallons Per Day (mgd)				
	10.0>Q>1.0	1.0>Q>0.25	0.25>Q>0.1	0.1>Q>0.025	Q<0.0251
Suspended Solids	3/week	2/week	1/week	Not monitored*	Not monitored*
Carbonaceous BOD	3/week	2/week	1/week	Not monitored*	Not monitored*
pH	Daily	Daily	Not monitored*	Not monitored*	Not monitored*
Metals, Total Cyanide	1/month	1/quarter	Not monitored*	Not monitored*	Not monitored*
*Influent is not monitored for the corresponding listed parameter as of 1997. Source: Ohio EPA, 1994a., p. 3					

Table 7 lists upstream/downstream self-monitoring requirements. It indicates that the majority of all wastewater dischargers in the watershed (corresponding to the two columns on the right hand side, as mentioned) are not required to perform upstream/downstream monitoring. For comparison, the owners/operators of larger plants with a discharge greater than .25 mgd, are required to monitor upstream/downstream for pH, ammonia, temperature, bacteria, hardness, dissolved oxygen, and metals, as shown in the two columns on the left hand side of the table. Plants discharging between 0.249 and 0.1 mgd are required to monitor for all parameters listed in table 6, except for metals (Ohio EPA, 1994a., p. 3).

Table 7 Upstream/Downstream Self-Monitoring Requirements					
Parameter	Design Flow (Q) in Millions of Gallons Per Day (mgd)				
	10.0>Q>1.0	1.0>Q>0.25	0.25>Q>0.1	0.1>Q>0.0251	Q<0.0251
pH	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Ammonia (NH_3)	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Temperature	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Bacteria	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Hardness	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Dissolved Oxygen	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Metals	1/month	1/quarter	Not monitored*	Not monitored*	Not monitored*
*Upstream/downstream areas of package plant discharges are not monitored for the corresponding parameter. Source: Ohio EPA, 1994a., p. 3					

Tables 4, 5, 6 and 7 show that it is difficult to assess the cumulative impact of these dischargers on the Upper Tuscarawas River Watershed because of the lack of monitoring requirements for the majority of the plants. Even though the two WWTPs, which correspond to the extreme left hand and middle column on Tables 4-7, contribute 93 percent of the total design flow, they only represent approximately 2 percent of the total number of plants in the watershed. Plants with design flows less than 0.1 mgd represent about 98 percent of the total number of WWTPs and account for 7 percent of the design flow. These smaller plants are not required to monitor the majority of nutrients, influent, and upstream/downstream (refer to the two columns on the right hand side of Tables 5-7). Over half (57 percent) of the package plants discharging less than 0.1 mgd are located in Subwatershed 3, nearly 25 percent are in Subwatershed 2, and Subwatersheds 4 and 5 each contain approximately 9 percent (refer to Table 4).

Discussion at recent public meetings raised the issue of a proposal by Akron to supply water and sewer services to communities in the Upper Tuscarawas River Watershed. NEFCO staff believes that there may not be a significant impact to the health of streams in the watershed regarding the proposed water utility supply from the City of Akron to Springfield and Coventry Township. Some streams may even see an improvement in water quality. Loadings of pollutants downstream of the Springfield #91 wastewater treatment plant may likely be reduced, due to the tying-in of home/semi-public sewage disposal systems and small wastewater treatment plants. Providing services to these areas would eliminate many discrete points of pollution sources, in effect reducing the total load to the Tuscarawas River. The net increase in flow would be observed somewhat in Long Lake and downstream of Long Lake out of the study area.

Pollutant Loads

The above discussions on self-monitoring reveal the need to analyze the pollutant loads for wastewater treatment plants. Plants with design flows less than 100,000 gallons per day (gpd) lack nutrient, influent, and upstream/downstream self-monitoring requirements. The total design flow for such plants is 303,400 gpd. Unfortunately, there are no USGS gaging stations in the watershed to measure flow. Because of this, it is difficult to accurately tabulate the total pollutant loads.

The watershed approach to environmental planning requires that the watershed be viewed as one hydrologic unit--with inputs and outputs of surface and ground waters coming from hydrologic subunits within the watershed (and even from aquifers that extend beyond the watershed boundary). It has been shown in this report that as one hydrologic unit, the watershed has a combined treated wastewater design flow of 4,426,400 gpd. This does not include the discharge of wastewater from off-lot HSDSs. There are an estimated 4,900 of these systems in the Summit County portion of the watershed (Summit County Health Department, Pers. Com., August, 1998). Each of these systems could potentially discharge 360 gallons of treated wastewater per day (NEFCO, 1997a, p. 18). Therefore, over one and a half million gallons per day, combined, could be discharged to the watershed from off-lot HSDSs. The locations of these systems, with respect to subwatersheds, are not readily available and therefore were not included in the calculation.

For all of these reasons, NEFCO recognizes that in order to protect/maintain the water quality of the Upper Tuscarawas River Watershed, each package plant with design flows less than 100,000 gpd would need to be monitored, to the same degree that a single plant with a design flow of 303,400 gpd is monitored. Only this would allow an analysis of pollutant loads from package plants in the watershed to be accurately completed. Also the location of each off-lot HSDS in the watershed would further identify which subwatersheds are most impacted by off-lot wastewater contributions to lakes and streams.

Potential Nonpoint Source Inventory

The term nonpoint source (NPS) refers to a water pollution that results from a variety of human land uses. Nonpoint source pollution occurs during rain or snow melt events and transports pollutants, through runoff, to a lake, stream, or ground water table. Since nonpoint source discharges are a product of weather patterns, they are more sporadic and intermittent than point source dischargers (Ohio EPA, 1997, p. 26).

Sources of potential nonpoint source pollution in the watershed include mineral extraction, landfills and dumps, oil and gas drilling activity, and road salt use. The major contributors are failing home sewage disposal systems, agriculture, construction and urban runoff (NEFCO 1996, p.69). An inventory of potential NPS pollutant contributors are described below based on land use, i.e., human activity, and natural limitations such as soils.

It is difficult to pinpoint the exact source of NPS pollution, adding to the reasons why it is one of the most complex environmental problems facing Ohio today. According to the 1990 Ohio EPA State of Ohio Nonpoint Source Assessment, nonpoint sources of pollution affect over 13,000 (45 percent) of Ohio's 29,000 perennial stream miles (ODNR and Ohio EPA, 1993, p. 3)

Unsewered Areas

Figure 5 illustrates the extent of sewered areas in the watershed and proposed sewer service areas. All present unsewered areas are a potential source of NPS pollution (Ohio EPA, 1997, p. 28). More than half of subwatersheds 2,3,4, and 5 is unsewered.

Individual home sewage disposal systems (HSDSs) are used to treat domestic wastewater before returning it to surface and ground waters. There are approximately one million of these systems in Ohio. These systems can offer a reliable method for treating wastewater, however; it is estimated that 25-50 percent of a county's HSDSs could be malfunctioning or failing (NEFCO, 1997c, p.4). Malfunctions or failure of these systems can be caused by poor operation and maintenance and inadequate design or construction, which can lead to a clogged leach field, overloading of the system hydraulically or organically, short circuiting in the septic tank, aerobic system, and/or leach field. All of these problems can result in insufficient treatment of wastewater or effluent. Problems also occur from installation of the systems in highly vulnerable ground water areas, e.g., thin soils over fractured or solutioned bedrock or very sandy soils with shallow water tables (ODNR and Ohio EPA, 1993, pp. 54-55). When these systems are operating improperly they can contribute nutrients, pathogens, heavy metals, and other pollutants to the watershed (Conservation Foundation, 1987, p. 106). Untreated sewage released from many failing on-site HSDSs goes unreported. There are an estimated 8,850 on-lot systems in the Summit County portion of the watershed alone (Summit County Health Department, Pers. Com., August, 1998). On-lot HSDSs were identified as a major source of impairment to Nimisila Creek stream segments studied in Subwatershed 5 by the Ohio EPA (Appendix A).

Identification of critical areas where HSDSs are likely to fail is three-fold. First, the map of sewered areas, shown in Figure 5, shows the general area of the watershed which is unsewered and can be a potential source of NPS pollution from HSDSs. Also, subwatersheds 2 and 3 contain the most significant concentrations of residences served with HSDSs (NEFCO, 1996, p. 79). Second, residential areas over twenty years old are more likely to contain malfunctioning or failing HSDSs since the average life expectancy of a properly functioning HSDS is about twenty years.

The third element, for the identification of critical areas where HSDSs are likely to fail relates to soil types. The soils in the immediate area and adjacent to the Portage Lakes, subwatershed 3, offer extremely high porosity and permeability (NEFCO, 1996, p. 77). These soils may not do an adequate job of treatment before the wastewater reaches the limiting layer. Poorly drained soils should also be taken into consideration when identifying critical areas for HSDS failure. Such soils can be easily overloaded and will have difficulty treating all the wastewater from a household. Both quickly and slowly permeable soil types increase the probability for HSDS failure, and could contribute higher levels of nutrients and bacteria to the surface and/or ground water.

There is a potential for the areas, which contain soils conducive for HSDS failure, to contaminate wells with disease causing organisms (see Pipeline, 1996, Vol. 7, No. 3). According to an article in a 1984 EPA Journal, “Sources of Ground Water Pollution,” by David Miller, septic disposal ranked the highest in total volume of wastewater disposal and is the most frequent source of ground water contamination.

Another major concern is the inflow of nutrients to the waterway. Algal growth in response to these nutrients can upset the treatment and disinfection processes (NEFCO, 1997d, p. 27).

The non-discharging (non-mechanical) semi-public sewage disposal systems, which are like HSDS, but serve operations such as convenience stores, gas stations and offices, were identified in the watershed. Appendix B lists the operation and its address, licensee, license number, and receiving subwatershed. One hundred and fifty of these systems have been identified in the watershed. Subwatershed 3 contains the highest percentage of these systems with 53 percent, Subwatershed 2 contains approximately 31 percent, Subwatershed 4 contains roughly 8 percent, there are approximately 5 percent in Subwatershed 5, and Subwatershed 1 contains 0 percent. At least seven operations are listed as restaurants, which should be connected to a package plant or larger sewage treatment plant (NEFCO, 1997a, p. 49).

Abandoned Drinking Water Wells

ODNR and Ohio EPA (1993) states that, "Less well recognized sources of contamination such as poorly constructed and non-regulated water supply wells, and abandoned water supply wells provide a direct avenue for contaminants to enter the ground water system" (p. 27). The ground water system is hydrologically connected to the surface water of the watershed. Once it is contaminated, ground water can become a potential NPS pollution to surface water.

Areas of the watershed that depend on ground water were identified by looking at Figures 4 and 5. Figure 4 depicts different land uses taking place within the watershed. Figure 5 shows areas with central water facilities. Residential, rural, commercial and industrial areas, without central water facilities, rely ground water as the source of drinking water.

Wells that have not been sealed properly, or wells that have been sealed but were poorly constructed, can cause shallow ground water or surface water to migrate downward into the aquifer (Fetter, 1994, p. 534). Recognizing this, the Ohio Department of Natural Resources, (ODNR), Division of Water, Ground Water Resources Section, began requiring that accurate and prompt water well sealing reports were to be filed with its agency, but that just began at the beginning of this decade.

ODNR and Ohio EPA (1993) has stated that, "Abandonment problems also occur in areas where the natural water quality over time will diminish the performance of a well. Instead of cleaning an existing well to improve yield, homeowners will often have a new well drilled and will fail to properly seal the old wells" (p. 30).

Trucking Activity

Trucking companies are important factors in economic development and growth. However; the locations of trucking companies, which contain loading docks and terminal yards, and primary roads in the watershed can indicate areas for potential sources of NPS pollution. These areas encompass tracts of nearly impermeable areas. Surface water runoff can transport spilled chemical compounds from dock surfaces, terminal yards, and roads. If storm water catch basins, which have been designed to retain pollutants, are not in place down gradient from these areas, this runoff can contaminate soils, ground water and/or streams. Severe water quality impacts could be expected if BMPs to avoid, contain and clean up spills are not implemented (NEFCO 1997a, p. 29).

As far as primary roads are concerned, state and interstate highways are often considered a more serious threat for NPS pollutants. This is because the Ohio Department of Transportation (ODOT) allows the transport of hazardous pollutants along these roads. (Refer to Figure 3 for the location of state and interstate highways in each subwatershed.)

Petroleum Production Activity

Figure 6 shows the distribution of all oil and gas drilling activity on record with Ohio Department of Natural Resources (ODNR), Division of Geological Survey, for the watershed. There are a total of 524 sites, which include: wells producing oil, plugged oil wells, wells producing gas, plugged gas wells, wells producing oil and gas, plugged oil and gas wells, potential drilling locations for oil and gas exploration, plugged dry holes, brine injection wells and unknown status. Potential drilling locations include areas which are currently permitted or have been permitted for drilling activity in the past. In most cases, expired permits become re-activated.

Table 8 breaks down how many sites are in each subwatershed:

Table 8
Oil and Gas Drilling Activity in the Upper Tuscarawas Watershed

Type of Well	**Subwatershed**				
	1	**2**	**3**	**4**	**5**
Oil Well	--	1	--	--	--
Plugged Oil Well	--	--	--	--	--
Gas Well	6	9	112	20	76
Plugged Gas Well	3	11	9	7	5
Oil and Gas Well	11	23	25	61	8
Plugged Oil and Gas Well	4	2	2	4	1
Permitted Location	10	5	8	2	2
Expired Permit Location	4	4	6	11	1
Plugged Dry Hole	7	18	17	5	4
Brine Injection Well	6	--	--	--	--
Unknown Status	12	1	1	--	--

Total	**63**	**74**	**180**	**110**	**97**

Every well drilled and shown on Figure 6 and listed in Table 8 is a potential source of NPS pollution. If wells are abandoned without proper plugging, pollutants from these sources could affect the watershed's ground water and surface water. For example, in Medina County, ODNR and Ohio EPA (1993) stated that, "Some wells have begun to spontaneously repressure, flowing oil and brine to the surface and into creeks" (p. 70). ODNR and Ohio EPA (1993) also stated that, "Ohio is the only oil and gas producing state that continues to allow use of prepared clay to seal surface casing and plug wells."

If BMPs to avoid, contain and/or mop up spills are not implemented, active oil and gas wells in the watershed can spill crude oil in unrecovered amounts on land and directly into the watershed's streams. Combined or alone, these unrecovered amounts of crude oil could have a negative impact on the watershed. Spilled crude oil can disrupt terrestrial and aquatic ecosystems, damage fish and waterfowl populations, and negatively affect recreation and economic development and growth (Miller, 1988, p.349). It can cause ground water, that is pumped for drinking water supplies, to have a foul taste and odor if a spill occurs near a ground water recharge zone.

In addition to oil and gas wells, oil and gas pipelines could have a negative impact on the watershed, if BMPs are not implemented to prevent rupturing these underground utilities. Four oil pipelines, five natural gas transmission lines, and a gas storage area were identified in the watershed. Figure 7 shows the approximate locations of these pipelines and storage areas, and their owners; it is for general reference only and should not be used to locate pipelines prior to digging or other construction activities. The pipelines were mapped by ODNR, Division of Geological Survey, over a large area using long, straight line segments. Consequently, the accuracy at the township level has been reduced.

However, the pipelines map is very useful at the watershed level. It conveys that there are four oil pipelines, a twelve-inch and three six-inch diameter lines. All four of these are present in Subwatershed 2. Subwatersheds 3 and 4 each contain segments of two of the six inch lines. Subwatersheds 1 and 5 do not contain any oil pipelines. There are two twenty inch, two eighteen inch, and one six inch gas transmission lines in the watershed. Subwatershed 1 contains a portion of one of the twenty inch lines, Subwatershed 2 contains a portion of one of the eighteen inch lines, Subwatershed 3 contains segments of both eighteen inch lines and one of the twenty inch lines, Subwatershed 4 has a small portion of an eighteen inch line, and Subwatershed 5, which is where a major control point is located, contains segments of all five gas transmission lines. Gas storage areas are present in subwatersheds 3 and 5.

Given the increasing amount of development activity in the watershed, all nine of these pipelines have the potential of being hit and damaged during excavations associated with such activity. If contingency plans are not implemented by decision makers and if BMPs are not implemented, by excavators, to avoid hitting and damaging one of these pipelines, the results could be catastrophic for the watershed and its occupants. Fires, explosions and engulfing smoke clouds, could be the worst-case scenario if a pipeline were to be hit and damaged by a spark-generating piece of excavating machinery. Afterward, the resulting loss of vegetation would exacerbate mass wasting in areas of the watershed with highly erodible soils and steep slopes. The increased sediment loading to the streams and burned or unburned hydrocarbons resulting from this chain of events, would greatly reduce the streams' assimilative capacity, which would likely impact water quality in the Tuscarawas River and Portage Lakes. Ohio's "call-before-you-dig" law helps reduce the potential of an underground utility being hit. Under this law, all excavators must call the Ohio Utilities Protection Service (O.U.P.S.), an answering service for utility locating companies, forty-eight hours before they dig or pay for all damages that result from hitting an underground utility. Natural gas transmission pipelines are given high priority by underground utility locators. These lines are marked (painted and flagged) with wider margins than smaller diameter lines. The owner of the transmission pipelines are informed of the date and location of the excavation so that they can oversee it when it takes place (NEFCO, 1997a, p. 29).

Underground Storage Tanks

Underground storage tanks (USTs) are used to store fluids for large industries, small businesses, farmers, and individual homeowners. Industries frequently store fuel, acids, metals, solvents, chemicals, and chemical wastes in USTs. Because such underground storage reduces worker exposure, plant clutter, and fire hazards, they are the most common form of storage for petroleum products at gas stations, plant sites, airports, and other areas where large volumes of fuel or other petroleum products are used. Many existing underground tanks are made of carbon steel and are not protected from corrosion. These steel tanks can range in size up to 10,000-gallon service station tanks and 50,000-gallon industrial tanks. The life expectancy of a steel underground storage tank is 15 to 20 years. Therefore, the rapid increase in the use of such tanks that began in the mid 1900s may be followed by an increasing problem of leaking tanks (Conservation Foundation, 1987, p. 131).

Regulations concerning USTs, which include reporting of leaking tanks, began in the late 1980s to protect human health and the environment. Fifty-one underground storage tanks were identified in the watershed from the Bureau of Underground Storage Tank Regulations' (BUSTRs) leaking underground storage tank (LUST) database files. Figure 8 shows their locations in the watershed. Almost half of these (45 percent) are located in Subwatershed 3. Subwatershed 5 contains almost 20 percent, and the remaining subwatersheds contain approximately 10 percent. Appendix C lists the facility name and address, facility identification number, priority, status of the USTs, (i.e., a confirmed release vs. a suspected release), class, last update, and eligibility of the incident for oversight and/or spending through the LUST Trust Fund (LTF) (see Appendix C for details).

In addition to LUST database files, BUSTR also has database files for regulated underground storage tanks (RUSTs). Often these regulated tanks have leak detectors or ground water monitoring wells, so as to lower the potential of a UST becoming a LUST, should a release of contaminants occur.

<u>Note:</u> BUSTR's rules were being revised at the time that this report was being written. They were expected to go through a formal review process starting September 1998. The final revised rules were not expected until about Spring 1999. Under the proposed rule changes, a site needing "no further action (NFA)" may have higher levels of contaminants present than the original rules allowed (BUSTR, Pers. Com, August 1998).

<u>Gasoline Use, Storage and/or Transportation</u>

As indicated earlier in this report, gasoline is often stored beneath the surface in underground storage tanks. Such tanks have a potential to corrode and leak their contents to surface and/or ground water.

Transportation of gasoline is also a potential NPS of pollution, due to leaks or spills, which can be transported to waterways through runoff events. The impact of gasoline transportation in the watershed can be assessed by looking at the location of roads, state routes, and interstate highways and their proximity to streams and lakes (Figure 3). Interstate 77 travels through all subwatersheds except 5. Interstate 277 travels through parts of Subwatersheds 1 and 2. Portions of State Routes 261, 59, and 764 are located in Subwatershed 1. State Route 224 travels north/south through Subwatersheds 1, 2, 3 and 5. State Route 241 also flows north/south and is located in portions of Subwatersheds 2, 4, and 5. State Route 619 travels east/west through Subwatersheds 2, 3, and 4. State Route 91 travels north/south through Subwatersheds 2 and 4.

<u>Agricultural Areas</u>

Runoff from agricultural areas in the watershed is a potential source of sediment, organic wastes, nutrients, pesticides, and herbicides. The tendency for agricultural pollutants to adversely affect water quality depends on soil properties, the pollutant characteristics, weather conditions, and farming practices.

Figure 4 illustrates that portions of Subwatersheds 2, 3, 4, and 5 contain agricultural land use areas. However, as the watershed continues to become more urbanized, agricultural areas are being converted to single family, recreational, commercial, or industrial use. This is gradually decreasing the impacts of agriculture on the watershed. Pollution associated with agriculture, such as sediment, is most likely being deposited in upstream lakes along the Tuscarawas River and tributaries to the Portage Lakes (NEFCO, 1996, p. 78).

<u>Construction Sites</u>

Construction sites are considered potential areas for NPS pollution because of sediment runoff into waterways. Excess sediment can cause volume loss in lakes and streams, increase the turbidity of the water, and smother fish spawning beds. Soil particles can also bind to other contaminants such as heavy metals and nutrients, thus transporting them into surface water. According to a Wisconsin Department of Natural Resources study, a stream's typical suspended sediment load is composed of sediments it receives from construction sites at the rate of about 4.4 tons/acre/year. Whereas, the next highest source of sediment--agricultural land in row crops without any BMPs that would ameliorate sediment yield--contributes about 1.7 tons/acre/year (ODNR and Ohio EPA, 1993, p.79). (Wisconsin and northeast Ohio have similar geomorphology).

Since the watershed is situated between the City of Akron and the City of Canton, there is a high potential for growth as urban sprawl continues. Subwatersheds 2,3,4, and 5 have experienced rapid rates of development during the past ten years. In fact, land development/suburbinization was listed as a source of impairment to studied stream areas along Metzger's Ditch in Subwatershed 4 (Appendix A). Present land use/land cover associated with agricultural, wooded/wetland, and open land/urban park (Figure 4) has the possibility for future development.

Active construction sites were identified through the Summit and Stark Soil and Water Conservation Districts (SWCDs). Portage County does not have any active construction sites in the watershed at this time. Table 9 lists the location, name of site, size, and start date on file for each subwatershed. All of these sites have Storm Water Pollution Prevention Plans (SWPPPs), in accordance with the requirements of the Clean Water Act. These plans utilize BMPs to ameliorate soil erosion, transport, and deposition. The SWCD SWPPPs' goal is to prevent as much sediment as possible from entering the watershed; however, there are limitations of the various BMPs utilized. For example, silt fences are designed to catch 75 percent of the sediment, whereas sediment basins can catch 90 percent. Proper installation and maintenance are also important to a particular BMP's success.(Summit SWCD, Pers. Com., January, 1999).

Table 9
Active Construction Sites in the Upper Tuscarawas River Watershed with Storm Water Pollution Prevention Plans (SWPPPs)

Subwatershed	Location	Name of Site	Size (Acres)	Start Date
2	City of Green	Camden Ridge	17.0	09/03/97
2	Springfield Twp.	Rolling Meadows Estates	53.0	05/30/97
2	Springfield Twp.	Terminal Warehouse Incorporated	16.0	05/14/98
2	Lake Twp.	Greentree Allotment	107.0	N/A
2	Lake Twp.	Glenwood Country Estates	10.0	N/A
2	Lake Twp.	Cricket Crossing	32.0	N/A
2	Lake Twp.	The Boroughs	43.3	N/A
3	City of Akron	Villages at Coventry	150.0	N/A
3	Coventry Twp.	Manchester Road Property	1.0	06/02/98
3	Coventry Twp.	Salt Wells	1.0	03/11/98
3	City of Green	Robins Trace	99.0	05/20/98
3	City of Green	The Estates at Meadow Wood	22.0	06/04/98
3	City of Green	Hyde Park Subdivision	102.0	10/15/94
3	City of Green	The Terraces on the Green	29.0	08/13/97
4	City of Green	Mystic Pointe	171.0	10/09/96
5	Jackson Twp.	Cedar Grove	13.0	N/A
5	Jackson Twp.	Portage Glen	24.2	N/A
5	Jackson Twp.	Marks Driving Range	14.0	N/A
Source: Summit Soil and Water Conservation District and Stark Soil and Water Conservation District, 1998				

Table 10 lists the total acres currently under construction for each subwatershed with Storm Water Pollution Prevention Programs.

Table 10 Total Number of Acres Under Construction in the Upper Tuscarawas River Watershed with SWPPPs	
Subwatershed	**Total Acres Under Construction**
1	0.0
2	278.3
3	301.0
4	171.0
5	51.2
Source: Summit Soil and Water Conservation District and Stark Soil and Water Conservation District, 1998	

In addition to the active construction sites included above, a future area of development is planned for an area just east of Dollar Lake, in Coventry Township (Subwatershed 3). This 80 acre site is designed for condominiums, apartments and cluster housing. There are an additional 35 acres of wetlands, owned by the same entity, which are not planned for development. Due to the close proximity of this proposed development to Dollar Lake and Feeder Race, it is recommended that appropriate sediment control measures be implemented.

Subwatersheds 2 and 3 contain the most area under construction at this time. However; Subwatersheds 4 and 5 have areas desirable for future development; therefore are likely to have considerable construction sites in the future.

Impervious Areas

Impervious areas in the watershed are those areas where vegetation has been replaced by nearly impermeable surfaces, such as roads, sidewalks, parking lots, and roof tops. The conversion of open space to residential and commercial use has occurred in almost 60 percent of the acreage noted to have changed land use from 1979 to 1990 (NEFCO, 1996, p. 80). As these are converted, the level of impervious cover increases and prevents the infiltration of water into the soil. This can reduce ground water recharge, exacerbate runoff and stream bank erosion, and impact the natural aquatic community. Research indicates that stream degradation occurs at levels of imperviousness as low as 10 percent (Ohio EPA, 1997, p.27). The location of residential and other urbanized areas, as well as roads, in the watershed indicate where a high degree of impervious surfaces are found (Figure 4).

Impervious areas can also be the source of a magnitude of pollutants, since gasoline, oil, and chemical spills are likely to occur on impervious surfaces, such as: trucking docks and yards, gasoline stations, and roads. The possibility of urban runoff/storm sewers to effect water quality has been documented in the Ohio EPA's 305b report (Appendix A). They were considered a primary or major source of impairment to monitored stream segments of the Tuscarawas River.

Golf Courses

A golf course can be a potential source of NPS pollution to surface and ground water if fertilizers, pesticides and herbicides, which keep the greens artificially green, are not applied in moderation and at appropriate times, hours before it rains. Seven golf courses were identified in the watershed. All of these are located in Summit County. Subwatershed 2 contains three golf courses: Firestone Raymond C., Chenoweth, and Firestone Country Club. One Firestone golf courses is located to the north, and the other to the south of the Firestone Reservoir. Turkeyfoot golf course is located in Subwatershed 3 directly north of Mud Lake. Subwatershed 4 contains three golf courses, which are all located in close proximity to streams: Mayfair, Ohio Prestwick, and Raintree. The close proximity to lakes and streams may raise the potential for these operations to be a source of NPS pollution to the watershed. Phone conversations with the majority of these golf courses indicate that most of the greens keepers were using some form of integrated pesticide management (Pers. Com., July 1998).

Nurseries/Greenhouses and Landscaping Operations

For the same reasons as stated above for golf courses, nurseries/greenhouses and landscaping operations can be potential sources of nutrients, pesticides and herbicides. Washing mobile spraying equipment can be an additional source of NPS pollution from the operations.

Twelve nurseries/green houses and/or landscaping operations were located in the watershed. Table 11 lists their name and address, and location by subwatershed.

Table 11
Nurseries/Green Houses and Landscaping Operations in the Upper Tuscarawas River Watershed

Name and Address of Operation	Location (Subwatershed)
Mary's Garden Center 1008 Brown St. Akron, OH 44301	1
Cardinal Tie Inc. 190 W. Waterloo Rd. Akron, OH 44319	1
Arlington Greenhouse 2129 S. Arlington St. Akron, OH 44306	2
Waples 3235 Sherbrook Dr. Uniontown, OH 44685	2
Metker-Ech Inc. 1421 Edison St. NW Hartville, OH 44632	2
K & S Greenhouse 60 W. Turkeyfoot Lake Rd. Akron, OH 44306	3
Earth 'N Wood Landscaping Supply 1818 S. Arlington Rd. Akron, OH 44306	3
Donzell's Flower and Garden Center 937 E. Waterloo Rd. Akron, OH 44306	3
Hoffman's Garden Center 10211/2 E. Caston Rd. Uniontown, OH 44685	3
Delbert Smith Inc. 12777 Mogadore Ave. NW Uniontown, OH 44685	4
MD Bolin & Associates 153 Spruce Dr. North Canton, OH 44720	5
Earth 'N Wood Products 5335 Strausser St. NW North Canton, OH 44720	5
Source: Summit County Farm Bureau, 1998 and Ameritech Yellow Pages Website (http://yp.ameritech.net).	

In addition to the operations listed above, a sod farm was identified directly to the east of Myersville Creek and just south of State Route 619. It has been proven to be contributing pesticides to Myersville Creek (Ohio EPA, Pers. Com., August 1998).

If vegetated buffer strips are in place down gradient they can assimilate some of these pollutants, but ground water contamination is still at risk from pesticides and herbicides. Operations relatively close to lakes and streams may raise its potential to be a source of NPS pollution to the watershed.

Lawn and Garden/Household Maintenance

Homeowners, in the watershed, using pesticides, herbicides and fertilizers to keep their yards artificially green and bug-free, can have a negative impact on ground water and surface water quality--if these chemical compounds and nutrients are not used with care and moderation. Pesticides and herbicides can soak through the ground and contaminate ground water, which most of the watershed relies on for a drinking water source. They can also be transported by runoff to streams, especially when it rains shortly after they are applied, and biologically amplify in food chains. Also, some undesirable insects and plants may become immune to a manufacturer's recommended dosage of a pesticide or herbicide, causing larger and larger doses to be needed and subsequently added to the watershed.

Fertilizers, if used in excess near the proximity of surface water, can add unwanted nutrients to streams. Excess nutrients in water can cause algae blooms and, thereby, increase the biological oxygen demand (BOD) in a stream. This reduction in oxygen may cause fish kills and reduce a stream's ability to assimilate other pollutants (NEFCO, 1997a, p. 44).

Spills associated with pesticide and herbicide use could occur frequently in the watershed, but the size of the spills are not large enough to be reportable by law (Ohio EPA, 1996, p.27). Most of these small spills by homeowners, therefore, go undocumented.

Some of these spills are accidental, but others occur intentionally simply because the spilled material is classified as household hazardous waste, which cannot be picked up by sanitary waste haulers. In the past, it has been easier and less expensive for the homeowner to dispose of household hazardous waste, such as paints, solvents, used motor oil, tires and batteries, on his/her own property. These items were usually, but unlawfully, dumped or buried in the soils behind a garage or barn, or perhaps down a storm sewer (NEFCO, 1997a, p. 44). In Summit County most or all of these items can be recycled at the Solid Waste District's household hazardous waste center in Stow.

Fuel Oil Use

The transport of fuel oil and above-ground storage tanks, containing fuel oil used for heating homes, are also potential sources of NPS pollution in the watershed. Unless BMPs, to avoid, contain and mop up fuel oil spills, are implemented, fuel oil use can contribute, significantly, to the impact of NPS pollution in the watershed (NEFCO, 1997a, p. 39).

Areas in the watershed lacking natural gas service were identified by the Central Locating Service in Akron. This service locates utilities for the "call-before-you-dig" law. These areas would have a higher potential for fuel oil use. The only area identified was the southwest portion of Subwatershed 3, including Franklin Township and the western portion of the City of Green around Turkeyfoot Lake and Nimisila Reservoir.

Salt Storage and Seasonal Spreading of Salt

The heavy application of deicing salt, as well as improper storage, can contribute to surface and ground water contamination. The salts are washed off roads with snow melt and can flow into surface water or seep into ground water. Chloride levels of 1,000 to 25,000 mg/l have been documented in road runoff (Conservation Foundation, 1987, p. 162).

Five salt storage sites were identified in the watershed. All of these sites are located in a covered area, such as a shed, to protect it from the elements and to minimize runoff. Table 12 lists the subwatershed, community, and street address location for each identified site, in addition to the average amount stored per month.

Table 12
Salt Storage Sites within the Watershed

Subwatershed	Community	Street Address	Average Amount Stored/Month (Tons)
2	Lake Twp.	12360 Market St. Hartville	75
3	Summit Co.	1405 Boettler Rd. Uniontown	500
3	Portage Lakes State Park	5031 Manchester Rd. Akron	2
3	Coventry Twp.	65 Wymore Dr. Akron	100-150
5	Green City	5383 Massillon Rd	75

Source: NEFCO, 1987

Transportation areas, e.g., roads and parking lots, are locations where large applications of road salt occurs during the winter months. High traffic roads, such as state and interstate highways, are prime targets for deicing efforts.

The application of road deicing salts can increase the salinity (dissolved solids) of surface and ground waters. High levels of dissolved solids can affect the taste and sodium content of drinking water (NEFCO, 1997a, p. 56). And, Ohio EPA (1997) states that, "High concentrations of salts can inhibit aquatic plant growth and have an adverse effect on aquatic life" (p. 33). This indicates that salt storage sites and transportation areas can be potential sources of NPS pollution to the watershed if BMPs are not implemented to minimize the release of its contents to the environment.

Polychlorinated Biphenyls (PCBs) Use

PCBs are mixtures of about 70 different, but closely related, chlorinated hydrocarbon compounds that are used/have been used in electrical transformers and capacitors. They enter the environment when transformers or capacitors leak, catch fire, or explode. Miller (1988) has stated that PCBs are insoluble in water, soluble in fats, and very resistant to biological and chemical degradation; thus they are biologically amplified in food chains. Even the healthiest of streams can have difficulty assimilating PCBs.

Hazardous levels of PCBs have resulted in fish consumption advisories by the Ohio Department of Health (ODH) for three areas of the watershed. High levels of PCBs were detected in fish tissue samples taken from the Ohio Canal, Lake Nesmith, and Summit Lake. A fish consumption warning, due to PCBs and Hexachloro-benzene, was also placed on a portion of the Tuscarawas River, just outside of the watershed, between Barberton and New Philadelphia. Refer to Appendix D for a listing of ODH Fish Consumption Advisories for the watershed.

While the exact location of PCBs sources have not been identified in the watershed, they are recognized as potential causes of nonpoint source pollution.

Mining Activity

Active mining in the watershed consists of sand and gravel open-pit operations. Aerial photos from 1995 and 1997, in addition to conversations with members of the local community, indicate that two such operations are present in the watershed. One operation is located at the northern tip of Subwatershed 4, on both sides of Myersville Creek, another is located in Subwatershed 5-southeast of Willowdale Lake on Nimisila Creek.

Active sand and gravel operations can be a source airborne sediments, and sediments transported by runoff, if BMPs to keep dust contained are not implemented.

The Ohio Department of Natural Resources, Division of Mines and Reclamation, topographic maps, and previous NEFCO reports (1985) identified several previous sand and gravel mining areas in Subwatersheds 2, 3, 4, and 5. Some abandoned pits could now be small ponds and lakes if they were abandoned when the water table was an impediment to the operation. These ponds and lakes would be hydrologically connected to ground water; they, or the abandoned equipment that they may contain, can be a source of NPS pollution, such as sediments and hydrocarbons, to ground water (NEFCO, 1997a, p. 54).

Clusters of abandoned coal mines were noted by NEFCO (1985) to the east of East Reservoir and Mud Lake. So far, drainage from these mines does not seem to be impacting water quality of inflowing streams (NEFCO, 1996, p. 76).

Industrial Land Use Areas

Active or abandoned industrial areas are considered potential areas for nonpoint source pollutants due to the use and disposal of a wide range of chemicals and other contaminants, which could impair surface or ground water quality.

Twenty-five active industrial operations were identified within the watershed boundary. Table 13 lists the name, address, and location by subwatershed for these operations.

Table 13 (cont.)
Active Industrial Operations in the Upper Tuscarawas River Watershed

Name and Address of Operation	City/Township	Location (Subwatershed)
Akron Polymer Lab 1080 S. Main St.	Akron	1
*Bridgestone/Firestone Inc. 1200 Firestone Pkwy.	Akron	1
*Goodrich B.F. (Chemical Division) 240 W. Emerling Ave.	Akron	1
*Hamlin Steel Products 2741 Wingate Ave.	Akron	1
Ohio Mechanical Handling Co. 1856 S. Main St.	Akron	1
*Hartville Ready Mix 1460 Edison St. NW	Hartville	2
Hinds Co. 2884 Killian Rd.	Springfield Township	2
Hinds Co. 2410 Massillon Rd.	Springfield Township	2
*Killian Latex 2064 Killian Rd.	Springfield Township	2
Modern Day Enterprises Inc. 708 Killian Rd.	Akron	2
NRM Extrusion 2542 S. Arlington Rd.	Akron	2
*Pressler Meats 2553 Pressler Rd.	Springfield Township	2
Pro-Fab Inc. 2570 Pressler	Springfield Township	2
Pioneer Plastics Corp. 3330 Massillon Rd.	Green	2

Table 13 (cont.) **Active Industrial Operations in the Upper Tuscarawas River Watershed**		
Universal Plastics 2587 S. Arlington Rd.	Akron	2
Akron Steel Fabricators Co. 3291 Manchester Rd.	Coventry Township	3
*BP Weaver Woodland Maywood & Kaylin Dr.	Franklin Township	3
Elastomer Enterprises/Empire Corp. 1946 Trapas Ave.	Akron	3
HM Design 3681 Manchester Rd.	Coventry Township	3
Industrial Rubber Machinery Inc. 503 Portage Lakes Dr.	Akron	3
Goodyear Industrial Products 3700 Massillon Rd.	Green	4
Machinery Exchange 3700 Massillon Rd.	Green	4
McAfee Tool & Die Inc. 1717 Boettler Rd.	Green	4
Goodyear Tire & Rubber Co. Airsprings Plant 2575 Greensburg Rd.	Green	5
Akron-Canton Regional Airport	North Canton	5
*Listed as an Industrial Direct Discharger (Process and Storm Water) with the Ohio EPA, August, 1998.		
Source: Ameritech Yellow Pages and Website (http:// yp.ameritech.com) and Ohio EPA, 1998.		

The Ohio EPA Division of Emergency and Remedial Response (DERR) has developed a database, referred to as the Master Sites List (MSL), to list and track DERR sites since 1988 and to manage program resources. The list is comprised of sites in Ohio where there is evidence of, or it is suspected that waste management has resulted in the pollution of air, water or soil and there is a confirmed or substantial threat to human health or the environment. These sites include operating or abandoned industrial facilities, contaminated or potentially contaminated public water supplies with the source of pollution undiscovered, or other locations where the environmental media is contaminated through a variety of waste management activities. Contaminated sediments were considered a slight or minor source of impairment to assessed segments of the Tuscarawas River (Appendix A). This may be due, in part, to the three sites on the MSL in close proximity to the Tuscarawas River.

Table 14 lists sites on the MSL in the watershed as of 01/01/97.

Table 14
Areas in the Upper Tuscarawas River Watershed on the Master Sites List (MSL)

County	Sitename and Address	USEPA ID#	Ohio ID#	*Type	Subwatershed Location
Summit	Firestone Tire & Rubber Co. 1200 Firestone Pkwy. Akron, OH 44317	OHD001288109	277-0302		1
Summit	Lockhart HB Const. Co. 800 W. Waterloo Rd. Akron, OH 44314	ODH002948347	277-0470		1
Summit	Barberton Aluminum & Metal Co. (SIA) 753 W. Waterloo Rd. Barberton, OH 44203	OHD980421572	277-0081		1
Summit	Summit Equipment and Supply Inc. 875 Ivor Ave. Akron, OH	OHD055523401	277-0778	A	1
Summit	Gastown Unit #3692/ Unknown Source 3540 S. Arlington Rd. Akron, OH 44312	Not Assigned	277-1311	W	2
Summit	Tru-Cast Products 2128 Killian Rd. Springfield Twp. 44312	OHD003452992	277-0826		2
Summit	Archmere Dr. a.k.a Rubber City S&G Archmere Dr. Akron, OH 44319	OHD980611883	277-0050	A	2
Summit	Kim Tam S.R. 91 Uniontown, OH 44685	Not Assigned	277-1119		2
Summit	Weaver Woodlands/ Franklin Twp. Maywood & Kaylin Dr. Franklin Twp. 43216	Not Assigned	277-1207	A	3
Stark	Industrial Excess Landfill (IEL) 1 mi. South of S.R. 619 & Cleveland Ave.	OHD000377911	276-0416	AN	4

*Type - Indicates if a site is Active (“A”), a Contaminated Public Water Supply (“W”) and/or a site on the federal National Priorities List (“N”). A site can be more than one type or none (indicated by a blank field).
Source: Ohio EPA website (http:www.epa.ohio.gov/derr/cres/msl.html).

A total of ten sites were located within the watershed. Subwatershed 1 contains four sites and Subwatershed 2 contains four sites. Subwatersheds 3 and 4 each contain one site on the MSL. Appendix E contains a brief description of the MSL.

The U.S. EPA has proposed a cleanup plan for the Summit Equipment and Supply site in subwatershed 1. This site was once a former scrap and salvage yard and is located west of Nesmith Lake. The proposed plan calls for: soil excavation, removal, and disposal of contaminated soils with high levels of PCBs, mercury, and copper; long-term monitoring of the site for toxic volatile organic compounds and heavy metals; ensuring that no wells are drilled on the site or nearby due to aquifer contamination; and allowing chromium on the property to degrade naturally to a less toxic and mobile form. The site is being managed by the Department of Defense because it was the source of 80 percent of the transformers that caused the PCB contamination. Nine other polluters are also being held liable for the cleanup.

Landfills and Dumps

Older sanitary landfill sites and open dumps were often unlined and uncovered and probably located without consideration to the potential water quality problems they could create. Percolation of leachate from landfills is inevitable unless the site is completely sealed so that no moisture enters. Heavy metals, pathogens, and other hazardous constituents can be included in the leachate.

Illegal disposal of unconfined quantities of hazardous or nonhazardous wastes ("midnight dumping") can also pose a continuous and uncontrolled threat to surface and/or groundwater (Conservation Foundation, 1987, p. 118).

Active or inactive landfills and dumps identified within the watershed include: solid waste and construction and demolition debris (C&D) landfills, in addition to industrial and scrap tire dumps. Table 15 lists the address, Political Subdivision (PSD), type of facility and waste, location by subwatershed, along with facility name, owner of record, size, and dates of operation, if available.

Adding to the operations identified in Table 15, a fly ash and tire debris dump is reported for a section of the Ohio Canal near Waterloo road (Akron City Health Department, Pers. Com., August, 1998). A septage land application site is also located on a farm at the end of Aqua Dale Drive in Green, in Subwatershed 3.

An initial clean-up, through the Coventry Township Solid Waste Management Authority Office, is proposed to take place in the next one to two years for the scrap tire dump on Manchester Road. If tire dumps catch fire they can produce pyrolytic oil runoff and pollute the environment (Summit County Health Department, Pers. Com., August, 1998).

Table 15
Active/Inactive Landfills and Dumps in the Upper Tuscarawas River Watershed

Facility Name and Address	PSD	Owner/ Operator of Record	Type of Facility	*Waste Types	Size (in Acres)	Subwatershed Location	Dates of Operation/ Status
Archmere Dr. Dump 2441 Mallard Rd.	Springfield Twp.	Summit County	Solid Waste	C&D, M, H	N/A	2	? - 1965/Inactive
1940 Tisdale Dr.	Green	N/A	C&D	C&D	N/A	2	?/Inactive
Coventry Twp. Dump N. Turkeyfoot Rd., NE of Vaughn Rd.	Coventry Twp.	Coventry Twp.	Solid Waste	M	N/A	3	?-1963-?/Inactive
245 Portage Lakes Dr.	Coventry Twp.	N/A	Solid Waste	M	N/A	3	N/A
1130 Kingston Rd.	Green	Ron Hoover	C&D	C&D	<2.0	3	?/Inactive
2368 S. Main St.	Coventry Twp.	Norton Salt	C&D	C&D	<1.0	3	?/Inactive
2977 Manchester Rd.	Coventry Twp.	Buckley Auto Wrecking	Scrap Tire	Tires (30 - 50K)	N/A	3	?/Inactive
780 E. Waterloo Rd.	Coventry Twp.	Lightener Tire	Scrap Tire	Tires (4 - 6K)	N/A	3	?/Active
Industrial Excess Landfill NE corner of Cleveland Ave and south of S.R. 619	Lake Twp.	N/A	Solid Waste, Industrial Waste	M, H,	~35.0	4	1962-1980/ Inactive
3046 Myersville Rd.	Green	Rubber City Sand & Gravel	C&D	C&D	2.0	4	?/Inactive
2632 E. Turkeyfoot Lake Rd.	Green	Paul Bailey	C&D	C&D	2.0-3.0	4	?/Inactive

Source: Summit County Health Department, Environmental Health Division, 1998 and Ohio EPA, Pers. Com., August, 1998

As far as landfills and dumps are concerned, it is suspected that the Industrial Excess Landfill (IEL) poses the greatest threat to water quality in the watershed. It was designated a federal Superfund site in 1984. The knowledge of explosive methane gas and groundwater contamination just west of the site contributed to a high hazardous ranking score and the placement of the IEL onto this priority list. Following this action, the government purchased thirteen homes, which were considered impacted by the IEL. Current ground water conditions do not demonstrate the presence of organic contamination off-site. Recent ground water sampling has been performed to determine whether previously detected inorganics are artifacts of sampling methodologies, or represent a portion of the actual contaminant load at the site.

The roughly 35 acre area was once a sand and gravel pit before it became a landfill in 1962. The landfill was originally used to dispose of fly ash, which is known to be high in trace metals. It has been reported that solid waste was also disposed of at the IEL. Liquid and drummed waste from industrial operations were discarded during the final years of the landfill's operation, until it closed in 1980.

It hasn't been demonstrated, but it is suspected that the landfill has a potential to impact surface water. The Ohio EPA 305b report (Appendix A) indicated that landfills were identified as both a major and threatening source of impairment to studied segments of Metzger's Ditch. The IEL is located just west of this stream and is the only landfill identified which is in close proximity to this stream. Larry Antonelli, with Ohio EPA's Division of Emergency and Remedial Response, does not believe that contaminates would be concentrated enough to affect the health of the Tuscarawas River. He does believe there is the possibility of ground water discharge to surface water at locations along Metzger's Ditch (Myersville Creek). The landfill sits roughly four feet above the water table in some areas.

A waterline was completed in 1991 to serve over one hundred households west of the dump after low-level contamination was found in some wells. The system was later expanded by Stark County, although only 60 percent of the households have tied into the alternate water supply. Ground water sampling over a year ago by the EPA revealed aluminum, iron, manganese, and thallium in monitoring wells off the site. These metals were found in levels that exceed federal health advisory standards. However, these metal species have secondary maximum contaminants levels (SMCLs) which are non-enforceable and correspond to aesthetic ground water quality. A new round of water testing will be performed by the companies being held liable for the clean-up. An estimated 55 locations will be sampled from ground water monitoring wells on and near the IEL. In addition, the U.S. EPA may test a few residential wells west of the dump. The testing will concentrate on the detection of metals and organic contaminants.

Regional ground water flow is from east to west. Ground water mounds have been identified to the north and southeast of the IEL. These mounds exhibit radial flow conditions; however, USGS has confirmed these local flow conditions are quickly overtaken by the kinetics of the east to west regional flow.

The Concerned Citizens of Lake Township (CCLT) is a grassroots group, which was organized in response to concerns from local residents regarding the risks associated with the assistance and clean-up of the IEL. Chris Borello, the president of CCLT, has been closely involved with IEL-related issues for fifteen years. It is her belief that radiation is present at the landfill, however; the Ohio EPA, USEPA, ATSDR, and the ODH disagree. The Ohio EPA believes that the most threatening contaminants to the water quality near the IEL include benzene, which was detected on-site at levels above the maximum contaminant level as mandated by the Federal Safe Drinking Water Act. Thallium, aluminum, and cadmium are also considered contaminants of concern by the EPA and have been detected in off and on-site groundwater samples. So far, no comprehensive study has been conducted to determine whether exposure to the landfill has caused health problems to the roughly 27,000 people who live within three miles of the IEL.

If the 1989 Record of Decision (ROD) by the USEPA is implemented without changes, millions of gallons of water will be pumped from beneath the IEL site and discharged into Metzger's Ditch (Myersville Creek) after treatment. The ROD requires the responsible companies to pump the contaminated water to the surface, where contaminants would be removed and the treated water would then be discharged into surface water.

The agencies are looking into ways to prevent further contamination of ground water by deterring rainwater from filtering into the buried waste and migrating to the water table. The construction of a clay cap and geosynthetic combination over the site has been proposed. An active methane gas venting system is in effect and expansion of this system is also up for discussion (Ohio EPA, Pers. Com., August, 1998).

Boating Activities

If motorized watercraft are not properly maintained, fuel leaks can discharge pollution directly into lakes and ponds. Heavy boating activity on lakes can also contribute to pollution by eroding unprotected shorelines. Plant biomass may be impaired through direct cutting and uprooting by scouring the sediment surface (Asplund, T.A. and C.M. Cook, 1997). Boating activity can also resuspend lake sediments, which decreases water clarity and, under specific conditions, releases pollutants originally bound to soil particles (Hansen, P.S. et. al., 1997).

A survey of the Portage Lakes revealed that heavy boating-use lakes did show some severe erosion on exposed shores. However, shoreline erosion was minimal for most parts of the lakes, with the majority of the lakes having some sort of protection along at least part of its shores. Types of protection identified included rip rap, retaining walls, and natural emergent vegetation (NEFCO, 1996 p. 55-63).

Nutrients from Natural Sources

Domestic animal and waterfowl feces can contribute to nutrient enrichment of lakes and streams. This can lead to excessive algal blooms resulting in oxygen depletion and fish kills.

The largest likely contributors to this problem are Giant Canada Geese, which have become the number one source of animal complaints in the Northeastern United States. The nuisance goose problem is caused, in part, by the expansion of favorable habitat--suburbia. The abundance of short, tender grass for grazing and habitats free of predators has allowed geese populations to rise. Lawns abutting a body of water are especially attractive to geese. Problems can be alleviated by planting tall trees, hedges, or tall grasses around the body of water (Moore, M. V., et al., 1998).

Conclusion

There are a wide variety of potential pollution sources in the watershed. Seventy-nine wastewater treatment plants and package plants are the primary point sources. The greatest combined flow of discharged wastewater from these plants occurs in Subwatershed 2. There are an estimated 4,900 off-site home sewage disposal systems (HSDSs) in the Summit County portion of the watershed. These can also be considered point sources, but their locations are very difficult to pinpoint. This makes determining their water quality impacts difficult.

The total pollutant loads contributed by the package plants in the watershed cannot be tabulated because adequate flow measurements are not available, and the majority of the plants have design flows less than 250,000 gallons per day (gpd). Only package plants with design flows above 250,000 gpd are monitored comprehensively. One way to get an accurate count of the pollutant loads is to require that all package plants in the watershed be monitored to the same degree that plants with design flows greater than 250,000 gpd are monitored.

Major sources of potential nonpoint source (NPS) pollution in the watershed are directly related to land use (human activity). Unsewered areas; abandoned drinking water wells; trucking activity; petroleum production activity; underground storage tanks (USTs); gasoline use, storage and/or transportation; agricultural areas; construction sites; impervious areas; nurseries/greenhouses and landscaping operations; lawn and garden/household maintenance; golf courses; fuel oil use; salt storage and seasonal spreading of salt; polychlorinated biphenyls (PCBs) use in electrical transformers; mining activity (past and present); industrial land use areas; boating activities; landfills and dumps; and nutrients from natural sources are all potential sources of NPS pollution in the Upper Tuscarawas River Watershed.

The majority of the watershed is unsewered. There is a very high potential for unsewered areas to be a source of untreated/poorly treated sewage, which contain nutrients and disease-causing organisms, when home sewage disposal systems fail.

NPS pollution from producing and plugged oil and gas wells can have a negative impact on the entire watershed. Additionally, trucking activity, fuel oil use, gasoline use, and underground storage tanks can contaminate the soils, surface water and ground water. Lawn and garden/household maintenance, though poorly documented, can be a source of nitrogen-phosphorus-potassium (N-P-K), pesticides, herbicides and household hazardous waste throughout the watershed.

Agricultural areas in the watershed can also be potential sources of N-P-K, pesticides, herbicides, organic wastes and associated disease-causing organisms. However, the impact of agricultural areas is gradually decreasing as agricultural areas are converted to single family, commercial, or industrial areas.

Construction sites can contribute sediment loadings to nearby lakes and streams through runoff events, and degrade water quality in streams or lakes. Heavy metals and nutrients can bind to soil particles and travel to the waterway along with sediment. Subwatersheds 2, 3, 4 and 5 are experiencing rapid rates of development as urban sprawl continues.

Impervious areas can facilitate the transportation of spilled pollutants and exacerbate runoff problems. All of the parking lots, roads, highways and state/interstate highways in the watershed are impervious areas. Subwatershed 1 contains the highest percentage of impervious area.

Other lesser known potential sources of NPS pollution in the watershed include abandoned and active sand and gravel mining operations, which can be a source of sediments and other pollutants; salt storage sheds, which can be a source of sodium (dissolved solids); and golf courses and nurseries, which can all be sources of N-P-K, pesticides and herbicides. Also, abandoned water wells, which can be a source of any pollutant that migrates down the annular space between the borehole and the casing and/or falls directly down the well, can be potential sources of NPS pollution (NEFCO, 1997a, p. 58).

Industrial land use areas, landfills and dumps can contribute a variety of chemical wastes to the watershed. These substances pose serious threats to water quality if they are not handled or disposed of properly. Subwatershed 4 contains the Industrial Excess Landfill (IEL), which has polluted groundwater and poses threats to surface water.

Upstream impoundments, channelization and unknown sources have been identified as sources responsible for use impaiment in monitored stream segments by the Ohio EPA. Flow and habitat alterations, metals, toxicity, nutrients, and organic enrichment are some of the identified causes for impairment of selected stream areas by the Ohio EPA (Appendix A). Considering all of these dispersed sources and causes of potential pollution, it has become apparent that the entire watershed has a high potential to be affected by pollution. However, Subwatershed 3 seems to be the most threatened from a variety of point and nonpoint source pollutants, although each subwatershed has one or more specific sources of pollution with a higher potential to impair surface and/or ground water quality than the other subwatersheds. Targeting efforts to maintain a riparian corridor and slow runoff in high risk areas may be an effective way to control some of the NPS pollution.

Future actions could include testing for the presence of contaminants downstream from nearby pollution sites. If a site is causing an impact on the watershed, targeting efforts to contain and clean up that site may also be an effective plan.

Pollution Potential Ratings

Table 16 summarizes the above mentioned identified point and potential nonpoint pollution sources and shows the Pollution Potential Ratings that were assigned to each subwatershed, for each of these sources. The Ratings were assigned using criteria mentioned throughout this report, in addition to ratings from meeting participants. Some of the criteria are summarized in Appendix F. Other criteria came in the form of expert opinions, which were gathered during a similar NEFCO study focusing on the Yellow Creek Watershed (NEFCO, 1997a). These expert opinions came from such agencies and organizations as the Medina and Summit County Health Departments, the Ohio EPA and DNR, the Medina and Summit Soil and Water Conservation Districts, the Cuyahoga River Remedial Action Plan (RAP) and the Cuyahoga River Community Planning Organization (CRCPO).

Each Rating is a whole number value ranging from 1 (virtually no potential) to 5 (very high potential to impair surface and/or ground water). As seen in Table 16, trucking activity and related maintenance, leaking underground storage tanks (LUSTs), gasoline use, impervious areas, and industrial land use areas have a high potential to impair the surface and/or ground water quality of Subwatershed 1. Whereas, it is off-lot and on-lot home/semi-public sewage disposal systems (HSDSs) and (SPSDSs), in addition to wastewater treatment plants (WWTPs), that have the highest potential to impair the waters of Subwatershed 2. By summing the ratings for each subwatershed, it can be seen that the greatest potential for identified pollution sources to have a negative impact on water quality and biological communities is located in Subwatershed 3, which is where the Portage Lakes are located. Both off-lot and on-lot HSDSs and SPSDSs have a very high potential to effect water quality in the Portage Lakes area. Subwatershed 4 is mainly threatened by impacts from landfills and dumps. Oil and gas pipelines and construction sites have a high potential to affect the water quality of Subwatershed 5.

Ranking of 24 Potential Pollution Sources

The previous discussion on Pollution Potential Ratings evaluated the potential for each pollution source to impair water quality on a subwatershed-by-subwatershed basis. This analysis continued with a ranking of the 24 identified potential pollution sources to the watershed, as a whole. To accomplish this, NEFCO decided that it would be appropriate to employ the existing rankings that were developed under the Ohio Comparative Risk Project (OCRP). The background of the OCRP and its "ranking of 45 potential threats to human health, ecosystems, and quality of life in Ohio" (Ohio EPA, July 1997, p. 1) can be found in Appendix H.

Each of the 24 identified potential pollution sources in the watershed was correlated to one of the 7 OCRP-ranked groups of the 45 threats. Some did not correlate directly, but they did correlate indirectly (Table 17). In instances where a potential pollution source correlated to more than one OCRP-ranked group, the group with the highest rank was chosen--since the higher ranked groups represent greater risks. For example, although there is construction and demolition debris (OCRP Group 6) from construction sites, uncontrolled development (OCRP Group 2) can also be correlated to construction sites and poses a greater threat. Consequently, this potential pollution source was correlated to OCRP Group 2.

The OCRP group number (1-7) was reassigned in reverse order to match the ordering scheme for the Pollution Potential Ratings that NEFCO developed (higher numbers in the Ratings indicate a greater potential to impair water quality; therefore, it was necessary for the OCRP ranked group numbers to reflect this). The reassigned OCRP group number was used as a weighting factor (Table 18). It was multiplied by the sum of all five Ratings that were developed for a given identified potential pollution source. The product of this multiplication is the ranking score (Table 18). Since the OCRP was used to help achieve these results, higher ranking scores indicate the potential pollution source with a greater threat to ecosystems, human health and the general quality of life in the watershed. The final ranked list of the 24 identified potential pollution sources to the watershed is shown in Table 19 along with the Pollution Potential Ratings.

Since off-lot (discharging) home/semi-public sewage disposal systems ranked the highest, they are deemed to present the greatest overall risk to the watershed. Future actions could include better management of these systems, especially in the subwatersheds with a high Pollution Potential Rating for these sources. Failing on-lot systems and landfills and dumps ranked the next highest, i.e., they each received the same ranking score. The Ratings on Table 19 indicate that off-lot and failing on-lot systems have a high to very high potential to impair the waters of Subwatershed 3. However, although this may be true, it should be recognized that Subwatershed 3 is the receiving watershed of Subwatersheds 2, 4, and 5. Since the Ratings in Table 19 indicate that off-lot and/or failing on-lot systems also have a high potential to impair the waters of Subwatershed 2, and a moderate potential to impair Subwatersheds 4 and 5; it is those subwatersheds that could be targeted, first, for better home sewage disposal system management practices. When dealing with the remaining identified potential pollution sources, the best results should be seen by taking this watershed approach to protecting/restoring water quality. However; this type of prioritization is not meant to overshadow the importance of localized impacts, which may be affecting designated uses such as primary recreation, which may be a vital component to an area's quality of life. In these areas, the watershed paradigm may not be appropriate.

Construction sites ranked third; and they have a high potential to impair the waters of Subwatersheds 3, 4 and 5. Industrial land use areas ranked fourth; and it has a high potential to impair the waters of Subwatershed 1. Trucking activity and related maintenance ranked fifth. Gasoline use ranked sixth. Leaking underground storage tanks and oil and gas pipelines both ranked seventh. Mining activity, agricultural areas and golf courses all ranked eighth. Oil and gas wells ranked ninth. Impervious areas ranked tenth. Nurseries/ greenhouses, and landscaping operation ranked eleventh. Lawn and garden/household maintenance activity ranked twelfth. Wastewater treatment plants and excess nutrients from natural sources ranked thirteenth. Salt storage and seasonal spreading of salt ranked fourteenth. Abandoned drinking water wells ranked fifteenth. Fuel oil use and PCBs ranked sixteenth. Boating activities ranked seventeenth. Registered underground storage tanks ranked eighteenth, due to insufficient information to evaluate it as a potential source.

Appendix I contains the ranking of 24 potential pollution sources for each of the five subwatersheds. Table 19 and Appendix I are significant environmental planning tools for the Upper Tuscarawas River Watershed. Future actions could use this information in conjunction with all of the figures and tables contained in the analyses, to identify sites that should be sampled for the presence of contaminants. If a site is causing a negative impact on the watershed, targeting efforts to contain and clean-up that site may be an effective plan. Also, local governments can use Table 19 and the tables in Appendix I and this analysis to protect/restore the water quality in their portion of the watershed when developing/revising zoning ordinances. Finally, for the reason that Table 19 and the tables in Appendix I are useful for breaking down the 24 identified potential pollution sources and the relatively large watershed into manageable pieces, is that organizers of public outreach/environmental education activities in the watershed can use it to help focus their efforts and limited resources. By doing these activities, the risks to human health, ecosystems, and quality of life in the watershed can be reduced, and the quality of water flowing from the Tuscarawas River and the Portage Lakes should continue to improve.