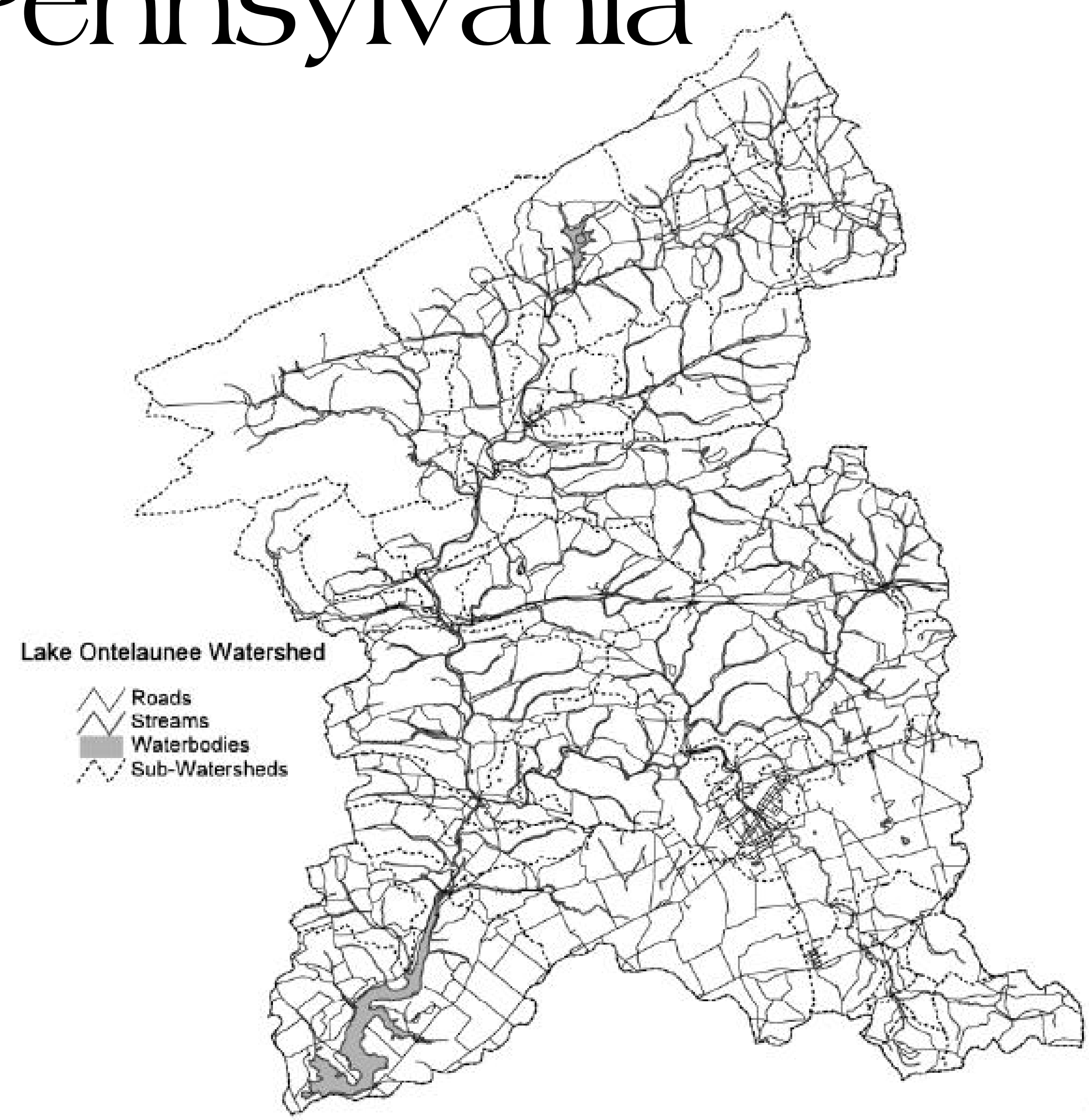
Watershed Assessment

Reading, Pennsylvania



Watershed Assessment

Reading, Pennsylvania

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Contents

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Executive Summary

As part of its commitment to the source water assessment program, the Pennsylvania Department of Environmental Protection (DEP) began a pilot project through an agreement with Region 3 of the Environmental Protection Agency. Under the project The Cadmus Group, Inc. studied three watersheds including the Ontelaunee. Cadmus delineated the watershed, reviewed potential and actual pollutant sources, analyzed the susceptibility of the watershed to the sources, and prepared a management plan consisting of a series of recommendations. This report is the summary of the project for the Reading Water Authority.

Several methods were employed to identify potential contaminants in the watershed: 1) review of point source pollution databases; 2) interview of key watershed stakeholder/informants and mapping; 3) windshield surveys of the watershed and more detailed observations of selected stream sections; 4) field sampling on four dates and a stressed stream analysis based on the sampling results; and 5) GIS land use modeling and nonpoint source pollution estimation using loading functions. The data collected from these methods were then used to determine key problems for the reservoir.

Key Concerns

Review of previous studies and several rounds of water quality sampling identified three key concerns for the watershed: 1) bacterial contamination, 2) sediment delivery to the reservoir, and 3) algae growth fueled by phosphorus. These three concerns are discussed below.

Bacterial Contamination

Contamination of watercourses by animal and human fecal material is a concern in the watershed. The sources of fecal pollution are, to a varying degree, also potential sources of *Giardia* and *Cryptosporidium*. cysts and oocysts. Three categories of potential fecal contamination examined in this study include:

- Point sources are potential sources of protozoans. There are three wastewater treatment plants located in the drainage basin, Lynn Township Sewage Treatment Plant, Kutztown Sewage Treatment Plant, and Moselem Springs Golf Course Wastewater Treatment Plant.

- Septic systems that are either malfunctioning, or have inadequate leach fields, are a source of cysts and oocysts.

- Nonpoint source pollution from stormwater runoff on agricultural lands, particularly runoff from pasture lands of livestock operations also contributes contaminants;

To place concern over fecal contamination in context, no confirmed viable *Cryptosporidium* oocysts have been found in finished water to date. The discussion over fecal contamination is one of a potential threat, not current health concern in treated water. That said, increasing concern over *Cryptosporidium*, places a greater burden on treatment systems. Minimizing upstream fecal contamination, especially human sources, affords an additional layer of public health protection by increasing the quality of raw water prior to treatment.

There has been historical concern that unsewered areas adjacent to the Maiden Creek, including Virginville and Lenhartsville, are sources of human fecal material. Cadmus noted high housing densities in areas not served by a wastewater treatment plant. On one occasion, wastewater was observed flowing down Route 143 in Virginville towards Sacony and Maiden Creeks.

Cadmus found concentrations greater than 10,000 per 100 ml of sample on at least one sampling date in the following pipe or gutter locations:

- Stormwater pipe, in Maiden Creek, just downstream of Lenhartsville
- Stormwater pipe, in Furnace Creek, in Lenhartsville
- Stormwater pipe, in concrete bulkhead in Virginville
- Gutter wash in Virginville

The high fecal coliform counts in Virginville and Lenhartsville should receive immediate attention. Recommendations for further action include establishing a watershed coalition and subcommittee, exploring assistance for small unsewered communities, and establishing a sampling effort.

Sedimentation and Erosion

Erosion of watershed soils and their ultimate transport to the reservoir are a second key concern in the watershed because sedimentation can reduce the capacity of the reservoir. Observers have noted that the upper reaches of the watershed in Richmond, Perry and Maiden Creek Townships are slowly filling in and reducing the reservoir's depth in those sections. F. X. Browne concluded that the lake had lost roughly 25 percent of its volume or 1,067 million gallons by 1992. Based on a fill date of 1938. This is an average rate of roughly 0.5 percent per year.

Algae Growth

Another sediment-related water quality problem is adsorbed pollutants. A portion of the pollutants attached to sediments can become dissolved again if conditions such as pH change. A key adsorbed pollutant is phosphorus. Previous studies have shown that much of annual phosphorus export from a watershed occurs during storm events, and that much of that phosphorus is adsorbed onto sediments. Once in the reservoir, the sediments can become re-suspended and phosphorus can be released. This internal phosphorus source can fuel eutrophication or enrichment of the reservoir and can cause undesirable algal growth. The algae can cause taste and odor problems in a water supply. Phosphorus transport to the reservoir from fertilizer use and manure spreading is a related concern.

Other findings include little impact from point sources except for the potential for *Giardia* and *Cryptosporidium* contribution. Pesticides also don't appear to be a major concern, although it is possible that there are localized spikes of concentration during peak application periods in the spring that have not been detected by previous sampling. There is little evidence to date that pesticides are a threat to the reservoir, however.

This study cataloged commercial and industrial sites. Little direct contribution of pollutants from these sites was observed, however, wash water from an automobile service facility may reach one of the upper reaches of Maiden Creek.

Recommendations

Management recommendations discussed in the report include the following:

- Develop an Active Watershed Coalition (section 9.1)
- Draw Up a Set of Short and Long-Term Goals (section 9.1)
- Focus on Key Issues (section 9.1)
- Develop Long-Term Sources of Funding and In-Kind Services (section 9.2)
- Develop a Long-Term Monitoring Program (section 9.3)
- Consider Hiring a Part-Time Watershed Inspector (section 9.4)

Specific recommendations include:

- Work with the state and with local communities to help solve the problem of fecal contamination from inadequate septic systems. Conduct sampling in support of this effort.
- Conduct a current reservoir volume study to determine the change in volume over the last 7 years.
- Conduct a detailed sediment study to focus sediment reduction efforts.
- Cadmus understands that the Authority is currently considering construction of sediment reduction measures including a sedimentation basin. Because reduction of sediment load is a long-term process, some nearer term engineering solution appears to be necessary.
- Actively promote protection of streamside buffer zones. These zones are vital for reducing sediment and nutrient loads. The land now held by the Authority is a vital resource that should be held and managed. The Authority should consider expanding its holdings through lease or purchase of buffer zones in

the lower reaches of the watershed. Agricultural programs such as the conservation reserve program can help in this regard (see Chapter 5).

- Work with appropriate agencies to develop BMP demonstration projects. The Chester Water Authority worked with several groups including the Pennsylvania Fish and Boat Commission to develop stream bank protection projects.
- Reach out to users of toxic materials to encourage responsible behavior. Approach automobile parts suppliers to encourage oil recycling. Discuss commercial and industrial floor drains with Pennsylvania's Class V well program.

1.0 INTRODUCTION: A WATERSHED APPROACH

The passage of the 1996 Amendments to the Safe Drinking Water Act (SDWA) has created a new focus on preventing drinking water contamination through source water protection. The Amendments redirect the regulatory focus from identifying and treating contamination at the water supply's intake towards maintaining the quality of the source water and preventing new contamination. Reducing or preventing chemical and microbiological contamination of source waters could allow water suppliers to avoid costly treatment or minimize monitoring requirements. Regulators could also save resources that would otherwise have to be devoted to compliance assistance, oversight, and enforcement.

Protection of drinking water sources requires the combined efforts of federal, state, and local government programs and citizen efforts devoted to environmental and public health management. The partnerships are necessary because prevention is often about land use and water management, which are addressed at the State and local levels. But, regulation of the activities conducted in the watershed is generally a Federal and/or State function. These partners also can share data, technical assistance, training and other tools to assist the water supply's efforts.

As part of its commitment to the source water assessment program, the Pennsylvania Department of Environmental Protection (DEP) began a pilot project. Through an agreement between DEP and the Environmental Protection Agency, Region 3, The Cadmus Group, Inc. is delineating the watershed, assessing susceptibility, and preparing a management plan for three surface water supplies. This report is the summary of that project for the Reading Water Authority.

1.1 New Requirements under the Safe Drinking Water Act

The Safe Drinking Water Act[1] requires States to establish programs for delineating source water areas of public water systems, and for assessing the susceptibility of these source waters to contamination. Delineation of the watershed involves evaluating hydrogeologic information about the source of supply, as well as water flow, recharge, and discharge information affecting the source waters.[2]

The contaminants of concern are those raw water contaminants regulated under the SDWA (contaminants with a maximum contaminant level (MCL), contaminants regulated under the Surface Water Treatment Rule, and the microorganism *Cryptosporidium*.)[3] In addition, States may include contaminants that are not regulated under the SDWA, but which the State has determined may present a threat to public health.

Potential sources of these contaminants include areas of established contamination such as Superfund sites and toxic release or spill sites. Other potential sources include those that generate, store, or use contaminants that may pose a threat if not properly controlled. Examples include: National Pollutant Discharge Elimination System (NPDES) permittees, underground storage tanks (USTs), underground injection wells, hazardous and non-hazardous waste management facilities, nonpoint sources (such as runoff of pesticides and nutrients from farmlands), and stormwater.

The risk of contamination by these sources is evaluated through examination of several factors. They include examination of the type of contaminant, the distance of the source from a stream channel, the distance or time of travel from an intake, the likelihood of a spill or mishap, and the toxicity of the contaminant. In the case of aquifers, studies

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[1]ß1453(a)(1-3) of the SDWA stipulates the State requirements for developing source water assessment programs.

[2]The SDWA permits States to draw the boundaries of watersheds along state political boundaries, but encourages States and systems to coordinate with their cross-border partners to ensure that the source waters are protected upstream of the border.

[3]The list includes *Cryptosporidium* because EPA is in the process of regulating this microorganism.

of soils and hydrology, and an examination of the fate and transport of the contaminants is also useful

Once potential contaminant sources to which a PWS may be susceptible are identified and inventoried, options for managing these sources need to be determined. The source water management plan identifies ways to reduce or eliminate the potential threat to drinking water supplies within source water protection areas. This can be accomplished either through federal, state, or local regulatory or statutory controls, or by using non-regulatory (voluntary) measures centered on an involved public. EPA's State Source Water Assessment and Protection Programs Guidance notes that while land-use controls, regulatory and pollutant source management measures, and other methods have traditionally been used for a variety of purposes in controlling impacts of land use and municipal growth. It further notes that only recently have these tools been employed to protect drinking water supplies on a large scale.

Critical to the implementation of the plan is the participation by the public and local stakeholders. Involving residents of the watershed, watershed associations, non-profit organizations like local conservancy groups, as well as the regulatory partners from the beginning of the project pays off in interest and investment in achieving the goals outlined in the management plan.

1.2 Pilot Projects in Pennsylvania

Three public water supplies using surface water sources were selected for the pilot projects: the City of Allentown, Chester Water Authority, and the City of Reading. An initial meeting between Anthony Consentino and Dan Kennedy of the Reading Water Authority, local stakeholders, EPA, DEP, and Cadmus began the project. Historical information about the system and watershed were presented, and areas of concern or problems noted in the watershed by the meeting participants were highlighted.

Using Geographic Information System (GIS) data obtained from DEP Cadmus delineated the watershed boundaries, which defined the source water protection area.

Other GIS data collected that helped spatially review the watershed's status included land use data, roads, water bodies, NPDES permittees (limited data), and soils data. The GIS data can be used to flag areas of concern for the assessment phase of the project.

An assessment of the source water protection areas was conducted through the spring and summer of 1998. The assessment combined field sampling and observations with searches of databases maintained by regulatory agencies to identify existing or potential sources of contamination. Additional interviews with state, county, and township staff and local citizen groups flagged other issues in the watershed. Finally, data obtained from fieldwork or databases were analyzed and, in some cases, modeled, to measure impact on the source water. Chapters 4 through 8 describe the information collected during the assessment.

The observations serve as the foundation for developing a management plan, which summarizes the next steps needed to ensure continued protection of the source waters. The data collected helped the team establish priorities for the watershed and the Authority. The next steps range from a recommendation to further study specific issues identified to suggestions for best management practices. The management options are provided in Chapter 9.

2.0 THE WATERSHED AND DRINKING WATER SYSTEM

2.1 Description

The Reading Area Water Authority withdraws water from Lake Ontelaunee and Maiden Creek to provide drinking water to the City of Reading, Kenhorst Borough, and parts of Cumru, Bern, Muhlenberg, Ontelaunee and Lower Alsace Townships. Lake Ontelaunee is located approximately 5 miles north of Reading in Berks County, Pennsylvania. Ontelaunee Creek, originating in Lehigh County, is the major tributary to Lake Ontelaunee. It flows southwest through western Lehigh County and northern Berks County to form Lake Ontelaunee behind a dam at Route 73. Ontelaunee Creek then flows southward into the Schuylkill River just north of the City of Reading.

Lake Ontelaunee is a 1,100-acre man made lake with a drainage area of approximately 127,318 acres (199 m^2). The Watershed covers parts of Berks, Lehigh and Schuylkill counties. Surface water enters the Lake mainly from Maiden Creek, and its main tributary Sacony Creek, with inputs from Bailey Creek, and other small tributaries that empty directly into the Lake. Two miles below the dam, Lake Ontelaunee discharge flows through Maiden Creek into the Schuylkill River, which joins the Delaware River to eventually empty into the Atlantic Ocean. The Lake holds approximately 3.3 million gallons of water and has an average depth of 7.2 feet (2.8 meters) with a maximum depth of 28 feet (8.5 meters). Lake Ontelaunee has a hydraulic retention time of 22.8 days and an average discharge of 221 cubic feet per second (cfs).[4] Lake Ontelaunee has lost a portion of its original capacity since the dam was built in the late 1930s, because of sedimentation.

More than 3,000 acres of shoreline are available to the public for recreational activities including biking, walking, fishing and hunting. Because the lake is a public water supply, lake access is limited to non-contact, non-boating activities.

[4] F.X. Browne, Inc. Diagnostic-Feasibility Study of Lake Ontelaunee. City of Reading, Berks County, Pennsylvania, April, 1994.

2.2 Geology and Lithology

Rocks from the Silurian and Ordovician geologic periods are the primary rocks found in the Lake Ontelaunee watershed. The Shawangunk and Bloomsburg Silurian formations are located in the northern part of the watershed in the Blue Mountains. They are composed of quartzitic sandstone and conglomerate with interbeds of shale. Shale found on the sides of the Blue Mountain is less resistant to weathering than sandstone found at the top of the mountain. The Hamburg Sequence and the Martinsburg Formation are Ordovician formations found in the middle and lower portions of the watershed. They are predominantly composed of shales and sandstones with limestone, dolomite and slate. Epler, Ontelaunee, Rickenbach, Stonehenge, Jacksonburg, and the Hershey and Myerstown Formations are also found within the middle and lower parts of the watershed. The limestone in the underlying geology tends to neutralize soil and surface water, creating neutral to alkaline lake water and agriculturally productive soils. Caverns and sinkholes are prevalent in the watershed resulting from the dissolution of limestone bedrock by water that forms cavities in the underlying geology.[5]

2.3 Topography

The Lake Ontelaunee Watershed is bounded to the north by the Blue Mountains. The intersection of Berks, Lehigh, and Schuylkill counties form the highest point in the watershed at 1,674. feet In the northwest section of the watershed, the Pinnacle (sandstone ridge overlooking Maiden Creek) stands at 1,615 feet. One last outstanding geologic feature is the Blue Rocks (large sandstone boulders) that have been displaced by the Blue Mountains. The lowest point in the watershed is the dam point, at 304 feet above sea level. Slopes in the watershed range from under 5 percent to over 20 percent, with a majority of the slopes between 5 to 15 percent. The Ontelaunee Creek flows through a broad flat valley at the northeast portion of the watershed. It is joined by several tributaries and forms Maiden Creek, the main stream feeding the Reservoir. Kistler Creek flows through a broad U-shaped valley and joins the Creek near Kempton. The other main tributary is Sacony Creek, which drains Kutztown. Mill Creek, a major

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[5] F.X. Browne, Inc. Op. Cit.

tributary of the Sacony drains the east portion of the watershed up through New Smithville.

2.4 Soils

Soil characteristics in the Lake Ontelaunee Watershed are generally suited for agricultural uses, although they are prone to erosion due to poor farming practices. Soils found in the mid-section of the watershed are predominantly Berks-Weikert-Bedington series derived from weathered shale and siltstone. They tend to be well drained. Soils in the southwest part of the watershed include Ryder-Fogelsville and Duffield-Washington. The Ryder-Fogelsville series is characterized by well-drained silty soils derived from cement rock. The Duffield-Washington series is derived from limestone bedrock and is also well drained. Soils along the upper slopes of the Blue Mountains contain soils from the Edgemont-Dekalb (on the ridges and side slopes) and Fleetwood-Extremely stony (found on steep stony areas of Blue Mountains) series. Soils in these two series are derived from sandstone, quartzite, and conglomerate. Little to no vegetation is found in areas with Fleetwood -Extremely stony soils. Laidig-Buchanan-Andover soils are found along the lower slopes of the Blue Mountains and are derived from shale, sandstone, and quartzite from the sides of the Blue Mountains which were deposited to form nearly level to gently rolling areas at the base of the mountain. These soils are colluvial soils, and tend to have slow permeability due to a firm, slowly penetrable layer in the subsoil. Montvallo soils may be found in part of the watershed located in Lehigh County, although the existence of these soils must be confirmed when additional soil maps are completed for the county.[6] [7] [8]

2.5 Land Use

[6] F.X. Browne, Inc Op. Cit.

[7] Natural Resources Conservation Service, National Cooperative Soil Survey. Official Series Description.

[8] Berks County Planning Commission. Natural Areas Inventory, 1991.

Land in the Lake Ontelaunee Watershed is primarily used for agricultural purposes. Based on Pennsylvania GIS data, the following approximate[9] areas by land use were determined (see Table 2-1). The watershed is over one third forest and one-third row crops, with the remainder in pasture. Other land uses combined account for just over three percent. In general, based on this land use pattern, contaminant concerns will be nonpoint sources of nutrients and sediments. Development can have an impact far greater than its land use proportion depending on what activities and operations take place and on the pattern of development. Discussion of the impact of housing and commercial sites is contained in later report sections.

Table 2-1

Land Use in the Ontelaunee Watershed

	Land Area		
	hectares	Acres	%
Water	707	1,747	1.4%
Developed	630	1,556	1.3%
Pasture	10,120	24,997	20.3%
Row Crops	18,809	46,459	37.8%
Forested	19,252	47,551	38.6%
Wetlands	282	696	0.6%
Barren	18	45	0.0%
Total	49,819	123,052	100.0%

2.6 Population

The population within the Lake Ontelaunee Watershed remains predominantly rural. Increased growth in the manufacturing and retail and wholesale trade sectors reported in previous reports is primarily for other portions of the counties. The population of Berks and Lehigh Counties grew roughly 4 percent in aggregate from 1990 to 1997 (Table 2-2).

[9] Depending on the scale of the original data and the date it was collected, land use data is inherently variable. For purposes of general watershed contaminant threat delineation, these data are sufficient.

Table 2-2: Population 1990-1997

	1990[10]	1997	Absolute Change	Percentage Change
Berks County, PA	336,523	354,057	17,534	5.2%
Lehigh County, PA	291,130	297,703	6,573	2.3%
Total	627,653	651,760	24,107	3.8%

Table 2-3 below shows population changes in municipalities that are fully in the Lake Ontelaunee watershed from 1990 to 1996 and Table 2-4 shows population changes in municipalities that lie partially in the watershed. The population of municipalities partially or wholly in the watershed has grown by approximately 6 percent in six years. The largest growth in the watershed is in Rockland Township in Berks County. Four municipalities, Kutztown, Lenhartsville, Lyons, and Perry Township, all in Berks County, have experienced a slight decrease in population. The population of Lenhartsville decreased most significantly, with a 2.6 percent reduction in population from 1990 to 1996.[11] Some municipalities, however, have seen more significant growth. For example, the population of Maidencreek Township located partially in the watershed increased by 59.4 percent in 6 years. Much of this growth is outside the watershed, however.

The total in Table 2-4 represents only municipalities that are partially within the watershed. The total is also skewed by Maidencreek Township, which includes the Route 222 corridor, much of which is outside the watershed. If this township is excluded the aggregate growth rate is 5.6 percent or less than 1 percent per year. This is consistent with the growth rate of townships within the watershed. In all, the growth rate in the watershed is less than 1 percent per year. The growth rate is small by percentage and small in an absolute sense with roughly 200 people added per year in the townships wholly located within the watershed. Excluding Maidencreek Township, the average

[10] Bureau of the Census. Estimates of the Population of Counties for July 1, 1997, and Population Change: April 1, 1990 to July 1, 1997, March, 17, 1998.

[11] Bureau of the Census. Op. Cit.

addition to townships partially in the watershed is roughly 105 persons per year of which only a portion is added to the watershed. Given this low growth rate, development is not a major issue for the watershed. The impact of development adjacent to stream channel should be reviewed on a case-by-case basis.

Table 2-3

Population of Municipalities Within the Watershed, 1990-1996[12]

	County	1990	1996	Absolute Change	Percent Change
Albany Township	Berks	1,547	1,630	83	5.4
Greenwich Township	Berks	2,977	3,129	152	5.1
Kutztown	Berks	4,704	4,681	-23	-0.5
Lenhartsville	Berks	195	190	-5	-2.6
Lynn Township	Lehigh	3,220	3,515	295	9.2
Lyons	Berks	499	482	-17	-3.4
Maxatawny Township	Berks	5,724	6,051	327	5.7
Rockland Township	Berks	2,675	3,139	464	17.3
Total*		21,541	22,817	1,278	5.9

* The total represents population only for the municipalities completely within the watershed

[12]Bureau of the Census. Op. Cit

Table 2-4

Population of Municipalities Partially in the Watershed, 1990-1996[13]

	County	1990	1996	Absolute Change	Percent Change
Maidencreek Township	Berks	3,397	5,416	2,019	59.4
Perry Township	Berks	2,516	2,486	-30	-1.2
Richmond Township	Berks	3,439	3,458	19	0.6
Windsor Township	Berks	2,101	2,248	147	7.0
Weisenberg Township	Lehigh	3,246	3,743	497	15.3
Total		14,699	17,351	2,652	18.0

2.7 General Hydrology

NOAA data collected for 1997 indicate that mean areal precipitation for the Lake Ontelaunee watershed was approximately 37.1 inches, 8.8 inches below normal.[14] Precipitation data reviewed for 1998. Each of the sampling periods followed periods of no or trace amounts of rain.

There were two USGS gages previously operated in the watershed. Station 01470720, at a tributary of Maiden Creek in Lenhartsville, operated from 1966 through 1980. It indicated an average flow of 12.63 cubic feet per second (cfs). Station 01470756 operated in Virginville on Maiden Creek from 1974 through 1995. It had a historical average flow of 263 cfs. Should the Reading Authority wish to model water quality in the future, historical flow data can be used to calibrate the model.

13 Bureau of the Census. Op. Cit.

14 National Weather Service Website. Mean Areal Precipitation and Departure From Normal. Http://marfcws1.met.psu.edu/Archive/1997/pa_dep_12.gif

2.8 The Drinking Water System

The Reading Area Water Authority supplies water to the largest population in the County, and provides the largest volume of water in the County. Approximately 86,000 persons, 78,080 of which are located in the City of Reading.[15] are serviced by the Reading Water Authority. The Authority provides water to many large, industrial, commercial, and institutional establishments in the City of Reading, Kenhorst Borough, and parts of Cumru, Bern, Muhlenberg, Ontelaunee, and Lower Alsace Townships. The Ontelaunee Township Authority, the Muhlenberg Township Water Authority, and the Bern Township Water Authority own and maintain their own water systems, but are supplied with water from the Reading Water Authority. The Reading Water Authority is also interconnected with the distribution systems of Mount Penn, West Reading, Wyomissing, and Shillington so that the Authority may provide them with water, if necessary.

Water withdrawn from the Lake flows by gravity to the Reading Water Treatment Plant (in operation since 1934).[16]. It is first treated with liquid alum for coagulation. Activated carbon is used to control taste and odor problems, and the water is pre-chlorinated to 0.9 mg/l. Flocculation and sedimentation are followed by filtration through multimedia filters at (something missing). If needed, lime is added to adjust pH. Chlorine, ammonia, and fluoride are added before it is supplied to the public, or piped to storage tanks.

The treatment plant has two 4 feet wide flocculation basin channels where water must make 20 to 30 turns before reaching the sedimentation basin. Three 2 million gallon sedimentation basins have a theoretical detention time of 9.6 hours or a 15 MGD flow rate, and 3.6 hours at a 40 MGD flow rate. Each basin is drained and cleaned 3 or 4 times a year. Eight filters, seven of which are operated at a time, contain 13 inches of

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[15] Berks County Planning Commission. Berks County Sewer and Water Systems Study, September, 1995.

[16] Department of Environmental Protection Bureau of Water Supply and Community Health, Safe Drinking Water Program. Results of the Filter Plant Performance Evaluation of the City of Reading Authority Public Water Supply #3060059, February 5-6, 1996.

anthracite, 9 inches of sand, and 3 inches of garnet. The filters are operated at a rate of 1.2 gallons per minute per square foot (gpm), and are backwashed after every 60 or 70 hours of operation. Backwashing takes approximately 8 minutes, and uses 140,000 gallons of water. Filter to waste is then used at a rate of 850 gpm until turbidity reaches 0.1 NTU. The filters are then operated at 850 gpm for 15 minutes, then increase to the normal operating rate of 1,300 gpm. The treatment plant has the capacity to treat 40 MGD with a filtration rate of 3 gpm/square foot, while the maximum average daily usage as of 1995 was only 18 MGD. On average, the Reading Treatment Plant treats 13 to 14 MGD of water. The Authority maintains a four-day supply of treated drinking water in storage reservoirs throughout the system.[17] A 10 million gallon tank stores finished drinking water that should provide at least 16 hours of retention time when demand is 15 MGD.[18]

2.9 Raw Water Quality

There are several sources of historic water quality data for Lake Ontelaunee and its watershed. Some brief comments on each data set follow.

- The United States Geologic Survey (USGS) at a station located on a tributary at Lenhartsville recorded water quality data. The station was operated until 1978, and a station located on Maiden Creek at Virginville until 1994.

- F.X. Browne conducted a lake study[19] that collected water sediment, lake depth, fish, and macroinvertebrate data. Selected data for the lake is summarized below. Sampling in the watershed was very limited.

[17] Berks County Planning Commission. Berks County Sewer and Water Systems Study, September, 1995.

[18] Department of Environmental Protection Bureau of Water Supply and Community Health, Safe Drinking Water Program. Results of the Filter Plant Performance Evaluation of the City of Reading Authority Public Water Supply #3060059, February 5-6, 1996.

[19] F.X. Browne, Inc Op. Cit.

- Pennsylvania's Department of Environmental Protection (DEP) assesses water quality in the state, and identifies water bodies that are impaired. These water bodies are listed in a list required by Section 305 (b) of the federal Clean Water Act (CWA). Lake Ontelaunee is on the 303(d) list because of sediment and nutrient problems. Pennsylvania also lists the priority of the Lake as "high".

- A 1991 set of samples collected by the conservation district showed elevated phosphorus in a stormwater pipe in Furnace Creek. Values of 3.3 and 4.2 mg/l were measured. These values are consistent with values for undiluted, untreated household wastewater. This pipe is discussed later in Chapter 4. Values for nitrate were extraordinarily high ranging from 8.8 to 42.9 mg/l. These values were collected using a Hach test kit. They are roughly 4 times higher than values in STORET, and measured by Browne and Cadmus. One possible explanation is that the kit recorded values of total nitrate rather than nitrate-N. This would account for the factor of 4 difference between the values collected by the conservation district and other readings.

- Cadmus reviewed STORET data available from Pennsylvania for this study. The data are limited with data from 14 stations, 10 in the Sacony watershed one in Moselem Creek and three in Maiden Creek. There are nutrient data for only three stations, the on e in Moselem Creek (1 sample) and two stations on Maiden Creek (12 and 13 samples respectively). The average concentrations are presented below. The data show little that is noteworthy except that nitrate is elevated in Moselem Creek.

Table 2-5

STORET Data for Ontelaunee Watershed

Station	Location[20]	Ammonia	Nitrite	Nitrate	Phosphorus
Maiden 1	At Route 662 Bridge	0.03	0.01	2.4	0.070
Maiden 2	At dam.	0.04	0.02	2.0	0.047
Moselem Creek	At Forge Hill Road	0.04	0.04	7.3	0.000

Following are summaries of several of the historical studies.

2.9.1 Lake Ontelaunee Study

Following are selected findings from Browne's 1994 study of Lake Ontelaunee:

- Three water quality stations, one near the dam (Station 1), one in the middle of the widest portion of the lake (Station 2), and one near the inlet (Station 3), were sampled monthly during the one year study.[21] Samples were collected from one meter below the water surface, and one meter above the lake bottom. Nine other tributary stations were sampled twice (Maiden Creek, Sacony Creek at confluence near Virginville, Ontelaunee Creek, Kistler Creek, Stony Run, Pine Creek, Furnace Run, Peters Creek Spring, and Moselem Creek.

- The lake stratified only in September indicating a well-mixed lake. Anoxic conditions were limited to a single sampling station for a short period only. Winter and spring Secchi disk transparencies were approximately 1 meter, then declined and remained at 0.5 m for the rest of the summer. Secchi depths between 0.5 and 1 m indicate eutrophic conditions for most of the year, and summer readings of 0.5 m indicate hypereutrophic conditions. Browne

[20] Locations were determined using latitude and longitudes supplied in the database.

[21] F.X. Browne, Inc. Op. Cit.

attributed the May transparency increase (3.6 m), to zooplankton grazing resulting in algae reduction which is plausible.

- Total phosphorous (TP) baseflow concentrations at the inlet ranged from 0.032 to 0.251 mg/l. An increase in the TP concentrations was observed during the summer months. During storm events, TP concentrations reached as high as 1.18 mg/l. Browne attributed significantly higher TP concentrations observed during summer months and storm events to TP loading from nonpoint sources. Seasonal average surface TP was 0.055 mg/l and ranged from 0.024 to 0.086 mg/l with concentrations highest during the summer months. Surface TP concentrations indicate that Lake Ontelaunee is generally eutrophic (TP levels between 0.02 and 0.03 mg/l), while summer TP concentrations approach hypereutrophic conditions (< 0.1 mg/l).

- Nitrate and nitrite concentrations in Lake Ontelaunee are consistent with annual patterns of biological activity in the lake. At the inlet, nitrate plus nitrite ranged from 1.74 to 4.40 mg/l. Maximum values were observed during the winter months. Total kjeldahl nitrogen[22] ranged from 0.5 to 0.86 mg/l, where maximum values were observed during warmer months. The difference in maximum values is due to the fact that inorganic nitrogen is incorporated into organic material as temperatures rise. These nitrogen levels are not high for an agricultural watershed and do not cause the nitrate level to approach the MCL of 10.0 mg/l.

2.9.2 Pennsylvania 303(d) List of Impaired Waters

Pennsylvania's Department of Environmental Protection (DEP) assesses water quality in the state, and identifies water bodies that are impaired through various programs. Section 305 (b) of the federal Clean Water Act (CWA) requires the Commonwealth of Pennsylvania to issue a report on all impaired waters. Section 303 (d)

[22] This analysis measures combined ammonia and organic nitrogen.

of the CWA requires the State to determine the impaired waters that will not support designated uses even after appropriate pollution control technology has been used. Sources and causes of impairment are included in the list. The State, or the EPA, must then develop Total Maximum Daily Load values (TMDLs) for each water body on the list. TMDLs identify the maximum allowable pollutant loads to a water body that will prevent water quality violations. The difficulty that all states including Pennsylvania face is how to address water body impairment caused by nonpoint sources.

Data used to assess water quality in Pennsylvania include the Surface Water Monitoring Program including data collected through the PA Water Quality Network (WQN). The WQN is run by the Bureau of Watershed Conservation and consists of fixed stations and reference stations to assess water quality and the effectiveness of water pollution management strategies. Chemical and physical analyses are performed monthly, and biological analyses are performed annually. All chemical data from the WQN is stored in the U.S. EPA STORET database. Cadmus reviewed STORET data but found little information for this watershed

Data from government agencies, universities, advisory groups, citizen monitoring groups, watershed associations, public interest groups, and sportsmen's groups were also solicited to utilize readily available data. After several validity and quality assurance checks, relevant data are included on the 303 (d) list.

Sources of impairment are assigned priority rankings based on the severity of pollution and uses of specific water bodies. The priority rankings correspond to TMDL development over the next 2 years. Sources that are considered a high priority for TMDL development include industrial and municipal point sources, package plants, combined sewer overflow, agriculture, silviculture, urban runoff/storm sewers, surface and subsurface mining, abandoned mine drainage, land disposal, and onsite waste water. Prioritizing stream segments allows the DEP to address the most severe pollution problems first. Cadmus recommends that the Authority contact the DEP to learn what actions may flow from the high priority ranking.

Waters in the Ontelaunee Watershed Identified on the Pennsylvania List of Waters, Section 303(d) List 1998[23]

Water Body Name	Stream Code/ PA Water Plan ID	Data Source	Source of Impairment	Cause of Impairment	Priority
Lake Ontelaunee (1,100 acres)	01985/03-B	Clean Lakes Project Phase I Report	Agriculture Urban Runoff/ Storm Sewers On site Wastewater Other	Nutrients Suspended Solids	High

[23] Pennsylvania Department of Environmental Protection, Commonwealth of Pennsylvania, Section 303(d) List 1998. August 7, 1998.

3.0 METHODOLOGY

There are five major components of a source water assessment program as defined by the EPA: 1) delineation of the source water protection area; 2) contaminant inventory; 3) susceptibility analysis; 4) public access; and 5) public participation. (USEPA, 1997). While these components are required by the EPA for all source water assessments, each water supply protection program needs to be tailored to the local issues and needs. The EPA and the State will provide general guidance and assistance to local protection programs, however, the active protection of the water supply and the key to long-term control are ultimately the responsibility of the local water purveyors in partnership with watershed residents, communities, businesses and other stakeholders (EPA, 1997).

3.1 Delineation of the Source Water Protection Area

For surface water systems, the delineation of the watershed is defined by all the land area, or watershed, that drains towards the water supply intake. For the three PA watersheds under this study, the watershed boundary was delineated on USGS topographical quads (1:24,000 scale) and were digitized and mapped using GIS software.

3.2 Contaminant Inventory

For each watershed a comprehensive inventory of potential sources of pollution were identified. These can be divided into point and nonpoint sources and are summarized in the text and tables and illustrated in a series of GIS maps. Point sources of pollution can be traced to a definable source or pipe. Nonpoint sources of pollution emanate from the land or air without a discernible discharge point and include agriculture, residential development, deicing salts (both storage and usage), forestry, dumps, mined lands, septic systems, streambank erosion, and roadbank erosion. Another potential concern is recreational boating. Likely source areas are first identified using land use maps obtained from state and county agencies. This basic inventory will provide the following information for potential nonpoint sources of pollution: location (map), area (size in acres if applicable), relative distance to water intake(if applicable), pollutant types by pollutant source (toxics, sediments, nutrients, salts, pesticides, pathogens, etc.), and pollutant type implication for water supply (i.e., pathogens-→disease and health consequences).

Several methods were employed to identify potential contaminants in the three watersheds: 1) review of point source pollution databases; 2) interview of key watershed stakeholder/informants and mapping; 3) stressed stream analysis sampling and windshield surveys of the watershed; and 4) GIS land use modeling and nonpoint source pollution estimation using loading functions. The data collected from these methods were then used as the basis for the susceptibility analysis.

- Point Sources-Available pollution data including: direct surface or groundwater discharges, NPDES permit and monitoring data, hazardous waste sites and spills, petroleum and chemical bulk storage facilities, salt storage facilities, and landfill/dump sites were collected from appropriate state and federal agencies. They are presented in maps and tables in following sections. These data provide important baseline information on location and extent of activity in each watershed/subwatershed contribution area.

- Stakeholder Interviews and Pollution Source Mapping-Key stakeholders/informants who live and work in the watershed from both public and private organizations were interviewed and asked about potential sources of pollution in the watershed. Their responses were summarized and included in the text. Additionally, large format (e-sized) GIS maps with roads, hydrology, subwatershed boundaries and land use were sent to a number of key stakeholders in each watershed to identify both point and nonpoint source potential pollution sources or problem areas. These maps were collected, reviewed, data were summarized, and entered into the GIS. Many of these points were also field checked. This procedure was found to be quite useful in identifying important areas not readily apparent in existing databases or through other conventional methods of pollution source assessment. In addition, the approach provided stakeholders with a meaningful avenue for public participation in both the fact-finding portion of the project and options for implementing the plan.

    1. Stressed stream analysis sampling and windshield surveys of the watershed-Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams (Makarewicz, 1993)[24]. Within a watershed, the approach can be used to identify impacted subwatersheds and within a particular stream reach, it can be used for determining how and where a stream community is adversely impacted by a pollution source or other disturbance (Makarewicz, 1993).

[24] Makarewicz, J.C. 1993. Stressed stream analysis. Waterworks.

Stressed stream analysis is a technique that divides the watershed into distinct segments, usually above and below major stream branches. Samples are taken at the beginning and end of each unit of the stream to determine the concentration of the pollutant under consideration. If the pollutant levels are higher from one branch than the other, it is likely that the higher levels indicate a pollution source(s) from the respective watershed. In addition, during the stressed stream sampling, windshield surveys or visual observations were made by Cadmus technical staff on the conditions of streambanks, roads, land uses and other potential sources identified by watershed stakeholders. These observations are incorporated into the appropriate text sections and tables that follow.

- GIS and Loading Functions. To estimate the nutrient and sediment loads exported to the reservoir by the watershed, Cadmus used GIS derived land uses for each subwatershed and applied literature loading functions. The purpose of this was to help prioritize future efforts. It will be necessary to apply more detailed models to examine pollutant sources at the subwatershed or finer scale. The next level of detail would be to apply a model such as Ground Water Loading Functions ? (GWLF) that uses the universal soil loss equation (USLE), precipitation data and Natural Resource Conservation Service (formerly Soil Conservation Service, or SCS) hydrology methods.

3.3 Nonpoint Source Pollution Loading Estimates

There are a number of methods to estimate nonpoint source pollution loading, from simply export coefficients, loading function models to rigorous mathematical research models. Export coefficients are a widely used technique which use representative values for the mass of pollutant generated per unit area per year (Reckhow, et al., 1980; Rast and Lee, 1983; Frink, 1991; Budd and Meals, 1994). As part of the Lake Champlain Basin Program, Budd and Meals reviewed the appropriate scientific literature and identified the following export values for three major land uses:

Table 3-1

Loading Coefficients for Various Land Uses

Parameter	Total Range	Most Frequently Reported	Selected Value
Forested Land			
Total Phosphorus	0.01-0.90	0.04-0.24	0.10
Soluble Reactive Phosphorus	0.007-0.170	0.03-0.07	0.05
Total Nitrogen	0.10-13.45	2.0-5.5	3.5
Agricultural Lands			
Total Phosphorus	0.10-7.17	.025-.081	.0.5
Soluble Reactive Phosphorus	0.09-4.48	0.09-0.22	0.15
Total Nitrogen	1.2-42.6	4.8-14.0	7.0
Urban Lands			
Total Phosphorus	0.03-11.6	1.00-1.91	1.50
Soluble Reactive Phosphorus	0.03-2.00	0.21-1.00	0.50
Total Nitrogen	1.6-38.5	6.1-10.2	8.5

Sediment yields can similarly be estimated using export coefficients with the following coefficients recommended by the EPA:

For each subwatershed in the Lake Ontelaunee watershed, export coefficients were used to estimate loading of nutrients and sediments using the following equation:

$$LD_k = A_k \text{ x } EC_{k,}$$

Where LD_k = annual load from land use
k; A_k = area in land use k; and
EC_k = areal export from land use k

Land use data derived from the GIS was used in conjunction with the loading export coefficients to estimate areal loading of nutrients and sediments. Estimates from each subwatershed were then used to rank each subwatershed against each other to define priority areas of concern.

In terms of the use of export coefficients, Budd and Meals made the following observations:

The primary advantage of the export coefficient method is its simplicity. The appropriate export coefficient for a particular land use is simply multiplied by the land area devoted to that land use to give the estimated annual load. The accuracy of the technique can be higher than more complex methods, because only one parameter - the export coefficient- must be chosen by the investigator (Reckhow, et al., 1990). However, the simplicity of the method is also its primary weakness-there are no provisions for year to year hydrologic variation; export coefficients are most applicable in years of "average" climatic conditions…

However, since this method is being used to compare subwatersheds against each other and not to estimate absolute loading amounts, this is deemed a reasonable approach to make a fair comparison.

3.4 Susceptibility Analysis

Watersheds are large and complex: it is difficult to efficiently and economically evaluate all of the potential sources of pollution. Using traditional methods of rapid evaluation and triangulating the results allows for a more accurate portrayal of the situation. It is important to select methods which -can be cross-checked against each other. In addition, the evaluation methods should help identify and/or prioritize pollution reduction implementation efforts that maximize returns on investment.

Another important consideration is to cast a fairly broad net in terms of evaluating sources of pollution. All potential sources of pollution should be evaluated in some manner to ensure that all possibilities are accounted for and to be "fair" to all land uses. The fairness issue arises particularly when a single land use dominates, such as agriculture. Farmers may feel that they are the only "targets" of a water quality improvement effort, unless it can be demonstrated that everything was considered.

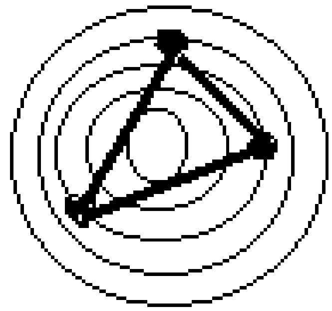


Figure 3–1

Triangulating Multiple Methods Can Increase the Reliability of an Assessment in Locating the “Bulls Eye” of Actual Impact or Importance

We used three methods of evaluation for rapid watershed appraisal of potential contaminant sources: a) key stakeholder/community informant interviews and database review; b) stress-stream analysis monitoring; and c) nonpoint source pollution loading estimates using GIS and loading coefficients or functions.

3.5 Potential Pollutant Sources

The following data sources were consulted in searching for potential contamination sources in the Ontelaunee Watershed.

3.5.1 Right to Know Environmental On-line Database

The Right to Know Network (RTK NET) (http://www.rtk.net) provides access to governmental databases, and information on conferences on the environment, housing, and sustainable development. RTK Net was established to provide information to the public to foster involvement in community and government decision-making. The RTK Net can be accessed via the World Wide Web, bulletin boards (bbs), or telnet. The RTK Net is sponsored by the Office of Management and Budget Watch and the Unison Institute, two non-profit organizations formed in response to the Emergency Planning and Community Right to Know Act in 1989. The following list details the environmental databases used in this watershed assessment, the years for which data are available, and the type of data that can be found in that database.

1. Permit Compliance System (PCS) Provides information on National Pollutant Discharge and Elimination System (NPDES) Permits from 1990 to the present. The PCS database provides facility name, address, location (latitude, and longitude), SIC code and description, the year of permit issue and expiration, inspection dates, monitoring requirements, and violations. For some facilities, the water basin and water body receiving the permitted discharge are identified, as well as the amount and type of discharge. The type of permit (i.e., storm water, industrial, etc.) is also provided. For "minor" facilities, PCS data may be incomplete.

- Toxic Release Inventory (TRI) Toxic release information is available for 1987 through 1995. Data is collected nationally from selected industries that manufacture, process or otherwise use compounds from a list of toxic or hazardous substances greater than applicable thresholds. The company's presence on a list does not mean that it necessarily releases large amounts of material to the environment. For example, a plastic former that molds plastic into shapes and ships them as product would be included if the plastic contains any listed compounds. They would be included on the list even if very little of the material were released to the environment through air, water or land pathways. A further complication is that disposal to a landfill located far away from the facility (and possibly outside of the watershed) would still cause the facility to be listed for a watershed.

  The database shows releases and transfers of toxic chemicals from manufacturers. The database shows the manufacturer's name, address, and latitude and longitude. Detailed accounts of amount and types of chemicals released or transferred is also provided by year of release or transfer. Manufacturers included in TRI should not necessarily be considered point sources of pollution. However, these manufacturers may be considered potential point sources of pollution if accidental spills or releases of chemical toxicants to the environment are deemed possible.

- Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS) CERCLIS provides detailed accounts of Superfund or potential Superfund sites, actions, and enforcement activities. Every known Superfund or potential Superfund site is identified in this database. The names, addresses, location, contact names, and dates of operation of facility sites are provided. Dates of discovery, National Priority List status and Hazard Ranking are also provided. Responsible parties, the lead agency in the investigation, and financial obligations are identified. The National Priority List (NPL) is also available. The NPL identifies facilities that need to be cleaned up under Superfund. The database identifies the facility location and provides brief descriptions of the site. Records of decision can also be searched through dial up numbers.

- Resource Conservation and Recovery Act Information System (RCRIS) The RCRIS database provides information on hazardous waste permits for generators, receivers and transporters of hazardous waste. Facility name and address, location (latitude and longitude) are identified, as well as the type and amount of hazardous waste transported, transferred, recycled, or disposed of. Violations are reported. No dates of data availability are reported.

The following databases can also be accessed through the RTK Net, although they were not searched for this watershed assessment. Further research may show these databases to be useful in identifying potential or actual point sources of surface or ground water pollution.

- Accidental Release Information Program (ARIP) This database provides information on accidental releases of pollutants to the environment. Data are available from 1986 through 1996.

- Emergency Response Notification System (ERNS) The ERNS database provides a description of accident reports where an accidental spill or release of an environmental toxicant was reported to the National Response Center. Data are available from 1987 to 1997.

RTK Net also searches: 1) Databases associated with health information, such as the Integrated Risk Information System (IRIS); 2) Roadmaps, a database with information on TRI chemicals; 3) The New Jersey Health Fact Sheets that describe health effects of TRI chemicals; 4) RM1's, which provides information on TRI chemicals; and 5) TSCATS, which provides data relating to the Toxic Substances Control Act. The RTK Net also provides information on enforcement activities through DOCKET, a database of court cases and enforcement actions. The web site also provides links to the Facility Index System (FINDS), the Chemical Update System (CUS), and Census data.

3.5.2 Environmental Protection Agency On-line Database Access

The Surf Your Watershed web site sponsored by the Environmental Protection Agency at http://www.epa.gov/surf provides information on many large scale watersheds and water basins across the U.S. This site provides links to many of the same databases accessed by the RTK Net including PCS, TRIS (TRI information system), RCRIS, CERCLIS, and ARIP. The EPA site also provides an index of watershed indicators, where available, information provided by States and Tribes, river corridors and wetlands restoration efforts, and provides links to other environmental web sites. Non point source projects in the watershed, community water sources (from the Safe Drinking Water Information System database), historical water data, water resources, water use (1990), and selected USGS abstracts can be accessed from this web site. The Envirofacts Warehouse, a retrieval system for all EPA environmental data, also provides links to air releases, grants information, facility index system (FINDS), and spatial data such as latitude and longitude, and EPA's spatial data library.

Watershed data can be searched for by United States Geologic Survey (USGS) Cataloging Unit, by zip code, city, stream, tribe, ecosystem protection efforts, or state. PCS data are presented in tabular form, where each discharge is identified. A description of each chemical, compound, or biological agent discharged is also available by clicking on underlined parameters (i.e., a description of dissolved oxygen, and total ammonia as nitrogen are provided). Links to the USGS allow users to access stream flow and water quality data from both current and discontinued gauging stations. Searches through the USGS site can be performed using Station gauge numbers, river or stream names, and water basins.

3.5.3 Commercial Databases

The following commercial products were used during this project. Each of them was relatively economical and was useful subject to the limitations described below.

- Dun & Bradstreet Corporation Information Services—Dun's Direct Access Database. This on-line dial-up database was used to locate the address, latitude, and longitude of businesses within the watershed. The database is relatively economical, costing roughly $.22 per abbreviated record, relatively simple to use, and much more complete than other commercial databases that we used for this project. Nevertheless, not all facilities could be located due to name changes, address changes, or inconsistencies in facility name reporting. Where addresses of potential point sources of pollution were known, this problem was overcome. The database also provides SIC codes and descriptions of each business.

- Delorme CD-ROM Set—Phone Search USA, version 3.0 (6 CDs), (1997) with Delorme Street Atlas USA, version 5.0 (1997). Cost: $69. Phone Search was used to locate addresses of facilities within the watershed. The primary feature of the software is that businesses or residences can be searched for by state, city, zip code, name, phone number, SIC (standard industrial classification) code, or street address. Search results can then be mapped using Street Atlas USA. This feature is powerful and allows a user to search for example, for all SIC codes beginning with “50” in a particular zip code. This list can be pared down to a subset of interest and mapped using the Street Atlas Program. An example of such a map is shown in Figure 3-2.

> The facility is located to the street level by the software. The actual location, confirmed in the field, is roughly half-way up the road.
>
> One limitation to the software is that if a business address is for a central office, the actual facility is not located. This Atlas program by itself can be used to locate and map gas stations, service stations, transportation centers (i.e., airports, bus terminals), and auto-related industries. This feature, however, is focused on trip services and is not a reliable locator of all businesses in a region. The maps can be printed, and labeled. This software also calculates routing directions, which maybe useful for field work and for designing field sampling routes.

The primary disadvantage to using the Delorme software was that it was not as complete as the Dun and Bradstreet database. For example, some gas stations located by Cadmus in the watershed were not listed in the Phone Search disk, or identified as a point of interest by the Street Atlas. However, using the Phone Search and Street Atlas disks were adequate starting places to locate possible point sources of water pollution in the watershed. They were also useful for finding map locations for businesses identified in the Dunn and Bradstreet database. The map atlas is also useful locating facilities where the latitude and longitude or street address is known. Because the disks cover all of the US, a statewide watershed effort would spend very little per watershed for these disks. In summary these disks are useful but should be used in conjunction with other data-gathering tools for identifying potential sources of pollution.

Reserved for Figure 3-2: Delorme Map Example (Unavailable Electronically)

3.6 Sampling Methods

Cadmus sampled the watershed on three occasions: March 20 – 21, June 3 – June 6, and July 30. Cadmus performed general observations and collected samples for analysis of ammonia, nitrate, total kjeldahl nitrogen, total phosphorus, total suspended solids (TSS), and fecal coliform bacteria. Cadmus used a combination of LaMotte field test kits and laboratory analysis for the nitrate and total phosphorus samples. Routinely nitrate samples were submitted for laboratory analysis and tested in the field to check the accuracy of the field test kits and sampling procedures. In general the accuracy of the kits was quite good. For total phosphorus the kits were used as a screening tool to test for the presence of high phosphorus levels. Whenever a level of 0.2 mg/l was found, a sample bottle was collected for later analysis.

The purpose of the sampling was to provide a brief point-in-time view of the watershed and to detect hot-spots of high concentrations of contamination. In keeping with EPA source water guidance these data were intended to supplement existing data and to focus future efforts. They were not intended however, as a complete water quality survey.

Sampling points are illustrated in Figures 3-3 through 3-5. They cover much of Maiden and Sacony Creeks and most of their major tributaries. Sampling data are also listed Appendix 3-1 in Table form.

Figure 3-3: Reservoir and Main Stem Sampling Points

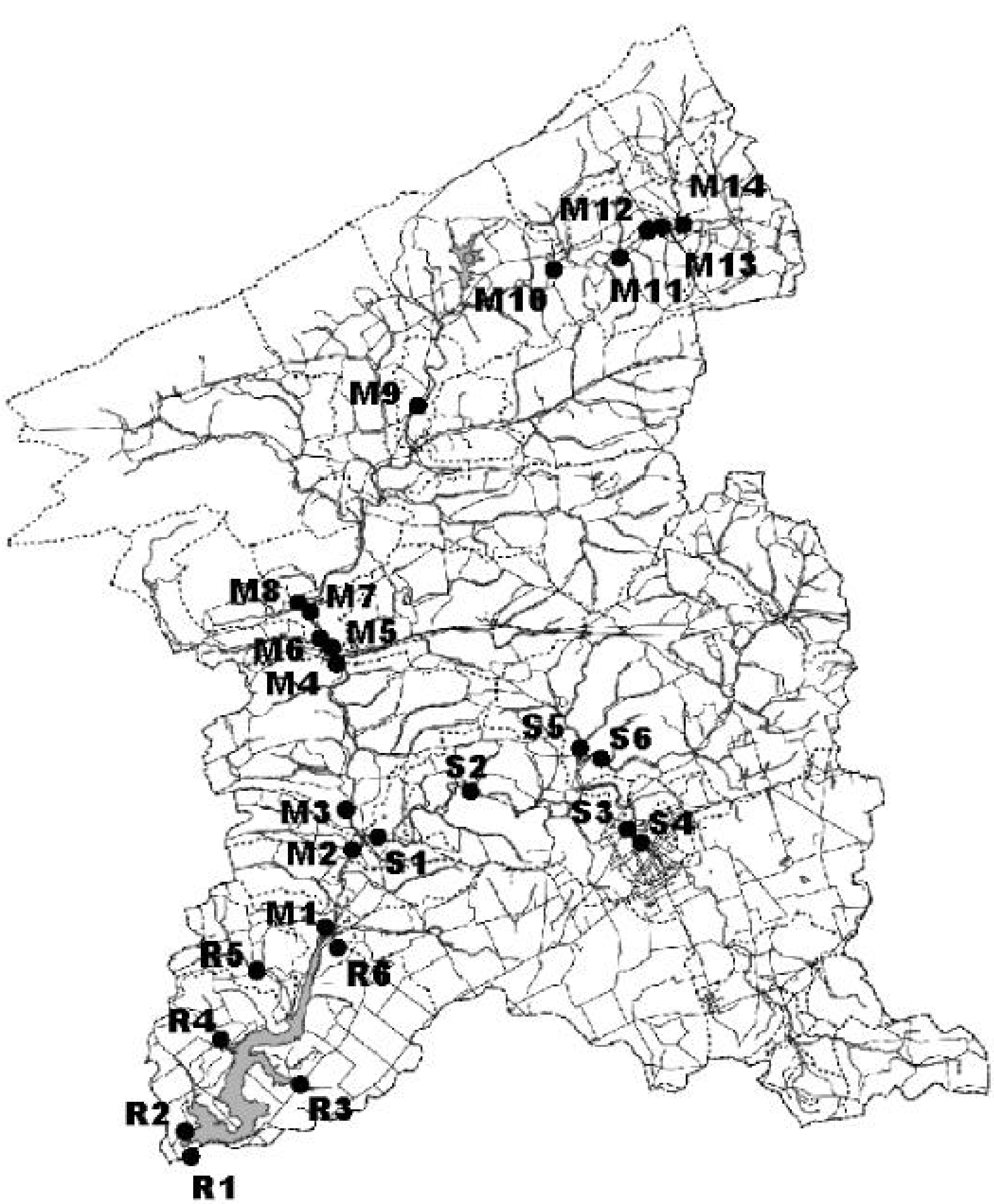


Figure 3-4: Tributary Sampling Points

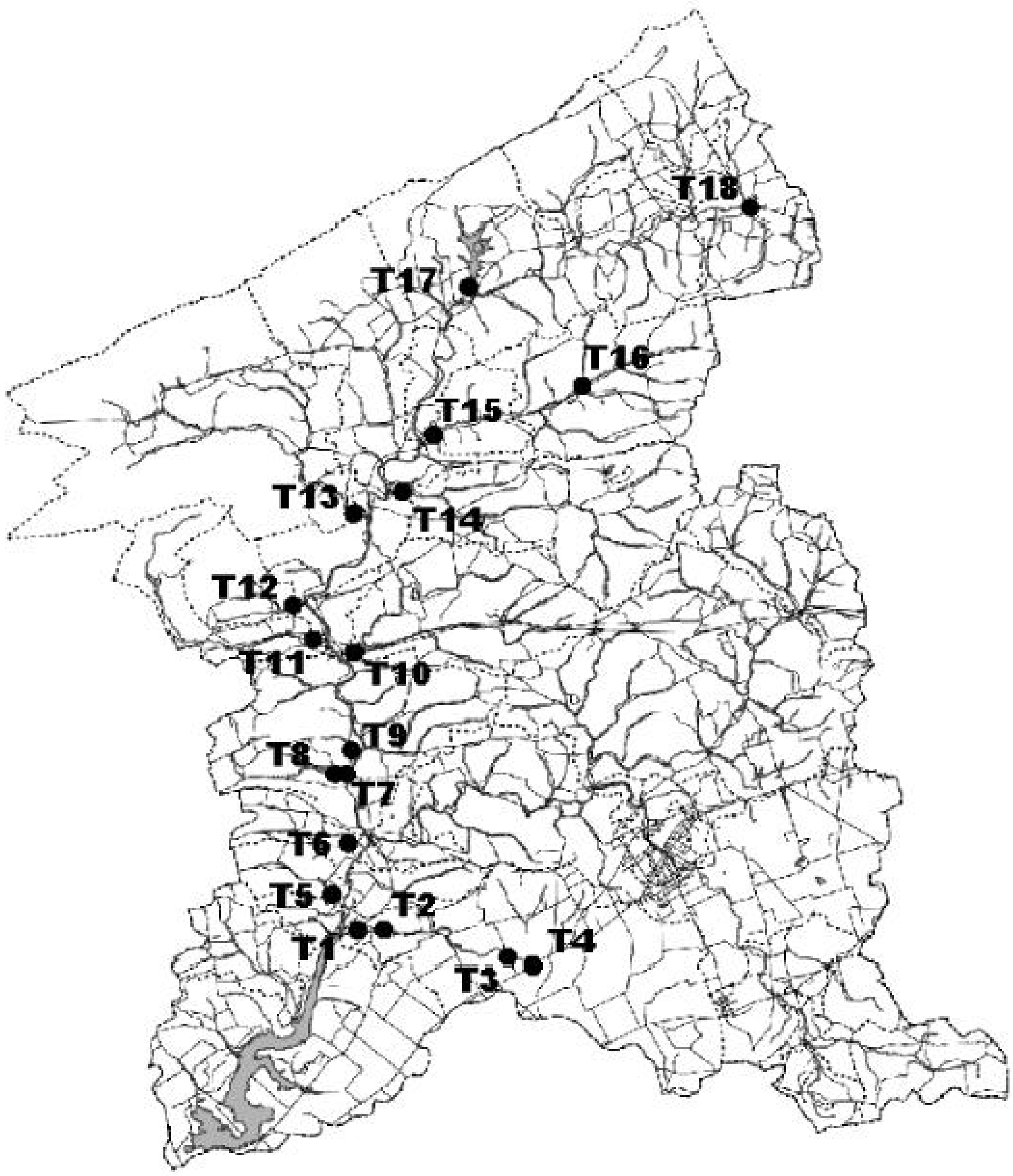
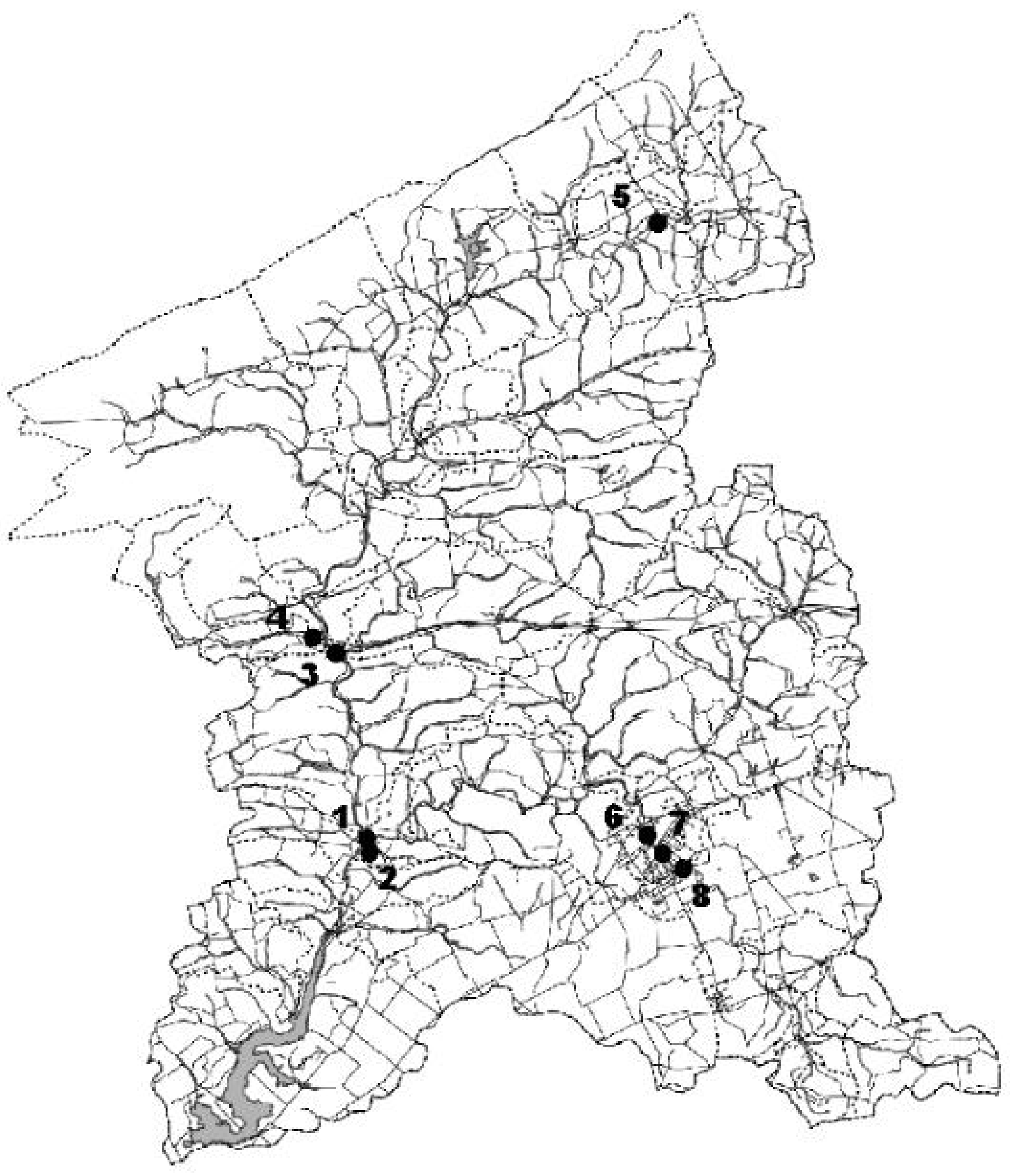


Figure 3-5: Source Sampling Points



4.0 WATERSHED ISSUE 1: FECAL CONTAMINATION

This chapter outlines one of the key issues for the watershed, which is the presence of fecal coliform, an indicator of fecal contamination in many reaches of the watershed, during dry weather. In addition to fecal coliform, contamination by *Giardia lamblia* and *Cryptosporidium parvum* is discussed. For each contaminant, causes of contamination and recommendations are outlined.

4.1 General Discussion

Two protozoan parasites of concern for public water supply systems are the organisms *Giardia lamblia* and *Cryptosporidium parvum*. Although other parasitic and disease-causing organisms may occur in source water, these two are most problematic due to their relative resistance to commonly applied disinfection schemes[25] and the limitations of currently available methods for monitoring their occurrence and determining viability[26].

4.2 Public Health Implications of Protozoan Parasites in Watersheds.

Both *Giardia* and *Cryptosporidium* cause acute diarrheal illness, with significant health implications for immunodeficient individuals. *Cryptosporidium* presents the greatest challenge of the two because its disinfection resistance is several-times higher than that of *Giardia* cysts - far exceeding commonly applied chlorine-based inactivation methods.

Disinfection resistance of *Giardia* and *Cryptosporidium* is attributed to the environmental resistance of their waterborne life cycle stages. These metabolically inert stages, *Giardia* cysts and *Cryptosporidium* oocysts, each have a tough outer wall, which is not easily compromised by practical doses of oxidizing agents. Water treatment

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[25] USEPA. *Cryptosporidium Drinking Water Health Advisory*. HECD Office of Science and Technology, Office of Water, 1993.

[26] Juranek, D.D., ET AL. Cryptosporidiosis and public health: workshop report. *Jour. AWWA*, 87:9:69 (September, 1995)

processes, which physically remove these pathogens from water, are therefore necessary to protect the public health from organisms in source water. Oocyst survival has been reported to exceed several months in cold, dark environments, and to last up to a year in low turbidity water.

Source water protection programs that address these protozoans may provide a significant reduction in the number of organisms reaching a potable water treatment facility. Reducing the overall number of organisms in the source water, minimizing the occurrence of sporadic high-concentration spikes of organisms, and optimizing water treatment performance to provide consistently high levels of particle removal all contribute to a greater assurance that viable organisms will not reach consumers. Unfortunately, the success of protection programs and targeted activities are not easily measurable in quantifiable terms given the limitations of analytical methodologies used to isolate and identify the organisms (see *"Measuring Success"*).

4.3 Sources of *Giardia* and *Cryptosporidium* in Watersheds

Occurrence of *Giardia* and *Cryptosporidium* in a particular watershed is determined by the different sources of the pathogens and the effect of precipitation and runoff events. The environmentally resistant stage of the life cycles of these protozoans are fecal in origin. Therefore, their contamination of a watershed may be caused by wastewater treatment plant effluent, other means of human waste disposal, direct deposition of animal waste, and runoff carrying animal waste. Both organisms are known to be carried by a myriad of mammalian animals with humans, cattle, lambs and pigs known to be capable of contributing large numbers of oocysts. While runoff and animal waste discharges may contribute sporadic plumes of pathogens in large numbers, source waters, which receive wastewater treatment plant discharges, are believed to contribute oocysts on a fairly continuous basis[27].

[27]LeChevallier, et.al. Occurrence of *Giardia* and *Cryptosporidium* spp. In Surface Water Supplies. Applied and Environmental Micro. Sept. 1991 p 2610-2616.

Even source waters with relatively low occurrence of cysts and oocysts in the raw water may experience large concentration spikes at the water treatment plant. This may occur if runoff washes contaminated waste material into the waterway, or if failure of a waste handling facility occurs and results in release of waste material into the source water. Other large concentration spikes may be due to transport of previously captured cysts and oocysts back to the plant headworks in backwash water recycling.

4.4 Sources Of *Giardia* And *Cryptosporidium* And Other Fecal Related Contamination In Reading's Watershed.

In the Ontelaunee Reservoir Watershed, contamination of watercourses by animal and human fecal material is a concern. The sources of fecal pollution may be assumed, to a varying degree, to also be potential sources of *Giardia* and *Cryptosporidium*. cysts and oocysts. Three categories of potential fecal contamination were identified in a 1994 study of Lake Ontelaunee [28].. Potentially significant sources of *Giardia* and *Cryptosporidium* include the following:

- Point sources are potential sources of protozoans. There are four wastewater treatment plants located in the drainage basin, Lynn Township Sewage Treatment Plant (STP), Kutztown STP, Lyons STP, and Moselem Springs Golf Course Wastewater Treatment Plant.

- Septic systems that are either malfunctioning, or have inadequate leach fields, are a source of cysts and oocysts.

- Nonpoint source pollution from stormwater runoff on agricultural lands, particularly runoff from pasture lands of livestock operations also contributes contaminants;

[28]Brown, F.X., Inc. Diagnostic-Feasibility Study of Lake Ontelaunee Pennsylvania, For: City of Reading Bureau of Water, Department of Streets and Public Improvement. April 1994.

Other, less significant, potential sources of cysts and oocyst contamination include recreational uses of the lake, wildlife, and an unknown, but likely, low potential derived from influences of the mushroom production industry.

To place concern over fecal contamination in context, no confirmed viable *Cryptosporidium* oocysts have been found in finished water to date. Elevated levels of cysts and oocysts found in the raw water of the Reading water treatment facilities were attributable to the practice of recycling backwash water to plant headworks. Raw water at the Reading water treatment plant was documented as having a relatively high concentration of oocysts in a sample collected by PADER on 2/13/96. Modifications to the recycling process have subsequently been made to eliminate this source of the parasites to the plant intake.

Therefore, the discussion over fecal contamination is one of a potential threat, but not one of a demonstrated health concern in treated water. That said, increasing concern over *Cryptosporidium*, places a greater burden on treatment systems. Minimizing upstream fecal contamination, especially human sources, affords an additional layer of public health protection by increasing the quality of raw water prior to treatment.

To locate areas of potential fecal contamination, Cadmus performed a screening level of sampling looking for evidence of fecal contamination. The following discussion outlines potential problem areas. Additional study to determine exact sources, such as dye studies were beyond the scope of this study. Cadmus collected 23 fecal coliform samples throughout the watershed on March 20 and 21. It had rained several days prior to our sampling effort. On June 3 Cadmus collected 4 additional samples from pipes that were suspected sources of fecal contamination. On a third site visit, Cadmus collected an additional 17 samples, collecting several samples in areas not previously sampled and collecting repeat samples from several stormwater pipes. In all, 38 different locations were sampled at least once. Sampling results are presented in detail in Appendix 4-1. Sample locations are illustrated in Figures 3-3 through 3-5. As a point of comparison, Table 4-1 shows rough numbers of microorganisms found in untreated domestic wastewater.

Where there is no limit for raw water in the Safe Drinking Water Act, Pennsylvania limits fecal coliform levels for various waters in its water quality standards.

- In recreational waters, fecal coliforms are limited to 200 per 100 ml for the swimming season and 1,000 per 100 ml for the remainder of the year.

- For waters with a designated use of drinking water, total coliforms are limited to a monthly average of 5,000 per 100 ml. Where there is not a set ratio between total and fecal coliforms, it is roughly 5:1. Therefore this limit is equivalent to a fecal limit of roughly 1,000 per 100 ml.

4.4.1 Point Sources

The four wastewater treatment plants located within the drainage basin (Lynn Township Sewage Treatment Plant, Kutztown Sewage Treatment Plant, Lyon STP and Moselem Springs Golf Course Wastewater Treatment Plant) and additional point source dischargers (identified by PA DEP permits) are listed in Table 4-2.

Table 4-1

Type and Numbers of Microorganisms Typically Found in Untreated Domestic Wastewater

Organism	Concentration (number/ml)
Total coliform	100,000 – 1,000,000
Fecal coliform	10,000 – 100,000
Fecal streptococci	1,000 – 10,000
Enterococci	100 – 1,000
Shigella	present
Salmonella	1 – 100
Pseudomonas aeroginosa	10 – 100
Clostridium perfringens	10 – 1,000
Mycobacterium tuberculosis	present
Protozoan cysts	10 – 1,000
Giardia cysts	0.1 – 100
Cryptosporidium cysts	0.1 – 10
Helminth ova	0.01 – 10
Enteric virus	10 - 100

Source[29]

Cryptosporidium can pass through wastewater plants. Any plant could, therefore be a source of these protozoans. Thinking on the fate, transport, and sampling procedures for these protozoans is still evolving. There is probably little for a water coalition to do regarding these plants at present. Long term, regulations and practices in wastewater may change as understanding in this area evolves.

[29] Tchobanoglous, George, and F. L. Burton. 1991. Wastewater Engineering: Treatment, Disposal, and Reuse. Metcalf and Eddy, Inc., McGraw-Hill Publishing Company: New York. Page 110.

Table 4-2

Point Source Discharges in the Lake Ontelaunee Watershed

Name	Address	Creek/Stream	NPDES Permit #
Allentown Cement Company	Fleetwood	Maiden Creek	PA001789
Camsco Farm B	Maidencreek Township	Peters Creek	No number provided
Martha Scott Apartments STP	Richmond Township	Moselem Creek	PA0053520
Moselem Development Co.	Richmond Township	Moselem Creek	PA0031348
Youse, Richard	Virginville	Un-named Tributary to Maiden Creek	PA0084344
Kutztown Foundry, DIV	Kutztown Borough	Sacony Creek	PA0070335
Kutztown Municipal Sewer Authority	45 Railroad Street Kutztown Borough	Sacony Creek	PA0031135
Schaffer, Kevin, S	Maxatawny Township	Mill Creek	PA0053155
Highland Estates/SEW	RR 2 Kutztown Borough	Un-named Tributary to Mill Creek	PA0070122
Gaffney, James J - STP	RR 1 Kempton	Stony Run Creek	PA0053708
Blue Rock MT Spr/IW	Lynn Township	Un-named Tributary to Ontelaunee Creek	PA0012343
Lyons WWTP	Lyons	Sacony Creek	Indicated by DEP sanitarian. Not in databases.
Lynn Township SEW AUTH	6949 Lochland Rd, New Tripoli, 18066 (Located on Allemangle Road)	Ontelaunee Creek	PA0070254
Paul Borman, Single Res. STP	7221 Borman Rd, New Tripoli, 18066	Un-named Tributary to Ontelaunee Creek	PA0062901

Note: The discharges to Pine Creek included in several previous studies on the Maiden Creek Watershed are actually discharges to a Pine Creek located in Schuylkill County, outside and northwest of the watershed.

Other, smaller point sources listed in previous studies include ones on Stony Run, Blue Rock Creek, Mill Creek, and Moselem Creek. While none of these point sources was studied in detail, sampling in these Creeks showed no high fecal coliform concentrations, except a March sample that showed a bacteria concentration greater than 400 per 100 ml at Mill Creek at Gun Club Road. While the source of the bacteria is not known and is not necessarily the listed point source, further investigation may be warranted.

4.4.2 Stormwater Sources of Fecal Contamination

There has been historical concern that unsewered areas adjacent to the Maiden Creek, including Virginville and Lenhartsville, are sources of human fecal material. A Richmond Township comprehensive plan [30] notes that there is no public sewer service in Richmond Township, and that there are "extensive problems with failing septic tank systems in…the Village of Virginville.… the long term solution to Virginville's failing septic tanks will probably involve a package sewage treatment plant."

Cadmus field observations noted high housing densities in areas not served by a wastewater treatment plant. On one occasion, wastewater was observed flowing down Route 143 in Virginville towards Sacony and Maiden Creeks. An operating outhouse was located in Lenhartsville, although it is well back from Maiden Creek. In a previous study[31], samples of 9 tributaries in the watershed showed fecal coliform values ranging from 200 to 3,100 during a storm event and 20 to 290 during winter base flow. Fecal coliform (FC) and fecal streptococcus (FS) values from the study are shown in Table 4-3. In general, the bacteria concentrations for both species were much higher during storm events.

During Browne's study, average fecal coliform (FC) concentrations for the inlet and outlet were 2,040 and 229 colonies per 100 ml, respectively. Failing septic systems were listed as the suspected cause of elevated fecal coliform concentrations in the lake.

Cadmus sampling found fecal coliform concentrations greater than 10,000 per 100 ml of sample on at least one sampling date in the following pipe or gutter locations:

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[30] Richmond Township and Fleetwood Borough Joint Comprehensive Plan, March 10, 1997.

[31] F. X. Browne, Op. Cit.

- Stormwater pipe, in Maiden Creek, just downstream of Lenhartsville
- Stormwater pipe, in Furnace Creek, in Lenhartsville
- Stormwater pipe, in concrete bulkhead in Virginville
- Gutter wash in Virginville

Table 4-3
Fecal Bacteria Concentrations Winter 1992/1993

Tributary	11-24-92			1-21-93		
	FC (#/100ml)	FS (#/100ml)	FC:FS[32]	FC (#/100ml)	FS (#/100ml)	FC:FS
Maiden Creek	480	720	0.67	80	50	1.60
Sacony Creek	1200	1,000	1.20	120	40	3.00
Peter’s Creek	1200	840	1.43	20	10	2.00
Stony Run	840	1,050	0.60	290	10	29.00
Ontelaunee Creek	680	240	2.83	50	5	10.00
Furnace Creek	3,100	1,740	1.78	10	5	2.00
Pine Creek	2,000	170	11.76	130	20	6.50
Kistler Creek	200	250	0.8	130	20	6.50
Moselem Creek	2,280	1,640	1.39	130	30	4.33

Source[33]: F. X. Browne, Inc.

The sample collected in a stormwater pipe roughly 100 yards upstream of Furnace Creek’s mouth had an extremely high fecal coliform concentration. A second stormwater pipe in Virginville also showed strong evidence of fecal contamination.

For a particular pipe or stream it is difficult to determine whether fecal bacteria

[32] Note that the FC/FS ratio for discerning between animal and human sources is no longer in favor because of different die-off rates of the two organisms. In fact Furnace Creek referenced as a septic problem in that study, and suspected as one in this study showed a FC:FS ratio of 2 or less for both samples, placing it in the intermediate range where either human or animal sources could be the cause of contamination.

[33] F.X. Browne, Inc. Op. Cit.

come from people or animals. For example in one pipe where bacteria counts varied widely between samples, it is possible that the bacteria come from animals seeking refuge in the pipe. The stormwater pipe located on the south bank of Furnace Creek just west of Route 143 has a different signature that points more strongly towards human fecal contamination. Samples collected in June and July had concentrations of 2,550,000 and 5,000 respectively. During sampling a septic odor was evident in the vicinity of the pipe. The lower concentration in July may have resulted from the stream backflowing into the pipe. The nitrate plus nitrite (0.64 mg/l), phosphorus (1.5 mg/l) and ammonia (9.6 mg/l) concentrations are consistent with domestic wastewater that has been diluted and has had some phosphorus and ammonia removal in soil. Table 4-4 shows typical nutrient concentrations of untreated wastewater for low and medium concentrated flows.

The high fecal coliform counts in Virginville and Lenhartsville should receive immediate attention. The bacteria may also indicate sources of both *Giardia* and *Cryptosporidium.* Recommendations for further action are discussed later in this section.

4.4.3 Other Nonpoint Sources of Fecal Contamination

Cadmus collected numerous samples in the watershed with elevated fecal coliform counts. The counts range from few (<2 per 100 milliliters of water) to counts in the thousands, and tens of thousands. In contrast, a sample collected in Lake Ontelaunee at the dam had a count of 50 per 100 ml. This may be because of die-off and sedimentation of fecal bacteria in the reservoir. The average retention time of the reservoir is 23 days, but is longer during periods of relative low flow.

Table 4-4

Typical Concentration of Untreated Domestic Wastewater (in mg/l)

	Concentration	
Contaminants	Low	Medium
Total Nitrogen (as N)	20	40
Organic	8	15
Free ammonia	12	25
Nitrites	0	0
Nitrates	0	0
Total Phosphorus (as P)	4	8
Organic	1	3
Inorganic	3	5

Source[34]

Concentrations greater than 1,000 in 100 ml of sample on at least one sampling date were found in the following streams. The underlined locations had concentrations greater than 10,000:

- Unnamed tributary to Maiden Creek near Onyx Cave
- <u>Tributary formed by outflow from Christman's Lake at Route 143</u>
- <u>Pine Creek at Route 143</u>
- Kistler Creek at Kistler Valley Road
- <u>School Creek at Route 143</u>
- Sacony Creek, just upstream of its mouth

It is difficult to discern between human- and animal-derived nonpoint sources of fecal material without detailed study. The primary source of animal fecal material is livestock, primarily cows, and to a lesser extent, wildlife including waterfowl populations. Human fecal material can come from direct connections of septic systems to stormwater drains, ponding of septic systems, and other malfunctions of septic systems.

[34] Tchobanoglous, Op. Cit. Page 109

Because Lake Ontelaunee is a public water supply, access is limited to non-contact and non-boating activities. However, much of the direct shoreline is open to the public for recreational activities. Fishing, hunting, walking and biking are primary public uses. These may potentially contribute some contaminants to the water, depending on the manner in which waste disposal facilities are provided and utilized. Waterfowl, small game, large game, and ice fishing also provide some potential for direct fecal contamination of the water.

The mushroom production industry is a significant industry within the watershed boundaries. However, it is not known if the compost used for mushroom growing is a contributor of cysts or oocysts - this depends on the methods used to manufacture the compost. Liquid runoff from the mushroom growing facilities is reported to be minimal, and it is assumed coinciding cyst/oocyst contamination would also be minimal.

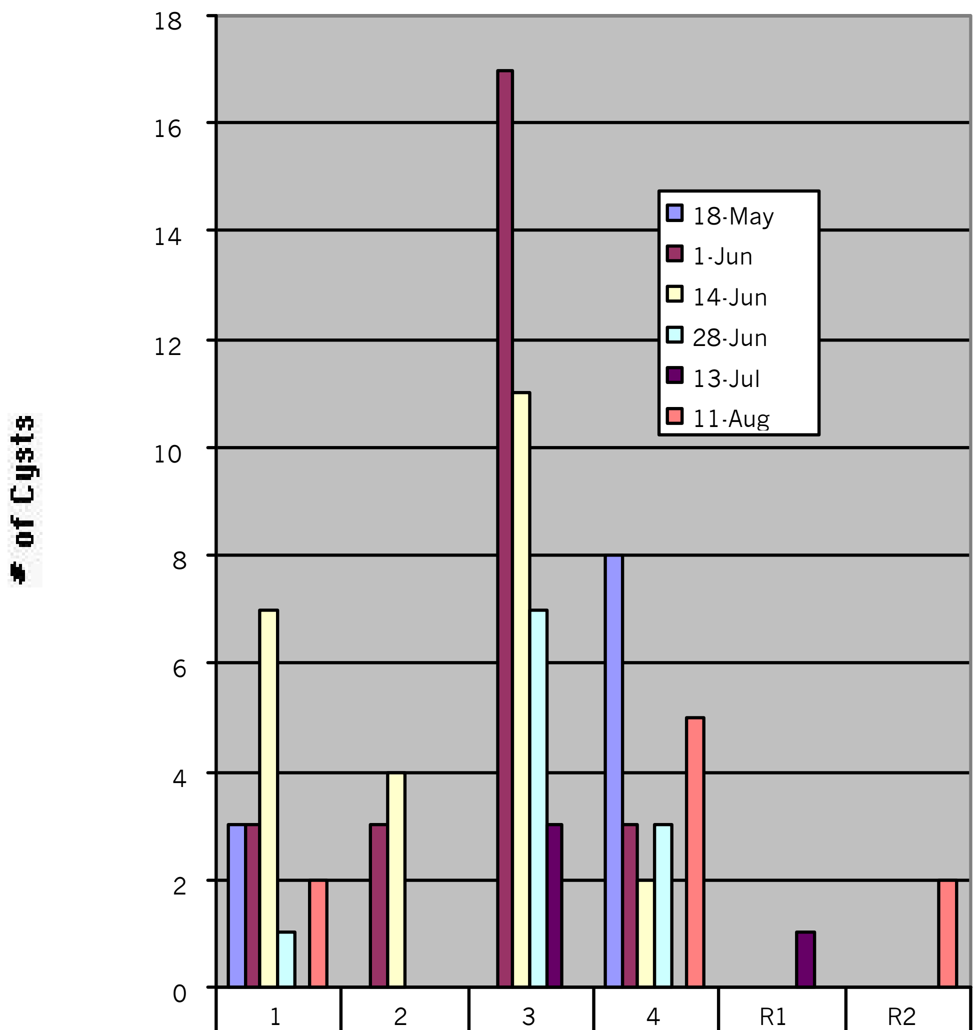
4.4.4 *Giardia* and Cryptosporidium Sampling

On May 18, June 1, 14, and 28, July 13, and August 8, the Pennsylvania DEP sampled 6 sites in the watershed for *Giardia* and Cryptosporidium. The results are presented in Tables 4-5 and 4-6. Sample locations and sample date weather comments are presented in Table 4-7. Sample sites are pictured in Figure 4-1.

The data for *Giardia* and Cryptosporidium vary substantially between sites and between sampling events. The sampling sites visited for each date also vary. For both organisms, counts were highest on June 1, following a thunderstorm. Counts for *Giardia* were also noticeably higher on June 14, a period of high flow, but not for *Cryptosporidium*. For *Giardia* cysts, Site 3 had counts consistently higher than the other stations. Because of the low counts of oocysts, no pattern between stations was discernable for *Cryptosporidium*.

Table 4-5

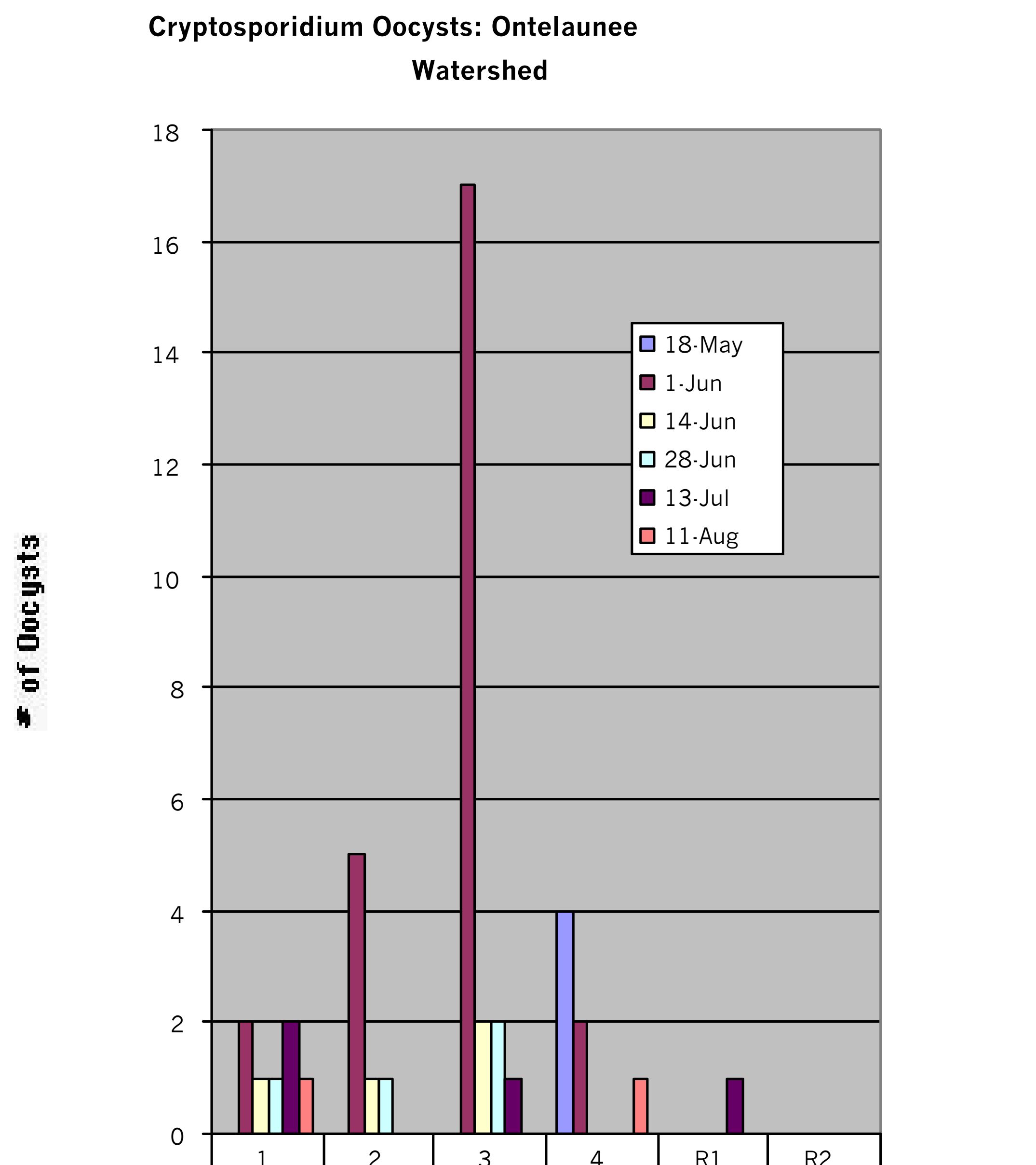
Giardia Cysts: Ontelaunee Watershed



	1	2	3	4	R1	R2
18-May	3	0	0	8		
1-Jun	3	3	17	3		
14-Jun	7	4	11	2		
28-Jun	1	0	7	3		
13-Jul	0		3		1	0
11-Aug	2			5	0	2

Sample Sites

Table 4-6



	1	2	3	4	R1	R2
18-May	0	0	0	4		
1-Jun	2	5	17	2		
14-Jun	1	1	2	0		
28-Jun	1	1	2	0		
13-Jul	2		1		1	0
11-Aug	1			1	0	0

Sample Sites

Table 4-7

Sampling Weather Notes and Locations

Date	Weather
5-18-98	No rain
6-1-98	Thunderstorm previous night
6-14-98	Rain, mod/high flow, turbid
6-28-98	Light rain
7-13-98	No rain
8-11-98	No rain
Sample Site	**Location**
Site 1	Maiden Creek at Pine Creek
Site R1	Maiden Creek at Pine Creek
Site 2	Maiden Creek Upstream of Sacony Creek
Site R2	Tributary to Maiden Creek
Site 3	Sacony Creek, upstream of mouth.
Site 4	Sacony Creek at Kutztown

Figure 4-1

4.5 Summary of Bacteriological Observations

Four stormwater pipes and gutters and three streams had samples with fecal coliform concentrations greater than 10,000 colonies per 100 ml. None of these samples was collected within 24 hours of any significant rain event. Because the samples were collected in relatively dry weather they point to direct contamination of the flows sampled. The majority of the contaminated samples collected in the stormwater pipes are almost certainly of human origin. These data call for immediate further study and rapid action. An additional three stream locations had concentrations between 1,000 and 10,000 during relatively dry weather and low flow. These values are much larger than those found historically, and are indications of direct fecal contamination.

4.6 Recommendations for a Monitoring Program for Fecal Contamination

To design and implement a successful monitoring program, reasonable expectations and goals must be established. Because potential sources of cysts and oocysts are well documented in the watershed, it would be reasonable to assume that some degree of contamination of the source water by these protozoans will continuously occur. It is also reasonable to assume that monitoring raw water concentrations at the water treatment plant intake would be problematic because of the significant algal blooms experienced in the eutrophic lake.

A source water protection plan focusing on protozoan parasites should concentrate on minimizing the contributions of controllable activities. A monitoring program could be targeted to measure the success of project sites or monitor the success of implementing BMPs at high-risk sources of cysts and oocysts (such as livestock operations involving calves or lambs). It may also be appropriate to incorporate *Giardia/Cryptosporidium* sampling at demonstration sites of agricultural BMPs, to demonstrate to farmers and agriculture extension agencies, the effectiveness (or lack of effectiveness) of BMPs in reducing *Giardia/Cryptosporidium* concentrations.

Data collected for this type of study must be evaluated within the limitations of the analytical methodologies used. A risk with current analytical methods is that they do not detect subtle increases or decreases in the concentration of organisms. They may also indicate the absence of the parasites when low levels occur. In addition sampling intervals may not capture sporadic high-concentration spikes.

Analytical methodologies currently employed to recover and identify cysts and oocysts from water are limited by poor recovery efficiencies and a low analytical precision rate. In particular, high concentrations of algae and other particulate material significantly confound currently available methods. Investigators of waterborne occurrence of these parasites also report difficulties discerning the significance of low and undetectable levels of the organisms in source water[35]. Additionally, some sources of these parasites in Reading's watershed would be expected to produce sporadic releases of the organisms in highly variable concentrations.

The uniqueness of individual waste handling operations, whether agricultural or municipal, makes it difficult to identify representative protozoan sample collection locations. Considerations for sample collection location include ensuring an adequate depth in the water column, whether the protozoan 'plume' is homogeneously mixed in the stream, and maintaining the required distance from shore to capture representative samples. Timing of samples is critical to obtain concentration spikes associated with runoff events or waste disposal system failures. Collecting an adequate number of samples is necessary to adequately characterize occurrence, given a diverse set of variables influencing contamination of the source water.

Despite these drawbacks, some utilities have established watershed monitoring programs. (Generally the systems utilize in-house analytical capability to limit costs.) They find the information useful to identify aberrations in raw water concentrations that trigger investigations of watershed activities, and to locate areas of the watershed warranting focused improvement programs. Often the sample collection and analysis procedures are modified to suit conditions at the sample site. Some flexibility is

[35] Crockett, C.S. and C.N. Haas. Understanding Protozoa in Your Watershed. Jour. AWWA. 89:9:62 (Sept. 1997)

available in the methods, however, detection limits, recovery and viability remain key issues regardless of the technique used.

Another strategy is to monitor for indicator organisms. Fecal coliform, while a useful test for general fecal contamination has a shorter survival time than many pathogens, particularly protozoan cysts. Fecal streptococci and *Clostridium perfingens* are other indicators that are of fecal origin. They are relatively easy to recover and survive better than coliforms in the environment.[36] Cadmus recommends that Reading consider monitoring for these indicators in a watershed sampling program.

[36] The Cadmus Group, August 1996. Cane Creek Reservoir Watershed Study. Page 4-28.

4.7 Septic System Management and Regulation

4.7.1 Sewage Enforcement Plans

Act 537, enacted by the Pennsylvania legislature in 1966, requires every municipality to develop and maintain an up-to-date sewage enforcement plan.[37] DEP's Water Program can reimburse up to 50 percent of the implementation costs.

Although DEP has the statutory and regulatory power to require these plans, municipal governments (such as a township board of supervisors, borough council or city council) are charged with developing and implementing an approved official sewage facilities plan that addresses existing or anticipated sewage disposal needs or problems. These plans may be updated when the municipality determines that the current plan is inadequate to meet the municipality's needs, or when DEP deems that a revision is necessary. In many cases, the plans are updated when new subdivisions are proposed. A municipality is responsible for administering its sewage disposal plan, and for operating and maintaining existing sewage facilities.[38] Many communities may not have completed the plans, however, according to interviews with the sewage enforcement officers, who are charged with overseeing the installation and compliance of on-lot septic systems (SEOs).

A resident of or a property owner in a municipality may request that DEP order the municipality to revise or implement its official plan. The resident or property owner must be able to show that the official plan is not being implemented; is inadequate to meet the resident's or property owner's needs; or that existing sewage facilities within the municipality are not being properly operated and maintained. This demand can only be made after a prior written demand had been submitted to the municipality, followed by

[37] The sewage disposal regulations of Pennsylvania's Department of Environmental Protection (DEP) are described in Title 25, Chapter 71 of the Commonwealth of Pennsylvania Code. They are promulgated under the Pennsylvania Sewage Act (Act 537).

[38] Act 537 of 1966, as amended; Pennsylvania Code, Title 25, ß 71.11, 71.12, and 71.71.

either a written refusal from the municipality or a failure by the municipality to respond to the complainant within 60 days.

If DEP orders the municipality to revise or implement its official plan, the municipality and the DEP will work out a timetable. If the municipality fails to revise or implement its plan within an acceptable time period, the plan will be placed in a disapproved status.

4.7.2 On-Lot Sewage Disposal Systems

Responsibilities for on-lot sewage disposal systems lie with local agencies. They are responsible for investigating and resolving any disputes or malfunctions. A local agency may be any local government agency (such as a single municipality, a combination of municipalities, or a county or joint county Department of Health) that is able to administer its on-lot sewage disposal permit program. The local agency employs one or more certified SEOs to issue, deny, or revoke septic system permits in accordance with state regulations and standards; inspect newly-installed systems to ensure proper installation; and investigate and resolve septic system malfunctions. SEOs have jurisdiction over on-lot sewage systems that have a capacity of 10,000 gallons a day or less. SEOs also have jurisdiction over any individuals or restaurants that discharge directly into streams.

DEP provides grants and reimbursements to local agencies and SEOs for permitting and other enforcement activities. DEP may issue a formal order to any municipality that does not adequately administer its sewage disposal program, or it may place the municipality's plan in disapproved status. Disapproved status means that a limitation will be placed on the issuance of on-lot system permits and that the Department will not issue any further permits that may be needed under the Clean Streams Law.[39]

Complaints about malfunctioning on-lot septic systems should be reported directly to the local agency, SEO, or the local government officials with jurisdiction in the municipality where the malfunction exists. Depending on the local agency, complaints may have to be received in writing.

The SEO will conduct an initial site investigation to document the conditions. If there is a malfunction, the SEO will try to determine the causes of the malfunction and to decide the extent of the repair needed. The local agency may issue a letter notifying the property owner of the alleged malfunction and allowing for voluntary compliance if a malfunction exists, or, he or she may issue a Notice of Violation. A Notice of Violation requires the submission of a sewage permit application for proper system repair.

After any necessary site testing has been done and an acceptable system design has been submitted, the SEO will issue the responsible property owner a permit to repair or replace the malfunctioning system,. If the responsible property owner fails to repair the malfunction, the SEO has the authority to fine or pursue legal action against the responsible property owner.

If the SEO fails to respond to the complaint in a satisfactory manner, the person making the complaint should go back to the local agency and renew the complaint. DEP will only take action if there is a pattern of unresponsiveness on the part of an SEO or municipality. DEP action could include the suspension or revocation of an SEOs certification or the withholding (or reduction) of a local agency's reimbursement for the administration of the on-lot septic system program.

4.7.3 Role of SEOs in Berks County

In Berks County, there is approximately one SEO for each municipality. Many municipalities hire engineering firms to perform the functions of the SEO.

Richmond: Richmond has hired an engineering firm to function as its SEO. The firm conducts two or three inspections a day among the communities it represents. More than half of the systems that are installed in the area are elevated sand mounds, which

[39]Act 537 of 1966, as amended; Pennsylvania Code, Title 25, ß 71.12, 71.32, 71.73, 71.74.

require four inspections during installation. In-ground systems will generally have one or two inspections. They also have authority over individuals / restaurants discharging into the stream.

If there is a complaint, for example, if the firm receives a call about an improper discharge or leak, the firm contacts the responsible party and requires them to correct the malfunction. The SEO position has adequate enforcement authority: they may issue fines and take their case to court, if necessary. It is not unusual to issue fines, but situations generally do not require them. The SEO Richmond has never required DEP's help to resolve a situation.

Lenhartsville: Unlike Richmond, Lenhartsville hires a resident as its SEO. The SEO does not perform regular inspections of the systems. When he receives a complaint, he does an on-site inspection and may require the responsible party to either repair or replace their system. He also performs an inspection when property changes hands. If the septic system does not pass the inspection, either the seller or the buyer must pay to have the system repaired or replaced. Regarding the high bacterial counts from the field samples, the SEO was not aware of any problems. He noted that there is a large resident population of Canada geese and mentioned potential problems from cattle farms on Kistler Creek. In 1993, F. X. Browne, Incorporated met with the individual that was the SEO at that time, and a septic problem in Lenhartsville was acknowledged.

In a separate 1996 report, problems with on-lot septic systems were identified. Berks County worked with Greenwich Township and the Lenhartsville Borough to write a joint comprehensive plan. A component of the plan is water and sewer planning. Under the plan three goals were identified.[40]

- Protect the groundwater supply and the water quality of the region.
- Consider conducting a joint feasibility study with the Township and the Borough to examine the long range feasibility of central water and sewer treatment.

[40] Greenwich Township and Lenhartsville Borough Joint Comprehensive Plan. 1996.

- Provide sufficient setbacks from the Maiden and Furnace Creeks for on-lot septic systems.

4.7.4 Procedures for Further Funding

Under PA Act 537, DEP provides up to 50 percent reimbursement for sewage improvements based on Plans developed by communities. A community must first develop such a plan to be considered for funding. At the writing of this report neither Lenhartsville nor Richmond Township have prepared these plans. As a first step the Reading Water Authority may want to contact James Novinger of the DEP at (717) 705-4707 to discuss the plan writing and funding process for small communities such as Virginville and Lenhartsville.

4.8 Recommendations

In this chapter we identified several likely sources of human fecal contamination and additional chronic sources of animal fecal contamination. We recommend that the Reading Water Authority and the partners that it regularly meets with establish an ongoing subcommittee to examine fecal contamination and explore possible short- and long-term solutions. Accordingly, there are several roles for a watershed coalition to take in approaching this problem. Additional sampling is necessary to further determine the source of the identified problems. A coalition might pool resources to conduct regular sampling, where different parties contribute various components. For example, Berks County Conservancy might supply volunteer labor, or labor under its grant. The water authority might arrange for sample analysis either in its own laboratory or in another laboratory. DEP could provide guidance in sample plan development. The SEOs could work with the group to focus on problem areas. These are examples of cooperative arrangements.. The actual details must be agreed by the committee members.

4.8.1 Watershed Coalition and Subcommittee

A coalition could help publicize the need for action in these problem areas and locate sources of assistance. Key coalition members might include the Berks County Planning Commission, the Berks County Conservancy, local municipal officials, Pennsylvania health officials, and the Pennsylvania DEP, Division of Drinking Water Management.

The Subcommittee would coordinate activities, set goals, and examine results of sampling programs. Related activities would include:

- Establishing a monitoring program in the watershed to detect chronic and episodic sources of fecal contamination.
- Approaching state wastewater authorities concerning funding availability for small unsewered communities.
- Examining the practicality of developing a *Giardia* and *Cryptosporidium* sampling program.
- Using, in part, existing institutions and resources to establish a program for manure and livestock handling BMPs that minimize manure contamination of the watershed.

Each of these points is discussed below.

4.8.2 Exploring Assistance for Small Unsewered communities

As discussed above, a key element of obtaining funding assistance from Pennsylvania for Lenhartsville and Virginville is an Act 537 Plan. While it is certainly not the Reading Water Authority's responsibility or authority to advocate on these town's behalf, Reading may want to clearly state its position and the problem of unsewered areas to their representatives. Similarly, prioritization for capital grants under the State Revolving Loan fund for wastewater should be pursued. While the small population of these townships may not elevate them in the ranking for loans, their impact on source waters for the Reading Area customers increases the number of people affected significantly.

4.8.3 Sampling

The three stormwater pipes with elevated fecal coliform counts warrant additional investigation. We recommend that the state, in concert with local sewer officials, determine the source of the bacteria. Useful methods include dye tracing and dry weather sampling.

Reading Water Authority should initiate a regular sampling program that examines bacteria, nutrients, and suspended solids in the watershed. Watershed source water protection can serve as an additional layer of safeguards in protecting public health, but this additional layer requires a long-term consistent effort. Long-term sampling can be used to find sources of contamination as we demonstrated by traveling up the Moselem and Sacony Creeks. Where the contaminants are nonpoint in nature, often screening sampling will identify a land use or a stream segment with a contamination problem. Additional study is usually necessary to further define the problem.

4.8.4 Suggested Efforts to Reduce Fecal Contamination in Reading's Watershed

While it is not feasible to completely eliminate *Giardia* and *Cryptosporidium* in the watershed, limiting manure transport to the waterway, and eliminating direct sources of human waste will likely concurrently limit cyst/oocyst contribution from the same sources.

Agricultural best management practices that manage livestock watering facilities, limit soil erosion, and eliminate direct animal access to streams will minimize direct fecal contamination of the waterway. Implementing manure-handling programs that prevent transport of fecal material during runoff events will also be beneficial. Involvement by and communication with the agricultural community will be critical to the acceptance of such BMPs.

Addressing the possibility of failing septic systems or untreated wastewater discharges to the watershed will reveal if these are potential sources of cysts/oocysts. Septic system management, including identification and repair or replacement of failing systems, would eliminate their contribution to watershed contamination.

Establishing a communications link between the three wastewater treatment plants and the water filtration facility would allow advanced notice of treatment upset or other potential causes of increased cyst/oocyst discharge. This would enable water treatment plant operators to prepare for changes in raw water quality and treatment effectiveness.

Working with the DEP sanitarian assigned to the watershed to examine the three municipal dischargers, and as needed, the smaller dischargers in the watershed, would help build this communication link.

Summary Recommendations:

- Establish Watershed Coalition and Subcommittee
- Explore Assistance for Small Unsewered communities
- Establish Sampling Effort
- Implement Efforts to Reduce Fecal Contamination in Reading's Watershed

5.0 READING ISSUE 2: SEDIMENTATION

Erosion of watershed soils and their ultimate transport to the reservoir is a key concern of the Water Authority. The Authority is concerned that sedimentation rates are excessive and that in time sedimentation could reduce the capacity of the reservoir. Observers have noted that the upper reaches of the watershed in Richmond, Perry and Maiden Creek Townships are slowly filling in and reducing the reservoir's depth in those sections. F. X. Browne concluded that the lake had lost roughly 25 percent of its volume or 1,067 million gallons by 1992. Based on a fill date of 1938. this is an average rate of roughly 0.5 percent per year.

5.1 Erosion/ Suspended Solids/Sedimentation

A portion of soil material that is eroded in the upper reaches of a watershed is delivered to the lower reaches of a watershed and ultimately to a reservoir. A portion of the material is released as suspended solids in the waters released by the dam. The remainder of material is retained in the reservoir and becomes sediment on the bottom of the reservoir. The erosion and sediment transport process occurs in all watersheds, even undisturbed ones. The key issue is the rate at which these processes occur.

5.2 Soil Erosion and Transport Processes

Erosion is the process that removes soil from its initial location through dissolution or loosening and allows it to be transported. Eroded soil is transported in a stream by several processes, including suspension and bed load. Lighter particles can become suspended in a stream as suspended solids. Typical sampling examines this portion of transported soil. Heavier particles travel along the bottom or bed of the stream and are called bed load. This material can be missed by water quality sampling. As suspended material and bed load moves down a stream, they can become deposited as sediment as the stream flow slows, because of widening or deepening of the stream. The portion of material that is transported to the bottom of a watershed or subwatershed of interest, is termed delivered sediment or sediment yield. The ratio of sediment delivered to the bottom of the watershed to the eroded soil is termed the sediment delivery ratio (SDR).

Based on the Ontelaunee Watershed's area of 199 square miles, the SDR is roughly 7.5 percent.

5.3 Is Sediment a Water Quality Problem?

Erosion and sediment transport can present several problems to water supplies. High suspended sediment loads that cause high turbidity can complicate water treatment. Turbidity can provide substrates for pathogens, can clog filters or shorten their life, and can make finding cysts more difficult. In Reading, the current filtration goal is 0.1 NTU[41]. High turbidity in raw water makes achieving that goal more difficult. In September 1998, Reading had a reservoir mixing episode in which turbidity and algal counts rose sharply, affecting the treatment process.

Another sediment-related water quality problem is adsorbed pollutants. Generally pollutants with positive charges adsorb or chemically attach to the clay fraction of sediments. While a portion of these pollutants are strongly attached to the sediments, a portion can become dissolved again if conditions such as pH change. A key adsorbed pollutant is phosphorus. Previous studies have shown that much of annual phosphorus export from a watershed occurs during storm events, and that much of that phosphorus is adsorbed onto sediments. Once in a reservoir the sediments can become re-suspended and phosphorus can be released. This internal phosphorus source can fuel eutrophication or enrichment of the reservoir and can cause undesirable algal growth. The algae can cause taste and odor problems in a water supply. Authority staff indicated that taste and odor problems periodically occur in the Ontelaunee Reservoir. Algae also may increase turbidity, and cause significant THM precursor problems. This issue is important to Reading, because they increase their use of disinfectant chemicals during episodes of algal infestations.

Other adsorbed pollutants include heavy metals. Previous sampling of sediments in the Ontelaunee Reservoir showed elevated concentrations of arsenic and lead. The source of the arsenic may be soil derived, and the source of the lead may be historic use of leaded gasoline.

As sediments reduce the capacity of the reservoir, operating flexibility is reduced. Typically reservoir operators draw water from varying depths throughout the year for water quality reasons. Water withdrawal from the surface layer may become undesirable if algal blooms cause unpleasant tastes and odors. Water from lower in the lake may be undesirable depending on seasonal oxygen content of the water and constituents such as manganese. In the Ontelaunee reservoir, the working capacity of the upper layers has been reduced because much of the sedimentation has taken place in shallow portions of the upper reaches of the reservoir.

If sedimentation continues at its present pace, the Authority will need to dredge portions of the reservoir in the future. This is an expensive undertaking, and one that can temporarily change conditions in the reservoir because of release of bottom sediments and increase in the turbidity of the reservoir.

5.4 Rates of Erosion and Sedimentation

Determining precise rates of erosion and sediment transport in a watershed is difficult for several reasons:

- Erosion is determined by field-scale practices. Changes in land cover practices from year to year can change erosion rates by a factor of two or more.
- Erosion is partly caused by physical forces associated with rainfall and water flow over land. For example, the extent to which heavy rainfall is correlated with the timing of plowing in a given year can affect the rate of erosion that year.

[41] Turbidity is measured in NTU or nephelometric turbidity units.

- A relatively small portion of eroded soil reaches a reservoir in a given year. The ratio of delivered material, or the SDR, can be as low as 5 percent for a large watershed. The SDR for a given subwatershed is a function of the soils of that watershed, the ratio of channel length to watershed area and other factors.

Detailed modeling of the watershed's erosion and sedimentation was not a focus of this project. However, several observations based on existing work and limited review of GIS data can help illustrate the magnitude of the sediment load and the uncertainty in precisely determining it.

- Browne developed a coarse relationship[42] between suspended solid load and storm flow using five storm data points. A sixth data point was eliminated because it had much higher values than the other storms. Using this relationship they calculated that roughly 22,201,268 kilograms of solids (22,201 metric tons) were delivered to the bottom of the watershed in 1992. Based on a reservoir trapping rate of 90 percent derived from the average residence time[43], this is an annual sedimentation rate of roughly 20,000 metric tons/yr.

2. Using the sediment accumulation volume measured in Browne's bathrythmic study, and several measured and literature values for the characteristics of accumulated sediments, roughly 3,300,000 metric tons of sediments were deposited in 54 years. This is equivalent to an average rate of roughly 61,000 metric tons/yr., or three times the estimated sediment delivery rate in the bullet above.

3. Cadmus developed a first-order erosion estimate based on literature loading functions. The erosion rate was estimated at roughly 978,000 metric tons per year. Using an estimated sediment delivery ratio of 7.5 percent, and a trapping rate of 90 percent, this is 61,000 metric tons per year.

Cadmus' first-order estimate of average annual sediment load is nearly identical to the apparent sedimentation rate measured by Browne (second bullet). Given the uncertainty in calculating accumulated sediments, for example, an error of 3 inches in average depth yields roughly a 10 percent error), and the coarseness of Cadmus' estimate,

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[42] Browne's work by necessity, was based on a coarse relationship between flow and suspended solid level, and was intended as a first-order approximation. Even with an outlying data point removed, the R^2 of the relationship used to calculate the loading was less than 0.7, indicating a good deal of acknowledged uncertainty in the estimate.

[43] Morris, G. L., and J. Fan. Reservoir Sedimentation Handbook. 1998.

this agreement is surprisingly close. Without additional study, the cause of the variation between these estimates and Browne's estimate of sedimentation is difficult to determine,

Clearly, the upper reaches of the reservoir are filling with sediment. The reason why refining this observation to determine the rate and source of the sedimentation is important is that it can help in sizing engineering solutions for sediment trapping and targeting watershed efforts. We recommend that a detailed study using detailed soil characteristics and detailed agriculture practices be completed to better understand soil erosion and sedimentation. This sedimentation study should include use of a low- to moderately-complex model such as Generalized Watershed Loading Function (GWLF) to investigate sediment loading, and should be done in cooperation with the local conservation district and the NRCS, the local practitioners of soil conservation.

5.5 Sources of Sediment

Cadmus applied a loading function approach to estimate sediment loads by land use and by subwatershed. Because erosion is a field specific process, and because this estimate is intended for prioritizing future efforts, these values should be used for comparison purposes only. Table 5-1 illustrates the results from the loading function analysis. Row crops deliver the most sediment load. While development can deliver a large load per unit area, at present it represents a small portion of the watershed sediment load, contributing on the order of 17 percent.

Table 5-2 shows erosion rates analyzed by subwatershed. Estimates of sediment contribution to the reservoir are not made on this basis because the sediment delivery ratio will vary greatly between subwatersheds, generally decreasing as the distance from the reservoir increases. For example, proportionally less erosion from the Ontelaunee and Upper Sacony Subwatersheds will be delivered to the reservoir than from the Lower Sacony, Moselem, and Reservoir Watersheds. Where the relative proportion of land area and erosion varies it is because of higher or lower concentration of row cropping. For example, Pine Creek, which contains a large amount of undisturbed land, accounts for 9 percent of the watershed area, but only 3 percent of erosion. Conversely, the Lower Sacony accounts for 6 percent of land area but 10 percent of erosion.

Table 5-1

Estimated Sediment Load By Land Use Category

	Land Area (hectares)	Fraction of Total	TP (kg/yr.)	SRP (kg/yr.)	TN (kg/yr.)	Soil Loss (metric tons)	Fraction of Total
Water	707	0.9%	0	0	0	-	0.0%
Developed	630	0.8%	895	298	5071	9,551	15.7%
Pasture	10,120	12.9%	4130	1239	57822	77	0.1%
Row Crops	18,809	23.9%	7947	2384	111264	51,316	84.1%
Forested	28,930	36.7%	1631	815	57071	29	0.0%
Wetlands	19,252	24.5%	0	0	0	-	0.0%
Barren	282	0.4%	27	9	155	42	0.1%
Total	78,730	100.0%	14630	4746	231383	61,015	100.0%

TP – Total phosphorus TN - Total Nitrogen

SRP - Soluble, reactive phosphorus

Table 5-2

Estimated Annual Erosion by Subwatershed

Subwatershed	Land Area	Proportion	Erosion (tons)	Proportion	Delivery Ratio
Kistler Creek	2,529	5.1%	50,158	4.5%	Low
Lower Sacony	3,101	6.3%	110,436	9.8%	Moderate
Mill Creek	5,933	12.1%	138,053	12.3%	Low
Moselem Creek	3,470	7.1%	102,517	9.1%	High
Ontelaunee Creek	10,174	20.7%	154,009	13.7%	Low
Pine Creek	4,615	9.4%	30,712	2.7%	Low
Reservoir Area	3,941	8.0%	88,693	7.9%	High
Maiden Creek	7,798	15.9%	267,904	23.8%	Moderate
Stony Run	2,313	4.7%	40,492	3.6%	Low
Upper Sacony	5,258	10.7%	141,007	12.5%	Low
Total	49,133	100.0%	1,123,980	100.0%	

During March 20 and 21, Cadmus sampled 12 sites for total suspended solids (TSS) to examine baseline conditions. There had been little rain the week before and little variation in sediment concentration was expected. None of the sites had extremely high levels, they ranged from 5 to 40 milligrams per liter (mg/l). The highest level (40) was measured at the mouth of the Sacony Creek and may indicate some erosion in the region. TSS levels in Kutztown were 7 mg/l indicating that the source of the sediment is probably in other reaches of the Sacony watershed. Limited follow –up sampling on June 3 and June 6, showed elevated TSS again at the mouth of the Sacony Creek (53 mg/l). On July 31 the Lynn POTW had a TSS of 16 mg/l, a value consistent with secondary treatment. Because none of the sampling rounds was a storm event, elevated TSS values were not expected, and the sampling was intended as a baseline review. Of the 14 samples collected, the two collected at the mouth of the Sacony are noteworthy in that they are higher than 13 of 14 TSS samples collected by Browne at the Reservoir, and higher than 3 of 6 storm values collected.[44] Considered in the context of Cadmus' loading function analysis, the lower Sacony accounts for 8 percent of land area but 13 percent of erosion. In addition, because the lower Sacony enters Maiden Creek only 2-1/2 miles

[44] Each of the six storm values was actually an average value from multiple samples collected during the storm event.

above the reservoir, it is closer than all but Moselem Creek and therefore will have a higher sediment delivery ratio. Its proportional contribution to sediment in the reservoir is therefore likely to be much greater than 13 percent.

During the watershed survey, large sediment deposits were noted in Maiden Creek at Route 662 and in the nearby mouth of Moselem Creek.

Table 5-3

TSS Sampling for the Lake Ontelaunee Watershed

Sample ID	Location	Sampling Date	TSS (mg/l)
R1	Ontelaunee Dam, Downstream	March 19-20, 1998	7
R2	Ontelaunee Dam	March 19-20, 1998	6
R4	Tributary at Ridge Road	March 19-20, 1998	20
R5	Bailey Creek	March 19-20, 1998	16
M1	Maiden Creek at 662 N	June 6, 1998	7
M6	Maiden Creek, West Bank Above Furnace	March 19-20, 1998	15
S1	Sacony Creek, at Mouth	March 19-20, 1998	40
		June 3, 1998	53
S2	Sacony Creek at Christman Rd	June 6, 1998	4
S3	Sacony Creek, Upstream of Kutztown POTW	March 19-20, 1998	7
S4	Sacony Creek, Downstream of Kutztown POTW	March 19-20, 1998	7
PS6	Kutztown POTW	March 19-20, 1998	22
T1	Moselem Creek near 662	March 19-20, 1998	14
T8	Christman's Lake, Outflow	March 19-20, 1998	7

Total suspended solids (TSS) were measured at the inflow and outflow of Lake Ontelaunee during 1991 and 1992. At the inlet station, the average baseflow surface TSS concentration was 16.77 mg/l, with a range of 0.05 to 73.00 mg/l. During storm events, TSS concentrations ranged from 18.00 mg/l to 126 mg/l. TSS concentrations at the outlet were noticeable lower than for the inlet, probably as a result of sediment trapping by the reservoir. Average concentrations were 7.7 mg/l with a range of 0.05 mg/l to 14.8 mg/l. A related depth study indicated that most sediment deposition occurs near the Maiden

Creek inlet.[45] In tributaries to Maiden Creek during storm events, TSS concentrations were two to twenty times higher than baseflow concentrations.

Erosion of stream channels themselves also contributes to sediment load. While the precise contribution of eroded channels is difficult to quantify without very specific investigations, the contribution of this source is probably overwhelmed by agricultural land use. Consider, for example, the Kistler Creek subwatershed. It produces roughly 50,000 tons of erosion per year, from an area of 2,530 hectares or 6,249 acres. The length of the main channel is approximately 10 miles. Hypothetically, assume that roughly 10 percent of the channel were eroding badly, losing 6 inches of soil per year from a 3 foot high bank. This is 7,500 cubic feet of soil. Assuming a bulk density of 2 g/cm^3, this is 469 tons of soil, much less than the roughly 50,000 tons discussed above. Even allowing for a much greater sediment contribution from the eroded stream banks, this example demonstrates that the field soil erosion is roughly 100 times greater than stream bank erosion.

5.6 How Can Erosion and Sediment Delivery be Decreased?

There are essentially two main strategies for reducing sediment load in the reservoir and in raw water: 1) reduce erosion upstream in the watershed; and 2) reduce delivery of eroded soils to the reservoir. As described previously, the majority of the watershed's sediment load is derived from row cropping, with developed lands a distant second. Therefore, any sediment reduction strategy needs to focus on croplands. While further monitoring and modeling can help prioritize efforts, preliminary results and the principle of sediment delivery discussed above point to focusing on land use near stream channels in the Lower Sacony.

Techniques for reducing sediment load can be categorized into nine strategies offered by Morris and Fan[46]:

[45] F.X. Browne, Inc. Diagnostic-Feasibility Study of Lake Ontelaunee. City of Reading, Berks County, Pennsylvania, April, 1994.

- Fit the activity to the soil, climate, and terrain
- Minimize the area and duration of soil disturbance
- Protect denuded soils
- Maximize vegetative cover
- Maximize infiltration
- Manage slopes to prevent flow concentration
- Prepare drainage ways to handle concentrated flows
- Trap sediment before it leaves site
- Protect and preserve vegetation in natural riparian buffers

Of the above principles, Strategy #1 is a large planning task involving federal and state programs that encourage farmers not to farm in areas such as wetlands and on highly erodible soils. Strategies #2 through #7 are the principles behind many forestry, construction, and agricultural best management practices (BMPs). Strategy 8 can involve both BMPs and riparian buffers. The last strategy can include a combination of farm assistance programs, cooperative stream bank programs, water system ownership or leasing of riparian lands, and land preservation.

Agricultural BMPs

There are many resources describing the design, installation, and performance of agricultural BMPs, and many can be accessed by the local Conservation District and the NRCS. Following is a list of selected organizations providing resources about BMPs.

[46] Morris G. L., and J. Fan. Op. Cit.

Table 5-4
Information Sources for Agricultural BMPs

Organization	Website	Address	Focus
The Soil and Water Conservation Service	www.swcs.org	7515 NE Ankeny Rd. Ankeny, IA 50021	Soil conservation, books, journal
Conservation Technology Information Center	www.ctic.purdue.edu	1220 Potter Dr., Room 170, West Lafayette, IN, 47906	Membership, BMP materials
Natural Resource Conservation Service	www.ncg.nrcs.usda.gov	Local and state offices	Agricultural conservation practices

There are also numerous federal, state, and local information sources on this topic. Usually, funding, education, and recruitment of individual farmers are larger limiting factors than a lack of technical information.

Following is an abbreviated list of agricultural BMPs designed to reduce erosion and sediment transport, that Cadmus observed in place in the watershed:

- Contouring

4. Strip Cropping
5. Riparian Grass Filter Strips
6. Conservation Tillage
7. Grassed Waterways
8. Terraces

The degree to which the use of these and other BMPs can be increased is a matter of funding, farm level education, and to a degree the staffing available at the local and regional level for implementation.

We strongly recommend that the Authority initiate a sediment reduction program in cooperation with agricultural service agencies. Additional recommendations are discussed in the next section. An upstream sediment reduction program is not a panacea, however. Morris and Fan[47] caution that there are limitations to what watershed management can accomplish in terms of reducing sedimentation:

> Even when successful, erosion control does not necessarily represent a complete solution to sedimentation problems. Erosion control requires a long-term commitment, and produces long term rather than short-term results. Land use changes that reduce erosion may not produce a short-term reduction in downstream sediment yield. Finally because erosion can never be reduced to zero, erosion control alone cannot achieve a sediment balance across a reservoir. Additional measures will eventually be required to remove sediment if the reservoir is to remain in operation, although erosion control can greatly delay this requirement.

It can be difficult to measure short-term results for the reasons discussed above in the discussion of variability in sedimentation estimates. Because the SDR in large subwatersheds can be 15 percent or lower, only a portion of the erosion reduction can be measured downstream. Other tools, including model simulation, field level measurement, and simple calculations like the universal soil loss equation USLE, can be used to verify results.

5.7 Recommendations

Cadmus recommends the following activities and actions. The degree that a watershed protection effort will be successful depends greatly on the degree that can be achieved through cooperation between local parties, and the extent to which resources can be pooled. Any effort faces resource constraints as we observed in each of the three pilot Pennsylvania watersheds. In each of them, funding through EQIP was inadequate to fully serve the needs of farmers wanting to participate in farm-scale cost sharing programs. As discussed later, there may be some opportunity for sharing and leveraging local resources in this area. The Berks County Conservancy has teams of volunteers and has a funding grant for study and implementation in the watershed. In another regional watershed, the company Orvis has funded habitat protection programs. Other sources of funding include 319 nonpoint source funds. [See funding section and main recommendation section]

[47] Morris G. L., and J. Fan. Op. Cit.

Specific recommendations include:

1. Cadmus recommends that the Authority undertake a detailed sedimentation study that would include some additional wet-weather sampling, and moderate-level modeling of sediment and erosion. Cadmus also recommends that the Authority consider commissioning a second reservoir sedimentation study. A 1999 study would examine the sedimentation over the six years since the last study. Specialized techniques including sediment dating can help determine if sedimentation rates have slowed in recent years. Chester Water Authority recently resampled their reservoir volume. The cost of the study was between $15,000 and $20,000.

2. Develop a watershed protection subcommittee with agricultural support agencies**.**

3. Explore with the local conservation district the use of federal and state programs for riparian protection. Focusing on these areas will not prevent erosion, but it can reduce the SDR. Other avenues for riparian protection have included funding by the Pennsylvania Fish and Boat Commission. The Chester Water Authority has completed several projects linking Commission funding with Authority resources and volunteer labor.

4. Consider seed grants from the Authority for innovative buffer zone protection. A key to successful coalitions is perception of benefit by participants. There is precedence for funding by water systems of watershed activities, for example in Syracuse, New York. The Authority and its customers are benefiting from the use of water from the watershed. The Authority may want to provide some level of resources to upstream conservation efforts. These resources could be in the form of seed funding, equipment, labor, or laboratory services.[48]

5. Explore purchasing or leasing riparian lands in the lower reaches of the watershed where SDR is high. The NRCS Conservation Reserve Program may be helpful in this regard. As outlined above, lands near stream channels and stream channels in the lower watershed have higher SDRs, and should receive priority for action.

6. Advocate additional stream bank fencing projects. There have been several stream bank fencing projects in the watershed to date. A watershed coalition that includes the Authority could advocate additional projects with farmers and agricultural service agencies. Funding and other means of support could be recruited from foundations, the Fish and Boat Commission, citizen groups, and other sources. The Berks County Conservancy and the Wildlands Conservancy in Allentown are knowledgeable and successful in convening groups and writing proposals for funding.

[48] This discussion is intended as a starting point for the watershed coalition to tailor a program to their watershed. Cadmus as an outside participant can suggest alternatives for resource sharing, but only stakeholders themselves can determine an equitable distribution of costs and benefits.

7. Prioritize subwatersheds for study and action. Limited dry-weather sampling points to the lower Sacony Creek Subwatershed, as an area for further activity.

8. Target BMP support in selected subwatersheds. Based on sampling and analysis, priority subwatersheds should be slated for implementation.

9. Examine operation of the dam and allowed discharge of sediment downstream. Dams with underflow gates such as Taintor gates can pass a portion of sediment behind the dam downstream, as was the case before the dam was constructed. Historically, the dam had some underflow capability, but these outlets were permanently closed. Trapping sediments, although not a design of the Ontelaunee Dam is a benefit to downstream habitat. The Authority would need to carefully work with the DEP prior to any operating change in the dam.

6.0 NUTRIENTS

Nitrogen and phosphorus are the primary nutrients of concern for water quality. Phosphorus is primarily a surface water concern, where in excessive amounts, it promotes algae blooms and lake eutrophication. Accordingly it can contribute to an increase of trihalomethane) THM precursors. In most fresh waters it is the limiting nutrient for algae growth, that is, it is the nutrient in shortest supply in relation to algae nutrient requirements. A previous study of Lake Ontelaunee found it to be phosphorus limited.[49] Elevated levels of phosphorus found in surface or groundwater is not known to be a human health concern.

Nitrogen, in the form of nitrate, can be a nonpoint source pollutant in both surface and groundwater and is a potential health concern at elevated levels. Nitrogen enrichment, primarily in marine systems such as the Chesapeake Bay, has been linked to low dissolved oxygen, and decreased numbers of aquatic animals and plants[50]. Some freshwater surface waterbodies with excessive loadings of nitrates can undergo eutrophication when nitrogen is the limiting nutrient.

Consumption of water with elevated levels of nitrate (generally greater than 100 mg/l) has caused over 2,000 cases of methemoglobinemia or “blue-baby syndrome” worldwide (Shuval and Gruener, 1972). Blue-baby syndrome is a potentially fatal health condition where nitrates are converted to nitrites, reducing the oxygen-carrying capacity of the blood, causing babies to appear “blue” (Van Es, 1991). Nitrites are known to react with other compounds including many pesticides to form nitrosamine compounds that are known animal carcinogens (Murdock, 1988).

To protect the public from this problem, the EPA has set the maximum contaminant level (MCL) for nitrate in drinking water at 10 mg/l. Not surprisingly, livestock are also susceptible to nitrate problems similar to humans. Drinking water or feeds high in nitrate can cause methemoglobinemia in livestock. Elevated nitrates have

[49] F. X. Browne, Op. Cit.
[50] Fisher, 1989.

also been shown to cause stillbirths in both cattle and humans. As discussed in this chapter, the main stems of the Maiden and Sacony Creeks and the Ontelaunee Reservoir have nitrate levels well below 5 mg/l or half of the MCL. Based on stream samples with nitrates near the MCL, some private wells in the watershed may be at or above the MCL for nitrate.

Other problems associated with high nitrogen levels include chlorination disinfection problems. Another large water system in Pennsylvania finds that during runoff periods when organic and other forms of nitrogen are high, they experience difficulty in controlling their disinfection chemistry.

6.1 Agricultural Use of Nutrients

Agriculture is the top ranking industry in Pennsylvania and requires efficient use of nutrients from manure and commercial fertilizers to be productive (Westmoreland, 1994). When nutrients are applied in the right amounts, at the right time and the right way, using the principles of a nutrient management planning, environmental problems can be minimized (Beegle, 1997). Improper use of nutrients has been shown to cause water quality problems in both surface and groundwater, both on and off the farm (Hall and Risser, 1993). While nutrient management employed according to agronomic standards has been shown to reduce nitrate levels in groundwater by 30%, nitrate levels in groundwater may still exceed EPA standards particularly on highly permeable soils (Hall and Risser, 1993).

Nitrogen, phosphorus and potash are the three major nutrients used for agricultural production. Other micronutrients and maintenance of pH levels are also essential for effective production. Nitrogen and phosphorus are the primary nutrients of concern for water quality.

There are several sources of nutrients in this watershed, agriculture is probably the primary one, but there are also a number of golf courses, homes and horticulture centers that could be additional sources. We saw evidence of good conservation practices, but didn't formally survey agricultural practices. Examples of grassed waterways, strip cropping, contour plowing, and riparian buffers were observed throughout the watershed. From conversations with the conservation district we noted that formal nutrient planning is limited and varies greatly between farms.

6.2 Sampling for Phosphorus and Nitrogen

Cadmus staff sampled the watershed on three occasions: March 20 – 21, June 3 – June 6, and July 30. Samples were collected for analysis of ammonia, nitrate, total kjeldahl nitrogen, and total phosphorus. A combination of LaMotte field test kits and laboratory analysis were used for the nitrate and total phosphorus samples. Routinely nitrate samples were submitted for laboratory analysis and tested in the field to check the accuracy of the field test kits and sampling procedures. In general the accuracy of the kits was quite good. For total phosphorus the kits were used as a screening tool to test for the presence of high phosphorus levels. Whenever a level of •0.2 mg/l was found, a sample bottle was collected for later analysis. Sampling results are summarized in Appendix 6-1.

In general, levels of total phosphorus were low reflecting its role as a limited nutrient. Available phosphorus is rapidly taken up by plant materials. In March sampling most samples had total phosphorus levels at less than 100 ppb with many registering below the detection limit. Exceptions were the Kutztown POTW (sampling point PS 6) with a concentration of 160 ppb (this is very low for a POTW which typically have levels of several parts per million) and a stream below the Campbell's facility (Sample Point R6) with a concentration of 490 ppb.

The purpose of this study was to find "hot spots", or sources of contamination, rather than to perform a detailed study of the phosphorus dynamics of the watershed. For this reason subsequent sampling used field test kits to screen for high phosphorus levels. Where high levels were indicated by the field kits, a sample was taken for laboratory analysis.

June sampling showed little phosphorus present except for a 680 ppb reading at the mouth of the Sacony. The source of this reading is unknown but may have been the Kutztown POTW. In July several samples showed high phosphorus levels:

Virginville Gutter Discharge	320 ppb
Furnace Creek Pipe	1,500 ppb
Lynn POTW	5,200 ppb

The first two samples are significant in that they are probably indicative of human waste or cleaners containing phosphorus. The third sample is typical of a secondary treatment system. Because each of the flows associated with these samples is small, the mass of phosphorus from these sources is also small and their impact on algae growth in the reservoir is also small.

Cadmus sampled for nitrates at 27 locations. Nitrate was elevated (>5 mg/l) in the following locations:

- Christman's Lake (5.3 mg/l)
- Moselem Creek, several locations (6.1, 10*, 7.0, 10* mg/l)
- Peter's Creek (8.6, 8.5 mg/l)
- Unnamed Tributary to Maiden Creek on Ontelaunee Trail (8.5 mg/l)
- Unnamed Tributary to reservoir below upper Campbell's facility (6.7 mg/l)
- Sacony Creek at Christman Road ((7.0 mg/l*)

* By field test kit.

The nitrate level either increased or stayed high[51] as samplers moved from the mouth of Moselem Creek to its source, indicating little instream losses and/or a constant

[51] The nitrate field test kits generally gives good results but give results that are hard to discern at nitrate levels greater than 7 mg/l. In fact, a reading of 10 mg/l at Kutz Road was analyzed as 7.7 mg/l by a laboratory method.

groundwater source of the nitrate. Probable sources of nitrate include the Moselem Springs Golf Club, the Berkleigh Country Club and crops adjacent to the Creek. Using field test kits to rapidly move upstream to detect sources of contamination proved to be a useful strategy.

Nitrate concentrations decreased as we moved from the main stem of Sacony Creek (S1) up to an un-named tributary of Mill Creek (S5) and to Mill Creek (S6). The Mill Creek sample accounts for substantial watershed area in Lehigh County, north to Seiberlingsville, in Maxatawney Township, and for a small area of Greenwich Township. Thus the apparent source of nitrate is the main stem of the Sacony as it travels from Longswamp and Rockland Townships through Kutztown.

Lake Ontelaunee is eutrophic and seasonally hypereutrophic according to Browne[52]. In simple terms nutrient loads to the lake are excessive. Recently, a period of low flow combined with lake mixing caused high concentrations of algae and suspended sediments to enter the treatment plant. One algae present in large numbers was the filamentous species *Anabaena*. Because it is a blue-green algae capable of fixing nitrogen, its growth is completely limited by phosphorus availability.

The nitrate levels measured in the watershed are elevated from agricultural activity and to a lesser extent human waste disposal, but are not exceptionally high in the surface waters measures. Two exceptions are Peter's Creek and Moselem Creek which have levels approaching or at 10 mg/l. There is no housing adjacent to Peter's Creek. Drinking water wells in the vicinity of Moselem Creek, however, probably have nitrate levels at or above the MCL of 10 mg/l.

[52] F. X. Browne, Op. Cit.

6.3 Estimates of Nitrogen and Phosphorus Loading

It is difficult to estimate nutrient contributions by nonpoint sources precisely without detailed modeling of hydrology and of fate and transport processes. For the purposes of simply establishing priorities for action and for further study export coefficient estimations are often sufficient. Cadmus applied literature values to estimate the load of phosphorus and nitrogen from various land uses for each of 10 subwatersheds. (We divided the watershed into 10 subwatersheds to examine variability of estimate loads in the Ontelaunee Watershed.) Table 6-1 shows estimated total phosphorus, soluble reactive phosphorus (SRP) and total nitrogen loads for each major land use in the watershed. The primary contributors of nutrients are row crops, pasture, and point sources for phosphorus, and row crops, pasture, and forest for nitrogen. Because these estimates are derived from loading functions, they should be viewed as approximate and useful for planning purposes only. They point out that the bulk of phosphorus comes from agricultural land uses, with a relatively smaller contribution by point sources. Because phosphorus strongly attaches to soil particles, well functioning septic systems will not be a significant source of phosphorus. Failing septic systems may supply phosphorus in limited locations but will not be significant contributors to the watershed as a whole.

By subwatershed, the Maiden Creek and the Lower Sacony contribute the most phosphorus per unit area. The main cause for the high value for the lower Sacony is the phosphorus contribution of the Kutztown POTW. Nitrogen loading is relatively even per hectare except for the lower Sacony because of the treatment plant load. Nitrogen loading also arises primarily from agricultural lands, but forest lands and to a lesser extent point sources contribute some of the load.

Table 6-1

Estimates of Nitrogen and Phosphorus Loading by Land Use

Land Use	Hectares	Percent	Total Phosphorus (Kg)	Percent	SRP (Kg/Yr.)	Total Nitrogen (kg)	Percent
Water	707	1.4%	-	0.0%	-	-	0.0%
Developed	630	1.3%	945	4.5%	298	5,356	1.8%
Pasture	10,120	20.3%	5,060	24.4%	1,239	70,842	24.2%
Row Crops	18,809	37.8%	9,405	45.3%	2,384	131,665	45.0%
Forested	19,252	38.6%	1,925	9.3%	815	67,380	23.0%
Wetlands	282	0.6%	4	0.0%	-	155	0.1%
Barren	18	0.0%	27	0.1%	9	155	0.1%
Point Sources			3,412	16.4%		17,060	5.8%
Total	49,819	100.0%	20,779	100.0%	4,746	292,613	100.0%

Table 6-2

Estimates of Nitrogen and Phosphorus Loading by Subwatershed

Subwatershed	Land Area (ha)	Percent	Total Phos. (kg)	Percent	Load kg/ha	Total Nit. (kg)	Percent	Load kg/ha
Kistler Creek	2529	5.1%	900	3.9%	0.36	14,421	4.9%	5.70
Lower Sacony	3100	6.3%	4,561	19.9%	1.47	34,138	11.7%	11.01
Mill Creek	5933	12.1%	2,311	10.1%	0.39	35,589	12.2%	6.00
Moselem Creek	3470	7.1%	1,554	6.8%	0.45	21,992	7.5%	6.34
Ontelaunee Creek	10173	20.7%	3,393	14.8%	0.33	55,236	18.9%	5.43
Pine Creek	4615	9.4%	919	4.0%	0.20	20,069	6.9%	4.35
Reservoir Area	3941	8.0%	1,527	6.7%	0.39	23,067	7.9%	5.85
Maiden Creek	7797	15.9%	4,829	21.1%	0.62	44,170	15.1%	5.66
Stony Run	2313	4.7%	822	3.6%	0.36	13,202	4.5%	5.71
Upper Sacony	5258	10.7%	2,059	9.0%	0.39	30,757	10.5%	5.85
Total	49,133	100.0%	22,878	100.0%	0.466	292,643	100.0%	5.95

Nitrogen is an important and essential plant nutrient. Crops obtain N from many sources including: soil organic matter, biological fixation, crop residues, animal manures and fertilizers. While N is found in many organic and inorganic forms, only inorganic ammonium and nitrate is available for crop uptake. A primary objective of N management is to have adequate nitrate available during the growing season, but to minimize the amount during fall, winter or early spring when nitrate may be transported to surface and groundwater (Klausner, 1997). The key to nitrogen fertilization without excessive losses is to calculate the crop nitrogen requirement, determine how much of this can be met from existing sources, and supplement the remainder with fertilizer nitrogen using proper timing and placement techniques (Van Es, 1991).

6.4.1 Sources of Nitrogen

- **Legumes and Grass Sods**-Legumes fix atmospheric N in sufficient quantities to meet their N requirements. When killed or plowed under, the organic N is mineralized, releasing inorganic N to the following crop. An economic fertilizer N rate of 130 to 150 pounds per acre is typical for continuous corn without manure. The table below illustrates the value of organic N from legumes (Klausner, 1997):

Corn Rotation	Economic Fertilizer N Rate (lbs./acre)
1st Year after alfalfa	20
2nd Year after alfalfa	60
3rd Year after alfalfa	130

- **Manure**-Manure is difficult to manage, but can provide a significant source of nutrients and therefore reduce or eliminate the need for commercial fertilizer inputs (Klausner, 1997). Manure also enhances the soil organic matter, improving water retention and nutrient availability (Van Es, 1991). The high nutrient content of manure permits a recycling of plant nutrients from crop to animal and back to crop again (Van Es, 1991). There are two forms of N in manure: unstable organic N in the form of urea and stable organic N. Both forms must be decomposed by microorganisms, but the urea component, representing up to 50% of the total, is rapidly available. The urea fraction must be incorporated in the soil and taken up by plants immediately or it is lost in the form of ammonia (See figure below). The more stable organic N fraction present in the feces is more slowly released and is based on a decay series of .35-.12-.05-.02. The sequence is illustrated below and means: 35% of the organic N is mineralized during the year applied (available), 12% of the initial organic N is available the second year, 5% in the third year and 2% in the fourth year (Klausner, 1997).

The value of N from manure as a replacement for fertilizer depends on the rate of application, degree of ammonia conservation and the number of years applied.

- **Soil Organic N** consists of plan and animal residues, soil organisms and by-products from these organisms. Organic matter releases many nutrients including N during decomposition. The rate of organic N mineralization is variable, depending on the soil and organic matter content, however ranges are typically between 40 to 80 pounds of N per acre annually. Soil organic N is an important source of available N and must be accounted for when determining fertilizer requirements.

- **Fertilizer N** is readily available to crops and is needed when other sources of N are not sufficient to meet the crop requirements. Excessive applications of fertilizer are wasteful, do not improve yields and will result in either ground or surface water contamination.

6.5 Components of Nutrient Management Planning

Strategic nutrient management is being encouraged in Pennsylvania's Nutrient Management Act and Penn State University's agronomy program (Beegle, 1997). A number of recent fact sheets found in the bibliography by Beegle and Lanyon describe Pennsylvania's approach to nutrient management. The following components highlight some of the best management practices included in a sound nutrient management plan.

- **Soil Testing**-This is the most important and least expensive component of nutrient management. Maintain a good soil testing program to monitor nutrient status of fields and to determine supplemental nutrient needs. Use PSNT testing to determine N amounts for corn before sidedressing.

- **Manure Testing**-Analyze samples periodically for nutrient content. At first, analyze several times a year until a reasonable nutrient content is determined. Manure application rates should be based on crop needs and other N credits.

- **Credit residual nitrogen from previous crops-**Legumes are sources of N that are often not credited sufficiently for their N value. A 50-75% alfalfa stand, for example, can supply 110 lbs./acre of N to the following crop.

- **Determine nutrients and value of manure-**Manure provides tremendous benefits to the soil beyond the three major nutrients including: calcium, sulfur, boron, magnesium, copper, and zinc. It also improves tilth, aeration, and water-holding capacity, reduces erosion, and promotes the growth of beneficial organisms in the soil. On a 50 cow dairy, approximately 1,400 tons of manure is produced per year. Depending on how it is stored and handled, that equates to: 7,000 pounds of N, 5,600 pounds of P, and 11,200 pounds of potash. Using a value of $3.68/ton, that amounts to $5,152 in fertilizer value (Westmoreland, 1994).

- **Determine how and when to apply manure-**Manure is often applied where it is the most convenient; near to the barn. In order to take advantage of the value of manure, it must be spread around the farm in an efficient and effective manner (Wright, 1995). While there are many methods to consider, such as daily spreading, spray irrigation or subsurface injection and many timing options, such fall, winter, spring or summer, the following recommendations avoid excessive losses to volatilization, runoff and leaching: determine rate by analyzing manure and the requirement of crop; apply just before spring planting and incorporate as soon as possible to avoid odors and runoff; conserve the high nutrient content of the liquid fraction during handling; give first priority to fields that require high nitrogen rates and low P and potash; spread manure as uniformly as possible (Van Es, 1991).

- **Determine manure rate-**After determining expected crop yields, soil test results, manure analysis, manure amounts, residual nitrogen from legumes, you can then determine the rate at which manure can be applied. Fields should be selected that require nutrients that already have or soon will have a growing crop. The availability of nitrogen will depend on the decay series described above. Nitrogen is most often the critical nutrient for determining manure application rates in Pennsylvania (Beegle, 1997). Since P levels in manure tend to be in higher concentrations than most crops need, P tends to build up in the soil and may cause eutrophication problems in receiving waterbodies. To minimize this problem, water conservation best management practices (contour strips, buffer strips near streams, conservation tillage) to reduce runoff should be used. Crop rotations that balance soil nutrients are also important. Corn has a high nitrogen demand and relatively low P requirement, resulting in P build-up in the soil. Rotating corn with alfalfa will not only provide nitrogen corn needs, but the alfalfa requires large amounts of P and potash.

- **Determine additional fertilizer needs-**To determine additional fertilizer needs for each field depends on crop requirements, soil test results, manure credits, legume credits, and starter amount. Use the fertilizer recommendation from Penn State's Agronomy Guide and available Penn State worksheets or computer programs that help calculate nutrient requirements and application rates (Beegle, 1997). For corn, a new approach for reducing excessive amounts is called the pre-sidedress nitrogen test (PSNT) or quick test. The approach involves using a starter fertilizer and before sidedressing fertilizer when the plants are 6-12" tall, measure available nitrogen using a PSNT kit. Apply sidedress amounts based on N concentrations in the soil (Klausner, 1992).

- **Calibrate spreader-**Calibration of the manure spreader is often one of the most overlooked activities on the farm. Spreading manure uniformly at a known rate ensures that crops will receive the recommended nutrient levels. Spreader calibration can be accomplished using several easy methods, depending on the type of manure (solid or liquid) and the type of available equipment (Beegle, 1997).

- **Consider erosion/runoff-**A sound nutrient management plan will optimize crop nutrient uptake, but may still result in water quality problems if erosion, runoff or infiltration are not taken into consideration. The following practices should be followed to minimize problems: use water conservation best management practices (contour strips, buffer strips near streams, conservation tillage), control runoff from barnyards, do not spread manure within 100 feet of open sinkhole unless manure is incorporated within 24 hours, do not spread manure within 100 feet of drinking water wells, do not spread manure in concentrated water flow areas when soil is frozen, snow covered or wet, do not spread manure within 100 feet of watercourses when the soil is frozen, snow covered or wet, or within 200 feet of watercourses when the slope is greater than 8% during times when the soil is frozen, snow covered, or saturated (Beegle, 1997).

- **Conduct yearly review-**The nutrient plan should be reviewed on an annual basis. Many factors can change on the farm that will need to be considered including: different types of crops grown, changes in equipment, feed inputs, amount of land used, number of livestock, water, bedding, etc. These factors will influence not only the amount of nutrients needed, but also the rate, timing and methods at which nutrients should be applied

6.6 Recommendations

A comprehensive nutrient management approach for watershed farms is economically infeasible because of limited planning and implementation resources. Efforts need to efficiently target priority areas and management practices to reduce nitrate levels. Short of completing comprehensive nutrient management on each farm, which has the greatest likelihood of reducing nitrate to desired levels, there are several components of nutrient management that could be implemented having the greatest potential to reduce offsite losses of nutrients with the least effort.

6.6.1 Technical Recommendations

9. **Control Runoff-**promote the use of standard, NRCS water conservation practices to reduce erosion and water runoff. These include contour strips, buffer strips near streams, conservation tillage (no-till or zone tillage), and cover crops. There is an excellent brochure titled "Pasture Management and Stream Fencing…What's in it for Me?" put out by the PA Chesapeake Bay Program that Reading may want to include in mailings along with the brochure written by Cadmus for this project.

10. **Manure Application-**manure should be tested to evaluate nutrient content and credited appropriately along with sods. Applications should be based on a plan. Timing of manure applications is very important, particularly during the non-growing season. Farmers should avoid applications before/during storm events and temporary storage may be needed to provide this flexibility. If daily spreading is used, during wet periods, fields with low runoff potential should be used.

11. **Fertilizer Application**-Use soil tests and apply recommended amounts of fertilizer, not exceeding 150 lbs. of N. Make sure manure and sod from previous rotations are credited appropriately. Use a split fertilizer application approach. Use 20-30 lbs. N of starter fertilizer and use PSNT testing when corn is 6-12" to determine side-dress rates. Avoid spraying N with herbicides.

12. **Target Areas**-If funding is available to target areas, focus on farms near tributary streams where direct discharges are likely. Do not exclude, however, other willing and respected farmers who want to cooperate. Developing a sense of trust in the practices and momentum in solving problems may not fall within the target areas in the early stages.

6.6.2 Organizational Recommendations

Many farmers in the watershed have cooperated with farm service agencies such as the USDA Natural Resources Conservation Service, County Soil and Water Conservation District and Cooperative Extension to review and implement conservation practices. An enhanced or more focussed effort could perhaps be initiated to address the problems in the watershed, if additional sources of funding can be found. A cooperative, interagency approach where the farmers, agencies and other interested/responsible organizations are brought together in a non-confrontational manner to work cooperatively to address the problems has proven useful in other watersheds, for example in the Tulpehocken in Pennsylvania. Joe Hoffman of the Berks County Conservancy has taken a lead role in that project and can speak to methods used in that effort.

- Coalition Organization-One or two people who have worked closely with the farmers and have their trust, should contact other appropriate support agencies/organizations to “call a meeting” with the watershed farm community. All farmers should be mailed an invitation and an agenda. The agenda should be prepared ahead of time and it is preferable to have one or more farmers be part of the meeting organization.

- Initial Meeting-The lead person(s) should direct the meeting at the beginning and a farmer chair, if possible, should be elected. A presentation on the “problem/issues” should be presented. Group should decide on direction, approach, funding, etc. The focus should be cooperation, education and support.

- Demonstrate and celebrate success. Later meetings/tours can be planned on farms to look at specific practices or approaches that have been found successful. While a watershed approach is required to solve the problem, a hands-on farmer-centered program is needed where results can be seen and believed. Where grant dollars are available, they should be used to demonstrate practices as described above.

7.0 PESTICIDES

7.1 Pesticide Use on Corn-National Summary

Pesticides are now used on almost all of the cropland in the U.S. that is planted with corn. Pesticides are usually applied in the spring but the exact timing of the application depends on the time of planting, which can vary between states by more than a month. In southern states, the heaviest planting periods usually begin in mid to late March and end in mid to late April. In the northern states, on the other hand, the most common planting period is usually during the month of May [53].

The five most heavily applied pesticides are, in descending order of total pounds applied, atrazine, metolachlor, acetochlor, cyanazine, and alachlor. The pesticides that are used on the largest percentage of corn acreage are atrazine (71% of acres), metolachlor (30%), dicamba (25%), acetochlor (22%), and cyanazine (13%). Atrazine is occasionally applied twice a year but the rest of the chemicals are generally only applied once[54].

There are few studies that reliably assess the nationwide occurrence of pesticides in ground and surface water. The U.S. Geological Survey (USGS), however, is currently running the National Water Quality Assessment (NAWQA) Program to determine the extent to which pesticides and other contaminants are present in the water resources of the United States. According to early results of the NAWQA program, in agricultural areas where corn is the dominant crop, atrazine (55% of samples) and metolachlor (42%) were detected the most frequently (of the pesticides mentioned above) while alachlor (12%) and cyanazine (5%) were detected much less frequently (Kolpin et al.)[55]. Dicamba

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[53] U.S. Department of Agriculture (USDA). December 1997. *Usual Planting and Harvesting Dates for U.S. Field Crops.* Agricultural Handbook Number 628, National Agricultural Statistics Service.

[54] U.S. Department of Agriculture (USDA). September 1997. *Agricultural Chemical Usage, 1996 Field Crops Summary.* National Agricultural Statistics Service.

[55] Kolpin, Dana W., Jack E. Barbash, and Robert Gilliom. U.S. Department of the Interior. 1998. *Occurrence of Pesticides in Shallow Ground Water of the United States: Initial Results from the National Water-Quality Assessment Program.* U.S. Geological Survey.

(<1%) was rarely detected in ground water studies while acetochlor was rarely sampled for because it did not come into use until 1994. In surface water studies of streams draining agricultural areas, although not necessarily corn areas, atrazine (77% of samples), metolachlor (73%), alachlor (36%), and cyanazine (28%) were all frequently detected while dicamba (<1%) was, once again, only rarely detected[56, 57].

7.2 Pesticide Use on Corn-Berks, Chester, Lancaster, and Lehigh Counties, Pennsylvania

Pesticide use on corn in Berks, Chester, Lancaster, and Lehigh Counties in Pennsylvania is somewhat different from pesticide use in other areas of the country. Corn is generally planted in Pennsylvania in the month of May but the actual time of planting may vary from year to year based on factors such as temperature and precipitation[58]. Pesticides are generally applied in this area in late April to early May but this varies with the time of planting.[59]

There is not much information available on pesticide use by county, however pesticide use on corn can be examined at the state level. The pesticides that are applied in the heaviest quantities in Pennsylvania are, in descending order, atrazine, metolachlor, acetochlor, 2,4-D, and dicamba. The pesticides that are applied to the greatest percent of acres planted with corn are, in descending order, atrazine, dicamba, 2,4-D, nicosulfuron, and metolachlor. Within Pennsylvania, 98% of the acres planted with corn are treated with herbicides and 54% with insecticides.[60]

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[56] U.S. Department of the Interior. July 1998. *Pesticides in Surface and Ground Water of the United States: Summary Results of the National Water Quality Assessment Program (NAWQA)-Provisional Data.* U.S. Geological Survey.

[57] It should be noted that there were different detection limits for some of these pesticides, a factor that may influence the percent of samples with detections.

[58] USDA Dec. 1997. Op. Cit.

[59] Andersen, Robert J. July 1998. Lancaster County Extension Office. Personal Communication.

[60] USDA Sept. 1997. Op. Cit.

A survey of farmers in the Pequea and Mill Creek watersheds in Lancaster County from 1989-1991 found that the two most commonly used pesticides on corn crops in the watershed were atrazine and metolachlor. Atrazine was applied to 79% of the total acres planted with corn. The annual application rate for atrazine ranged from 0.16 to 2.0 pounds per acre and an average rate of 0.90 pounds per acre. Metolachlor, which was applied in the greatest quantity over the three-year period, was applied to 63% of all corn acres at an average application rate of 1.20 pounds per acre (the application rate ranged from 0.21 to 4.0 pounds per acre). Alachlor was the third most heavily applied chemical. It was applied to 17% of corn acres with an average annual application rate of 1.39 pounds per acre. (This pattern of use is significantly different from current low statewide estimates of alachlor use.) Pendimethalin was the fourth most frequently used herbicide in the Pequea and Mill Creek watersheds. It was used on 16% of corn acreage and was applied at a rate of 0.99 pounds per acre. Cyanazine was applied to 11% of the corn acres at an annual average rate of 1.5 pounds per acre. Dicamba, 2,4-D, and nicosulfuron, three of the chemicals which are currently commonly used in Pennsylvania, were used in the study but were not among the top five chemicals in pounds used or acres treated.[61]

The reason that chemical use patterns in these two watersheds differ from use patterns on a statewide level may be related to either local conditions that lead farmers to choose one chemical over another or to changes in pesticide use practices between 1991 and 1996. For example, there was a downward trend in the alachlor application rate from 1.55 to 1.28 pounds per acre over the course of the study period[62] . Thus, alachlor use in the county may have continued to decline and it may have been replaced by another chemical.

The survey also asked the farmers if they used domestic water supply wells and whether they had had those wells tested. Half of those who reported that they had tested for pesticides had detections of pesticides in their wells. Of the five most commonly used

[61] Bingaman, D.D., G.M. Heistand, and C.K. Greene. November 1994. *Lancaster County Agricultural Pesticide Use Practices Report for the Pequea-Mill Creek Watersheds.* Pennsylvania Department of Agriculture.

[62] Bingaman. Op. Cit.

pesticides in the Pequea and Mill Creek watersheds, atrazine, alachlor, metolachlor, and cyanazine were identified as priority leachers (defined in Bingaman et al. as commonly used pesticides that have a high potential to leach to ground water).

The USGS has conducted several studies on the effect of pesticide use on ground water and surface water quality in southeastern Pennsylvania. It should be cautioned before examining the results of these studies, however, that it is impossible to study only the occurrence of pesticides applied to corn crops since there are other crops in the area that may receive applications of the same pesticides. The studies, though, provide an indication of the extent to which pesticides used on corn are found in the water resources of the area.

One study conducted by Fishel and Lietman[63] was to determine the extent to which herbicides are found in ground water in the Upper Conestoga River Basin. This basin is mostly in Lancaster County but it does include small sections of Berks and Chester Counties. Atrazine, simazine, alachlor, and metolachlor were the herbicides that were detected most frequently in wells in agricultural areas. The number of wells with detections remained relatively constant throughout the year but there were variations in the seasonal concentrations that were detected. Atrazine and metolachlor were found at their highest concentrations in the spring while simazine was found at its highest concentration in the summer and alachlor was found at its highest concentrations in the fall. Atrazine and alachlor were found at concentrations equal to or greater than the MCL in some of the samples during the spring and fall, respectively.

One study by Reed and Koerkle[64] examined the concentrations of herbicides in the Conestoga River and Pequea Creeks, streams that drain much of Lancaster County.

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[63] Fishel, David K. and Patricia L. Lietman. 1986. U.S. Department of the Interior. *Occurrence of Nitrate and Herbicides in Ground Water in the Upper Conestoga River Basin, Pennsylvania.* Water Resources Investigations Report 85-4202, U.S. Geological Survey.

[64] Reed, Lloyd A. and Edward H. Koerkle. U.S. Department of the Interior. 1997. Herbicide Concentrations in and Loads Transported by the Conestoga River and Pequea Creek, Lancaster County, Pennsylvania, 1992-1995. Water-Resources Investigations Report 97-4124, U.S. Geological Survey.

During stormflow periods[65] from 1992-1995,samples were collected to test whether concentrations of pesticides in streams and rivers were higher in the first few months after planting than during other times of the year. Concentrations were generally found to be higher during the period from May-July than during any other time of the year. Concentrations of atrazine exceeded the MCL of 3 g/L in over 10 percent of the samples collected.

The USGS, as part of the NAWQA Program, conducted an assessment of water quality in the lower Susquehanna River basin that includes most of Lancaster and parts of Chester and Berks counties. Only 10 of the hundreds of samples collected from wells and stream water in the basin had concentrations of pesticides that exceeded drinking water standards. Most of the sampling was done during periods of dry weather, but 8 of the 10 samples that had pesticide concentrations that exceeded the MCL were affected by storms. The most commonly detected pesticides in the study area were atrazine, metolachlor, simazine, prometon, alachlor, and cyanazine. All of these pesticides, except prometon and simazine, are commonly used on corn (Lindsey et al.). One of the NAWQA studies found a statistically significant relationship between the percent of a basin planted in corn and alachlor, metolachlor, atrazine, and cyanazine yields in surface water[66]. Seasonal variations in pesticide concentrations were found in streams but the extent of these variations differed depending on the timing of pesticide applications in the area and the type of bedrock (which influences the extent to which pesticides will either runoff or infiltrate into ground water) in the area[67] .

7.3 Sampling, Existing Data, and Observation

[65]A stormflow period is defined as a period during which the level of the stream is 0.2 feet higher than it is during the prevailing base flow conditions.

[66] Hainly, Robert A. and Joan M. Kahn. U.S. Department of the Interior. "Factors Affecting Herbicide Yields in the Chesapeake Bay Watershed, June 1994." *Journal of the American Water Resources Association.* 32(5) (October 1996).

[67] Lindsey, Bruce D., Kevin J. Breen, Michael D. Bilger, and Robin A. Brightbill. U.S. Department of the Interior. 1998. *Water Quality in the Lower Susquehanna River Basin, Pennsylvania and Maryland, 1992-1995.* Circular 1168, U.S. Geological Survey.

Screening for herbicides at four sites showed no measurable levels of common herbicides, although the sampling may have been conducted before most herbicides would be applied. In another Pennsylvania watershed Cadmus observed the practice of filling a pesticide sprayer from a local creek. This practice includes some risk of washing pesticide residues directly into creeks.

Several existing data sources discuss herbicides in the system and the watershed. F.X. Browne[68] analyzed for 2-4-D and 2,4,5 Silvex in lake sediments and found none**.**

Data submitted to the EPA by the Authority showed no detections for the following components of herbicides, pesticides, and fumigants:

Alachlor	Endothall
Carbofuran	Ethylene dibromide
Chlorodane	Methoxychlor
1,2-Dibromo-3-chloropropane	Oxamyl (Vydate)
Dichlorobenzen	Picloram
Dichloroethane	Pentachlorphenol (preservative)

7.4 Recommendations

We recommend sampling in one or more subwatersheds with agricultural activity soon after the time of herbicide application. The Authority should work with the local agriculture service agencies to understand the timing of applications in the watershed and conduct at least one round of sampling concurrently. Sampling in the reservoir, while a true indication of the contaminant threat at that moment of sampling, will not detect pesticides in most cases, because of their relatively short life in the environment. A positive result from a sample collected in the subwatershed will indicate whether material is entering a particular Creek, although it does not necessarily indicate a raw water problem for the Authority because of the ability of modern pesticides to degrade.

[68] F.X. Browne, Inc. Op. Cit.

8.0 POTENTIAL POLLUTANT SOURCES

Cadmus examined potential pollutant sources in the watershed using the following methods:

- Stakeholder Interviews
- Site Visits of Selected Dischargers
- Review of Federal and State Databases
- Review of Commercial Databases
- Windshield Survey of Watershed

While nonpoint sources pose a greater threat to the watershed, The Authority should periodically review the status of point sources in the watershed. Several categories of potential pollutant sources are discussed below.

8.1 Point Sources

A list of point sources found in existing studies and various databases is shown in Table 8-1. With the exception of the Kutztown Foundry, the remaining NPDES permittees discharge primarily sewage. Related bacteriological concerns were discussed in a previous section. Data on these sources can be gathered through the PCS database described in Chapter 3. Cadmus found no direct evidence of water quality problems linked to dischargers.

The Authority may want to establish a dialogue with some or all of these sources. Discussions of permit compliance, however, should handled with care by the Reading Authority. While the Authority has a strong vested interest in discharges being legal and proper, it has no legal authority to compel discharges to alter their behavior. Further, over-exuberant pursuit of dischargers could damage a coalition and leave potential stakeholders not trusting the Authority. The Authority needs to consider local stakeholders and consult with the DEP sanitarian or appropriate DEP NPDES officials, prior to approaching issues of permit compliance.

Table 8-1

Point Source Discharges in the Lake Ontelaunee Watershed

Name	Address	Creek/Stream	NPDES Permit #
Allentown Cement Company	Fleetwood	Maiden Creek	PA001789
Camsco Farm B	Maidencreek Township	Peters Creek	No number provided
Martha Scott Apartments STP	Richmond Township	Moselem Creek	PA0053520
Moselem Development Co.	Richmond Township	Moselem Creek	PA0031348
Youse, Richard	Virginville	Un-named Tributary to Maiden Creek	PA0084344
Kutztown Foundry, DIV	Kutztown Borough	Sacony Creek	PA0070335
Kutztown Municipal Sewer Authority	45 Railroad Street Kutztown Borough	Sacony Creek	PA0031135
Schaffer, Kevin, S	Maxatawny Township	Mill Creek	PA0053155
Highland Estates/SEW	RR 2 Kutztown Borough	Unnamed Tributary to Mill Creek	PA0070122
Gaffney, James J - STP	RR 1 Kempton	Stony Run Creek	PA0053708
Blue Rock MT Spr/IW	Lynn Township	Unnamed Tributary to Ontelaunee Creek	PA0012343
Lynn Township SEW AUTH	6949 Lochland Rd, New Tripoli, 18066 (Plant is located on Allemangle Road in Lynn Township)	Ontelaunee Creek	PA0070254
Paul Borman, Single Res. STP	7221 Borman Rd, New Tripoli, 18066	Unnamed Tributary to Ontelaunee Creek	PA0062901

Note: The discharges to Pine Creek included in several previous studies on the Maiden Creek Watershed are actually discharges to a Pine Creek located in Schuylkill County, outside and northwest of the watershed.

Following are observations related to the listed point sources:

13. Several years ago, volunteer stream walkers noted temperatures in excess of 100°F downstream of the heated water discharge of the Kutztown Foundry.[69] Cadmus did not measure stream temperatures, but during March 1998, sampled the heated water discharge. The samples were warm to the touch but were probably not in excess of 100°F. Because of the level of dilution on that day (not directly measured, but roughly several 100 to 1), little impact on stream temperature was expected or noticed. Temperature rise is an ecological concern and may be a priority for some watershed stakeholders. It does not directly affect drinking water quality, however.

- The Allentown Cement Company has a discharge permit. According to their environmental manager, the permit is for flows from dewatering pumps. Although the flows are sampled for up to 20 constituents, the manager indicated that no problems had been found to date. Because Cadmus' role was to foster communication for a potentially expanded watershed coalition, Cadmus did not press to inspect the facility or review their sampling data. Their explanation, however, sounded plausible.

- The Campbell's Company has a discharge permit for Peter's Creek, however, no evidence of a discharge pipe was found. According to their environmental staff Campbell's only discharge permit is for spray irrigation in the facility overlooking the reservoir. The plant staff was kind enough to take one of our staff on a tour of the upper facility, despite the fact they were operating on standby power because of a tornado that occurred the day before. Campbell's staff pointed out lagoons and indicated that they were currently sealed underneath with no overflow discharges. Historically, Authority staff noted that there had been an overflow of material on the southeast of the property onto several leased fields. Cadmus' role was to foster communication for a potentially expanded watershed coalition, not to directly inspect facilities. In keeping with this role we gathered information but did not inspect the facility or discharge.

- The discharge of the Lynn POTW had an ammonia reading of 22 mg/l on July 30, high for a secondary plant. The ammonia concentration in Ontelaunee Creek, several hundred feet downstream was 4.8 mg/l, a high level for freshwater streams. Ammonia is most toxic to fish life at pHs and higher temperatures, often found in summer months. This is, however, not a direct concern for drinking water quality. Most of the ammonia also probably converted to other forms long before it reaches the reservoir. A sample analyzed for ammonia plus organic nitrogen (also called Total Kjeldahl Nitrogen or TKN) taken at the intake on March 20, was 1.1 mg/l, a value within the typical range for reservoirs.

In general, point sources are not a key issue for the Reading Authority, but might deserve some attention after the Authority has addressed the key issues identified. We recommend that the Authority open a dialogue with these permittees for informational

[69] Joe Hoffman, Berks County Conservancy. Personal conversation, August 1998.

purposes. Typically large installations draw attention and suspicion from some stakeholders, whether warranted on not. In other cases historical problems can cause lingering concerns even years or decades after a problem has been fixed. It is in the permittee's interest to work the Authority to minimize naturally occurring but sometimes misplaced fears where there is no problem, to minimize potential problems before they grow, and to publicize their efforts at maintaining or improving their environmental performance (i.e., good press).

8.2 Industrial and Commercial Sites

Depending on their operational procedures and on the material that they handle, industrial and commercial sites can pose nearly no threat or a real threat to drinking water sources. The Ontelaunee watershed has very little concentrated development except for a portion of Route 222 that borders the southeast corner of the watershed, and Kutztown. Lenhartsville, a very small center has limited commercial activity. Industrial sites include the Foundry in Kutztown, the Allentown Cement Plant, and the two Campbell's/Vlassic facilities near to the reservoir. To find industrial and commercial facilities, Cadmus reviewed the federal databases described above, used the Phone Search CD, queried a Dun and Bradstreet on-line database, and performed limited review during field work. Sites including Superfund sites and facilities listed as releases of toxic material (see Section on TRI), are listed in Appendix 8-1.

8.2.1 Industrial and Commercial Users of Toxic Materials

The Toxic Release Inventory (TRI) collects data nationally from selected industries that manufacture, process or otherwise use compounds from a list of toxic or hazardous substances greater than applicable thresholds. The general thresholds are: manufacture or process greater than 25,000 pounds per year, or otherwise use greater than 10,000 pounds. Therefore a facility that uses greater than roughly 1,200 gallons of a cleaner or solvent per year would be required to report. Inclusion on the list does not mean that the facility has been in any way irresponsible, or that it poses a threat to surface and groundwaters. It simply indicates that the facility processes in someway, a moderate to large amount of material that has the potential to be toxic or hazardous. We obtained the list and present it here as a starting point for the Reading Authority. The Authority and other stakeholders may want to review the list. An outreach effort should probably include mailings to these facilities to alert them to the efforts that Reading is making. A facility that is located adjacent to a stream or that there is local concern about may warrant further contact by the Authority or by other groups.

Facilities listed in TRI located in the watershed are listed in Appendix 8-1. An example of information available about these facilities is shown in Chapter 3.

8.2.2 Automobile-Related Commercial Facilities

Auto-related services, including automobile body shops, repair shops, and gas stations, are potential sources for numerous contaminants harmful to the watershed. Several inorganic and volatile organic drinking water contaminants regulated under the Safe Drinking Water Act (SDWA) are commonly found in these businesses, as indicated in Table 8-2.

It is critical in all cases, but particularly in unsewered areas, to know how these businesses handle and dispose of the materials that may contain these contaminants. Commonly, automobile service stations spray service bay wastewater to an outside surface or down service bay floor drains to a septic tank or dry well. It is important to realize that these practices may eventually contaminate local supplies of drinking water, either through percolating down to the groundwater or through surface runoff or storm drains.. In other words, what is poured down the drain today may appear in your drinking water tomorrow.

Table 8-2

Compounds Potentially Found in Material Used in Automotive-Related Activities

Gas Stations	
cis 1, 2-Dichloroethylene	**Tetrachloroethylene (Perk)**
Trichloroethylene (TCE)	**1,1,2,2-Tetrachloroethane**
Automobile, Body Shops/Repair Shops	
Arsenic	**Lead**
Barium	**Mercury**
Benzene	**Nickel**
Cadmium	**Tetrachloroethylene (or Perk)**
Chlorobenzene	**1,1,1-Trichloroethane**
Copper	**Trichloroethylene (or TCE)**
Dichloromethane (or Methylene Chloride)	**1,1,2,2-Tetrachloroethane**
cis 1,2-Dichloroethylene	**Xylene**
1,4-Dichlorobenzene	

While there are regulations imposing requirements for proper disposal, few state programs have the staff needed to ensure that the regulated community complies with the requirements. Often there are problems because the business does not realize their responsibilities or the problems that they may cause. There are best management practices that can be implemented to protect groundwater and surface water drinking water sources. Sending an informational brochure or paying a visit to the site to hand-deliver educational materials will increase their awareness and may improve handling and disposal methods.

There are a variety of automotive-related commercial sites spread throughout the watershed. To these facilities, Cadmus reviewed the federal databases described above, used the Phone Search CD, queried a Dun and Bradstreet on-line database, and performed limited review during field work.

Automobile-related businesses are illustrated in Figure 8-1. They are also listed in Appendix 8-2. (Some of the businesses for which there is no exact location (latitude, longitude) are listed in the table but not shown on the map.) In general the facilities are located throughout the watershed. Of most concern are ones that are located adjacent to a stream, where material that inadvertently entered the Creek would be directly transported to the reservoir. Other sites located away from a stream channel can pose a *potential* threat to groundwater but pose less of a *potential* threat to the reservoir. We noticed the following during our fieldwork.

- A small automobile repair facility is located in Kempton adjacent to Kistler Creek. Cadmus staff observed that work is performed outside in front of the facility (presumably on warm days) and that wash water flowed under the building to the Creek. While there is not necessarily a current pollution problem, this presents some *potential* risk of contamination to the Creek.

8.2.3 Other Commercial Facilities

There a variety of other miscellaneous commercial facilities not otherwise listed in TRI, in lists of point sources, or in the list of automotive-related businesses. Most of them are small and pose limited or no potential threat to the reservoir. In this report we have identified several tools for located such facilities including Dun and Bradstreet and the Phone and Street Map Atlas CDs. The most valuable method of determining potential threats is local knowledge. Local knowledge is not always accurate, in some cases suspicions of pollutant problems prove unfounded. Nevertheless knowledge of watershed inhabitants and past studies is a good starting point for further investigations. Following are observations concerning one local business.

Reserved for Figure 8-1

- With local interviews providing the general location, Cadmus staff located a furniture stripping business on Route 662, just north of its junction with Stitzel Road. The site is located several hundred feet west of a very small tributary of Bailey Creek. The tributary is essentially a grown-over drainage swale. The site of the business is unkempt with numerous drums in sight. Based on some historical observations related to Cadmus, the site may be a local source of groundwater contamination. One avenue of investigation could be testing wells on adjacent properties. It is unlikely that small spills of volatile materials from this site would be detectable in Bailey Creek or in the Reservoir, however.

8.3 Conclusions

Many commercial and industrial facilities handle materials that are potentially toxic including solvents, cleaners, and industrial raw materials. The potential threat to water quality and the related susceptibility of the Reservoir is related to the following factors:

Nature of the material
Operating and handling procedures
Distance from a Stream Channel
Distance to the reservoir by stream

The first two factors are under the control of the facility and can be affected to some degree by the Authority and a watershed coalition. We recommend that the Authority begin an outreach program to commercial and industrial facilities communicating the need for careful handling procedures for materials and for stormwater. PA DEP may be able to help with its programs in commercial and industrial stormwater, Class V well[70], and hazardous waste programs.

[70] Class V wells include septic systems, dry wells and other similar devices that can direct flow under the ground surface.

In general, facilities with no subsurface disposal, responsible material handling procedures, and little contact between their materials and rainwater pose little or no threat to ground and surface waters. Facilities with outdoor activities including use of fluids or fuels can pose some threat to surface waters. Facilities with floor drains tied to dry wells or septic systems can pose a threat to groundwaters.

Recommendations:

- Examine the lists of facilities provided.
- Field check the list as needed.
- Discuss potential threats with local stakeholders.
- Send outreach materials on the Watershed and on good practices.
- Determine if any of them deserve further attention. For example, does the facility have a history of problems? Is the facility located adjacent to a stream?
- Contact facilities as needed to gain their support.

9.0 RECOMMENDATIONS

This chapter outlines recommendations for developing a source water protection program for the Ontelaunee Reservoir. It summarizes topic-specific recommendations contained in Chapters 4 through 8 and presented additional recommendations for structuring the effort of both the Authority and a wider coalition.

Recommendations discussed in this Chapter include the following:

- Develop an Active Watershed Coalition (section 9.1)
- Draw Up a Set of Short and Long-Term Goals (section 9.1)
- Focus on Key Issues (section 9.1)
- Develop Long-Term Sources of Funding and In-Kind Services (section 9.2)
- Develop a Long-Term Monitoring Program (section 9.3)
- Consider Hiring a Part-Time Watershed Inspector (section 9.4)

Additional recommendations from previous Chapters are summarized in section 9.5.

9.1 Watershed Coalitions

One of the key recommendations of this study is that the Authority should initiate a coalition for protecting the watershed that has strong involvement from the Authority but that extends beyond the reach and the interests of the Authority. This section outlines why a coalition is a valid approach. It is drawn from the direct experience of one of the report authors in developing successful multi-group coalitions.

9.1.1 Why Form a Watershed Coalition?

Long-term, sustainable high water quality depends on watershed protection. Watersheds, however, are not easily protected from potential sources of pollution, at least without a concerted

> *Pollution does not respect political boundaries.*

effort and thoughtful process. One of the obvious problems in "managing a watershed" is a lack of control. No one entity has total watershed responsibility or authority and pollution will not respect the boundaries set by individuals, corporations or political entities. Further, all uses of lands and activities in the watershed contribute in some way to the overall integrity of the water reaching a municipal intake. And, the risk, fate and transport of pollutants vary from one land use or activity to the next.

We are all part of the problem, we are all part of the solution.

While this scenario makes water quality protection a seemingly impossible task for a water purveyor, understanding this reality is the first step towards creating an effective watershed control program. It is the very notion of "lack of control" or no one agency can solve problems alone and a shared responsibility for the problem that helps to create an opportunity to join forces with other watershed stakeholders. While other stakeholders may not have the same interests or derive the same benefits, i.e., irrigation, private drinking water, fishing, boating, etc., most can be brought to the "table" because of a shared dependence or recognition of the importance of the water resource.

Watershed coalitions provide a focus for cooperation and effective problem solving.

Bringing together other stakeholders to form a partnership or coalition is an essential and proven approach to manage water quality in a watershed. At the heart of a watershed coalition is the recognition that cooperation and a long-term commitment to shared decision-making is required to minimize pollution and solve problems over the long run. A watershed coalition or partnership creates a focus for cooperation and problem-solving that goes beyond the means and capability of any one entity. Having the resources and talents of all stakeholders at the table leads to a more creative and a community-centered approach, as opposed to a "one-sized fits all" scheme that often emerges from one entity. Indeed, many potential sources of pollution simply cannot be regulated away. Homeowners who dump waste oil on the ground or over-fertilize their lawns will not be stopped by regulations. They need a good dose of education on a regular basis of the importance of water quality protection and what behaviors constitute good stewardship. Other land users require financial assistance to make significant improvements for water quality protection (i.e., installation of agricultural best management practices).

Coalition synergy: the sum is greater than its parts.

The Canandaigua Lake watershed in New York State, for example, first approached source water protection as an engineering problem needing regulatory solutions. The result was neither practical nor acceptable to the community. A coalition approach was used as a focus for cooperation and management. Sixteen sources of pollution were analyzed and implementation plans were created for each source. For agriculture, all the agriculture stakeholders (farmers, farm service agencies, farm organizations, and businesses) were invited to participate in a Agriculture Advisory Committee. The committee was chaired and largely made up of watershed farmers, with the support of the agriculture service agencies. The committee came up with a vision, goals, objectives and a strategy for a comprehensive farm assessment approach. Sources of funding were also identified to help put the program into action. The result has not only been successful in terms of participation, implementation and pollution reduction (over $500,000 in state and federal grants were received in the last year for implementation), but the agricultural community is much more supportive of watershed protection now that they have a voice in the process.

The Canandaigua example also highlights another important advantage of establishing a viable watershed coalition: funding. At this point and time, there are a number of state and federal grant programs available for water quality protection. All of them place a great importance on having a watershed partnership in place, recognizing the fact that more can be accomplished by working together than apart. Well organized and effective watershed coalitions are much more competitive when seeking water quality funding.

Obviously, coalitions hang on the concept of cooperation and shared decision-making. Building relationships and trust with and among key stakeholders is a critical element of any partnership. This takes time and patience, and a willingness to commit key personnel and resources to the process. Many coalitions falter when they do not recognize and promote this important aspect of forming and sustaining a coalition.

What are some other lessons learned from other successful watershed coalitions from around the country? It helps when there is convincing evidence of watershed problems, such as over-development or agricultural pollution, and monitoring data to support these claims. And more importantly, if these threats are tied to the economic value of the resource, such as a potential loss of property values or drinking water cost will rise.

There needs to be a demonstrated willingness to cooperate in solving problems by the key stakeholders. It is not enough to talk about it, there needs to be a few key individuals who are committed to the concept of a coalition and are able to organize and generate thinking among others. After the coalition is assembled, a clear vision and obtainable goals need to be established and there needs to be a demonstrated advantage to stakeholders for participating. If people/organizations are brought into the process, they need to be able to take ownership of the project in a meaningful way.

Another critical element in the concept of a coalition found elsewhere is public participation. In successful watershed coalitions in the Finger Lakes Region of New York State, public participation is primarily represented by citizen lake or watershed associations. These citizen organizations are particularly effective in a coalition because they have a keen interest (often an economic interest) in protecting water quality, a pool of volunteers for coalition projects and they often have important political influence.

While watershed coalitions may seem like the long way around to solve pollution problems, it turns out it is the only tested and proven way to minimize pollution over the long term. The achievements and rewards of a successful partnership often go beyond the imagination of any one stakeholder because of the synergistic effects of cooperative learning and problem-solving.

9.1.2 Key Stakeholders

As outlined in the following sections, a coalition should be built on enlightened self-interest in the watershed and should be grown as issues demand. Starting too large and arbitrarily including groups without an interest can sometimes reduce the effectiveness of a watershed effort. Cadmus consulted on the refinement of a state-wide watershed coalition in a northeast state. The main obstacle the effort faces was that it was too inclusive including agency staff that did not understand the link between their job and the watershed coalition. The effort would have been much more effective had it started with a core of key staff and built outwards.

A partial list of parties that should be invited to participate include:

- The Reading Area Water Authority
  - The Conservation District
  - Town managers
  - Berks County Conservancy
  - Natural Resource Conservation Service
  - Cooperative Extension
  - Individual farmers
  - Environmental Groups
  - WREN
  - The Kutztown Wellhead Protection Committee

9.1.3 Watershed Coalition Principles

Everyone lives, works and plays in a watershed. And almost everything we do impacts the health of the watershed's natural, economic and social resources. How we manage watersheds also can impact economic health.

Through its work with watershed partnerships, the Conservation Technology Information Center has compiled the following "Top Ten Hint List" for successful watershed coalitions or partnerships.

- Think small. The smaller the watershed, the easier the partners can relate or connect to it. In addition, the smaller the watershed, the faster it will react to changes in management practices such as precision farming or land sues such as green strips.

- Bring everyone to the table. Successful watershed efforts include everyone who has a stake in the watershed. This enables the group to build consensus on what needs to be done and how to do it. Leaving a critical stakeholder out of the process at any step may cause unnecessary problems later.

- Great leaders plant seeds and nurture them. They facilitate the group to reach consensus, plant new or different ideas when necessary and assist the group in nurturing those new ideas. Effective watershed leaders are great communicators. They listen and expand on others' ideas, and make sure every idea is explored and that all stakeholders are heard.

- Ask for free advice and in-kind services. For example, if you need a video, ask the local television station for script and production assistance. If you need monitoring, assistance, work with you local water department and your local school system. And don't forget that saying thank you in public will go a long way toward getting additional help the next time. One bonus tip: No one give money to a group without a plan for how to use it. Financial assistance can come from unusual places and innovative source once the group has a solid plan.

- Encourage teaching. Allow watershed stakeholders to teach each other. No idea is too simple to be discussed. For example, a farmer can teach the basics of watering, fertilizer application and pest management to homeowners.

- Seek common interests, not positions. By working to find the common interest of all stakeholders, you'll establish a strong foundation for an effective watershed management plan. One way to do this is to get past opposing positions by asking why a stakeholder has taken a particular position. Keep asking why again and again. It usually takes seven layers of "whys" to uncover an interest that is common to other stakeholders.

- Celebrate your successes. Regardless of how small, celebrate progress. Whether your group measures progress by the number of canoe trips, miles of buffer strips or acres of no-till farming, reaching milestones are important. One more bonus tip: Be kind to each other; you may need that person to agree with you later.

- Ask not "do you like it?" but ask "can you live with it?" Remember, you probably will propose many ideas before the group reaches a common point of agreement. What's important in reaching consensus is that everyone can agree to live with a decision.

- Conflict can be healthy-if managed positively. Conflicting views or ideas often become a third view or idea that can be near healthy for the group's efforts and the watershed's health.

- Patience. Patience. Patience. We didn't get to where we are today overnight, and we won't get to where we're going tomorrow. When you set a lofty goal, break it down in smaller steps. Before you know it, you'll have reached your goal.

9.2 Financing A Watershed Effort

Critical to the success of any management plan is adequate financing. This section offers an overview of resources available from federal sources, Pennsylvania, and non-profit and private organizations. The list is not exhaustive, but it does flag several significant funding channels to fund critical water quality protection projects, such as conservation buffers, wetland restoration, and cropland retirement. Other programs provide resources for planning and technical assistance needed to determine the best route to water quality protection.

A useful resource is the comprehensive guide to funding and technical assistance programs, "Wetland and Riparian Stewardship in Pennsylvania". The guide is a publication by the Bureau of Watershed Conservation in the PA DEP, and summarizes all of the programs listed below as well as many others. To obtain a copy, contact the Bureau at P.O. Box 8555, Harrisburg, PA 17110 (717) 787-5259 or the Alliance for the Chesapeake Bay at (717) 236-8825.

9.2.1 Federal programs:

U.S. Department of Agriculture , Farm Service Agency (FSA)

Conservation Reserve Program (CRP)

The CRP protects highly erodible and environmentally sensitive lands with grass, trees, and other long-term cover. This voluntary long-term cropland retirement program provides farmers an annual per-acre rent plus the cost of establishing a permanent land cover (usually grass or trees). Land eligible for enrollment includes cropland that is physically and legally capable of being cropped in a normal manner, and that has been planted in any 2 years from 1992 to 1996. Annual payments amount to approximately $50 per enrolled acre, based on the soil's productivity prior to submitting a bid. In exchange, the participant converts highly erodible or environmentally sensitive cropland from production to vegetative cover for 10 to 15 years.

Acreage accepted into the program is evaluated according to several environmental factors, as well as the cost of the annual rental rates requested by each producer. The environmental criteria include water quality benefits from reduced erosion, runoff, and leaching; on-farm benefits of reduced erosion; long-term retention benefits; air quality benefits from reduced wind erosion; and wildlife habitat benefits. Some parcels are designated Federal Conservation Priority Areas (e.g., the Chesapeake Bay and surrounding areas). A State also may designate up to 10 percent of their remaining cropland as a State Conservation Priority Area. Filter strips and riparian buffer areas adjacent to water bodies along waterways are eligible for a 10 percent incentive payment to promote their enrollment.

Producers may submit bids for high priority conservation practices yielding highly desirable environmental benefits at any time. The practices include filter strips, riparian buffers, shelter belts, field windbreaks, living snow fences, grass waterways, shallow water areas for wildlife, salt-tolerant vegetation, and certain EPA-designated wellhead protection areas. For other lands, periodic sign-ups take place. The most recent was in March 1997. A meeting among Pennsylvania FSA offices about the next general sign-up will be held in mid-October of this year. Contact your county FSA or Conservation District, or the State Office of the USDA FSA at Suite 320, One Credit Union Place, Harrisburg, PA 17110. Contact: Rex Wright (717) 782-4547.

Conservation Reserve Enhancement Program

The FSA is developing a variation on the CRP program called the Conservation Reserve Enhancement Program that will require some level of state matching funds for high priority areas such as water quality, wildlife habitat, or erosion control. Details will be coming out shortly in the federal register. Maryland had the first pilot program installing buffers around waters affected by the pfiesteria organism. Other states drafting plans are Illinois, Minnesota, New York, Oregon, Delaware, Pennsylvania, Virginia, Washington, and Wisconsin. Acreage will be limited to 100,000 acres per state. Check with State Farm Agency officials for details, or to recommend priority areas. Mary Ann Rozum is the Program Leader - Water Quality. USDA CSREES Ag Box 2210, Room 803. Washington, D.C. 20250-2210 (202) 401-4533

U.S. Department of Agriculture, Natural Resources Conservation Service

Environmental Quality Incentives Program (EQIP)

The 1996 Farm Bill established EQIP to encourage agricultural best management practices. EQIP works primarily in locally identified areas where there are significant natural resource concerns such as soil erosion, water quality and quantity, wildlife habitat, wetlands, and forest and grazing lands. The program provides funding to farmers and ranchers for implementation of voluntary structural, vegetative, and land management practices called for in 5- to 10-year contracts. The program pays up to 75 percent of the costs of conservation practices, with a limit to any one person of $10,000 annually and $50,000 for the life of the contract.

Examples of projects that can be funded through cost-sharing payments include animal waste management facilities, terraces, filter strips, tree planting and creation of permanent wildlife habitat. Cost sharing may pay up to 75 percent of the costs of certain conservation practices. Nationally, half of the funding for EQIP is targeted to livestock-related natural resource concerns and the remainder to other significant conservation priorities.

Priority is given to areas where State or local governments offer financial, technical, or educational assistance and to areas where agricultural improvement will help meet water quality objectives. The proposals are submitted from the District offices to the NRCS State Conservationist, who selects the projects. The District Offices base their recommendations on input and information from a wide range of interests, including agriculture, local government, environmental groups, water and sewer authorities, and area planning organizations. The coalition built through the system's efforts for watershed protection and the results of this study can be used to help promote the system's need for funding, elevating its status in the priority ranking. The water supply should contact the local NRCS office to discuss how the system could help the office in its efforts to secure funding.

Watershed Surveys and Planning

The Watershed and Flood Prevention Act (P.L. 83-566) authorized this program. The program is designed to assist Federal, State, and local agencies and tribal governments in their efforts to protect watersheds from damage caused by erosion, floodwater, and sediment. A second purpose is to conserve and develop water and land resources. Resource concerns include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries.

The types of surveys and plans prepared include watershed plans, river basin surveys and studies, flood hazard analyses, and flood plain management assistance. The plans are to identify solutions that use land treatment and nonstructural measures to solve resource problems.

Wetlands Reserve Program

The program is a voluntary program to restore wetlands, which allows landowners to control access to their land. In exchange for a permanent conservation easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the cost of restoring wetlands. For a 30-year easement, landowners can receive up to 75 percent of the value of what would be provided for a 30-year easement on the same site and 75 percent of the restoration cost. Easements set limits on how the lands may be used in the future.

If no easement is involved, voluntary agreements can be drawn up for a minimum of 10-years that establish wetland protection and restoration as the primary land use for the duration of the agreement. The agreements can provide for 75 percent of the restoration cost.

Conservation Districts often refer projects from interested landowners to Ducks Unlimited, a private organization devoted to habitat restoration and improvement for wildlife.

Ducks Unlimited partners with NRCS and the US Fish and Wildlife Service on these projects, contacting the farmers and helping put them in touch with various funding sources, including the wetlands reserve program. (For example, Ducks Unlimited also works with the Wildlife Habitat Incentives Program through NRCS, which provides financial incentives to develop habitat for fish and wildlife on private lands.) Contact the County Conservation District or Ducks Unlimited.

U.S. Department of the Interior, Fish and Wildlife Service

Partners for Wildlife

Restoring fish and wildlife habitat through reestablishment of wetlands, riparian areas, and native grasslands is the main focus of the program. The project partners include Ducks Unlimited, Natural Resources Conservation Service, County Conservation Districts, private landowners, and the National Fish and Wildlife Foundation, among others. The program offers technical assistance and projects meeting certain criteria may be eligible for a cost-share or total coverage by the U.S. Fish and Wildlife Service.

Contact Dave Putnam, Partners for Wildlife Coordinator, U.S. Fish and Wildlife Service, 315 South Allen Street, Suite 322, State College, PA 16801. (814) 234-4090.

9.2.2 State Programs

Department of Conservation and National Resources, Bureau of Forestry

Keystone Fund

The program provides two types of funding: Planning, Implementation, and Technical Assistance Grants (PITA) grants to municipalities and appropriate organizations for planning, acquisition, development, and/or rehabilitation of public park, recreation, and conservation areas and facilities, rails-to-trails projects, and rivers conservation projects. Appropriate organizations are non-profit organizations dedicated to the preservation and protection of rail corridors for future use or conservation and protection of river resources and values.

Keystone Acquisition and Development Grants involve acquisition, development, and rehabilitation of the projects described in the PITA grants.

Community grants are available for municipalities to explore linear corridors of open space along streams, shorelines, wetlands, etc, as well as to inventory important natural areas, habitats for species of special concern, significant plant communities, and areas important for open space, recreation, and wildlife habitat. (Inventories are done on a county or multi-county level.)

Other grants are provided to municipalities and organizations to develop river conservation plans, studying watersheds or rivers to identify significant river resources, potential threats to these resources, and recommend restoration, maintenance, or enhancement actions. A final river conservation plan must be prepared, and grantees may petition to place the studied river or river segment on the Pennsylvania Rivers Conservation Registry.

Rivers on the Registry are eligible for grants to resolve specific projects identified in the conservation plan, such as easements or land acquisition, stream bank stabilization, and construction type activities..

The PITA and acquisition and development program grants fund up to 50 percent of eligible costs for rivers conservation projects, with a maximum $50,000 grant. There is no maximum limit for other kinds of projects. In-kind services, including the salary, certain fringe benefits, and mileage of the grantee's paid staff or documented donated services and volunteer time, may be used to qualify for the match. Applicants may submit one application per program (community, rivers, or rails-to-trails program) and no more than two grant applications per funding cycle.

An open enrollment period is active now, August 10-October 30, 1998. Contact the Central Office of the DCNR, Bureau of Recreation and Conservation, P.O. Box 8475, Harrisburg, PA 17105-8475, (717) 787-7672 for an application. Applicants may be referred to field staff, who work closely with local government officials, organizations, and citizens regarding the grant application procedures and process. The Central Office and field offices coordinate selection and administration of projects.

Statewide Nonpoint Source Pollution Program, Federal Clean Water Act - Section 319 Nonpoint Source Implementation Grants

The program provides grants for local, nonpoint source pollution projects. Agriculture, silviculture, construction, urban runoff, resource extraction, on-lot septic systems, and stream bank modifications are the types of eligible projects. Projects must be implementation-oriented, demonstrate new techniques, and document environmental improvements. Comprehensive watershed projects are encouraged.

Funding for two-year implementation periods with grants of $2 to $3 million per grant, the program requires that 25 percent of construction costs come from non-federal sources. The State must prove 40 percent matching funds.

Department of Environmental Protection

Pennsylvania State Revolving Loan Fund

Under the 1996 Amendments to the Safe Drinking Water Act, federal funding is available to states every year between 1997-2004, as long as states provide a 20 percent match. The funds can be used to provide low interest loans to public water systems to improve the treatment and distribution of water. A percentage of the funds can be used for source water assessment and protection activities. Eligible activities include an assessment program, a source water protection/source water petition program, purchase of land or conservation easements, and a wellhead protection program.

This project was conducted with funds available from the set-aside for the assessment program. (An assessment is designed to delineate the boundaries of areas providing source waters for the system and identify the origins of regulated and unregulated contaminants in the delineated area to determine the system's susceptibility to such contaminants.)

The source water petition program allows States to assist systems or local government with development of voluntary, local, incentive-based partnerships to reduce the presence of contaminants, provide technical or financial assistance, and develop recommendations for long-term source water protection strategies. Petitions must address either regulated pathogenic organisms or contaminants at levels that the State has determined are not reliably and consistently below the health risk-based maximum contaminant level promulgated by EPA.

Loans are available for acquiring land or conservation easements to protect source waters and to implement voluntary measures to facilitate compliance with national primary drinking water regulations (such as wellhead protection programs).

Pennsylvania Game Commission

Pasture Stream Bank Fencing Program

The program establishes wildlife habitat along stream corridors accessible to the public for hunting. Participating landowners must be enrolled in the Pennsylvania Game Commission's Public Access Program, which opens private land to public hunting and trapping. The project installs electric fencing and plants trees and shrubs suitable for streambank stabilization and wildlife food and cover. The program provides funding ranging from donated shrubs from local organizations to an all-expense paid stream bank fencing project. Landowners must agree to maintain the fencing in place for a 10-year period to allow the vegetation a chance to establish and generally the fence must be placed at least 10 feet from the streambank.

The program uses contractors to install fencing, and prefers to wait until they have accepted several projects for the same area. This point can delay the project for up to three years, in some cases.

Contact Dennis Neideigh, Pennsylvania Game Commission, Bureau of Land Management, 2001 Elmerton Avenue, Harrisburg, PA 17110-9797. (717) 787-6400.

Pennsylvania Department of Agriculture

Clean and Green Tax Incentives (The Pennsylvania Farmland and Forest Land Assessment Act)

The County Board of Assessment can grant a preferential assessment for ten or more contiguous acres of land devoted to agricultural, forest reserve, or open space purpose. Land is assessed at the use value rather than the prevailing market value.

Contact the Pennsylvania Department of Agriculture, 2301 N. Cameron Street, Harrisburg, PA 17110, (717) 783-3167.

9.2.3 Nonprofit Organizations

MARSH Program, *Ducks Unlimited*

This privately funded organization frequently partners with local, State, and Federal organizations to provide technical assistance and funding for implementation of projects protecting habitat for waterfowl.

One project funded by cost-share assistance of up to 50 percent is the Matching Aid to Restore States Habitat (MARSH Program). Public agencies and private conservation groups can submit applications for projects that protect or restore North American Waterfowl Management Plan sites.

Contact the regional MARSH coordinator. David Wise (717) 733-0301, or National Headquarters at 1155 Connecticut Avenue, NW #800, Washington, DC 20036.

American Greenways Dupont Awards

Grants between $500 and $2,500 are available to community groups, nonprofit organizations, and public agencies that promote greenway development. The American Greenways Dupont Awards, a partnership project of DuPont, The Conservation Fund, and the National Geographic Society, provides small grants to stimulate the planning and design of greenways in communities throughout America. The Fund is now collaborating in Pennsylvania with the state's Environmental Council, Department of Conservation and Natural Resources, and Rails-to-Trails Conservancy chapter to begin a greenway effort. The ambitious goal: to create a system of linked open spaces in urban, suburban, and rural areas of Pennsylvania. The William Penn Foundation and the Howard Heinz Endowment provided seed funding for the project.

Land Trusts

These private, nonprofit corporations seek to protect land and land resources for wildlife habitat or natural areas, open spaces, recreational land (especially trail and river corridors), and farmland. The land is protected either through direct acquisition or through conservation easements. Conservation easements protect the land from development in perpetuity, but the landowner retains ownership and becomes eligible for some tax benefits.

9.3 Long Term Water Quality Monitoring

During this study Cadmus employed a variety of data collection techniques including review of historical studies, analysis of GIS land use maps, interviews with various parties, and direct field observation and water quality analysis. While each of the techniques proved valuable, there is no substitute for targeted water quality data.

Water quality data is useful for a variety of purposes including the following:

- Understanding the general water quality of the streams and the reservoir for the period that sampling is taking place. The data can be extended to understand un-monitored periods to a limited extent.
- Understanding variation in water quality between sites and over time.
    - Identifying hot-spots that require further study and possible remediation action. For example this study identified several areas where bacteria counts are elevated.
    - Demonstrating the need for action and the general sources of contaminants.

9.3.1 Where to Sample?

Cadmus recommends that sampling be performed at the mouths of tributaries prior to their entering Sacony, Maiden, or Ontelaunee Creeks. The advantage to this sampling strategy is that pollutant sources are less diluted and easier to detect. During this study pollutants were detected in tributaries and in pipes feeding them but rarely found in the main Creeks. Because roads parallel much of the main Creeks, sampling can be performed rapidly from bridges crossing the tributaries.

A moderate-sized sampling plan could include sites T1, T7, T11, T12, T13, T14, and T 15 to capture many of the tributaries. To represent the main Creeks Points M1, M4, M9, M11, and M14 would give a broad view of Maiden and Ontelaunee Creeks, and sites S1, S2, S5, S6, and S3 would cover Sacony Creek. These 17 points could be covered in a day of sampling using a dip sampler from bridges, including some time to perform field analyses. If samples are simply gathered for later laboratory analysis, roughly two-thirds of a day would be sufficient.

9.3.2 When and How Often to Sample?

The answer to when and how often to sample is dependant somewhat on budget constraints. Assuming a moderately-funded program we recommend sampling at least quarterly, preferably once per month for the first year. These sample runs could be scheduled in advance and would usually capture conditions during base flows (because there are more days without storms than there are with storms).

We recommend that the Authority (or coalition depending on how tasks are divided) plan to sample at least two storm events during the first year of sampling. As discussed in the next subsection, key parameters to sample are total suspended solids, phosphorus, and nitrogen. Because sampling during rain storms is time-consuming, and extra care must be taken we recommend cutting the sample stations down to less than ten unless multiple sampling crews operate simultaneously.

9.3.3 What to Sample?

As above, the number and type of analyses will be constrained by budget. This can be ameliorated somewhat by the use of field test kits for screening as discussed in the next subsection. The analyses performed should serve two purposes:

- Provide additional information on key water quality problems already identified (i.e., bacteria, sediment, nutrients)
- Keep watch for the appearance of new contaminants, or those missed by earlier sampling.

We recommend that most of the effort be spent on the first point with a lesser amount on screening for new contaminants. The base sampling for dry weather should include at a minimum TSS, total phosphorus, nitrate plus nitrite nitrogen, and bacterial indicators. For suspected or known sources of wastewater, ammonia or TKN should be added. If sampling budget allows and further detail is needed ammonia or TKN, and soluble phosphorus can be added for stream samples.

Although they do not directly relate to drinking water quality temperature and dissolved oxygen are fundamental ecological indicators and should be added if other coalition members want them.

9.3.4 How to Extend Limited Sampling Resources

There are a variety of strategies for extending what can be accomplished with limited sampling resources. Following are several examples:

- In this study resources were conserved by using a LaMotte field test kit for phosphorus. Whenever the test kit showed a positive reading (>0.2 mg/l), a sample was collected for later laboratory analysis. The cost of the kit analysis was roughly $0.50 per sample, while the laboratory cost was roughly $20 per sample. In this manner, the cost for screening for sites with high phosphorus was greatly decreased without a loss of accuracy. This method would not be appropriate, however, where an accurate reading of total phosphorus was needed for modeling wastewater discharges or for examining biological responses of the stream to phosphorus inputs. As a screen for pollutant sources the method provided a good level of accuracy at a fraction of the cost.
- Cadmus used a LaMotte field test kit for nitrate nitrogen. When the kit reading was either low (<1 mg/l) or high (>5 mg/l) a sample bottle was also generally filled for later laboratory analysis. Test kit and laboratory analyses were compared and the agreement was quite good nearly always within 1 mg/l at the high range (5-10 mg/l), and more accurate at lower concentrations. As with phosphorus, this was a good strategy for minimizing the cost of searching for waste sources. It would not be appropriate for performing a detailed waste load or ecological study.
- To reduce the cost of using a contract laboratory, the Authority could provide in-kind services to the coalition for parameters already routinely measured. If the samples could be combined with current analyses, additional set-up time could be reduced.
- To reduce sampling labor, volunteers could be used to collect dry weather samples. It is vital that the volunteers receive organized and detailed training. In North Carolina, the Department of Environmental Management makes creative use of monitoring consortia that use a combination of paid and volunteer monitors that are highly trained. For further reading consult an article by Brewer and Clements on monitoring consortia.[71] A current effort in

[71] Brewer, Kimberly, Trevor Clements, The Cadmus Group. Monitoring Consortiums: A key Tool in the Watershed Approach, In Watershed '96: Mooving Ahead Together. June 8-12, 1996, Baltimore Maryland.

Pennsylvania is making us of knowledgeable senior citizens for monitoring. Chris Kocher of the Wildlands Conservancy[72] has used high school students for a similar purpose.

- Various agencies including the Pennsylvania DEP collect water quality data. The authority should keep in contact with the regional DEP to encourage agency monitoring and to gain access to historical data.

9.4 Recommended Additional Activities for the Coalition and Authority

This section discusses activities discussed elsewhere in the report that can be performed by a coalition by the Authority, or by other agencies.

9.4.1 Outreach

Once a watershed protection effort is underway, communicating that effort to parties in the watershed is vital. Another function of outreach could be to educate land owners and influence behavior by various parties, for example automotive-related commercial facilities (see Chapter 8). Included with this report is an outreach brochure written by Cadmus for this project. Outreach to the agricultural community is best done in close cooperation with the agricultural agencies. The Berks County Conservancy and the Wildlands Conservancy in Allentown are very experienced and successful in reaching out to a variety of communities. A video of some of the Wildlands Conservancy's educational efforts is included under separate cover. Following are examples of outreach efforts that Cadmus recommends:

- Work with the agricultural service agencies to publicize the watershed coalition. Encourage participation.
- Approach hunting and fishing groups and agencies to publicize the watershed effort and invite cooperative efforts.
- Discuss with the conservancy strategies for filming and screening a public TV spot.
- Have the coalition included on appropriate web pages including the Pennsylvania Berks County Notebook.
- Approach local chapters of national organizations including Trout Unlimited, Ducks unlimited, and the Nature Conservancy to share information and invite involvement.
    - Publicize the effort to local, state, and federal agencies to encourage support, funding, and in-kind services.

[72] Wildlands Conservancy, 3701 Orchid Place, Emmaus, PA 18049, (610) 965-4397.

9.4.2 Hire Watershed Staff

We recommend that the Authority hire a part time watershed inspector to service the upper watershed beyond the Authority's land holdings. The position could be filled with an existing staff member or with a new hire. The position could also be filled by the member of another organization although how they would represent the Authority and its interests would be a challenge. The inspector could perform a variety of functions including the following:

- Conduct regular field visits to observe the watershed.
- Conduct water quality sampling.
- Work with the watershed coalition
- Coordinate in-kind services provided by the Authority to the Coalition
- Coordinate volunteers
- Help staff subcommittees of the Coalition that would work on issues including bacterial contamination from inadequate sewer and septic systems and nonpoint sources of sediment and nutrients.

9.4.3 Recommended Activities

Following are selected recommendations discussed elsewhere in the report:

- Work with the state and with local communities to help solve the problem of fecal contamination from inadequate septic systems. Conduct sampling in support of this effort.
    - Conduct a current reservoir volume study to determine the change in volume over the last 7 years.
- Conduct a detailed sediment study to focus sediment reduction efforts.
- Cadmus understands that the Authority is currently considering construction of sediment reduction measures including a sedimentation basin. Because reduction of sediment load is a long-term process, some nearer term engineering solution appears to be necessary.
- Actively promote protection of stream-side buffer zones. These zones are vital for reducing sediment and nutrient loads. The land now held by the Authority is a vital resource that should be held and managed. The Authority should consider expanding its holdings through

lease or purchase of buffer zones in the lower reaches of the watershed. Agricultural programs such as the conservation reserve program can help in this regard (see Chapter 5).

- Work with appropriate agencies to develop BMP demonstration projects. The Chester Water Authority worked with several groups including the Pennsylvania Fish and Boat Commission to develop stream bank protection projects.
    - Reach out to users of toxic materials to encourage responsible behavior. Approach automobile parts suppliers to encourage oil recycling. Discuss commercial and industrial floor drains with EPA Region III's Class V well program.[73]

9.5 Summary

In this report Cadmus recommended that the Authority help convene a watershed coalition that would both focus on the core issues identified: bacterial contamination, and sedimentation, and would also address longer term issues such as non-point sources of nutrients. The process of building a maintaining this effort is long-term and by its nature cooperative. Investment in source water protection will pay dividends in a healthier watershed, an additional layer of drinking water protection, and a deeper understanding and appreciation of the watershed. Should the Authority have any questions regarding the report or their efforts they can call David Korn at the Cadmus Group, Inc. in Waltham, Massachusetts.

[73] Rural floor drains often drain to dry wells. States often include dry wells in programs termed Class V injection well control. EPA Region III has primacy for this program in Pennsylvania.