


PHILADELPHIA WATER DEPARTMENT – BELMONT & QUEEN LANE TREATMENT PLANTS (PWSID #1510001) SOURCE WATER ASSESSMENT REPORT


This report was produced for the Pennsylvania Department of Environmental Protection in accordance with the Source Water Assessment and Protection Plan.

Prepared by The Philadelphia Water Department
January 2, 2002

<u>*With support from:*</u>
Citizens' Home Water Utilities
Philadelphia Suburban Water Company
Pennsylvania American Water Company
Pennsylvania Department of Environmental Protection
Camp Dresser & McKee

PADEP Contract: ME350056

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PHILADELPHIA WATER DEPARTMENT – BELMONT & QUEEN LANE TREATMENT PLANTS (PWSID #1510001)
SECTION 1: GENERAL SCHUYLKILL RIVER WATERSHED SOURCE WATER ASSESSMENT REPORT

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Executive Summary – Schuylkill River Watershed Assessment

The 1996 Safe Drinking Water Act Amendments required the assessment of all source water supplies across the country to identify potential sources of contamination, the vulnerability and susceptibility of water supplies to that contamination, and public availability of the information. In response to this charge, the Schuylkill River Source Water Assessment Partnership, comprised of the Pennsylvania Department of Environmental Protection, the Philadelphia Water Department, the Philadelphia Suburban Water Company, and the Pennsylvania American Water Company, conducted an assessment with stakeholders to identify water supply protection priorities in the Schuylkill River watershed. The following summary includes two main sections. One section discusses the various characteristics and observations made through collection of watershed wide information. The remaining section provides a brief listing of the main recommendations based on the observations and analysis of watershed data.

Observations & Characterization

- The Schuylkill River has been an important source of drinking water in the region for over two centuries. Philadelphia began using the Schuylkill River as a water supply in 1801.

- The Schuylkill River has been historically impacted by mining activities. Many of the dams along the river were originally built to support the canal system for mining or to trap mining wastes.

- During the late 1800s, untreated sanitary and industrial wastewater was discharged directly into the River. This combined with pollution from mining forced many communities away from the river as a water supply or caused significant investments in additional treatment capabilities.

- The Schuylkill River Watershed is approximately 1900 square miles encompassing portions of 11 counties with almost 3 million residents

- Approximately 1.75 million people in the watershed receive drinking water from the Schuylkill River and its tributaries. About 80 percent of those persons receive drinking water from surface water supplies withdrawing water from the river below Pottstown.

- Between 700 and 900 million gallons of water are withdrawn every day from ground and surface water within the Schuylkill River watershed. Between 570 to 600 million gallons are withdrawn every day from surface water (streams and rivers) for a variety of purposes.

- Approximately 40 percent of the surface water withdrawn from the Schuylkill River and its tributaries is used for drinking water. Another 30 percent is used for thermoelectric power generation. The remaining amounts of surface water are used for agriculture, commercial and mining.

- Over 75 percent of the total stream length within the Schuylkill River watershed is comprised of first and second order streams.

- Studies indicate that the amount of developed land within the Schuylkill River watershed ranges between 14 and 30 percent.

- Recent land use studies have concluded that the amount of developed land within the watershed is increasing as agricultural and forested lands decrease. The developed land areas are found mainly in the lower watershed, near major cities, or transportation corridors.

- The Perkiomen Creek Watershed and the area along the river from Phoenixville to Reading have seen the greatest population increases between 1990 and 2000. The area along the Schuylkill River from Philadelphia to Conshohocken has seen a significant decrease in population over the past decade. This data suggests more persons are moving upriver and contributing to sprawl.

- The areas along the Schuylkill River from Conshohocken to Reading have seen the greatest increases in developed lands (up to 8%) between 1990 and 2000. The Wissahickon Creek, Valley Creek, and Perkiomen Creek subwatersheds have also seen significant increases (up to 8%) in developed lands the past decade. Depending on the area, more than half the developed land was originally agricultural or forested lands.

- Over 3,000 potential point sources were identified within the Schuylkill River watershed. Most of these potential sources do not and will never discharge into the Schuylkill River, but may store, generate, or transport hazardous chemicals.

- Sewer systems, dry cleaners, and machine/metal working shops were among the most frequently identified potential point sources.

- The highest concentrations of potential point sources were located in the most highly developed sub-watersheds.

- Monocacy Creek, Wissahickon Creek, and Valley Creek had the greatest number of dischargers per acre of drainage area. Based upon drainage area and flow, the Wissahickon Creek had the highest discharger density.

- A total of 543 million gallons of petroleum, gasoline, and crude oil are stored in above ground storage tanks in the watershed. The tanks range in size from 250 gallons to 13 million gallons and range in age from 1 to 98 years old. The storage tanks were determined to hold 159 different substances or chemicals.

- Schuylkill River water quality has significantly improved over the past twenty years. As the impacts of point sources have been reduced over the years, the importance of non-point sources such as stormwater runoff from developed areas within the watershed has become evident.

- While dissolved solute and metal levels have increased over the past few decades, dissolved oxygen and nutrients have significantly improved, due to reductions in agricultural runoff and improved wastewater treatment.

- Over the past decade, levels of alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon, and turbidity have increased in the mainstem river and throughout portions of the watershed.

- Increases in levels of solids, salts, and metals are believed to result from contaminated runoff resulting from increased development, increased use of deicing chemicals, and from acid mine drainage. If current trends continue, there will be impacts on drinking water supplies that require additional treatment and costs to make the water potable for drinking.

- Analysis of water quality trends suggests that conductivity trends may provide a good indicator of trends in other water quality parameters.

- Of the 53 percent of the 2522 miles of streams and creeks within the watershed that have been assessed, nearly 73% of the streams have attained their applicable water quality standards and designated uses.

- Watersheds within the more highly developed downstream areas of the watershed have the highest percentage of stream length that are impaired.

- Flow variability and nutrients were listed as the two most frequent primary causes of impairment in the watershed.

- Stormwater runoff from urban and suburban areas was identified as the cause of over half of the impaired stream lengths within the watershed.

- Federal, state, and private grants have provided almost $20 million for environmental projects within the Schuylkill River watershed over the past seven years. Almost 50 percent of the grants awarded were used for restoration projects.

- Grants were awarded to 76 recipients, with county and municipal groups receiving the majority of funds.

- On a per capita basis, the Valley Creek subwatershed received the greatest amount of funding (> $55 per person) out of 18 subwatersheds. The most challenged and impaired watersheds tended to be located in developed areas.

Watershed Recommendations

- Grant funding should be directed towards restoration projects and the formation of watershed organizations along the main stem of the Schuylkill River between Philadelphia and Reading. This will benefit the water supply for communities from Philadelphia to Pottstown or 1.75 million people. Special legislation, zoning, ordinances, and regulations should also be developed for this water supply protection area.

- Both sewer system capacity and integrity as well as treatment plant capacity during wet weather periods represent the greatest and most difficult sewage related issue in the watershed. Infrastructure improvements for adequate wastewater collection and treatment systems are needed to address infiltration and inflow or system capacity issues. These improvements will eliminate events such as overflowing manholes of raw sewage into downstream water supplies.

- Raw sewage discharges by communities such as New Philadelphia and Middleport need to be eliminated and treated with proper wastewater treatment. This is not consistent with national and statewide sanitary practices.

- Discharges from Combined Sewer Overflow Systems such as Bridgeport and Norristown upstream of drinking water intakes need to be reduced and controlled. These discharges can significantly impact pathogen concentrations in downstream water supplies.

- Wastewater dischargers should be encouraged and given incentives to switch to ultraviolet light disinfection and/or filtration of effluents to reduce *Cryptosporidium* pathogen levels and viability from discharges.

- It is recommended that the DRBC and three PADEP regions covering the Schuylkill River Watershed develop a watershed wide approach to addressing permit requirements. One suggestion would be a uniform fecal coliform discharge limit for any wastewater discharge upstream of a drinking water intake in the watershed.

- Incentives for townships and communities along the mainstem Schuylkill River from Reading to Philadelphia are needed to mitigate stormwater impacts on water supplies.

- Strict enforcement of the Phase II stormwater regulations is recommended for communities discharging into protection priority areas for drinking water supplies.

- Acid Mine Drainage needs to be addressed and mitigated to reduce significant loadings of metals into downstream water supplies. The Pine Knot/Oak Hill acid mine drainage site in Schuylkill County is potentially the greatest single known source of metals discharging into the Schuylkill River. Efforts should be focused towards the remediation of this site.

- Interaction and communication with petroleum pipeline owners and operators, railroads, and road or bridge construction crews needs to be developed and improved. It is important for these stakeholders to understand water supply issues and impacts from catastrophic accidents and right of way spraying of herbicides. Therefore a series of emergency response workshops needs to be held to raise awareness of the issue.

- Given the catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the mainstem Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that the USGS should be involved in the implementation of the early warning system.

- An accurate time of travel study needs to be conducted on the Schuylkill River to determine the time various spills will take to arrive at various water supply intakes and the amount of dilution under various flow scenarios. This should be incorporated into a computer model for emergency planning simulations using various chemicals and scenarios. This is also an important component necessary to make information from the early warning system more useful. The USGS should be involved in the implementation of this effort.

- Signage should be developed in sensitive water supply areas along roadways and bridges that include phone numbers to contact water suppliers during emergencies and spills. The signs should include a unique identification number corresponding to a known location for the water supplier.

- A special workshop with street departments and PennDot should be held to develop a strategy to reduce salt impacts from road salt application. This may include strategies to acquire special funding for salt misting trucks to reduce salt application in sensitive areas.

- Agricultural land that is preserved should have specific riparian buffer and streambank fencing requirements included in its preservation status.

- Additional incentives and efforts should be allocated to develop, monitor, and implement nutrient management and conservation plans for farms in sensitive water supply areas.

- Active agricultural lands adjacent to streams in sensitive water supply areas should be required to have riparian buffers or streambank fencing to reduce impacts from livestock activity, pasture runoff, and crop runoff.

- Agricultural protection activities should be focused in Berks County and along the mainstem Schuylkill River between Philadelphia and Reading. Efforts should build on the successes of the Berks County Conservancy in this area.

- USDA funding such as EQUP and CRP, that remove agricultural lands from production in sensitive water supply areas should be increased, more easily available, and discussed more aggressively with farmers. Water suppliers should also be included in EQUP and CRP funding decisions in order to maximize water supply protection.

- Areas of intense or concentrated agricultural activity should also be prioritized for protection and mitigation efforts.

- Special erosion controls and ordinances to reduce stormwater impacts from future development and erosion are needed in protection priority areas for water supplies.

- Conservation Districts need more assistance in addressing erosion control and stormwater runoff issues from development.

- The sediment impounded behind dams should be removed prior to removal of the dam. Future dam removal projects funded by PADEP or DCNR must have this component to reduce washdown impacts of impounded sediment from rain events after the dam is removed.

- The U.S. Fish and Wildlife, PA Game Commission, park managers, golf course managers, and water suppliers should develop and implement a regional management plan to address the exploding population of non-migratory Canada Geese

- Township officials along the protection priority corridor should be educated about stormwater impacts on water supplies through meetings, workshops, or mailings.

- The results of the local source water assessments need to be presented directly to local township officials. The common issues from multiple water supplies should also be provided to show how everybody lives downstream and feels the impact from pollution.

- There are significant needs for improved GIS information in order to conduct improved assessments for the watershed. This includes up to date land use, pipeline, preservation, and agricultural information.

- Water quality monitoring in the watershed needs improved coordination. Sentinel monitoring locations for tracking long term trends in water quality need to be established.

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Section 1
General Schuylkill River Watershed

1.1 Introduction

Key Points

- The Schuylkill River Source Water Assessment Partnership, comprised of the Pennsylvania Department of Environmental Protection, the Philadelphia Water Department, the Philadelphia Suburban Water Company, and the Pennsylvania American Water Company, is collecting and evaluating the data necessary to identify water supply protection priorities in the Schuylkill River Watershed.

The ability to obtain safe and potable drinking water has always been a key component in the location and development of communities. The quantity and quality of the drinking water supply has often defined a community's ability to grow and succeed. Therefore, protecting, maintaining, and improving the quality of a community's water supply is vital in ensuring its future.

The importance of water supply integrity has been recognized throughout the United States by municipalities and water suppliers who have implemented efforts to protect the drinking water supplies of their communities. From rural wells, to the rivers supplying potable water to big cities, everyone is getting involved in protecting the source of their drinking water.

In addition to local efforts, federal regulations, resources, and initiatives have been implemented to protect drinking water sources. These include the Clean Water Act (CWA), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Safe Drinking Water Act (SDWA).

Most recently, the Safe Drinking Water Act Reauthorization in 1996 included a specific component for source water protection called the Source Water Assessments (SWAs). The SWAs are a process involving water suppliers, watershed organizations and other stakeholders, which identify the protection priorities of the water supply. Water suppliers will be required to make this information available to the public in their Consumer Confidence Reports in order to help the public understand the source of their drinking water and the challenges that must be met to protect it. It is important to note that these assessments are of the raw water sources prior to drinking water treatment, not assessments of the performance or compliance of public water systems.

As part of its federal requirement to conduct the SWAs, the Pennsylvania Department of Environmental Protection (PADEP) sought to involve water suppliers and the community in the SWA process. It is believed that the partnership approach will increase the potential for public, community, and water supplier involvement to address source water issues after the assessments have been completed.

Using this partnership approach, the Schuylkill River Source Water Assessment Partnership was formed. The partnership includes water suppliers working with the state to conduct the assessments. The state contractor, the Philadelphia Water Department, has partnered with the Philadelphia Suburban Water Company and the Pennsylvania American Water Company to lead the Schuylkill River Source Water Assessment Partnership, and conduct source water assessments for 42 surface water supplies within the Schuylkill River Watershed.

1.1.1 New Requirements Under SDWA

Key Points

- **The 1996 amendments to the Safe Drinking Water Act require States to implement Source Water Assessment Programs.**

The EPA has supported efforts by States and communities to protect their water sources from contamination since 1986, with the establishment of the Wellhead Protection (WHP) Program and other federal initiatives. Encouraged by the WHP program's success, the EPA has set new goals for source water protection. By 2005, the EPA's goal is to have either Source Water Protection, Wellhead Protection, or Watershed Protection Programs in place for 60% of the country's population served by community water (source: EPA State Source Water Assessment and Protection Programs Guidance, August 1997, EPA 816-R-97-009, Office of Water 4606).

The amendments to the 1996 Safe Drinking Water Act include requirements for states to establish and implement Source Water Assessment Programs (SWAPs) that accomplish the following:

1. Set forth the state's strategic approach to conducting the assessments

2. Delineate the boundaries of the areas providing source waters for public water supply (PWS)

3. Identify, to the extent practical, the origins of regulated and certain unregulated contaminants in the delineated area in order to determine the susceptibility of PWSs to such contaminants

4. Complete the assessments within two years after EPA approval, with an opportunity to extend this period up to 18 months

5. Make the results of the source water assessments available to the public.

The intent of Congress by requiring the SWAs was to show water suppliers, municipalities, and the public the potential challenges facing their sources of drinking water and to develop local voluntary support for source water protection programs.

The PADEP has already been working hard to meet these requirements by developing an approved SWA Program and Plan and by hiring contractors to help assess a portion of its 14,000 water sources. In addition, the PADEP has set aside resources and monies in the forms of grants for communities that apply to develop local source water protection plans after assessments are finished. These plans were designed to be linked to the Growing Green Grant application process. Additional preference would be given to grant applications that can show that the proposed activities are linked to an approved Source Water Protection Plan or River Conservation Plan for that community. Therefore, local organizations seeking funds to conduct protection efforts would eventually be better coordinated to conduct efforts that can protect local water supplies.

1.2 Background and History

1.2.1 Description of the Schuylkill River Watershed

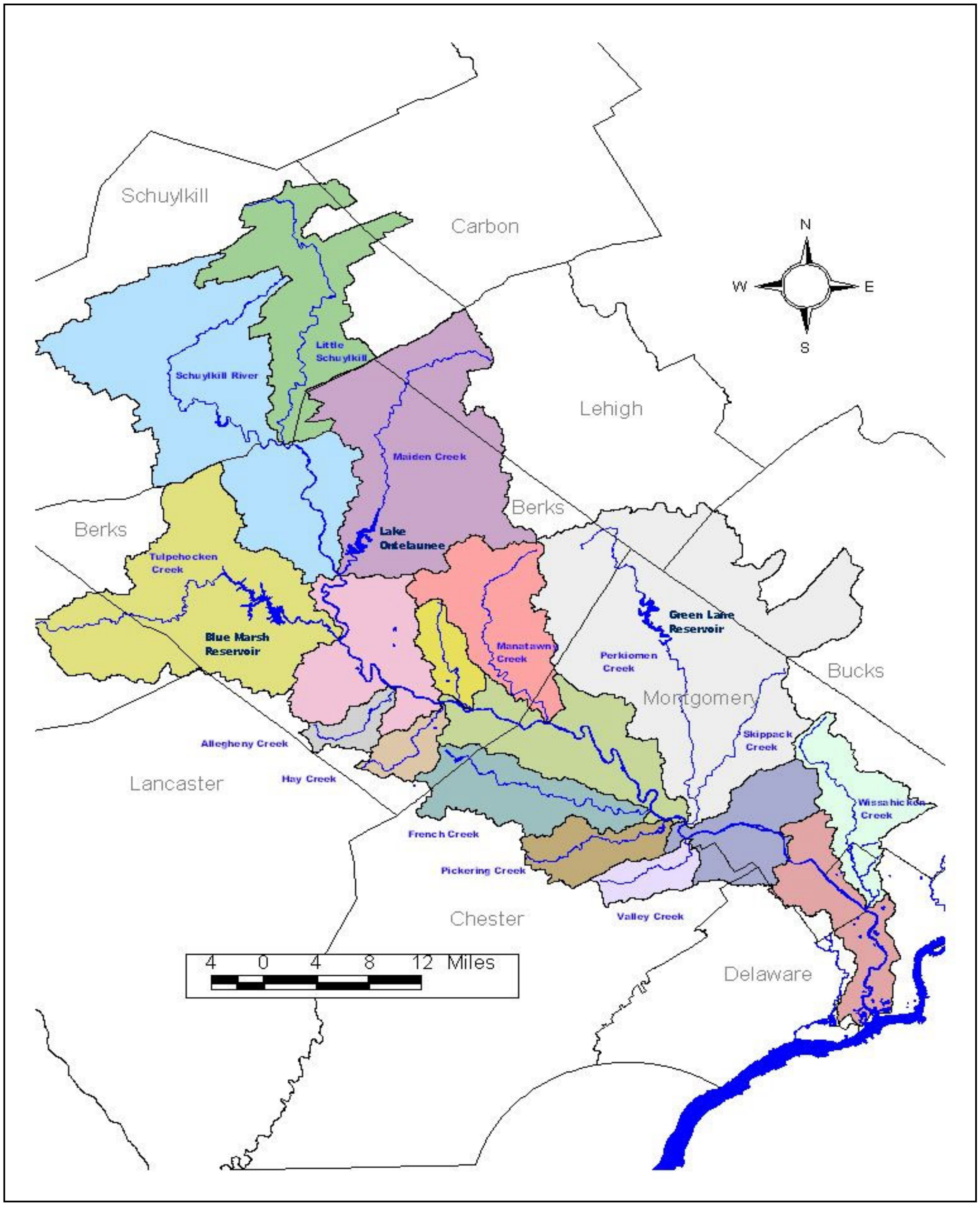
Key Points

- **Early colonial settlements along the Schuylkill River in the 1600s were established at the river's mouth and confluence with the Delaware River.**
- **Today, over 3,000,000 people live within the 2,000 square-mile watershed.**

The Schuylkill River Watershed is over 130 miles long, includes over 180 tributaries, and drains an area of 2,000 square miles. The watershed is located in southeastern Pennsylvania and is comprised of eleven counties and over three million residents. The headwaters of the Schuylkill River drain approximately 270 square miles of Schuylkill County and flow in a southeasterly direction into the tidal waters at the river's confluence with the Delaware Estuary. The basin includes large parts of Schuylkill, Berks, Montgomery, Chester and Philadelphia counties and smaller parts of Carbon, Lehigh, Lebanon, Lancaster, Bucks and Delaware counties. The major towns and cities along the river are Pottsville, Reading, Pottstown, Phoenixville, Norristown, Conshohocken and Philadelphia.

Figure 1.2.1-1 presents a map of the entire Schuylkill River Drainage Basin, its subwatersheds, and its tributaries.

Figure 1.2.1-1 Schuylkill River Drainage Basin



1.2.2 History of the Schuylkill River Watershed

Key Points

- The effects of historical coal mining in the headwaters of the Schuylkill River Watershed can still be observed today.
- Through the late 1800s, untreated sanitary and industrial wastewater was discharged directly into the river.
- Population growth in the Schuylkill River Basin increased the amount of wastewater discharged into the river, and changed the quantity and quality of stormwater runoff.
- In response to the accumulation of coal culm in the river, the Commonwealth of Pennsylvania prohibited the pollution of state waters, including the discharge of mining wastes into the river.
- Philadelphia began using the Schuylkill River as a potable water supply in 1801.
- Today, the Schuylkill River Watershed is the source of potable water for 1.8 million people.

1.2.2.1 Colonial Settlement

The initial settlement along the Schuylkill River began at the river's mouth and confluence with the Delaware River. Prior to colonial settlement by the British, the lower Schuylkill River Basin was the home of the Lenape Indians. In the early 1600s, Dutch and Swedish settlers also made the lower Schuylkill River Basin their home. It was not until the arrival of the British that settlement within the basin rapidly expanded.

William Penn chose the mouth of the Schuylkill River to establish the colonial city of Philadelphia, based on the region's physical features. The site was comprised of high dry land, the Atlantic Coastal Plain, and was flanked by the Delaware and Schuylkill rivers, which Penn envisioned would lead to rapid commercial and residential development along both rivers. During colonial times, both rivers also served as vital food sources (shad, herring, salmon and sturgeon) and provided cultural and recreational resources. The region still maintains vestiges of its Indian heritage; e.g. Wissahickon, an area within the watershed, is an Indian name for catfish. Similarly, many of the current town names were Indian words describing the local environmental conditions; Passyunk means "a level place below hills" and Cohocksink means "pinelands" (Toffey, 1982).

Since the city's founding by William Penn in 1682, significant alterations to the land and riverfront occurred to accommodate industrial and residential development. Along the Schuylkill riverfront, nearly all of the woodlands were cleared to make room for industrial development. During the 1700s and early 1800s, land development along both sides of the Schuylkill River south of central Philadelphia was mostly agricultural and recreational, except for elite residential development near the present-day Fairmount Dam. The original mouth of the Schuylkill was comprised of a small stream, tidal flats, and several marshy islands. These lands were filled and drained by man-made canals, and tidal waters were diked to create thousands of acres of agricultural lands. The city estimates that approximately 7,000 acres of shallow water habitats existed at the time of Penn. Today only 500 acres remain (Philadelphia City Planning Commission, 1982).

1.2.2.2 Industrialization

Coal was discovered in the headwaters of the watershed as early as the 1770s. Commercial mining began in the 1820s and rapidly expanded with the completion of the Schuylkill River canal system in 1824. Initial mining efforts were limited to shallow mines above the water table. By 1835, several mines were excavating below the water table and pumping the mine water into the Schuylkill River. Coal production reached its peak in the 1920s, declined during the depression, rose again during World War II, and then declined to the present low rate. Figure 1.2.2-1 summarizes the cumulative production of coal in the Schuylkill River Basin.

Figure 1.2.2-1 Cumulative Coal Production in the Schuylkill River Basin

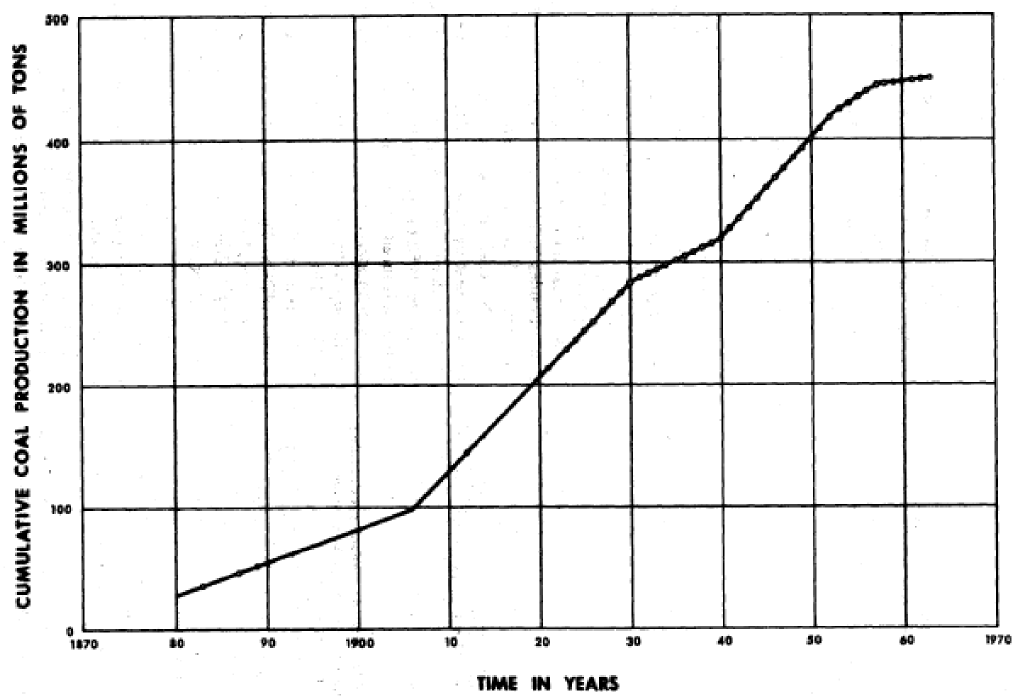


Figure 1.2.2-1 Cumulative Coal Production in the Schuylkill River Basin

Source: Water Resources of the Schuylkill River Basin, Water Resources Bulletin, Bulletin No. 3, United States Department of the Interior, Geological Survey, 1968.

The coalbeds in the Schuylkill Basin are part of Pennsylvania's southern anthracite coalfield. In areas of historic mining, land was stripped away to expose the coal vein. This soil was discarded and placed into piles next to the mining operation. These spoil piles are a source of coal fines, or culm, that if not properly contained, can run off into nearby streams. As the culm settles, it can cover the streambeds that serve as habitats for macroinvertebrates. Culm often contains iron pyrite, which is known for causing impacts to the stream bottom, but it also negatively impacts the water column by producing acid mine drainage. During industrialization, large discharges of culm into the river destroyed fish habitats and choked the flow of the river, increasing the frequency and magnitude of flood events.

As mining production increased, the impact on the Schuylkill River became more serious. Waters were acidic from the headwaters to Reading. In addition to acid mine drainage, coal processing introduced large amounts of sediment into the waterway. The accumulation of acid discharges and particulate waste from coal mining in the headwaters resulted in a lifeless Schuylkill River by the turn of the 20th Century.

Besides the adverse impacts of coal mining, the corresponding growth of industrialization also impacted the waters of the Schuylkill River. By the mid-1800s, the full force of industrialization had reshaped the development along the river's banks: industries, utilities and rail facilities replaced residential and recreational development along the riverfront below the Fairmount Dam in Philadelphia. Between the 1690s and 1860s, a series of dams within the Wissahickon Creek provided hydropower to run 24 mills (corn, wool, paper, etc). The advent of coal, steam, rail, and highway systems also impacted the waters of the Wissahickon, resulting in the clear cutting of woodlands for fuel and development and rock blasting along the shorelines to create space for transportation networks (West, 1985). Similar occurrences took place in booming industrial towns such as Manayunk, Conshohocken, Norristown and Phoenixville, all of which discharged their wastes directly into the Schuylkill River and its tributaries.

A sanitary survey conducted by the Philadelphia Water Department in 1884 provided an overview of the variety and magnitude of the contaminant sources to the Schuylkill River at that time. Beginning in Reading, the sources of pollution included two gasworks, five tanneries, one soap mill, several slaughterhouses, two paper mills, one woolen mill, nine hat factories, five breweries and two malt houses, rolling mills and hardware mills, as well as several others. To provide some insight to the amount of pollution discharged into the Schuylkill at that time, discharges from two of these sources, the Reading Gas-orks and one of the tanneries, are described here. The Reading Gasworks discharged, on average during the winter months, 150 gallons per day (GPD) to 250 GPD of a thick, pulpy, black matter, directly into the river. One out of the five tanneries on the river discharged up to 4,000 gallons of wastewater per day. Soaking animal skins in water for two or three days created this wastewater containing animal wastes, as well as lime, salt, alum, aniline dyes, and eggs.

The borough of Pottstown produced the greatest amount of pollution. Pottstown is located on the West Bank of the Schuylkill River just below the mouth of Manatawny Creek, and about 40 miles above the Fairmount Dam. The population of the town was 5,000; the population of the area including the suburbs was 9,000. The sources of the pollution included three natural watercourses that ran through the town and drained washwater from about two-fifths of the population, mostly through the street gutters, as well as water closet drainage from over one hundred houses that drained into the river. The Philadelphia and Reading Railroad Station water closets also drained into the river. After it was determined that drinking water should not be taken from the river, the Pottstown intake was moved upstream.

Between Pottstown and Reading (about 20 miles) agriculture was the main source of pollution entering the river. The largest polluter was at Birdsboro, located almost half way between the two towns, where about 20 houses had indirect washwater drainage into Hay Creek, a tributary of the Schuylkill River. The Phoenixville District extended from the pumping station to the upper boundary of Norristown. The source of the greatest pollution at the time of the 1884 watershed survey was in the borough of Phoenixville, on the east bank of the Schuylkill, 28 miles above Fairmount Dam. The population of about 7,500 resided primarily along both sides of the French Creek. The creek received washwater from about 800 people, and also received a large amount of human waste from the Phoenix Iron Company. Besides human wastes, a few slaughterhouses also discharged to the creek.

The borough of Norristown, on the left bank of the Schuylkill, had a population of 14,500 in 1884. Most of the pollution from Norristown was drainage of foul water matter into the river or its tributaries. The sources of this foul water included an oil factory, oil refineries, slaughterhouses, woolen and cotton mills, iron factories, breweries, etc. Stony Creek was the most grossly polluted tributary of the Schuylkill River in the whole valley; it received hospital drainage and the wastewater from Norristown sources.

Population in the basin was initially concentrated in Philadelphia. By the time of the revolution, the population had increased to 35,000. By the mid-1850s, the population of Philadelphia/Philadelphia County reached 460,000. Table 1.2.2-1 presents the historical population growth for the county areas within the watershed.

Table 1.2.2-1 Population by County within the Schuylkill River Watershed

County	1900	1910	1920	1930	1940	1950	1960	1990	2000
Berks	151,000	175,000	191,733	221,503	230,584	243,360	260,645	336,523	373,638
Bucks	10,000	12,100	11,319	12,905	14,597	16,210	18,996	541,174	597,635
Carbon	6,400	10,500	15,167	15,242	14,164	12,454	10,388	56,838	58,802
Chester	27,200	30,000	30,890	35,233	37,778	45,290	65,585	376,396	433,501
Delaware	1,400	1,800	1,636	2,453	2,402	2,942	4,339	547,651	550,864
Lebanon	7,300	8,000	8,320	8,654	9,013	10,097	11,334	113,744	120,327
Lehigh	4,900	4,100	4,015	3,910	4,166	4,543	5,307	291,130	312,090
Montgomery	115,400	137,800	156,997	200,083	216,117	257,496	356,512	678,111	750,097
Philadelphia	387,900	519,700	638,000	669,100	658,700	694,400	627,500	1,585,577	1,517,550
Schuylkill	76,100	95,100	104,265	115,860	113,404	103,590	94,571	152,585	150,336
Total	788,000	994,000	1,162,000	1,285,000	1,301,000	1,390,000	1,453,000	4,001,618	4,864,840

The early impacts of population growth on the watershed stemmed from the use of the river as a common disposal site for residential sewage and refuse. During colonial times, residential waste was disposed of in pits in backyards until it was declared a health problem. Thereafter, canals were built to drain the sewage directly to the rivers. By 1867, Philadelphia had constructed 67 miles of sewers; by 1900 there were 848 miles, and by 1944, more than 1,800 miles (Barber, 1885). As population grew with the development of industry in the upstream reaches of the Schuylkill River, domestic and industrial pollution posed a threat to Philadelphia's water supply.

Population growth also impacted water quality through land use changes. Wooded areas are not easily eroded and therefore do not release significant amounts of sediment during rainfall events. However, as the population grew, wooded areas were stripped and converted into agricultural lands or urban areas. Agricultural stormwater runoff included sediment and high concentrations of nutrients as well as herbicides and pesticides. Urban development reduced the percentage of permeable surface resulting in increased stormwater runoff, stream flows and velocities. Powerful stormwater flows eroded stream banks, causing sediment transfer that disrupted aquatic habitats and resulted in silt buildup behind dams. Today, urban stormwater is often contaminated with pollutants such as nutrients from lawn fertilizers as well as pollutants that have settled on paved surfaces.

1.2.2.3 Transportation

The Schuylkill River also served as an important transportation waterway. The Schuylkill Navigation Company constructed a 108-mile canal between 1817 and 1824. The canal connected Philadelphia and Carbon County and was comprised of 116 locks and 38 dams. Operation of the canal was slowly abandoned in the upper reaches due to high maintenance requirements, which were due in part to the silting of the river and canal with fine coal particles, or culm.

During the coal-mining era, chunks of coal and rock were separated using a hydraulic device. During this separation process, a byproduct of fine coal and rock particles in a water matrix was created. This byproduct was eventually disposed of in the nearby waterway. These wastes soon became a nuisance, and began to choke the river and canals with sediment, creating both navigation and flooding problems. This compelled the Commonwealth of Pennsylvania to pass legislation that prohibited the pollution of state waters, and later abandoned all discharge of mining wastes into those waters. This legislation enabled the creation of a unique project which was completed in 1954, the Schuylkill River Desilting Project. The project combined dredging of the clogged river with planning and construction of desilting basins to abate the impacts of coal mining upstream of the Fairmount Dam. In short, this project removed the sand, gravel, and coal culm mixture from the bottom of the river and placed it into impounding basins to dewater. Once the dredged material was sufficiently dry, it was carried to a processing plant, where the coal culm was separated from the denser sand and gravel. The coal culm was sold. Today, there is much less culm that makes its way into the Schuylkill River, so the need for desilting appears to be decreasing.

Extensive railroad networks were built during the early 1800s with numerous terminals along both the Schuylkill and Delaware riverfronts. In 1928 the river was totally abandoned, as railroads succeeded as a faster and cheaper mode of transportation (Biesecker, 1968a).

1.2.2.4 Dams

There are three dams on the major tributaries of the Schuylkill River and ten dams on the main stem. Dams on the tributaries include Blue Marsh Reservoir on Tulpehocken Creek, Ontelaunee Reservoir on Maiden Creek, and Green Lane Reservoir on Perkiomen Creek. Blue Marsh has an estimated sediment trap efficiency of 83%. Ontelaunee and Green Lane Reservoirs are water supply facilities with theoretical trap efficiencies of 73 and 86%, respectively (Brune, 1953).

There are three dams within the upper portion of the Schuylkill River Basin that are downstream from the coal fields and were designed to trap the coal fines and other sediments discharged from mining and coal preparation operations. The Tamaqua Dam, which is on the Little Schuylkill River, Auburn Dam, which is on the main stem upstream from the Little Schuylkill River, and Kernsville Dam, which is on the main stem just downstream from the confluence with the Little Schuylkill River, are dredged periodically by the state. About 10.7 million cubic yards of material have been removed from behind the three dams since they were completed in 1951 (USGS, 1985b). The trap efficiency of the three desilting basins is estimated to be about 93%.

The remaining seven dams within the basin are remnants of a navigation system for barge traffic on the Schuylkill River. This system existed as the Schuylkill Navigation Company from 1825 until 1904. The original system was comprised of 38 dams, 32 canal segments, one tunnel, and 116 locks. This system enabled barges to navigate between Pottstown and Philadelphia, a distance of approximately 108 miles. Many of the remnants remained until the desilting project began in 1950. The Felix Dam, the uppermost of the seven dams located between Maiden Creek and Reading, was recently breached by Hurricane Floyd in September 1999. This suggests that many of the other dams of similar age and disrepair could be breached. The sediments in the pool behind the dam could contain remnants of contaminants from decades past. Therefore sediment removal must be performed carefully so there is no possible impact on downstream water supplies.

The Black Rock, Vincent, Norristown, and Plymouth dams, on the lower part of the river, are remnants of the original structures build in the first half of the 19th century. These dams are rock-filled, timber-crib structures that are anchored to bedrock with iron dowels. Plymouth and Vincent dams are owned and maintained by the Commonwealth of Pennsylvania. The Philadelphia Electric Co. owns and maintains Black Rock and Norristown dams; both provide the necessary water depth at the cooling-water intakes of electric generating plants near the dams. The Flat Rock Dam, owned by the state, is a concrete gravity spillway, built in 1977 at the site of the old navigation dam. The Fairmount Dam, which is the lowermost dam located on the river, is also a concrete gravity spillway owned and maintained by the City of Philadelphia. All of the dams are low-level structures, ranging in height from 8 to 12 ft. Tables 1.2.2-2 and 1.2.2-3 summarize dam locations and characteristics, respectively.

Table 1.2.2-2 Dams along the Schuylkill River

Dam	River Mile
Vincent	44.8
Black Rock	36.7
Norristown	24.1
Plymouth	20.8
Flat Rock	15.7
Fairmount	8.4

Table 1.2.2-3 Dam and Pool Characteristics

Name of Dam	Drainage Area Above Dam (sq. mi.)	Approximate Height (ft)	Approximate Length (ft)	Approximate Pool Length(mile)	Approximate Pool Area (acres)	Approximate Pool Volume (MGD)
Plymouth	1,777	9	530	1	40	192
Norristown	1,765	12	900	3.5	180	670
Black Rock	1,296	11	370	2.9	95	274
Vincent	1,150	12	350	2.1	70	220
Felix	647	24	450	3.5	110	480
Kernville	340	17	600	1.25	54	190
Auburn	157	16	500	2.28	3	620

From: USGS, 1985

1.2.2.5 Water Supply

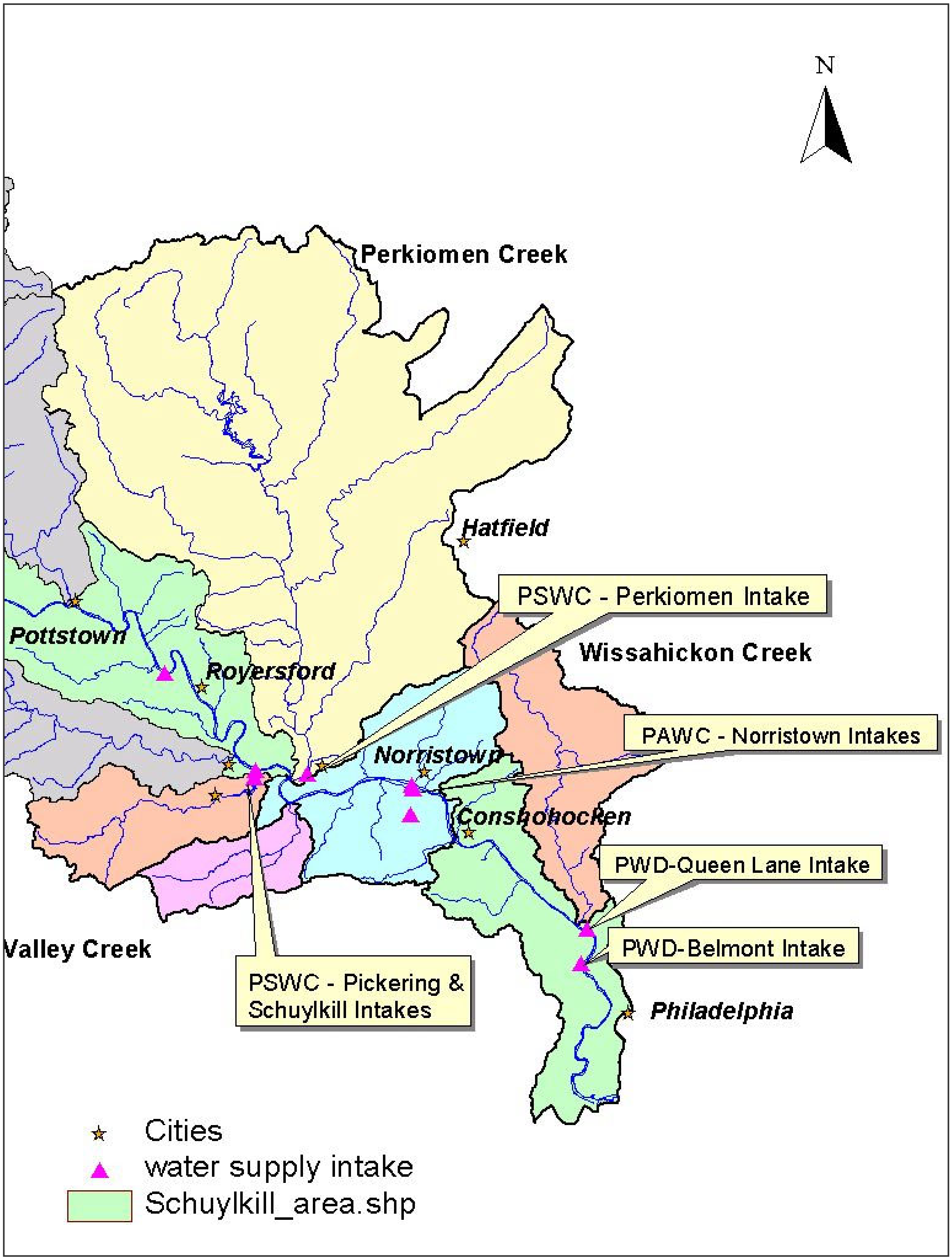
Philadelphia began using the Schuylkill River as a source of potable water supply in 1801. Today, a total of 265 million gallons of water is withdrawn from 57 surface water intakes located within the Schuylkill River Watershed each day to supply the needs of over 1.8 million people.

In colonial Philadelphia, the city's water supply was largely derived from wells. However, in 1793, a major yellow-fever epidemic and lack of water to cleanse streets or fight fires raised the awareness of the safeness of the city's water supply. In 1798, the city created the Joint Committee on Supplying the City with Water, also known as The Watering Committee. Philadelphia hired Benjamin Henry Latrobe to study the water supply and quality problem and to design a solution. He found that the city wells were contaminated by cesspools located too close to the public pumps and hydrants. Latrobe recommended the construction of a water supply and distribution system that would extract water from the Schuylkill River and distribute it throughout the city through mains constructed from bored logs and propelled by a combination of steam powered pump stations and gravity feed. In 1801, the first phase of the system and a pump house at Chestnut Street went into operation.

After several years of operation, continued improvements, and increased demand for water, the Watering Committee began to look for an alternative method to supply water to the city. The new facility included an intake from the fast flowing waters of the Schuylkill River, at what is currently the location of Fairmount Dam, a steam powered pump house, and a reservoir to store pumped water. The city began operation of these new facilities in 1815. By 1819, the city initiated plans to convert the steam engines to waterpower in conjunction with construction of the Fairmount Dam. The Fairmount Dam was completed in 1821 and the steam engines were replaced by water powered engines in 1822. Concurrently, the Flat Rock Dam was constructed upstream in Manayunk for the Schuylkill Navigation Company. The neoclassical Fairmount Waterworks building, reservoir, and gardens, as well as the water wheels and pumps, were a major attraction for visitors to Philadelphia. By the 1830s, this system had become the model water supply system for large urban centers in America and abroad. (Philadelphia Museum of Art, 1988)

Water supply intakes within the watershed are shown on Figure 1.2.2-2.

Figure 1.2.2-2 Locations of Water Supply Intakes in the Schuylkill River Basin



1.2.2.6 Historical Improvements in Source Water Quality

As advances were made to improve water supply to the growing region of Philadelphia, industrial development and population increased at a rapid rate along all stretches of the Schuylkill River, as did the amounts of waste discharged directly into the river. The dams on the Schuylkill River, which were constructed to facilitate transportation, provide hydropower, and secure water supply, interrupted the river's natural flow patterns and its assimilative capacity to handle the increasing amounts of pollution. This combination of activities began to adversely impact the city's source water quality as early as the 1800s.

For example, the Schuylkill Fishing Company, established in 1732, was a fishing society with a clubhouse at the foot of the falls near Fairmount. When the Fairmount Dam was constructed, the company moved to a point downstream, and approximately 90 years after its founding, it closed due to high pollution levels that destroyed fish populations in the tidal Schuylkill (Philadelphia City Planning Commission, 1982).

Pollution and silt accumulated in the Schuylkill River and posed a serious threat to the Philadelphia water supply. Prior to the turn of the 19^{th} century, the Pennsylvania Board of Health had issued 111 orders to stop discharging untreated wastes between Reading and Philadelphia (Biesecker, 1968). Finally in 1945, legislation was passed to address two key issues: the accumulated silt which hampered navigation of the river and caused increases in flood events and flooded terrain, and the pollution from coal, industrial, and municipal wastes which threatened the ability of water treatment systems to provide pure water supplies. The Brunner Act, required the cessation of pollution from coal wastes entering the river and the Desilting Act provided for the removal and disposal of silt deposits in the waterway and on the banks from the headwaters to Norristown Dam (Biesecker, 1968).

1.2.3 Physiography, Geology and Soils

Key Points

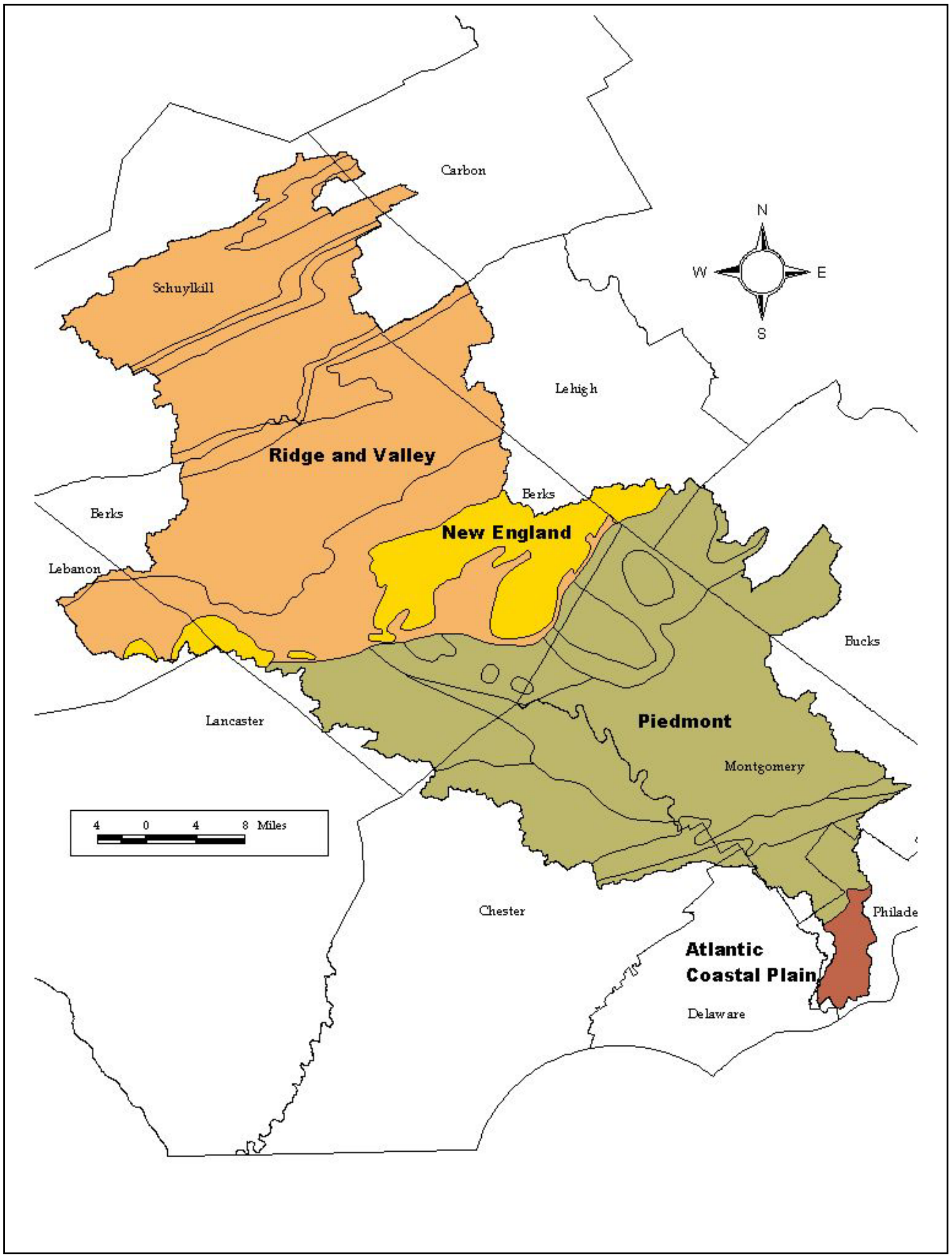
- The Schuylkill River drains over 1900 square miles between its origins in the Appalachian Mountains and its confluence with the Delaware River.
- The Schuylkill River flows through the Valley and Ridge, New England, Piedmont and Atlantic Coastal Plain physiographic provinces.
- The physical properties of the soils in the Schuylkill River Basin determine their susceptibility to erosion.

1.2.3.1 Regional Physiography

The Schuylkill River Basin is characterized by many diverse landforms and various physiographic provinces in southeastern Pennsylvania. It includes 12 major sub-watershed systems. The river has its origins in Schuylkill County in the Appalachian Mountains, and it drains over 1,900 square miles between the mountains and its confluence with the Delaware River at Philadelphia.

The Schuylkill River flows through four physiographic provinces. From upstream to downstream, they are the Valley and Ridge, New England, Piedmont and Atlantic Coastal Plain as shown on Figure 1.2.3-1. The Valley and Ridge Province is comprised of the mountains in the Appalachian Mountain section and rolling farmlands in the Great Valley. Elevations in the Valley and Ridge Province vary up to 1,800 feet above mean sea level (msl). The Appalachian Mountain section of the watershed is comprised the Blue Mountain Province, a long narrow mountain ridge separated by narrow and wide valleys. The Blue Mountain Province rises more than 1,200 feet above msl. The Great Valley lies south of Blue Mountain and consists of broad lowlands. The New England Province includes the Reading Prong, which is composed of the small mountains east of Reading. The Triassic Lowland of the Piedmont Province is characterized by rich farmland and low rolling hills, whereas the Piedmont Uplands include steep hills with urban development. The rolling hills of the Piedmont Province reach about 500 feet above msl. The Atlantic Coastal Plain Province is mainly lowlands with numerous streams and marshlands at about 100 feet above msl.

Figure 1.2.3-1 Physiographic Provinces of the Lower Schuylkill River Watershed



The headwaters drain approximately 300 square miles in the Appalachian Mountains and include the Valley and Ridge Province. The Appalachian Mountain section of the Valley and Ridge strata has been sharply folded along a northeast axis, and the more resistant sandstones and quartzites form prominent ridges that extend across the entire width of the basin, except where they are breached by the Schuylkill River and its major tributaries. This is a diverse, mountainous part of the basin with as much as 1,000 feet of relief between the ridges and the valley floors (USGS, 1985B). The Schuylkill and Little Schuylkill rivers cut through a series of valleys and ridges that run in a northeast-southwest direction. The valleys are narrow and surrounded by high, steep hills. A large part of the southern anthracite coal field is located in this province.

The river flows out of the Appalachian Mountain section at the water gap that forms the boundary between Schuylkill and Berks counties, and enters the Great Valley section. Rolling hills are the predominant landform in this section. Two major tributaries, Tulpehocken and Maiden creeks, drain virtually all the land in the Great Valley. Both of these tributaries enter the Schuylkill River just upstream of Reading.

Downstream of Reading, the river flows into the Triassic Lowland section of the Piedmont Province. This section is characterized by a broad, undulating plain with scattered rolling hills. Perkiomen Creek drains 362 square miles of land in this section. Other tributaries include Pigeon Creek, which drains 14 square miles, and French Creek, which drains 70 square miles. A slightly steeper section of the Piedmont, the Piedmont Upland, occupies the lower part of the Schuylkill River Basin. This is a hilly section of the province with narrow valleys and steep slopes. Wissahickon Creek, which drains 64 square miles, is the major tributary.

The last physiographic province found in the Schuylkill River Basin is the Coastal Plain. About 20 square miles of the basin are in this province, most of it is downstream of Fairmount Dam and the final water supply intakes in Philadelphia.

1.2.3.2 Subwatershed Physical Settings

Upper Schuylkill Subwatershed

The headwaters of the Schuylkill River drain approximately 270 square miles within Schuylkill County. This part of the basin is rough and mountainous with peak elevations of 1,000 feet. The valley and ridges are approximately east-west trending with the main valley and river cut narrowed by high, steep hills and ridges. A large portion of this drainage area includes the southern anthracite coal field. South of the coal field, the Schuylkill is joined by the Little Schuylkill River. This portion of the watershed lies in the Appalachian Mountain Province. Rock formations underlying this section of the watershed are sandstones and shales. The soils are characteristically well-drained or moderately well-drained shaly loan or silt loams located on slight to moderate slopes, and have a low to medium erosion potential, respectively (The Academy of Natural Sciences Patrick Center, the Natural Lands Trust, and the Conservation Fund, 2001).

From the confluence of the Little Schuylkill River, the Schuylkill flows through a gap in Blue Mountain, then across open rolling farmlands. This section of the river to the southern most portion of the watershed just south of Leesport lies in the Great Valley Province. Rock formations underlying this section of the watershed are sandstones, shales, and carbonate. The soils are well-drained silty loams with gravel and/or shale, and have a low to medium erosion potential (The Conservation Fund, 2000).

Little Schuylkill Subwatershed
The Little Schuylkill River's headwaters drain approximately 138 square miles. The Little Schuylkill River Watershed drains into the Schuylkill River just south of the coal fields. The entire watershed lies within the Appalachian Mountain Province. Rock formations underlying this section of the watershed are sandstones and shales. The soils are characteristically well drained or moderately well-drained shale loan or silt loams located on slight to moderate slopes, and have a low to medium erosion potential, respectively (The Conservation Fund 2000, Schuylkill RCP).

Maiden Creek Subwatershed
The headwaters of Maiden Creek lie in Lehigh County. This watershed drains into the Schuylkill River two miles south of Leesport. The majority of the watershed lies within the Great Valley Province with the southeastern portion in the Reading Prong section. Rock formations underlying the Great Valley section of the sub-watershed are sandstones, shales and carbonate. The soils are well-drained silt loams with gravel and/or shale, and have a low to medium erosion potential. Rock formations in the Reading Prong Province are mostly metamorphic and igneous rocks with some quartzite and limestone. The slopes in this region are very steep, and soils have a high erosion potential (The Conservation Fund, 2000).

Tulpehocken Creek Subwatershed
The headwaters of Tulpehocken Creek start in Lebanon County and join the Schuylkill River west of Reading. The drainage area is 216 square miles. The Tulpehocken Creek flows through the Great Valley Province. A small portion of the upper watershed area in Berks County lies in the Appalachian Mountain Province with the remainder in the Great Valley Province. In addition, a small portion of the southern stretch of the watershed lies in the Reading Prong Province. Rock formations underlying the Appalachian Mountain Province are sandstones and shales.
The soils are characteristically well drained or moderately well drained shaly loam or silt loams located on slight to moderate slopes, and have a low to medium erosion potential, respectively. Rock formations underlying the Great Valley section of the sub-watershed are sandstones, shales and carbonate. The soils are well-drained silty loams with gravel and/or shale, and have a low to medium erosion potential. Rock formations in the Reading Prong Province are mostly metamorphic and igneous rocks with some quartzite and limestone. The slopes in this region are very steep and soils have a high erosion potential (The Conservation Fund, 2000).

Middle Schuylkill Subwatershed

The Middle Schuylkill River is characterized as the length of the river between the confluences of Maiden Creek and Perkiomen Creek. This portion of the river flows through the Great Valley Province, then just south of Reading, it flows between the Reading Prong and South Mountain as the province changes to Triassic Lowlands. In this region, the Triassic Lowlands are characteristically rolling hills and fertile farm areas. In Berks County, there are several small tributaries to the Schuylkill River: Allegheny, Hay, Monocacy and Manatawny Creeks. Within Chester County the tributaries are French and Pickering Creeks.

Rock formations underlying the Great Valley section of the sub-watershed are sandstones, shales and carbonate. The soils are well-drained silty loams with gravel and/or shale, and have a low to medium erosion potential. Rock formations in the Reading Prong Province are mostly metamorphic and igneous rocks with some quartzite and limestone. The slopes in this region are very steep and soils have a high erosion potential. The Triassic Lowlands are comprised of mostly sedimentary rock formations including lava flow, sills, limestone, quartz, shale, sandstone, mudstone and siltstone. The soils are generally silt loams with gravel or shale and have a high to medium erosion potential (The Conservation Fund, 2000).

Perkiomen Creek Subwatershed

The mouth of Perkiomen Creek is approximately one mile north of Valley Forge. Perkiomen Creek is the largest tributary to the Schuylkill River with a drainage area of 362 square miles. This subbasin lies entirely in the Triassic Lowlands and is underlain by sedimentary rock formations. The Triassic Lowlands are comprised of several rock formations including lava flow, sills, limestone, quartz, shale, sandstone, mudstone and siltstone. The soils are generally silt loams with gravel or shale and have a high to medium erosion potential (The Conservation Fund, 2000).

Lower Schuylkill Subwatershed

Between the confluence of Perkiomen Creek and Norristown, the Schuylkill River lies within the Triassic Lowland and delineates the borders of Chester and Montgomery Counties. As the river flows through Norristown it passes into the Piedmont Uplands. In the Piedmont Uplands, a region of broad, rolling hills and valleys, the river crosses the Chester Valley, a narrow valley of low relief. Valley Creek, a small tributary to the Schuylkill in Chester County, lies in the Piedmont Uplands. The confluence with Valley Creek is just south of Perkiomen Creek's confluence with the Schuylkill River.

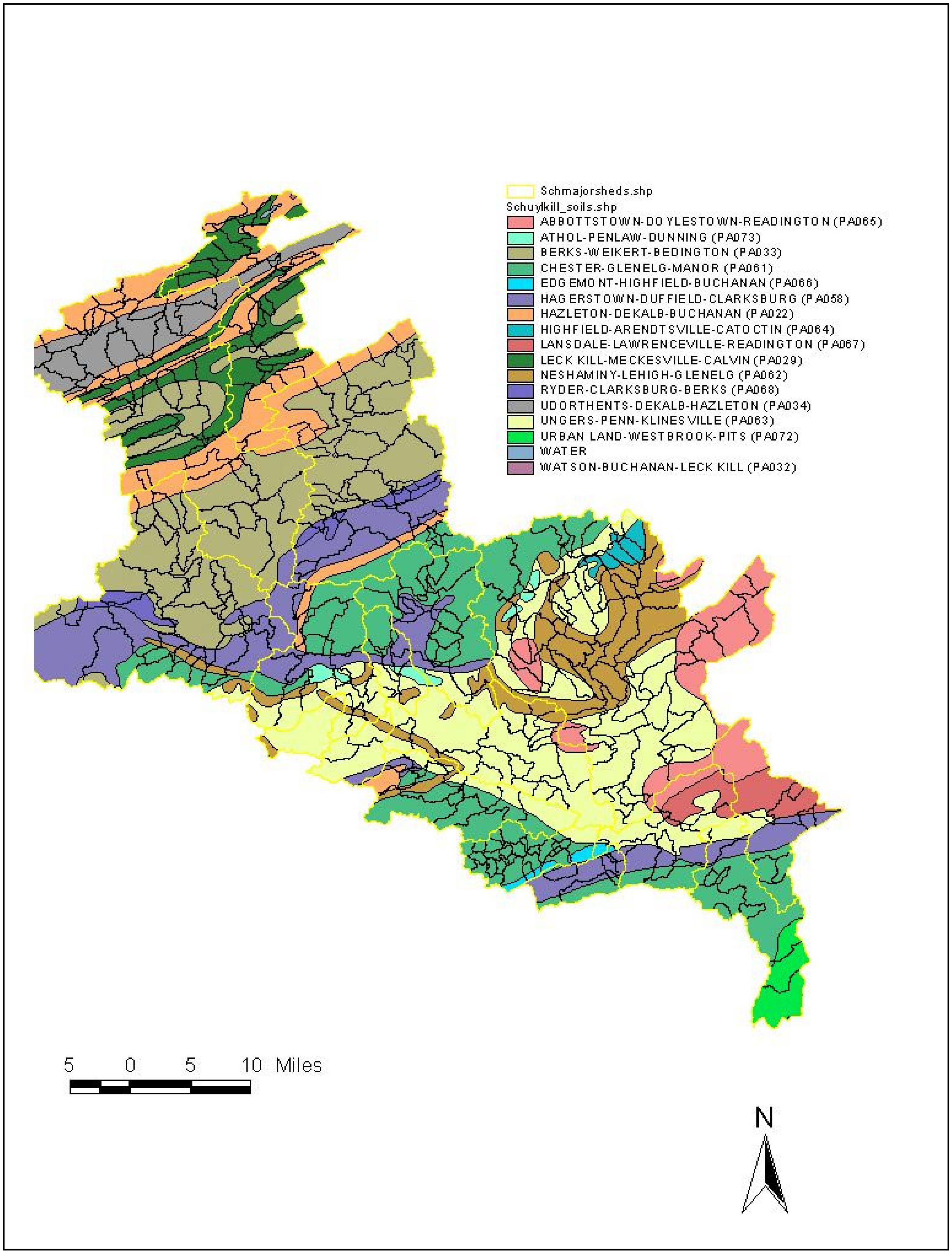
In Philadelphia County, the Wissahickon Creek Subbasin drains into the Schuylkill River south of Manayunk. Wissahickon Creek includes a drainage area of 63.8 square miles. Its headwaters are in Montgomery County in the Triassic Lowland and it flows through the Piedmont Uplands. South of the Wissahickon confluence, the Schuylkill River crosses the fall line and flows into the Atlantic Coastal Plain Province. The portion of the Schuylkill River below Fairmount Dam is an estuary with tidal fluctuations of about 5.5 feet.

The Triassic Lowlands are comprised of several rock formations including lava flow, sills, limestone, quartz, shale, sandstone, mudstone and siltstone. The soils are generally silt loams with gravel or shale and have a high to medium erosion potential. The Piedmont Uplands are underlain by metamorphic and igneous rocks with a surface of silt loam soils that have a low to high erosion potential. Rock formations in the Atlantic Coastal Plain are unconsolidated sediments including clays, sands, gravel and silt. Soils in this region are loams with some sand or gravel with medium to high erosion potential (The Conservation Fund, 2000).

1.2.3.3 Geology and Soils

The physical properties of the soils are the determining factor in the sediment-transport characteristics of the Schuylkill River and its tributaries. The soils, in turn, are determined by the geology and weathering processes of the rock material. Figure 1.2.3-2 displays the general distribution of soils and parent rocks in the Lower Schuylkill River Basin.

Figure 1.2.3-2 General Distribution of Soils and Parent Rocks in the Lower Schuylkill River Basin



Sandstones and shales primarily underlie the Appalachian Mountain section of the basin. The soils formed from these clastic rocks are generally very coarse soils formed on steep slopes. Many of the soils found in this area are classified as gravelly or stony loams. The section also contains a large part of the southern anthracite field. Much of the land surface in the coal field is occupied by strip mines, piles of unconsolidated overburden, or waste piles from coal breaker plants.

The soils of the Great Valley are formed in the residuum of shale and carbonate rocks. The northern part of the section is underlain by gray shale interbedded with sandstones, red shales and some limestones. The soils in this section are mostly stony loams and shaly, silty loams. As with the soils of the Appalachian Mountain section, erosion potential is reduced because of the size of the soil particles. The lower one-third of the Great Valley is underlain by various limestone and dolomite formations, and the soils formed from these rocks generally are silty loams. These soils are more subject to erosion because they are predominantly silts and clays.

Most soils formed in the Reading Prong section of the basin are silty loams or channery silty loams. They formed in material weathered from granitic gneiss and other metamorphic or igneous rocks that predominate in the section.

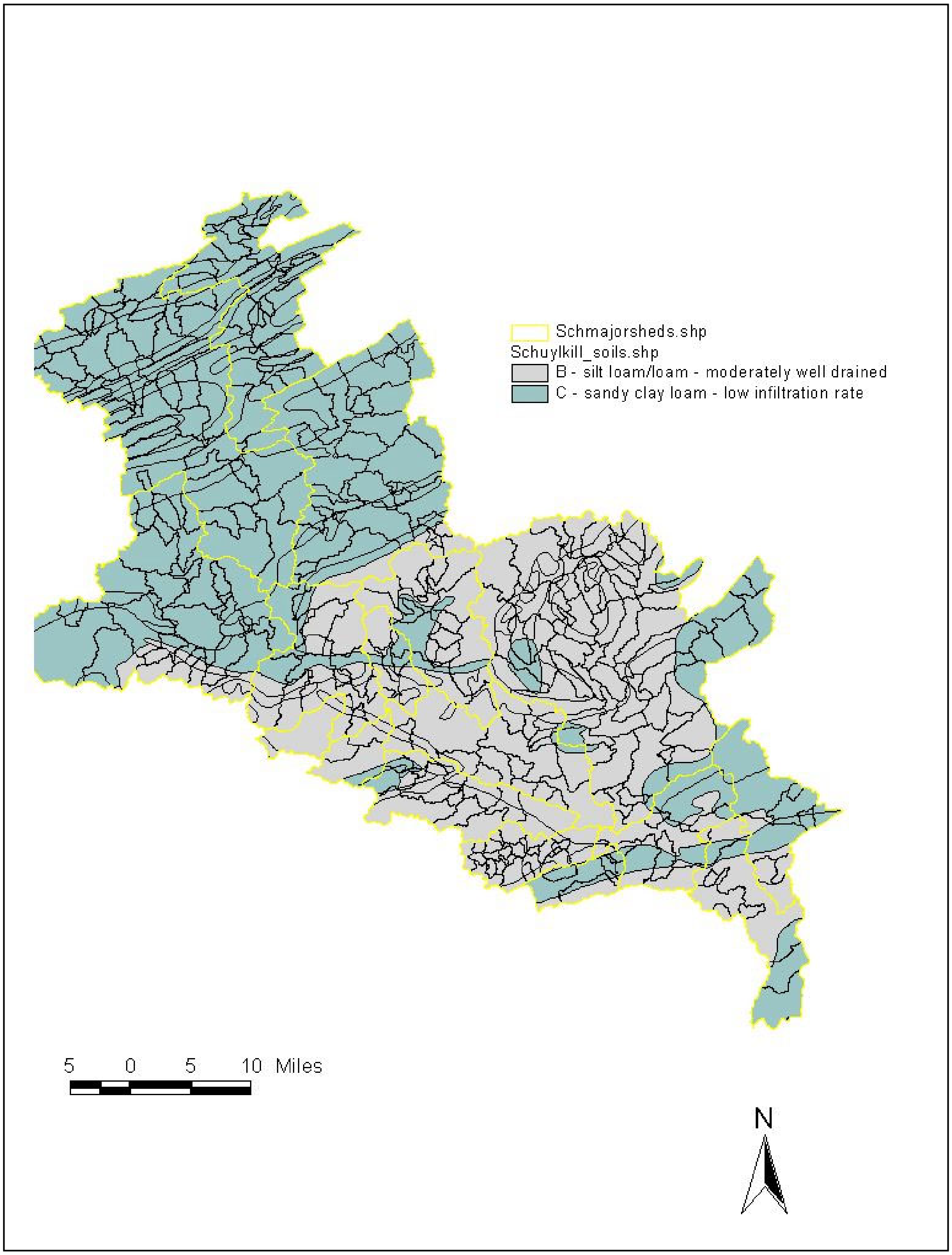
The Triassic Lowland section of the basin is underlain by several different geologic formations. The area south and west of the river, which includes the area drained by Pigeon and Angelica Creeks, is underlain by limestone conglomerates mixed with shales and sandstones. Deep, sandy loams and shaly soils are formed from these rocks. The area north and east of the river, which includes the area drained by the Perkiomen and Skippack Creeks and by part of the Manatawny Creek, is underlain by mudstones, reddish-brown shales, and siltstones. The shaly silt loams that form above the shales are shallow and subject to erosion.

Silty loams are the dominant soils in the basin downstream from the Perkiomen Creek. The soils in the areas drained by Valley and Plymouth Creeks, and partially by Wissahickon Creek are underlain by a narrow band of limestone. The other tributaries in the lower basin are underlain by channery, silty loam soils formed in the residuum of mica, schist, and gneiss. Many of the soils in the lower basin are classified as urban land because the soil profile has been reworked during the cut-and-fill operations of construction projects. They generally have the same soil particle size distribution as the original silty loams.

New urban land or urban construction sites on Piedmont soils may contribute as much as 100 tons of sediment per acre each year (Yorke and Herb, 1978). Runoff from lawns, parking lots, and streets may contribute much of the trace metals and organic substances that enter the lower part of the Schuylkill River.

A majority of the soils in the Upper Watershed are comprised of the sandy clay loam type or Group C. Group C soils are of a moderately fine to fine texture and have low infiltration rates ranging between 0.13 and 0.38 centimeters per hour (cm/hour). The Middle Watershed is comprised of the silty loam and loam or Group B soils. These soils are mainly moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have infiltration rates between 0.38 and 0.76 cm/hour. The Lower Watershed is comprised of both group B and C soils, as evidenced by Figure 1.2.3-3.

Figure 1.2.3-3 Soil Types in the Lower Schuylkill River Watershed



Comparing the infiltration rates, a well-drained Group B soil can infiltrate typical rainstorms that are less than 0.5 inches (1.27 cm) in less than two hours, whereas it takes the group C soils almost four hours to infiltrate the same amount of water. Lower infiltration rates increase the potential amount of runoff from the land and increase pollutant transport from streams to rivers. In addition, the topography or slope steepness in these areas also has significant impacts on pollutant transport.

Within the major hydrological classifications and groups of soils, there are 16 specific subtypes in the Schuylkill River Watershed. As shown in Table 1.2.3-1, these soil subtypes vary with location in the watershed, but mainly two or three types dominate within a given sub-watershed. In some cases, large portions of the watershed are one soil type. The Berks, Chester, Hagerstown, Hazelton, Neshaminy, and Ungers soil classifications define approximately 76 percent of the watershed soils. As shown in Table 1.2.3-1, these soils are generally well drained, generate moderate runoff during rain events, and are located on significant slopes. The only poorly-drained soil, the Abbottstown soil, is located in the headwaters areas of the Wissahickon and Perkiomen Creek watersheds.

Table 1.2.3-1 Prevalence of Various Soil Types in the Lower Half of the Schuylkill River Watershed (Pottstown to Philadelphia)

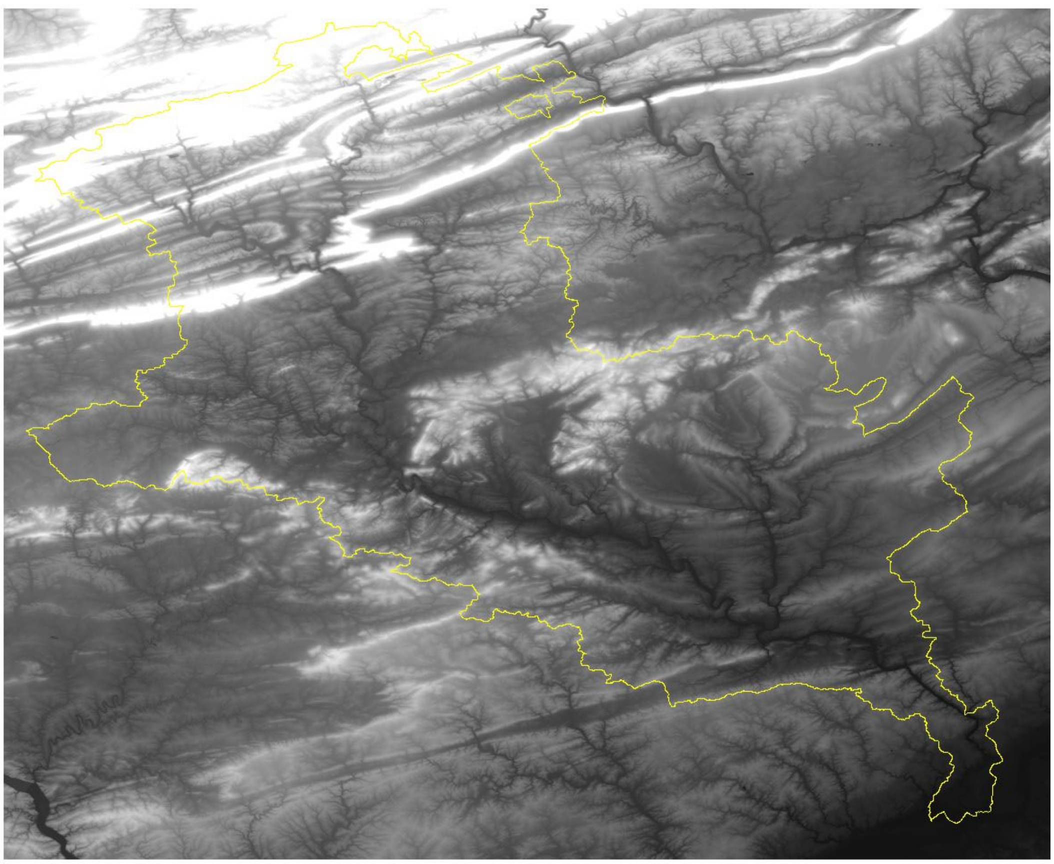
Soil Type	Percentage of Watershed	Slopes %	Permeability	Runoff	Drainage	Found on
Abbottstown-Doylestown-Readington (PA065)	13	0-15	Slow to moderate	Slow to medium	Poorly drained	Level to sloping concave upland flats, depressions and drainage ways
Athol-Penlaw-Dunning (PA073)	0	0-35	Moderate	Slow to rapid	Well drained	Level to moderately steep convex and dissected upland ridge tops and side slopes
Chester-Glenelg-Manor (PA061)	19	0-65 (mostly 3-10)	Moderate	Medium	Well drained	Upland divides and slopes
Edgemont-Highfield-Buchanan (PA066)	1	0-70	Moderate to moderately rapid	Rapid	Well drained	Sloping hills and ridges
Hagerstown-Duffield-Clarksburg (PA058)	6	0-45 (mostly 15)	Moderate	Moderate to rapid	Well drained	Valley floors and adjacent hills
Lansdale-Lawrenceville-Readington (PA067)	5	0-25	Moderate to moderately rapid	Moderate	Well drained	Rolling uplands
Neshaminy-Lehigh-Glenelg (PA062)	15	1 to 45	Moderately slow	Slow to very rapid	Well drained	Level to steep uplands
Ungers-Penn-Klinesville (PA063)	36	0-50	Moderate or moderately rapid	Medium to rapid	Well drained	Gently sloping to steep slopes

Note: Data from NRCS Official Soil Classifications and PASDA soil

These characteristics make runoff of persistent and conservative contaminants into the rivers and streams very possible if no management practices are in place. These attributes also affect the quantity of the runoff that may erode streambanks.

The general topography of the watershed can indicate where runoff issues may be important. Development on steeply sloping areas can create more of an impact on river water quality than development on gently sloped areas due to the potential to transport polluted runoff farther and faster. As shown in Figure 1.2.3-4 a digital elevation model demonstrates the elevations of the various areas of the watershed. The steep valley areas are where the color gradation changes quickly and dramatically. These would be considered sensitive areas where runoff from particular sources or activities could have a potentially significant impact on river or stream water quality. These are also areas that would be ideal for preservation and protection against development pressure to minimize future runoff issues.

Figure 1.2.3-4 Digital Elevation Model of the Lower Schuylkill River Watershed



1.2.4 Hydrology

Key Points

- Seasonal variations in Schuylkill River flow are driven by precipitation and evaporation.
- Only about half of the precipitation falling upon the Schuylkill River Drainage Basin reaches the river. The rest is lost to evaporation, transpiration and consumptive use.
- Over 75% of the total stream length within the Schuylkill River Watershed is comprised of first- and second-order streams.
- The physical properties of the soils in the Schuylkill River Basin determine their susceptibility to erosion.

The Schuylkill River Basin typically has humid climates with a wide range of both daily and annual temperatures. The physiographic features have a great effect upon the weather and climate of various areas within the basin. The tendency for equal lines of temperature is dependent on ground elevation and latitude. Greater temperature and precipitation variations are experienced in the Appalachian Mountain physiographic sections than in the Coastal Plain and Piedmont areas. The mean annual temperature in the watershed is 52°F; the winter and summer averages are 31°F and 72°F, respectively (Biesecker et al., 1968). Average annual precipitation ranges from 43 inches per year in the Coastal Plain area to 45 to 50 inches per year in the Appalachian Mountains.

Long-term historical data was initially assessed in order to gauge recent decade scale trends against the backdrop of natural regional variation in climate and hydrology. Monthly climate data based on a regional composite index developed by the National Climatic Data Center (NCDC) are available from 1895 through the present day. Historical climate data has been further summarized here by calculating annual totals for precipitation and averages for temperature based on monthly figures.

Annual precipitation in the Philadelphia area has shown a steady increase through the 1900s, with an extended period of drought in the 1960s. Precipitation was high in the 1970s and has most recently varied around the long-term mean for annual precipitation. Annual temperatures in the region have not shown such a strong trend over the entire century, although temperatures appear to have increased dramatically over the first half of the century, while decreasing since then, as shown by Figure 1.2.4-1.

Assessments of historical flow in the Schuylkill River, measured as daily averaged flow at the Fairmount Dam, indicate an increase in stabilization of flow over the recent past, particularly from 1970 through the present, as shown on Figure 1.2.4-2. Average daily flows prior to 1970 dropped below 100 cubic feet per second (CFS) at Philadelphia in eleven summers, but this has not occurred since 1966.

Recent decade scale patterns in climate and river flow for the region were also assessed to ascertain direct connections between these parameters and Philadelphia Water Department (PWD) intake water quality data. Monthly data for precipitation through the 1990s indicates extended dry periods through 1991 and 1997, along with severe short-term drought from May through July 1999 as illustrated by Figure 1.2.4-3. February has been particularly dry through the period, while the August average has been unusually high for summer months. Departures from monthly averages indicate variation from mean precipitation levels and are often a better indicator of climatic condition than are absolute values of precipitation.

Figure 1.2.4-1 Long Term Average Annual Temperature at Philadelphia

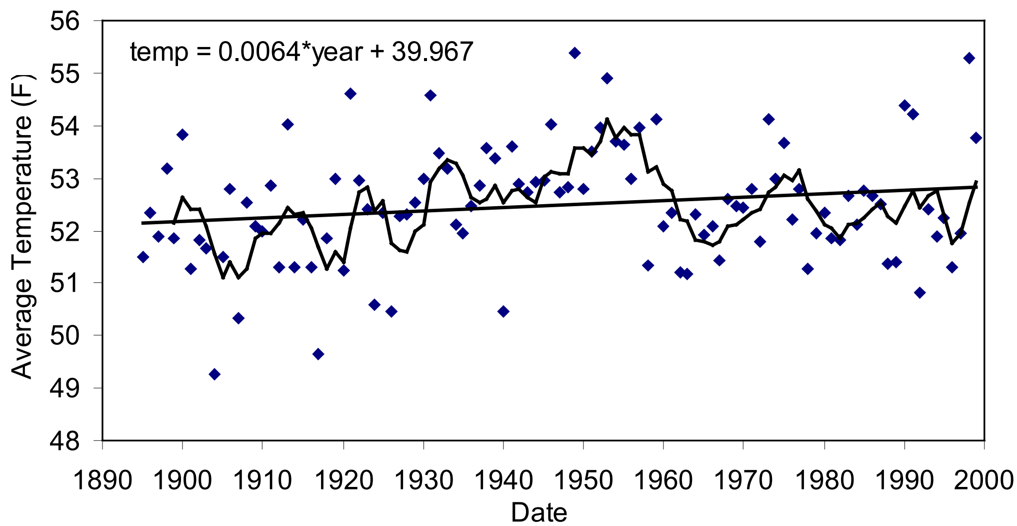


Figure 1.2.4-2 Long-Term Average Annual Temperature at Philadelphia

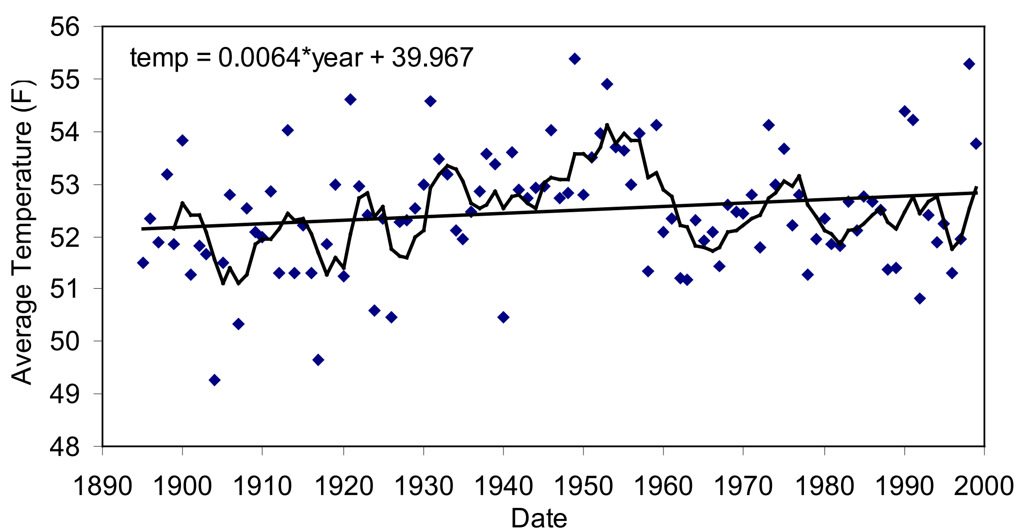
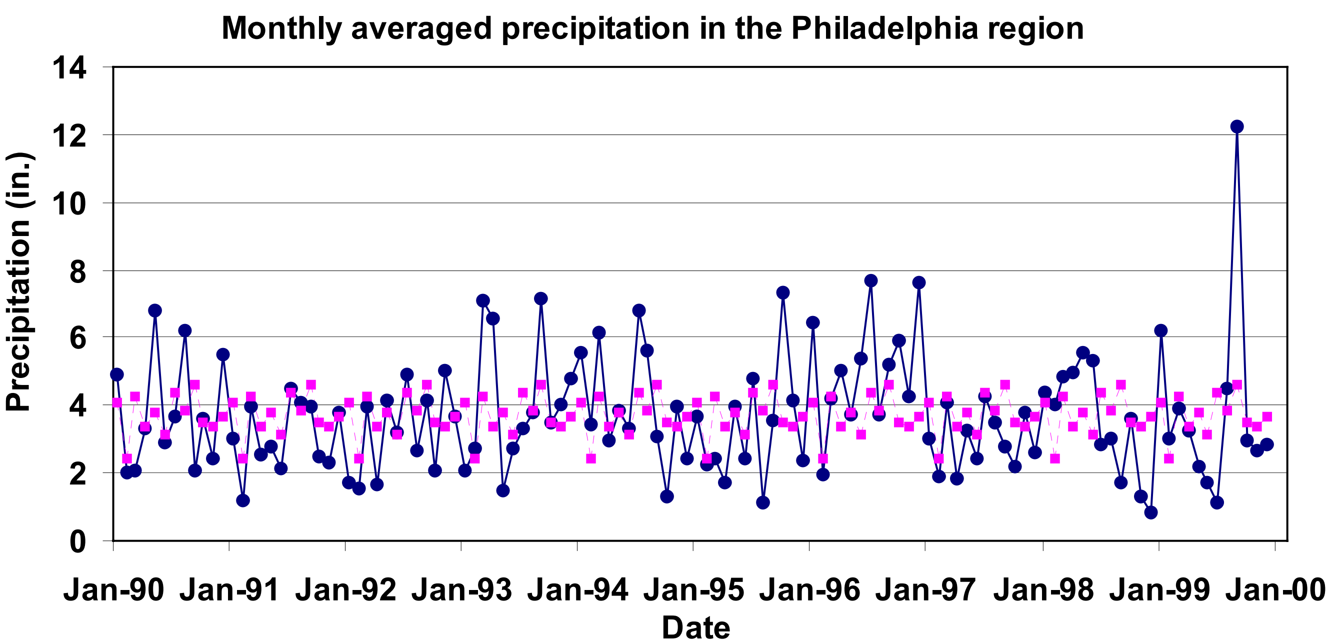
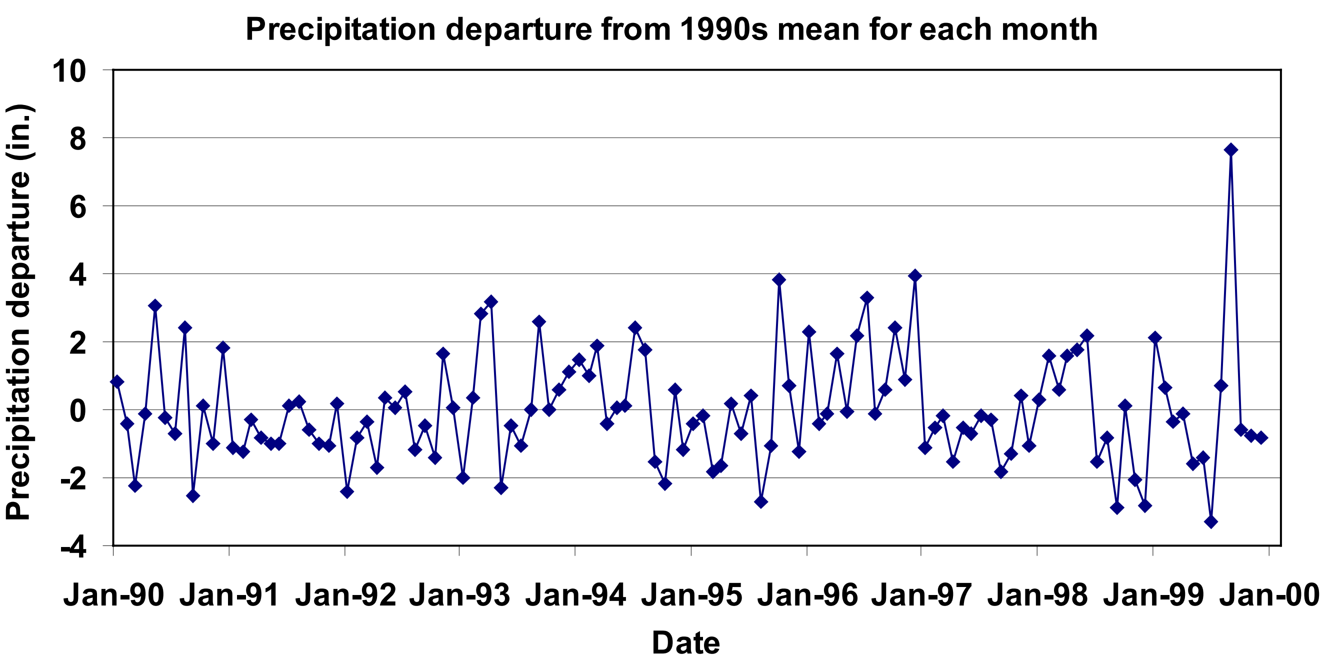


Figure 1.2.4-3 Precipitation trends in Southeastern Pennsylvania through the 1990's

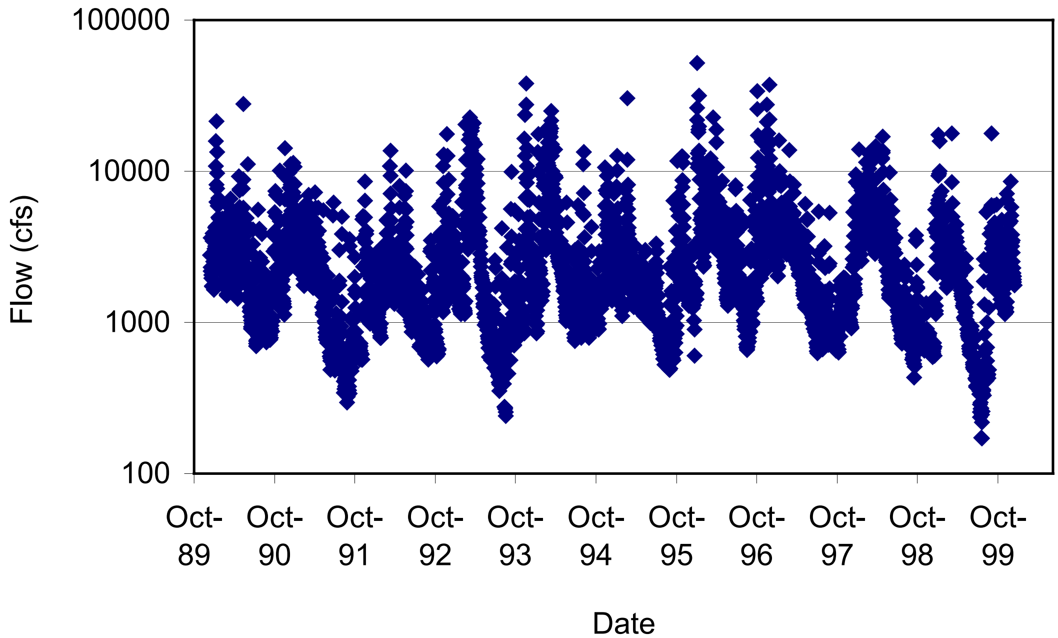
Small squares in top panel indicate 1990's monthly flow averages. Deviation from monthly averages indicates interannual trends toward particularly wet or dry weather. Averages are calculated by calendar month, so deviation in January, for instance, is the difference between the 1990's average January precipitation, and that occurring in a given year.





Average annual Schuylkill River flow at Philadelphia is 2,721 CFS. Daily average Schuylkill River flow at Fairmount Dam through the 1990s is summarized in Figure 1.2.4-4 and indicates extremely low flow conditions in summer 1999, with less-pronounced low flow occurring in 1991 and 1993. Lowest flows through the decade were not always associated with extended low levels of summer precipitation, suggesting that evaporation, groundwater storage, and surface water removal are important components in the water budget of the region. Based on monthly averages, no long-term temporal trends in flow were evident through this period (n = 120, Rho = -0.013, P = 0.884 for non-parametric rank order regression).

Figure 1.2.4-4 Daily Average Schuylkill River Flow through the 1990's



Seasonal variation is driven primarily by precipitation, which is highest in spring, and evaporation, which is highest in summer months. Lowest flows occurred in 1993 and 1999. Minimum flows are consistently higher through the 1990s than earlier in the century (see Figure 1.2.4-2).

1.2.4.1 Surface Water

Runoff in the Schuylkill River Basin has a distinct seasonal variation. The most runoff occurs during winter or early spring, and the lowest amount of runoff occurs during the late summer or early fall. Runoff is chiefly dependent on the amount of rainfall that a specific area receives; after the winter months, the accumulated snow melts in the early spring creating additional runoff. During the dry late summer months, there is very little runoff.

In the Schuylkill River Basin, Tamaqua, which is in the Appalachian Mountains, receives the most precipitation and runoff, and runoff decreases with the amount of precipitation from north to south. As a result of loss of precipitation by evaporation, transpiration, and consumptive use, only about half of the precipitation falling within the watershed reaches surface waters.

Pollution has been a serious problem in the Schuylkill River Basin for many years. Mine drainage in the headwaters has exacerbated the water quality problems caused by domestic waste discharge, because the resulting toxic environment inhibits stream self-purification. The microorganisms that would normally oxidize the organic wastes are either destroyed or hindered by the acidic environment produced by mine drainage. Thus, the organic waste is preserved until the stream environment becomes favorable for microbiological activity. Below the confluence of the Schuylkill River and Maiden and Tulpehocken creeks, stream conditions are favorable for development of decay organisms.

Table 1.2.4-1 summarizes the locations, drainage areas, annual mean flows, and annual runoff at 21 gauging stations along the Schuylkill River. The first gauging station listed is the northernmost one located along the Little Schuylkill River. The last gauging station on the chart is located along the lower portion of the Schuylkill River.

Table 1.2.4-2 and Figure 1.2.1-1 describe the size and location of the various tributaries and drainage areas within the Schuylkill River Basin. As shown, the Perkiomen and Tulpehocken creeks are the largest tributaries discharging to the Schuylkill River and can have significant impacts on Schuylkill water quality.

Table 1.2.4-1 Stream Gauging Data in the Schuylkill River Basin

Station ID	Location	Drainage Area (mi^2)	Period of Record	Annual Mean Flow (cfs)	Annual Runoff (Inches)	10% Exceeds (cfs)	50% Exceeds (cfs)	90% Exceeds (cfs)
01468500	Schuylkill at Landingville	133	1947-1953 1963-1965 1973-1999	278	28.43	560	195	75
01469500	Little Schuylkill at Tamaqua	43	1933-1999	84.2	N/A	177	51	13
01470500	Schuylkill at Berne	355	1947-1999	716	27.41	1480	450	158
01470779	Tuplehocken Creek Near Bernville	67	1975-1999	108	22.13	183	85	43
01470853	(1)Furnace Creek at Robesonia	4	1983-1999	6.87	22.33	14	4.7	1.4

Station ID	Location	Drainage Area (mi^2)	Period of Record	Annual Mean Flow (cfs)	Annual Runoff (Inches)	10% Exceeds (cfs)	50% Exceeds (cfs)	90% Exceeds (cfs)
01470960	Tuplehocken Creek at Blue Marsh Dam	175	1979-1999	273	N/A	539	174	65
01471000	Tuplehocken Creek Near Reading	211	1980-1999	320	N/A	625	213	83
01471510	Schuylkill River at Reading	880	1977-1999	1630	N/A	3330	1070	400
01471875	Manatawny Creek Near Spangsville	57	1993-1999	91	21.73	171	58	22
01471980	Manatawny Creek Near Pottstown	86	1974-1999	131	20.86	243	85	34
01472000	Schuylkill River at Pottstown	1147	1928-1999	1909	N/A	3860	1300	473
01472157	French Creek Near Phoenixville	59	1969-1999	89	20.47	170	56	20
01472198	Perkiomen Creek at East Greenville	38	1982-1999	60.4	21.59	115	37	15
01472199	West Branch Perkiomen at Hillegrass	23	1982-1999	38.1	22.43	74	23	7.9
01472620	East Branch Perkiomen Near Dublin	4	1990-1999	41.2	N/A	62	42	13
01472810	East Branch Perkiomen Near Schwenksville	59	1991-1999	126	N/A	191	72	48
01473000	Perkiomen Creek at Graterford	279	1957-1999	411	N/A	831	180	60
01473169	Valley Creek Near Valley Forge	21	1983-1999	32.3	21.09	52	23	15
01473900	Wissahickon Creek at Fort Washington	21	N/A	N/A	N/A	N/A	N/A	N/A
01474000	Wissahickon Creek Mouth at Philadelphia	64	1966-1999	104	22.02	177	60	28
01474500	Schuylkill River at Philadelphia	1893	1932-1999	2721	N/A	5850	1670	430

Table 1.2.4-2 Characteristics of Tributaries in the Schuylkill River Watershed (from Bottom of Watershed to Top of Watershed by River Mile Location)

Major Subwatershed	Drainage Area (mi^2)	River Mile Location	Length (mi)
Lower Schuylkill (Philadelphia-Conshocken)*	69.6	<20.5	20.5
Wissahickon Creek	63.6	12.8	24.2
Middle Schuylkill 1 (Norristown - Valley Forge)*	64.8	20.5-32	11.5
Valley Creek	23.3	30.6	10.4
Middle Schuylkill 2 (Phoenixville-Pottstown)*	103.0	32-63	31
Perkiomen Creek	366.3	32.3	37.8
Pickering Creek	38.8	34	14.8
French Creek	70.1	35.6	23
Manatawny Creek	91.5	54.2	23.7
Monocacy Creek	25.8	60.6	12
Middle Schuylkill 3 (Douglassville - Reading)*	98.1	63-86	23
Hay Creek	22.1	63.1	12.1
Allegheny Creek	17.9	67.7	11
Tulpehocken Creek	219.2	76.8	37.6
Maiden Creek	216.0	86.7	29.3
Little Schuylkill River	136.8	102.1	34.2
Upper Schuylkill	287.6	>135	49

**These watershed boundaries were selected for the purpose of the study.*

Table 1.2.4-3 provides information about the characteristics of the reservoirs in the watershed. As shown, the detention time in these reservoirs is significant, which impacts both water quality and zone delineation boundaries.

Table 1.2.4-3 Reservoir Characteristics in the Schuylkill River Watershed

Water Body	Average Width	Average Depth	Surface Area	Length	Volume (billions of gallons)	Detention Time
Pickering Creek	460 ft	11 ft *	4,804,020 sq ft 0.1723 sq miles	9,395 ft 1.78 miles	0.4	34 days
Green Lane Reservoir	888 ft	16.4 ft *	43,302,856 sq ft 1.5533 sq miles 996.0 acres	74,648 ft 14.14 miles	4.4 *	62 days 0.12 years or 44.2 days (dry)
Blue Marsh Lake	1073 ft	20.5 ft **	1150 acres ** 1.57 sq miles*** 1012 acres***	42,240 ft ** 63,805 ft *** 12.1 miles***	7.7 **	0.08 years (dry weather) or 30 days (wet weather)
Lake Ontelaunee	1331 ft	7.2 ft **	1100 acres** 1.61 sq miles*** 1031.4 acres ***	29,354 ft *** 5.5 miles***	3.3 **	22.8 days **

* *Data from Philadelphia Suburban Water Company*
** *Data obtained from technical reports*
*** *Data obtained from GIS analysis*

"Stream order" is an indicator of the relative size and location of a stream within a watershed. According to Leopold (1994), stream order is a "measure of the position of a stream in the hierarchy of tributaries". First-order streams are small streams with no tributaries. Second-order streams are formed by the confluence of two first-order streams. The tributaries of second-order streams are all first-order streams. When two second-order streams flow together, they form a third-order stream, that may have both first- and second-order streams as tributaries. When two third-order streams meet, they form a fourth-order stream and so on. In general, stream flow, velocity, width and depth increase with increasing stream order, while the gradient of the streambed decreases. Table 1.2.4-4 summarizes the length of streams within the Schuylkill River Watershed by stream order. More than 75% of the total stream length within the Schuylkill River Watershed is comprised of first- and second-order streams.

Table 1.2.4-4 Summary Length by Stream Order for the Schuylkill River Watershed

Stream Order	Kilometers	Percent of Streams
1	2476.58	56.56%
2	863.56	19.72%
3	459.85	10.50%
4	298.68	6.82%
5	124.74	2.85%
6	103.89	2.37%
7	51.34	1.17%

Source: Schuylkill River Conservation Plan (Conservation Fund), 2001

1.2.4.2 Flooding

The three branches of the Schuylkill - the West Branch, the main stem, and the Little Schuylkill River - traverse the basin above Blue Mountain. In August 1955, the greatest flooding event occurred along the Little Schuylkill River. This destructive flood was especially damaging to the Tamaqua area because Tamaqua was built in a narrow valley, and the streams that flowed through the city were overwhelmed by runoff. From Blue Mountain downstream to Reading, the flood plain was generally unoccupied. Between Reading and Philadelphia, the flood plain was occupied mostly by commercial and industrial establishments, which suffered nearly 70% of the total flood damage in that event. Within this area, the most extensive damage occurred throughout Reading, Birdsboro, Pottstown, Norristown, Conshohocken, Manayunk, and Philadelphia. In 1958, the damage from the 1955 flood was estimated to be $1,295, 000.

Tulpehocken Creek is host to Blue Marsh Lake, which has a volume of 7.7 billion gallons and is a man-made reservoir maintained and operated by the Army Corps of Engineers near the town of Reading. Other reservoirs/lakes are located within the Schuylkill River

Basin. Lake Ontalaunee, a man-made reservoir maintained and operated by the Reading Water Authority, is the primary source of water for the City of Reading.

1.2.4.3 Groundwater

There are four principal groups of aquifers in the Schuylkill River Basin: unconsolidated deposits, crystalline rocks, carbonate rocks, and clastic rocks. The best areas for large supplies of groundwater are the areas underlain by carbonate rocks in the Great Valley and the areas underlain by unconsolidated deposits in the Coastal Plain. The basin contains a wide range of rock types, as shown in Figure 1.2.3-2, impacting the capacity to store and transmit water.

All aquifers in the Schuylkill River Basin are composed of consolidated rocks, with the exception of the Coastal Plain deposits in Philadelphia and the thick, weathered mantle in a few isolated areas. Groundwater can occur under water table or artesian conditions. Water table conditions are much more common within the Schuylkill River Basin. Below the water table, the spaces between the soil particles can store or transmit water. These areas have high porosities and permeabilities. The consolidated rocks have very little porosity, except for a few of the coarse sandstone beds, and their ability to store and transmit water is small. In most aquifers throughout the basin, water moves through and is stored in openings developed along joints, fractures, faults, and cleavage and bedding planes in the rock. These conditions were formed when rocks were stressed by movements in the earth's crust, and they may be enlarged by solution, earthquakes, and earth tides.

The bedding thickness is probably not an important factor in the permeability of carbonate rocks. Chemical weathering along the fractures is a more important factor, as it enlarges the fractures so that they are large enough to transmit water. A zone of weathered rock underlies the land surface throughout the basin. The thickness of this zone ranges from a few feet to more than 100 feet over some of the limestone terrain. Weathered rock has a higher porosity than unweathered rock, and where it does not contain large amounts of clay, it may have a high permeability.

Groundwater flows with very low velocities. Water that reaches the water table is in contact with the rocks of the aquifer for a much longer time than it is in contact with the atmosphere or soil. Therefore, much of the dissolved solids in groundwater is derived from aquifers, as contact time between the water and the rock increases, the mineral content of the water also increases to the saturation point. Groundwater in many areas may be contaminated by on-site disposal of domestic waste.

1.2.4.3.1 Stressed Groundwater Areas

In 1999, The Delaware River Basin Commission (DRBC) adopted regulations that establish groundwater withdrawal limits for 76 watersheds that fall either entirely or partly within the Groundwater Protected Area of Southeastern Pennsylvania.

The Protected Area, where more stringent regulations apply to groundwater withdrawals than they do in the rest of the Delaware River Basin, was established by the commission in 1980 at the request of the Commonwealth of Pennsylvania after it became evident that development was negatively impacting groundwater levels. The goal is to prevent depletion of groundwater and to protect the interests and rights of lawful users of the same water source, as well as balance and reconcile alternative and conflicting uses of limited water resources in the region.

Declining water tables in the Protected Area have reduced flows in some streams that are groundwater fed, resulting in some stream beds that are totally dry. This reduction in baseflows affects downstream water uses, negatively impacts aquatic life, and can reduce the capacity of waterways in the region to assimilate pollutants.

The Protected Area uses a two-tiered system of water withdrawal limits. The first tier serves as a warning that a subbasin is "potentially stressed". The second tier establishes a maximum groundwater withdrawal limit. In potentially stressed subbasins, applicants for new or expanded groundwater withdrawals are required to implement one or more programs to mitigate adverse impacts of additional groundwater withdrawals. Acceptable programs include conjunctive use of groundwater and surface water, expanded water conservation programs, programs to control groundwater infiltration, and artificial recharge and spray irrigation.

The Ground Water Protected Area Regulations for Southeastern Pennsylvania also:

- Provide incentives for holders of existing DRBC dockets and Protected Area permits to implement one or more of the above programs to reduce the adverse impacts of their groundwater withdrawals. If docket or permit holders successfully implement one or more programs, the commission will extend the docket or permit duration for up to ten years

- Specify criteria for the issuance and review of dockets and permits as well as procedures for revising withdrawal limits to correspond with integrated water resource plans adopted by municipalities for subbasins

- Establish protocol for updating and revising withdrawal limits to provide additional protection for streams designated by the Commonwealth of Pennsylvania as "high quality," or "wild, scenic, or pastoral," as defined by the state's Scenic Rivers Program.

The Ground Water Protected Area includes 1,200 square miles and 127 municipalities. In addition to the Neshaminy Creek Watershed, other large drainage areas include the Brandywine Creek, Perkiomen Creek, and Wissahickon Creek subbasins.

In addition to all of Montgomery County, the following areas in surrounding counties fall within the Protected Area:

Berks: the townships of Douglass, Hereford, and Union.

Bucks: the townships of Bedminster, Buckingham, Doylestown, East Rockhill, Hilltown, Lower Southampton, Middletown, Milford, New Britain, Newtown, Northampton, Plumstead, Richland, Upper Southampton, Warminster, Warrington, Warwick, West Rockhill, and Wrightstown; the boroughs of Chalfont, Doylestown, Dublin, Hulmeville, Ivyland, Langhorne, Langhorne Manor, New Britain, Newtown, Penndel, Perkasie, Quakertown, Richlandtown, Sellersville, Silverdale, Telford, and Trumbauersville.

Chester: the townships of Birmingham, Charlestown, East Bradford, East Coventry, East Goshen, East Pikeland, Easttown, East Vincent, East Whiteland, North Coventry, Schuylkill, South Coventry, Thornbury, Tredyffrin, Warwick, West Bradford, West Goshen, Westtown, Willistown, and West Whiteland; the boroughs of Elverson, Malvern, Phoenixville, Spring City and West Chester.

Lehigh: Lower Milford Township.

1.2.4.4 Water Usage

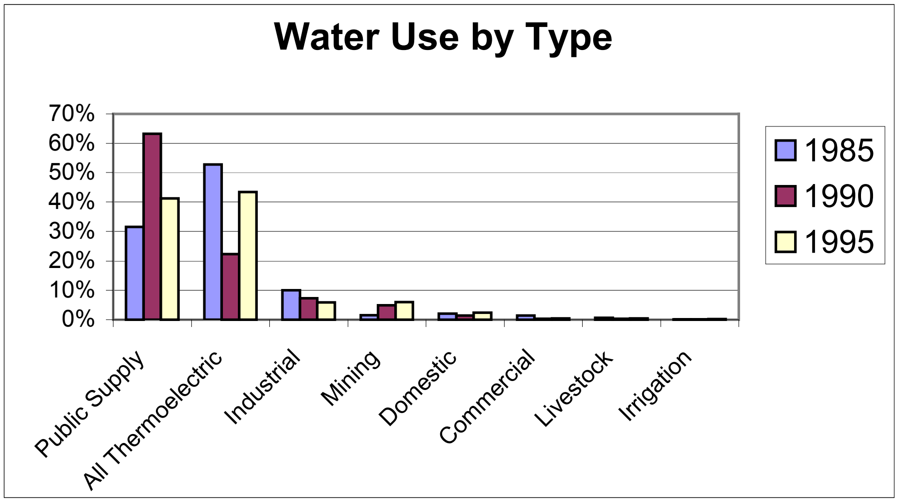
The amount of water withdrawn from the Schuylkill River Watershed is substantial and can influence water quality. USGS estimates that over 669 million gallons of water are withdrawn per day from the Schuylkill River Watershed. Over 76% of that water is withdrawn from surface sources such as streams, lakes, reservoirs, and the river itself. Most of the water withdrawn from the watershed is used for water supply and thermoelectric power for cooling (see Table 1.2.4-5 and Figure 1.2.4-5).

Table 1.2.4-5 Water Withdrawn per Day in the Schuylkill River Watershed 1985-1995 (source USGS)

	1985	1990	1995
Groundwater	96.89	219.26	127.02
Surface Water	572.15	683.3	603.62
Total	669.04	902.56	730.64

Withdrawals are Shown in Millions of Gallons Per Day

Figure 1.2.4-5 Amount of Water Withdrawal from the Schuylkill River Watershed by Use



Over 1.7 million people are supplied with surface water withdrawn from the Schuylkill River and its tributaries. As shown in Figures 1.2.4-6 and 1.2.4-7, the Philadelphia Water Department, Philadelphia Suburban Water Company, and Pennsylvania American Water Company withdraw over 80% of the water supplied for potable use and almost 75% of the population serviced from the surface supplies of the Schuylkill River Watershed.

Figure 1.2.4-6 Percentage of Surface Water Withdrawn from the Schuylkill River Watershed by Water Suppliers

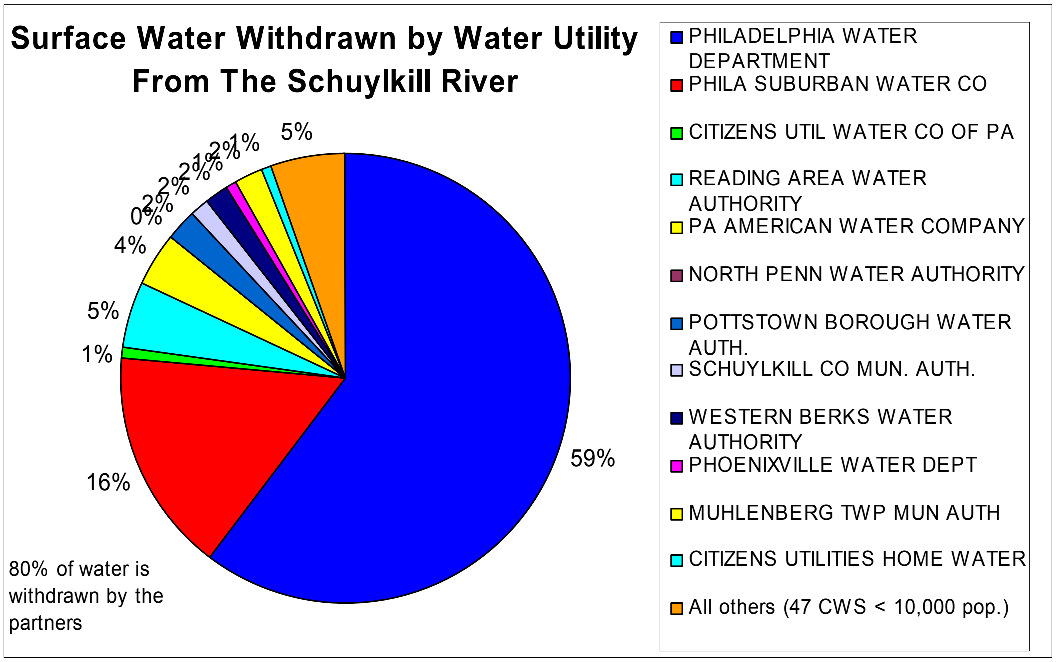
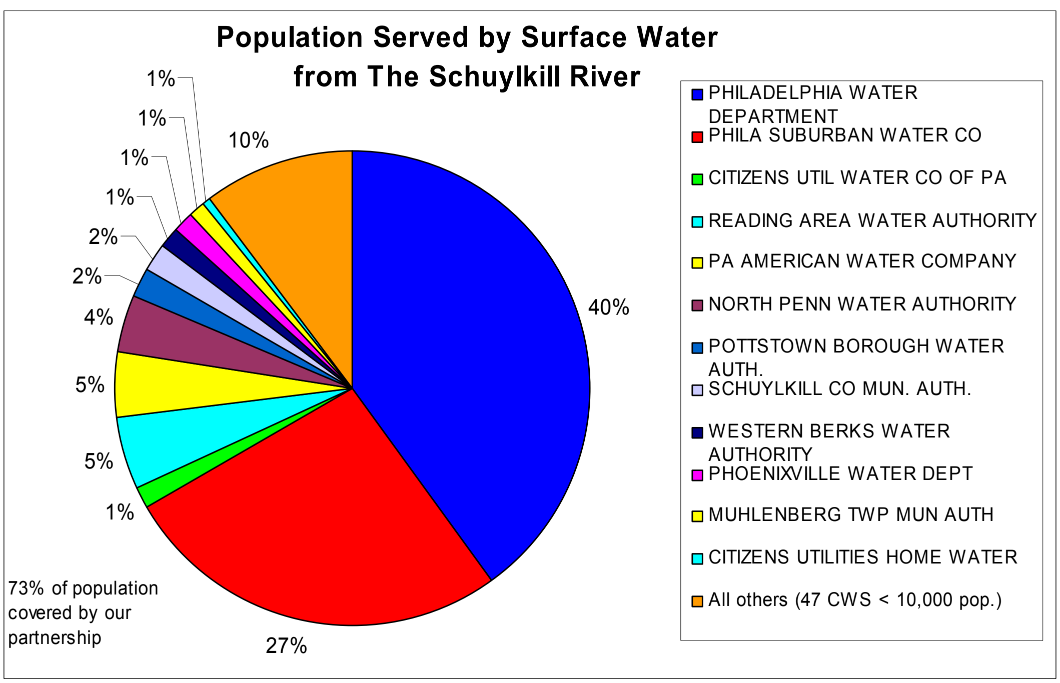


Figure 1.2.4-7 Percentage of Population Supplied from the Schuylkill River Watershed by Water Suppliers



1.2.5 Land Use in the Schuylkill River Watershed

Key Points

- Studies indicate that the amount of developed land within the Schuylkill River Watershed ranges between 14 and 30 %.
- Recent land use studies have concluded that the amount of developed land within the Schuylkill River Watershed is increasing, as agricultural and forested lands decrease.
- The developed land areas are found mainly in the lower watershed, near major cities or transportation corridors.

Parts of 11 counties are located within the Schuylkill River Watershed. Of these 11 counties, only 4 (Berks, Chester, Montgomery, and Schuylkill counties) have nearly 10% or more of the watershed within their boundaries (Figure 1.2.5-1) Berks, Chester, and Montgomery counties represent nearly 70% of the land area in the Schuylkill River Watershed. Berks County itself comprises 40%, or 750 square miles, of the watershed, and is almost completely within the watershed boundaries, suggesting that land use activities within the county can have significant impacts on river water quality. More than 80% of the total land area of Berks and Montgomery counties lies within the watershed, as shown in Figure 1.2.5-2. Between 10 and 40% of Schuylkill, Philadelphia, Chester, Lehigh, and Bucks counties are within the Schuylkill River Watershed.

Figure 1.2.5-1 Percentage of Land Area in the Schuylkill River Watershed within Each County

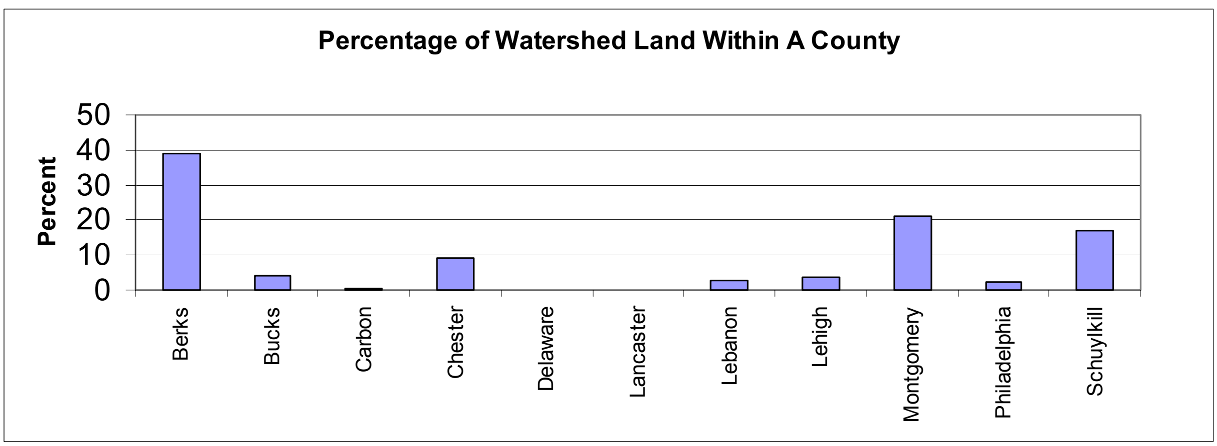
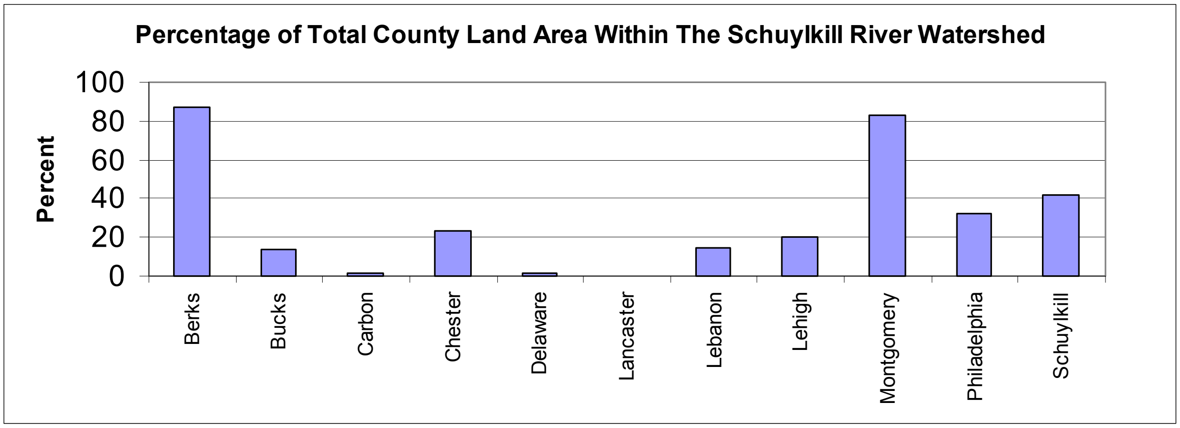


Figure 1.2.5-2 Percentage of Total County Land Area within the Schuylkill River Watershed



Philadelphia County, located at the downstream end of the watershed, includes only two percent of the watershed land area, but represents the single largest population and water supply withdrawal in the watershed. Bucks, Montgomery, Chester, and Delaware counties, which border Philadelphia, are in the middle of the watershed and represent suburban areas surrounding the city with varying amounts of development. Berks, Carbon, Lebanon, Lehigh, and Schuylkill counties make up the upper reaches of the watershed and are the least developed areas within it.

Land use characterization of the Schuylkill Watershed included a review of the United States Department of Agriculture (USDA), Delaware Valley Regional Planning Commission (DVRPC), and the United States Geologic Survey (USGS) data inventories. Development of these three characterizations of land use within the watershed differed in approach, and hence, yielded different assessments of land use. However, all three characterizations indicate that development within the Schuylkill River Watershed continues to increase. Due to the fact that the USGS's data set is more detailed and includes the entire watershed, it was selected for the susceptibility analysis, as described later in this document. The USDA, DVRPC and USGS characterizations of land use within the Schuylkill River Watershed are each described below.

USDA National Resources Inventory

As shown in Figure 1.2.5-3, the most recent studies by the USDA have estimated that the Schuylkill River Watershed is 28% developed, 34% agricultural, and 32% forested land. Table 1.2.5-1 and Figure 1.2.5-4 summarize the changes in land use that have occurred during the period from 1982 until 1997. The changes in land use during this time indicate that the amount of developed land in the watershed has increased by over 30% in the past 15 years, while agricultural land has decreased by almost 14%. Forested lands decreased by just under five percent.

Figure 1.2.5-3 Overview of Schuylkill River Watershed Land Use (%)

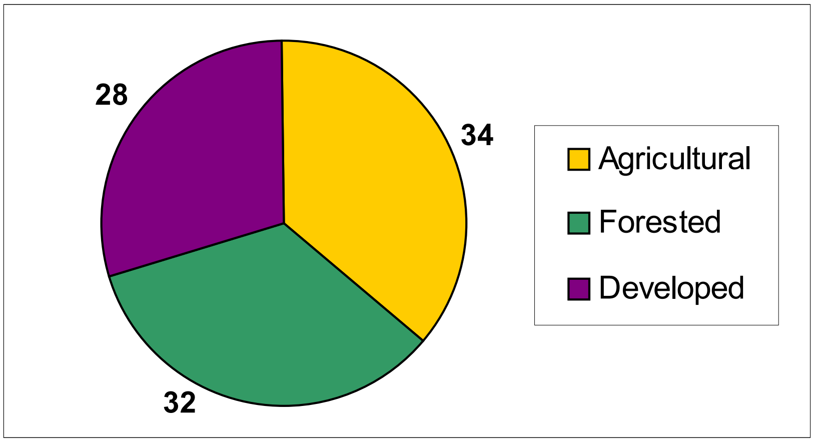
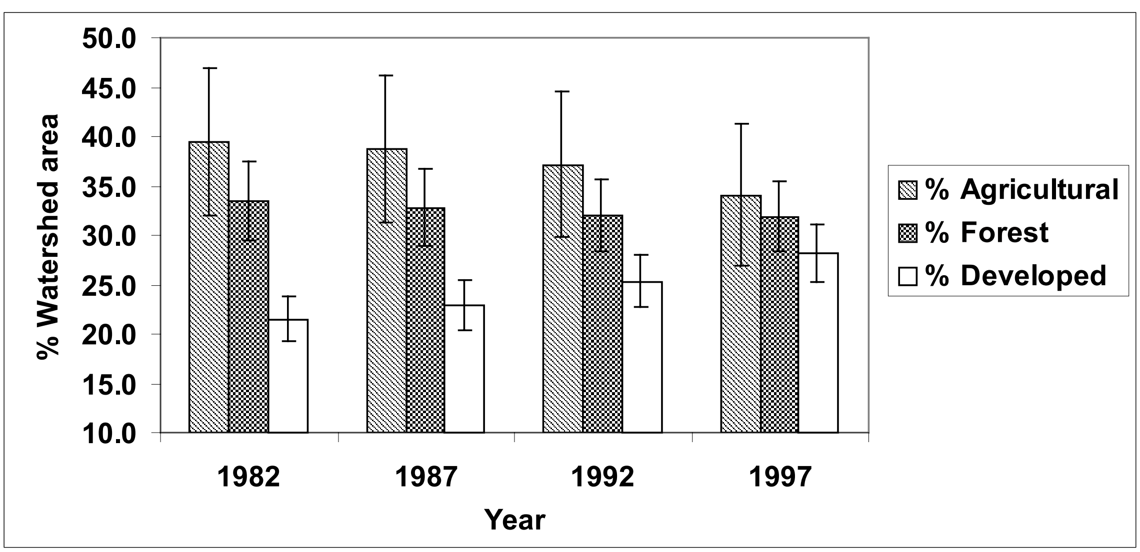


Table 1.2.5-1 Land Use Changes in the Schuylkill River Watershed: 1982-1997

Year	% Agricultural	% Developed	% Forested
1982	39.5	21.5	33.5
1987	38.8	22.8	32.8
1992	37.2	25.3	32.1
1997	34.0	28.3	31.9

Source: NRI, 2001
*Note: To calculate % change in agricultural land from 1982 to 1997: [(34.0-39.5)/39.5] * 100 = -13.9%*

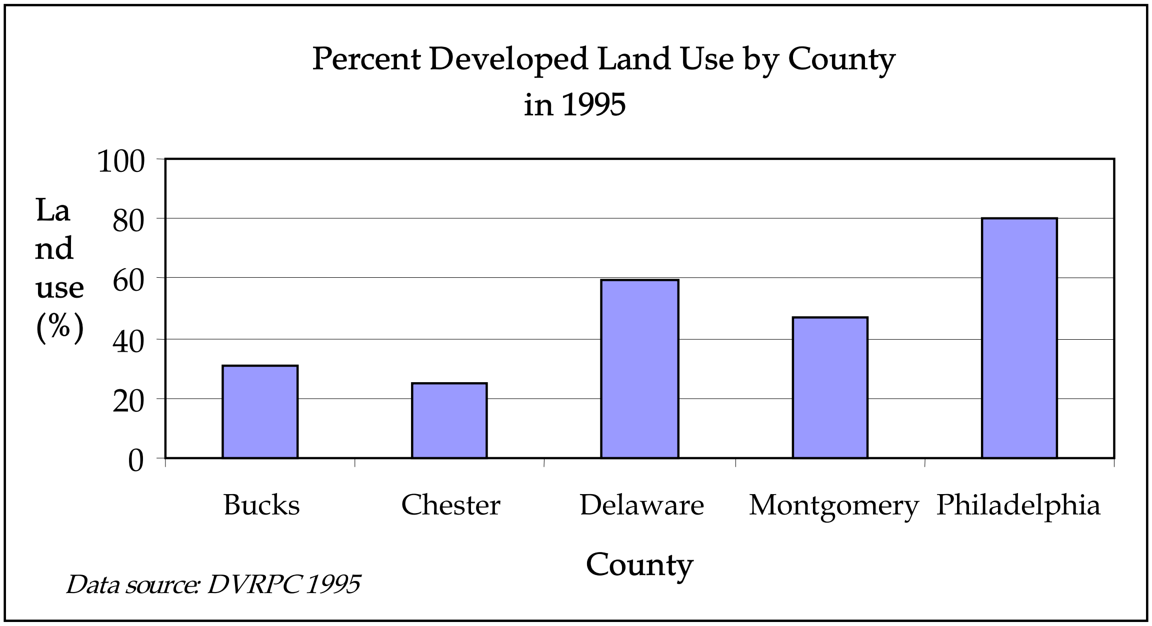
Figure 1.2.5-4 Change in Land Use in the Schuylkill Watershed
Data is from the National Resources Inventory, 2001. Error bars indicate 95% confidence intervals for data in broad land use categories. Agricultural land includes all pasture, grazing and crop lands. Developed land includes all urban land and rural transportation lands.



DVRPC Land Use Data Set

The DVRPC data includes five of Schuylkill Watershed's 11 counties (Bucks, Chester, Delaware, Montgomery, and Philadelphia). Figure 1.2.5-5 provides a breakdown of the developed land use in 1995 for those counties, based upon the DVRPC data set.

Figure 1.2.5-5 Percent of Developed Land Use by County in 1995



The DVRPC data was supplemented with information collected from Berks County Planning Commission to show development trends in the counties. As shown in Figures 1.2.5-6 and 1.2.5-7, Philadelphia and Delaware counties have been significantly developed, have reached their development limits, and have observed decreases in their populations over the past two decades. Residents leaving the densely developed areas are suspected to have moved to nearby counties that are less developed, thus starting the cycle of suburban sprawl. The developed land area and population in Montgomery County continue to increase, making it first in total developed land area and second in population in the six county area. Twenty-five to thirty-five percent of Bucks, Chester, and Berks counties is developed, but due to the large size of these counties, they have nearly the same amount of total developed land area in square miles as Montgomery County.

Figure 1.2.5-6 Percentage of Developed Land Area by County

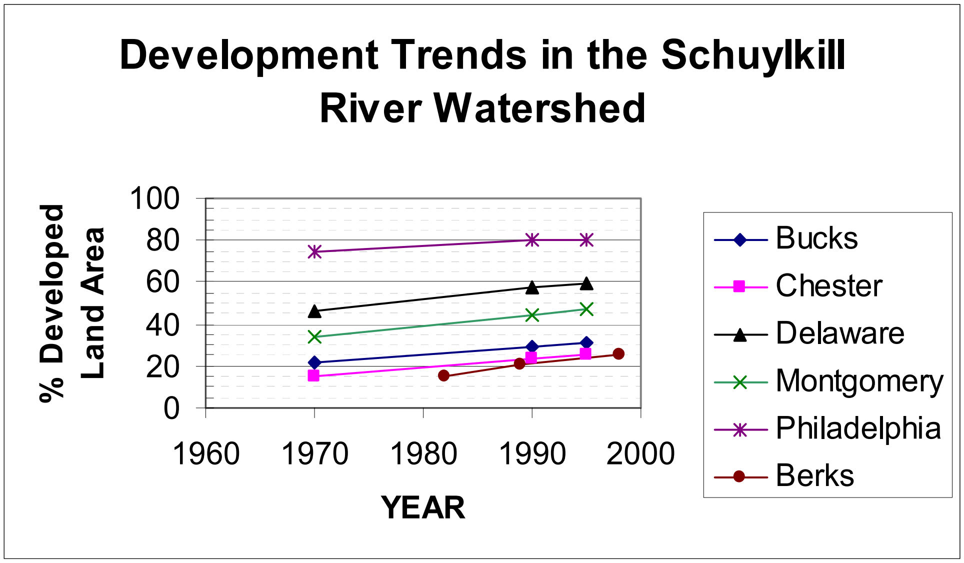


Figure 1.2.5-7Changes in Developed Land Area by County (in sq. miles)

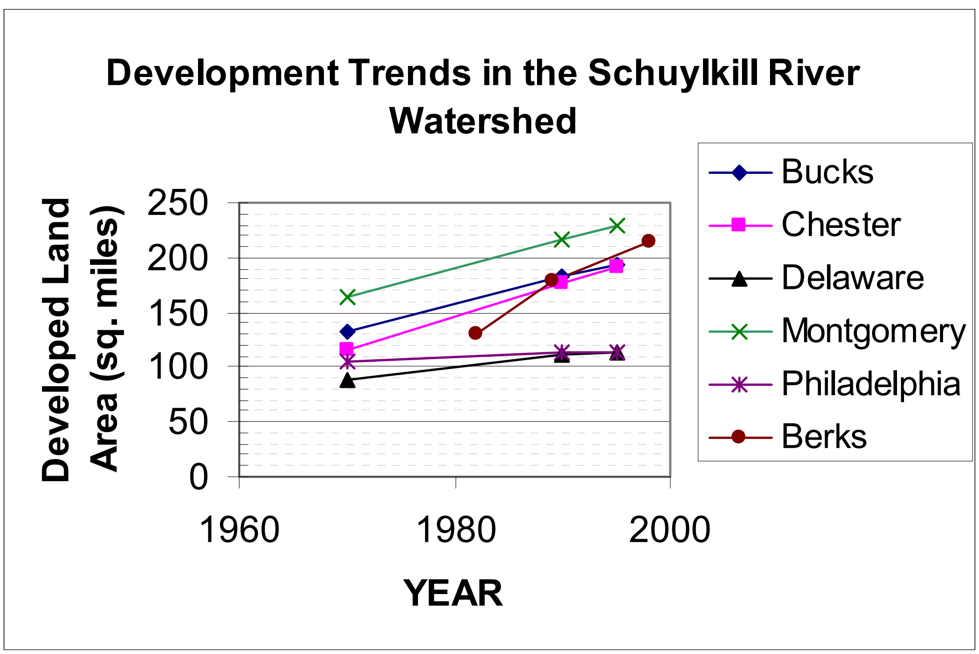
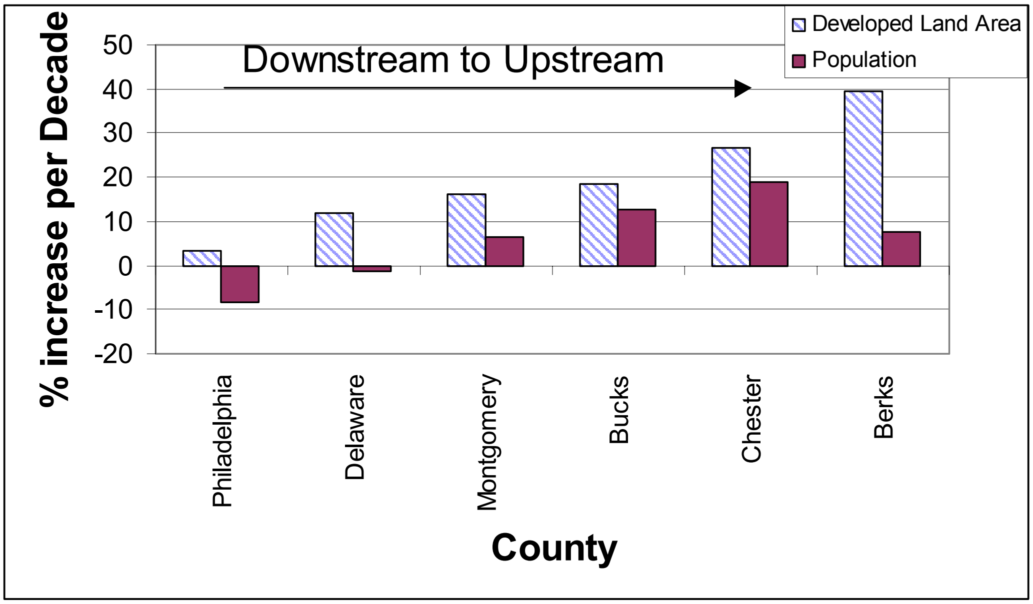


Figure 1.2.5-8 shows that population and developed land area have been increasing significantly per decade in the suburban areas of the watershed, as development expands from the city to the suburbs and beyond. These trends also show that the most significant changes area occurring in Berks, Chester, and Montgomery counties, which comprise approximately 70% of the land area in the Schuylkill River Watershed.

Figure 1.2.5-8 Percent Change in Developed Land and Population per Decade by County in the Philadelphia Region



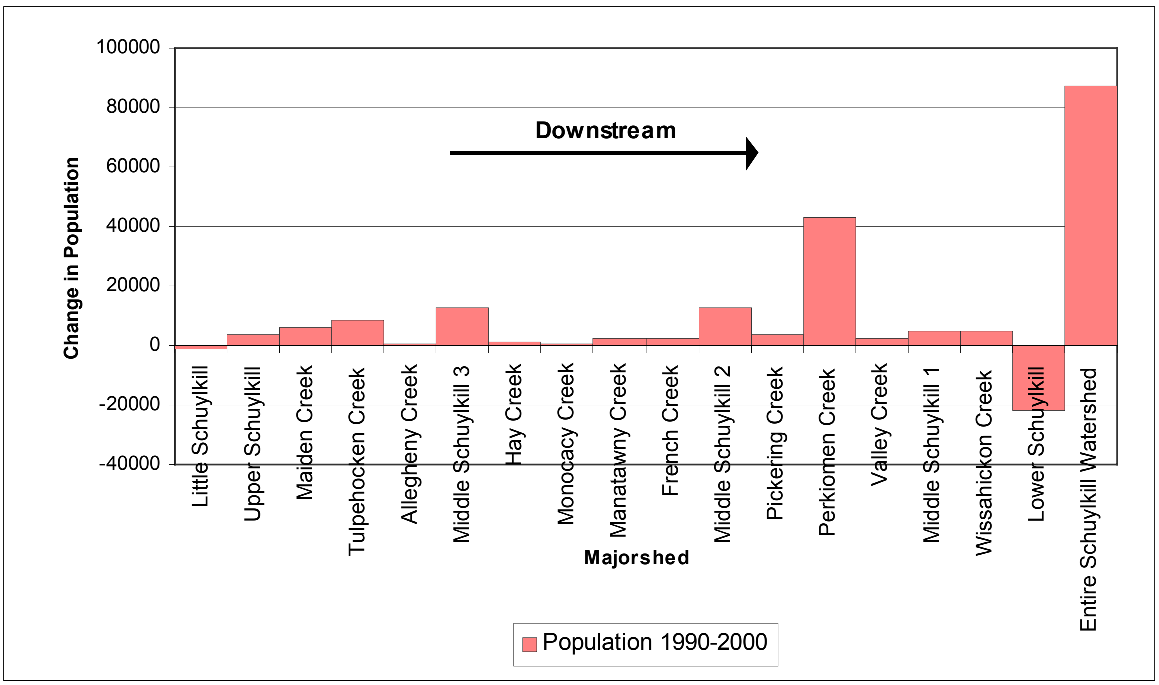
Modified Land Use Methodology for the USGS Dataset

To further characterize the Schuylkill Watershed, the National Land Cover Dataset (NLCD) was obtained from the USGS website, http://edcftp.cr.usgs.gov/pub/edcuser/vogel/states. The NLCD is a 21-class land cover classification and is based on the USGS's early-mid 1990's 30-meter Landsat thematic mapper (TM) supplemented with additional data analysis and interpretation of the Landsat data. The Schuylkill Watershed includes 14 of the 21 NLCD land cover categories: high and low intensity residential, commercial/industrial/transportation, forested, agricultural, wetlands, mining, and transitional.

Identifying and characterizing potential contaminant sources within the Schuylkill River Watershed is one focus of the Source Water Assessment Program. Reliable characterization of land use within the watershed is important for the source water assessment process, as it is the basis for estimating non-point source loadings. The USGS data set was used as the basis for the land use characterization in the Schuylkill River Watershed because it is believed to be the most accurate characterization available.

The existing land use coverage was updated with 2000 Census data populations to account for increases in residential development since the land use data was developed. The 2000 Census population was intersected with the land uses in ArcInfo GIS. The 2000 Census population intersection with the NLCD data identified residential development in areas characterized as agriculture and open space (e.g. wooded and forested) in the NLCD coverage. In these areas, the land use designations were modified as high or low intensity residential to reflect the growth in population and as a result, the increase in residential area. Figure 1.2.5-9 shows the population change by major watershed as well as the entire Schuylkill Watershed from 1990 to 2000, according to census data. The greatest increase is seen in the Perkiomen Creek Watershed. A decrease in population in the Lower Schuylkill Watershed, which includes more urban and developed areas such as Philadelphia and Montgomery counties, reflects the influence of suburban sprawl, as people move out into the surrounding suburban counties.

Figure 1.2.5-9 Population Change from 1990 to 2000 by Major Watershed



Increased commercial areas are associated with increased residential development. To incorporate the commercial development, a ratio of acreage of commercial area per person was calculated based upon the 1990 Census populations. The differences between the 1990 and 2000 Census populations were compiled for each subwatershed. These differences were used along with the estimates of commercial area per person to estimate the changes in commercial area within each subwatershed.

Figures 1.2.5-10 and 1.2.5-11 display the results of the updating methodology applied to the NLCD land use coverage. Decreases in agricultural and forested areas result from increases in development (i.e., residential and commercial/industrial/transportation). After systematically modifying the USGS's NLCD data set, originating in the early-mid 1990's, an increase in developed area of almost 30,000 acres, or over two percent, was identified in the Schuylkill Watershed. Residential land development generally increased in the downstream reaches of the Schuylkill Watershed, especially in the larger subwatersheds.

Figure 1.2.5-10 Change in Developed Areas by Major Subwatershed

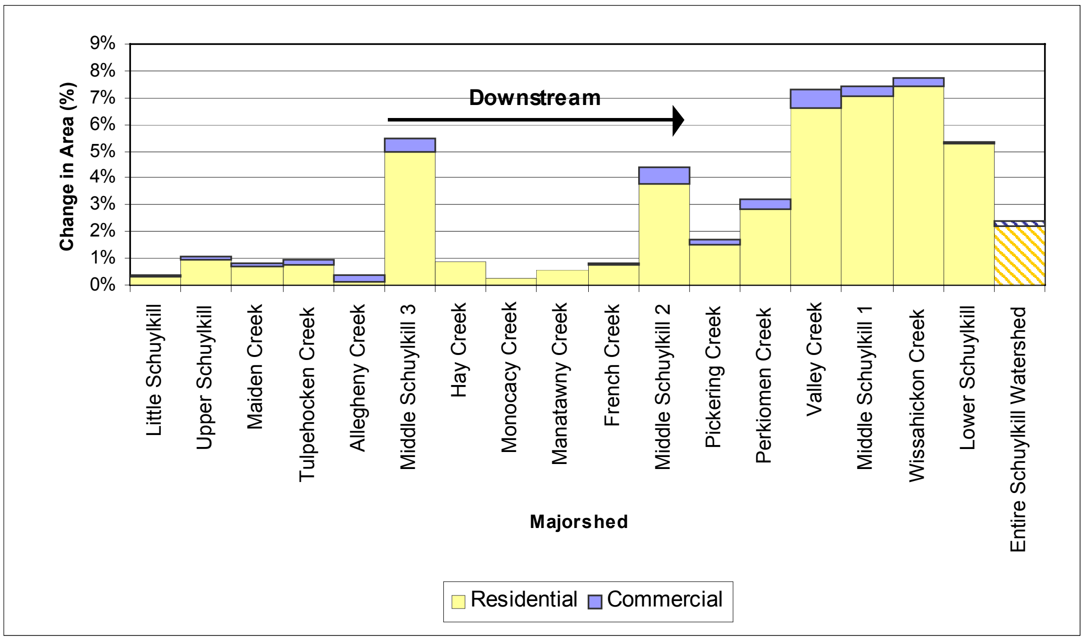


Figure 1.2.5-11 Change in Agricultural and Forested Areas by Major Subwatershed

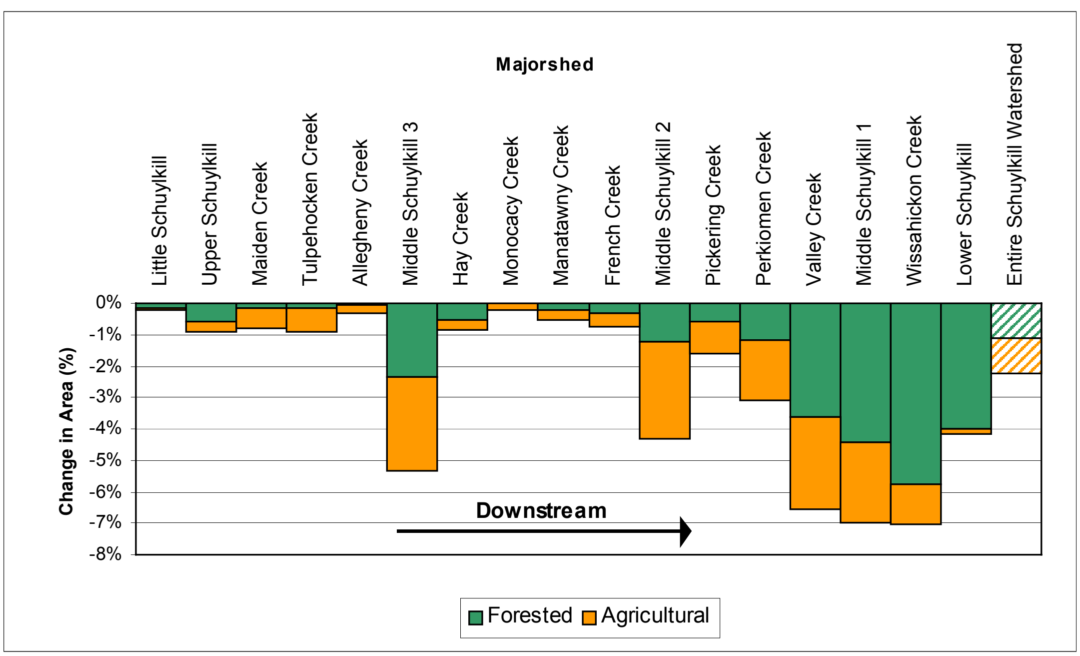


Table 1.2.5-2 summarizes the land use characterization for the Schuylkill River Watershed area and reflects modifications in residential development and increases in commercial areas. More than 83% of the Schuylkill Watershed is characterized as agriculture, forests, and wetlands. Developed and urbanized areas account for about 14% of the entire area.

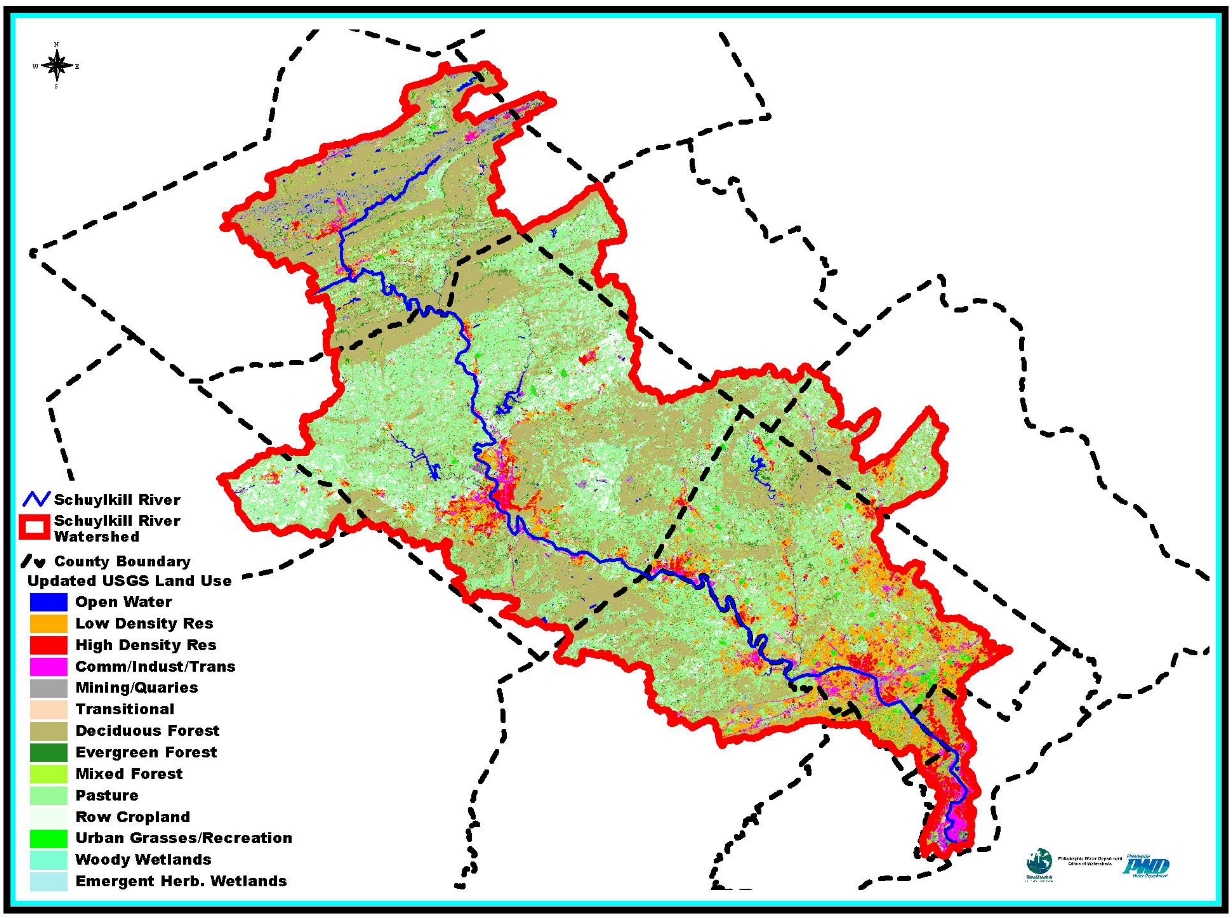
Table 1.2.5-2 Updated Land Use Categories

Land Use Category	Subcategory	Area (acres)	Percentage of Schuylkill Watershed Area
Agricultural	Pasture/Hay	357285	29.1%
	Row Crops	86891	7.1%
Commercial/Industrial/Transportation		35633	2.9%
Forested	Deciduous Forest	481255	39.3%
	Evergreen Forest	37569	3.1%
	Mixed Forest	52414	4.3%
Open Water		15118	1.2%
Quarries/Strip Mines/Gravel Pits		13707	1.1%
Residential	High Intensity Residential	36024	2.9%
	Low Intensity Residential	90686	7.4%
Transitional		4083	0.3%
Urban/Recreational Grasses		7427	0.6%
Wetlands	Emergent Herbaceous Wetlands	4276	0.3%
	Woody Wetlands	3738	0.3%

While this land use characterization is believed to provide the most accurate and up-to-date coverage of land use in the Schuylkill River Watershed, it results in a lower estimate of developed land than do the USDA and DVRPC characterizations. Nevertheless, all three land use characterizations demonstrate a consistent trend of increased development within the watershed. Development of a current land use map of the entire Schuylkill River Watershed would be most useful in establishing current levels of developed land area within the watershed.

Figure 1.2.5-12 shows the updated NLCD coverage, but does not reflect the new commercial development since those areas cannot be spatially represented. As shown in Figure 1.2.5-12, the most developed areas tend to be aggregated at the bottom of the watershed and follow major transportation corridors or are located near Philadelphia, Norristown, Pottstown, and Reading. The majority of agricultural lands are located in the middle and upper part of the watershed in Berks and Chester counties. The majority of forested lands are located in the upper portion of the watershed in Berks and Schuylkill Counties.

Figure 1.2.5-12 Updated Land Use in the Schuylkill River Watershed



1.3 Summary of Past Reports and Studies

1.3.1 Introduction

Key Points

- A number of studies have been completed to characterize the Schuylkill River and its tributaries.

Recently, numerous governmental agencies, watershed organizations, educational institutions, and citizen groups have focused their efforts on improving the ecology of the Schuylkill River and its tributaries. A listing of reports and studies completed by these groups is given below as a resource reference. Due to the size and complexity of the Schuylkill Watershed, it should be noted that this list is not exhaustive.

1.3.2 Schuylkill River Studies

The ***Delaware Estuary Monitoring Report*** was prepared by the Delaware Estuary Program in August 1998. The objective of the report was to establish a monitoring program and an accompanying database to evaluate the current status and future trends of water quality in the estuary.

The City of Philadelphia Planning Commission delivered a technical report on ***Philadelphia's River Resources*** in June 1982. This report was prepared in order to characterize water quality on the Schuylkill and Delaware rivers, and to assist in land use planning of the riverfront. Consequently, recommendations for improved environmental and land management of the riverfront were developed.

Stephen Hammell prepared a report on ***Planning for Water Quality Monitoring and Riparian Restoration in the Schuylkill Watershed, Working Draft*** for the Schuylkill Riverkeeper Program in March 1996. The report is a compilation of extracts from other reports assessing the biological, chemical and physical conditions of the river and its tributaries.

The Delaware Riverkeeper Network published ***River for Renewal: A Look at the Restoration Potential of the Schuylkill River,*** in March 1996. The report was funded by the Wyomissing Foundation, the William Penn Foundation, and the Tortuga Foundation, and was based in part on ***Planning for Water Quality Monitoring and Riparian Restoration In the Schuylkill Watershed, Working Draft*** (Hammell, 1996). The study takes into consideration the current conditions of the river, including water quality and ecology, and assesses its potential for rehabilitation.

The ***Schuylkill River Watershed Conservation Plan*** was produced through a partnership of the Academy of Natural Sciences, the Natural Lands Trust, and The Conservation Fund in October 2000. The aim of the report was to highlight conservation issues, develop an inventory of land and water resources, and make recommendations for future projects at the site-specific, local, and community levels. The report is divided into three main sections: water quality, landscape sustainability, and institutional assessment.

Chester-Betz Engineers prepared the ***Summary of Data Report August 1976 Water Quality Investigations Schuylkill River and Neshaminy Creek*** for the Delaware Valley Regional Planning Commission and the Pennsylvania Department of Environmental Resources in September 1978. This report was conducted after the analysis of historical water quality information conducted during the initial COWAMP phase of the COWAMP/208 program indicated that much of the past data collected was insufficient. The previous data lacked spatial and temporal continuity.

Chester-Betz Engineers prepared chapter VI ***Existing Water Use and Quality*** (revision of 12/5/77) for the Delaware Valley Regional Planning Commission and the Pennsylvania Department of Environmental Resources in May 1978. This report discusses the evaluation of existing water quality information, the large-scale stream sampling conducted under COWAMP/208, and the water quality modeling program.

J.K. Stamer, T.H. Yorker, and G.L. Pederson prepared the ***Distribution and Transport of Trace Substances in the Schuylkill River Basin from Bern to Philadelphia, Pennsylvania***. This paper is a compilation of data collected between the dates of October 1978 and March 1981, by the U.S. Geological Survey (USGS). Between these dates, the USGS assessed the water quality of the Schuylkill River Basin in Pennsylvania from the headwaters to the Fairmont Dam. In particular, they researched the transport of trace metals including arsenic, beryllium, cadmium, copper, lead, mercury, nickel, and zinc. They also tested for organic substances, particularly organochlorine insecticides and polychlorinated biphenyls.

Thomas H. Yorke, John K. Stamer, and Gary L. Pederson prepared the ***Effects of Low-Level Dams on the Distribution of Sediment, Trace Metals, and Organic Substances*** in ***the Lower Schuylkill River Basin, Pennsylvania***. This report represents the results from part of the USGS's *River Quality Assessment Program,* where they evaluated the effects of low-level dams in the lower basin on the distribution and transport of sediment and trace substances.

1.3.3 Schuylkill River Tributary Studies

L. Robert Kimball & Associates, Inc. prepared the ***Upper Schuylkill River Tributaries Assessment Report*** for the Schuylkill Conservation District. The objectives of this study were to identify major non-point source/acid mine drainage (NPS/AMD) sources within the upper Schuylkill River Watershed area. The group obtained existing analytical/physical data associated with those discharges and evaluated the impacts with regards to water quality. Based on their conclusions, a priority list of NPS/AMD sources would be produced for which general remediation strategies could be developed.

1.3.3.1 Hay Creek

The Berks County Conservancy concluded the *Hay Creek Preliminary Assessment* in June of 1999. The purpose of the report was to foster awareness of watershed planning, restoration and protection throughout Berks County, in an effort to forestall potentially harmful impacts on the Hay Creek Watershed.

1.3.3.2 Lake Ontelaunee

F. X. Browne, Inc. produced a *Diagnostic Feasibility Study of Lake Ontelaunee* in April 1994. The study was performed for the City of Reading, who uses the Lake as its primary drinking water source. The goals of the study included establishing existing water quality conditions and outlining feasible control and restoration methods.

1.3.3.3 Little Lehigh Creek

The Wildlands Conservancy issued the *Little Lehigh Creek Stream Corridor Restoration Project Stream Status Report* for the Harry C. Trexler Trust in January 1994. Chemical and biological testing was performed to establish baseline stream conditions, upon which future management decisions could be weighed.

1.3.3.4 Maiden Creek

The Center for Watershed Stewardship at the Pennsylvania State University prepared the *Maiden Creek Watershed Keystone Project*, as part of the Student Technical Experience in Problem Solving (STEPS) agreement with the Berks County Conservancy, in May 2000. Data about land and water resources, biological activity, and watershed characteristics were collected, areas of concern were identified, and management options were explored.

1.3.3.5 Perkiomen Creek

In August 1999, the *West Branch Perkiomen Creek Preliminary Assessment* was completed by the Berks County Conservancy. The study took into account land use/recreation, historical resources by municipality, point sources of discharges and general water quality.

1.3.3.6 Sandy Run Creek

The Montgomery County Planning Commission, Abington Township, Springfield Township, Upper Dublin Township, and Whitemarsh Township prepared the *Sandy Run Creek Watershed Conservation Plan*. This paper reviews a wide range of watershed topics, from water quality to vegetation. Also included in this document are the conservation plan goals that were established by the Sandy Run Coalition.

1.3.3.7 Saucony Creek

The Berks County Conservancy released a *Groundwater Study of the Saucony Creek Marsh* in May 2000, based on data collected from May through October 1988. The project began as an attempt to shed some light onto the workings of the marsh ecosystem, as a response to a proposal from Eastern Industries to discharge water from a nearby limestone quarry into the marsh.

1.3.3.8 Tulpehocken Creek

A *Macroinvertebrate Analysis of the Tulpehocken Creek and its Tributaries* was conducted by the Berks County Conservancy in July of 1996. The purpose of the study was to collect and identify macroinvertebrates and use this data as an indicator of water quality.

The Berks County Conservancy prepared a *Qualitative Analysis of the Tulpehocken Creek and its Tributaries*, for the Tulpehocken Creek/Blue Marsh Lake Steering Committee, in August 1996. The intent of the report was to inform local farmers and developers how best management practices may be used to decrease contaminant loading to the Tulpehocken Creek from agricultural runoff, suburban development, and industrial wastes. This, in turn, will take steps toward improving the creek's tributaries, the largest of which is Blue Marsh Lake.

Aqua-Link, Inc. issued the *Blue Marsh Lake Final Report* for the Berks County Conservancy in September 1999, as a supplement to the draft report *Blue Marsh Lake Water Quality Evaluation Assessment of Major Chemical, Physical, and Biological Parameters* (Hall and Dougherty, September 1998). This report, funded by the United States Environmental Agency (USEPA) and PADEP under the Clean Water Act, was compiled to fill in some missing elements of the aforementioned draft, and therefore should not be considered as a "stand alone" document.

The results of a study of the *Fish and Wildlife Resources in the Tulpehocken Creek Watershed* were issued by the U.S. Department of the Interior and the Fish & Game Commission of State College, PA in April 1997. The report was prepared for use in development of a watershed protection plan/environmental assessment to be used in application for federal assistance under the Watershed Protection and Flood Prevention Act (PL-566). The focus was on the fish, mammal, amphibian, reptile, bird, and plant resources present in the watershed. Point and non-point sources of pollution in the watershed were also discussed in relation to their effects on the fish and wildlife.

The United States Department of Agriculture (USDA), Forest Service, and Northeastern Area State & Private Forestry prepared a *Forest Resource Report for the Tulpehocken Creek Watershed* in November 1996. The report identified a list of issues and concerns, and suggested the establishment/enhancement of riparian buffers along the creek's banks.

The USDA, in cooperation with the Berks County Conservation District, the Lebanon County Conservation District, and the Berks County Conservancy, completed the *Tuplehocken Creek Final Watershed Protection Plan and Environmental Assessment* in November 1997. The goal of the report was twofold: to develop a plan for treating non-point source pollution (in order to improve water quality and aquatic habitats), and to improve management practices (in order to sustain agricultural productivity and profitability). The plan encompasses the Tulpehocken Creek, as well as several tributaries, the most notable of which is Blue Marsh Lake.

The Berks County Conservancy and the Scenic Rivers Division, Bureau of Water Resources Management, Pennsylvania Department of Environmental Resources completed the *Tulpehocken Creek Scenic River Study*. Under the Scenic Rivers Act, the Scenic Rivers System prescribes procedures and criteria for protecting, administrating, and establishing the system and adding new components through a set of standard procedures. The act assures the people of the opportunity to refresh their spirits with these values of unspoiled waterways. The area studied the entire Tulpehocken Creek (in Berks and Lebanon Counties) and a small section of the Cacoosing Creek.

1.3.3.9 Wissahickon Creek

Stephanie Craighead (The Fairmont Park Commission), John Wood (Montgomery County Planning Commission), and Terry Hough (The Pennsylvania Department of Conservation and Natural Resources) prepared the *Wissahickon Creek River Conservation Plan*, in December 1999. The document is the result of a team effort that involved 14 municipalities of the Wissahickon Watershed. The document describes every aspect of the watershed, from soils and geology to water quality. As an end product it outlines the goals of the Wissahickon Creek River Conservation Plan.

1.3.3.10 Wyomissing Creek

The Berks County Conservancy presented the *Wyomissing Creek Study Streamwalk Observations and Analysis* in May 1992. The purpose of the study was to assess the current condition of the creek. Water quality parameters, invertebrates, and the flora and fauna in and surrounding the area were observed and analyzed.

1.3.3.11 Watershed Assessments

The *Watershed Assessment: Reading Pennsylvania* was prepared for the USEPA by the Cadmus Group, Inc. The Cadmus Group, Inc. studied three watersheds including Ontelaunee, as part of the PADEP's commitment to the source water assessment program. The group looked at all 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 document is a summary of the project for the Reading Water Authority.

1.4 Identification of Universal Water Quality Issues

1.4.1 Introduction to Water Quality

Key Points

- Schuylkill River water quality has significantly improved over the past 20 years.
- As the impacts of point sources discharging to the Schuylkill River have been reduced over the years, the importance of non-point sources such as stormwater runoff from developed areas within the watershed has become evident.
- While dissolved solute levels have increased over the past few decades, levels of dissolved oxygen and nutrients have significantly improved, due to reductions in agricultural runoff and improved wastewater treatment.

The Schuylkill River is a much healthier river now than it was over the past century, when it was branded as "too thin to cultivate, too thick to drink". The periods of the river running black with culm, smelling of raw sewage, covered in sheens of oils, or foaming with detergent bubbles are now gone, resulting in tremendous improvements in fish, wildlife, and water quality over the past 20 years. These improvements can be directly related to the following major events:

- The decline of the coal industry;
- The decline in the presence and size of the manufacturing industry (steel, paper mills, textiles, glass, etc) throughout the watershed;
- The increased cost of oil;
- The construction of sewers and sewage treatment plants;
- The improvements in sewage and industrial waste treatment plants;
- The Clean Water Act;
- Regulations limiting the presence of phosphates in detergents; and
- Regulations phasing out the use of certain toxic chemicals.

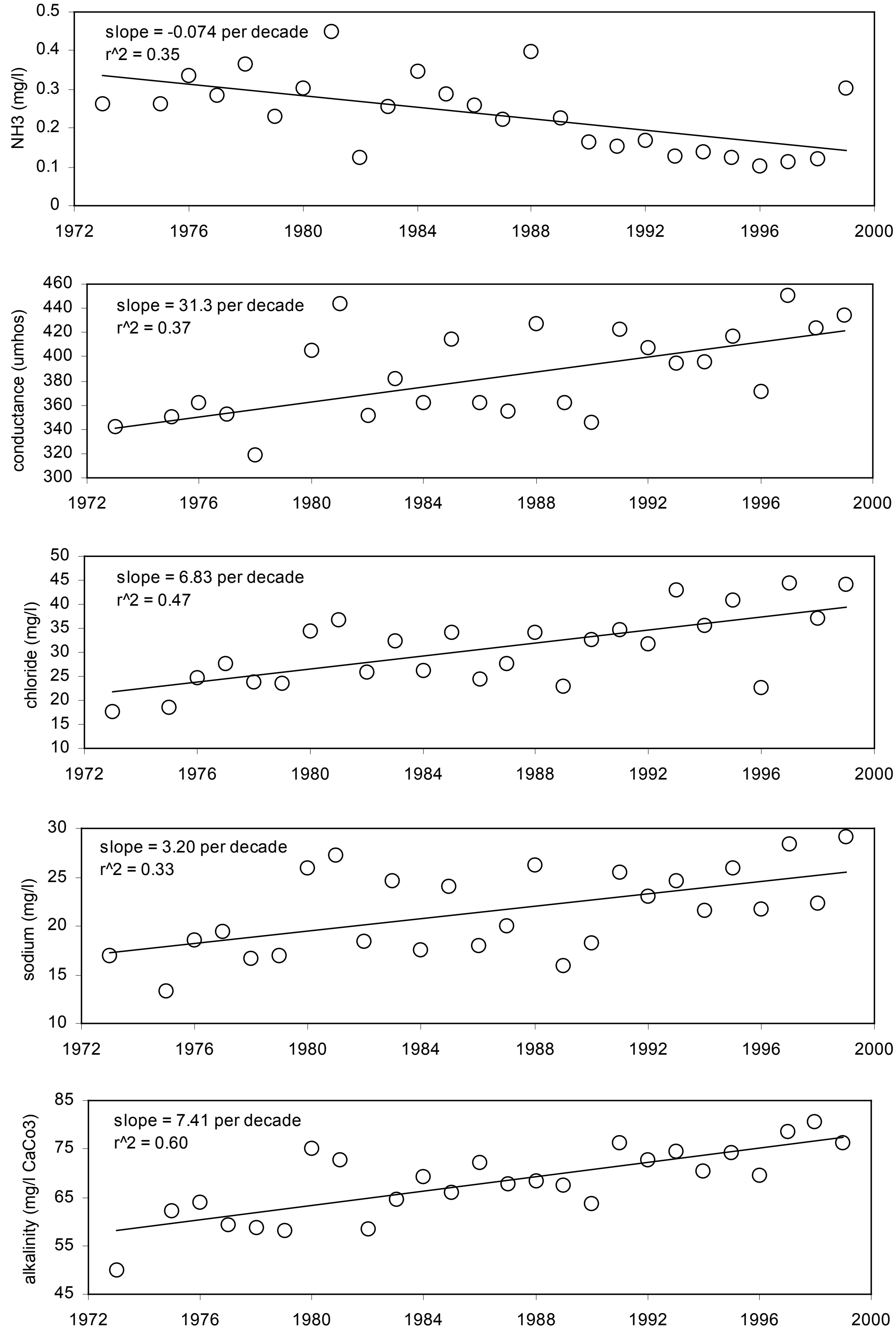
While some of these improvements were related to regulatory initiatives, most changes in water quality were caused by the activities that occurred in the watershed. These recent improvements in water quality have allowed us to see that in a growing number of areas, the main challenges to water quality now come from polluted runoff and not point source discharges. Therefore, the focus of activities that impact water quality are now becoming as much land use related as they are specific point source or facility related.

The process of examining changes in water quality over time is very difficult. The data usually is not available to characterize long periods of record for most chemical parameters. If data is available, changes in analytical methods over time can skew results. It is important to note that based on these factors, the following sections attempt to examine the trends in water quality data based on the data that is available. Therefore, just because a change is noticed at one location does not mean that it is occurring at all locations. In addition, just because data is not available to characterize an area of the watershed does not mean that the water quality is good or bad.

General temporal analysis focused on long-term and past decade trends in water quality in the Schuylkill River at Philadelphia. This site was chosen because it is at the downstream end of the Schuylkill River Watershed, had the most significant and extensive monitoring data available, and because it provides evidence of the dominant changes in long term water quality in the watershed as a whole. Ultimately, it is believed that impacts observed at Philadelphia are possibly occurring at a number of locations along the river and throughout its tributaries to some extent. However, this does not mean that every trend observed at Philadelphia may be happening to the same extent, or at all, in other parts of the watershed. It is hoped that as coordination of watershed monitoring is improved to provide appropriate data to describe long-term trends, evaluations at other key locations throughout the watershed can be performed.

Three decades of changes in levels of water quality indicators, such as alkalinity, conductance, chlorides, sodium and ammonia, are summarized in Figure 1.4.1-1.

Figure 1.4.1-1 Changes in Water Quality Indicators in the Schuylkill River at Philadelphia



Analysis of the data yielded the following observations:

- Philadelphia Water Department (PWD) intake data indicate significant increases in dissolved solute concentrations through the 1990s, including elevated levels of sodium, chloride, alkalinity, dissolved solids, and conductivity. These trends appear to extend back through the early 1970s. If they continue, they have the potential to adversely affect drinking water treatment processes for the City of Philadelphia in the future.

- Spatial analysis of conductivity data throughout the watershed indicates that the observed trends are common throughout the watershed.

- If the increasing trends in alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon and turbidity in the river water continue over the next two decades, there will be impacts on water treatment process operation and/or finished water quality. This could result in additional water treatment costs or reduced consumer confidence for many water suppliers in the watershed.

- Increased mass transport levels of sodium and chloride, particularly in winter months through the 1990s, suggest that increased deposition of road salts are significantly impacting water quality at Philadelphia's Schuylkill River drinking water intakes.

- Though this study focused on adverse changes in river water quality parameters, the Schuylkill River has seen significant improvements in important water quality parameters such as dissolved oxygen, ammonia, nitrate, and phosphorous since the 1970s. Schuylkill River nutrient levels (nitrogen and phosphorus measures) have remained stable or decreased over the past decade due to decreased agricultural runoff within the watershed, along with improved wastewater treatment practices. Dissolved oxygen values have been steadily increasing over the past several decades.

1.4.2 Long-Term Water Quality, Historical Trends, and Comparison to Other Rivers

Key Points

- Compared to other rivers in the northeastern United States, the Schuylkill River has some of the highest dissolved solute concentrations.
- Levels of nitrates, chlorides and total residue in the Schuylkill River have increased over the years.

Previous assessments of century-long water quality trends in the Schuylkill River and other northeastern watersheds have demonstrated long term increases in salt concentrations through the 1900s. For instance, nitrate, chloride and total residuals all increased steadily in the Schuylkill River from 1900 through 1970 (Please see Table 1.4.2-1 and Figure 1.4.2-1). These indicators of water quality appeared to level off and remain relatively stable from 1970 through 1990, most likely as a result of improved wastewater treatment and slowing rates of development in the northeastern region (Jaworski and Hetling 1996). Increased national prosperity following the recession of the late 1980s spurred a strong increase in development in suburban regions, including parts of Bucks, Berks, Lehigh, Montgomery and Chester counties within the Schuylkill Watershed. This recent development appears to be causing increases in solute concentrations, driven by increasing wastewater discharge and increased solids transport directly related to land use change.

Recent water quality assessments have indicated long-term temporal increases in nutrient fluxes in major waterways (e. g. Bollinger et al. 1999) in the United States, which may have adverse impacts on water supplies for both drinking water and irrigation systems. These recent trends are apparently driven by major increases in diffuse loading of solutes from both agricultural and urban sources (Novotny and Olem 1994, Reimold 1998). While agricultural sources typically result in increases in nutrient and herbicide concentrations, urban sources of solutes, particularly from highway runoff, can result in increased loading rates of a more diverse suite of solutes. This analysis addresses many of the potential solutes derived from both sources. Urbanization in the Schuylkill River Watershed has resulted in decreases in land used for agricultural purposes, so long-term decreases in nutrient loading along with long-term increases in other dissolved solutes, including metals and other inorganic constituents, might be expected. Effects of increased loading of solutes to the Schuylkill River can be complicated by changes in specific ion activities which are directly related to ionic strength, organic content and other bulk water chemistry characteristics that are dynamic as well (Buckler and Granato 1999, Bricker 1999).

Recent changes in water quality are critical in the Schuylkill River in particular, as this river has some of the highest dissolved solute concentrations of all water supply sources in the northeast. Of twelve major northeastern rivers assessed by Jaworski and Hetling (1996), the Schuylkill had the highest nitrate and total residue (total solids – TS) levels, and the second-highest chloride levels measured as averaged concentrations from 1990 to 1993. Additionally, for the period 1900 to 1993, the Schuylkill had the highest average rate of increase of all watersheds surveyed for nitrate and chloride (by a factor of two over the second-highest rates in the Potomac River) and the second-highest rate of increase in total residuals (just behind the Potomac). These changes are summarized in Table 1.4.2-1. Based on watershed area, the Schuylkill also has the highest mass transport rate for nitrate and ammonia of all major eastern rivers (Jaworski et al. 1997). As such, the Schuylkill has historically been, and is still currently, a heavily impacted major river water supply source.

Table 1.4.2-1 Summary of Historical and Current Water Quality Concentrations and Rates of Change For Northeastern Watersheds

Watershed	USGS Station No.	Timeframe	NO_3(1) (mg/l)	NO_3(2) (mg/l)	NO_3 Change (mg/l/yr)	Cl(1) (mg/l)	Cl(2) (mg/l)	Cl Change (mg/l/yr)	T Res(1) (mg/l)	T Res(2) (mg/l)	T Res Change (mg/l/yr)
Schuylkill	1474500	1913-1993	0.27	2.9	0.0329	6	30	0.3	122	229	1.3375
Potomac	1646580	1921-1993	0.6	1.76	0.0161	3.3	13	0.1347	103	203	1.3689
Delaware	1463500	1906-1993	0.25	1.01	0.0087	2.9	13	0.1161	70	104	0.3908
Blackstone	1111230	1890-1993	0.21	0.97	0.0074	5	44	0.3766	60	154	0.9126
WB Susquehanna	1553500	1906-1993	0.16	0.7	0.0062	4	8	0.046	74	137	0.7241
Rappahannock	1668000	1929-1993	0.15	0.55	0.0063	1.1	5	0.0619	43	53	0.1587
Hudson	1385000	1906-1993	0.18	0.52	0.0039	4	17	0.1494	108	119	0.1264
Connecticut	1184000	1888-1993	0.08	0.35	0.0026	1.5	11	0.0905	53	67	0.1333
Merrimack	1100000	1888-1993	0.07	0.32	0.0024	1.8	19	0.1638	43	68	0.2381
James	2035000	1906-1993	0.06	0.3	0.0028	2.3	9	0.077	89	100	0.1264
Androscoggin	1059010	1906-1993	0.02	0.18	0.0019	2.3	12.5	0.1229	42	66	0.2892
St. John	1015000	1921-1993	0.02	0.15	0.0018	0.7	2.9	0.0306	45	65	0.2778
Average			0.17	0.81	0.0078	2.9	15.4	0.1393	71	114	0.5087

Note: (1) = Earliest historical year
(2) = Four year average for the period 1990-1993
Source: Jaworski et al. 1996

Figure 1.4.2-1 Historical Nitrate, Chloride and Total Residue in Eastern US Rivers *From Jaworski et al., 1990*

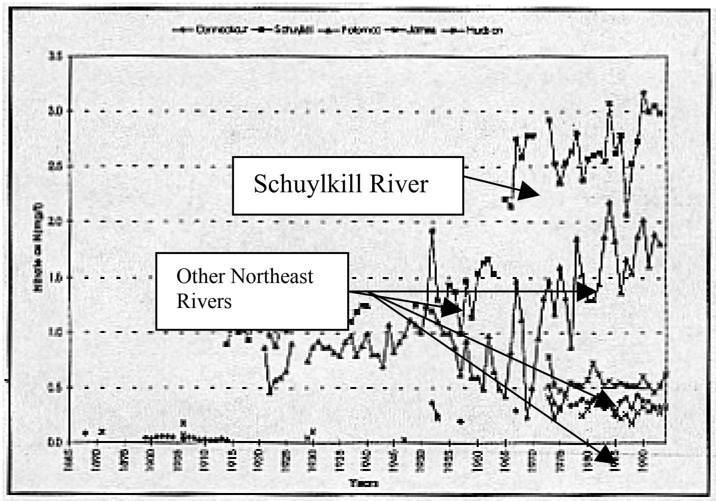


Figure 2. Nitrate Trends.

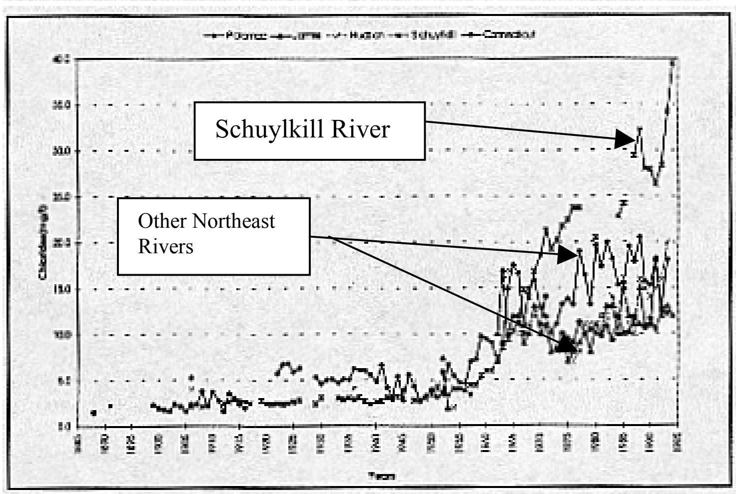


Figure 3. Chloride Trends.

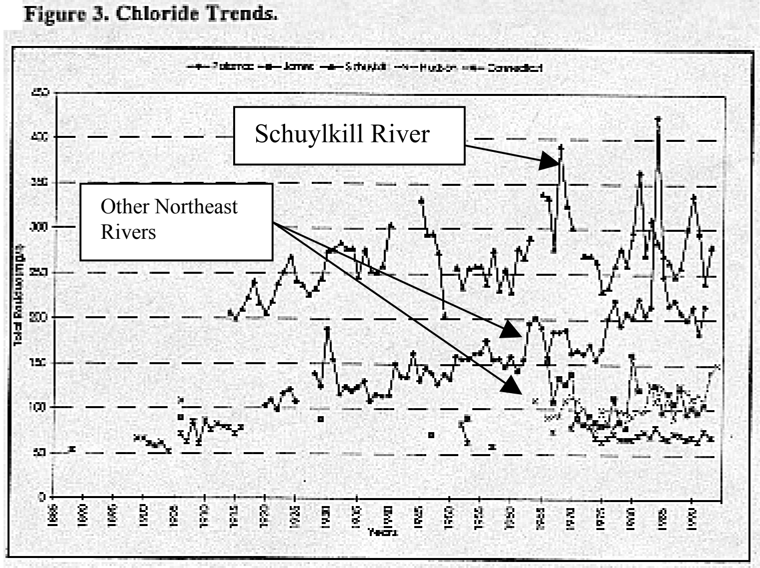


Figure 4. Total Residue Trends.

1.4.3 Changes in River Water Quality Over the Past Decade

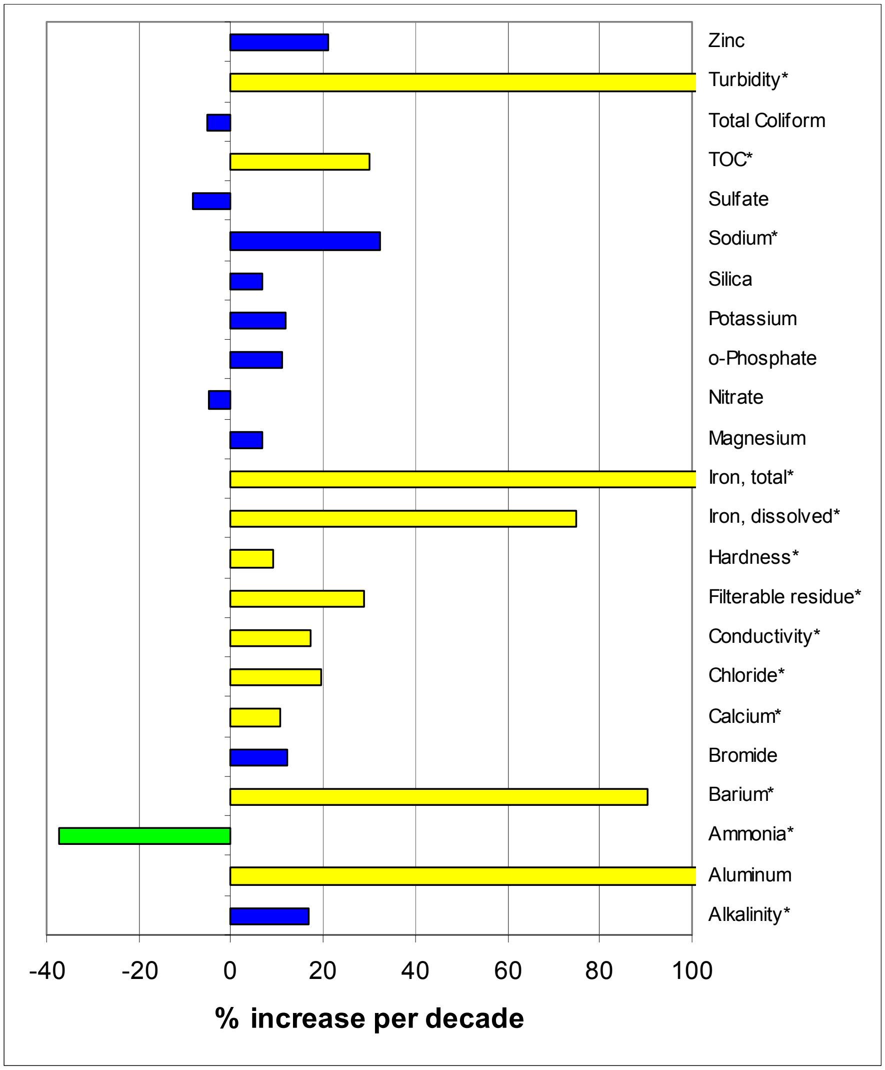
Key Points

- Over the past decade, levels of alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon, and turbidity in the Schuylkill River have increased.
- Increases in levels of solids, salts, and metals are believed to result from contaminated runoff due to increased development, increased use of deicing chemicals, and from acid mine drainage.
- As point sources throughout the watershed have been abated, levels of coliforms, nitrate, and ammonia have decreased.

Trends in river water quality over the past decade were examined in order to identify sources of contamination, and to predict future water quality concerns. This process involved the examination of data from 135 different water quality parameters measured at the Philadelphia Water Department river intakes between 1990 and 1999 and data from STORET for the Schuylkill River Watershed between 1970 and 2000. Of that data set, only 35 parameters had sufficient numbers of measurements or detectable results to conduct a proper analysis that included comparisons between parameters and regional climate and development patterns.

Analysis of the remaining data identified the following trends in water quality changes as shown in Figure 1.4.3-1 and Tables 1.4.3-1 and 1.4.3-2. Overall, 19 water quality parameters increased in concentration over the past decade, while levels of only 2 parameters (ammonia and sulfate) were observed to decrease significantly, and another two parameters changed very little (nitrate and total coliforms). Of the 19 water quality parameters exhibiting increased trends, most were salts and metals. Future increases in alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon and turbidity in the river water could potentially impact water treatment process operation and finished water quality and therefore required further investigation.

Figure 1.4.3-1 Percent Change per Decade in Schuylkill River Quality Parameters at Philadelphia, PA between 1990 and 1999



** Represents parameters with statistically significant increasing or decreasing trends*

The observed trends led to efforts to determine the origins and types of sources and activities that would significantly impact river water quality. These observed trends suggested that although significant improvements to protect river water quality have been made for point sources, the sources of the changes in these parameters were most likely due to polluted runoff. If all of the affected parameters were regulated for point source discharges during this period without changes, then it suggests other sources may be impacting these changes. Salts, such as sodium and chloride, that appear to be increasing at significant rates in the river can be the result of increased application of deicing chemicals in the watershed due to increased road, sidewalk, and parking lot areas in the watershed (see Table 1.4.3-3). Other parameters exhibiting increases, such as aluminum, iron, and turbidity, can be the result of increased erosion of land surfaces and streambanks due to new construction or increased flows in streams from development and acid mine drainage. The increases in salts and metals also impact conductivity, which has significantly increased throughout the watershed.

Table 1.4.3-1 Parameters that May Have Water Treatment Operation, Distribution System, or Finished Water Quality Impacts over the Past Decade or by 2020 Given Current Trends

Parameter	Mean	Max	Min	Predicted Mean Concentration in 2020
Alkalinity (mg/l as CaCo3)	73.9	128	30	101
Turbidity (NTU)	7.85	94.5	0.15	20.9
Conductivity (umhos)	409	775	145	568
o-Phosphate	0.217	1.421	0.027	0.261
Zinc	0.03	0.5	<0.01	.055
Hardness (degrees)	133	251	0.231	162
Iron, total	0.77	40	<0.05	1.25
Iron, dissolved	0.054	0.28	<0.05	0.117
TOC	2.82	7.11	1	4.84
Chloride	41.2	128	8	56.2
Sodium	25	76	0.1	42.3
Manganese, dissolved	0.068	0.2	<0.02	0.116

Units are mg/l unless otherwise specified.
Predicted concentrations are based on linear trends from 1990-2000.

Table 1.4.3-2 Summary of Water Quality Changes in the Schuylkill River During the 1990's that May Impact Water Treatment and Possible Sources

Parameter	Group	Change	Possible Sources/Activities
Conductivity	Physical	Increasing	Polluted Runoff
Chloride & Sodium	Salts	Increasing	Road Runoff
Phosphorous	Nutrients	Increasing	Fertilizers, Farming, Wastewater Discharge
Nitrate	Nutrients	Decreasing	Improved Wastewater Treatment, Less Agricultural Activity in Watershed
Ammonia	Nutrients	Decreasing	Improved Wastewater Treatment, Less Agricultural Activity in Watershed
Total Organic Carbon	Organics	Increasing	Sewage, Decaying Material
TDS/TSS/Turbidity	Particulates	Increasing	Erosion, Construction, Farming/Tilling
Manganese, Aluminum, & Iron	Metals	Increasing	Acid Mine Drainage and Construction

Table 1.4.3-3 Reference Pollutant Concentrations (mg/l) in Roadway Runoff

Table data excerpted from Reimhold (1998), FHWA - Federal Highway Administration Study Data (Reimhold, 1998), NURP - National Urban Runoff Pollutants Study (Reimhold, 1998).

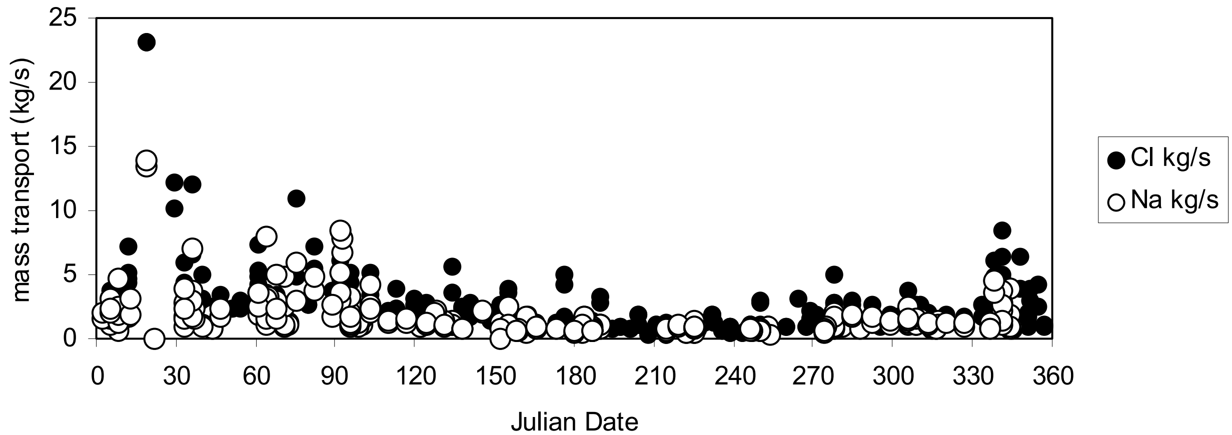
Pollutant	Normal Highway Runoff (FHWA)	Highway Snow Wash-Off (FHWA)	Urban Runoff (NURP)
Chloride	13	400 - 5600	
Total Suspended Solids	93	204	100
Nitrate	0.660	0.680	0.680
Total Phosphorus	0.293	0.570	0.330
Copper	39	91	34
Lead	234	549	144
Zinc	217	420	160

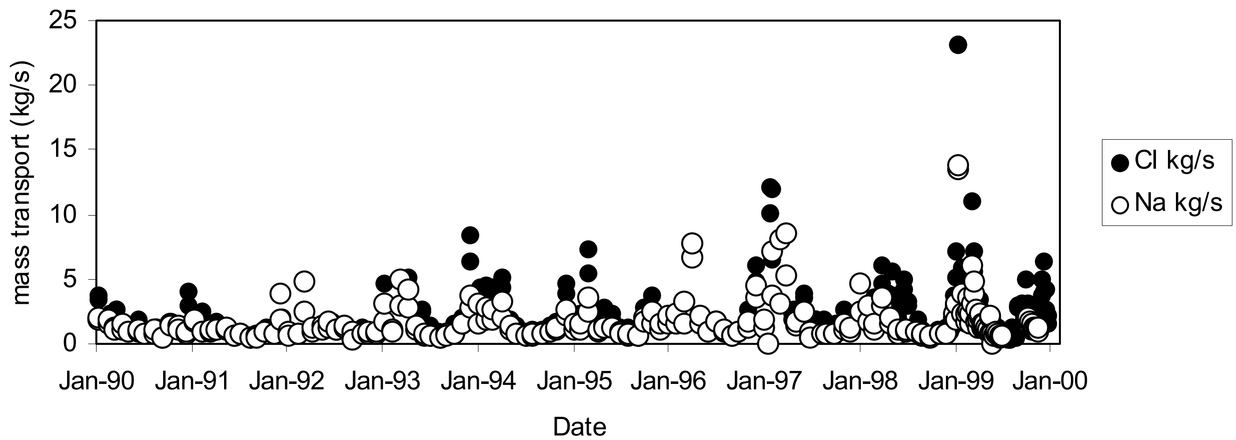
Solute mass transport rates also increased over the course of the 1990s, providing further evidence for adverse impacts of regional development on water quality. Rates of mass transport were calculated for individual samples based on the daily averaged flow rates for specific sample dates. Trends in Na and Cl fluxes indicate seasonal variation in mass transport, with highest rates of flux occurring during winter months when salt applications for road deicing can contribute dissolved solids to river water. Increases in flux rates for both ions are evident on a decade scale, with the most striking trends occurring in maximum measured flux rates through the period.

While relatively low discrete flux rates can be measured at any given time, maximum measured discrete fluxes within a given year are dramatically increasing, suggesting that major storm related discharge is driving increased solute transport in the watershed (Figure 1.4.3-2). Increased flux rates (which are calculated by multiplying an individual concentration measure by the average flow for that day) are direct evidence for increased loading rates and transport through the system.

Figure 1.4.3-2 Bulk Mass Transport of Sodium and Chloride in the Schuylkill River in the 1990's

The top panel illustrates elevated concentrations in winter months associated with stormwater discharge and deposition of road salts for deicing. The bottom panel illustrates dramatic increases through the decade possibly driven by the fast rate of development in suburban areas within the watershed.





The plausibility that changes in water quality at Philadelphia were representative of other watershed locations was analyzed by comparing trends at Philadelphia with water quality data throughout the watershed. To date, only the analysis of watershed-wide conductivity data is complete. Figure 1.4.3-3 shows the changes in conductivity in the main stem of the Schuylkill River from near its headwaters (Berne) down to Philadelphia over the past decade. As shown, conductivity decreases between the acid mine drainage-impacted headwaters and the outer boundaries of heavy suburban development in the watershed (Pottstown). However, conductivity increases significantly again between Pottstown and Philadelphia. It is not known whether these increases are related to development, increased roadways/impervious cover runoff, or the characteristics of geology and groundwater.

Figure 1.4.3-3 Watershed-wide Trends in Percent Increase per Decade in Conductivity in the mainstem of the Schuylkill River from 1990-1999

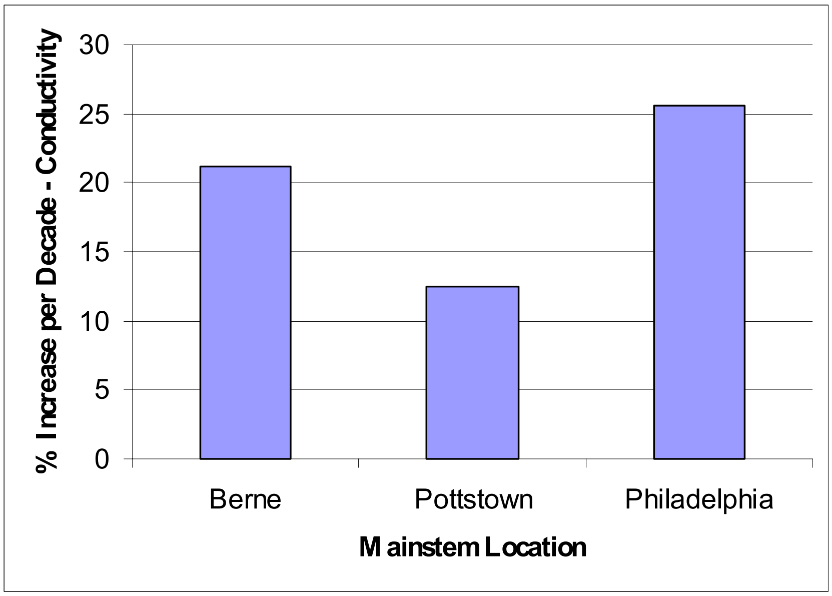


Figure 1.4.3-4 compares the changes in conductivity in the tributaries to the Schuylkill River over the past decade. As shown, several watersheds have observed significant changes in conductivity over the past decade. The median increase per decade for all locations combined was 15%, but ranged from 3 to 70%, depending upon the location. Valley Creek, Trout Creek, and French Creek in Chester County and Maiden Creek in Berks County have also observed significant increases in conductivity. As shown in Table 1.4.3-4, the greatest conductivity was observed in the Valley Creek and Wissahickon watersheds and was approximately two to three times the conductivity observed in other tributaries and locations upstream in the watershed. Figures 1.4.3-5 and 1.4.3-6 provide an in-depth view of the conductivity trends in the Maiden Creek and Valley Creek Watersheds.

Table 1.4.3-4 Spatial Comparison of Water Quality Parameters in the Schuylkill River Watershed

All parameters in mg/L unless otherwise noted.

Location	Conductivity (umhos)	Total Phosphorus	Chloride	Ammonia	Nitrate	Total Dissolved Solids	Total Organic Carbon
Wissahickon Creek	548.4	0.596		0.075	4.398	365.2	4.21
Valley Creek	508.2	0.038	65.4		2.188	400.4	1.48
Little Valley Creek	474.7	0.080			1.972		
Schuylkill River (Berne)	387.1	0.040		0.095	1.184	307.3	1.99
Schuylkill River (Philadelphia)	373.2	0.183	32.8	0.14	3.031	257.5	3.49
Tulpehocken Creek	367.6	0.077	19.4	0.086	4.735	248.8	2.65
Schuylkill River (Pottstown)	357.0	0.116		0.101	3.110	322.8	2.94
Trout Creek	304.0		23.6		1.970		
Perkiomen Creek	276.4	0.092		0.066	1.596	202.8	4.28
Maiden Creek	255.7	0.049		0.089	3.092	179.0	2.96
Crabby Creek	225.1	0.037	37.9		3.666	203.8	1.56
Green Lane Reservoir	220.7	0.228		1.07	0.065		
Pickering Creek	210.1	0.020	24.0		1.698		
French Creek	154.2	0.045	12.0		1.487		
Pine Creek(Lobachsville)	112.0	0.020	6.5	0.03	0.807	91.5	2.03
Northkill Creek	19.8	0.019	1.4	0.031	0.180	85.2	2.1

These elevated concentrations and increases in conductivity in the watershed are cumulatively translated into increased conductivity at Philadelphia's water supply intakes near the bottom of the Schuylkill River Watershed. The elevated concentrations, proximity to Philadelphia's water intakes, and amount of developed land area in the Wissahickon Creek and Valley Creek watersheds make them priorities for investigations into polluted runoff impacts and controls. In addition, the significant changes in conductivity in the Maiden Creek, French Creek, and Trout Creek watersheds indicate that these areas are worthy of in-depth investigation and protection efforts to identify and mitigate the sources of these impacts to reduce their future affect on river water quality. It appears that changing conductivity may also indicate the areas of future non-point source impacts from other contaminants for protection prioritization.

Figure 1.4.3-4 Watershed-wide Trends in Percent Increase per Decade in Conductivity in the Tributaries of the Schuylkill River from 1990-1999

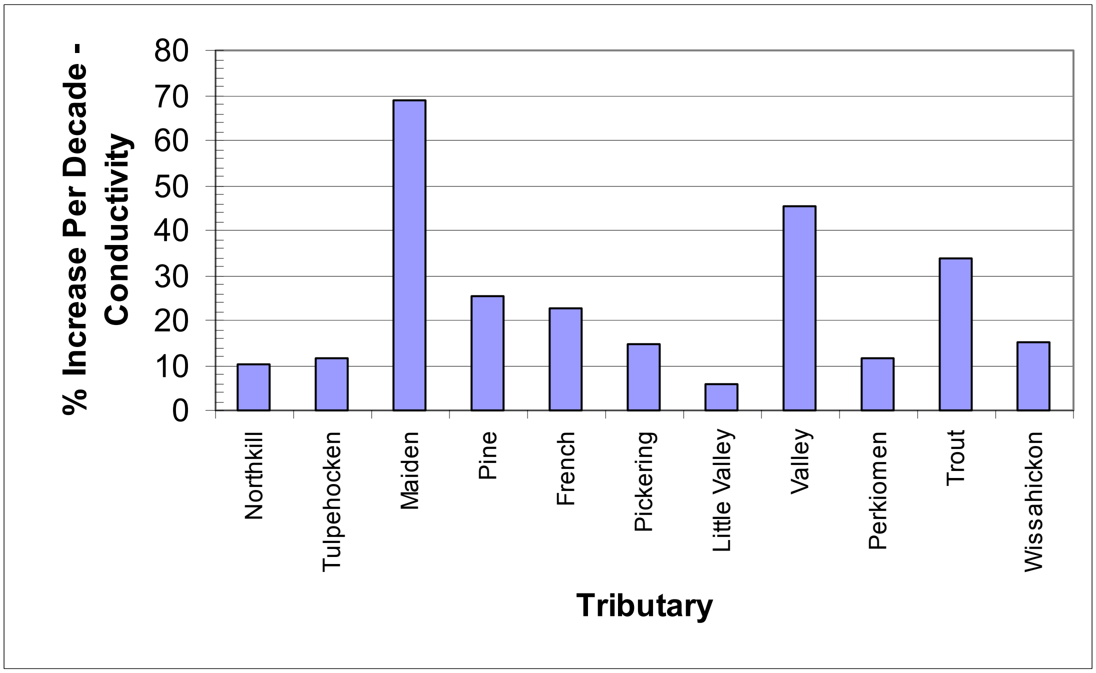


Figure 1.4.3-5 Increased Conductivity Trends in the Maiden Creek Watershed 1990-1994

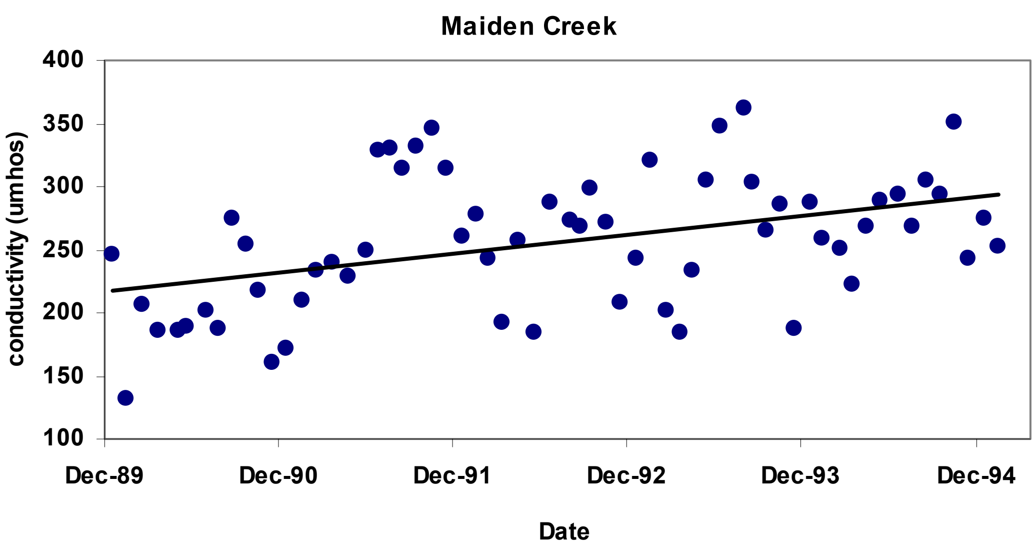
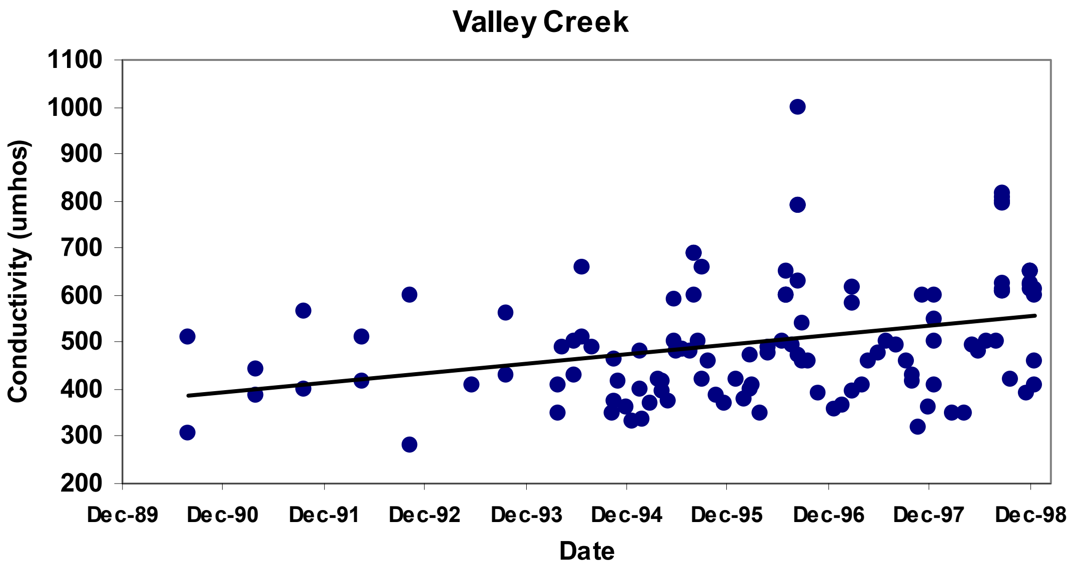


Figure 1.4.3-6 Increased Conductivity Trends in the Valley Creek Watershed 1990-1998



1.4.4 Differences in Water Quality Throughout the Watershed

Key Points

- Subwatersheds with high levels of conductivity tend to have higher levels of phosphorus, chloride, nitrate and total dissolved solids.
- Conductivity measurements may serve as an indicator of areas within the watershed that are being impacted by non-point sources.

Spatial analyses were also performed to determine if there were relationships between the mean conductivity in a watershed and other water quality parameters (see Table 1.4.3-4). Though water quality data throughout the watershed was limited, correlations between the mean conductivity and total phosphorous, chloride, nitrate, ammonia, total dissolved solids, and total organic carbon were discovered. As shown in the tables below, watersheds with higher conductivity tended to have higher concentrations of other water quality parameters. Mean watershed conductivity also correlated with mean values of total phosphorous, chloride, nitrate, and total dissolved solids (see Table 1.4.4-1). These correlations suggest that the abundant and frequently measured conductivity data may provide a useful screening tool to identify watershed areas with water quality challenges. In addition, these correlations also suggest that trends in conductivity may be useful for indicating changes in certain water quality parameters (most inorganic or ionic water quality parameters) and serve as a indicative parameter for tracking watershed health.

Table 1.4.4-1 Spearman Rank Order Correlations of Mean Conductivity and Mean Water Quality Parameters in the Schuylkill River Watershed

Mean Conductivity versus	Number of watersheds	R value	p-level
Mean Total Phosphorous	12	.672505	.016569
Mean Chloride	8	.785714	.020815
Mean Ammonia (NH3)	7	.357143	.431611
Mean Nitrate (NO3)	13	.730769	.004548
Mean Total Dissolved Solids	8	.904762	.002008
Mean Total Organic Carbon	8	.261905	.530923

Analysis of water quality data, impaired stream information, and observations from watershed surveys led to the conclusions that were made regarding the universal water quality issues which are presented in Table 1.4.4-2.

Table 1.4.4-2 Universal Water Quality Issues

Source Type	Activity	Contaminant Source	Lower Watershed	Middle Watershed	Upper Watershed
Nonpoint Source	Mining/Acid Mining Drainage (AMD)	AMD and Metals			X
	Agricultural runoff	Nutrients, herbi-cides/pesticides, pathogens		X	X
	Urban/Suburban Runoff	Salts, nutrients, metals	X	X	
	Erosion	Sediment	X	X	
	Construction	Sediment	X	X	
Point Source	Sewage Discharge	Pathogens, Nutrients	X	X	X
	Abandoned Industrial Facilities	Metals, Organics	X	X	
	Industrial Discharges	Organics, Metals	X	X	
Special/Spills	Oil Pipelines	Organics	X	X	
	Truck/Railroads	Organics	X	X	
	Tire Piles/ Junkyards	Special	X	X	X
	Dams	Contaminated sediment	X	X	
	AST / USTS	Organics	X	X	

1.4.5 Analysis of Stream Impairments and Sources in the Schuylkill River

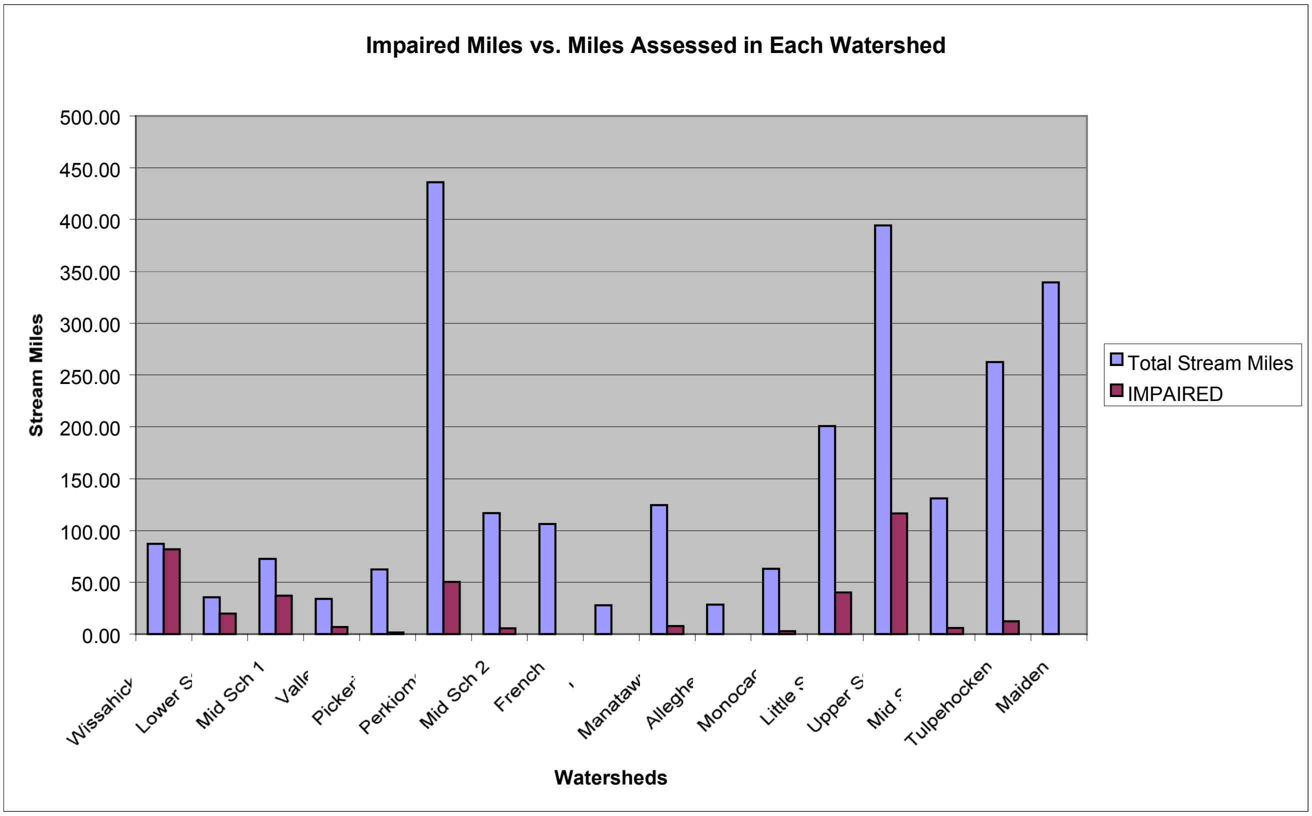
Key Points

- Fifty-seven percent of the 2,522 miles of streams and creeks within the Schuylkill River Watershed have been assessed to determine their compliance with applicable water quality standards.
- Nearly 73% of the assessed stream miles have attained applicable water quality standards.
- Watersheds within the more highly developed downstream areas of the watershed have the highest percentage of stream length that has been impaired.
- Flow variability is one of the most significant causes of impairment identified within the watershed.
- Stormwater runoff from urban and suburban areas was identified as the cause of over half of the impaired stream lengths within the watershed.
- Although water quality data suggests that pathogens are a concern throughout the entire watershed, very few segments are listed as having pathogens as the primary cause of impairment.

In accordance with Section 305 (b) of the Federal Clean Water Act, the Pennsylvania Department of Environmental Protection (PADEP) prepared a 305 (b) Water Quality Assessment Report in 2000. The Report summarizes water quality management programs, water quality standards, and point and non-point source controls. The Schuylkill River Watershed includes 2,522 miles of streams and creeks. Fifty-seven percent, or 1,428 miles, within the watershed have been assessed in order to determine compliance with applicable water quality standards. Almost 73 % of the stream miles that have been assessed – 1,039 miles - have attained the applicable water quality standards. Streams that are impacted by contaminant sources (point sources, or non-point sources such as stormwater runoff or acid mine drainage) so that water quality standards are not met, are designated as impaired. Twenty-seven percent of the stream miles (389 miles) that have been assessed do not meet applicable water quality standards and are designated as impaired. To date, 1,084 miles of streams within the watershed have not been assessed.

Figure 1.4.5-1 shows the percentage of assessed miles within each watershed that do not meet water quality standards and have been designated as impaired.

Figure 1.4.5-1 Impaired Miles vs. Miles Assessed in Each Watershed



The Wissahickon Creek, Lower Schuylkill and Middle Schuylkill (1) watersheds have the greatest percentages of impaired stream miles. No impairments were identified in the French Creek, Hay Creek, Allegheny Creek and Maiden Creek Watersheds.

Excessive algal growth, flow alterations, metals, nutrients, other habitat alterations, pathogens, PCB's, salinity/TDS/chlorides, siltation, water/flow variability, and organic enrichment/low dissolved oxygen have all been identified as causes of impairment within the Schuylkill River Watershed. Figure 1.4.5-2 and Table 1.4.5-1 summarize the miles of impairment and their primary causes throughout the Schuylkill River Watershed. The leading cause of impairment has been identified as water/flow variability.

Figure 1.4.5–2 Causes of Impairment Within the Schuylkill River Watershed

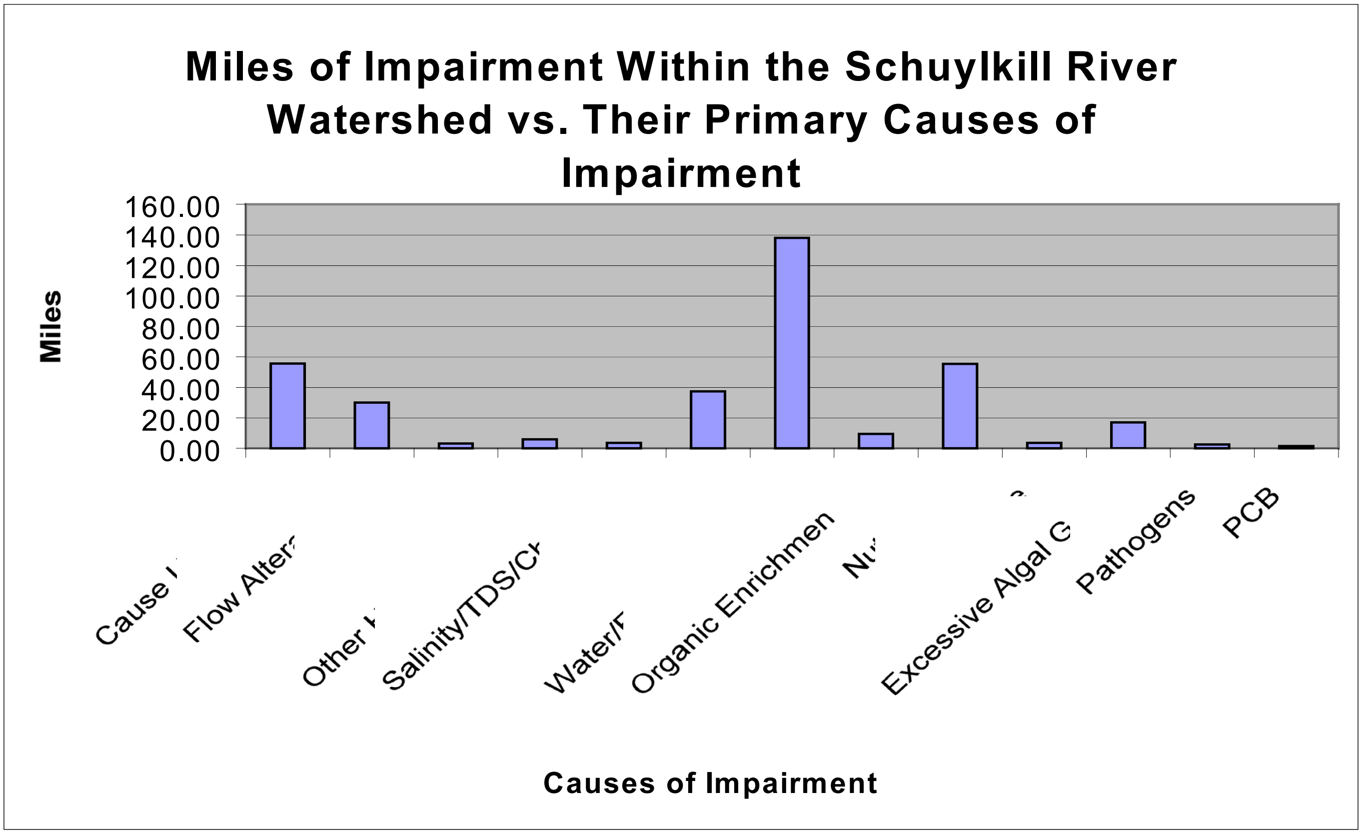


Table 1.4.5-1 Breakdown of Total Miles of Impairment by Primary Causes

Watershed	Total Miles
Cause Unknown	55.65
Flow Alterations	29.88
Metals	2.99
Other Habitat Alterations	5.86
Salinity/TDS/Chlorides	3.43
Siltation	37.48
Water/Flow Variability	138.18
Organic Enrichment/Low D.O.	9.32
Nutrients	55.38
Chlorine	3.51
Excessive Algal Growth	16.83
Pathogens	2.58
PCB	1.41

Point and non-point sources, such as agriculture, industrial and municipal point sources, urban stormwater runoff, small residential runoff, and acid mine drainage, can all contribute to impairment, as shown below by Figure 1.4.5-3 and Table 1.4.5-2.

Figure 1.4.5-3 Miles of Impairment within the Schuylkill River Watershed vs. Their Primary Sources of Impairment

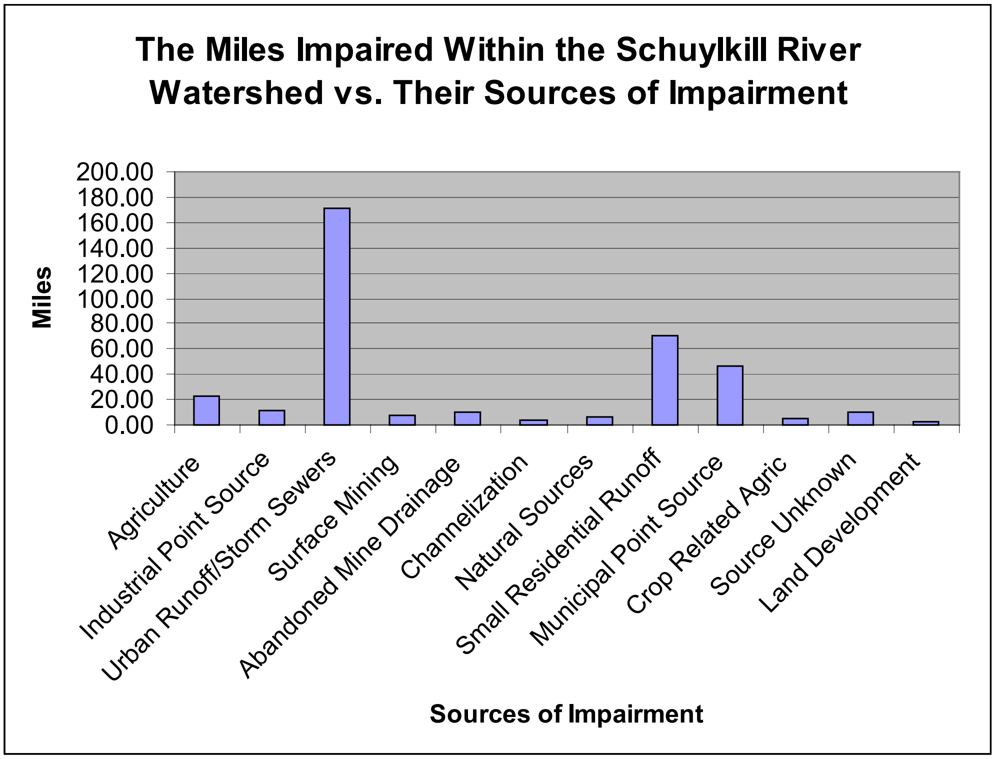


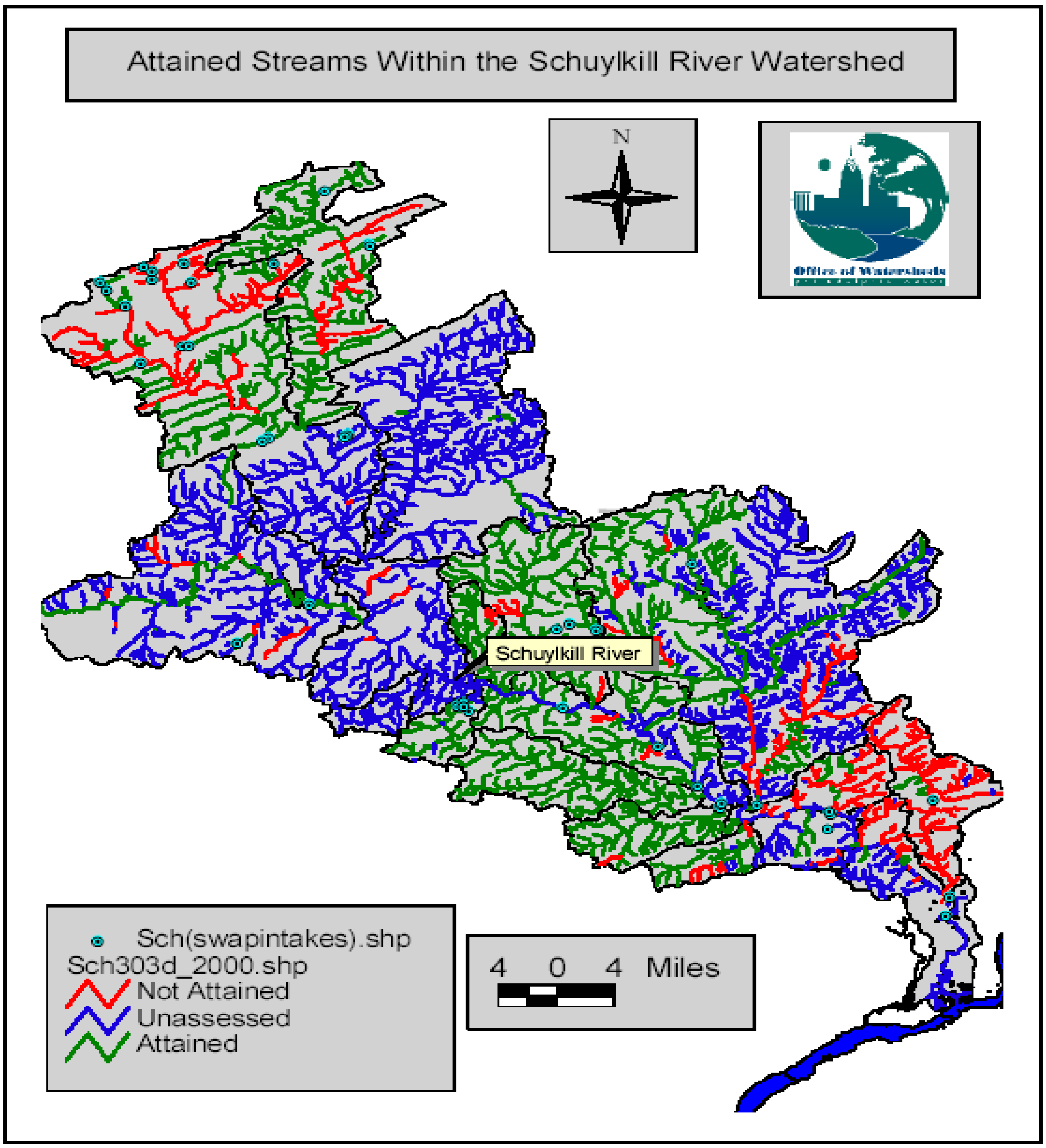
Table 1.4.5-2 Breakdown of Miles of Impairment by Sources

Source of Impairment	Total
Urban Runoff/Storm Sewers	107.09
Agriculture (General)	18.09
Small Residential Runoff	17.60
Source Unknown	10.48
Industrial Point Source	10.43
Abandoned Mine Drainage	9.84
Surface Mining	7.37
Natural Sources	6.37
Crop Related Agriculture	5.54
Channelization	3.57
Land Development	2.70
Municipal Point Source	0.19

Figure 1.4.5-4 displays the status of stream assessment within the Schuylkill River Watershed. Green lines represent streams where applicable water quality standards are being met. The red lines represent impaired streams where water quality standards are not being attained. The blue lines represent the streams that have not been assessed yet.

Impaired stream reaches are most common in the northwest and northeast sections of the watershed. The central portion of the watershed has the greatest amount of unassessed streams, compared to the rest of the watershed. More efforts should be made to assess this central portion (Berks County) of the Schuylkill River Watershed.

Figure 1.4.5-4 Stream Assessment within the Schuylkill River Watershed



1.4.6 Universal Water Quality Issues

Key Points

- Potential sources of contaminants affecting Schuylkill River water quality include acid mine drainage, sanitary wastewater, abandoned industrial sites, agricultural and construction runoff, contaminated sediments released during dam removal, catastrophic accidents, road runoff, and wildlife.
- Acid mine drainage from Schuylkill County is believed to be the largest source of metals (such as manganese) affecting source water quality throughout the Schuylkill River.
- Untreated or inadequately treated sanitary wastes can contribute significant bacterial loads to the river.
- Abandoned industrial sites and dumpsites located within the river's floodplain could significantly impact downstream water users.
- Erosion resulting from agricultural activities and pathogens from livestock wastes introduce sediment and microbials into the river.
- Erosion from construction sites without well-maintained sediment controls can significantly increase sediment loads to the river. To date, impacts from catastrophic accidents and spills have been insignificant, due to skillful, well-prepared responses.
- Storm runoff containing deicing salts and herbicides from right-of-way application cause increased levels of chlorides, sodium, SOCs, and urea in the river.
- Algal blooms resulting from excessive nutrients can significantly affect water treatment requirements.
- Increasing populations of Canada geese in the watershed have resulted in increased levels of coliform in localized stretches of the river.

Based on the analysis of the water quality data, stream impairment data, stakeholder input, and more than 12 watershed inspections, a number of specific issues were identified that have impacts throughout the watershed. These issues are:

- Acid mine drainage
- Discharges from septic systems, sewerage systems, and wastewater treatment plants
- Dumping, tire piles, salvage yards, and abandoned industry in or near the floodplain
- Agricultural runoff of herbicides, pesticides, fertilizer, sediment, and phosphorus
- Erosion and construction runoff
- Dam removal and sediment releases
- Catastrophic accidents and spills, particularly oil delivery spills, from roads, trains, and fires
- Road runoff
- Wildlife management

These topics will be discussed in detail throughout this section.

1.4.6.1 Acid Mine Drainage

There are 244 known surface and underground mining facilities in the Schuylkill River Watershed. Mining of coal, iron, calcium, and stone make up 85 % of those operations. Although coal mining has historically been the most predominant, iron mining is now just as common. Approximately 27 % (81) of the mines currently operating in the watershed are coal mines located in the Upper Schuylkill Watershed within Schuylkill County (See Figure 1.4.6-1).

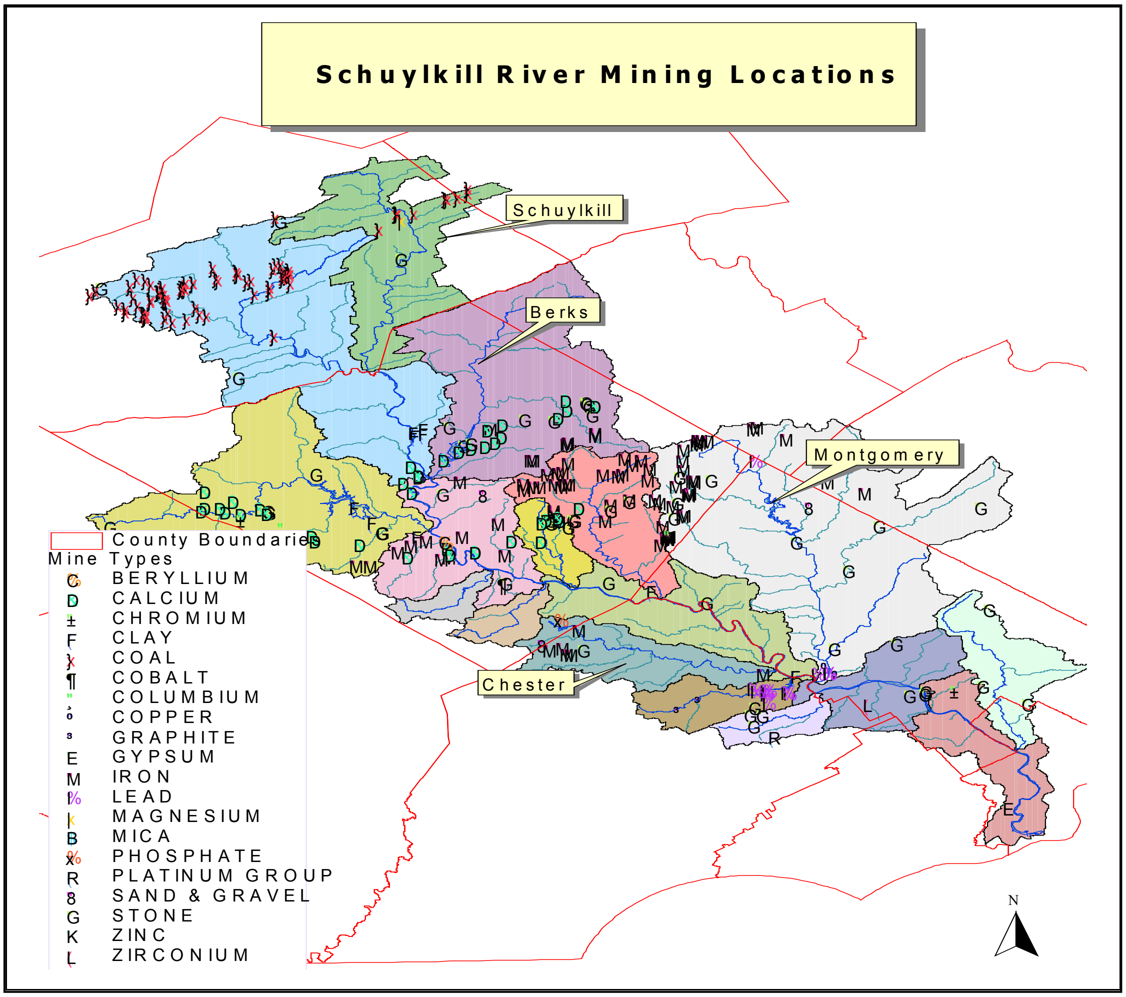
Acid Mine Drainage (AMD) is generated when the iron sulfide-bearing materials created by the interaction of the sulfate in coal beds and sulfate-reducing bacteria are exposed to oxygen in air or water during mining. The iron sulfides react with the oxygen to produce hydrogen sulfide, which makes the water more acidic. As the water becomes more acidic, its ability to leach metals from the existing rock layers increases. Therefore, the water from mines is not only acidic, but often contains increased concentrations of aluminum, iron, manganese, calcium, magnesium, and sulfate. Acid mine discharges can come from shafts, tunnels, boreholes, drifts, and seeps. AMD can also come from culm piles or spoil piles that run off into nearby streams.

According to a study sponsored by the Schuylkill Headwaters Association, Schuylkill Riverkeeper, and Eastern Pennsylvania Coalition for Abandoned Mine Reclamation, there are 108 abandoned mine drainage locations currently impacting the Upper Schuylkill River Watershed. This study documented the contaminant loadings of 35 locations for ranking, and identified 11 priority sites for remedial action.

The 11 priority sites were ranked based on their locations, feasibilities, interest, and impacts. The sites listed are as follows:

- Pine Knot/Oak Hill Mine Tunnel and Boreholes
- Pine Forest Mine Borehole
- Mary D Mine Borehole and Seeps
- Bell Colliery Drift
- Kaska Mine Outfall
- Silver Creek Mine Discharge
- Kaska Silt Dam
- Eagle Hill Mine Discharge
- Otto Mine Air Shaft
- Morea Mine
- Repplier Mine Water Level Tunnel

Figure 1.4.6-1 Mining Locations in the Schuylkill River Watershed



Concentrations of metals in acid mine drainage can be quite significant and can occur continuously or sporadically after rainfall events. PWD conducted a brief analysis of the discharge data from the 11 priority sites to determine if the loadings could be a major source impacting metals concentrations throughout the entire watershed. Metal concentrations at Philadelphia were estimated by summing up the annual metal loads produced by the AMD sites and then dividing them by the annual cumulative flow volume in the river based on the average annual mean flow. Based on this comparison, Figure 1.4.6-2 shows that AMD discharge produces large enough loads of iron and manganese to account for a majority of the concentrations observed at Philadelphia. Therefore, acid mine drainage from Schuylkill County is probably the largest source of metals, such as manganese, impacting source water quality for the entire Schuylkill River.

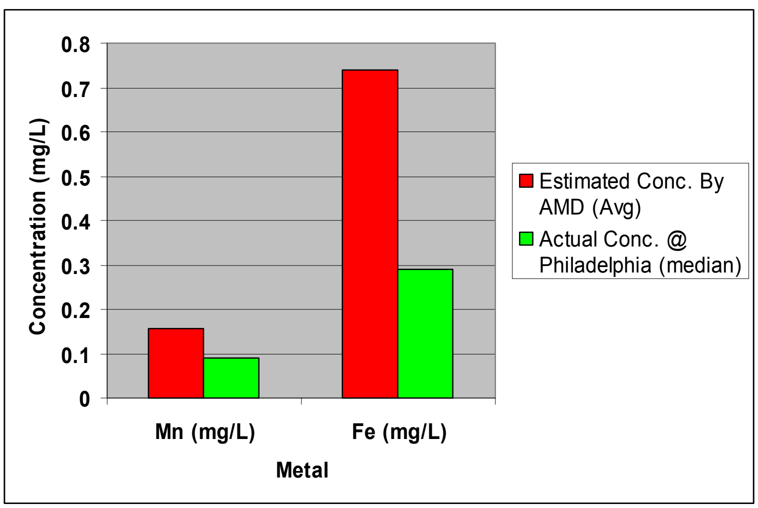
Based upon the analysis, the following 5 AMD sites in Schuylkill County account for a majority of the observed discharge of manganese into the Schuylkill River:

- Pine Knot-Oak Hill Drainage Tunnel
- Silver Creek Mine Pool Discharge
- Eagle Hill Mine Pool Discharge
- Milford Colliery Discharge/Brockton Overflow
- Otto Primary Discharge

These 5 locations stretch across all branches of the Upper Schuylkill Watershed and cover the major areas of Schuylkill County. The Oak Hill bore tunnels nearby the Pine Knot location are also the greatest observed discharge of iron into the watershed from AMD. Efforts should be focused on remediating these 6 discharges in Schuylkill County in order to improve source water quality for downstream water suppliers and over 1.8 million persons.

Figure 1.4.6-2 Comparison of Average Concentrations of Iron and Manganese Estimated in the Schuylkill River at Philadelphia by Acid Mine Discharge to Actual Concentrations Measured at Philadelphia

AMD from Schuylkill County is the most likely largest continuous source of metals that impact water quality in the Schuylkill River Watershed.



1.4.6.2 Discharges from Septic Systems, Sewerage Systems, and Wastewater Treatment Plants

Improper wastewater collection and treatment causes pathogens and nutrients to impact the quality of source water supplies, recreational water quality, and aquatic life. Improper wastewater collection and treatment may result in the following:

- Wet weather overflows of raw sewage by the sewer system (manholes and pump stations) due to treatment plant capacity limitations

- Wet weather overflows of raw sewage by the sewer system (manholes and pump stations) due to lack of collection system capacity and infiltration/inflow sanitary sewer overflows (SSOs)
- Wet weather overflows of raw sewage by the sewer system due to combined sewer overflow systems (CSOs)
- Wet weather overflows of raw or partially treated wastewater by the treatment plant due to treatment plant capacity limitations or lack of treatment upgrades.
- Dry weather overflows caused by blockages (tree roots, grease, etc.) sometimes due to poor collection system maintenance.
- Dry weather discharges of raw sewage due to defective sewer lateral connections and improperly operated CSOs
- Routine discharges of raw sewage due to lack of adequate septic systems, sewerage systems, and enforcement
- Routine discharges of raw sewage due to failing septic systems
- Periodic discharges of partially treated sewage due to treatment plant performance limitations

Most of these issues can be observed throughout the Schuylkill River Watershed. Though not as prevalent as in the original watershed inspections conducted in the 1880's, 120 years of progress still have not brought adequate and proper sewerage systems to the entire watershed, and discharges of raw sewage occur to this day. In Schuylkill County, raw sewage is known to discharge from New Philadelphia and Middleport areas from "wildcat" sewers (illegal sewers discharging directly to the river). In addition, there are numerous cabins and cottages throughout the watershed that are suspected of making illicit discharges into the river and local streams and lakes. Some are discharging raw sewage, while others are operating with septic systems that have failed, or septic systems that are not located on properly draining soils or which drain to areas of fractured rock and limestone. In addition, there are several communities with CSO discharges upstream of drinking water intakes. These include Philadelphia, Bridgeport, Norristown, Minersville, Coaldale, Mahanoy City, Ashland, Shenandoah, Tamaqua, and Pottsville.

Other than raw sewage, partially treated sewage or inconsistent limits in discharge permits are also an issue. According to a brief investigation of discharge permits in the Schuylkill River Watershed, it was observed that there are disconnects in the allowable limits of fecal coliform discharges into the Schuylkill River. In the Southeast Department of Environmental Protection (DEP) region that covers the Chester, Bucks, Philadelphia, and Montgomery County area, the fecal coliform discharge limit is 200 cfu/100ml year round. However, in Berks County, part of the Southcentral regional

DEP office in Harrisburg, fecal coliform discharge limits from wastewater discharge can reach 10,000 cfu/100mL during winter or non-recreational periods. Similar seasonal limits were observed in Schuylkill County, part of the Northeast DEP region. It was determined that these seasonal limits are related to whole effluent toxicity issues in the discharge from chlorine by the wastewater plants. The Delaware River Basin Commission (DRBC) has also decided that the toxicity of the chlorine discharges to fish during these periods was a greater concern than pathogens because little recreation was occurring.

However, the current permits allow wastewater dischargers to release more pathogens during the winter, upstream of water supply intakes. Also, the excess bacteria can and will survive in sediments in reservoirs and lakes and can be re-suspended by increased river flows, turnover, or recreational activity in the spring and summer. For example, the City of Reading Wastewater Treatment Plant (WWTP) has a fecal coliform discharge limit of 10,000 cfu/ml in the winter that extends into April. Reading is the largest wastewater discharger upstream of water supply intakes in the entire watershed. Therefore, the current discharge limits seem to encourage the discharge of more pathogens and bacteria in areas upstream of drinking water supplies.

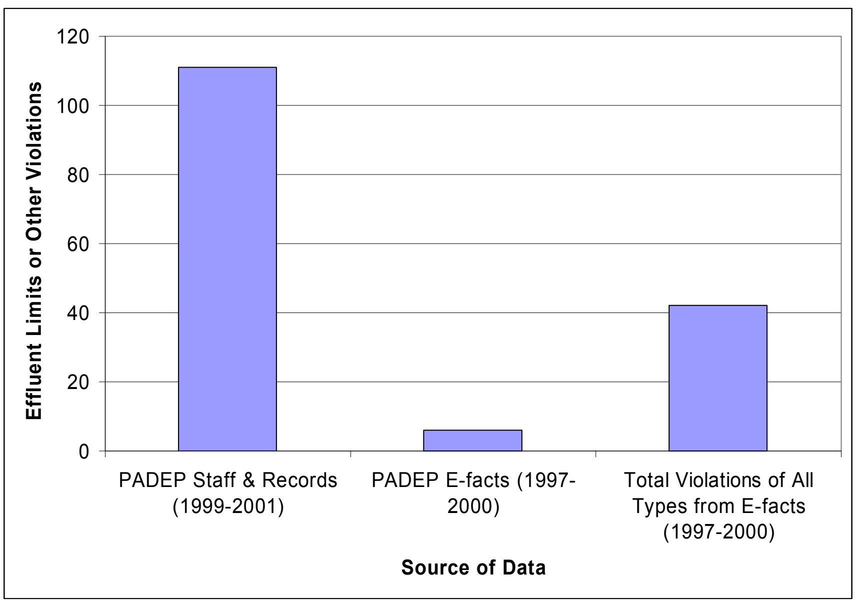
It is recommended that the DRBC and three PADEP regions develop a watershed wide approach to addressing permit requirements. One suggestion would be a uniform fecal coliform discharge limit for any wastewater discharge upstream of a drinking water intake in the watershed. For small wastewater systems that have problems meeting toxicity requirements, ultraviolet light disinfection would be recommended. Ultraviolet light disinfection is preferred because it inactivates bacteria, such as *Cryptosporidium*.

Some wastewater plants in the watershed do not perform properly and can discharge inadequately treated water on occasion. An investigation of the available electronic databases to determine the level of compliance of wastewater dischargers in the watershed was conducted. These databases are somewhat difficult to understand and often give users the impression that paper or administrative violations are equivalent to effluent limit discharge violations, because they are all considered non-compliance events. However, in reality, effluent violations represent the most severe threat to the environment and water supplies. Therefore, dischargers (or wastewater treatment plants) with more effluent violations speak of chronic problems that require greater investigation.

Utilizing the PADEP E-facts website, data on violations by 71 wastewater dischargers in the Schuylkill River Watershed were compiled from 1997 to 2000. The most frequent violation observed was an effluent limit violation. Overall, the database reported 23 effluent limit violations for this period by 12 sewage treatment plants (STPs), or 17 % of the STPs. The average number of effluent limit violations by the plants observed was approximately 2, but some plants had up to 7 effluent limit violations. In addition to effluent limit violations, 8 violations for the discharge of untreated sewage were reported for 4 plants (5 % of the STPs). Of those plants, an average of 2 violations was observed with a maximum of 3 violations reported.

The next level of the investigation focused on the types of effluent limit violations, by working with DEP inspectors in the Southeast region to compile specific violation data. Also, the exercise served as a good way to check the accuracy of the electronic databases from E-facts and Envirofacts to see if they are outdated or inaccurate. Based upon our focused comparison of 17 dischargers in the Schuylkill River Watershed, it was determined that the electronic databases tended to significantly underestimate the number of violations by some dischargers. Also, some dischargers that appeared to have no violations reported in the electronic databases actually had many violations. Figure 1.4.6-3 compares the accuracy of the electronic PADEP E-facts database to actual records compiled by PADEP staff. As shown, there are large discrepancies between the virtual information and reality.

Figure 1.4.6-3 Comparison of Sources of Violation Information for the PADEP Southeast Region: PADEP staff and records vs. PADEP E-facts Electronic Database



Note: the government databases tend to underestimate the extent of effluent limit violations occurring.

The in-depth examination of the types of violations shows that of the 111 effluent limit violations reported for the 17 sewage treatment plants, over 75 % of the violations were total suspended solids violations. The lack of ability to adequately treat total suspended solids suggests that the treatment plant and sewer system are experiencing problems during wet weather periods.

The impacts of wet weather issues extend beyond wastewater treatment plant performance. Sometimes the lack of treatment capacity by the wastewater treatment plant causes a "back up" in the sewer system entering the wastewater plant and results in overflows at manholes and pump stations (Figure 1.4.6-4). Other times, the infiltration and inflow of rainwater and groundwater into the sewer pipes themselves, either due to age or disrepair of the sewer system, will also cause manholes and pump stations to overflow. The communities most affected by these issues are older communities with decaying infrastructure and new communities without enough sewer and treatment capacity to handle the increased residential populations as people move further out from urban areas. Overall, sewer system capacity and integrity as well as treatment plant capacity during wet weather periods represent the greatest and most difficult sewage related issues in the watershed.

Figure 1.4.6-4 Overflowing Manhole Nearby a Stream

Though some communities are facing consent orders and enforcement action against them due to stormwater runoff problems, other communities are working hard to address stormwater issues. For example, Pottstown has been working hard to address inflow and infiltration issues and has become a model for other communities to emulate. The City of Philadelphia has also made strides to identify and mitigate defective laterals as well as piloting innovative stormwater reduction techniques.

There is a small percentage of dischargers that have effluent violations, while the majority (83 %) of the 71 wastewater plants work hard to protect the river by discharging properly treated wastewater. The Exeter WWTP (Figure 1.4.6-5) is an example of one the well-operated wastewater treatment plants in the watershed. The Exeter WWTP has won numerous awards for its excellent performance and was even nominated for national awards.

Figure 1.4.6-5 Exeter Wastewater Treatment Plant
The Exeter WWTP is an example of one of almost 60 well-operated wastewater treatment facilities in the Schuylkill River Watershed.

1.4.6.3 Dumping, Tire Piles, Salvage Yards, and Abandoned Industry Near the Floodplain

The Schuylkill Watershed was one of the first areas in the United States to feel the effects of industrialization and mining. However, as coal mining, metal manufacturing, and other manufacturing industries have declined, the sites of these industrial activities were abandoned, leaving valuable riparian area damaged and unrestored. Some of these abandoned sites have old spoil piles, or lagoons that still leach remnants of contaminated materials. These sites are also neglected, and therefore there is no one organization responsible for the monitoring or mitigation of the old lagoons and spoil piles. These abandoned and somewhat isolated areas also encourage dumping and general neglect by the nearby communities since they are considered to be hazardous eyesores.

In addition to abandoned industrial sites, there are numerous salvage yards and several trash transfer stations located along the river and stream banks. These sites appear to be in or near areas prone to flooding, and seem to have limited environmental practices in place to prevent contaminated runoff or debris from entering the river. Old oil tanks and chemical containers in or near areas prone to flooding have been observed at some of these facilities and warrant special concern. Other areas include tire piles, as shown by Figure 1.4.6-6, which if ignited by vandalism or accident, will result in significant damage to the entire Schuylkill River below them.

Figure 1.4.6-6 Tire Piles and Trash Dumping along the Schuylkill River
The trash dumping and dead deer on the right were recently cleaned up thanks to the Greater Pottstown Watershed Alliance.

1.4.6.4 Agricultural Runoff

Agricultural activities without proper controls can release pathogens, nutrients, herbicides, pesticides, and sediment into streams, which impacts source water quality, recreational water quality, and aquatic life. More than one-third of the Schuylkill River Watershed is agricultural land. Most of the agricultural land is located in Berks County, which is one of the top five counties in Pennsylvania for agricultural commodities, livestock, and production.

Over the past several decades, the amount of agricultural land has been decreasing in the Schuylkill River Watershed, but this does not mean that the level of agricultural activity is decreasing proportionally. It is suspected that residential development of agricultural land is concentrating agricultural activity into smaller areas that can lead to greater impacts on water quality.

Erosion and runoff of soils during tillage and farming release significant amounts of sediment and nutrients into the streams and rivers if there aren't proper riparian buffer strips in place. In addition, cattle access to streams causes significant damage to the streambank and makes it more susceptible to erosion. Runoff of livestock wastes also releases pathogens into water supplies. Figure 1.4.6-7 illustrates agricultural uses of land within the watershed.

Figure 1.4.6-7 Cows in the Stream and Farming Tillage Impacts on Sediment and Nutrients

Despite the potential for significant negative impacts by agricultural activities, agricultural lands also represent the simplest and cheapest areas for potential restoration and protection. In fact, many farmers are actively pursuing a variety of techniques to help protect and restore local streams. As shown in Figure 1.4.6-8, a number of farmers are installing specially designed cattle crossings and streambank fencing to reduce the impacts of cattle on streams. Other farmers are even establishing riparian buffers to protect the streambank and to filter out harmful nutrients.

Figure 1.4.6-8 Farmers Installing Cattle Crossings (left) and Streambank Fencing with Riparian Buffers (right) to Limit the Impacts of Livestock on Streambanks and Filter Runoff from Pastures in Berks County.

1.4.6.5 Development, Construction, and Erosion Runoff

The Schuylkill River Watershed is developing at a significant rate. With this development comes the construction of homes, highways, and businesses to support that growth. This construction usually entails significant disturbance and moving of earth. The impacts of runoff from construction sites can range from negligible to significant, depending on the characteristics of the construction site, the types of erosion controls that are implemented, and the maintenance of those control structures. There are many types of controls that include the placement of sediment barriers or fences, or bags, which trap sediment in storm drains. Erosion and sediment control plans must be submitted for review to the township and/or county Soil Conservation District. However, the amount of time and personnel available from both the township and county conservation district are limited, compared to the significant amount of submittals by the numerous developers and developed sites. In addition, the amount of time and staff available to inspect sites in order to observe if the proposed erosion controls are in place are also severely limited, and frequently, priorities are driven by complaints from citizens.

As shown in Figures 1.4.6-9 and 1.4.6-10, the impacts of runoff from construction can be severe, releasing significant amounts of sediment into local waterways. The combined impact from the sediment releases at these locations in certain areas can lead to increased dredging and reduced storage capacity in water supply reservoirs. These impacts have been observed on Lake Ontelaunee, the City of Reading's water supply reservoir. In addition, sediments carry phosphorus into lakes and streams, causing algal blooms. The excess nutrients cause our reservoirs to become eutrophic.

Figure 1.4.6-9 Photographs of the Impacts of Runoff from Construction: Lake Ontelaunee

Top left and right: Erosion and runoff from highway construction and construction runoff. Bottom: the impacts of construction runoff that includes increase dredging of reservoirs or decreased water supply storage.

Figure 1.4.6-10 Aerial View of Green Lane Reservoir Before and After a Storm Event
Even visually the amount of sediment entering the lake can be quite significant from runoff and erosion (photos courtesy Philadelphia Suburban Water Company).

1.4.6.6 Dam Removal and Sediment Releases

There are a large number of major and minor dams along the streams and mainstem river in the watershed. A number of these dams are very old, abandoned, or in disrepair. A significant amount of sediment, some very old and containing toxic contaminants from historical industrial pollution, resides behind these dams (see Figure 1.4.6-11). Recently, there have been efforts nationwide to remove many of these dams from streams because they inhibit the ability of fish to migrate upstream and spawn. Though these activities are meant to improve aquatic life, they also can negatively impact the water quality downstream for water supplies. The dams are usually removed in such a way as to limit the initial flushing of sediment downstream. However, after heavy storms, these sediment piles that remain are washed downstream to other dams, water supply intakes, or water supply reservoirs. Therefore, in order to minimize negative water quality impacts, dam removal efforts need to be coupled with sediment dredging and sediment pile removal, as well as streambank stabilization (via plantings) to limit damage done by receding stream water.

Figure 1.4.6-11 Sediments Remaining behind Felix Dam after Breaching from Hurricane Floyd

1.4.6.7 Catastrophic Accidents and Spills

At any given time throughout the watershed, an accident that releases contaminants that can directly impact the quality of a water supply can occur. These catastrophic events can require public water supply withdrawals to stop for periods of time ranging from a few hours to several days, limiting available water to affected communities. Water suppliers and communities are prepared to deal with such accidents since their emergency response planning included preparation for just such occasions, and therefore the impacts on the public in general are limited. However, when an accident of significant nature does occur under conditions that cannot be anticipated, the impact can be quite dramatic. For example, in the Schuylkill River Watershed alone this year, there were several fuel oil spills or discharges into waterways, two railroad tanker car derail-ments, two major fires along the river at large industrial facilities, underground storage tank spills, and various spills of gasoline and oil onto roads and bridges, which leaked into local streams.

Two fires were quite significant and if not for the skill and preparation of local and government officials they could have impacted the water supply for PAWC Norristown and Philadelphia. One of the fires was the explosion of the transformer station at Barbadoes Island (see Figure 1.4.6-12). The intake for Norristown is right near the island itself. Luckily, containment dikes contained the spilling transformer coolants, and well-prepared emergency response crews did not spray additional water that would result in release of washdown to the river. The other major fire was at Bridgeport, at an industrial park that contained over 50 different businesses, including furniture stripping and painting, automotive repair, and printing activities. Though the businesses were small and did not require individual reporting of the hazardous chemicals on-site, the combined amount of hazardous chemicals on-site was quite significant and fueled the fire and explosions for over 2 days. The industrial park was located on the riverbank. The fire washdown from the site entered the storm drains at the industrial park and was able to discharge into the canal along the river. Fortunately, emergency response and containment/clean up crews were able to contain wash down and runoff to the canal area. Therefore, no significant amounts of washdown and chemicals entered the river and water supplies were protected.

Regarding railroad hazards, fortunately, the tanker car derailments that occurred this year were located below the water supply intakes for the City of Philadelphia, but only by a few miles. One tanker car derailment accident spilled several thousand gallons of sulfuric acid into the river (see Figure 1.4.6-13). The other tanker car derailment involved an empty car, but it contained remnants of styrene, a volatile organic chemical. One tanker car can contain up to 14,000 gallons of hazardous chemicals. In this area, most railroad lines run along the Schuylkill and Delaware Rivers and pass through Philadelphia. Therefore, given the significant amount of shipping through this corridor, the risk and possibility of a tanker car derailment and release of hazardous material into the Schuylkill River is fairly low, but real.

Figure 1.4.6-12 Local Television and Newspaper Coverage of the Bridgeport Fire
Fire runoff and washdown into the river can impact water supplies.

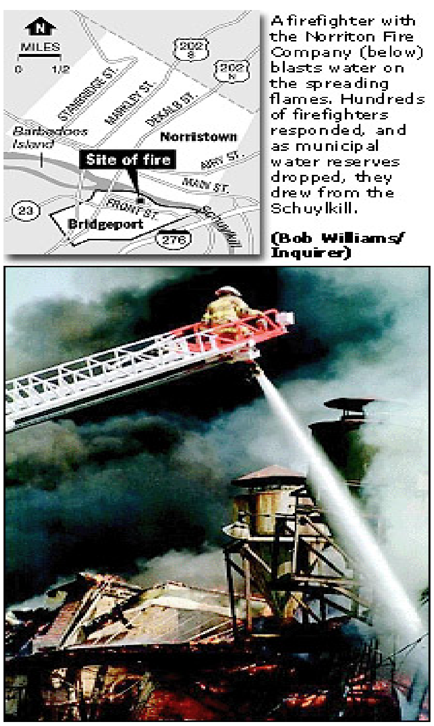


Figure 1.4.6-13 Tanker Car Derailment in Philadelphia
Tanker cars can carry up to 14,000 gallons of hazardous materials.

In addition to the fires and tanker car derailments, a number of fuel oil and unidentified oil spills were reported. Some of these were due to overfilling of fuel oil into tanks and spilling into nearby storm drains. Several oil spills such as the one in Conshohocken were suspected to be due to releases from local gas stations or automotive repair areas, but the sources were never identified. In some cases, persons even dump oil down storm drains without realizing that it can enter the river and impact their water supply. The results of an oil spill from an automotive repair facility into Green Lane Reservoir are illustrated on figure 1.4.6-14.

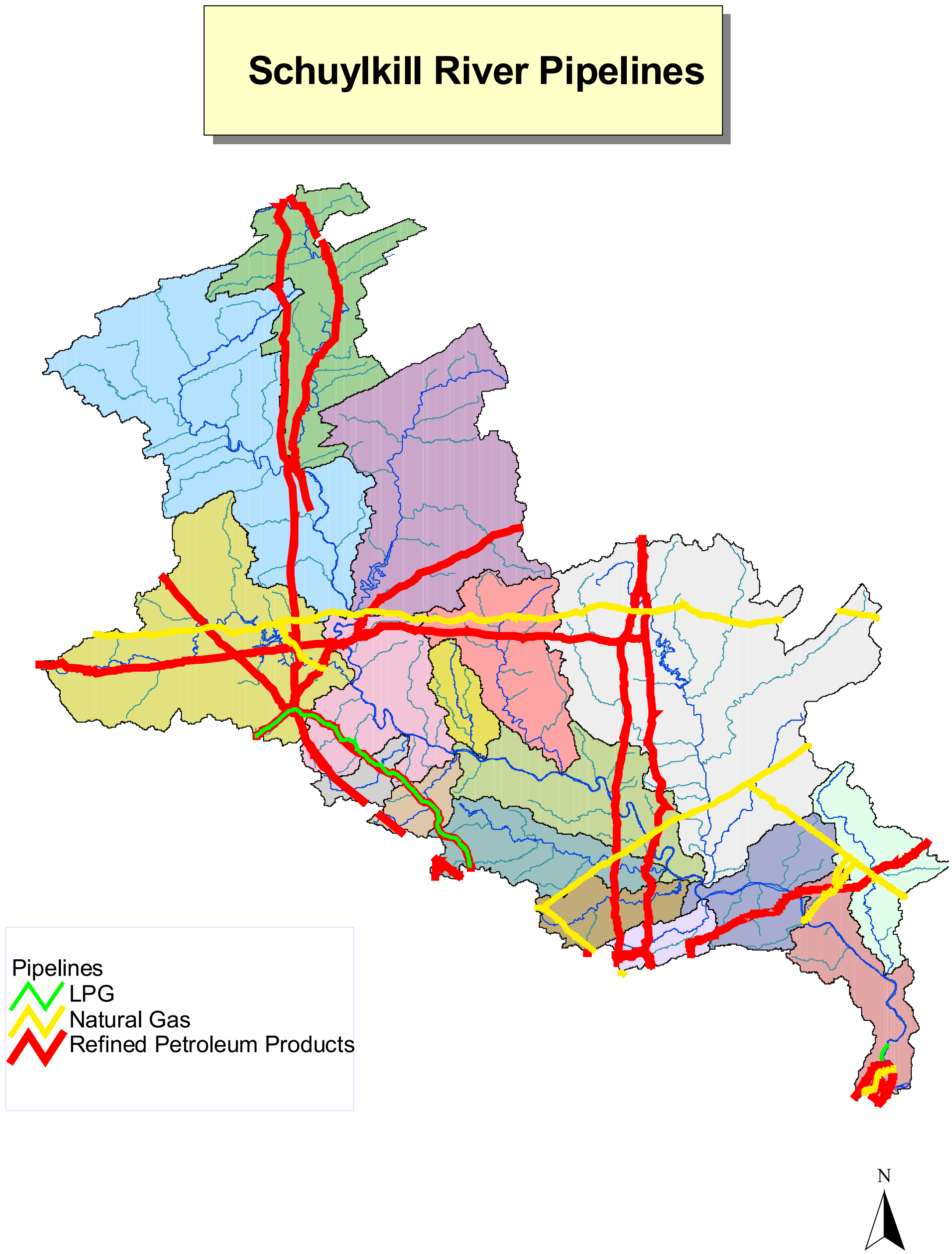
Figure 1.4.6-14 Cleanup of an Oil Spill at Green Lane Reservoir from an Automotive Repair Facility

Beyond the known incidents of this year alone, there are past incidents that continue to concern water suppliers. For example, in the past, petroleum pipelines have broken, releasing thousands of gallons of petroleum into local groundwater supplies, streams, and water supplies. The river has many major petroleum pipeline crossings, unknown to many people. The age and location of these pipelines are largely unknown and the petroleum suppliers are just now voluntarily supplying partial information to local and federal governments. It is believed that these pipelines are of significant age and nearing their service life expectancy. Locations of known pipelines are shown on Figure 1.4.6-15.

The highways and bridges that cross the Schuylkill River and its tributaries also represent significant opportunities for impacts on water supplies. In the event of an accident, tanker trucks carrying gasoline or fuel oil can spill thousands of gallons of their cargo into storm drains on roads and bridges that discharge directly into the stream or river. In some cases, since many roads follow along the banks of the river and streams, entire trucks can run off the road and into the stream or river, releasing their cargo. In addition to the possibility of impacts due to direct spills from trucks and cars, bridge maintenance activities have been known to release chemicals into the river itself. The painting of bridges can result in the release of paints and solvents if not handled properly and applied with the appropriate controls.

Figure 1.4.6-15 Petroleum and Natural Gas Pipelines in the Schuylkill River Watershed

Petroleum pipelines cross the Schuylkill River and its tributaries in many places and may be reaching the end of their service life. Due to voluntary mapping requirements, only a portion of the pipelines in the watershed may be identified on GIS.



1.4.6.8 Road Runoff

In addition to the numerous types of spills and catastrophic impacts from accidents on highways and bridges, maintenance of roadways and parks can also impact water quality. The maintenance of highway shoulders includes spraying of herbicides such as glyphosate to kill weeds growing beside the highway. The evidence of spraying can be observed in summer and fall, when it may be possible to notice a brown swath of dead plant material including portions of nearby trees within 20-50 feet of the highway shoulder. Though the application of these materials is important for the maintenance and protection of the highway, they are sometimes sprayed into storm drains or nearby waterways where they can persist and impact water quality. This effect could be significant given the significant number of miles of highway in southeastern Pennsylvania and numerous miles of roadway adjacent to streams and rivers.

Another concern from road runoff is the release of road salts during winter application periods, as illustrated by figure 1.4.6-16. Concentrations of salts, such as sodium and chloride, have increased significantly over the past several decades. These increasing trends seem to be linked to the increased development and impervious cover in the watershed as more highways, driveways, walkways, and parking lots are built in the watershed. The application of salts to these surfaces to make them safe for travel is important. However, at some time in the future, these practices may need to be addressed in order to reduce impacts on waterways before they significantly impact water supplies or aquatic life. Several water supplies in the Northeastern U.S. have similar issues with the impacts of salt application on water quality and have developed programs to reduce application and mitigate impacts in sensitive areas. Salt mist spraying before storms using special trucks is an example of a new technology that can be used in the Schuylkill River Watershed to reduce salt application and mitigate salt runoff impacts.

Another example of the negative impacts of runoff can be found in the situation that occurred in the winter of 1994 when some communities ran out of salt and began using fertilizer as a deicer on sidewalks and driveways. The urea in the fertilizer reacted with the chlorine at a treatment plant and caused major taste and odor problems. This occurrence highlights the need to educate community members about the preventable negative impacts of runoff.

Figure 1.4.6-16 Road Salt Application During the Winter

1.4.6.9 Algae Impacts

The growth and die-off of various types of algae can have significant impacts on water treatment. Diatoms can bloom and clog the filtration process requiring increased filter backwashing. When blue-green filamentous algae die, they release very minute concentrations of chemicals that are not harmful to human health, but which make the water taste and smell unpleasant. The removal of these chemicals requires additional and costly treatment. Algal blooms are caused by excess nutrients in the aquatic system, as well as the loss of shade cover from trees along the stream and river.   The reduction of nutrients from agricultural runoff, sewage discharge, and lawn fertilizer application are important components in preventing these situations. Preventing the loss of riparian buffer and shade trees along the stream and river would also keep this problem from worsening. A dramatic duckweed bloom that occurred on the Schuylkill River in August of 1999 is illustrated below by Figure 1.4.6-17.

Figure 1.4.6-17 Picture of a Duckweed Bloom on the Schuylkill River (8/16/99) that Turned the River Green for Several Miles and Made the National News
(Photo from Philadelphia Inquirer)
The low flows and slow flows behind dams, large amounts of sunlight, and excessive concentrations of nutrients in the Schuylkill River provide the proper conditions for such algae blooms.

1.4.6.10 Wildlife Management

The Schuylkill River Watershed provides refuge to many wonderful birds and animals. However, there are certain conditions in which any animal can damage the land and water resources in a given area (see Figure 1.4.6-18). Damage can be caused by a significant and unnatural proliferation of a species, the inhibition of migratory activities, destruction of predatory species, or other factors. The impacts of large and ever-increasing populations of geese in this watershed and nationwide are well known. Figure 1.4.6-18 depicts a local goose population. Locally, geese have been found to impact areas for most major water supplies, which has resulted in the closing of the Deep Creek Lake (part of the Green Lane Reservoir Area) in Montgomery County to swimming. Studies by the Philadelphia Suburban Water Company identified that geese were responsible for 70 % of the *E. coli* bacteria in the Deep Creek Lake.

There are a number of techniques that are being employed in order to protect land and water resources from the geese. Some of these involve educating people not to feed the geese in sensitive areas, while others include scaring the geese with noises or dogs. The last resort used in most cases usually involves the active hunting of geese or egg addling to control skyrocketing resident populations in various areas.

Deer have also been identified in various suburban and urban areas as the cause of negative impacts on local land and water resources. Park and land areas that provide habitat for deer, but prevent hunting due to nearby homes, have experienced increasing deer populations. In some cases, the herd becomes unnaturally large and starts to damage the trees and undergrowth through heavy feeding. The loss of undergrowth in old canopy forest areas is significant and leads to increased erosion. In addition, deer can be vectors for many pathogens.

Overall, it is recommended that water suppliers, park managers, golf course managers, state and federal wildlife officials, and wildlife experts should meet in order to develop a deer and geese management plan for the Schuylkill River Watershed. This would help to combine the resources of various individual efforts into a comprehensive and more effective form of action.

Figure 1.4.6-18 Geese Damaging Land Near a Water Supply Intake
The skyrocketing population of resident non-migratory geese throughout Pennsylvania and the entire United States is damaging land and water resources.

1.4.7 Watershed Monitoring: Current and Future Needs

Key Points

- Monitoring within the Schuylkill River Watershed is conducted by 18 water suppliers, government agencies, academic institutions, and community and environmental groups.
- Water quality monitoring efforts should be coordinated, and the data should be compiled, organized and shared.
- There are over 200 routine monitoring locations in the Schuylkill River Watershed.
- Over 50 % of the monitoring sites are focused in areas that represent only 25 % of the entire watershed (French, Valley, Pickering, and Perkiomen creeks).
- Valley Creek has five times more monitoring locations than other sections of the watershed.

Understanding the current and future water quality challenges facing water suppliers and the Schuylkill River Watershed requires analysis of data collected over time at different locations in the watershed. However, the current approach to monitoring has not been coordinated or planned. At any given time, there are five public agencies conducting professional routine monitoring of the Schuylkill River Watershed. Each of the 18 water suppliers in the watershed conducts some form of monitoring at their 42 intakes. In addition, community groups conducting routine monitoring of nearby streams share their data with the Schuylkill Riverkeeper. Other community organizations conduct monitoring, but do not share it with other organizations due to lack of time, technical capabilities, and resources. Overall, no coordinated compilation and analysis of water quality data to support spatial comparisons of water quality and water quality issues throughout the watershed has been observed to date.

Most of the energy and effort that goes into routine monitoring is focused upon specific issues and projects in particular subwatersheds or areas of the Schuylkill River. For example, monitoring by the U.S. Army Corps of Engineers is focused on the recreational quality of Blue Marsh Lake. The National Park Service monitors Valley, Pickering, and French creeks for recreational quality considerations. Water suppliers tend to monitor their intake water quality for process adjustment considerations. Table 1.4.7-1 provides a description of the organizations that conduct routine monitoring in the Schuylkill River Watershed and the level of monitoring that is conducted. As shown, almost one quarter of the routine monitoring sites in the watershed are staffed by volunteers (not including water supplier monitoring).

Not including water suppliers, there are 180 known locations where routine monitoring is occurring in the Schuylkill River Watershed. Figure 1.4.7-1 provides a breakdown of the number of locations within the various subwatersheds of the Schuylkill River. Including water suppliers, there may possibly be 200 routine monitoring locations in the Schuylkill River Watershed. This would suggest that there is a routine monitoring location to characterize every 10 square miles of the approximately 2,000 square-mile watershed. However, this is not the case. As shown in Figures 1.4.7-1 and 1.4.7-2, over

50 % of the monitoring sites are located in four subwatersheds that represent 25 % of the total watershed area. Those four watersheds are the French, Valley, Pickering, and Perkiomen Creek watersheds. Almost 30 % of the monitoring sites are located along the main stem of the river, covering almost 100 miles.

Table 1.4.7-1 Summary of Routine Watershed Monitoring

Organization	Focus Area (s)	Level of Monitoring	Parameter Groups	# of monitoring locations
National Park Service	Valley, Pickering, and French Creeks	Professional	Physical, inorganics, and metals	69
PADEP	Perkiomen, Maiden, Manatawny, Tulpehocken Creeks	Professional	Physical, inorganics, and metals. Limited microbiological	13
USEPA	Schuylkill River near King of Prussia	Professional	Physical, inorganics, and metals	12
USGS	Pickering, Perkiomen, and French Creeks	Professional	Physical, inorganics, organics, SOCs, and metals parameters	18
US Army Corps of Engineers	Tulpehocken Creek & Blue Marsh Reservoir	Professional	Physical, inorganics, organics, SOCs, microbiological and metals parameters	10
Schuylkill Riverkeeper	All except Maiden, Tulpehocken, & Valley Creeks	Volunteers	Simple physical parameters, limited inorganics and metals	48
Lower Merion Conservancy	Lower Merion Twp tribs – Lower Schuylkill	Volunteers	Simple physical parameters, limited inorganics and metals	8
Water Suppliers	All	Professional	Varies, but mostly inorganics, metals, microbiological Limited organics	42 possible, but 7-10 with almost weekly or daily data for many parameters

Figure 1.4.7-1 Number of Monitoring Sites in Schuylkill Subwatersheds

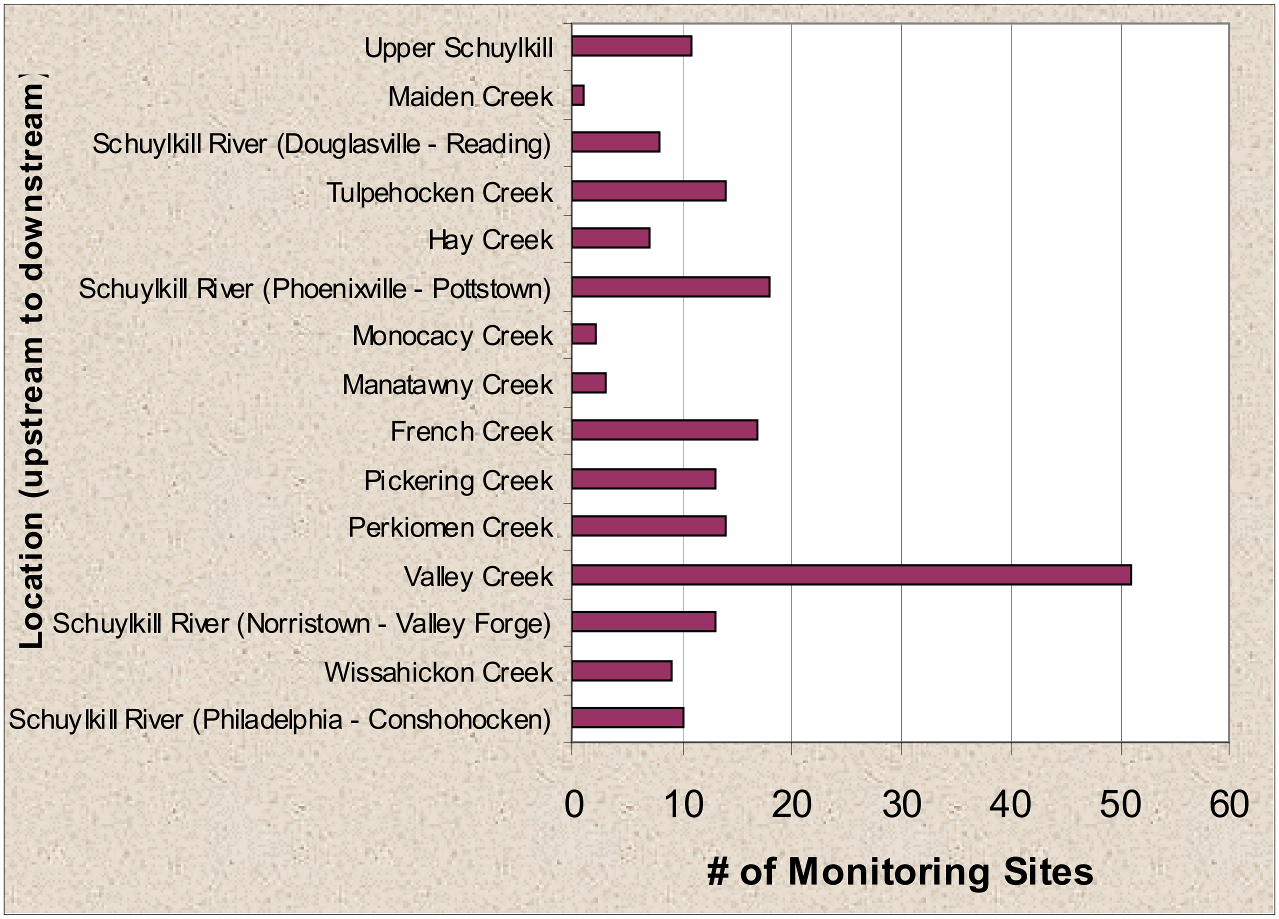
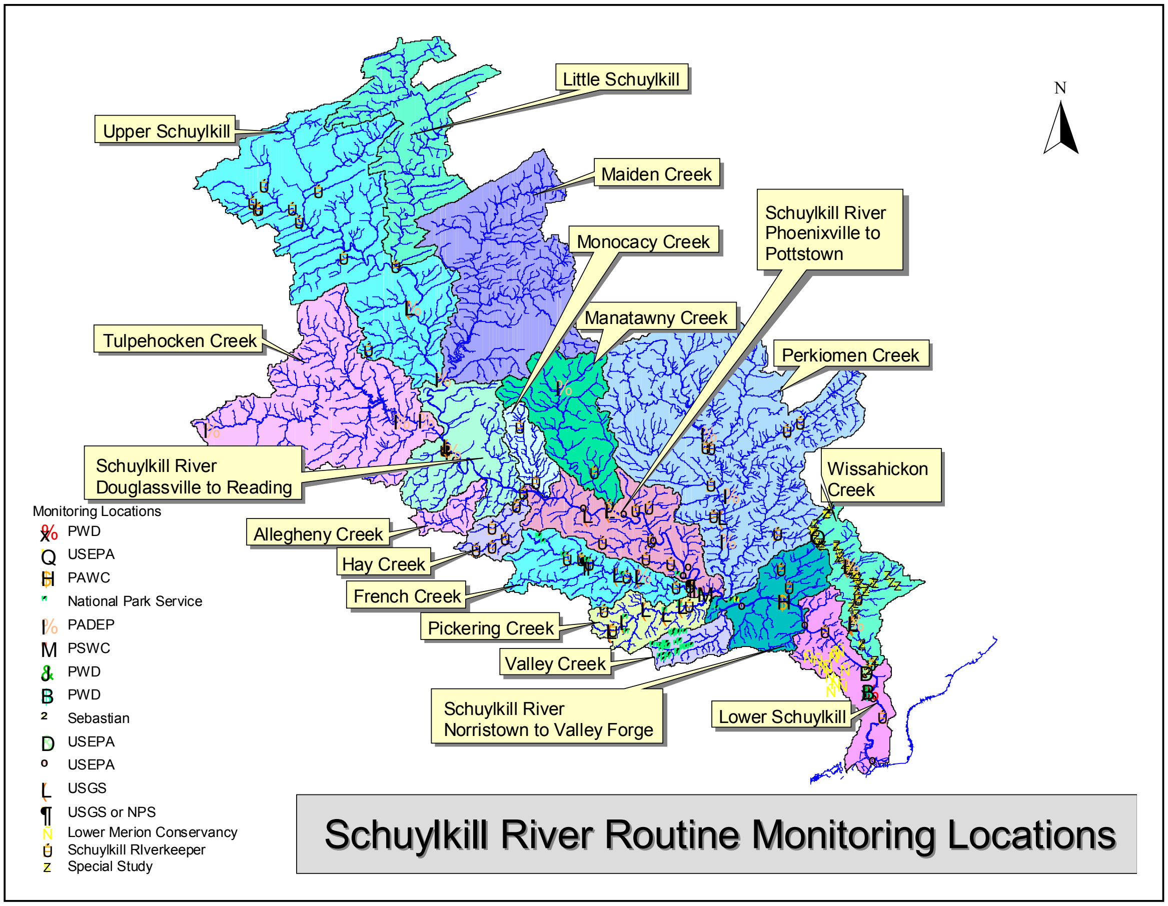


Figure 1.4.7-2 Routine Monitoring Locations by Organizations in the Schuylkill River Watershed



The quantity and type of monitoring is also important, in addition to the issue of where routine water quality monitoring is occurring. For example, though STORET indicated that a number of sites were monitored by NPS, USGS, and PADEP, that does not always mean that these sites were active for the same periods. For example, the USGS may monitor a number of locations, but it has only collected data from different time periods (70's, 80's, and 90's) for those locations. In addition, as project goals and water quality studies change, so do the selection of parameters. Therefore, monitoring may appear to be continuous at a location, but not for every desired parameter. In order to conduct any meaningful analysis of the water quality for a given watershed, sometimes data from multiple locations has to be pooled together into one data set for analysis.

In addition to the 200 potential sites for water quality data, there are numerous special studies conducted by water suppliers, community organizations, universities, county health departments, dischargers, and public agencies with little or no knowledge of one another, or of methods of coordination or data sharing. For example, although Blue Marsh Lake is extensively monitored by the U.S. Army Corps of Engineers during the spring and summer, it is also studied by Albright College and the Berks County

Conservancy. The different monitoring locations and parameters, as well as different seasons and sampling frequencies (USACE tends to conduct most of its monitoring during the summer) lead to various conclusions about the quality of the lake.

Wissahickon Creek is another example of a location where a variety of water quality monitoring programs have been conducted in recent years. As shown in Figure 1.4.7-2, various special studies were conducted by PWD at almost 33 sampling locations. At times during this period, dischargers, community groups, and a consultant were conducting various levels of monitoring for their own special studies as well. None of this data has been combined to date.

Overall, based on the information available from an analysis of the amount, types, and locations of monitoring in the watershed, the following monitoring requirements were identified:

- A data clearinghouse for water quality data needs to be created and made available to all organizations. A format for data reporting should be sent to all organizations that want to participate.

- An organization in the watershed needs to be properly funded in order to be responsible for compiling, organizing, and monitoring the water quality data from the numerous stakeholders in the watershed.

- Organizations that conduct monitoring should form a consortium for the purpose of frequent discussion of monitoring efforts and plans in order to promote better coordination and sharing of data.

- More monitoring locations are needed in locations throughout the watershed, other than the Pickering, Perkiomen, Valley, and French creeks.

- All monitoring organizations should agree on selecting standard monitoring stations for various parameters. It is recommended that the standard locations be placed close to the mouths of the major tributaries to the watershed. The long-term Riverkeeper sites and certain water supply intakes may be the best places to start when selecting these sites. Routine monitoring would be conducted at these stations over long periods of time in order to examine changes and trends in water quality over the years, seasons, or decades. This information will be used as part of a report card system for water quality improvement.

- Long term monitoring should be conducted for manganese, aluminum, iron, sodium, chloride, turbidity, total suspended solids, dissolved oxygen, temperature, ammonia, total phosphorus, orthophosphate, nitrate, *E. coli*, and fecal coliforms. Currently, most monitoring does not include coliform measurements. Efforts should be made to transfer data from hardcopy format in special studies into electronic format.

1.5 Inventory of Potential Point Sources of Contamination

Key Points

- **Potential point and non-point sources of contamination throughout the watershed were compiled from a variety of databases.**

Based on PADEP guidelines for the statewide Source Water Assessment Program (SWAP), a contaminant inventory of point and non-point sources was developed. The inventory is an essential part of assessing the source water for a drinking water supply intake, because it compiles potential contaminant sources within the 5 hour, 25 hour, and beyond 25 hour time of travel delineation zones. A watershed-wide inventory was developed because the zones for the 42 water intakes encompass the entire Schuylkill Watershed. The watershed inventory provides insight into the clustering of sources by major subwatersheds within the Schuylkill.

The focus of this discussion is the watershed-wide point source contaminant inventory. Non-point sources are discussed in the land use (section 1.2.5) section of this document and within intake-specific sections 2.2.3 and 3.2.3.

Point source data was compiled from various Federal and State databases available on the Internet, as well as from self-assessment data provided by water suppliers. Sources were checked by stakeholders, and verified for correct active status and location. An ACCESS database was developed to efficiently store and manage information describing the point sources

The following federal databases were reviewed to identify point sources in the Schuylkill River Watershed:

- Permit Compliance System (PCS)
- Resource Conservation and Recovery Act Information System (RCRIS)
- Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS)
- Toxic Release Inventory (TRI)

Regulated aboveground storage tanks (ASTs) were also compiled from the PADEP Storage Tank Program. Another initial source of data was provided by self-assessment forms. The self-assessment, required by the state SWAP, provides intake-specific input as to which sources are of priority concern.

The databases were queried for facility, process, and violation information. Facility information included name, facility identification numbers, owner, and location (street address and/or latitude, longitude). Process information included data quantifying onsite contaminants and quantities and/or loading rates. Violation information was related to type (administrative, operation or effluent violation) and frequency.

1.5.1 Point Source Contaminant Inventory

Key Points

- **Over 3,000 potential point sources were identified within the 1,900 square-mile Schuylkill River Watershed.**

Once the database compilation and population were completed, a watershed-wide inventory of potential contaminants was developed for the Schuylkill River. The land area covered by the inventory extends over 1,900 square miles, 300 subwatersheds, and 3,000 point sources. The inventory is sorted by major sub-watershed and posted on the Schuylkill Source Water Assessment project website, www.schuylkillswa.org. The full inventory or an inventory for a subwatershed of particular interest is available for download from the website or by contacting PADEP.

An example of the inventory for the Manatawny Watershed, a major subwatershed of the Schuylkill is provided in Figure 1.5.1-1. The example shows some of the pertinent attributes associated with the various source types. If a field is blank, then the information was not available. The number of blank fields gives an idea of the incompleteness of much of the downloaded data, especially for SIC codes, contaminants, and quantities.

For PCS facilities, the name, address, NPDES ID, SIC code description, minor/major designation, flow rate, contaminant groups, and violation remark are indicated. A major facility has a flow rate of 1 MGD or greater.

Attributes shown for RCRA facilities are generally the same as for PCS. Instead of minor/major designation, RCRA facilities are differentiated on size as large quantity generators (LQG) or small quantity generators (SMG). A LQG generates more than 2,200 pounds of hazardous waste per calendar month. Flow rates do not apply to most RCRA sites, which are mostly industrial facilities with aboveground or underground storage tanks. An AST download from PADEP is used to supplement the scarce quantity information for RCRA sites. AST data attributes include fairly complete capacity and contaminant information for each site.

TRI attributes include similar fields as the PCS and RCRA facilities. Quantity information is available as ranges, such as 1,000 to 9,999 kg per year. The quantity shown is an average over all available years. If the facility had a release, then the maximum range value is used in the average, otherwise the minimum is used. TRI quantity refers to the amount used or generated on-site. Releases in TRI may be to air, water or land.

Attributes for CERCLA facilities include basic information such as name and EPA ID. In addition, a flag is shown to indicate whether the facility is on the National Priority List (NPL) or not. Quantity and capacity data for CERCLA facilities is limited to two facilities watershed wide. The number of enforced violations is also provided.

Figure 1.5.1-1 Point Source Contaminant Inventory for the Manatawny Watershed

Watershed: Manatawny Creek

AST Summary

Name	Address	City	Zip	Facility ID	Total Tankage (gal)	Releases	Contaminants
A & L HANDLES INC.	244 SHOEMAKER RD	POTTSTOWN	19464	46-05203	1,500	No	VOC
AUTO SVC	63 W HIGH ST	POTTSTOWN	19464	46-14902	131,000	No	VOC,PH

CERCLA Summary

Name	Address	City	Zip	Facility ID	NPL Status	# of Units	# of Enforcements
BERKMONT IND-UNICAST DIV	6TH & WASHINGTON STS	BOYERTOWN	19512	PAD008129864	NOT ON NPL	1	0
BOYERTOWN LANDFILL	UNOBTAINABLE	BOYERTOWN	19512	PAD980508394	NOT ON NPL	1	0
BOYERTOWN SCRAP	ROUTE 562	BOYERTOWN	19512	PAD037672062	NOT ON NPL	1	4
BRENAHAN, EJ INC - MCCARTER 5000TH PLT	RIVER & YARNELL RDS	POTTSTOWN	19464	PAD063299202	NOT ON NPL	1	0
COLEBROOKEDALE LANDFILL	SHENKEL HILL RD	AUDUBON	19407	PAD069780810	NOT ON NPL	1	0
DOUGLASS-EARL TCE	RD #2 - FANCYVILLE RD	BOYERTOWN	19512	PAD981105075	NOT ON NPL	1	0
FARLEY METALS	OLD READING PIKE (P O BOX)	POTTSTOWN	19464	PAD002386704	NOT ON NPL	1	0
GIBBONS WASTE OIL	SAINT PETERS RD STAR RTE	POTTSTOWN	19464	PAD980537963	NOT ON NPL	1	0
KEYSTONE GREY IRON FOUNDRY CO	KEIM & CROSS ST	POTTSTOWN	19464	PAD002378818	NOT ON NPL	1	0
PECO LOTS # 5,7,8 & 9	INDUSTRIAL HIGHWAY	POTTSTOWN	19464	PAD987352200	NOT ON NPL	1	0
POTTSTOWN ABANDONED TRAILER SITE	RT 100 & STATE ST	POTTSTOWN	19464	PAD981736804	NOT ON NPL	1	3
POTTSTOWN DISP SER	SELL RD & RTE 20	POTTSTOWN	19464	PAD064351028	NOT ON NPL	1	0

1.5.2 Inventory Characterization

Key Points

- Over 3,000 potential point sources were identified within the watershed.
    - The highest concentrations of potential point sources were located in the most highly developed subwatersheds, the Middle and Lower Schuylkill subwatersheds.
    - Sewer systems, dry cleaners, and machine/metal working shops were among the most frequently identified potential point sources.
    - Monocacy Creek, Wissahickon Creek and Valley Creek had the greatest number of dischargers per acre of drainage area.

1.5.2.1 Entire Watershed Inventory Summary

The inventory has been compiled for the entire Schuylkill Watershed and its major subwatersheds. With more than 3,000 point sources throughout the watershed, the characterization highlights the types of sources (PCS, RCRA, etc.) that exist and where those sources are concentrated. Table 1.5.2-1 presents the number of facilities for a particular source type for each major subwatershed. Note that source types for some facilities overlap. For example, the same facility may be both a permit holder (PCS), and an RCRA facility or a TRI facility.

Table 1.5.2-1 Summary of Point Source Types by Major Watershed

Major Watershed	# of PCS Facilities	# of RCRA Facilities	# of ASTs	# of TRI Facilities	# of CERCLA Facilities	# of Self-Assessment Facilities
Lower Schuylkill	44	***400***	***102***	42	62	22
Wissahickon Creek	29	158	36	18	42	6
Middle Schuylkill 1	38	274	51	24	55	9
Valley Creek	14	86	20	17	17	3
Perkiomen Creek	***123***	298	71	***60***	***71***	15
Middle Schuylkill 2	41	135	45	24	15	***67***
Pickering Creek	10	13	1	5	4	15
French Creek	10	53	2	6	11	11
Manatawny Creek	17	27	12	2	12	1
Monocacy Creek	6	0	2	0	0	1
Hay Creek	3	1	2	0	5	0
Middle Schuylkill 3	45	76	57	44	23	7
Tulpehocken Creek	33	45	23	17	12	3
Maiden Creek	28	11	11	9	5	0
Upper Schuylkill	57	79	29	28	33	2
Little Schuylkill	17	26	2	8	15	3
Unknown Subshed	61	3	0	0	0	0
TOTAL	576	1685	466	304	382	165

Table 1.5.2-1 indicates that for three of the six potential source types - PCS, TRI, and CERCLA, the Perkiomen Creek Watershed has the greatest number of sites. This is consistent with the fact that the Perkiomen Creek Watershed encompasses a greater land area than any of the other subwatersheds. The Lower Schuylkill Watershed has the largest number of RCRA facilities and the Middle Schuylkill Two Watershed has the largest number of sources identified by water supplier self-assessments. The AST data indicates that the Lower Schuylkill has the greatest number of ASTs. These tallies do not necessarily mean that the sources are significant with respect to contamination of the drinking water supplies. The ranking analysis for each intake determines significance by accounting for other source characteristics, such as time of travel to the intake, water quality impact, or number of violations.

The data from Table 1.5.2-1 is further analyzed based on watersheds with the three highest occurrences of each source type. This compilation is summarized in Table 1.5.2 - 2. This table clearly shows that Middle Schuylkill One and Three, the Lower Schuylkill, and the Perkiomen have high concentrations of sources. Across all source types, with the exception of PCS, the Lower Schuylkill has one of the three highest clusters. This is consistent with the significant industrial land use within the Lower Schuylkill Watershed. Although the Upper Schuylkill Watershed is mostly agricultural or forested land, it has the third-highest number of dischargers. Many dischargers cannot be located due to missing latitude/longitude information, as indicated by the 61 sites within an unknown subwatershed. Self-assessment data indicates that water supplier concerns generally align well with where sites are concentrated. Water suppliers listed the most sites in Middle Schuylkill Two, followed by the Lower Schuylkill, and Perkiomen Creek.

Table 1.5.2-2 Major Subwatershed Source Type Occurrence

Source Type		**Major Watershed**	**Number of Facilities**	**Source Type**		**Major Watershed**	**Number of Facilities**
PCS	1st	Perkiomen Creek	123	TRI	1st	Perkiomen Creek	60
	2nd	Unknown Subshed	61		2nd	Middle Schuylkill 3	44
	3rd	Upper Schuylkill	57		3rd	Lower Schuylkill	42
RCRA	1st	Lower Schuylkill	400	CERCLA	1st	Perkiomen Creek	71
	2nd	Perkiomen Creek	298		2nd	Lower Schuylkill	62
	3rd	Middle Schuylkill 1	274		3rd	Middle Schuylkill 1	55
ASTs	1st	Lower Schuylkill	102	Self-Assessment	1st	Middle Schuylkill 2	67
	2nd	Perkiomen Creek	71		2nd	Lower Schuylkill	22
	3rd	Middle Schuylkill 3	57		3rd	Perkiomen Creek	15

Table 1.5.2-3 summarizes the most frequently reported types of industrial facilities, based upon SIC codes. The most frequently occurring potential point sources are sewerage systems and dry cleaning plants. Using the PADEP land use-based activities defined in the SWAP document, industrial machine/metal working shops, industrial chemical manufacturers and industrial foundries are most prevalent in the watershed.

Table 1.5.2-3 Schuylkill Watershed Top Point Sources by Industrial Classification

SIC Code/Description	**Number**	**PADEP Land Use/Activity**	**Number**
4952 - Sewerage Systems	148	Industrial – Machine/Metalworking Shops	190
7216 - Drycleaning Plants, Except Rug Cleaning	120	Industrial - Chemical Manufacturer	162
2752 - Commercial Printing, Lithographic	36	Industrial - Foundries or Metal Fabricators	153
2899 - Chemicals And Chemical Preparations, Not Elsewhere Classified	27	Misc. - NPDES Locations	148
2834 - Pharmaceutical Preparations	27	Commercial - Dry Cleaners	122

Although Tables 1.5.2-1 through 1.5.2-3 identify the watersheds in which the groups of source types are located, as well as the most common industries, the drainage areas of the subwatersheds were not considered. By normalizing the number of potential sources in a subwatershed by drainage area, a better representation of clustering and cumulative impacts may be ascertained. Because existing dischargers are more of a concern for cumulative impacts than other potential sources (such as ASTs, RCRA sites or TRI facilities), the data for PCS dischargers was normalized, as described below.

1.5.2.2 PCS Dischargers

Table 1.5.2-4 lists the number of PSC dischargers within each major subwatershed, normalized by drainage area. Although the greatest number of dischargers was located within the Perkiomen Creek and the Upper Schuylkill River watersheds, the normalized data identifies other subwatersheds of concern. A greater density of PCS facilities is found within the Wissahickon Creek, Valley Creek, and Monocacy watersheds.

Table 1.5.2-4 Watershed Clustering of Dischargers on a Drainage Area Basis

Major Subwatershed	# of PCS Facilities	Drainage Area (acres)	#/DA (#/acre)
Wissahickon Creek	29	153030	190 x 10-6
Valley Creek	14	75636	185 x 10-6
Monocacy Creek	6	34407	174 x 10-6
Hay Creek	3	24844	121 x 10-6
Perkiomen Creek	123	1598076	77 x 10-6
Manatawny Creek	17	239681	71 x 10-6
Pickering Creek	10	151869	66 x 10-6
Upper Schuylkill	57	1087682	52 x 10-6
French Creek	10	215117	47 x 10-6
Little Schuylkill	17	442667	38 x 10-6
Tulpehocken Creek	33	901705	37 x 10-6
Middle Schuylkill 1	38	1186773	32 x 10-6
Maiden Creek	28	990006	28 x 10-6
Middle Schuylkill 2	41	2400223	17 x 10-6
Middle Schuylkill 3	45	2648033	17 x 10-6
Lower Schuylkill	44	3674006	12 x 10-6
Unknown Subshed	61	-	-
Total	**576**	**15823755**	**36 x 10-6**

Discharger data is further normalized by median flow in Table 1.5.2-5. Median flow from the period of record at USGS at the nearest gauge to the major subwatershed was used. If more than one gauge was associated with the subwatershed, then a drainage area weighted average value was used. When normalized by flow, as well as by drainage area, clusters of PCS sites are found in the Wissahickon Creek, French Creek, and Little Schuylkill River watersheds.

Table 1.5.2-5 Watershed Clustering of Dischargers on a DA/Flow Basis

Major Subwatershed	# of PCS Facilities	#/DA (#/acre)	Median Flow (cfs)	#/DA/Flow (#/acre/cfs)
Wissahickon Creek	29	190 x 10-6	60	316 x 10-8
French Creek	10	47 x 10-6	56	83 x 10-8
Little Schuylkill	17	38 x 10-6	51	75 x 10-8
Manatawny Creek	17	71 x 10-6	369	19 x 10-8
Valley Creek	14	185 x 10-6	978	19 x 10-8
Monocacy Creek	6	174 x 10-6	1300	13 x 10-8
Tulpehocken Creek	33	37 x 10-6	312	12 x 10-8
Upper Schuylkill	57	52 x 10-6	528	10 x 10-8
Hay Creek	3	121 x 10-6	1300	9 x 10-8
Perkiomen Creek	123	77 x 10-6	873	9 x 10-8
Pickering Creek	10	66 x 10-6	1670	4 x 10-8
Middle Schuylkill 1	38	32 x 10-6	1670	2 x 10-8
Maiden Creek	28	28 x 10-6	1670	2 x 10-8
Middle Schuylkill 3	45	17 x 10-6	1177	1 x 10-8
Middle Schuylkill 2	41	17 x 10-6	1556	1 x 10-8
Lower Schuylkill	44	12 x 10-6	1670	0.7 x 10-8
Unknown Subshed	61	-	-	-
Total	576	36 x 10-6	1670	2 x 10-8

The inventory of dischargers or PCS facilities throughout the Schuylkill Watershed is summarized in Table 1.5.2-6. Although, in all, 576 dischargers are found throughout the watershed, only 43 are major dischargers (<1 MGD). Almost of all these are wastewater treatment plants. In fact, wastewater treatment plants comprise the largest component, 148 of 576, for both major and minor dischargers. After sewerage systems, gasoline and petroleum bulk stations, water suppliers, and mobile home sites comprise 55 of the remaining 428 dischargers.

Table 1.5.2-6 PCS Discharger Summary

Total Dischargers	576
Major Dischargers	43
Major Sewerage Systems	35
Top 5 Discharge Types by SIC Code 4952 – Sewerage Systems 5541 – Gasoline Service Stations 5171 – Petroleum Bulk Stations 4941 – Water Supplier 6515 – Mobil Home Sites	 148 15 14 14 12
Dischargers with Available DMR Data	54
Most Common Parameters with DMR Data	Total Suspended Solids Ammonia Nitrogen BOD5 Total Copper Oil & Grease
Most Common Parameters for Effluent Limits	Total Suspended Solids pH Fecal Coliform Ammonia Nitrogen Dissolved Oxygen
Discharge Flow Rate Range	0.03 – 9.75 MGD

Because so many of the dischargers are minor, Discharge Monitoring Report (DMR) data was only available for 54 sites. The data spanned June 1984 through December 2000. The most common parameters found in the DMRs and effluent limits are indicated in Table 1.5.2-6. The common DMR parameters – TSS and BOD5 - correlate with turbidity and TOC (DBP precursor), which are of concern from a source water perspective. Metals such as copper, as well as oil and grease, also pose a concern for drinking water supplies.

Discharge Monitoring Report (DMR) data is further summarized in Table 1.5.2-7 based on maximum reported quantities and parameter groups. The parameter groups generally follow those identified in the PADEP SWAP guidance document. These groupings are used to rank potential contaminant sources in the intake-specific report sections. Since the ranking analysis was based on DMR maximum quantity data, the data was compiled in Table 1.5.2-7 to provide a frame of reference. The data also gives an idea, on a pounds-per-day basis, as to the "worst case" order of magnitude of a discharge. This data was available for only 54 of the 576 dischargers in the Schuylkill Watershed and is generally linked to major dischargers. With that in mind, the data truly represents a worst-case estimate of individual loads being discharged into the Schuylkill River.

Table 1.5.2-7 Summary of Available DMR Data

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported	Mean Max Quantity	Count of Max Quantities
Cryptosporidium/ Giardia	Not Available			
Nutrients	Ammonia as Nitrogen	0 - 32550	121	2837
	Nitrate-Nitrite as Nitrogen	0.0002 - 7.2	1.2	22
DBP Precursors	BOD5	0 - 70783	1883	1320
Petroleum Hydrocarbons	Oil & Grease	0 - 3753	86	603
Salts	Not Available			
Total/Fecal Coliform	Fecal Coliform (col/day)	45.75 - 84	65	2
Turbidity	Total Suspended Solids	0 - 802396	1316	6032
Nutrients	Phosphorus	0 - 527	21	581
VOC	1,1,1-Trichloroethane	0.001 - 0.09	0.03	37
	1,1,2-Trichloroethane	0.001 - 0.07	0.01	18
	1,1- Dichloroethane	0.001 - 0.02	0.01	18
	1,1-Dichloroethylene	0.0001 - 0.05	0.01	83
	1,2-Dichloroethane	0.001 - 0.02	0.01	18
	1,2-Dichloropropane	0.001 - 0.02	0.01	19
	1,2-trans-Dichloroethylene	0.001 - 0.02	0.01	18
	1,3-Dichloropropylene	0.001 - 0.02	0.01	18
	2-Chloroethylvinyl ether	0.038 - 0.08	0.07	3
	Acrolein	0.045 - 0.80	0.43	36
	Acrylonitrile	0.005 - 0.92	0.32	58
	Benzene	0.001 - 0.02	0.01	18
	Bromoform	0.004 - 0.05	0.02	14
	Carbon Tetrachloride	0.001 - 0.02	0.01	18
	Chlorobenzene	0.001 - 0.02	0.01	18
	Chloroethane	0.001 - 0.02	0.01	18
	Chloroform	0.001 - 0.51	0.07	84
	Dibromochloromethane	0.004 - 0.05	0.02	14
	Dichlorobromomethane	0.004 - 0.05	0.02	14
	Ethylbenzene	0.001 - 0.02	0.01	18
	Methyl Bromide (Bromomthane)	0.004 - 0.09	0.03	14
	Methyl Chloride (Chloromethane))	0.001 - 0.09	0.02	32
	Methylene Chloride	0.001 - 0.02	0.01	18
	Tetrachloroethene	0.001 - 0.09	0.03	56
	Toluene	0.001 - 0.02	0.01	18
	Trichloroethene	0 - 1.13	0.08	90
	Vinyl Chloride	***0.001 - 1.21***	***0.04***	***39***
SOC	1,2,4-Trichlorobenzene	0.001 - 0.02	0.01	17
	1,2-Diichlorobenzene	0.001 - 0.02	0.01	19
	1,3-Dichlorobenzene	0.001 - 0.02	0.01	17
	1,4-Dichlorobenzene	0.001 - 0.02	0.01	17
	2,4-Dichlorophenol	0.001 - 0.02	0.01	18
	2,4-Dimethylphenol	0.001 - 0.04	0.02	18
	2,4-Dinitrophenol	0.003 - 0.11	0.05	18

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported	Mean Max Quantity	Count of Max Quantities
	2,4-Dinitrotoluene	0.001 - 0.02	0.01	18
	2,6-Dinitrotoluene	0.001 - 0.05	0.01	18
	2-Chlorophenol	0.001 - 0.02	0.01	17
	2-Nitrophenol	0.001 - 0.02	0.01	17
	4,6-Dinitro o-Cresol	0.001 - 0.06	0.02	18
	4-Nitrophenol	0.001 - 0.02	0.01	18
	Acenapthene	0.001 - 0.02	0.01	18
	Acenaphthylene	0.001 - 0.02	0.01	18
	Anthracene	0.001 - 0.02	0.01	18
	Benzo (A) Anthracene	0.001 - 0.02	0.01	18
	Benzo (A) Pyrene	0.001 - 0.02	0.01	18
	Benzo (B) Fluoranthene	0.001 - 0.03	0.01	18
	Benzo (K) Fluoranthene	0.001 - 0.03	0.01	18
	Bis (2-Ethylhexyl) Phthalate	0.001 - 0.02	0.01	17
	Chrysene	0.001 - 0.02	0.01	18
	Di-n-Butylphthalate	0.001 - 0.02	0.01	18
	Diethylmethyl phthalate	0.001 - 0.02	0.01	18
	Dimethylphthalate	0.001 - 0.02	0.01	18
	Fluoranthene	0.001 - 0.02	0.01	18
	Fluorene	0.001 - 0.02	0.01	18
	Hexachlorobenzene	0.001 - 0.02	0.01	18
	Hexachlorobutadiene	0.001 - 0.02	0.01	18
	Hexachloroethane	0.001 - 0.02	0.01	17
	Napththalene	0.001 - 0.11	0.06	62
	Nitrobenzene	0.001 - 0.13	0.02	18
	Phenanthrene	0.001 - 0.02	0.01	18
	Phenol	0.001 - 9.00	0.43	32
	Phenol, Total	***0 - 14.50***	***0.90***	***318***
	Pyrene	0.001 - 0.02	0.01	17
Metals	Aluminum, Total	0.00051 - 18.5	1.54	92
	Antimony, Total	0.0006 - 0.0	0.02	33
	Arsenic, Total	0.0003 - 0.1	0.01	32
	Beryllium, Total	0 - 0.3	0.02	258
	Cadmium, Total	0 - 1.1	0.07	322
	Chromium, Total	0 - 9.0	0.32	430
	Chromium, Hexavalent	0 - 2.2	0.16	587
	Copper, Total	0 - 11.1	1.16	843
	Iron, Total	***1 - 36.0***	***7.73***	***59***
	Lead, Total	0.00013 - 4.7	0.19	412
	Mercury, Total	0 - 0.0	0.00	106
	Molybdenum, Total	3.58 - 6.6	5.24	7
	Nickel, Total	0 - 19.9	0.38	427
	Selenium, Total	0.0006 - 0.0	0.02	36
	Silver, Total	0 - 1.4	0.05	184
	Thallium, Total	0.0003 - 0.0	0.01	33
	Zinc, Total	0 - 33.2	2.23	486

[1] All quantities in lbs./day, unless otherwise indicated.
[2] Shading indicates the parameter with the largest maximum DMR value.

Table 1.5.2-7 shows that total suspended solids (TSS) loads are the highest of any parameter and have the greatest number of reported quantities. Total suspended solids are related to the turbidity parameter group. Turbidity is another indicator of particulates in the water supply, but it is a more meaningful measure of performance in drinking water treatment. Maximum and average ammonia loads are greater than phosphorus loads. The table also indicates the various volatile organic compounds (VOCs) and synthetic organic compounds (SOCs) discharged into the Schuylkill River. Vinyl chloride has the single greatest VOC discharge of 1.2 pounds per day (lbs./day). Relative to the other VOC discharges, acrylonitrile and acrolein are also large average quantities. Total phenols are the largest discharged quantity for the SOCs. Otherwise, quantities of SOC discharges are similar. Of the metals, iron is clearly the largest discharged quantity. High maximum quantities are also reported for aluminum, total chromium, total copper, total lead, total nickel, and total zinc. Chromium and lead pose the greatest risk in drinking water.

1.5.2.3 RCRA/AST Facilities

As summarized in Table 1.5.2-8, RCRA facilities comprise many of the point sources in the Schuylkill River Watershed. However, only 205 of the 1,685 RCRA facilities are designated as large quantity generators (LQGs). Data describing the industry type or capacity of the facilities is limited. Taking into account the limited number of SIC codes, most RCRA facilities are dry cleaning plants, followed by printing shops, and automotive repair shops. Relatively few RCRA sites were cited for violations. Capacity information for use in ranking sites is available for merely 161 sites, and contaminant information was not available. Reported capacities ranged from 100 to 965,000 gallons for the RCRA sites with available data.

Table 1.5.2-8 RCRA Facility Summary

Total RCRA Facilities	1685
Large Quantity Generators	205
Facilities with SIC Codes	580
Top 5 RCRA Industry Types by SIC Code 7216 – Dry Cleaning Plants 2752 & 2759 – Commercial Printing 7537 – Automotive Transmission Repair Shops 3471 – Electroplating, Plating, Polishing, etc. 2834 – Pharmaceutical Preparations	 120 22 16 10 10
RCRA Facilities with Violations	161
RCRA Facilities with Capacity/Volume Data	58
Range of Capacity	100 – 965,000 gallons 107 – 8,220,000 gal/day
Most Common Parameters/Contaminants	Not Applicable – no contaminants linked to RCRA downloads

As mentioned previously, RCRA data was supplemented with AST information from PADEP. PADEP AST data included useful and detailed information relating to tank age, contaminants, and volumes. AST data is summarized in Table 1.5.2-9.

Table 1.5.2-9 AST Facility Summary

Total AST Facilities	466
AST Facility Overlap with RCRA Facilities	74
Total Number of Tanks	2077
Tank Capacity Range	250 gal – 13 MG
Tank Age Range	1 – 98
Number of Different Parameters/Contaminants	138
Most Common Parameters and Quantities by Number of Tanks Misc. Hazardous Substance Diesel Fuel Gasoline	 662 tanks/25 MG 251 tanks/6 MG 211 tanks/186 MG
Most Common Parameters/Contaminants and Quantities by Total Volume Gasoline Crude Oil Heating Oil	 183 MG 136 MG 108 MG

Table 1.5.2-9 shows that 466 facilities throughout the Schuylkill Watershed have aboveground storage tanks on-site. Of those facilities, only 74 overlap with the RCRA facilities. This may be due to RCRA sites also having underground storage tanks on-site. The AST data is useful for characterizing potential contaminant sources in the watershed. Tanks range in capacity from 250 gallons to 13 million gallons and range in age from 1 to 98 years old. Older tanks may pose a greater risk for spills and leaks. The tanks contain 138 different substances. The most common of these by volume is gasoline, followed by crude oil, and heating oil. The significance of these tanks as contamination sources depends on factors such as the total volume of substance at any one site, tank age, and the time of travel to the drinking water intake. These factors are considered in the intake-specific susceptibility ranking.

1.5.2.4 TRI Facilities

A summary of TRI sources is presented in Table 1.5.2-10. A facility is listed in the TRI if a chemical from the inventory is used or manufactured on site. These sites do not necessarily discharge the listed chemical(s). Data describing on-site chemicals, quantities of chemicals used or manufactured in a given year, and releases to air, water or the ground is available for the TRI sources.

Table 1.5.2-10 indicates that 304 TRI facilities are found in the Schuylkill Watershed. An SIC code is identified for 283 of these industries. SIC codes are linked to activities that PADEP identified in the state SWAP document. Based on activity, most TRI facilities are foundries, chemical manufacturers, or machine shops.

Chemical and quantity data is very complete for the TRI facilities, however quantities are presented as ranges. Copper, sulfuric acid, and toluene are the most common chemicals listed by the various TRI sites. Release information was available for 288 of the TRI facilities. A petroleum refinery in Philadelphia, downstream of any drinking water intake, has the greatest number of reported releases. A chemical manufacturer of dyes in Berks County and a manufacturer of medicinal chemicals in Montgomery County have the next highest numbers of reported releases.

Table 1.5.2–10 TRI Facility Summary

Total TRI Facilities	304
Facilities with SIC Codes	283
Top 3 TRI Industry Types by Activity Foundries or Metal Fabricators Chemical Manufacturer Machine/Metalworking Shops	 62 59 54
Top 3 TRI Industries by SIC Code 2899 - Chemical Preparation 2834 – Pharmaceutical Preparations 5171 – Petroleum Bulk Stations	 11 8 7
Facilities with Quantity Data	282
Most Common Parameters for Facilities with Quantity Data Copper Sulfuric Acid Toluene Chromium Nickel	 0 – 999,999,999 kg/yr. 0 – 49,999,999 kg/yr. 0 – 99,999,999 kg/yr. 0 – 99,999,999 kg/yr. 0 – 9,999,999 kg/yr.
Facilities with Release Data	288
Facilities with Greatest Number of Releases Petroleum Refinery - Philadelphia County Chem. Manufacturer–Dyes/Pigments–Berks County Chem. Man.-Medicinal Chemicals – Montgomery County	 193 releases to water 180 releases to water 96 releases to water

1.5.2.5 CERCLA Facilities

Although data characterizing CERCLA facilities in the Schuylkill Watershed is limited, Table 1.5.2-11 summarizes the available information. While 382 CERCLA facilities are located within the watershed, only 22 are on the final National Priority List (NPL). Information for about 80 of the CERCLA facilities is available through the RCRA and TRI databases, where those facilities are also listed. Only 31 sites are found in the floodplain. Since information on the Superfund sites is so limited, these sites are screened or ranked subjectively for the intakes. The low number of NPL sites and sites in the floodplain is considered in the subjective screening.

Table 1.5.2–11 CERCLA Facility Summary

Total Number of CERCLA Facilities	382
Number on the NPL List	22
Number also listed as RCRA	64
Number also listed as TRI	18
Number in Flood Plain	31

1.6 Identification of Restoration Efforts

Key Points

- Federal, State and private grants have provided almost $20 million for environmental projects within the Schuylkill River Watershed over the past seven years.
- Grants were awarded to 76 recipients, with county and municipal groups receiving the majority of funds.
- Almost 50 % of the grants awarded were used for restoration projects.

In order to gain an understanding of the current levels of environmental stewardship and awareness within watersheds, a compilation of grants and restoration projects was completed. State, Federal and private grant sources identified the levels of funding that they provided through various programs to respective watersheds within the Schuylkill River Basin from 1995 to 2001.

These programs include the Pennsylvania Department of Environmental Protection's (PA-DEP) 319 Nonpoint Source Program, the Growing Greener Program, the Pennsylvania Department of Conservation and Natural Resource's (PA-DCNR) Rivers Conservation Plan Program, and Pennsylvania's Coastal Zone Management Program. Also included were Pennsylvania's Natural Resources Conservation Service's (NRCS) Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Watershed Protection and Flood Prevention Act (PL-566) Program, and the Environmental Quality Incentives Program (EQIP). In addition, private sources of funding were also compiled, including the William Penn Foundation, the Pew Charitable Trusts and The Pennsylvania League of Women's Voters. Additional sources of funding included federal funds via the Army Corps of Engineers (USACOE), the United States Environmental Protection Agency (EPA), the United States Fish and Wildlife Service (FWS), and the National Science Foundation (NSF).

From the data received, the Schuylkill River Watershed had a total of $18,115,196 awarded within its boundaries for the time period of 1995 to 2001, with most of the grant dollars being awarded post-1997. The watershed with the highest funding level was the Lower Schuylkill with $5,837,791 in grants. The watershed with the lowest funding level was the Allegheny Creek Watershed with $21,578. Please see Figure 1.6-1 below for a complete comparison of watersheds.

Figure 1.6-1 Distribution of Grant Dollars within Schuylkill River Subwatersheds

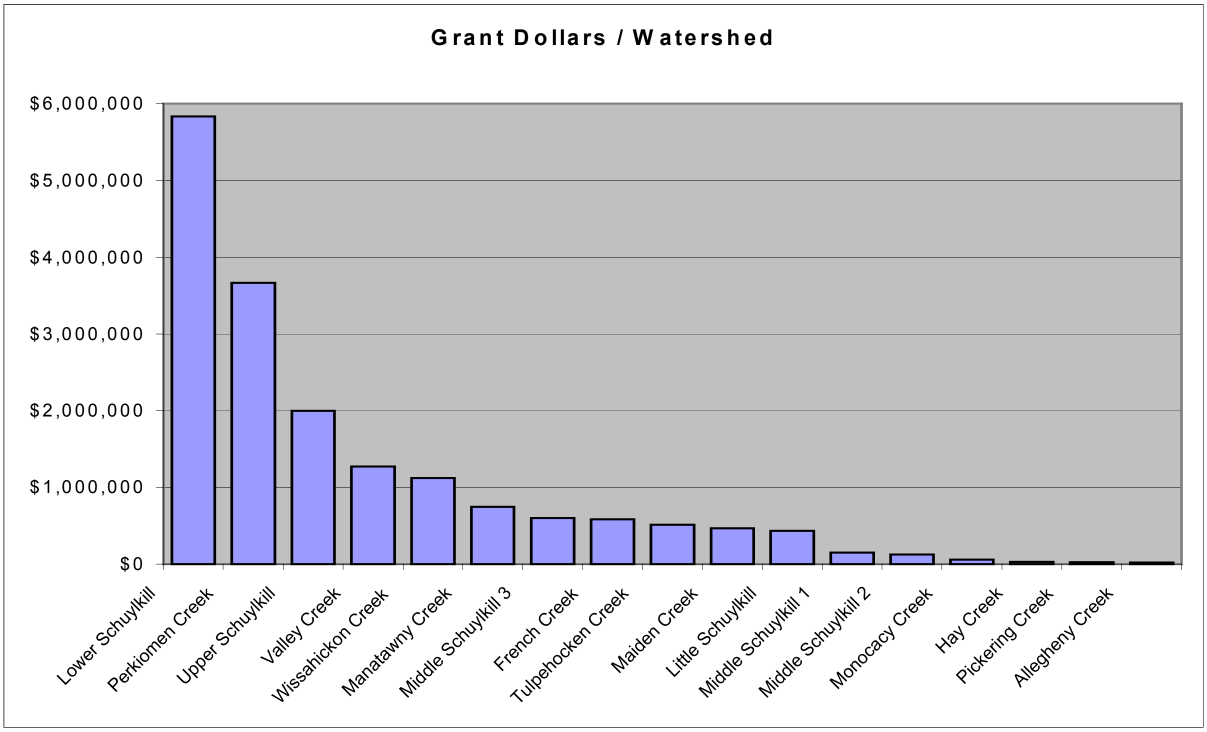
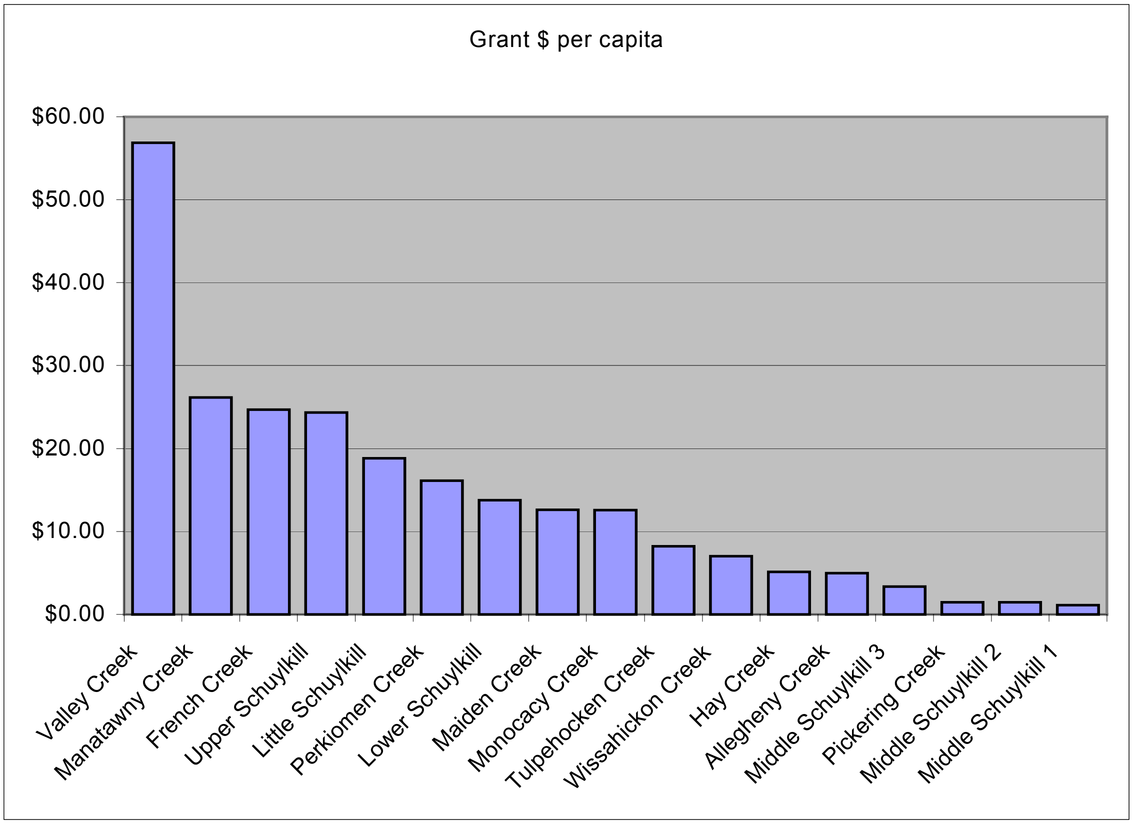


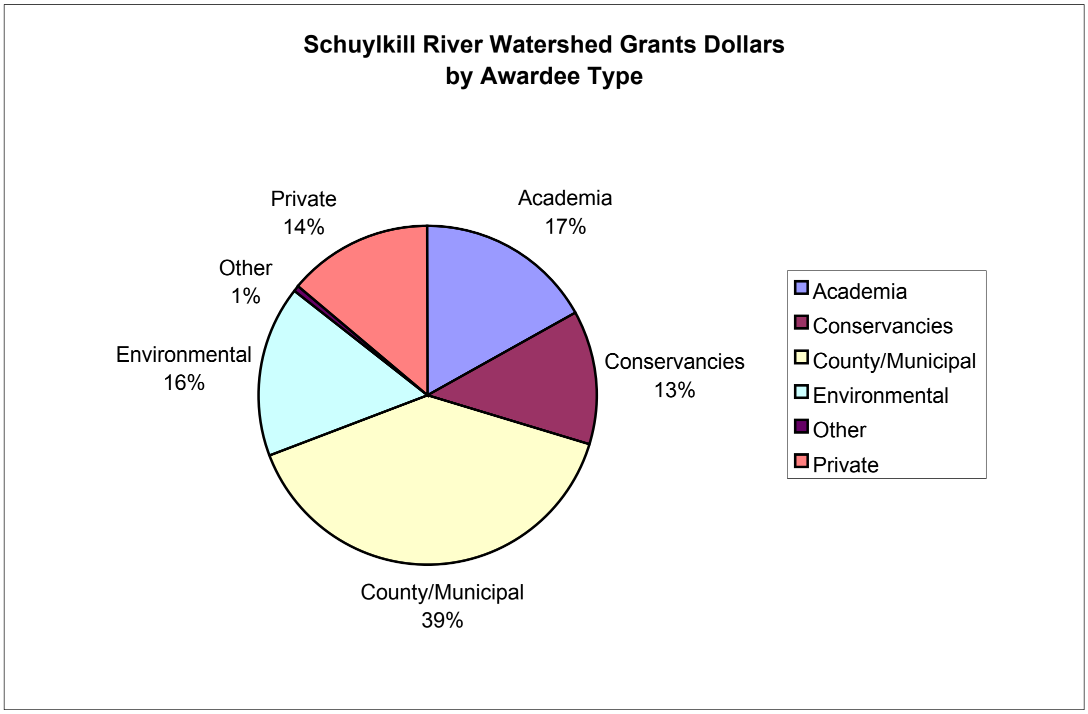
Figure 1.6-2 shows the grant dollars broken up by dollars per capita for each subwatershed. The Valley Creek Watershed ranked number one in terms of grant dollars per capita, with a total of $56.88 awarded per capita. This watershed was the recipient of a large research grant awarded by the National Science Foundation and the Environmental Protection Agency to Drexel University to study the effects of suburban sprawl on water resources. The watershed with the lowest funding was the Middle Schuylkill One, with a $1.12 per capita. The other main stem drainage basins, named Middle Schuylkill Two, and Middle Schuylkill Three, also scored very low in this category. This situation reflects the current organizational status of environmental stewards within the Schuylkill River Watershed. Most of the environmental groups are focused on the watersheds or main tributaries to the river, with very little civic focus on the main stem of the river itself.

Figure 1.6-2 Grant Money per Capita Awarded within each Schuylkill River Subwatershed



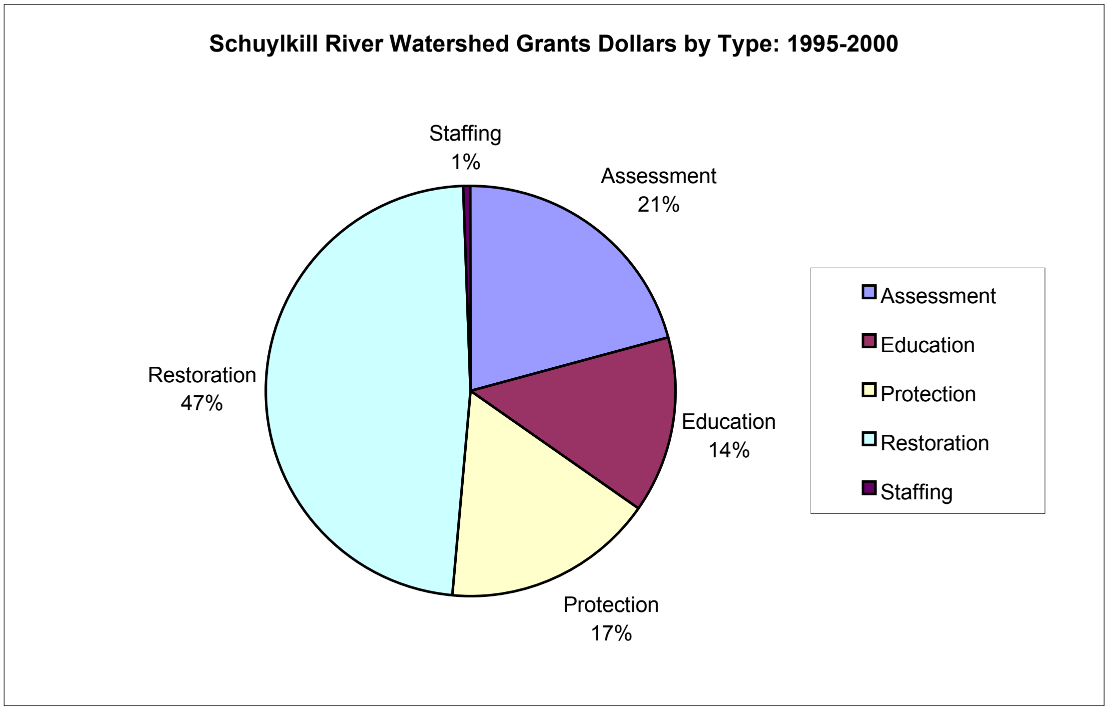
There were a total of 76 different organizations that received grants that applied to the Schuylkill River Watershed. Figure1.6-3 illustrates the percentage of grant dollars that went to each type of grant recipient. County and Municipal groups received the majority of funding within the Schuylkill River Watershed. Academic applicants, such as universities, were the next highest recipient types along with environmental groups and conservancy groups.

Figure 1.6-3 Distribution of Schuylkill River Watershed Grants by Recipient Type



Out of the total $18,115,196 awarded within the Schuylkill River Watershed, most of the grant dollars were spent for remediation /restoration projects. Figure 1.6-4 shows the breakdown in percentage of the total amount of grant dollars by project type.

Figure 1.6-4 Distribution of Schuylkill River Watershed Grants by Project Type



The listing of the stakeholders involved in restoring the Schuylkill River Watershed and its inherent values can be broken up into the following different categories: Government, Academic, Environmental, and Consultants.

1.7 Public Participation Process

Key Points

- **Public kick-off meetings, Technical Advisory Group meetings, media articles and a website were some of the methods used to involve the public in the SWAP.**

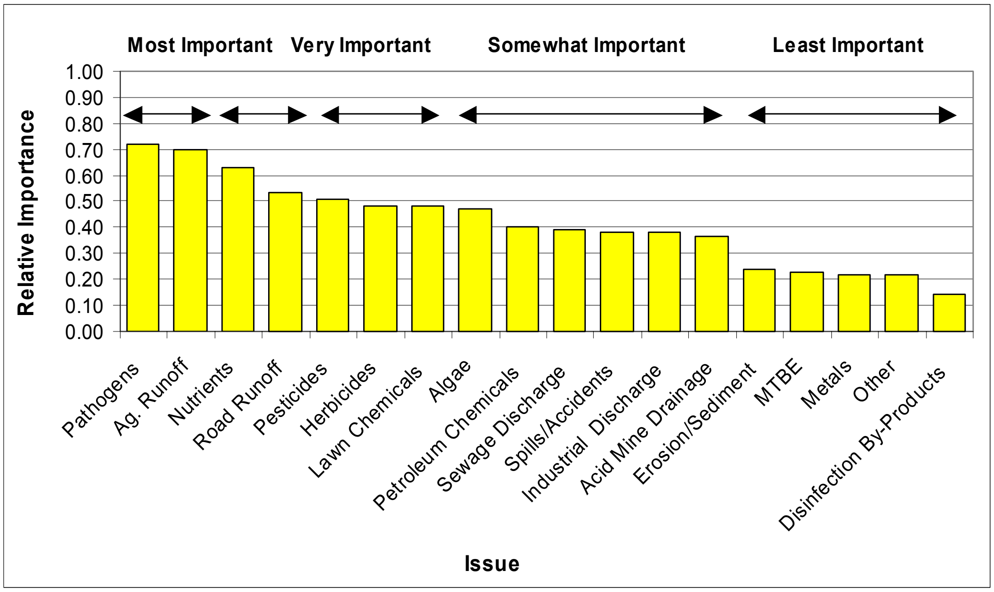
Several avenues were available for stakeholder and public involvement in the Schuylkill Source Water Assessment Program. These included:

- Public kickoff meetings
- Public wrap-up meetings
- Technical advisory group meetings
- Legal notices
- Newspaper articles
- SWAP website

This multi-faceted approach provided opportunities for the partnership to introduce the public and stakeholders to the source water assessment program and process, and for the partnership to obtain information and feedback from the public. Overall, these avenues appear to have been successful at reaching the public and stakeholders. Four public meetings resulted in 37 attendees, 5 advisory group meetings resulted in 147 attendees (about 29 persons per meeting), 9 legal notices were published, 15 newspaper articles were published about the project, and the website has been accessed 521 times to date. Public wrap-up meetings discussing the results of the project are anticipated for spring 2002.

One of the important goals of gathering stakeholder input was to determine the perceived importance of various water quality issues, so that comparisons could be conducted after the assessment was completed. According to the stakeholder input, the 17 water quality issues that were ranked fell into five general priority bins going from most important to least important (see Figure 1.7-1). Overall, pathogens, agricultural runoff, and nutrients were of greatest concern to stakeholders. Erosion and sedimentation control, MTBE, metals, and disinfection by-product precursors were considered the least important.

Figure 1.7-1 Ranking of Water Quality Issues by Stakeholders



1.7.1 Advisory Groups

Key Points

- **An open Technical Advisory Group (TAG) was established to facilitate communication among stakeholders and to gather information about the watershed.**
- **The TAG meets quarterly to assist the Source Water Assessment Partnership in the SWAP process.**

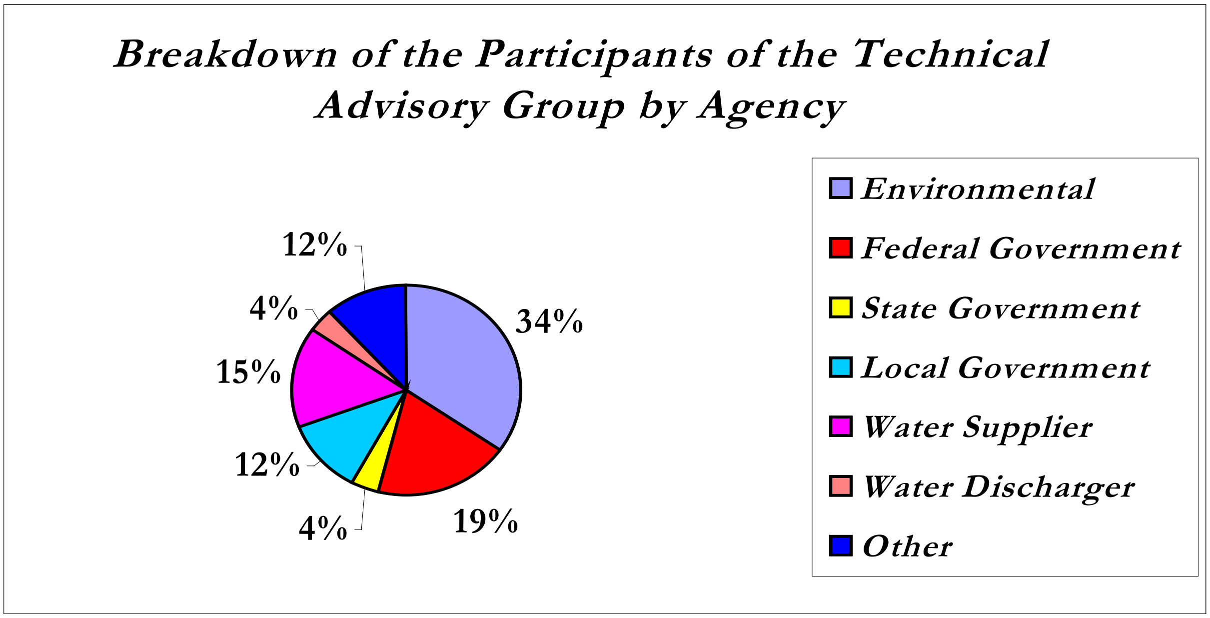
In order to better facilitate communication among the Source Water Assessment Partnership and the regions of the Schuylkill River Watershed to be assessed, an open Technical Advisory Group (TAG) was formed. This TAG was developed by the partnership as a way to closely interact with the stakeholders, and in turn, to gather integral information about each region of the Schuylkill River Watershed. All of the 200 stakeholders were invited by the partnership to participate. Meeting quarterly, it is the primary responsibility of the TAG to inject public interest into the SWA process. Moreover, others duties of this group include:

- Sharing information with stakeholders
- Verifying the information put forth by the partnership
- Providing input on the assessment techniques and criteria used by the partnership
- Offering general information regarding the areas local to each TAG
- Participating in public outreach and education
- Describing current protection activities
- Identifying “potential” sources of contamination and preservation
- Assisting in the development of summary reports

Technical Advisory Group Participants

Composed of watershed organizations, public interest groups, dischargers, suppliers, and local government agencies, the TAG offers a broad variety of perspectives and visions. The following graph is illustrative of the various types of agencies participating in the Technical Advisory Group (see Figure 1.7.1-1).

Figure 1.7.1-1 Technical Advisory Group Breakdown



The following is a summation of some of the TAG's participants:

It is the mission of the *Department of Environmental Protection (DEP)* to protect the air, land, and water of Pennsylvania from pollution, and to provide for the health and safety of its citizens through a cleaner environment. DEP works as a partner with individuals, organizations, governments, and businesses for the prevention of pollution and the restoration of natural resources. It achieves these goals via public service, protection, teamwork, communication, and pollution prevention. DEP is the State agency largely responsible for administering Pennsylvania's environmental laws and regulations. Its responsibilities include: reducing air pollution; making sure that our drinking water is safe; protecting water quality in our rivers and streams; making sure waste is handled properly; managing the Commonwealth's recycling programs and helping citizens prevent pollution and comply with the Commonwealth's environmental regulations. DEP is committed to general environmental education and encouraging effective public involvement in setting environmental policy.

Incorporated in 1969, the *Western Berks Water Authority* supplies water to the Borough of Wyomissing from its water treatment plant located on the Tulpehocken Creek, thereby meeting all of the water needs of the residents of Wyomissing, West Reading, and Shillington. The Western Berks Water Authority also supplies water to Mohnton and Lincoln Park, as well as portions of Cumru Township, and small quantities to the Citizens Utility Water Company, the Blue Marsh Lake Park and the fire companies. The authority's present water system facilities include a complete water treatment plant capable of supplying up to eight million gallons of water per day. The authority aligns with the Borough of Wyomissing's mission to provide services identified with the tradition of excellent living in Wyomissing.

PennFuture is an organization that takes pride in defending the environment. In achieving its mission of defending nature, PennFuture effectively resists those who attack the environment and rallies against those who fail to do their duty to protect it. By combating global warming, smog, acid rain, and illness, and by advocating the increase of desperately needed funding for farmland preservation, among other things, PennFuture is making great strides in assuring that polluters and their allies no longer decide the fate of the environment and the economy. Comments and concerns may be voiced to Brenna Herpmann at (800) 321-7775. PennFuture's mailing address is 212 Locust Street, Suite 410, Harrisburg, PA 17101.

In order to share the responsibility of managing the water resources of the Delaware River Basin, the ***Delaware River Basin Commission (DRBC)*** was formed by the signatory parties of the Delaware River Basin Compact (Delaware, New Jersey, New York, Pennsylvania, and the United States). Since its inception on October 27, 1961, the very day that Compact became law, DRBC has been a pacesetter in environmental protection. As mentioned in its mission statement, DRBC focuses mainly on protecting, enhancing, and developing the water resources of the Delaware River Basin for the benefit of present and future generations. In achieving their mission, DRBC has developed such programs as water pollution abatement, water supply allocation, regulatory review (permitting), water conservation initiatives, regional planning, drought management, and flood control. Questions, comments, and concerns may be forwarded to Jon Zangwill via e-mail, zangwill@drbc.state.nj.us or telephone, (609) 883-9500 x 307. DRBC's mailing address is 25 State Police Drive, West Trenton, NJ 08628.

The ***Schuylkill River Greenway Association*** is a membership organization that has been working with citizens, community groups, and a host of other partners for almost 25 years. The primary objective of the association is to promote the advocacy of river resources and open space. In 1995, with the designation of the Schuylkill River Corridor as Pennsylvania's seventh Heritage Park, the association expanded its mission to include such focal points as the conservation of the historic and cultural resources within the watershed as well as the economic development of such resources. Inquiries may be voiced to Executive Director Dixie Swenson via telephone, (610) 372-3916 or e-mail, srga@ptd.net. The Schuylkill River Greenway Association's mailing address is 960 Old Mill Road, Wyomissing, PA 19610-2522.

Clean Water Action (CWA) is a national citizens' organization that works toward the following goals: affordable water, prevention of health-threatening pollution, creation of environmentally safe jobs and businesses, and the empowerment of people to make democracy work. In addition, CWA organizes grassroots groups, coalitions, and campaigns with the common interest of protecting health and quality of life, so that they may better promote environmental well-being within a community. The mailing address of the CWA National Office is 4455 Connecticut Avenue NW – Suite A300, Washington, DC 20008-2328 (Telephone: (202) 895-0420). The mailing address of the CWA Philadelphia Office is 1201 Chestnut Street, #602, Philadelphia, PA 19107. All inquires may be directed to Bob Wendelgass at the Philadelphia Office via e-mail, bwendelgass@cleanwater.org or telephone, (215) 640-8800.

Since its inception in 1950, the *Montgomery County Planning Commission (MCPC)* has made great strides in promoting order and development while also preserving the elements of the Montgomery County Watershed that define the community's quality of life. The MCPC is an advisory body on the following subjects: land transportation of all types, the environment, water and sewer service, parks and open space, farmland preservation, stormwater management, site design, housing, zoning, development patterns, and the demographic trends within Montgomery County. MCPC is composed of 9 member-appointed board members as well as a professional staff of 44, all of whom provide support to municipal governments via innovative solutions to the challenges at hand. All questions, comments, and concerns may be voiced to MCPC Director, Kenneth B. Hughes via telephone, (610) 278-3722. The MCPC mailing address is P.O. Box 311, Norristown, PA 19404-0311.

The mission of the *Schuylkill Riverkeeper Program* is to protect and restore the Schuylkill River and its tributaries and habitats through advocacy, enforcement, and citizen action. The Riverkeeper is a field office of the Delaware Riverkeeper Network and collaborates with the Patrick Center for Environmental Research at the Academy of Natural Sciences. The primary focus of the Riverkeeper Program is to identify and restore degraded streambanks throughout the Schuylkill River Watershed while also working with landowners to address the effects of sediment and nutrient pollution on waterways, all of which is encompassed within the Schuylkill Riverkeeper's Streambank Restoration Project. All inquiries may be directed to Chari Towne via telephone, (610) 469-6005 or e-mail, srk@worldlynx.net. The mailing address of the Schuylkill Riverkeeper Program is P.O. Box 459, St. Peters, PA 19470-0459.

The *Berks County Conservancy*, a non-profit organization established in 1974, is dedicated to preserving Berks County's unique cultural and environmental heritage for the benefit of future generations. In order to achieve this, the conservancy has focused its efforts on the preservation of agricultural land and open space, the protection of the quality of the streams and ground water of Berks County, and the preservation of historic landmarks and scenic landscapes, all of which contribute to a sustainable future for the Berks County Community. Simply put, protecting water, habitat, and the natural environment are conservancy priorities. Questions may be forwarded to Joseph Hoffman, Director of Environmental Management, via telephone, (610) 372-4992. Berks County Conservancy's mailing address is 960 Old Mill Road, Wyomissing, PA 19610.

It is the mission of the *Nature Conservancy* to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters needed to survive. Since its inception in 1951, the Nature Conservancy, the world's largest private international conservation group, has formed partnerships with communities, businesses, and individuals in order to pave the road for the protection of millions of acres of valuable lands and waters worldwide. It is the commitment of the Nature Conservancy to expand the boundaries of conservation in order to save Earth's last great places for future generations. All questions, comments, and concerns may be directed to Randy Gray, State Director, via telephone, (610) 834-1323 x116. The Nature

Conservancy's mailing address is 1100 East Hector Street, Suite 470, Conshohocken, PA 19428.

Formed in September 1995 when the Lower Merion-Narberth Watershed Association merged into the Lower Merion Preservation Trust, the *Lower Merion Conservancy* has since acted to protect the Lower Merion area's natural and historic resources, open space, and watersheds for residents and future generations by promoting collective responsibility for these resources via education, advocacy, and research. Questions and concerns may be voiced to Executive Director Mike Weilbacher at (610) 645-9030. The mailing address of the Conservancy is 1301 Rose Glen Road, Gladwyne, PA 19035.

The *Natural Lands Trust* is a nonprofit regional land trust that is committed to working with the region's communities to protect old-growth forests, diverse wildflower meadows, and dynamic wetlands. Through acquisition, conservation, easements, planning, and education, this organization encourages others to ensure the preservation of natural and cultural resources for many generations to come. Questions may be forwarded to Andy Pitz at (610) 353-5587. The mailing address of the Trust is 1031 Palmer's Mill Road, Media, PA 19063.

Incepted in 1964, the *Perkiomen Watershed Conservancy* has since been dedicated to protecting and conserving the natural resources within the Perkiomen Creek Watershed. This nonprofit organization reaches out to the surrounding community via environmental education and land conservation and protection. Questions, comments, and concerns may be forwarded to Executive Director Tish Ryan at (610) 287-9383. The mailing address of the Conservancy is 1 Skippack Pike, P.O. Box 55, Schwenksville, PA 19473.

It is the mission of the *Pennsylvania Environmental Council (PEC)* to improve the quality of life for all Pennsylvanians. In doing so, PEC enhances the Commonwealth's natural and man-made environments by integrating the advocacy, education, and implementation of both community and regional action programs. Director of Watersheds Programs, Ann Smith, will be accepting questions, concerns, and comments at (215) 563-0250. The mailing address of the PEC is 117 South 17th Street, Suite 2300, Philadelphia, PA 19103-5022.

Technical Advisory Group Meetings

Six TAG meetings were held as of September, 2001. The following table outlines the date, location, and number of attendees of each meeting.

Table 1.7.1-1 Summary of Technical Advisory Group Meeting Dates and Locations

Meeting	Date	Location	Number of Attendees
1	October 25, 2000	DEP Offices Conshohocken, PA	47
2	January 17, 2001	DEP Offices Conshohocken, PA	29
3	April 4, 2001	DEP Offices Conshohocken, PA	24
4	May 9, 2001	DEP Offices Conshohocken, PA	28
5	June 13, 2001	DEP Offices Conshohocken, PA	19
6	September 24, 2001	DEP Offices Conshohocken, PA	14
			Total Attendees 161

Summarization of Technical Advisory Group Meeting Minutes

These meetings were, in essence, forums for discussion during which local stakeholders were encouraged to voice their concerns and share their opinions of the project. The following is a summation of the minutes from the first five meetings:

MEETING 1

This meeting acted as an introduction to the Schuylkill River Watershed as well as to the Source Water Assessment Program. The watershed of the Schuylkill River was described as a significant industrial, agricultural, and commercial corridor, a home to three million people in Pennsylvania in which 40% of the land is forested, 48% is agricultural, and 12% is developed. The region was cited as a source of heritage, history, culture, and recreation.

The specific aspects of the Schuylkill River Watershed as a source of drinking water supply are as follows:

- 58 surface water intakes
- 47 intakes for systems serving < 10,000
- 265 MGD withdrawn on average from the river and its tributaries
- serves over 1.8 million people

The Source Water Assessment (SWA) was explained to be a multi-phase process. The process identifies potential or existing sources of contamination, evaluates the vulnerability/susceptibility of a water supply to contaminant sources, and identifies protection priorities and activities for the water supply. The ultimate goal of a SWA was specified as developing local sources of water protection initiatives and educating the public about the source of their drinking water and its challenges. The SWA was depicted as an iterative and continuous process of assessing, planning, and implementing.

Utilities and stakeholders were encouraged to become interested in the SWAs because the program was based on federal regulations mandated by Congress. Responding to requests by the public to know more about their water supply and how to protect it, Congress included provisions for a SWA within the Safe Drinking Water Act Reauthorization of 1996. It is the goal of Congress to have 50% of the United States population enveloped under Source Water Protection Plans by 2005.

The SWAs were said to benefit the stakeholders present at the meeting because stakeholders of the TAG would be directly involved by:

- Identifying sources of contamination and areas for protection
- Having their organization highlighted for interested persons to contact/join
- Determining potential linkages between their efforts and protection efforts
- Increasing potential funding opportunities by incorporating projects into approved SWA plans

The Schuylkill River SWA area to be covered is comprised of 42 surface water intakes, 3 PADEP regions, 2,000 square miles of area, 130 miles of river, and 10 counties. The organization of the SWA was described as two distinct, but linked phases.

Phase I is inclusive of:

- 7 intakes
- 4 water systems
- 73% of the population
- 80% of river withdrawal for drinking water supplies
- Bottom of the watershed
- Industrial/urban/suburban issues

Phase II includes:

- 35 intakes
- 14 water systems
- 27% of the population
- 20% of withdrawal

- Headwaters to middle of river
- Rural, mining, agricultural, suburban issues

A schedule and timeline were presented in which Phase I, which began in July 2000, was marked for completion by December 2001. Phase II is scheduled to begin in July 2001 and end in July 2003.

MEETING 2

Phase I of the SWA was further discussed at this meeting. Of particular focus was the Stakeholder Survey, a document that was sent to stakeholders prior to the meeting, which listed key contaminant issues and requested that the stakeholders rank those issues on a relative scale of zero to one, with one being of the highest priority. Those stakeholders who responded to the survey included one municipal water supplier, one federal agency, and nine not-for-profit agencies. These respondents ranked pathogens and agricultural runoff as the issues having the highest priority with a ranking of approximately 0.7. On the opposite end of the scale, disinfection by-products were ranked as having the lowest priority with a score of 0.2.

The water quality of the Schuylkill River was also discussed. Parameters affecting water treatment were identified. When discussing contaminant source issues, it was determined that contaminant issues will vary with each perspective. For instance, the outlook of a fisherman will be significantly different than that of the upstream water suppliers and, likewise, the downstream water suppliers will have a differing perspective than that of the stakeholders. Table 1.7.1-2 outlines the parameters of concern from both a drinking water perspective and a finished water quality perspective.

Table 1.7.1-2 Perspectives on Water Quality Parameters of Concern

Drinking Water Perspective	Finished Water Quality Perspective
• Algae – clogs filters • Alkalinity and pH – affect coagulation • Turbidity – impacts coagulant and residual management costs • Metals – require additional chemicals for removal	• Algae – may cause taste and odor episodes • Salts – not removed by treatment and affects those on low sodium diets • *Cryptosporidium* – resistant to chlorine and may affect immune compromised subpopulations • Total Organic Carbon and Bromide – affect disinfection by-product formation

Water quality data, spanning a period of 30 years (1970 – 2000), for dozens of locations in the Schuylkill River Watershed had been compiled from several organizations. Of this data, conductivity, nutrients, metals, salts, and dissolved oxygen were identified as the most frequently monitored parameters, with pesticides, herbicides, and pathogens making up those parameters that are less frequently monitored.

MEETING 3

At Meeting Three, the four main sources of contaminant source compilation were established:

- Right to Know (RTK) Network (www.rtk.net)
- Envirofacts (www.epa.gov/enviro)
- Efacts (www.dep.state.pa.us/dep/efacts/resources)
- ESRI Business MapPro

Within the RTK and Envirofacts systems, four federal databases were accessed: PCS (Permit Compliance System), RCRIS (Resource Conservation and Recovery Act Information System), CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Act Information System), and TRI (Toxic Release Inventory). In order to populate the databases, data was downloaded from RTK by county and then "clipped" in RTK for the purpose of eliminating those data points outside of the watershed boundaries. Missing "x-y" coordinates were filled in by geocoding in ArcView and cross-referencing the same facility with other databases and Envirofacts. Facility data was then further cross-referenced with Envirofacts. Quality and contaminant data was populated via Envirofacts.

A second keynote feature of this meeting was the discussion of the process used to evaluate and prioritize the most critical sources within the Schuylkill River Watershed.

It was determined that this process must be:

- Inclusive of all potential sources
- Equitably applied everywhere within the watershed
- Logical and well-founded
- Reproducible and defensible

In order to satisfy this need, EVAMIX was introduced. This is a computerized matrix-based mixed-data, multi-criteria evaluation method and ranking tool. EVAMIX uses a pair-by-pair comparison of each source against each other source via a criterion. This method is capable of performing hundreds of comparisons and calculations while handling units properly, as well as considering both quantitative and qualitative criteria. This method results in a single number or "appraisal score," that encompasses all of the data included in the criteria as well as the criteria weights. This number is also representative of the relative rank of "source x" against all other sources, which in turn provides a strong foundation for assigning priorities to each particular source. EVAMIX is used primarily for decision support. Using this framework, it is possible to evaluate alternatives, prioritize options, organize data to facilitate decisions, formalize and document the decision process, and act as evidence in defense of the decision made.

It was determined that the results gathered from the EVAMIX matrix will be further reviewed and "reality checked." Any results for high-ranking sources will be added to other sources outside the scope of the analysis, e.g., highway spills, pipeline breaks, etc. All high-ranking sources will be flagged for follow-up data collection in a later phase in order to verify results. Zones were broken down into categories "A", "B", and "C" and calculated using the Geographical Information System (GIS) and river time travel estimates. The zone delineation is as follows, beginning with an area-wide inventory:

- Zone A: critical segment, all potential sources
- Zone B: second segment, all significant sources
- Zone C: remainder, just area-wide inventory

The goal of the Schuylkill Source Water Assessment was again cited as gaining an understanding of which sources within the Schuylkill River Watershed are most significant and which are not as critical. In doing so, a better understanding of present water quality concerns as well as a sharper focus on the most critical sites will be provided. This, in turn, will lead to a more limited number of high priority sites within the Schuylkill River Watershed.

MEETING 4

One main topic of this meeting was the population of missing data to characterize sources. The Schuylkill River SWA Approach offers controlled screening for point sources as well as for non-point sources, which will allow for an end result of a limited number of high priority sites, i.e., approximately 50 sites per intake. Missing information including flow, quantity, chemical group, and SIC code matching PADEP activity were identified.

Another keynote point of this meeting is significance screening, which aids in the development of the best estimate of quantity, concentration at the release point, as well as the dilution at the intake. The steps to be taken regarding this approach are as follows:

- Development of the best estimate of the worst case release (quantity)
- Calculation of concentration at the release point
- Calculation of dilution at the intake
- Comparison to "Threshold Impact"

When too little data is available, screening will be conducted using the number of releases, the amount stored, the chemical stored, and the location relative to the floodplain. Other steps include choosing a Threshold Value in terms of Drinking Water Standards and Ambient Mean Concentrations, determining a background concentration, calculating discharge in order to increase concentration by ten percent of ambient or of standard at the intake, and calculating the amount of spill of pure contaminant where appropriate.

Table 1.7.1-3 outlines the contaminant categories suggested at this meeting, as well as their potential fields, for the purpose of populating the databases.

Table 1.7.1-3 Proposed Contaminant Categories and Thresholds

Suggested Contaminant Categories	Potential Fields
Fecal Coliform	• Possible Threshold: 200 count/100ml • Threshold Type: Contact Recreational Water Standard • Discharge Volume to Exceed Threshold: 100 MGD of wastewater die off at 2,000 count/100 ml • Spill size to Exceed Threshold: Not Applicable
Turbidity (TSS)	• Possible Threshold: 10 mg/l • Threshold Type: Ambient Concentration • Discharge Volume to Double Threshold: 5 MGD at 200 mg/l (average wastewater) • Spill Size to Double Threshold: 10,000 lbs. of silt runoff in one day
Nutrients (Phosphorous)	• Possible Threshold: 0.12 mg/l • Threshold Type: Ambient • Discharge Volume to Exceed Threshold: 5 MGD to raise by 10% • Spill Size to Exceed Threshold: 110 lbs. of pure Phosphorous in one day
VOC (total)	• Possible Threshold: 5 parts per billion (ug/l) • Threshold Type: Drinking Water Standard for Benzene • Discharge Volume to Exceed Threshold: Not Applicable • Spill Size to Exceed Threshold: < 5 gallons per day of pure product
Metals (Pb as indicator)	• Possible Threshold: 0.015 mg/l • Threshold Type: Drinking water treatment trigger value • Discharge Volume to Exceed Threshold: approx. 1.5 MGD of industrial wastewater at 10 mg/l • Spill Size to Exceed Threshold: approx. 15 lbs. per day
Cryptosporidium/Giardia	• Possible Threshold: 1 oocyst per liter • Threshold Type: Drinking Water Guideline Value • Discharge Volume to Exceed Threshold: 10 oocysts per liter
Nitrates	• Possible Threshold: 10 mg/l • Threshold Type: Drinking Water Standard • Discharge Volume to Exceed Threshold: > 50 MGD • Spill Size to Exceed Threshold: 10,000 lbs.
DPB Precursors (TOC)	• Possible Threshold: 2.7 mg/l • Threshold Type: Ambient Median Value • Discharge Volume to Raise Threshold by 10%: 4 MGD of wastewater at 100 mg/l • Spill Size to Exceed Threshold: approx. 2,000 lbs. per day
Petroleum Hydrocarbons (TPH)	• No Identified Possible Threshold • Threshold Type: Ambient (data sparse) • Discharge Volume to Exceed Threshold: Not yet determined
Salts (Chloride as indicator)	• Possible Threshold: 250 mg/l • Type of Threshold: Drinking Water Standard • Discharge Volume to Exceed Threshold: 1 MGD of brine (sea water) • Spill Size to Exceed Threshold: 200,000 lbs. of salt per day

MEETING 5

The primary focus of this meeting was on Source Priority Ranking. In essence, three questions needed to be answered:

- Are criteria missing?
- Are the qualitative scores properly defined?

- Are the criteria priorities (weighting factors) satisfactory to the group?

At this meeting the diverse group including water suppliers, stakeholders, and dischargers reached a consensus on the criteria and the weighing factors to be used for ranking the sources. The group also agreed that the nine criteria of Relative Impact at Intake, Time of Travel, Existing Removal Capacity, Impact on Treatment, Potential Health Impacts, Potential for Release/Controls, Potential for Release Frequency, Violation Type/Frequency, and Location were sufficient to complete the ranking criteria. It was agreed that no other criteria were missing.

Weighing factors and qualitative definitions were determined for the criteria being used to rank sources across all contaminant categories as well as within the six individual categories, thus answering the three primary questions posed. Tables 1.7.1-4 and 1.7.1-5 outline the actual criteria, criteria type, and the percentages agreed upon for both the nine contaminant categories and the six individual contaminant categories at this fifth meeting of the SWA. These are summarized by Figures 1.7.1-2 and 1.7.1-3

Table 1.7.1-4 Consensus Weighing Values for Nine Criteria

Criteria	Type	Weight (%)
Relative Impact at Intake	Intake Related	12
Time of Travel	River Flow Related	5
Existing Removal Capacity	Intake Related	10
Impact on Treatment	Intake Related	10
Potential Health Impacts	User Related	20
Potential for Release/Controls	Source Related	14
Potential for Release/Frequency	Source Related	14
Violation Type/Frequency	Source Related	10
Location	River Flow Related	5

(To be used in the EVAMIX analysis across contaminant categories)

Figure 1.7.1-2 Summary of Criteria Types for Contaminant Categories

Contaminant Categories
Source Related Factors: 38%
Intake Related Factors: 32%
User Related: 20%
River Flow Related: 10%

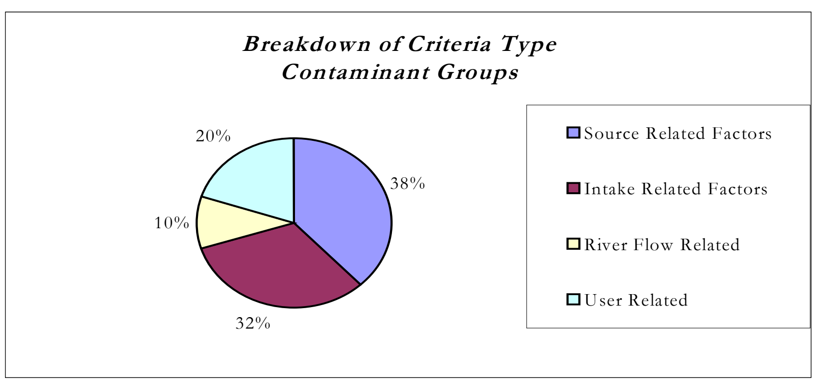


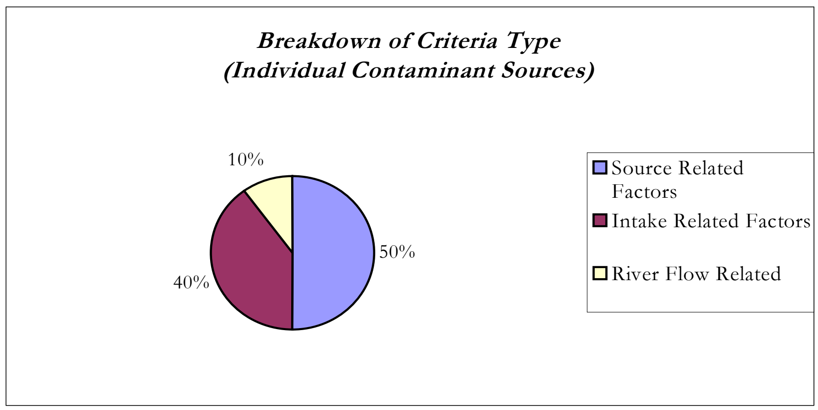
Table 1.7.1-5 Consensus Weighing Values for Six Criteria

Criteria	Type	Weight (%)
Relative Impact at Intake	Intake Related	40
Time of Travel	River Flow Related	5
Potential for Release/Controls	Source Related	20
Potential for Release/Frequency	Source Related	15
Violation Type/Frequency	Source Related	15
Location	River Flow Related	5

(To be used in the EVAMIX analysis within individual contaminant categories)

Figure 1.7.1-3 Summary of Criteria Types for Individual Contaminant Categories

Individual Contaminant Categories
Source Related Factors: 50%
Intake Related Factors: 40%
River Flow Related: 10%



These rankings will be later used to prioritize contaminant sources for source water protection efforts.

1.7.2 Public Meetings

Key Points

- Thirty-seven people attended the four public kick-off meetings held to introduce the SWAP.

Four public kick-off meetings were conducted to educate the public about the importance of the Source Water Assessment Program (SWAP). Each public kick-off meeting utilized the following general approach in order to generate public interest:

- Press releases produced by the Philadelphia Water Department and the local stakeholders were sent to the local media and newspapers
- Legal notices were sent to the local media and newspapers
- Advertisements were published in the Pennsylvania Department of Environmental Protection (PADEP)'s *Update*

Hosted by local watershed organizations to promote a sense of credibility as well as to establish a connection with local residents, these meetings were, in essence, informational forums where members of the public were able to voice their concerns as well as share their visions for the project. The following table outlines the host, location, date, and number of attendees for each of the four aforementioned public meetings.

Table 1.7.2-1 Public Kickoff Meetings Held for Lower Schuylkill Intakes

Meeting	Host(s)	Location	Date	Number of Attendees
1	Schuylkill Riverkeeper & Greater Pottstown Watershed Alliance	Montgomery County Community College, West Campus Pottstown, PA	2/15/01	14
2	Wissahickon Valley Watershed Association	Wissahickon Valley Watershed Association Ambler, PA	2/20/01	8
3	Perkiomen Valley Watershed Conservancy	Perkiomen Valley Watershed Conservancy Schwenksville, PA	3/13/01	7
4	Schuylkill Environmental Education Center	Schuylkill Environmental Education Center Philadelphia, PA	3/14/01	8
				Total Attendees 37

A standard meeting agenda was developed and followed at each meeting. This agenda consisted of an introduction and an explanation of the purpose of the meeting. Another component of this agenda was an overview of Source Water Assessments, which included a brief, yet thorough, description of the SWAP as well as the areas to be assessed, i.e., the Schuylkill River Watershed. In addition, a discussion of contaminant source issues and water quality concerns was a keynote feature of the agenda. Finally, each meeting was concluded with an exercise in identification of potential contaminant sources, in which the attendees were asked to identify local sites that may impact the water supply. Questions, concerns, and comments were addressed as they were raised.

Prior to these kick-off meetings, several avenues were pursued in an attempt to notify the public of their occurrence. Letters produced by the Philadelphia Water Department, local stakeholders, and watershed groups specifying the location and directions, date, time and nature of the meetings were mailed to numerous stakeholders, including many of the businesses, government agencies, and environmental organizations located within or affected by the Schuylkill River Watershed. The information contained in these letters was also posted on the SWAP website, www.schuylkillswa.org. In order to further generate public interest, various watershed groups and local stakeholders posted flyers throughout their respective areas and sent press releases to their local newspapers. Additionally, many of those local newspapers featured articles describing the nature of the meetings as well as the outcome, where applicable. Legal notices detailing the location, time, and date of each meeting were printed in the local newspapers in each area with which the SWAP is affiliated, for the purpose of opening the meetings to everyone within the watershed. Table 1.7.2-2 is illustrative of the publications in which the legal notices appeared, the dates of publication, and the general areas reached.

Table 1.7.2-2 Legal Notices Published for Public Kickoff Meetings

Date Of Notice	Publication Name	Area Reached
2/11/01	The Norristown Times Herald	Norristown, PA
2/14/01	The Ambler Gazette	Ambler, PA
2/17/01	The Lansdale Reporter	Lansdale, PA
2/19/01	The Norristown Times Herald	Norristown, PA
2/22/01	The Pottstown Mercury	Pottstown, PA
3/11/01	The Norristown Times Herald	Norristown, PA
3/11/01	The Pottstown Mercury	Pottstown, PA
3/12/01	The Philadelphia Daily News	Philadelphia, PA
3/12/01	The Philadelphia Inquirer	Philadelphia, PA

One article, featured in the April 30, 2001 edition of The Pottstown, clearly demonstrates how these kick-off meetings have impacted the public. At the February 15, 2001 meeting, hosted by the Greater Pottstown Watershed Alliance and the Schuylkill Riverkeeper, residents of North Coventry Township were stunned by photographs of pollution sources lining the Schuylkill River on Route 724 between Scholl Road and the Union Township Line. In response to the discouraging photos they had seen, eighteen volunteers hailing from North Coventry, Pottstown, the Pottsgroves, Phoenixville, Sanatoga, and Bryn Mawr, among other places, met at the site on Saturday, March 24, 2001 and a massive clean-up ensued. Two dump trucks of trash, two pickup trucks of metal scrap, and 40 tires were picked up. The February 15, 2001 kick-off meeting acted as a catalyst in enticing the public to take the action necessary to preserve the beauty and utility of their surrounding waterways.

1.7.3 Website

Key Points

- SWAP project information is available through the project website, www.schuylkillswa.org.

A website was developed for the project (*www.schuylkillswa.org*) to provide a location where information about the project could be easily accessed by the public and stakeholders (see Figure 1.7.3-1). Though this was a task beyond the scope of the contract, it was considered a necessary form of information delivery. Most importantly, the website was considered the most efficient way of providing the advisory group meeting information, meeting handouts, and meeting minutes without producing a significant burden of production on staff, given that there are more than 200 stakeholders to whom information must be mailed on at least a quarterly basis.

The website was set up to provide general information about the purpose of the SWAP and contact information. It also provided links to information about public meetings, advisory group meetings, meeting materials, general watershed information, limited maps, watershed organizations, and general water quality information. Another special feature was an on-line stakeholder survey that stakeholders could fill out to provide information about their water quality issues.

Figure 1.7.3-1 Schuylkill River SWAP Website (www.schuylkillswa.org)

1.8 General Recommendations for the Schuylkill River Watershed

The compilation of extensive field surveys, interviews with numerous stakeholders, and the examination of water quality, land use, and impaired stream information were compiled into the recommendations listed below for the Schuylkill River Watershed. These recommendations address 12 different categories, including general watershed protection ideas and specific activities related to watershed issues.

1.8.1 Grant Funding and Watershed Organizations

- Based on the protection priority areas, restoration projects, and grant funding information available, it is apparent that there is a need for more restoration projects and watershed organizations for protection of the main stem of the Schuylkill River between Philadelphia and Reading. Restoration projects in the priority corridor should be given special consideration and hopefully promote development of local sponsors in these areas more effectively.

- Development of a regional water supply/watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection. This would include a special matching source water protection grant fund for the Schuylkill River Watershed that members would contribute to the state for matching. The watershed council including representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and fund projects with the most value to water supply protection.

- The Allegheny, Hay, and Pickering creeks appear to have received low amounts of grant funding for protection and restoration efforts, even though they are water supplies for Birdsboro and Philadelphia Suburban. This may be due in part to the fact that most of the watershed is protected. Therefore, the continued protection and preservation of these areas are important.

- A watershed organization should be established for the Pickering Creek Watershed.

1.8.2 Protection and Preservation

- A coordinated regional protection plan needs to be developed and adopted by water suppliers, planning commissions, and municipalities for establishment and protection of sensitive and high priority protection areas to the multiple and overlapping water supply areas between Reading and Philadelphia.

- Existing greenspace along the Schuylkill River in the protection area between Philadelphia and Reading should be preserved.

- Conservation easements should be acquired, zoning areas adjusted, or local ordinances enacted in order to reduce stormwater impacts from future development in the protection priority corridor between Philadelphia and Reading.

- The TMDL process and requirements along the Schuylkill River should include components to address drinking water impacts.

The same protection priority corridor along the main stem of the Schuylkill River for PWD's intakes overlaps significantly with the protection priority areas for Pennsylvania American Water Company – Norristown, Philadelphia Suburban Water Company, Phoenixville Boro, Citizen's Utilities – Royersford, and Pottstown Boro water supply intakes. The runoff and point sources in this corridor impact the water supplies for more than 1.3 million people that receive drinking water from these sources in the area encompassed by Berks, Chester, Montgomery, and Philadelphia counties. Therefore, the protection priority corridor requires special attention, legislation, and regulation. This includes special legislative actions and regulatory designation of this area to provide opportunities for enhanced discharges and reduced stormwater runoff impacts.

The Schuylkill River Corridor needs special assistance, as evidenced by stream impairments and recreational water quality issues. Given that many industries also withdraw water for electric generation and that the majority of persons in the watershed reside in or near the protection corridor and conduct recreation in or along it, the benefits to aquatic life, recreation, industry, and quality of life for citizens in general are significant and cannot be ignored. Coincidentally, the protection priority corridor is also the focus of significant efforts for the creation of greenways and recreational trails. In this case, the desire for increased recreational opportunities and greenways coincides with a desire to protect water supplies, and represents a significant opportunity for numerous stakeholders.

Priority for funding of Growing Greener and DCNR grants for projects in the protection priority area should be given to projects that address sustainable mitigation of stormwater impacts and restoration or preservation of areas. In addition, agricultural land within the protection priority corridor would also be given easier access and higher priority for USDA funding, such as EQUP or CRP, in order to keep sensitive land areas out of production and protect local streams. PADEP and USDA could designate farms within the priority protection area as high priority for development of nutrient management plans. Townships located within the priority protection area should also be required to adopt a uniform ordinance to address stormwater impacts from current and future activities.

1.8.3 Sewage Discharge and Regulatory Enforcement

- Overall, both the sewer system capacity and integrity and the treatment plant capacity during wet weather periods represent the greatest and most difficult sewage-related issue in the watershed. Infrastructure improvements for adequate wastewater collection and treatment systems are needed to address infiltration and inflow or system capacity issues. These improvements will eliminate events such as overflowing manholes of raw sewage into downstream water supplies.

- Raw sewage discharges by communities such as New Philadelphia and Middleport need to be eliminated and wastewater treatment systems constructed and operated. Combined, the aforementioned communities represent raw sewage discharges from several thousand people directly into the Schuylkill River. These practices are not consistent with standard wastewater treatment requirements typically enforced nationwide.

- Discharges from combined sewer overflows (CSO) systems upstream of drinking water intakes, such as Bridgeport and Norristown, need to be reduced and controlled. These discharges can significantly impact pathogen concentrations in downstream water supplies.

- Wastewater dischargers should be encouraged and given incentives to switch to ultraviolet light disinfection and/or filtration of effluents in order to reduce *Cryptosporidium* pathogen levels and viability from discharges. Permits for discharge from new wastewater facilities or plant expansions should include ultraviolet light disinfection requirements.

- It is recommended that the DRBC and three PADEP regions covering the Schuylkill River Watershed develop a watershed-wide approach to addressing permit requirements. One suggestion would be a uniform fecal coliform discharge limit for any wastewater discharge upstream of a drinking water intake in the watershed.

- Compliance requirements for industries and municipalities discharging wastewater into the protection priority corridor between Philadelphia and Reading should be enforced.

- Encouragement of rigorous and regular revision and implementation of ACT 537 Sewage Facilities Management Plans in Montgomery, Chester, Berks, and Schuylkill counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems.

1.8.4 Stormwater Runoff Impacts

- Incentives for townships and communities along the main stem of the Schuylkill River from Reading to Philadelphia are needed to mitigate stormwater impacts on water supplies.

- The Phase II stormwater regulations should be fully implemented and enforced throughout the watershed, with first priority for compliance monitoring and inspections recommended for communities discharging into protection priority areas for drinking water supplies.

1.8.5 Acid Mine Drainage Impacts

Acid mine drainage needs to be addressed and mitigated to reduce significant loadings of metals into downstream water supplies. The Pine Knot/Oak Hill acid mine drainage site in Schuylkill County is perhaps the greatest single known source of metals discharging into the Schuylkill River. Efforts should be focused towards the remediation of this site.

1.8.6 Spills and Accidents/Emergency Response

- Interaction and communication with petroleum pipeline owners and operators, as well as railroad, road and bridge construction crews needs to be developed and improved. It is important for these stakeholders to understand water supply issues and impacts from catastrophic accidents and spraying of herbicides on rights-of-way. Therefore, a series of emergency response workshops needs to be coordinated to include the following parties:

    - PEMA
    - PECO
    - CSX/Conrail
    - PennDot
    - Local Street Department Construction and Maintenance Managers

- Given the potentially catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the main stem of the Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that the USGS be involved in the implementation of the early warning system.

- New permits should be banned for new storage tanks and facilities that use or store toxic chemicals including petroleum products within the 100 year floodplain of the river and its tributaries. The PADEP should also develop and implement a long-term plan to relocate, reduce, or eliminate tanks and sources with toxic chemicals that are currently located within the floodplain.

- An accurate time-of-travel study needs to be conducted on the Schuylkill River to determine the time various spills will take to arrive at various water supply intakes and the amount of dilution under various flow scenarios. This should be incorporated into a computer model for emergency planning simulations using various chemicals and scenarios. This is also an important component necessary to make information from the early warning system more useful. The USGS should be involved in the implementation of this effort.

- In sensitive water supply areas along roadways and bridges, signage should be erected, which would include phone numbers to contact water suppliers during emergencies and spills. The signs should include a unique identification number corresponding to a known location for the water supplier.

- A special workshop with street departments and PennDot should be held in orderto develop a strategy to reduce salt impacts from road salt application. This may include strategies to acquire special funding for salt misting trucks to reduce salt application in sensitive areas.

1.8.7 Agricultural Impacts

- Agricultural land that is preserved should have specific riparian buffer and streambank fencing requirements included in its preservation status.

- Additional incentives and efforts should be allocated to develop nutrient management plans for farms in sensitive water supply areas.

- Active agricultural lands adjacent to streams in sensitive water supply areas should be required to have riparian buffers or streambank fencing to reduce impacts from livestock activity, pasture runoff, and crop runoff. Livestock releasing fecal material directly into a stream represent a direct waste discharge to a water body and therefore, should be subject to the similar regulations and permit requirements as other dischargers.

- Agricultural protection activities should be focused in Berks County and along the main stem of the Schuylkill River between Philadelphia and Reading.

- The targeting of USDA funding for water quality protection under EQIP and enrollment of CRP lands should give consideration to sensitive water supply areas, and the programs should be made more accessible to farmers. To maximize water supply protection, water suppliers should be consulted in connection with the allocation of EQIP and CRP funds.

- Areas of intense or concentrated agricultural activity should also be prioritized for protection and mitigation efforts.

1.8.8 Erosion and Sedimentation Issues

- Special erosion controls and ordinances to reduce stormwater impacts from future development and erosion are needed in protection priority areas for water supplies.

- Conservation Districts need more assistance in addressing erosion control and stormwater runoff issues from development.

- The sediment impounded behind dams should be removed prior to removal of the dam. Future dam removal projects funded by PADEP or DCNR must have this component to reduce washdown impacts of impounded sediment from rain events after the dam has been removed.

1.8.9 Wildlife Impacts

- The U.S. Fish and Wildlife, PA Game Commission, park managers, golf course managers, and water suppliers should develop and implement a regional management plan to address the exploding population of non-migratory Canada Geese.

1.8.10 Public Education

- Township officials along the protection priority corridor should be educated about stormwater impacts on water supplies through meetings, workshops, or mailings.

- The results of the local source water assessments need to be presented directly to local township officials. Common issues from multiple water supplies should also be provided to show how everybody lives downstream and feels the impact from pollution.

1.8.11 Data and Informational Needs for Improved Protection and Assessment Efforts

- An accurate watershed-wide land use GIS coverage is necessary for TMDLs and runoff impact estimates.

- GIS coverages of farms, types of agriculture, farming density, and EQUP/CRP lands, or lands with conservation easements, should be developed for the entire watershed.

- GIS coverages of the sanitary and stormsewer collection systems and outfalls in watershed communities should be developed.

- Updated and accurate locations of the many known point sources, as well as their outfall locations are necessary since currently, many are off by far distances in comparisons between GIS and reality.

- Detailed GIS coverages of the age and location of petroleum pipelines in the watershed should be developed.

- Detailed GIS coverages of location, type of activity, and dollar amounts spent on various restoration, education, and protection efforts in the watershed should be compiled.

- A GIS coverage of the land use zoning for various townships and proposed future development corridors should be created to prioritize future protection and preservation efforts.

- Violation information for dischargers on the E-facts and Envirofacts websites for PADEP and EPA are incorrect and outdated. Efforts should be made to make this information more accurate and up-to-date.

- Updated information regarding the status and impacts from CERCLA sites and abandoned industry in the watershed should be compiled.

- A cumulative loading analysis of various discharges and runoff in the watershed should be performed.

- Actual and accurate estimates or reported values of contaminant concentrations from dischargers should be electronically available.

1.8.12 Water Quality Monitoring and Data Recommendations

Overall, based on the information available from an analysis of the amount, types, and locations for monitoring in the watershed, the following is needed:

- A data clearinghouse for water quality data needs to be created and made available to all organizations. A format for data reporting should be sent to all organizations that want to participate.

- An organization in the watershed needs to be properly funded and made responsible for the compilation, organization, and monitoring of water quality data from the numerous stakeholders in the watershed.

- Organizations that conduct monitoring should form a consortium for frequent discussions of monitoring efforts and plans in order to promote better coordination and sharing of data.

- More monitoring locations are needed in places other than the Pickering, Perkiomen, Valley, and French creeks.

- All monitoring organizations should agree on selecting standard monitoring stations for various parameters. It is recommended that the stations be placed close to the mouths of the major tributaries to the watershed. The long-term Riverkeeper sites and certain water supply intakes may be the best place to start in selecting these sites. These standard stations would have routine monitoring conducted over long periods of time in order to examine changes and trends in water quality over years, seasons, or decades. This information will be used as part of a report card system for water quality improvement.

- Long term monitoring should be conducted for manganese, aluminum, iron, sodium, chloride, turbidity, total suspended solids, dissolved oxygen, temperature, ammonia, total phosphorus, orthophosphate, nitrate, E. coli, and fecal coliforms. Currently, most monitoring does not include coliform measurements.

- Efforts should be made to transfer data from hardcopy format in special studies into electronic format.

- Additional funding and training of groups such as the Schuylkill Riverkeeper Volunteer Monitoring Network, Alarm, and Stroud Center is necessary in order to enhance the quality and breadth of parameters conducted for analysis at standard sites.


PHILADELPHIA WATER DEPARTMENT – BELMONT & QUEEN LANE TREATMENT PLANTS (PWSID #1510001)
SECTION 2: BELMONT INTAKE
SOURCE WATER ASSESSMENT REPORT


This report was produced for the Pennsylvania Department of Environmental Protection in accordance with the Source Water Assessment and Protection Plan.

Philadelphia Water Department

Prepared by The Philadelphia Water Department
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Schuylkill River SWA
Protect Our Health from Source to Tap

Office of Watersheds
philadelphia water

Executive Summary - Belmont WTP Intake Source Water Assessment

The 1996 Safe Drinking Water Act Amendments required the assessment of all source water supplies across the country to identify potential sources of contamination, the vulnerability and susceptibility of water supplies to that contamination, and public availability of the information. In response to this charge, the Schuylkill River Source Water Assessment Partnership, comprised of the Pennsylvania Department of Environmental Protection, the Philadelphia Water Department, the Philadelphia Suburban Water Company, and the Pennsylvania American Water Company, conducted the assessment with stakeholders to identify water supply protection priorities in the Schuylkill River watershed. The following summary includes two main sections. One section discusses the various characteristics and observations made through collection of watershed wide information. The remaining section provides a brief listing of the main recommendations based on the results of the analysis.

High Protection Priority Issues and Activities

Overall, the following activities were identified as having high priority for protection efforts to address:

- Sanitary Sewer Overflows of raw sewage from sewer collection systems, sewage lift stations, and manholes from upstream communities
- Combined Sewer Overflows from upstream communities such as Bridgeport and Norristown
- Urban, residential, and agricultural runoff from various areas of the watershed, mostly located along the mainstem of the Schuylkill River from Reading to Philadelphia
- Discharges from municipal and industrial sources such as sewage treatment plants and chemical manufacturing facilities
- Acid Mine Drainage from Schuylkill County
- Spill and accidents from cars, tanker trucks, railroad cars, pipelines, tire piles, and fires at industrial facilities near the river and its tributaries

Observations & Characterization

- The source of water for the Philadelphia Water Department – Belmont Water Treatment Plant is surface water from the Schuylkill River. An average of 60 million gallons is withdrawn from the river per day.
- The Belmont Water Treatment Plant serves approximately 250,000 customers in West Philadelphia.
- The water supply intake is located in Fairmount Park section of Philadelphia near the intersection of West River Drive and Montgomery Avenue along the Schuylkill River

- Approximately 1,900 square miles of land covering portions of 11 counties including large sections of Berks, Schuylkill, Montgomery, and Chester Counties drain into the river upstream from the intake. The land upstream of the intake is 47% forested/greenspace, 36 % agricultural, and 14 % developed. Approximately 3 million people live in the Schuylkill River Watershed.

- Water withdrawn from the Schuylkill River is coagulated, settled, filtered, and disinfected with chlorine to make it safe prior to distribution to customers. Drinking water quality meets or exceeds all state or federal requirements.

- Schuylkill River water quality has significantly improved over the past twenty years. As the impacts of point sources have been reduced over the years, the importance of non-point sources such as stormwater runoff from developed areas within the watershed has become evident.

- While dissolved solute and metal levels have increased over the past few decades, dissolved oxygen and nutrients have significantly improved, due to reductions in agricultural runoff and improved wastewater treatment.

- Over the past decade, levels of alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon, and turbidity have increased in the mainstem river and throughout portions of the watershed.

- Increases in levels of solids, salts, and metals are believed to result from contaminated runoff resulting from increased development, increased use of deicing chemicals, and from acid mine drainage. If current trends continue, there will be impacts on drinking water supplies that require additional treatment and costs to make the water potable for drinking.

- Over 3,000 potential point sources were identified upstream of the Belmont WTP intake. Most of these potential sources do not and will never discharge into the Schuylkill River, but may store, generate, or transport hazardous chemicals. Only 15% of these sources discharge into the river or local streams. Wastewater dischargers were the most prevalent discharging source.

- Approximately 2547 of these sources if discharged into the river during a heavy storm could have their contents reach the Belmont Intake within 25 hours. Approximately 420 sources could have their contents reach the Belmont intake within 5 hours.

- The most prevalent industries upstream were sewerage systems, dry cleaning plants, and commercial printing facilities.

- Volatile organic chemicals (solvents, degreasers, paints, etc) and metals were the most prevalent contaminant types related to upstream sources.

- A total of 36.5 million gallons of petroleum, gasoline, and crude oil are stored in above ground storage tanks upstream of the Belmont WTP intake. The tanks range in size from 250 gallons to 4 million gallons and range in age from 1 to 98 years old. A total of 123 different substances or chemicals are stored in the storage tanks.

- The Schuylkill River Runoff Loading Model was developed to estimate contaminant loadings to the River from storm runoff.

- The model used the physical characteristics of the sub-watersheds, meteorological data, updated land use information, and event mean concentrations for the nine parameters of interest to estimate average daily contaminant loadings within each of the Belmont intake's zones of contribution.

- The developed areas associated with industrial/commercial land use and residential uses were estimated to contribute the highest per acre loadings of most of the contaminants evaluated, including disinfection by-products, metals, nutrients, petroleum hydrocarbons, salts, and coliforms.

- Unit *cryptosporidium* and turbidity loadings were higher from agricultural areas.

- A series of successive screenings was used to identify those sources that have the greatest potential to affect water quality at the Belmont intake.

- Five non-conservative contaminant categories and five conservative contaminant categories were selected to represent all potential contaminants.

- For each category, a threshold value indicative of the significance of the concentrations of contaminants that could result from a potential spill or discharge was defined.

- EVAMIX, a multi-criteria software package was used to prioritize the potential significance of each of the potential point sources within Belmont's Zone A and Zone B, and to evaluate the potential significance of non-point sources estimated by the Schuylkill River Runoff Loading Model.

- Criteria that were given various weighting by the Technical Advisory Group were the main components used in the EVAMIX evaluation. These criteria included potential impact, time of travel, location, public health implications, discharge frequency and controls, violations, removal capacity, and treatment impacts.

- NPDES and nonpoint source discharges within the Belmont intake's Zone A and Zone B were determined to have the highest protection priorities in the watershed.

- The potential significance of each source of contamination was designated A (potentially significant source of highest protection priority) through F (Potential source of lowest protection priority). Those sources ranked A through C are potentially significant sources of contamination to the Belmont intake.

- All of the highest ranked sources are either NPDES sites or stormwater loadings from specific sub-watersheds.

- Contaminant sources actually discharging to the River (e.g., NPDES permitted point sources, or stormwater runoff) are estimated to have greater potential significance than those with only the potential to release contaminants to the River (e.g, a spill or leak).

- EVAMIX was also used to rank potential sources for each contaminant category. Table I provides a summary of the sources and contaminants of significance.

Protection Recommendations

- Overall, the primary protection areas to focus PWD's protection efforts include the mainstem areas of the Schuylkill River between Reading and Philadelphia, and the Wissahickon Creek to protect and improve PWD's water supply.

- The Perkiomen Creek, Valley Creek, Manatawny Creek and Tulpehocken Creeks appear to have secondary protection priority. However other parts of the watershed may need limited attention for contaminant specific issues (i.e. metals and acid mine drainage).

Based on the results of the susceptibility analysis, water quality data, and stream impairments, it is clear that the impacts from stormwater runoff need to be addressed from the communities along the mainstem of the Schuylkill River from Reading to Philadelphia. Efforts to reduce these impacts would require the following components:

- Development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection. This would include a special matching source water protection grant fund for the Schuylkill River Watershed that members would contribute to the state for matching. The watershed council including representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and fund projects with the most value to water supply protection.

- Development of a coordinated regional protection plan that will be adopted by water suppliers, planning commissions, and municipalities for establishment and protection of sensitive and high priority protection areas to the multiple and overlapping water supply areas between Reading and Philadelphia.

- Enforcement of rigorous and regular revision and implementation of ACT 537 Sewage Facilities Management Plans in Montgomery, Chester, Berks, and Schuylkill Counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems.

- Development of incentives for upstream communities to mitigate stormwater runoff

- Education of township officials along the protection priority corridor about stormwater impacts

- Preservation of existing greenspace along the Schuylkill River in the protection area

- Acquisition of conservation easements or adjustment of zoning areas or local ordinances to reduce stormwater impacts due to future development in the protection priority corridor between Philadelphia and Reading

- The Phase II stormwater regulations should be fully implemented and enforced, with first priority for compliance monitoring and inspections recommended for communities discharging into protection priority areas for drinking water supplies.

- Enforcement of compliance requirements for industries and municipalities discharging wastewater into the protection priority corridor between Philadelphia and Reading

- Development and support of watershed or local community/environmental organizations to restore and protect various segments of the protection priority corridor between Philadelphia and Reading

- Ensure that TMDL process and requirements along the Schuylkill River include components to address drinking water impacts

- Development of special state or federal legislation that provides funding and authority for water supply protection efforts in the protection priority corridor between Philadelphia and Reading

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- A workshop should be sponsored by PADEP to educate golf courses about the benefits of joining the environmental certification program by the Audobon Society.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts

In addition to those efforts mentioned above, the following specific actions are recommended for protection efforts in the Wissahickon Creek Watershed:

- Development of regulatory and financial incentives for enhanced wastewater discharge for pathogen removal and inactivation to address *Cryptosporidium* impacts

- Development of incentives and controls for mitigation of stormwater runoff impacts. This includes requiring that current TMDL efforts in the watershed include specific components to address drinking water issues and concerns. This will provide an example of how the Safe Drinking Water Act and Clean Water Act should be integrated.

- Conduct and examination of current zonings and ordinances with the Montgomery County Planning Commission, Montgomery County Conservation District, and local townships to determine ways they can be enhanced to address current and future stormwater impacts. Identify areas where innovative techniques and incentives can be used to mitigate stormwater impacts and assist in the development and implementation of these efforts.

- Support of existing greenways, riparian corridor areas, and future riparian corridor easement and acquisition being conducted by the Wissahickon Valley Watershed Association and Montgomery County

- Encourage and support the development of an Act 167 Stormwater Management Plan for the Wissahickon Creek.

The Philadelphia Suburban Water Company already works with numerous stakeholders to protect its water supply in the Perkiomen Creek. Therefore, it is recommended that any protection efforts be coordinated with the Philadelphia Suburban Water Company environmental initiatives and programs in the Perkiomen Creek Watershed.

In addition to the previous specific geographic recommendations, the following general efforts are recommended:

- Emergency Response Planning activities should be focused on priority AST, TRI, and RECRA facilities since they have been shown to have the greatest relative impact on water quality. Efforts should also be initiated to collect more detailed data on these sites for reprioritization.

- Given the catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the mainstem Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that USGS should be involved in the implementation of the early warning system.

- Long-term protection efforts should focused on improving the quality of wastewater discharges and stormwater runoff. These will have the greatest overall impacts on improving source water quality.

- Sources of pathogens appear to be the sources of greatest priority to PWD when examined in the overall rankings. Therefore, these sources should be addressed accordingly.

- Given the significant amount of activity in the watershed by various organizations, protection efforts should be coordinated in such a way as to support and enhance existing efforts in the watershed.

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- Special mechanisms and funding should be developed to allow the distribution of monies to support or initiate specific initiatives outside the City of Philadelphia that will protect or restore the water supply. This may involve development of a quasi-governmental or non-profit organization that can raise funds and distribute them to various organizations conducting protection activities beneficial to PWD. This organization may also need the ability acquire conservation easements or land in sensitive areas to maintain protected areas.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts.

Public Meetings and Participation

- Public Kick-off meetings, Technical Advisory Group meetings, media articles and a website were some of the methods used to involve the public in the Source Water Assessment Program (SWAP)

- A Technical Advisory Group (TAG) was established to facilitate communication among stakeholders, and to gather information about the watershed. The TAG met quarterly to assist the SWAP process.

- Two public kick-off meetings were held in the Philadelphia area. Meetings were advertised in many local newspapers.

- Project information was available to the public and stakeholders through the project website at www.schuylkillswa.org.

Table I – Summary of Protection Priorities From Various Upstream Sources

Source	Protection Priority	Description	Priority Area(s)	Contaminants
Treated Sewage	A – C (Moderate – High)	Wastewater discharges from wastewater treatment plants	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment, organic chemicals
Untreated Sewage	A (High)	Combined sewer overflows	Bridgeport, Norristown, & Schuylkill County	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients
Urban/Residential Runoff	A – C (Moderate – High)(	Stormwater runoff from roads, parking lots, roofs	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, metals, sediment
Agricultural Runoff	A – C (Moderate – High)	Stormwater runoff from croplands, pastures, livestock	Perkiomen Creek & Tulpehocken Creek	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment
Acid Mine Drainage	A (High)	Discharge from abandoned coal mining areas	Schuylkill County	Metals
Industrial Facilities	C (Moderate)	Facilities that store or use hazardous chemicals	Reading to Philadelphia	Metals, nutrients, organic chemicals
Above Ground Storage Tanks	C (Moderate)	If storage tank spilled into river	Reading to Philadelphia	Petroleum hydrocarbons, metals, phosphorus
Landfills	C (Moderate)	Leaching of contaminants into streams	Reading to Philadelphia	Petroleum hydrocarbons, metals
Spills and Accidents	A – C (Moderate – High)	Car, truck, train, or pipeline accident spilling benzene	Watershed wide	Petroleum hydrocarbons, organic chemicals

Note: *Petroleum hydrocarbons include chemicals found in oils and greases*
Organic chemicals include chemicals found in solvents, degreasers, varnishes, paints, gasoline, plastics, insect and weed killers.
Rankings: *A – highest protection priority, B- moderately high protection priority, C-moderate protection priority, D through F low protection priorities.*

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Section 2
PWD-Belmont Water Treatment Plant

2.1 Watershed and Drinking Water System

2.1.1 Watershed

Key Points

- **The Philadelphia Water Department's Belmont Intake is the first public water supply intake on the Schuylkill River above the confluence with the Delaware Estuary.**

The Philadelphia Water Department's Belmont Intake is located at Schuylkill River mile ten. As shown in Figure 2.1.1-1, the intake is located approximately 2 miles above Fairmount Dam, which is the uppermost tidal limit of the Schuylkill River. Peter's Island is about 200 yards upstream of the intake. The Belmont Intake draws water from the pool created by the existence of Fairmont Dam.

The drainage area of the basin above the Belmont Intake is approximately 1,890 square miles. Land use of the area just upstream of the intake is primarily under the stewardship of the Fairmount Park Commission and is generally parkland, with some riparian buffer and a site of heavy recreation and boating. The closest active USGS flow monitoring station is located at Fairmount Dam. Moving upstream from the mouth of the Schuylkill River, the Belmont Intake is the first public water supply intake (see Figure 2.1.1-2) above the river's confluence with the Delaware Estuary.

Figure 2.1.1-1 Aerial Photograph of Belmont Intake

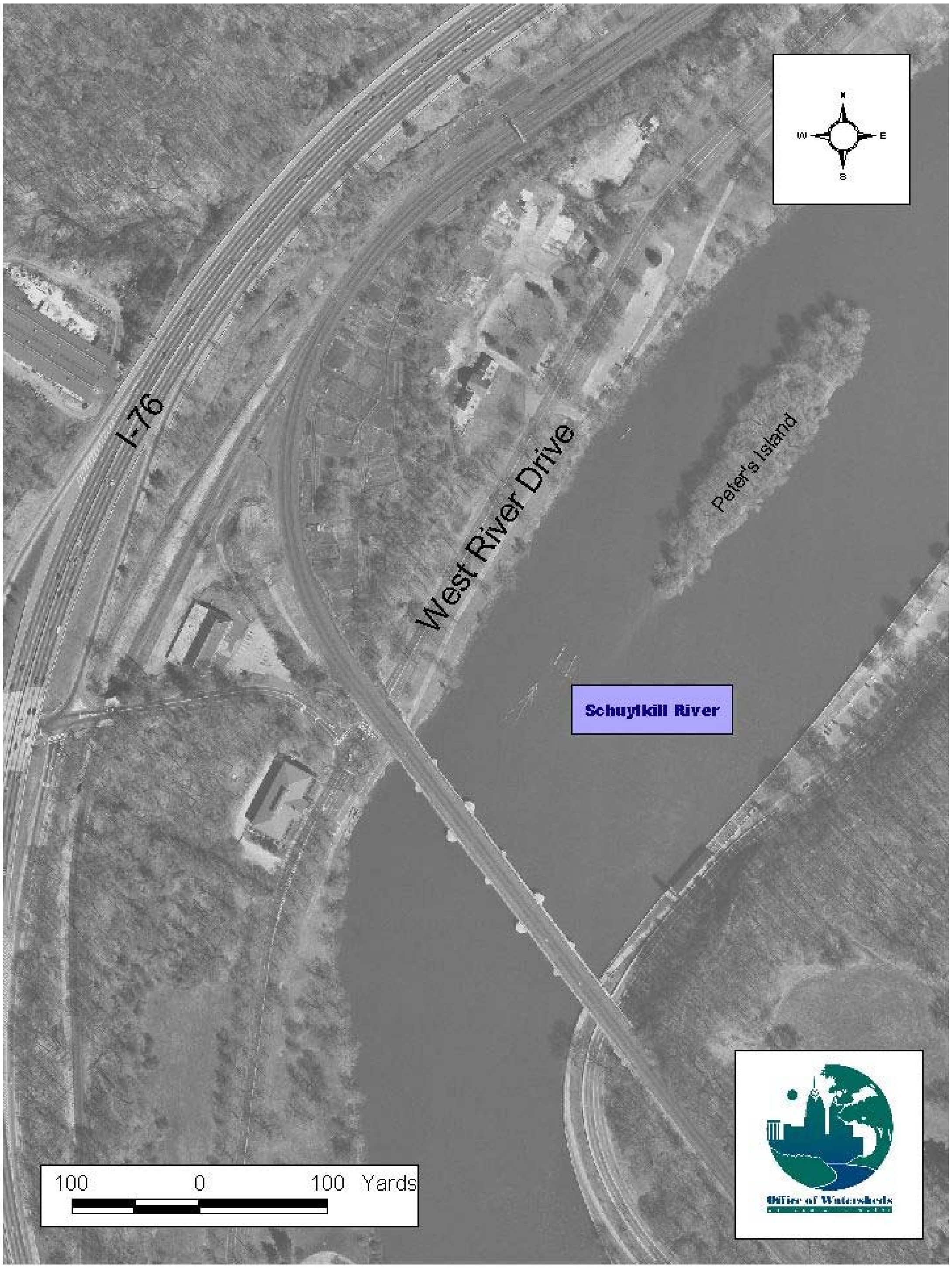
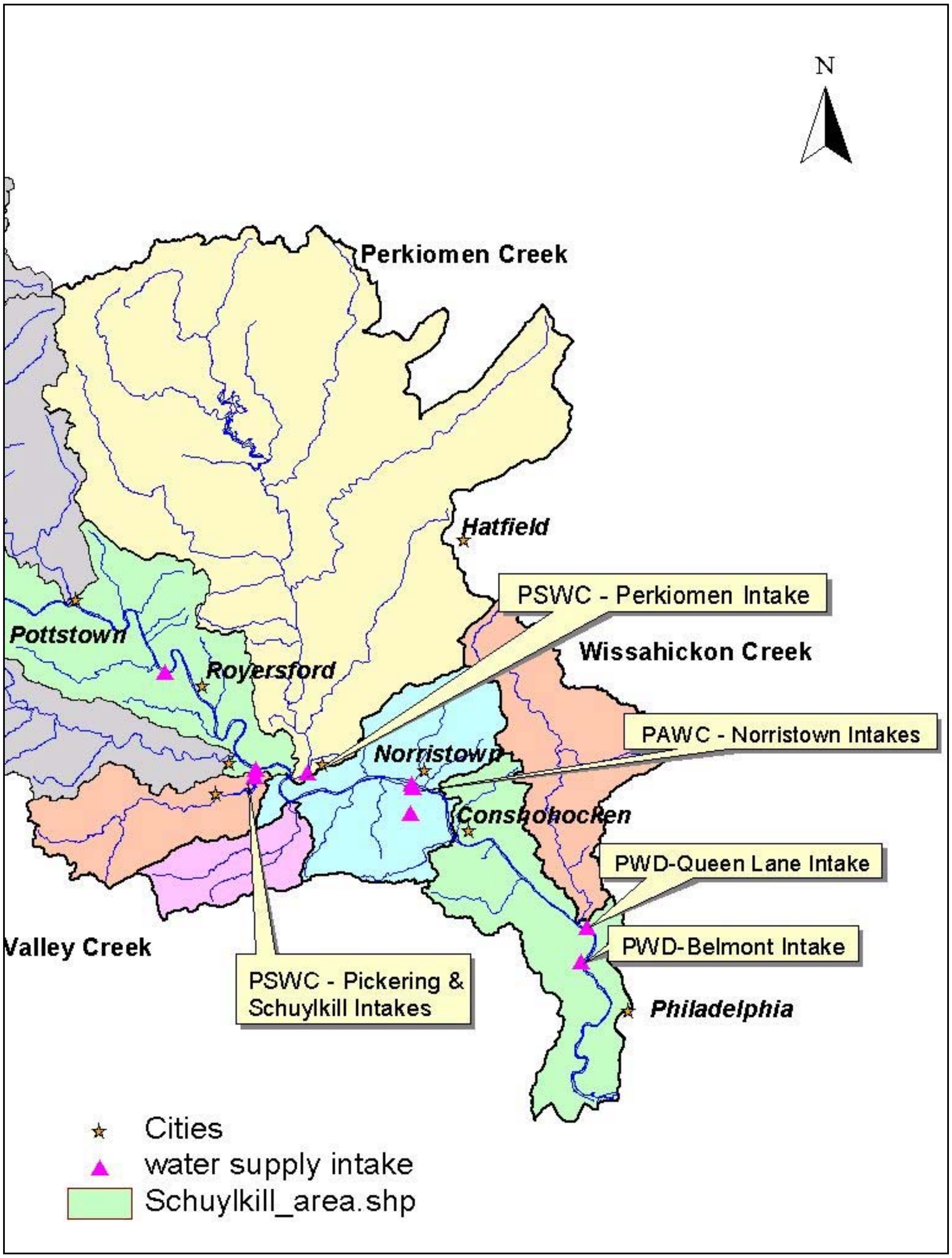


Figure 2.1.1-2 Location of Water Supply Intakes in the Lower Schuylkill River Watershed



2.1.2 Geology, Soils, Hydrology, Physiography and Topography

Key Points

- **Topography and types of soils in the watershed affect the amount and quality of runoff produced during precipitation events.**
- **Soils in the Lower Schuylkill River Watershed are generally well drained, and generate moderate amounts of runoff.**
- **The Wissahickon Creek is the nearest tributary upstream of the Belmont Intake.**
- **The Belmont Intake is located in the Atlantic Coastal Plain physiographic province.**

2.1.2.1 Geology and Soils

The physical properties of the soils are the determining factor in the sediment-transport characteristics of the Schuylkill River and its tributaries. The soils, in turn, are determined by the geology and weathering processes of the rock material. The area north and east of the river, which includes the area drained by the Perkiomen and Skippack creeks and by part of the Manatawny Creek, is underlain by mudstones, reddish-brown shales, and siltstones. The shaly silt loams that form above the shales are shallow and subject to erosion.

Silty loams are the dominant soils in the basin downstream from the Perkiomen Creek. The soils in the areas drained by Valley and Plymouth creeks, and partially by Wissahickon Creek, are underlain by a narrow band of limestone. The other tributaries in the lower basin are underlain by channery silty loam soils formed in the residuum of mica schist and gneiss. Many of the soils in the lower basin are classified as urban land because the soil profile has been reworked during the cut-and-fill operations of construction projects. They generally have the same soil particle size distribution as the original silty loams.

New urban land or urban construction sites on Piedmont soils may contribute as much as 100 tons of sediment per acre each year (Yorke and Herb, 1978). Runoff from lawns, parking lots, and streets may contribute much of the trace metals and organic substances that enter the lower part of the Schuylkill River.

There are 16 specific soil subtypes in the Schuylkill River Watershed. Table 2.1.2-1 summarizes the characteristics of the soil types found in the Schuylkill River Watershed, and Figure 2.1.2-1 illustrates their distribution throughout the Lower Schuylkill River Basin. Typically, two or three types dominate within a given subwatershed. The Abbottstown, Chester, Neshaminy, and Ungers soil classifications define approximately 74% of the watershed soils.

Figure 2.1.2-1 Soil Types in the Lower Schuylkill River Basin

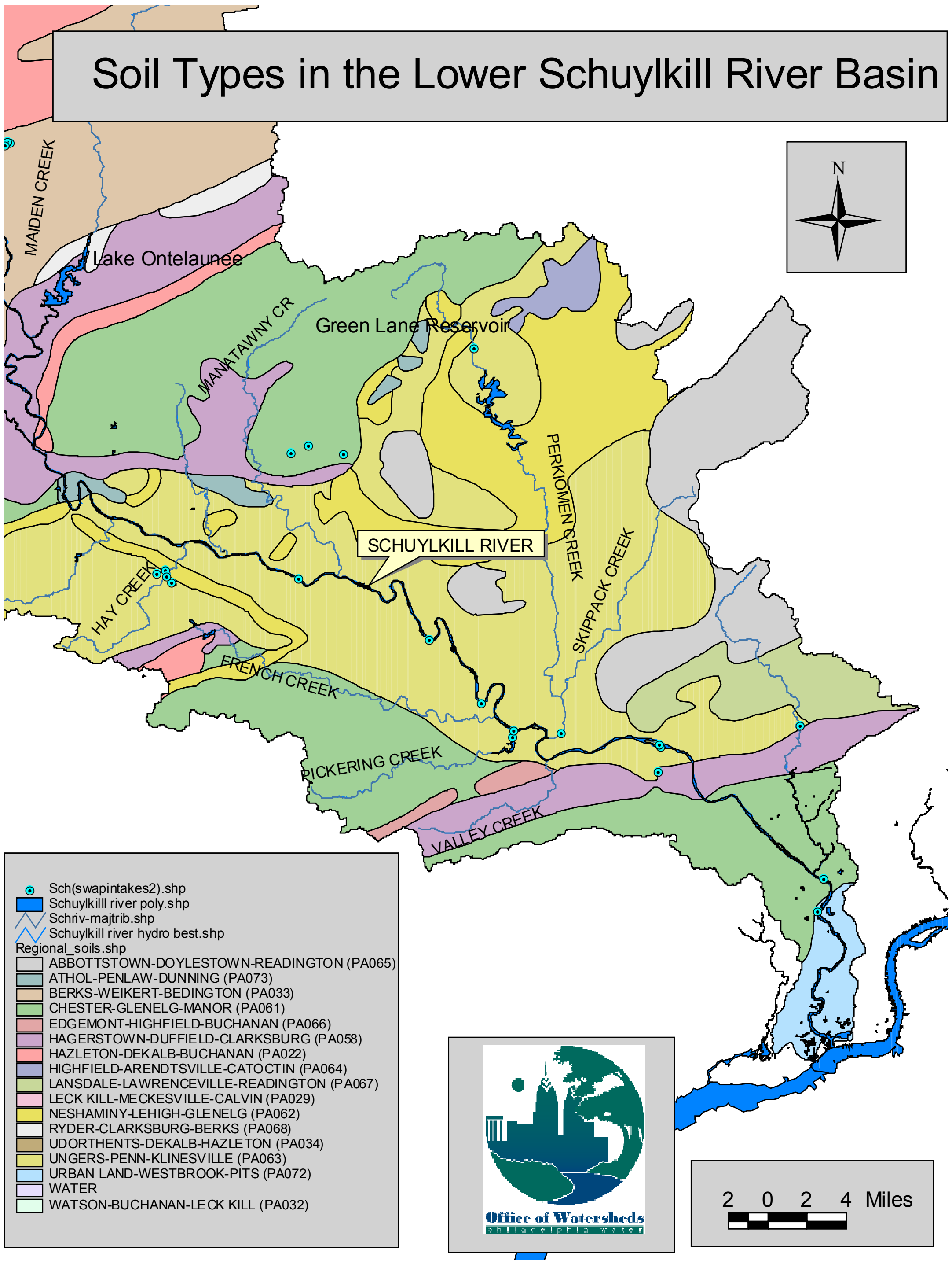


Table 2.1.2.-1 indicates that these soils are generally well drained, generate moderate runoff, and are located on significant slopes. The only poorly drained soil, the Abbottstown soil, is located in the headwater areas of the Wissahickon and Perkiomen Creek watersheds.

Table 2.1.2-1 Prevalence of Various Soil Types in the Lower Schuylkill River Watershed (Pottstown to Philadelphia)

Soil Type	Percent of watershed	Slopes (%)	Permeability	Runoff	Drainage	Found on
Abbottstown-Doylestown-Readington (PA065)	13	0-15	Slow to moderate	Slow to medium	Poorly drained	Level to sloping concave upland flats, depressions and drainageways
Athol-Penlaw-Dunning (PA073)	0	0-35	Moderate	Slow to rapid	Well drained	Level to moderately steep convex and dissected upland ridge tops and side slopes
Chester-Glenelg-Manor (PA061)	19	0-65 (mostly 3-10)	Moderate	Medium	Well drained	Upland divides and slopes
Edgemont-Highfield-Buchanan (PA066)	1	0-70	Moderate to moderately rapid	Rapid	Well drained	Sloping hills and ridges
Hagerstown-Duffield-Clarksburg (PA058)	6	0-45 (mostly 15)	Moderate	Moderate to rapid	Well drained	Valley floors and adjacent hills
Lansdale-Lawrenceville-Readington (PA067)	5	0-25	Moderate to moderately rapid	Moderate	Well drained	Rolling uplands
Neshaminy-Lehigh-Glenelg (PA062)	15	1 to 45	Moderately slow	Slow to very rapid	Well drained	Level to steep uplands
Ungers-Penn-Klinesville (PA063)	36	0-50	Moderate or moderately rapid	Medium to rapid	Well drained	Gently sloping to steep slopes

Note: Data from NRCS Official Soil Classifications and PASDA soil coverage

The lower watershed is comprised of both Group B and Group C soils. Group B soils are mainly moderately well to well-drained soils with moderately fine to moderately coarse textures with transmission rates between 0.38 and 0.76 centimeters per hour (cm/hour). Group C soils are of a moderately fine to fine texture and have low infiltration rates. These soils have transmission rates between 0.13 and 0.38 cm/hr.

Typical rainstorms that are less than 0.5 inches (1.27 cm) can infiltrate a well-drained Group B soil in less than two hours, whereas it will take the group C soils almost 4 hours to allow the same amount of infiltration. The lower infiltration rates increase the potential amount of runoff and pollutant transport from the land. In addition, the topography or slope steepness in these areas will also have significant impacts on pollutant transport.

2.1.2.2 Hydrology

The Lower Schuylkill River Watershed consists of the land areas draining directly to the Schuylkill River and four major tributaries, as shown on Figure 2.1.2-2. Table 2.1.2-2 indicates that the Perkiomen Creek is the largest tributary in this area. The Wissahickon Creek is the closest tributary discharging into the Schuylkill River above the Belmont and Queen Lane WTP intakes for the City of Philadelphia. However, due to the location of the discharge of the Wissahickon Creek into the Schuylkill River on the opposite (east) side of the River from the Belmont Intake, little influence on water quality is observed.

Table 2.1.2-2 Characteristics of Tributaries in the Lower Schuylkill River Watershed (from bottom of watershed to top of watershed by river mile location)

Major Subwatershed	Drainage Area (mi^2)	River Mile Location	Length (mi.)
Lower Schuylkill (Philadelphia-Conshocken)*	69.6	<20.5	20.5
Wissahickon Creek	63.6	12.8	24.2
Middle Schuylkill 1 (Norristown - Valley Forge)*	64.8	20.5-32	11.5
Valley Creek	23.3	30.6	10.4
Middle Schuylkill 2 (Phoenixville-Pottstown)*	103.0	32-63	31
Perkiomen Creek	366.3	32.3	37.8
Pickering Creek	38.8	34	14.8

**These watershed boundaries were selected for purpose of the study*

In the lower half of the Schuylkill River Watershed, there are two major reservoirs. As shown in Table 2.1.2-3, Green Lane Reservoir is the largest and stores over 4.4 billion gallons of water. Contaminants may settle out in the reservoirs, and accumulate in the sediments for future release. There are seven dams across the river in the bottom half of the watershed that were designed to trap sediment and coal culm. These dams are beginning to exceed their service life and in some cases have failed. Similar, but smaller dams on the tributaries are also being removed to improve aquatic life. Because these dams trap significant amounts of contaminated sediment behind them, their removal should be handled carefully.

Table 2.1.2-3 Reservoir Characteristics for the Lower Schuylkill River Watershed

Water Body	Average Width	Average Depth	Surface Area	Length	Volume (billions of gallons)	Detention Time
Pickering Creek	460 ft	11 ft *	4,804,020 sq. ft 0.1723 sq. miles	9,395 ft 1.78 miles	0.4	34 days
Green Lane Reservoir	888 ft	16.4 ft *	43,302,856 sq. ft 1.5533 sq. miles	74,648 ft 14.14 miles	4.4 *	62 days

**Data from Philadelphia Suburban Water Company*

As indicated in Figure 2.1.2-2, there are a number of flow monitoring stations in the Lower Schuylkill River Basin. However, only a few have continuous data that is suitable for long term characterization. Table 2.1.2-4 lists four active gagging stations that are located within the Lower Schuylkill Subwatershed; Perkiomen Creek at Graterford, Valley Creek near Valley Forge, Wissahickon Creek at the mouth of Philadelphia, and Schuylkill River at Philadelphia. Table 2.1.2-4 summarizes the drainage area in square miles, annual mean flow, and annual runoff and the 10, 50, and 90% exceedance limits.

Table 2.1.2-4 Active Gauging Stations within the Lower Schuylkill Subwatershed

Station ID	Location	Drainage Area (mi^2)	Period of Record	Annual Mean Flow (cfs)	Annual Runoff (Inches)	10% Exceeds (cfs)	50% Exceeds (cfs)	90% Exceeds (cfs)
01473000	Perkiomen Creek at Graterford	279	1957-1999	411	N/A	831	180	60
01473169	Valley Creek Near Valley Forge	21	1983-1999	32.3	21.09	52	23	15
01474000	Wissahickon Creek Mouth at Philadelphia	64	1966-1999	104	22.02	177	60	28
01474500	Schuylkill River at Philadelphia	1893	1932-1999	2721	N/A	5850	1670	430

cfs – cubic feet per second

Recent decade scale patterns in climate and river flow for the region were also assessed to ascertain direct connections between these parameters and PWD intake water quality data. Daily averaged data for the Schuylkill River flow at the Fairmount Dam through the 1990s, shown on Figure 2.1.2-3, indicates extremely low flow conditions in summer 1999, with less pronounced low flow occurring in 1991 and 1993. The lowest flows through the decade were not always associated with extended low levels of summer precipitation, suggesting that evaporation, groundwater storage and surface water removal are important components in the water budget of the region.

Figure 2.1.2-2 Hydrologic Features of the Lower Schuylkill River Basin

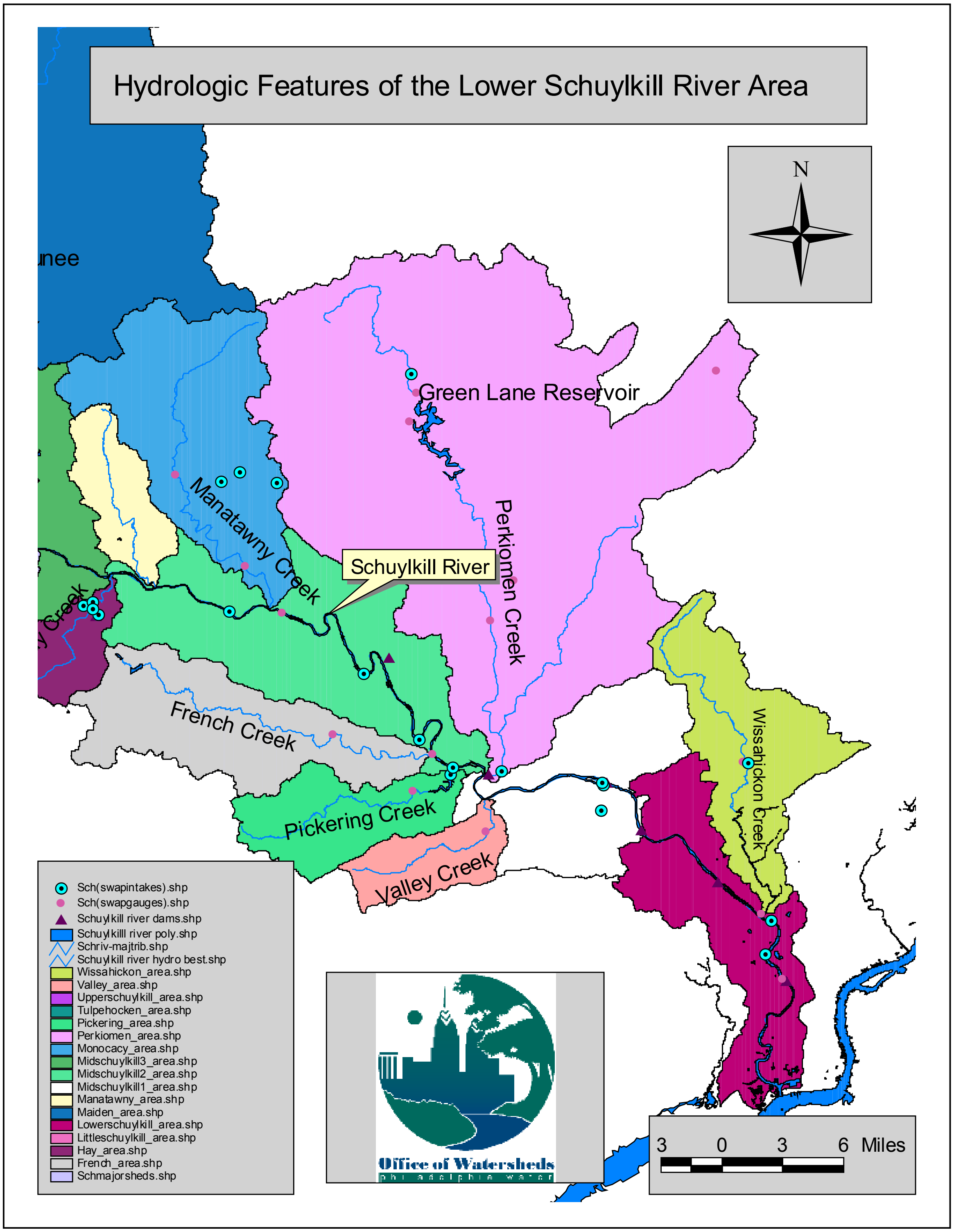
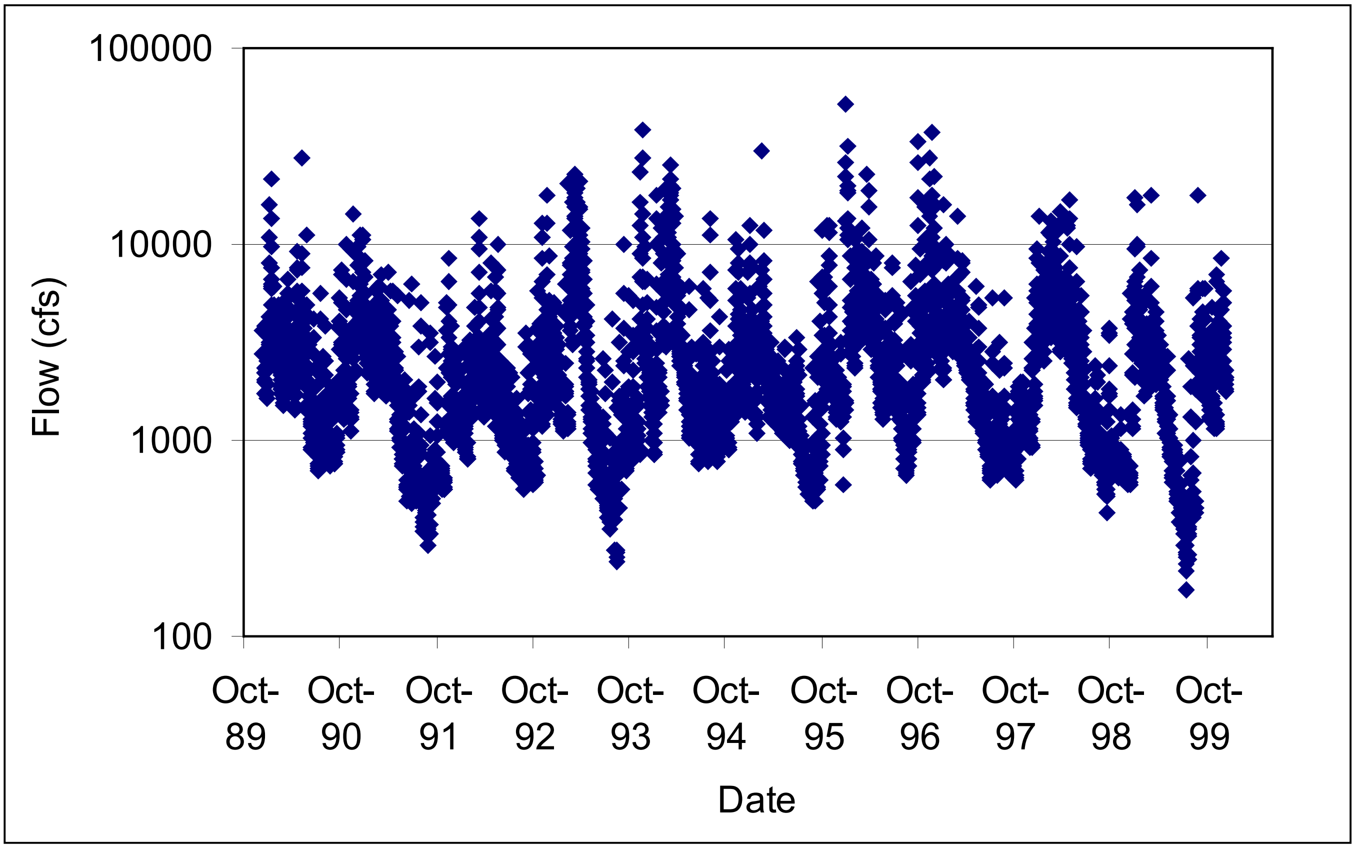


Figure 2.1.2-3 Daily Schuylkill River Flow at Fairmount Dam



Based on the trends of precipitation in the area, during the spring and winter seasons, runoff plays a significant role in pollution. During the drier seasons, pollution is caused by point sources rather than non-point sources.

2.1.2.3 Physiography

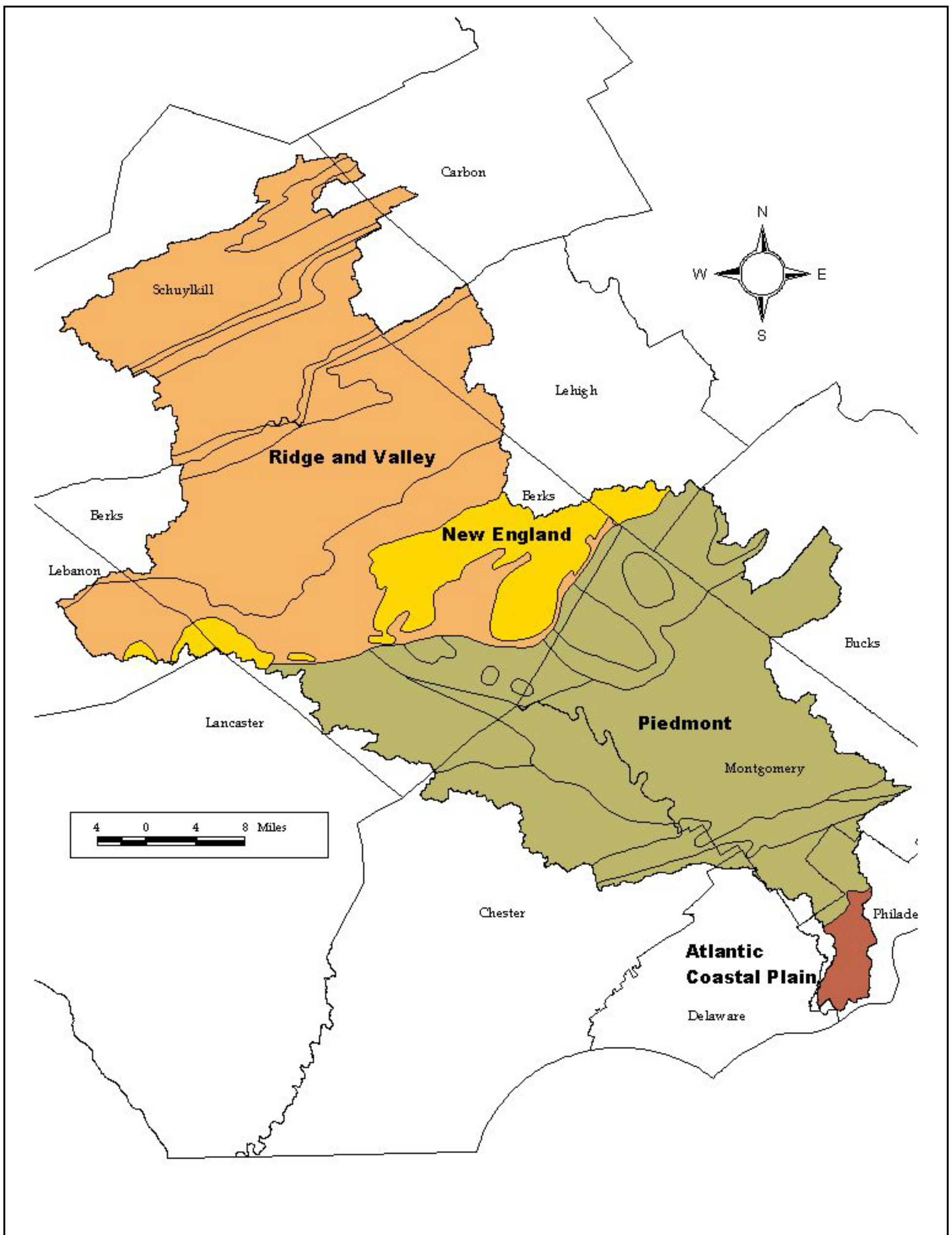
The Schuylkill River flows through four physiographic provinces: the Valley and Ridge, New England, Piedmont and Atlantic Coastal Plain. PWD's Belmont Intake is located in the Atlantic Coastal Plain Province. The last physiographic province represented in the Schuylkill River Basin is the Atlantic Coastal Plain, as shown in Figure 2.1.2-4. About 20 square miles of the basin is in this province, and most of it is located downstream of the Fairmount Dam to the Delaware River. The Atlantic Coastal Plain is mainly lowlands with numerous streams and marshlands. This particular section of the Schuylkill River is an estuary, which experiences a range of tidal fluctuations of about 5.5 ft.

The Belmont WTP is located in Philadelphia County, where the Wissahickon Creek Subbasin drains into the Schuylkill River south of Manayunk. Wissahickon Creek includes a drainage area of 63.8 square miles. The creek's headwaters are in Montgomery County in the Triassic Lowland and it flows through the Piedmont

Uplands. South of the Wissahickon confluence, the Schuylkill River crosses the fall line and flows into the Atlantic Coastal Plain Province.

Further upstream from Philadelphia, the Schuylkill River delineates the borders of Chester and Montgomery counties. Here, as the river flows through Norristown, it passes into the Piedmont Uplands. In the Piedmont Uplands, a region of broad, rolling hills and valleys, the river crosses the Chester Valley, a narrow valley of low relief. Valley Creek, a small tributary to the Schuylkill in Chester County, lies in the Piedmont Uplands. The confluence of Valley Creek with the Schuylkill River is just south of Perkiomen Creek's confluence with the Schuylkill River.

Figure 2.1.2-4 Physiographic Areas of the Lower Schuylkill River Watershed

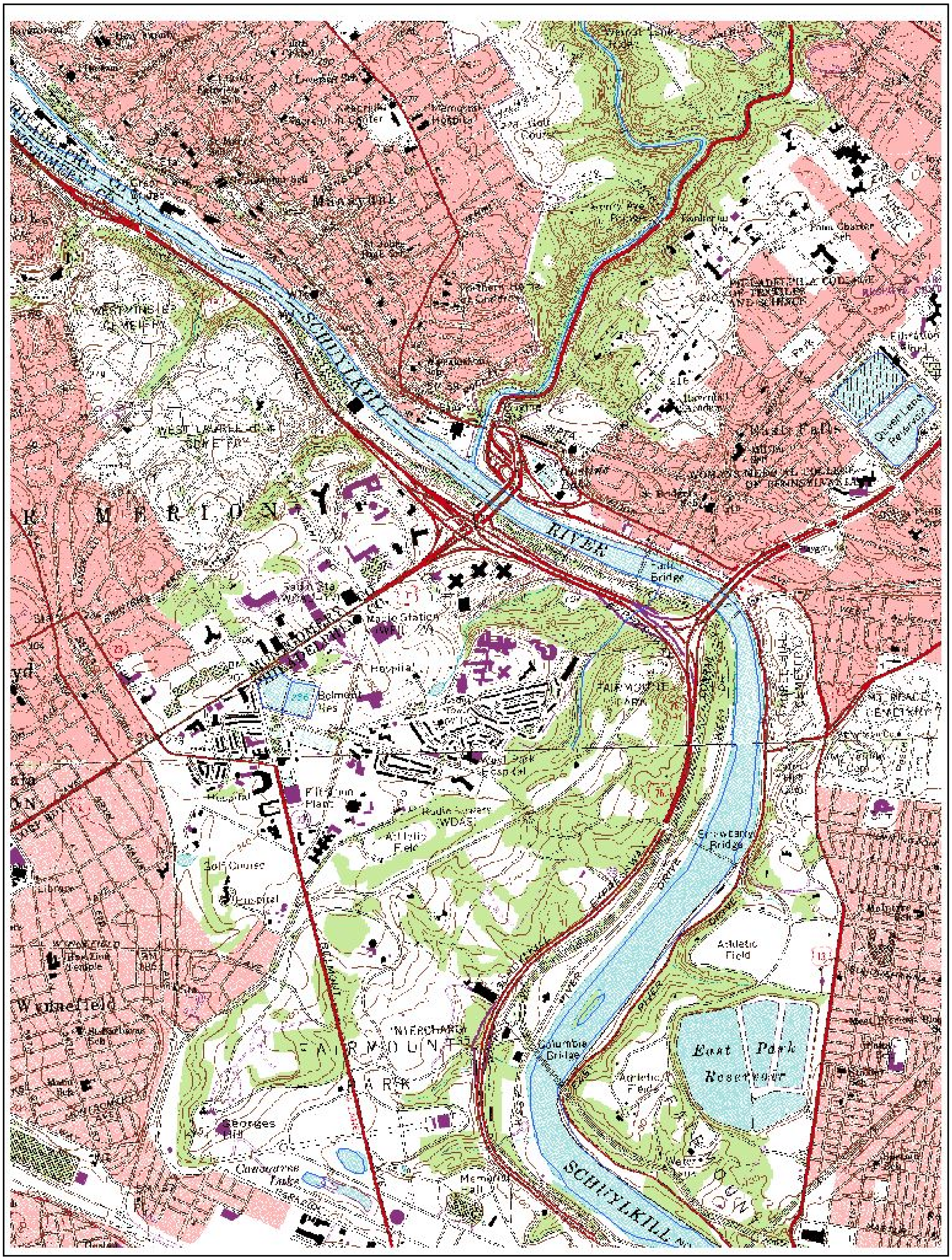


2.1.2.4 Topography

The combination of geologic, soil, and hydrologic characteristics found in the watershed make runoff of conservative contaminants from land activities into the adjacent surface waters very possible if no mitigation strategies are implemented. These characteristics also affect the quantity of the flow that can erode streambanks and deposit sediment in reservoirs.

The topography of the watershed, as illustrated by Figure 2.1.2-5, indicates where significant runoff may be generated. Land-based activities on steeply sloping areas may generate more runoff and associated contaminants than those located on gentler slopes due to the potential to transport polluted runoff farther and faster. The steeply sloping areas are considered to be sensitive areas where runoff from various activities could have a potentially significant impact on river water quality. These areas are ideal for preservation and protection from development to prevent increased runoff and contamination in the future.

Figure 2.1.2-5 Topographic Features of the Lower Schuylkill River Watershed



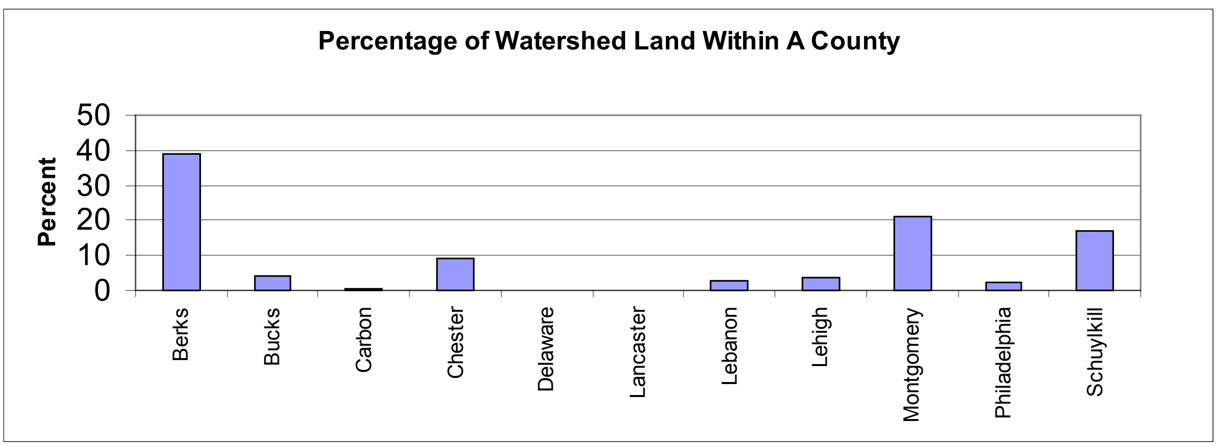
2.1.3 Land Use

Key Points

- **Recent land use studies conclude that the amount of developed land within the Schuylkill River watershed ranges between 14 and 30%.**
- **Studies of changing land use patterns in the watershed agree that the amount of developed land is increasing, as agricultural and forested lands decrease.**
- **Developed land areas are found mainly in the lower Schuylkill River Watershed, near major cities and transportation corridors.**
- **The area surrounding the Belmont Intake is primarily wooded and recreational, while the area inland from the river is residential.**

Parts of eleven counties are located within the Schuylkill River Watershed. Of those 11 counties, only 4 (Berks, Chester, Montgomery, and Schuylkill counties) have nearly ten percent or more of the watershed within their boundaries (Figure 2.1.3-1).

Figure 2.1.3-1 Percentage of Land Area in the Schuylkill River Watershed within Each County



Belmont WTP is at the downstream end of the watershed, where Philadelphia accounts for only two percent of the watershed land area, but the single largest population and water supply withdrawal in the watershed. Bucks, Montgomery, Chester, and Delaware counties are suburban areas bordering Philadelphia, and are located in the middle of the watershed. Berks, Carbon, Lebanon, Lehigh, and Schuylkill counties make up the upper reaches of the watershed and are the least developed areas in the watershed.

As shown in Figure 2.1.3-2, the most recent studies by the USDA have estimated that the Schuylkill River Watershed is 28% developed, 34% agricultural, and 32% forested land. Table 2.1.3-1 and Figure 2.1.3-3 provide the details of this breakdown in five-year intervals spanning the period from 1982 until 1997. Based on the changes in land use from 1982 to 1997, the amount of developed land has increased by over 30% over the past 15 years, while agricultural land in the watershed has decreased by almost 14% and forested lands decreased by just under 5%.

Figure 2.1.3-2 Overview of Schuylkill River Watershed Land Use (percent)

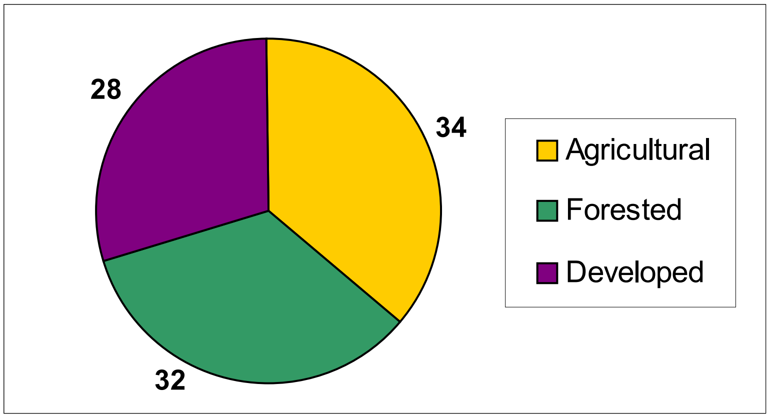


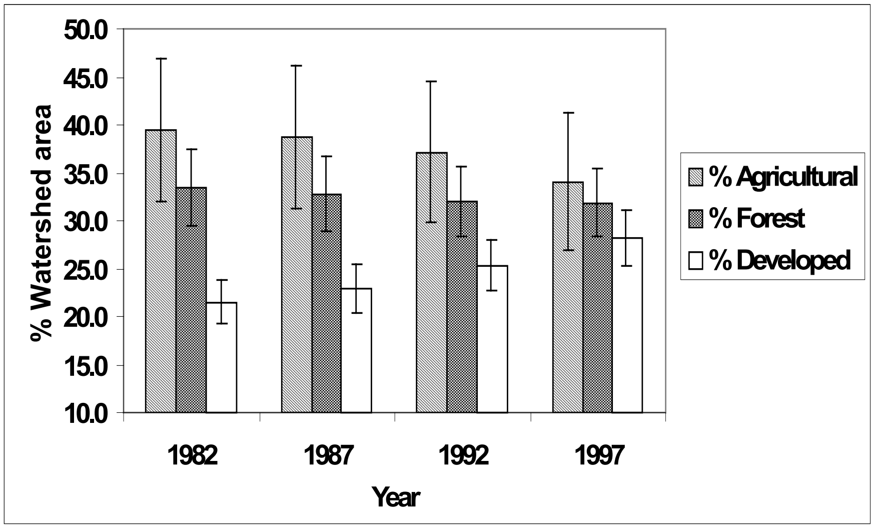
Table 2.1.3-1 Land Use Changes in the Schuylkill River Watershed: 1982-1997

Year	Percent Agricultural	Percent Developed	Percent Forested
1982	39.5	21.5	33.5
1987	38.8	22.8	32.8
1992	37.2	25.3	32.1
1997	34.0	28.3	31.9

Source: NRI, 2001
*Note: To calculate percent change in agricultural land from 1982 to 1997: [(34.0-39.5)/39.5] * 100 = -13.9%*

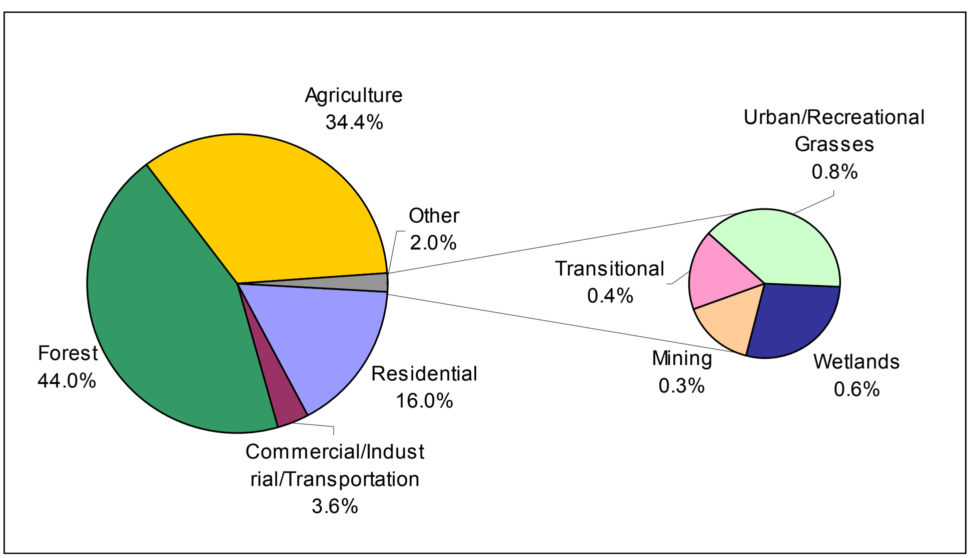
Figure 2.1.3-3 Changing Land Use in the Schuylkill Watershed

Data is from the National Resources Inventory, 2001. Error bars indicate 95% confidence intervals for data in broad land use categories. Agricultural land includes all pasture, grazing and croplands. Developed land includes all urban land and rural transportation lands.



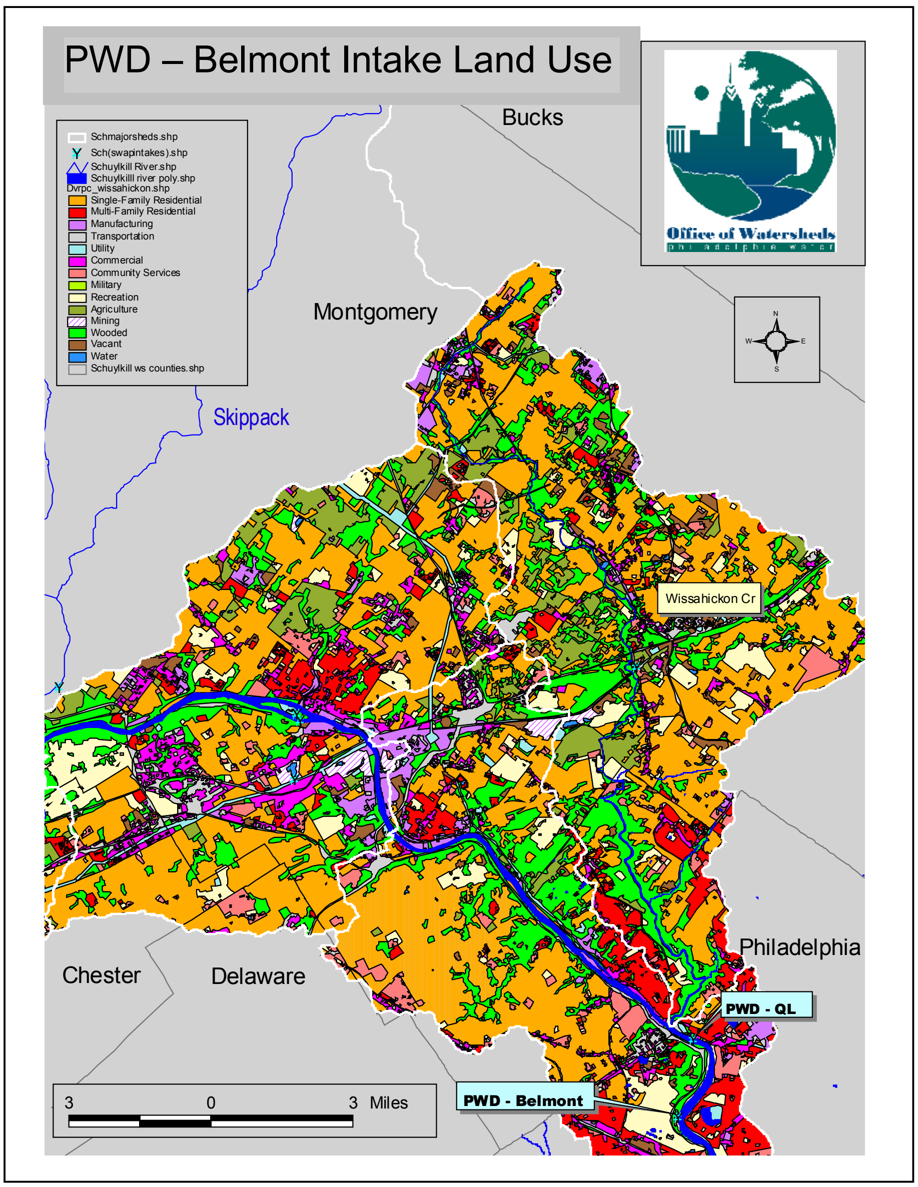
The USGS's National Land Cover Dataset (NLCD) landuse coverage, detailed in Section 1.2.5, characterizes the entire Schuylkill Watershed. Figure 2.1.3-4 shows the updated NLCD coverage for the Schuylkill Watershed area within the Zone B delineation for the PWD Belmont Intake. According to this information, almost 80% of this area is characterized as agriculture, forests, or wetlands. The majority of the remaining 20% is developed area.

Figure 2.1.3-4 Updated NLCD Land Use for PWD Belmont Intake Zone B Delineation



As shown in Figure 2.1.3-5, the green area surrounding the Belmont Intake is primarily wooded and recreational areas. Across the river from the intake, the land is mostly residential. Beyond the immediate area surrounding the intake, most of the land is used for light to heavy manufacturing and residential areas as indicated by the red and orange coloring. Except for the areas surrounding the cities of Conshohocken and Norristown, a significant portion of the land area adjacent to the Schuylkill River has either been established as green space through township and county initiatives or through right of way areas established by the railroads. Areas indicated as industry may actually be abandoned or inactive property based on field inspections and tours of this watershed area.

Figure 2.1.3-5 Belmont Intake Land Use (DVRPC)



2.1.4 Drinking Water System

Key Points

- **The 60 million gallon per day (MGD) Belmont Water Treatment Plant (WTP) provides water to 270,000 people in western and southwestern Philadelphia.**
- **The Belmont Water Treatment Plant has won several awards for its outstanding treatment performance.**

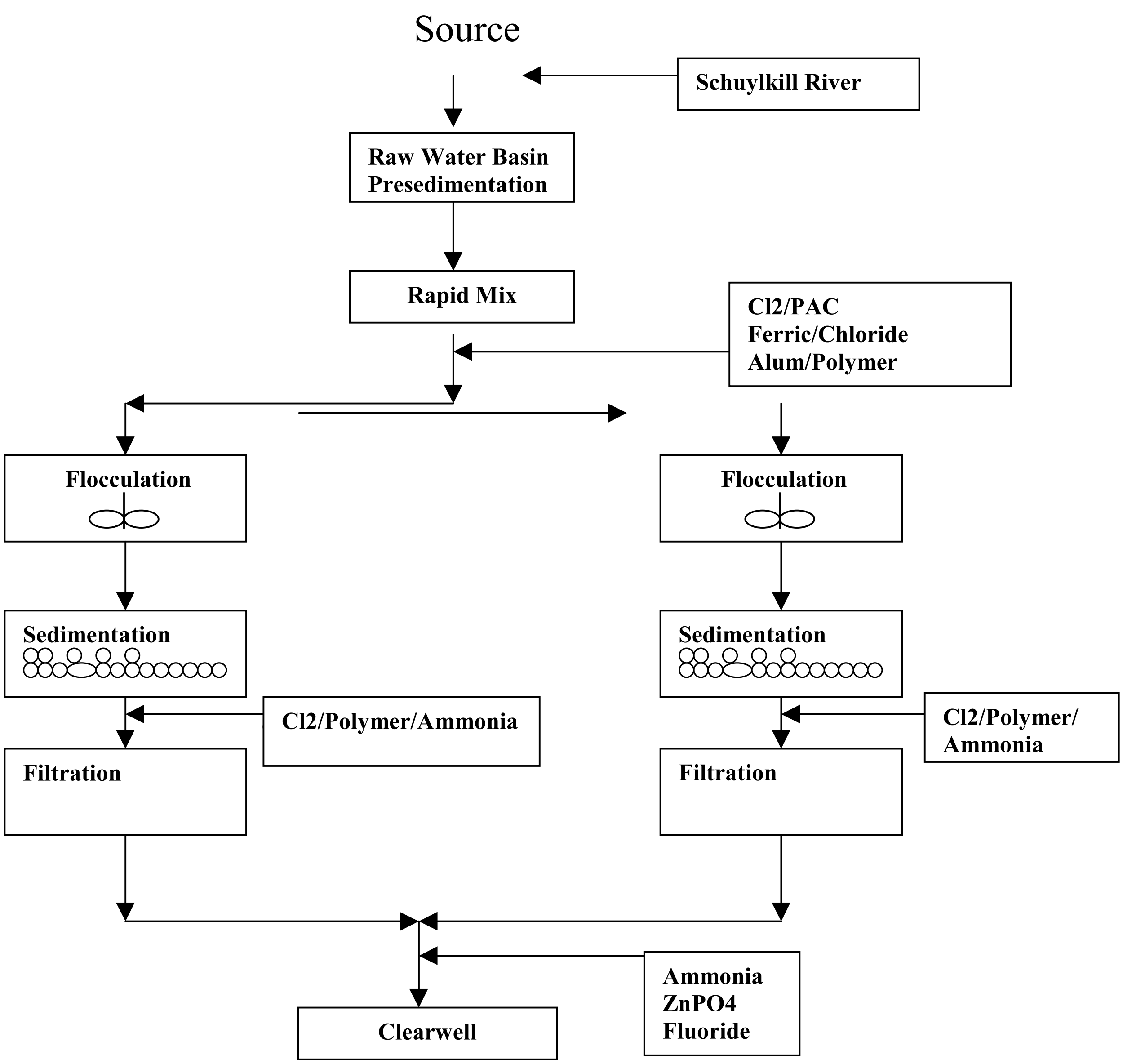
The Belmont Water Treatment Plant (PWSID 1510001) of the Philadelphia Water Department is located ten miles from the mouth of the Schuylkill River in Philadelphia County. Raw water is pumped from the Schuylkill River at a daily average rate of 60 million gallons per day (MGD) with a maximum capacity of 90 MGD. Located just south of City Line Avenue, the Belmont treatment plant services the entire region of Philadelphia west of the Schuylkill River. Treated water from the Belmont WTP is delivered to about 270,000 people or 17% of the population of the west and southwest regions of the city of Philadelphia. The treatment plant is shown below in Figure 2.1.4-1.

Figure 2.1.4-1 Philadelphia Water Department's Belmont Water Treatment Plant

A process treatment schematic is found in Figure 2.1.4-2. After raw water is pumped from the Schuylkill intake, it passes through screens for removal of large debris (leaves, branches, etc.) and is then held in a large basin at the Belmont WTP for at least 24 hours.

The basin allows silt, sand, and other large particles to settle prior to conventional treatment. The pre-sedimentation basin has particular importance to remove pollutants during rain events or high flow conditions, when high concentrations of silt and large particles result from re-suspension of river sediment and runoff. Additionally, an oxidant or powdered activated carbon (PAC) may be added to the pre-sedimentation basin to mitigate algae or taste and odor episodes.

Figure 2.1.4-2 Schematic of Water Treatment Process at the Belmont WTP



After pre-sedimentation, the coagulant ferric chloride is typically used to destabilize particles such as clay and viruses. Following coagulant addition, two stages of flocculation with gentle mixing are provided to allow the destabilized particles to agglomerate. Flocculation detention time is about 60 to 70 minutes. After floc is formed, it settles in basins with two to four hours of detention time. The floc that settles to the bottom of the basin and is removed as sludge, which is sent to a City of Philadelphia Water Pollution Control Facility (WPCF). A chemical addition point, for chlorine, polymer, or pH adjustment is available after sedimentation.

Clarified water is then treated with dual media filtration. Dual media consists of anthracite and sand and removes remaining suspended material. Filters are usually terminated after two days time, prior to severe headloss or breakthrough. Twenty-eight filters are available at the Belmont WTP. At average daily flow, the loading rate is less than two gallons per minute per square foot (gpm/sf). Upon termination, a filter is backwashed and spent backwash water is sent to the WPCF.

Disinfection at Belmont is achieved through addition of chlorine in the pre-sedimentation basin and after sedimentation. After filtration, ammonia is added for chloramination. This maintains a total chlorine residual of about two milligrams per liter (mg/L) in the distribution system for microbial control. After filtration, fluoride and zinc orthophosphate are also added to prevent tooth decay and for corrosion control, respectively. Filtered water is then stored in a clearwell and eventually pumped through a high-service pump station to the distribution system of the west and southwestern sections of Philadelphia.

2.1.5 Raw Water Quality

Key Points

- **Schuylkill River water quality is monitored to assess potential health risks, aesthetics, and treatment requirements.**
- **The Philadelphia Water Department routinely monitors pH, color, alkalinity, hardness, total dissolved solids, conductivity, turbidity, coliform, *Giardia* and *Cryptosporidium*, total organic carbon, UV absorbance, bromide, nitrogen, phosphorus, iron, manganese, sulfate, chloride and sodium at their Belmont Intake. Many other parameters are monitored as part of special studies.**
- **Turbidity and other suspended contaminants in the river tend to increase as a function of precipitation, runoff and river flow.**
- **Salt levels in the river appear to fluctuate seasonally, perhaps in response to application of road salts during the winter.**
- **Conductivity, alkalinity, chloride and sodium as well as 15 other well quality parameters have increased at the Belmont Intake over the past decade. Increased pollution from runoff is the most likely source of these changes.**
- **Nearly 70% of the 809 miles of streams and creeks in the lower half of the Schuylkill River Watershed have been assessed. Applicable water quality standards were attained in two-thirds of the stream miles that were assessed.**
- **Stream impairments in the lower Schuylkill River Watershed are primarily caused by stormwater runoff from urban and suburban areas, and by municipal point sources.**

2.1.5.1 Water Quality Summary

Water Quality Parameters and Their Significance

A variety of parameters can be used to measure the health of our streams and rivers, as well as the suitability of these surface waters as a source of potable water supply. Table 2.1.5-1 summarizes the specific parameters sampled for at PWD's Belmont Intake. Table 2.1.5-1 also identifies the time period over which sampling was conducted, and the frequency of sampling. Most of the data is collected regularly by staff at the water treatment plant (WTP). That data is supplemented by measurements collected for compliance with the Information Collection Rule and by raw water measurements obtained at a pilot treatment facility located at the WTP.

Table 2.5.1-1 shows that an extensive amount of data has been collected to characterize almost all parameter groups at the Belmont Intake. Data generally spans 1990 to the present. A significant data set for parameters such as total suspended solids, metals, and nutrients, was available for detailed analysis of spatial and temporal trends. Data was very sparse for synthetic and volatile organic compounds, as well as for radionuclides.

Statistical summaries were developed for those parameter groups with sufficiently large data sets. Available water quality data for VOCs, SOCs, and radionuclides are analyzed separately due to incompleteness. In the statistical summaries, the minima and maxima are presented to show the range of values and variability of the data.

The means and medians are presented to show the central tendencies of the parameters – typically measured levels. A mean that is significantly greater than the median indicates that one or two high values are affecting the mean. Similarly, a mean that is significantly lower than the median indicates that one or two low values are reducing the average. The number of samples shows how many measurements were included in the computation of the statistics. The number of samples is related to the sampling frequency and time period given in Table 2.1.5-1. The number of non-detect measurements and the detection limit are also listed, where applicable. These were not included in computations of the minima, maxima, means and medians.

Table 2.1.5-1 Belmont Intake Sampling Summary

Parameter Group	Parameter	Frequency of Sampling	Time Frame	
Physical Parameters	pH	Daily	Jan-90	Feb-01
	Apparent Color	Weekly	Jan-90	May-93
			Apr-98	Feb-01
	Alkalinity	Daily	Jan-90	Feb-01
	Hardness	Weekly	Jan-90	Jul-99
	Total Dissolved Solids	Monthly	Jan-90	Jun-93
			Nov-96	Jan-99
	Conductivity	Weekly	Jan-90	Dec-99
Particulates & Microbial Contaminants	Turbidity	Daily	Jan-90	Feb-01
	TSS	Monthly	Jan-90	Jun-93
			Nov-96	Jan-99
	Total coliform	Weekly	Jul-94	Feb-01
	E. coli	Weekly	Jul-95	Feb-01
	Giardia			
	Cryptosporidium			
DBP Precursors - (Organic Compounds & Bromide)	TOC	Weekly	Sep-93	Feb-01
	UVAbs@254nm	Weekly	Sep-93	Feb-01
	SUVA	Weekly	Sep-93	Feb-01
	Bromide	Weekly	May-95	Feb-01
Inorganic Compounds – Nutrients	Ammonia	Daily	Jan-90	Jul-00
	Nitrite	Weekly	Jan-90	Jun-93
	Nitrate	Monthly	Jan-90	Nov-92
		Weekly	Jun-97	Dec-99
	D. Orthophosphate	Weekly	Jan-90	Jun-93
		Weekly	Jan-97	Dec-99
	T. Phosphate	Monthly	Jan-90	Jun-93
Inorganic Compounds – Metals	Iron	Weekly	Jan-90	Feb-01
	Manganese	Weekly	Jan-90	Feb-01
	Arsenic	Quarterly	Mar-90	Jul-99
	Sulfate	Sporadic	Feb-90	Jun-93
		Weekly	Nov-96	Dec-99
Inorganic Compounds – Secondary Contaminants	Chloride	Monthly	Jan-90	Jun-97
		Weekly	Jul-97	Dec-99
	Sodium	Monthly	Jan-90	Dec-98
		Weekly	Jan-99	Nov-99

Statistical results are discussed with respect to drinking water standards, which apply to the treated water. Although these standards or Maximum Contaminant Levels (MCLs) apply to treated water, they provide a good perspective on the quality of the raw water. Raw water quality results are also discussed with respect to impacts on treatment and finished water quality.

Physical Parameters

Physical parameters such as pH, alkalinity, color, taste, odor and conductivity may not be directly related to health risks but can be important measures of consumer satisfaction, as well as treatability.

The presence of very low levels of compounds that cause taste and odor events in drinking water can generate consumer complaints. Color, if not treated properly, can affect public perception of the water. Colored water generally indicates a higher level of organics or iron. Acid mine drainage from the Upper Schuylkill River Watershed may be contributing to manganese, and consequently, the color. Excessive nutrients can cause algae to bloom, which are also related to taste and odor compounds. Compounds that cause taste and odor or color do not generally pose health risks. However, they must be controlled to produce water that consumers want to drink. Expensive chemicals such as powdered activated carbon, potassium permanganate or ozone may need to be added during treatment to control formation. Effective watershed management can potentially save significantly on chemical treatment costs.

Two important parameters in maintaining effective treatment of drinking water are pH and alkalinity. They are monitoring tools that are essential to the drinking water treatment process. A water supply with high alkalinity may have increased chemical costs, because more pretreatment chemicals will be required for pH adjustment. Higher alkalinity is usually a naturally occurring phenomenon based on the hydrology of the region. Elevated pH levels can be indicative of algal blooms in the raw water supply. Algae are a concern because they can potentially clog WTP filters and because they can release very low levels of taste and odor compounds.

Conductivity measures the amount of ions (positive and negative) in the water and the ability of the water to conduct electricity. High levels of conductivity usually indicate high levels of salts, metals, or nutrients in the water. This parameter is a cheap and easy measurement used frequently in water quality studies. Table 2.1.5-2 summarizes the levels of physical parameters measured at PWD's Belmont Intake.

Table 2.1.5-2 Physical Parameters of Source Water

Parameter	Units	Min	Max	Mean	Median	Number of Samples
pH	pH units	6.9	9.5	7.7	7.7	4669
Apparent Color	CU	3	406	41	28	440
Alkalinity	mg/L as $CaCO_3$	17	118	72	72	4628
Hardness	mg/L as $CaCO_3$	60	251	131	129	306
TDS	mg/L	1	450	203	209	79
Conductivity	µmhos/cm	145	745	393	381	493

The statistics for the physical parameters show that the Schuylkill River is typical of most rivers in the northeast. The maximum pH of 9.5 at Belmont results from the algal blooms that can occur in late spring and early summer. The great range in apparent color, with the maximum of about 400 color units, is related to rain events. Apparent color measures color due to particulates and turbidity, as well as naturally occurring dissolved organic material. Consequently, apparent color values are influenced by rain events that increase the turbidity in the river.

The range in alkalinity is quite wide. In general, changes in alkalinity are related to base flow changes in the river. The median alkalinity and hardness of about 70 and 130 milligrams per liter (mg/L) as $CaCO_3$, respectively, are reflective of moderately hard water. Increased hardness and alkalinity can increase chemical costs associated with reducing pH at the water treatment plant. Variability in total dissolved solids and conductivity may be due to changing salt levels in the river. Salt levels appear to fluctuate seasonally with the use of road salt in winter. Some of these seasonal and flow related trends are described in more detail in the spatial and temporal analysis sections.

Turbidity and Microbial Contaminants

Turbidity measures the clarity of the water. As water gets cloudier, the turbidity increases. This indicates that fine suspended particles that obscure light rays are present in the water. Turbidity can be caused by nearby roads, construction, erosion, and agricultural runoff. Levels of turbidity depend on the type of soils, slopes, land cover, and rain intensity.

Levels of microbial contaminants or pathogens determine whether a stream is safe for recreational swimming and help gauge the amount of fecal pollution entering it. Typical pathogen testing includes total coliforms, fecal coliforms, viruses, *E. coli*, *Giardia*, and *Cryptosporidium*.

As Table 2.1.5-3 shows, statistics for the particulates and microbial parameters are influenced by rain and runoff. On average, river turbidity and total suspended solids at Belmont are quite low with medians of 5 nephelometric turbidity units (NTU) and 13 mg/L, respectively. Maximum values of 804 NTU and 453 mg/l show how turbidity and solids can increase significantly as a result of rain events. As river flow increases above the annual median flow of 1,600 cubic feet per second (cfs), turbidity generally increases. Consequently, rain events may increase chemical usage at the WTP, but observed levels of turbidity are treatable. The pre-sedimentation basin at the WTP at Belmont is used to settle out much of these solids, prior to treatment.

Table 2.1.5-3 Particulate and Microbial Contaminants at Belmont Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
Turbidity	NTU	0.2	804	13	5	4662
TSS	mg/L	1	453	35	13	59
Total Coliforms		5	35000	2817	860	275
E. coli		0	9000	495	130	263

Microbials will also increase during rain events, similar to the other particulates. Accordingly, median values for total coliforms and *E. coli* are one to two orders of magnitude lower than the maximum values. Although these parameters increase during rain events, disinfection with chlorine kills the *E. coli* and total coliform prior to distribution to consumers. However, disinfectant demand and associated costs may increase.

Table 2.1.5-4 *Giardia* and *Cryptosporidium* Detected at the Belmont WTP Intake in 2000

Pathogen	# Samples	Min	Max	Median	Average	Total Volume Examined (L)	# Positive	Percent Positive
Crypto.	36	0	0.55	0	0.062	166	7	19 percent
Giardia	36	0.00	10.50	0.34	1.15	166	23	64 percent

All concentrations in oocysts/L unless otherwise noted.

Table 2.1.5-4 summarizes the most recent results for 2000. As shown, *Giardia* is found frequently indicating routine impacts by sewage discharges upriver, while *Cryptosporidium* is detected in only one of five samples collected.

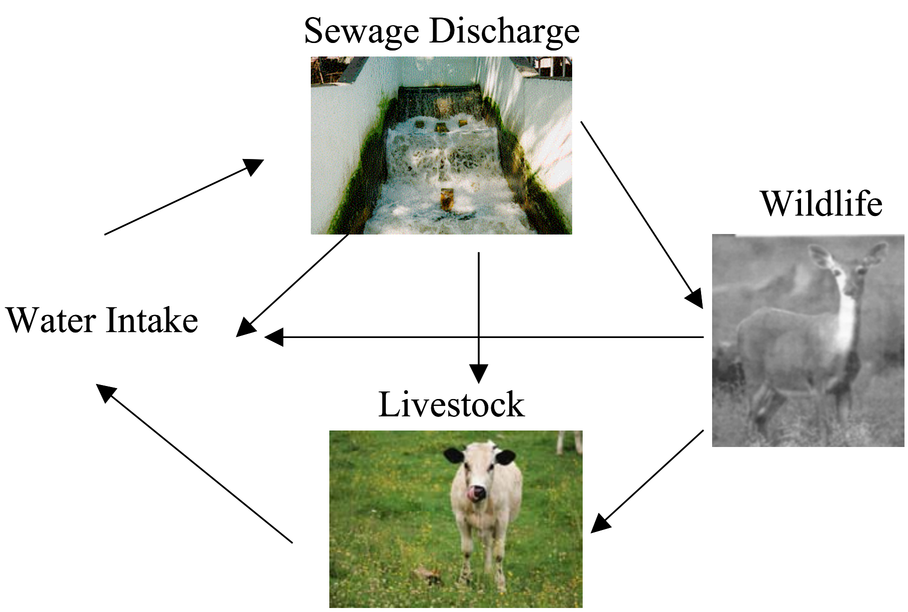
PWD has been studying *Giardia* and *Cryptosporidium* in their water supply since 1994. Since then a number of special studies have been conducted to identify the sources and influences on the concentrations of these pathogens in the river. However, the technology to adequately detect and analyze water samples for *Cryptosporidium* is not considered reliable or accurate enough for risk assessments and detailed quantitative comparisons. Given the limitations of the analytical methods, the following have been determined:

- *Giardia* and *Cryptosporidium* are detected more often in the river during storm events.

- *Giardia* and *Cryptosporidium* are typically found at higher concentrations in the river during storm events and correlate with higher turbidity concentrations.
- *Giardia* and *Cryptosporidium* are typically found at higher concentrations during winter and spring when water temperatures are colder and oocyst survival is improved.
- *Giardia* and *Cryptosporidium* are routinely found in sewage effluents.

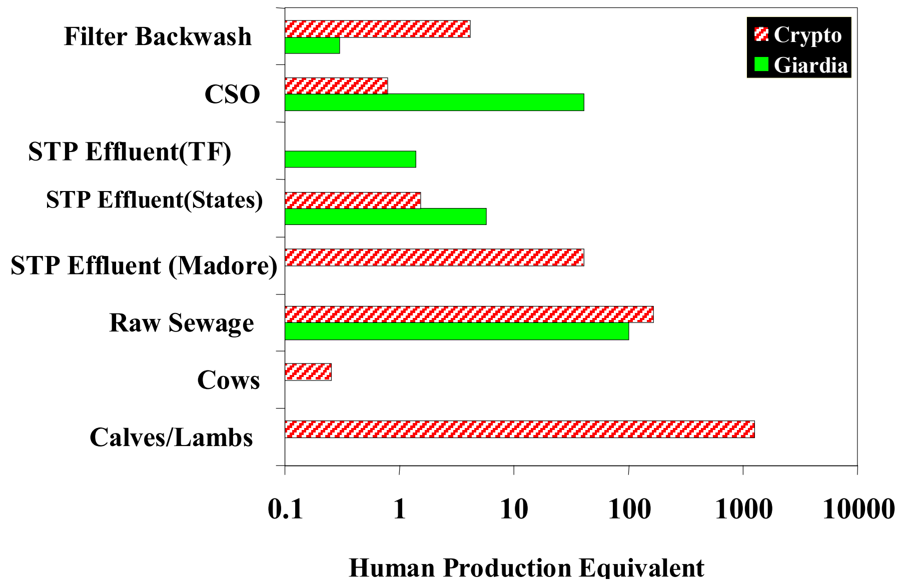
The previous findings indicate that runoff and sewage discharge influence the presence and concentrations of *Cryptosporidium* and *Giardia* in the Lower Schuylkill River Basin. Figure 2.1.5-1 provides a theoretical description of the cycle of how the pathogens are moved from one source to another and eventually into the river or water supply. As shown in Figure 2.1.5-2, one calf can produce as much *Cryptosporidium* in a day as 1,000 infected persons or over 100 adult cattle. Therefore, keeping young animals away from sensitive water supply areas is prudent.

Figure 2.1.5-1 Theoretical Pathogen Transport Cycles in a Multi-Use Watershed



Information to date suggests that treatment processes are sufficiently removing these pathogens. According to cases of cryptosporidiosis reported in Philadelphia from 1997 to 1999, none were related to drinking water. In fact, the main risk factors for cryptosporidiosis were identified as travel, swimming, contact with an infected person, day care, or farm animal contact. This is further corroborated by the observation that more cases of cryptosporidiosis are reported during the summer months when travel and swimming occur. During the summer months, *Cryptosporidium* and *Giardia* are found at their lowest levels in the local rivers and streams.

Figure 2.1.5-2 Comparison of Amount Produced by Various Sources of *Cryptosporidium* and *Giardia*



Disinfection By-product Precursors

Precursor compounds react with other chemicals (such as chlorine or ozone) used in the disinfection process to treat drinking water and may create disinfection by-products (DBPs). High levels of DBPs may cause human health impacts. Some of the precursors that are tested for include bromide, total organic carbon, and UV absorbance.

Total organic carbon (TOC) may include volatile organic compounds (VOCs) and synthetic organic compounds (SOCs), but is mostly comprised of natural organic matter from the decomposition of leaves and plants. The naturally occurring compounds that comprise TOC form chlorinated organic compounds, such as chloroform. These chlorinated organics may be carcinogens at certain levels of exposure. Absorbance of UV light is a good surrogate for dissolved natural organic matter and does not require the same level of technical laboratory analysis as TOC.

Bromide is a concern because it reacts with ozone to form bromate, a potential carcinogen. Bromide also reacts with chlorine and organics to form brominated chlorine by-products that may pose health risks.

The analytes shown in Table 2.1.5-5 are typical measures of DBP precursors. The agreement between the mean and median TOC values indicate that TOC at Belmont is typically less than 3 mg/L. This is a relatively low level of natural organic matter. The maximum TOC of 7.2 mg/L may be rain/run-off related, because TOC measures particulate organics. However, TOC increases in the summer and early fall due to more plant growth and decomposition. Formation of chlorination by-products is of particular concern during those seasons. UV absorbance shows similar trends as TOC.

Table 2.1.5-5 Organic Compounds – DBP Precursors at Belmont Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
Total Organic Carbon	mg/L	1.0	7.2	2.8	2.7	460
UV Abs@254nm	cm^{-1}	0.012	0.774	0.084	0.076	463
Bromide	□g/L	10	385	96	75	245

Bromide levels in the Schuylkill River are considered to be elevated compared to other rivers nationally. The maximum value, close to 400 micrograms per liter (µg/L), was typical of levels measured during the drought in the summer of 1999. As base flow in the river decreases, bromide levels increase significantly. This can be a potential concern for use of ozone as a disinfectant since bromate has a MCL of ten µg/L. Bromide may also form harmful by-products in the presence of chlorine and organic matter.

Inorganic Compounds - Nutrients

Nutrients can cause excessive algal growth that can harm fish and impact water treatment. These measurements can determine the impacts of nutrient runoff from lawns, gardens, farms, and other sources. Some of the major nutrients measured are nitrite, nitrate, ammonia, phosphorus, and orthophosphate. High levels of nutrients cause algal blooms. The algae can then clog filters at the water treatment plant, or upon dying, release very small amounts of chemicals (parts per trillion levels) that can make the water taste or smell bad. Though these chemicals are not harmful, they must be removed during water treatment, using powdered activated carbon. Table 2.1.5-6 provides an overview of nutrient levels at the Belmont Intake.

Table 2.1.5-6 Inorganic Compounds – Nutrients at Belmont Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
Ammonia	mg/L as N	0.01	0.93	0.10	0.07	4199
Nitrite	mg/L as N	0.01	0.08	0.05	0.05	43
Nitrate	mg/L as N	0.63	4.2	2.9	2.9	131
Dissolved Orthophosphate	mg/L as P	0.02	0.67	0.17	0.14	279
Total Phosphorous	mg/L as P	0.08	0.47	0.20	0.17	41

Median levels of the nutrients are fairly low and do not significantly affect drinking water treatment. Nitrite values are of particular concern in drinking water treatment due to blue baby syndrome. A general guideline for this is one mg/L of nitrite, which the maximum at Belmont is well below. The maximum value of total nitrate of four mg/L is also well below the MCL of ten mg/L. (DeZuane, 1997).

Inorganic Compounds – Metals

The presence of metals can cause various types of impacts on drinking water. Some metals, such as lead, may pose health risks at certain concentrations, if not removed at the WTP. The presence of lead in raw water is usually indicative of an industrial source. Lead is usually removed from the raw water by filtration. It may later leach into the water supply from distribution system pipes, but this can be controlled by chemical treatment.

Manganese is a concern for drinking water treatment because it can cause an unsightly color in the water at very low concentrations. Treatment of manganese with powdered activated carbon or potassium permanganate can be very costly. High levels of metals may also impact aquatic life. Metals are usually found at high levels in those areas of the Schuylkill River Watershed impacted by acid mine drainage. PWD monitors levels of arsenic, lead, iron and manganese, as shown in Table 2.1.5-7.

Table 2.1.5-7 Inorganic Compounds – Metals at Belmont Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples	# of Non-Detects	Detection limit
Arsenic	Mg/L	0.001	0.004	0.001	0.001	22	11	0.001-0.01
Lead	Mg/L	0.001	0.041	0.004	0.003	43	3	0.001
Iron	Mg/L	0.025	40	0.58	0.29	623	0	
Manganese	Mg/L	0.005	1.6	0.11	0.09	575	0	

Lead and arsenic data are shown because they may pose potential health risks if present in the water supply. Median values at the intake are below the current MCLs of 0.015 mg/L and 0.050 mg/L for lead and arsenic, respectively. The iron values shown in Table 2.1.5-7 are quite variable, with a median of 0.3 mg/L and a maximum of 40 mg/L. Iron levels can increase significantly at Belmont due to rain events. Higher iron increases treatment costs for chemical addition and sludge disposal. The manganese data also shows variability that can be attributed to rain events. The median value of 0.09 mg/L for raw water at the intake is in excess of the Maximum Contaminant Level Goal for finished water of 0.02 mg/L. At Belmont, this is treated by using potassium permanganate or chlorine, resulting in increased treatment costs.

Inorganic Compounds – Secondary Contaminants

Salts are the secondary contaminant considered. Salts indicate whether the stream is a freshwater or saltwater environment. Salts are not typically removed by the water treatment process. High levels of salt in drinking water are not desirable for those with low-sodium diets. Sodium and chloride are the two major constituents of salts measured.

Table 2.1.5-8 presents statistics for sodium and chloride. Salt levels increase during the winter, as described further in the temporal analysis sections. From a drinking water perspective, high sodium values are of concern for individuals with hypertension. The median/mean value of about 22 mg/L is slightly above the EPA guidance value of 20 mg/L. Use of road salts in the winter should be limited.

Table 2.1.5-8 Inorganic Compounds – Secondary Contaminants at Belmont Intake

Parameter	Units	Min	Max	Mean	Median	Number o f Samples
Chloride	Mg/L	8	76	38	37	150
Sodium	Mg/L	0.03	44	23	22	140

Synthetic Organic Compounds
Pesticides and herbicides comprise most of the synthetic organic compounds (SOCs). SOCs are manufactured chemicals that generally last a long time in the environment and may have toxic effects on human and aquatic life. Dozens of pesticides and herbicides, which can be tested for in water, exist. Generally, atrazine, a herbicide used for farming and agriculture is the most heavily used and widely found. The EPA website has more details about pesticides and herbicides, if more information is required.

Table 2.1.5-9 lists the SOCs tested for at the PWD intakes. Table 2.1.5-10 shows the SOCs that were detected in the Schuylkill River during a fall 2000 monitoring event. As shown in tables 2.1.5-9 and 2.1.5-10, a number of SOCs that have been banned or have limited use are still being detected in the river. In addition, though 6 of the 18 SOCs detected were related to farming, the others appear to be related to urban, residential, commercial, transportation, or industrial activities (please see Table 2.1.5-12). It is also interesting to note the diversity of chemicals detected in upstream watershed areas such as the Wissahickon Creek. The detection of a number of pesticides and herbicides in this stream suggests that there is still significant use of herbicides and pesticides in this mainly residential watershed.

Table 2.1.5-11 compares the SOCs detected in or near the PWD Schuylkill intakes with those detected in the Delaware Watershed based upon preliminary results of the USGS NAWQA study. As shown, there are a number of common SOCs such as atrazine, alachlor, metolachlor, and simazine. These were all herbicides that are associated with agricultural activities. The similarities suggest that these activities have impacts on water resources throughout the Delaware River Basin and are not unique to the Schuylkill River.

Table 2.1.5-9 Herbicides, Pesticides, and SOCs Results for the Queen Lane and Belmont WTPs

	1995	1996	1997	1998	1999	2000
PESTICIDES						
Alachlor	ND	ND	ND	NA	NA	+
Aldicarb	NA	ND	NA	NA	NA	NA
Aldicarb Sulfone	NA	ND	NA	NA	NA	NA
Aldicarb Sulfoxide	NA	ND	NA	NA	NA	NA
Atrazine	+	+	ND	**+**	ND	**+**
Carbaryl	NA	ND	NA	NA	NA	ND
Carbofuran	ND	ND	ND	NA	NA	ND
Chlordane	ND	ND	ND	NA	NA	NA
Hexachlorocyclopentadiene	ND	ND	ND	NA	NA	+
Lindane	ND	ND	ND	NA	NA	ND
Methomyl	NA	ND	NA	NA	NA	NA
Methoxychlor	ND	ND	ND	NA	NA	ND
Oxamyl	ND	ND	ND	NA	NA	ND
Simazine	ND	ND	ND	NA	NA	+
3-Hydroxcarbofuran	NA	ND	NA	NA	NA	NA
HERBICIDES						
Dalapon	+	ND	NA	NA	NA	NA
Dicamba	NA	ND	NA	NA	NA	NA
Endothall	ND	ND	ND	NA	NA	ND
Metolachlor	+	ND	NA	NA	NA	NA
Metribuzin	NA	ND	NA	NA	NA	NA
Pentachlorophenol	+	+	ND	ND	ND	+
Picloram	ND	ND	ND	NA	NA	ND
Propachlor	NA	ND	NA	NA	NA	NA
SYNTHETIC ORGANIC CHEMICALS						
Benzo[a]Pyrene	ND	ND	ND	NA	NA	ND
Di-2(ethylhexyl)Adipate	ND	ND	ND	NA	NA	ND
Di-2(ethylhexyl)Phthalate	+	+	ND	ND	ND	ND
1, 2-Dibromo-3-Chloropropane	ND	ND	ND	NA	NA	ND
Ethylene Dibromide	ND	ND	ND	NA	NA	ND

NA = Not Analyzed; ND = Not Detected; + indicates a positive detection

Table 2.1.5-10 SOCs Detected in Lower Schuylkill River Watersheds During Fall 2000 Monitoring Study

Chemical Name	MDL	Concentration Ranges	Wissahickon Creek	Manayunk Canal
Lindane*	0.0038	0.0052	Yes	ND
Dieldrin	0.0038	0.004-0.03	ND	ND
Alachlor	0.15	0.21	ND	Yes
Diethylphthalate	0.04	0.05-0.13	Yes	Yes
Fluorene	0.02	0.02	Yes	Yes
Phenanthrene	0.02	0.02-0.06	Yes	ND
Dibutylphthalate	0.11	0.11-0.19	Yes	Yes
Pyrene	0.02	0.05-0.09	Yes	Yes
Benzo(a)anthracene	0.02	0.03 - 0.05	Yes	ND
Chrysene	0.02	0.03 - 0.05	Yes	Yes
Benzo(a)flouranthrene	0.05	0.05 - 0.07	Yes	Yes

**insecticide for seed, lumber, livestock, pest control, most use restricted in 1980's*

Table 2.1.5-11 Comparison of SOCs Detected To Date by USGS NAWQA Study in the Delaware River Watershed

Chemical Name
Atrazine
Metalochlor
Simazine
Prometon
Diazinon
Carbaryl
Tebutheiuron
Trifluralin
Alachlor
Chlorpyrifos
Cyanazine
Acetochlor

Note: Shaded chemicals were also detected at the PWD WTPs in the Schuylkill River Watershed

Table 2.1.5-12 Uses and Possible Sources of Herbicides, Pesticides, and SOCs Detected at the PWD WTPs

Synthetic Organic Chemical	Use	Associated Activity
Atrazine	Herbicide	Farming (96percent used for corn & soybeans)
Hexachlorocyclopentadiene	Pesticide	Chemical/Petroleum Processing
Simazine	Herbicide	Farming
Dalapon	Herbicide	Farming
Metolachlor	Herbicide	Farming - used to control certain broadleaf and annual grassy weeds in field corn, farming, highway right of ways, and orchards
Pentachlorophenol*	Herbicide	Wood finishing / furniture
Di-2(ethylhexyl)phthalate	SOC	Unknown
Lindane**	Insecticide	Farming, golf courses, orchards, landscaping
Dieldrin	Insecticide, termiticide	Residential/agricultural termite / pesticide application
Alachlor	Herbicide on corn and soybeans	Farming
Diethylphthalate	Plasticizer, component in the processing of polyvinyl chloride (PVC)	PVC manufacturing, solvent; aircraft lubes; insect repellent, stp effluents, landfill leachate, tire manufacturing
Fluorene	Resins and dyes	Wastewater, petroleum production, landfill leachate, urban runoff, combustion, resins, dyes
Phenanthrene	Dyes, explosives, pharmaceuticals, fossil fuels	Wood and fossil fuel combustion, garages, metal foundries, timber processing
Dibutylphthalate	Insect repellent, plasticizer, solvent	Plastic production, landfill leachate, wastewater, pulp mills
Pyrene	Biochemical research and fossil fuels	Crude oil, tire manufacturing, fossil fuel combustion, aluminum manufacturing
Benzo(a)anthracene	Coal Tar/Crude Oil	Exhaust emissions, plastics production
Chrysene	Coal Tar	Exhaust emissions, telephone poles, railroad ties
Benzo(a)flouranthrene	Fossil Fuels	Exhaust emissions

**wood preservative, herbicide, defoliant - non-wood uses banned in 1987; antimicrobial disinfectant*
***insecticide for seed, lumber, livestock, pest control, most use restricted in 1980's*

Volatile Organic Compounds

Volatile organic compounds (VOCs) are synthetic, lightweight compounds that vaporize or evaporate easily. Some VOCs such as vinyl chloride and benzene are known to be carcinogenic, while others such as chloroform are suspected to be cancer-causing agents. Industrial point sources account for most direct discharges into surface waters, but municipal wastewater plants constitute a second major source. In general, VOCs are used in solvent and degreasing compounds. Some VOCs are frequently connected with hazardous waste sites. These pollutants, a result of industrialization, are usually present at extremely low concentrations that do not appear to pose immediate health risks.

Note that most organic compounds in water are naturally occurring and VOCs comprise ten percent of the total organic material found in water. (De Zuane 1997).

Measurements of volatile organic compounds (VOCs) at the Belmont Intake are sparse compared to the other parameters. Table 2.1.5-13 summarizes the VOCs analyzed for in PWD's drinking water. Table 2.1.5-14 is a summary of VOCs detected at the intakes. The data was broken into two sets due to time of sampling. The first set was based on mostly monthly sampling from January, 1990 through November, 1992. The second set was a discrete sampling event on May 14, 1991.

Table 2.1.5-13 Regulatory VOCs Tested for in PWD's Drinking Water

Contaminant Name	MCL	MDL
Benzene	0.005	0.0005
Carbon Tetrachloride	0.005	0.0005
1, 2-Dichloroethane	0.005	0.0005
o-Dichlorobenzene	0.6	0.0005
p-Dichlorobenzene	0.075	0.0005
1, 1-Dichloroethene	0.007	0.0005
cis-1, 2-Dichloroethene	0.07	0.0005
Trans-1, 2-Dichloroethene	0.1	0.0005
Dichloromethane	0.005	0.0005
1, 2-Dichloropropane	0.005	0.0005
Ethylbenzene	0.7	0.0005
Monochlorobenzene	0.1	0.0005
Styrene	0.1	0.0005
Tetrachloroethene	0.005	0.0005
Toluene	1	0.0005
1,2,4-Trichlorobenzene	0.07	0.0005
1, 1, 1-Trichloroethane	0.2	0.0005
1, 1, 2-Trichloroethane	0.005	0.0005
Trichloroethene	0.005	0.0005
m,p-Xylenes	10	0.0005
o-Xylene	10	0.0005

Results in mg/L
MCL = Maximum **C**ontaminant **L**evel
MDL = Method **D**etection **L**imit
(Note: These chemicals were not detected in the finished water)

Table 2.1.5-14 Volatile Organic Compound Summary at Belmont Intake

	# of Parameters Analyzed	Parameters	Frequency of Sampling	Total # of Samples	# of Non-Detects	Time Frame	
Set 1	55	See Table 2.1.5-16 for those detected	monthly*	1133	1064	1/90	11/92
Set 2	5	Bromomethane Chloroethane Chloromethane carbon tetrachloride vinyl chloride	discrete	5	5	5/14/91	

Fifty-five different parameters were analyzed in the first data set yielding a total number of 1,133 samples. However, VOCs were only detected in 69 of those samples. During the discrete sampling event on May 14, 1991, only five compounds were analyzed. During the 1991 sampling event, no VOCs were detected above the detection limit of 0.3 μg/L.

Table 2.1.5-15 summarizes the results of the monthly sampling conducted from 1990 to 1992. Of those compounds detected, benzene, chloroform, o-dichlorobenzene, total xylenes, and toluene are currently regulated. Benzene was measured below its MCL of five μg/L. Toluene and xylene were also detected well below their regulatory limits of one and ten μg/L, respectively. Chloroform, dibromochloromethane, and total trihalomethanes all constitute trihalomethanes. Their presence is indicative of chlorine in the river, either due to an industrial source, chlorinated wastewater discharges, or road salt. The maximum value noted for chloroform of 1.8 μg/L is well below the MCL of 100 μg/L. Total trihalomethanes were also measured less than the current limit of 80 μg/L.

Table 2.1.5-15 Summary of Detectable VOCs at Belmont Intake

Compounds Detected	Units	Min	Max	# of Samples Detected	Detection Limit	MCL
1,2,3 trichloropropane	μg/L	0.7	1.4	2	0.3	0.8
Benzene	μg/L	0.3	0.4	2	0.3	5
Chloroform	μg/L	0.3	1.8	17	0.3	100
Dibromochloromethane	μg/L	0.3	0.3	20	0.3	TTHM <80
Methylene chloride	μg/L	0.3	1.0	6	0.3	5
o-dichlorobenzene	μg/L	0.3	0.3	1	0.3	600
o-xylene	μg/L	0.3	0.3	1	0.3	10
Toluene	μg/L	0.3	0.9	5	0.3	1,000
Total trihalomethanes	μg/L	0.4	1.8	12	0.3	TTHM <80

A further examination of regulatory VOC monitoring of 21 chemicals at the Belmont intake from 1994 to 1999 did not identify VOCs related to source water impacts. Typically, other than the occasion of a gasoline, fuel oil, petroleum pipeline break, or related spill, VOCs from point or non-point sources have not had a routine or regulatory compliance impact on water quality in the 1990s at the Belmont WTP Intake.

MTBE is a specific VOC produced as a gasoline additive used to reduce air pollution. However, it is quite persistent and is easily tasted or smelled at very low concentrations and can impact drinking water aesthetics. Monitoring was conducted by PWD for methyl tertiary-butyl ether (MTBE) during periods from 1996 to 2000. Maximum concentrations detected were 3.8 ug/L, which is well below the recommended limits of 20 ug/L. Data to date for the Schuylkill River indicates that concentrations are highest during the summer periods when recreational boating is at its peak in the river. Recreational boat engines and in particular, jet skis or wave runners, have been observed by studies in California to represent the most significant source of MTBE. Boat engines and jet skis can release uncombusted gasoline directly into the water.

Radionuclides

Radioactivity is not typically a major health concern in surface waters based on actual concentrations and frequency of detections. Nevertheless, surface waters may be susceptible to radioactive contaminants from nuclear industrial accidents. Increased use of radioisotopes in the health industry may also be a potential source of pollution. Some radionuclides are naturally occurring due to soil and rock decomposition. Naturally occurring radionuclides are found at much higher concentrations in groundwater, than in surface water. The major concern with radionuclides is that they cannot be removed by known chemical or physical treatment and are generally very persistent in the environment. Natural decay can be an extremely slow process.

Radioactivity in water may be caused by four general categories of radiation: alpha and beta particles, gamma rays and neutrons. Chronic effects of radiation are still not well identified, so pending further research, health authorities have followed a basic tenet of keeping exposure to the lowest level. Maximum contaminant levels (MCLs) of gross alpha particles, gross beta particles and combined radium isotopes (226 + 228) are 5 pCi/L, 4 mrem/yr., and 5 pCi/L, respectively. Strontium-90 is another isotope of particular concern due to its toxicity and persistence (DeZuane, 1997).

Radionuclide data was available from a report prepared by Exelon Nuclear for locations downstream of the Limerick Generating Station (LGS) 10-20 miles upstream of the Norristown plant. Exelon prepares annual Radiological Environmental Operating Reports in accordance with LGS Technical Specifications. The reports summarize the Radiological Environmental Monitoring Program (REMP). The report provides the data needed to evaluate whether the LGS is impacting downstream drinking water quality.

Sampling for the 2000 REMP spanned January 1 through December 31, 2000. Data for surface water and drinking water samples were examined for potential impacts at the PWD intakes. The LGS has a permitted storage facility for contaminated soils, sediments and sludges from onsite treatment. In order to assess whether any radionuclide transport is evident, surface water samples are taken at Vincent Dam, 1.75 miles southeast of the storage site. Samples are also taken from control locations that should not be affected by transport from the storage site. The results from 2000 surface water sampling are found below in Table 2.1.5-16.

Table 2.1.5-16 Radionuclide Summary – Surface Water Stations near Limerick Generating Station [1]

Analyte (pCi/L)	Lower Limit of Detection (LLD) [4]	# of Analyses	Indicator Locations [2] Range	Indicator Locations [2] Mean	Control Locations [3] Range	Control Locations [3] Mean	MCL	Location w/ Highest Annual Mean
Tritium	2000	11	52 to 157	108	-6 - 157	80	20,000	Vincent Dam (Indicator)
Gamma Spec		31						Perkiomen PS (Control)
Mn-54	15		-1.3 to 2.5	0.2	-1.2 to 2.9	0.6		
Co-58	15		-2 to 1.9	0.1	-2.7 to 3.5	0.5		
Co-60	15		-1.3 to 2.2	0.3	-0.8 to 3	0.7		
Fe-59	30		-0.1 to 5.6	1.9	-3 to 7.3	1.8		
Zn-65	30		-8 to 5.7	-1.6	-7 to 8.2	-0.3		
Zr-95	30		-3 to 5.3	1.0	-3 to 6.8	1.3		
Nb-95	15		-1.6 to 2.5	0.6	-0.7 to 3.4	1.3		
Cs-134	15		-7 to 2.4	-2.5	-11 to 4.8	-2.2		
Cs-137	18		-1.5 to 3.4	0.3	-2 to 3.3	0.8		
Ba-140	60		-3 to 27	4.5	-4 to 18	4.0		
La-140	15		-1.9 to 7.8	1.0	-1 to 4.2	1.4		

Notes:

[1] Data is from Appendix A of LGS 2000 Annual Radiological Environmental Operating Report.

[2] Indicator Location is Vincent Dam - 1.75 miles SE of storage site

[3] Control Locations are Perkiomen Pumping Station - 7.3 miles E & the Limerick Intake - 0.2 miles SW of storage site.

[4] LLD is defined as the smallest concentration of radioactive material that would yield a net count with only a 5% possiblity of falsely concluding a blank observation

Results may be shown as negative values because background activity is subtracted from the sample activity. Very small changes in radioactivities were measured. Consequently, higher background levels were sometimes reported than measured sample levels. Overall, surface water sampling clearly indicates no radionuclide transport from the storage site at the LGS. Tritium levels were slightly higher on average at the indicator location compared to the controls. However, levels were well below the Lower Limit of Detection and the MCL. Gamma Spec samples were all measured higher at the control location, than at the indicator site. The REMP report also states that levels of radiological activity in surface water samples were less than baseline levels before LGS became operational.

In addition to the surface water locations, the REMP obtains samples at nearby drinking water intakes. The intake sampling locations on the Schuylkill River include Philadelphia Suburban Water Company, Phoenixville Water Works, Citizen's Utility, and the Pottstown Water Authority. Pottstown, at river mile 53, is upstream of LGS and is a control location for the drinking water sampling program. Citizen's Utility, 2.5 miles downstream, is the closest water intake to LGS. Table 2.1.5-17 summarizes the radiological sampling at the drinking water stations of the REMP.

Table 2.1.5-17 Radionuclide Summary – Drinking Water Locations near Limerick Generating Station(1)

Analyte (pCi/L)	Lower Limit of Detection (LLD) [4]	# of Analyses	Indicator Locations [2]		Control Locations [3]		MCL	Location w/ Highest Annual Mean
			Range	Mean	Range	Mean		
Gross Beta Soluble	4	48	1.4 to 4.6	3.1	1..0 to 5.6	3.0	50	PSWC (Indicator)
Gross Beta Insoluble	4	48	-1.7 to 1.9	0.3	-1 to 1.8	0.3		PSWC (Indicator)
Tritium	2000	16	17 to 157	90	-2.5 to 152	63	20,000	PSWC (Indicator)
Gamma Spec		48						
Mn-54	15		-1.7 to 5.8	0.5	-0.7 to 4.1	0.9		Pottstown Water (Control)
Co-58	15		-1.8 to 3.5	0.4	-0.9 to 2.7	0.5		PSWC (Indicator)
Co-60	15		-1.9 to 2.9	0.6	-1 to 4.7	0.8		Pottstown Water (Control)
Fe-59	30		-1.6 to 11	1.6	-2.5 to 8.3	1.2		PSWC (Indicator)
Zn-65	30		-8 to 5.9	-1.3	-5 to 5.7	-0.6		Citizen's (Indicator)
Zr-95	30		-1.4 to 7.4	1.2	-1.0 to 7.3	1.3		PSWC (Indicator)
Nb-95	15		-1.7 to 6.4	0.8	-0.9 to 3.1	0.4		PSWC (Indicator)
Cs-134	15		-9 to 4.6	-2.5	-5 to 4.4	-1.4		Pottstown Water (Control)
Cs-137	18		-1.1 to 4.2	0.7	-2.5 to 3.8	0.5		Citizen's (Indicator)
Ba-140	60		-9 to 23	3.0	-4 to 11	2.7		PSWC (Indicator)
La-140	15		-1.1 to 4.4	0.8	-0.9 to 4.7	1.1		Pottstown Water (Control)

Notes:
[1] Data is from Appendix A of LGS 2000 Annual Radiological Environmental Operating Report.
[2] Indicator Locations are Citizen's Home Utility, PSWC - Sch.River Intake, & Phoenixville Water Works
[3] Control Location is Pottstown Water Authority - 5.84 miles WNW of LGS.
[4] LLD is defined as the smallest concentration of radioactive material that would yield a net count with only a 5% possiblity of falsely concluding a blank observation

Similar to the surface water locations, tritium was the only radionuclide that was measured somewhat higher on average at the indicator locations than at the control. Tritium values were again well below the LLD and the MCL. Gross beta and gamma spec results were very low, with no significant differences between the indicators and control. Exelon concluded in the 2000 Annual Report that the LGS was having no adverse impact on the environment (Exelon, 2000). Drinking water quality at PWD's Schuylkill River intakes do not appear to be affected by current operations at the Limerick Generating Station.

The presence of the Limerick Nuclear Generating Station requires monitoring for the presence of radionuclides in PWD's finished drinking water. As shown in Table 2.1.5-18, only Gross Beta radionuclides have been detected, at levels far below the regulated limits in the finished water from Schuylkill River sources. No other radionuclides have been detected.

Table 2.1.5-18 Radionuclides in PWD Drinking Water Effluents (1999)

Parameter	MCL	MDL	Effluent Concentration (pCi/L)
Gross Alpha	15 pCi/L	3 pCi/L	ND
Gross Beta	50 pCi/L ~ 4 mrem	4 pCi/L	4.79
Strontium-90	8 pCi/L	2 pCi/L	ND
Tritium	20,000 pCi/L	1000 pCi/L	ND

MCL = Maximum **C**ontaminant **L**evel – a regulatory limit by the USEPA or PADEP
MDL = Method **D**etection **L**imit – the level of a contaminant that can be detected by current testing methods
NA = Not **A**nalyzed
ND = Not **D**etected (less than the MDL)

Algae and Taste and Odor Compounds

Blue green algae can have significant impacts on the taste and odor of water and require costly treatment to remove its unpleasant impacts. Typically, blue-green algae impacts occur during the spring in April and May, when water temperatures are colder, but they can occur in the fall and winter. Diatoms typically impact treatment operation by clogging filters and reducing filter run times. Diatom blooms usually occur during the summer months. Table 2.1.5-19 provides a summary of the monthly total algae and diatom concentrations in the Schuylkill River. They are mainly dictated by the availability of nutrients. As shown, diatoms make up a significant portion of the total algae observed in the water supply during the summer months.

Table 2.1.5-19 Monthly Concentrations of Algae and Diatoms at the Belmont WTP Intake -1999

	BELMONT WTP INTAKE					
	TOTAL ALGAE			TOTAL DIATOMS		
MONTH	AVERAGE	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM
April	5150	2600	7200	3675	1700	7000
May	2550	2000	3200	2500	1900	3200
June	4400	1200	12700	4386	1200	12700
July	114467	5600	501800	113033	2700	501700
August	3233	900	7000	3050	900	6500
September	1800	900	2600	1450	800	2000

2.1.5.2 Temporal Water Quality Analysis

PWD operates two drinking water intakes on the Schuylkill River in Philadelphia. As the intakes are in close proximity, it was first assumed that watershed scale properties and recent temporal trends in the Schuylkill River Valley would similarly affect the source water quality at both intakes. With this in mind, an analysis of water quality data from both intakes was conducted. This analysis consisted of assessing variation in climate, flows and water quality over a variety of time scales. Weather patterns and river flow rates were studied over the period of record, typically on the order of the past century. General trends in water quality were assessed using data collected in the Schuylkill River at Philadelphia by the USGS and PWD over the period 1973-1999. Trends in precipitation chemistry and water quality data collected exclusively at the Queen Lane and Belmont intakes were assessed for the past decade, with available data from 1990 through 1999.

Seasonal trends in water quality at the Belmont Intake from 1990 through 1999 (Figure 2.1.5-3) were typical of those found in north temperate river systems, although solute concentrations in the Schuylkill are at the high end of the range for these rivers in general. Dissolved orthophosphate (ortho-P) was typically low in winter, and higher in summer months. Despite seasonal fluctuations driven mainly by flow variation, dissolved ortho-P remained well above limiting levels for phytoplankton growth in all seasons. Ammonia exhibited its highest levels in the wintertime, although it was nearly always a small fraction of the total dissolved inorganic nitrogen (which was mostly nitrate). Nitrate levels were measured less frequently, but were typically lowest in spring associated with high flows and peaks in phytoplankton growth. Highest nitrate concentrations were measured in December and January, but these were never near the MCL of ten mg/l. Bulk measures of dissolved solutes, including conductance and alkalinity, exhibited clear seasonal trends, with maximum levels occurring in summer and fall when flows were lowest. Concentrations of relatively stable conservative ions like chloride and fluoride would generally be expected to mirror the trends in conductivity, with highest levels occurring in late summer. For fluoride, this pattern was observed, but chloride exhibited high levels intermittently in wintertime as well, suggesting impacts of deicing treatments to roadways during winter storms. Turbidity appeared to be lowest in general during summer months, when precipitation and flow levels are lower and storms are infrequent. Manganese displayed no apparent trend, but was periodically at levels as high as 1.6 mg/l through the period of study.

Long-term variation at the intake is dominated by the previously mentioned patterns of increasing solute levels including measures of conductivity, alkalinity, chloride and sodium. Ammonia levels have generally decreased through the 1990s, although levels were elevated in winter months in all years (Figure 2.1.5-4). Conductance, alkalinity, chloride and sodium levels all increased through the decade at Belmont, with sodium levels increasing at the fastest rate relative to initial (1990) concentrations.

Figure 2.1.5-3 Seasonal Patterns in Water Quality at Belmont Intake

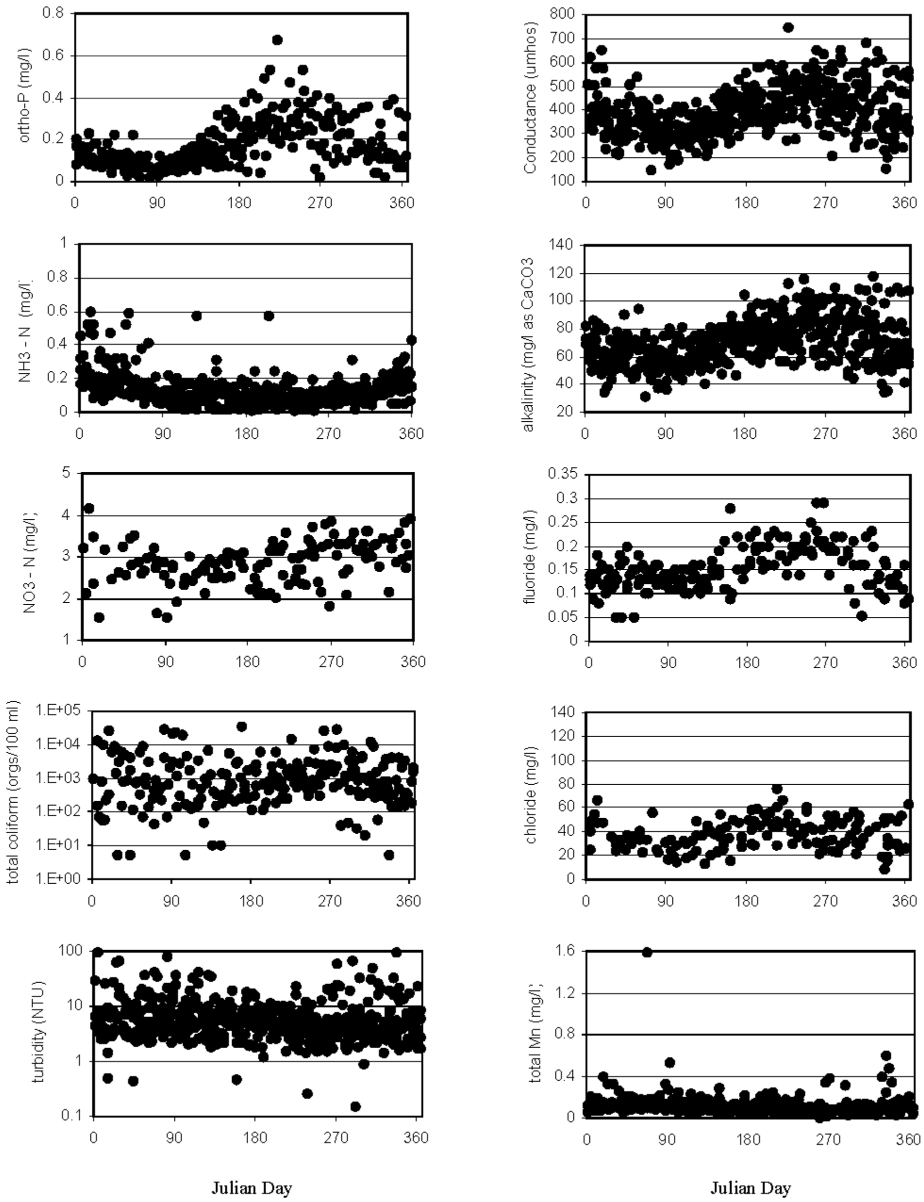
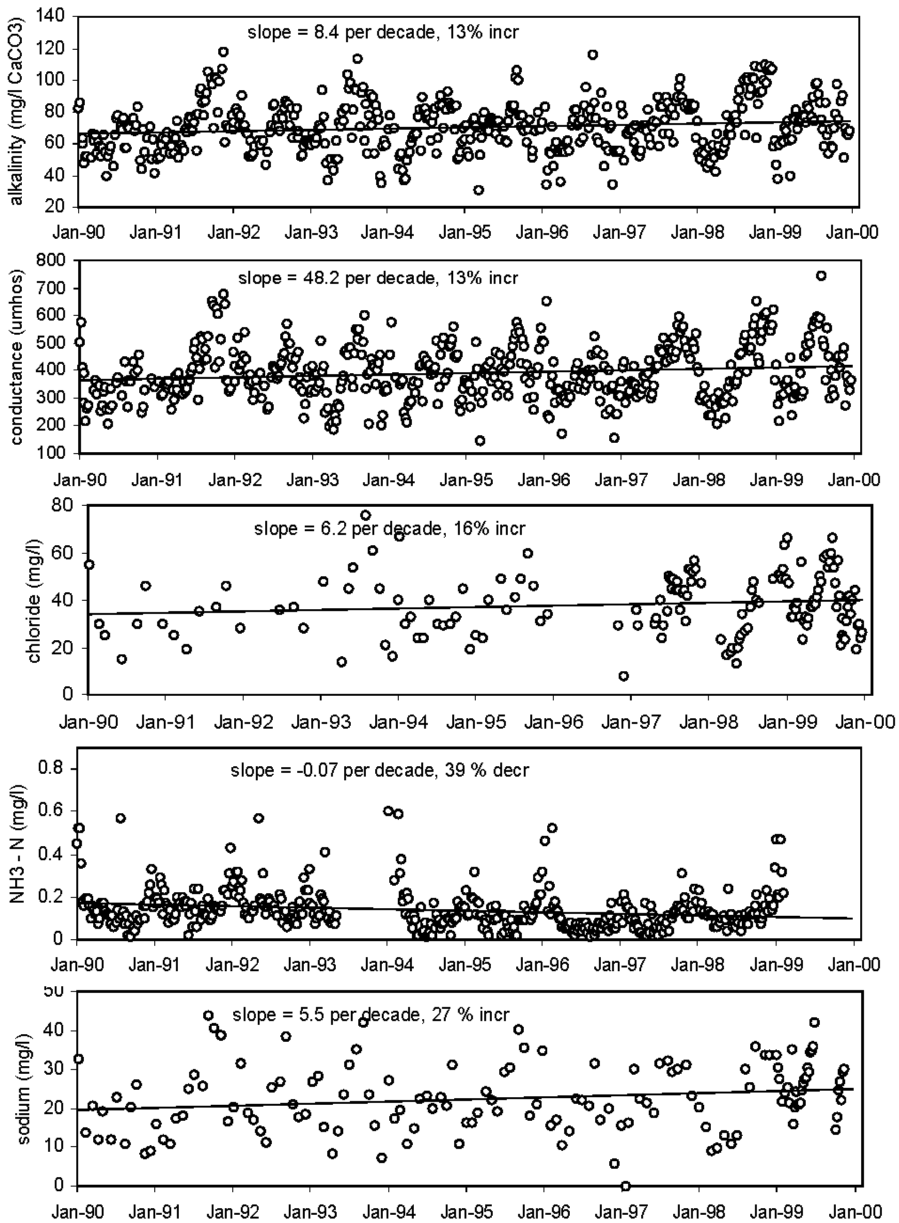


Figure 2.1.5-4 Decadal Trends in Water Quality at PWD's Belmont Intake



2.1.5.3 Spatial Water Quality Analysis

Spatial analysis of water quality along the lower and middle Schuylkill is completed for some of the parameters of interest. This enables a determination as to whether the order of magnitude of data at Belmont agrees with other nearby intakes. Spatial analysis also shows whether temporal peaks and dips at Belmont agree with the other intakes. Agreement among the various locations helps to validate trends.

Turbidity
A box plot summary of turbidity data at five locations in the Lower and Middle Schuylkill River watersheds is found in Figure 2.1.5-5. Turbidity data is readily available for the drinking water intakes, since it is the basis of a standard for finished water quality. Turbidity is a surrogate of suspended material. The statistics were based on data over the same time frame, January 1998 through July 2000. The Belmont Intake is the furthest downstream at river mile 10, with Queen Lane at mile 12, Pennsylvania American Water Company at mile 24, Philadelphia Suburban Water Company at mile 34, and Citizen's Home Water Utility at mile 41.

Figure 2.1.5-5 Summary of Spatial Turbidity Trends: Jan –98 – Aug-00

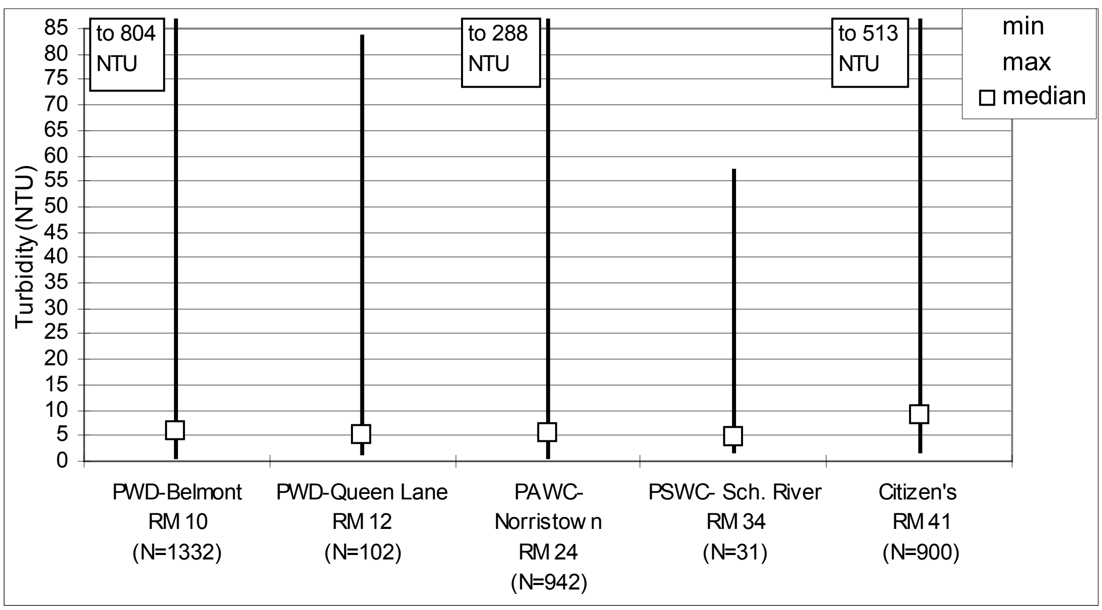
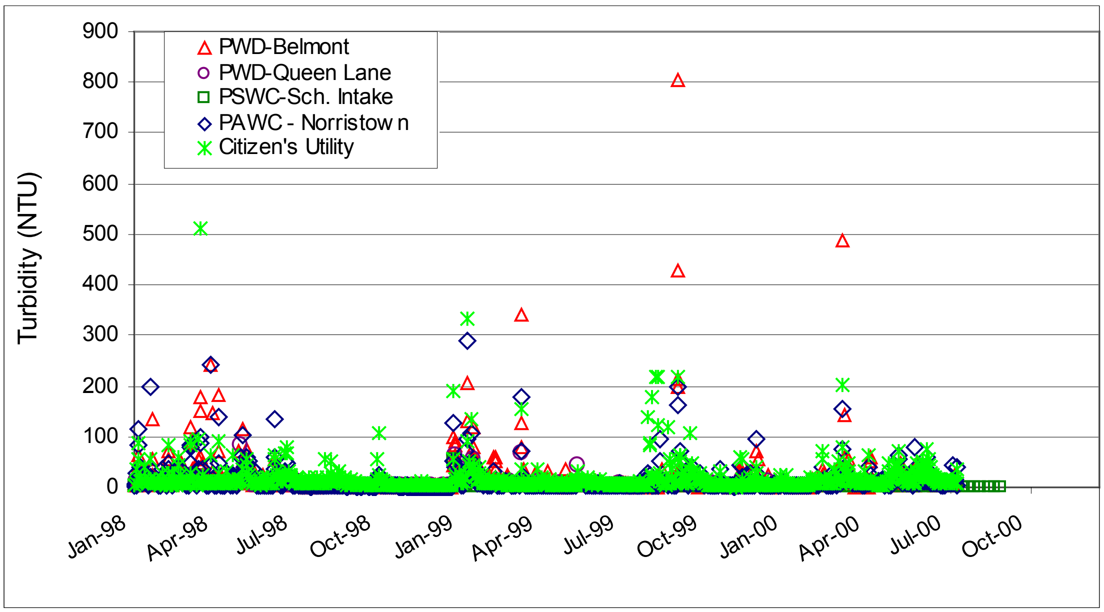


Figure 2.1.5-5 shows that median turbidity agrees well at the different locations and is about five NTU. The exception is the most upstream point of Citizen's Utility with a slightly higher median of ten NTU. A great deal of variability is evident in the maximum values compared to the minima and medians. This variability is tied to run-off of particulates during rain events. Differences in the magnitude of the maximum values with location are due to disparities in the amount and time of sampling. Some locations such as Belmont, with more data, captured a wider range of turbidity. The discrete turbidity data for these locations over the same time frame is found in Figure 2.1.5-6.

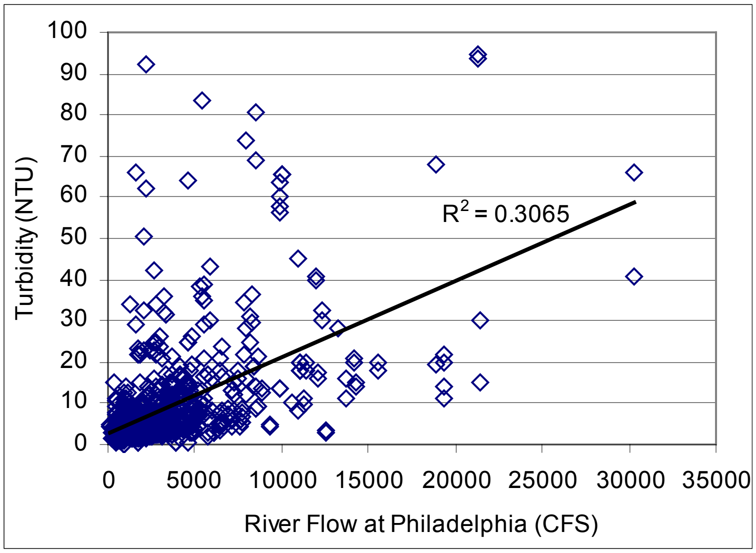
Data at the five locations in Figure 2.1.5-6 follow similar temporal trends. Times of peaks agree well. For example, Hurricane Floyd occurred in mid-September 1999, peaks in excess of 100 NTU are clearly evident at three of the five locations. Locations that do not show the same peak are because sampling frequency was not as regular and the event was not captured. This supports that the peaks are run-off related because run-off and rain events generally affect the watershed regionally.

Figure 2.1.5-6 Spatial Turbidity Trends from Jan-98 through Jul-00



A plot shown in Figure 2.1.5-7 of average daily river flow and turbidity further substantiates the effect of runoff on increased turbidity levels in the river. Turbidity measurements from Belmont and Queen Lane were combined and plotted as a function of flow for days where data for both parameters were available. An increasing linear trend is clear.

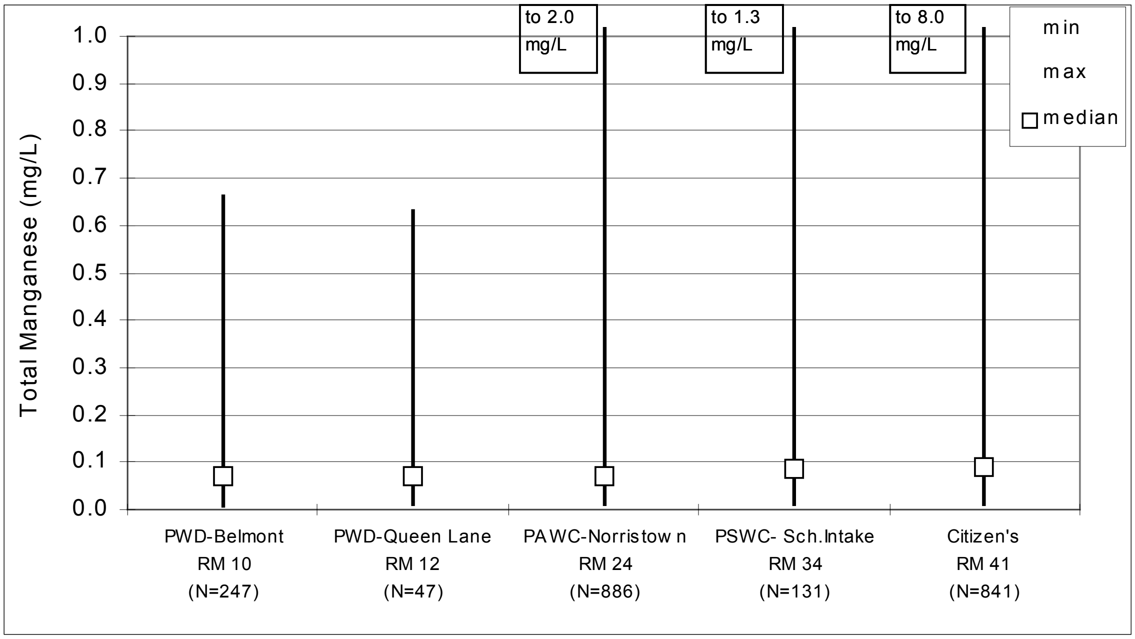
Figure 2.1.5-7 Turbidity/Flow Trends

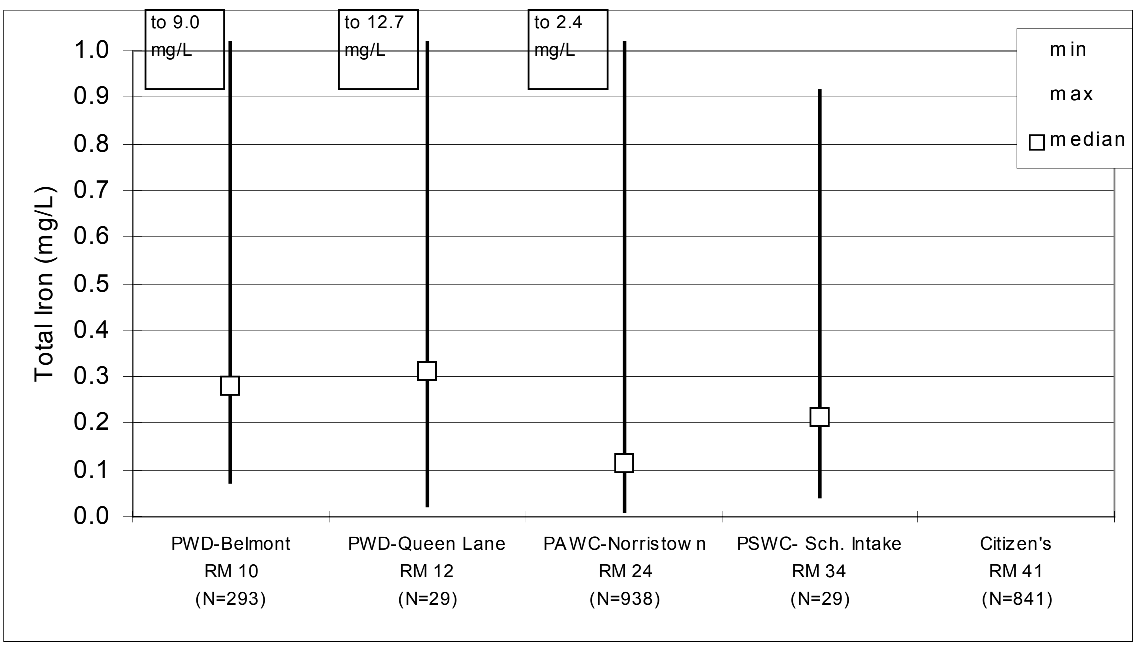


Metals: Iron and Manganese

Figure 2.1.5-8 presents a box plot summary of total manganese and iron data at the same four to five locations in the Lower and Middle Schuylkill River watersheds. Citizen's Utility did not analyze samples total iron. The box plot for manganese shows that the median is fairly constant across all locations at about 0.08 mg/L. Median manganese shows a slight increase at the two most upstream locations. Similar to turbidity, iron and manganese variability at each location, as indicated by the maximum values compared to the minima and medians, may be attributed to rain events. Rain events can increase runoff from land or increase acid mine drainage from Upper Schuylkill Watershed upstream locations. Differences in the magnitude of maximum values among the locations may be due to different sampling dates and times. Maximum manganese values up to eight mg/L can significantly affect treatment and chemical costs at the water treatment plants.

Figure 2.1.5-8 Summary of Spatial Trends of Manganese and Iron



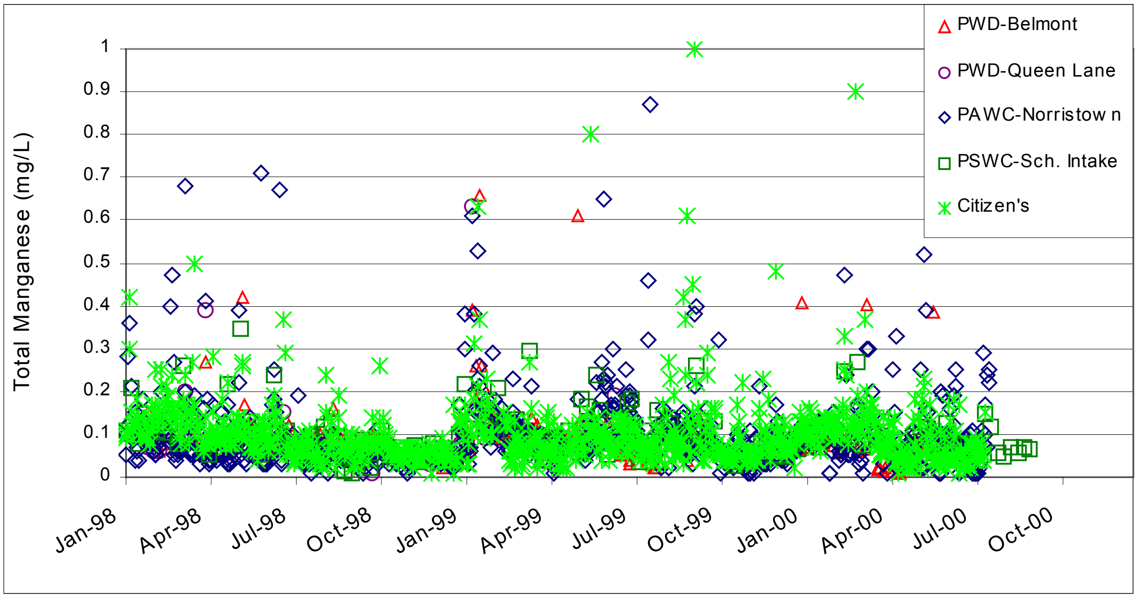


The box plot for iron shows more variability of median values with location than manganese. Median iron is about 0.3 mg/L for the Philadelphia locations, decreases to 0.1 mg/L at Norristown and increases to 0.2 mg/L at the Philly Suburban Intake downstream of Phoenixville. Perhaps this is due to different sampling dates over the time frame, but it may also indicate that certain locations are more susceptible to other point or non-point sources of iron. Maximum values are also highest at the Philadelphia intakes. Iron, similar to manganese and turbidity, has a great deal of variability at each individual location. This may be attributed to sources related to rain events. Discrete iron and manganese data for the time frame of January 1998 to August 2000 is presented in Figure 2.1.5-9 to further examine some of these trends.

Figure 2.1.5-9 demonstrates that temporal trends are generally consistent at the four to five locations. Similar to Figure 2.1.5-8, the plot shows that at each location, total manganese is typically less than 0.10 mg/L, but excursions occur. More variability is seen in the iron data. Specifically, data at Belmont is quite scattered, compared to PAWC at Norristown. These are the two locations with daily data. This is consistent with the difference in median values noted previously. Iron and manganese trend similarly with time and location, in terms of peaks and dips. Peaks are believed to be related to either increased particulate loads from run-off or increased acid mine drainage from the Upper Schuylkill Watershed during rain events. The relation of increased rain to maximum manganese and iron is evident from Figure 2.1.5-8, which shows trends between river flow and manganese and iron concentrations at Belmont and Queen Lane.

As seen in Figure 2.1.5-10, manganese trends well with average daily flow at Philadelphia, while more data scatter is evident in the iron graph. Both graphs show that as river flow increases (due to rain) metal concentrations increase. Rain may be increasing the load due to run-off from the land, particularly construction sites. Rain may also be increasing the load from upstream acid mine drainage locations.

Figure 2.1.5-9 Spatial Trends in Manganese and Iron from Jan-98 through Jul-00



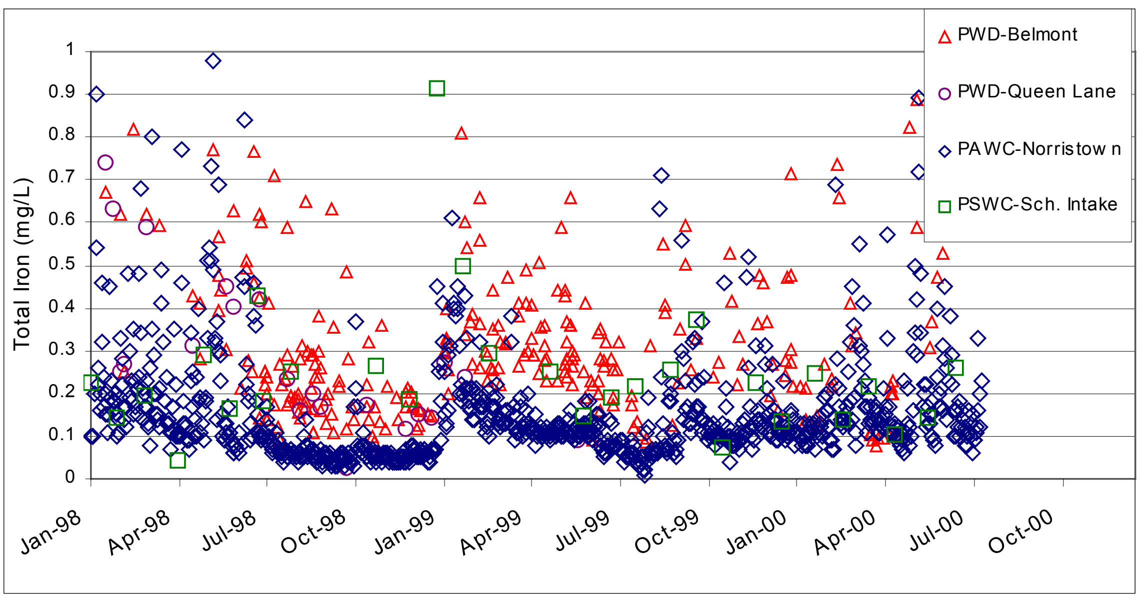
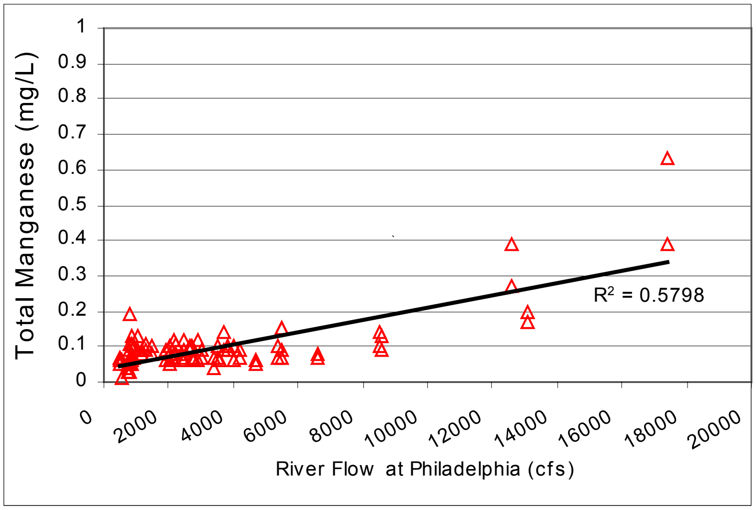
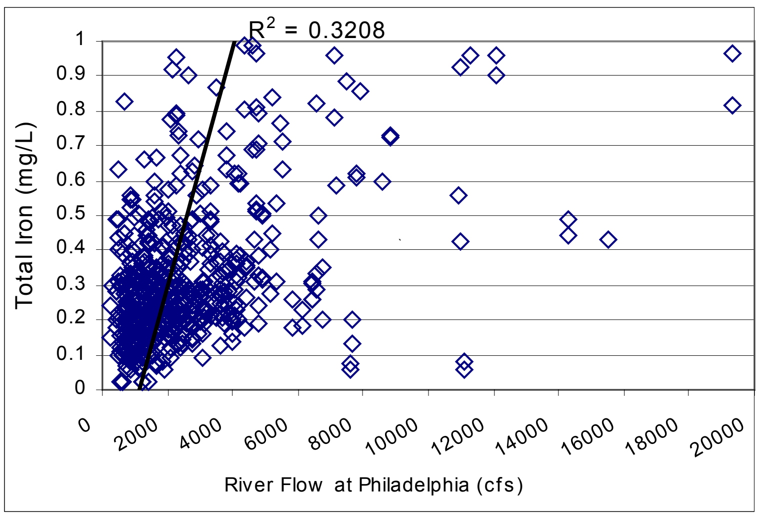


Figure 2.1.5-10 Flow Trends in Manganese and Iron





Nutrients

Figure 2.1.5-11 presents a box plot summary of available nutrient data for the Lower and Middle Schuylkill River Watershed intakes. PWD and PSWC had data for total ammonia, total nitrate, and dissolved orthophosphate over the time frame from January 1998 through July 2000. For all three parameters, Queen Lane Intake shows a somewhat higher median value. Perhaps this is indicative of an influence of the Wissahickon Creek at Queen Lane. Maximum values vary most significantly from median and minimum values.

The discrete data used in the summary is found in Figure 2.1.5-12. The discrete data also shows that Queen Lane consistently measures higher nutrient values. Temporal trends, as discussed in section 2.1.5.2, are also evident. Ammonia shows distinct peaks in the winter. This is due to either lack of biological nitrification in the cold water or use of urea as road salt. Nitrate and dissolved orthophosphate trend together.

Figure 2.1.5-11 Summary of Spatial Trends of Nutrients

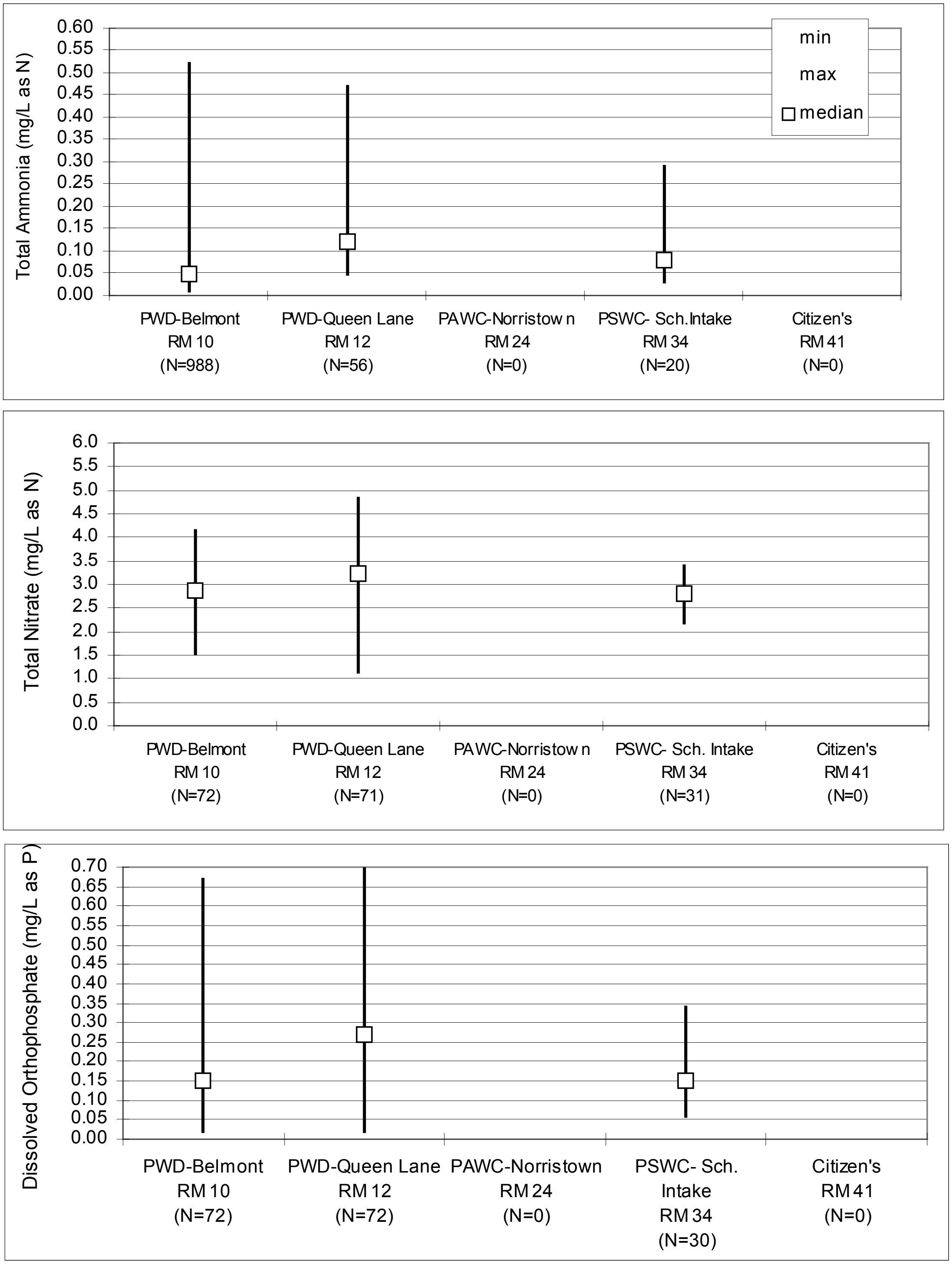
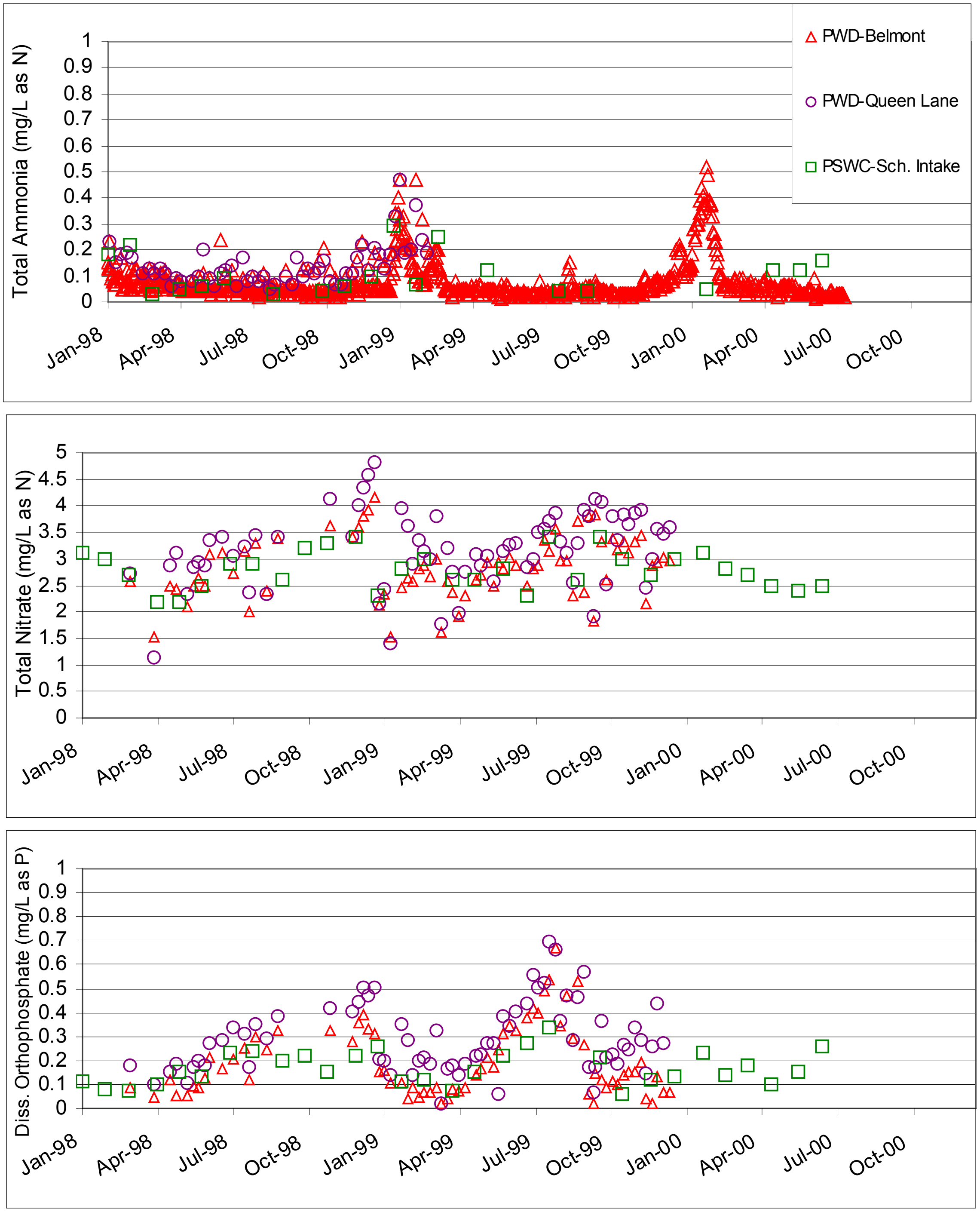
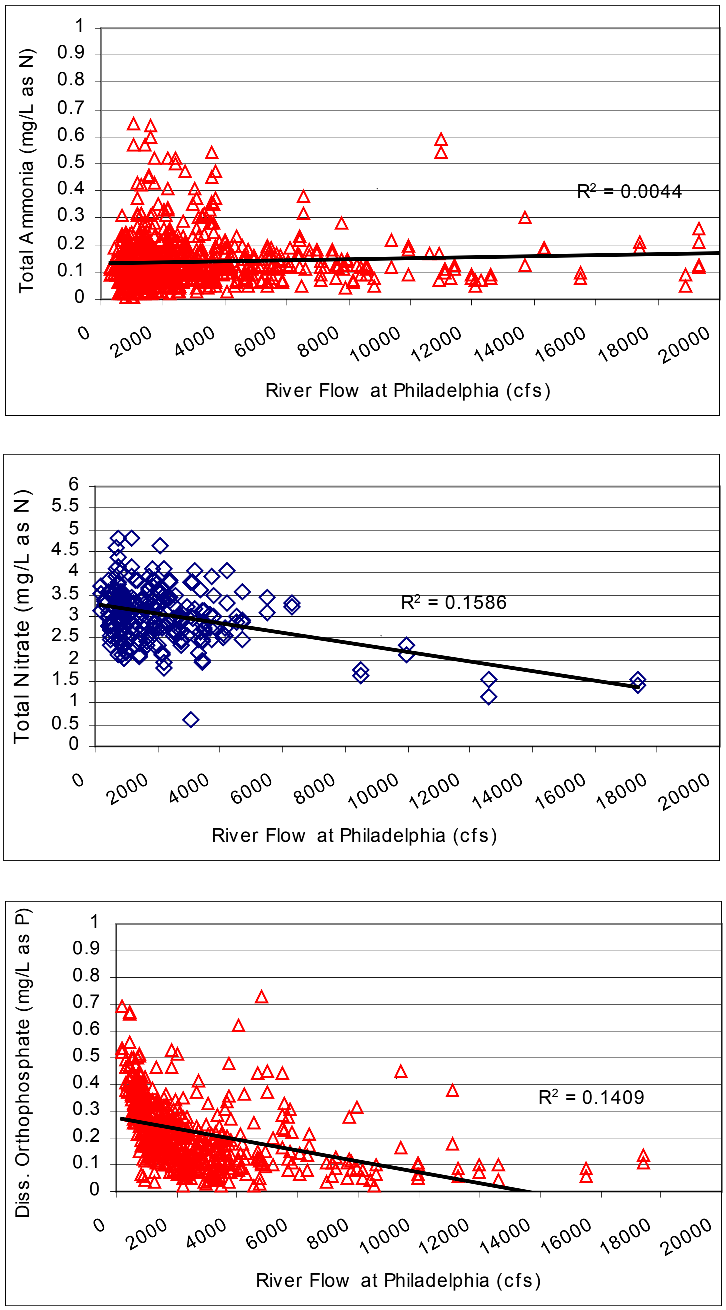


Figure 2.1.5-12 Spatial Trends of Nutrients from Jan-98 through Jul-00



Lastly, Figure 2.1.5-13 examines whether any of the available nutrients trend with river flow. Positive trends would indicate river concentrations of nutrients are runoff related. Ammonia levels in Figure 2.1.5-13 do not increase significantly with flow. Nitrate and dissolved orthophosphate levels decrease with flow, although the linear correlation is poor. This suggests that these nutrients are not greatly influenced by rain and runoff. This is probably because the nutrients analyzed are in dissolved form and are not affected by particulate runoff loads.

Figure 2.1.5-13 Flow/Nutrient Trends from Jan-90 through Jul-99



Bromide Spatial/Temporal Analysis

Special studies have been undertaken by the Philadelphia Water Department to understand more about the nature and presence of bromide in the water supply. Bromide is a concern for water treatment because under certain conditions and levels it can react with the chemicals used for disinfection such as chlorine or ozone to create disinfection by-products (DBPs). Exposure to specific DBPs over a lifetime could create chances for chronic illnesses such as cancer. Therefore, identifying and understanding the sources of these chemicals that can create potential DBPs is important. As shown in Figure 2.1.5-14, bromide is typically at its highest levels during periods of low river flow. This association suggests that the sources of bromide are typically point sources (discharges) or from groundwater that feeds the river during low-flow periods. Further efforts to identify the dominant sources of bromide are underway. Samples collected along the main stem of the Schuylkill River to date suggest that bromide levels almost double between Royersford and Phoenixville, as shown by Figure 2.1.5-15. Whether this is caused by geochemical reactions in soils with groundwater in the area or if it is from point source discharges is still being determined. Bromide sampling locations in the lower Schuylkill River Watershed are identified in Figure 2.1.5-16.

Figure 2.1.5-14 Historical Bromide Levels at PWD's Intakes

Notice the highest levels are associated with periods of low flow suggesting a groundwater or point source influence.

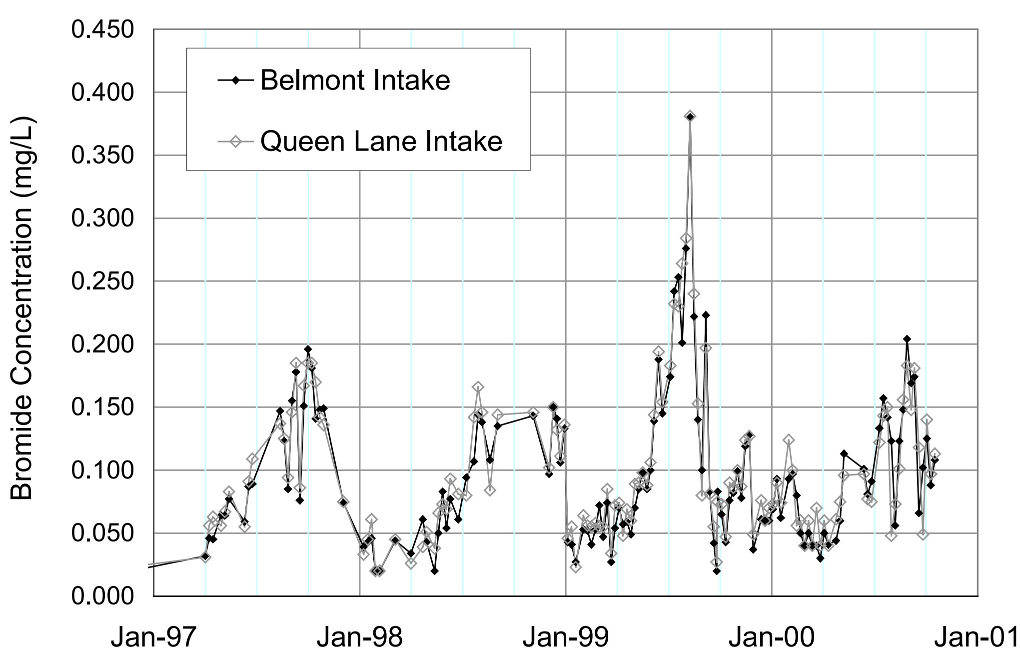
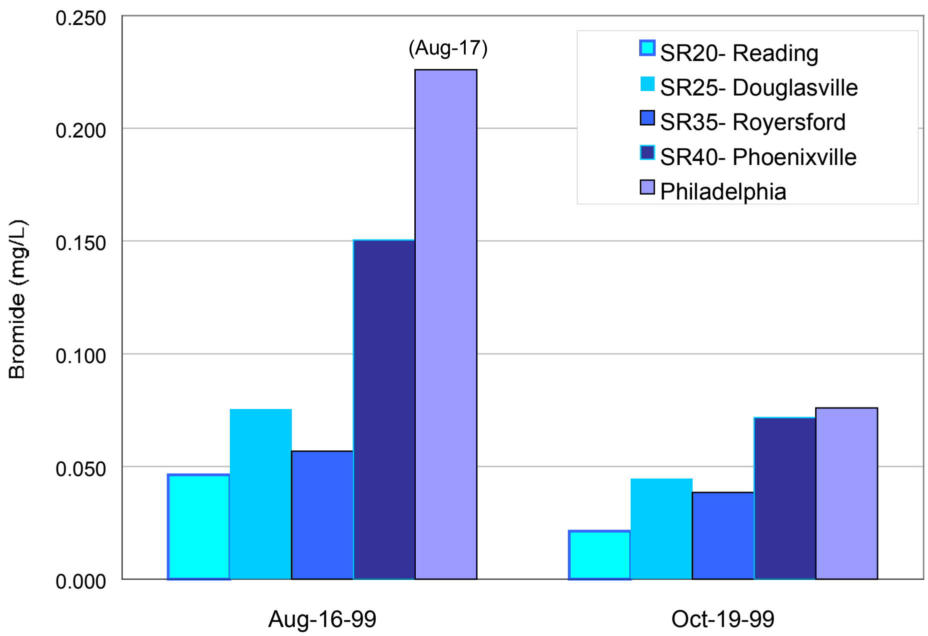
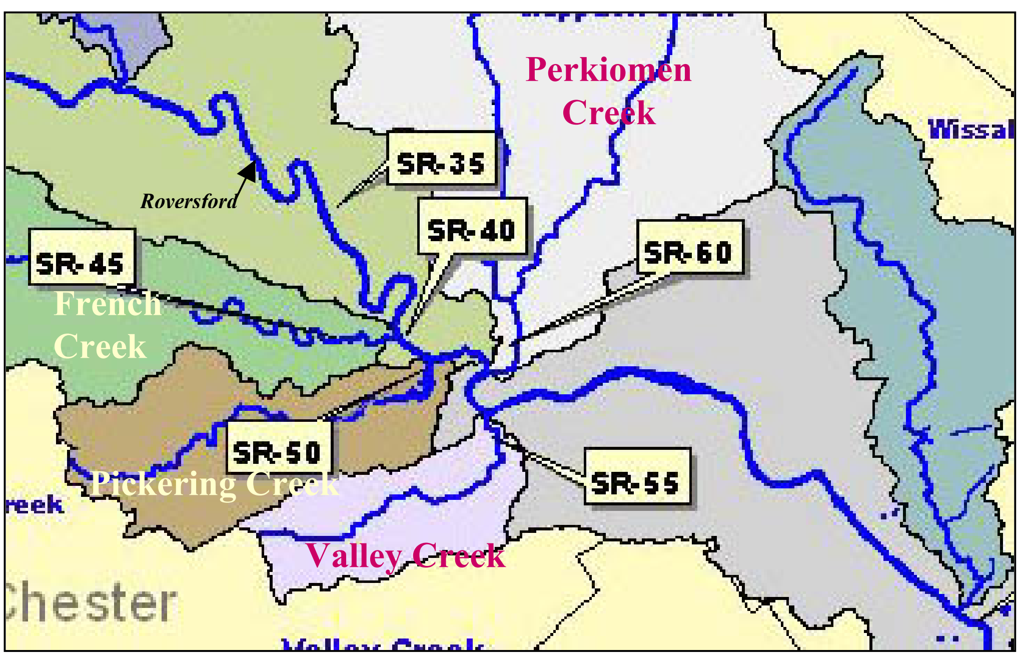


Figure 2.1.5-15 Spatial Comparison of Bromide Levels in the Schuylkill River



Notice that levels Typically Double Downstream of Phoenixville
(Source: Obolensky, 2000)

Figure 2.1.5-16 Lower Schuylkill River Bromide Monitoring Locations (Obolensky, 2000)



2.1.5.4 Analysis of Stream Impairments and Sources

Key Points

- **Almost 70% of the 809 stream miles within the Lower Schuylkill River Watershed have been assessed to determine their compliance with existing water quality standards.**
- **Water quality standards were attained along two-thirds (370 miles) of the streams that were assessed.**
- **Stormwater runoff from urban and residential areas, and municipal point sources were responsible for the majority of stream impairments within the Lower Schuylkill River Watershed.**
- **Over 90% of the Wissahickon Creek Watershed was designated as impaired.**

In accordance with Section 305(b) of the Federal Clean Water Act, the Pennsylvania Department of Environmental Protection (PADEP) prepared a 305(b) Water Quality Assessment Report in 2000. The Report summarizes water quality management programs, water quality standards and point and non-point source controls. The lower half of the Schuylkill River Watershed includes 809 miles of streams and creeks. Almost 70% (553.74 miles) of these stream miles have been assessed to determine compliance with water quality standards. Applicable water quality standards were attained in two-thirds of the stream miles that were assessed (369.94 miles). Streams that are impacted by contaminant sources (point sources, or non-point sources such as storm water runoff or acid mine drainage) so that water quality standards are not met are designated as impaired. One-third of the stream miles that have been assessed (183.8 miles) do not meet applicable water quality standards, and are designated as impaired. To date, 255.27 miles, or 31.55%, of the stream miles have not been assessed.

Figure 2.1.5-17 displays sources of impairment throughout the lower half of the Schuylkill River Watershed. Stormwater runoff from urban and residential areas and municipal point sources were responsible for the majority of the stream impairments identified in the Lower Schuylkill River Watershed.

Figure 2.1.5-18 displays the causes of stream impairments throughout the lower half of the Schuylkill River Watershed. The leading causes of impairment are nutrients and water/flow variability. Table 2.1.5-20 summarizes the number of miles impacted by each of the listed sources for each of the subwatersheds within the lower half of the Schuylkill River Watershed. Sources causing impairments vary by watershed. For example, the primary sources of impairment in the Wissahickon Creek are urban runoff/stormwater and municipal point sources. However, the Middle Schuylkill (Two) and Valley Creek have significant portions that are impaired by agricultural related sources. Stormwater runoff related sources still play as much as, if not more of a significant role in stream impairments than point sources.

Figure 2.1.5-17 Summary of Miles Impaired by Primary Sources (Source PADEP)

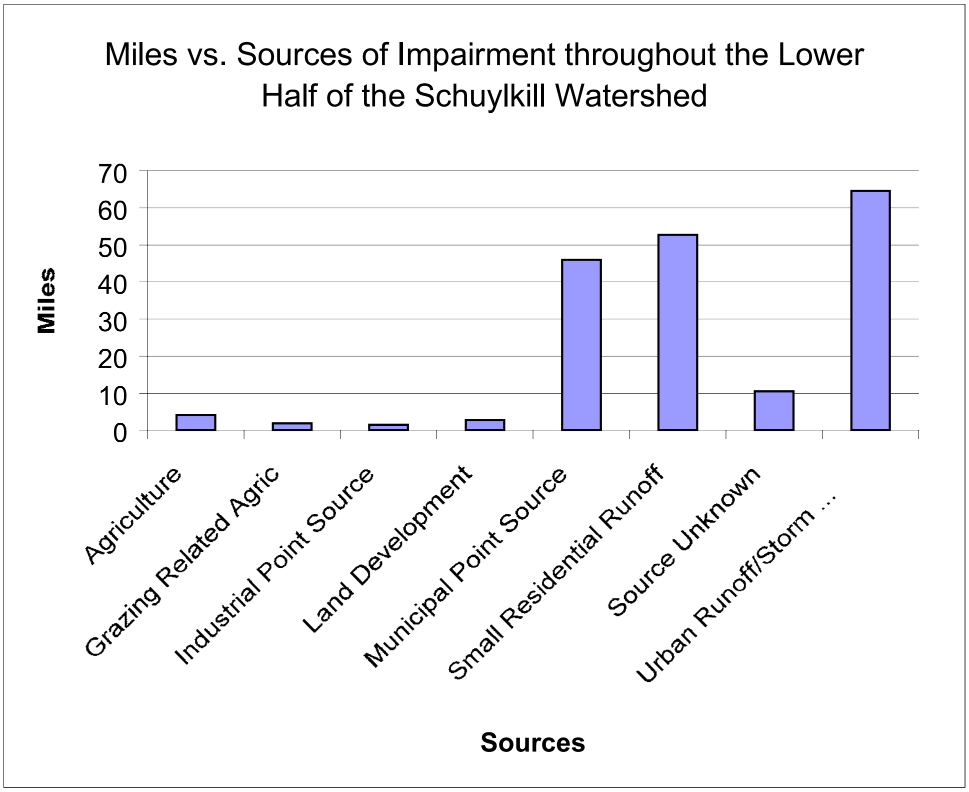


Figure 2.1.5-18 Summary of Miles of Impairment by Primary Causes

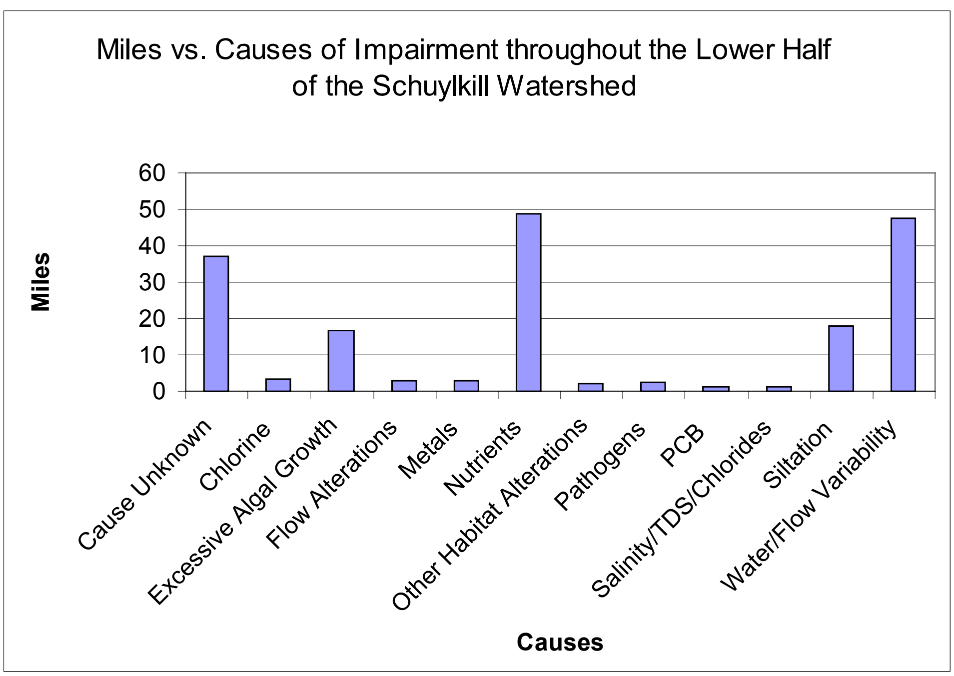


Table 2.1.5-20 Miles of Impairment by Primary Source and Watershed

Watershed	Middle Schuylkill (1)	Middle Schuylkill (2)	Wissahickon	Valley	Pickering	Perkiomen
Agriculture	0	2.58	0	0	0	1.45
Grazing Related Agriculture	0.42	0	0	1.4	0	0
Industrial Point Source	0	0	0	1.41	0	0
Land Development	0	0	0	0	0	2.7
Municipal Point Source	0.5	0	27.99	0	0	17.55
Small Residential Runoff	27.16	2.85	0	0	0	23.63
Urban Runoff/ Stormwater	6.95	0	47.86	3.97	1.82	4
Source Unknown	2.98	0	6.14	0	0	1.36

Note: miles of stream impaired by a given source.

Additionally, Table 2.1.5-21 breaks down the number of miles impacted by each of the listed causes for each of the watersheds within the lower half of the Schuylkill River Watershed. Table 2.1.5-21 shows that each of the six watersheds is impacted by different contaminants. For example, the Wissahickon and Perkiomen creeks have significant portions impaired by water and flow variability. However, the Valley and Pickering creeks are primarily impaired by nutrients or unknown causes. Overall the Pickering Creek had the least impaired stream miles (3%), while the Wissahickon Creek had the greatest amount of impaired stream miles (94 %) (see Figures 2.1.5-19 and 2.1.5-20).

Table 2.1.5-21 Breakdown of Miles of Impairment by Primary Cause and Watershed

Watershed	Middle Schuylkill (1)	Middle Schuylkill (2)	Wissahickon	Valley	Pickering	Perkiomen
Chlorine	0	0	3.51	0	0	0
Excessive Algal Growth	0	0	0	0	0	16.38
Flow Alterations	0	2.85	0	0	0	0
Metals	2.98	0	0	0	0	0
Nutrients	0.42	0	33.33	5.37	0	9.66
Other Habitat Alterations	0	0	2.29	0	0	0
Pathogens	0	2.58	0	0	0	0
PCB	0	0	0	1.41	0	0
Salinity/TDS/Chlorides	0	0	0	0	0	1.14
Siltation	0.65	0	10.46	0	0	6.48
Water/Flow Variability	8.36	0	23.01	0	0	13.79
Cause Unknown	24.68	0	6.14	0	1.82	0

(Source: PADEP)

Figure 2.1.5-19 Percentage of Watershed Miles Impaired and Assessed in the Lower Schuylkill River Basin. (Source: PADEP)

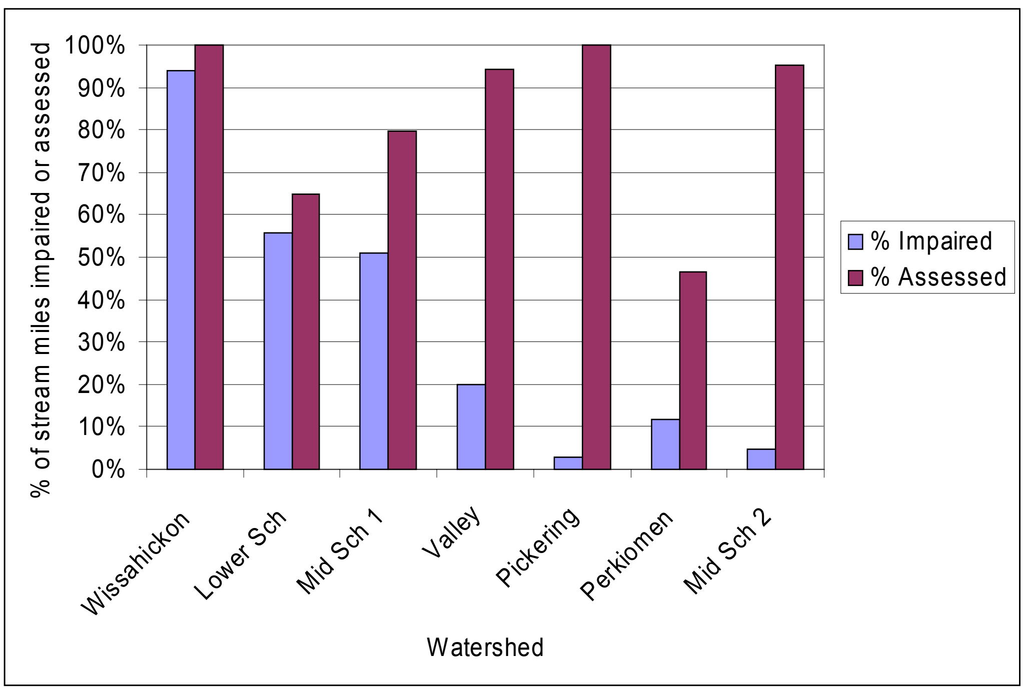
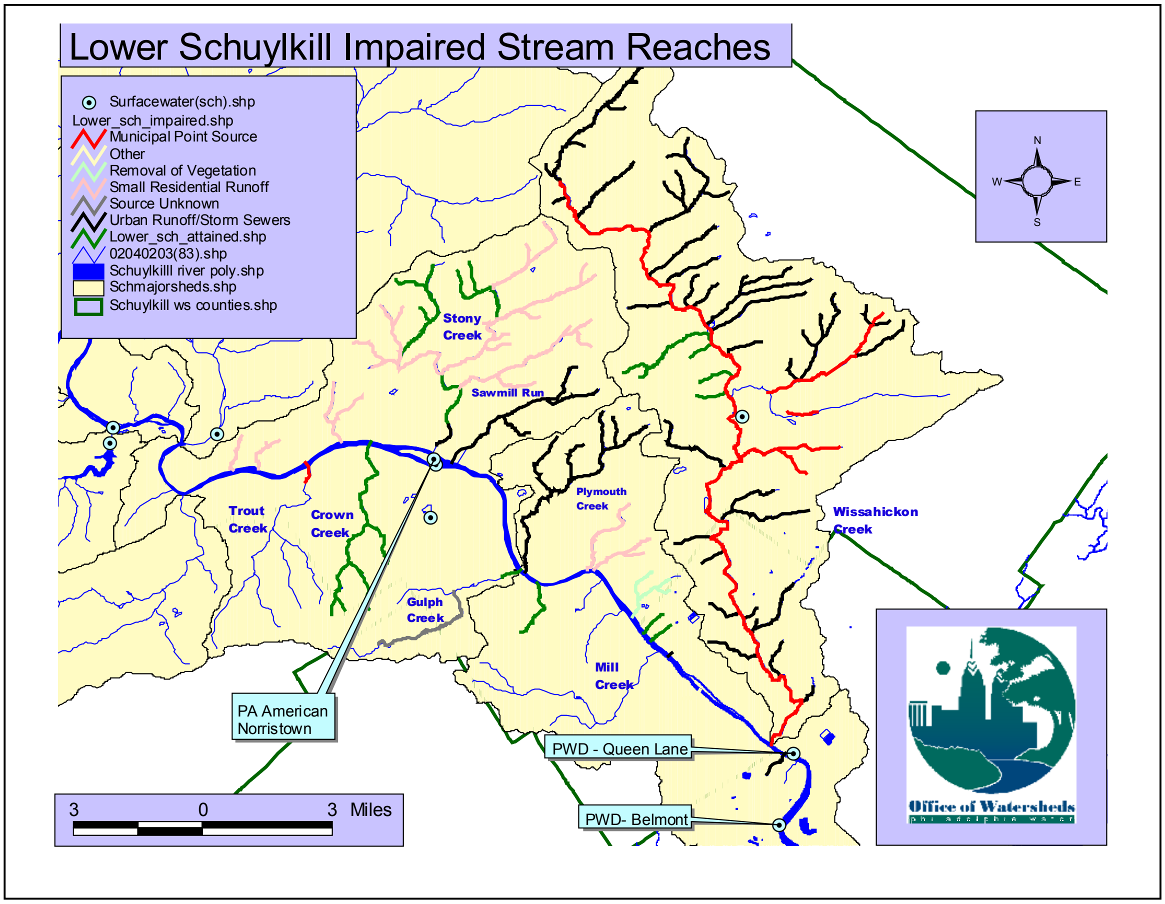


Figure 2.1.5-20 Impaired Stream Reaches in the Lower Schuylkill River Watershed



2.2 Source Water Assessment

2.2.1 Delineation of Source Water Assessment Zones

Key Points

- **Zone A, the area within a 5-hour time of travel of Philadelphia Water Department's Belmont Intake, includes 67.5 square miles of the Schuylkill River Watershed.**
- **Zone B, the area between the 5-hour and the 25-hour time of travel of the Belmont Intake, includes 1,260 square miles of the watershed.**
- **Zone C, the area beyond the 25-hour time of travel incorporates the remainder of the 1,900 square-mile Schuylkill River Watershed.**

The Belmont water supply intake receives water from a drainage area greater than 1300 square miles. Identification of all potential contaminant sources within such a large area requires a systematic approach to examine the area in such a way as to identify all pertinent sources. This approach, as defined by the PADEP's SWAP Plan, involves a segmentation approach that divides the watershed into zones based on the proximity of a potential contaminant source to a water supply intake. This method assumes that proximity is directly linked to a potential source's impact on a water supply in most cases. Using this logic, the PADEP's SWAP Plan divided the source water assessment area for a given intake into the following three zones and prioritized all contaminant source identification accordingly:

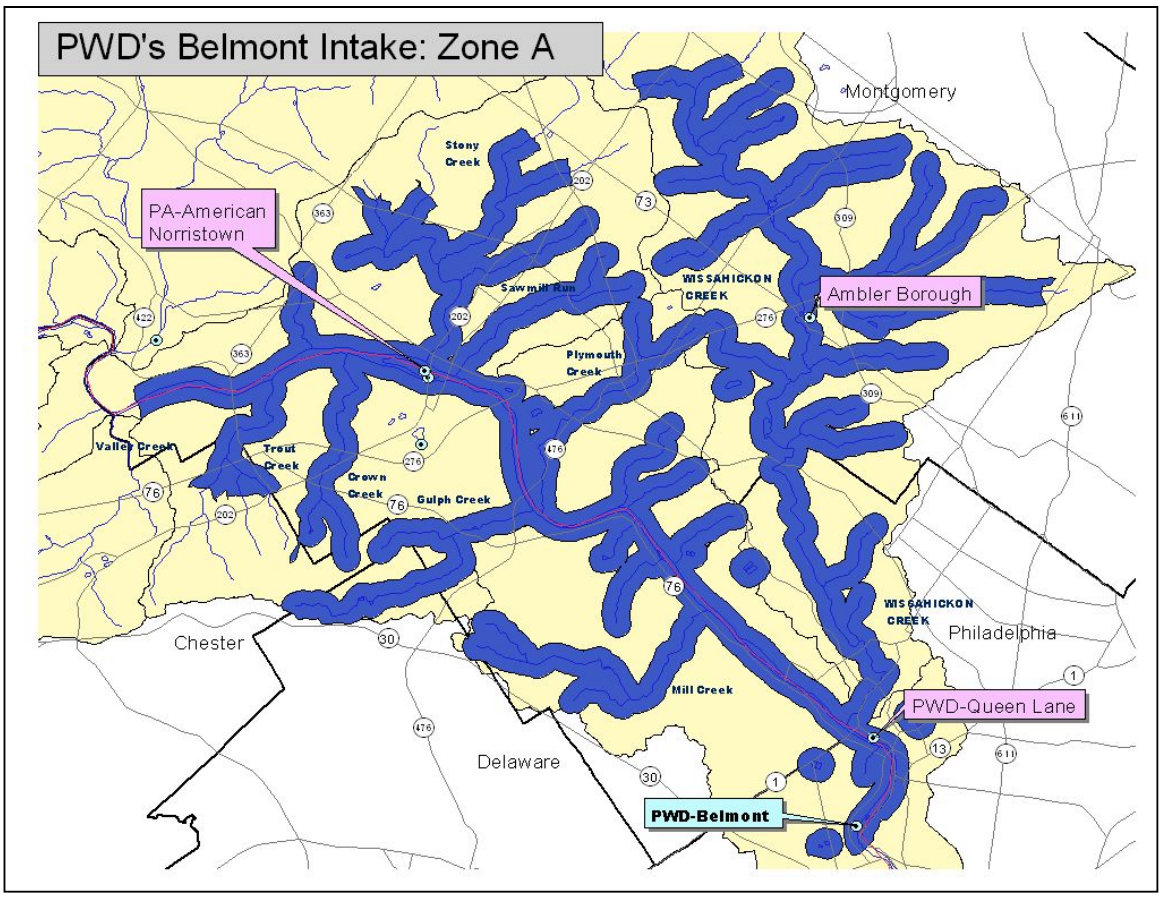
Zone A - This is the critical area of highest potential impact on the water supply, as proximity to the water supply's intake results in reduced response times and potential lower dilution and attenuation of a contaminant. Any potentially significant source within a five-hour time of travel of the water supply including one-quarter mile downstream and within a one-quarter mile-wide area on either side of the river/stream from the water supply, should be included in the contaminant inventory. These may include large and small discharges, catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Zone B - This is the area between the 5-hour and 25-hour time of travel to a given water supply intake, including a two mile-wide area on either side of the river or stream extending upstream to the 25-hour time of travel boundary. Only significant potential sources of contamination are identified for inclusion in the contaminant inventory. This generally represents larger discharges (>one million gallons per day), catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Zone C - This is the area greater than 25-hour time of travel to a given water supply intake. All major potential sources of contamination are identified for inclusion in the contaminant inventory. This generally represents larger discharges (>one to ten million gallons per day), catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Figure 2.2.1-1 displays the different zones delineated for the Belmont water supply intake for the Philadelphia Water Department. As shown, Zone A encompasses an area of 67.5 square miles and continues upstream of the intake to river mile 30 at Valley Forge. Zone A consists of almost the entire Wissahickon Creek Watershed and the direct drainages to the Schuylkill River up to the mouth of Valley Creek. These direct drainages include Stony Creek, Mill Creek, Trout Creek, Gulph Creek, Plymouth Creek and Sawmill Run.

Figure 2.2.1-1 PWD's Belmont Intake: Zone A



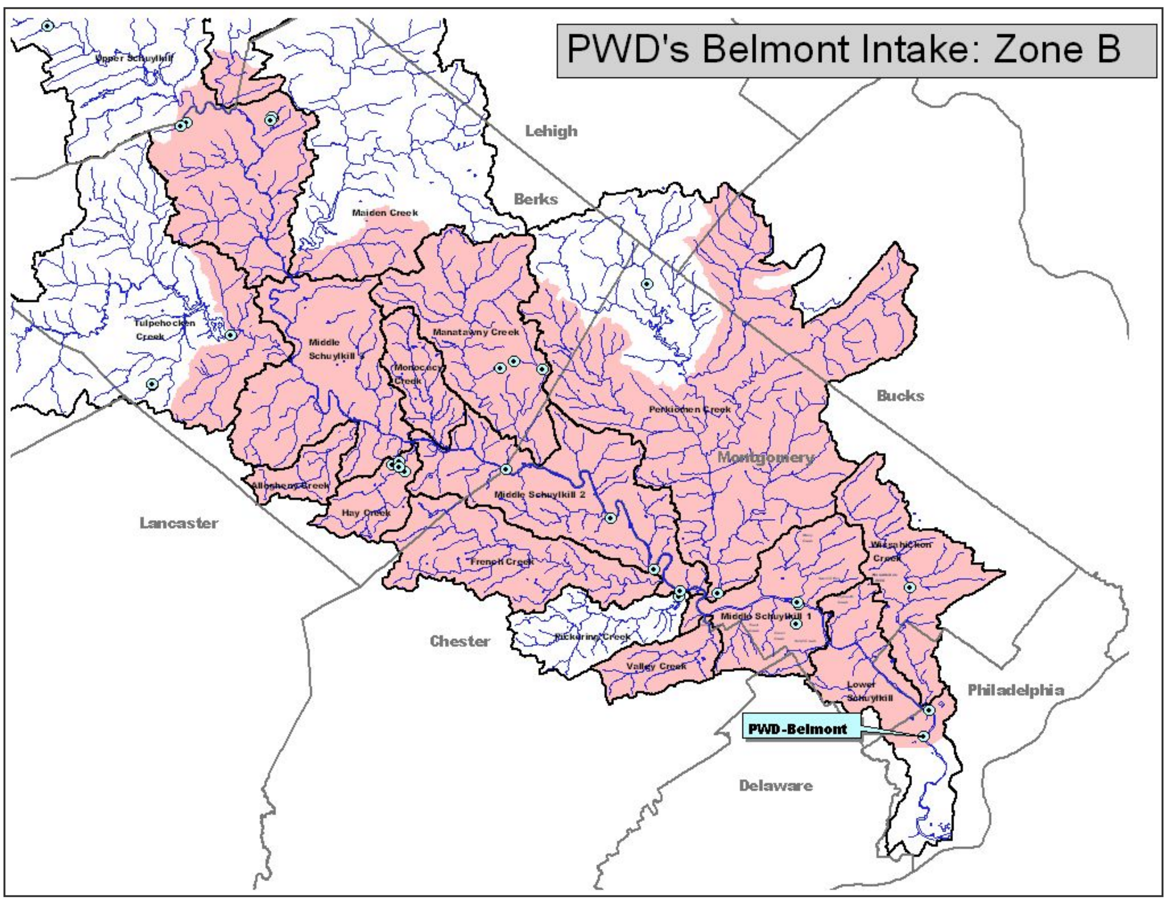
Zone B encompasses an area of 1,260 square miles and extends upstream to river mile 106 as shown by Figure 2.2.1-2. For the Belmont Intake, Zone B extends upstream from the intake to approximately 1.5 miles south of Auburn, PA. Zone B also includes all the tributaries below the Maiden and Tulpehocken creeks. Zone B includes about half of the Maiden Creek Watershed, part of the Tulpehocken Creek Watershed below Blue Marsh Reservoir, and part of the Little Schuylkill River up to Greenwald, PA. Zone C consists of the remainder of the watershed, primarily the headwaters of the Schuylkill River, most of the Little Schuylkill River, the majority of the Tulpehocken Creek Watershed and the headwaters of the Maiden Creek Watershed.

Also shown in Figure 2.2.1-2 are the locations of other water supply intakes within the zones delineated for the water supply. As shown in Figure 2.2.1-1 and 2.2.1-2, the Zone A or B from the Belmont Intake overlaps with the Zone A or B from numerous other intakes. This overlapping of zones allows for a more detailed assessment of potential sources for the whole watershed area.

As described above, the time of travel of a release from a potentially significant source of contamination combined with the characteristics of that source will determine whether it is included in the contaminant inventory.

All of the zones of delineation were determined and provided by the United States Geological Survey (USGS) and approved by PADEP for use in the Source Water Assessments. These zones of delineation were considered the most accurate descriptions available and improved upon the zone criteria described above.

Figure 2.2.1-2 PWD's Belmont Intake: Zone B



2.2.2 Point Source Contaminant Inventory

Key Points

- **Over 3,000 potential point sources were identified within the 1,900 square mile Schuylkill River Watershed.**
- **Most of these potential sources do not – and will never – discharge to the Schuylkill River. They have been identified so that water suppliers can assess their potential impacts upon the water supply, and identify appropriate protective measures.**
- **Over 1,400 RCRA facilities are located upstream of the Belmont Intake.**
- **Most of the RCRA facilities are not large quantity generators.**
- **Sewerage systems, dry cleaners and commercial print shops are the most common.**
- **VOCs, metals and petroleum hydrocarbons were the most frequently reported contaminants.**

2.2.2.1 Method

Based on PADEP guidelines for the statewide Source Water Assessment Program (SWAP), a contaminant inventory of point and non-point sources was developed. The inventory is an essential part of assessing the drinking water supply for the intake, because it compiles potential contaminant sources within the 5-hour, 25-hour, and beyond 25-hour time of travel delineation zones. This inventory is a powerful list enabling the water supplier to better understand their source water. The inventory is also the stepping-stone to prioritizing potential contaminant sources. The prioritization or ranking of contaminant sources is discussed in the Susceptibility Analysis described in Section 2.2.4 below.

The focus of this report section is the point source contaminant inventory. Non-point sources are discussed in land use section 1.2.5 and within intake section 2.2.3. Point source data was compiled from various federal and state databases available on the Internet, as well as from self-assessment data provided by water suppliers. Sources were checked by stakeholders and verified for correct active status and location. An ACCESS database was developed to efficiently store and manage information describing the point sources.

Database Compilation

The following federal databases were accessed for point sources in the Schuylkill Watershed:

- Permit Compliance System (PCS);
- Resource Conservation and Recovery Act Information System (RCRIS);
- Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS); and

- Toxic Release Inventory (TRI).

Regulated aboveground storage tanks (ASTs) were also compiled from the PADEP Storage Tank Program. Another initial source of data was provided by self-assessment forms. The self-assessment, required by the state SWAP, provides intake specific input as to which sources are of priority concern.

The databases were queried for facility, process, and violation information. Facility information included items such as name, facility identification numbers, owner, and location (street address and/or latitude, longitude). GIS information was used to locate the Schuylkill Watershed sources within the Belmont delineation zones. Process information included data identifying on-site contaminants and the quantities and/or loading rates. Violation information was related to type (administrative versus operation or effluent violation) and frequency.

Database Population

For many of the facilities, certain pieces of information required for ranking, such as contaminants and quantities, were still missing upon compiling the source database. This data was simply unavailable through the federal databases for many of the minor dischargers and RCRA facilities. Consequently, missing information was populated based on educated assumptions using the known data. Data population of missing fields affects the susceptibility analysis more than the inventory. The inventory discussed in this section is based on actual downloaded data.

Note that individual site contaminants were downloaded, where available, for each facility. Each contaminant was associated with one of ten categories. These categories were generally based on contaminant groups described in the PADEP SWAP guidance document. The contaminant categories were subgrouped into non-conservative (total/fecal coliform, turbidity, nutrients, VOC/SOCs, metals) and conservative (*Cryptosporidium*/*Giardia*, nutrients, DBP precursors, petroleum hydrocarbons, and salts) categories. Nutrients were included in both the non-conservative and conservative categories, because phosphorous is mostly associated with particulates and nitrogen compounds are typically dissolved.

2.2.2.2 Results

Point Source Contaminant Inventory

After the database compilation and population were completed, inventories specific to each intake were developed. PWD's Belmont Intake was delineated into three zones based on travel time. Zones A and B, the area of the watershed within a 25-hour travel time of the intake, encompass over 1,300 square miles. Zone C extends beyond 25 hours of travel time and essentially captures the remainder of the Schuylkill Watershed. Consequently, the inventory of sources throughout the three zones is quite extensive for the Belmont Intake.

The completed inventory for Belmont compiles over 3,000 sources and is too voluminous to append within this report. The complete inventory is available for download from the Schuylkill Source Water Assessment website –

www.schuylkillswa.org. The inventory is sorted into three sections for zones A, B, and C and subsorted by source type, PCS, RCRA, etc. The inventory indicates facility information such as name, city and county. The source of the data is also indicated, that is, RCRA, PCS, etc. Other pertinent information includes industry classification by SIC code, whether the facility is a Large Quantity Generator for RCRA sites, and a major discharger for PCS sites. If information was available for a specific facility, such as on-site or discharged chemicals, quantities of chemicals, capacity of the site, and discharge flow rates, it is listed.

Inventory Characterization

Data from the complete Belmont inventory summarized in Table 2.2.2-1 identifies the most common contaminant source types and the zones in which they are concentrated. The characterization also seeks to find common industries or dischargers and the most common contaminants by category. The table is organized by source type (PCS, RCRA, etc…) and zone of delineation (A, B, or C). Note that there is overlap for some facilities with source type. For example, the same facility may be both a permit holder (PCS), a RCRA facility or a TRI facility.

Even accounting for overlap among source types, Table 2.2.2-1 indicates that a number of sources are found upstream of the Belmont Intake. On a positive note, the least number of sources are found in the area of the watershed within Zone A, 5 hours of travel time. Most sources are found within Zone B, between 5 and 25 hours of travel time. RCRA facilities are the most numerous with greater than 1,400, followed by PCS dischargers, and aboveground storage tanks. There are over 400 direct discharges in the watershed upstream of Belmont, however only 50 are within Zone A. These sources are ranked for significance with respect to other criteria, such as contaminant category, quantity, and violations, in Section 2.2.4.

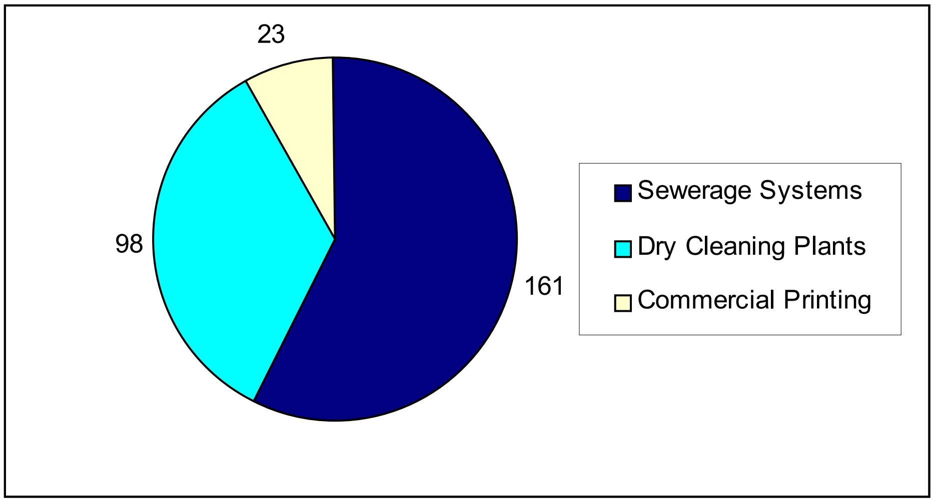
Table 2.2.2-1 Summary of Point Source Types Delineation Zone

Source Type	Zone A, < 5hr	Zone B, >5 hr and < 25 hr	Zone C, > 25 hr	Total
PCS	47	274	149	470
RCRA	230	1024	188	1442
AST	64	279	53	396
TRI	26	200	52	278
CERCLA	28	241	63	332
Self-Assessment	25	109	24	158
Total	420	2,127	529	3,076

Figure 2.2.2-1 shows the most common industry types, based on SIC code, throughout the Belmont delineation zones. The top three industry types are shown. The data is

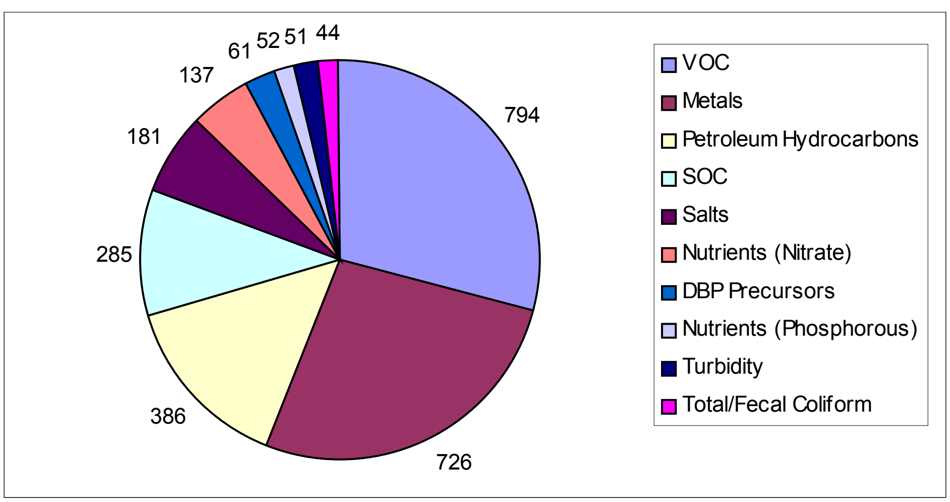
somewhat limited due to the amount of missing SIC codes, especially for the dischargers. Despite its limitations, the data provides an insightful overview of the prevalence of various industry types within the overall delineation zone. Sewerage systems were most numerous, followed by dry cleaning plants, and commercial printing operations.

Figure 2.2.2-1 Prevalent Industry Types for the Belmont Intake



Similar to Figure 2.2.2-2, parameter groups are summarized based on prevalence throughout the Belmont delineation zones in Figure 2.2.2-1. This is again based on a limited data set. Contaminant information was most complete for TRI sources. With this in mind, available data shows that VOCs are the most common contaminants reported by the sources, followed by metals and petroleum hydrocarbons. This is useful for water suppliers to keep in mind in monitoring efforts and surveillance of raw water.

Figure 2.2.2-2 Prevalent Contaminant Categories for the Belmont Intake



PCS Dischargers

A characterization of dischargers or PCS facilities within the Belmont Intake's delineation zone is examined in Table 2.2.2-2. Out of 470 dischargers, 40 are major (>one MGD). Wastewater treatment plants comprise the largest component, 161 of 470, for both major and minor dischargers. After sewerage systems, gasoline and water suppliers are the most common discharger types.

Table 2.2.2-2 PCS Discharger Summary

Total Dischargers	470
Major Dischargers	40
Major Sewerage Systems	35
Facilities with SIC Codes	420
Top 3 Discharge Types by SIC Code 4952 - Sewerage Systems 5541 - Gasoline Service Stations 4941 – Water Suppliers	 161 16 14
Dischargers with Available DMR Data	52
Most Common Parameters with DMR Data	Total Suspended Solids Ammonia Nitrogen BOD5 Total Copper Total Phosphorus
Discharge Flow Rate Range (from DMRs)	1 – 43 MGD

Because so many of the dischargers are minor, Discharge Monitoring Report (DMR) data was available for 52 sites. The data spanned June 84 through January 2001. The most common parameters found in the DMRs and effluent limits are indicated in Table 2.2.2-2. The common DMR parameters – TSS and BOD5 - correlate with turbidity and TOC (DBP precursor), which are of concern from a source water perspective. Copper poses some concern in drinking water supplies, but other metals are much more toxic with respect to human health risks. The prevalence of nutrients is expected due to the number of wastewater plants.

Discharge Monitoring Report (DMR) data for Belmont sources are further summarized in Table 2.2.2-3 based on maximum reported quantities and parameter groups. This summary is quite similar to the watershed wide summary presented in Section 1.5, because Belmont's delineation zone covers the majority of the Schuylkill Watershed. The parameter groups generally follow those laid out in the PADEP SWAP guidance document. These grouping are used to rank potential contaminant sources in the intake report sections.

Since the ranking analysis is based on DMR maximum quantity data, this data is compiled in Table 2.2.2-3 to provide a frame of reference. The data also gives an idea, on a pounds per day basis, as to the "worst case" order of magnitude of releases. Note from Table 2.2.2-3 that this data was available for only 52 of the 470 dischargers in the delineation zone for Belmont. Available data was generally linked to major dischargers. With that in mind, the data truly represents a worst-case estimate of individual loads being discharged in the Schuylkill Watershed within the delineation zones of the Belmont Intake.

Table 2.2.2-3 Summary of Available DMR Data

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
Cryptosporidum/ Giardia	Not Available					
Nutrients	Ammonia as N	0	-	32550	113	2527
	Nitrate-Nitrite as N	0.00023	-	7.2	1.2	22
DBP Precursors	BOD5	0	-	21727	546	1045
Petroleum Hydrocarbons	Oil & Grease	0	-	164	22	322
Salts	Not Available					
Total/Fecal Coliform	Fecal Coliform (col./day)	46	-	84	65	2
Turbidity	Total Suspended Solids	0	-	802396	659	5588
Nutrients	Phosphorus, Total as P	0	-	527	21	581
VOC	1,1,1-Trichloroethane	0.001	-	0.09	0.03	37
	1,1,2-Trichloroethane	0.001	-	0.07	0.01	18
	1,1-Dichloroethane	0.001	-	0.02	0.01	18
	1,1-Dichloroethylene	0.000	-	0.05	0.01	83
	1,2-Dichloroethane	0.001	-	0.02	0.01	18
	1,2-Dichloropropane	0.001	-	0.02	0.01	19
	1,2-trans-Dichloroethylene	0.001	-	0.02	0.01	18
	1,3-Dichloropropylene	0.001	-	0.02	0.01	18
	2-Chloroethylvinyl ether	0.038	-	0.08	0.07	3
	Acrolein	0.045	-	0.80	0.43	36
	Acrylonitrile	0.005	-	0.92	0.32	58
	Benzene	0.001	-	0.02	0.01	18
	Bromoform	0.004	-	0.05	0.02	14
	Carbon Tetrachloride	0.001	-	0.02	0.01	18
	Chlorobenzene	0.001	-	0.02	0.01	18
	Chloroethane	0.001	-	0.02	0.01	18
	Chloroform	0.001	-	0.51	0.07	84
	Dibromochloromethane	0.004	-	0.05	0.02	14
	Dichlorobromomethane	0.004	-	0.05	0.02	14
	Ethylbenzene	0.001	-	0.02	0.01	18
	Methyl Bromide (Bromomthane)	0.004	-	0.09	0.03	14
	Methyl Chloride (Chloromethane)	0.001	-	0.09	0.02	32

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
	Methylene Chloride	0.001	-	0.02	0.01	18
	Tetrachloroethylene	0.001	-	0.09	0.03	56
	Toluene	0.001	-	0.02	0.01	18
	Trichloroethylene	0.000	-	1.13	0.08	90
	Vinyl Chloride	***0.001***	***-***	***1.21***	***0.04***	***39***
SOC	1,2,4-Trichlorobenzene	0.001	-	0.02	0.01	17
	1,2-Dichlorobenzene	0.001	-	0.02	0.01	19
	1,3-Dichlorobenzene	0.001	-	0.02	0.01	17
	1,4-Dichlorobenzene	0.001	-	0.02	0.01	17
	2,4-Dichlorophenol	0.001	-	0.02	0.01	18
	2,4-Dimethylphenol	0.001	-	0.04	0.02	18
	2,4-Dinitrophenol	0.003	-	0.11	0.05	18
	2,4-Dinitrotoluene	0.001	-	0.02	0.01	18
	2,6-Dinitrotoluene	0.001	-	0.05	0.01	18
	2-Chlorophenol	0.001	-	0.02	0.01	17
	2-Nitrophenol	0.001	-	0.02	0.01	17
	4,6-Dintiro-o-Cresol	0.001	-	0.06	0.02	18
	4-Nitrophenol	0.001	-	0.02	0.01	18
	Acenaphthene	0.001	-	0.02	0.01	18
	Acenaphthylene	0.001	-	0.02	0.01	18
	Anthracene	0.001	-	0.02	0.01	18
	Benzo (a) Anthracene	0.001	-	0.02	0.01	18
	Benzo (a) Pyrene	0.001	-	0.02	0.01	18
	Benzo (b) Fluoranthene	0.001	-	0.03	0.01	18
	Benzo (k) Fluoranthene	0.001	-	0.03	0.01	18
	Bis (2-Ethylhexyl) Phthalate	0.001	-	0.02	0.01	17
	Chrysene	0.001	-	0.02	0.01	18
	Di-n-Butylphthalate	0.001	-	0.02	0.01	18
	Diethyl Phthalate	0.001	-	0.02	0.01	18
	Dimethylphthalate	0.001	-	0.02	0.01	18
	Fluoranthene	0.001	-	0.02	0.01	18
	Fluorene	0.001	-	0.02	0.01	18
	Hexachlorobenzene	0.001	-	0.02	0.01	18
	Hexachlorobutadiene	0.001	-	0.02	0.01	18
	Hexahloroethane	0.001	-	0.02	0.01	17
	Naphthalene	0.001	-	0.11	0.06	62
	Nitrobenzene	0.001	-	0.13	0.02	18
	Phenanthrene	0.001	-	0.02	0.01	18
	Phenol	0.001	-	9.00	0.43	32
	Phenols, total	***0.003***	***-***	***11.80***	***1.41***	***149***
	Pyrene	0.001	-	0.02	0.01	17

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
Metals	Aluminum	0.0005	-	18.50	1.54	92
	Antimony	0.0006	-	0.04	0.02	33
	Arsenic	0.0003	-	0.09	0.01	32
	Beryllium	0	-	0.25	0.02	258
	Cadmium	0	-	1.08	0.07	322
	Chromium	0	-	9.00	0.38	309
	Chromium, hexavalent	0	-	2.20	0.18	466
	Copper	0	-	11.10	1.16	843
	Fluoride	0.27	-	1.79	1.09	32
	Iron	***1***	***-***	***36.00***	***7.73***	***59***
	Lead	0.00013	-	4.70	0.19	412
	Mercury	0	-	0.03	0.00	106
	Molybdenum	3.58	-	6.62	5.24	7
	Nickel	0	-	19.90	0.38	427
	Selenium	0.0006	-	0.05	0.02	36
	Silver	0	-	1.40	0.05	184
	Thallium	0.0003	-	0.02	0.01	33
	Zinc	0	-	33.20	2.23	486

[1] All quantities in lbs./day, unless otherwise indicated.
[2] Shading indicates the parameter with the largest maximum DMR value.

Table 2.2.2-3 shows that total suspended solids loads are the highest of any parameter and have the greatest number of reported quantities. Total suspended solids are related to the turbidity parameter group. Turbidity is another indicator, such as TSS, of particulates in the water supply, but is a more meaningful measure of performance in drinking water treatment. Microbial data is very scarce, with only two reportable maximum quantities for fecal coliform. Maximum and average ammonia loads are greater than phosphorus loads. The Table also indicates the various VOCs and SOCs discharged into the Schuylkill River. Vinyl chloride has the single largest discharged VOC quantity of 1.2 pounds per day. Relative to the other VOCs, acrylonitrile and acrolein are also large average maximum discharge quantities. Total phenols are the largest discharged quantity of SOCs. Otherwise, quantities are similar across the many synthetic organic compounds. Of the metals, iron is clearly the largest discharged quantity. High maximum quantities are also reported for aluminum, total chromium, total copper, total lead, total nickel, and total zinc. Chromium and lead pose the greatest risk in drinking water.

RCRA/AST Facilities
As summarized in Table 2.2.2-4, RCRA facilities comprise many of the point sources within the Belmont Intake's delineation zone. However, only 42 out of the 1,442 RCRA facilities are designated as Large Quantity Generators. Data describing the industry type or capacity of the facilities is limited. Taking into account the limited number of SIC codes, most RCRA facilities are dry cleaning plants, followed by automotive repair

shops, and printing shops. A relatively low number of RCRA sites are cited as having violations. Capacity information for use in ranking sites is available for merely 50 sites, and contaminant information is not available. A range of 100 to about 1 million gallons gives an idea of the capacity for the RCRA sites with available data.

Table 2.2.2-4 RCRA Facility Summary

Total RCRA Facilities	1442
Large Quantity Generators	42
Facilities with SIC Codes	462
Top 3 RCRA Industry Types by SIC Code 7216 – Dry Cleaning Plants 7537 – Automotive Transmission Repair Shops 2752 & 2759 – Commercial Printing	 97 14 14
RCRA facilities with Violations	76
RCRA facilities with Capacity/Volume Data	50
Range of Capacity	100 – 965,000 gallons 107 – 8,220,000 gal/day
Most Common Parameters/Contaminants	Not Applicable – no contaminants linked to RCRA downloads

RCRA data was supplemented with Aboveground Storage Tank information from PADEP. PADEP AST data included useful and detailed information as to tank age, contaminants and volumes. AST data is summarized in Table 2.2.2-5.

Table 2.2.2-5 AST Facility Summary

Total AST Facilities	396
AST Facility overlap with RCRA facilities	71
Total Number of Tanks	1,649
Tank Capacity Range	250 gal – 4 MG
Tank Age Range	1 – 98 years
Number of Different Parameters/Contaminants	123
Most Common Parameters and Quantities by Number of Tanks Misc. Hazardous Substance Diesel Fuel Gasoline	 564 tanks/3.7 MG 202 tanks/4.4 MG 142 tanks/7.1 MG
Most Common Parameters/Contaminants and Quantities by Total Volume Heating Oil Gasoline Diesel	 25 MG 7.1 MG 4.4 MG

Table 2.2.2-5 shows that 396 facilities throughout Belmont's delineation zones have aboveground storage tanks. Of those facilities, only 71 overlap with the RCRA facilities. This may be due to RCRA sites also comprising underground storage tanks. The AST data is still useful for characterizing potential contaminant sources in the watershed. Tanks range in capacities from 250 gallons to 4 million gallons and range in age from 1 to 98 years old. Older tanks may pose a greater risk for spills. The tanks contain 123 different substances. The most common of these by volume, as labeled in the original PADEP data, is a non-specific hazardous substance. The specific chemical was not given. After miscellaneous hazardous substances, gasoline and diesel fuel are most common by volume. The significance of these tanks as contamination sources depends on factors such as the total volume of substance at any one site, tank age, and the time of travel to the intake. These factors are considered in the intake specific susceptibility ranking.

TRI Facilities

A summary of TRI sources is presented in Table 2.2.2-6. A facility is listed in the TRI if a chemical from the inventory is used or manufactured on site. These sites are not necessarily dischargers. Data on which chemicals are on–site, quantities of chemicals, and releases are available for the TRI sources. The range of quantities is how much is used or manufactured in a given year. Releases may be to air, water or land. How much of a given chemical and which chemical is released are not provided.

With that in mind, Table 2.2.2-6 indicates that 278 TRI facilities are found in the delineation zone for Belmont. A SIC code is identified for 270 of these industries. SIC codes are linked to activities that PADEP identified in the state SWAP document. Based on activity, most TRI facilities are foundries, chemical manufacturers or machine shops.

Chemical and quantity data is very complete for the TRI facilities, however quantities are presented as ranges. Copper, sulfuric acid, and chromium are the most common chemicals listed by the various TRI sites. Quantity ranges for these chemicals are shown in Table 2.2.2-6. This amount of substance is not necessarily released into a water body. Limited information is available on the number of releases to water for 263 of the TRI facilities. Based on this, chemical manufacturers have had the most reported number of releases.

Table 2.2.2-6 TRI Facility Summary

Total TRI Facilities	278
Facilities with SIC Codes	270
Top 3 Industry Types by Activity	
Foundries or Metal Fabricators	49
Chemical Manufacturer	47
Machine/Metalworking Shops	42
Top 3 TRI Industries by SIC Code	
2899 - Chemical Preparation	9
2834 – Pharmaceutical Preparations	7
3324 – Steel Foundries	6
Facilities with Quantity Data	263
Most Common Parameters for Facilities with Quantity Data	
Copper	0 – 999,999,999 kg/yr.
Sulfuric Acid	0 – 49,999,999 kg/yr.
Chromium	100 – 99,999,999 kg/yr.
Nickel	0 – 9,999,999 kg/yr.
Toluene	100 – 9,999,999 kg/yr.
Facilities with Release Data	269
Facilities with Greatest Number of Releases	
Chem. Manufacturer–Dyes/Pigments–Berks County	180 releases to water
Chem. Manufacturer-Medicinal Chemicals – Mont. Cty.	96 releases to water
Chem. Manufacturer – Industrial Chemicals-Berks Cty.	84 releases to water

CERCLA Facilities

Although data for CERCLA facilities is limited, Table 2.2.2-7 summarizes the available information within 25-hour time of travel and beyond for the Belmont Intake. Three hundred thirty-two CERCLA facilities are in the Belmont delineation zone, but only 22 are on the final National Priority List. Information for about 80 of the CERCLA facilities is available through the RCRA and TRI databases, where those facilities are also listed. Only 30 sites are found in the flood plain and only 22 sites are on the NPL list for Superfund restoration, so finding more data is not critical for the majority of the sites. Since information on the Superfund sites is so limited, these sites are screened or ranked narratively. The low number of NPL sites and sites in the floodplain is considered in the narrative screening.

Table 2.2.2-7 CERCLA Facility Summary

Total Number of CERCLA Facilities	332
Number on the NPL List	22
Number also listed as RCRA	62
Number also listed as TRI	18
Number in Flood Plain	30

2.2.3 Runoff Loading Summary

Key Points

- **The Schuylkill River Runoff Loading Model was developed to estimate contaminant loadings to the river from storm runoff.**
- **The model uses the physical characteristics of the subwatersheds, meteorological data, updated land use information, and event mean concentrations for the nine parameters of interest to estimate average daily contaminant loadings within each of the Belmont Intake's zones of contribution.**
- **The developed land areas associated with industrial/commercial land use and residential uses are estimated to contribute the highest per-acre loadings of most of the contaminants evaluated, including disinfection by-products, metals, nutrients, petroleum hydrocarbons, salts and coliforms.**
- **Unit *Cryptosporidium* and turbidity loadings are higher from agricultural areas.**

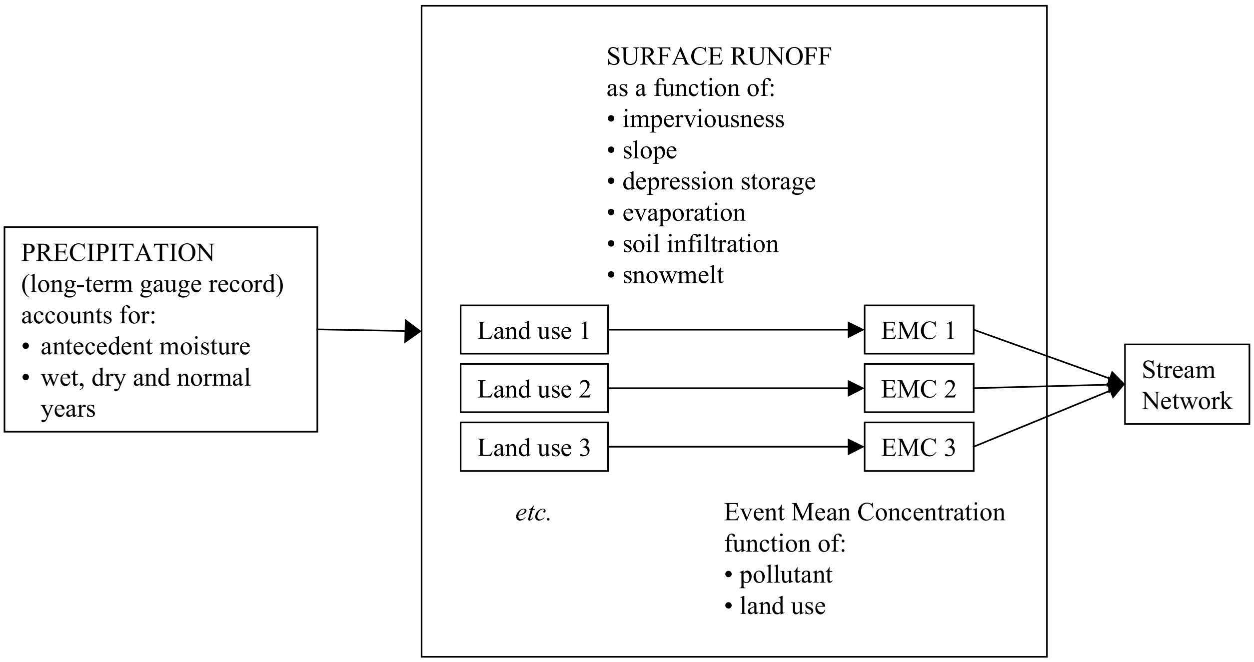
The Schuylkill River Source Water Assessment Partnership developed the Schuylkill Runoff Loading Model (SRLM) in an effort to estimate pollutant loads from rainfall runoff throughout the watershed. The SRLM results provide information on the relative contributions of surface runoff from various land use categories, as well as from different geographical areas. The procedure incorporates collection of data, model development and simulation, and post-processing of output data for further use in the susceptibility analysis. A database management system (DBMS) was created to assist with storing parameter data, creating the model, and post-processing model outputs.

2.2.3.1 Method

The RUNOFF Module of the U.S. EPA's Stormwater Management Model (SWMM) simulates rainfall-runoff quantities and quality at specified inlet locations. Figure 2.2.3-1 displays the structure of the SWMM RUNOFF Module. The model inputs subshed parameters, rainfall time-series, climatic data, and event mean concentrations (EMCs) for the land use categories, and outputs annual and monthly pollutant loads for the length of the simulation period. The model incorporates infiltration, depression storage, and roughness to estimate runoff flow and ultimately, runoff pollutant quantities.

The amount of a particular pollutant reaching the receiving stream is dependent on the volume of surface runoff and the concentration of that constituent in the runoff. An EMC is the total mass load of a pollutant yielded from a site during a storm divided by the total runoff water volume discharged during the storm. EMCs are related to the constituent of interest and the land use type. For a subshed, the surface runoff from a particular land use predicted by SWMM RUNOFF, is multiplied by the EMC for that land use type to yield a loading rate.

Figure 2.2.3-1 Watershed Loading Model Schematic Diagram



Subcatchments

The subcatchments of the Schuylkill River Watershed ultimately drain into the Delaware River Basin. The Schuylkill Watershed is composed of 356 subwatersheds and the area tributary to the PWD Belmont Intake includes 176 of the 356 subwatersheds, about 56% of the Schuylkill Watershed. The subwatersheds were further divided into land use categories to track the contributing pollutant loads from each land use category. The land use categories were based on the USGS's NLCD dataset updated with 2000 Census data for residential and commercial areas, as detailed in Section 1.2.5.

The land use categories distinguish the amount of rainfall that runs off the surface of the subwatershed, as opposed to infiltrating into the subsurface or entering the atmosphere through evapotranspiration. For example, during a storm, more rainfall runs off from a residential area than from a forested area, since there are more impervious surfaces such as driveways, roads, and buildings in developed areas. The forested area retains more of the rainfall, which either infiltrates into the ground or evaporates. For modeling purposes, the land use categories were summed for each subwatershed in order to track individual land use loading contributions to the totals for each subwatershed. Figure 2.2.3-2 and Table 2.2.3-1 below summarize the land use characterization for the Schuylkill River Watershed area within the Zone B delineation for the PWD Belmont Intake and reflects modifications in residential development and increases in commercial areas based on increases in populations from the Census Bureau. For the defined area, almost 80% is characterized as agriculture, forests, and wetlands. Developed and urbanized areas account for about 20% of the Zone B delineated area for the PWD Belmont Intake.

Figure 2.2.3-2 Land Use Characterization for PWD Belmont Intake Zone B

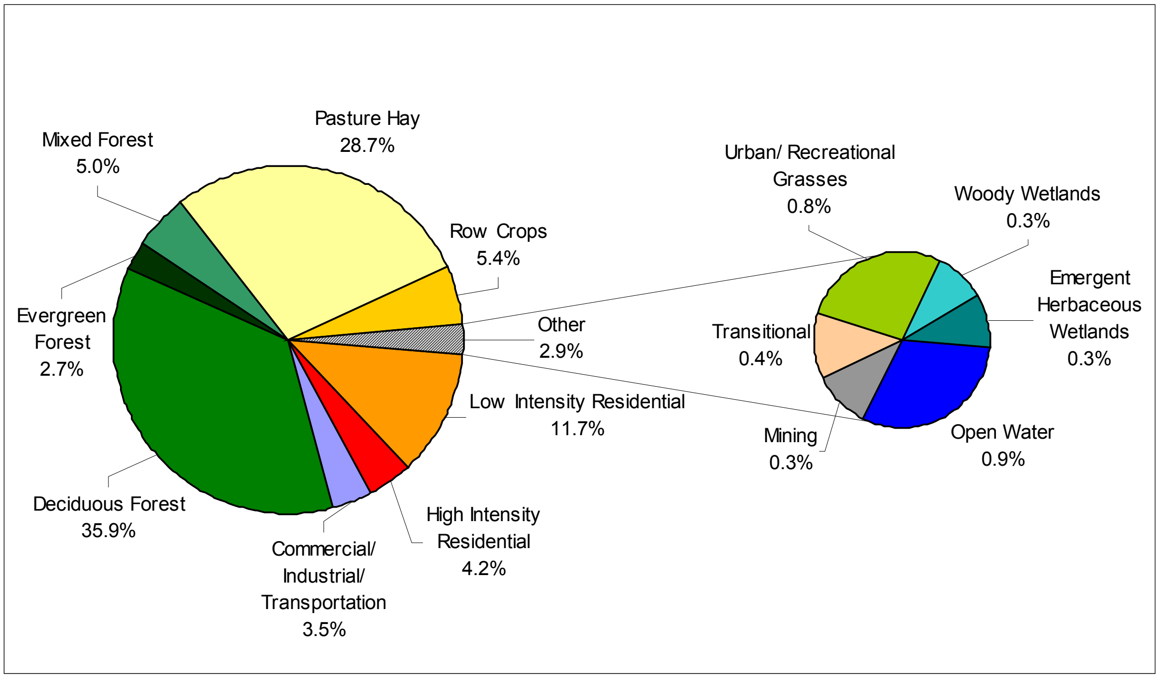


Table 2.2.3-1 Updated Land Use Categories

Land use Category	Subcategory	Area (acres)	Percentage of Zone B Delineated Area
Agricultural	Pasture/Hay	196,850	28.7%
	Row Crops	36,854	5.4%
Commercial/Industrial/Transportation		24,178	3.5%
Forested	Deciduous Forest	246,243	35.9%
	Evergreen Forest	18,461	2.7%
	Mixed Forest	34,468	5.0%
Open Water		6,068	0.9%
Quarries/Strip Mines/Gravel Pits		2,062	0.3%
Residential	High Intensity Residential	28,665	4.2%
	Low Intensity Residential	80,094	11.7%
Transitional		2,423	0.4%
Urban/Recreational Grasses		5,390	0.8%
Wetlands	Emergent Herbaceous Wetlands	1,994	0.3%
	Woody Wetlands	1,765	0.3%

The percentage of impervious area for all land use categories, excluding residential, were estimated according to values extracted from the Water Management Model (WMM) and adjusted during the calibration. The percentage of impervious area for residential areas was calculated using Hick's methodology, which calculates the percentage of total impervious area as a function of the population density.

For pervious areas, the portion of precipitation that runs off is affected by slope, depression storage, infiltration, vegetative cover, and evapotranspiration. Infiltration is determined primarily by the type of soil. The SWMM RUNOFF Module simulates infiltration using the Green-Ampt theory for both saturated and unsaturated soils. The Green-Ampt infiltration routine relates infiltration rate to the moisture conditions of the surface and the total volume of rainfall infiltrated. For the SLRM, the soil information was downloaded from the Natural Resources Conservation Service (NRCS) and the soils GIS coverage was intersected with subwatersheds to identify the soil types in each subwatershed.

Event Mean Concentrations (EMCs)

Applying EMCs to calculated runoff volumes provides reasonable estimates of runoff pollutant loadings. EMCs for the soluble pollutant categories were assigned according to the land use category. The SWMM RUNOFF Module allows the model to assume a constant concentration of a constituent for the duration of the storm event. The quantity of a constituent in surface runoff is a function of constant EMCs associated with the land use categories. The RUNOFF model water quality parameters included *Cryptosporidium*, disinfection by products, metals and heavy metals, conservative nutrients, non-conservative nutrients, petroleum hydrocarbons, salts, turbidity, and total/fecal coliform. For each of these contaminant types, a surrogate constituent was selected. For example, chloride was used as the surrogate for salts and the EMCs for chloride were used in the model.

Runoff volumes are computed for each land use category based on percent imperviousness of the land use, annual rainfall, slope of the subwatershed, evaporation, infiltration, and depression storage. This analysis was performed on a subwatershed-by-subwatershed basis and the results were used to determine load distributions according to the land use category. The pollutant mass load estimate is computed for each land use within each subwatershed as a product of the EMC and the surface runoff. By estimating the pollutant loading over the area of a land use type within a subwatershed and summing for all land uses, the total pollutant load from a subwatershed can be computed.

Meteorological Data

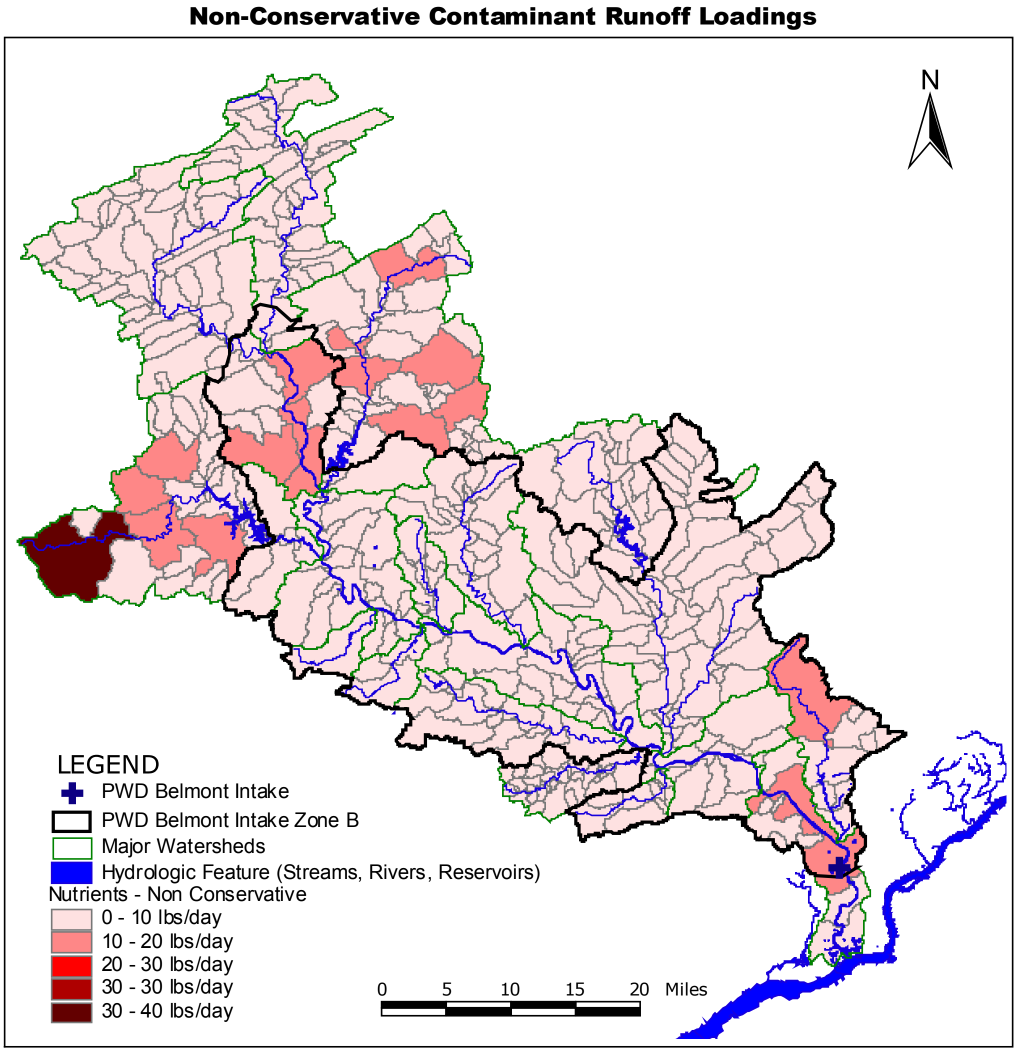
The amount of surface runoff is primarily driven by the precipitation. Long-term climate and precipitation records were used to drive the hydrology of the system. Using a long-term record represents a wide range of hydrologic conditions that occur in a given climate. Using a long-term record on a continuous basis accounts for antecedent moisture conditions and more accurately represents initial conditions at the beginnings of storm events. Snowfall and snowmelt affect the quantity and timing of surface runoff during the winter months and have been included in the long-term continuous simulation.

If available, rainfall, wind, and temperature data for a period of over ten years (1990-2000) were collected for RUNOFF model simulations. The hourly rainfall data were obtained from the National Weather Service (NWS) at stations in and surrounding the Schuylkill River Watershed. The hourly data was further discretized into 15-minute increments. To account for snowmelt, the daily minimum and maximum temperatures and average monthly wind speeds were obtained for the period of simulation.

2.2.3.2 Results

The SRLM was used to quantify contaminant loads for all pollutant categories included in the susceptibility analysis except for volatile organic compounds. Generally, the greater contaminant loads are found in the lower portion of the watershed. These areas tend to have more development, and thus greater impervious surfaces and runoff volumes. Figure 2.2.3-3 shows the results for the watershed for non-conservative nutrients for which the surrogate phosphorus was chosen. The darker areas, representing higher load estimates, are located closer to streams and rivers and are observed to be further downstream in the watershed. The lighter areas are less developed and less surface runoff results from rainfall events. The subwatersheds with greater pollutant loads tend to be within the Zone B delineation for the PWD Belmont Intake.

Figure 2.2.3-3 Non-Conservative Contaminant Runoff Loadings



The Zone A delineated area for an intake is defined as the area within a five-hour time of travel of the water supply intake, including one-quarter mile downstream and within a one-quarter mile wide area on either side of the stream from the intake. For the contaminant loads from rainfall-runoff, Zone A includes parts of the Middle Schuylkill, Wissahickon, and Lower Schuylkill subwatersheds. Over half of the area is developed, which results in greater runoff volume and consequently, higher pollutant loads.

Zone B for PWD's Belmont Intake encompasses Zone A and area further upstream in the Schuylkill Watershed. Since Zone B contains more area, the pollutant loads are greater for Zone B than for Zone A. As previously described, the area contained in the Zone B delineation is about 20% impervious surfaces, while Zone A contains more than 50%

impervious area. The average daily contaminant loadings for each of the Belmont Intake's zones are summarized below by Table 2.2.3-2.

Table 2.2.3-2 Calculated Average Daily Contaminant Loadings

Zone	*Crypto-sporidium*	Disinfection by Products	Metals and Heavy Metals	Conservative Nutrients	Non-Conservative Nutrients	Petroleum Hydrocarbons	Salts	Turbidity	Total/ Fecal Coliform
	(oocysts/ day)	(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	(coliforms/ day)
A	4.7E+07	2923	13	571	82	4865	972	3.7E+04	2.4E+12
B*	2.3E+08	9437	25	2546	463	11076	2026	2.8E+05	4.5E+12
Total A&B	2.8E+08	12360	38	3117	545	15942	2997	3.2E+05	6.9E+12

** Zone B values exclude Zone A*

On a smaller scale, the contributions from each of the major subwatersheds are summarized in Tables 2.2.3-3 and 2.2.3-4 below. Table 2.2.3-3 summarizes the total daily loads for each major subwatershed listed from upstream to downstream in the Schuylkill Watershed. Since only portions of some major subwatersheds are included in the Zone B delineation and the sizes of the subwatersheds vary, the values listed in Table 2.2.3-4 are the total daily loads divided by the contributing area of each major subwatershed. This provides a load per acre per day value. For instance, although the Middle Schuylkill Subwatershed One has less contributing area to the Belmont Intake than the Middle Schuylkill Two, the Middle Schuylkill One Subwatershed has higher estimated pollutant loads for salts than the Middle Schuylkill Two. This is because the Middle Schuylkill One Subwatershed has more than twice the per acre loading as the Lower Schuylkill Two Subwatershed. Per acre loading is influenced by the amount of runoff and the Event Mean Concentration of the land uses within the subwatershed.

Table 2.2.3-3 Daily Contaminant Loads for Major Subwatersheds

Majorshed*	**Area (acres)**	***Cryptosporidium*** (oocysts/ day)	**Disinfection by Products** (lbs./day)	**Metals/Heavy Metals** (lbs./day)	**Conservative Nutrients** (lbs./day)	**Non-Conservative Nutrients** (lbs./day)	**Petroleum Hydrocarbons** (lbs./day)	**Salts** (lbs./day)	**Turbidity** (lbs./day)	**Total/ Fecal Coliform** (coliforms/day)
Little Schuylkill	10750	3.2E+06	215	0.04	46	9	2	54	5.4E+03	5.6E+09
Upper Schuylkill	59584	4.8E+07	1253	1.09	486	100	88	651	6.5E+04	1.9E+11
Maiden Creek	15212	5.8E+06	241	0.50	87	16	43	239	8.5E+03	9.4E+10

Majorshed*	Area (acres)	*Cryptosporidium* (oocysts/ day)	Disinfection by Products (lbs./day)	Metals/Heavy Metals (lbs./day)	Conservative Nutrients (lbs./day)	Non-Conservative Nutrients (lbs./day)	Petroleum Hydrocarbons (lbs./day)	Salts (lbs./day)	Turbidity (lbs./day)	Total/ Fecal Coliform (coliforms/day)
Tulpehocken Creek	25994	1.9E+07	601	1.34	196	38	118	660	2.4E+04	2.4E+11
Allegheny Creek	11442	1.6E+06	76	0.12	15	3	16	92	1.8E+03	2.3E+10
Middle Schuylkill 3	62849	2.6E+07	1455	5.59	283	42	473	2440	2.4E+04	1.0E+12
Hay Creek	14160	1.7E+06	87	0.10	20	4	7	50	2.3E+03	1.8E+10
Monocacy Creek	16495	5.5E+06	139	0.17	59	12	8	100	8.0E+03	1.5E+10
Manatawny Creek	58602	1.3E+07	451	0.64	156	30	44	308	1.9E+04	1.0E+11
French Creek	44912	9.0E+06	369	0.62	88	17	55	323	1.1E+04	1.1E+11
Middle Schuylkill 2	65959	1.8E+07	818	2.73	192	31	244	1272	1.8E+04	5.0E+11
Perkiomen Creek	173024	6.6E+07	2518	6.62	700	131	516	2743	8.0E+04	1.2E+12
Valley Creek	15810	8.3E+06	504	1.96	94	14	152	829	1.0E+04	3.3E+11
Middle Schuylkill 1	40614	2.0E+07	1222	5.61	243	35	429	2160	1.6E+04	1.0E+12
Wissahickon Creek	40754	2.2E+07	1355	6.22	267	39	418	2043	1.8E+04	1.1E+12
Lower Schuylkill	32216	1.6E+07	1055	4.92	185	24	383	1978	6.9E+03	8.9E+11

** Areas reflect portions of the majorshed within the boundary of the Zone B delineation.*

Table 2.2.3-4 Daily Contaminant Loads per Acre for Major Subwatersheds

Majorshed*	Area (acres)	*Cryptosporidium* (oocysts/ day-acre)	Disinfection by Products (lbs./day-acre)	Metals/Heavy Metals (lbs./day-acre)	Conservative Nutrients (lbs./day-acre)	Non-Conservative Nutrients (lbs./day-acre)	Petroleum Hydrocarbons (lbs./day-acre)	Salts (lbs./day-acre)	Turbidity (lbs./day-acre)	Total/ Fecal Coliform (coliforms/day-acre)
Little Schuylkill	10750	296	0.020	3.3E-06	0.004	0.001	0.000	0.005	0.505	5.2E+05
Upper Schuylkill	59584	797	0.021	1.8E-05	0.008	0.002	0.001	0.011	1.091	3.2E+06
Maiden Creek	15212	381	0.016	3.3E-05	0.006	0.001	0.003	0.016	0.557	6.2E+06
Tulpehocken Creek	25994	726	0.023	5.2E-05	0.008	0.001	0.005	0.025	0.912	9.3E+06

Majorshed*	Area (acres)	*Cryptosporidium* (oocysts/ day-acre)	Disinfection by Products (lbs./day-acre)	Metals/Heavy Metals (lbs./day-acre)	Conservative Nutrients (lbs./day-acre)	Non-Conservative Nutrients (lbs./day-acre)	Petroleum Hydrocarbons (lbs./day-acre)	Salts (lbs./day-acre)	Turbidity (lbs./day-acre)	Total/ Fecal Coliform (coliforms/day-acre)
Allegheny Creek	11442	141	0.007	1.1E-05	0.001	0.000	0.001	0.008	0.154	2.0E+06
Middle Schuylkill 3	62849	410	0.023	8.9E-05	0.005	0.001	0.008	0.039	0.376	1.6E+07
Hay Creek	14160	122	0.006	7.1E-06	0.001	0.000	0.001	0.004	0.161	1.2E+06
Monocacy Creek	16495	336	0.008	1.0E-05	0.004	0.001	0.000	0.006	0.485	9.0E+05
Manatawny Creek	58602	214	0.008	1.1E-05	0.003	0.001	0.001	0.005	0.332	1.7E+06
French Creek	44912	200	0.008	1.4E-05	0.002	0.000	0.001	0.007	0.247	2.5E+06
Middle Schuylkill 2	65959	269	0.012	4.1E-05	0.003	0.000	0.004	0.019	0.277	7.6E+06
Perkiomen Creek	173024	381	0.015	3.8E-05	0.004	0.001	0.003	0.016	0.463	7.1E+06
Valley Creek	15810	528	0.032	1.2E-04	0.006	0.001	0.010	0.052	0.636	2.1E+07
Middle Schuylkill 1	40614	493	0.030	1.4E-04	0.006	0.001	0.011	0.053	0.403	2.5E+07
Wissahickon Creek	40754	538	0.033	1.5E-04	0.007	0.001	0.010	0.050	0.434	2.7E+07
Lower Schuylkill	32216	485	0.033	1.5E-04	0.006	0.001	0.012	0.061	0.214	2.8E+07

** Areas reflect portions of the majorshed within the boundary of the Zone B delineation.*

Another example is the Perkiomen Subwatershed. Although the estimated total daily contaminant loads for the Perkiomen Subwatershed are relatively high in all contaminant categories, the load per area is much lower than the Middle Schuylkill and the Lower Schuylkill subwatersheds, since about 90% of the area is agriculture or forested. High overall loads occur because the Perkiomen Subwatershed is much larger than the other subwatersheds.

The contaminant loading results for the area within Zone B, including Zone A, for the Belmont Intake are summarized below:

Cryptosporidium: The areas of highest pollutant estimates are located in the Upper Schuylkill and Perkiomen subwatersheds. On a per acre basis, the highest load intensity occurs in the Upper Schuylkill and Tulpehocken subwatersheds.

Disinfection by-Products: The higher EMCs for disinfection by-products are associated with developed land use categories such as commercial/industrial/ transportation and residential. The areas of highest pollutant estimates are located in the Perkiomen subwatershed, with relatively high loading also occurring in the Wissahickon and

Middle Schuylkill subwatersheds. On a per acre basis, the most concentrated loading occurs downstream in the Valley Creek, Middle Schuylkill One, Wissahickon, and Lower Schuylkill subwatersheds.

Metals/Heavy Metals: The areas of highest pollutant loading estimates are located in the Wissahickon and Perkiomen subwatersheds. On a per acre basis, the most concentrated loading occurs downstream in the Valley Creek, Middle Schuylkill One, Wissahickon, and Lower Schuylkill subwatersheds.

Conservative Nutrients: The areas of highest pollutant loading estimates are located in the Perkiomen and Upper Schuylkill subwatersheds. On a per acre basis, the most concentrated loading occurs upstream in the Upper Schuylkill and Tulpehocken subwatersheds.

Non-conservative Nutrients: The areas of highest pollutant loading estimates are located in the Perkiomen and Upper Schuylkill subwatersheds. On a per acre basis, the most concentrated loading occurs upstream in the Upper Schuylkill subwatershed.

Petroleum Hydrocarbons: The highest EMCs for petroleum hydrocarbons are associated with commercial/industrial/transportation areas, followed by residential land use categories. The areas of highest pollutant loading estimates are located in the Middle Schuylkill Three and Perkiomen subwatersheds. Other relatively high loading areas are along the Middle Schuylkill One and Lower Schuylkill subwatersheds, as well as along the Wissahickon subwatershed. On a per acre basis, the most concentrated loading occurs downstream in the Valley Creek, Middle Schuylkill One, Wissahickon, and Lower Schuylkill subwatersheds.

Salts: The higher EMCs for salts are associated with developed land use categories such as commercial/industrial/transportation, mining, and residential. The areas of highest pollutant loading estimates are located in the Middle Schuylkill Three and Perkiomen subwatersheds. On a per acre basis, the most concentrated loading occurs downstream in the Valley Creek, Middle Schuylkill One, Wissahickon, and Lower Schuylkill subwatersheds.

Turbidity: The highest EMCs for turbidity are associated with agricultural and forested areas, followed by wetlands, then developed land use categories. The areas of highest pollutant loading estimates are located in the Upper Schuylkill and along Perkiomen Creek. The Tulpehocken and Valley Creek watersheds have high estimates of turbidity loads per acre from runoff.

Total/Fecal Coliform: the areas of highest pollutant loading estimates are located in the Perkiomen and Wissahickon watersheds. On a per acre basis, the most concentrated loading occurs downstream in the Valley Creek, Middle Schuylkill One, Wissahickon, and Lower Schuylkill subwatersheds.

The summary of the results from the SLRM show the pollutant loads over the entire watershed from each of the smaller subwatershed. The contaminant loads are not only dependent on the land use type, but also soil properties, subwatershed slopes, depression storage, and climate conditions. The estimates from the SLRM were further used in the qualitative loading analysis portion of the susceptibility analysis.

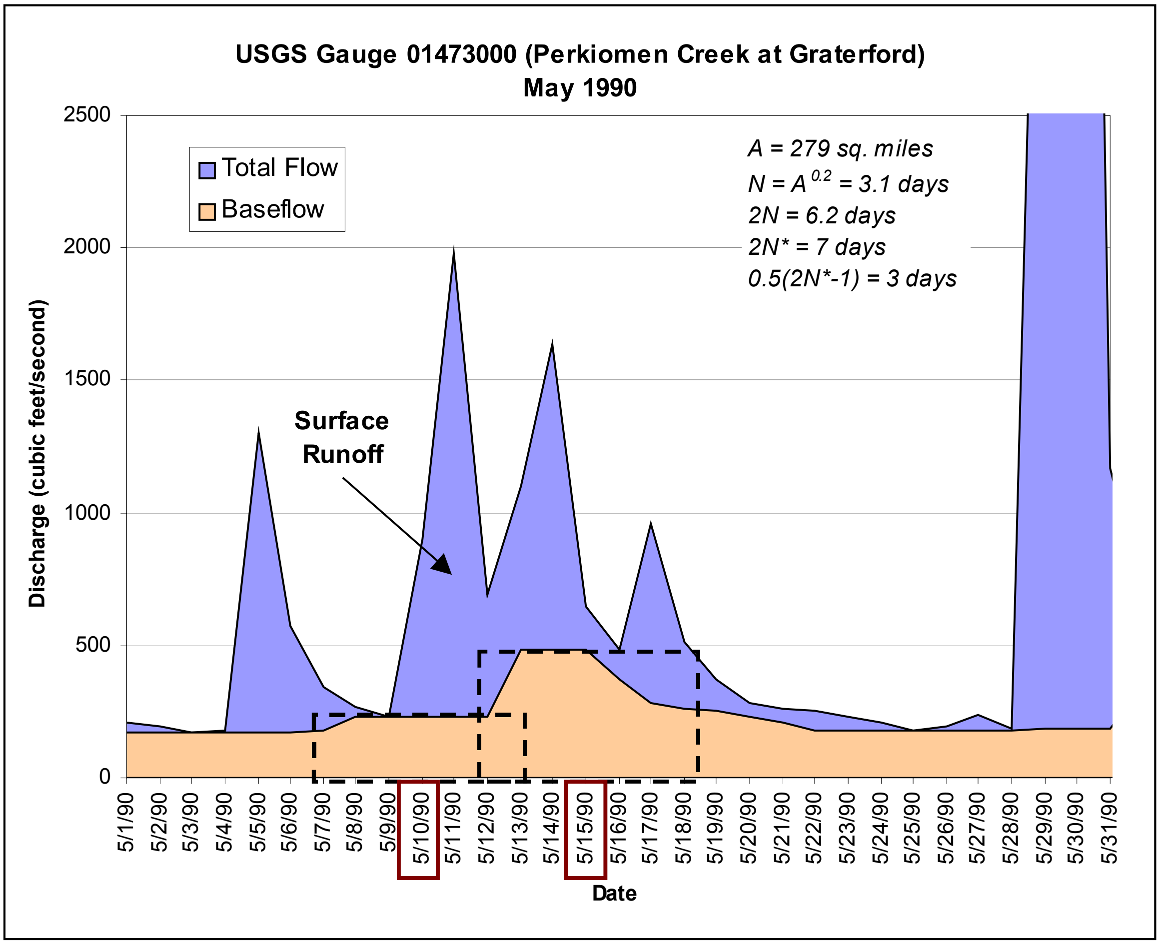
2.2.3.3 Hydrograph Separation for Baseflow and Runoff Calibration

In order to assess the reliability of the pollutant loads from SWMM, a hydrograph separation analysis was performed to compare with estimated runoff quantities and water quality loads from the SLRM. A hydrograph separation program was created in SAS® to divide the total flow into baseflow and surface runoff. This program was modeled after the USGS's HYSEP computer program, but assumes only one of its three hydrograph separation methods, the sliding-interval method. The hydrograph separation yields total flow, baseflow, and runoff values in daily, monthly, seasonal, and annual averages. The daily average flows were obtained from the USGS for gauges located in the Schuylkill River Basin.

The sliding-interval method associates a baseflow with a selected day by taking an equal interval before and after that day and assigning the lowest discharge to that day. The intervals are calculated based on the drainage area. For example, as shown in Figure 2.2.3-4, the drainage area for the USGS gauge located in Perkiomen Creek at Graterford is 279 square miles and the interval after surface runoff is 3.1 days. The interval for finding the baseflow is applied before and after a specified day. Thus, total duration is twice the calculated interval (6.2 days) and then rounded to the nearest odd number greater than that value (7 days) to include the interval before and after and that day as well. Three is the minimum duration used in the sliding interval method. The selected day should be the median with equal durations before and after to associate the lowest discharge within the entire interval. For Perkiomen Creek at Graterford, the total interval is seven days and the "windows" for May 10, 1990 and May 15, 1990 are displayed in Figure 2.2.3-4. The baseflow designated to March 10, 1990 is 232 cubic feet per second (cfs) and March 15, 1990 is 484 cfs.

The surface runoff is the difference between the total streamflow and the baseflow, as described above. In Figure 2.2.3-4 the darker shaded area (light purple), is the remainder of the total flow that is designated as surface runoff.

Figure 2.2.3-4 Hydrograph Separation Analysis for the Perkiomen Creek at Graterford for May 1990



The hydrograph separation was conducted for the active USGS gauges in the Schuylkill Watershed. The values are average annual flows in cubic feet per second and inches per year for the period of record available for each gauge. The percent runoff is the amount of total flow that is assumed to be surface runoff. The total flow, baseflow, and runoff values were converted to inches per year by dividing the flows by the drainage area. Excluding the stations that are influenced by inter-basin transfers of water supply in the East Branch Perkiomen (Stations 01472620 and 01472810), the average annual runoff is 7.7 inches per year.

Since there is seasonal variation in the flows, the average baseflow and surface runoff values were also calculated by season. Generally, the average seasonal baseflow was highest in the spring, winter, summer, then fall (in descending order). Often the average seasonal baseflow was two to three times greater in the spring than the summer. Seasonal surface runoff for the winter, spring, summer, and fall averaged 9.9, 9.5, 4.7, 6.1 inches per year, respectively.

The USGS streamflow hydrograph separation results were used to calibrate the results from the SLRM. Since there is evidence of seasonal variability, the calibration of the SLRM was done on a seasonal basis. Comparing the simulated values with the hydrograph separation results, parameters in the SLRM were further refined.

2.2.4 Susceptibility Analysis

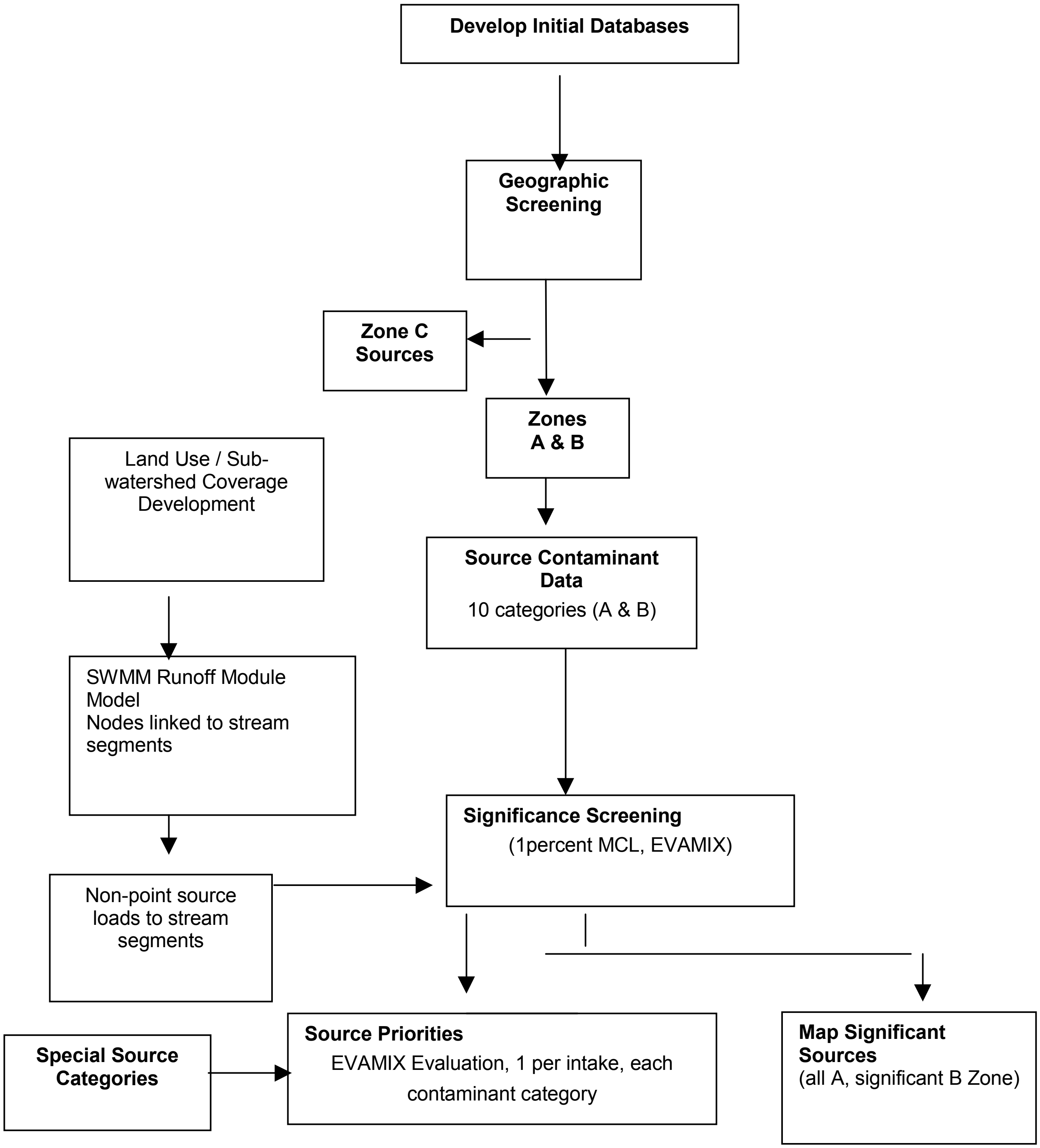
Key Points

- **A series of screenings was used to identify those sources that have the greatest potential to affect water quality at the Belmont Intake.**
- **Five non-conservative contaminant categories and five conservative contaminant categories were selected to represent all potential contaminants.**
- **For each category, a threshold value indicative of the significance of the concentrations of contaminants that could result from a potential spill or discharge was defined.**
- **EVAMIX, a multi-criteria software package was used along with information from the Technical Advisory Group, to prioritize the potential significance of each of the potential point sources within Belmont's Zone A and Zone B, and to evaluate the potential significance of non-point sources estimated by the Schuylkill River Runoff Loading Model.**
- **NPDES and non-point source discharges within the Belmont intake's Zone A and Zone B were determined to have the highest protection priorities in the watershed.**
- **The potential significance of each source of contamination was designated A (potentially significant source of highest protection priority) through F (potential source of lowest protection priority). Those sources ranked A through C are potentially significant sources of contamination to the Belmont intake.**
- **All of the highest ranked sources are either NPDES sites or storm water loadings from specific sub-watersheds.**
- **Contaminant sources actually discharging to the River (e.g., NPDES permitted point sources, or stormwater runoff) are estimated to have greater potential significance than those with only the potential to release contaminants to the River (e.g., a spill or leak).**
- **EVAMIX was also used to rank potential sources for each contaminant category.**

2.2.4.1 Method

Because of the large number of potential sources of contamination that have been identified, the method behind the susceptibility analysis relies on a process of successive screenings. These screenings help focus the efforts of source water protection on those sources that have the greatest potential to affect the water quality of the source water at the intake. The process of screening is shown in Figure 2.2.4-1, and described in this section. The section starts with an introduction to the ten contaminant categories being considered.

Figure 2.2.4-1 Source Prioritization Flow Diagram



Contaminant Categories

There are two difficulties faced in trying to prioritize potential sources of contamination of the drinking water. Because the Schuylkill River Watershed is very large, there are thousands of potential sources to be assessed. In addition, the assessments must also cover a full range of contaminant types. The PADEP guidance indicates that the best approach is to try to group all potential contaminants into a limited number of contaminant groups, and then assess all sources for each of the contaminant categories. For this study, ten contaminant categories have been developed. For each category, a planning level threshold concentration based either on ambient water quality in the Schuylkill River, or on regulatory standards such as the drinking water standard has been developed. This threshold value is used as a relative measure of the significance of contaminant concentrations that could potentially occur due to a spill or discharge from each of the sources. Each category is summarized below.

Non-Conservative Contaminants

There are five contaminant categories that can be considered "non-conservative" contaminants. Once spilled or discharged into the river, the concentration that results will decrease as the spill moves downstream, either because the contaminant dies off, evaporates into the air, or attaches itself to silt particles and settles to the bottom of the river. The non-conservative contaminant categories are:

1. Total/Fecal Coliform: Fecal coliform is used as the indicator contaminant for this category. The suggested threshold value is the recreational water standard of 200 count/100 ml. Fecal coliform tends to die off over time within the river.

2. Turbidity: Turbidity can be measured directly, but most existing data relates to Total Suspended Solids (TSS), and this is used as an indicator for turbidity. The suggested threshold comes from median ambient conditions in the river, of approximately 10 mg/l. TSS tends to settle to the bottom of the river over time.

3. Nutrients: There are several contaminants in the nutrient category. Phosphorous was selected as one indicator for this category. The suggested threshold value comes from the median ambient conditions in the river, of approximately 0.12 mg/l. Some portion of the total phosphorus concentration is associated with phosphorus adhering to silt particles, which tend to settle to the bottom of the river over time.

4. VOC/SOC: This category is particularly challenging because it includes hundreds of compounds. To meet this challenge, it was decided that the total amount of VOC/SOC present at a site would be used as an indicator for this category. Because there are so many different potential threshold values for this large and diverse category, a very conservative threshold of 5 ug/l is used. This is the drinking water standard for benzene, as well as many other toxic solvents. By comparing the total VOC/SOC concentration generated by a spill or discharge with this conservative threshold, even small spills or discharges will be deemed significant. VOCs and some SOCs can evaporate or "volatilize" from the river, others can attach themselves to silt and settle to the bottom of the river. Both have the effect of reducing concentrations in the river over time.

5. Metals: This category is also challenging because numerous metals are included. The total amount of metals present at a site is used as an indicator. Because there are many different potential threshold values for various metals, a conservative threshold of 0.015 mg/l was selected. This is the regulatory standard for lead in drinking water, and is lower than for most metals. Most metals tend to attach themselves to silt and settle to the bottom of the river, reducing concentrations in the river over time.

Conservative Contaminants
Five contaminant categories can be considered to be "conservative". Concentrations of conservative contaminants are only affected by dilution, and do not decrease through other means. The five categories are:

6. *Cryptosporidium/Giardia*: A potential threshold value is difficult to define for this important potential contaminant category for surface water sources. A value of only 1 oocyst per liter has been selected for a screening threshold based on potential health impacts.

7. Nutrients: Nitrate, a second, common nutrient was also selected for analysis because of its prevalence in the watershed. The drinking water standard of 10 mg/l was used for the threshold value.

8. DBP Precursors: Disinfection by-products are a concern for drinking water systems that disinfect with chlorination. A good indicator for this contaminant category is Total Organic Carbon (TOC). The threshold value was set based on the median ambient concentration in the river of approximately 2.7 mg/l.

9. Petroleum Hydrocarbons: Oil and oil-based products are common contaminants. This category contains a large variety of individual contaminants, and Total Petroleum Hydrocarbons (TPH) was chosen as the indicator contaminant. A threshold value of 5 mg/l was selected, based primarily on standards applied at hazardous waste site remediation.

10. Salts: For this category, chloride was selected as the indicator contaminant. The drinking water standard of 250 mg/l was selected as the threshold value.

Zone Based Screening
The first screen applied to eliminate less important potential sources makes use of the zone concept recommended by PADEP for use in the SWAP:

- Zone A: the critical segment covering ¼ mile on either side of the stream upstream of the intake within a 5-hour travel time to the intake. All potential sources within this zone are included in the subsequent steps.

- Zone B: a second segment located within 2 miles of either side of the stream upstream of the intake, within a 25-hour travel time to the intake. All potential sources within this zone are also included in the subsequent steps.

- Zone C: the rest of the upstream watershed. These sources remain listed in the database, but are eliminated from further analysis because they are deemed less significant than sources in zones A and B.

The PADEP zone concept is used to narrow the list of sources down to include only those with higher priority. Potential sources within Zone C sources are dropped from further analysis within this preliminary assessment, leaving those sources within zone A or B for the intake.

Multi-Criteria Evaluation (EVAMIX)
Following the zone based screening, the most important screening and evaluation method used for most of the analysis relied on a multi-criteria evaluation software package called EVAMIX. EVAMIX is a matrix-based, multi-criteria evaluation program that makes use of both quantitative and qualitative criteria within the same evaluation, regardless of the units of measure. The algorithm behind EVAMIX is unique in that it maintains the essential characteristics of quantitative and qualitative criteria, yet is designed to eventually combine the results into a single appraisal score. This critical feature gives the program much greater flexibility than most other matrix based evaluation programs, and allows the evaluation team to make use of all data available to them in its original form.

EVAMIX makes a pair by pair comparison of all contaminant sites under evaluation across all evaluation criteria, resulting in thousands of computations. The computations eventually result in an overall appraisal score. This is a single number, attached to a single alternative, and represents the overall worth of that alternative relative to the other alternatives based on the criteria selected, and the weights attached to the criteria. This number is used to determine the final ranking of alternatives from best to worst, or most important to least important.

EVAMIX offers several important advantages when used in planning studies:

- The alternatives under consideration are clearly defined

- The criteria used in evaluating the alternatives are explicit and measurable

- The algorithm can handle both quantitative and qualitative data, utilizing all available data to the highest degree of measurability possible

- The priorities underlying the evaluation are made explicit, and can be flexibly applied to highlight the effect that weighting has on the final ranking

- The technique is flexible enough to handle new data as it becomes available

- The technique is applied using widely available software (Excel spreadsheets)

The use of EVAMIX requires the development of a two dimensional matrix consisting of the options to be evaluated (columns) and a set of evaluation criteria (rows). For every combination of options and criteria, a score is assigned. The choice of the criteria is governed, in part, by the need for the scoring to be as objective as possible. By objective, we mean that the scores should represent impartial data and information useful in making decisions. The criteria must be clear and unambiguously defined, and can be set up as either quantitative criteria (e.g. threshold concentration in percent, time of travel in hours), or qualitative criteria (e.g. discharge frequency, location etc.).

The other input variable required for the evaluation procedure is the selection of weighting factors for each of the criteria. While the scoring process strives to be as objective as possible and is carried out by the project team, the selection of weights is inherently subjective and should be done by the decision-makers, planners, or stakeholders. Unlike the matrix of scores, numerous possible weight sets are possible, and all are equally "valid".

A workshop was held in June 2001, at which members of the Technical Advisory Group participated in an exercise designed to develop a representative set of criteria weights. These weights formed the basis for the evaluation.

Point Source Screening
Point source data comes from a number of data sources, and each database can contain hundreds of potential sources. Less significant point sources needed to be screened out, leaving only the most important sources for final ranking. A slightly different screening approach was needed for each type of source because of the data available and the structure of the databases.

The point source screening approaches for each of the main data sources are summarized in this section.

1. PCS Database

This database contained over 500 individual facilities, over 200 of which are wastewater or sewage disposal facilities. These can be divided into major facilities with discharges of more than 1 million gallons per day (mgd) and minor facilities with discharges of less than 1 mgd. Default flows of 1 mgd for large facilities and 0.1 mgd for small facilities were used along with assumed concentrations based on the site SIC code and existing median concentrations for similar facilities where data were unavailable. The screening approach consisted of calculating potential concentrations of contaminants resulting from each source at the intake, and comparing against threshold values for each contaminant category. The estimated concentration at the intake for each site included in the PCS data was calculated including dilution at the intake but not including decay, volatilization, or die off. If the impact was more than 1 percent of the threshold, it passed the screen, otherwise it was screened out.

2. CERCLA

There were almost 400 CERCLA sites representing hazardous waste sites of all kinds. These are known sites that have contamination, but cannot easily be fit into our point source screening because there is no discharge data or concentration data. For this reason, they must be handled separately in a narrative analysis that considers such characteristics as whether or not the site was on the National Priority List, if the site was in Zone A for the intake, if the site was in the flood plain, and if the site was identified within the self-assessment zone of the intake. The process and results are discussed in greater detail in Section 2.2.4.3.

3. RCRA

There are more than 1500 RCRA facilities in the study area with little actual data on quantities stored or used at the sites. To address this problem, default quantities were assigned. Chemicals used at each facility were estimated based on SIC codes. Where such codes were unavailable, the State Guidance categories were used.

The screening approach for RCRA sites contained several steps.

1. RCRA sites with only Underground Storage Tanks (USTs) were screened out because they pose little threat to the surface waters.

2. RCRA sites that are not UST or Aboveground Storage Tanks (ASTs) were screened using the following guidelines:

    - Floodplain: if the site is not in the floodplain, it is screened out, and

    - If there are no reported spills, violations, or releases according to the Right to Know data, it is screened out.

3. Those sites with ASTs required a separate EVAMIX screening. There were over 300 of such sites with listed ASTs. The procedure for performing the impact screening relied on EVAMIX and the following screening criteria:

Total Tank Volume: in gallons of total tank volume. Larger tank volume meant a higher priority.

Volume Weighted Chemical Ranking: an additive score representing the types of chemicals stored onsite, each weighted by the percent of total tank volume used to store that category of contaminant. In this case, the chemicals are rated according to their impact on the treatment system and the ease with which the current treatment can handle the contaminant in the raw water. This results in a ranking of contaminant categories in order of decreasing importance to the treatment process with points assigned as follows: VOCs/SOCs (10), *Crytosporidium* (9), Metals (8), Petroleum Hydrocarbon (7), Nitrate (6), TSS (5), Chloride (4), TOC/DBP precursors (3), Phosphorus (2), Fecal Coliform (1). Each contaminant category gets a score (10 for

VOCs, 9 for *Cryptosporidium* etc. down to 1 for Fecal Coliform.) For each category, the rank number is multiplied by the fraction of total tank volume of that contaminant to the total tank volume onsite. The weighted categories are then added up. For example, a site with VOCs (10,000 gal tank) and salts (90,000 gal) would score 10 x 0.1 + 4 x 0.9 = 4.6.

Leaks Reported: a qualitative score of 1 for a leak, a score of 0 for no leak.

Tank Age: a quantitative score in years after date of installation.

Location: a qualitative score that checks if the site is within floodplain or not (score of 3), in Zone A (score of 2), or in Zone B (score of 1).

Travel Time: a quantitative score in hours based on the time of travel from the site to the intake using peak flows.

The criteria were weighted, based on the results of the Technical Advisory Group and discussions with the project team. The weights are:

- Tank Age: 12 percent
- Total Tank Volume: 36 percent
- Vol. Weighted Chemical Ranking: 15 percent
- Leak History: 10 percent
- Location: 21 percent
- Travel Time: 5 percent

The screening of RCRA sites resulted in two lists of sites moving through the screen: non-AST sites that reported spills and are within the floodplain, and ASTs that pass the EVAMIX screening.

4. TRI Sites

There are over 300 TRI sites that manufacture or use toxic chemicals. These sites, however, do not discharge contaminants. The database lists the contaminants onsite, including: VOCs, metals, nutrients, and chloride. To focus on the high priority sites, an EVAMIX screening was required, base on the following criteria:

Location: if in flood plain (3 points), zone A (2 points) or zone B (1 point):

Chemicals Listed: a score was given based on the acute effects on health of each contaminant category, resulting in the following scores: VOCs/SOCs (10), *Cryptosporidium* (9), Metals (8), Petroleum Hydrocarbon (7), Nitrate (6), TSS (5), Chloride (4), TOC, /DBP precursors (3), Phosphorus (2), Fecal Coliform (1). For sites with more than one category, the scores were the sum of the rank of chemicals listed (e.g. a site with VOCs and Metals would score 10+8 = 18)

Amount Stored: based on the range listed in the database, in kg per year

Number of releases to water: total number of releases in database

Travel Time: the time of travel from a spill at the site to the intake.

Criteria weights were applied within the EVAMIX screening as follows:

- Location: 15 percent
- Chemicals Listed: 20 percent
- Amount Stored: 35 percent
- Number of releases to water: 25 percent
- Travel Time: 5 percent

Non-point Source Runoff Screening

Potential non-point sources were identified using the SWMM model and Event Mean Concentrations (EMCs) to calculate total annual pollutant loading for each subwatershed.

Because there are over 300 subwatersheds, EVAMIX screening was applied using three criteria. These were:

1. Relative Impact at Intake (weight 60 percent):

This criterion is based on the concentration of a contaminant caused by the potential source at the intake as a percent of the contaminant category threshold value. Since there are potentially 10 values, one for each contaminant category, only the highest ranked category or greatest relative impact chemical category was used for this criterion.

2. Time of Travel (weight 20 percent):

This is a criterion calculated as the time of travel from the potential source to the intake, based on high flow velocity.

3. Location (weight 20 percent)

This criterion scored watersheds as 2 if in Zone A, and 1 if in Zone B.

The highest ranked subwatersheds passed through to the full ranking of sources.

Source Priorities: Full EVAMIX Ranking of All Sites
Finally, all the significant (those that passed the screening) point sources and runoff loads (entered as pseudo point sources) were prioritized, accomplishing the main goal of the assessment. There were two types of final rankings. The first ranking was a combined ranking of sites from all categories, compared against each other. The second ranking was by contaminant type, with all significant sources contributing to a particular contaminant category included.

Multi-criteria Ranking using EVAMIX: Combined Sources
EVAMIX was used to rank all sources over the entire range of contaminant categories. Full ranking allowed us to compile a final list of sources, independent of contaminant class. The following criteria were used:

Relative Impact at Intake (weight 12 percent):

This criterion is based on the concentration of contamination potentially caused by the source at the intake as a percent of the contaminant category threshold value. Since there are potentially 10 values, one for each contaminant category, only the highest ranked category or greatest relative impact chemical category was used for this criterion.

Time of Travel (weight 5 percent):

This is a criterion calculated as the time of travel from source to intake, based on high flow velocity.

Potential for Release/Controls (weight 14 percent):

This was developed using the qualitative categories taken from the State SWAP guidelines.

High: no control practices, or a regulated discharge not in compliance with regulations (4 points)

Medium/High: a non-point source with no BMP in place, or regulated discharge and in compliance with regulations (3 points)

Medium: a non-point source with BMP in place, or a point source not regulated but contained in some way (retaining wall, double walled tank etc.) with no emergency response plan (2 points)

Low: a regulated point source by the State, containment, and/or emergency response plan (1 point)

Potential Release Frequency (weight 14 percent):

A qualitative criterion based on the following scores:

Very High: a continuous discharger, 5 points

High: an intermittent or rainfall related (CSO, SSO, NPS) discharger, 4 points

Medium: a discharge with roughly a monthly frequency, 3 points

Low: a discharge with roughly an annual frequency, 2 points

Very Low: a discharge that occurs only as a catastrophic spill, or a storm related discharge with about a 100-year occurrence frequency, 1 point

Violation Type/Frequency (weight 10 percent):

A qualitative criterion based on the following scoring:

High: Operation or Effluent Violations, 3 points

Medium: Management Violations, 2 points

Low: Administrative Violations or none, 1 point

In this case, points are cumulative for each violation within the last 3 years in each category. For example two violations for not filing paperwork (2x1) plus an effluent violation (3 points) would result in a score of 5 points.

Location (weight 5 percent):

A qualitative criterion based on GIS analysis according to the following categories:

In the Floodplain: 3 points

In Zone A: 2 points

In Zone B: 1 point

Existing Removal Capacity (weight 10 percent):

A criterion with qualitative scoring based on the chemical released and the ability of the existing treatment to remove it. Scoring was according to the following system:

Not removed (salts, radionuclides, nitrates): 3 points

Limited removal (Cryptosporidium, SOCs, VOCs, Petroleum Hydrocarbons, Phosphorus, TOC): 2 points

High removal (fecal coliform, TSS, metals): 1 point.

Scores were cumulative for each category present at the site.

Impact on Treatment Operation (weight 10 percent):

A criterion with qualitative scoring based on the contaminant released and its impact on the operation of the treatment systems in place. Scoring was according to the following system.

High (TSS, VOCs, Petroleum Hydrocarbon): 4 points

Medium/High (metals, TOC): 3 points

Medium (*Cryptosporidium*, nitrate, phosphorus): 2 points

Low (fecal coliform, chloride, radionuclides): 1 point

The score is cumulative over all categories present.

Potential Health Impacts (weight 20 percent):

A criterion with qualitative scoring based on the contaminant released and its potential acute impact on health if not removed. Scoring was according to the following system:

High (*Cryptosporidium*, SOCs, VOCs, radionuclides, fecal coliform): 3 points

Medium (TOC, metals, nutrients, nitrate): 2 points

Low (salts, TSS, phosphorus): 1 point

The score is cumulative over all categories present.

This ranking resulted in a single list of sources for the intake showing high, medium, and low priority sources from all categories.

EVAMIX Ranking by Contaminant Category
Ranking by contaminant category was completed using six criteria and the multi-criteria evaluation program EVAMIX. Criteria (with weights from the June 2001 Task Force Meeting) are given below.

Relative Impact at Intake (weight 40 percent):

This criterion is based on the concentration of contamination potentially caused by the source at the intake as a percent of the contaminant category threshold value.

Time of Travel (weight 5 percent):

This is a criterion calculated as the time of travel from source to intake, based on high flow velocity.

Potential for Release/Controls (weight 20 percent):

This was developed using the qualitative categories taken from the State SWAP guidelines.

High: no control practices, or a regulated discharge not in compliance with regulations (4 points)

Medium/High: a non-point source with no BMP in place, or regulated discharge and in compliance with regulations (3 points)

Medium: a non-point source with BMP in place, or a point source not regulated but contained in some way (retaining wall, double walled tank etc.) with no emergency response plan (2 points)

Low: a regulated point source by the State, containment, and/or emergency response plan (1 point)

Potential Release Frequency (weight 15 percent):

A qualitative criterion based on following scores:

Very High: a continuous discharger, 5 points

High: an intermittent or rainfall related (CSO, SSO, NPS) discharger, 4 points

Medium: a discharge with roughly a monthly frequency, 3 points

Low: a discharge with roughly an annual frequency: 2 points

Very Low: a discharge that occurs only as a catastrophic spill, or a storm related discharge with about a 100-year occurrence frequency, 1 point

Violation Type/Frequency (weight 15 percent):

A qualitative criterion based on the following scoring:

High: Operation or Effluent Violations, 3 points

Medium: Management Violations, 2 points

Low: Administrative Violations or none, 1 point

In this case, points are cumulative for each violation within the last 3 years in each category. For example two violations for not filing paperwork (2x1) plus an effluent violation (3 points) would result in a score of 5 points.

Location (weight 5 percent):

A qualitative criterion based on GIS analysis according to the following categories:

In the Floodplain: 3 points

In Zone A: 2 points

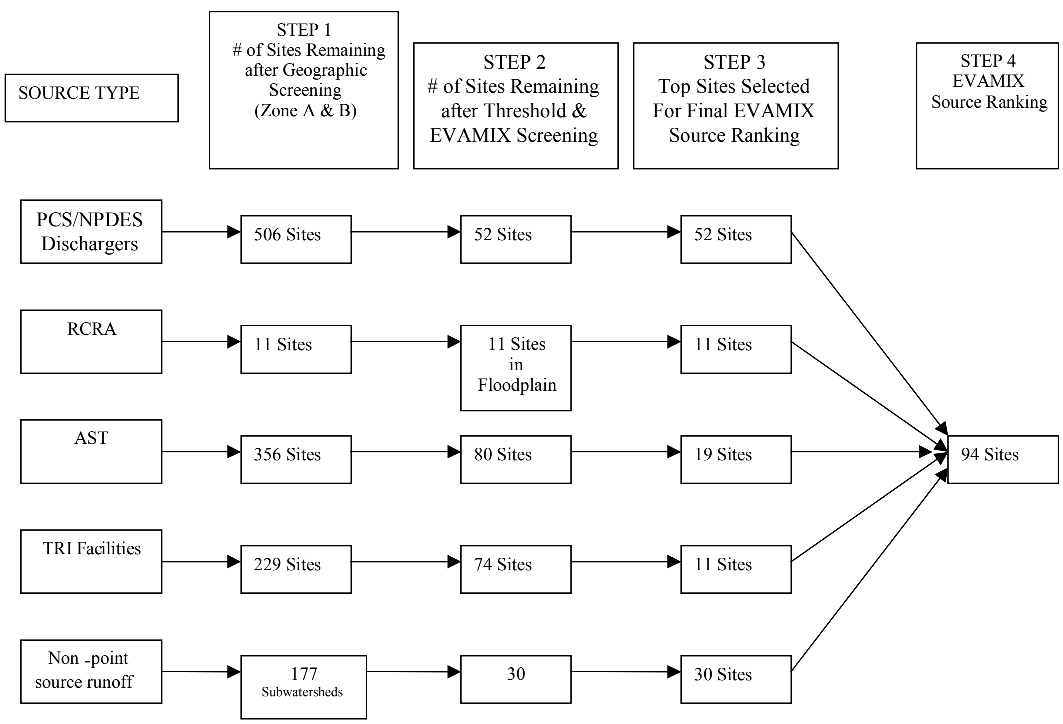
In Zone B: 1 point

Results from each of the ten contaminant categories based evaluations resulted in a listing of high, medium, and low priority sites for that contaminant category.

2.2.4.2 Results

Figure 2.2.4-2 is a flow diagram of the screening and ranking process that was used to successively select the most important sites from each of the databases available, and combine them in an organized manner to produce a final list of high priority sites. The process can be compared to a playoff elimination process, with various divisions providing a set number of teams to the overall playoff. Like such playoff structures, it can occur that a site will not be included in the final list because it was eliminated in competition with other sites within its categories. (To follow the analogy, the 4th best team in a division is not invited to the playoffs, even if it is better than the 3rd best team from another, weaker division, because only the top three teams are invited from each division.) Despite this fact, the process does provide the top sites from each database category, and provides valuable insight into the relative importance of each category of sites. Enough sites were included from each category to make sure that no highly ranked sites would be overlooked.

Figure 2.2.4-2 Screening and Ranking Process



The diagram shows that there were several screening steps (or elimination rounds) leading to the final ranking. These are described briefly below.

Zone Based Screening
The inventory of potential sources of contamination started with all of the sites included in the PCS, RCRA, AST, and TRI databases. After all had been located and coordinates assigned, those in Zone C were eliminated from consideration. This left 321 sites from the PCS database (essentially those with a surface water discharge permit), 345 sites listed with above ground storage tanks (ASTs), and 226 facilities from the TRI database (sites that generate or handle toxic chemicals). In addition, all of the subwatersheds that are upstream of the Belmont intake and within the travel times of Zones A or B were also included (176 subwatersheds). RCRA sites that had underground storage tanks were eliminated. It was decided that only RCRA sites located within the flood plain were of concern in this round of analysis, and the 11 sites that met this condition were included in the analysis.

Database Based Screening
The zone based screening still left over 1000 sites that needed to be screened further to a manageable number. This was done either by simple threshold screening, based on the amount of contaminants stored or used, or by a more complex evaluation using several criteria.

Threshold Based Screening
For one of the categories, (PCS) simple threshold screening was an effective approach for screening.

PCS Sites: As described in section 2.2.4.1, the percent change in the concentration of a chemical at the intake due to releases from each site could be roughly estimated, and this was used to screen the 506 PCS (NPDES) sites. This threshold screening was performed to select the largest dischargers. A cutoff of a 1 percent change in concentration at the intake was established, based on the percent increase by the discharged mass loading. Of the 506 sites, only 52 discharges could potentially affect concentrations by more than 1 percent. Most of the others were much too small to have a measurable impact and were eliminated from further analysis.

Criteria Based Screening
For the AST sites, TRI sites, and the subwatersheds (stormwater pollutant loading), a more sophisticated approach was required to adequately select the most important sites from each category. Several criteria were used with the multi-criteria evaluation program EVAMIX to perform each of these screening analyses. EVAMIX output was used to complete the screening by ranking the sites in descending order of importance and then selecting the top sites based on the results of the ranking.

AST Sites: EVAMIX screening resulted in a ranking of all the sites based on six criteria. The criteria were age of the tank, storage volume of the tank, chemical ranking based on the mix of chemicals onsite, whether there had been leaks in the past, the location relative to the river, and the travel time to the intake (see section 2.2.4.1 for details). From the 356 sites, the 80 highest ranked sites passed the screen into the final ranking. Of these, the top ranked 19 sites were used in the final screening evaluation. In general, AST sites scored low in comparison to the other types of sites, and fewer were included to allow more room for TRI, PCS, and subwatersheds (NPS or non-point sources). The results of the final ranking (Table 2.2.4-1) confirmed that most AST sites had very low rankings, with only 1 site making it into the top 94 sites.

TRI Sites: EVAMIX screening resulted in a ranking of all the TRI sites based on five criteria. The criteria were amount of chemical stored, chemical ranking based on the mix of chemicals onsite, whether or not releases to water have been reported, the location relative to the river, and the travel time to the intake (see section 2.2.4.1 for details). From the 229 sites, the 74 highest ranked sites passed the screen into the final ranking. Of these, the top 11 sites were used in the final ranking analysis.

NPS Subwatersheds: There were 177 subwatersheds that could be considered to be in the Belmont intake's zone A or B. A screening of these subwatersheds for their potential impact due to stormwater pollutant loading was performed using EVAMIX and three criteria. The first criterion was the relative impact, measured as the expected concentration from the pollutant runoff at the intake, divided by the threshold number for that contaminant category. Because there were 9 contaminant categories relevant to stormwater runoff, the highest relative impact was used. The other two criteria were location and time of travel to the intake. The subwatersheds or NPS sources were relatively important, and the 30 highest ranked subwatersheds were included in the final ranking.

Source Priorities: Full EVAMIX Ranking of All Potential Sources

All of the significant point sources and runoff loads (entered as pseudo-point sources) that passed the screening process were lumped together for a final ranking, once again using EVAMIX. There were 132 mixed sites. Because EVAMIX can only handle evaluations of fewer than 100 sites, the final screening occurred in two steps, eventually producing a list of the top 94 sites for the Belmont Intake. This important, final ranking of the mixed group of sites used the nine criteria described above in section 2.2.4.1. The criteria weights were those established during the Technical Advisory Group workshop.

1. Relative Impact at Intake (weight 12 percent)

2. Time of Travel (weight 5 percent):

3. Potential for Release/Controls (weight 14 percent):

4. Potential Release Frequency (weight 14 percent):

5. Violation Type/Frequency (weight 10 percent):

6. Location (weight 5 percent):

7. Existing Removal Capacity (weight 10 percent):

8. Impact on Treatment Operation (weight 10 percent):

9. Potential Health Impacts (weight 20 percent):

Table 2.2.4-1 lists the 94 point sources and non-point sources that passed the screening. The table is organized into roughly three groups of sites in descending order of priority as calculated by EVAMIX. The table has eight columns.

Column 1: Source ID code: a unique database source code

Column 2: Source Name, the name as listed in the database

Column 3: Primary database containing information about the source used in the analysis

Column 4: Point Source subwatershed (NPS)

Column 5: Zone (either A or B)

Column 6: Estimated time of travel to the intake under high flow conditions

Column 7: Relative impact at the intake

Column 8: High, Medium, or Low Ranking based on EVAMIX numerical ranking output, nine criteria and selected criteria weights

Table 2.2.4-1 Final Ranking of Sources for Combined Contaminant Categories

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	13.5	9.85	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	9.59	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	29.40	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	27.2	4.04	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.67	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	7.48	Highest-A
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	15.47	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	11.5	16.00	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	6.5	891.44	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	6.42	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	6.5	11.78	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	8.63	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	12.22	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	18.07	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	17.6	0.17	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	14.2	0.17	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	24.1	4.45	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3800	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	2.83	Highest-A
3787	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	2.39	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	6.5	0.17	Highest-A
3804	Stony Creek-024	NP	Stony Creek	Zone A	8.0	7.69	Highest-A
3807	Trout Creek-027	NP	Trout Creek	Zone A	9.0	4.20	Highest-A
3788	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	10.80	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	17.1	0.17	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	5.16	Highest-A
3789	Sandy Run-009	NP	Sandy Run	Zone A	9.7	3.38	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	25.8	1.48	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	15.5	0.17	Highest-A
3783	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	7.36	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	16.0	1.71	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	6.28	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	26.4	9.36	Moderately High-B
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	14.5	0.17	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	20.5	0.17	Moderately High-B
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	13.15	Moderately High-B
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	12.69	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	38.1	0.17	Moderately High-B
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	143.04	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	26.7	5.78	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	24.1	0.17	Moderately High-B
3815	Valley Creek-035	NP	Valley Creek	Zone B	12.1	4.64	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	23.8	1.71	Moderately High-B
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	3.44	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	30.8	0.17	Moderately High-B
3934	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	3.08	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	26.66	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	2.69	Moderately High-B
3827	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	3.63	Moderately High-B
3944	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	4.46	Moderately High-B
3837	East Branch Perkiomen Creek-057	NP	East Branch Perkiomen Creek	Zone B	21.5	3.60	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	17.5	0.17	Moderately High-B
3973	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	4.77	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	9.58	Moderately High-B
3838	Mill Creek-058	NP	Mill Creek	Zone B	27.1	4.38	Moderately High-B
3839	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	4.27	Moderately High-B
3948	Manatawny Creek-168	NP	Manatawny Creek	Zone B	27.8	4.82	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	1.48	Moderately High-B
3840	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	8.03	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.17	Moderately High-B
3841	Morris Run-061	NP	Morris Run	Zone B	30.2	6.40	Moderately High-B
3843	East Branch Perkiomen Creek-063	NP	East Branch Perkiomen Creek	Zone B	30.8	4.28	Moderately High-B
4018	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	6.76	Moderately High-B
3985	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	4.47	Moderate-C
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.17	Moderate-C
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.17	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3989	Plum Creek-209	NP	Plum Creek	Zone B	35.6	11.02	Moderate-C
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.17	Moderate-C
4062	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	13.34	Moderate-C
3988	Little Cacoosing Creek-208	NP	Little Cacoosing Creek	Zone B	37.7	4.62	Moderate-C
4023	Willow Creek-243	NP	Willow Creek	Zone B	38.1	7.23	Moderate-C
4063	Irish Creek-283	NP	Irish Creek	Zone B	38.6	15.75	Moderate-C
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.17	Moderate-C
4066	Pigeon Creek-286	NP	Pigeon Creek	Zone B	40.2	7.96	Moderate-C
4065	Lesher Run-285	NP	Lesher Run	Zone B	41.2	5.36	Moderate-C
4069	Schuylkill River-289	NP	Schuylkill River	Zone B	41.7	10.45	Moderate-C
4067	Mill Creek-287	NP	Mill Creek	Zone B	41.7	10.26	Moderate-C
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	1.71	Moderate-C
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	34.0	0.17	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.17	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.17	Moderate-C
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.49	1.71	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	37.0	1.71	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Flood Plain	22.4	6166	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	24.6	34067	Moderate-C
3178	MALVERN TERM	AST	Little Valley Creek	Zone B	15.4	15566041	Moderate-C
2228	HENKEL CORP.	TRI	Wissahickon Creek	Zone B	11.6	1202	Moderate-C
2191	LONZA INC.	TRI	Schuylkill River	Flood Plain	5.49	15206	Moderate-C
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	4.50	3234	Moderate-C
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	27.2	5978	Moderate-C
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Flood Plain	4.50	1255	Moderate-C
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Flood Plain	20.0	55978	Moderate-C
2185	FINNAREN & HALEY INC.	TRI	Schuylkill River	Flood Plain	4.50	2179	Moderate-C
2352	DANA CORP. PARISH DIVISION	TRI	Schuylkill River	Zone B	32.5	144641	Moderate-C
2219	HONEYWELL INC. PROCESS CONTROL DIV.	TRI	Sandy Run	Zone A	13.5	1270592	Moderate-C

The final results of the rankings are broken down into six major categories according to PADEP's SWA Plan. These are represented by designations A through F, with A representing sources of highest protection priority and gradually decreasing to F for sources of lowest protection priority. This designation process was initially designed for intakes with a limited number of sources where the whole inventory could be ranked. However, given the large number of sources and the ranking process, sources that are represented by designations D through F were screened out in the significance screening process. Therefore, the sources ranked in the document are considered potentially significant sources of contamination and fall into categories A through C. They are described in Table 2.2.4-2.

Table 2.2.4-2 Contaminant Source Ranking Designations

Designation	Description
Potentially Significant Sources of Contamination to Water Supply	
A	Potentially Significant Source of Highest Protection Priority
B	Potentially Significant Source of Moderately High Protection Priority
C	Potentially Significant Source of Moderate Protection Priority
Remaining Sources From Inventory Screened Out By Significance Screening Criteria	
D	Potential Source of Moderately Low Protection Priority
E	Potential Source of Low Protection Priority
F	Potential Source of Lowest Protection Priority

As shown, the sources in categories A through C may require additional ground-truthing in order to provide a more accurate designation of their significance. Although not considered to be potentially significant, sources in category D may need to be evaluated as more information becomes available.

The results provide significant insight into the relative threat that various types of sources might have on the water quality at the intake. The key results are:

- All of the highest ranked sites are either NPDES sites from the PCS database or stormwater pollutant loading represented by various subwatersheds. The top 17 ranked sources are NPDES, and 24 of the top 31 sites are included in this category.
- Stormwater or NPS loading appears to also represent a high priority. There are 7 subwatersheds with stormwater related loading in the top 31 sites.
- TRI sites are generally ranked lower. There are no TRI sites in the top 50 sites, and all TRI sites are found in the "moderate" priority category.
- RCRA sites, with or without ASTs, are generally ranked the lowest of all of the types of sites. Almost all of these sites did not make it into the top 94 sites.

- Results indicate that with a balanced assessment, those contaminant sources that are actually discharging to the river (NPDES permitted point sources or stormwater runoff) represent the greatest concern. Those with only the potential to release contaminants through spills or leaks (TRI, RCRA, AST) are generally given a lower priority.

- Despite the low overall rankings, the highest potential relative impacts appear to occur with the TRI and AST sites. The relative impact numbers show that, were a catastrophic spill or leak to occur at these highly ranked sites, concentrations at the intake could potentially be very high.

- Health Impacts, as scored in the assessment, had a large influence on the resulting rankings, with those sites ranked high on potential health impacts ranking as important sites.

- Treatment Impacts were also important in the final rankings, with those sites scoring high on potential impact to the treatment process also ending up highly ranked in the overall assessment.

- The geographic distribution of significant sources showed that most of the category A sources were from nearby drainage areas of the Wissahickon Creek and Schuylkill River below Valley Forge. Approximately 75 percent of the potentially significant sources (categories A-C) were located in the Wissahickon Creek, Perkiomen Creek, and Schuylkill River drainage areas.

- A comparison of the types of sources indicated by the ranking process with the sources indicated by water quality analysis and impaired stream information (see section 2.1.5) corroborates that NPDES discharges and polluted runoff (non-point sources) from developed areas are the most important influences on water quality at the PWD Belmont Intake.

The rankings provided in Table 2.2.4-1 are based on a careful evaluation of existing data in the databases described in section 2.2.2. They are only as accurate as the data provided, and serve as a good starting point for data collection and field "ground-truthing" of these sites.

Figure 2.2.4-3 is a map of the site locations for point sources and subwatersheds in the Lower Schuylkill Watershed that scored highest in the ranking process. Figure 2.2.4-4 shows the point sources and subwatersheds in the upper part of the watershed that scored the highest in the ranking process. The numbers indicated on the map correspond to identification numbers of the various sources in the tables.

Figure 2.2.4-3 Priority Point Sources and Subwatersheds for PWD's Belmont Intake in the Lower Schuylkill Watershed

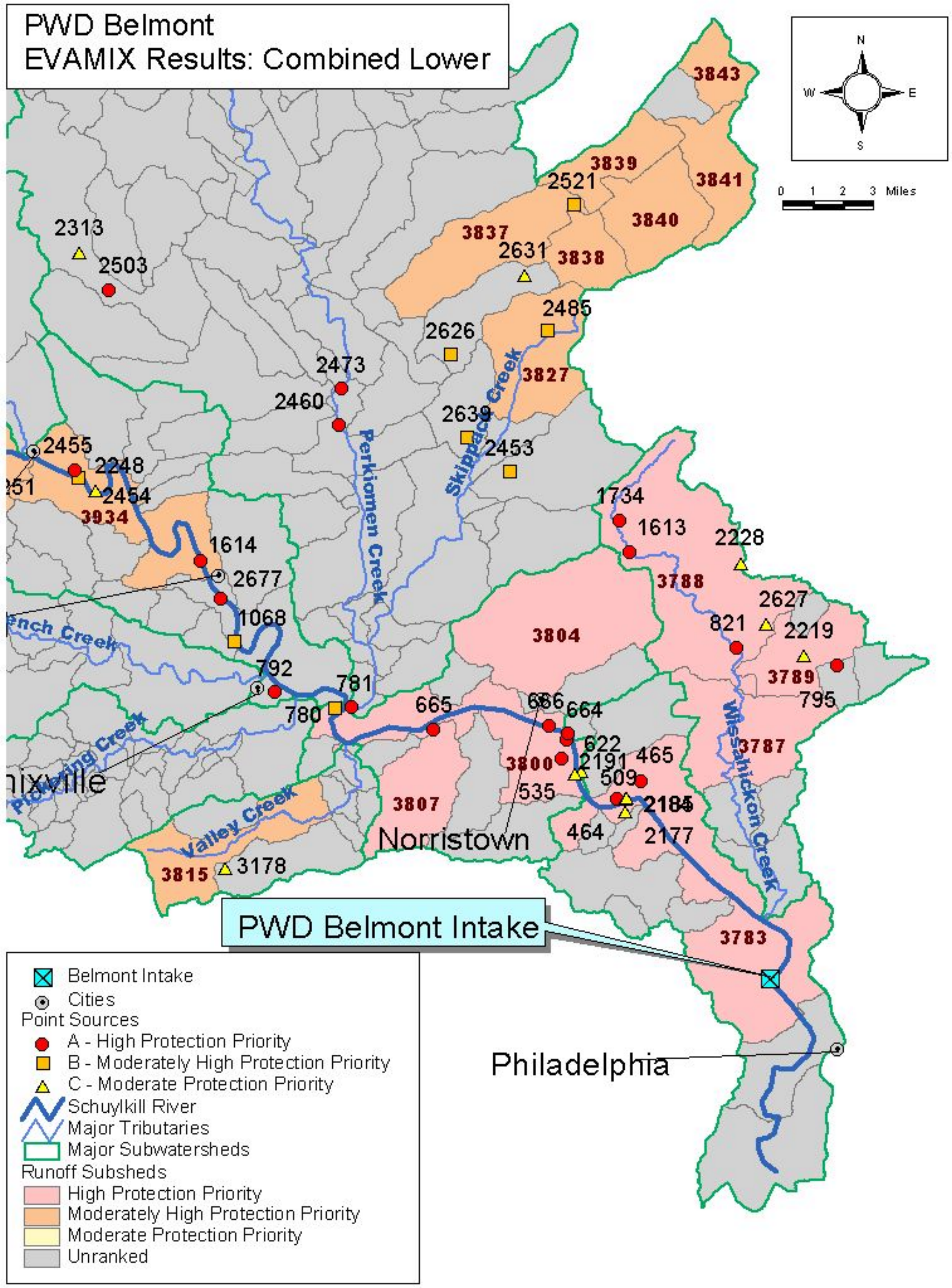
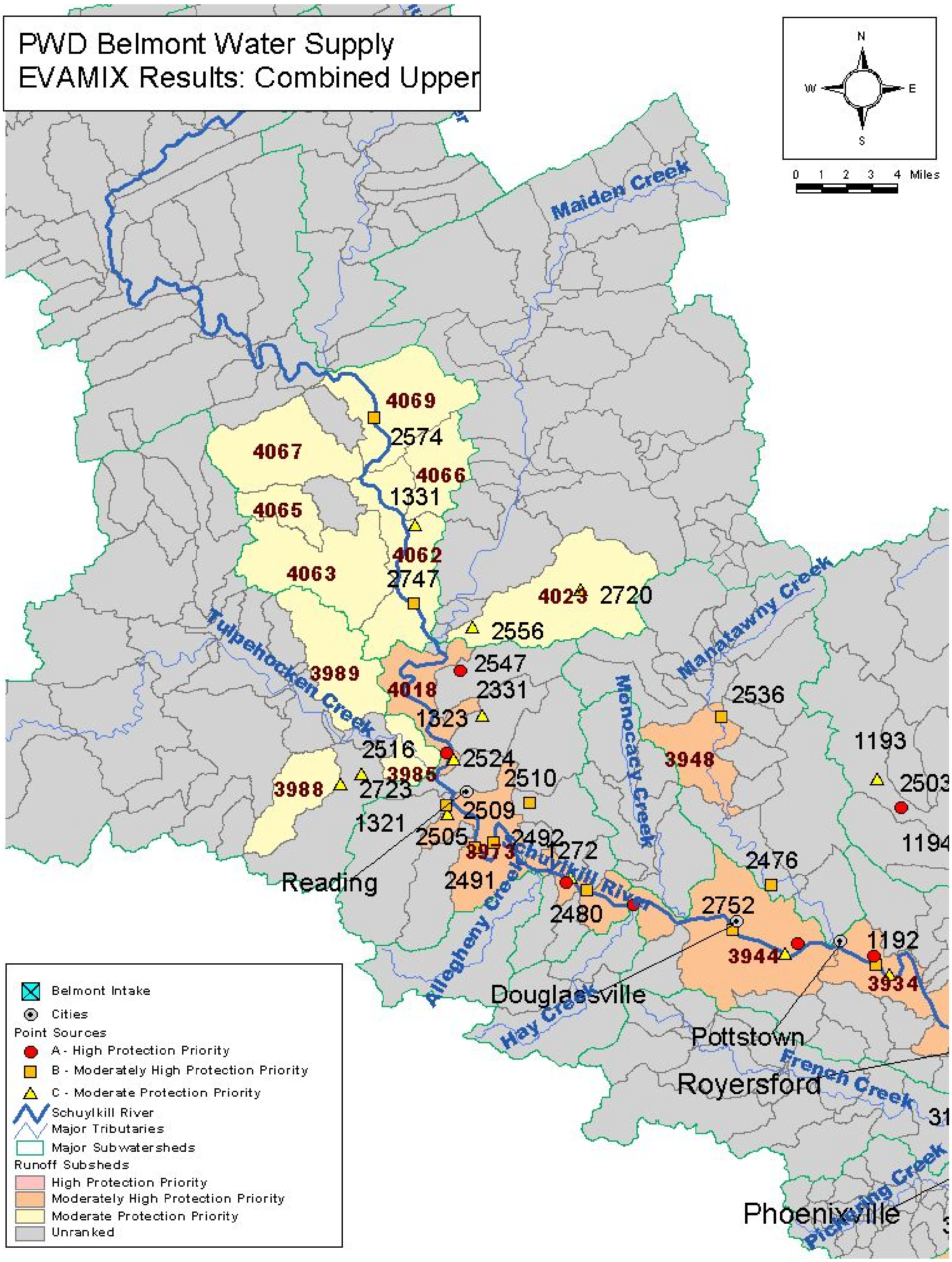


Figure 2.2.4-4 Priority Point Sources and Subwatersheds for PWD's Belmont Intake in the Upper Schuylkill Watershed



EVAMIX Ranking by Contaminant Category

The extensive screening of sites done for the combined ranking was not suitable for use in the contaminant-by-contaminant evaluation. The combined ranking screening was done in part based on the types of chemicals stored, and thus could conceivably screen out numerous sites for a given contaminant, simply because that contaminant is less critical than another contaminant. For those contaminant categories where the number of sites was too large, a simple threshold screening was performed based on the impact of that contaminant source on the potential concentration at the intake. In general, the following approach was used for selecting sites from each category for final ranking by contaminant category:

- 52 sites from the PCS database were included (including all the major dischargers);
- All 11 RCRA sites were included; and
- The top ranked 20 sites from the TRI database, the top 20 sites from the AST database, and the top 30 sites from the NPS database were included.

Ranking by contaminant category was completed using EVAMIX and six criteria (weights were provided by the technical advisory committee at the June, 2001 workshop):

1. Relative Impact at Intake (weight 40 percent)

2. Time of Travel (weight 5 percent)

3. Potential for Release/Controls (weight 20 percent)

4. Potential Release Frequency (weight 15 percent)

5. Violation Type/Frequency (weight 15 percent)

6. Location (weight 5percent)

Tables 2.2.4-3 through 2.2.4-12 provide the rankings of the primary potential sources of each contaminant group. Each Table has 8 columns:

Column 1: Source ID code: a unique database source code

Column 2: Source Name, the name as listed in the database

Column 3: Primary database containing information about the source used in the analysis

Column 4: Point Source subwatershed (NPS)

Column 5: Zone (either A or B)

Column 6: Estimated time of travel to the intake under high flow conditions

Column 7: relative impact at the intake

Column 8: Final rank category based on nine criteria and selected criteria weights

Salts

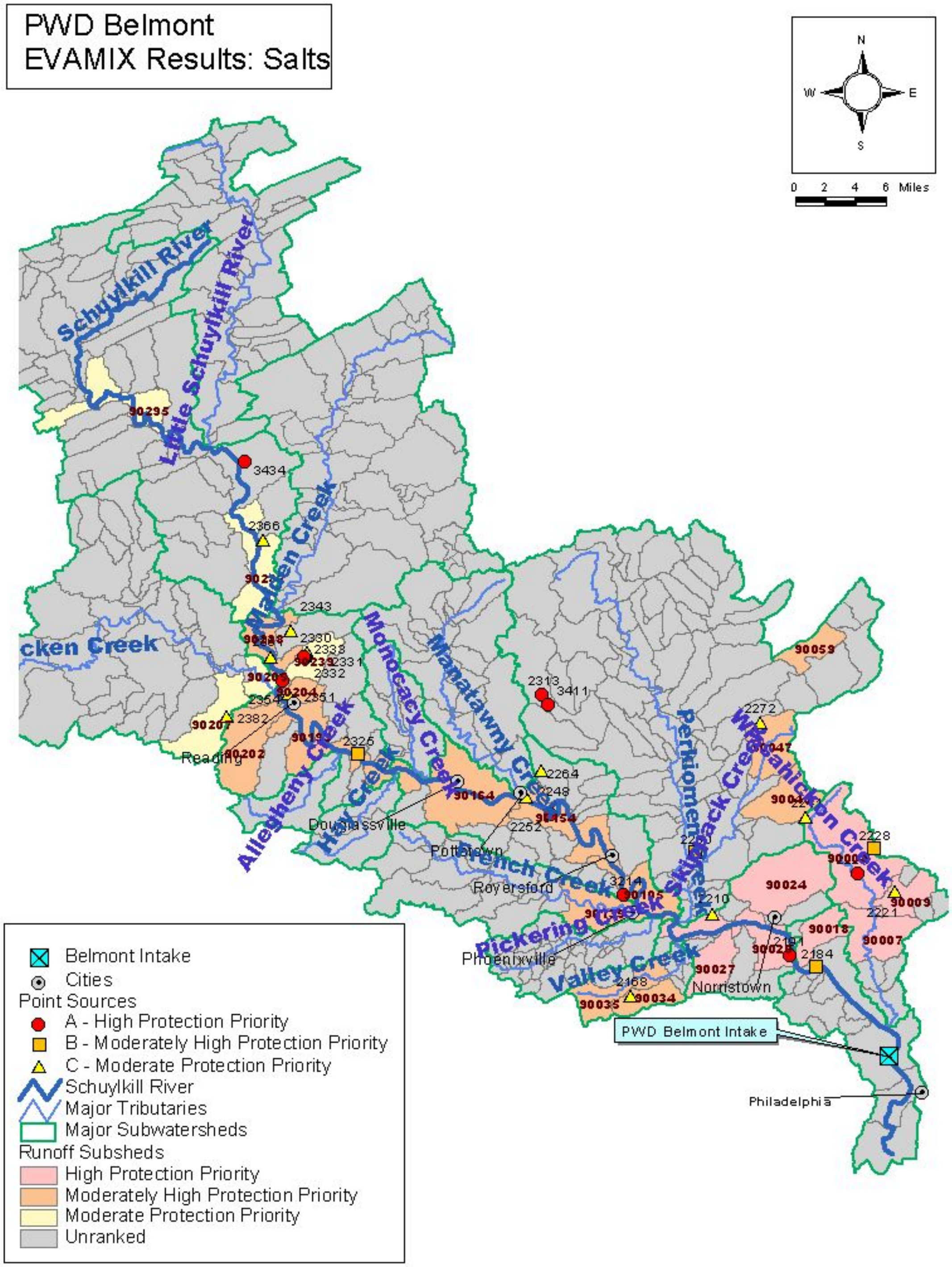
Table 2.2.4-3 shows the results of the ranking for salts, as represented by estimated sources of chloride. The Table indicates that the highest priority sources of chlorides are either stormwater runoff from urbanized watersheds, or potential releases of industrial salts from industrial sites as represented by sites listed in the TRI database. It should be noted that neither type of source individually appears to provide sufficient loading to cause water quality impairments at the intake, but combined, especially during winter periods, the runoff may result in some impacts. Geographically, most of the highest priority sources were located in the area near Norristown and along the Wissahickon Creek, as shown by Figure 2.2.4-5.

Table 2.2.4-3 Contaminant Category Ranking for Salts (Chlorides)

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	24.6	4.15	Highest-A
2333	GENERAL BATTERY CORP. READING SMELTER DIV.	TRI	Bernhart Creek	Floodplain	34.0	1.37	Highest-A
2191	LONZA INC.	TRI	Schuylkill River	Floodplain	5.5	0.05	Highest-A
3214	PHOENIXVILLE WTP	AST	Schuylkill River	Floodplain	14.5	1.89	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	0.03	Highest-A
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	5.5	0.02	Highest-A
3411	BOYERTOWN WWTP	AST	Swamp Creek	Zone B	24.1	2.22	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	0.02	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	0.02	Highest-A
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	0.03	Highest-A
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Floodplain	20.0	0.07	Highest-A
90027	Trout Creek-027	NP	Trout Creek	Zone A	9.0	0.02	Highest-A
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.02	Highest-A
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	32.5	0.46	Highest-A
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	0.06	Highest-A
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	43.3	2.33	Highest-A
2224	RHONE-POULENC AG CO.	TRI	Wissahickon Creek	Floodplain	11.0	0.48	Moderately High-B
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Floodplain	34.0	0.10	Moderately High-B
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	27.2	0.26	Moderately High-B
2228	HENKEL CORP.	TRI	Wissahickon Creek	Zone B	11.6	0.05	Moderately High-B
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	11.5	0.01	Moderately High-B
90035	Valley Creek-035	NP	Valley Creek	Zone B	12.1	0.01	Moderately High-B
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	13.2	0.01	Moderately High-B
90135	French Creek-135	NP	French Creek	Zone B	13.1	0.01	Moderately High-B
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	14.5	0.02	Moderately High-B
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	0.01	Moderately High-B
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	17.0	0.01	Moderately High-B
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	0.01	Moderately High-B
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	0.01	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	0.02	Moderately High-B
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Floodplain	4.5	0.14	Moderately High-B
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	0.01	Moderately High-B
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	32.0	0.02	Moderately High-B
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	0.02	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	32.0	0.01	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	0.01	Moderate-C
90239	Bernhart Creek-239	NP	Bernhart Creek	Zone B	33.5	0.01	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	0.01	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	0.01	Moderate-C
2156	ALPHACHEM INC. EASTERN BLENDING CENTER	TRI	Schuylkill River	Zone A	1.0	0.02	Moderate-C
2168	WORTHINGTON STEEL CO.	TRI	Little Valley Creek	Floodplain	14.8	0.08	Moderate-C
2332	EXIDE CORP. READING SLI	TRI	Bernhart Creek	Floodplain	34.0	0.30	Moderate-C
2252	POTTSTOWN PLATING WORKS INC.	TRI	Schuylkill River	Floodplain	21.0	0.03	Moderate-C
2210	GMT MICROELECTRONICS CORP	TRI	Schuylkill River	Zone B	8.5	0.01	Moderate-C
2343	NGK METALS CORP.	TRI	Laurel Run	Floodplain	35.1	0.07	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	14.8	0.05	Moderate-C
2221	NOVARTIS CONSUMER HEALTH INC.	TRI	Sandy Run	Zone B	15.4	0.01	Moderate-C
2272	H. W. LONGACRE INC.	TRI	Skippack Creek	Zone B	19.0	0.05	Moderate-C
2264	STEEL PROCESSING INC. POTTSTOWN INDL. COMPLEX	TRI	Sprogles Run	Zone B	21.0	0.01	Moderate-C
2351	CROMPTON & KNOWLES COLORS INC.	TRI	Schuylkill River	Zone B	32.0	0.14	Moderate-C
2330	YUASA EXIDE INC	TRI	Bernhart Creek	Zone B	34.5	0.06	Moderate-C
2382	HOFFMANN IND. INC.	TRI	Cacoosing Creek	Zone B	37.0	0.02	Moderate-C
2366	BRUSH WELLMAN INC.	TRI	Schuylkill River	Zone B	39.7	0.04	Moderate-C

Figure 2.2.4-5 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Salts in the Schuylkill River Watershed



Cryptosporidium

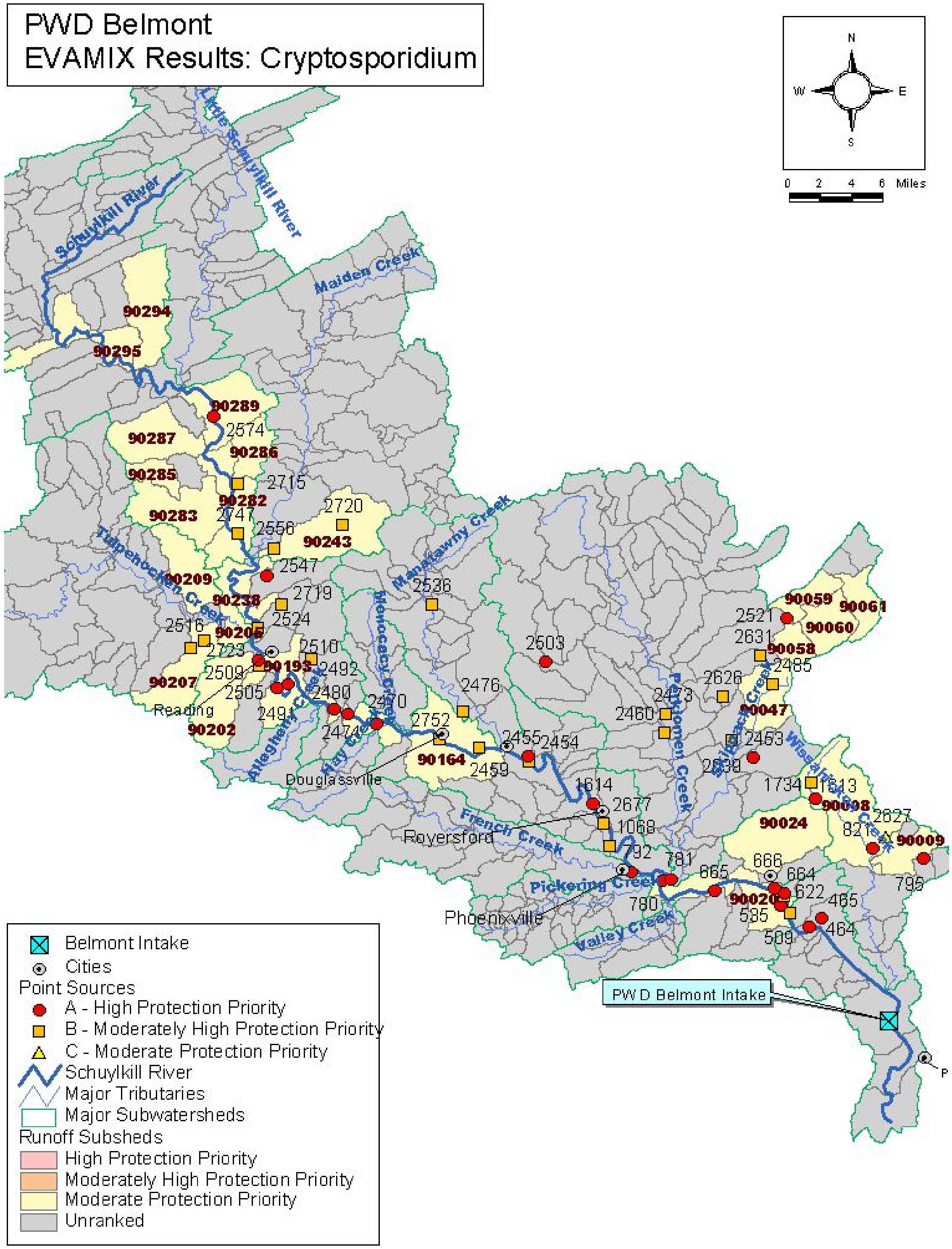
Table 2.2.4–4 shows the results of the ranking for pathogens, as represented by estimated sources of *Cryptosporidium*. The Table indicates that sources of pathogens are either stormwater runoff from agricultural or urbanized watersheds, and permitted discharges from wastewater treatment plants. NPDES sources are represented in the high priority category (category A), while NPS sites are in the lower caterory (category C). Most sources appear to be relatively minor contributors. However, there are some sources that could provide sufficient loads to have a cumulative impact on the water quality. Geographically, a larger number of sources from farther upstream into the Reading and Berks County areas were included as compared to other contaminant categories. Another potentially significant source that could not be properly incorporated into this analysis are the 11 communities upstream with combined sewer overflow systems. The overflows of raw sewage during wet weather events were roughly estimated and compared to the other potentially significant sources. Based on this analysis, the CSO discharges from the communities of Bridgeport and Norristown would be considered potentially significant sources for highest protection priority (category A). The remaining 9 communities, including Minersville, Tamaqua, and Greater Pottsville in Schuylkill County would be considered moderate protection priority sites (category C) since they are much further away from the Belmont intake. Figure 2.2.4-6 illustrates the priority point sources and subwatersheds for *Cryptosporidium* in the Schuylkill River Watershed.

Table 2.2.4-4 Contaminant Category Ranking for *Cryptosporidium*

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	0.0093	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	0.0093	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	0.0093	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	0.0093	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	0.0093	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	0.0093	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	0.0093	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	0.0093	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	0.0093	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	0.0093	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	0.0093	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	0.0093	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.0093	Highest-A
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	0.0093	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	0.0093	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	0.0093	Highest-A
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	0.0093	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	0.0093	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	0.0093	Highest-A
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	0.0093	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	0.0093	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.0093	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	0.0093	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	0.0093	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	0.0093	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	0.0093	Highest-A
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	0.0093	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	0.0093	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	0.0093	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	0.0093	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	0.0093	Moderately High-B
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.0009	Moderately High-B
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	0.0093	Moderately High-B
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.0009	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.0009	Moderately High-B
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.0009	Moderately High-B
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.0009	Moderately High-B
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.0009	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.0009	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.0009	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.0009	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.0009	Moderately High-B
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.0009	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.0009	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.0009	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.0009	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.0009	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.0009	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.0009	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.0009	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.0009	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.0009	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	0.0023	Moderate-C
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	0.0027	Moderate-C
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	0.0018	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.0009	Moderate-C
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	0.0011	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	38.6	0.0025	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	0.0023	Moderate-C
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.0008	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	35.6	0.0019	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	41.7	0.0018	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	0.0013	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	0.0013	Moderate-C
90287	Mill Creek-287	NP	Mill Creek	Zone B	41.7	0.0015	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	0.0011	Moderate-C
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	0.0008	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	0.0008	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	0.0010	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	0.0009	Moderate-C
90286	Pigeon Creek-286	NP	Pigeon Creek	Zone B	40.2	0.0013	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	30.2	0.0010	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	38.1	0.0011	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	27.1	0.0008	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	32.0	0.0009	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	0.0009	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	0.0008	Moderate-C
90285	Lesher Run-285	NP	Lesher Run	Zone B	41.2	0.0008	Moderate-C

Figure 2.2.4-6 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for *Cryptosporidium* in the Schuylkill River Watershed



Fecal Coliform

Table 2.2.4-5 shows the results of the ranking for fecal coliform. The Table indicates that sources are either stormwater runoff from agricultural or urbanized watersheds, and permitted discharges from wastewater treatment plants. Although both sources are represented in the high priority category (category A), the results suggest that periodic loading from stormwater is orders of magnitude higher than the loading from wastewater treatment plants. The table shows that during dry weather flows, wastewater loading is insignificant at the Belmont intake, but that during storm events, fecal coliform would be expected to increase by orders of magnitude. Another potentially significant source that could not be properly incorporated into this analysis are the 11 communities upstream with combined sewer overflow systems. The overflows of raw sewage during wet weather events were roughly estimated and compared to the other potentially significant sources. Based on this analysis, the CSO discharges from the communities of Bridgeport and Norristown would be considered to be potentially significant sources of highest protection priority (category A). The remaining 9 communities, including Minersville, Tamaqua, and Greater Pottsville in Schuylkill County would be considered moderate protection priority sites (category C) since they are much further away from the Belmont intake. Overall, there was a broad geographic distribution of potentially significant sources of fecal coliforms in the watershed. This may be due to the fact that die-off was not factored into the analysis. Figure 2.2.4-7 illustrates the priority point sources and subwatersheds for coliform in the Schuylkill River Watershed. The high priority subwatersheds are located along the Lower Schuylkill River and in the Wissahickon and Stony Creek watersheds.

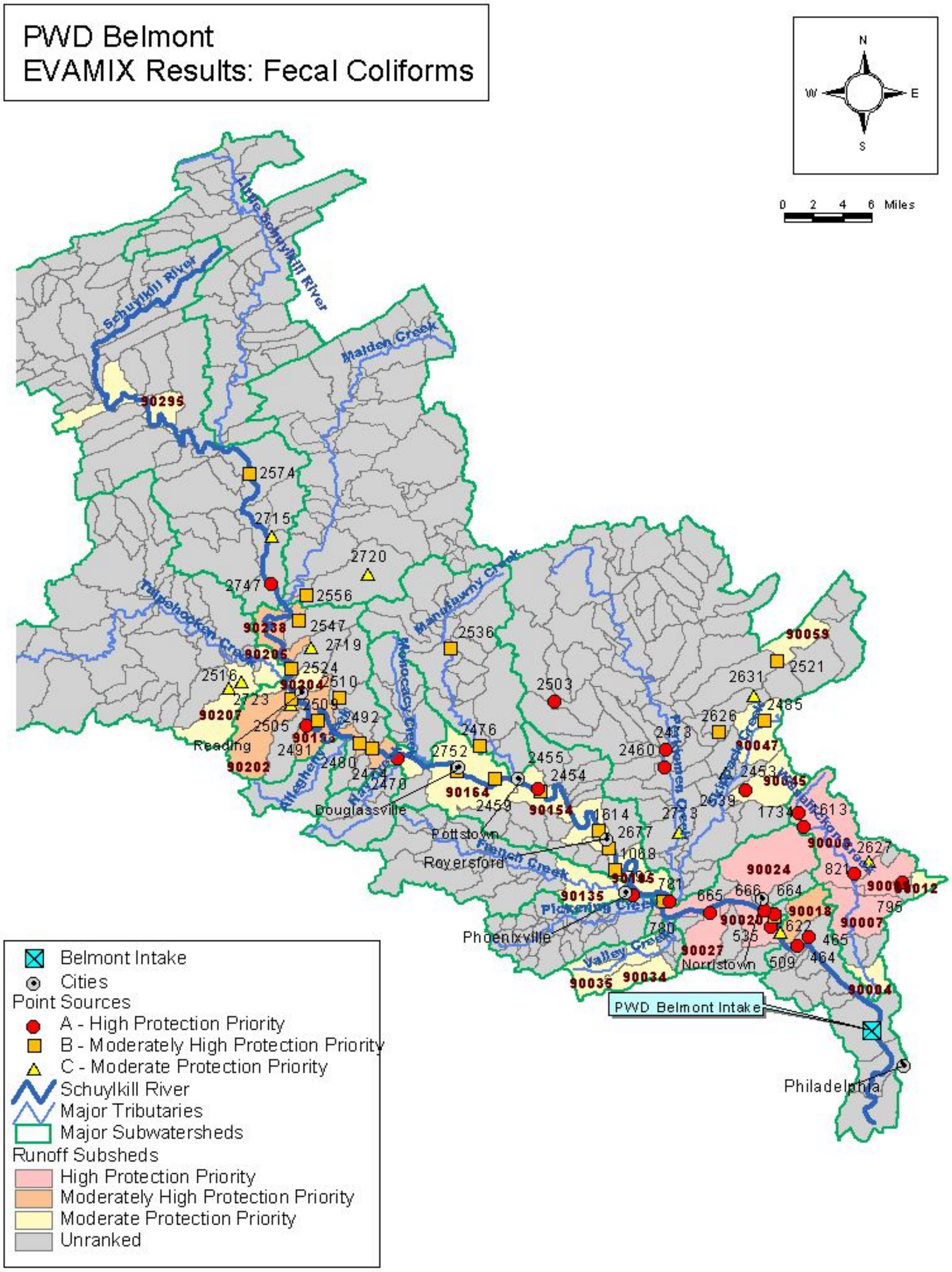
Table 2.2.4-5 Contaminant Ranking for Fecal Coliform

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	7.363	Highest-A
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	4.701	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	3.783	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	0.009	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	0.009	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	0.009	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	0.009	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	0.009	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	2.830	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	0.009	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	0.009	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	0.009	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.001	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	0.009	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.001	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	0.009	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	0.009	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	0.009	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	0.009	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	0.009	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.001	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.001	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	0.009	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	0.000	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.001	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	2.277	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	0.009	Moderately High-B
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	0.009	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.001	Moderately High-B
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	0.009	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	0.009	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	0.009	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.009	Moderately High-B
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	0.009	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.001	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.009	Moderately High-B
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.001	Moderately High-B
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	2.154	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.001	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	0.009	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.001	Moderately High-B
90027	Trout Creek-027	NP	Trout Creek	Zone A	9.0	2.052	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	0.009	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	0.009	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.001	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	0.009	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	5.5	1.730	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.001	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.001	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	0.009	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.001	Moderately High-B
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	2.267	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.001	Moderate-C
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.001	Moderate-C
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.001	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	2.218	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.001	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	0.009	Moderate-C
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.001	Moderate-C
90012	Sandy Run-012	NP	Sandy Run	Zone A	12.9	1.391	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.001	Moderate-C
90004	Wissahickon Creek-004	NP	Wissahickon Creek	Zone A	2.1	1.130	Moderate-C
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	17.0	1.626	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	32.0	1.946	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	1.835	Moderate-C
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	32.0	1.917	Moderate-C
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	1.483	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	12.1	1.378	Moderate-C
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	11.5	1.334	Moderate-C
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	13.2	1.355	Moderate-C
90135	French Creek-135	NP	French Creek	Zone B	13.1	1.170	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	1.264	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	1.321	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	1.298	Moderate-C
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	0.009	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	1.259	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.001	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	0.009	Moderate-C

Figure 2.2.4-7 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Fecal Coliform in the Schuylkill River Watershed



Metals

Table 2.2.4-6 provides the results of the heavy metal source ranking. Results generally show that NPDES permitted discharges are the primary sources. Some TRI sites with significant storage or use of metals are also rated as high priority sources, primarily because a catastrophic leak or spill would result in extremely high concentrations. Non-point sources from urbanized watersheds are generally a medium priority. Most of the TRI and AST sites fall into the moderate protection priority category (category C). However, it is important to note that acid mine drainage could not be included in this analysis and may be a more significant source than any of the other source categories (see section 2.1.5.4). Most sites were located in the watershed below Pottstown. However, a few sites were in the Reading and Upper Schuylkill areas. Figures 2.2.4-8 and 2.2.4-9 identify the priority point sources and subwatersheds for metals in the lower and upper parts of the Schuylkill River Watershed.

Table 2.2.4-6 Contaminant Category Ranking for Metals

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2339	ELECTRIC COIL SERVICE INC.	TRI	Laurel Run	Floodplain	35.1	1692328.8	Highest-A
2333	GENERAL BATTERY CORP. READING SMELTER DIV.	TRI	Bernhart Creek	Floodplain	34.0	488073.1	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	1.5	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	1.5	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	3.5	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	1.5	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	1.5	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	9.9	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	7.7	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	2.7	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	1.5	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.1	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	4.6	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.1	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.1	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	1.5	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	1.5	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.1	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.1	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	1.5	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	4.3	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	1.5	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	29.4	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.1	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	1.5	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.1	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	0.7	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.1	Highest-A
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.1	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	5.3	Highest-A
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.1	Highest-A
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	1.5	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	4.0	Moderately High-B
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	1.5	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	1.5	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch	Floodplain	17.5	0.1	Moderately

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
			Skippack Creek				High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	26.7	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.1	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	1.5	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.1	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	7.5	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.1	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	1.5	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.1	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	15.5	Moderately High-B
2231	ANCHOR GLASS CONTAINER CORP.	TRI	Schuylkill River	Zone B	16.0	112878.3	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.1	Moderately High-B
90004	Wissahickon Creek-004	NP	Wissahickon Creek	Zone A	2.1	0.4	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	1.5	Moderately High-B
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	2.4	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	1.5	Moderately High-B
2200	CHEMALLOY CO. INC.	TRI	Schuylkill River	Zone A	6.0	35154.3	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.1	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	1.0	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	5.5	0.6	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.93066025	0.9	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	1.5	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.1	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	1.2	Moderately High-B
756	PENN MED TECHNOLOGY	RCRA	Gulph Creek	Floodplain	5.5	0.0	Moderately High-B
2193	BETHLEHEM STEEL CORP. - LUKENS PLATE CONSHOHOCKEN DIV.	TRI	Plymouth Creek	Zone A	6.0	10339	Moderately High-B
467	EVER READY CLEANERS	RCRA	Schuylkill River	Floodplain	1.0	0.0	Moderately High-B
90027	Trout Creek-027	NP	Trout Creek	Zone A	9.0	0.7	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	1.6	Moderately High-B
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.7	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.1	Moderate-C
2215	YARWAY CORP.	TRI	Wissahickon Creek	Zone B	10.4	38677	Moderate-C
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	32.5	123314	Moderate-C
2352	DANA CORP. PARISH DIVISION	TRI	Schuylkill River	Zone B	32.5	144641	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.0	Moderate-C
90012	Sandy Run-012	NP	Sandy Run	Zone A	12.9	0.4	Moderate-C
1187	SPRING CITY FOUNDRY	RCRA	Schuylkill River	Floodplain	15.5	0.0	Moderate-C
2190	PHILADELPHIA GEAR CORP.	TRI	Crow Creek	Zone A	10.0	6107	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL	NPDES	Perkiomen Creek	Zone B	14.5	0.1	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
	INSTITUTE						
2225	HANDY & HARMAN TUBE CO INC	TRI	Stony Creek	Zone B	9.5	6642.4	Moderate-C
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	14.5	3469.3	Moderate-C
3353	NORRISTOWN FILTRATION PLT	AST	Schuylkill River	Zone A	7.0	9265.5	Moderate-C
2420	RAHNS SPECIALITY METALS	TRI	Perkiomen Creek	Zone B	15.0	3723.1	Moderate-C
2161	DAMASCUS - BISHOP TUBE CO. INC.	TRI	Little Valley Creek	Zone B	15.4	4273.1	Moderate-C
2240	PRECISION TUBE CO. INC	TRI	Wissahickon Creek	Zone B	15.4	3568.0	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Floodplain	22.4	6166.3	Moderate-C
2376	HEYCO METALS INC.	TRI	Schuylkill River	Floodplain	34.5	58103.3	Moderate-C
3321	COLORCON INC	AST	Wissahickon Creek	Zone B	14.8	40150.5	Moderate-C
2256	HAMMOND LEAD PRODUCTS	TRI	Schuylkill River	Zone B	22.4	15654.0	Moderate-C
2332	EXIDE CORP. READING SLI	TRI	Bernhart Creek	Floodplain	34.0	35434.3	Moderate-C
2353	BALDWIN HARDWARE MFG CORP	TRI	Schuylkill River	Zone B	31.0	11802.7	Moderate-C
2343	NGK METALS CORP.	TRI	Laurel Run	Floodplain	35.1	20465.9	Moderate-C
3411	BOYERTOWN WWTP	AST	Swamp Creek	Zone B	24.1	37062.0	Moderate-C
2356	CAMBRIDGE-LEE INDS. READING TUBE DIV.	TRI	Schuylkill River	Zone B	36.6	15795.1	Moderate-C
2330	YUASA EXIDE INC	TRI	Bernhart Creek	Zone B	34.5	5486.0	Moderate-C
2366	BRUSH WELLMAN INC.	TRI	Schuylkill River	Zone B	39.7	17223.7	Moderate-C
2328	CAN CORP. OF AMERICA INC.	TRI	Willow Creek	Zone B	39.1	3761.2	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	33.5	18531.0	Moderate-C
2375	PENNSYLVANIA STEEL FNDY. & MACHINE CO.	TRI	Schuylkill River	Zone B	43.3	7429.3	Moderate-C

Figure 2.2.4-8 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Metals in the Lower Schuylkill River Watershed

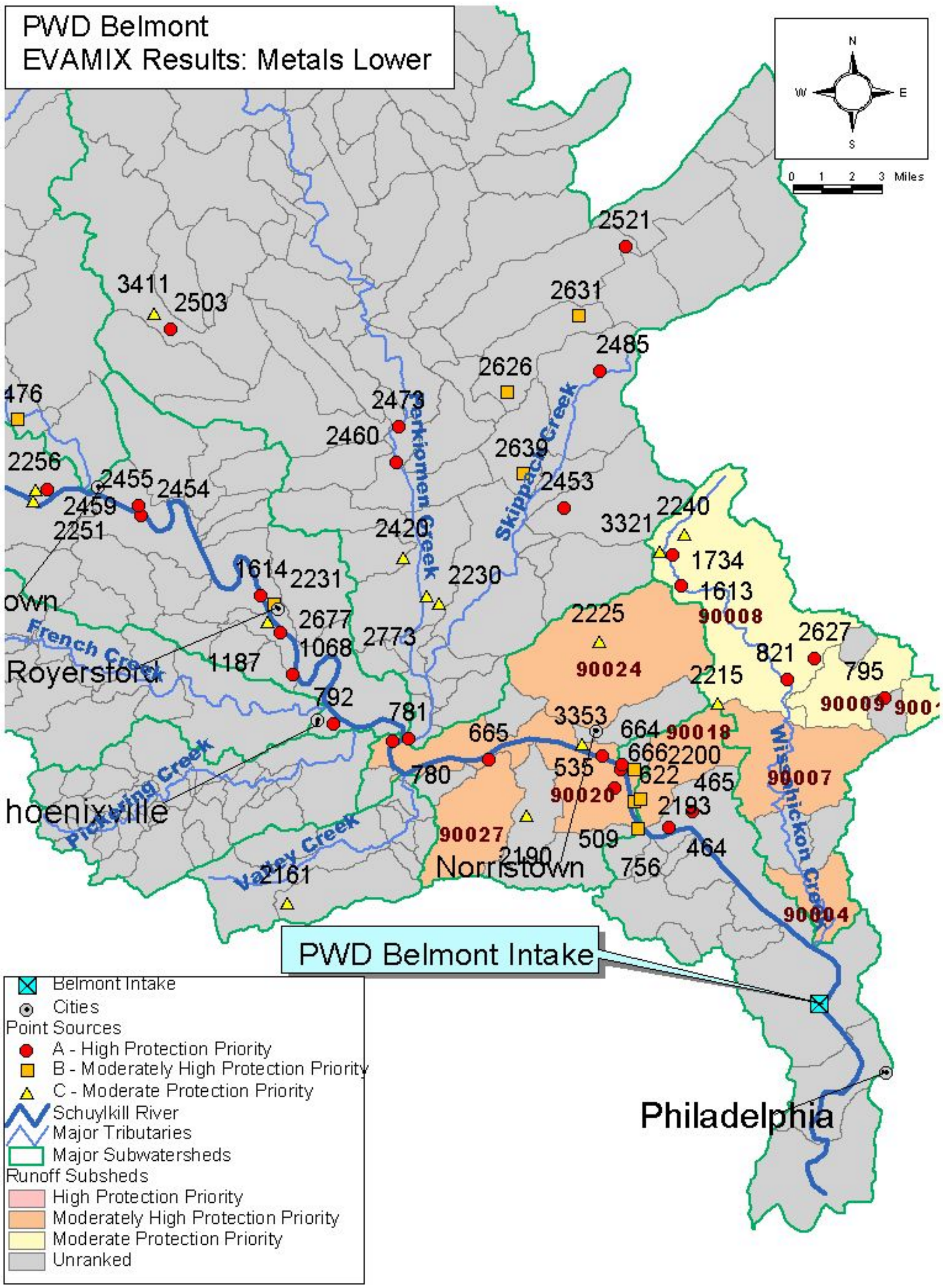
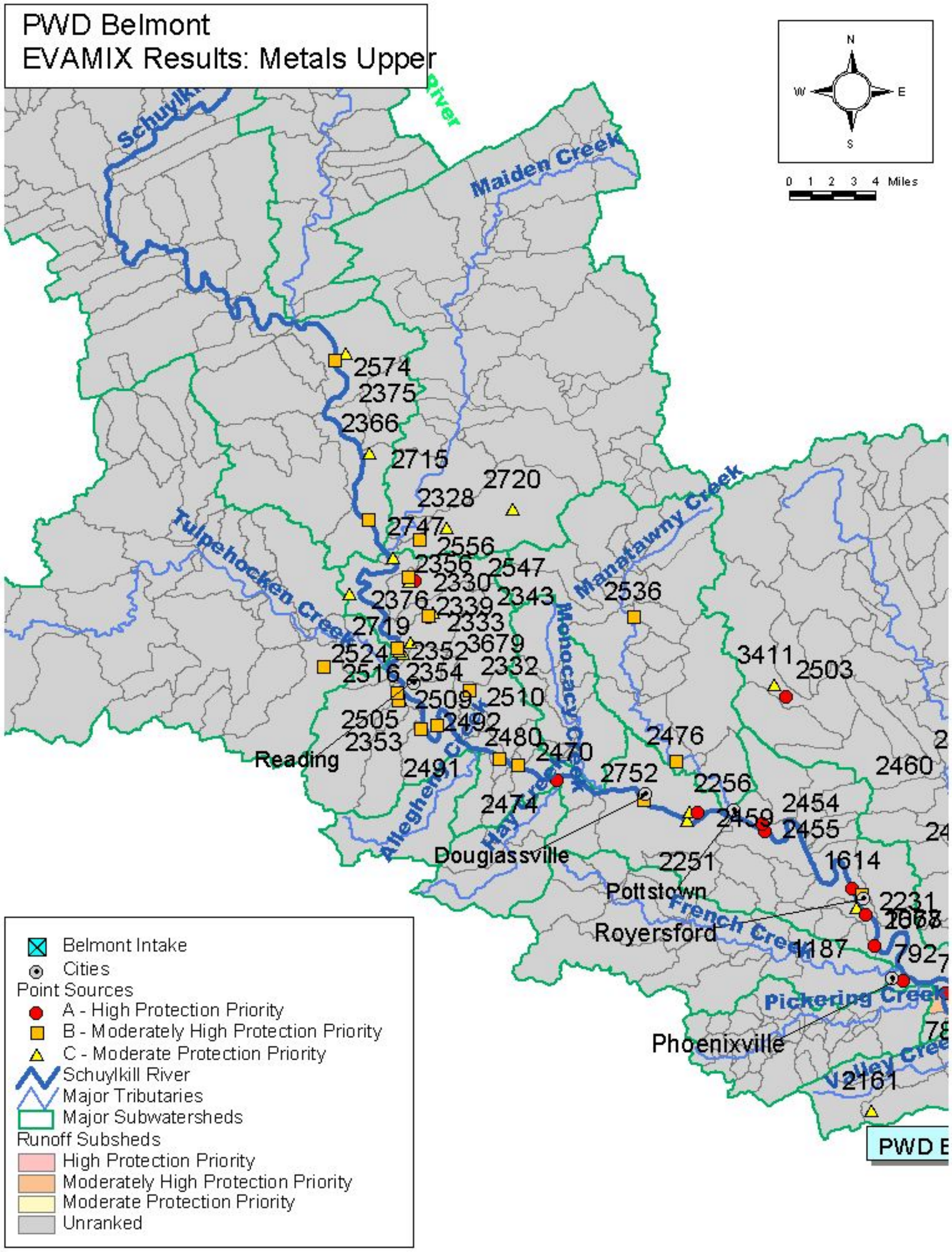


Figure 2.2.4-9 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Metals in the Upper Schuylkill Watershed



Nitrates

Table 2.2.4-7 shows the ranking of sites for nitrate loading. The high category (category A) is dominated by NPDES dischargers, primarily wastewater treatment plants. Most of the loading from these sites appears to be relatively low, and is not likely to cause a cumulative impact that would cause an exceedance of the nitrate standard at the intake. Moderate priority sites (category C) are a mixture of NPDES sites, TRI sites, and non-point runoff from storm water. Only nine of the 81 potentially significant sources were located within the five-hour time of travel (zone A). Therefore, efforts to reduce nitrate impacts will be necessary watershed wide. Figures 2.2.4-10 and 2.2.4-11 illustrate the priority point sources and subwatersheds for nitrates in the lower and upper Schuylkill River watersheds.

Table 2.2.4-7 Contaminant Category Ranking for Nitrates

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	14.5	636.6	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	130.2	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	1.6	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	5.5	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	3.1	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	2.5	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	0.8	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	2.6	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	0.3	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	0.5	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	1.0	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	3.9	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.0	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.0	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	2.1	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.0	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	3.0	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.0	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.0	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	1.3	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	1.3	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	1.4	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	0.1	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.0	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	9.0	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	1.5	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	0.3	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.0	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.0	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.0	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	2.0	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.0	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.1	Moderately

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
							High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	0.1	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.0	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	0.1	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	2.3	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.0	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.1	Moderately High-B
2189	METLAB CO	TRI	Cresheim Creek	Zone B	5.3	42.5	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.0	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.0	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	0.3	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.0	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	0.1	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.0	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	0.1	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	0.1	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.0	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	1.0	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.0	Moderately High-B
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	0.1	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.0	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	0.1	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	0.0	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.0	Moderate-C
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	0.1	Moderate-C
2154	TASTYKAKE BAKING CO.	TRI	Schuylkill River	Zone B	1.0	0.2	Moderate-C
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	0.1	Moderate-C
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.0	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.0	Moderate-C
2192	CHEF FRANCISCO OF PA	TRI	Crow Creek	Zone B	9.5	0.2	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	24.6	19.0	Moderate-C
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Floodplain	20.0	0.4	Moderate-C
2183	JOHNSON MATTHEY CSDNA	TRI	Trout Creek	Zone B	10.5	0.1	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	0.0	Moderate-C
2179	ALEX C. FERGUSSON INC.	TRI	Valley Creek	Zone B	14.8	0.2	Moderate-C
2221	NOVARTIS CONSUMER HEALTH INC.	TRI	Sandy Run	Zone B	15.4	0.1	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	0.0	Moderate-C
2422	ROSENBERGERS DAIRIES INC.	TRI	Skippack Creek	Zone B	18.5	0.3	Moderate-C
2272	H. W. LONGACRE INC.	TRI	Skippack Creek	Zone B	19.0	0.3	Moderate-C
2273	WAMPLER-LONGACRE INC.	TRI	Skippack Creek	Zone B	19.0	0.3	Moderate-C
2415	MOYER PACKING CO.	TRI	Skippack Creek	Zone B	19.0	0.3	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	0.11	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	0.06	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	27.2	0.51	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	0.05	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	27.1	0.04	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	27.8	0.05	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	0.07	Moderate-C
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Floodplain	34.0	0.14	Moderate-C
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	32.5	3.61	Moderate-C

Figure 2.2.4-10 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Nitrates in the Lower Schuylkill Watershed

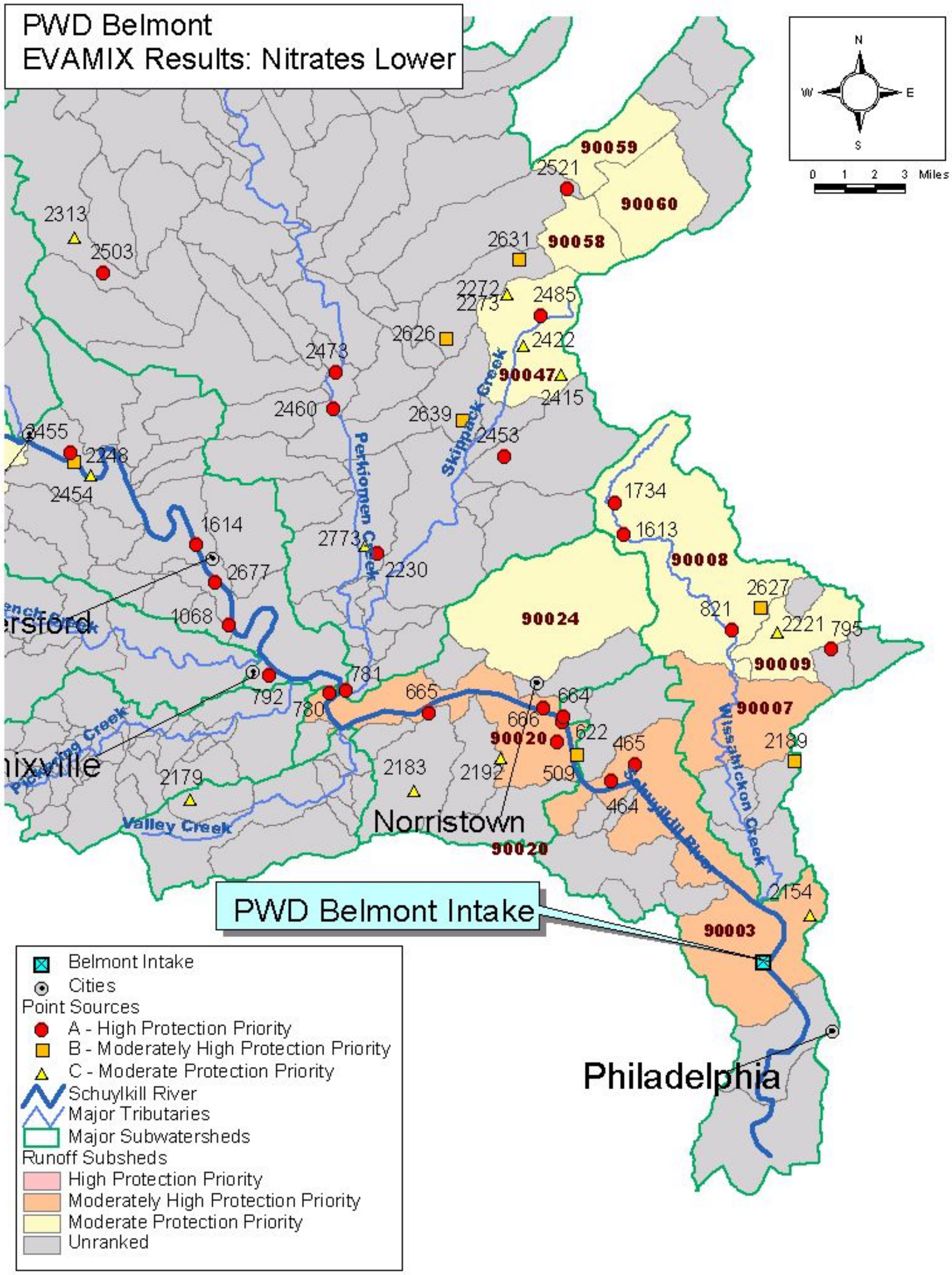
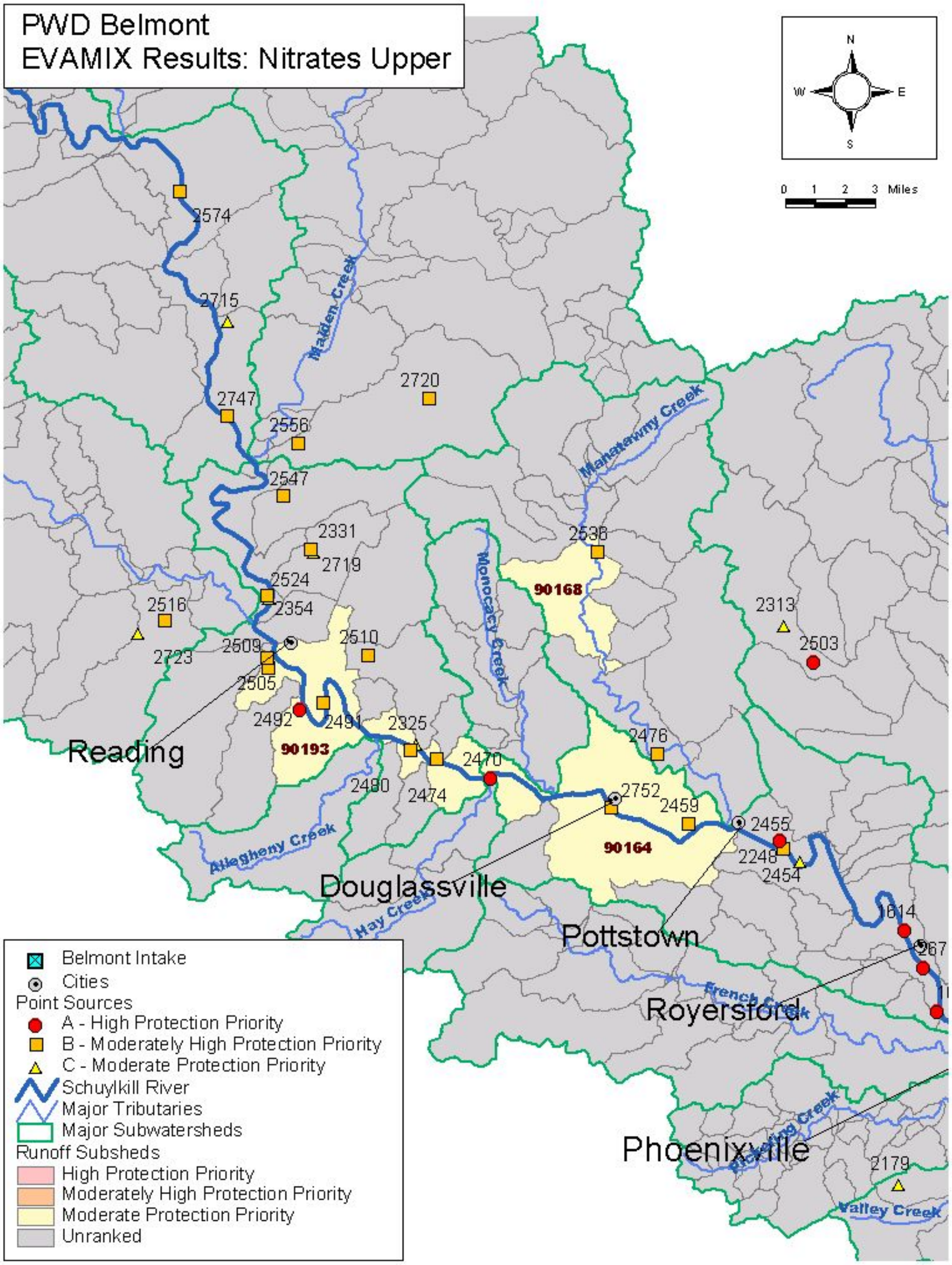


Figure 2.2.4-11 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Nitrates in the Upper Schuylkill Watershed



Petroleum Hydrocarbons

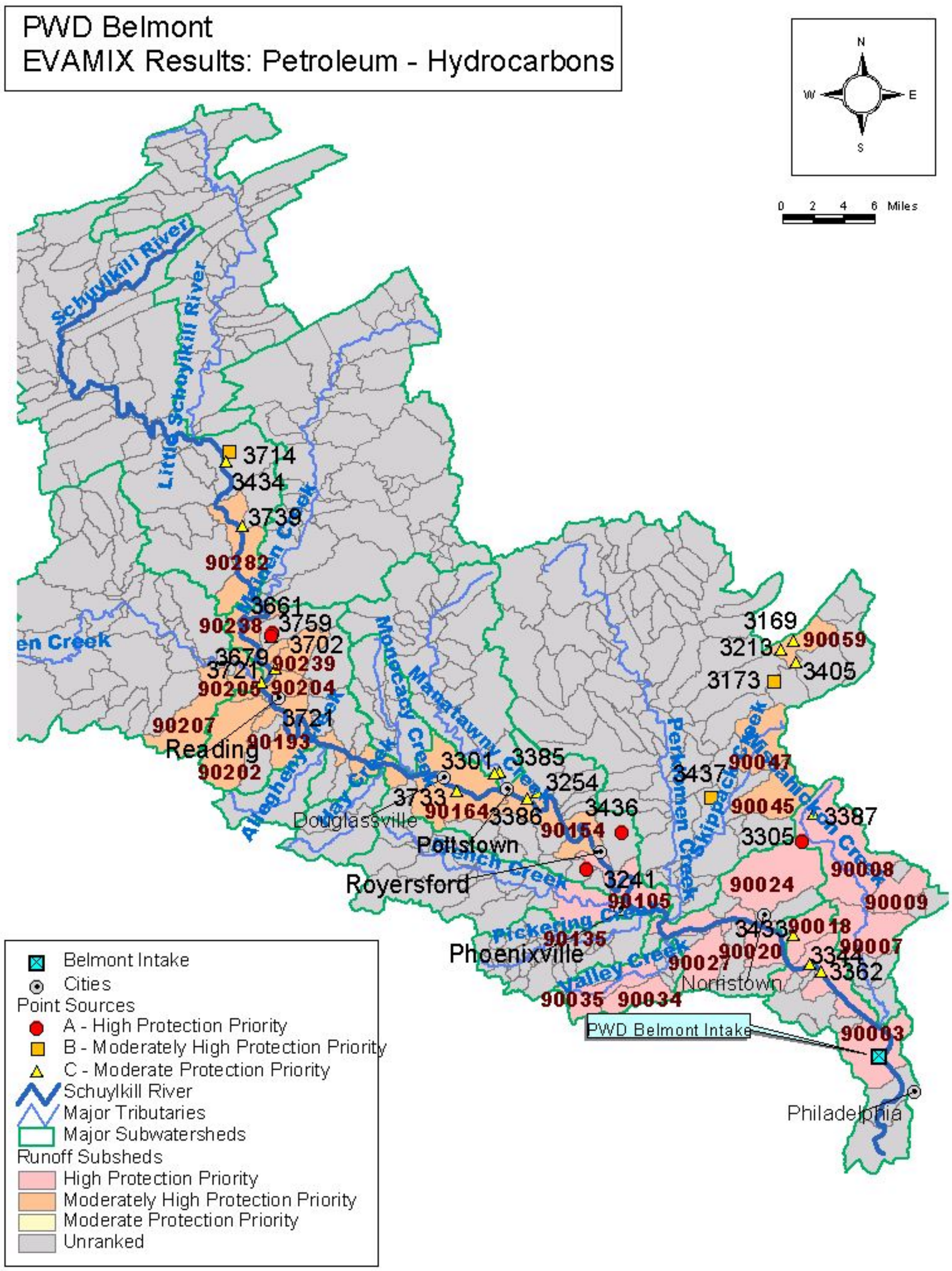
There were a limited number of significant sources of petroleum hydrocarbons, as shown in Table 2.2.4-8. Only above ground storage tanks containing fuel, or stormwater runoff were identified as significant potential sources of petroleum hydrocarbon loading. Most of the high priority sites are either fuel storage facilities (with a low probability of release but potentially very high concentrations), or stormwater runoff with lower concentrations but frequent occurrence. All of the potentially significant sources of AST identified were in Zone B, the 5 to 25 hour time of travel range. Twelve non-point source runoff subwatersheds were identified as potentially significant sources of high protection priority. Figure 2.2.4-12 illustrates the priority point sources and subwatersheds for petroleum hydrocarbons in the Schuylkill River watershed. Most of the high priority subwatersheds are located in the lower portion of the watershed, including Wissahickon, Stony, Trout, Valley, and French Creeks.

Table 2.2.4-8 Contaminant Category Ranking for Petroleum Hydrocarbons

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3702	BERKS FUEL STORAGE CO INC	AST	Laurel Run	Zone B	34.5	741240	Highest-A
3241	PLOTTS OIL BULK PLT	AST	Stony Run	Zone B	16.0	312247	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	3	Highest-A
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	5.5	2	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	2	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	2	Highest-A
90027	Trout Creek-027	NP	Trout Creek	Zone A	9.0	2	Highest-A
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	3	Highest-A
3305	REIT FUEL OIL CO BLUE BELL	AST	Stony Creek	Zone B	11.0	185310	Highest-A
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	2	Highest-A
3759	COLUMBIA PETRO	AST	Laurel Run	Zone B	34.5	234977	Highest-A
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	6	Highest-A
3436	OEH LERT Bros. Fuel Oil	AST	Mingo Creek	Zone B	16.5	185310	Highest-A
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	11.5	1	Highest-A
90035	Valley Creek-035	NP	Valley Creek	Zone B	12.1	1	Highest-A
90135	French Creek-135	NP	French Creek	Zone B	13.1	1	Highest-A
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	13.2	1	Highest-A
3173	FARM AND HOME OIL CO. INC.	AST	Mill Creek	Zone B	27.7	185310	Moderately High-B
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	1	Moderately High-B
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	17.0	1	Moderately High-B
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	1	Moderately High-B
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	1	Moderately High-B
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	2	Moderately High-B
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	1	Moderately High-B
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	43.3	188135	Moderately High-B
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	32.0	1	Moderately High-B
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	32.0	2	Moderately High-B
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	2	Moderately

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
							High-B
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	1	Moderately High-B
90239	Bernhart Creek-239	NP	Bernhart Creek	Zone B	33.5	1	Moderately High-B
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	1	Moderately High-B
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	1	Moderately High-B
3437	ROBERT MARSHALL INC	AST	Skippack Creek	Zone B	16.5	85243	Moderately High-B
3301	FARM & HOME OIL CO	AST	Manatawny Creek	Zone B	22.4	92655	Moderate-C
3733	COLUMBIA PETRO CORP	AST	Schuylkill River	Zone B	22.9	92655	Moderate-C
3433	JAY GRESS INC	AST	Plymouth Creek	Zone B	6.5	55593	Moderate-C
3213	HESTON S SWARTLEY TRANS CO INC	AST	East Branch Perkiomen Creek	Zone B	27.1	92655	Moderate-C
3362	LONZA INC.	AST	Schuylkill River	Zone A	4.0	9266	Moderate-C
3344	QUAKER CHEMICAL CORP.	AST	Schuylkill River	Zone A	4.5	9266	Moderate-C
3387	DE WALKER & SON INC	AST	Wissahickon Creek	Zone B	15.4	46328	Moderate-C
3739	SANTILLI OIL CO INC	AST	Pigeon Creek	Floodplain	40.2	69121	Moderate-C
3721	GOSHERTS QUALITY FUELS	AST	Schuylkill River	Floodplain	32.5	46328	Moderate-C
3254	OCCIDENTAL CHEMICAL CORP.	AST	Sprogles Run	Zone B	20.0	42621	Moderate-C
3386	EDWARD J SWEENEY & SONS	AST	Schuylkill River	Zone B	20.5	29279	Moderate-C
3169	M & S OIL	AST	East Branch Perkiomen Creek	Zone B	27.7	18531	Moderate-C
3385	WALTER F SCHWAB CO	AST	Manatawny Creek	Zone B	22.4	4633	Moderate-C
3405	WH KNEAS LUMBER CO	AST	East Branch Perkiomen Creek	Zone B	27.1	4633	Moderate-C
3661	KOCH MATERIALS CO.	AST	Laurel Run	Zone B	34.5	18531	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	33.5	4633	Moderate-C
3714	ES SAVAGE INC	AST	Schuylkill River	Zone B	43.3	9266	Moderate-C

Figure 2.2.4-12 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Petroleum Hydrocarbons in the Schuylkill River Watershed



Phosphorus

Table 2.2.4-9 shows the ranking of sites for phosphorus loading. Like nitrates, the high protection priority category (category A) is dominated by NPDES dischargers, primarily wastewater treatment plants. Most of the loading from these sites appears to be relatively low, and is not likely to cause a cumulative impact that would cause significant water quality impairment at the intake. There are a few very large industrial sites that are also included in the high category, primarily due to the high potential concentrations should a spill occur. Moderate priority sites are mainly a mixture of TRI sites and non-point runoff from stormwater. A large majority of the potentially significant sources were located in the drainage areas along the mainstem Schuylkill River. Figures 2.2.4-13 and 2.2.4-14 illustrate the priority point sources and subwatersheds for phosphorous in the lower and upper Schuylkill River Watersheds.

Table 2.2.4-9 Contaminant Category Ranking for Phosphorus

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	33.5	2316.38	Highest-A
2434	RICHARDSAPEX INC.	TRI	Schuylkill River	Zone A	2.0	892.00	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	0.93	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	0.93	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	0.93	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	0.93	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	0.93	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	0.93	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	0.93	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	0.93	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	0.93	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	0.93	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.16	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.15	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.15	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	0.93	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	0.93	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.15	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	13.15	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.15	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	0.93	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	4.20	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.15	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	0.93	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	3.44	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	0.93	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.15	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	5.70	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.15	Highest-A
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.15	Highest-A
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.15	Highest-A
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	0.93	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.93	Moderately High-B
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	0.93	Moderately

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
							High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	0.93	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.15	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	0.93	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.15	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	0.93	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.15	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.93	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.15	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	0.93	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.15	Moderately High-B
2225	HANDY & HARMAN TUBE CO INC	TRI	Stony Creek	Zone B	9.5	176.28	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	0.93	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.15	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	0.93	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.15	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	0.93	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	0.93	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.15	Moderately High-B
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Floodplain	4.5	40.19	Moderately High-B
2191	LONZA INC.	TRI	Schuylkill River	Floodplain	5.5	3.53	Moderately High-B
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	1.46	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.15	Moderately High-B
2158	NAMICO INC.	TRI	Schuylkill River	Floodplain	2.0	7.58	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	0.65	Moderately High-B
2171	SIMPSON PAPER CO.	TRI	Schuylkill River	Floodplain	3.5	14.10	Moderately High-B
2156	ALPHACHEM INC. EASTERN BLENDING CENTER	TRI	Schuylkill River	Zone A	1.0	10.58	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.15	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	1.25	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	1.56	Moderately High-B
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.60	Moderately High-B
2228	HENKEL CORP.	TRI	Wissahickon Creek	Zone B	11.6	35.26	Moderate-C
2199	RESCO PRODS. INC.	TRI	Schuylkill River	Zone A	6.0	11.54	Moderate-C
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	4.5	4.87	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.15	Moderate-C
2218	LEHIGH VALLEY DAIRIES INC.	TRI	Sandy Run	Floodplain	13.5	21.15	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	18.0	0.62	Moderate-C
2179	ALEX C. FERGUSSON INC.	TRI	Valley Creek	Zone B	14.8	17.63	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	14.8	3.70	Moderate-C
2244	SERMATECH INTL. INC.	TRI	Mingo Creek	Zone B	17.5	14.46	Moderate-C
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	27.2	15.87	Moderate-C
2249	TUSCAN LEHIGH DAIRIES L.P.	TRI	Towamencin Creek	Zone B	19.5	3.53	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	0.63	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	0.71	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	27.1	0.67	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	0.93	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	27.8	0.77	Moderate-C
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Floodplain	34.0	6.70	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	1.12	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	30.2	0.83	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	0.88	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	0.62	Moderate-C
2324	ATOFINA CHEMICALS INC.	TRI	Schuylkill River	Zone B	26.7	2.64	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	0.70	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	35.6	1.27	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	1.77	Moderate-C
2395	EAGLE CHEMICAL CO.	TRI	Schuylkill River	Zone B	34.0	21.15	Moderate-C
2361	INDUSTRIAL METAL PLATING INC.	TRI	Schuylkill River	Zone B	33.5	17.63	Moderate-C
90208	Little Cacoosing Creek-208	NP	Little Cacoosing Creek	Zone B	37.7	0.64	Moderate-C
2370	PREMIUM BEVERAGE PACKERS INC.	TRI	Schuylkill River	Zone B	32.0	2.12	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	38.1	1.15	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	38.6	1.91	Moderate-C
2368	MISCO PRODS. CORP.	TRI	Schuylkill River	Zone B	33.5	7.40	Moderate-C

Figure 2.2.4-13 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Phosphorus in the Lower Schuylkill River Watershed

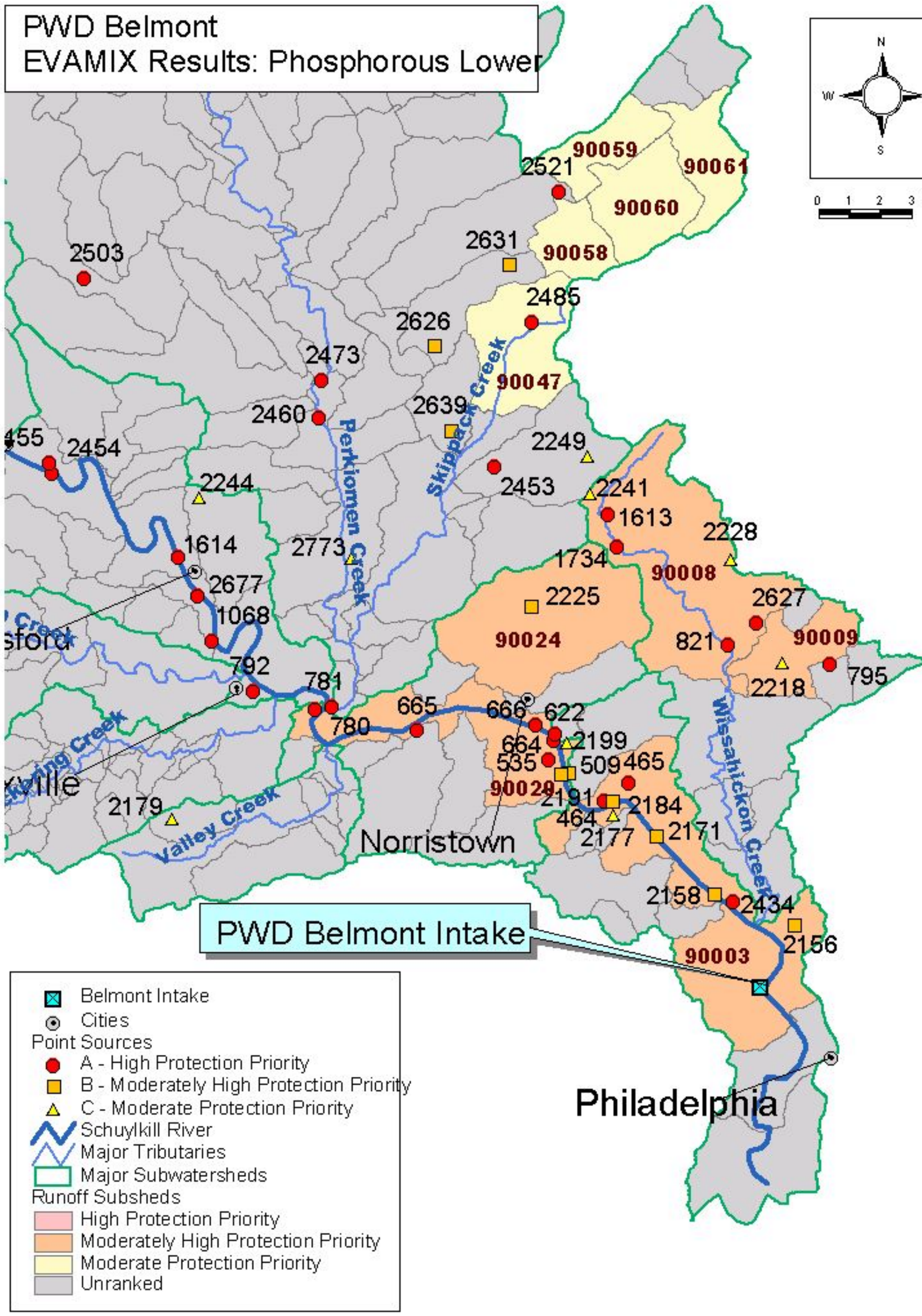
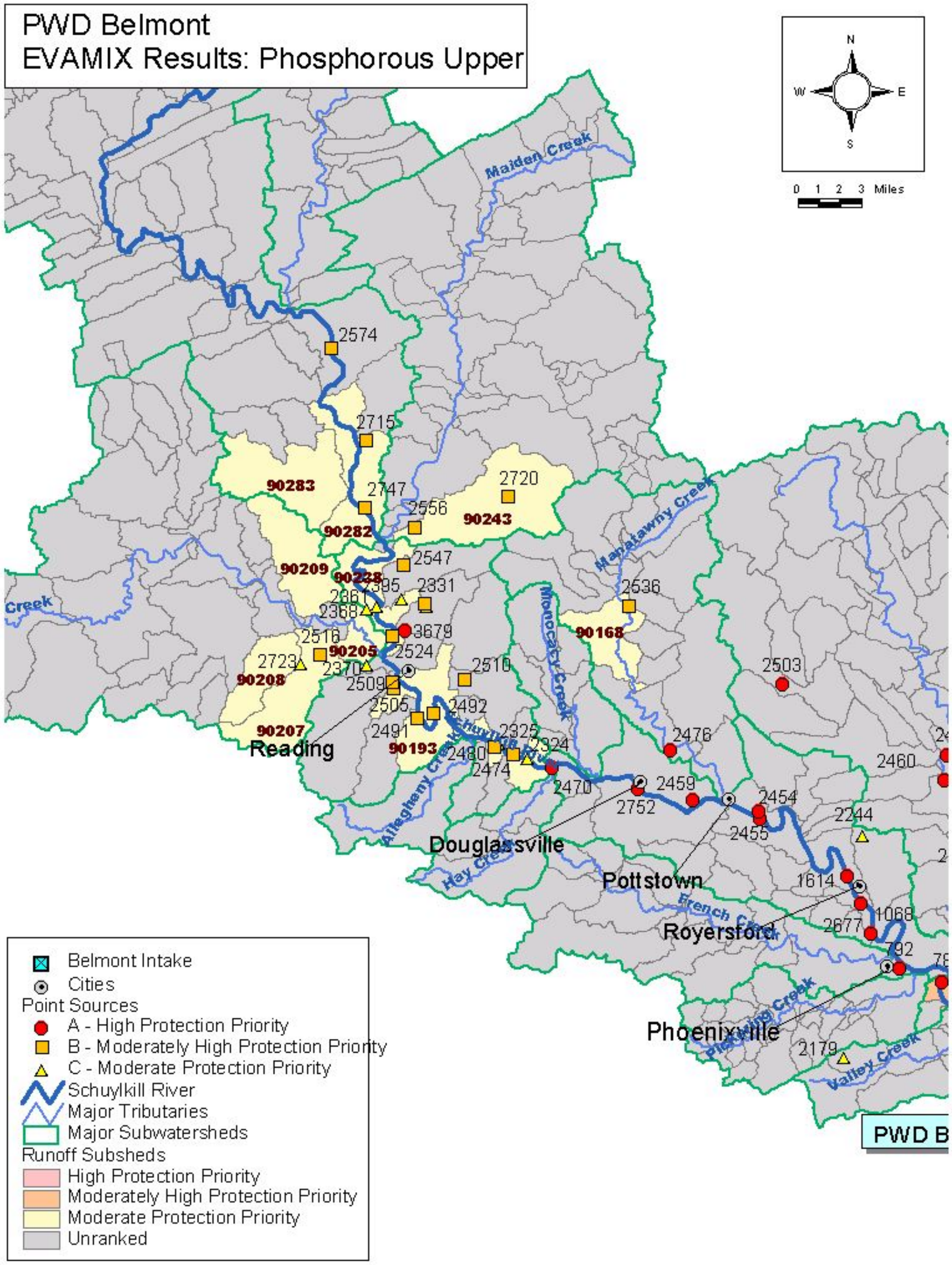


Figure 2.2.4-14 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Phosphorus in the Upper Schuylkill River Watershed



Disinfection By-Product (Total Organic Carbon)

Table 2.2.4-10 provides the results of the ranking of potential sources of total organic carbon (TOC). In this case, all of the high protection priority sites (category A) are NPDES discharges from wastewater treatment plants. In general, NPS sites appear to have a lower total load and impact on water quality than do the NPDES sites. TRI and AST sites are all found in the low priority category. Figures 2.2.4-15 and 2.2.4-16 illustrate the priority point sources and subwatersheds for total organic carbon in the lower and upper Schuylkill River watersheds.

Table 2.2.4-10 Contaminant Category Ranking for Total Organic Carbon (Disinfection By-product Surrogate)

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	143.04	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	18.07	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	14.97	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	20.80	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	10.43	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	6.42	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	6.98	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	12.69	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	8.63	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	9.59	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	6.20	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	5.16	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	3.52	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	6.28	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	9.36	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	4.45	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.17	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.17	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.17	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	1.71	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	1.71	Highest-A
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	5.78	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.17	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.17	Highest-A
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	9.58	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.17	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	0.71	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	0.41	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.17	Highest-A
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	1.71	Highest-A
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	1.71	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.17	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.53	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	1.71	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.17	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.17	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	1.71	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.17	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.17	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	1.15	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.17	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.17	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	1.71	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.17	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.17	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	1.71	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.17	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	1.71	Moderately High-B
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	2.92	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.17	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.17	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.17	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	5.5	1.27	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	5.5	0.74	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	5.9	0.90	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	2.10	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	1.52	Moderately High-B
3158	CROMBY GENERATING STATION	AST	Schuylkill River	Floodplain	14.5	10.30	Moderately High-B
90027	Trout Creek-027	NP	Trout Creek	Zone A	9.0	0.88	Moderate-C
2171	SIMPSON PAPER CO.	TRI	Schuylkill River	Floodplain	3.5	0.10	Moderate-C
90009	Sandy Run-009	NP	Sandy Run	Zone A	9.7	0.94	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.17	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	12.1	0.75	Moderate-C
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	16.0	0.69	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	0.73	Moderate-C
2229	AJAX/ACORN STAMPING & MFG INC.	TRI	Perkiomen Creek	Zone B	14.5	0.24	Moderate-C
2236	COLORCON INC	TRI	Wissahickon Creek	Zone B	14.8	0.20	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Floodplain	22.4	0.87	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	14.8	0.02	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	1.71	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	1.10	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	24.6	0.24	Moderate-C
2268	MOYER PACKING CO.	TRI	Skippack Creek	Zone B	19.0	0.47	Moderate-C
2267	HATFIELD QUALITY MEATS INC.	TRI	Skippack Creek	Zone B	18.5	0.13	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	0.78	Moderate-C
2249	TUSCAN LEHIGH DAIRIES L.P.	TRI	Towamencin Creek	Zone B	19.5		Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	0.67	Moderate-C
2337	CITY OF READING WASTEWATER TREATMENT PLANT	TRI	Schuylkill River	Floodplain	30.1	0.94	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	1.14	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	32.0	0.80	Moderate-C
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	32.0	0.77	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	0.67	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	0.69	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	35.6	0.65	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	1.04	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	38.1	0.83	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	38.6	0.79	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	41.7	1.02	Moderate-C
90287	Mill Creek-287	NP	Mill Creek	Zone B	41.7	0.69	Moderate-C
2329	GIORGIO FOODS INC.	TRI	Willow Creek	Zone B	39.1	0.003	Moderate-C
2378	MID ATLANTIC CANNERS ASSOC.	TRI	Schuylkill River	Zone B	42.8	0	Moderate-C

Figure 2.2.4-15 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for TOC in the Lower Schuylkill River Watershed

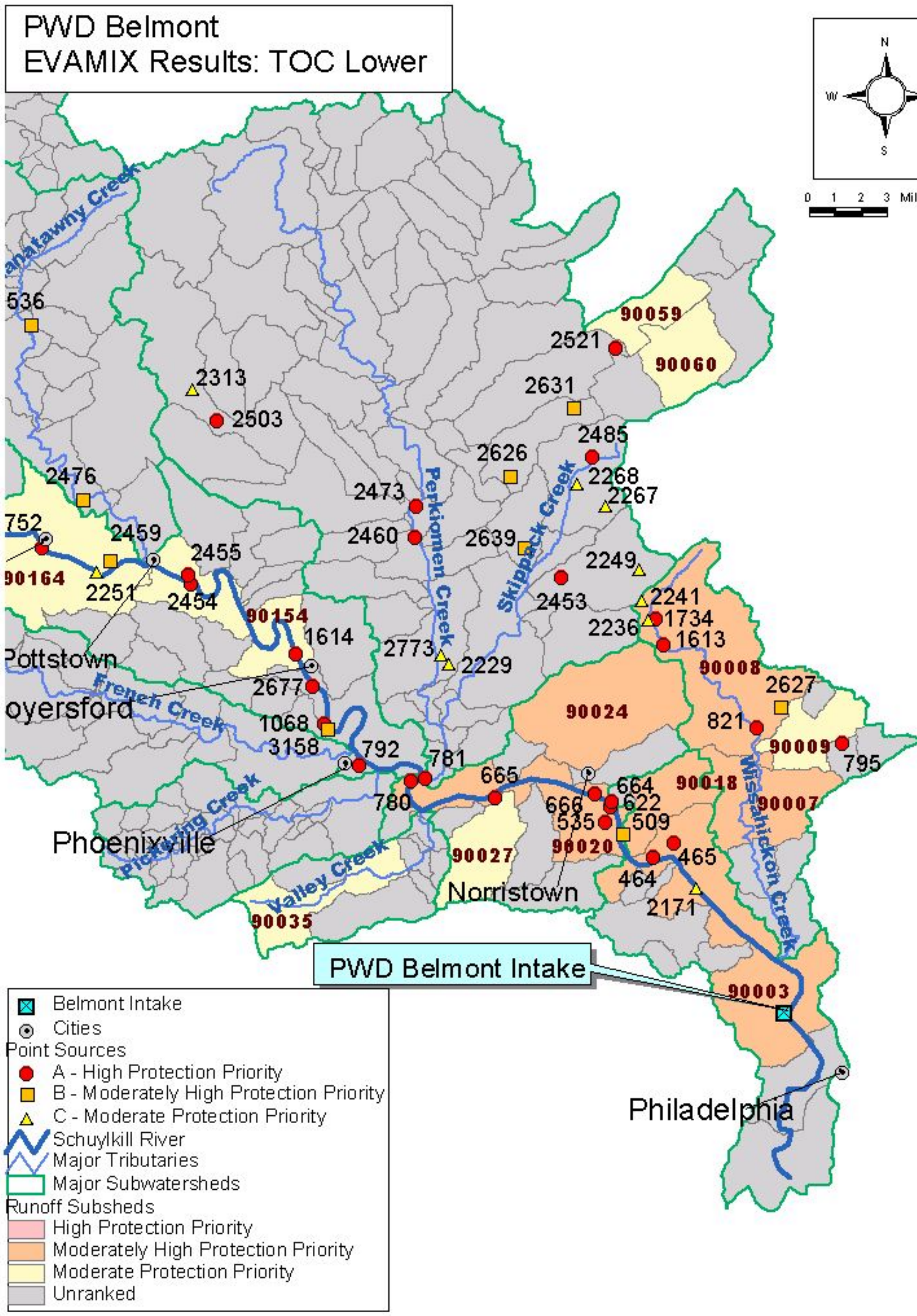
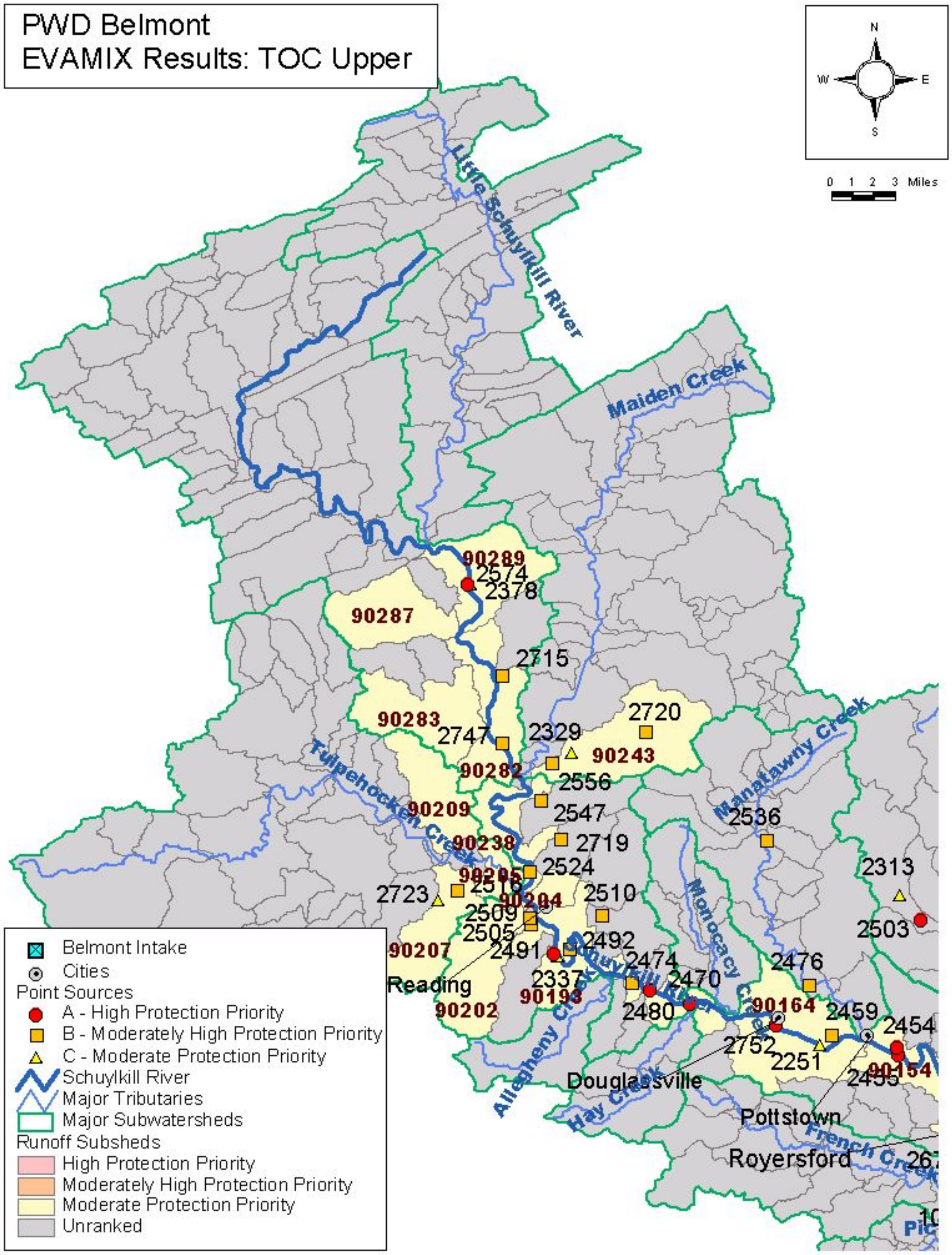


Figure 2.2.4-16 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for TOC in the Upper Schuylkill River Watershed



Turbidity *(Total Suspended Solids)*

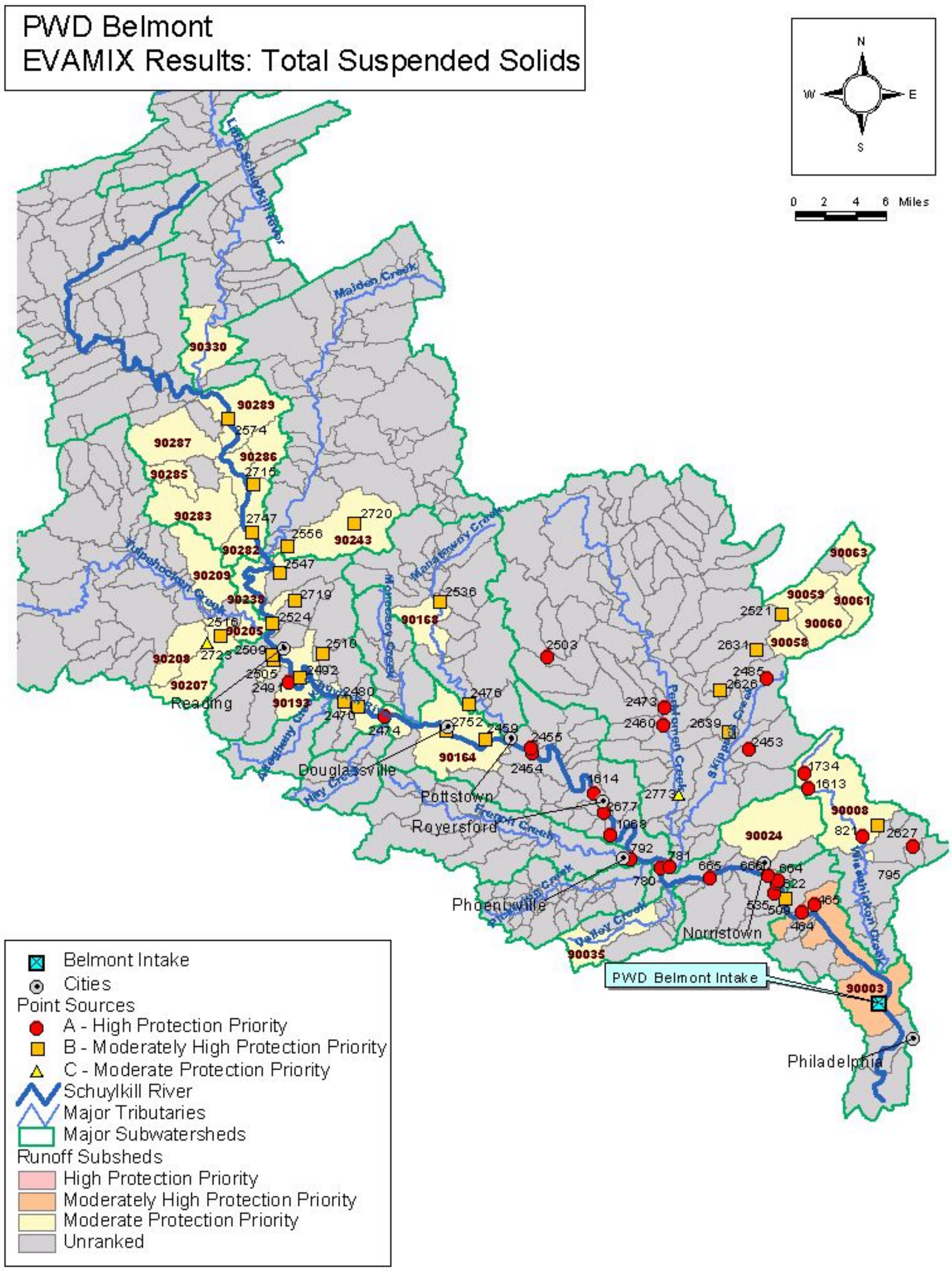
Turbidity was analyzed using total suspended solids (TSS) as a surrogate. Table 2.2.4 – 11 provides the results of the final ranking of turbidity sources. Only stormwater runoff and NPDES discharges were identified as potentially significant sources of TSS. The stormwater runoff (NPS sites) tends to show much higher loading with less frequency. The NPDES sites have lower rates of TSS loading, however, they are more constant discharges. Loading rates from non-point sources appear high enough to cause concern for cumulative impacts at the intake during storm events. Figure 2.2.4-17 illustrates the priority point sources and subwatersheds for total suspended solids Schuylkill River watersheds.

Table 2.2.4-11 Contaminant Category Ranking for Total Suspended Solids

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Floodplain	6.5	891.44	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Floodplain	11.5	16.00	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	4.5	1.67	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Floodplain	6.5	11.78	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	4.5	9.19	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	30.5	61.48	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	9.7	12.22	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	7.53	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	12.3	6.08	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	6.0	2.22	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	25.32	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	2.32	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	11.0	11.12	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Floodplain	6.5	0.03	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Floodplain	14.2	0.03	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Floodplain	17.6	0.03	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	12.5	1.16	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Floodplain	24.1	1.02	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	17.5	1.55	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Floodplain	17.1	0.03	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Floodplain	15.5	0.03	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Floodplain	16.0	0.52	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Floodplain	14.5	0.03	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Floodplain	25.8	1.19	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	19.5	1.14	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Floodplain	20.5	0.03	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Floodplain	26.4	2.75	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.03	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Floodplain	26.7	4.00	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	9.7	0.03	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	29.6	1.98	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Floodplain	24.1	0.03	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	0.06	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Floodplain	23.8	0.98	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	32.0	2.69	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Floodplain	17.5	0.03	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.14	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	21.5	0.03	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Floodplain	38.1	0.03	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Floodplain	30.8	0.03	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	29.6	0.26	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	24.6	0.03	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	0.14	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	42.8	2.50	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	31.0	0.03	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	38.6	0.03	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	5.5	0.54	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	36.3	0.35	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Floodplain	34.0	0.03	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	41.7	0.06	Moderately High-B
90003	Schuylkill River-003	NP	Schuylkill River	Zone B	0.5	4.69	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	39.7	0.03	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	9.1	10.80	Moderate-C
90024	Stony Creek-024	NP	Stony Creek	Zone A	8.0	7.69	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	14.5	0.03	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	12.1	4.64	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	21.5	4.46	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Floodplain	37.0	0.51	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	26.2	4.77	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	28.3	8.03	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	27.1	4.38	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	27.1	4.27	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	27.8	4.82	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	30.2	6.40	Moderate-C
90063	East Branch Perkiomen Creek-063	NP	East Branch Perkiomen Creek	Zone B	30.8	4.28	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	32.5	6.76	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	32.5	4.47	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	35.6	11.02	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	37.1	13.34	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	38.6	15.75	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	34.9	4.23	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	38.1	7.23	Moderate-C
90208	Little Cacoosing Creek-208	NP	Little Cacoosing Creek	Zone B	37.7	4.62	Moderate-C
90286	Pigeon Creek-286	NP	Pigeon Creek	Zone B	40.2	7.96	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	41.7	10.45	Moderate-C
90287	Mill Creek-287	NP	Mill Creek	Zone B	41.7	10.26	Moderate-C
90285	Lesher Run-285	NP	Lesher Run	Zone B	41.2	5.36	Moderate-C
90330	Little Schuylkill River-330	NP	Little Schuylkill River	Zone B	46.1	5.39	Moderate-C

Figure 2.2.4-17 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for Total Suspended Solids in the Schuylkill River Watershed



VOCs

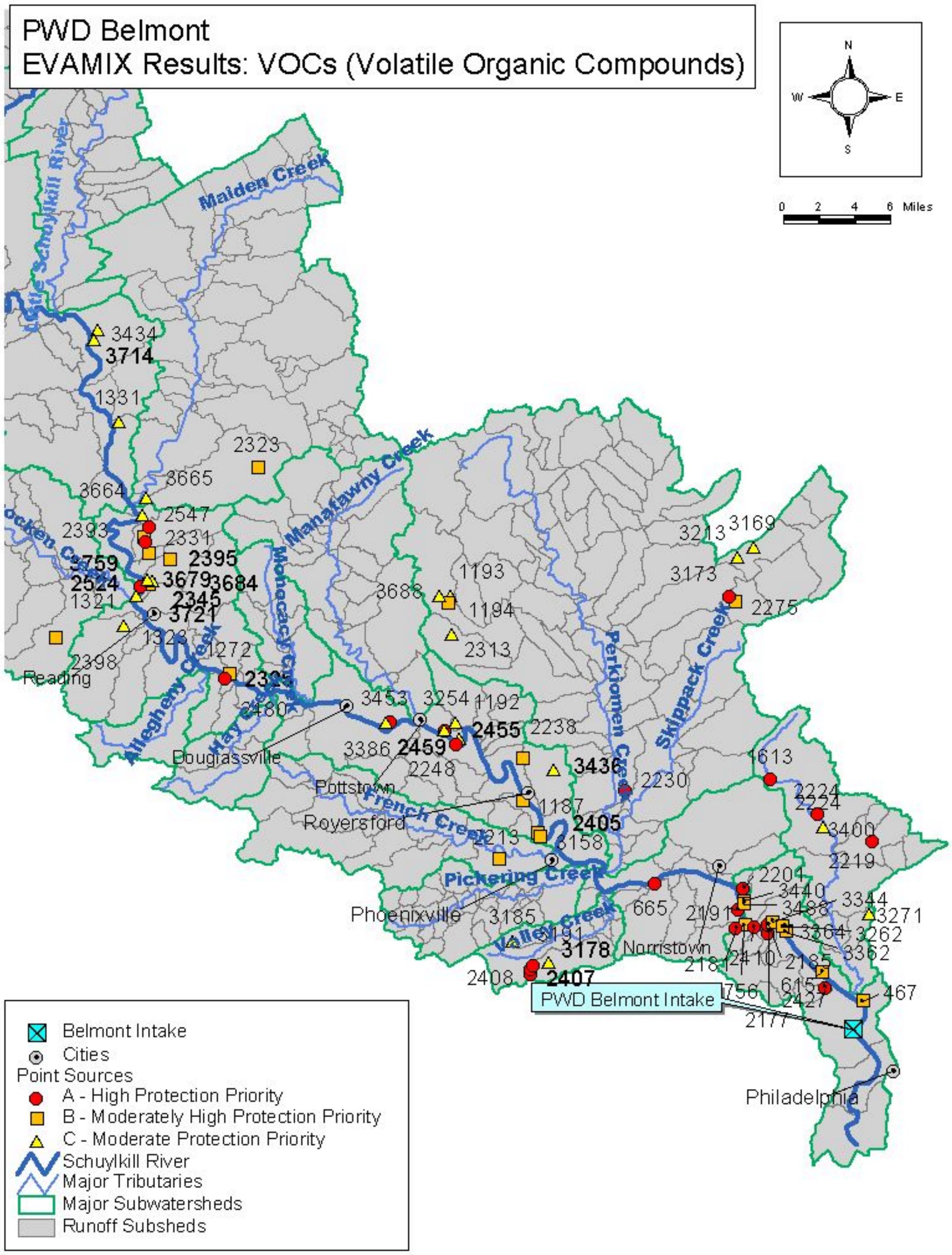
Table 2.2.4-12 shows the results of the ranking of volatile organic compound (VOC) sites. In this case, the only significant potential sources of VOCs are storage tanks (ASTs), industrial sites from the TRI database, or wastewater treatment plants. The high protection priority category (category A) is a mixture of AST, TRI, and NPDES sites. The moderately high and moderate protection priority categories are primarily AST and RCRA sites. The NPDES sites appear to load VOCs at a low rate, and are not likely to cause water quality impairment at the intake. The AST, and TRI sites would require a spill to cause water quality impairment, but resulting concentrations would be very high. RCRA sites were difficult to assess for potential loading. Figure 2.2.4-18 illustrates the priority point sources for volatile organic compounds in the Schuylkill River watersheds.

Table 2.2.4-12 Contaminant Category Ranking for Volatile Organic Compounds

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3759	COLUMBIA PETRO	AST	Laurel Run	Zone B	34.5	18869025	Highest-A
3178	MALVERN TERM	AST	Little Valley Creek	Zone B	15.4	15566041	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Floodplain	13.5	1.1	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	9.0	1.1	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	20.5	26.3	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Floodplain	27.2	2.8	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	21.9	0.7	Highest-A
3262	COOPERS CREEK CHEMICAL CORP.	AST	Schuylkill River	Zone A	4.0	4169475	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	35.1	0.0	Highest-A
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	32.5	4.1	Highest-A
2219	HONEYWELL INC. PROCESS CONTROL DIV.	TRI	Sandy Run	Zone A	13.5	1270592	Highest-A
2410	ASHLAND CHEMICAL CO DIV ASHLAND OIL INC	TRI	Schuylkill River	Floodplain	5.0	46201	Highest-A
2191	LONZA INC.	TRI	Schuylkill River	Floodplain	5.5	15206	Highest-A
2185	FINNAREN & HALEY INC.	TRI	Schuylkill River	Floodplain	4.5	2179	Highest-A
2181	COOPERS CREEK CHEMICAL CORP.	TRI	Gulph Creek	Zone A	5.5	64484	Highest-A
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Floodplain	20.0	55978	Highest-A
2201	SPRAY PRODS. CORP.	TRI	Plymouth Creek	Zone A	6.5	2077	Highest-A
2224	RHONE-POULENC AG CO.	TRI	Wissahickon Creek	Floodplain	11.0	4654	Highest-A
2427	STEVENSON, W. N. CO.	TRI	Schuylkill River	Zone B	2.0	6143	Highest-A
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	4.5	3234	Highest-A
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	14.5	4992	Highest-A
3173	FARM AND HOME OIL CO. INC.	AST	Mill Creek	Zone B	27.7	3706200	Highest-A
2407	MOBIL OIL MALVERN TERMINAL	TRI	Little Valley Creek	Zone B	15.4	258926	Moderately High-B
2408	SUNOCO INC. (R&M) MALVERN TERMINAL	TRI	Little Valley Creek	Zone B	15.4	174141	Moderately High-B
2405	CROMBY GENERATING STATION	TRI	Schuylkill River	Zone B	14.5	50770	Moderately High-B
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	24.6	34067	Moderately High-B
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Floodplain	34.0	1392	Moderately High-B
2213	PIERCE & STEVENS CHEMICAL CORP	TRI	French Creek	Zone B	15.4	2822	Moderately High-B
2238	STANLEY TOOLS ROYERSFORD PLANT	TRI	Schuylkill River	Zone B	16.5	1416	Moderately High-B
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	27.2	5978	Moderately High-B
756	PENN MED TECHNOLOGY	RCRA	Gulph Creek	Floodplain	5.5	0.0	Moderately High-B
2345	GLIDDEN CO THE	TRI	Bernhart Creek	Zone B	33.5	33436	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
1187	SPRING CITY FOUNDRY	RCRA	Schuylkill River	Floodplain	15.5	0.0	Moderately High-B
2275	FRES-CO SYSTEM USA INC.	TRI	Mill Creek	Zone B	27.7	3304.3	Moderately High-B
467	EVER READY CLEANERS	RCRA	Schuylkill River	Floodplain	1.0	0.0	Moderately High-B
615	CONTAINER CORP OF AMERICA	RCRA	Schuylkill River	Floodplain	2.5	0.0	Moderately High-B
3588	QUEEN LANE WTP	AST	Schuylkill River	Zone A	1.0	741240	Moderately High-B
2393	CARLOS R. LEFFLER INC.TUCKERTON FACILITY	TRI	Laurel Run	Zone B	34.5	177695	Moderately High-B
2395	EAGLE CHEMICAL CO.	TRI	Schuylkill River	Zone B	34.0	1523	Moderately High-B
2398	SUNOCO INC. (R&M) MONTELLO TERMINAL	TRI	Cacoosing Creek	Zone B	38.4	128448	Moderately High-B
3362	LONZA INC.	AST	Schuylkill River	Zone A	4.0	370620	Moderately High-B
2323	GARDEN STATE TANNING – FLEETWOOD	TRI	Willow Creek	Zone B	42.2	2509	Moderately High-B
3488	MONTGOMERY CHEM	AST	Plymouth Creek	Zone A	6.0	315027	Moderately High-B
3158	CROMBY GENERATING STATION	AST	Schuylkill River	Floodplain	14.5	444744	Moderately High-B
3400	ROTELLE INC	AST	Wissahickon Creek	Zone A	10.4	281671	Moderate-C
3271	METLAB CO	AST	Cresheim Creek	Zone B	5.3	325868	Moderate-C
3185	HCI EAST FALLS CORP	AST	Valley Creek	Zone B	14.8	555930	Moderate-C
3191	WORTHINGTON STEEL CO.	AST	Little Valley Creek	Zone B	14.8	296496	Moderate-C
3436	OEH LERT Bros. Fuel Oil	AST	Mingo Creek	Zone B	16.5	370620	Moderate-C
3386	EDWARD J SWEENEY & SONS	AST	Schuylkill River	Zone B	20.5	555930	Moderate-C
3254	OCCIDENTAL CHEMICAL CORP.	AST	Sprogles Run	Zone B	20.0	370620	Moderate-C
3721	GOSHERTS QUALITY FUELS	AST	Schuylkill River	Floodplain	32.5	370620	Moderate-C
3453	PAM OIL INC	AST	Schuylkill River	Zone B	22.4	315824	Moderate-C
3213	HESTON S SWARTLEY TRANS CO INC	AST	East Branch Perkiomen Creek	Zone B	27.1	370620	Moderate-C
3169	M & S OIL	AST	East Branch Perkiomen Creek	Zone B	27.7	370620	Moderate-C
1194	BOYERTOWN SANITARY DISPOSAL CO	RCRA	Minister Creek	Floodplain	24.1	0.3	Moderate-C
1193	CABOT PERFORMANCE MATERIALS	RCRA	Swamp Creek	Floodplain	25.2	2.8	Moderate-C
3684	CARPENTER TECHNOLOGY CORP	AST	Bernhart Creek	Zone B	33.5	370620	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	33.5	333558	Moderate-C
3665	TEXTILE CHEM EK1	AST	Willow Creek	Zone B	38.1	555930	Moderate-C
1192	OCCIDENTAL CHEMICAL CORP.	RCRA	Schuylkill River	Zone B	20.0	5.8	Moderate-C
3664	TEXTILE CHEMICAL CO INC	AST	Schuylkill River	Zone B	36.1	370620	Moderate-C
1321	BALDWIN HARDWARE MFG CORP	RCRA	Wyomissing Creek	Floodplain	32.4	0.2	Moderate-C
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	43.3	555930	Moderate-C
1272	CROMPTON & KNOWLES CORP GIBRALTAR PLT	RCRA	Schuylkill River	Zone B	27.2	76.2	Moderate-C
3714	ES SAVAGE INC	AST	Schuylkill River	Zone B	43.3	370620	Moderate-C
1323	CARPENTER TECHNOLOGY CORP	RCRA	Bernhart Creek	Zone B	33.5	19.55	Moderate-C
1331	BRUSH WELLMAN INC.	RCRA	Schuylkill River	Zone B	39.7	62.71	Moderate-C

Figure 2.2.4-18 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for VOCs in the Schuylkill River Watershed



2.2.4.3 Narrative Results

Potentially Significant CERCLA Sources

There are 378 CERCLA sites in the watershed; 22 of these sites are on the National Priority List (NPL) for clean up by the USEPA. Approximately 274 of those CERCLA sites fall within the Zone A and B (5 to 25-hour times of travel) from the Belmont Intake during extreme high flow conditions. Only 27 of those 274 sites are within the Zone A (5-hour time of travel) from the Belmont Intake.

Of those 27 sites in Zone A, six are within the floodplain. Overall, 18 sites are within the floodplain of Zone A and B from the Belmont intake. It is very difficult to quantify the types and extent of contamination at a CERCLA site as well as the contaminant's ability to migrate and impact a surface water supply. Therefore, a simple screening process was developed to determine which CERCLA sites may be a potentially significant source of contamination to the water supply. Sites that were considered to be significant met one or several of the following characteristics:

- The site is a National Priority List Site and considered to be contaminated and of concern by the USEPA;
- The site is within Zone A of the Belmont intake;
- The site is within the floodplain;
- The site is not currently being cleaned up by USEPA; and
- The site is identified by stakeholders as contaminated and of concern to the local community.

The priority ranking of the sites used the following criteria:

- A site met multiple criteria from above;
- A site was closer to the intake than another; and
- A site had a higher surface water migration score than another site or overall migration score according to rankings provided at www.scorecard.org.

Using these criteria, 22 NPL sites were identified within the watershed. Two of the NPL sites reside within the floodplain, 18 fall within the Zone A and B of PWD's Belmont Intake. NPL sites are considered to be significant due to their history of contamination and local environmental impacts that require cleanup by the USEPA. As shown in Table 2.2.4-13, Montgomery, Chester, Berks, and Bucks counties are the top four counties in Pennsylvania when ranked by the number of NPL sites within them. Table 2.2.4-14 has a summary list of the most frequently detected chemicals at NPL sites in several counties within the Schuylkill River Watershed. As shown, the most common contaminants at these sites are volatile organic compounds and metal compounds.

Table 2.2.4-13 County Rankings in PA for Number of NPL Sites

Rank	County	Number of Superfund Sites
1	MONTGOMERY	16
2	CHESTER	12
3	BERKS	8
4	BUCKS	7
5	ADAMS	4
	ALLEGHENY	4
	LANCASTER	4
	LEHIGH	4
	MERCER	4
	MONROE	4
	YORK	4
6	DELAWARE	3
	SCHUYLKILL	3

Source www.scorecard.org

Table 2.2.4-14 Most Frequently Detected Chemicals at NPL Sites in Various Counties Draining into the Schuylkill River Watershed

Contaminant	County
TCE	Berks
Diethanolamine	Berks
1,1,1-Trichlorethane	Bucks
Zinc	Bucks
Trichlorethylene	Chester
Nickel Compounds	Chester
Vinyl Chloride	Lehigh
Copper	Lehigh
TCE	Montgomery
Copper	Montgomery
Methyl Isobutyl Ketone	Philadelphia
Nickel Compounds	Philadelphia
Mercury	Schuylkill
Barium Compounds	Schuylkill

Source www.scorecard.org

In addition to NPL sites there were another 18 CERCLA sites in the floodplain upstream of the Belmont intake. These sites were examined for potential significance along with the other CERCLA sites identified by stakeholders as potentially significant sources of concern.

The final ranking of the NPL sites is provided in Table 2.2.4-15. The rankings identified 18 NPL sites and 3 additional CERCLA sites that are considered to be potentially significant sources of contamination. Three of the sites were located within the Zone A (5 hour) travel time to the Belmont Intake. All remaining sites are located in Zone B (<25 hour). The sites of protection priority C are sites that have been cleaned up, contained, or are being utilized by businesses again and should represent little threat to the environment.

There is no way to adequately quantify all of these sites for proper comparison in the overall EVAMIX prioritization rankings. However, based on the limited information available, it appears that the CERCLA sites would potentially rank very low compared to other potentially significant sources in the watershed from the combined ranking.

Spills and Accidents

The Schuylkill River Watershed is a major transportation corridor for railroads and trucking. In addition, there are several major petroleum pipelines located within the watershed. The volumes of chemicals transported by these means are quite significant. A tanker truck can normally hold about 5,000 gallons of a chemical. A railroad tanker car can normally hold about 14,000 gallons of a chemical. A pipeline, if it breaks and spills contaminants for an hour or more can spill between 1,000 to 10,000 gallons of a chemical depending on its size.

Hypothesizing that an accident were to spill the partial or entire contents of these sources into the river, estimates show that the impacts on downstream local water supplies could be severe, even up to 100 miles downriver of the spill. Assuming that a pipeline, railroad tanker car, or even tanker truck spilled benzene even 10 miles upriver from the water supply intake, only 10 gallons of benzene would need to make it to the river during a normal flow day for concentrations in the river to cause significant impacts on water quality. This would either require the water treatment plant to stop withdrawing water from the river or require special treatment of the water with carbon.

Table 2.2.4-15 Potentially Significant CERCLA Sources for the Belmont WTP Intake

Rank	Zone	Site Name	Chemicals	Floodplain	NPL Status
A	A	TYSONS DUMP	VOCs		NPL
A	B	DOUGLASVILLE DISPOSAL SITE	VOCs, metals	YES	NPL
A	B	MOYERS LANDFILL	VOCs, metals		NPL
A	B	BERKS LANDFILL	VOCs, metals		NPL
A	B	OCCIDENTAL CHEMICAL CORP.	VOCs	YES	NPL
A	B	FOOTE MINERAL CO	VOCs, metals		NPL
B	B	RECTICON/ALLIED STEEL CORP	VOCs		NPL
B	B	BROWN'S BATTERY BREAKING	metals	YES	NPL
B	B	NORTH PENN - AREA 1	VOCs		NPL
B	B	NORTH PENN - AREA 7	VOCs		NPL
B	B	MALVERN TCE	VOCs		NPL
B	B	SALFORD QUARRY	VOCs, metals		Proposed
B	B	CRATER RESOURCES/KEYSTONE COKE/ALAN WOOD	VOCs, metals		NPL
B	A	MIQUON LANDFILL	Herbicides/Pesticides, metals		NOT ON NPL
B	A	POTTSTOWN INDUSTRIES COMPLEX	Unknown		NOT ON NPL
B	B	PHOENIXVILLE PIPE & TUBE LP STEEL CORP	Unknown		NOT ON NPL
C	B	HENDERSON RD SUPERFUND SITE	VOCs, metals		NPL
C	B	STANLEY KESSLER	VOCs		NPL
C	B	KIMBERTON SITE	VOCs, metals		NPL
C	B	COMMODORE SEMICONDUCTOR GROUP	VOCs		NPL
C	B	NORTH PENN - AREA 12	VOCs		NPL

Under more extreme conditions, up to 100 gallons of benzene would need to be spilled for a similar impact. These estimates do not take into account the potential loss of benzene due to holding in pockets in the river or binding to sediments and other material as it flows downstream. Therefore, higher concentrations of 1,000 gallons of benzene spilled from an accident would most likely have a severe impact on water quality at the intake even if it were spilled during a rain event 100 miles upriver.

In terms of their overall priority compared to the other sources provided in the combined ranking, spills and accidents can have one of the greatest relative impacts on water quality and require some moderate level of protection priority. An early warning system on the Schuylkill River such as the system present on the Ohio River would help to prevent such severe impacts in the event of a spill.

Radionuclides

The presence of the Limerick Nuclear Generating Station upriver requires monitoring for the presence of radionuclides in the finished drinking water. To date, special monitoring has only detected Gross Beta radionuclides at levels far below the regulated limits in the finished water from Schuylkill River sources. All other types of radionuclides have not been detected.

Regardless of the lack of observed impact from these sources, they were still identified. There were only two sources of radionuclides identified in the Schuylkill River Watershed. They are the Limerick Nuclear Generating Station and the Unitech Laundry Facility. The Limerick NGS does not directly discharge any waters into the Schuylkill River from its process and radionuclides are only considered to potentially enter the river through airborne deposition. The Unitech Laundry located in Royersford cleans the uniforms from the operations at the Limerick NGS. It currently discharges wastewater to the local sewage treatment plant but may be treating and discharging its process water to the river directly. This was mainly the result of issues associated with radionucludes in the biosolids from the local sewage treatment plant that were to be used for land application.

Given that current water quality data does not suggest any radionuclide issues with these sources and the current controls and monitoring in place to protect against them, these sources would be considered a medium protection priority and would tend to fare lower than other sources identified in the combined ranking.

2.2.5 Qualitative Loading Analysis

Key Points

- **Quantitative Contaminant Loading Analyses are difficult to implement as it is not possible to accurately characterize all of the factors affecting potential contaminant releases and transport.**
- **Qualitative contaminant loading analyses can provide order-of-magnitude assessments that will help to identify potentially significant major loads**
- **Non-point sources associated with stormwater runoff were identified as significant sources of salts, *Cryptosporidium*, fecal coliform, nitrates, petroleum hydrocarbons, phosphorus, disinfection by-products, and total suspended solids.**

2.2.5.1 Method

Performing a quantitative pollutant loading analysis requires a substantial investment in data collection. For example, for sites that actually discharge wastewater to the river on a continuous or intermittent basis, accurate data on discharge rates and concentrations of contaminants in the discharge water are required. For sites that store chemicals, accurate data on the amount and type of chemical stored are required, and a series of assumptions must be made about the probability of leaks or spills occurring. The analysis must also account for natural sources of certain contaminants and a calibrated non-point source or runoff-loading model is needed to add stormwater-related loadings to the calculations. For this reason, a quantitative contaminant loading analysis goes well beyond the scope of this study, and the data collected is not sufficiently accurate to allow a quantitative analysis to be performed.

Despite the limitations that the data impose, a more qualitative analysis of contaminant loading is still valuable, and can provide important insight into the relative magnitude of the impacts that the major contaminant sources might have on the water quality within the watershed. The approach to performing the analysis is summarized by the following steps.

Step 1: Loading Estimates

- For sites that have continuous or intermittent discharges, estimates of annual contaminant loading for each contaminant category are calculated by multiplying median discharge concentration times average annual discharge rate.
- For sites that simply store or use chemicals onsite, there is no logical way to estimate point loading because contaminants are only released through spills or leaks. An extreme estimate of potential loading can be made by assuming stored chemicals in the largest tank onsite are released through a catastrophic tank failure and are all spilled to the surface water.

- For non-point source pollutant loading, estimates for each contaminant category were provided by the SWMM model results on an annual basis.

Step 2: Loading Magnitude Comparisons

The loading estimates produced in step one are of widely varying accuracy. The SWMM model stormwater loads may be generally accurate, however, they are based on Event Mean Concentrations that may or may not be representative of local conditions within the watershed. The loading estimates for point source dischargers range from accurate for dischargers who regularly monitor their discharges and report results (usually the larger sources), to highly speculative where data had to be filled in for both concentration and discharge rate (many of the smaller dischargers). The loading estimates for sites that store or use chemicals are not based on data, and represent a speculation on potential leaking or spilling that probably overestimates loading by a considerable margin.

Despite the disparity in accuracy, the total annual loads can be contrasted with each other, and general conclusions about the magnitude of each type of source drawn. These estimates will also be compared to estimates of contaminant loads from natural or more regional sources (e.g. acid mine drainage) where information or data are available. The intent is not to calculate actual estimates of loading rates, but to better understand which sources are most likely to be major sources, and which appear to be minor sources.

Step 3: Reality Check

Because of the highly speculative nature of the loading estimates, annual average contaminant loads can be summed, and divided by annual average flow rates in the river to estimate an in-stream concentration. The calculated concentration can be compared to in-stream sampling data and conclusions drawn about the degree of overestimation or underestimation that the loading estimates appear to represent.

2.2.5.2 Results

Only a general, qualitative analysis of contaminant loading can be made with the sketchy data available for this analysis. A cumulative loading analysis goes well beyond the scope of this analysis and is not attempted here. The qualitative loading analysis is based on the loading estimates produced by the database in support of the evaluation of sites, and only provides an indication of the relative importance of each potential source.

Loading Estimates

Using the database, order of magnitude estimates of loads from each type of source can be made. These are discussed here in a general sense for the sites in the major databases.

Each source is rated according to the relative impact that the source might have on ambient river concentrations.

- Low: if the sites do not appear to contribute enough load to even register as a portion of the ambient concentration. Generally, each of these sites if discharging or spilling to the river, would only change the concentration at the intake by less than 1%.

- Medium: if the sites could be contributing a low percentage of the actual ambient concentrations. Generally, each of these sites, if discharging or spilling to the river, would change the concentration at the intake 1 to 25%.

- High: if the sites could or are one of the major contributors of this contaminant. Generally, each of these sites, if discharging or spilling to the river, would change concentrations at the intake by more than 25%.

A distinction is made between sources that are contributing and those that could, but only if spills or leaks occur.

Table 2.2.5-1 provides a summary of the estimated combined contributions by the various source types under either normal or abnormal (such as the primary storage tank spilling all its contents) conditions. The table also provides comments on whether the indicated, cumulative sources appear to drive or influence water quality when compared to water quality data. "Yes" indicates that current water quality day corroborates the indicated source contributions. "Partial" indicates that current water quality data only partially corroborates the source contributions. "No" indicates that no real correspondence exists between the source contributions and water quality data.

Table 2.2.5 -1 Qualitative Combined Contributions to River Water Quality

Contaminant	NPDES (dischargers)	NPS (runoff)	TRI (toxic facilities)	AST (storage tanks)	Matches with Reality?
Salts	Low	Low	Low	Medium	Yes
Cryptosporidium	Low	Low	Low	Low	Partial
Fecal coliforms	Low	Medium	Low	Low	Yes
Nitrate	Medium-High	Low	Medium-High*	Low	Yes
Metals	Medium	Medium	High*	High*	Partial
Phosphorus	Low-Medium	Medium	Medium*	High*	Yes
Petroleum Hydrocarbons	Low	Medium	Low	High*	No
Disinfection-by-Products	Medium-High	Medium	Low	Low	Partial
Turbidity	Medium-High	Medium	Low	Low	Partial
Volatile Organic Compounds	Low-Medium	Low	High*	High*	Yes

** Abnormal and highly unlikely situation would require the simultaneous release of contaminants from all facilities or storage tanks.*

As shown, estimates for salts, fecal coliforms, nitrate, phosphorus, and volatile organic compounds appear to match well with current water quality data observations. However, the estimate for petroleum hydrocarbons does not match. Petroleum hydrocarbons are rarely, if ever, measured at the intake. Some categories, such as metals, only show partial matches. Source contributions for metals, such as lead and copper, do generally match water quality. However, source contributions do not correlate with iron and manganese intake levels, which are greatly influenced by acid mine drainage. Therefore, the qualitative loading analysis, which is based on conservative assumptions, only provides some very general indications about the impacts of various sources. This analysis requires further refinement as part of a true cumulative analysis for a TMDL in order to provide more accurate predictions.

Salts

NPDES (permitted dischargers): Low

Permanent discharges, but at very low concentrations.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of salts during the winter, but does not appear to be a concern.

TRI (generators/handlers): Low

Sites could contribute minor amounts, but only do so through spill or leaks.

AST (above ground tanks): Medium

A few potential sites could affect water quality, but only through a catastrophic spill.

Comparison of the loading results to actual seasonal trends in water quality data (section 2.1.5) shows that the results of both analyses indicate that NPS (stormwater) runoff is the main source of salts in the watershed. The qualitative loading results further indicate that the cumulative impact of these sources from developed areas is probably not significant, however, long term trends appear to suggest that the cumulative impacts could become more significant and the source of the increasing concentrations in the river.

Cryptosporidium

NPDES (permitted dischargers): Low

These are one of only two sources, however, the loading rate is relatively low, and does not result in significant concentrations in the ambient water under normal circumstances.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of *Cryptosporidium* from certain land uses, and is probably responsible for almost all the background levels found in the river.

TRI (generators/handlers): Low

Not a source

AST (above ground tanks): Low

Not a source.

Comparison of the qualitative loading data with actual water quality data from research studies conducted by PWD, suggest that the elevated concentrations observed during storm events are most likely due to stormwater runoff from developed areas and pasture lands. However, during non-rainfall periods, it appears that NPDES discharges in particular from wastewater treatment plants are the main source of daily concentrations observed in the Schuylkill River. Therefore, efforts to reduce mean daily concentrations of *Cryptosporidium* in the river should focus on reducing the impacts from wastewater discharge, while efforts to reduce peak concentrations should focus on mitigating stormwater runoff from pastures and developed areas.

Fecal Coliform
NPDES (permitted dischargers): Low

These sites are one of only two sources, however, the loading rate is relatively low, and does not result in significant concentrations in the ambient water under normal circumstances.

NPS (stormwater runoff loading): Medium

Stormwater runoff is the primary source and is probably responsible for almost all the background levels found in the river. This is usually seen in the extreme variability of fecal counts responding to rainfall events.

TRI (generators/handlers): Low

Not a source

AST (above ground tanks): Low

Not a source.

Comparison of the qualitative loading data with actual water quality data suggests that the elevated concentrations observed during storm events are most likely due to stormwater runoff from developed areas and pasture lands. However, during non-rainfall periods, it appears that coliforms can originate from a number of sources including wastewater discharges, leaking septic tanks, leaking sewers, “wildcat” or illegal sewage discharges, geese, and livestock.

Metals
NPDES (permitted dischargers): Medium

NPDES discharges may account for some of the metal concentration found at the intake. The amounts, cumulatively, could represent a low but significant percent of total metal loading for certain metals.

NPS (stormwater runoff loading): Medium

Stormwater runoff can be a significant source of metals during storm events, with runoff often contributing copper, zinc, cadmium, and other metals at relatively low concentrations to the water.

TRI (generators/handlers): High (potential only)

Sites could contribute major amounts of metal to the river, but only do so through spill or leaks. The amounts stored, if spilled, could cause order of magnitude exceedences of the drinking water standards at the intake for short periods of time.

AST (above ground tanks): High (potential only)

Sites could contribute major amounts of metal to the river, but only do so through spill or leaks. The amounts stored, if spilled, could cause order of magnitude exceedences of the drinking water standards at the intake for short periods of time.

Though the qualitative analysis suggests that TRI and AST sites have the potential for the greatest cumulative impacts, it would require numerous simultaneous catastrophes in the watershed for this to occur. Based on analysis of long-term trends, it appears that concentrations of metals are increasing in the river. Also water quality data suggests most metals increase during storm events. The only metal that does not always increase during rain events is manganese. In section 1.4.6.1, it was shown that concentrations measured from acid mine drainage discharges can actually be responsible for everyday concentrations of iron and manganese observed in the Schuylkill River. Also, spatial analyses in section 2.1.5 also observed a decrease in metals concentrations with distance downriver. Therefore, though it is estimated qualitatively that NPDES discharges appear to have a medium impact on metal concentrations in the river, it is more likely that stormwater runoff and acid mine drainage are the driving factors cumulatively influencing water quality trends in the river.

Nitrates
NPDES (permitted dischargers): Medium - High

Permitted discharges of wastewater contribute a steady load of nitrates to the river, but in general do not result in concentrations that approach the drinking water standard.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of nitrate, especially runoff from agricultural lands. Overall loading, however, appears to be low.

TRI (generators/handlers): Medium – High (potential only) Generally not a source, although a few sites appear to have the potential to be a temporary source of high concentrations if a spill were to occur.

AST (above ground tanks): Low

Not a significant source.

Analysis of observed nitrate concentrations in sections 2.1.5 and 1.5 show that nitrate and ammonia concentrations are decreasing in the river. Also, seasonal fluctuations in nitrate concentrations appear to be dominated by biological activity in the river.

However, analysis of impairment data in section 2.1.5.4 suggests that nutrients are one of the top three leading causes of impairments in the lower half of the Schuylkill River Watershed. Upon further examination, these impairments may be more related to phosphorus than nitrate. Overall, the combined information suggests that improvements by wastewater discharge and reduced agricultural runoff have benefited the watershed, but the cumulative impacts of nitrate from both point and non-point sources combined may still play a significant role in determining stream health.

Petroleum Hydrocarbons
NPDES (permitted dischargers): Low

Not a significant source.

NPS (stormwater runoff loading): Medium

Stormwater runoff is a source of petroleum hydrocarbons during storm events, particularly from urban areas. Measurable concentrations at the intake are likely to be the result from stormwater runoff.

TRI (generators/handlers): Low

Not a source.

AST (above ground tanks): High (potential only)

This is only a source if spilled or leaked. The amounts stored at many sites, however, mean that a spill could have significant impact, with very high concentrations occurring following a spill.

As observed, petroleum hydrocarbons from non-point source runoff and aboveground storage tanks were considered to have the greatest potential qualitative impacts. Petroleum hydrocarbon impacts are typically observed from spills caused by accidents or releases. The impacts of hydrocarbons from stormwater runoff have not been observed in either water quality data or stream impairment descriptions to date. Therefore, the observed cumulative impact of various sources on hydrocarbons is low, but the observed impact from an individual source during an accident can be significant.

Phosphorus
NPDES (permitted dischargers): Low - Medium

Wastewater discharges are a source of phosphorus, but at amounts that are not likely to have a large effect on ambient concentrations at the intake.

NPS (stormwater runoff loading): Medium Stormwater runoff can be a source of phosphorus in runoff from residential and agricultural areas. Concentrations may occasionally be high, causing a measurable impact at the intake.

TRI (generators/handlers): Medium (potential only)

Some sites could contribute significant amounts, but only do so through spill or leaks.

AST (above ground tanks): High (potential only)

In general, not a source, however one or two sites notes as storing phosphorus.

Analysis of observed orthophosphate concentrations in sections 2.1.5 and 1.5 show that orthophosphate concentrations are increasing in the river. Seasonally, orthophosphate concentrations also appear their greatest during spring when runoff and rainfall occurs. In addition, analysis of impairment data in section 2.1.5.4 suggests that nutrients are one of the top three leading causes of impairments in the lower half of the Schuylkill River Watershed. Upon further examination, these impairments may be more related to phosphorus than nitrate. Overall, the combined information suggests that the cumulative release of phosphorus from non-point sources may be the most significant contribution for control.

Disinfection By-Product (Total Organic Carbon)
NPDES (permitted dischargers): Medium - High

Wastewater discharges are one of the major sources of TOC, and can be having a measurable impact on concentrations at the intake.

NPS (stormwater runoff loading): Medium

Stormwater runoff is a major source of TOC during storm events, and contribution can come for a variety of land uses, including parkland and wooded areas.

TRI (generators/handlers): Low

Sites could contribute minor amounts, but only do so through spill or leaks.

AST (above ground tanks): Low

Not a significant source.

Total organic carbon can come from many sources including agriculture, decaying leaves and algae, and sewage discharge. However, the nature of the organic matter from those sources can be significantly different and have significantly different impacts on the formation of disinfection by-products when they react with chlorine. Water quality data in section 1.4 suggests that TOC has increased in the river over the past decade. Since the population in the watershed has not changed significantly in the past decade, it is doubtful that NPDES discharges are the influencing cumulative source related to this increase. However, during this period developed land throughout the watershed has increased. These observations suggest that the combined impact from the many non-point sources in the watershed may be driving the increasing concentrations observed in the river.

Turbidity (Total Suspended Solids)
NPDES (permitted dischargers): Medium - High

Wastewater discharges are a major source of TSS, and probably have a measurable impact at the intake.

NPS (stormwater runoff loading): Medium

Stormwater runoff is the major source of TSS during storm events, and can cause large increases in concentration for periods of time during and after a storm.

TRI (generators/handlers): Low

Not a source.

AST (above ground tanks): Low

Not a source.

Though the qualitative analysis suggests that NPDES discharges can be a controlling source of turbidity, water quality data suggests otherwise. In fact, data shows that non-point source runoff tends to control turbidity due to its increased values during the wetter seasons. NPDES discharges may contribute to the daily non-rain event turbidity levels, but water quality data to date does not clearly suggest any impact on turbidity from dry weather discharges.

VOCs
NPDES (permitted dischargers): Low - Medium

Generally not a significant source of VOCs however can discharge measurable amounts.

NPS (stormwater runoff loading): Low

Not a significant source.

TRI (generators/handlers): High (potential only)

Sites could contribute significant amounts, but only do so through spill or leaks. A spill would result in orders of magnitude increase above drinking water standards.

AST (above ground tanks): High (potential only)

Sites could contribute significant amounts, but only do so through spill or leaks. A spill would result in orders of magnitude increase above drinking water standards.

As observed, volatile organic compounds toxic release facilities and aboveground storage tanks were considered to have the greatest potential qualitative impacts. Analysis of the limited VOC data does not suggest any impacts from particular point sources or facilities. Past experiences tend to suggest that individual sources such as accidents and spills that release benzene or toluene are most likely to impact the water supply. Therefore, the observed cumulative impact and likelihood from various sources of VOCs is low, but the observed impact from an individual source during an accident can be significant.

2.2.6 Watershed Protection and Restoration Activities

Key Points

- **Restoration activities within the Lower Schuylkill River Watershed and the Wissahickon Creek Watershed are within Zone A of the Philadelphia Water Department's Belmont Intake.**
- **The Lower Schuylkill River Watershed was awarded $5,837,791 in grant funding within the past seven years.**
- **Over 50% of the grants funded restoration projects within the watershed.**
- **The Wissahickon Creek Watershed was awarded $1,124,625 in grants within the past seven years.**
- **Nearly 40% of the Wissahickon Creek grant funds are being used to fund urban stormwater best management practices demonstration projects.**

In order to gain an understanding of the current levels of environmental stewardship and awareness within watersheds, a compilation of grants and restoration projects was completed. State, Federal and private grant sources identified the levels of funding that they provided through various programs to respective watersheds from 1995 to 2001.

These programs include the Pennsylvania Department of Environmental Protection's (PA-DEP) 319 Non-point Source Program and the Growing Greener Program, the Pennsylvania Department of Conservation and Natural Resources (PA-DCNR) Rivers Conservation Plan Program, and Pennsylvania's Coastal Zone Management Program. Also included were Pennsylvania's Natural Resource and Conservation Service's (NRCS) Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Watershed Protection and Flood Prevention Act (PL-566) Program, and the Environmental Quality Incentives Program (EQIP). In addition, private sources of funding were also compiled, including the William Penn Foundation, the Pew ChariTable Trusts and The Pennsylvania League of Women's Voters. Additional sources of funding included federal funds via the Army Corps of Engineers (USACOE), the United States Environmental Protection Agency (EPA), the United States Fish and Wildlife Service (FWS), and the National Science Foundation (NSF).

Restoration activities within the Lower Schuylkill River Watershed and the Wissahickon Creek Watershed are within the Zone A limit of PWD's Belmont Intake. The Lower Schuylkill ranked first out of 17 subsheds for total dollars spent with $5,837,791, which corresponds to $83,913.68/square mile. The Wissahickon Creek Watershed ranked fifth out of 17 subsheds with a total of $1,124,625, which corresponds to $17,674.44/square mile.

Figure 2.2.6-1 summarizes the distribution of grant dollars by project type. Over 50% of the grant funds were allocated for restoration projects in the watershed.

Figure 2.2.6-1 Distribution of Lower Schuylkill River Watershed Grants by Project Type

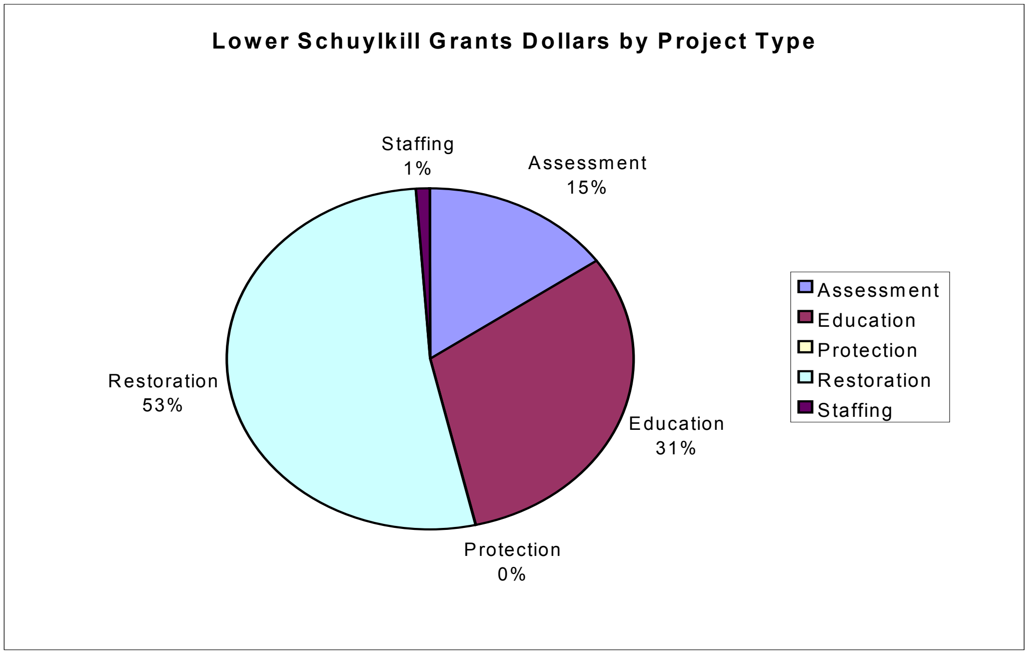


Table 2.2.6-1 lists the grants received within the Lower Schuylkill River Watershed from 1995-2001. The largest project funded was the Fairmount Water Works, receiving approximately 33% of the total funding for the watershed. The Fairmount Water Works will serve as the educational center for the region in terms of water resources and the connection between anthropogenic activities and environmental sustainability.

Table 2.2.6-1 Projects Receiving Grants in the Lower Schuylkill River Watershed from 1995-2001

Grant	Awardee	Project Description	Source	Year
$30,000	Philadelphia Urban Resource Partnership	Hire a director	PA DEP 319	1995
$50,000	Philadelphia Water Department	Waterworks exhibits	PA CZM	1995
$30,000	Philadelphia Urban Resource Partnership	Hire a director	PA DEP 319	1996
$3,600	Friends of the Manayunk Canal	Towpath map	DELEP	1997
$21,238	Fairmount Park Commission	Footbridge, observation deck	PA CZM	1998
$11,600	Pennsylvania Environmental Council	Environmental education	PA CZM	1998
$7,389	Schuylkill River Keeper	Riparian planting		1998
$27,500	Lower Merion Conservancy	Headquarters renovation	WPF	1999
$2,956	Manayunk Development Corporation	Environmental education	PA LoWV	1999
$7,200	Montgomery County Lands Trust	Land preservation	WPF	1999
$3,000	Philadelphia Water Department	Riparian buffer restoration	PA LoWV	1999
$3,000	Philadelphia Water Department	Riparian planting	DELEP	1999

Grant	Awardee	Project Description	Source	Year
$66,000	Schuylkill River Development Council	Bridge restoration	WPF	1999
$144,540	Schuylkill River Development Council	Riparian parkland	WPF	1999
$2,200	Manayunk Development Corporation	Towpath tour	DELEP	1999
$55,300	Villanova University	Wetland restoration; urban bmps	PA DEP 319	1999
$150,000	Bryn Mawr College	Stormwater wetland	PA GG	2000
$25,300	Fairmount Park Commission	Lake restoration	PA GG	2000
$20,000	Friends of the Manayunk Canal	Restoration Plan	PA GG	2000
$1,100,000	Fund for the Fairmount Water Works	Restoration and education	WPF	2000
$56,415	Manayunk Development Corporation	NPS pollution education	PA GG	2000
$2,906	Manayunk Development Corporation	Environmental education	PA LoWV	2000
$750,000	Philadelphia Water Department	Fairmount Water Works	PA GG	2000
$3,000	Philadelphia Water Department	Riparian buffer restoration	PA LoWV	2000
$200,000	Philadelphia Water Department	Stormwater bmps at a school	PA GG	2000
$11,000	Riverbend Environmental Education Center	Watershed models; education	PA GG	2000
$2,910	John Bartram Association	Fishing on the Schuylkill	DELEP	2000
$550,000	Schuylkill Center for Env. Education	Environmental education, trails	WPF	2000
$797,500	Schuylkill River Development Council	Masterplan for tidal Schuylkill	WPF	2000
$3,500	Schuylkill River Keeper	Riparian planting		2000
$55,000	University City District	Clark park revitalization plan	WPF	2000
$85,020	Upper Merion Township	Streambank restoration	PA GG	2000
$10,120	Villanova University	Stormwater bmps on campus	PA GG	2000
$25,000	Riverbend Env. Education Center	Develop a master site plan	PA GG	2001
$120,000	Lower Merion Township	Develop Rolling Hill Park trail	PA GG	2001
$350,000	Fairmount Park Commission	Develop East Fairmount Park	PA GG	2001
$240,000	Philadelphia Water Department	Fairmount Water Works	PA GG	2001
$59,112	Villanova University	Detention basin into wetland	PA GG	2000
$85,500	Villanova University	Porous concrete demonstration	PA GG	2001
$385,000	Bryn Mawr College	Ashbridge Memorial Park	PA GG	2001
$34,985	The Miquon School	Crayfish Creek restoration	PA GG	2001
$250,000	University of Pennsylvania	Public stormwater management	PA GG	2001

Figure 2.2.6-2 summarizes the distribution of grant dollars for the Wissahickon Creek Watershed by project type. Seventy-five percent of the funds were allocated for restoration projects.

Figure 2.2.6-2 Distribution of Wissahickon Creek Watershed Grants by Project Type

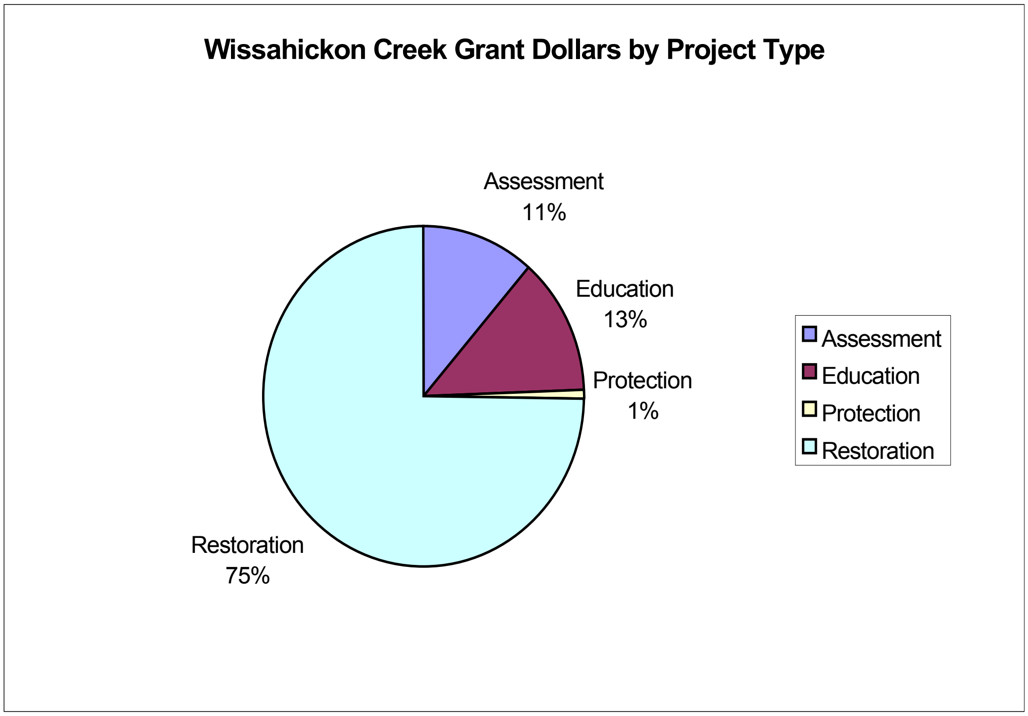


Table 2.2.6-2 shows the grants awarded within the Wissahickon Creek Watershed. The majority of grant dollars (39%) within the Wissahickon have gone to the Morris Arboretum (University of Pennsylvania) for demonstration projects for urban stormwater best management practices.

Table 2.2.6-2 Projects Receiving Grants in the Wissahickon Creek Watershed from 1995-2001

Grant	Awardee	Project Description	Source	Year
$76,250	Morris Arboretum	Urban bmps	PA DEP 319	1997
$108,750	Morris Arboretum	Urban bmps	PA DEP 319	1998
$115,273	Schuylkill River Keeper	Streambank stabilization		1998
$30,000	Lower Gwynedd Township	Urban bmps retrofits	PA WRAP	1999
$8,400	Montgomery County Land Trust	Land preservation	WPF	1999
$127,101	Morris Arboretum	Urban bmps	PA DEP 319	1999
$33,426	Schuylkill River Keeper	Streambank restoration		1999
$4,626	Schuylkill River Keeper	Streambank restoration		1999
$5,004	Schuylkill River Keeper	Streambank restoration		1999
$20,000	Wissahickon Valley W.A.	Water quality monitoring	PA DEP 319	1999
$24,515	Alliance for a Sustainable Future	Stormwater quality monitoring	PA GG	2000
$75,560	Alliance for a Sustainable Future	Stormwater quality monitoring	PA GG	2000

Grant	Awardee	Project Description	Source	Year
$20,633	Center in the Park	Educational curriculum	PA GG	2000
$3,300	Bioblitz with NLREEP: FPC	Streambank restoration	DELEP	2000
$4,035	Schuylkill River Keeper	Streambank restoration		2000
$3,038	Schuylkill River Keeper	Streambank restoration		2000
$3,000	Stroud Water Research Center	Water quality monitoring	PA LOWV	2000
$126,500	Morris Arboretum	Environmental education	WPF	2000
$26,000	Wissahickon Restoration Volunteers	Streambank restoration	PA GG	2000
$53,500	Wissahickon Valley W.A.	Streambank restoration	PA GG	2000
$5,714	Stroud Water Research Center	Macroinvertebrate analysis	WYO & WPF	1995-2000
$100,000	Ambler Borough	DAF	PA GG	2001
$150,000	Philadelphia Water Department	Stormwater treatment wetland	PA GG	2001

2.2.7 Public Participation Process

Key Points

- **Public kick-off meetings, Technical Advisory Group meetings, media articles and a website were some of the methods used to involve the public in the Source Water Assessment Program (SWAP).**
- **A Technical Advisory Group was established to facilitate communication among stakeholders, and to gather information about the watershed.**
- **The TAG meets quarterly to assist the Source Water Assessment Partnership in the SWAP process.**
- **Sixteen people attended the two public kick-off meetings held to introduce the SWAP.**
- **SWAP project information is available through the project website, www.schuylkillswa.org.**

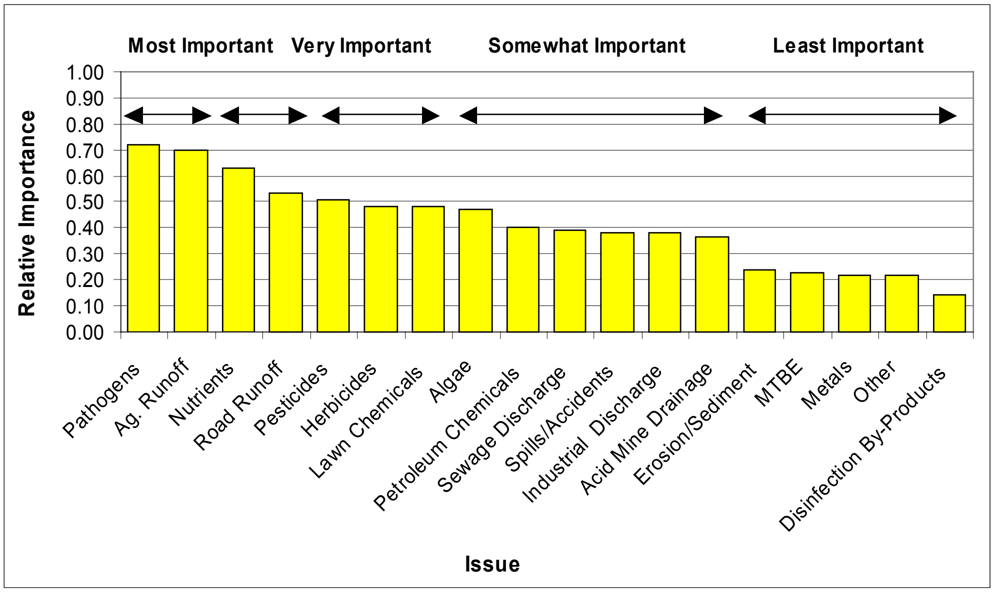
The involvement of the public in the Schuylkill Source Water Assessments included several avenues to provide opportunities for stakeholder and public involvement. These included:

- Public Kickoff Meetings
- Public Wrap-up Meetings
- Technical Advisory Group Meetings
- Legal Notices
- Newspaper Articles
- SWAP Website

Overall these avenues appear to have been successful at reaching the public and stakeholders. Two public meetings resulted in 16 attendees, 5 advisory group meetings resulted in 147 attendees (about 29 persons per meeting), 3 legal notices/ advertisements were published, 5 newspaper articles were published about the project, and the website has been accessed 521 times to date. Public Wrap-up meetings discussing the results of the project are anticipated for Spring 2002.

One of the important goals of gathering stakeholder input was to determine the perceived importance of various water quality issues so that comparisons could be conducted once the assessment was completed. According to the stakeholder input, the 17 water quality issues that were ranked fell into 5 general priority bins going from most important to least important (see Figure 2.2.7-1). Overall, pathogens, agricultural runoff, and nutrients were of greatest concern by stakeholders. Erosion and sedimentation control, metals, and disinfection by-product precursors were considered the least important.

Figure 2.2.7-1 Ranking of Water Quality Issues by Stakeholders



2.2.7.1 Advisory Groups

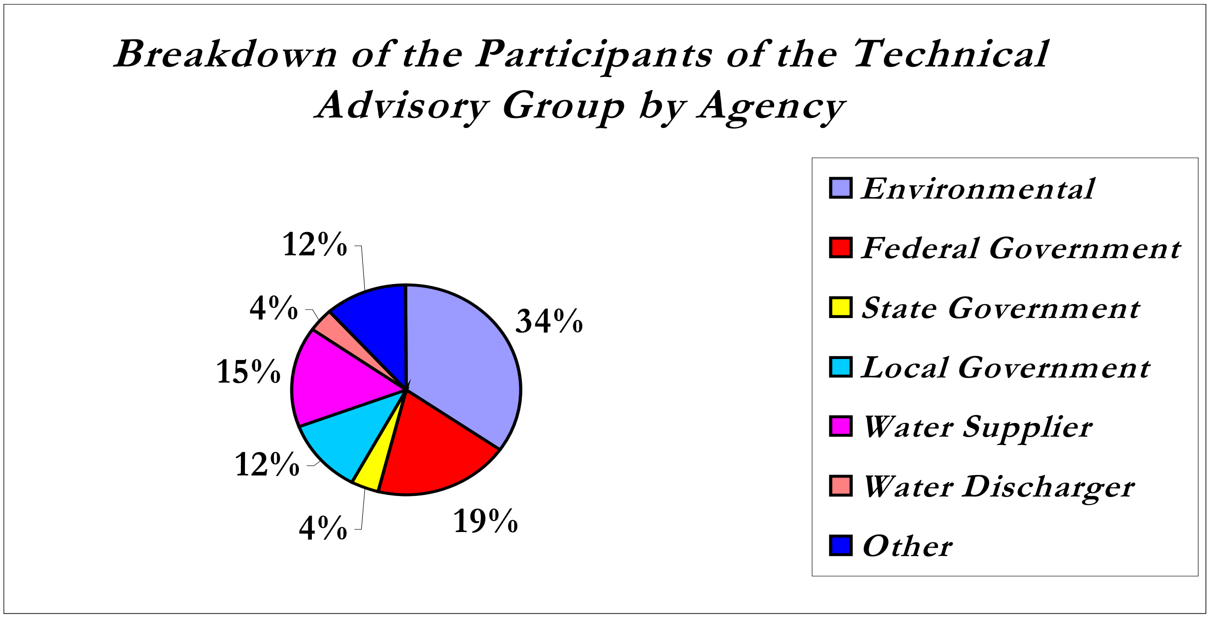
In order to better facilitate communication among the Source Water Assessment Partnership and the regions of the Schuylkill River Watershed to be assessed, an open Technical Advisory Group (TAG) was formed. This TAG was developed by the Partnership as a way to closely interact with the stakeholders, and in turn, gather integral information about each region of the Schuylkill River Watershed. All of the 200 stakeholders were invited by the partnership to participate. Meeting quarterly, it is the primary responsibility of the TAG to inject public interest into the Source Water Assessment (SWA) process. Moreover, other duties of this group include:

- Sharing information with stakeholders;
- Verifying the information put forth by the partnership;
- Providing input on the assessment techniques and criteria used by the partnership;
- Offering general information regarding the areas local to each TAG;
- Participating in public outreach and education;
- Describing current protection activities;
- Identifying "potential" sources of contamination and preservation;
- Assisting in the development of summary reports.

Technical Advisory Group Participants

Composed of watershed organizations, public interest groups, dischargers, suppliers, and local government agencies, the TAG offers a broad variety of perspectives and visions. The following graph is illustrative of the various types of agencies participating in the Technical Advisory Group (see Figure 2.2.7-2).

Figure 2.2.7-2 Technical Advisory Group Breakdown



The following is a summation of some of the TAG's participants:

It is the mission of the ***Department of Environmental Protection (DEP)*** to protect the air, land, and water of Pennsylvania from pollution and to provide for the health and safety of its citizens through a cleaner environment. DEP works as partners with individuals, organizations, governments, and businesses for the prevention of pollution and the restoration of natural resources and achieves these goals via public service, protection, teamwork, communication, and pollution prevention. DEP is the state agency largely responsible for administering Pennsylvania's environmental laws and regulations. Its responsibilities include: reducing air pollution; making sure that our drinking water is safe; protecting water quality in our rivers and streams; making sure waste is handled properly; managing the commonwealth's recycling programs and helping citizens prevent pollution and comply with the commonwealth's environmental regulations. DEP is committed to general environmental education and encouraging effective public involvement in setting environmental policy.

Incorporated in 1969, the ***Western Berks Water Authority*** supplies water to the Borough of Wyomissing from its water treatment plant located on the Tulpehocken Creek, thereby meeting all of the water needs of the residents of Wyomissing, West Reading, and Shillington. The Authority also supplies water to Mohnton and Lincoln Park, as well as portions of Cumru Township, and small quantities to the Citizens Utility Water Company, the Blue Marsh Lake Park and the fire companies. The authority's present water system facilities include a complete water treatment plant with a capacity of supplying up to eight million gallons of water per day. Aligns with the Borough of Wyomissing's mission to provide services identified with the tradition of excellent living in Wyomissing.

PennFuture is an organization that takes pride in defending the environment. In achieving it mission of defending nature, PennFuture effectively resists those who attack it and rallies against those who fail to do their duty to protect it. By combating global warming, smog, acid rain, and illness and advocating the increase of desperately needed funding for farmland preservation, among other things, PennFuture is making great strides in assuring that polluters and their allies no longer decide the fate of the environment and the economy. Comments and concerns may be voiced to Brenna Herpmann at (800) 321-7775. PennFuture's mailing address is 212 Locust Street, Suite 410, Harrisburg, PA 17101.

In order to share the responsibility of managing the water resources of the Delaware River Basin, the ***Delaware River Basin Commission*** *(DRBC)* was formed by the signatory parties of the Delaware River Basin Compact (Delaware, New Jersey, New York, Pennsylvania, and the United States). Since its inception on October 27, 1961, the very day that Compact became law, DRBC has been a pacesetter in environmental protection. As mentioned in its mission statement, DRBC focuses mainly on protecting, enhancing, and developing the water resources of the Delaware River Basin for the benefit of present and future generations. In achieving their mission, DRBC has developed such programs as water pollution abatement, water supply allocation, regulatory review (permitting), water conservation initiatives, regional planning, drought management, and flood control. Questions, comments, and concerns may be forwarded to Jon Zangwill via e-mail, zangwill@drbc.state.nj.us or telephone, (609) 883-9500 x 307. DRBC's mailing address is 25 State Police Drive, West Trenton, NJ 08628.

The ***Schuylkill River Greenway Association*** is a membership organization that has been working with citizens, community groups, and a host of other partners for close to 25 years. The primary objective of the association is to promote the advocacy of river resources and open space. In 1995, with the designation of the Schuylkill River Corridor as Pennsylvania's seventh Heritage Park, the association expanded its mission to include such focal points as the conservation of the historic and cultural resources within the watershed as well as the economic development of such resources. Inquiries may be voiced to Executive Director Dixie Swenson via telephone, (610) 372-3916 or e-mail, srga@ptd.net. The Schuylkill River Greenway Association's mailing address is 960 Old Mill Road, Wyomissing, PA 19610-2522.

Clean Water Action (CWA) is a national citizens' organization that works toward the following goals: affordable water, prevention of health-threatening pollution, creation of environmentally safe jobs and businesses, and the empowerment of people to make democracy work. In addition, CWA organizes grass roots groups, coalitions, and campaigns with the common interest of protecting health and quality of life, so that they may better promote environmental well being within a community. The mailing address of the CWA National Office is 4455 Connecticut Avenue NW – Suite A300, Washington, DC 20008-2328 (Telephone: (202) 895-0420). The mailing address of the CWA Philadelphia Office is 1201 Chestnut Street, #602, Philadelphia, PA 19107. All inquires may be directed to Bob Wendelgass at the Philadelphia Office via e-mail, bwendelgass@cleanwater.org or telephone, (215) 640-8800.

Since its inception in 1950, the ***Montgomery County Planning Commission (MCPC)*** has made great strides in promoting order and development while also preserving the elements of the Montgomery County watershed that define the community's quality of life. The MCPC is an advisory body on the following subjects: land transportation of all types, the environment, water and sewer service, parks and open space, farmland preservation, stormwater management, site design, housing, zoning, development patterns, and the demographic trends within Montgomery County. MCPC is composed of 9 member-appointed Board Members as well as a professional staff of 44, all of who provide support to municipal governments via innovative solutions to the challenges at hand. All questions, comments, and concerns may be voiced to MCPC Director, Kenneth B. Hughes via telephone, (610) 278-3722. The MCPC mailing address is P.O. Box 311, Norristown, PA 19404-0311.

The mission of the ***Schuylkill Riverkeeper Program*** is to protect and restore the Schuylkill River, its tributaries and habitats, through advocacy, enforcement, and citizen action. The Riverkeeper is a field office of the Delaware Riverkeeper Network and collaborates with the Patrick Center for Environmental Research at the Academy of Natural Sciences. The primary focus of the Riverkeeper Program is to identify and restore degraded streambanks throughout the Schuylkill River Watershed while also working with landowners in order to address the effects of sediment and nutrient pollution on waterways, all of which is encompassed within the Schuylkill Riverkeeper's Streambank Restoration Project. All inquiries may directed to Chari Towne via telephone, (610) 469-6005 or e-mail, srk@worldlynx.net. The mailing address of the Schuylkill Riverkeeper Program is P.O. Box 459, St. Peters, PA 19470-0459.

The ***Berks County Conservancy***, a non-profit organization established in 1974, is dedicated to preserving Berks County's unique cultural and environmental heritage for the benefit of future generations. In order to achieve this, the conservancy has focused its efforts on the preservation of agricultural land and open space, the protection of the quality of the streams and groundwater of Berks County, and the preservation of historic landmarks and scenic landscapes, all of which contribute to a sustainable future for the Berks County community. Simply put, protecting water, habitat, and the natural environment are conservancy priorities. Questions may be forwarded to Joseph Hoffman, Director of Environmental Management, via telephone, (610) 372-4992. Berks County Conservancy's mailing address is 960 Old Mill Road, Wyomissing, PA 19610.

It is the mission of the ***Nature Conservancy*** to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters needed to survive. Since its inception in 1951, the Nature Conservancy, the world's largest private international conservation group, has formed partnerships with communities, businesses, and individuals in order to pave the road for the protection of millions of acres of valuable lands and waters worldwide. It is the commitment of the Nature Conservancy to expand the boundaries of conservation in order to save the Earth's last great places for future generations. All questions, comments, and concerns may be directed to Randy Gray, State Director, via telephone, (610) 834-1323 x116. The Nature Conservancy's mailing address is 1100 East Hector Street, Suite 470, Conshohocken, PA 19428.

Formed in September 1995 when the Lower Merion-Narberth Watershed Association merged into the Lower Merion Preservation Trust, the ***Lower Merion Conservancy*** has since acted to protect the Lower Merion area's natural and historic resources, open space, and watersheds for residents and future generations by promoting collective responsibility for these resources via education, advocacy, and research. Questions and concerns may be voiced to Executive Director Mike Weilbacher at (610) 645-9030. The mailing address of the conservancy is 1301 Rose Glen Road, Gladwyne, PA 19035.

The ***Natural Lands Trust*** is a nonprofit regional land trust that is committed to working with the region's communities to protect old-growth forests, diverse wildflower meadows, and dynamic wetlands. Through acquisition, conservation, easements, planning, and education, this organization encourages others to ensure the preservation of natural and cultural resources for many generations to come. Questions may be forwarded to Andy Pitz at (610) 353-5587. The mailing address of the Trust is 1031 Palmer's Mill Road, Media, PA 19063.

Incepted in 1964, the ***Perkiomen Watershed Conservancy*** has since been dedicated to protecting and conserving the natural resources within the Perkiomen Creek Watershed. This nonprofit organization reaches out to the surrounding community via environmental education and land conservation and protection. Questions, comments, and concerns may be forwarded to Executive Director Tish Ryan at (610) 287-9383. The mailing address of the conservancy is 1 Skippack Pike, P.O. Box 55, Schwenksville, PA 19473.

It is the mission of the ***Pennsylvania Environmental Council (PEC)*** to improve the quality of life for all Pennsylvanians. In doing so, PEC enhances the commonwealth's natural and man-made environments by integrating the advocacy, education, and implementation of both community and regional action programs. Director of Watersheds Programs, Ann Smith, will be accepting questions, concerns, and comments at (215) 563-0250. The mailing address of the PEC is 117 South 17th Street, Suite 2300, Philadelphia, PA 19103-5022.

Technical Advisory Group Meetings
Six TAG meetings were held as of September 2001. The following table outlines the date, location, and number of attendees of each meeting.

Table 2.2.7-1 Summary of Technical Advisory Group Meeting Dates and Locations

Meeting	Date	Location	Number of Attendees
1	October 25, 2001	DEP Offices Conshohocken, PA	47
2	January 17, 2001	DEP Offices Conshohocken, PA	29
3	April 4, 2001	DEP Offices Conshohocken, PA	24
4	May 9, 2001	DEP Offices Conshohocken, PA	28
5	June 13, 2001	DEP Offices Conshohocken, PA	19
6	September 24, 2001	DEP Offices Conshohocken, PA	14
			Total Attendees 161

Summarization of Technical Advisory Group Meeting Minutes
These meetings were, in essence, discussion forums in which local stakeholders were enabled to voice their concerns and share their opinions of the project. The following is a summation of the minutes from the first five meetings:

MEETING 1

This meeting acted as an introduction to the Schuylkill River Watershed as well as to the Source Water Assessments. The Schuylkill River Watershed was described as a significant, industrial, agricultural, and commercial corridor, a home to three million people in Pennsylvania, in which 40% of the land is forested, 48% is agricultural, and 12% is developed. The region was cited as a source of heritage, history, culture, and recreation.

- The specific aspects of the Schuylkill River Watershed as a drinking water supply are as follows:
- 58 surface water intakes
- 47 intakes for systems serving < 10,000
- 265 MGD withdrawn on average from the river and its tributaries
- serves over 1.8 million people

The Source Water Assessments were explained to be a multi-phase process. The process identifies potential or existing sources of contamination, evaluates the vulnerability/susceptibility of a water supply to contaminant sources, and determines protection priorities and activities for the water supply. The ultimate goal of a SWA was specified as developing local sources of water protection initiatives and educating the public about the source of their drinking water and its challenges. The SWA was depicted as an iterative and continuous process of assessing, planning, and implementing.

Utilities and stakeholders were encouraged to take an interest in the SWAs because the program was based on federal regulations mandated by Congress. Responding to requests by the public to know more about their water supply and how to protect it, Congress included provisions for a SWA within the Safe Drinking Water Act Reauthorization of 1996. It is the goal of Congress to have 50% of the United States population enveloped under Source Water Protection Plans by 2005.

The SWAs were said to benefit the stakeholders present at the meeting because stakeholders of the TAG would be directly involved by:

- Identifying sources of contamination and areas for protection
- Having their organization highlighted for interested persons to contact/join
- Determining potential linkages between their efforts and protection efforts
- Increasing potential funding opportunities by incorporating projects into approved SWA plans

The Schuylkill River SWA area to be covered was said to be comprised of 42 surface water intakes, 3 PADEP regions, 2,000 square miles of area, 130 miles of river, and 10 counties. The organization of the SWA was described as two distinct, but linked phases.

Phase I is inclusive of:

- seven intakes
- four water systems
- 73% of the population
- 80% of river withdrawal for drinking water supplies
- bottom of the watershed
- industrial/urban/suburban issues

Phase II includes:

- 35 intakes
- 14 water systems
- 27% of the population
- 20% of withdrawal
- headwaters to middle of river
- rural, mining, agricultural, suburban issues

A schedule and timeline were presented in which Phase I, which began in July 2000, was marked for completion by December 2001. Phase II is scheduled to begin in July 2001 and end in July 2003.

MEETING 2

At this meeting Phase I of the SWAs were discussed in greater detail. Of particular focus was the Stakeholder Survey, a document that was sent to stakeholders prior to the meeting which noted key contaminant issues and asked that the recipients rank those issues on a relative scale of zero to one, with one being of the highest priority. Those stakeholders who responded to the survey included one municipal water supplier, one federal agency, and nine not-for-profit agencies. These respondents ranked pathogens and agricultural runoff as those issues having the highest priority with a ranking of approximately 0.7. On the opposite end of the scale, disinfection by-products were ranked as having the lowest priority with a score of 0.2.

The water quality of the Schuylkill River was also discussed. Parameters affecting water treatment were identified. When discussing contaminant source issues, it was determined that contaminant issues will vary with each perspective. For instance, the outlook of a fisherman will be significantly different from that of the upstream water suppliers and likewise, the downstream water suppliers will have a differing perspective than that of the stakeholders. Table 2.2.7-2 outlines the parameters of concern from both a drinking water perspective and a finished water quality perspective.

Table 2.2.7-2 Parameters of Concern for Drinking Water and Finished Water Quality

Drinking Water Perspective	Finished Water Quality Perspective
• Algae – clogs filters • Alkalinity & pH – affect coagulation • Turbidity – impacts coagulant & residual management costs • Metals – require additional chemicals for removal	• Algae – may cause taste & odor episodes • Salts – not removed by treatment & affect those on low sodium diets • *Cryptosporidium* – resistant to chlorine & may affect immune compromised sub-populations • Total Organic Carbon & Bromide – affect disinfection by-product formation

Water quality data, spanning a period of 30 years (1970 – 2000), for dozens of locations in the Schuylkill River Watershed had been compiled from several organizations. Of this data, conductivity, nutrients, metals, salts, and dissolved oxygen were identified as the most frequently monitored parameters, with pesticides, herbicides, and pathogens making up those parameters that are less frequently monitored.

MEETING 3

At this meeting the four main sources of contaminant source compilation were established:

- Right to Know Network (www.rtk.net)
- Envirofacts (www.epa.gov/enviro)
- Efacts (www.dep.state.pa.us/dep/efacts/resources)
- ESRI Business MapPro

Within the RTK and Envirofacts systems, four Federal databases were accessed: PCS (Permit Compliance System), RCRIS (Resource Conservation and Recovery Act Information System), CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Act Information System), and TRI (Toxic Release Inventory). In order to populate the databases, data was downloaded from RTK by county and then "clipped" in RTK for the purpose of eliminating those data points outside of the watershed boundaries. Missing "x-y" coordinates were filled in by geocoding in ArcView and cross-referencing the same facility with other databases and Envirofacts. Facility data was then further cross-referenced with Envirofacts. Quality and contaminant data was populated via Envirofacts.

A second keynote feature of this meeting was the discussion of the process used to evaluate and prioritize the most critical sources within the Schuylkill River Watershed. It was determined that this process must be:

- Inclusive of all potential sources
- Equitably applied everywhere within the watershed

- Logical and well-founded
- Reproducible and defensible

In order to satiate this need, EVAMIX was introduced. This is a computerized matrix based evaluation method and ranking tool that uses a pair-by-pair comparison of each source against each other source via a criterion. This method is capable of performing hundreds of comparisons and calculations while handling units properly, as well as quantitative and qualitative criteria. This method results in a single number or "appraisal score," which is the single number that encompasses all of the data included in the criteria as well as the criteria weights. This number is also representative of the relative rank of Source A against all other sources, which in turn provides a strong foundation for assigning priorities to each particular source. The primary use of EVAMIX is decision support; via this system, it is possible to evaluate alternatives, prioritize options, organize data to facilitate decisions, formalize and document the decision process, and act as evidence in defense of the decision made.

It was determined that the results gathered from the EVAMIX matrix will be further reviewed and "reality checked." Any results for high-ranking sources will be added to other sources outside the scope of the analysis, e.g., highway spills, pipeline breaks, etc. All high-ranking sources will be flagged for follow-up data collection in a later phase in order to verify results.

Zones were broken down into categories "A," "B," and "C" and calculated using the Geographical Information System (GIS) and river time travel estimates. The zone delineation is as follows, beginning with an area-wide inventory:

- Zone A: critical segment, all potential sources
- Zone B: second segment, all significant sources
- Zone C: remainder, just area wide inventory

The goal of the Schuylkill Source Water Assessment was again cited as gaining an understanding of which sources within the Schuylkill River Watershed are most significant and which are not as critical. In doing so, a better understanding of present water quality concerns as well as a sharper focus on the most critical sites will be provided. This, in turn, will lead to a more limited number of high priority sites within the Schuylkill River Watershed.

MEETING 4

A main topic of this meeting was the population of missing data. The Schuylkill River Approach offers controlled screening for point sources as well as for non-point sources which will allow for an end result of a limited number of high priority sites, i.e., approximately 50 sites per intake. Missing information including flow, quantity, chemical group, and SIC code matching PADEP activity were identified.

Another keynote point of this meeting is significance screening, which aids in the development of the best estimate of quantity, concentration at the release point, as well as the dilution at the intake. The steps to be taken regarding this approach are as follows:

- Development of the best estimate of the worst case release (quantity)
- Calculation of concentration at the release point
- Calculation of dilution at the intake
- Comparison to "Threshold Impact"

When too little data is available, screening will be conducted using the number of releases, the amount stored, the chemical stored, and the location relative to the floodplain. Other steps include choosing a Threshold Value in terms of Drinking Water Standards and Ambient Mean Concentrations, determining a background concentration, calculating discharge in order to increase concentration by 10percent of ambient or of standard at the intake, and calculating the amount of spill of pure contaminant where appropriate.

Table 2.2.7-3 outlines the contaminant categories suggested at this meeting as well as their potential fields, for the purpose of populating the databases.

Table 2.2.7-3 Suggested Contaminant Categories and Their Potential Fields

Suggested Contaminant Categories	Potential Fields
Fecal Coliform	• Possible Threshold: 200 count/100ml • Threshold Type: Contact Recreational Water Standard • Discharge Volume to Exceed Threshold: 100 MGD of wastewater die off at 2000 count/100 ml • Spill size to Exceed Threshold: Not Applicable
Turbidity (TSS)	• Possible Threshold: 10 mg/l • Threshold Type: Ambient Concentration • Discharge Volume to Double Threshold: 5 MGD at 200 mg/l (average wastewater) • Spill Size to Double Threshold: 10,000 lb. of silt runoff in one day
Nutrients (Phosphorous)	• Possible Threshold: 0.12 mg/l • Threshold Type: Ambient • Discharge Volume to Exceed Threshold: 5 MGD to raise by 10percent • Spill Size to Exceed Threshold: 110 lb. of pure Phosphorous in one day
VOC (total)	• Possible Threshold: 5 parts per billion (ug/l)

Suggested Contaminant Categories	Potential Fields
	• Threshold Type: Drinking Water Standard for Benzene • Discharge Volume to Exceed Threshold: Not Applicable • Spill Size to Exceed Threshold: < 5 gallons per day of pure product
Metals (Pb as indicator)	• Possible Threshold: 0.015 mg/l • Threshold Type: Drinking water treatment trigger value • Discharge Volume to Exceed Threshold: approx. 1.5 MGD of industrial wastewater at 10 mg/l • Spill Size to Exceed Threshold: approx. 15 lb. per day
Cryptosporidium/Giardia	• Possible Threshold: 1 oocyst per liter • Threshold Type: Drinking Water Guideline Value • Discharge Volume to Exceed Threshold: 10 oocysts per liter
Nitrates	• Possible Threshold: 10 mg/l • Threshold Type: Drinking Water Standard • Discharge Volume to Exceed Threshold: > 50 MGD • Spill Size to Exceed Threshold: 10,000 lb.
DPB Precursors (TOC)	• Possible Threshold: 2.7 mg/l • Threshold Type: Ambient Median Value • Discharge Volume to Raise Threshold by 10percent: 4 MGD of wastewater at 100 mg/l • Spill Size to Exceed Threshold: approx. 2000 lb. per day
Petroleum Hydrocarbons (TPH)	• No Identified Possible Threshold • Threshold Type: Ambient (data sparse) • Discharge Volume to Exceed Threshold: Not yet determined
Salts (Chloride as indicator)	• Possible Threshold: 250 mg/l • Type of Threshold: Drinking Water Standard • Discharge Volume to Exceed Threshold: 1 MGD of brine (sea water) • Spill Size to Exceed Threshold: 200,000 lb. of salt per day

MEETING 5

The primary focus of this meeting was on Source Priority Ranking. In essence, three questions needed to be answered:

- Are criteria missing?
- Are the qualitative scores properly defined?
- Are the criteria priorities (weighting factors) satisfactory to the group?

It was at this meeting that the diverse group including water suppliers, stakeholders, and dischargers reached a consensus on the criteria and the weighting factors to be used for the ranking sources. The group also agreed that the nine criteria of Relative Impact at Intake, Time of Travel, Existing Removal Capacity, Impact on Treatment, Potential Health Impacts, Potential for Release/Controls, Potential for Release Frequency, Violation Type/Frequency, and Location were sufficient to complete the ranking criteria. It was agreed upon that no other criteria were missing. Weighting factors and qualitative definitions were determined for the criteria being used to rank sources across all contaminant categories as well as within the six individual categories, thus answering the three primary questions posed. Tables 2.2.7-4 and 2.2.7-5 outline the actual criteria, criteria type, and the percentages agreed upon for both the nine contaminant categories and the six individual contaminant categories at this fifth meeting of the SWA. Figures 2.27-3 and 2.2.7-4 graphically depict this breakdown.

Table 2.2.7-4 Consensus Weighting Values for Nine Criteria

Criteria	Type	Weight (percent)
Relative Impact at Intake	Intake Related	12
Time of Travel	River Flow Related	5
Existing Removal Capacity	Intake Related	10
Impact on Treatment	Intake Related	10
Potential Health Impacts	User Related	20
Potential for Release/Controls	Source Related	14
Potential for Release/Frequency	Source Related	14
Violation Type/Frequency	Source Related	10
Location	River Flow Related	5

(To be used in the EVAMIX analysis across contaminant categories)

Figure 2.2.7-3 Breakdown of Criteria Type for Contaminant Groups

Contaminant Categories
Source Related Factors: 38%
Intake Related Factors: 32%
User Related: 20%
River Flow Related: 10%

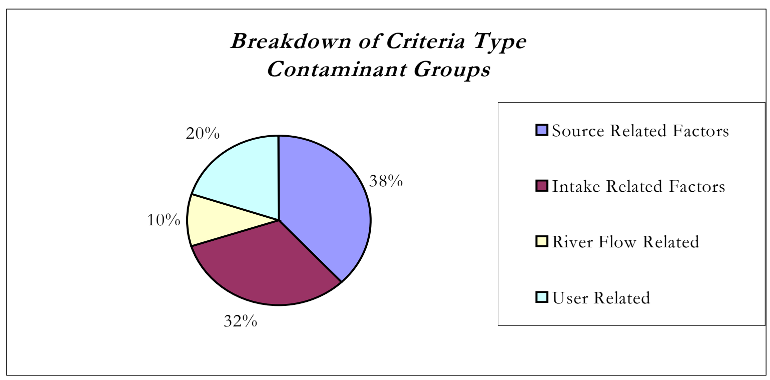


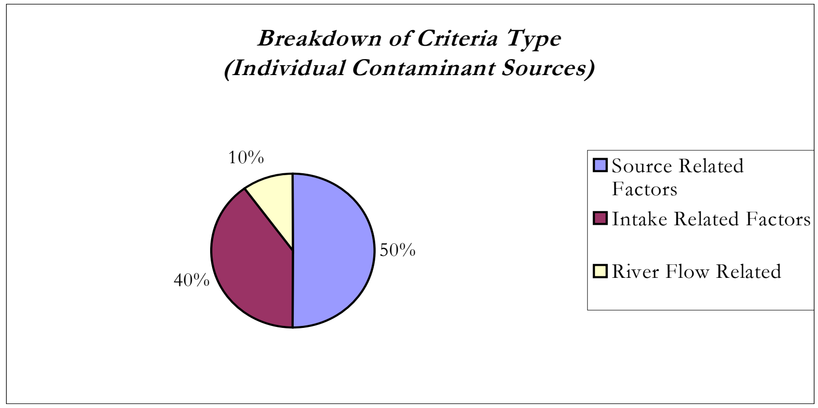
Table 2.2.7-5 Consensus Weighting Values for Six Criteria

Criteria	Type	Weight (percent)
Relative Impact at Intake	Intake Related	40
Time of Travel	River Flow Related	5
Potential for Release/Controls	Source Related	20
Potential for Release/Frequency	Source Related	15
Violation Type/Frequency	Source Related	15
Location	River Flow Related	5

(To be used in the EVAMIX analysis within individual contaminant categories)

Figure 2.2.7-4 Breakdown of Criteria Type for Individual Contaminant Groups

Individual Contaminant Categories
Source Related Factors: 50%
Intake Related Factors: 40%
River Flow Related: 10%



2.2.7.2 Public Meetings

In an attempt to better educate the public about the importance of the Source Water Assessment Program (SWAP), two public kick-off meetings were conducted. Each public kick-off meeting utilized the following general approach in order to generate public interest:

- Press releases produced by the Philadelphia Water Department and the local stakeholders were sent to the local media and newspapers
- Legal notices were sent to the local media and newspapers
- Advertisements were published in the Pennsylvania Department of Environmental Protection (PADEP)'s *Update*

Hosted by local watershed organizations to promote a sense of credibility as well as to establish a connection with local residents, these meetings were, in essence, informational forums where members of the public were able to voice their concerns as well as share their visions for the project. Table 2.2.7-6 outlines the host, location, date, and number of attendees for the two public meetings.

Table 2.2.7-6 Public Kickoff Meetings Held for PWD's Intakes

Meeting	Host(s)	Location	Date	Number of Attendees
1	Wissahickon Valley Watershed Association	Wissahickon Valley Watershed Association Ambler, PA	2/20/01	8
2	Schuylkill Environmental Education Center	Schuylkill Environmental Education Center Philadelphia, PA	3/14/01	8
				Total Attendees 16

A standard meeting agenda was developed and followed at each meeting. The agenda included an introduction, an explanation of the purpose of the meeting and an overview of Source Water Assessments, which included a brief yet thorough description of the SWAP as well as the areas to be assessed, i.e., the Schuylkill River Watershed. In addition, a discussion of contaminant source issues and water quality concerns was a keynote feature of the agenda. Finally, each meeting was concluded with an exercise in identification of potential contaminant sources, in which the attendees were asked to identify local sites that may impact the water supply. Questions, concerns, and comments were addressed as they were raised.

Prior to these kick-off meetings, several avenues were pursued in an attempt to notify the public. Letters produced by the Philadelphia Water Department, local stakeholders, and watershed groups specifying the location and directions, date, time and nature of the meetings were mailed to numerous stakeholders, including many of the businesses, government agencies, and environmental organizations located within or affected by the Schuylkill River Watershed. The information contained in these letters was also posted on the SWAP website, www.schuylkillswa.org. In order to further generate public interest, various watershed groups and local stakeholders posted flyers throughout their respective areas and sent press releases to their local newspapers. Additionally, many of the local newspapers featured articles describing the nature of the meetings as well as the outcome, where applicable. Legal notices detailing the location, time, and date of each meeting were printed in the newspapers local to each area with which the SWAP is affiliated for the purpose of opening the meetings to everyone within the watershed. Table 2.2.7-7 is illustrative of the publications in which the legal notices appeared, the dates of publication, and the general areas reached

Table 2.2.7-7 Legal Notices Published for Public Kickoff Meetings

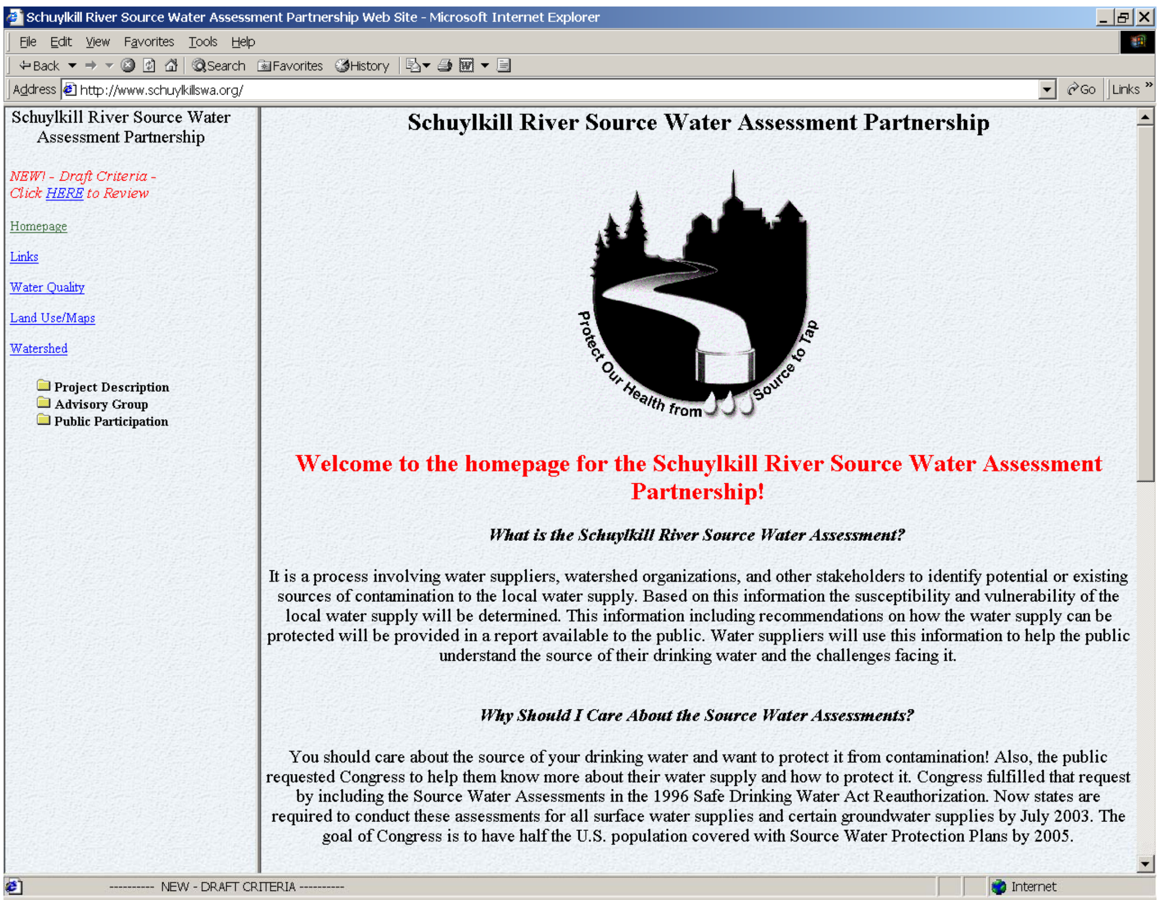
Date of Notice	Publication Name	Area Reached
2/14/01	The Ambler Gazette	Ambler, PA
3/12/01	The Philadelphia Daily News	Philadelphia, PA
3/12/01	The Philadelphia Inquirer	Philadelphia, PA

2.2.7.3 Website

A website was developed for the project (*www.schuylkillswa.org*) in order to provide a location where information about the project could be easily accessed by the public and stakeholders (see Figure 2.2.7-5). Though this was a task beyond the scope of the contract, it was considered to be a necessary form of information delivery. Most importantly, the website was considered to be the best way of providing the advisory group meeting information, meeting handouts, and meeting minutes without producing a significant burden of production on staff, given that there are over 200 stakeholders to mail information to on a quarterly basis at minimum.

The website was set up to provide general information about the purpose of the SWAPs and who to contact for information. It also provided links to information about public meetings, advisory group meetings, meeting materials, general watershed information, limited maps, watershed organizations, and general water quality information. Another special feature was an on-line stakeholder survey that stakeholders could fill out information about their water quality issues.

Figure 2.2.7-5 Picture of Schuylkill River SWAP Website (www.schuylkillswa.org)



2.2.8 Belmont Intake Conclusions and Recommendations

The following section discusses the findings of the assessment, and provides recommendations for projects and initiatives that are general (for the entire watershed), regional, and intake specific. It also attempts to provide some specific examples of the best management practices that could be employed on some of the recommended projects.

Overall, the following activities were identified as having high priority for protection efforts to address:

- Sanitary sewer overflows of raw sewage from sewer collection systems, sewage lift stations, and manholes from upstream communities
- Combined sewer overflows from upstream communities such as Bridgeport and Norristown
- Urban, residential, and agricultural runoff from various areas of the watershed, mostly located along the main stem of the Schuylkill River from Reading to Philadelphia
- Discharges from municipal and industrial sources such as sewage treatment plants and chemical manufacturing facilities
- Acid mine drainage from Schuylkill County
- Spill and accidents from cars, tanker trucks, railroad cars, pipelines, tire piles, and fires at industrial facilities near the river and its tributaries

Table 2.2.8-1 summarizes the protection priorities assigned to the various types of sources overall and for each contaminant category that could be quantified. As described above, runoff/non-point sources and municipal or industrial discharges had the greatest overall priority compared to other sources.

It is important to note that just because an activity is given a high priority that does not mean that any individual site is in violation of current environmental laws and regulations or impacts on the water quality at the facility. An activity with a high ranking means that it could possibly have a high potential to negatively impact the water supply quality under certain conditions.

Table 2.2.8.1 Summary of Protection Priority of Various Types of Potential Contaminant Sources

(A-C = significant protection priority, D-F = lower protection priority)

Contaminant Group	Permitted Municipal and Industrial Dischargers (NPDES)	Urban, Residential, and Agricultural Runoff	Industrial Facilities with Toxic Releases (TRI)	Hazardous Waste Facilities (RCRA)	AST (storage tanks)	CERCLA (landfills)	CSOs & SSOs	Acid Mine Drainage	Spills & Accidents
Overall (combined)	A-C	A-C	C	D-F	C	C	A	A	A
Chloride	D-F	A-C	A-C	D-F	A	C	D-F	D-F	A
Cryptosporidium	A-C	C	D-F	D-F	D-F	D-F	A	D-F	A
Fecal Coliforms	A-C	A-C	D-F	D-F	D-F	D-F	A	D-F	A
Metals	A-C	B-C	A-C	B-C	C	C	N/A	A	A
Nitrate	A-C	B-C	A-C	D-F	D-F	D-F	C	D-F	A
Petroleum Hydrocarbons	D-F	A-B	D-F	D-F	A-C	A	D-F	D-F	A
Phosphorus	A-C	B-C	A-C	D-F	A	D-F	C	D-F	A
Disinfection By Products	A-C	B-C	C	D-F	A	C	D-F	D-F	C
Turbidity	A-C	B-C	D-F	D-F	D-F	D-F	D-F	D-F	C
Volatile Organic Compounds	A	D-F	A-B	B-C	A-C	C	D-F	D-F	A
Herbicides/Pesticides	N/A	A	N/A	B-C	D-F	C	N/A	D-F	A
Radionuclides	A*	D-F	D-F	D-F	D-F	D-F	D-F	D-F	C

**only two locations*
Note: if only one source fell into a protection priority, that rank was given to the type of source for a given contaminant group
Just because an activity is given a high priority does not mean that any individual site is in violation of current environmental laws and regulations. An activity with a high ranking means that it could possibly have a high potential to negatively impact the quality of the water supply under certain conditions.

Geographically, most of the priority point sources for the Belmont Intake are located within priority non-point source watersheds. In fact, over 82% of the point sources fell within priority non-point source watershed areas. Over 90% of the high-protection priority point sources fell within priority non-point source watershed areas. Therefore, it appears that, in general, protection and restoration efforts should be focused in those areas.

Tables 2.2.8-2 and 2.2.8-3 provide summaries of the protection priorities for point and non-point sources in various watershed areas. Overall, the primary focus of PWD's protection efforts to protect and improve their water supply should include the main stem areas of the Schuylkill River between Reading and Philadelphia, and the Wissahickon Creek subwatersheds. The Valley Creek, Perkiomen Creek, Manatawny Creek, and Tulpehocken Creek subwatersheds have secondary protection priority. However other parts of the watershed may need limited attention for contaminant specific issues (i.e. metals and acid mine drainage).

Table 2.2.8-2 Summary of Protection Priority Ranking of Various Main Stem Schuylkill Areas for Point and Non-point Sources

	Protection Priority			
River Segment	**A High**	**B Moderately High**	**C Moderate**	**D-F Low**
Philadelphia – Conshohocken	N & P			
Conshohocken – Norristown	N & P			
Norristown to Valley Forge	N & P			
Valley Forge to Phoenixville	N & P			
Phoenixville to Royersford	P			N
Royersford to Pottstown	P	N & P	P	
Pottstown to Douglassville	P	N & P	P	
Douglassville to Reading	P	N & P	P	
Reading to Leesport	P	N & P	P	
Upper Schuylkill	P*	P		N
Little Schuylkill River	P*			N

** untreated sewage communities and acid mine drainage only*
N – Non-point source runoff, P- Point sources

Table 2.2.8-3 Summary of Protection Priority Ranking of Various Tributaries for Point and Non-point Sources

	Protection Priority			
Tributary / Watershed	**A High**	**B Moderately High**	**C Moderate**	**D-F Low**
Wissahickon Creek	N & P		P	
Perkiomen Creek	P	N & P	P	
Valley Creek		N	P	
Pickering Creek				N & P
French Creek				N & P
Manatawny Creek		N & P		
Monocacy Creek				N & P
Hay Creek				N & P
Allegheny Creek				N & P
Tulpehocken Creek			N & P	
Maiden Creek				N & P

2.2.8.1 General Recommendations

Based on the results of the susceptibility analysis, water quality data, and stream impairments, it is clear that the impacts from stormwater runoff need to be addressed from the communities along the main stem of the Schuylkill River from Reading to Philadelphia. Efforts to reduce these impacts require:

- Development of incentives for upstream communities to mitigate stormwater runoff;
- Education of township officials along the protection priority corridor about stormwater impacts;
- Preservation of existing greenspace along the Schuylkill River in the protection area;
- Acquisition of conservation easements or adjustment of zoning areas or local ordinances to reduce stormwater impacts from future development in the protection priority corridor between Philadelphia and Reading;
- Enforcement of the Phase II stormwater regulations for townships in the protection priority corridor between Philadelphia and Reading;
- Enforcement of compliance requirements for industries and municipalities discharging wastewater into the protection priority corridor between Philadelphia and Reading;
- Development and support of watershed or local community/environmental organizations to restore and protect various segments of the protection priority corridor between Philadelphia and Reading;

- Ensure that TMDL process and requirements along the Schuylkill River include components to address drinking water impacts;

- Development of special state or federal legislation that provides funding and authority for water supply protection efforts in the protection priority corridor between Philadelphia and Reading.

- Include *Cryptosporidium* impacts in the permitting process for wastewater dischargers upstream of drinking water intakes.

In addition, the following actions are recommended for protection efforts in the Wissahickon Creek Watershed:

- Development of regulatory and financial incentives for enhanced wastewater discharge for pathogen removal and inactivation to address *Cryptosporidium* impacts;

- Development of incentives and controls for mitigation of stormwater runoff impacts. This includes requiring that current TMDL efforts in the watershed include specific components to address drinking water issues and concerns. This will provide an example of how the Safe Drinking Water Act and Clean Water Act should be integrated.

- Conduct an examination of current zonings and ordinances with the Montgomery County Planning Commission, Montgomery County Conservation District, and local townships to determine ways they can be enhanced to address current and future stormwater impacts. Identify areas where innovative techniques and incentives can be used to mitigate stormwater impacts and assist in the development and implementation of these efforts.

- Support of existing greenways, riparian corridor areas, and future riparian corridor easement and acquisition being conducted by the Wissahickon Valley Watershed Association and Montgomery County;

- Encourage and support the development of an Act 167 Stormwater Management Plan for the Wissahickon Creek.

The Philadelphia Suburban Water Company already works with numerous stakeholders to protect its water supply in the Perkiomen Creek. Therefore, it is recommended that any protection efforts be coordinated with the Philadelphia Suburban Water Company environmental initiatives and programs in the Perkiomen Creek Watershed.

In addition to the previous specific geographic recommendations, the following general efforts are recommended:

- Emergency Response Planning activities should be focused on priority AST, TRI, and RCRA facilities since they have been shown to have the greatest relative impact on water quality. Efforts should also be initiated to collect more detailed data on these sites for reprioritization. Also, state authorities should be encouraged to implement a 2-hour notice requirement for downstream users from spills instead of allowing 24- hour requirement since most spills can make it to a number of intakes in less than a day under various conditions.

- Given the potential catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the main stem Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that USGS should be involved in the implementation of the early warning system.

- Long-term protection efforts by PWD should be focused on enhancing wastewater discharges and mitigating stormwater runoff. These will have the greatest overall impacts on improving source water quality.

- Sources of pathogens appear to be the sources of greatest priority to PWD when examined in the overall rankings. Therefore, these sources should be addressed accordingly.

- Given the significant amount of activity in the watershed by various organizations, protection efforts should be coordinated in such a way as to support and enhance existing efforts in the watershed.

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- A workshop should be sponsored by PADEP to educate golf courses about the benefits of joining the environmental certification program by the Audobon Society.

- Special mechanisms and funding should be developed to allow the distribution of monies to support or initiate specific initiatives outside the City of Philadelphia that will protect or restore the water supply. This may involve development of a quasi-governmental or non-profit organization that can raise funds and distribute them to various organizations conducting protection activities beneficial to PWD. This organization may also need the ability acquire conservation easements or land in sensitive areas to maintain protected areas.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts.

2.2.8.2 Regional Recommendations:

There are several regional recommendations based on the results of the study and stakeholder input. These include the following:

- Development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection. This would include a special matching source water protection grant fund for the Schuylkill River Watershed that members would contribute to the state for matching. The watershed council, including representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations, would then review the grant applications and fund the projects with the most value to water supply protection.

- Development of a coordinated regional protection plan that will be adopted by water suppliers, planning commissions, and municipalities for establishment and protection of sensitive and high priority protection areas to the multiple and overlapping water supply areas between Reading and Philadelphia.

- Enforcement of rigorous and regular revision and implementation of ACT 537 Sewage Facilities Management Plans in Montgomery, Chester, Berks, and Schuylkill counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems.

Recommendation #1 – A Watershed Coalition and Local Source Water Protection Grant Funding Process

The development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection is strongly needed in the watershed. The goal is to develop a partnership of state, public, and private organizations to specifically address and implement source water protection projects. Conceptually, members of the coalition would be required to pay a membership fee to a state matching fund account. The membership fee would be based on the size of the organization and type of organization. For example, large water suppliers would be required to pay the largest membership fees (several thousand dollars) while small water suppliers would only be required a token $50-$100 fee. The fees for planning commissions, public agencies, or environmental organizations would need to be determined.

The membership fee would be placed in a special state fund that is matched by that state for implementation of source water protection projects. Requests for proposals would be distributed to watershed organizations and other stakeholders to implement protection projects. Suggested locations and types of projects based on the results of the Source Water Assessments and regional source water protection plan will be recommended to proposers depending on the area of the project. Representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and recommend funding to projects with the most value to water supply protection.

For example, if the membership raised $100,000 and was matched by PADEP into this special fund, a total of $200,000 would be available for projects. This could fund four to five specific protection projects a year such as parking lot bmps, streambank restoration, riparian buffer plantings, streambank fencing, detention pond retrofits, etc. This would result in potentially 20 coordinated and focused source water protection projects being implemented in high protection priority areas over four years. This positive interaction with local community organizations would also raise awareness of source water protection issues and increase public awareness and potentially spur other project partnerships between private, public, and community organizations beyond the confines of the grant process and the watershed coalition.

Recommendation #2 - A Regional Source Water Protection Plan For Protection of the Source Water Protection Priority Corridor from Philadelphia to Reading

The same high priority protection areas along the main stem Schuylkill River from the SWAs of PWD's intakes overlaps significantly with the protection priority areas from SWAs for the Pennsylvania American Water Company – Norristown, Philadelphia Suburban Water Company, Phoenixville Boro, Citizen's Utilities – Royersford, and Pottstown Boro water supply intakes. Therefore, the development of a regional source water protection plan for these intakes would provide the necessary coordination of source water protection projects to prevent duplication, overlap, and conflicting source water protection efforts. This plan would designate "home" areas where each water supplier would lead specific localized efforts and "team" areas where all water suppliers shared interest and need to coordinate and organize efforts accordingly.

This protection corridor also warrants special assistance, as evidenced by stream impairments and recreational water quality issues. The runoff and point sources in this corridor impact the water supplies for the over 1.3 million people that receive drinking water from these sources in the Berks, Chester, Montgomery, and Philadelphia county area. Given that many industries also withdraw water for electric generation and the majority of persons in the watershed reside in or near the protection corridor and conduct recreation in or along it, the benefits to aquatic life, recreation, industry, and quality of life for citizens in general are significant and cannot be ignored. The protection priority corridor is also coincidentally the location of significant efforts for greenway creation and recreational trails. In this case, the desire for increased recreational opportunities and greenways coincides with a desire for greenways to protect water supplies and represents a significant opportunity for numerous stakeholders to benefit.

Priority for funding of Growing Greener and DCNR grants for projects in the protection priority area should be given to projects that address sustainable mitigation of stormwater impacts and restoration or preservation of areas. In addition, agricultural land within the protection priority corridor would also be given easier access and higher priority for USDA funding such as EQIP or CRP to keep sensitive land areas out of production to protect local streams. PADEP and USDA could designate farms within the priority protection area as high priority for development of nutrient management plans. Townships located within the priority protection area should also be required to adopt uniform ordinances to address stormwater impacts from current and future activities.

Recommendation #3 – Rigorous Enforcement of Act 537 Sewage Facilities Management Plan Revision and Implementation

A number of the sewage related issues identified during the assessment were related to the operation, maintenance, and planning of sewer systems in the watershed. Therefore, rigorous enforcement, revision, and implementation of ACT 537 Sewage Facilities Management Plan are required throughout Montgomery, Chester, Berks, and Schuylkill counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems. The ACT 537 already has many components in it designed to assist counties with addressing sewer overflow problems and be linked or integrated with Phase II stormwater compliance for municipalities since many overflows are stormwater related.

2.2.8.3 Intake Specific Recommendations: Example Project List and Best Management Practices

There a numerous specific projects that can be implemented throughout the watershed to protect and improve water supplies. The following list of projects provides a project title and location, potential project partners, and a general description of the components that could be incorporated into the protection project.

It may not be possible to implement all of the projects listed due to numerous unforeseen and unknown issues. Therefore, the list should be used as a resource to brainstorm and provide techniques for other projects that may be just as effective and valuable for source water protection. Specific descriptions and pictures of technologies and techniques that have been used locally or nationally to address a specific issue are provided in section 2.2.8.4 so that the reader can envision the mentioned technologies.

Some specific projects or initiatives include:

1. Extension of the Belmont Intake Protection Area Meadow

2. Venice Island and Manayunk Canal development/redevelopment ordinances, runoff controls, and best management practices

3. Lower Merion Township riparian buffer protection & stormwater mitigation

4. Alternative road salt technology initiative

5. Mitigation of illegal sewage discharges and failing septic systems and park land creation at River Road

6. Innovative stormwater controls for redevelopment of waterfront properties in Conshohocken, Norristown, Bridgeport, and Pottstown business & industrial parks

7. Best management practices at city and suburban golf courses

8. Corporate environmental stewardship program

Project #1 - Extension of the Belmont Intake Protection Area Meadow

Location: West River Drive, Fairmount Park

Partners: Philadelphia Water Department, Fairmount Park Commission

Description: This project would extend the current demonstration meadow at the Belmont Intake approximately 0.25 miles upstream to the Strawberry Mansion Bridge. This would provide a riparian buffer to reduce runoff and erosion impacts near the intake as well as deter geese. The area would have interpretive and educational signage to educate park users about the source of their water.

Project #2 - Venice Island and Manayunk Canal development/redevelopment ordinances, runoff controls, and best management practices

Location: Venice Island / Manayunk Canal

Partners: Manayunk Development Corporation, Philadelphia Planning Commission, Developers, Philadelphia Streets Department, Philadelphia Water Department, Fairmount Park Commission

Description: The development of a focused stormwater plan for this highly developed area should include special ordinances developed for the Manayunk / Venice Island Area that require the installation of appropriate technologies to treat and/or reduce the amount or intensity of runoff from parking lots and rooftops prior to discharge into the Manayunk Canal or Schuylkill River. It would also include a program of several focused public/private partnership projects to reduce and/or treat stormwater runoff from parking lots and rooftops. This could include the use of rain barrels, development of rain gardens on vacant lots, infiltration swales or ditches in parking lots, and planting of trees in parking lots to reduce temperature impacts.

Project #3 - Lower Merion Township riparian buffer protection & stormwater mitigation

Location: Saw Mill Run, Mill Creek, and Gulley Run.

Partners: Lower Merion Township, Lower Merion Conservancy, Philadelphia Water Department, Philadelphia Country Club

Description: Develop ordinances preventing mowing of streambank areas while identifying partners for streambank plantings to reduce erosion or demonstrate aesthetically pleasing alternatives to mowed streambanks. A series of projects to reduce stormwater runoff could be implemented in areas of high impervious cover that have no runoff controls such as detention basins. In these areas projects such as infiltration ditches and swales for ground runoff or rain barrels for roof runoff should be piloted.

Project #4 - Alternative road salt technology initiative

Location(s): West River Drive, Kelly Drive, Chestnut Hill, Manayunk, Belmont, City Line Avenue, Lower Merion Township

Partners: Manayunk Development Corporation, Philadelphia Streets Department, Philadelphia Water Department, Pennsylvania Department of Environmental Protection, Lower Merion Township

Another component would also include testing alternative technologies to reduce the amount of salt applied to roads and parking lots in the area during the winter while maintaining safety. This could include finding funding sources to acquire special "fogging" machines that put down light mists of salt water on a road that require less salt application on an area.

Project #5 - Mitigation of illegal sewage discharges and failing septic systems and park land creation at River Road

Location: River Road, Philadelphia

Partner: Federal Emergency Management Agency, The State of Pennsylvania, The City of Philadelphia, and Schuylkill Environmental Education Center

Description: Failing septic systems or illegal sewage discharges into the river upriver from floodplain properties on River Road, jeopardize the recreational water quality of the Schuylkill River and the entrance to the Manayunk Canal. A long-term program of acquisition of the properties to link the Schuylkill Environmental Education Center and Fairmount Park area along the canal to the Philadelphia City limits would eliminate these discharges and reduce future issues with floodplain development in the area.

Project #6 - Innovative stormwater controls for redevelopment of waterfront properties in Conshohocken, Norristown, Bridgeport, and Pottstown business & industrial parks

Location: Riverfront areas along Conshohocken, Norristown, Bridgeport, and Pottstown

Partners: Municipalities, Montgomery County Planning Commission, Philadelphia Water Department, Pennsylvania American Water Company, Philadelphia Suburban Water Company, Montgomery County Conservation District

Description: This project includes installation of new technologies to treat and/or reduce the amount or intensity of runoff from parking lots and rooftops prior to discharge into the Schuylkill River. It would also include a program of several focused public/private partnership projects to reduce and/or treat stormwater runoff from parking lots and rooftops. This could include the use of rain barrels, development of rain gardens on vacant lots, infiltration swales or ditches in parking lots, pervious pavement, conversion of detention basins into treatment wetlands, and planting of trees in parking lots to reduce temperature impacts and reduce rainfall that reaches the pavement. These technologies could be implemented upon initial construction/redevelopment or be added to currently redeveloped areas in such a way as to improve aesthetics.

Project # 7 – Encouraging best management practices at city and suburban golf courses

Location(s): Walnut Lane Golf Course, Philadelphia Country Club, and Eagle Lodge Country Club

Partners: Philadelphia Water Department, Lower Merion Township, Whitemarsh Township, Philadelphia Department of Recreation, Riverbend Environmental Education Center, Schuylkill Environmental Education Center, Philadelphia Country Club, and Eagle Lodge Country Club

Description: The three golf courses mentioned are located in high priority areas for source water protection. The owners, managers, and members of the golf course need to be educated about the importance of their property and how significant it is to the protection of the water supply. Also, efforts should be made to inventory and examine the environmental practices of the golf courses to identify improvements that can be made over time. One specific way is to encourage the golf courses to obtain Audobon certification, which requires certain levels of self-audit and successful implementation. Since the country clubs are located nearby two very active environmental centers with good education programs and members of both the country clubs may also be members of the environmental centers, they should be involved in the process to maximize education opportunities and build neighborhood public-private environmental relationships.

Project # 8 – A corporate environmental stewardship program

Project Partners: PWD, Partnership for the Delaware Estuary, Chester County Water Resources Authority, Schuylkill Environmental Education Center, Schuylkill Riverkeeper

Description: A program that engages, educates, and rewards businesses for participating in and completing various levels of source water protection should be established. The goals of this program include the following:

- Increase businesses' awareness about the water supply and runoff impacts

- Provide opportunities for businesses to engage in piloting, demonstrating, or implementing various activities to reduce runoff from their location or other location(s) identified by stakeholders

2.2.8.4 Data Needs

Based on the various analyses that were conducted to identify specific sources of contamination, their location, and other characteristics, the following data gaps and information needs were identified.

Study of Cryptosporidium Presence in Wastewater Effluents

The national guidance documents for the SWAPs and DEP's own SWAP process has very specific interests in identifying and ranking sources of *Cryptosporidium*. However, the information, data, and tools were not available at the local level for an accurate analysis of this information. Preliminary studies by the Philadelphia Water Department, Philadelphia Suburban Water Company, and the PADEP have detected *Cryptosporidium* frequently at elevated levels in raw and treated sewage. The potential contribution of the pathogen *Cryptosporidium* from wastewater discharges, unsewered communities, and illicit discharges upstream of drinking water supplies is necessary to understand the daily impacts they have on pathogen challenges to the water treatment plants downstream. This could lead to strategies to reduce routine levels or viability of *Cryptosporidium* from discharges and better protect water supplies. Over the past three years, the Water Environment Research Federation has been conducting a research method to accurately detect and quantify levels of *Cryptosporidium* in wastewater. This study is almost complete and it is recommended that local studies that are conducted use this new method.

Shared GIS Information

Compilation and housing of up-to-date GIS information for upstream municipalities including sewer and stormsewer infrastructure characteristics (sewersheds, outfalls), zoning areas, ACT 167 information, preserved or potentially preserved agricultural land, county and township park lands, lands with conservation easements. Better information on abandoned or historical industrial sites and brownfields is also needed. Suggested partners interested in housing this information include the Delaware River Basin Commission.

2.2.8.5 Selection of Best Management Practices in Proposed Protection Projects

Selection of best management practices (BMPs) requires the careful weighting of various factors including capital and operational costs, land consumption, and effectiveness. This section describes the various costs and choices when selecting any BMPs.

There are two types of BMPs that can be employed to address stormwater runoff, structural and non-structural. Structural practices usually involve the construction of some control structure or device. Non-structural practices usually involve activities that include changing public behavior and land use practices through education, training, and legal requirements. A comprehensive list of these practices is provided below in Tables 2.2.8-4 and 2.2.8-5.

Table 2.2.8-4 Structural BMPs for Stormwater Control

Ponds
Dry extended detention ponds
Wet ponds
Infiltration practices
Infiltration basin
Infiltration trench
Porous pavement
Filtration practices
Bio-retention
Sand and organic filters
Vegetative practices
Stormwater wetland
Grassed swales
Grassed filter strip
Runoff pretreatment practices
Catch basins/Catch basin insert
In-line storage
Manufactured products for stormwater inlets

Table 2.2.8-5 Nonstructural BMPs for Stormwater Control

Experimental practices
Alum injection
On-lot Treatment
On-Lot treatment
Better site design
Buffer zones
Open space design
Urban forestry
Conservation easements
Infrastructure planning
Narrower residential streets
Eliminating curbs and gutters
Green parking
Alternative turnarounds
Alternative pavers
BMP inspection and maintenance
Ordinances for post-construction runoff
Zoning

Employment and selection of the various structural BMP techniques and technologies requires additional familiarity with the pros and cons of the technologies, site selection and design issues, operation and maintenance and costs. Tables 2.2.8-6 and 2.2.8-7 provide examples of estimates of capital and maintenance costs of various structural BMPs. Table 2.2.8-8 provides estimated land consumption for various structural BMPs. Table 2.2.8-9 provides a description of the various contaminants non-structural BMPs can address. Table 2.2.8-10 through 14 provide data on the effectiveness of pollutant removal by various BMPs. These tables are taken directly from EPA's website at **URL:** http://www.epa.gov/ost/stormwater/usw_d.pdf .

Table 2.2.8-6 Base Costs of Typical Applications of Stormwater BMPs

BMP Type	Typical Cost ($/BMP)	Application	Data Source
Retention Basin	$100,000	50-Acre Residential Site (Impervious Cover = 35%)	Adapted from Brown and Schueler (1997b)
Wetland	$125,000	50-Acre Residential Site (Impervious Cover = 35%)	Adapted from Brown and Schueler (1997b)
Infiltration Trench	$45,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from SWRPC (1991)
Infiltration Basin	$15,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from SWRPC (1991)
Sand Filter	$35,000-$70,000[2,3]	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from Brown and Schueler (1997b)
Bioretention	$60,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from Brown and Schueler (1997b)
Grass Swale	$3,500	5-Acre Residential Site (Impervious Cover = 35%)	Adapted from SWRPC (1991)
Filter Strip	$0-$9,000[3]	5-Acre Residential Site (Impervious Cover = 35%)	Adapted from SWRPC (1991)

1. Base costs do not include land costs.
2. Total capital costs can typically be determined by increasing these costs by approximately 30%.
3. A range is given to account for design variations.

Source: *http://www.epa.gov/ost/stormwater/usw_d.pdf*

Table 2.2.8-7 Operation and Maintenance Cost Estimates

BMP	Annual Maintenance Cost (% of Construction Cost)	Source(s)
Retention Basins and Constructed Wetlands	3%-6%	Wiegand et al, 1986 Schueler, 1987 SWRPC, 1991
Detention Basins[1]	<1%	Livingston et al, 1997; Brown and Schueler, 1997b
Constructed Wetlands[1]	2%	Livingston et al, 1997; Brown and Schueler, 1997b
Infiltration Trench	5%-20%	Schueler, 1987 SWRPC, 1991
Infiltration Basin[1]	1%-3%	Livingston et al, 1997; SWRPC, 1991
	5%-10%	Wiegand et al, 1986; Schueler, 1987; SWRPC, 1991
Sand Filters[1]	11%-13%	Livingston et al, 1997; Brown and Schueler, 1997b
Swales	5%-7%	SWRPC, 1991
Bioretention	5%-7%	(Assumes the same as swales)
Filter strips	$320/acre (maintained)	SWRPC, 1991

1. Livingston et al (1997) reported maintenance costs from the maintenance budgets of several cities, and percentages were derived from costs in other studies

Table 2.2.8-8 Land Consumption of Various BMPs

BMP Type	Land consumption (% of Impervious Area)
Retention Basin	2-3%
Constructed Wetland	3-5%
Infiltration Trench	2-3%
Infiltration Basin	2-3%
Porous Pavement	0%
Sand Filters	0%-3%
Bioretention	5%
Swales	10%-20%
Filter Strips	100%

Note: Represents the amount of land needed as a percent of the impervious area that drains to the practice to achieve effective treatment.
Source: Claytor and Schueler, 1996

Table 2.2.8-9 Non-Structural BMPs Suited to Controlling Various Pollutants
Pollutant Appropriate BMPs

	BMPS
Solids	Street Sweeping Land Use Modifications
Oxygen-Demanding Substances	Street Sweeping Education: Storm Drain Stenciling Land Use Modifications Education: Pet Scoop Ordinance Illicit Connections Eliminated
Nitrogen and Phosphorus	Street Sweeping Education: Pet Scoop Ordinance Land Use Modifications Proper Materials Handling Illicit Connections Eliminated Education: Lawn Care Materials Storage and Recycling
Pathogens	Illicit Connections Eliminated Land Use Modifications Education: Pet Scoop Ordinance
Petroleum Hydrocarbons	Street Sweeping Education: Storm Drain Stenciling Proper Materials Handling Illicit Connections Eliminated Materials Storage and Recycling Land Use Modifications
Metals	Street Sweeping Education: Storm Drain Stenciling Proper Materials Handling Illicit Connections Eliminated Materials Storage and Recycling Land Use Modifications
Synthetic Organics	Illicit Connections Eliminated Education: Storm Drain Stenciling Proper Materials Handling Education: Lawn Care Materials Storage and Recycling Land Use Modifications
Temperature	Land Use Modifications
pH	Illicit Connections Eliminated Proper Materials Handling Materials Storage and Recycling Land Use Modifications

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 2.2.8-10 Structural BMP Expected Pollutant Removal Efficiency

BMP Type	Typical Pollutant Removal (percent)				
	Suspended Solids	Nitrogen	Phosphorus	Pathogens	Metals
Dry Detention Basins	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Retention Basins	50 - 80	30 - 65	30 - 65	< 30	50 - 80
Constructed Wetlands	50 - 80	< 30	15 - 45	< 30	50 - 80
Infiltration Basins	50 - 80	50 - 80	50 - 80	65 - 100	50 - 80
Infiltration Trenches/ Dry Wells	50 - 80	50 - 80	15 - 45	65 - 100	50 - 80
Porous Pavement	65 - 100	65 - 100	30 - 65	65 - 100	65 - 100
Grassed Swales	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Vegetated Filter Strips	50 - 80	50 - 80	50 - 80	< 30	30 - 65
Surface Sand Filters	50 - 80	< 30	50 - 80	< 30	50 - 80
Other Media Filters	65 - 100	15 - 45	< 30	< 30	50 - 80

Source: Adapted from US EPA, 1993c.

Table 2.2.8-11 Pollutant Removal by Infiltration Practices

Parameter	Median or Average Removal Efficiency (percent)	Number of Observations
Total Phosphorus	65	5
Ammonia-Nitrogen	83	3
Nitrate	82	3
Total Nitrogen	83	2
Suspended Solids	89	2
Organic Carbon	82	1
Lead	98	1
Zinc	99	1

Source: Brown and Schueler, 1997a

Table 2.2.8-12 Pollutant Removal by Retention Basins

Parameter	Median or Average Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	34	-12	90	20
Total Phosphorus	46	0	91	44
Ammonia-Nitrogen	23	-107	83	14
Nitrate	23	-85	97	27
Organic Nitrogen	23	2	34	6
Total Nitrogen	30	-12	85	24
Suspended Solids	70	-33	99	43
Bacteria	74	-6	99	10
Organic Carbon	35	-30	90	29
Cadmium	47	-25	54	5
Chromium	49	25	62	5
Copper	55	10	90	18
Lead	67	-97	95	34
Zinc	51	-38	96	32

Source: Brown and Schueler, 1997a

Table 2.2.8-13 Pollutant Removal Efficiency of Constructed Wetland Systems

Parameter	Median Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	23	-30	78	12
Ortho-Phosphate	28	-109	93	7
Total Phosphorus	46	-120	97	37
Ammonia-Nitrogen	33	-86	62	15
Nitrate	46	4	95	18
Organic Nitrogen	7	-36	39	7
Total Nitrogen	24	-20	83	11
Suspended Solids	76	-300	98	26
Bacteria	78	55	97	3
Organic Carbon	28	-31	93	15
Cadmium	69	-80	80	6
Chromium	73	38	98	3
Copper	39	2	84	10
Lead	63	23	94	17
Zinc	54	-74	90	16

Sources: Strecker at al (1992); Organic Carbon, Bacteria and Metals from Brown and Schueler, 1997a

Table 2.2.8-14 Pollutant Removal Efficiency of Open Channel Vegetated Systems

Parameter	Average or Median Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	11	-45	72	8
Total Phosphorus	15	-100	99	18
Ammonia-Nitrogen	3	-19	78	4
Nitrate	11	-100	99	13
Organic Nitrogen	39	11	86	3
Total Nitrogen	11	-100	99	10
Suspended Solids	66	-100	99	18
Bacteria	-25	-100	0	5
Organic Carbon	23	-100	99	11
Cadmium	49	20	80	6
Chromium	47	14	88	5
Copper	41	-35	89	15
Lead	50	-100	99	19
Zinc	49	-100	99	19

Source: Brown and Schueler, 1997a

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

2.2.8.6 Descriptions and Pictures of Technologies for Stormwater Control

Though many technologies are recommended for use of best management practices, not everyone can envision how they would look and operate. The following section provides descriptions and pictures of these technologies. More detailed information such as design criteria, pros and cons to construction and operation, technical fact sheets, effectiveness, and various diagrams are also provided on EPA's websites at the following URLs.

http://www.epa.gov/npdes/menuofbmps/post.htm

http://www.epa.gov/ost/stormwater/usw_c.pdf

The following descriptions have been taken from these websites to provide the reader with descriptions of the following BMP technologies and techniques:

- Infiltration trenches
- Bio-retention areas
- Stormwater wetlands

- Infiltration basins
- Wet ponds
- Dry extended detention ponds
- Grass filter strips
- Grass swales
- Green parking
- Porous pavement
- Sand and organic filters
- Catch basins and inserts
- Stormwater inlet products
- Log veins and coir fabric for streambank restoration

Bioretention Areas
Post-construction Stormwater Management in New Development and Redevelopment

Bioretention areas can be used in parking areas to collect and treat storm water (Source: University of Maryland, 2000)

Description

Bioretention areas are landscaping features adapted to provide on-site treatment of stormwater runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff forms ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. Typically, the filtered runoff is collected in a perforated underdrain and returned to the storm drain system.

Infiltration Basin
Post-construction Stormwater Management in New Development and Redevelopment

Infiltration basins are designed to collect storm water from impervious areas and provide pollutant removal benefits through detention and filtration

Description

An infiltration basin is a shallow impoundment which is designed to infiltrate stormwater into the ground water. This practice is believed to have a high pollutant removal efficiency and can also help recharge the ground water, thus restoring low flows to stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Stormwater Wetland
Post-construction Stormwater Management in New Development and Redevelopment


A storm water wetland detains storm water, removes pollutants, and provides habitat and aesthetic benefits (Source: The Bioengineering Group, Inc., no date)

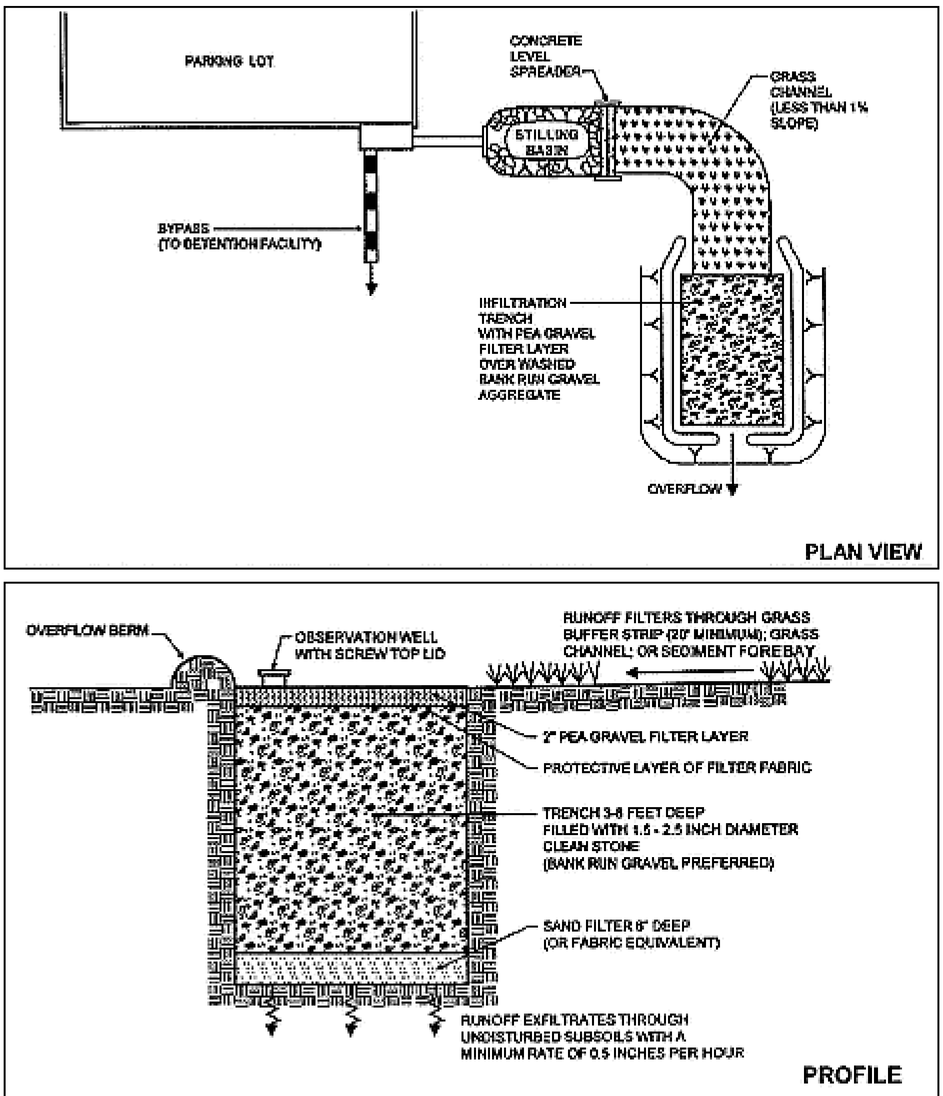
Description

Stormwater wetlands (a.k.a. constructed wetlands) are structural practices similar to wet ponds (see Wet Pond fact sheet) that incorporate wetland plants into the design. As stormwater runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake within the practice. Wetlands are among the most effective stormwater practices in terms of pollutant removal and they also offer aesthetic value. Although natural wetlands can sometimes be used to treat stormwater runoff that has been properly pretreated, stormwater wetlands are fundamentally different from natural wetland systems. Stormwater wetlands are designed specifically for the purpose of treating stormwater runoff, and typically have less biodiversity than natural wetlands in terms of both plant and animal life. Several design variations of the stormwater wetland exist, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland.

A distinction should be made between using a constructed wetland for stormwater management and diverting stormwater into a natural wetland. The latter practice is not recommended because altering the hydrology of the existing wetland with additional stormwater can degrade the resource and result in plant die-off and the destruction of wildlife habitat. In all circumstances, natural wetlands should be protected from the adverse effects of development, including impacts from increased stormwater runoff. This is especially important because natural wetlands provide stormwater and flood control benefits on a regional scale.

Infiltration Trench
Post-construction Stormwater Management
in New Development and Redevelopment
Description

An infiltration trench (a.k.a. infiltration galley) is a rock-filled trench with no outlet that receives stormwater runoff. Stormwater runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. The primary pollutant removal mechanism of this practice is filtering through the soil.



A schematic of an infiltration trench (Source: MDE, 2000)

Grassed Filter Strip
Post-construction Stormwater Management
in New Development and Redevelopment

Grassed filter strips protect water quality by filtering pollutants before they reach the water (Source: USDA, 1997)

Description

Grassed filter strips (vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal. One challenge associated with filter strips, however, is that it is difficult to maintain sheet flow, so the practice may be "short circuited" by concentrated flows, receiving little or no treatment.

Grassed Swales
Post-construction Stormwater Management
in New Development and Redevelopment

Grassed swales can be used along roadsides and parking lots to collect and treat storm water runoff

Description

The term swale (a.k.a. grassed channel, dry swale, wet swale, biofilter) refers to a series of vegetated, open channel management practices designed specifically to treat and attenuate stormwater runoff for a specified water quality volume. As stormwater runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Variations of the grassed swale include the grassed channel, dry swale, and wet swale. The specific design features and methods of treatment differ in each of these designs, but all are improvements on the traditional drainage ditch. These designs incorporate modified geometry and other features for use of the swale as a treatment and conveyance practice.

Wet Ponds
Post-construction Stormwater Management in New Development and Redevelopment

The primary functions of a wet pond are to detain storm water and facilitate pollutant removal through settling and biological uptake

Description

Wet ponds (a.k.a. stormwater ponds, retention ponds, wet extended detention ponds) are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Ponds treat incoming stormwater runoff by settling and algal uptake. The primary removal mechanism is settling as stormwater runoff resides in this pool, and pollutant uptake, particularly of nutrients, also occurs through biological activity in the pond. Wet ponds are among the most cost-effective and widely used stormwater practices. While there are several different versions of the wet pond design, the most common modification is the extended detention wet pond, where storage is provided above the permanent pool in order to detain stormwater runoff in order to provide settling.

Dry Extended Detention Pond
Post-construction Stormwater Management in New Development and Redevelopment

A dry extended detention pond is designed to temporarily detain runoff during storm events

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. However, they are often designed with small pools at the inlet and outlet of the basin. They can also be used to provide flood control by including additional flood detention storage.

Porous Pavement
Post-construction Stormwater Management in New Development and Redevelopment

A porous pavement parking lot (Source: Invisible Structures, no date)

Description

Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot stormwater to infiltrate directly and receive water quality treatment. There are a few porous pavement options, including porous asphalt, pervious concrete, and grass pavers. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous gridded systems with open areas designed to allow grass to grow within the void areas. Other alternative paving surfaces can help reduce the runoff from paved areas but do not incorporate the stone trench for temporary storage below the pavement (see Green Parking fact sheet). While porous pavement has the potential to be a highly effective treatment practice, maintenance has been a concern in past applications of the practice.

Green Parking
Post-construction Stormwater Management in New Development and Redevelopment

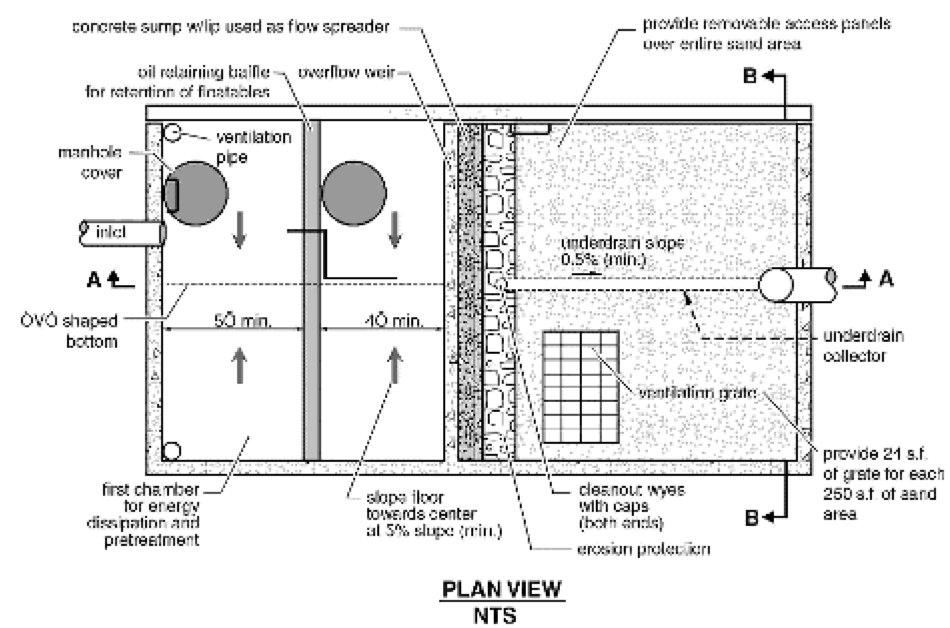
A green parking lot at the Orange Bowl in Miami, Florida (Source: Invisible Structures, no date)

Description

Green parking refers to several techniques applied together to reduce the contribution of parking lots to the total impervious cover in a lot. From a stormwater perspective, application of green parking techniques in the right combination can dramatically reduce impervious cover and, consequently, the amount of stormwater runoff. Green parking lot techniques include setting maximums for the number of parking lots created, minimizing the dimensions of parking lot spaces, utilizing alternative pavers in overflow parking areas, using bioretention areas to treat stormwater, encouraging shared parking, and providing economic incentives for structured parking.

Sand and Organic Filters
Post-construction Stormwater Management
in New Development and Redevelopment
Description

Sand filters are usually two-chambered stormwater practices; the first is a settling chamber, and the second is a filter bed filled with sand or another filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering medium. There are several modifications of the basic sand filter design, including the surface sand filter, underground sand filter, perimeter sand filter, organic media filter, and Multi-Chamber Treatment Train. All of these filtering practices operate on the same basic principle. Modifications to the traditional surface sand filter were made primarily to fit sand filters into more challenging design sites (e.g., underground and perimeter filters) or to improve pollutant removal (e.g., organic media filter).



Schematic of a sand filter (Source: King County, Washington, 2000)

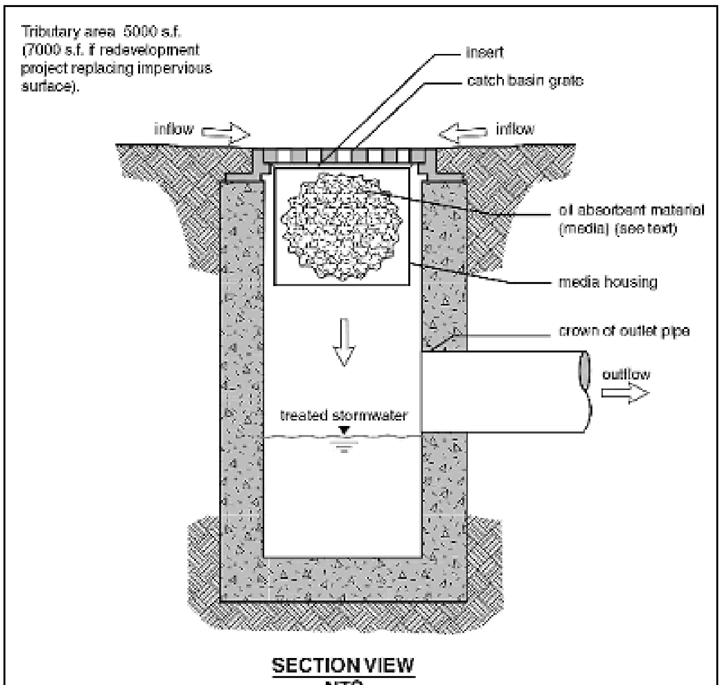
Catch Basins/Catch Basin Inserts
Post-construction Stormwater Management in New Development and Redevelopment

A worker inserts a catch basin insert for oil and grease, trash, debris, and sediment removal from storm water as it enters the storm drainage system (Source: AbTech Industries, 2001)

Description

A catch basin (a.k.a. storm drain inlet, curb inlet) is an inlet to the storm drain system that typically includes a grate or curb inlet and a sump to capture sediment, debris, and associated pollutants. They are also used in combined sewer overflow (CSO) watersheds to capture floatables and settle some solids. Catch basins act as pretreatment for other treatment practices by capturing large sediments. The performance of catch basins at removing sediment and other pollutants depends on the design of the catch basin (e.g., the size of the sump) and maintenance procedures to retain the storage available in the sump to capture sediment. Catch basin efficiency can be improved using inserts, which can be designed to remove oil and grease, trash, debris, and sediment. Some inserts are designed to drop directly into existing catch basins, while others may require extensive retrofit construction.

Manufactured Products for Stormwater Inlets
Post-construction Stormwater Management in New Development and Redevelopment



The typical design of a catch basin insert is a set of filters that are specifically chosen to address the pollutants expected at that site (Source: King County, Washington, 2000)

Description

A variety of products for stormwater inlets known as swirl separators, or hydrodynamic structures, have been widely applied in recent years. Swirl separators are modifications of the traditional oil-grit separator and include an internal component that creates a swirling motion as stormwater flows through a cylindrical chamber. The concept behind these designs is that sediments settle out as water moves in this swirling path. Additional compartments or chambers are sometimes present to trap oil and other floatables. There are several different types of proprietary separators, each of which incorporates slightly different design variations, such as off-line application. Another common manufactured product is the catch basin insert. These products are discussed briefly in the Catch Basin fact sheet.

Examples of Materials Used in a Streambank Restoration and Protection: Log veins redirect streamflow back to the center channel or slow side stream velocities protecting the streambank. The coir fabric stabilizes the streambank and allows new plantings such as tall warm seasoned grasses time to grow. Over time the coir fabric biodegrades back into the soil.

Conversion of Detention Ponds and Construction of Treatment Wetlands: A typical detention pond that is mowed has little water quality benefit and can be converted into something more beneficial. Treatment wetlands can be aesthetically pleasing and ecologically diverse. Both of the areas shown above are located in the Philadelphia Region.

2.2.9 PWD-Belmont Intake Public Summary

Introduction

As part of the requirements of the 1996 Safe Drinking Water Act Reauthorization, the Pennsylvania Department of Environmental Protection (PADEP) has been conducting assessments of all potentially significant sources of contamination to all public drinking water sources. The Philadelphia Water Department has prepared this Source Water Assessment Public Summary to provide information to support local and state efforts to protect the quality of the City of Philadelphia's drinking water sources. The information in this summary pertains to the water supply area for the Philadelphia Water Department's Belmont Water Treatment Plant. The water withdrawn for the Belmont Water Treatment Plant is treated and meets all state and federal regulations for safety and quality before being distributed to West Philadelphia. The assessment conducted for the Belmont Water Treatment Plant is of the "source" (river water) rather than "tap" (drinking) water. Information on "tap" (drinking) water quality is available from the Philadelphia Water Department's Annual Consumer Confidence Report that can be obtained by calling 215-685-6300 or visiting the website at www.phila.gov.

What is the Source of Your Drinking Water?

The source of water for the Philadelphia Water Department – Belmont Water Treatment Plant is surface water from the Schuylkill River. An average of 60 million gallons is withdrawn from the river per day. The water system serves approximately 250,000 customers in West Philadelphia. The water supply intake is located in Fairmount Park section of Philadelphia. Approximately 1,900 square miles of land covering portions of 11 counties including large sections of Berks, Schuylkill, Montgomery, and Chester counties that drain into the river upstream from the intake. The land upstream of the intake is 47% forested/greenspace, 36% agricultural, and 14% developed. Approximately 3 million people live in the Schuylkill River Watershed.

Water Quality and Treatment Information

Water withdrawn from the Schuylkill River is coagulated, settled, filtered, and disinfected with chlorine prior to distribution to customers. Drinking water quality meets or exceeds all state or federal requirements. In addition, the Belmont Water Treatment Plant participates in the Partnership for Safe Water program. This program is an intensive voluntary program nationwide by water suppliers that strives for optimized water quality well beyond that required by state and federal agencies.

Evaluation of Significant Sources of Contamination

This assessment identifies and evaluates the possibility for contaminants to potentially enter the Schuylkill River upstream from the water intake prior to treatment. The contaminants addressed in this assessment include those regulated under the federal Safe Drinking Water Act as well as those PADEP has determined may present a concern to human health. These sources are then ranked to determine their protection priority to the water supplier. The protection priority is the level of importance and potential contamination a particular source represents for the water supply. A description of the protection priority assigned to various types of sources upstream from the Belmont Intake is provided in Table 2.2.9-1. Each type of source has a qualitative protection priority rating ranging from A to F. The "A" rating is considered a source of highest protection priority, while "F" is considered lowest protection priority. Sources with ratings between "A" and "C" are considered potentially significant sources for protection consideration. Sources with rating between "D" and "F" are considered to have less significance.

As indicated in Table 2.2.9-1, discharges of treated and untreated sewage upstream of the water intake were given the highest protection priority due to their potential to release pathogens and nutrients into the water supply. Polluted runoff from stormwater was also given a high protection priority due to the potential impacts of runoff from urban areas and agricultural lands that introduce pathogens, nutrients, and sediment into the water supply. Acid mine drainage was also considered a high protection priority due to the impacts it has on metal concentrations in the river.

Ongoing Source Water Protection Activities
The Philadelphia Water Department (PWD) has an active source water protection program that works closely with state, federal, and local officials to address water quality issues. PWD also participates in various activities with upstream dischargers, businesses, communities, water suppliers, and watershed organizations that encourage communication, cooperation, education, protection, and restoration of the Schuylkill River and its tributaries.

Source Water Protection Needs
Overall, the primary areas to protect and improve PWD's water supply include the areas along the Schuylkill River between Reading and Philadelphia, the Wissahickon Creek, and Lower Perkiomen Creek. The Valley Creek, French Creek, and Tulpehocken creeks have secondary protection priority. In addition, other specific parts of the watershed may need limited attention for contaminant specific issues (i.e. acid mine drainage in Schuylkill County).

Based on these observations, the areas along the main stem Schuylkill River between Reading and Philadelphia should be considered a priority protection corridor and have special protective regulations and legislation to restore and protect water quality. This includes development of initiatives to reduce or prevent pathogens such as *Cryptosporidium* from entering the river.

Long-term protection efforts should be focused on enhancing wastewater discharges and mitigating stormwater runoff from urban and residential areas. These will have the greatest overall impacts on improving source water quality and the Schuylkill River.

How to Obtain More Information
This Source Water Assessment Public Summary was completed in December 2001. Individuals interested in learning more about this water system and watershed can contact the Philadelphia Water Department at 215-685-6300 or access information from the internet at www.phila.gov/departments/water or www.schuylkillswa.org.

Table 2.2.9-1 – Summary of Protection Priorities for Various Upstream Sources

Source	Protection Priority	Description	Priority Area(s)	Contaminants
Treated Sewage	A – C (Moderate – High)	Wastewater discharges from wastewater treatment plants	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment, organic chemicals
Untreated Sewage	A (High)	Combined and sanitary sewer overflows/discharges	Bridgeport, Norristown, & Schuylkill County	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients
Urban/Residential Runoff	A – C (Moderate – High)	Stormwater runoff from roads, parking lots, roofs	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, metals, sediment
Agricultural Runoff	A – C (Moderate – High)	Stormwater runoff from croplands, pastures, livestock	Perkiomen Creek & Tulpehocken Creek	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment
Acid Mine Drainage	A (High)	Discharge from abandoned coal mining areas	Schuylkill County	Metals
Industrial Facilities	C (Moderate)	Facilities that store or use hazardous chemicals	Reading to Philadelphia	Metals, nutrients, organic chemicals
Above Ground Storage Tanks	C (Moderate)	If storage tank spilled into river	Reading to Philadelphia	Petroleum hydrocarbons, metals, phosphorus
Landfills	C (Moderate)	Leaching of contaminants into streams	Reading to Philadelphia	Petroleum hydrocarbons, metals
Spills and Accidents	A – C (Moderate – High)	Car, truck, train, or pipeline accident spilling benzene	Watershed wide	Petroleum hydrocarbons, organic chemicals

Note: *Petroleum hydrocarbons include chemicals found in oils and greases. Organic chemicals include chemicals found in solvents, degreasers, varnishes, paints, gasoline, plastics, insect and weed killers.*

How Do I Get Involved in Protecting the River and My Water Supply?

There are many ways you can help protect the river and your water supply. You can join a local watershed organization, join a citizens advisory committee, or write your state and local representatives or congressmen about your views and opinions on issues. Instead of joining organizations, you can also lend a hand when these various organizations conduct trash cleanup, stream restoration, tree planting activities, stenciling storm drains, or conducting stream monitoring. Even the smallest of things can help protect your stream, river, or water supply. Just simply calling the proper authorities when you see illegal dumping, dead fish, or other polluting activities can make a big difference (see Table 2.2.9-2). Below are a list of numbers to call for various situations and a list of websites to find more information about local watershed and environmental organizations in the area (see Table 2.2.9-3).

Table 2.2.9-2 Who to Call to Report Various Situations

Situation	Who To Call	Phone
Dead Fish	Fish & Boat Commission PADEP	717-626-0228 800-541-2050
Illegal Dumping & Related Pollution Activities	PADEP Environmental Police Unit	800-541-2050 215-685-6300
Sewage Spills	PADEP PWD	800-541-2050 215-685-6300
Oil & Gas Spills / Accidents	PADEP PWD	800-541-2050 215-685-6300

Table 2.2.9-3 Getting Involved: Places to go for More Information About Local Organizations

Information About	Phone Number	Website Address
Philadelphia Area Watershed Organizations	215-685-6300	www.schuylkillswa.org
Wissahickon Creek	215-646-8866	www.wvwa.org
Fairmount Park Friends Groups	215-685-0000	www.schuylkillswa.org
Schuylkill Riverkeeper	610-469-6005	email: srk@worldlynx.net
Perkiomen Watershed	610-287-9383	www.schuylkillswa.org
Tidal Schuylkill River	215.985.9393	www.srdc.net
Lower Merion Area	610-353-5587	www.schuylkillswa.org

Philadelphia Water Department – Belmont & Queen Lane Treatment Plants (PWSID #1510001)
Section 3: Queen Lane Intake
Source Water Assessment Report

This report was produced for the Pennsylvania Department of Environmental Protection in accordance with the Source Water Assessment and Protection Plan.

Philadelphia Water Department

Prepared by The Philadelphia Water Department
January 2, 2002

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Camp Dresser & McKee

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Schuylkill River SWA
Protect Our Health from Source to Tap

Office of Watersheds
philadelphia water

Executive Summary – Queen Lane WTP Source Water Assessment

The 1996 Safe Drinking Water Act Amendments required the assessment of all source water supplies across the country to identify potential sources of contamination, the vulnerability and susceptibility of water supplies to that contamination, and public availability of the information. In response to this charge, the Schuylkill River Source Water Assessment Partnership, comprised of the Pennsylvania Department of Environmental Protection, the Philadelphia Water Department, the Philadelphia Suburban Water Company, and the Pennsylvania American Water Company, conducted the assessment with stakeholders to identify water supply protection priorities in the Schuylkill River watershed. The following summary includes two main sections. One section discusses the various characteristics and observations made through collection of watershed wide information. The remaining section provides a brief listing of the main recommendations based on the results of the analysis.

High Protection Priority Issues and Activities

Overall, the following activities were identified as having high priority for protection efforts to address:

- Sanitary Sewer Overflows of raw sewage from sewer collection systems, sewage lift stations, and manholes from upstream communities
- Combined Sewer Overflows from upstream communities such as Bridgeport and Norristown
- Urban, residential, and agricultural runoff from various areas of the watershed, mostly located along the mainstem of the Schuylkill River from Reading to Philadelphia
- Discharges from municipal and industrial sources such as sewage treatment plants and chemical manufacturing facilities
- Acid Mine Drainage from Schuylkill County
- Spill and accidents from cars, tanker trucks, railroad cars, pipelines, tire piles, and fires at industrial facilities near the river and its tributaries

Observations & Characterization

- The source of water for the Philadelphia Water Department – Queen Lane Water Treatment Plant is surface water from the Schuylkill River. An average of 80 million gallons is withdrawn from the river per day.
- The Queen Lane Water Treatment Plant serves approximately 350,000 customers in Philadelphia covering the area between the Schuylkill River and Broad Street (Route 611)
- The water supply intake is located in Fairmount Park section of Philadelphia near the intersection of Kelly Drive and City Line Avenue along the Schuylkill River.

- Depending upon flow conditions, between 11 to 28 percent of the water withdrawn by the Queen Lane WTP can originate from the Wissahickon Creek. Water quality data shows that the Wissahickon Creek regularly influences water quality at the Queen Lane intake.

- Approximately 1,900 square miles of land covering portions of 11 counties including large sections of Berks, Schuylkill, Montgomery, and Chester Counties drain into the river upstream from the intake. The land upstream of the intake is 46% forested/greenspace, 35 % agricultural, and 18 % developed. Approximately 3 million people live in the Schuylkill River Watershed.

- Water withdrawn from the Schuylkill River is coagulated, settled, filtered, and disinfected with chlorine to make it safe prior to distribution to customers. Drinking water quality meets or exceeds all state or federal requirements.

- Schuylkill River and Wissahickon Creek water quality has significantly improved over the past twenty years. As the impacts of point sources have been reduced over the years, the importance of non-point sources such as stormwater runoff from developed areas within the watershed has become evident.

- While dissolved solute and metal levels have increased over the past few decades, dissolved oxygen and nutrients have significantly improved, due to reductions in agricultural runoff and improved wastewater treatment.

- Over the past decade, levels of alkalinity, conductivity, sodium, chloride, bromide, iron, manganese, total organic carbon, and turbidity have increased in the mainstem river and throughout portions of the watershed.

- Increases in levels of solids, salts, and metals are believed to result from contaminated runoff resulting from increased development, increased use of deicing chemicals, and from acid mine drainage. If current trends continue, there will be impacts on drinking water supplies that require additional treatment and costs to make the water potable for drinking.

- Just under 3,000 potential point sources were identified upstream of the Queen Lane WTP intake. Most of these potential sources do not and will never discharge into the Schuylkill River, but may store, generate, or transport hazardous chemicals. Only 14% of these sources discharge into the river or local streams. Wastewater dischargers were the most prevalent discharging source.

- The most prevalent industries upstream were sewerage systems, dry cleaning plants, and commercial printing facilities.

- Volatile organic chemicals (solvents, degreasers, paints, etc) and metals were the most prevalent contaminant types related to upstream sources.

- A total of 36.5 million gallons of petroleum, gasoline, and crude oil are stored in above ground storage tanks upstream of the Queen Lane WTP intake. The tanks range in size from 250 gallons to 4 million gallons and range in age from 1 to 98 years old. The storage tanks were determined to hold 123 different substances or chemicals.

- The Schuylkill River Runoff Loading Model was developed to estimate contaminant loadings to the River from storm runoff.

- The model used the physical characteristics of the sub-watersheds, meteorological data, updated land use information, and event mean concentrations for the nine parameters of interest to estimate average daily contaminant loadings within each of the Queen Lane intake's zones of contribution.

- The developed areas associated with industrial/commercial land use and residential uses were estimated to contribute the highest per acre loadings of most of the contaminants evaluated, including disinfection by-products, metals, nutrients, petroleum hydrocarbons, salts, and coliforms.

- Unit *cryptosporidium* and turbidity loadings were higher from agricultural areas.

- A series of successive screenings was used to identify those sources that have the greatest potential to affect water quality at the Queen Lane intake.

- Five non-conservative contaminant categories and five conservative contaminant categories were selected to represent all potential contaminants.

- For each category, a threshold value indicative of the significance of the concentrations of contaminants that could result from a potential spill or discharge was defined.

- EVAMIX, a multi-criteria software package was used to prioritize the potential significance of each of the potential point sources within Queen Lane's Zone A and Zone B, and to evaluate the potential significance of non-point sources estimated by the Schuylkill River Runoff Loading Model.

- Criteria that were given various weighting by the Technical Advisory Group were the main components used in the EVAMIX evaluation. These criteria included potential impact, time of travel, location, public health implications, discharge frequency and controls, violations, removal capacity, and treatment impacts.

- NPDES and nonpoint source discharges within the Queen Lane intake's Zone A and Zone B were determined to have the highest protection priorities in the watershed.

- The potential significance of each source of contamination was designated A (potentially significant source of highest protection priority) through F (Potential source of lowest protection priority). Those sources ranked A through C are potentially significant sources of contamination to the Queen Lane intake.

- All of the highest ranked sources are either NPDES sites (dischargers) or storm water loadings from specific sub-watersheds.

- Contaminant sources actually discharging to the River (e.g., NPDES permitted point sources, or stormwater runoff) are estimated to have greater potential significance than those with only the potential to release contaminants to the River (e.g, a spill or leak).

- EVAMIX was also used to rank potential sources for each contaminant category. Table I provides a summary of the sources and contaminants of significance.

Protection Recommendations

- Overall, the primary protection areas to focus PWD's protection efforts include the mainstem areas of the Schuylkill River between Reading and Philadelphia, and the Wissahickon Creek to protect and improve PWD's water supply.

- The Perkiomen Creek, Valley Creek, Manatawny Creek and Tulpehocken Creeks appear to have secondary protection priority. However other parts of the watershed may need limited attention for contaminant specific issues (i.e. metals and acid mine drainage).

Based on the results of the susceptibility analysis, water quality data, and stream impairments, it is clear that the impacts from stormwater runoff need to be addressed from the communities along the mainstem of the Schuylkill River from Reading to Philadelphia. Efforts to reduce these impacts would require the following components:

- Development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection. This would include a special matching source water protection grant fund for the Schuylkill River Watershed that members would contribute to the state for matching. The watershed council including representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and fund projects with the most value to water supply protection.

- Development of a coordinated regional protection plan that will be adopted by water suppliers, planning commissions, and municipalities for establishment and protection of sensitive and high priority protection areas to the multiple and overlapping water supply areas between Reading and Philadelphia.

- Enforcement of rigorous and regular revision and implementation of ACT 537 Sewage Facilities Management Plans in Montgomery, Chester, Berks, and Schuylkill Counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems.

- Development of incentives for upstream communities to mitigate stormwater runoff

- Education of township officials along the protection priority corridor about stormwater impacts

- Preservation of existing greenspace along the Schuylkill River in the protection area

- Acquisition of conservation easements or adjustment of zoning areas or local ordinances to reduce stormwater impacts due to future development in the protection priority corridor between Philadelphia and Reading

- The Phase II stormwater regulations should be fully implemented and enforced, with first priority for compliance monitoring and inspections recommended for communities discharging into protection priority areas for drinking water supplies.

- Enforcement of compliance requirements for industries and municipalities discharging wastewater into the protection priority corridor between Philadelphia and Reading

- Development and support of watershed or local community/environmental organizations to restore and protect various segments of the protection priority corridor between Philadelphia and Reading

- Ensure that TMDL process and requirements along the Schuylkill River include components to address drinking water impacts

- Development of special state or federal legislation that provides funding and authority for water supply protection efforts in the protection priority corridor between Philadelphia and Reading

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- A workshop should be sponsored by PADEP to educate golf courses about the benefits of joining the environmental certification program by the Audobon Society.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts.

In addition to those efforts mentioned above, the following specific actions are recommended for protection efforts in the Wissahickon Creek Watershed:

- Development of regulatory and financial incentives for enhanced wastewater discharge for pathogen removal and inactivation to address *Cryptosporidium* impacts

- Development of incentives and controls for mitigation of stormwater runoff impacts. This includes requiring that current TMDL efforts in the watershed include specific components to address drinking water issues and concerns. This will provide an example of how the Safe Drinking Water Act and Clean Water Act should be integrated.

- Conduct and examination of current zonings and ordinances with the Montgomery County Planning Commission, Montgomery County Conservation District, and local townships to determine ways they can be enhanced to address current and future stormwater impacts. Identify areas where innovative techniques and incentives can be used to mitigate stormwater impacts and assist in the development and implementation of these efforts.

- Support of existing greenways, riparian corridor areas, and future riparian corridor easement and acquisition being conducted by the Wissahickon Valley Watershed Association and Montgomery County

- Encourage and support the development of an Act 537 Stormwater Management Plan for the Wissahickon Creek.

The Philadelphia Suburban Water Company already works with numerous stakeholders to protect its water supply in the Perkiomen Creek. Therefore, it is recommended that any protection efforts be coordinated with the Philadelphia Suburban Water Company environmental initiatives and programs in the Perkiomen Creek Watershed.

In addition to the previous specific geographic recommendations, the following general efforts are recommended:

- Emergency Response Planning activities should be focused on priority AST, TRI, and RECRA facilities since they have been shown to have the greatest relative impact on water quality. Efforts should also be initiated to collect more detailed data on these sites for reprioritization.

- Given the catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the mainstem Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that USGS should be involved in the implementation of the early warning system.

- Long-term protection efforts should be focused on enhancing wastewater discharges and mitigating stormwater runoff. These will have the greatest overall impacts on improving source water quality.

- Sources of pathogens appear to be the sources of greatest priority to PWD when examined in the overall rankings. Therefore, these sources should be addressed accordingly.

- Given the significant amount of activity in the watershed by various organizations, protection efforts should be coordinated in such a way as to support and enhance existing efforts in the watershed.

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- Special mechanisms and funding should be developed to allow the distribution of monies to support or initiate specific initiatives outside the City of Philadelphia that will protect or restore the water supply. This may involve development of a quasi-governmental or non-profit organization that can raise funds and distribute them to various organizations conducting protection activities beneficial to PWD. This organization may also need the ability acquire conservation easements or land in sensitive areas to maintain protected areas.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts.

Public Meetings and Participation

- Public Kick-off meetings, Technical Advisory Group meetings, media articles and a website were some of the methods used to involve the public in the Source Water Assessment Program (SWAP)

- A Technical Advisory Group (TAG) was established to facilitate communication among stakeholders, and to gather information about the watershed. The TAG met quarterly to assist the SWAP process.

- Two public kick-off meetings were held in the Philadelphia area. Meetings were advertised in many local newspapers.

- Project information was available to the public and stakeholders through the project website at www.schuylkillswa.org.

Table I – Summary of Protection Priorities From Various Upstream Sources

Source	Protection Priority	Description	Priority Area(s)	Contaminants
Treated Sewage	A	Wastewater discharges from wastewater treatment plants	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment, organic chemicals
Untreated Sewage	A	Combined sewer overflows	Bridgeport, Norristown, & Schuylkill County	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients
Urban/Residential Runoff	A - C	Stormwater runoff from roads, parking lots, roofs	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, metals, sediment
Agricultural Runoff	A-C	Stormwater runoff from croplands, pastures, livestock	Perkiomen Creek & Tulpehocken Creek	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment
Acid Mine Drainage	A	Discharge from abandoned coal mining areas	Schuylkill County	Metals
Industrial Facilities	A-C	Facilities that store or use hazardous chemicals	Reading to Philadelphia	Metals, nutrients, organic chemicals
Above Ground Storage Tanks	A-C	If storage tank spilled into river	Reading to Philadelphia	Petroleum hydrocarbons, metals, phosphorus
Landfills	C	Leaching of contaminants into streams	Reading to Philadelphia	Petroleum hydrocarbons, metals
Spills and Accidents	A-C	Car, truck, train, or pipeline accident spilling benzene	Watershed wide	Petroleum hydrocarbons, organic chemicals

Note: *Petroleum hydrocarbons include chemicals found in oils and greases. Organic chemicals include chemicals found in solvents, degreasers, varnishes, paints, gasoline, plastics, insect and weed killers.*
Rankings: *A – highest protection priority, B- moderately high protection priority, C-moderate protection priority, D through F low protection priorities.*

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3.1 Watershed and Drinking Water System

3.1.1 Watershed

Key Points

- **The Philadelphia Water Department's Queen Lane Intake is the second public water supply intake on the Schuylkill River above the confluence with the Delaware Estuary.**
- **Under certain flow conditions, water quality at the Queen Lane Intake is influenced by the Wissahickon Creek, which discharges to the Schuylkill River directly upstream of the intake.**

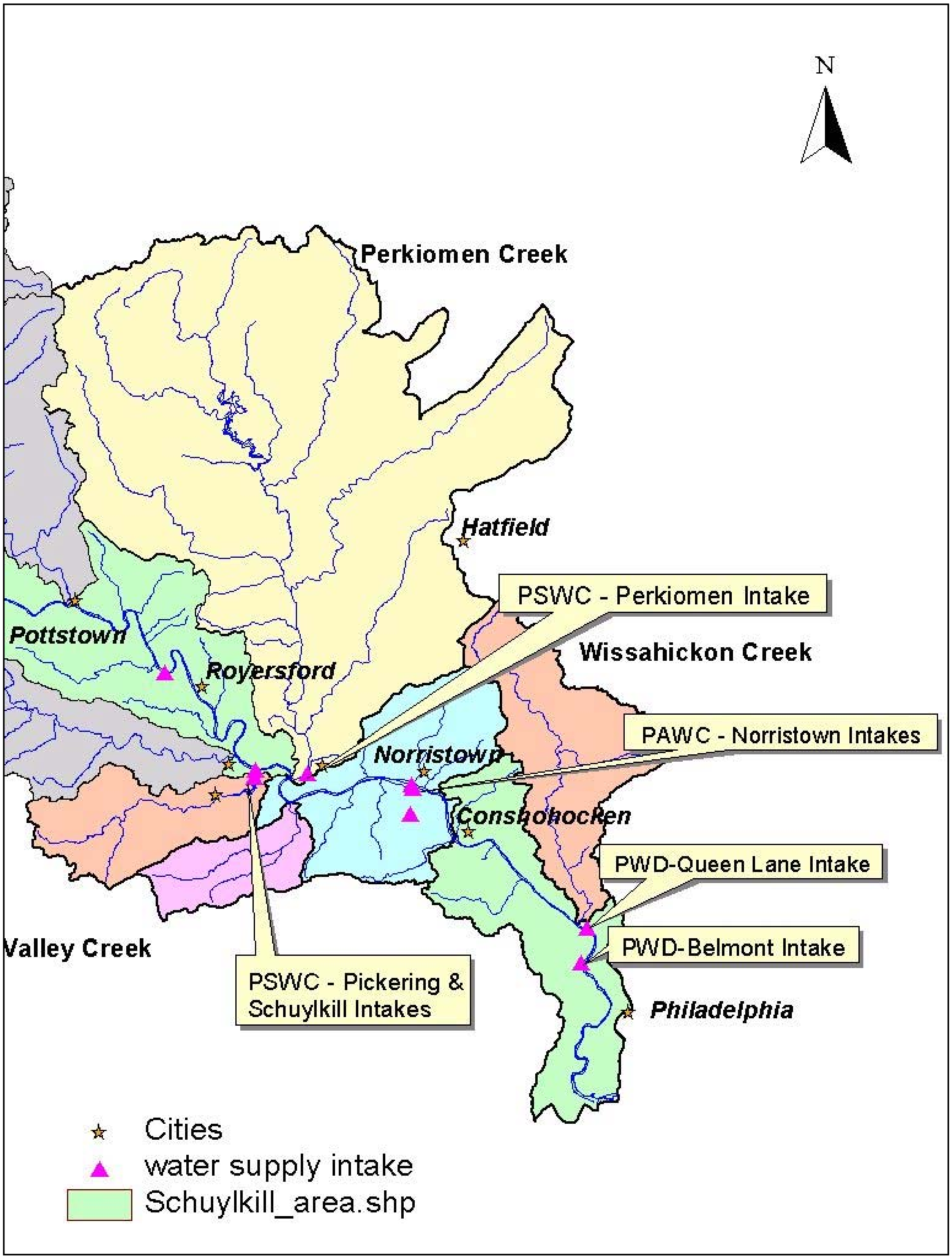
The Philadelphia Water Department's Queen Lane Intake is located 12 miles from the mouth of the Schuylkill River and directly downstream of the confluence of the Wissahickon Creek and the Schuylkill River. It is located approximately four miles above the Fairmount Dam, which is the uppermost tidal limit on the Schuylkill River.

The drainage area of the basin above the Queen Lane Intake is approximately 1,888 square miles. Land use in the area upstream of the intake is primarily commercial/ industrial, located in Manayunk and on the Montgomery County side of the river. Interstate 76 travels directly along the western side of the river all the way to Conshohocken. Water quality at the Queen Lane Intake is also heavily influenced by the Wissahickon Creek. Due to channel hydrology and intake location, approximately 11 to 28% of the water supply entering the Queen Lane Intake originates from Wissahickon Creek.

There are two active USGS gauge stations located near the intake. One is a gauge located at the mouth of the Wissahickon Creek directly before the confluence with the Schuylkill River. The other gauge is located at Fairmount Dam. Moving upstream from the mouth of the Schuylkill River, the Queen Lane Intake is the second public water supply intake (see Figure 3.1.1-2).

Figure 3.1.1-1 Aerial Photograph of Queen Lane Intake

Figure 3.1.1-2 Location of Water Supply Intakes in the Lower Schuylkill River Watershed



3.1.2 Geology, Soils, Hydrology, Physiography, and Topography

Key Points

- **Topography and types of soils in the watershed affect the amount and quality of runoff produced during precipitation events.**
- **Soils in the Lower Schuylkill River Watershed are generally well drained and generate moderate amounts of runoff.**
- **Approximately 11 to 28% of the flow entering the Queen Lane Intake originates from the Wissahickon Creek.**
- **The Queen Lane Intake is located in the Atlantic Coastal Plain physiographic province.**

3.1.2.1 Geology and Soils

The physical properties of the soils are the determining factors in the sediment-transport characteristics of the Schuylkill River and its tributaries. The soils, in turn, are determined by the geology and weathering processes of the rock material. The area north and east of the river, which includes the area drained by the Perkiomen and Skippack Creeks and by part of the Manatawny Creek, is underlain by mudstones, reddish-brown shales, and siltstones. The shaly silt loams that form above the shales are shallow and subject to erosion.

Silty loams are the dominant soils in the basin downstream from the Perkiomen Creek. The soils in the areas drained by Valley and Plymouth creeks, and partially by Wissahickon Creek are underlain by a narrow band of limestone. The other tributaries in the lower basin are underlain by channery, silty loam soils formed in the residuum of mica schist and gneiss. Many of the soils in the lower basin are classified as urban land because the soil profile has been reworked during the cut-and-fill operations of construction projects. They generally have the same soil particle size distribution as the original silty loams.

New urban land or urban construction sites on Piedmont soils may contribute as much as 100 tons of sediment per acre each year (Yorke and Herb, 1978). Runoff from lawns, parking lots, and streets may contribute much of the trace metals and organic substances that enter the lower part of the Schuylkill River.

There are 16 specific soil subtypes in the Schuylkill River Watershed. Table 3.1.2-1 summarizes the characteristics of the soil types found in the Schuylkill River Watershed, and Figure 3.1.2-1 illustrates their distribution throughout the Lower Schuylkill River Basin. Typically, two or three types dominate within a given subwatershed. The Abbottstown, Chester, Neshaminy, and Ungers soil classifications define approximately 74% of the watershed soils. Table 3.1.2-1 indicates that these soils are generally well drained, generate moderate runoff, and are located on significant slopes. The only poorly-drained soil, the Abbottstown soil, is located in the headwater areas of the Wissahickon and Perkiomen Creek Watersheds.

Figure 3.1.2-1 Soil Types in the Lower Schuylkill River Basin

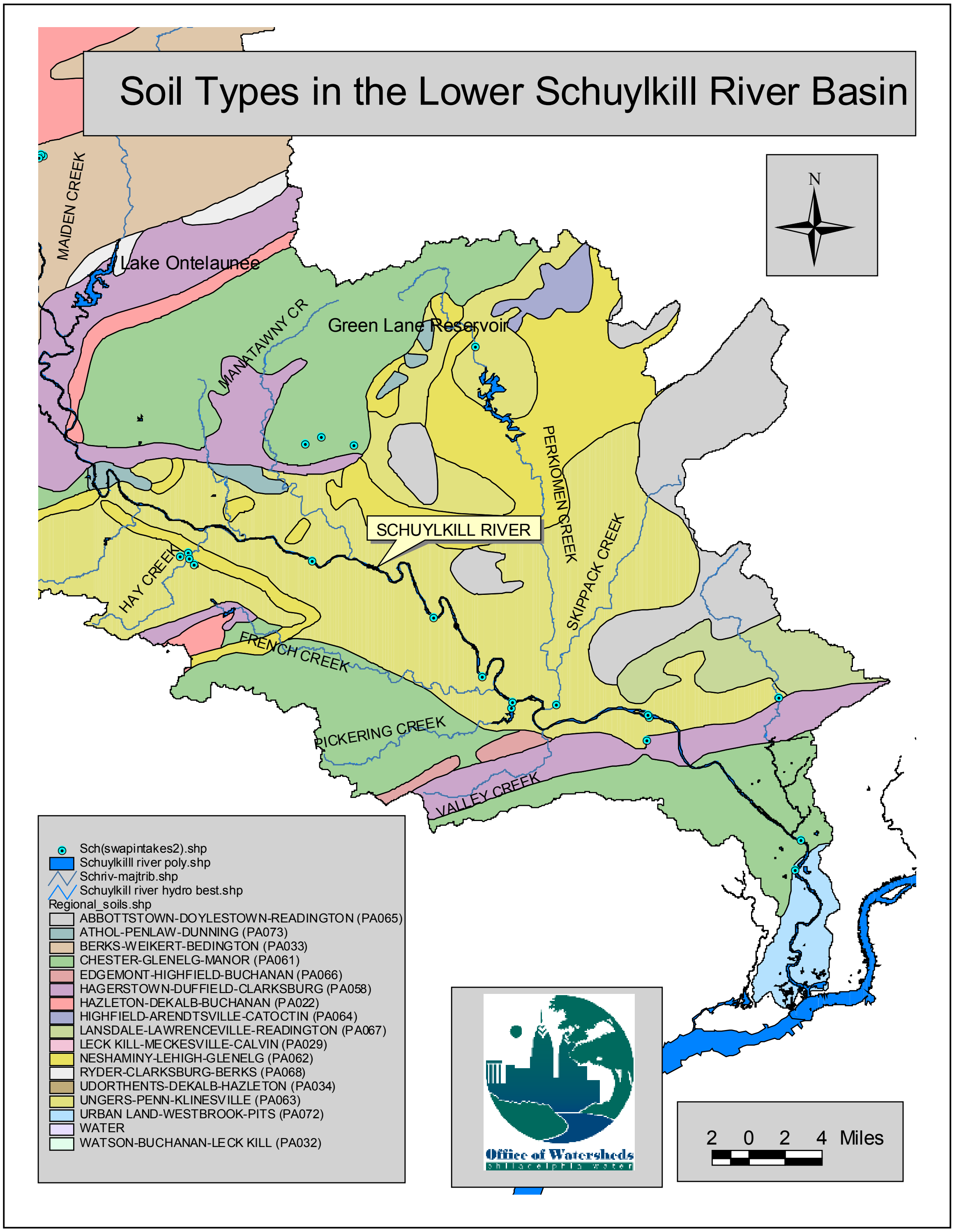


Table 3.1.2-1 Prevalence of Various Soil Types in the Lower Schuylkill River Watershed (Pottstown to Philadelphia)

Soil Type	Percent of watershed	Slopes (%)	Permeability	Runoff	Drainage	Found on
Abbottstown-Doylestown-Readington (PA065)	13	0-15	Slow to moderate	Slow to medium	Poorly drained	Level to sloping concave upland flats, depressions and drainageways
Athol-Penlaw-Dunning (PA073)	0	0-35	Moderate	Slow to rapid	Well drained	Level to moderately steep convex and dissected upland ridge tops and side slopes
Chester-Glenelg-Manor (PA061)	19	0-65 (mostly 3-10)	Moderate	Medium	Well drained	Upland divides and slopes
Edgemont-Highfield-Buchanan (PA066)	1	0-70	Moderate to moderately rapid	Rapid	Well drained	Sloping hills and ridges
Hagerstown-Duffield-Clarksburg (PA058)	6	0-45 (mostly 15)	Moderate	Moderate to rapid	Well drained	Valley floors and adjacent hills
Lansdale-Lawrenceville-Readington (PA067)	5	0-25	Moderate to moderately rapid	Moderate	Well drained	Rolling uplands
Neshaminy-Lehigh-Glenelg (PA062)	15	1 to 45	Moderately slow	Slow to very rapid	Well drained	Level to steep uplands
Ungers-Penn-Klinesville (PA063)	36	0-50	Moderate or moderately rapid	Medium to rapid	Well drained	Gently sloping to steep slopes

Note : Data from NRCS Official Soil Classifications and PASDA soil coverage

The lower watershed is comprised of both group B and C soils. Group B soils are mainly moderately well to well-drained soils with moderately-fine to moderately-coarse textures with transmission rates between 0.38 and 0.76 centimeters per hour (cm/hour). Group C soils are of a moderately-fine to fine texture and have low infiltration rates. These soils have transmission rates between 0.13 and 0.38 cm/hr.

Typical rainstorms that are less than 0.5 inches (1.27 cm) can infiltrate a well-drained Group B soil in less than two hours, whereas it will take the group C soils almost 4 hours to allow the same amount of infiltration. The lower infiltration rates increase the potential amount of runoff and pollutant transport from the land. In addition, the topography or slope steepness in these areas will also have significant impacts on pollutant transport.

3.1.2.2 Hydrology

The Lower Schuylkill River Watershed consists of the land areas draining directly to the Schuylkill River and four major tributaries, as shown on Figure 3.1.2-2. Table 3.1.2-2 indicates that the Perkiomen Creek is the largest tributary in this area. The Wissahickon Creek is the closest tributary discharging into the Schuylkill River above the Belmont and Queen Lane WTP Intakes for the City of Philadelphia. However, because the Wissahickon Creek discharges into the Schuylkill River on the same (east) riverside as the Queen Lane Intake, it has significant influence on the water quality at Queen Lane.

Table 3.1.2-2 Characteristics of Tributaries in the Lower Schuylkill River Watershed (From Bottom of Watershed to Top of Watershed by River Mile Location)

Major Subwatershed	Drainage Area (mi^2)	River Mile Location	Length (mi)
Lower Schuylkill (Philadelphia-Conshocken)*	69.6	<20.5	20.5
Wissahickon Creek	63.6	12.8	24.2
Middle Schuylkill 1 (Norristown - Valley Forge)*	64.8	20.5-32	11.5
Valley Creek	23.3	30.6	10.4
Middle Schuylkill 2 (Phoenixville-Pottstown)*	103.0	32-63	31
Perkiomen Creek	366.3	32.3	37.8
Pickering Creek	38.8	34	14.8

**These watershed boundaries were selected for purpose of the study*

In the lower half of the Schuylkill River Watershed, there are two major reservoirs. As shown in Table 3.1.2-3, Green Lane Reservoir is the largest and stores over 4.4 billion gallons of water. Contaminants may settle out in the reservoirs, and accumulate in the sediments for future release. There are seven dams across the river in the lower half of the watershed that were designed to trap sediment and coal culm. These dams are beginning to exceed their service life, and in some cases, have failed. Similar, but smaller dams on the tributaries are also being removed to improve aquatic life. Because these dams trap significant amounts of contaminated sediment behind them, their removal should be handled carefully.

Table 3.1.2-3 Reservoir Characteristics for the Lower Schuylkill River Watershed

Water Body	Average Width	Average Depth	Surface Area	Length	Volume (billions of gallons)	Detention Time
Pickering Creek	460 ft	11 ft *	4,804,020 sq ft 0.1723 sq miles	9,395 ft 1.78 miles	0.4	34 days
Green Lane Reservoir	888 ft	16.4 ft *	43,302,856 sq ft 1.5533 sq miles	74,648 ft 14.14 miles	4.4 *	62 days

** Data from Philadelphia Suburban Water Company*

As indicated in Figure 3.1.2-2, there are a number of flow-monitoring gauging stations in the Lower Schuylkill River Basin. However, only a few have continuous data that is suitable for long term characterization. Table 3.1.2-4 lists four active gauging stations that are located within the Lower Schuylkill Subwatershed. They are: Perkiomen Creek at Graterford, Valley Creek near Valley Forge, Wissahickon Creek at the mouth of Philadelphia, and Schuylkill River at Philadelphia. Table 3.1.2-4 summarizes the drainage area in square miles, annual mean flow, annual runoff, and the 10, 50, and 90% exceedance limits.

Table 3.1.2-4 Active Gauging Stations within the Lower Schuylkill Subwatershed

Station ID	Location	Drainage Area (mi^2)	Period of Record	Annual Mean Flow (cfs)	Annual Runoff (Inches)	10% Exceeds (cfs)	50% Exceeds (cfs)	90% Exceeds (cfs)
01473000	Perkiomen Creek at Graterford	279	1957-1999	411	N/A	831	180	60
01473169	Valley Creek Near Valley Forge	21	1983-1999	32.3	21.09	52	23	15
01474000	Wissahickon Creek Mouth at Philadelphia	64	1966-1999	104	22.02	177	60	28
01474500	Schuylkill River at Philadelphia	1893	1932-1999	2721	N/A	5850	1670	430

cfs – cubic feet per second

Recent decade scale patterns in climate and river flow for the region were also assessed to ascertain direct connections between these parameters and PWD Intake water quality data. Daily averaged data for the Schuylkill River flow at the Fairmount Dam through the 1990s, as seen in Figure 3.1.2-3, indicates extremely low flow conditions in summer 1999, with less pronounced low flow occurring in 1991 and 1993. The lowest flows through the decade were not always associated with extended low levels of summer precipitation, suggesting that evaporation, groundwater storage and surface water removal are important components in the water budget of the region.

Figure 3.1.2-2 Hydrologic Features of the Lower Schuylkill River Area

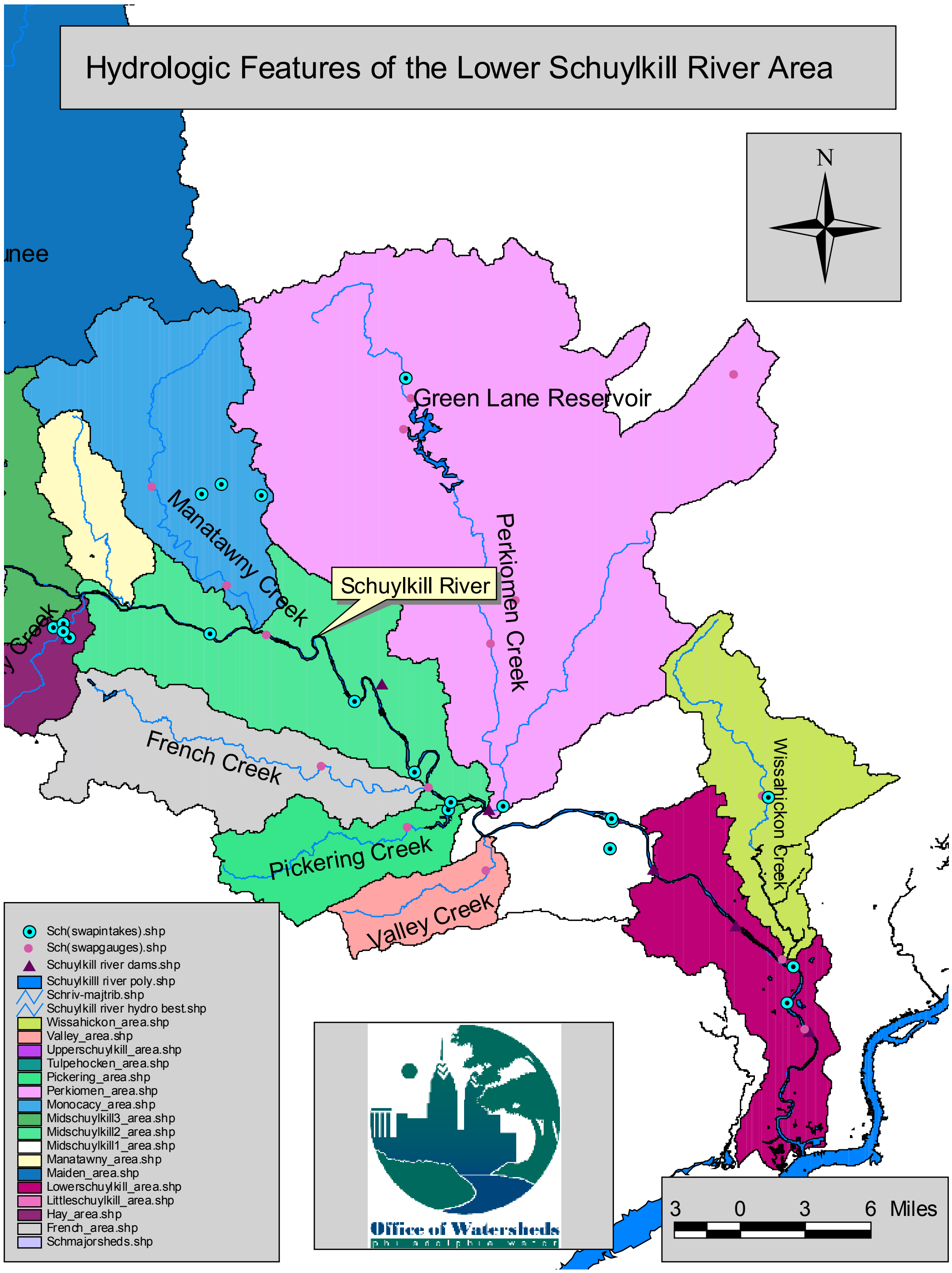
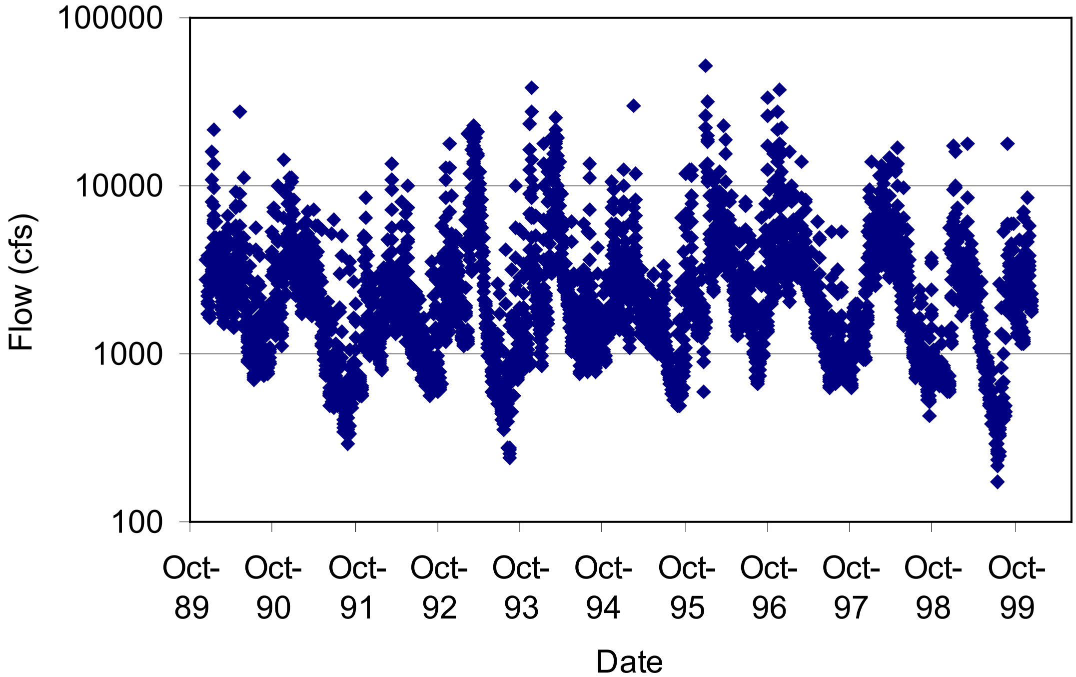


Figure 3.1.2-3 Schuylkill River Flow at Fairmont Dam



Based on the trends of precipitation in the area, during the spring and winter seasons, runoff plays a significant role in pollution. During the drier seasons, pollution is caused by point sources rather than non-point sources.

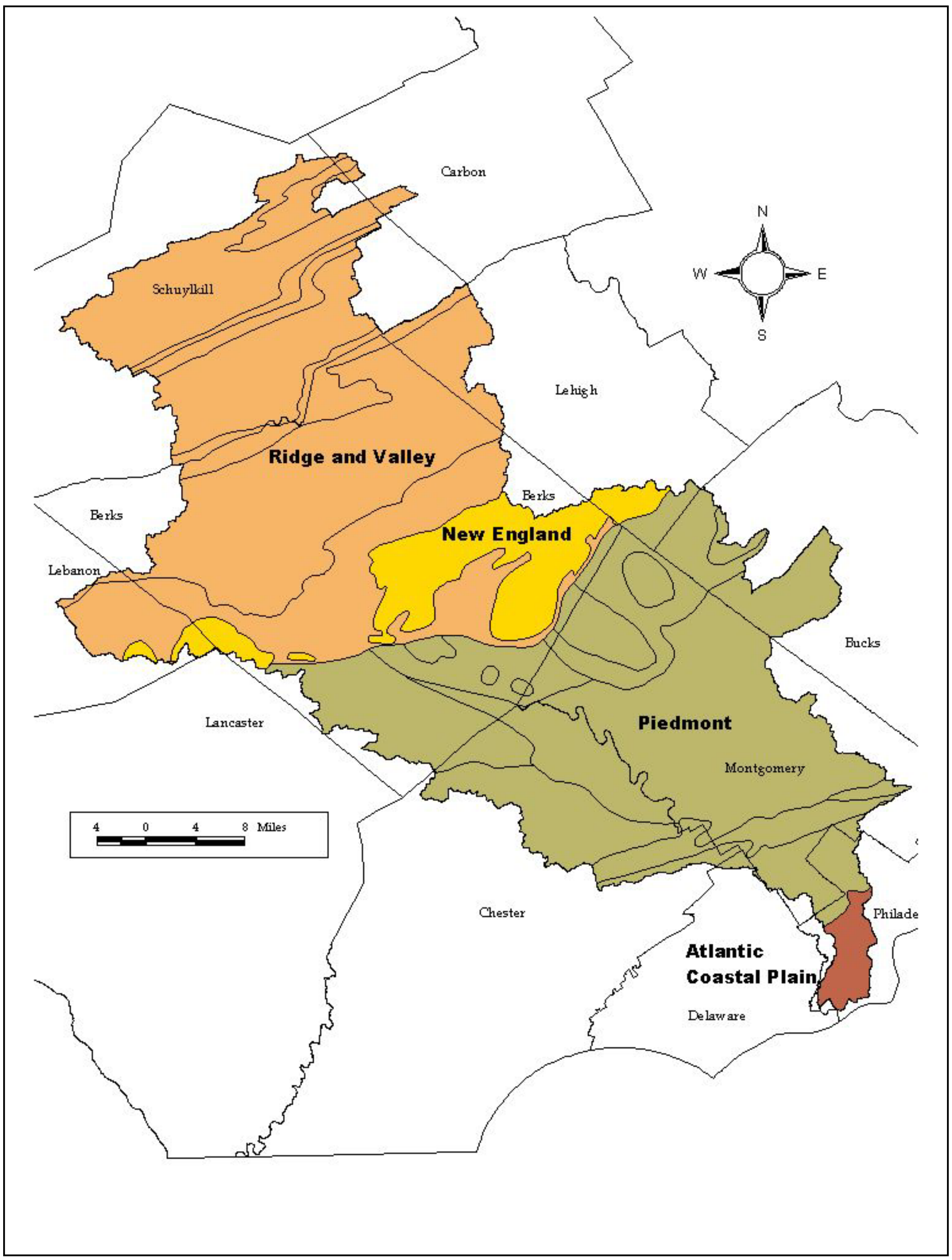
3.1.2.3 Physiography

The Schuylkill River flows through four physiographic provinces: the Valley and Ridge, New England, Piedmont and Atlantic Coastal Plain. PWD's Queen Lane WTP is located in the Atlantic Coastal Plain Province. The last physiographic province represented in the Schuylkill River Basin is the Atlantic Coastal Plain, as shown in Figure 3.1.2-4. About 20 square miles of the basin is in this province, and most of it is located downstream of the Fairmount Dam to the Delaware River. The Atlantic Coastal Plain is mainly lowlands with numerous streams and marshlands. This particular section of the Schuylkill is an estuary, which experiences a range of tidal fluctuations of about 5.5 ft.

The Queen Lane WTP is located in Philadelphia County, where the Wissahickon Creek Subbasin drains into the Schuylkill River south of Manayunk. The Wissahickon Creek includes a drainage area of 63.8 square miles. Its headwaters are in Montgomery County and in the Triassic Lowland and it flows through the Piedmont Uplands. South of the Wissahickon confluence, the river crosses the fall line and flows into the Atlantic Coastal Plain province.

Further upstream from Philadelphia, the Schuylkill River delineates the borders of Chester and Montgomery counties. Here, as the river flows through Norristown, it passes into the Piedmont Uplands. In the Piedmont Uplands, a region of broad, rolling hills and valleys, the river crosses the Chester Valley, a narrow valley of low relief. Valley Creek, a small tributary to the Schuylkill in Chester County, lies in the Piedmont Uplands. The confluence of Valley Creek with the Schuylkill River is just south of Perkiomen Creek's confluence with the Schuylkill River.

Figure 3.1.2-4 Physiographic Areas of the Lower Schuylkill Watershed

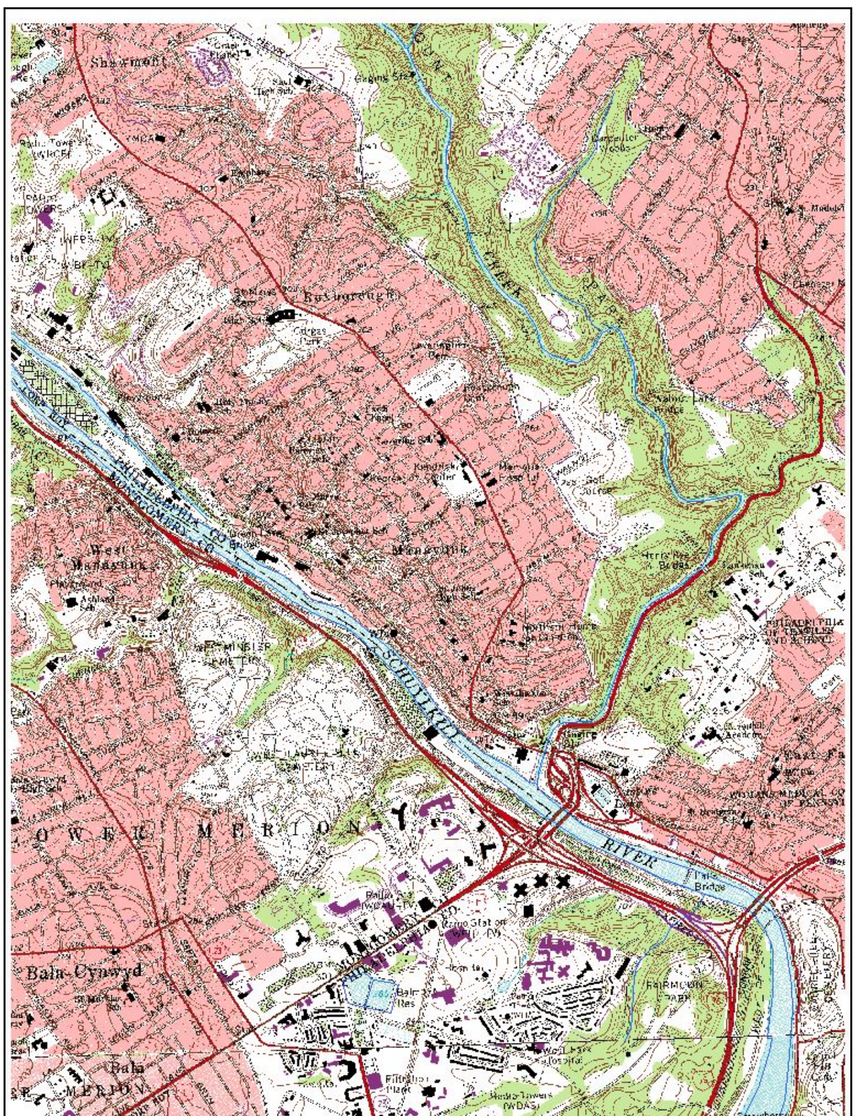


3.1.2.4 Topography

The combination of geologic, soil, and hydrologic characteristics found in the watershed make runoff of conservative contaminants from land activities into the adjacent surface waters very possible if no mitigation strategies are implemented. These characteristics also affect the quantity of the flow that can create erosion of streambanks and deposit sediment in reservoirs.

The topography of the watershed indicates where significant runoff may be generated. Land-based activities on steeply sloping areas may generate more runoff and associated contaminants than those located on gentler slopes due to the potential to transport contaminated runoff farther and faster. The steeply sloping areas shown on Figure 3.1.2-5 are considered to be sensitive areas where runoff from various activities could have a potentially significant impact on river water quality. These areas are ideal for preservation and protection from development to prevent increased runoff and contamination in the future.

Figure 3.1.2-5 Topographic Map of Queen Lane WTP Intake Area



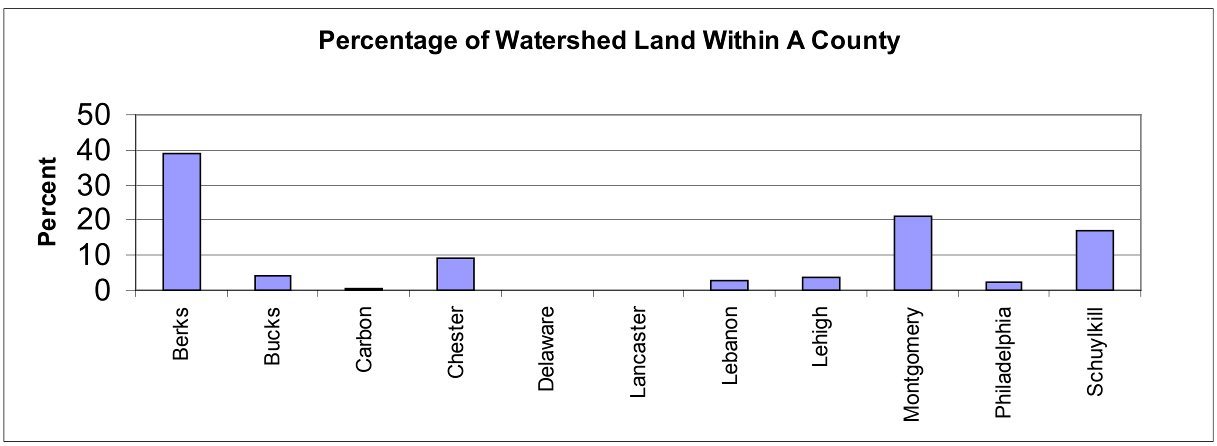
3.1.3 Land Use

Key Points

- **Recent land use studies conclude that the amount of developed land within the Schuylkill River Watershed ranges between 14 and 30%.**
- **Studies of changing land use patterns in the watershed conclude that the amount of developed land is increasing, as agricultural and forested lands decrease.**
- **Developed land areas are found mainly in the Lower Schuylkill River Watershed, near major cities and transportation corridors.**
- **The area surrounding the Queen Lane Intake is primarily forested, with some residential and commercial areas.**

Parts of 11 counties are located within the Schuylkill River Watershed. Of these 11 counties, only 4 (Berks, Chester, Montgomery, and Schuylkill counties) have nearly ten percent or more of the watershed within their boundaries (Figure 3.1.3-1).

Figure 3.1.3-1 Percentage of Land Area in the Schuylkill River Watershed within Each County



The Queen Lane WTP is at the downstream end of the watershed, where Philadelphia accounts for only two percent of the watershed land area, but represents the single largest population and water supply withdrawal in the watershed. Bucks, Montgomery, Chester, and Delaware Counties are suburban areas bordering Philadelphia that make up the middle of the watershed and represent suburban areas surrounding the city with varying amounts of development. Berks, Carbon, Lebanon, Lehigh, and Schuylkill Counties in the upper reaches of the watershed are the least developed areas.

As shown in Figure 3.1.3-2, the most recent studies by the USDA have estimated that the Schuylkill River Watershed is 28% developed, 34% agricultural, and 32% forested. Table 3.1.3-1 and Figure 3.1.3-3 both provide the details of this breakdown in five-year intervals spanning the period from 1982 until 1997. Based on the changes in land use from 1982 to 1997, the amount of developed land has increased by over 30% in the past 15 years, while agricultural land in the watershed has decreased by almost 14% and forested lands decreased by just under 5%.

Figure 3.1.3-2 Overview of Schuylkill River Watershed Land Use (%)

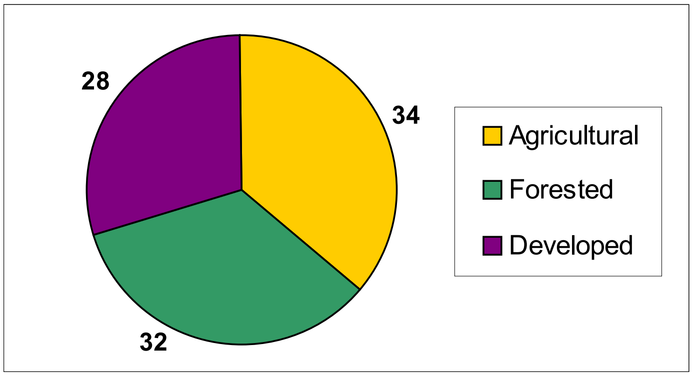


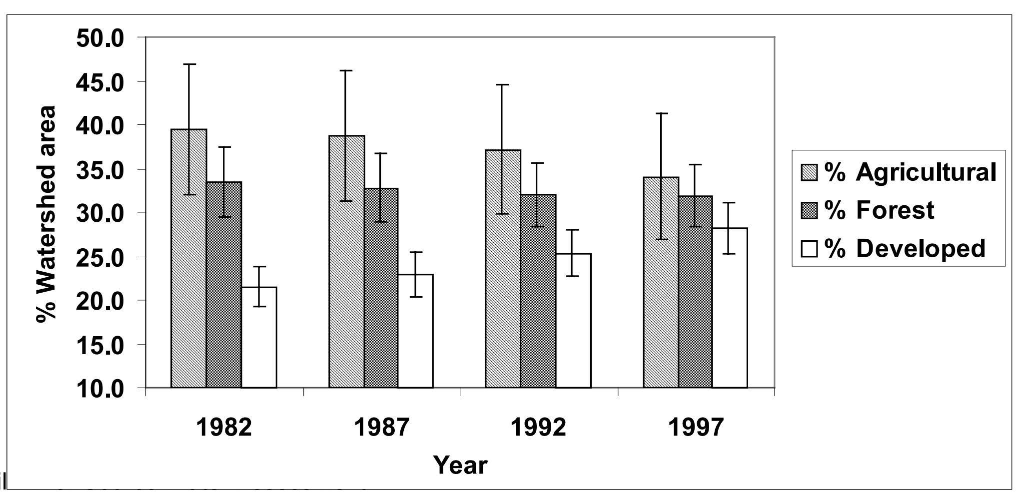
Table 3.1.3-1 Land Use Changes in the Schuylkill River Watershed: 1982-1997

Year	% Agricultural	% Developed	% Forested
1982	39.5	21.5	33.5
1987	38.8	22.8	32.8
1992	37.2	25.3	32.1
1997	34.0	28.3	31.9

Source : NRI, 2001
*Note: To calculate % change in agricultural land from 1982 to 1997: [(34.0-39.5)/39.5] * 100 = -13.9%*

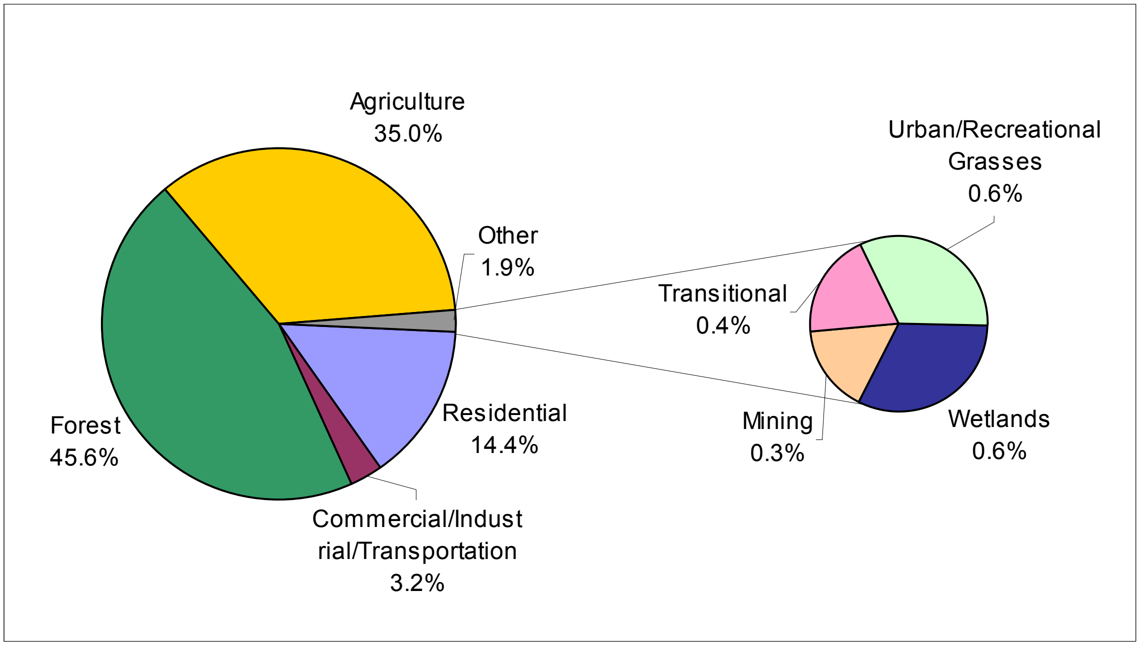
Figure 3.1.3-3 Changing Land Use in the Schuylkill Watershed

Data is from the National Resources Inventory, 2001. Error bars indicate 95 % confidence intervals for data in broad land use categories. Agricultural land includes all pasture, grazing and croplands. Developed land includes all urban land and rural transportation lands.



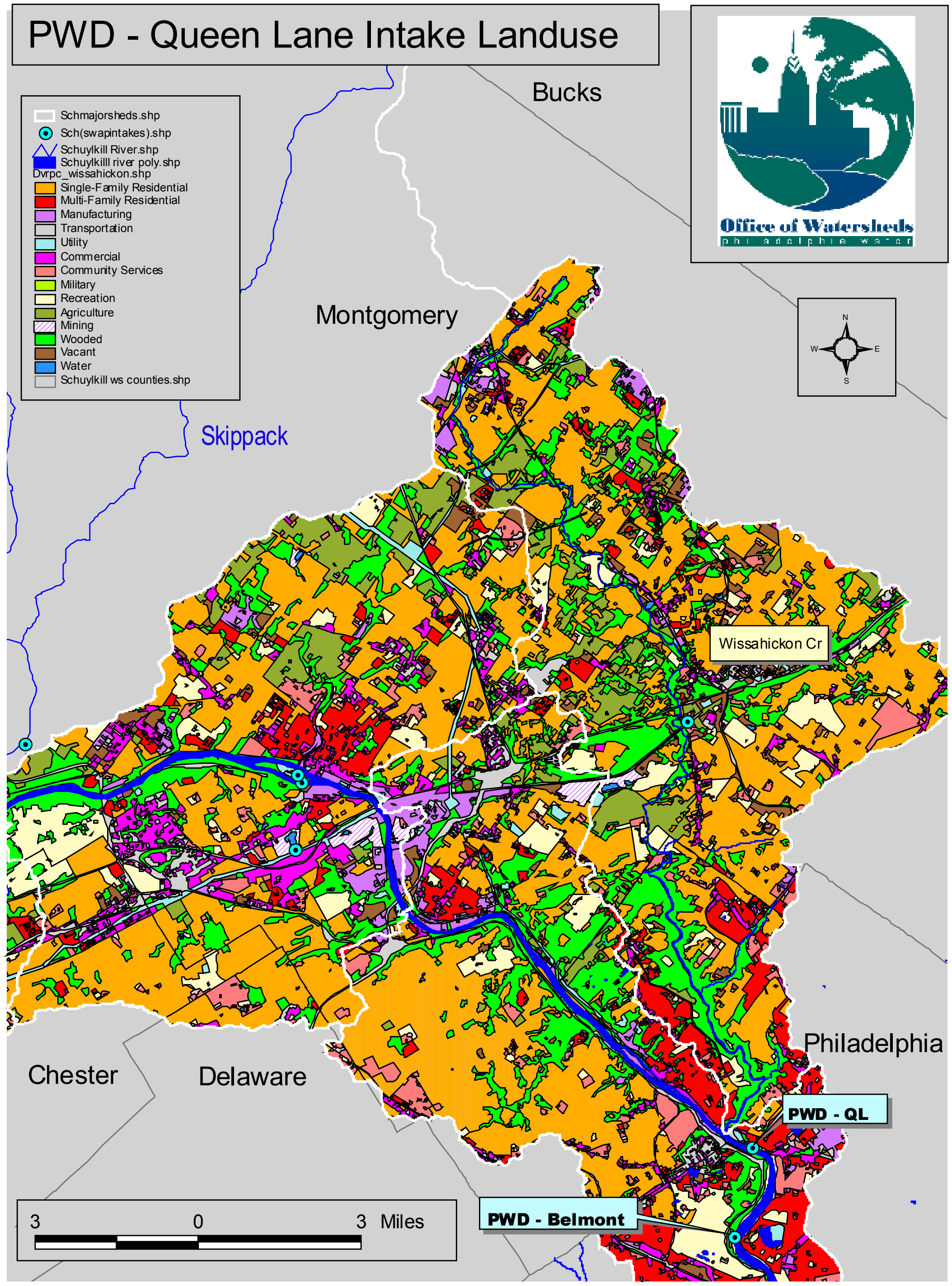
The USGS's National Land Cover Dataset (NLCD) landuse coverage, detailed in Section 1.2.5, characterizes the entire Schuylkill Watershed. Figure 3.1.3-4 shows the updated NLCD coverage for the Schuylkill Watershed Area within the Zone B delineation for the PWD Queen Lane Intake. According to this information, over 80% of this area is characterized as agriculture, forests, or wetlands. The majority of the remaining 20% is developed area.

Figure 3.1.3-4 Updated NLCD Land Use for PWD Queen Lane Intake Zone B Delineation



As shown in Figure 3.1.3-5, the area surrounding the Queen Lane Intake is primarily wooded, commercial, and residential areas. Across the river from the intake, the land is mostly forested. Besides the immediate area surrounding the intake, most of the land is used for residential purposes.

Figure 3.1.3-5 Queen Lane Intake Land Use (DVRPC)



3.1.4 Drinking Water System

Key Points

- **The 85 MGD Queen Lane Water Treatment Plant provides water to about 900,000 people in the northwestern section of Philadelphia.**
- **The Queen Lane Water Treatment Plant (WTP) has won several awards for its outstanding treatment performance.**

The Philadelphia Water Department's Queen Lane Water Treatment Plant (PWSID 1510001), located 12 miles from the mouth of the Schuylkill River in Philadelphia County, is shown in figure 3.1.4-1. Raw water is pumped from the Schuylkill River at a daily average flow rate of 85 MGD. Located in the East Falls section of the city, the Queen Lane Water Treatment Plant provides water to about 900,000 people in the northwest region of Philadelphia. The service area is outlined by the Schuylkill River to the west, Roberts Avenue and Tabor Road to the south, and the borders of the city to the north and east.

Figure 3.1.4-1 Philadelphia Water Department's Queen Lane Water Treatment Plant

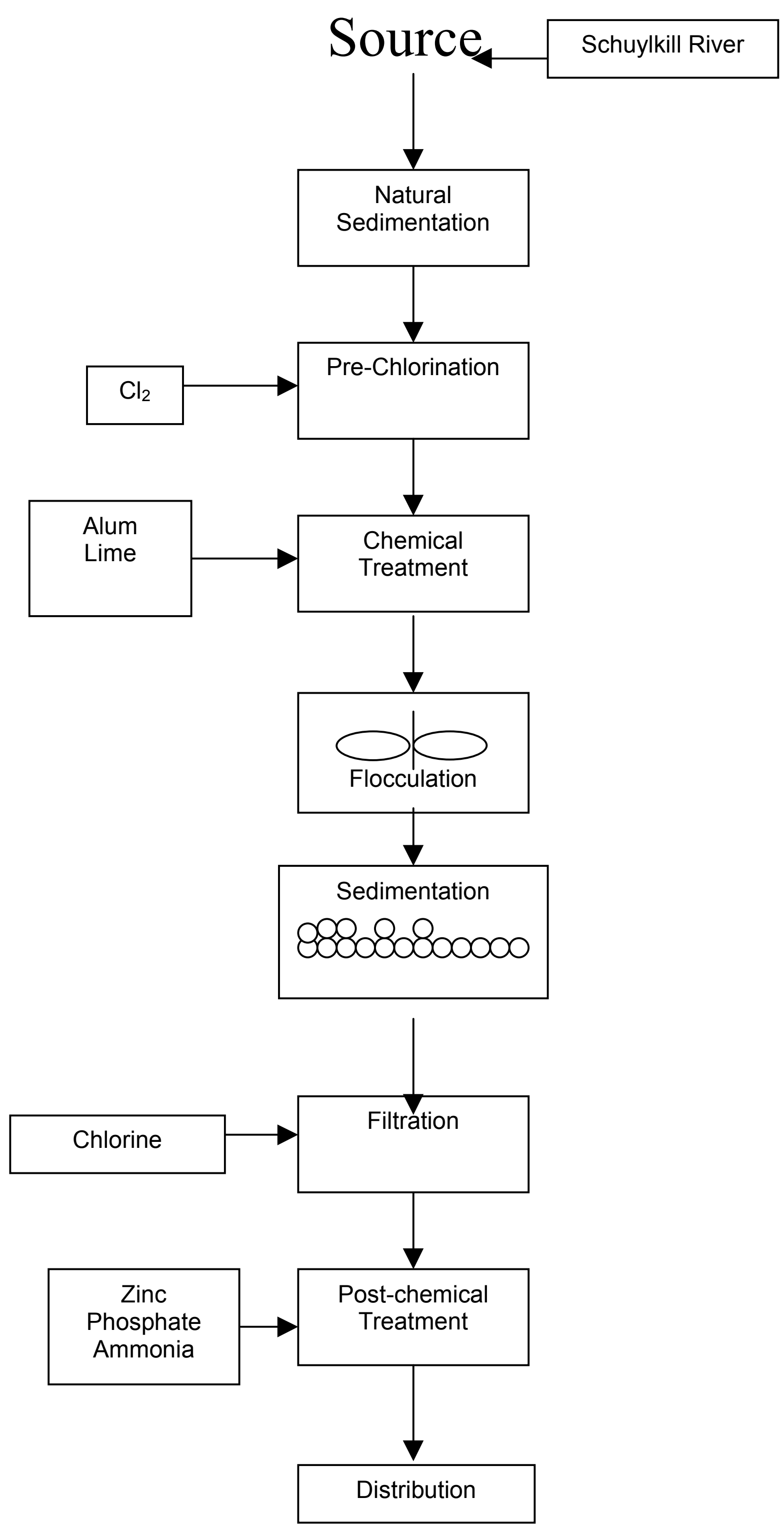
A process treatment schematic is shown by Figure 3.1.4-2. Raw water pumped from the Schuylkill Intake passes through screens for removal of large debris (leaves, branches, etc.) and is then held in a reservoir for at least 20 hours. The reservoir allows silt, sand, and other large particles to settle prior to downstream conventional treatment. The pre-sedimentation basin has the particularly important role of removing pollutants during rain events or high flow conditions when high concentrations of silt and large particles result in re-suspension of river sediment and runoff. Additionally, an oxidant or powdered activated carbon (PAC) may be added to the pre-sedimentation basin to mitigate algae or taste and odor episodes.

The reservoir is located on a hill, so that the height of the reservoir provides sufficient hydraulic pressure to allow water to flow through the plant by gravity. This saves considerable money in pumping and electrical costs. After pre-sedimentation, ferric chloride or aluminum sulfate (alum) is used as a coagulant to destabilize viruses and small particles such as clay. Following coagulant addition, two-stages of flocculation with gentle mixing are provided to allow the destabilized particles to agglomerate. Flocculation detention time is about 60 to 70 minutes. Once floc is formed, it settles in basins with two to four hours of detention time. The floc settles to the bottom of the basin and is removed as sludge that is sent to a City of Philadelphia Water Pollution Control Facility (WPCF). A chemical addition point for chlorine, polymer, or pH adjustment is available after sedimentation.

Clarified water is then treated with dual media filtration or rapid sand filtration. Dual media consists of anthracite coal and sand and removes remaining suspended material. Filters are usually terminated after two days time, prior to severe headloss or break-through. Thirty-five filters are available at Queen Lane. At average daily flow, the loading rate is less than two gallons per minute per square foot (gpm/sf). Upon termination, a filter is backwashed and spent backwash water is sent to the WPCF.

Disinfection at Queen Lane is achieved through the addition of chlorine in the pre-sedimentation basin and after sedimentation. After filtration, ammonia is added for chloramination. This maintains a total chlorine residual of about two milligrams per liter (mg/L) in the distribution system for microbial control. After filtration, fluoride and zinc orthophosphate are also added to prevent tooth decay and for corrosion control, respectively. Filtered water is then stored in two clearwells and eventually pumped to the distribution system of the west and southwestern sections of Philadelphia.

Figure 3.1.4-2 Process Treatment Schematic for the Queen Lane Water Treatment Plant



3.1.5 Raw Water Quality

Key Points

- **Schuylkill River Water Quality is monitored to assess potential health risks, aesthetics, and treatment requirements.**
- **The Philadelphia Water Department routinely monitors pH, color, alkalinity, hardness, total dissolved solids, conductivity, turbidity, coliform, *Giardia* and *Cryptosporidium*, total organic carbon, UV absorbance, bromide, nitrogen, phosphorus, iron, manganese, sulfate, chloride and sodium at the Queen Lane Intake. Many other parameters are monitored as part of special studies.**
- **Turbidity and other suspended contaminants in the river tend to increase as a function of precipitation, runoff and river flow.**
- **Salt levels in the river appear to fluctuate seasonally, perhaps in response to the application of road salts during the winter.**
- **Conductivity, alkalinity, chloride, sodium and 15 other water quality parameters have increased at the Queen Lane Intake over the past decade. Increased pollution from runoff is the most likely source of these changes.**
- **Almost 70% of the 809 stream miles within the Lower Schuylkill River Watershed has been assessed to determine compliance with existing water quality standards.**
- **Water quality standards were attained along two-thirds (370 miles) of the streams that were assessed.**
- **Stormwater runoff from urban and residential areas and municipal point sources were responsible for the majority of stream impairments within the Lower Schuylkill River Watershed.**
- **Over 90% of the Wissahickon Creek Watershed has been designated as impaired.**

3.1.5.1 Water Quality Summary

Water Quality Parameters and Their Significance

A variety of parameters can be used to measure the health of our streams and rivers, as well as the suitability of these surface waters as a source of potable water supply. Table 3.1.5-1 summarizes the specific parameters sampled for at PWD's Queen Lane Intake, as well as the frequency of sampling, and the time period when sampling occurred. Most of the data was collected during routine sampling by staff at the water treatment plant (WTP). That data is supplemented by data collected for compliance with the Information Collection Rule and by data collected at a pilot treatment facility located at the WTP.

Table 3.1.5-1 Queen Lane Intake Sampling Summary

Parameter Group	Parameter	Frequency of Sampling	Time Frame	
Physical Parameters	pH	Weekly	Jan-90	Dec-99
	Apparent Color	Weekly	Jan-90	May-93
	Alkalinity	Weekly	Jan-90	Dec-99
	Hardness	Monthly	Jan-90	Dec-92
	Total Dissolved Solids	Monthly	Jan-90 Nov-96	Jun-93 Jan-99
	Conductivity	Weekly	Jan-90	Dec-99
Particulates & Microbial Contaminants	Turbidity	Weekly	Jan-90	Dec-99
	TSS	Monthly	Jan-90	Jun-93
	Total Coliform	Sporadic Weekly	Mar-91 Apr-95	Jan-95 Dec-99
	E. coli	Monthly	May-95	Dec-99
DBP Precursors - (Organic Compounds)	TOC	Weekly	Sep-93	Feb-00
	UV Abs @254nm	Weekly	Jul-93	May-99
Inorganic Compounds – Nutrients	Ammonia	Weekly	Jan-90	Feb-99
	Nitrite	Monthly	Jan-90	Jun-93
	Nitrate	Monthly	Jan-90	Jun-93
	D. Orthophosphate	Weekly	Jan-90	Jun-93
	T. Phosphate	Weekly	Jan-90	Jun-93
Inorganic Compounds – Metals	Lead	Bimonthly Quarterly	Feb-90 Feb-93	Dec-92 Jun-99
	Iron	Weekly	Jan-90	Jun-99
	Manganese	Weekly	Jan-90	Jul-99
Inorganic Compounds – Secondary Contaminants	Sodium	Monthly	Jan-90	Nov-99
	Chloride	Bimonthly Monthly	Jan-90 Jan-93	Oct-92 Dec-99

Summary Table 3.1.5-1 shows that an extensive amount of data has been collected from 1990 to the present in order to characterize almost all parameter groups at the Queen Lane Intake. A significant data set for parameters such as total suspended solids, metals, and nutrients, was available for detailed analysis of spatial and temporal trends. Data was very sparse for synthetic and volatile organic compounds, as well as for radionuclides.

Statistical summaries were developed for the parameter groups with sufficiently large data sets. In the statistical summaries, the minima and maxima are presented in order to show the range of values and variability of the data. The means and medians are presented to show the central tendencies of the parameters – typically measured levels. A mean that is significantly greater than the median indicates that one or two high values are affecting the mean. Similarly, a mean that is significantly lower than the median indicates that one or two low values are reducing the average. The number of samples shows how many points were included in the statistics. The count is related to the sampling frequency and time period given in Table 3.1.5-1. The number of non-detect measurements and the detection limit are also listed, where applicable. These were not included in computations of the minima, maxima, means, and medians.

Statistical results are discussed with respect to drinking water standards, which apply to the treated water. Although these standards or Maximum Contaminant Levels (MCLs) apply to treated water, they provide a good perspective on the quality of the raw water. Raw water quality results are also discussed with respect to impacts on treatment and finished water quality. Water quality parameters of interest are described below.

Physical Parameters

Physical parameters such as pH, alkalinity, color, taste, odor, and conductivity may not be directly related to health risks but can be important measures of consumer satisfaction, as well as treatability.

The presence of very low levels of compounds that cause taste and odor events in drinking water can generate consumer complaints. Color, if not treated properly, can also affect public perception of the water. Colored water generally indicates a higher level of organics or iron. Acid mine drainage from the upper watershed may be contributing to manganese, and consequently color. Excessive nutrients can cause algal blooms, which are related to the taste and odor compounds. Compounds that cause taste and odor or color do not generally pose health risks. However, these compounds must be controlled to produce water that consumers want to drink. Expensive chemicals such as powdered activated carbon, potassium permanganate, or ozone may need to be added during treatment to control formation. Effective watershed management can potentially save significantly on chemical treatment costs.

Two important parameters in maintaining effective treatment of drinking water are pH and alkalinity. They are monitoring tools that are essential to the drinking water treatment process. A water supply with high alkalinity may have increased chemical costs, because more pretreatment chemicals will be required for pH adjustment. Higher alkalinity is usually a naturally occurring phenomenon based on the hydrology of the region. Elevated pH levels can be indicative of algal blooms in the raw water supply. Algae are a concern because they can potentially clog WTP filters and because they can release very low levels of taste and odor compounds.

Conductivity measures the amount of ions (positive and negative) in the water and the ability of the water to conduct electricity. High levels of conductivity usually indicate high levels of salts, metals, or nutrients in the water. This parameter is a cheap and easy measurement used frequently in most water quality studies. Table 3.1.5-2 summarizes levels of physical parameters measured at PWD's Queen Lane Intake.

Table 3.1.5-2 Physical Parameters at Queen Lane Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
pH[1]	pH units	7.1	9.2	7.8	7.8	506
Apparent Color	CU	2	100	30	25	170
Alkalinity	mg/L as $CaCO_3$	30	128	77	78	505
Hardness	mg/L as $CaCO_3$	64	223	136	137	306
TDS	mg/L	113	402	254	260	65
Conductivity	μmhos/cm	146	775	425	419	495

[1] pH MCL represents a "reasonable goal for drinking water quality"

The statistics for the physical parameters show that the Schuylkill River is typical of most rivers in the northeast. The maximum pH of 9.2 at Queen Lane is indicative of the algal blooms that can occur in late spring and early summer. The range in apparent color can be related to rain events. Apparent color measures color due to particulates and turbidity, as well as naturally occurring dissolved organic material. Consequently, apparent color values are influenced by rain events that increase the turbidity in the river.

The range in alkalinity is quite wide. In general, changes in alkalinity are related to base flow changes in the river. The median alkalinity and hardness of about 80 and 140 mg/L as $CaCO_3$ respectively, are reflective of moderately hard water. Increased hardness and alkalinity can increase chemical costs associated with reducing pH at the water treatment plant. Variability in total dissolved solids and conductivity may be due to changing salt levels in the river. Salt levels appear to fluctuate seasonally with the use of road salt in winter.

Turbidity and Microbial Contaminants

Turbidity measures the clarity of the water. As it gets cloudier, the turbidity increases. This indicates that fine suspended materials that obscure light rays are present in the water. Turbidity can be caused by nearby roads, construction, erosion, and agricultural runoff. Levels of turbidity depend on the type of soils, slopes, land cover, and rain intensity.

Levels of microbial contaminants or pathogens determine whether a stream is safe for recreational swimming and help gauge the amount of fecal pollution entering it. Typical pathogen testing includes total coliforms, fecal coliforms, viruses, *E. coli*, *Giardia*, and *Cryptosporidium*.

As Table 3.1.5-3 shows, levels of particulates and microbial parameters are influenced by rain and runoff. On average, river turbidity and total suspended solids at Queen Lane are quite low, with medians of four NTU and 12 mg/L, respectively. Maximum values of 95 NTU and 408 mg/l show how turbidity and solids can increase significantly as a result of rain events. As river flow increases above the annual median flow of 1,600 cfs, turbidity generally increases, requiring increased chemical usage at the WTP. The pre-sedimentation basin at the Queen Lane WTP is used to settle out much of these solids prior to treatment.

Table 3.1.5-3 Particulate and Microbial Contaminants at Queen Lane

Parameter	Units	Min	Max	Mean	Median	Number of Samples	MCL
Turbidity[1]	NTU	0.2	95	7.8	3.9	500	1
TSS	mg/L	0.10	408	41	12	60	
Total Coliforms	Col/100 mL	6	95000	6150	3000	234	≤ 5% of monthly samples may be positive
E. coli	Col/100 mL	0.3	9000	885	420	223	≤ 5% of monthly samples may be positive

[1] Turbidity MCL for unfiltered supplies

Microbials will also increase during rain events, similar to the other particulates. Accordingly, median values for total coliforms and *E. coli* are one to two orders of magnitude lower than the maximum values. Although these parameters increase during rain events, disinfection with chlorine kills the *E. coli* and total coliform prior to distribution to consumers. However, disinfectant demand and associated costs may increase.

Table 3.1.5-4 summarizes the *Giardia* and *Cryptosporidium* detected at the Queen Lane WTP Intake for 2000.

Table 3.1.5-4 *Giardia* and *Cryptosporidium* Detected at the Queen Lane WTP Intake in 2000

Pathogen	N	Min	Max	Median	Average	Total Volume Examined (L)	# positive samples	% positive samples
Cryptosporidium	16	0	1	0	0.11	182.33	6	38%
Giardia	16	0	20.75	1.375	3.72	182.33	13	81%

All concentrations in oocysts/L unless otherwise noted

As shown, *Giardia* is found frequently, thus indicating that sewage discharges upriver routinely impact the river, while *Cryptosporidium* is detected in only one of five samples collected. The cumulative average raw water *Cryptosporidium* concentration from 1994 to 2000 was 0.08 oocysts/L.

PWD has been studying *Giardia* and *Cryptosporidium* in the water supply since 1994. Since then, a number of special studies have been conducted to identify the sources and influences on the concentrations of these pathogens in the river. However, the technology to adequately detect and analyze water samples for *Cryptosporidium* is not considered reliable or accurate enough for risk assessments and detailed quantitative comparisons. Given the limitations of the analytical methods the following observations have been observed:

- *Giardia* and *Cryptosporidium* are detected more often in the river during storm events.
- *Giardia* and *Cryptosporidium* are typically found at higher concentrations in the river during storm events and correlate with higher turbidity concentrations.
- *Giardia* and *Cryptosporidium* are typically found at higher concentrations during winter and spring when water temperatures are colder and oocyst survival is improved.
- *Giardia* and *Cryptosporidium* is routinely found in sewage effluents.

The previous findings indicate that runoff and sewage discharge influence the presence and concentrations of *Cryptosporidium* and *Giardia* in the Lower Schuylkill River Basin. Figure 3.1.5-1 provides a theoretical description of the cycle of how the pathogens are moved from one source to another an eventually into the river or water supply. As shown in Figure 3.1.5-2, one calf can produce as much *Cryptosporidium* in a day as 1,000 infected persons or more than 100 adult cattle. Therefore, keeping young animals away from sensitive water supply areas is prudent.

Information to date suggests that the treatment process is sufficiently removing these pathogens. No cases of cryptosporidiosis reported in Philadelphia from 1997 to 1999 were related to drinking water. In fact, the main risk factors for cryptosporidiosis were identified as travel, swimming, contact with an infected person, day care, or farm animal contact. This is further corroborated by the observation that more cases of cryptosporidiosis are reported during the summer months when travel and swimming occur. During the summer months, *Cryptosporidium* and *Giardia* are found at their lowest levels in the local rivers and streams.

Figure 3.1.5-1 Theoretical Pathogen Transport Cycles in a Multi-Use Watershed

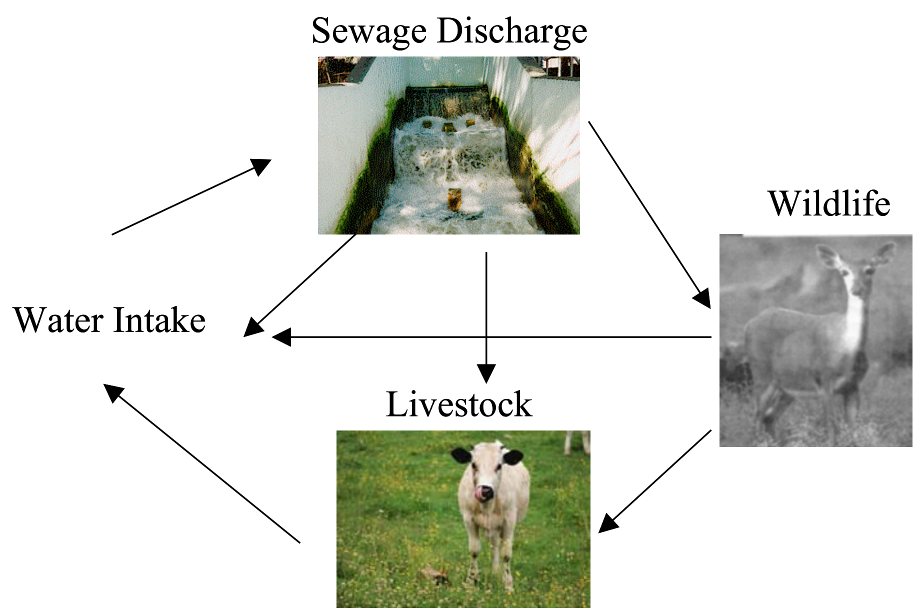
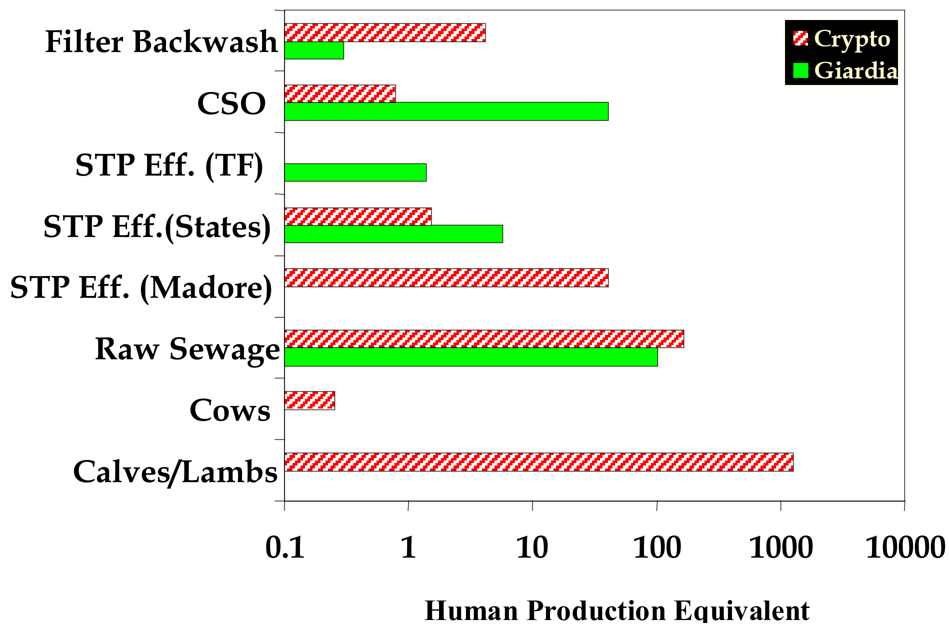


Figure 3.1.5-2 Comparison of Amounts Produced by Various Sources of Cryptosporidium and Giardia

(Note: STP effluent values based on discharge of 10 mgd)



Disinfection By-product Precursors

Precursor compounds react with other chemicals (such as chlorine or ozone) used in the disinfection process to create disinfection by-products (DBPs). High levels of DBPs may cause human health impacts. Some of the precursors that are tested for include bromide, total organic carbon, and UV absorbance.

Total organic carbon (TOC) may include volatile organic compounds (VOCs) and synthetic organic compounds (SOCs), but is mostly comprised of natural organic matter from decomposition of leaves and plants. The naturally occurring compounds that comprise TOC form chlorinated organic compounds, such as chloroform. These chlorinated organics may be carcinogenic at certain levels of exposure. Absorbance of UV light is a good surrogate for dissolved natural organic matter and does not require the same level of technical laboratory analysis as TOC.

Bromide is a concern because it reacts with ozone to form bromate, a potential carcinogen. Bromide also reacts with chlorine and organics to form brominated chlorine by-products that may pose health risks. The analytes shown in Table 3.1.5-5 are typical measures of DBP precursors. Comparing the mean and median values of TOC at Queen Lane, it indicated that the TOC levels are typically less than three mg/L. The maximum TOC value of 7.1 mg/L may be rain/run-off related, because TOC measures particulate organics. TOC increases seasonally during the summer and early fall due to greater plant growth and decomposition. Formation of chlorination by-products is of particular concern during those seasons. UV shows similar trends as TOC.

Table 3.1.5-5 Organic Compounds – DBP Precursors at Queen Lane Intake

Parameter	Units	Min	Max	Mean	Median	Number of samples
Total Organic Carbon	mg/L	1.7	7.1	2.9	2.7	298
UV Abs@254nm	cm^{-1}	0.037	0.337	0.086	0.075	167

Inorganic Compounds - Nutrients

Nutrients can cause excessive algal growth that can harm fish and impact water treatment. These measurements can identify the impacts of nutrient runoff from lawns, gardens, farms, and other sources. Some of the nutrients measured are nitrate, ammonia, phosphorus, and orthophosphate. High levels of nutrients cause algal blooms. The algae can then clog filters at the water treatment plant or upon dying release very small amounts of chemicals (parts per trillion levels) that can make the water taste or smell bad. Though these chemicals are not harmful, water treatment must add chemicals such as powdered activated carbon to remove them, which is usually expensive.

Table 3.1.5-6 provides an overview of the nutrient content of the Lower Schuylkill River at Queen Lane and its variability. Nitrite values are of particular concern in drinking water treatment due to blue baby syndrome. Median levels of the nutrients are fairly low and do not significantly affect drinking water treatment. The maximum value of total nitrite and nitrate measured, 0.10 mg/L and 4.8 mg/L, respectively, are well below the general guidelines of one mg/L MCL of nitrite and a ten mg/L MCL of nitrate.

Table 3.1.5-6 Inorganic Compounds – Nutrients at Queen Lane Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
Ammonia	mg/L as N	0.01	0.88	0.14	0.12	429
Nitrite	mg/L as N	0.03	0.10	0.05	0.05	42
Nitrate	mg/L as N	0.63	4.8	3.2	3.3	129
Dissolved Orthophosphate	mg/L as P	0.04	1.4	0.27	0.25	168
Total Phosphate	mg/L as P	0.02	1.4	0.27	0.25	279

Inorganic Compounds – Metals

The presence of metals can have various types of impacts on drinking water. Some metals, such as lead, may pose health risks at certain concentrations, if not removed at the WTP. The presence of lead in raw water is usually indicative of an industrial source. Lead is usually removed from the raw water by filtration. It may later leach into the water supply from distribution system pipes, but this can be controlled by chemical treatment.

Manganese is a concern for drinking water treatment because it can cause an unsightly color in the water at very low concentrations. Treatment of manganese with powdered activated carbon or potassium permanganate can be very costly. High levels of metals may also impact aquatic life. Metals are usually found at high levels in the Schuylkill Watershed in areas impacted by acid mine drainage. PWD monitors levels of lead, iron and manganese, as shown by Table 3.1.5-7.

Table 3.1.5-7 Inorganic Compounds – Metals at Queen Lane Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples	# of Non-Detects	Detection Limit
Lead	Mg/L	0.001	0.06	0.006	0.003	43	3	0.001
Iron	Mg/L	0.025	25	0.81	0.37	623	0	
Manganese	Mg/L	0.005	1.59	0.108	0.09	575	0	

Median lead levels in the Schuylkill River, before treatment, are below the current MCL of 0.015 mg/L. Lead is usually easily treated with corrosion inhibitors prior to distribution. The iron values shown in Table 3.1.5-7 are quite variable, with a median of 0.4 mg/L and a maximum of 25 mg/L. Iron levels can increase significantly at Queen Lane due to rain events. Higher iron levels increase treatment costs of chemical additions and sludge disposal. The manganese data also shows variability that can be attributed to rain events. The median value of 0.09 mg/L is in excess of the Maximum

Contaminant Level for finished water of 0.05 mg/L. At Queen Lane, this is treated using potassium permanganate or chlorine, which increases overall treatment costs.

Inorganic Compounds – Secondary Contaminants

Salts are the primary secondary contaminant considered. Salts indicate whether the stream is a freshwater or saltwater environment. Salts are not typically removed by the water treatment process. High levels of salt in the drinking water are not desirable for those with low-sodium diets. Sodium and Chloride are the two major constituents of salts measured.

Table 3.1.5-8 summarizes sodium and chloride levels measured at the Queen Lane Intake. Salt levels have been found to increase during the winter. From a drinking water perspective, high sodium values can be an area of concern for those individuals with hypertension. The median/mean value of about 27 mg/L is above the EPA guidance value of 20 mg/L. Use of road salts in the winter should be limited.

Table 3.1.5-8 Inorganic Compounds – Secondary Contaminants at Queen Lane Intake

Parameter	Units	Min	Max	Mean	Median	Number of Samples
Chloride	mg/L	10	128	44	44	150
Sodium [1]	mg/L	0.01	76	27	27	140

[1] 20 mg/L is a guidance value not an MCL

Synthetic Organic Compounds

Pesticides and herbicides comprise most of the synthetic organic compounds (SOCs). Synthetic organic compounds are manufactured chemicals that generally last a long time in the environment and may have toxic effects on human and aquatic life. Dozens of pesticides and herbicides exist which can be tested for in water. Generally, atrazine, a herbicide used for farming and agriculture, is the most heavily used and widely found. The EPA website has more details about pesticides and herbicides, if more information is required.

Synthetic Organic Chemicals (SOCs) are characterized as environmentally resistant and usually linked to various health impacts. As shown in Tables 3.1.5-9 and 3.1.5-10, a number of SOCs that have been banned or have limited use are still being detected in the river. In addition, though 6 of the 18 SOCs detected were related to farming, the others appear to be related to urban, residential, commercial, transportation, or industrial activities (please see Table 3.1.5-12). It is also interesting to note the diversity of chemicals detected in upstream watershed areas such as the Wissahickon Creek. The detection of a number of pesticides and herbicides in this stream suggests that there is still significant use of herbicides and pesticides in this mainly residential watershed.

Table 3.1.5-11 compares the SOCs detected in or near the PWD Schuylkill Intakes with those detected in the Delaware Watershed based upon preliminary results of the USGS NAWQA study. As shown, there are a number of common SOCs such as atrazine, alachlor, metolachlor, and simazine. These are all herbicides that are associated with agricultural activities. These similarities suggest that these activities have impacts on water resources throughout the Delaware River Basin and are not unique to the Schuylkill River.

Table 3.1.5-9 Herbicides, Pesticides, and SOCs Results for the Queen Lane and Belmont WTPs

	1995	1996	1997	1998	1999	2000
PESTICIDES						
Alachlor	ND	ND	ND	NA	NA	+
Aldicarb	NA	ND	NA	NA	NA	NA
Aldicarb Sulfone	NA	ND	NA	NA	NA	NA
Aldicarb Sulfoxide	NA	ND	NA	NA	NA	NA
Atrazine	+	+	ND	**+**	ND	**+**
Carbaryl	NA	ND	NA	NA	NA	ND
Carbofuran	ND	ND	ND	NA	NA	ND
Chlordane	ND	ND	ND	NA	NA	NA
Hexachlorocyclopentadiene	ND	ND	ND	NA	NA	+
Lindane	ND	ND	ND	NA	NA	ND
Methomyl	NA	ND	NA	NA	NA	NA
Methoxychlor	ND	ND	ND	NA	NA	ND
Oxamyl	ND	ND	ND	NA	NA	ND
Simazine	ND	ND	ND	NA	NA	+
3-Hydroxcarbofuran	NA	ND	NA	NA	NA	NA
HERBICIDES						
Dalapon	+	ND	NA	NA	NA	NA
Dicamba	NA	ND	NA	NA	NA	NA
Endothall	ND	ND	ND	NA	NA	ND
Metolachlor	+	ND	NA	NA	NA	NA
Metribuzin	NA	ND	NA	NA	NA	NA
Pentachlorophenol	+	+	ND	ND	ND	+
Picloram	ND	ND	ND	NA	NA	ND
Propachlor	NA	ND	NA	NA	NA	NA
SYNTHETIC ORGANIC CHEMICALS						
Benzo[a]Pyrene	ND	ND	ND	NA	NA	ND
Di-2(ethylhexyl)Adipate	ND	ND	ND	NA	NA	ND
Di-2(ethylhexyl)Phthalate	+	+	ND	ND	ND	ND
1, 2-Dibromo-3-Chloropropane	ND	ND	ND	NA	NA	ND
Ethylene Dibromide	ND	ND	ND	NA	NA	ND

NA = Not Analyzed; ND = Not Detected; + indicates a positive detection

Table 3.1.5-10 SOCs Detected in Lower Schuylkill River Watersheds during Fall 2000 Monitoring Study

Chemical Name	MDL	Concentration Ranges	Wissahickon Creek	Manayunk Canal
Lindane*	0.0038	0.0052	Yes	ND
Dieldrin	0.0038	0.004-0.03	ND	ND
Alachlor	0.15	0.21	ND	Yes
Diethylphthalate	0.04	0.05-0.13	Yes	Yes
Fluorene	0.02	0.02	Yes	Yes
Phenanthrene	0.02	0.02-0.06	Yes	ND
Dibutylphthalate	0.11	0.11-0.19	Yes	Yes
Pyrene	0.02	0.05-0.09	Yes	Yes
Benzo(a)anthracene	0.02	0.03 - 0.05	Yes	ND
Chrysene	0.02	0.03 - 0.05	Yes	Yes
Benzo(a)flouranthrene	0.05	0.05 - 0.07	Yes	Yes

**Insecticide for seed, lumber, livestock, pest control, most use restricted in 1980's*

Table 3.1.5-11 Comparison of SOCs Detected to Date by USGS NAWQA Study in the Delaware River Watershed

Chemical Name
Atrazine
Metalochlor
Simazine
Prometon
Diazinon
Carbaryl
Alachlor
Chlorpyrifos
Cyanazine
Acetochlor

Note: Shaded chemicals were also detected at the PWD WTPs in the Schuylkill River Watershed

Table 3.1.5-12 Uses and Possible Sources of Herbicides, Pesticides, and SOCs Detected at the PWD WTPs

Synthetic Organic Chemical	Use	Associated Activity
Atrazine	Herbicide	Farming (96% used for corn & soybeans)
Hexachlorocyclopentadiene	Pesticide	Chemical/Petroleum Processing
Simazine	Herbicide	Farming
Dalapon	Herbicide	Farming
Metolachlor	Herbicide	Farming - used to control certain broadleaf and annual grassy weeds in field corn, farming, highway right of ways, and orchards
Pentachlorophenol*	Herbicide	Wood finishing / furniture
Di-2(ethylhexyl)phthalate	SOC	Unknown
Lindane**	insecticide	Farming, golf courses, orchards, landscaping
Dieldrin	insecticide, termiticide	Residential/agricultural termite / pesticide application
Alachlor	herbicide on corn and soybeans	Farming
Diethylphthalate	plasticizer, component in the processing of polyvinyl chloride (PVC)	PVC manufacturing, solvent; aircraft lubes; insect repellent, stp effluents, landfill leachate, tire manufacturing
Fluorene	Resins and dyes	Wastewater, petroleum production, landfill leachate, urban runoff, combustion, resins, dyes
Phenanthrene	Dyes, explosives, pharmaceuticals, fossil fuels	Wood and fossil fuel combustion, garages, metal foundries, timber processing
Dibutylphthalate	Insect repellent, plasticizer, solvent	Plastic production, landfill leachate, wastewater, pulp mills
Pyrene	Biochemical research and fossil fuels	Crude oil, tire manufacturing, fossil fuel combustion, aluminum manufacturing
Benzo(a)anthracene	Coal Tar/Crude Oil	Exhaust emissions, plastics production
Chrysene	Coal Tar	Exhaust emissions, telephone poles, railroad ties
Benzo(a)flouranthrene	Fossil Fuels	Exhaust emissions

**Wood preservative, herbicide, defoliant - non-wood uses banned in 1987; antimicrobial disinfectant*
***Insecticide for seed, lumber, livestock, pest control, most use restricted in 1980's*

Volatile Organic Compounds

Volatile organic compounds (VOCs) are synthetic, lightweight compounds that vaporize or evaporate easily. Some VOCs such as vinyl chloride and benzene are known to be carcinogenic, while others such as chloroform are suspected to be cancer-causing agents. Industrial point sources account for most direct discharges into surface waters, but municipal wastewater plants constitute a second major source. In general, VOCs are used in solvent and degreasing compounds. Some VOCs are frequently connected with hazardous waste sites. These pollutants, a result of industrialization, are usually present at extremely low concentrations that do not appear to pose immediate health risks. Note that most organic compounds in water are naturally occurring and VOCs only comprise ten percent of the total organic material found in water.

Measurements of VOCs at the Queen Lane Intake are sparse compared to the other parameters. Table 3.1.5-13 is a summary of the available data. The data was broken into two sets due to time of sampling. The first set was based on mostly monthly sampling from January, 1990 through November, 1992. The second set was a discrete sampling event on May 14, 1991.

Table 3.1.5-13 Volatile Organic Compound Summary at Queen Lane

	# of Parameters Analyzed	Parameters	Frequency of Sampling	Total # of Samples	# of Non-Detects	Time Frame	
Set 1	48	See Table 3.1.5-13,below for those detected	Monthly*	1036	964	1/90	11/92
Set 2	38	None detected	Discrete	38	38	5/14/91	

**Generally monthly – some parameters had less and some more*

Forty-eight different parameters were analyzed in the first data set yielding a total number of 1,036 samples. However, VOCs were only measured above the detection limit in 72 of those samples. The data for those compounds with detectable concentrations are further summarized in Table 3.1.5-14. In the discrete sampling event on May 14, 1991, 38 volatile organic compounds were analyzed, but none were measured above the detection limit of 0.5 μg/L.

In Table 3.1.5-14, all of the compounds found in the raw water were well below the required limits for treated water. VOC levels at the Queen Lane Intake are very similar to those found at Belmont Intake for the same sampling period. One exception is bromodichloromethane, which was not detected at the Belmont Intake but was found on eight occasions at Queen Lane, with a maximum of six μg/L. Chloroform was also detected at higher levels at Queen Lane (8.9 compared to 1.8 μg/L) than at the Belmont Intake. Chloroform, dibromochloromethane, bromodichloromethane and total trihalomethanes all constitute trihalomethanes. Their presence is indicative of chlorine in the river, either due to an industrial source, chlorinated wastewater discharges, or road salt.

Table 3.1.5-14 Summary of Detectable VOCs at Queen Lane Intake

Compounds Detected	Units	Min	Max	Number of Samples (# detected)	Detection Limit	MCL
Chloroform	μg/L	0.3	8.9	27	0.3	100
Bromodichloromethane	μg/L	0.3	6	8	0.3	TTHM < 80
Dibromochloromethane	μg/L	0.3	1.7	5	0.3	TTHM < 80
total trihalomethanes	μg/L	0.4	17	21	0.3	TTHM < 80
Methylene chloride	μg/L	0.5	0.7	3	0.3	5
1,2,3 trichloropropane	μg/L	1	1	1	0.3	0.8*

Compounds Detected	Units	Min	Max	Number of Samples (# detected)	Detection Limit	MCL
Benzene	µg/L	0.3	0.4	2	0.3	5
o-dichlorobenzene	µg/L	0.3	0.4	2	0.3	600
Toluene	µg/L	0.3	0.5	3	0.3	1000

The data summarized on Table 3.1.5-14 also indicates that benzene, toluene, and o-dichlorobenzene were well below their MCLs. Benzene and toluene are associated with fuel oil. O-dichlorobenzene is associated with production of pesticides and dyes. One, two, three trichloropropane at one µg/L was the only compound detected in the raw water in excess of the proposed finished water limit of 0.8 µg/L.

A further examination of regulatory VOC monitoring for 21 chemicals at the Queen Lane Intake from 1994 to 1999 did not observe VOCs related to source water impacts (see Table 3.1.5-15). Typically, other than the occasion of a gasoline, fuel oil, petroleum pipeline break, or related spill, VOCs from point or non-point sources have not had a routine or regulatory impact on water quality in the 1990s at the Queen Lane WTP Intake.

Methyl tertiary-butyl ether (MTBE) is a VOC that is produced as a gasoline additive and used to reduce air pollution. However, it is quite persistent and is easily tasted or smelled at very low concentrations and can impact drinking water aesthetics. PWD monitored MTBE during from 1996 to 2000. The maximum concentration detected was 3.8 ug/L, well below the recommended limit of 20 ug/L. Data to date for the Schuylkill River indicates that concentrations are greatest during the summer periods when recreational boating is at its peak in the river. Recreational boat engines and in particular, jet skis or Wave Runners have been observed by studies in California to represent the most significant source of MTBE. Boat engines and jet skis can release uncombusted gasoline directly into the water.

Table 3.1.5-15 Regulatory VOCs Tested for in PWD's Drinking Water

Contaminant Name	MCL	MDL
Benzene	0.005	0.0005
Carbon Tetrachloride	0.005	0.0005
1, 2-Dichloroethane	0.005	0.0005
o-Dichlorobenzene	0.6	0.0005
p-Dichlorobenzene	0.075	0.0005
1, 1-Dichloroethene	0.007	0.0005
cis-1, 2-Dichloroethene	0.07	0.0005
trans-1, 2-Dichloroethene	0.1	0.0005
Dichloromethane	0.005	0.0005
1, 2-Dichloropropane	0.005	0.0005
Ethylbenzene	0.7	0.0005

Contaminant Name	MCL	MDL
Monochlorobenzene	0.1	0.0005
Styrene	0.1	0.0005
Tetrachloroethene	0.005	0.0005
Toluene	1	0.0005
1,2,4-Trichlorobenzene	0.07	0.0005
1, 1, 1-Trichloroethane	0.2	0.0005
1, 1, 2-Trichloroethane	0.005	0.0005
Trichloroethene	0.005	0.0005
m,p-Xylenes	10	0.0005
o-Xylene	10	0.0005

Results in mg/L
MCL = Maximum **C**ontaminant **L**evel
MDL = Method **D**etection **L**imit
Note: These chemicals were not detected in the finished water

Radionuclides
Radioactivity is not typically a major health concern in surface waters based on actual concentrations and frequency of detections. Nevertheless, surface waters may be susceptible to radioactive contaminants from nuclear industrial accidents. Increased use of radioisotopes in the health industry may also be a potential source of pollution. Some radionuclides are naturally occurring due to soil and rock decomposition. Naturally occurring radionuclides are found at much higher concentrations in groundwater, than in surface water. The major concern with radionuclides is that they cannot be removed by known chemical or physical treatment and are generally very persistent in the environment. Natural decay can be an extremely slow process.

Radioactivity in water may be caused by four general categories of radiation: alpha and beta particles, gamma rays and neutrons. Chronic effects of radiation are still not well identified, so pending further research, health authorities have followed a basic tenet of keeping exposure to the lowest level. Maximum contaminant levels (MCLs) of gross alpha particles, gross beta particles and combined radium isotopes (226 + 228) are 5 pCi/L, 4 mrem/yr, and 5 pCi/L, respectively. Strontium-90 is another isotope of particular concern due to its toxicity and persistence.

Radionuclide data was available from a report prepared by Exelon Nuclear for locations downstream of the Limerick Generating Station (LGS) 10 to 20 miles upstream of the Norristown plant. Exelon prepares annual Radiological Environmental Operating Reports in accordance with LGS Technical Specifications. The reports summarize the Radiological Environmental Monitoring Program (REMP). The report provides the data needed to evaluate whether the LGS is impacting downstream drinking water quality.

Sampling for the 2000 REMP spanned January 1 through December 31, 2000. Data for surface water and drinking water samples were examined for potential impacts at the

PWD Intakes. The LGS has a permitted storage facility for contaminated soils, sediments and sludges from onsite treatment. In order to assess whether any radionuclide transport is evident, surface water samples are taken at Vincent Dam, 1.75 miles southeast of the storage site. Samples are also taken from control locations that should not be affected by transport from the storage site. The results from 2000 surface water sampling are found below in Table 3.1.5-16.

Table 3.1.5-16 Radionuclide Summary – Surface Water Stations near Limerick Generating Station [1]

Analyte (pCi/L)	Lower Limit of Detection (LLD) [4]	# of Analyses	Indicator Locations [2] Range	Indicator Locations [2] Mean	Control Locations [3] Range	Control Locations [3] Mean	MCL	Location w/ Highest Annual Mean
Tritium	2000	11	52 to 157	108	-6 - 157	80	20,000	Vincent Dam (Indicator)
Gamma Spec		31						Perkiomen PS (Control)
Mn-54	15		-1.3 to 2.5	0.2	-1.2 to 2.9	0.6		
Co-58	15		-2 to 1.9	0.1	-2.7 to 3.5	0.5		
Co-60	15		-1.3 to 2.2	0.3	-0.8 to 3	0.7		
Fe-59	30		-0.1 to 5.6	1.9	-3 to 7.3	1.8		
Zn-65	30		-8 to 5.7	-1.6	-7 to 8.2	-0.3		
Zr-95	30		-3 to 5.3	1.0	-3 to 6.8	1.3		
Nb-95	15		-1.6 to 2.5	0.6	-0.7 to 3.4	1.3		
Cs-134	15		-7 to 2.4	-2.5	-11 to 4.8	-2.2		
Cs-137	18		-1.5 to 3.4	0.3	-2 to 3.3	0.8		
Ba-140	60		-3 to 27	4.5	-4 to 18	4.0		
La-140	15		-1.9 to 7.8	1.0	-1 to 4.2	1.4		

Notes:

[1] Data is from Appendix A of LGS 2000 Annual Radiological Environmental Operating Report.

[2] Indicator Location is Vincent Dam - 1.75 miles SE of storage site

[3] Control Locations are Perkiomen Pumping Station - 7.3 miles E & the Limerick Intake - 0.2 miles SW of storage site.

[4] LLD is defined as the smallest concentration of radioactive material that would yield a net count with only a 5% possiblity of falsely concluding a blank observation

Results may be shown as negative values because background activity is subtracted from the sample activity. Very small changes in radioactivities were measured. Consequently, higher background levels were often reported as compared to the levels reported from the measured samples. Overall, surface water sampling clearly indicates no radionuclide transport from the storage site at the LGS. Tritium levels were slightly higher on average at the indicator location compared to the controls. However, levels were well below the Lower Limit of Detection and the MCL. Gamma Spec samples were all measured higher at the control location, than at the indicator site. The REMP report also states that levels of radiological activity in surface water samples were less than baseline levels before LGS became operational.

In addition to the surface water locations, the REMP obtains samples at nearby drinking water intakes. The intake sampling locations on the Schuylkill River include Philadelphia Suburban Water Company, Phoenixville Water Works, Citizen's Utility, and the Pottstown Water Authority. Pottstown, at river mile 53, is upstream of LGS and is a control location for the drinking water sampling program. Citizen's Utility, two and one-half miles downstream, is the closest water intake to LGS. Table 3.1.5-17 summarizes the radiological sampling at the drinking water stations of the REMP.

Table 3.1.5-17 Radionuclide Summary – Drinking Water Locations near Limerick Generating Station(1)

Analyte (pCi/L)	Lower Limit of Detection (LLD) [4]	# of Analyses	Indicator Locations [2]		Control Locations [3]		MCL	Location w/ Highest Annual Mean
			Range	Mean	Range	Mean		
Gross Beta Soluble	4	48	1.4 to 4.6	3.1	1..0 to 5.6	3.0	50	PSWC (Indicator)
Gross Beta Insoluble	4	48	-1.7 to 1.9	0.3	-1 to 1.8	0.3		PSWC (Indicator)
Tritium	2000	16	17 to 157	90	-2.5 to 152	63	20,000	PSWC (Indicator)
Gamma Spec		48						
Mn-54	15		-1.7 to 5.8	0.5	-0.7 to 4.1	0.9		Pottstown Water (Control)
Co-58	15		-1.8 to 3.5	0.4	-0.9 to 2.7	0.5		PSWC (Indicator)
Co-60	15		-1.9 to 2.9	0.6	-1 to 4.7	0.8		Pottstown Water (Control)
Fe-59	30		-1.6 to 11	1.6	-2.5 to 8.3	1.2		PSWC (Indicator)
Zn-65	30		-8 to 5.9	-1.3	-5 to 5.7	-0.6		Citizen's (Indicator)
Zr-95	30		-1.4 to 7.4	1.2	-1.0 to 7.3	1.3		PSWC (Indicator)
Nb-95	15		-1.7 to 6.4	0.8	-0.9 to 3.1	0.4		PSWC (Indicator)
Cs-134	15		-9 to 4.6	-2.5	-5 to 4.4	-1.4		Pottstown Water (Control)
Cs-137	18		-1.1 to 4.2	0.7	-2.5 to 3.8	0.5		Citizen's (Indicator)
Ba-140	60		-9 to 23	3.0	-4 to 11	2.7		PSWC (Indicator)
La-140	15		-1.1 to 4.4	0.8	-0.9 to 4.7	1.1		Pottstown Water (Control)

Notes:
[1] Data is from Appendix A of LGS 2000 Annual Radiological Environmental Operating Report.
[2] Indicator Locations are Citizen's Home Utility, PSWC - Sch.River Intake, & Phoenixville Water Works
[3] Control Location is Pottstown Water Authority - 5.84 miles WNW of LGS.
[4] LLD is defined as the smallest concentration of radioactive material that would yield a net count with only a 5% possiblity of falsely concluding a blank observation

Similar to the surface water locations, tritium was the only radionuclide that was measured somewhat higher on average at the indicator locations than at the control. Tritium values were again well below the LLD and the MCL. Gross beta and gamma spec results were very low, with no significant differences between the indicators and control. Exelon concluded in the 2000 Annual Report that the LGS was having no adverse impact on the environment (Exelon, 2000). Drinking water quality at PWD's Schuylkill River Intakes does not appear to be affected by current operations at the Limerick Generating Station.

The presence of the Limerick Nuclear Generating Station requires monitoring for the presence of radionuclides in PWD's finished drinking water. As shown in Table 3.1.5-18, only Gross Beta radionuclides have been detected, at levels far below the regulated limits in the finished water from Schuylkill River sources. No other radionuclides have been detected.

Table 3.1.5-18 Radionuclides in PWD Drinking Water Effluents (1999)

Parameter	MCL	MDL	Effluent Concentration (pCi/L)
Gross Alpha	15 pCi/L	3 pCi/L	ND
Gross Beta	50 pCi/L ~ 4 mrem	4 pCi/L	4.79
Strontium-90	8 pCi/L	2 pCi/L	ND
Tritium	20,000 pCi/L	1000 pCi/L	ND

MCL = Maximum **C**ontaminant **L**evel – a regulatory limit by the USEPA or PADEP
MDL = Method **D**etection **L**imit – the level of a contaminant that can be detected by current testing methods
NA = Not **A**nalyzed
ND = Not **D**etected (less than the MDL)

Algae and Taste and Odor Compounds
Blue green algae can have significant impacts on the taste and odor of the water and require costly treatment to remove its unpleasant impacts. Typically, the impacts of blue-green algae may be seen during the spring in April and May when water temperatures are colder; instances of blue-green algae may also occur in the fall and winter. Diatoms impact treatment operation by clogging filters and reducing filter run times. Diatom blooms usually occur during the summer months. Table 3.1.5-19 provides a summary of the monthly total algae and diatom concentrations in the Schuylkill River. Concentrations are mainly dictated by the availability of nutrients. As shown, diatoms make a significant portion of the total algae observed in the water supply during the summer months.

Table 3.1.5-19 Monthly Concentrations of Algae and Diatoms at the Queen Lane WTP Intake -1999

	Total Algae			Total Diatoms		
Month	**Average**	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**
July	51,683	700	268,600	51,650	700	268,600
August	3,225	900	9,000	3,225	900	9,000
September	567	200	1,300	567	200	1,300
April	4,100	3,400	5,100	3,967	3,400	4,800
May	2,775	1,400	3,900	2,775	1,400	3,900
June	6,920	900	29,400	6,860	900	29,200

3.1.5.2 Temporal Water Quality Analysis

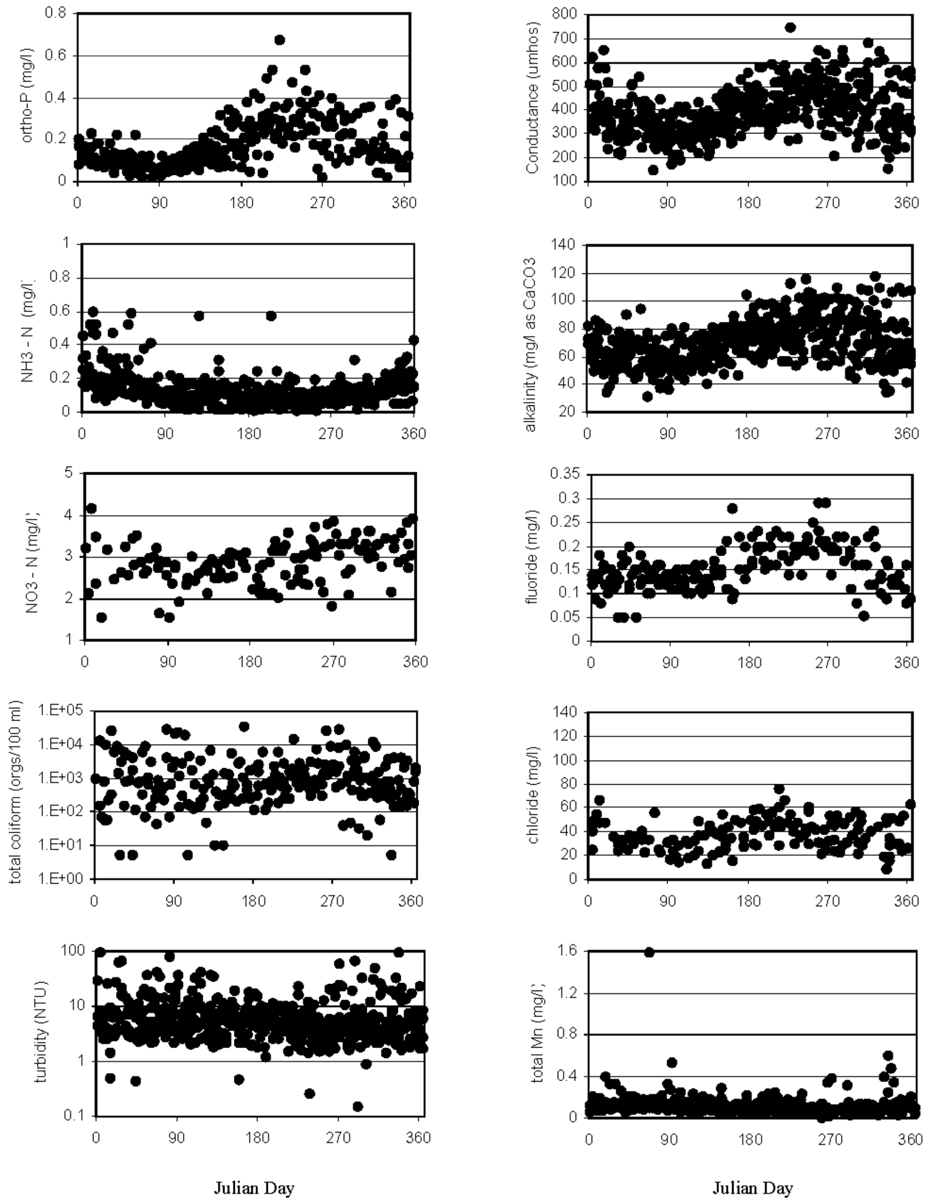
PWD operates two drinking water intakes on the Schuylkill River in Philadelphia. As the intakes are in close proximity, it was first assumed that watershed scale properties and recent temporal trends in the Schuylkill River Valley would similarly affect the source water quality at both intakes. With this in mind, an analysis of water quality data from both intakes was conducted. This analysis consisted of assessing variation in climate, flows and water quality over a variety of time scales. Weather patterns and river flow rates were studied over the period of record, typically on the order of the past century. General trends in water quality were assessed using data collected in the Schuylkill River at Philadelphia by the USGS and PWD over the period 1973-1999. Trends in precipitation chemistry and water quality data collected exclusively at the Queen Lane and Belmont Intakes were assessed for the past decade, with available data from 1990 through 1999.

Seasonal trends at the Queen Lane Intake were similar to those observed at Belmont just a short distance downstream (Figure 3.1.5-3). Dissolved orthophosphate was generally associated with flow conditions, with the lowest levels associated with high flows in the spring. Highest concentrations were observed in late summer along with annual low flows. Dissolved inorganic nitrogen, measured as ammonia and nitrate, was typically lowest in springtime, with ammonia exhibiting maximum concentrations in January when temperatures were lowest. Conductivity and alkalinity were generally a function of flows, and were highest in late summer and fall. Fluoride concentrations followed patterns similar to conductivity. Extreme elevated levels of fluoride in late summer may indicate the influence of residual dissolved solids from upstream wastewater treatment plants. Chloride levels exhibited an additional seasonal peak during the winter months, associated with road salt loading for winter storm deicing.

Long-term trends in water quality at Queen Lane were qualitatively similar to those observed at the Belmont Intake. Most measures of dissolved solids loading increased significantly through the decade. The rates of increase at Queen Lane were slightly higher than those found at Belmont, suggesting an additional source of solids loading to water drawn at Queen Lane. While ammonia levels have decreased, annual fluctuations still occur, with maximum levels exceeding 0.4 mg/l most winters. Increases in alkalinity levels, particularly during summer months, can potentially affect treatment processes at Queen Lane, by increasing the levels of acid addition needed for effective coagulation in solids removal operations.

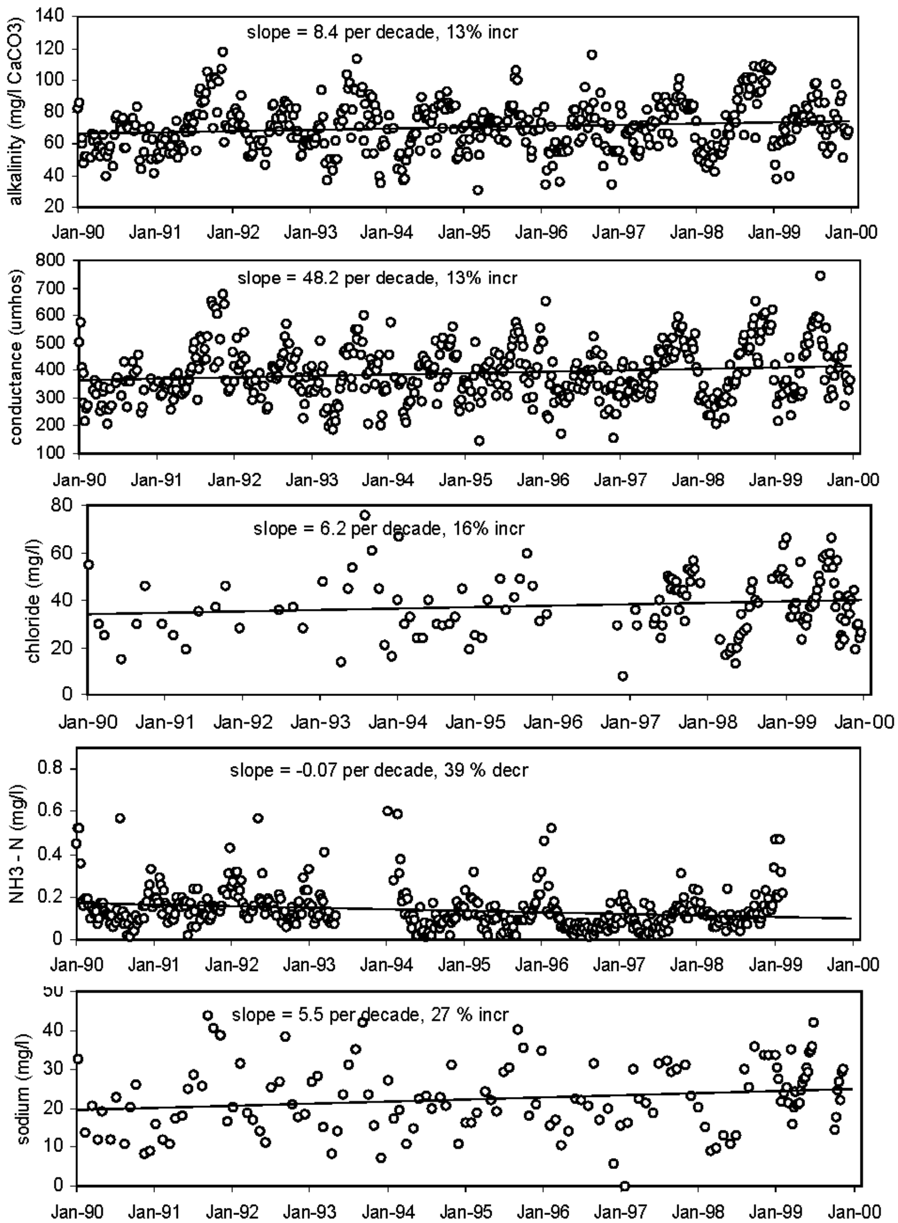
Unlike the Belmont Intake, the Queen Lane Intake appears to be heavily impacted by water quality in Wissahickon Creek, a tributary entering the Schuylkill River just upstream from Queen Lane. As a result, levels of many water quality parameters including ortho-P, nitrate and coliform bacteria are higher at Queen Lane than at Belmont, and other locations in the Schuylkill River between Flat Rock Dam and Fairmount Dam. Levels of manganese, however, were lower at Queen Lane than at Belmont, but the reason for this is undetermined.

Figure 3.1.5-3 Seasonal Patterns in Water Quality at Queen Lane Intake



The impact of Wissahickon Creek on water quality at Queen Lane has generally been driven by flow rates. When flows are high, a greater proportion of the water collected at Queen Lane originated from Wissahickon Creek. Based on simultaneous nitrate measurements made in the Schuylkill above Wissahickon Creek, and those made at the mouth of the creek and at Queen Lane, the Wissahickon Creek can contribute as little as 3% and as much as 87% of the water taken into the Queen Lane plant (Interlandi and Johnson Report in Progress). Water quality in Wissahickon Creek over the long term has varied in similar fashion to water quality in the Schuylkill River. Nutrient levels including total phosphorus and ammonia have decreased since 1970, while levels of nitrate, conductivity and alkalinity steadily increased with increasing levels of development upstream (Figure 3.1.5-4). Nitrate levels appear to have leveled off over the 1990s, and have not exceeded the MCL of ten mg/l in any samples collected since 1988. As a receiving stream for several municipal wastewater discharges, the Wissahickon also has elevated coliform levels, particular during storm flows. As a result, water collected at Queen Lane has higher measured bacterial levels than those found at PWD's Belmont Intake, or other areas in this reach of the Schuylkill River.

Figure 3.1.5-4 Decadal Trends in Water Quality at PWD's Queen Lane Intake



3.1.5.3 Spatial Water Quality Analysis

Spatial analysis of water quality along the Lower and Middle Schuylkill is completed for some of the parameters of interest. This enables a determination as to whether the order of magnitude of data at Queen Lane is consistent with other nearby intakes. Spatial analysis also shows whether temporal peaks and dips at Queen Lane are consistent with the other intakes. Agreement among the various locations helps to validate trends.

Turbidity

A box plot summary of turbidity data at five locations in the Lower and Middle Schuylkill River Watersheds is found in Figure 3.1.5-5. Turbidity data is readily available for the drinking water intakes, since it is the basis for a standard for finished water quality. Turbidity is a surrogate of suspended material. The statistics were based on data over the same time frame, January 1998 through July 2000. The Belmont Intake is the furthest downstream at river mile 10, with Queen Lane at mile 12, Pennsylvania American Water Company at mile 24, Philadelphia Suburban Water Company at mile 34, and Citizen's Home Water Utility at mile 41.

Figure 3.1.5-5 Summary of Turbidity Spatial Trends from Jan -98 – Aug-00

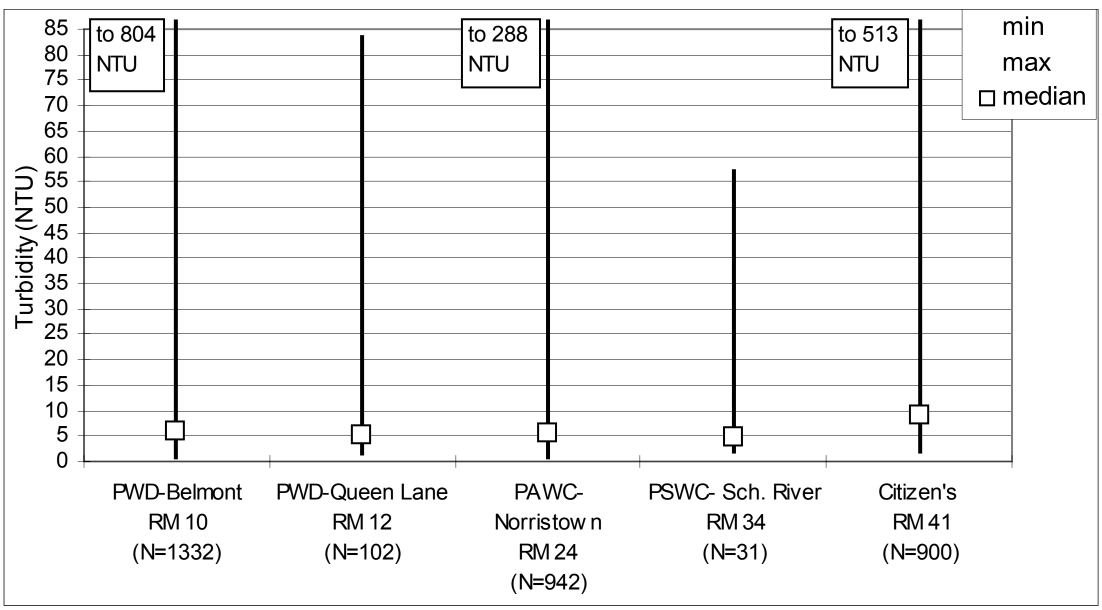
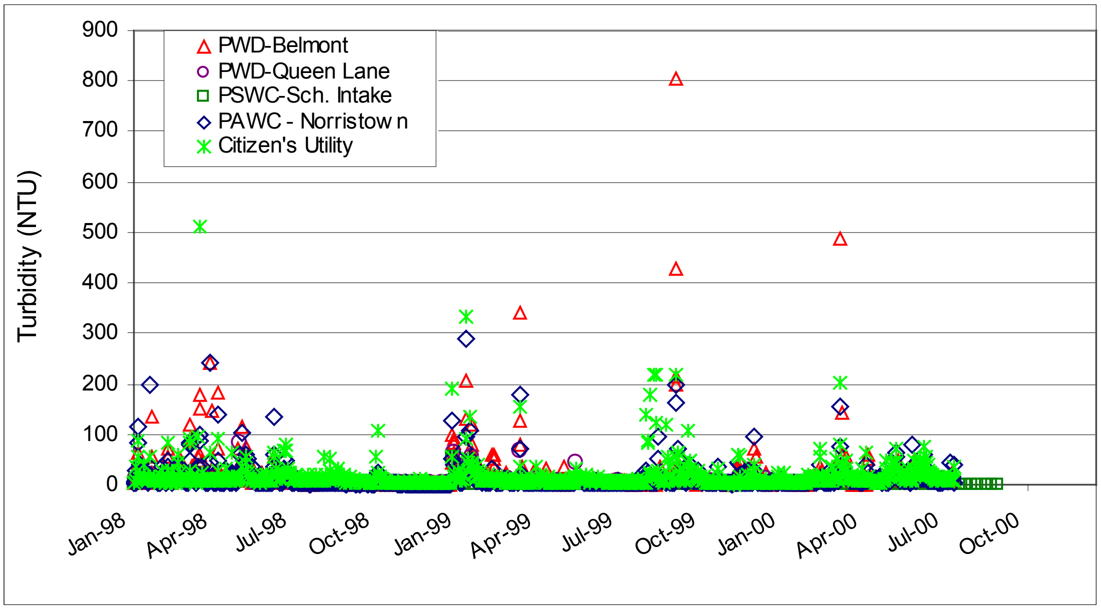


Figure 3.1.5-5 shows that median turbidity agrees well at the different locations and is about five NTU. The exception is the most upstream point of Citizen's Utility with a slightly higher median of ten NTU. A great deal of variability is evident in the maximum values compared to the minima and medians. This variability is tied to run-off of particulates during rain events. Differences in the magnitude of the maximum values with location are due to disparities in the amount and time of sampling. Some locations such as Belmont, with more data, captured a wider range of turbidity. The

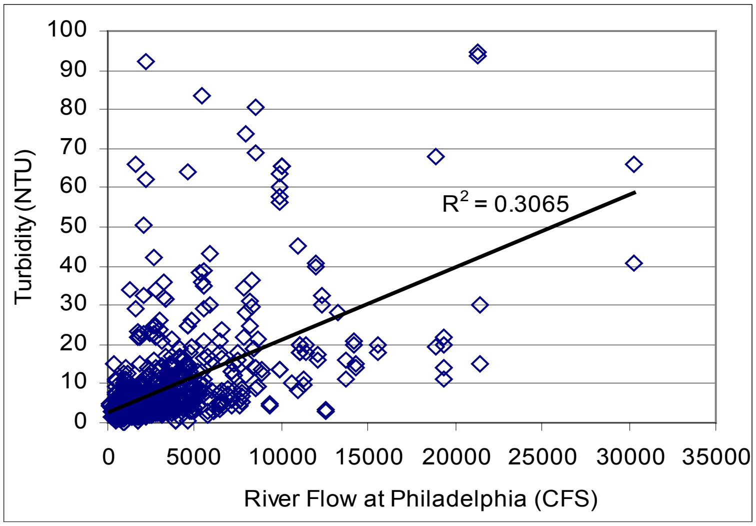
discrete turbidity data for these locations over the same time frame is found in Figure 3.1.5-6.

Figure 3.1.5-6 Spatial Turbidity Trends from Jan-98 through Jul-00



Data at the five locations in Figure 3.1.5-6 follow similar temporal trends. Times of peaks agree well. For example, Hurricane Floyd occurred in mid-September 1999, when peaks in excess of 100 NTU are clearly evident at three of the five locations. Locations that do not show the same peak are because sampling data were not as regular and the event was not captured. This supports that the peaks are run-off related because run-off and rain events generally affect the watershed regionally. A plot in Figure 3.1.5-7 of average daily-river flow and turbidity further substantiates the effect of run-off on increased turbidity levels in the river. Turbidity from Belmont and Queen Lane was combined and plotted as a function of flow for days when data for both parameters were available. An increasing linear trend is clear.

Figure 3.1.5-7 Turbidity/Flow Trends



Metals: Iron and Manganese

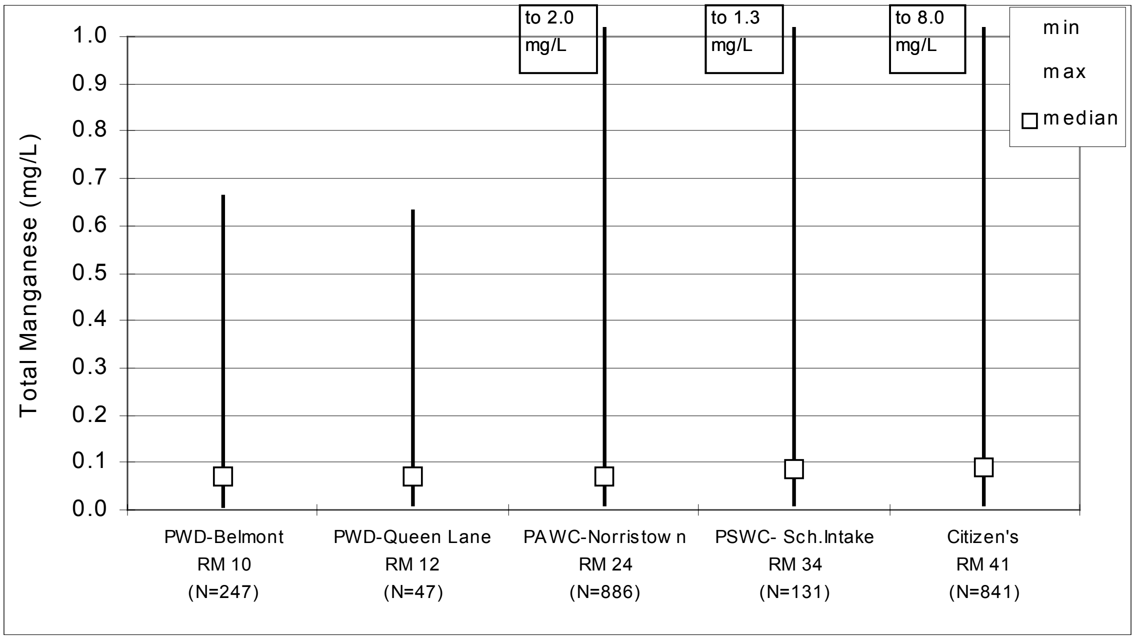
Figure 3.1.5-8 on the following page presents a box plot summary of total manganese and iron data at the same four to five locations in the Lower and Middle Schuylkill River Watersheds. Citizen's Utility did not analyze for total iron. The box plot for manganese shows that the median is fairly constant across all locations at about 0.08 mg/L. Median manganese shows a slight increase at the two most upstream locations. Variability at each location, as indicated by the maximum values compared to the minima and medians, may be attributed to rain events. Rain events can increase run-off from land or increase acid mine drainage from upstream Upper Schuylkill Watershed upstream locations. Differences in the magnitude of maximum values among the locations may be due to different sampling dates and times. Maximum manganese values of up to eight mg/L can significantly affect treatment and chemical costs at the water treatment plants.

The box plot for iron shows more variability of median values with location than manganese. Median iron is about 0.3 mg/L for the PWD locations, decreases to 0.1 mg/L at PAWC Norristown and increases to 0.2 mg/L at the PSWC Intake downstream of Phoenixville. Perhaps this is due to different sampling dates over the time frame, but it may also indicate that certain locations are more susceptible to other point or non-point sources of iron. Maximum values are also highest at the PWD Intakes. Iron, similar to manganese and turbidity, has a great deal of variability at each individual location. This may be attributed to sources related to rain events. Discrete iron and manganese data for the time frame of January 1998 to August, 2000 is presented in Figure 3.1.5-9 to further examine some of these trends.

Figure 3.1.5-9 demonstrates that temporal trends are generally consistent at the four to five locations. Similar to Figure 3.1.5-8, the plot shows that at each location, total manganese is typically less than 0.10 mg/L, but excursions occur. More variability is seen in the iron data. Specifically, data at Belmont is quite scattered compared to PAWC at Norristown. These are the two locations with daily data. This is consistent with the difference in median values noted previously. Iron and manganese trend similarly with time and location, in terms of peaks and dips. Peaks are believed to be related to either increased particulate loads from run-off or increased acid mine drainage from the Upper Schuylkill during rain events. The relation of increased rain to maximum manganese and iron is evident from Figure 3.1.5-8, which shows trends between river flow and manganese and iron concentrations at Belmont and Queen Lane.

As seen in Figure 3.1.5-10, manganese trends well with average daily flow at Philadelphia, while more data scatter is evident in the iron graph. Both graphs show that as river flow increases (due to rain) metal concentrations increase. Rain may be increasing the load due to run-off from the land, particularly construction sites. Rain may also be increasing the load from upstream acid mine drainage locations.

Figure 3.1.5-8 Summary of Manganese and Iron Spatial Trends



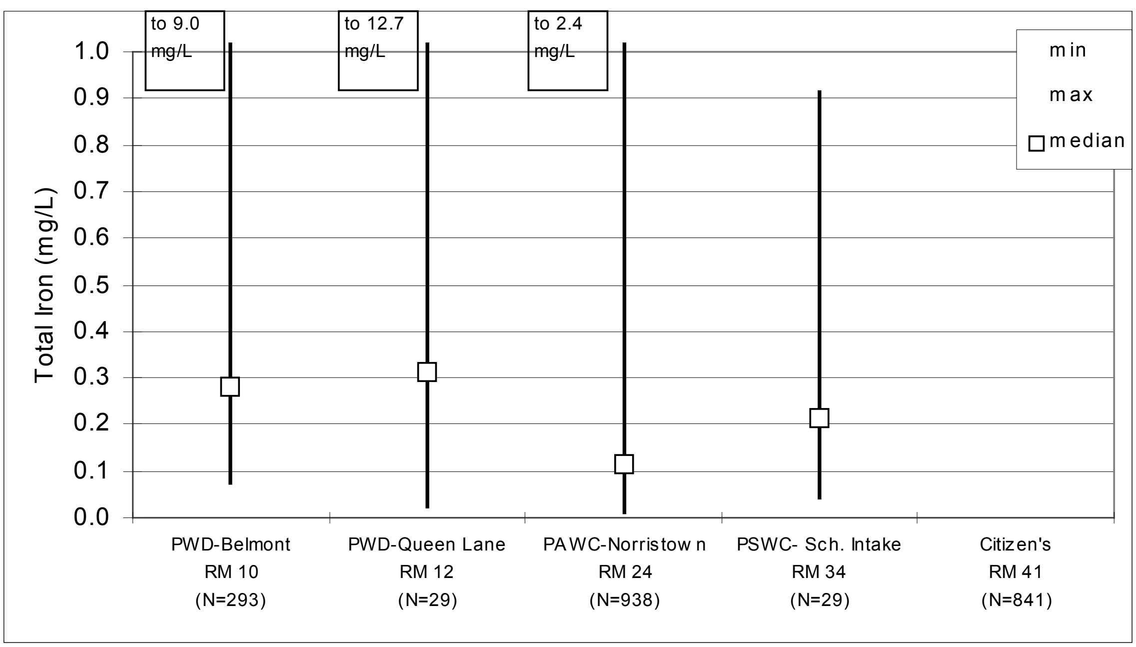
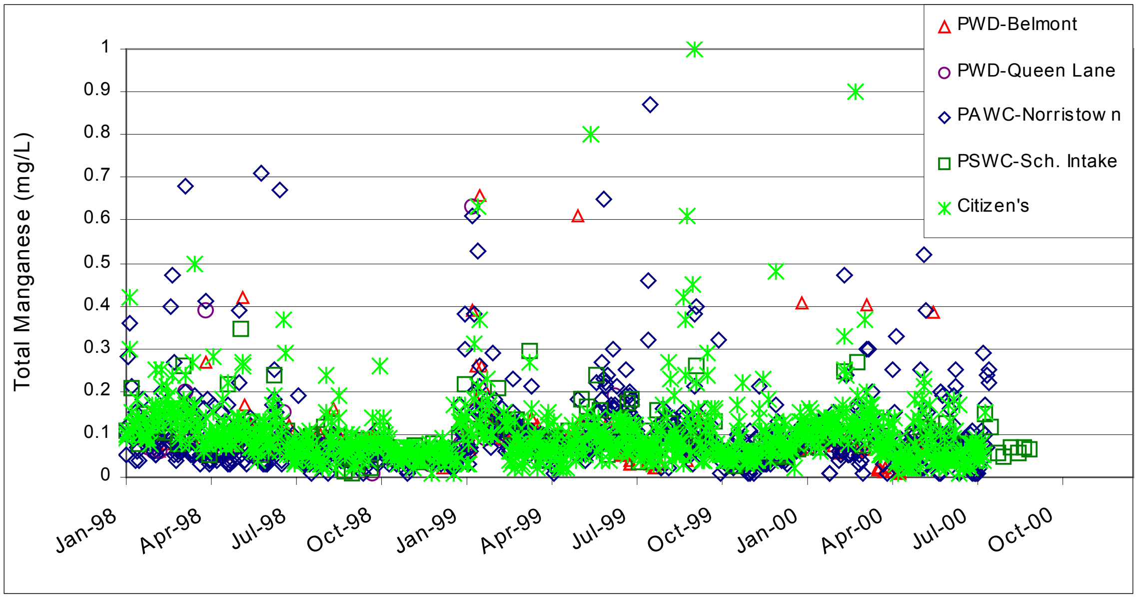


Figure 3.1.5-9 Spatial Trends in Manganese and Iron from Jan-98 through Jul-00



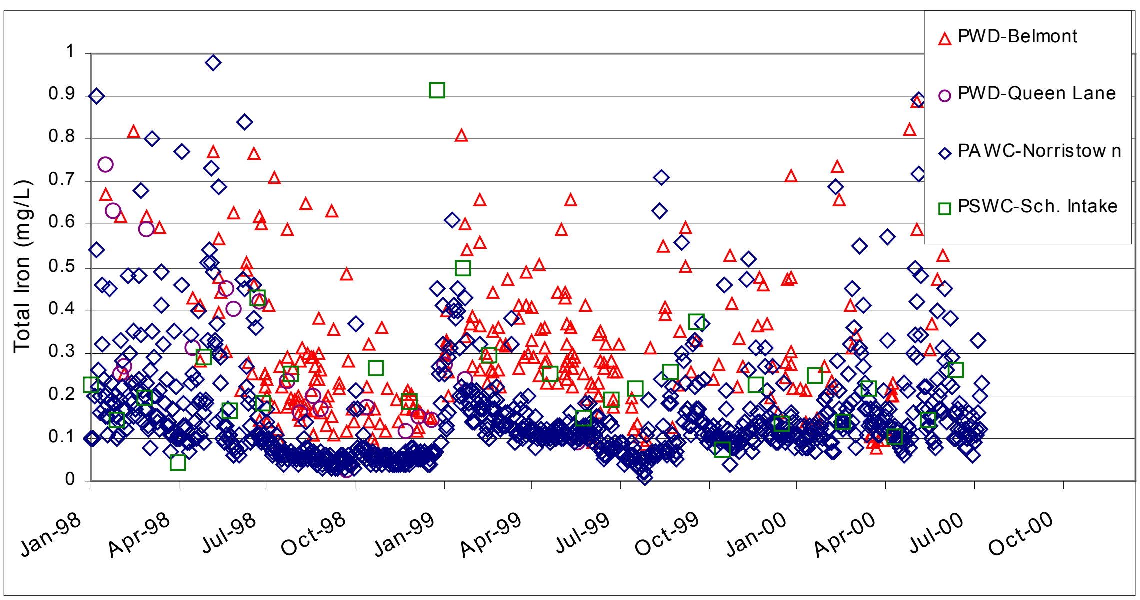
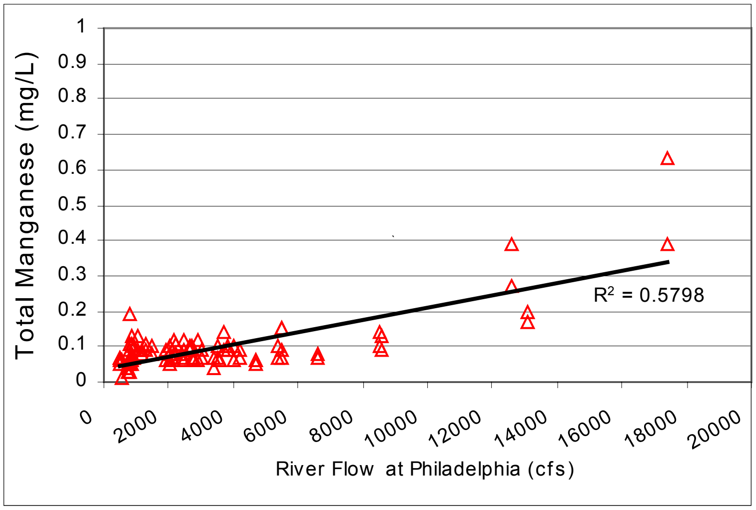
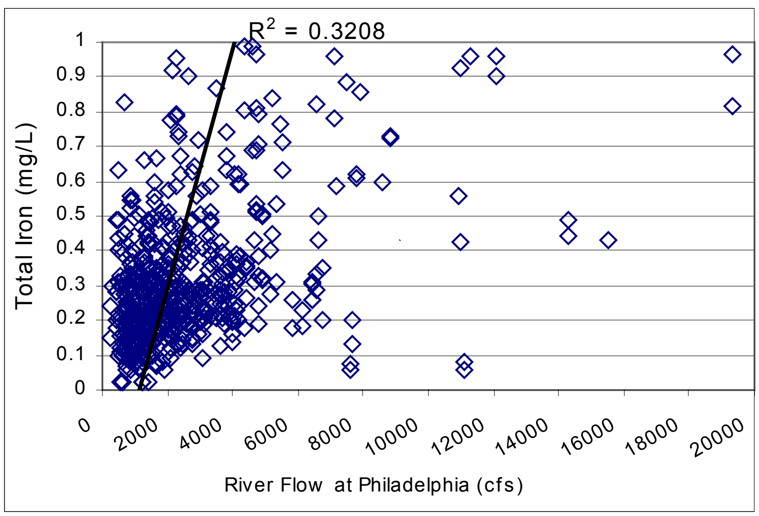


Figure 3.1.5-10 Correlation of Flow with Manganese and Iron from Jan-90 through Jul-99





Nutrients

Figure 3.1.5-11 on the following page presents a box plot summary of available nutrient data for the Lower and Middle Schuylkill River Watershed Intakes. PWD and PSWC had data for total ammonia, total nitrate, and dissolved orthophosphate over the time frame from January 1998 through July 2000. For all three parameters, Queen Lane Intake shows somewhat higher median values. Perhaps this is indicative of an influence of the Wissahickon Creek at Queen Lane. Maximum values vary most significantly from median and minimum values.

The discrete data used in the summary is found in Figure 3.1.5-12. The discrete data also shows that Queen Lane consistently measures higher nutrient values. Temporal trends as discussed in section 3.1.5.2 are also evident.

Figure 3.1.5-11 Summary of Spatial Trends of Nutrients

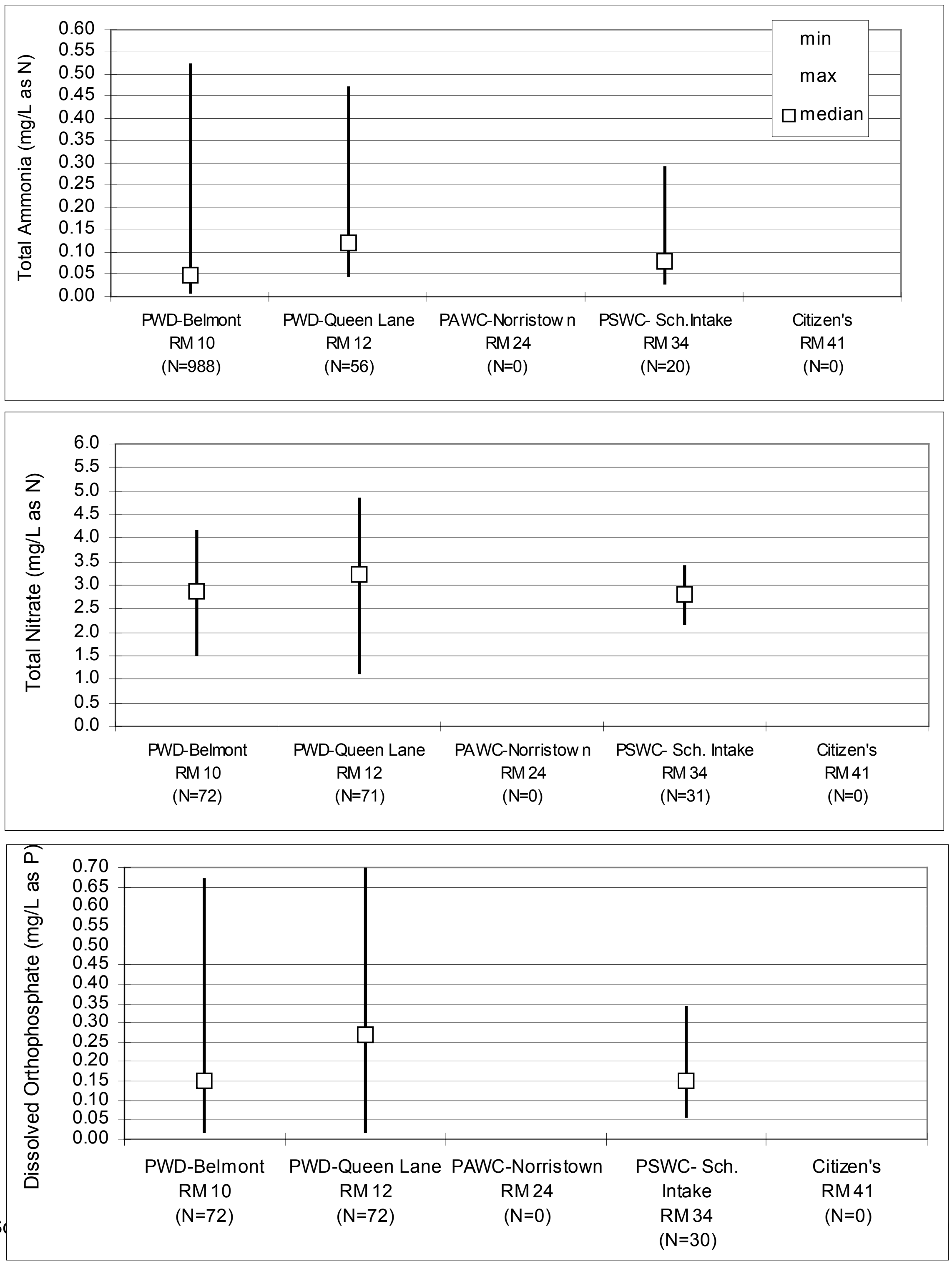
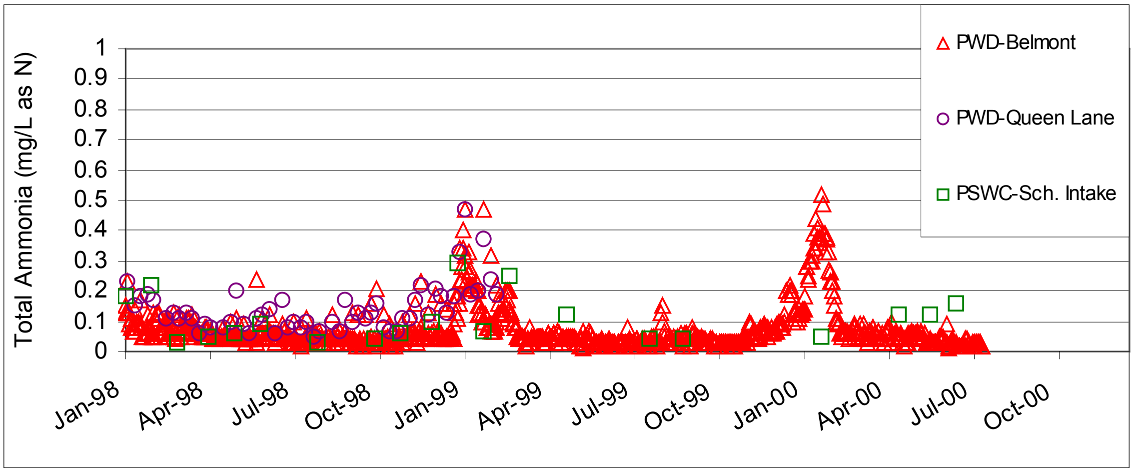
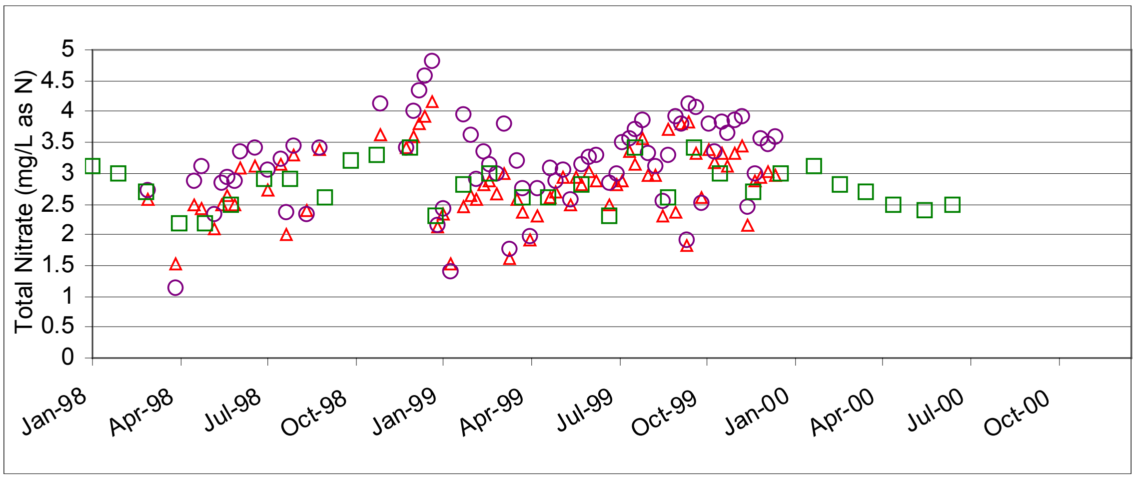
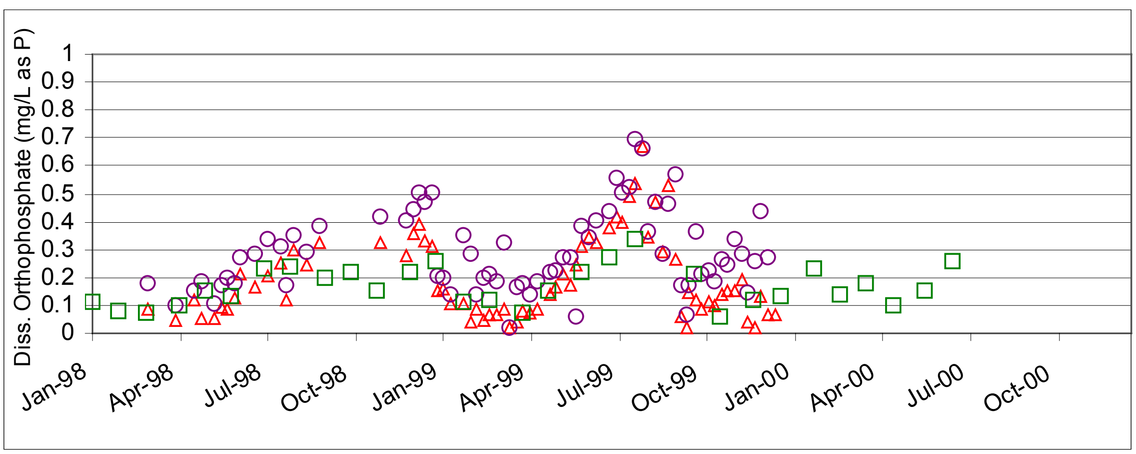


Figure 3.1.5-12 Spatial Trends of Nutrients from Jan-98 through Jul-00

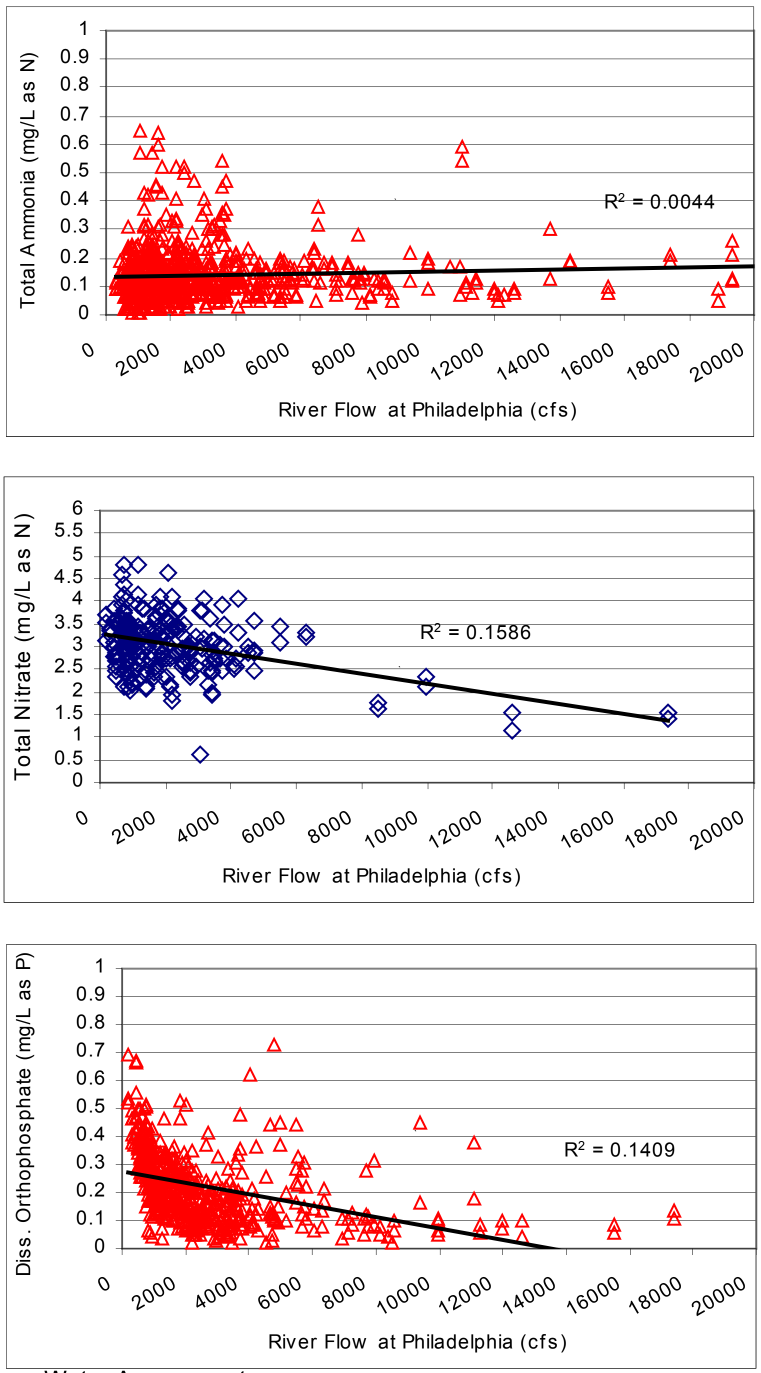






Lastly, Figure 3.1.5-13 examines whether any of the available nutrients trend with river flow. Positive trends would indicate river concentrations of nutrients are runoff related. Ammonia levels in Figure 3.1.5-13 do not increase significantly with flow. Nitrate and dissolved orthophosphate levels decrease with flow, although the linear correlation is poor. This suggests that these nutrients are not greatly influenced by rain and runoff. This is probably because the nutrients analyzed are dissolved in form and not affected by particulate runoff loads.

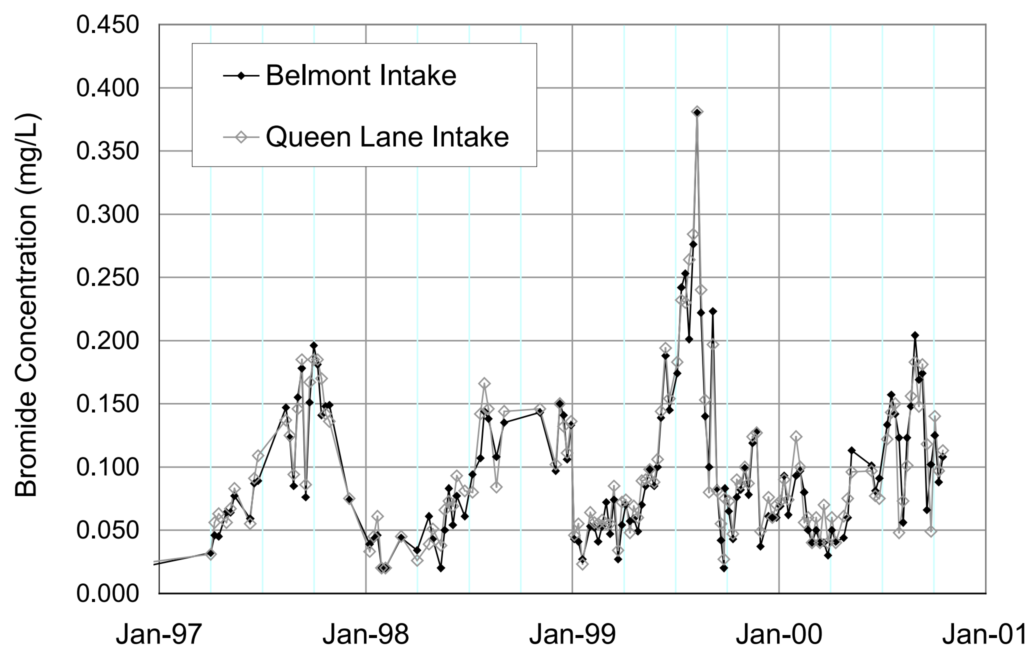
Figure 3.1.5-13 Flow/Nutrient Trends from Jan-90 through Jul-99



Bromide Spatial/Temporal Analysis

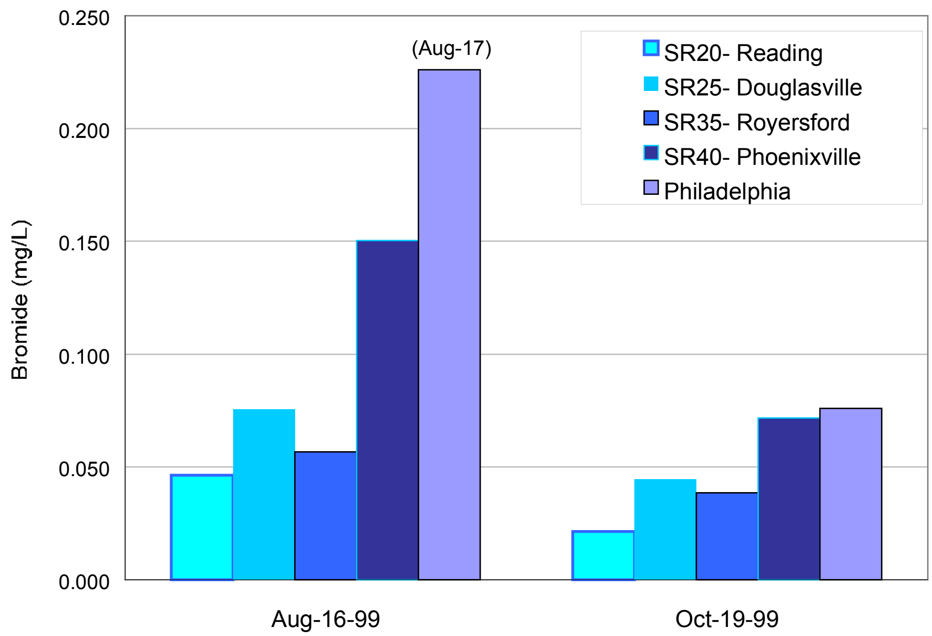
Special studies have been undertaken by the Philadelphia Water Department to understand more about the nature and presence of bromide in the water supply. Bromide is a concern for water treatment because under certain conditions and levels it can react with the chemicals used for disinfection such as chlorine or ozone to create disinfection by-products (DBPs). Exposure to specific DBPs over a lifetime could create chances for chronic illnesses such as cancer. Therefore, identifying and understanding the sources of these chemicals that can create potential DBPs is important. As shown in Figure 3.1.5-14, bromide is typically at its highest levels during periods of low-river flow. This association suggests that the sources of bromide are typically point sources (discharges) or from groundwater that feeds the river during low-flow periods. Further efforts to identify the dominant sources of bromide are underway. Samples collected along the main stem of the Schuylkill River to date suggest that bromide levels almost double between Royersford and Phoenixville, as shown by Figure 3.1.5-15. Whether this is caused by geochemical reactions in soils with groundwater in the area or if it is from point source discharges is still being determined. Bromide sampling locations along the river are illustrated by Figure 3.1.5-16.

Figure 3.1.5-14 Historical Bromide Levels at PWD's Intakes.



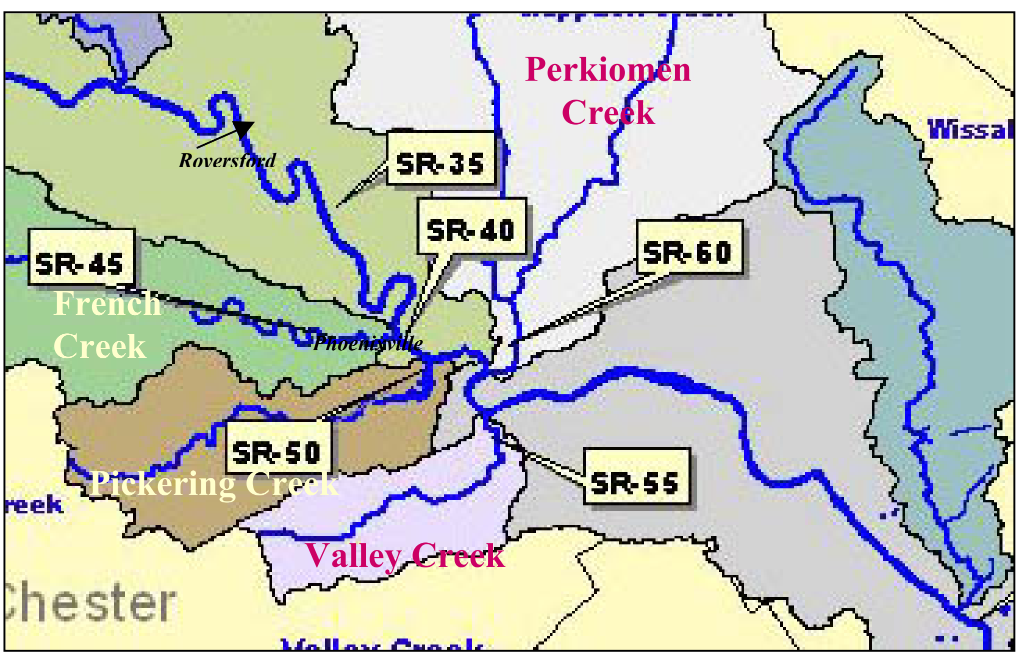
Notice the highest levels are associated with periods of low flow suggesting a groundwater or point source influence.

Figure 3.1.5-15   Spatial Comparison of Bromide Levels in the Schuylkill River



Notice that levels typically double downstream of Phoenixville. (Source: Obolensky, 2000)

Figure 3.1.5-16 Lower Schuylkill River Bromide Monitoring Locations *(Obolensky, 2000)*



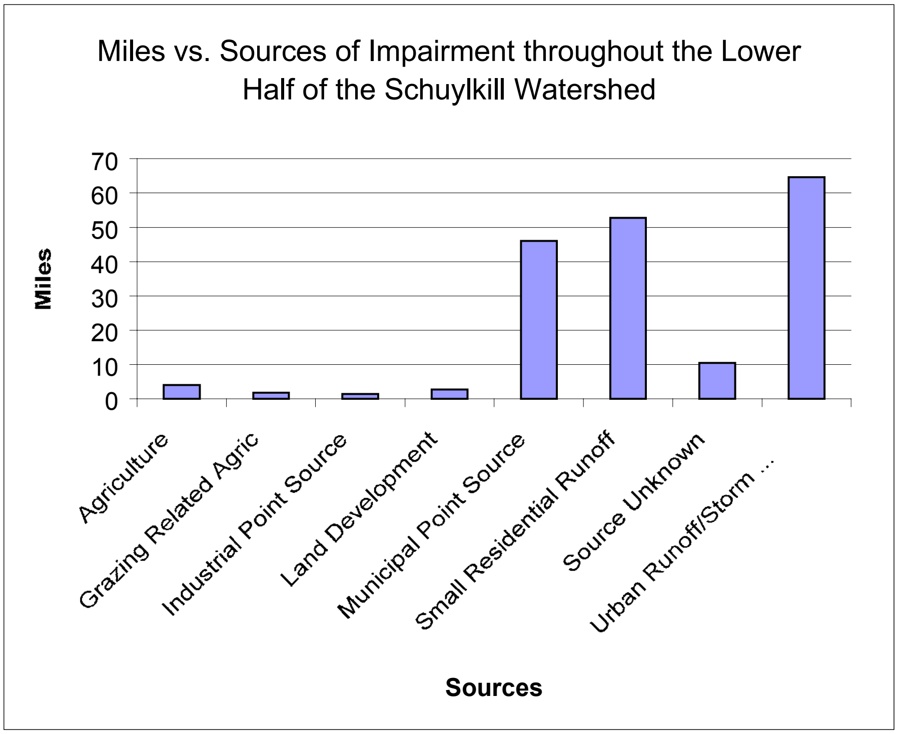
3.1.5.4 Analysis of Stream Impairments and Sources

In accordance with Section 305(b) of the Federal Clean Water Act, the Pennsylvania Department of Environmental Protection (PADEP) prepared a 305(b) Water Quality Assessment Report in 2000. The Report summarizes water quality management programs, water quality standards and point and non-point source controls. The lower half of the Schuylkill River Watershed includes 809 miles of streams and creeks. Almost 70% (553.74 miles) of these stream miles have been assessed to determine compliance with water quality standards. Applicable water quality standards were attained in two-thirds of the stream miles that were assessed (369.94 miles). Streams that were impacted by contaminant sources so much so (point sources, or non-point sources such as storm water runoff or acid mine drainage) that water quality standards are not met are designated as impaired. One-third of the stream miles that have been assessed (183.8 miles) do not meet applicable water quality standards, and are designated as impaired. To date, 255.27 miles, or 31.55% of the stream miles have not been assessed.

Figure 3.1.5-17 displays sources of impairment throughout the lower half of the Schuylkill River Watershed. Stormwater runoff from urban and residential areas and municipal point sources were responsible for the majority of the stream impairments identified in the Lower Schuylkill River Watershed.

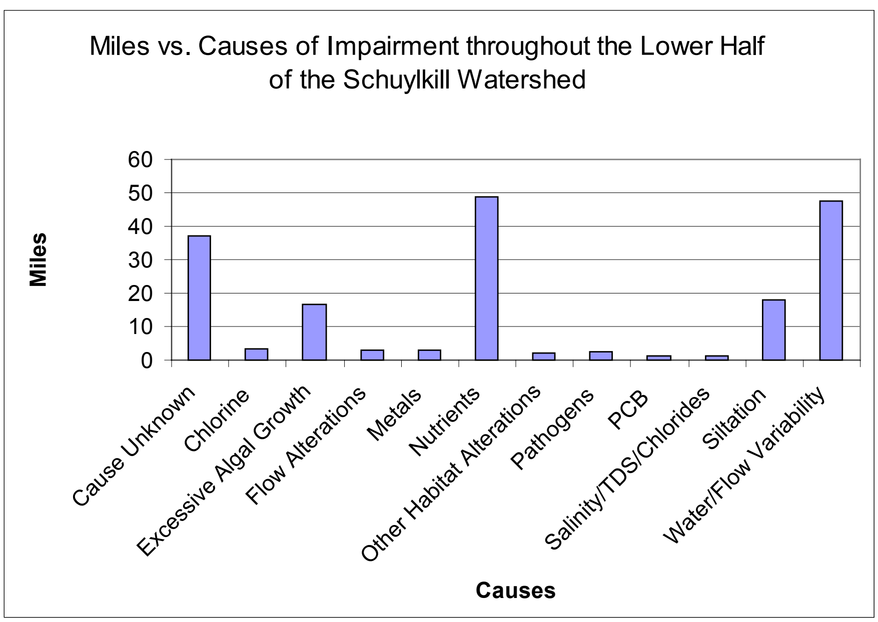
Figure 3.1.5-18 displays the causes of stream impairments throughout the lower half of the Schuylkill River Watershed. The leading causes of impairment are nutrients and water/flow variability. Table 3.1.5-20 summarizes the number of miles impacted by each of the listed sources for each of the subwatersheds within the lower half of the Schuylkill River Watershed. Sources causing impairments vary by watershed. For example, the primary sources of impairment in the Wissahickon Creek are urban runoff/stormwater and municipal point sources. However, the Middle Schuylkill (Two) and Valley Creek have significant portions that are impaired by agricultural related sources. Regardless of the individual characteristics, runoff related sources still play as much, if not more, of a significant role in stream impairments than point sources do.

Figure 3.1.5-17 Summary of Miles Impaired by Primary Sources



(Source: PADEP)

Figure 3.1.5-18 Summary of Miles of Impairment by Primary Causes



(Source: PADEP)

Table 3.1.5-20 Miles of Impairment by Primary Source and Watershed

Watershed	Middle Schuylkill (1)	Middle Schuylkill (2)	Wissahickon	Valley	Pickering	Perkiomen
Agriculture	0	2.58	0	0	0	1.45
Grazing Related Agriculture	0.42	0	0	1.4	0	0
Industrial Point Source	0	0	0	1.41	0	0
Land Development	0	0	0	0	0	2.7
Municipal Point Source	0.5	0	27.99	0	0	17.55
Small Residential Runoff	27.16	2.85	0	0	0	23.63
Urban Runoff/ Stormwater	6.95	0	47.86	3.97	1.82	4
Source Unknown	2.98	0	6.14	0	0	1.36

Note: miles of stream impaired by a given source.

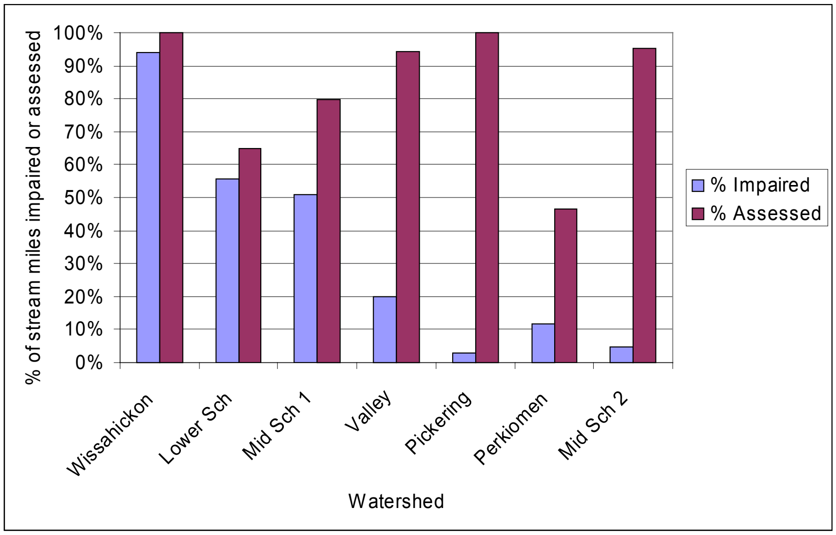
Additionally, Table 3.1.5-21 breaks down the number of miles impacted by each of the listed causes for each of the watersheds within the lower half of the Schuylkill River Watershed. Table 3.1.5-21 shows that each of the six watersheds is impacted by different contaminants. For example, the Wissahickon and Perkiomen Creeks have significant portions impaired by water and flow variability. However, the Valley and Pickering Creeks are primarily impaired by nutrients or unknown causes. Overall the Pickering Creek had the least impaired stream miles (3%), while the Wissahickon Creek had the greatest amount of impaired stream miles (94%) (see Figures 3.1.5-19 and 3.1.5-20).

Table 3.1.5-21 Breakdown of Miles of Impairment by Primary Cause and Watershed

Watershed	Middle Schuylkill (1)	Middle Schuylkill (2)	Wissahickon	Valley	Pickering	Perkiomen
Chlorine	0	0	3.51	0	0	0
Excessive Algal Growth	0	0	0	0	0	16.38
Flow Alterations	0	2.85	0	0	0	0
Metals	2.98	0	0	0	0	0
Nutrients	0.42	0	33.33	5.37	0	9.66
Other Habitat Alterations	0	0	2.29	0	0	0
Pathogens	0	2.58	0	0	0	0
PCB	0	0	0	1.41	0	0
Salinity/TDS/Chlorides	0	0	0	0	0	1.14
Siltation	0.65	0	10.46	0	0	6.48
Water/Flow Variability	8.36	0	23.01	0	0	13.79
Cause Unknown	24.68	0	6.14	0	1.82	0

(Source: PADEP)

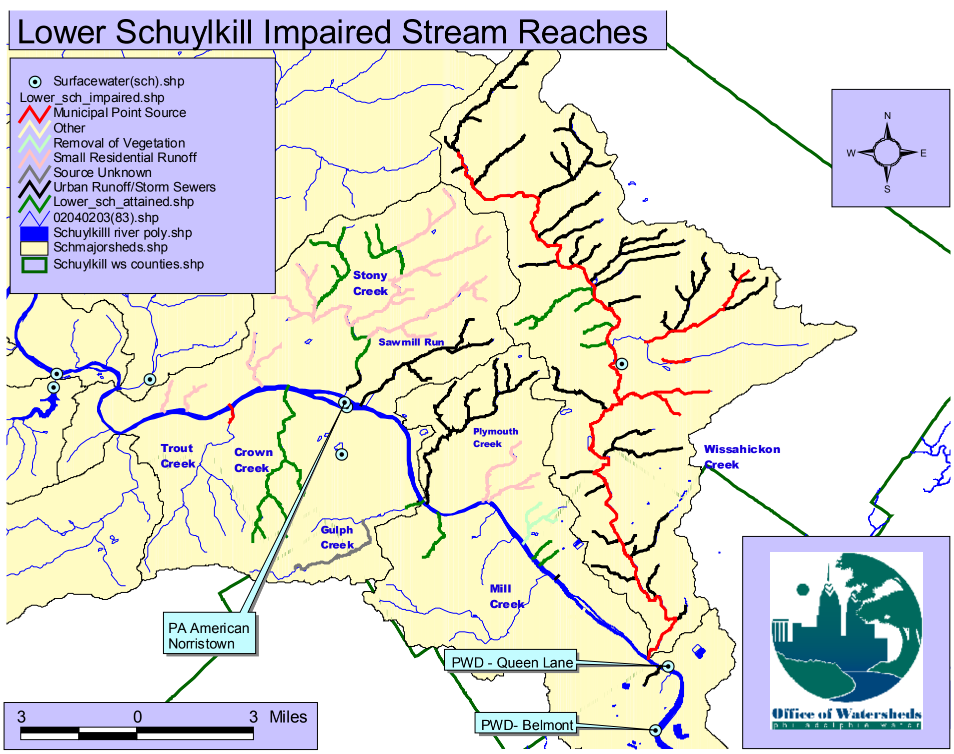
Figure 3.1.5-19 Percentage of Watershed Miles Impaired and Assessed in the Lower Schuylkill River Basin



(Source: PADEP)

Figure 3.1.5-20 Impaired Stream Reaches in the Lower Schuylkill River Basin

Red lines indicated municipal point sources, black lines indicate urban runoff, and pink lines indicate small residential runoff as a primary source of impairment. Green lines indicate stream reaches that have attained their designated use and are not impaired. Light blue lines indicate areas impaired by removal of vegetation.



3.2 Source Water Assessment

3.2.1 Delineation of Source Water Assessment Zones

Key Points

- **Zone A, the area within a five-hour time of travel of the Philadelphia Water Department's Queen Lane Intake, includes 73.7 square miles of the Schuylkill River Watershed.**
- **Zone B, the area between the 5-hour and the 25-hour time of travel of the Queen Lane Intake, includes 1,271 square miles of the watershed.**
- **Zone C, the area beyond the 25-hour time of travel incorporates the remainder of the 1,900 square-mile Schuylkill River Watershed.**

The Queen Lane water supply intake receives water from a drainage area greater than 1,900 square miles. Identification of all potential contaminant sources within such a large area requires a systematic approach to examine the area in such a way as to identify all pertinent sources. This approach defined by the PADEP's SWAP Plan involves a segmentation approach that divides the watershed into zones based on the proximity of a potential contaminant source to a water supply intake. This method assumes that proximity is directly linked to a potential source's impact on a water supply in most cases. Using this logic, the PADEP's SWAP Plan divided the source water assessment area for a given intake into the following three zones and prioritized all contaminant source identification accordingly:

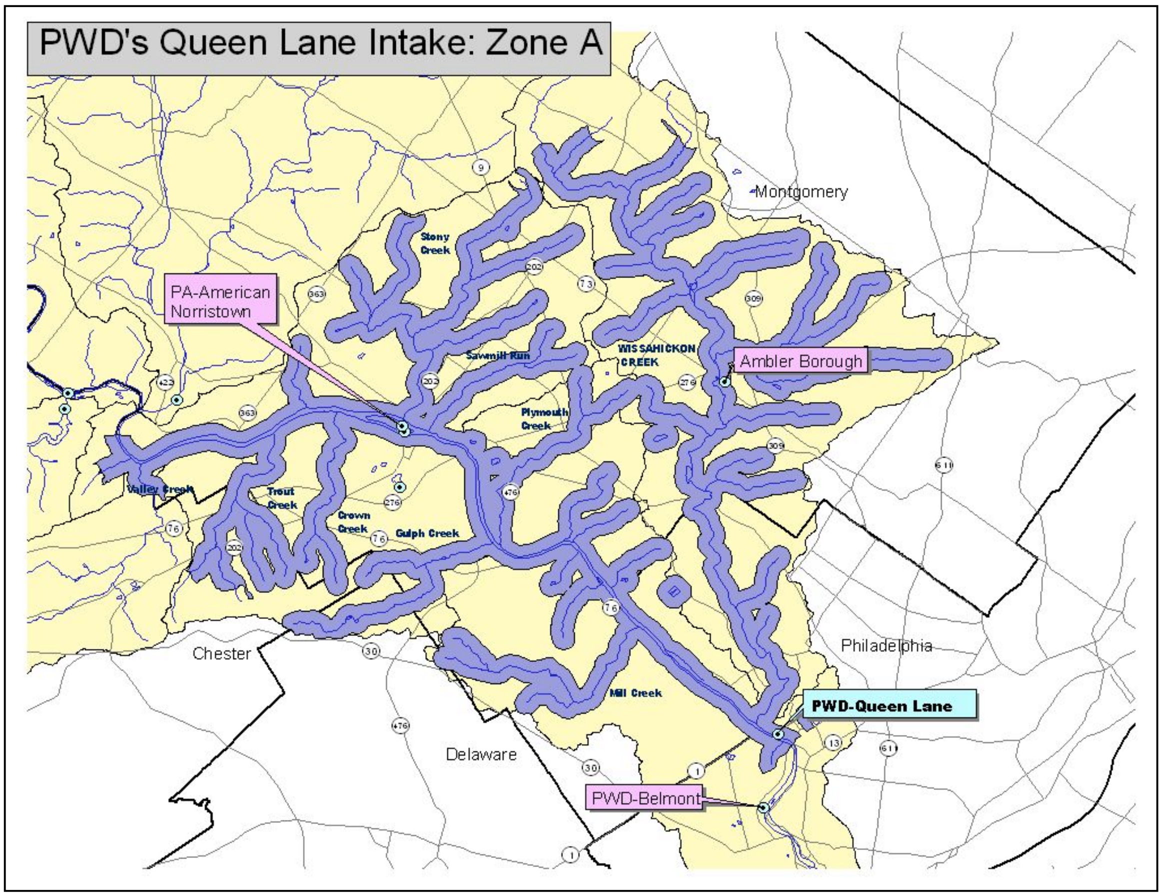
Zone A - This is the critical area of highest potential impact on the water supply, since proximity to the water supply intake results in reduced response times and potential lower dilution and attenuation of a contaminant. Any potentially significant source within a five-hour time of travel of the water supply, including one-quarter mile downstream and within a one-quarter mile-wide area on either side of the river/stream from the water supply, should be included in the contaminant inventory. These may include large and small discharges, catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Zone B - This is the area between the 5-hour and 25- hour time of travel to a given water supply intake, including a two mile-wide area on either side of the river or stream extending upstream to the 25-hour time of travel boundary. Only significant potential sources of contamination are identified for inclusion in the contaminant inventory. This generally represents larger discharges (>one million gallons per day), catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Zone C - This is the area greater than 25-hours time of travel to a given water supply intake. All major potential sources of contamination are identified for inclusion in the contaminant inventory. This generally represents larger discharges (less than one to ten million gallons per day), catastrophic event related sources (broken oil pipelines and chemical storage tanks), large runoff sources, or special contaminant sources.

Figure 3.2.1-1 displays the different zones delineated for the Queen Lane water supply intake for the Philadelphia Water Department. As shown, Zone A encompasses an area of 73.7 square miles and continues upstream of the intake to river mile 31 at Valley Forge. Zone A consists of almost the entire Wissahickon Creek Watershed and the direct drainages to the Schuylkill River to directly upstream and including portions of Valley Creek. These direct drainages include Stony Creek, Mill Creek, Trout Creek, Gulph Creek, Plymouth Creek and Sawmill Run.

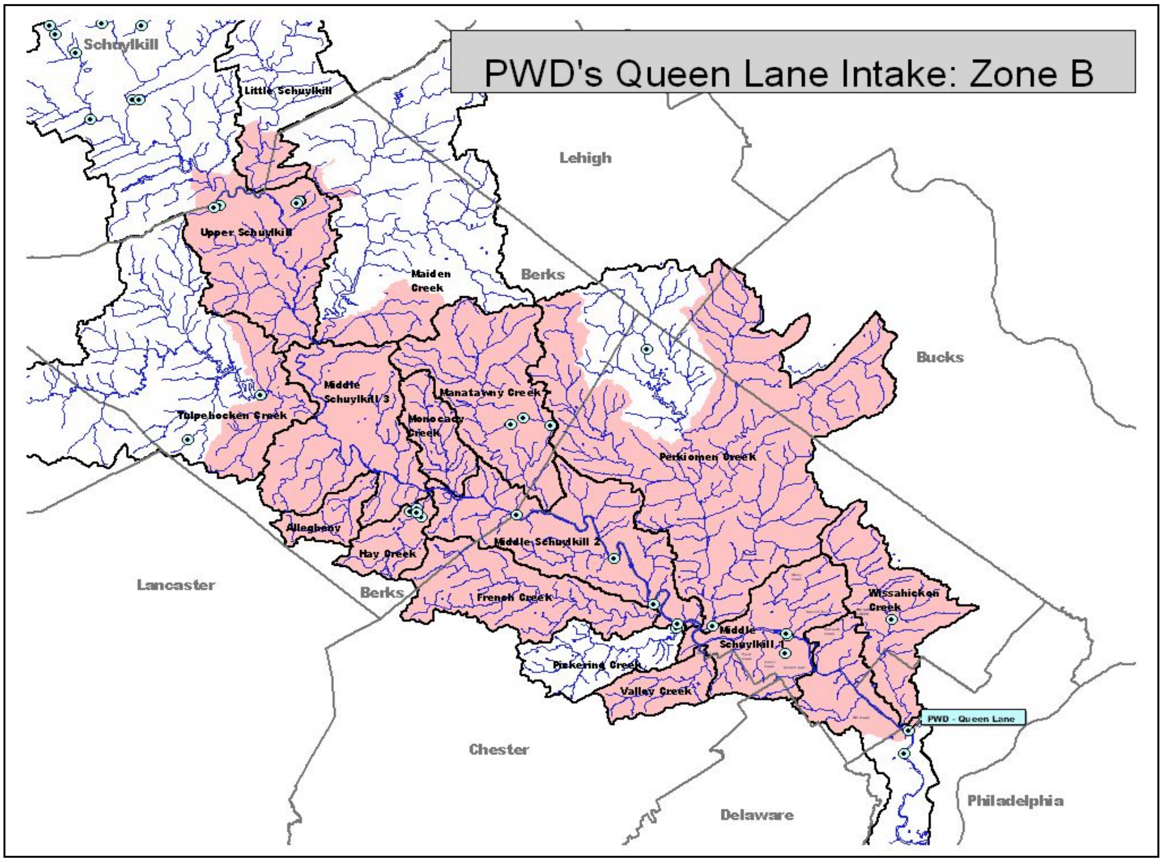
Figure 3.2.1-1 PWD's Queen Lane Intake: Zone A



Zone B encompasses an area of 1,271 square miles and extends upstream to river mile 108. For the Queen Lane Intake, Zone B extends upstream from the intake to the town of Auburn, PA. Zone B also includes all the tributaries below the Maiden and Tulpehocken creeks. Zone B includes about half of the Maiden Creek Watershed, part of the Tulpehocken Creek Watershed below Blue Marsh Reservoir, and part of the Little Schuylkill River up to Greenawald, PA. Zone C consists of the remainder of the watershed, primarily the headwaters of the Schuylkill River, most of the Little Schuylkill

River, the majority of the Tulpehocken Creek Watershed and the headwaters of the Maiden Creek Watershed.

Figure 3.2.1-2 PWD's Queen Lane Intake: Zone B



The locations of other water supply intakes within the zones delineated for the water supply are also shown in Figure 3.2.1-2 is As shown in Figures 3.2.1-1 and 3.2.2-2, the Zone A or B from the Queen Lane Intake overlaps with the Zone A or B from numerous intakes. This overlapping of zones allows for a more detailed assessment of potential sources for the whole watershed area.

As described above, the time of travel of a release from a potentially significant source of contamination combined with the characteristics of that source will determine whether it is included in the contaminant inventory.

All of the zones of delineation were determined and provided by the United States Geological Survey (USGS) and approved by PADEP for use in the Source Water Assessments. These zones of delineation were considered the most accurate descriptions available and improved upon the zone criteria described above.

3.2.2 Point Source Contaminant Inventory

Key Points

- **Over 3,000 potential point sources were identified within the 1,900 square-mile Schuylkill River Watershed.**
- **Most of these potential sources do not now, and will never, discharge to the Schuylkill River. They have been identified so that water suppliers can assess their potential impacts upon the water supply, and identify appropriate protective measures.**
- **Over 1,400 RCRA facilities are located upstream of the Queen Lane Intake.**
- **Most of the RCRA facilities are not large quantity generators.**
- **Sewerage systems, dry cleaners, and commercial print shops were the most common industrial facilities identified.**
- **VOCs, metals, and petroleum hydrocarbons were the most frequently reported contaminants.**

3.2.2.1 Method

Based on PADEP guidelines for the Statewide Source Water Assessment Program (SWAP), a contaminant inventory of point and non-point sources was developed. The inventory is an essential part of assessing the drinking water supply for the intake, because it compiles potential contaminant sources for the delineation zones within the 5-hour, 25-hour and beyond 25-hour times of travel. This inventory is a powerful list enabling the water suppliers to better understand their source water. The inventory is also the stepping stone to prioritizing potential contaminant sources. The prioritization or ranking of contaminant sources is completed in the Susceptibility Analysis step.

The focus of this report section is the point source contaminant inventory. Non-point sources are discussed in land use sections 1.2.5 and within intake section 3.2.3. Point source data was compiled from various Federal and State databases available on the Internet, as well as from self-assessment data provided by water suppliers. Sources were checked by stakeholders and verified for correct active status and location. An Access database was developed to efficiently store and manage information on the point sources.

Database Compilation

The following Federal databases were accessed for point sources in the Schuylkill Watershed:

- Permit Compliance System (PCS);
- Resource Conservation and Recovery Act Information System (RCRIS);
- Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS); and
- Toxic Release Inventory (TRI).

Regulated aboveground storage tanks (ASTs) were also compiled from the PADEP Storage Tank Program. Another initial source of data was provided by self-assessment forms. The self-assessment, required by the State SWAP, provides intake-specific input as to which sources are of priority concern.

The databases were queried for facility, process, and violation information. Facility information included items such as name, facility identification numbers, owner, and location (street address and/or latitude, longitude). GIS information was used to locate the Schuylkill Watershed sources were within the Queen Lane delineation zones. Process information included data on which contaminants were on-site and the quantities and/or loading rates. Violation information was related to type (administrative versus operation or effluent violation) and frequency.

Database Population
For many of the facilities, certain pieces of information required for ranking, such as contaminants and quantities, were still missing upon compiling the source database. This data was simply unavailable through the Federal databases for many of the minor dischargers and RCRA facilities. Consequently, missing information was populated based on educated assumptions using the known data. Details on data population are available in Appendix S.5. Data population of missing fields affects the susceptibility analysis more than the inventory. The inventory discussed in this section is based on actual downloaded data.

Note that individual site contaminants were downloaded, where available, for each facility. Each contaminant was associated with one of ten categories. These categories were generally based on contaminant groups described in the PADEP SWAP guidance document. The contaminant categories were subgrouped into non-conservative (total/fecal coliform, turbidity, nutrients, VOC/SOCs, metals) and conservative (*Cryptosporidium*/*Giardia*, nutrients, DBP precursors, petroleum hydrocarbons, and salts) categories. Nutrients were included in both the non-conservative and conservative categories, because phosphorous is mostly associated with particulates and nitrogen compounds are typically dissolved.

3.2.2.2 Results

Point Source Contaminant Inventory
After the database compilation and population were completed, inventories specific to each intake were developed. PWD's Queen Lane Intake was delineated into three zones based on travel time. Zones A and B, the area of the watershed within a 25-hour travel time, encompass over 1,300 square miles. Zone C extends beyond 25 hours of travel time and essentially captures the remainder of the Schuylkill Watershed. Consequently, the inventory of sources throughout the three zones is quite extensive for Queen Lane.

The completed inventory for Queen Lane compiles about 3,000 sources and is too voluminous to append within this report. The complete inventory is available for downloading from the Schuylkill Source Water Assessment website – http://www.schuylkillswa.org. The inventory is sorted into three sections for zones A, B, and C and sub-sorted by source type, PCS, RCRA, etc. The inventory indicates facility information such as name, city, and county. The source of the data is also indicated, that is, RCRA, PCS, etc. Other pertinent information includes industry classification by SIC code, whether the facility is a Large Quantity Generator for RCRA sites, and a major discharger for PCS sites. If information was available for a specific facility, such as on-site or discharged chemicals, quantities of chemicals, capacity of the site, and discharge flow rates, it is listed.

Inventory Characterization

Data from the complete Queen Lane inventory, summarized in Table 3.2.2-1, identifies the most common source types and the zones in which they are concentrated. The characterization also seeks to find common industries or dischargers and the most common contaminants by category. The table is organized by source type (PCS, RCRA, etc.) and zone of delineation (A, B, or C). Note that there is overlap for some facilities with source type. For example, the same facility may be a permit holder (PCS), a RCRA facility and/or a TRI facility.

Even accounting for overlap among source types, Table 3.2.2.1 indicates that a number of sources are found upstream of Queen Lane. On a positive note, the least number of sources across the various source types is typically found within five hours of travel time. The most sources are found within zone B, between 5 and 25 hours of travel time. RCRA facilities are the most numerous with greater than 1,400, followed by PCS dischargers, and aboveground storage tanks. Over 400 direct discharges are being made into the watershed upstream of Queen Lane, however only 45 are within zone A. These sources are ranked for significance with respect to other criteria, such as contaminant category, quantity, and violations, in Section 3.2.4.

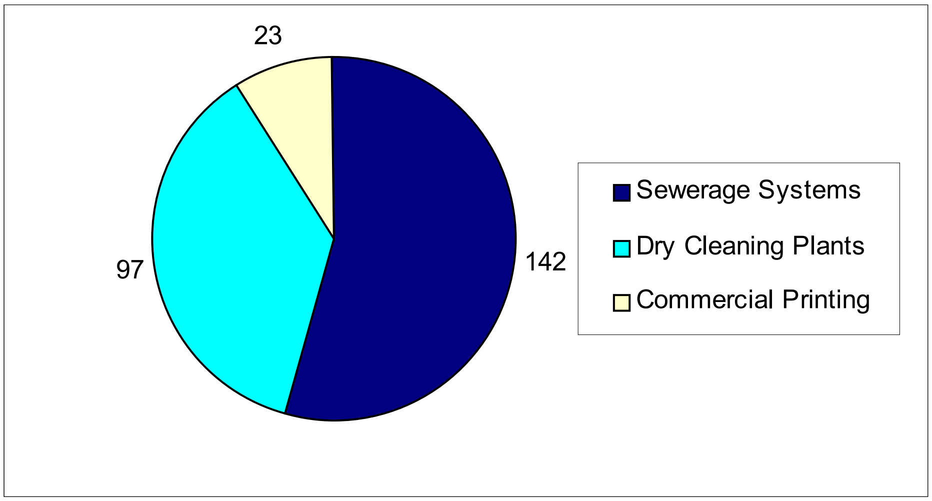
Table 3.2.2-1 Summary of Point Source Types Delineation Zone

Source Type	Zone A, < 5hr	Zone B, >5 hr and < 25 hr	Zone C, > 25 hr	Total
PCS	45	239	125	409
RCRA	237	1009	186	1432
AST	61	279	53	393
TRI	26	198	52	276
CERCLA	34	235	63	332
Self-Assessment	25	107	24	156
Total	428	2,067	503	2,998

Figure 3.2.2-1 shows the three most common industry types, based on SIC code, throughout the Queen Lane delineation zones. The data is somewhat limited due to the amount of missing SIC codes, especially for the dischargers. Despite its limitations, the data gives an insightful overview of the prevalence of various industry types within the

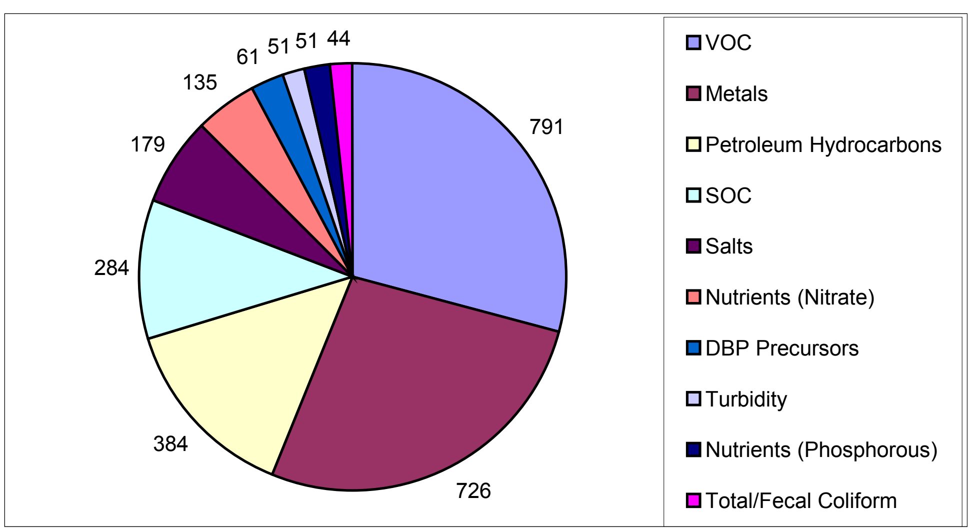
overall delineation zone. Sewerage systems were most numerous, followed by dry cleaning plants, and commercial printing operations.

Figure 3.2.2-1 Prevalent Industry Types for the Queen Lane Intake



Similar to Figure 3.2.2-2, parameter groups are summarized based on prevalence throughout the Queen Lane delineation zones. This is again based on a limited data set. Contaminant information was most complete for TRI sources. With this in mind, available data shows that VOCs are the most common contaminant reported by the sources, followed by metals and petroleum hydrocarbons. This is useful for water suppliers to keep in mind in monitoring efforts and surveillance of raw water.

Figure 3.2.2-2 Prevalent Contaminant Categories for the Queen Lane Intake



PCS Dischargers

A characterization of dischargers or PCS facilities within Queen Lane's delineation zone is examined in Table 3.2.2-2. Out of 409 dischargers, 40 are major (<1 MGD). Wastewater treatment plants comprise the largest component, 142, for both major and minor dischargers. After sewerage systems, gasoline and water suppliers are the most common discharger types.

Table 3.2.2- 2 PCS Discharger Summary

Total Dischargers	409
Major Dischargers	40
Major Sewerage Systems	35
Facilities with SIC Codes	362
Top 3 Discharge Types by SIC Code 4952 - Sewerage Systems 5541 - Gasoline Service Stations 4941 – Water Suppliers	 142 13 13
Dischargers with Available DMR Data	51
Most Common Parameters with DMR Data	Total Suspended Solids BOD5 Ammonia Nitrogen Total Copper Total Phosphorus
Discharge Flow Rate Range (from DMRs)	1 – 43 MGD

Because so many of the dischargers are minor, Discharge Monitoring Report (DMR) data was available for 51 sites. The data spanned June 1984 through January 2001. The most common parameters found in the DMRs and effluent limits are indicated in Table 3.2.2-2. The common DMR parameters – TSS and BOD5 – correlate with turbidity and TOC (DBP precursor), which are more of a concern from a source water perspective. Copper poses some concern in drinking water supplies, but other metals are much more toxic with respect to human health risks. The prevalence of nutrients is expected due to the number of wastewater plants.

Discharge Monitoring Report (DMR) data for Queen Lane sources is further summarized in Table 3.2.2-3 based on maximum reported quantities and parameter groups. This summary is quite similar to a watershed-wide summary presented in Section 1.5 and 2.2.2, because the delineation zones for Belmont and Queen Lane are very close. Both cover the majority of the Schuylkill Watershed. The parameter groups generally follow those laid out in the PADEP SWAP guidance document. These groupings are used to rank potential contaminant sources in the intake report sections.

Since the ranking analysis is based on DMR maximum quantity data, this data is compiled in Table 3.2.2-3 to provide a frame of reference. The data also gives an idea, on a pounds-per-day basis, as to the "worst case" order of magnitude of releases. Note from Table 3.2.2-3 that this data was available for 51 of the 409 dischargers in the delineation zone for Queen Lane. Available data was generally linked to major dischargers. With that in mind, the data truly represents a worst-case estimate of individual loads being discharged into the Schuylkill within the delineation zone of Queen Lane.

Table 3.2.2-3 Summary of Available DMR Data

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
Cryptosporidium/ *Giardia*	Not Available					
Nutrients	Ammonia as N	0	-	32550	113	2527
	Nitrate-Nitrite as N	0.00023	-	7.2	1.2	22
DBP Precursors	BOD5	0	-	21727	546	1045
Petroleum Hydrocarbons	Oil & Grease	0.00005	-	164	22	322
Salts	Not Available					
Total/Fecal Coliform	Fecal Coliform (col/day)	46	-	84	65	2
Turbidity	Total Suspended Solids	0.002	-	802396	659	5588
Nutrients	Phosphorus, Total as P	0	-	527	21	581
VOC	1,1,1-Trichloroethane	0.001	-	0.09	0.03	37
	1,1,2-Trichloroethane	0.001	-	0.07	0.01	18
	1,1-Dichloroethane	0.001	-	0.02	0.01	18
	1,1-Dichloroethylene	0.000	-	0.05	0.01	83
	1,2-Dichloroethane	0.001	-	0.02	0.01	18
	1,2-Dichloropropane	0.001	-	0.02	0.01	19
	1,2-trans-Dichloroethylene	0.001	-	0.02	0.01	18
	1,3-Dichloropropylene	0.001	-	0.02	0.01	18
	2-Chloroethylvinyl ether	0.038	-	0.08	0.07	3
	Acrolein	0.045	-	0.80	0.43	36
	Acrylonitrile	0.005	-	0.92	0.32	58
	Benzene	0.001	-	0.02	0.01	18
	Bromoform	0.004	-	0.05	0.02	14
	Carbon Tetrachloride	0.001	-	0.02	0.01	18
	Chlorobenzene	0.001	-	0.02	0.01	18
	Chloroethane	0.001	-	0.02	0.01	18
	Chloroform	0.001	-	0.51	0.07	84
	Dibromochloromethane	0.004	-	0.05	0.02	14
	Dichlorobromomethane	0.004	-	0.05	0.02	14
	Ethylbenzene	0.001	-	0.02	0.01	18

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
	Methyl Bromide (Bromomthane)	0.004	-	0.09	0.03	14
	Methyl Chloride (Chloromethane)	0.001	-	0.09	0.02	32
	Methylene Chloride	0.001	-	0.02	0.01	18
	Tetrachloroethylene	0.001	-	0.09	0.03	56
	Toluene	0.001	-	0.02	0.01	18
	Trichloroethylene	0	-	1.13	0.08	90
	Vinyl Chloride	***0.001***	***-***	***1.21***	***0.04***	***39***
SOC	1,2,4-Trichlorobenzene	0.001	-	0.02	0.01	17
	1,2-Dichlorobenzene	0.001	-	0.02	0.01	19
	1,3-Dichlorobenzene	0.001	-	0.02	0.01	17
	1,4-Dichlorobenzene	0.001	-	0.02	0.01	17
	2,4-Dichlorophenol	0.001	-	0.02	0.01	18
	2,4-Dimethylphenol	0.001	-	0.04	0.02	18
	2,4-Dinitrophenol	0.003	-	0.11	0.05	18
	2,4-Dinitrotoluene	0.001	-	0.02	0.01	18
	2,6-Dinitrotoluene	0.001	-	0.05	0.01	18
	2-Chlorophenol	0.001	-	0.02	0.01	17
	2-Nitrophenol	0.001	-	0.02	0.01	17
	4,6-Dintiro-o-Cresol	0.001	-	0.06	0.02	18
	4-Nitrophenol	0.001	-	0.02	0.01	18
	Acenaphthene	0.001	-	0.02	0.01	18
	Acenaphthylene	0.001	-	0.02	0.01	18
	Anthracene	0.001	-	0.02	0.01	18
	Benzo (a) Anthracene	0.001	-	0.02	0.01	18
	Benzo (a) Pyrene	0.001	-	0.02	0.01	18
	Benzo (b) Fluoranthene	0.001	-	0.03	0.01	18
	Benzo (k) Fluoranthene	0.001	-	0.03	0.01	18
	Bis (2-Ethylhexyl) Phthalate	0.001	-	0.02	0.01	17
	Chrysene	0.001	-	0.02	0.01	18
	Di-n-Butylphthalate	0.001	-	0.02	0.01	18
	Diethyl Phthalate	0.001	-	0.02	0.01	18
	Dimethylphthalate	0.001	-	0.02	0.01	18
	Fluoranthene	0.001	-	0.02	0.01	18
	Fluorene	0.001	-	0.02	0.01	18
	Hexachlorobenzene	0.001	-	0.02	0.01	18
	Hexachlorobutadiene	0.001	-	0.02	0.01	18
	Hexahloroethane	0.001	-	0.02	0.01	17
	Naphthalene	0.001	-	0.11	0.06	62
	Nitrobenzene	0.001	-	0.13	0.02	18
	Phenanthrene	0.001	-	0.02	0.01	18
	Phenol	0.001	-	9.00	0.43	32

Parameter Group	Parameters with DMR Max Quantities [1]	Range of Max Quantity Reported			Mean Max Quantity	Count of Max Quantities
	Phenols, total	***0.003***	***-***	***11.80***	***1.41***	***149***
	Pyrene	0.001	-	0.02	0.01	17
Metals	Aluminum	0.0005	-	18.50	1.54	92
	Antimony	0.0006	-	0.04	0.02	33
	Arsenic	0.0003	-	0.09	0.01	32
	Beryllium	0	-	0.25	0.02	258
	Cadmium	0	-	1.08	0.07	322
	Chromium	0	-	9.00	0.38	309
	Chromium, hexavalent	0	-	2.20	0.18	466
	Copper	0	-	11.10	1.16	843
	Fluoride	0.27	-	1.79	1.09	32
	Iron	***1***	***-***	***36.00***	***7.73***	***59***
	Lead	0.00013	-	4.70	0.19	412
	Mercury	0	-	0.03	0.00	106
	Molybdenum	3.58	-	6.62	5.24	7
	Nickel	0	-	19.90	0.38	427
	Selenium	0.0006	-	0.05	0.02	36
	Silver	0	-	1.40	0.05	184
	Thallium	0.0003	-	0.02	0.01	33
	Zinc	0	-	33.20	2.23	486

[1] All quantities in lbs/day, unless otherwise indicated.
[2] Shading indicates the parameter with the largest maximum DMR value.

Table 3.2.2-3 shows that total suspended solids loads are the highest of any parameter and have the greatest number of reported quantities. Total suspended solids are related to the turbidity parameter group. Turbidity is another indicator, such as TSS, of particulates in the water supply, but is a more meaningful measure of performance in drinking water treatment. Microbial data is very scarce, with only two reportable maximum quantities for fecal coliform. Maximum and average ammonia loads are greater than phosphorus loads. The table also indicates the various VOCs and SOCs discharged into the Schuylkill River. Vinyl chloride has the single largest discharged VOC quantity of 1.2 lbs/day. Relative to the other VOCs, acrylonitrile and acrolein are also large average maximum discharge quantities. Total phenols are the largest discharged quantity for the SOCs. Otherwise, quantities are similar across the many synthetic organic compounds. Of the metals, iron is clearly the largest discharged quantity. High maximum quantities are also reported for aluminum, total chromium, total copper, total lead, total nickel, and total zinc. Chromium and lead pose the greatest risk in drinking water.

RCRA/AST Facilities

As summarized in Table 3.2.2-4, RCRA facilities comprise many of the point sources within Queen Lane's delineation zones. The breakdown of RCRA facilities for Queen Lane is essentially the same as for Belmont. Only 44 out of the 1,432 RCRA facilities are designated Large Quantity Generators. Data describing the industry type or capacity of the facilities is limited. Taking into account the limited number of SIC codes, most RCRA facilities are dry cleaning plants, followed by automotive repair shops, and printing shops. A relatively low number of RCRA sites are cited as having violations. Capacity information for use in ranking sites is available for merely 50 sites, and contaminant information is not available. A range of 100 to about 100,000 gallons gives an idea of the capacity for the RCRA sites with available data.

Table 3.2.2-4 RCRA Facility Summary

Total RCRA Facilities	1432
Large Quantity Generators	44
Facilities with SIC Codes	462
Top 3 RCRA Industry Types by SIC Code 7216 – Dry Cleaning Plants 7537 – Automotive Transmission Repair Shops 2752 – Commercial Printing	 97 14 14
RCRA facilities with Violations	76
RCRA facilities with Capacity/Volume Data	50
Range of Capacity	100 – 96,500 gallons 107 – 8,220,000 gal/day
Most Common Parameters/Contaminants	Not Applicable – no contaminants linked to RCRA downloads

RCRA data was supplemented with Aboveground Storage Tank information from PADEP. PADEP AST data included useful and detailed information as to tank age, contaminants and volumes. AST data is summarized in Table 3.2.2-5.

Table 3.2.2-5 AST Facility Summary

Total AST Facilities	393
AST Facility overlap with RCRA facilities	71
Total Number of Tanks	1638
Tank Capacity Range	252 gal – 4 MG
Tank Age Range	1 – 98 years
Number of Different Parameters/Contaminants	123
Most Common Parameters and Quantities by Number of Tanks Misc. Hazardous Substance Diesel Fuel Gasoline	 556 tanks/3.4 MG 201 tanks/4.4 MG 141 tanks/7.1 MG
Most Common Parameters/Contaminants and Quantities by Total Volume Heating Oil Gasoline Diesel	 25 MG 7.1 MG 4.4 MG

Table 3.2.2-5 shows that 393 facilities throughout Queen Lane's delineation zones, have aboveground storage tanks. Of those facilities, only 71 overlap with the RCRA facilities. This may be due to RCRA sites also comprising underground storage tanks. The AST data is still useful for characterizing potential contaminant sources in the watershed. Tanks range in capacities from about 250 gallons to 4 million gallons and range in age from 1 to 98 years old. Older tanks may pose a greater risk for spills. The tanks contain 123 different substances. The most common of these by volume, as labeled in the original PADEP data, is a non-specific hazardous substance. The specific chemical was not given. After miscellaneous hazardous substances, gasoline and diesel fuels are the most common by volume. The significance of these tanks as contamination sources depends on factors such as the total volume of substance at any one site, tank age, and the time of travel to the intake. These factors are considered in the intake specific susceptibility ranking.

TRI Facilities

A summary of TRI sources is presented in Table 3.2.2-6. As explained in detail in Appendix S.5, a facility is listed in the TRI if a chemical from the inventory is used or manufactured on site. These sites are not necessarily discharges. Data on which chemicals are on–site, quantities of chemicals, and releases are available for the TRI sources. The range of quantities is how much is used or manufactured in a given year. Releases may be to air, water or land. Information regarding how much of a given chemical and which chemical is released is not provided.

With that in mind, Table 3.2.2-6 indicates that 276 TRI facilities are found in the delineation zones for Queen Lane. A SIC code is identified for 268 of these industries.

SIC codes are linked to activities that PADEP identified in the State SWAP document. Based on activity, most TRI facilities are foundries, chemical manufacturers, or machine shops.

Chemical and quantity data is very complete for the TRI facilities, however quantities are presented as ranges. Copper, sulfuric acid, and chromium are the most common chemicals listed by the various TRI sites. Quantity ranges for these chemicals are shown in Table 3.2.2-6. This amount of substance is not necessarily released into a water body. Limited information is available on the number of releases to water for 261 of the TRI facilities. Based on this, chemical manufacturers in Montgomery and Berks counties have had the most reported number of releases.

Table 3.2.2-6 TRI Facility Summary

Total TRI Facilities	276
Facilities with SIC Codes	268
Top 3 Industry Types by Activity Foundries or Metal Fabricators Chemical Manufacturer Machine/Metalworking Shops	 49 46 41
Top 3 TRI Industries by SIC Code 2899 - Chemical Preparation 2834 – Pharmaceutical Preparations 3324 – Steel Foundries	 8 7 6
Facilities with Quantity Data	261
Most Common Parameters for Facilities with Quantity Data Copper Sulfuric Acid Chromium Nickel Toluene	 0 – 999,999,999 kg/yr 0 – 49,999,999 kg/yr 100 – 99,999,999 kg/yr 0 – 9,999,999 kg/yr 100 – 9,999,999 kg/yr
Facilities with Release Data	267
Facilities with Greatest Number of Releases Chem. Manufacturer–Dyes/Pigments–Berks County Chem. Manufacturer-Medicinal Chemicals – Mont. Cty. Chem. Manufacturer – Industrial Chemicals-Berks Cty.	 180 releases to water 96 releases to water 84 releases to water

CERCLA Facilities

Although data for CERCLA facilities is limited, Table 3.2.2-7 summarizes what information is available within 25 hours time of travel and beyond for the Queen Lane Intake. Three hundred thirty-two CERCLA facilities are in Queen Lane's delineation zone, but only 21 are on the final National Priority List. Information for about 80 of the CERCLA facilities is available through the RCRA and TRI databases, where those facilities are also listed. Only 30 sites are found in the flood plain and 21 sites are on the NPL list for Superfund restoration. Due to the low number of high-risk sites, based on flood plain and NPL status, finding more data is not critical for the majority of the sites. Since information on the Superfund sites is so limited, these sites are screened or ranked narratively. The low number of NPL sites and sites in the floodplain is considered in the narrative screening.

Table 3.2.2-7 CERCLA Facility Summary

Total Number of CERCLA Facilities	332
Number on the NPL List	21
Number also listed as RCRA	62
Number also listed as TRI	18
Number in Flood Plain	30

3.2.3 Runoff Loading Summary

Key Points

- **The Schuylkill River Runoff Loading Model was developed to estimate contaminant loadings to the river from storm runoff.**
- **The model uses the physical characteristics of the subwatersheds, meteorological data, updated land use information, and event mean concentrations for the nine parameters of interest to estimate average daily contaminant loadings within each of the Queen Lane Intake's zones of contribution.**
- **The developed areas associated with industrial/commercial land use and residential uses are estimated to contribute the highest per-acre loadings of most of the contaminants evaluated, including disinfection by-products, metals, nutrients, petroleum hydrocarbons, salts, and coliforms.**
- **Unit *Cryptosporidium* and turbidity loadings are higher from agricultural areas.**

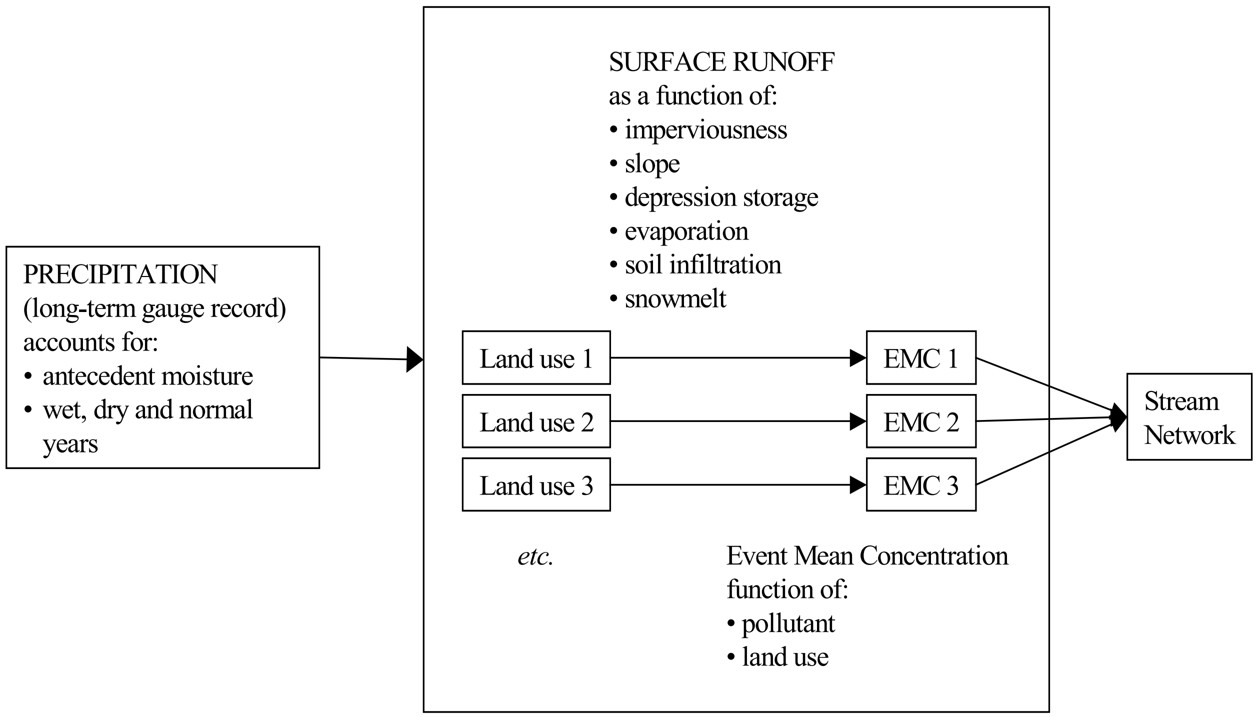
The Schuylkill River Source Water Assessment Partnership developed the Schuylkill Runoff Loading Model (SRLM) in an effort to estimate pollutant loads from rainfall runoff throughout the watershed. The SRLM results provide information on the relative contributions of surface runoff from various land use categories, as well as, from different geographical areas. The procedure incorporates collection of data, model development and simulation, and post-processing of output data for further use in the susceptibility analysis. A database management system (DBMS) was created to assist with storing parameter data, creating the model, and post-processing model outputs.

3.2.3.1 Method

The RUNOFF module of the U.S. EPA's Storm Water Management Model (SWMM) simulates rainfall runoff quantities and quality at specified inlet locations. Figure 3.2.3-1 displays the structure of the SWMM RUNOFF model. The model inputs subshed parameters, rainfall time-series, climatological data, and event mean concentrations (EMCs) for the land use categories, and outputs annual and monthly pollutant loads for the length of the simulation period. The model incorporates infiltration, depression storage, and roughness to estimate runoff flow and ultimately, runoff pollutant quantities.

The amount of a particular pollutant reaching the receiving stream is dependent on the volume of surface runoff and the concentration of that constituent in the runoff. An EMC is the total mass load of a pollutant yielded from a site during a storm divided by the total runoff water volume discharged during the storm. EMCs are related to the constituent of interest and the land use type. For a subshed, the surface runoff from a particular land use predicted by SWMM RUNOFF is multiplied by the EMC for that land use type to yield a loading rate.

Figure 3.2.3-1 Watershed Loading Model Schematic Diagram



Subcatchments
The subcatchments of the Schuylkill River Watershed ultimately drain into the Delaware River Basin. The Schuylkill Watershed is composed of 356 subsheds and the area tributary to the PWD Queen Lane Intake includes 179 of the 356 subbasins, about 57 percent of the Schuylkill Watershed. The subwatersheds were further divided into land use categories to track the contributing pollutant loads from each land use category. The land use categories were based on the USGS's NLCD dataset updated with 2000 Census data for residential and commercial areas, as detailed in Section 1.2.5.

The land use categories distinguish the amount of rainfall that runs off the surface of the subwatershed, as opposed to infiltrating into the subsurface or entering the atmosphere through evapotranspiration. For example, during a storm, more rainfall becomes surface runoff in a residential area than in a forested area, since there are more impervious surfaces such as driveways, roads, and buildings in developed areas. The forested area retains more of the rainfall, which either infiltrates into the ground or evaporates. For modeling purposes, the land use categories were summed for each subwatershed in order to track individual land use loading contributions to the totals for each subwatershed. Figure 3.2.3-2 and Table 3.2.3-1 below summarize the land use characterization for the Schuylkill River Watershed area within the Zone B delineation for the PWD Queen Lane Intake and reflect modifications in residential development and increases in commercial areas based on increases in populations from the Census Bureau. For the defined area, almost 80% is characterized as agriculture, forests, and wetlands. Developed and urbanized areas account for about 20% of the Zone B delineated area for the PWD Queen Lane Intake.

The percentage of impervious area for all land use categories, excluding residential, were estimated according to values extracted from the Water Management Model (WMM) and adjusted during the calibration. The percentage of impervious area for residential areas was calculated using Hick's methodology, which calculates the percentage of total impervious area as a function of the population density.

For pervious areas, the portion of precipitation that runs off is affected by slope, depression storage, infiltration, vegetative cover, and evapotranspiration. Infiltration is determined primarily by the type of soil. The SWMM RUNOFF model simulates infiltration using the Green-Ampt theory for both saturated and unsaturated soils. The Green-Ampt infiltration routine relates infiltration rate to the moisture conditions of the surface and the total volume of rainfall infiltrated. For the SLRM, the soil information was downloaded from the Natural Resources Conservation Service (NRCS) and the soils GIS coverage was intersected with subwatersheds to identify the soil types in each subwatershed.

Figure 3.2.3-2 Land Use Characterization for PWD Queen Lane Intake Zone B

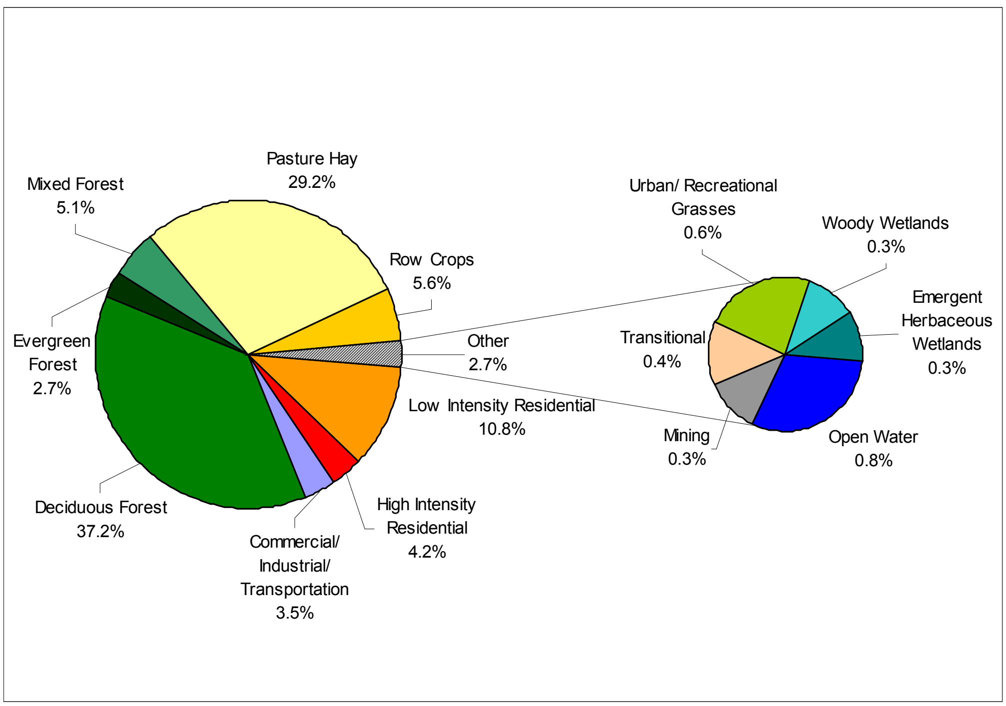


Table 3.2.3-1 Updated Land Use Categories

Landuse Category	Subcategory	Area (acres)	Percentage of Zone B Delineated Area
Agricultural	Pasture/Hay	205033	29.2%
	Row Crops	39024	5.6%
Commercial/Industrial/Transportation		22190	3.2%
Forested	Deciduous Forest	261690	37.2%
	Evergreen Forest	20287	2.9%
	Mixed Forest	35558	5.1%
Open Water		5835	0.8%
Quarries/Strip Mines/Gravel Pits		2104	0.3%
Residential	High Intensity Residential	23991	4.2%
	Low Intensity Residential	76064	10.8%
Transitional		2548	0.4%
Urban/Recreational Grasses		4300	0.6%
Wetlands	Emergent Herbaceous Wetlands	2012	0.3%
	Woody Wetlands	2043	0.3%

Event Mean Concentrations (EMCs)

Applying EMCs to calculated runoff volumes provides reasonable estimates of runoff pollutant loadings. EMCs for the soluble pollutant categories were assigned according to the land use category. The SWMM RUNOFF module allows the model to assume a constant concentration of a constituent for the duration of the storm event. The quantity of a constituent in surface runoff is a function of constant EMCs associated with the land use categories. The RUNOFF model water quality parameters included *Cryptosporidium*, disinfection by-products, metals and heavy metals, conservative nutrients, non-conservative nutrients, petroleum hydrocarbons, salts, turbidity, and total/fecal coliform. For each of these contaminant types, a surrogate constituent was selected. For example, chloride was used as the surrogate for salts and the EMCs for chloride were used in the model.

Runoff volumes are computed for each land use category based on percent imperviousness of the land use, annual rainfall, slope of the subwatershed, evaporation, infiltration, and depression storage. This analysis was performed on a subwatershed-by-subwatershed basis, and the results were used to determine load distributions according to the land use category. The pollutant mass load estimate is computed for each land use within each subwatershed as a product of the EMC and the surface runoff. By estimating the pollutant loading over the area of a land use type within a subwatershed and summing for all land uses, the total pollutant load from a subwatershed can be computed.

Meteorological Data

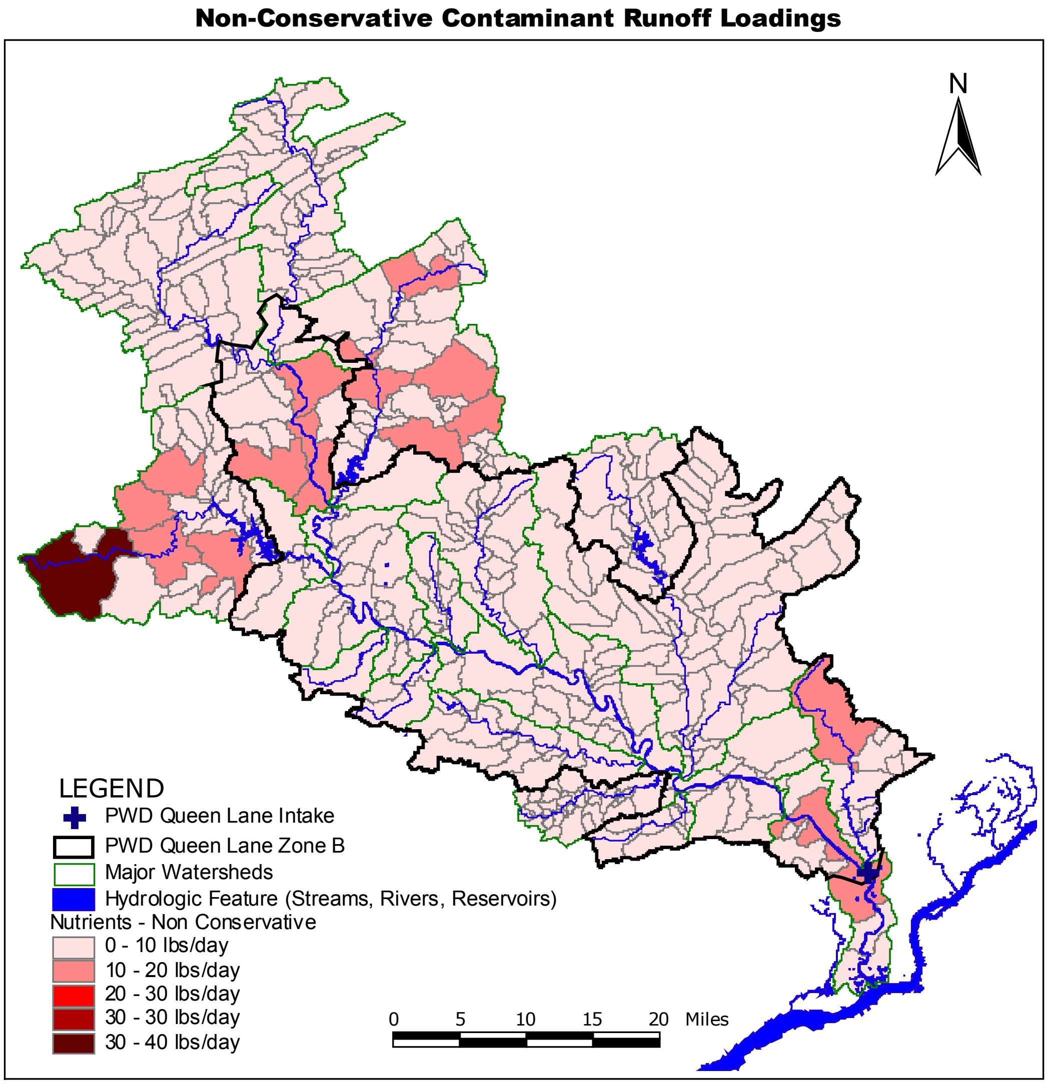
The amount of surface runoff is primarily driven by the precipitation. Long-term climate and precipitation records were used to drive the hydrology of the system. Using a long-term record represents a wide range of hydrologic conditions that occur in a given climate. Using a long-term record on a continuous basis accounts for antecedent moisture conditions and more accurately represents initial conditions at the beginnings of storm events. Snowfall and snowmelt affect the quantity and timing of surface runoff during the winter months and have been included in the long-term continuous simulation.

If available, rainfall, wind, and temperature data for a period over ten years (1990-2000) were collected for RUNOFF model simulations. The hourly rainfall data was obtained from the National Weather Service (NWS) at stations in and surround the Schuylkill Watershed. The hourly data was further discretized into 15-minute increments. To account for snowmelt, the daily minimum and maximum temperatures and average monthly wind speeds were obtained for the period of simulation.

3.2.3.2 Results

The SRLM was used to quantify contaminant loads for all pollutant categories included in the susceptibility analysis except for volatile organic compounds. Generally, the greater contaminant loads are found in the lower portion of the watershed. These areas tend to have more development, and thus greater impervious surfaces and runoff volumes. Figure 3.2.3-3 shows the results for the watershed for non-conservative nutrients for which the surrogate phosphorus was chosen. The darker areas, representing higher load estimates, are located closer to streams and rivers and are observed to be further downstream in the watershed. The lighter areas are less developed and less surface runoff results from rainfall events. The subwatersheds with greater pollutant loads tend to be within the Zone B delineation for the PWD Queen Lane Intake.

Figure 3.2.3-3 Non-conservative Contaminant Runoff Loadings



The Zone A delineated area for an intake is defined as the area within a five-hour time of travel of the water supply including one-quarter mile downstream and within a one-quarter mile wide area on either side of the stream from the intake. For the contaminant loads from rainfall runoff, Zone A includes parts of the Middle Schuylkill, Wissahickon, and Lower Schuylkill Watersheds. Over half of the area is developed, which results in greater runoff volume and, consequently, higher pollutant loads.

Zone B for PWD's Queen Lane Intake encompasses Zone A and area further upstream in the Schuylkill Watershed. Since Zone B contains more area, the pollutant loads are greater for Zone B than for Zone A. As previously described, the area contained in the Zone B delineation is about 20% impervious surfaces, while Zone A contains more than

50% impervious area. The average daily contaminant loadings for each of the Queen Lane Intake's zones are summarized below by Table 3.2.3-2.

Table 3.2.3-2 Calculated Average Daily Contaminant Loadings

Zone	*Cryptosporidium*	Disinfection By-products	Metals and Heavy Metals	Conservative Nutrients	Non-Conservative Nutrients	Petroleum Hydrocarbons	Salts	Turbidity	Total/ Fecal Coliform
	(oocysts/ day)	(lbs/day)	(lbs/day)	(lbs/day)	(lbs/day)	(lbs/day)	(lbs/day)	(lbs/day)	(coliforms /day)
A	4.7E+07	2949	13.5	576	83	975	4886	3.7E+04	2.4E+12
B*	2.4E+08	9364	22.3	2592	480	1815	10105	3.0E+05	4.0E+12
Total A&B	2.8E+08	12313	35.8	3167	563	2790	14991	3.4E+05	6.4E+12

** Zone B values exclude Zone A*

On a smaller scale, the contributions from each of the major subwatersheds are summarized in Tables 2.2.3-3 and 2.2.3-4 below. Table 2.2.3-3 summarizes the total daily loads for each major subwatershed listed from upstream to downstream in the Schuylkill Watershed. Since only portions of some major subwatersheds are included in the Zone B delineation and there are variations in sizes of the major subwatersheds, the values listed in Table 2.2.3-4 are the total daily loads divided by the contributing area of each major subwatershed. For instance, although the Middle Schuylkill One Subwatershed has less contributing area to the Queen Lane Intake than the Middle Schuylkill Two subwatershed, the Schuylkill One has a greater load of metal than the Middle Schuylkill Two. This is because the per acre metal loading of Middle Schuylkill One is significantly higher than the per acre metal loading of Middle Schuylkill Two. This can be caused by greater impervious cover (more runoff), as well as more industrial land use.

Table 3.2.3-3 Daily Contaminant Loads for Major Subwatersheds

Majorshed*	**Area (acres)**	***Cryptosporidium*** (oocysts/ day)	**Disinfection by Products** (lbs/day)	**Metals/Heavy Metals** (lbs/day)	**Conservative Nutrients** (lbs/day)	**Non-Conservative Nutrients** (lbs/day)	**Petroleum Hydrocarbons** (lbs/day)	**Salts** (lbs/day)	**Turbidity** (lbs/day)	**Total/ Fecal Coliform** (coliforms/day)
Little Schuylkill	10750	3.2E+06	215	0.04	46	9	2	54	5.4E+03	5.6E+09
Upper Schuylkill	90330	6.1E+07	1924	1.95	658	132	144	1048	8.6E+04	3.3E+11
Maiden Creek	15212	5.8E+06	241	0.50	87	16	43	239	8.5E+03	9.4E+10
Tulpehocken Creek	25994	1.9E+07	601	1.34	196	38	118	660	2.4E+04	2.4E+11
Allegheny Creek	11442	1.6E+06	76	0.12	15	3	16	92	1.8E+03	2.3E+10
Middle Schuylkill 3	62849	2.6E+07	1455	5.59	283	42	473	2440	2.4E+04	1.0E+12
Hay Creek	14160	1.7E+06	87	0.10	20	4	7	50	2.3E+03	1.8E+10
Monocacy Creek	16495	5.5E+06	139	0.17	59	12	8	100	8.0E+03	1.5E+10
Manatawny Creek	58602	1.3E+07	451	0.64	156	30	44	308	1.9E+04	1.0E+11
French Creek	44912	9.0E+06	369	0.62	88	17	55	323	1.1E+04	1.1E+11
Middle Schuylkill 2	65959	1.8E+07	818	2.73	192	31	244	1272	1.8E+04	5.0E+11
Perkiomen Creek	176313	6.6E+07	2510	6.55	702	131	511	2712	8.1E+04	1.2E+12
Valley Creek	15810	8.3E+06	504	1.96	94	14	152	829	1.0E+04	3.3E+11
Middle Schuylkill 1	40614	2.0E+07	1222	5.61	243	35	429	2160	1.6E+04	1.0E+12
Wissahickon Creek	40754	2.2E+07	1355	6.22	267	39	418	2043	1.8E+04	1.1E+12
Lower Schuylkill	12485	4.7E+06	346	1.66	61	8	125	662	2.7E+03	2.9E+11

** Areas reflect portions of the major shed within the boundary of the Zone B delineation.*

Table 3.2.3-4 Daily Contaminant Loads per Acre for Major Subwatersheds

Majorshed*	Area (acres)	*Cryptosporidium* (oocysts/ day-acre)	Disinfection by Products (lbs/day-acre)	Metals/Heavy Metals (lbs/day-acre)	Conservative Nutrients (lbs/day-acre)	Non-Conservative Nutrients (lbs/day-acre)	Petroleum Hydrocarbons (lbs/day-acre)	Salts (lbs/day-acre)	Turbidity (lbs/day-acre)	Total/ Fecal Coliform (coliforms/day-acre)
Little Schuylkill	10750	296	0.020	3.3E-06	0.004	0.001	0.000	0.005	0.505	5.2E+05
Upper Schuylkill	90330	671	0.021	2.2E-05	0.007	0.001	0.002	0.012	0.948	3.7E+06
Maiden Creek	15212	381	0.016	3.3E-05	0.006	0.001	0.003	0.016	0.557	6.2E+06
Tulpehocken Creek	25994	726	0.023	5.2E-05	0.008	0.001	0.005	0.025	0.912	9.3E+06
Allegheny Creek	11442	141	0.007	1.1E-05	0.001	0.000	0.001	0.008	0.154	2.0E+06
Middle Schuylkill 3	62849	410	0.023	8.9E-05	0.005	0.001	0.008	0.039	0.376	1.6E+07
Hay Creek	14160	122	0.006	7.1E-06	0.001	0.000	0.001	0.004	0.161	1.2E+06
Monocacy Creek	16495	336	0.008	1.0E-05	0.004	0.001	0.000	0.006	0.485	9.0E+05
Manatawny Creek	58602	214	0.008	1.1E-05	0.003	0.001	0.001	0.005	0.332	1.7E+06
French Creek	44912	200	0.008	1.4E-05	0.002	0.000	0.001	0.007	0.247	2.5E+06
Middle Schuylkill 2	65959	269	0.012	4.1E-05	0.003	0.000	0.004	0.019	0.277	7.6E+06
Perkiomen Creek	176313	376	0.014	3.7E-05	0.004	0.001	0.003	0.015	0.457	6.9E+06
Valley Creek	15810	528	0.032	1.2E-04	0.006	0.001	0.010	0.052	0.636	2.1E+07
Middle Schuylkill 1	40614	493	0.030	1.4E-04	0.006	0.001	0.011	0.053	0.403	2.5E+07
Wissahickon Creek	40754	538	0.033	1.5E-04	0.007	0.001	0.010	0.050	0.434	2.7E+07
Lower Schuylkill	12485	379	0.028	1.3E-04	0.005	0.001	0.010	0.053	0.215	2.3E+07

** Areas reflect portions of the major shed within the boundary of the Zone B delineation.*

Although the estimated total daily contaminant loads for the Perkiomen Subwatershed are relatively high in all contaminant categories, the load per area is much lower than the Middle Schuylkill and the Lower Schuylkill subwatersheds, since about 90% of the area is agriculture or forested. Also, the Perkiomen Subwatershed is ten times larger and has greater total pollutant loads than the area contributed by the Maiden Creek Watershed to the Zone B delineation, yet the Maiden Creek Watershed has comparable pollutant loads per area for most of the contaminant categories.

The contaminant loading results for the area within Zone B, including Zone A, for the Queen Lane Intake are summarized below:

<u>Cryptosporidium</u>: The concentrated areas of highest pollutant estimates are located in the Perkiomen and Upper Schuylkill through which the main-stem Schuylkill River flows. The Wissahickon and Middle Schuylkill also have high estimates of *Cryptosporidium* loads from runoff. The Tulpehocken and Upper Schuylkill have the highest daily loads per area, because a relatively high percentage of these subwatershed areas are characterized as pasture or hay, which has the highest EMC for *Cryptosporidium*.

<u>Disinfection by-Products</u>: The higher EMCs for disinfection by-products are associated with developed land use categories such as commercial/industrial/ transportation and residential. The areas of highest pollutant loading are located in the Upper Schuylkill and Perkiomen watersheds. Wissahickon Creek, Valley Creek, and Middle Schuylkill One have relatively high daily pollutant loads per area.

<u>Metals/Heavy Metals</u>: The concentrated areas of highest pollutant estimates are located in the Perkiomen, Wissahickon, Middle Schuylkill One and Middle Schuylkill Three watersheds. On a per area basis, Valley Creek, Perkiomen Creek, Middle Schuylkill One and Lower Schuylkill contribute the most metal loading.

<u>Conservative Nutrients</u>: The concentrated areas of highest pollutant estimates are located in throughout the Upper Schuylkill and Perkiomen Creek subwatersheds. The Wissahickon Creek, Tulpehocken Creek, and Upper Schuylkill watersheds have high estimates of daily loads per acre.

<u>Non-conservative Nutrients</u>: The concentrated areas of highest pollutant estimates are located in throughout the Upper Schuylkill and Perkiomen Creek subwatersheds. No watersheds stand out as having high estimates of daily loads per acre.

<u>Petroleum Hydrocarbons</u>: The highest EMCs for petroleum hydrocarbons are associated with commercial/industrial/transportation areas, followed by residential land use categories. The concentrated areas of highest pollutant estimates are located in the Middle Schuylkill, the Wissahickon and the Perkiomen watersheds. The highest daily loads per area occur in lower portions of the watershed, Valley Creek, Wissahickon Creek, and the Lower and Middle Schuylkill River.

<u>Salts</u>: The higher EMCs for salts are associated with developed land use categories such as commercial/industrial/transportation, mining, and residential, listed in decreasing order. The concentrated areas of highest pollutant estimates are located in the Middle Schuylkill, Wissahickon, and Perkiomen watersheds. and Lower Schuylkill. The highest daily loads per area occur in lower portions of the watershed, Valley Creek, Wissahickon Creek, and the Lower and Middle Schuylkill River.

Turbidity: The concentrated areas of highest pollutant estimates are located in the Upper Schuylkill and Perkiomen Creek. On a per acre basis, the highest loads occur in the Upper Schuylkill and Tulpehocken Creek watersheds.

Total/Fecal Coliform: Generally, the concentrated areas of highest pollutant estimates are located in the Middle Schuylkill, the Wissahocken Creek and Perkiomen watersheds. The highest daily loads per area occur in lower portions of the watershed: Valley Creek, Wissahickon Creek, and the Lower and Middle Schuylkill River.

The summary of the results from the SLRM show the pollutant loads over the entire watershed to the smaller subwatershed contributions. The contaminant loads are not only dependent on the land use types, but also soil properties, subwatershed slopes, depression storage, and climate conditions. The estimates from the SLRM were further used in the qualitative loading analysis portion of the susceptibility analysis.

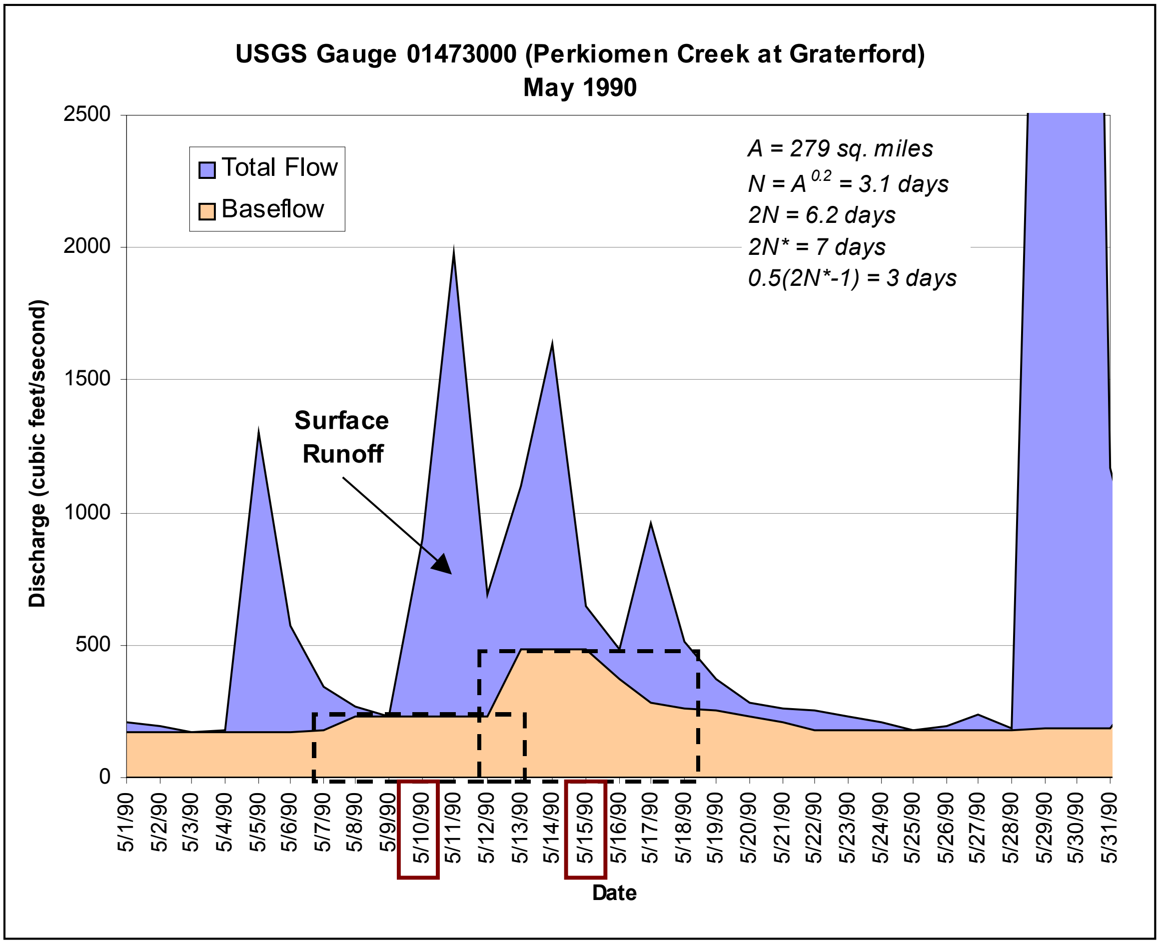
3.2.3.3 Hydrograph Separation for Baseflow and Runoff Calibration

In order to assess the reliability of the pollutant loads from SWMM, a hydrograph separation analysis was done to compare with runoff quantities and water quality loads from the SLRM. A hydrograph separation program was created in SAS® to divide the total flow into baseflow and surface runoff. This program was modeled after the USGS's HYSEP computer program, but assumes only one of its three hydrograph separation methods, the sliding-interval method. The hydrograph separation yields total flow, baseflow, and runoff values in daily, monthly, seasonal, and annual averages. The daily average flows were obtained from the USGS for gauges located in the Schuylkill River Basin.

The sliding-interval method associates a baseflow with a selected day by taking an equal interval before and after that day and assigning the lowest discharge to that day. The intervals are calculated based on the drainage area. For example, as shown in Figure 3.2.3-4, the drainage area for the USGS gauge located in the Perkiomen Creek at Graterford has a drainage area of 279 square miles. The interval after surface runoff is 3.1 days. The interval for finding the baseflow is applied before and after a specified day. Thus, total duration is twice the calculated interval (6.2 days) and then rounded to the nearest odd number greater than that value (7 days) to include the interval before and after and that day as well. Three is the minimum duration used in the sliding interval method. The selected day should be the median with equal durations before and after to associate the lowest discharge within the entire interval. For the Perkiomen Creek at Graterford, the total interval is 7 days and the "windows" for May 10, 1990 and May 15, 1990 are displayed in Figure 3.2.3-4. The baseflow designated to March 10, 1990 is 232 cubic feet per second and March 15, 1990 is 484 cubic feet per second.

The surface runoff is the difference between the total streamflow and the baseflow, as described above. In Figure 3.2.3-4 the darker shaded area (light purple), is the remainder of the total flow that is designated as surface runoff.

Figure 3.2.3-4 Hydrograph Separation Analysis for the Perkiomen Creek at Graterford for May 1990.



The hydrograph separation was conducted for the active USGS gauges in the Schuylkill Watershed. The values are average annual flows in cubic feet per second and inches per year for the period of record available for each gauge. The percent runoff is the amount of total flow that is assumed to be surface runoff. The total flow, baseflow, and runoff values were converted to inches per year by dividing the flows by the drainage area. Excluding the stations that are influenced by interbasin transfers of water supply in the East Branch Perkiomen (Stations 01472620 and 01472810), the average annual runoff is 7.7 inches per year.

Since there is seasonal variation in the flows, the average baseflow and surface runoff values were also calculated by season. Generally, the average seasonal baseflow was highest in the spring, winter, summer, and then fall (in descending order). Often the average season baseflow was two to three times greater in the spring than the summer. Seasonal surface runoff for the winter, spring, summer, and fall averaged 9.9, 9.5, 4.7, 6.1 inches per year, respectively.

The USGS streamflow hydrograph separation results were used to calibrate the results from the SLRM. Since there is evidence of seasonal variability, the calibration of the SLRM was done on a seasonal basis. Comparing the simulated values with the hydrograph separation results, parameters in the SLRM were further refined.

3.2.4 Susceptibility Analysis

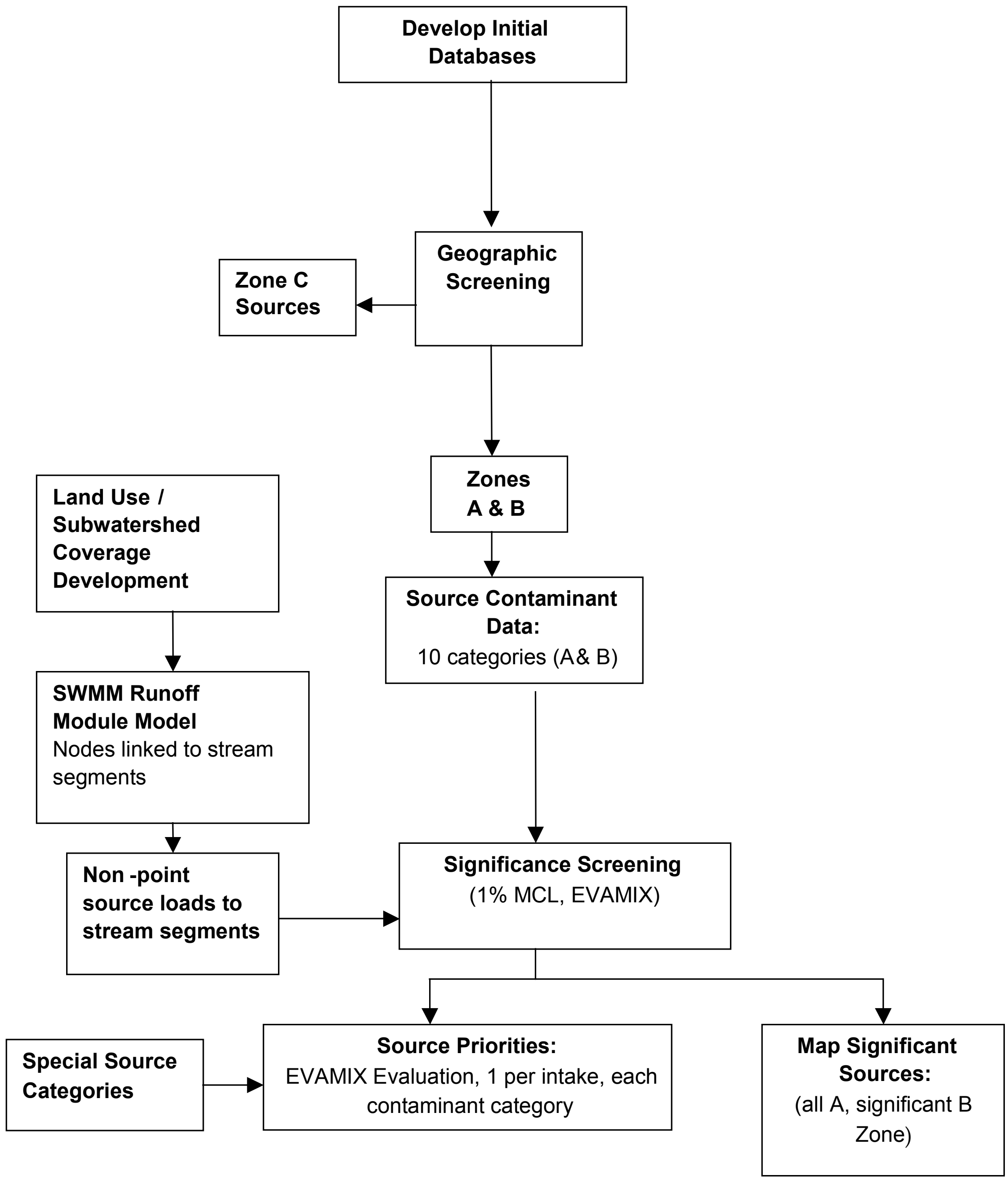
Key Points

- **A series of successive screenings was used to identify those sources that have the greatest potential to affect water quality at the Queen Lane Intake.**
- **Five non-conservative contaminant categories and five conservative contaminant categories were selected to represent all potential contaminants.**
- **For each category, a threshold value indicative of the significance of the concentrations of contaminants that could result from a potential spill or discharge was defined.**
- **EVAMIX, a multi-criteria software package, was used along with information from the Technical Advisory Group, to prioritize the potential significance of each of the potential point sources within Queen Lane's Zone A and Zone B, and to evaluate the potential significance of non-point sources estimated by the Schuylkill River Runoff Loading Model.**
- **NPDES and nonpoint source discharges within the Queen Lane Intake's Zone A and Zone B were determined to have the highest protection priorities in the watershed.**
- **The potential significance of each source of contamination was designated A (potentially significant source of highest protection priority) through F (Potential source of lowest protection priority). Those sources ranked A through C are potentially significant sources of contamination to the Queen Lane Intake.**
- **All of the highest ranked sources are either NPDES sites or storm water loadings from specific subwatersheds.**
- **Contaminant sources actually discharging to the river (e.g., NPDES permitted point sources, or stormwater runoff) are estimated to have greater potential significance than those with only the potential to release contaminants to the river (e.g, a spill or leak).**
- **EVAMIX was also used to rank potential sources for each contaminant category.**

3.2.4.1 Method

Because of the large number of potential sources of contamination that have been identified, the method behind the susceptibility analysis relies on a process of successive screenings. These screenings help focus the efforts of source water protection on those sources that have the greatest potential to affect the water quality of the source water at the intake. The process of screening is shown in Figure 3.2.4-1, and described in this section. The section starts with an introduction to the ten contaminant categories being considered.

Figure 3.2.4–1 Flow Diagram of Screening Process



Contaminant Categories

There are two difficulties faced in trying to priorities potential sources of contamination of the drinking water. Because the Schuylkill Watershed is very large, there are thousands of potential sources to be assessed. In addition, the assessments must also cover a full range of contaminant types. The PADEP guidance indicates that the best approach is to try to group all potential contaminants into a limited number of contaminant groups, and then assess all sources for each of the contaminant categories. For this study, ten contaminant categories have been developed. For each category, a planning level threshold concentration based either on ambient water quality in the Schuylkill River, or on regulatory standards such as the drinking water standard has been established. This threshold value is used as a relative measure of the significance of contaminant concentrations that could potentially occur due to a spill or discharge from each of the sources. Each category is summarized below.

Non-Conservative Contaminants

There are five contaminant categories that can be considered "non-conservative" contaminants. That means that, once spilled or discharged into the river, the concentration that results will decrease as the spill moves downstream, either because the contaminant dies off, evaporates into the air, or attaches itself to silt particles and settles to the bottom of the river. The non-conservative contaminant categories are:

1. Total/Fecal Coliform: Fecal coliform is used as the indicator contaminant for this category. The suggested threshold value is the recreational water standard of 200 count/100 ml. Fecal coliform tends to die off over time within the river.

2. Turbidity: Turbidity can be measured directly, but most existing data relates to Total Suspended Solids (TSS), and this is used as an indicator for turbidity. The suggested threshold comes from median ambient conditions in the river, approximately ten mg/l. TSS tends to settle to the bottom of the river over time.

3. Nutrients: There are several contaminants in the nutrient category. Phosphorous was selected as one indicator for this category. The suggested threshold value comes from the median ambient conditions in the river, approximately 0.12 mg/l. Some portion of the total phosphorus concentration is associated with phosphorus adhering to silt particles, and tends to settle to the bottom of the river over time.

4. VOC/SOC: This category is particularly challenging because it includes hundreds of compounds. To meet this challenge, it was decided that the total amount of VOC/SOC present at a site would be used as an indicator for this category. Because there are so many different potential threshold values for this large and diverse category, a very conservative threshold of five ug/l is used. This is the drinking water standard for benzene, as well as many other of the most toxic solvents. By comparing the total VOC/SOC concentration generated by a spill or discharge with this conservative threshold, even small spills or discharges will be deemed significant. VOCs and some SOCs can evaporate or "volatilize" from the river; others can attach themselves to silt and settle to the bottom of the river. Both have the effect of reducing concentrations in the river over time.

5. Metals: This category is also challenging because numerous metals are included. The total amount of metals present at a site is used as an indicator. Because there are many different potential threshold values for various metals, a conservative threshold of 0.015 mg/l was selected. This is the regulatory standard for lead in drinking water, and is lower than for most metals. Most metals tend to attach themselves to silt and settle to the bottom of the river, lowering concentrations in the river over time.

Conservative Contaminants
Five contaminant categories can be considered to be "conservative". Concentrations of conservative contaminants are only affected by dilution, and do not decrease through other means. The five categories are:

6. *Cryptosporidium/Giardia*: A potential threshold value is difficult to define for this important potential contaminant category for surface water sources. A value of only one oocyst per liter has been selected for a screening threshold based on potential health impacts.

7. Nutrients: Nitrate, a second common nutrient was also selected for analysis because of its prevalence in the watershed. The drinking water standard of ten mg/l was used for the threshold value.

8. DBP Precursors: Disinfection by-products are a concern for drinking water systems that chlorinate. A good indicator for this contaminant category is Total Organic Carbon (TOC). The threshold value was set based on the median ambient concentration in the river of approximately 2.7 mg/l.

9. Petroleum Hydrocarbons: Oil and oil-based products are common contaminants. This category contains a large variety of individual contaminants, and Total Petroleum Hydrocarbons (TPH) was chosen as the indicator contaminant. A threshold value was selected of five mg/l based primarily on standards applied at hazardous waste site remediation.

10. Salts: For this category, chloride was selected as the indicator contaminant. The drinking water standard of 250 mg/l was selected as the threshold value.

Zone Based Screening
The first screen applied to eliminate less important sources makes use of the zone concept recommended by PADEP for use in the SWAP:

- Zone A: the critical segment covering ¼ mile on either side of the stream upstream of the intake within a five-hour travel time to the intake. All potential sources within this zone are included in the subsequent steps.

- Zone B: a second segment located within two miles of either side of the stream upstream of the intake, within a 25-hour travel time to the intake. All potential sources within this zone are also included in the subsequent steps.

- Zone C: the rest of the upstream watershed. These sources remain listed in the database, but are eliminated from further analysis because they are deemed less significant than sources in zones A and B.

The PADEP zone concept is used to narrow the list of sources down to those with higher priority. Zone C sources are dropped from further analysis within this preliminary assessment, leaving those sources within zone A or B for the intake.

Multi-Criteria Evaluation (EVAMIX)
Following the zone based screening, the most important screening and evaluation method used for most of the analysis relied on a multi-criteria evaluation software package called EVAMIX. EVAMIX is a matrix-based, multi-criteria evaluation program that makes use of both quantitative and qualitative criteria within the same evaluation, regardless of the units of measure. The algorithm behind EVAMIX is unique in that it maintains the essential characteristics of quantitative and qualitative criteria, yet is designed to eventually combine the results in a single appraisal score. This critical feature gives the program much greater flexibility than most other matrix based evaluation programs, and allows the evaluation team to make use of all data available to them in its original form.

EVAMIX makes a pair by pair comparison of all contaminant sites under evaluations across all evaluation criteria, resulting in thousands of computations. The computations eventually result in an overall appraisal score. This is a single number, attached to a single alternative, and represents the overall worth of that alternative relative to the other alternatives based on the criteria selected, and the weights attached to the criteria. This number is used to determine the final ranking of alternatives from best to worst, or most important to least important.

EVAMIX offers several important advantages when used in planning studies:

- The alternatives under consideration are clearly defined;
- The criteria used in evaluating the alternatives are explicit and measurable;
- The algorithm can handle both quantitative and qualitative data, utilizing all available data to the highest degree of measurability possible;
- The priorities underlying the evaluation are made explicit and can be flexibly applied to highlight the effect that weighting has on the final ranking; the technique is flexible enough to handle new data as it becomes available; and the technique is applied using widely available software (Excel spreadsheets).

The use of EVAMIX requires the development of a two dimensional matrix consisting of the options to be evaluated (columns) and a set of evaluation criteria (rows). For every combination of options and criteria, a score is assigned. The choice of the criteria is governed, in part, by the need for the scoring to be as objective as possible. By objective, we mean that the scores should represent impartial data and information useful in making decisions. The criteria must be clear and unambiguously defined, and can be set up as either quantitative criteria (e.g. threshold concentration in percent, time of travel in hours), or qualitative criteria (e.g. discharge frequency, location etc.).

The other input variable required for the evaluation procedure is the selection of weighting factors for each of the criteria. While the scoring process strives to be as objective as possible and is carried out by the project team, the selection of weights is inherently subjective and should be done by the decision makers, planners, or stakeholders. Unlike the matrix of scores, numerous possible weight sets are possible, and all are equally "valid".

A workshop was held in June 2001, at which members of the Technical Advisory Group participated in exercise designed to develop a representative set of criteria weights. These weights formed the basis for the evaluation.

Point Source Screening

Point source data come from a number of data sources, and each database can contain hundreds of potential sources. Less important point sources needed to be screened out leaving only the most important sources for final ranking. A slightly different screening approach was needed for each type of source because of the data available and the structure of the databases.

The point source screening approaches for each of the main data sources are summarized in this section.

1. PCS Database

This database contained over 500 individual facilities, over 200 of which are wastewater or sewage disposal facilities. These can be divided into major facilities with discharges of more than one MGD and minor facilities with discharges of less than one MGD. Default flows of one MGD for large facilities and 0.1 MGD for small facilities were used along with assumed concentrations based on the site SIC code and existing median concentrations for similar facilities where data were unavailable. The screening approach consisted of calculating potential concentrations of contaminants resulting from each source at the intake, and comparing against threshold values for each contaminant category. The estimated concentration at the intake for each site included in the PCS data was calculated including dilution at the intake but not including decay, volatilization, or die off. If the impact was more than one percent of the threshold, it passed the screen, otherwise it was screened out.

2. CERCLA

There were almost 400 CERCLA sites representing hazardous waste sites of all kinds upstream from the Belmont WTP Intake. These are known sites that have contamination, but cannot easily be fit into a simple point source screening because there is no information on the discharges and concentrations from these sites. For this reason, they must be handled separately in a narrative analysis that uses simple criteria and engineering judgment to determine which sites are of the most concern.

The narrative evaluation considered the following:

- Presence in the floodplain (FEMA 100 year floodplain);
- Location/Distance/Time of travel to the intake;
- National Priority Site Listing (Superfund);
- Status of cleanup at the site;
- Surface Water Migration Score from SCORECARD (www.scorecard.com) representing potential for migration of contamination from the site to surface water, and
- Identified by stakeholders and water suppliers as site of concern.

A site in the floodplain would be a higher priority for protection. However, this ignores that in some cases, storm sewers could transport contamination to a stream. This is a secondary screen. All remaining sites not in the floodplain will be screened out if they are not an NPL site.

Of all the CERLCA sites, 23 sites are part of the National Priority List. Within that group, several were mentioned by stakeholders as sources of concern.

3. RCRA

There are more than 1,500 RCRA facilities in the study area with little actual data on quantities stored or used at the sites. To address this problem, default quantities were assigned. Chemicals used at each facility were estimated based on SIC codes. Where such codes were unavailable, the State Guidance categories were used.

The screening approach for RCRA sites contained several steps:

1. RCRA sites with only Underground Storage Tanks (USTs) were screened out because they pose little threat to the surface waters.

2. RCRA sites that are not UST or Aboveground Storage Tanks (ASTs) were screened using the following guidelines:

    - Floodplain: if the site is not in the floodplain, it is screened out, and
    - If there are no reported spills, violations, or releases according to the Right to Know data, it is screened out.

3. Those sites with ASTs required a separate EVAMIX screening. There were over 300 sites with listed ASTs. The procedure for performing the impact screening relied on EVAMIX and the following screening criteria:

Total Tank Volume: in gallons of total tank volume. Larger tank volume meant a higher priority.

Volume Weighted Chemical Ranking: an additive score representing the types of chemicals stored onsite, each weighted by the percent of total tank volume used to store that category of contaminant. In this case, the chemicals are rated according to their impact on the treatment system and the ease with which the current treatment can handle the contaminant in the raw water. This results in a ranking of contaminant categories in order of decreasing importance to the treatment process with points assigned as follows: VOCs/SOCs (ten), Crytosporidium (nine), Metals (eight), Petroleum Hydrocarbon (seven), Nitrate (six), TSS (five), Chloride (four), TOC/DBP precursors (three), Phosphorus (two), Fecal Coliform (one). Each contaminant category gets a score (ten for VOCs, nine for Cryptosporidium etc. down to one for Fecal Coliform. For each category, the rank number is multiplied by the fraction of total tank volume of that contaminant to the total tank volume onsite. The weighted categories are then added up. For example, a site with VOCs (10,000 gal tank) and salts (90,000 gal) would score 10 x 0.1 + 4 x 0.9 = 4.6.

Leaks Reported: a qualitative score of one for a leak, a score of zero for no leak.

Tank Age: a quantitative score in years after date of installation.

Location: a qualitative score that checks if the site is within floodplain or not (score of three), in Zone A (score of two), or in Zone B (score of one).

Travel Time: a quantitative score in hours based on the time of travel from the site to the intake using peak flows.

The criteria were weighted based on the results of the Technical Advisory Group and discussions with the project team. The weights are:

- Tank Age: 12%
- Total Tank Volume: 36%
- Vol. Weighted Chemical Ranking: 15%
- Leak History: 10%
- Location: 21%
- Travel Time: 5%

The screening of RCRA sites resulted in two lists of sites moving through the screen: non-AST sites that reported spills and are within floodplain, and ASTs that pass the EVAMIX screening.

4. TRI Sites

There are over 200 TRI sites that manufacture or use toxic chemicals. These sites, however, do not discharge contaminants. The database lists the contaminants onsite, including: VOCs, metals, nutrients, and chloride. To focus on the high priority sites, an EVAMIX screening was required, base on the following criteria:

Location: if in flood plain (three points), zone A (two points) or zone B (onw point):

Chemicals Listed: a score was given based on the acute effects on health of each contaminant category, resulting in the following scores: VOCs/SOCs (ten), Crytosporidium (nine), Metals (eight), Petroleum Hydrocarbon (seven), Nitrate (six), TSS (five), Chloride (four), TOC, /DBP precursors (three), Phosphorus (two), Fecal Coliform (one). For sites with more than one category, the scores were the sum of the rank of chemicals listed (e.g. a site with VOCs and Metals would score 10 + 8 = 18).

Amount Stored: based on the range listed in the database, in kg per year

Number of releases to water: total number of releases in database

Travel Time: the time of travel from a spill at the site to the intake.

Criteria weights were applied within the EVAMIX screening as follows:

- Location: 15
- Chemicals Listed: 20
- Amount Stored: 35
- Number of releases to water: 25
- Travel Time: 5

Non-point Sources Runoff Screening
Potential non-point sources were identified using the SWMM model and Event Mean Concentrations (EMCs) to calculate total annual pollutant loading for each subwatershed.

Because there are over 150 subwatersheds, EVAMIX screening was applied using three criteria. These were:

Relative Impact at Intake (weight 60%):

This criterion is based on the concentration of contamination potentially caused by the source at the intake as a percent of the contaminant category threshold value. Since there are potentially ten values, one for each contaminant category, only the highest ranked category or greatest relative impact chemical category was used for this criterion.

Time of Travel (weight 20%):

This is a criterion calculated as the time of travel from source to intake, based on high flow velocity.

Location (weight 20%):

This criterion scored watersheds as two if in Zone A, and one if in Zone B.

The highest ranked subwatersheds passed through to the full ranking of sources.

Source Priorities: Full Evamix Ranking of All Sites
Finally, all the significant (those that passed the screening) point sources and runoff loads (entered as pseudo point sources) were prioritized, accomplishing the main goal of the assessment. There were two types of final rankings. The first ranking was a combined ranking of sites from all categories, compared against each other. The second ranking was by contaminant type, with all significant sources contributing to a particular contaminant category included.

Multi-criteria Ranking using EVAMIX: Combined Sources
EVAMIX was used to rank all sources over the entire range of contaminant categories. Full ranking allowed us to compile a final list of sources, independent of contaminant class. The following criteria were used:

Relative Impact at Intake (weight 12%):

This criterion is based on the concentration of contamination potentially caused by the source at the intake as a percent of the contaminant category threshold value. Since there are potentially ten values, one for each contaminant category, only the highest-ranked category or greatest relative impact chemical category was used for this criterion.

Time of Travel (weight 5%):

This is a criterion calculated as the time of travel from source to intake, based on high flow velocity.

Potential for Release/Controls (weight 14%):

This was developed using the qualitative categories taken from the State SWAP guidelines.

High: no control practices, or a regulated discharge not in compliance with regulations (four points)

Medium/High: a non-point source with no BMP in place, or regulated discharge and in compliance with regulations (three points)

Medium: a non-point source with BMP in place, or a point source not regulated but contained in some way (retaining wall, double-walled tank etc.) with no emergency response plan (two points)

Low: a regulated point source by the State, containment, and/or emergency response plan (one point)

Potential Release Frequency (weight 14%):

A qualitative criterion based on following scores:

Very High: a continuous discharger, five points

High: an intermittent or rainfall related (CSO, SSO, NPS) discharger, four points

Medium: a discharge with roughly a monthly frequency, three points

Low: a discharge with roughly an annual frequency, two points

Very Low: a discharge that occurs only as a catastrophic spill, or a storm related discharge with about a 100-year occurrence frequency, one point

Violation Type/Frequency (10%):

A qualitative criterion based on the following scoring:

High: Operation or Effluent Violations, three points

Medium: Management Violations, two points

Low: Administrative Violations or none, one point

In this case, points are cumulative for each violation within the last three years in each category. For example two violations for not filing paperwork (2 x 1) plus an effluent violation (three points) would result in a score of five points.

Location (weight 5%):

A qualitative criterion based on GIS analysis according to the following categories:

In the Floodplain: three points

In Zone A: two points

In Zone B: one point

Existing Removal Capacity (weight 10%):

A criterion with qualitative scoring based on the chemical released and the ability of the existing treatment to remove it. Scoring was according to the following system:

Not removed (salts, radionuclides, nitrates): three points

Limited removal (*Cryptosporidium*, SOCs, VOCs, Petroleum Hydrocarbons, Phosphorus, TOC): two points

High removal (fecal coliform, TSS, metals): one point.

Scores were cumulative for each category present at the site.

Impact on Treatment Operation (weight 10%):

A criterion with qualitative scoring based on chemical released and its impact to the operation of the treatment systems in place. Scoring was according to the following system.

High (TSS, VOCs, Petroleum Hydrocarbon): four points

Medium/High (metals, TOC): three points

Medium (*Cryptosporidium*, nitrate, phosphorus): two points

Low (fecal coliform, chloride, radionuclides): one point

The score is cumulative over all categories present.

Potential Health Impacts (weight 20%):

A criterion with qualitative scoring based on the contaminant released and its potential acute impact on health if not removed. Scoring was according to the following system:

High (*Cryptosporidium*, SOCs, VOCs, radionuclides, fecal coliform): three points

Medium (TOC, metals, nutrients, nitrate): two points

Low (salts, TSS, phosphorus): one point

The score is cumulative over all categories present.

This ranking resulted in a single list of sources for the intake showing high, medium, and low priority sources from all categories.

EVAMIX Ranking by Contaminant Category
Ranking by contaminant category was completed using six criteria and the multi-criteria evaluation program EVAMIX. Criteria (with weights from the June 2001 Technical Advisory Group Meeting) are given below.

Relative Impact at Intake (weight 40%):

This criterion is based on the concentration of contamination potentially caused by the source at the intake as a percent of the contaminant category threshold value.

Time of Travel (weight 5%):

This is a criterion calculated as the time of travel from source to intake, based on high flow velocity.

Potential for Release/Controls (weight 20%):

This was developed using the qualitative categories taken from the State SWAP guidelines.

High: no control practices, or a regulated discharge not in compliance with regulations (four points)

Medium/High: a non-point source with no BMP in place, or regulated discharge and in compliance with regulations (three points)

Medium: a non-point source with BMP in place, or a point source not regulated but contained in some way (retaining wall, double walled tank etc.) with no emergency response plan (two points)

Low: a regulated point source by the state, containment and/or emergency response plan (one point)

Potential Release Frequency (weight 15%):

A qualitative criterion based on following scores:

Very High: a continuous discharger, five points

High: an intermittent or rainfall related (CSO, SSO, NPS) discharger, four points

Medium: a discharge with roughly a monthly frequency, three points

Low: a discharge with roughly an annual frequency: two points

Very Low: a discharge that occurs only as a catastrophic spill, or a storm related discharge with about a 100-year occurrence frequency, one point

Violation Type/Frequency (weight 15%):

A qualitative criterion based on the following scoring:

High: Operation or Effluent Violations, three points

Medium: Management Violations, two points

Low: Administrative Violations or none, one point

In this case, points are cumulative for each violation within the last three years in each category. For example two violations for not filing paperwork (2x1) plus an effluent violation (three points) would result in a score of five points.

Location (weight 5%):

A qualitative criterion based on GIS analysis according to the following categories:

In the Floodplain: three points

In Zone A: two points

In Zone B: one point

Results from each of the ten contaminant categories based evaluations resulted in a listing of high, medium, and low priority sites for that contaminant category.

Final Ranking Categories

The final results of the rankings are broken down into six major categories according to the PADEP's SWA Plan. These are represented by designations A through F with A representing sources of highest protection priority and gradually decreasing to F for sources of lowest protection priority. This designation process was initially designed for intakes with a limited number of sources where the whole inventory could be ranked. However, given the large number of sources and the ranking process, sources that are represented by designations D through F were screened out in the significance screening process. Therefore, the sources ranked in the document are considered potentially significant sources of contamination and will fall into categories A through C. They are described in Table 3.2.4-1. The numbers indicated on the map correspond to identification numbers for the various sources in the tables.

Table 3.2.4-1 Contaminant Source Ranking Designations

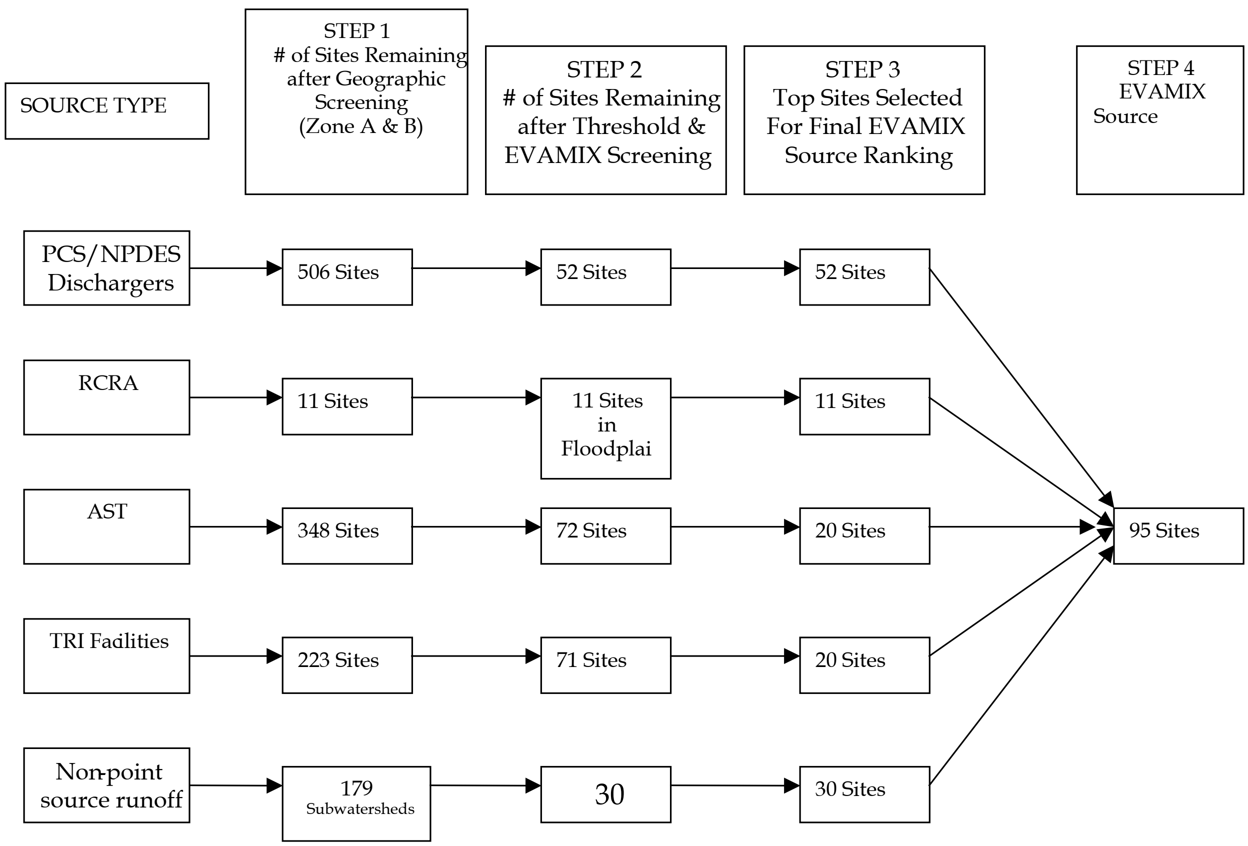
Designation	Description
Potentially Significant Sources of Contamination to Water Supply	
A	Potentially Significant Source of Highest Protection Priority
B	Potentially Significant Source of Moderately High Protection Priority
C	Potentially Significant Source of Moderate Protection Priority
Remaining Sources From Inventory Screened Out By Significance Screening Criteria	
D	Potential Source of Moderately Low Protection Priority
E	Potential Source of Low Protection Priority
F	Potential Source of Lowest Protection Priority

As shown, the sources in categories A through C may require additional ground-truthing in order to provide a more accurate designation of their significance. Sources in category D though not considered potentially significant may need to be evaluated as more information becomes available that may make them more potentially significant.

3.2.4.2 Results

Figure 3.2.4-2 is a flow diagram of the screening and ranking process. The process was used to successively select the most important sites from each of the databases available, and combine them in an organized manner to produce a final list of high priority sites. The process can be compared to a playoff elimination process, with various divisions providing a set number of teams to the overall playoff. Like such playoff structures, it can occur that a site will not be included in the final list because it was eliminated in competition with other sites within its categories. (To follow the analogy, the fourth best team in a division is not invited to the playoffs, even if it is better than the third best team from another, weaker division, because only the top three teams are invited from each division.) Despite this fact, the process does provide the top sites from each database category, and provides valuable insight into the relative importance of category of sites.

Figure 3.2.4-2 Screening and Ranking Process



Enough sites were included from each category to make sure that no highly ranked sites would be overlooked.

The diagram shows that there were several screening steps (or elimination rounds) leading to the final ranking. These are described briefly below.

Zone Based Screening
The lists of potential sources of contamination started with all of the sites included in the PCS, RCRA, AST, and TRI databases. Once all had been located and coordinates assigned, those in Zone C were eliminated from consideration. This left 506 sites from the PCS database (essentially those with a surface water discharge permit), 348 sites listed with above ground storage tanks (ASTs), and 223 facilities from the TRI database (sites that generate or handle toxic chemicals). In addition, all of the subwatersheds that are upstream of the intake and within the travel times of Zone A or B were also included (179 subwatersheds). RCRA sites that only had underground storage tanks were also

eliminated. It was decided that only RCRA sites located within the floodplain were of concern in this round of analysis, and the 11 sites that met this condition were included in the analysis.

Database Based Screening
The zone based screening still left over 1,000 sites that needed to be screened further to a manageable number. This was done either by simple threshold screening, based on the amount of contaminants stored or used, or by a more complex evaluation using several criteria.

Threshold Based Screening
For one of the categories, (PCS) simple threshold screening was an effective approach for screening.

PCS Sites: As described in section 3.2.4.1, the percent change in the concentration of a chemical at the intake due to releases from each site could be roughly estimated, and this was used to screen the 506 PCS (NPDES) sites. This threshold screening was performed to select the largest dischargers. A cutoff of a 1 percent change in concentration at the intake was used as the threshold percentage. The percent change was based on the assumed or actual discharger load being input at the intake. Assuming the load was at the intake was considered to be a conservative approach. Of the 506 sites, only 52 sites could potentially affect concentrations at the intake by more than one percent. Most of the others were much too small to have a measurable impact and were eliminated from further analysis.

Criteria Based Screening
For the AST sites, TRI sites, and the subwatersheds (stormwater pollutant loading), a more sophisticated approach was required to adequately select the most important sites from each category. Several criteria were used, along with the multi-criteria evaluation program EVAMIX to perform each of these screening analyses. Sites were ranked in descending order of importance, and the top sites were selected based on the results of the ranking.

AST Sites: EVAMIX screening resulted in a ranking of all the sites based on six criteria. The criteria were age of the tank, storage volume of the tank, chemical ranking based on the mix of chemicals onsite, whether there have been leaks in the past, the location relative to the river, and the travel time to the intake (see section 3.2.4.1 for details). From the 348 sites, the 72 highest ranked sites passed the screen, and the top 20 sites were included in the final ranking. AST sites in general scored low in comparison to the other types of sites, and fewer were included to allow more room for TRI, PCS, and subwatersheds (NPS or non-point sources). The results of the final ranking (Table 3.2.4 - 1) confirmed that most AST sites had very low rankings.

TRI Sites: EVAMIX screening resulted in a ranking of all the TRI sites based on five criteria. The criteria were amount of chemical stored, chemical ranking based on the mix of chemicals onsite, whether or not releases to water have been reported, the location relative to the river, and the travel time to the intake (see section 3.2.4.1 for details).

From the 223 sites, 71 sites passed through the screening procedure, and the 20 highest ranked sites were used in the final ranking.

NPS Subwatersheds: There were 179 subwatersheds that could be considered to be within the Queen Lane intake's zone A or B. A screening of these 179 subwatersheds for their potential impact due to stormwater pollutant loading was performed using EVAMIX and three criteria. The first criterion was the relative impact, measured as the expected concentration from the pollutant runoff at the intake, divided by the threshold number for that contaminant category. Because there were nine contaminant categories relevant to stormwater runoff, the highest relative threshold was used (excluding fecal coliform). The other two criteria were location and time of travel to the intake. The subwatersheds or NPS sources were relatively important, and the 30 highest ranked subwatersheds were included in the final ranking.

Source Priorities: Full EVAMIX Ranking of All Potential Sources
All of the significant point sources and runoff loads (entered as pseudo-point sources) that passed the screening process were lumped together for a final ranking, once again using EVAMIX. There were 132 mixed sites. Because EVAMIX can only handle evaluations of fewer than 100 sites, the final screening occurred in two steps, eventually producing a list of the top 95 sites for the Queen Lane Intake. This important, final ranking of the mixed group of sites used the nine criteria described above in section 3.2.4.1. The criteria weights were those established during the Technical Advisory Group workshop.

Relative Impact at Intake (weight 12%)

Time of Travel (weight 5%):

Potential for Release/Controls (weight 14%):

Potential Release Frequency (weight 14%):

Violation Type/Frequency (weight 10%):

Location (weight 5%):

Existing Removal Capacity (weight 10%):

Impact on Treatment Operation (weight 10%):

Potential Health Impacts (weight 20%):

Table 3.2.4 -2 lists the 95 point sources and non-point sources that passed the screening. The table is organized into roughly three groups of sites in descending order of priority as calculated by EVAMIX. The table has eight columns.

Column 1: Source ID code: a unique database source code

Column 2: Source Name, the name as listed in the database

Column 3: Primary database containing information about the source used in the analysis

Column 4: Point Source subwatershed (NPS)

Column 5: Zone (either A or B)

Column 6: Estimated time of travel to the intake under high flow conditions

Column 7: Relative impact at the intake

Column 8: The priority group (A is highest, B next highest, and C lowest) based on nine criteria and selected criteria weights

Table 3.2.4-2 Final Ranking of Sources for Combined Contaminant Categories

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	9.9	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	9.6	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	29.4	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	4.0	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.7	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	7.5	Highest-A
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	15.5	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	16.0	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	891.4	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	6.4	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	11.8	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	8.6	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	12.2	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	18.1	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.2	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.2	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	4.5	Highest-A
3800	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	2.8	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.2	Highest-A
3787	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	2.4	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.2	Highest-A
3804	Stony Creek-024	NP	Stony Creek	Zone A	7.0	7.7	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	5.2	Highest-A
3807	Trout Creek-027	NP	Trout Creek	Zone A	8.0	4.2	Highest-A
3788	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	10.8	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.2	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	1.5	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3789	Sandy Run-009	NP	Sandy Run	Zone A	8.7	3.4	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	1.7	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	6.3	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.2	Moderately High-B
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	9.4	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.2	Moderately High-B
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	12.7	Moderately High-B
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	13.1	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.2	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	5.8	Moderately High-B
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	143.0	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.2	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	1.7	Moderately High-B
3815	Valley Creek-035	NP	Valley Creek	Zone B	11.1	4.6	Moderately High-B
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	3.4	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.2	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	26.7	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	2.7	Moderately High-B
3934	Schuylkill River-154	NP	Schuylkill River	Zone B	15.0	3.1	Moderately High-B
3827	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	3.6	Moderately High-B
3944	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	4.5	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.2	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	9.6	Moderately High-B
3973	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	4.8	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	1.5	Moderately High-B
3838	Mill Creek-058	NP	Mill Creek	Zone B	26.1	4.4	Moderately High-B
3839	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	4.3	Moderately High-B
3948	Manatawny Creek-168	NP	Manatawny Creek	Zone B	26.8	4.8	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.2	Moderately High-B
3840	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	27.3	8.0	Moderately High-B
3841	Morris Run-061	NP	Morris Run	Zone B	29.2	6.4	Moderately High-B
3843	East Branch Perkiomen Creek-063	NP	East Branch Perkiomen Creek	Zone B	29.8	4.3	Moderately High-B
4018	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	6.8	Moderately High-B
3985	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	4.5	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.2	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.2	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.2	Moderately High-B
3989	Plum Creek-209	NP	Plum Creek	Zone B	34.6	11.0	Moderate-C
4062	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	13.3	Moderate-C
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.2	Moderate-C
4023	Willow Creek-243	NP	Willow Creek	Zone B	37.1	7.2	Moderate-C
4063	Irish Creek-283	NP	Irish Creek	Zone B	37.6	15.8	Moderate-C
4066	Pigeon Creek-286	NP	Pigeon Creek	Zone B	39.2	8.0	Moderate-C
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	1.7	Moderate-C
4065	Lesher Run-285	NP	Lesher Run	Zone B	40.2	5.4	Moderate-C
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.2	Moderate-C
4069	Schuylkill River-289	NP	Schuylkill River	Zone B	40.7	10.45	Moderate-C
4067	Mill Creek-287	NP	Mill Creek	Zone B	40.7	10.26	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.17	Moderate-C
4110	Little Schuylkill River-330	NP	Little Schuylkill River	Zone B	45.1	5.39	Moderate-C
4075	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	8.86	Moderate-C
4074	Pine Creek-294	NP	Pine Creek	Zone B	47.6	9.21	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.17	Moderate-C
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	1.71	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	1.71	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Flood Plain	21.4	6166	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	23.6	34067	Moderate-C
3178	MALVERN TERM	AST	Little Valley Creek	Zone B	15.4	15566041	Moderate-C
2228	HENKEL CORP.	TRI	Wissahickon Creek	Zone B	10.6	1202	Moderate-C
2191	LONZA INC.	TRI	Schuylkill River	Flood Plain	4.5	15206	Moderate-C
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	3.5	3234	Moderate-C
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	26.2	5978	Moderate-C
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Flood Plain	3.5	1255	Moderate-C
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Flood Plain	19.0	55978	Moderate-C
2352	DANA CORP. PARISH DIVISION	TRI	Schuylkill River	Zone B	31.5	144641	Moderate-C
2185	FINNAREN & HALEY INC.	TRI	Schuylkill River	Flood Plain	3.5	2178	Moderate-C
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	13.5	4992	Moderate-C
2219	HONEYWELL INC. PROCESS CONTROL DIV.	TRI	Sandy Run	Zone A	12.5	1270592	Moderate-C

The final results of the rankings are broken down into six major categories according to the PADEP's SWA Plan. These are represented by designations A through F with A representing sources of highest protection priority and gradually decreasing to F for sources of lowest protection priority. This designation process was initially designed for intakes with a limited number of sources where the whole inventory could be ranked. However, given the large number of sources and the ranking process, sources that are represented by designations D through F were screened out in the significance screening process. Therefore, the sources ranked in the document are considered potentially significant sources of contamination and will fall into categories A through C.

As shown, the sources in categories A through C may require additional ground truthing in order to provide a more accurate designation of their significance. Although not considered to be potentially significant, sources in category D may need to be evaluated as more information becomes available.

The results provide significant insight into the relative threat that various types of sources might have on the water quality at the intake. The key results are:

- All of the highest ranked sites are either NPDES sites from the PCS database or stormwater pollutant loading represented by various sub-watersheds. Twenty-four of the 30 highest ranked sites are NPDES sites.

- Stormwater or NPS loading appears to also represent a high priority. Stormwater loadings are of comparable magnitude to those from the NPDES sites in general, although they are not continuous discharges.

- TRI sites are generally ranked lower. There are no TRI sites in the top 50 sites, and all TRI sites are found in the "C" or moderate protection priority category.

- RCRA sites, with or without ASTs are generally ranked the lowest of all the types of potentially significant sites. RCRA sites did not make it into the top 95 site list.

- Results indicate that with a balanced assessment, those contaminant sources that are actually discharging to the river (NPDES permitted point sources or stormwater runoff) represent the greatest concern. Those with only the potential to release contaminants through spills or leaks (TRI, RCRA, AST) are generally given a lower priority.

- Despite the low overall rankings, the highest potential relative impacts appear to occur with the TRI and AST sites. The relative impact numbers show that, were a catastrophic spill or leak to occur at these highly ranked sites, concentrations at the intake could be potentially very high. Therefore, emergency planning activities should focus on these facilities.

- Health Impacts, as scored in the assessment, had a large influence on the resulting rankings, with those sites ranked high on potential health impacts coming out in the general ranking as important sites.

- Treatment Impacts were also important in the final rankings, with those sites scoring high on potential impact to the treatment process often tending toward a higher ranking in the overall assessment.

- The geographic distribution of significant sources showed that most of the category A sources were from nearby drainage areas of the Wissahickon Creek and Schuylkill River below Phoenixville. Approximately 75% of the potentially significant sources (categories A-C) were located in the Wissahickon Creek, Perkiomen Creek, and Schuylkill River drainage areas. Given the known influence on Queen Lane Intake water quality by the Wissahickon Creek, the sources identified in the Wissahickon Creek should be given the greatest protection priorities.

- A comparison of the types of sources indicated by the ranking process with the sources indicated by analysis of water quality data and impaired stream information (see section 3.1.5) corroborates that NPDES discharges and polluted runoff (non-point sources) from developed areas are the most important sources of influence on water quality at the PWD Queen Lane Intake.

The rankings provided in Table 3.2.4-2 are based on a careful evaluation of existing data in the databases described in section 3.2.2. They are only as accurate as the data provided, and serve as a good starting point for data collection and field "ground truthing" of these sites.

Figure 3.2.4-3 is a map of the site locations for point sources and subwatersheds in the Lower Schuylkill Watershed that scored highest in the ranking process. Figure 3.2.4-4 shows the point sources and subwatersheds in the upper part of the watershed that scored the highest in the ranking process.

Figure 3.2.4-3 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake in the Lower Schuylkill River Watershed

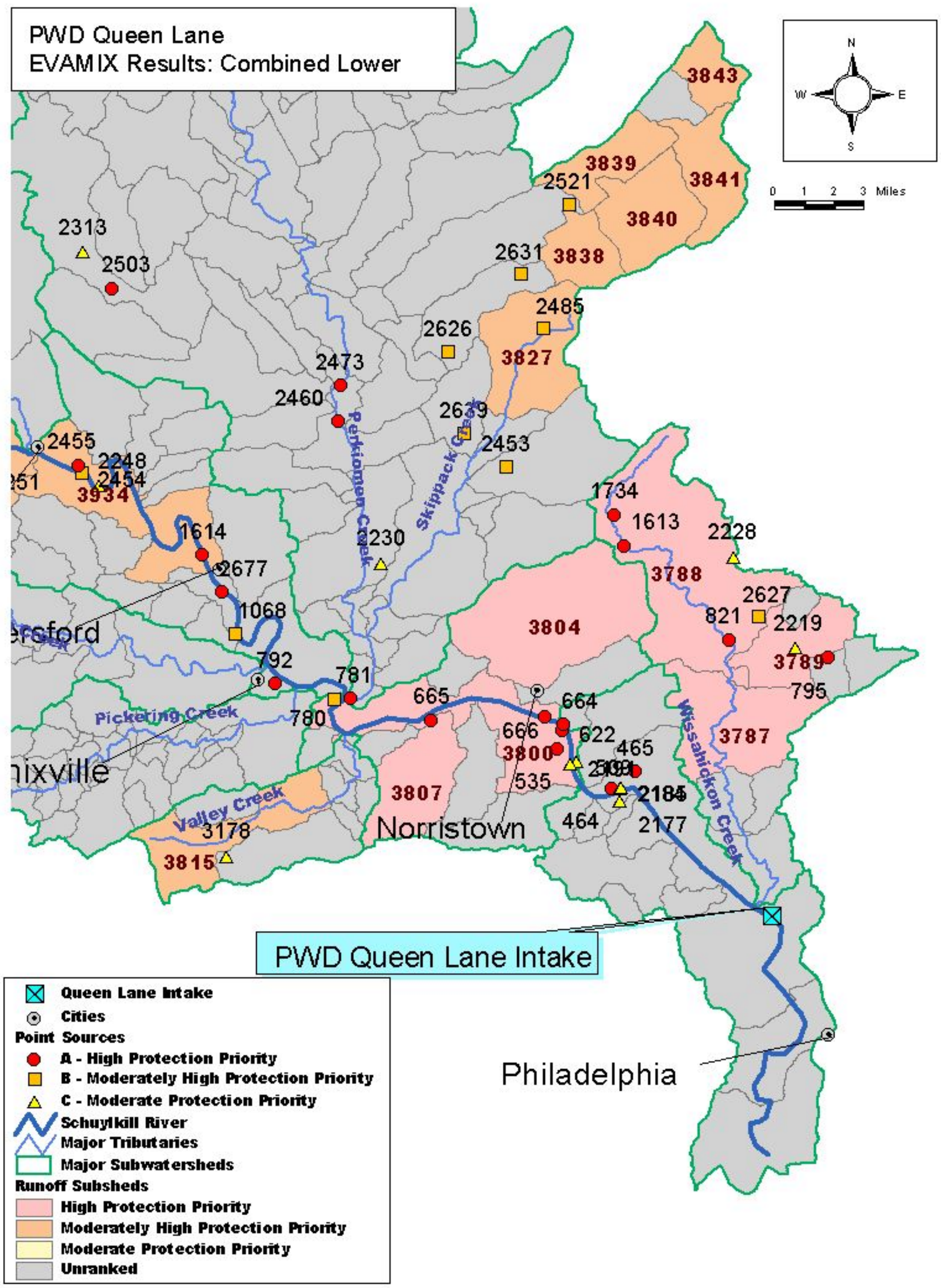
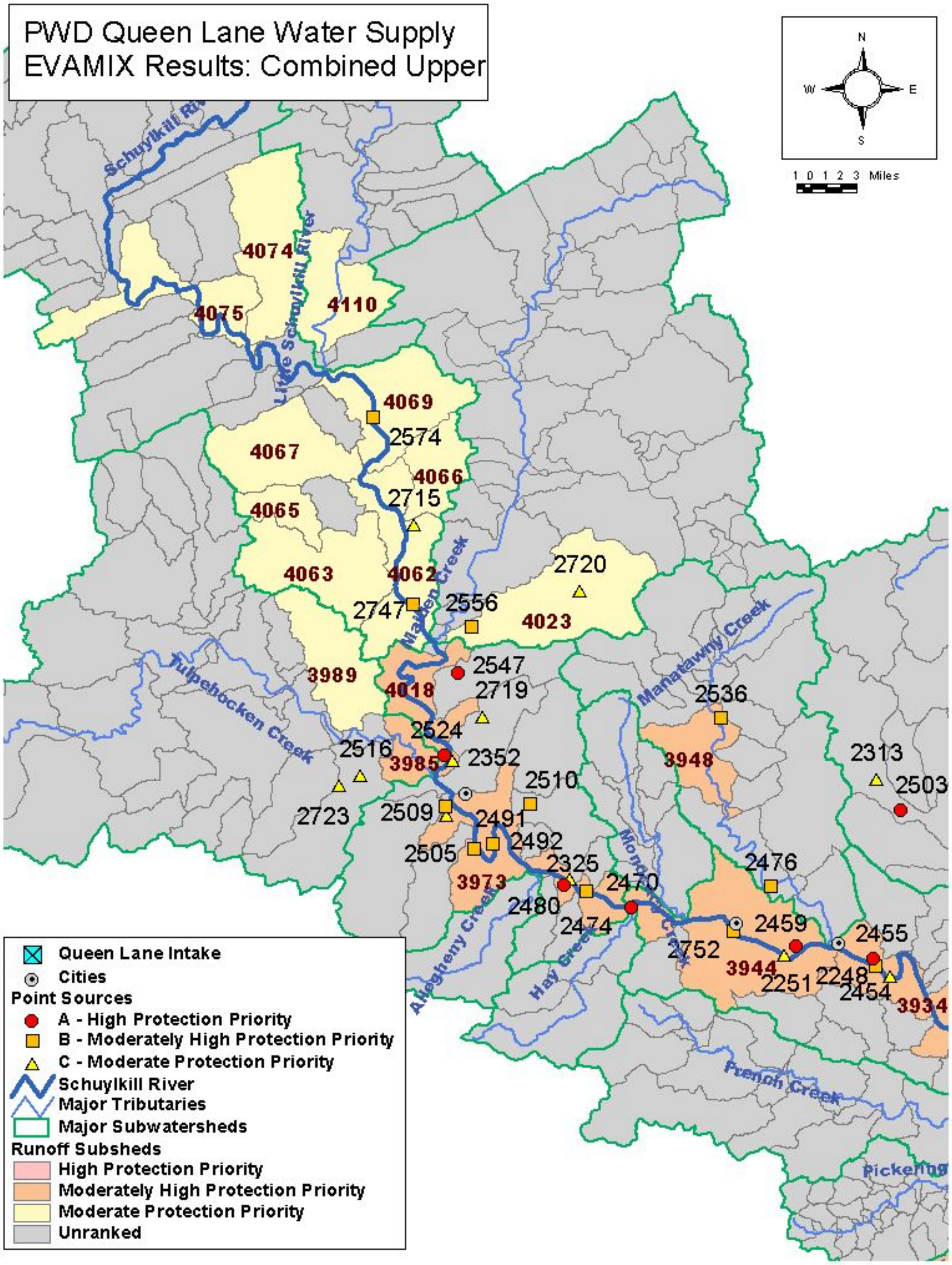


Figure 3.2.4-4 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake in the Upper Schuylkill River Watershed



EVAMIX Ranking by Contaminant Category

The extensive screening of sites done for the combined ranking was not suitable for use in the contaminant-by-contaminant evaluation. The screening was done in part based on the types of chemicals stored, and thus could conceivably screen out numerous sites for a given contaminant simply because that contaminant is less critical than another contaminant. For those contaminant categories where the number of sites was too large, a simple threshold screening was performed based on the potential concentration of the contaminant from that source at the intake. In general, the following approach was used for selecting sites from each category for final ranking by contaminant category:

- Approximately 50 sites from the PCS database were included (all the major dischargers);
- All 11 RCRA sites were included; and
- The top ranked 20 sites each from the TRI and AST databases, and the top 30 NPS sites were included.

Ranking by contaminant category was completed using EVAMIX and six criteria (weights were provided by the Technical Advisory Group at the June, 2001 workshop):

Relative Impact at Intake (weight 40%)

Time of Travel (weight 5%)

Potential for Release/Controls (weight 20%)

Potential Release Frequency (weight 15%)

Violation Type/Frequency (weight 15%)

Location (weight 5%)

Tables 3.2.4-3 through 3.2.4 -12 provide the rankings of the primary potential sources of each contaminant group. Each table has eight columns:

Column 1: Source ID code: a unique database source code

Column 2: Source Name, the name as listed in the database

Column 3: Primary database containing information about the source used in the analysis

Column 4: Point Source subwatershed (NPS)

Column 5: Zone (either A or B)

Column 6: Estimated time of travel to the intake under high flow conditions

Column 7: Relative impact at the intake

Column 8: Relative priority groupings based on nine criteria and selected criteria weights

Salts

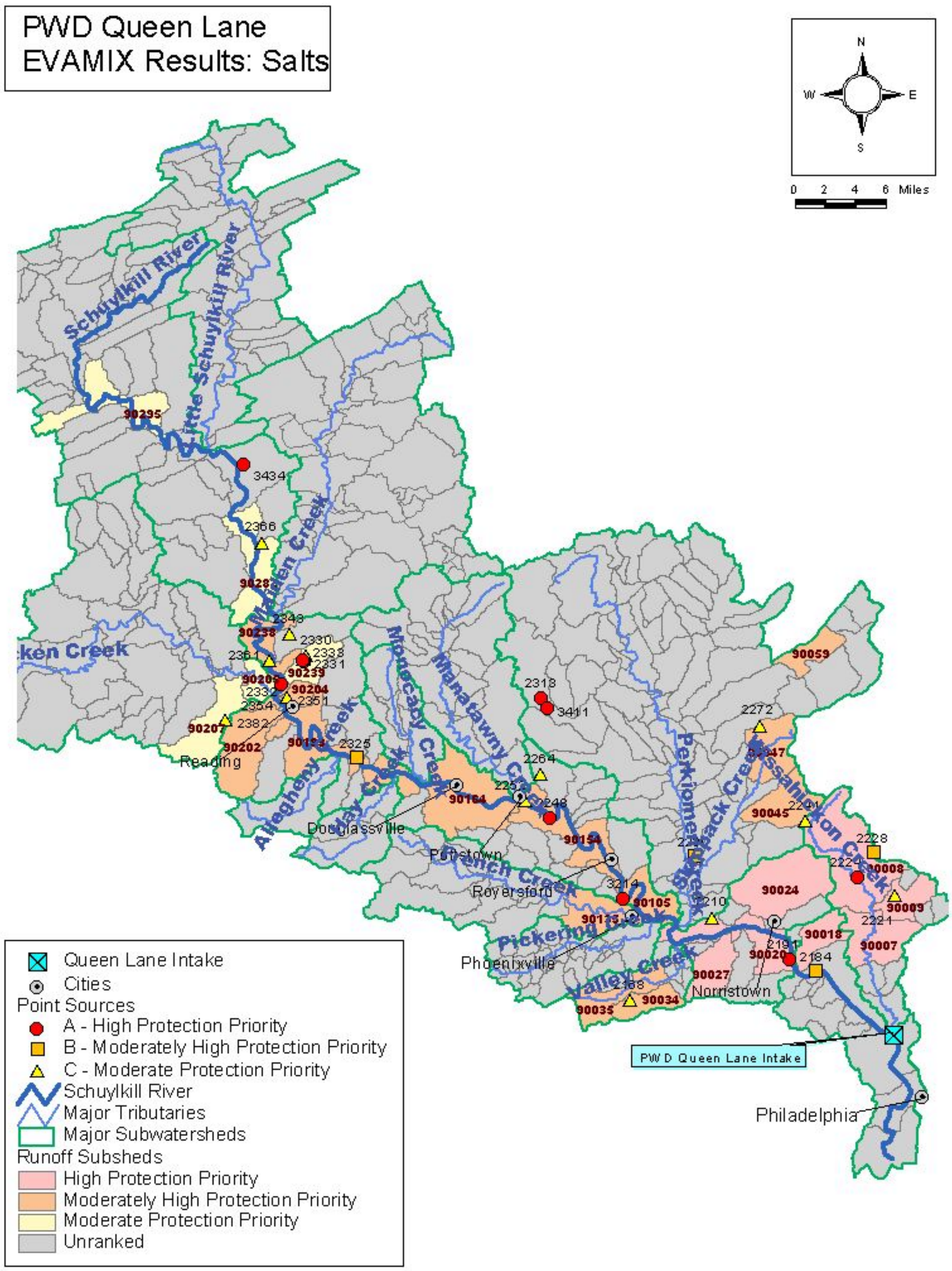
Table 3.2.4-3 shows the results of the ranking for salts, as represented by estimated sources of chloride. The table indicates that the major sources of chlorides are either stormwater runoff from urbanized watersheds, or potential releases of industrial salts from industrial sites as represented by sites listed in the TRI or AST database. It should be noted that neither type of source appears to provide sufficient loading to cause water quality impairments at the intake, but during winter periods, the combined runoff may have some impacts. Geographically most of the highest protection priority subwatersheds were located in Trout, Stony and Wissahickon Creeks, and along the downstream part of the Schuylkill River, as shown by Figure 3.2.4-5.

Table 3.2.4-3 Contaminant Category Ranking for Salts (Chloride)

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	23.6	4.15	Highest-A
2333	GENERAL BATTERY CORP. READING SMELTER DIV.	TRI	Bernhart Creek	Flood Plain	33.0	1.37	Highest-A
2191	LONZA INC.	TRI	Schuylkill River	Flood Plain	4.5	0.05	Highest-A
3214	PHOENIXVILLE WTP	AST	Schuylkill River	Flood Plain	13.5	1.89	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	0.03	Highest-A
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	4.5	0.02	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	0.02	Highest-A
3411	BOYERTOWN WWTP	AST	Swamp Creek	Zone B	23.1	2.22	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	0.02	Highest-A
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	0.03	Highest-A
90027	Trout Creek-027	NP	Trout Creek	Zone A	8.0	0.02	Highest-A
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Flood Plain	19.0	0.07	Highest-A
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	0.02	Highest-A
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	31.5	0.46	Highest-A
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	42.3	2.33	Highest-A
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Flood Plain	33.0	0.10	Highest-A
2224	RHONE-POULENC AG CO.	TRI	Wissahickon Creek	Flood Plain	10.0	0.48	Highest-A
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	26.2	0.26	Moderately High-B
2228	HENKEL CORP.	TRI	Wissahickon Creek	Zone B	10.6	0.05	Moderately High-B
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	10.5	0.01	Moderately High-B
90035	Valley Creek-035	NP	Valley Creek	Zone B	11.1	0.01	Moderately High-B
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	12.2	0.01	Moderately High-B
90135	French Creek-135	NP	French Creek	Zone B	12.1	0.01	Moderately High-B
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	13.5	0.02	Moderately High-B
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	15.0	0.01	Moderately High-B
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	16.0	0.01	Moderately High-B
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	0.01	Moderately High-B
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	0.01	Moderately High-B
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	0.02	Moderately High-B
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Flood Plain	3.5	0.14	Moderately High-B
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	0.01	Moderately High-B
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	31.0	0.02	Moderately High-B
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	0.02	Moderately High-B
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	31.0	0.01	Moderately High-B
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	0.01	Moderate-C
90239	Bernhart Creek-239	NP	Bernhart Creek	Zone B	32.5	0.01	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	0.01	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	0.01	Moderate-C
2168	WORTHINGTON STEEL CO.	TRI	Little Valley Creek	Flood Plain	13.8	0.08	Moderate-C
2332	EXIDE CORP. READING SLI	TRI	Bernhart Creek	Flood Plain	33.0	0.30	Moderate-C
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	0.01	Moderate-C
2252	POTTSTOWN PLATING WORKS INC.	TRI	Schuylkill River	Flood Plain	20.0	0.03	Moderate-C
2343	NGK METALS CORP.	TRI	Laurel Run	Flood Plain	34.1	0.07	Moderate-C
2210	GMT MICROELECTRONICS CORP	TRI	Schuylkill River	Zone B	7.5	0.01	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	13.8	0.05	Moderate-C
2221	NOVARTIS CONSUMER HEALTH INC.	TRI	Sandy Run	Zone B	14.4	0.01	Moderate-C
2272	H. W. LONGACRE INC.	TRI	Skippack Creek	Zone B	18.0	0.05	Moderate-C
2264	STEEL PROCESSING INC. POTTSTOWN INDL. COMPLEX	TRI	Sprogles Run	Zone B	20.0	0.01	Moderate-C
2351	CROMPTON & KNOWLES COLORS INC.	TRI	Schuylkill River	Zone B	31.0	0.14	Moderate-C
2330	YUASA EXIDE INC	TRI	Bernhart Creek	Zone B	33.6	0.06	Moderate-C
2361	INDUSTRIAL METAL PLATING INC.	TRI	Schuylkill River	Zone B	32.5	0.01	Moderate-C
2382	HOFFMANN IND. INC.	TRI	Cacoosing Creek	Zone B	36.0	0.02	Moderate-C
2366	BRUSH WELLMAN INC.	TRI	Schuylkill River	Zone B	38.7	0.04	Moderate-C

Figure 3.2.4-5 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Salts in the Schuylkill River Watershed



Cryptosporidium

Table 3.2.4-4 shows the results of the ranking for pathogens, as represented by estimated sources of *Cryptosporidium*. The table indicates that the only sources of pathogens are either stormwater runoff from agricultural or urbanized watersheds, and permitted discharges from wastewater treatment plants. Only the NPDES sites are represented in the high protection priority category (category A). Most sources appear to be relatively minor contributors. Geographically, a larger number of sources from farther upstream into the Reading and Berks County areas were included as compared to other contaminant categories. Another potentially significant source that could not be properly inserted into this analysis are the 11 communities upstream with combined sewer overflow systems. The overflows of raw sewage during wet weather events was roughly estimated and compared to the other potentially significant sources. Based on this analysis the CSO discharges from the communities of Bridgeport and Norristown would be considered potentially significant sources of highest protection priority as well (category A). The remaining nine communities including Minersville, Tamaqua, and Greater Pottsville in Schuylkill County would be considered moderate protection priority sites (category C) since they are much further away from the intake. Figure 3.2.4-6 illustrates the priority point sources and subwatersheds for *Cryptosporidium* in the Schuylkill River Watershed.

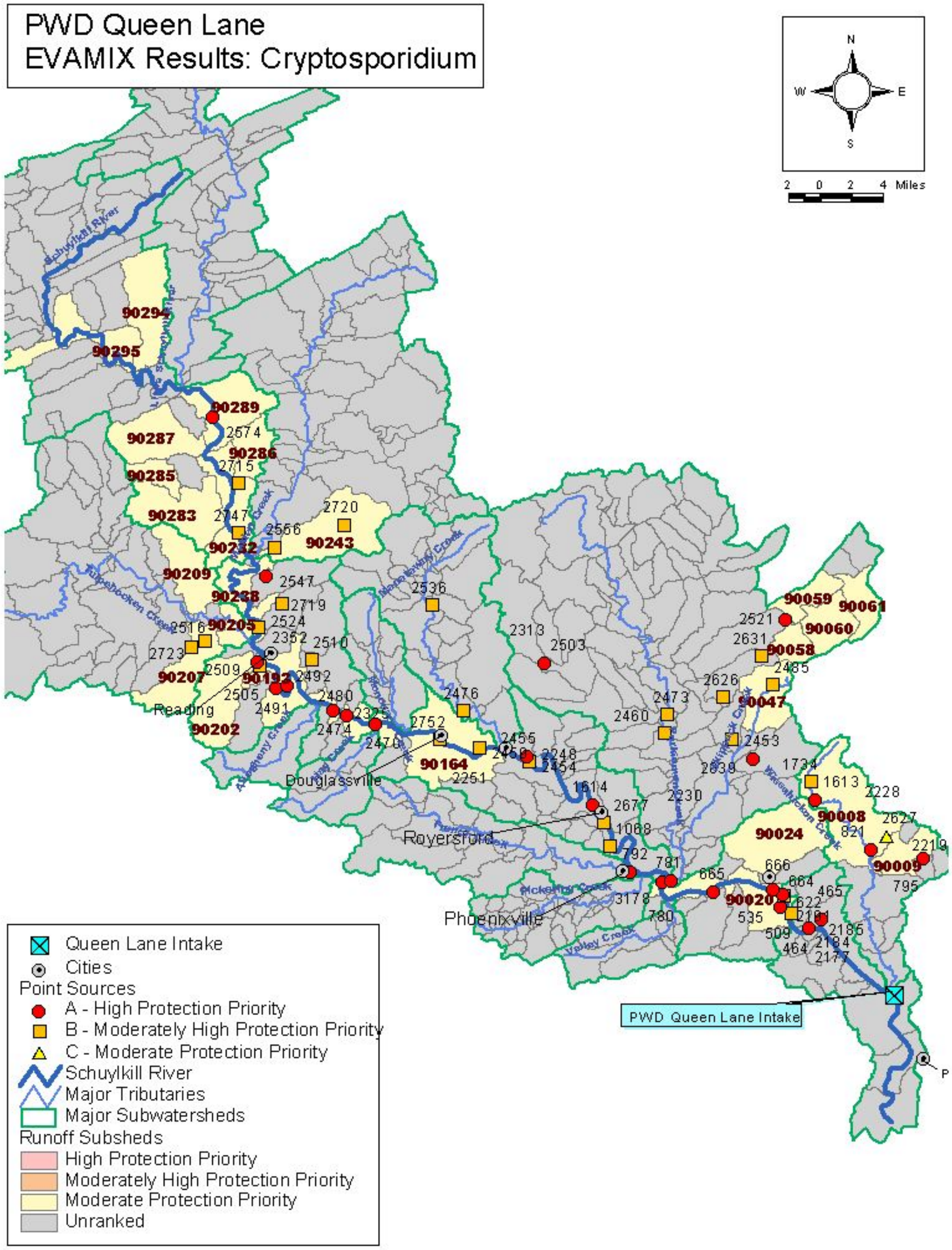
Table 3.2.4-4 Contaminant Category Ranking for *Cryptosporidium*

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	0.009	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	0.009	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	0.009	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	0.009	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	0.009	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	0.009	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	0.009	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	0.009	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	0.009	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	0.009	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	0.009	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	0.009	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.009	Highest-A
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	0.009	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	0.009	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	0.009	Highest-A
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	0.009	Highest-A
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	0.009	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	0.009	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	0.009	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	0.009	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.009	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	0.009	Highest-A
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	0.009	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	0.009	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	0.009	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	0.009	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	0.009	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	0.009	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	0.009	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	0.009	Moderately High-B
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.001	Moderately High-B
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	0.009	Moderately High-B
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.001	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.001	Moderately High-B
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.001	Moderately High-B
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.001	Moderately High-B
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.001	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.001	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.001	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.001	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.001	Moderately High-B
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.001	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.001	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.001	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.001	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.001	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.001	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.001	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.001	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.001	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.001	Moderate-C
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	0.002	Moderate-C
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	0.002	Moderate-C
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	0.001	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	37.6	0.003	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	0.002	Moderate-C
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	0.001	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	34.6	0.002	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	40.7	0.002	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	27.3	0.001	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	0.001	Moderate-C
90287	Mill Creek-287	NP	Mill Creek	Zone B	40.7	0.002	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	0.001	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	0.001	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	0.001	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	0.001	Moderate-C
90286	Pigeon Creek-286	NP	Pigeon Creek	Zone B	39.2	0.001	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	29.2	0.001	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	37.1	0.001	Moderate-C
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	0.001	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	26.1	0.001	Moderate-C
90294	Pine Creek-294	NP	Pine Creek	Zone B	47.6	0.001	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	31.0	0.001	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	0.001	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	0.001	Moderate-C
90285	Lesher Run-285	NP	Lesher Run	Zone B	40.2	0.001	Moderate-C

Figure 3.2.4-6 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for *Cryptosporidium* in the Schuylkill River Watershed



Fecal Coliform

Table 3.2.4-5 shows the results of the ranking for fecal coliform. The table indicates that the only sources are either stormwater runoff from agricultural or urbanized watersheds, and permitted discharges from wastewater treatment plants. Although both sources are represented in the high priority category (category A), the results suggest that periodic loading from stormwater is orders of magnitude higher than the loading from wastewater treatment plants. The table shows that during dry weather flows, wastewater loading is insignificant at the Queen Lane Intake, but that during storm events, fecal coliform would be expected to increase by orders of magnitude. Another potentially significant source that could not be properly incorporated into this analysis are the 11 communities upstream with combined sewer overflow systems. The overflows of raw sewage during wet weather events was roughly estimated and compared to the other potentially significant sources. Based on this analysis the CSO discharges from the communities of Bridgeport and Norristown would be considered potentially significant sources of highest protection priority as well (category A). The remaining nine communities including Minersville, Tamaqua, and Greater Pottsville in Schuylkill County would be considered moderate protection priority sites (category C) since they are much further away from the Queen Lane Intake. Overall, there was a broad geographic distribution of potentially significant sources of fecal coliforms in the watershed. This may be due to the fact that die-off was not factored into the analysis. Figure 3.2.4-7 illustrates the priority point sources and subwatersheds for coliform in the Schuylkill River Watershed. The highest priority subwatersheds were in the Wissahickon and Stony Creeks, and along the lower part of the Schuylkill River.

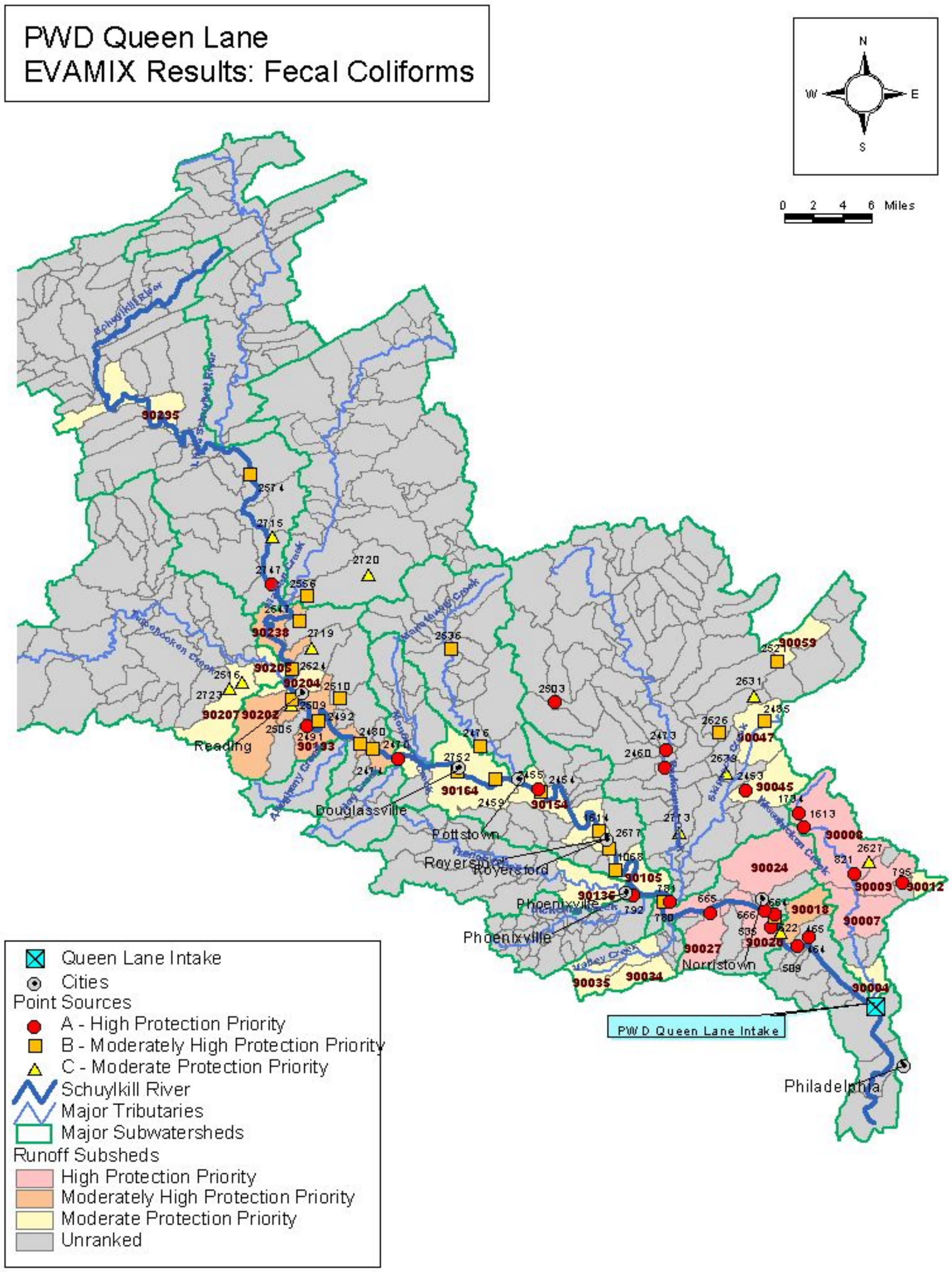
Table 3.2.4-5 Contaminant Category Ranking for Fecal Coliform

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	4.70	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	3.78	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	2.83	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	0.01	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	0.01	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	0.01	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	0.01	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	0.01	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	0.01	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	2.28	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	0.01	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.00	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	0.01	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	0.01	Highest-A
1734	BOROUGH OF NORTH	NPDES	Wissahickon	Flood Plain	13.2	0.00	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
	WALES		Creek				
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	2.15	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	0.01	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	0.01	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	0.01	Highest-A
90027	Trout Creek-027	NP	Trout Creek	Zone A	8.0	2.05	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	0.01	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	0.01	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	0.01	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.00	Highest-A
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.00	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	0.00	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.00	Moderately High-B
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.00	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.01	Moderately High-B
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	0.01	Moderately High-B
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	0.01	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	0.01	Moderately High-B
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	0.01	Moderately High-B
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	2.27	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	0.01	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.01	Moderately High-B
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	0.01	Moderately High-B
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.00	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	0.01	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	0.01	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.00	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	4.5	1.73	Moderately High-B
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	2.22	Moderately High-B
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.00	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.00	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.00	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	0.01	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	0.01	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.00	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	0.01	Moderately High-B
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	31.0	1.95	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.00	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.00	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	31.0	1.92	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	1.83	Moderate-C
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.00	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.00	Moderate-C
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	16.0	1.63	Moderate-C
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.00	Moderate-C
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	0.01	Moderate-C
90012	Sandy Run-012	NP	Sandy Run	Zone A	11.9	1.39	Moderate-C
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.00	Moderate-C
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.00	Moderate-C
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	15.0	1.48	Moderate-C
90004	Wissahickon Creek-004	NP	Wissahickon Creek	Zone A	1.1	1.13	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.00	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	11.1	1.38	Moderate-C
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	10.5	1.33	Moderate-C
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	12.2	1.35	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	1.32	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	1.26	Moderate-C
90135	French Creek-135	NP	French Creek	Zone B	12.1	1.17	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	1.30	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	1.26	Moderate-C
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	1.27	Moderate-C
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	0.01	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.00	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	0.01	Moderate-C

Figure 3.2.4-7 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Fecal Coliform in the Schuylkill River Watershed



Metals

Table 3.2.4-6 provides the results of the heavy metal source ranking. Results generally show that NPDES permitted discharges are the primary sources. Some TRI sites with significant storage or use of metals are also rated as high protection priority sources, primarily because a catastrophic leak or spill would result in extremely high concentrations. Non-point sources from urbanized watersheds are generally a medium priority. Most of the TRI, RCRA and AST sites fall into the moderate protection priority category (category C). However, it is important to note that acid mine drainage could not be included in this analysis and may be a more significant source than any of the other source categories (see section 3.1.5.4). Most sites were located in the watershed below Pottstown. However, a few sites were in the Reading and Upper Schuylkill areas. Figures 3.2.4-8 and 3.2.4-9 identify the priority point sources and subwatersheds for metals in the lower and upper parts of the Schuylkill River Watershed.

Table 3.2.4-6 Contaminant Category Ranking for Metals

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2339	ELECTRIC COIL SERVICE INC.	TRI	Laurel Run	Flood Plain	34.1	1692328.8	Highest-A
2333	GENERAL BATTERY CORP. READING SMELTER DIV.	TRI	Bernhart Creek	Flood Plain	33.0	488073.1	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	1.5	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	1.5	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/ WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	3.5	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	1.5	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	1.5	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	9.9	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	7.7	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	2.7	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	1.5	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.1	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	4.6	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.1	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.1	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	1.5	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	1.5	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.1	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.1	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	1.5	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	4.3	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	1.5	Highest-A
1068	PECO ENERGY CO-	NPDES	Schuylkill River	Flood Plain	13.5	0.1	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
	CROMBY GENERATING						
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	29.4	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	1.5	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	0.7	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.1	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.1	Highest-A
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.1	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	5.3	Highest-A
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.1	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	1.5	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	4.0	Moderately High-B
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	1.5	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	1.5	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.1	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	26.7	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.1	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	1.5	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.1	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	7.5	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.1	Moderately High-B
2510	ANTIETAM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	1.5	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.1	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	15.5	Moderately High-B
2231	ANCHOR GLASS CONTAINER CORP.	TRI	Schuylkill River	Zone B	15.0	112878.3	Moderately High-B
90004	Wissahickon Creek-004	NP	Wissahickon Creek	Zone A	1.1	0.4	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.1	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	1.5	Moderately High-B
2200	CHEMALLOY CO. INC.	TRI	Schuylkill River	Zone A	5.0	35154.3	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	1.5	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.1	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	1.0	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	4.5	0.6	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	0.9	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	1.5	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.1	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	1.2	Moderately High-B
756	PENN MED TECHNOLOGY	RCRA	Gulph Creek	Flood Plain	4.5	0.0	Moderately High-B
2193	BETHLEHEM STEEL CORP. - LUKENS PLATE CONSHOHOCKEN DIV.	TRI	Plymouth Creek	Zone A	5.0	10338.6	Moderately High-B
90027	Trout Creek-027	NP	Trout Creek	Zone A	8.0	0.7	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	1.6	Moderate-C
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	0.7	Moderate-C
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.1	Moderate-C
2215	YARWAY CORP.	TRI	Wissahickon Creek	Zone B	9.4	38677.4	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	31.50721741	123314.4	Moderate-C
2352	DANA CORP. PARISH DIVISION	TRI	Schuylkill River	Zone B	31.5	144641.1	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.0	Moderate-C
90012	Sandy Run-012	NP	Sandy Run	Zone A	11.9	0.4	Moderate-C
1187	SPRING CITY FOUNDRY	RCRA	Schuylkill River	Flood Plain	14.5	0.0	Moderate-C
2190	PHILADELPHIA GEAR CORP.	TRI	Crow Creek	Zone A	9.0	6106.5	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.1	Moderate-C
2225	HANDY & HARMAN TUBE CO INC	TRI	Stony Creek	Zone B	8.5	6642.4	Moderate-C
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	13.5	3469.3	Moderate-C
3353	NORRISTOWN FILTRATION PLT	AST	Schuylkill River	Zone A	6.0	9265.5	Moderate-C
2420	RAHNS SPECIALITY METALS	TRI	Perkiomen Creek	Zone B	14.0	3723.1	Moderate-C
2161	DAMASCUS - BISHOP TUBE CO. INC.	TRI	Little Valley Creek	Zone B	14.4	4273.1	Moderate-C
2240	PRECISION TUBE CO. INC	TRI	Wissahickon Creek	Zone B	14.4	3568.0	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Flood Plain	21.4	6166.3	Moderate-C
3321	COLORCON INC	AST	Wissahickon Creek	Zone B	13.8	40150.5	Moderate-C
2376	HEYCO METALS INC.	TRI	Schuylkill River	Flood Plain	33.6	58103.3	Moderate-C
2256	HAMMOND LEAD PRODUCTS	TRI	Schuylkill River	Zone B	21.4	15654.0	Moderate-C
2332	EXIDE CORP. READING SLI	TRI	Bernhart Creek	Flood Plain	33.0	35434.3	Moderate-C
2353	BALDWIN HARDWARE MFG CORP	TRI	Schuylkill River	Zone B	30.0	11803	Moderate-C
2343	NGK METALS CORP.	TRI	Laurel Run	Flood Plain	34.1	20466	Moderate-C
3411	BOYERTOWN WWTP	AST	Swamp Creek	Zone B	23.1	37062	Moderate-C
2330	YUASA EXIDE INC	TRI	Bernhart Creek	Zone B	33.6	5486	Moderate-C
2356	CAMBRIDGE-LEE INDS. READING TUBE DIV.	TRI	Schuylkill River	Zone B	35.6	15795	Moderate-C
2366	BRUSH WELLMAN INC.	TRI	Schuylkill River	Zone B	38.7	17224	Moderate-C
2328	CAN CORP. OF AMERICA INC.	TRI	Willow Creek	Zone B	38.1	3761	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	32.5	18531	Moderate-C
2375	PENNSYLVANIA STEEL FNDY. & MACHINE CO.	TRI	Schuylkill River	Zone B	42.3	7429	Moderate-C

Figure 3.2.4-8 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Metals in the Lower Schuylkill River Watershed

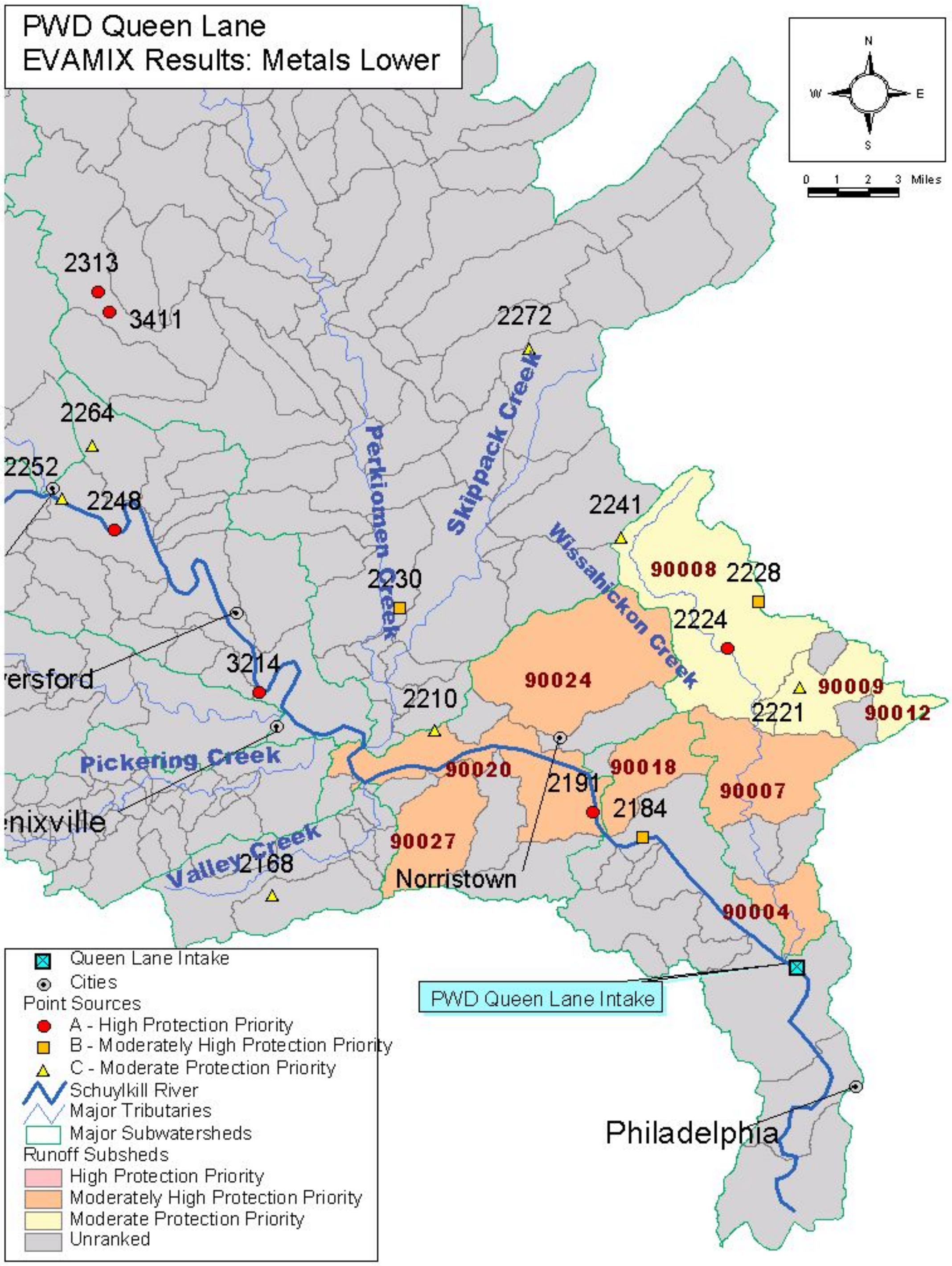
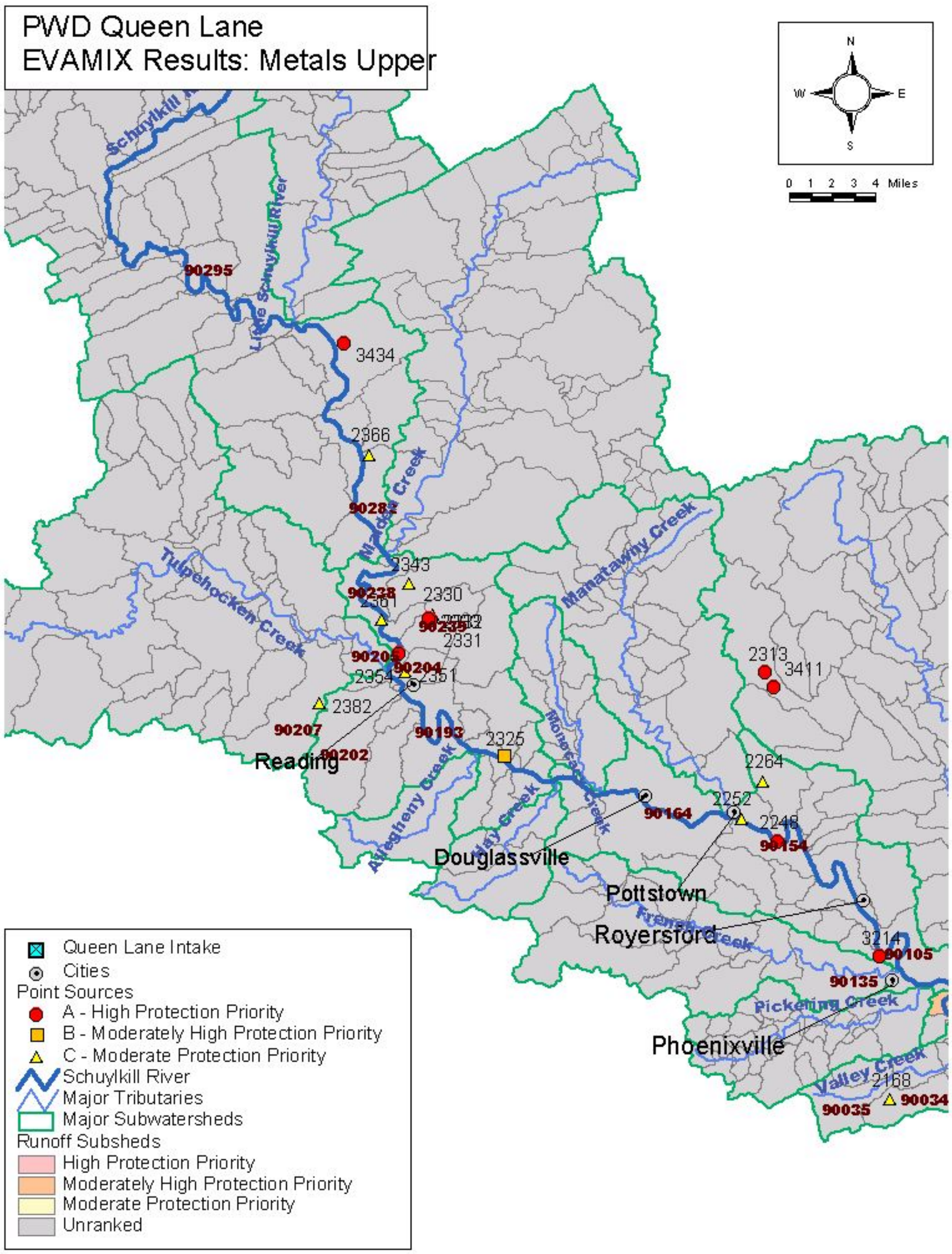


Figure 3.2.4-9 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Metals in the Upper Schuylkill River Watershed



Nitrates

Table 3.2.4-7 shows the ranking of sites for nitrate loading. The high category (category A) is dominated by NPDES dischargers, primarily wastewater treatment plants. Most of the loading from these sites appears to be relatively low, and is not likely to cause a cumulative impact that would cause an exceedance of the nitrate standard at the intake. Moderately high priority sites (category B) are a mixture of NPDES sites and non-point runoff from storm water. Only twelve of the 87 potentially significant sources were located within the five-hour time of travel (zone A). Therefore, efforts to reduce nitrate impacts will be necessary watershed wide. Figures 3.2.4-10 and 3.2.4-11 illustrate the priority point sources and subwatersheds for nitrates in the Lower and Upper Schuylkill River watersheds. Moderately high priority subwatersheds are located in Wissahickon Creek and the downstream part of the Schuylkill River.

Table 3.2.4-7 Contaminant Category Ranking for Nitrates

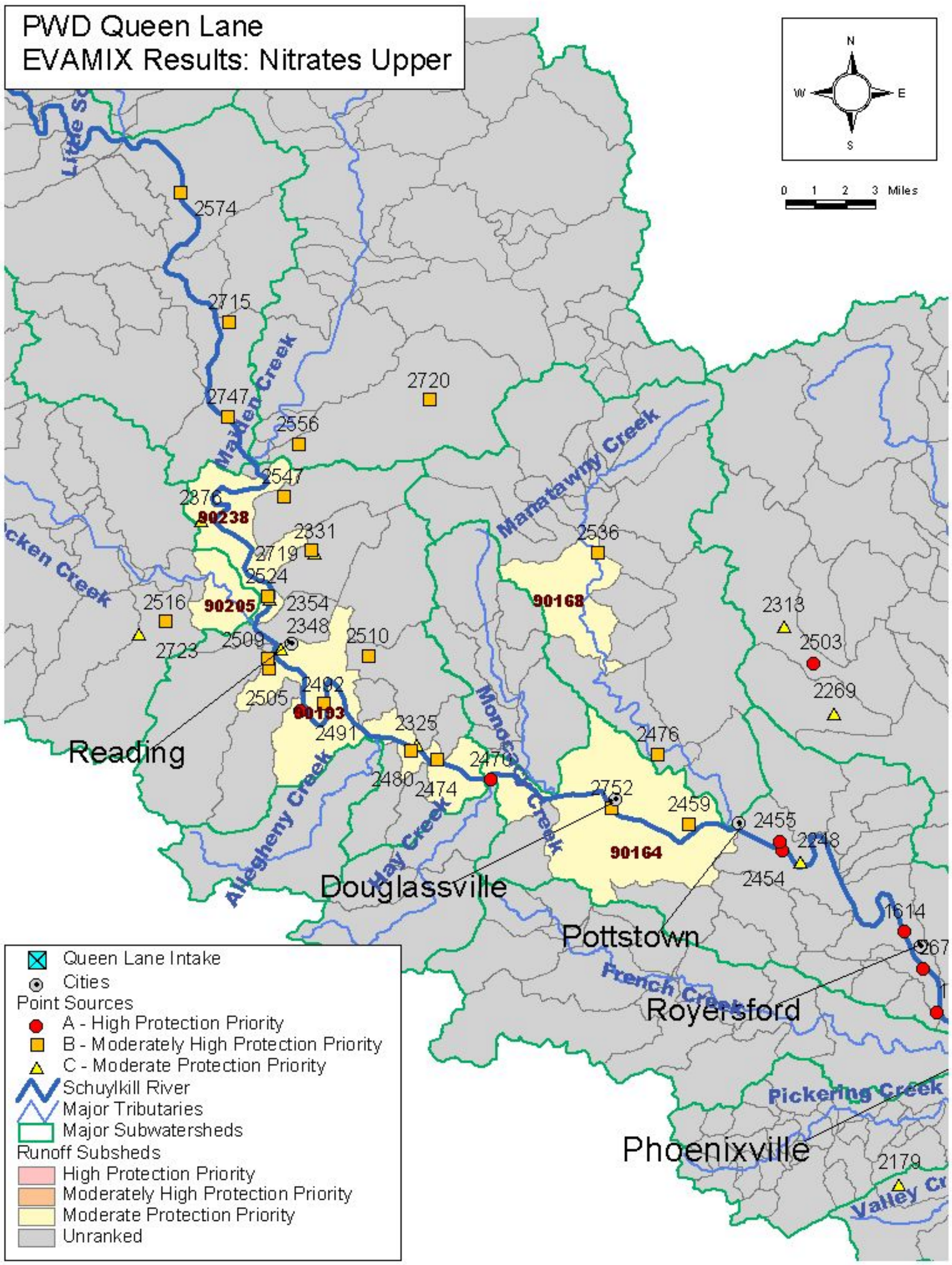
Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	13.5	636.59	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	130.18	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	1.64	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	5.46	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	2.49	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	3.13	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	0.79	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	2.64	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	0.33	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	0.49	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	0.97	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	3.90	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.01	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.01	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	2.14	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	2.97	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.01	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.01	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.01	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	1.25	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	0.10	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	1.44	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	1.26	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.01	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	8.96	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	1.48	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	0.26	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.01	Highest-A
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.01	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.01	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.01	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	2.05	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	0.13	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.01	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.12	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	0.11	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	2.35	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.01	Moderately High-B
2189	METLAB CO	TRI	Cresheim Creek	Zone B	4.3	42.46	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.01	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.11	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	0.27	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.01	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.01	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	0.11	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.01	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	0.11	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	0.11	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.01	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	0.97	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	0.06	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.01	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	0.05	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	0.09	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.01	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	0.12	Moderately High-B
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	0.05	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.01	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.01	Moderate-C
2183	JOHNSON MATTHEY CSDNA	TRI	Trout Creek	Zone A	9.5	0.14	Moderate-C
2192	CHEF FRANCISCO OF PA	TRI	Crow Creek	Zone B	8.5	0.18	Moderate-C
2234	UNIFORM TUBES INC.	TRI	Perkiomen Creek	Zone B	14.0	0.13	Moderate-C
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Flood Plain	19.0	0.41	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	23.6	19.00	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	0.04	Moderate-C
2179	ALEX C. FERGUSSON INC.	TRI	Valley Creek	Zone B	13.8	0.21	Moderate-C
2221	NOVARTIS CONSUMER HEALTH INC.	TRI	Sandy Run	Zone B	14.4	0.15	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	0.05	Moderate-C
2422	ROSENBERGERS DAIRIES INC.	TRI	Skippack Creek	Zone B	17.5	0.25	Moderate-C
2272	H. W. LONGACRE INC.	TRI	Skippack Creek	Zone B	18.0	0.25	Moderate-C
2273	WAMPLER-LONGACRE INC.	TRI	Skippack Creek	Zone B	18.0	0.25	Moderate-C
2415	MOYER PACKING CO.	TRI	Skippack Creek	Zone B	18.0	0.25	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	0.06	Moderate-C
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	26.2	0.51	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	0.05	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	26.1	0.04	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	0.11	Moderate-C
2269	MRS. SMITH'S INC.	TRI	Minister Creek	Zone B	22.0	0.17	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	26.8	0.05	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	27.3	0.07	Moderate-C
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Flood Plain	33.0	0.14	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	29.2	0.05	Moderate-C
2354	CARPENTER TECHNOLOGY CORP	TRI	Schuylkill River	Zone B	31.5	3.61	Moderate-C
2348	GARDEN STATE TANING - READING	TRI	Schuylkill River	Flood Plain	30.0	0.25	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	0.07	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	0.05	Moderate-C
2376	HEYCO METALS INC.	TRI	Schuylkill River	Flood Plain	33.6	1.40	Moderate-C

Figure 3.2.4-10 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Nitrates in the Lower Schuylkill River Watershed

Figure 3.2.4-11 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Nitrates in the Upper Schuylkill River Watershed



Petroleum Hydrocarbons

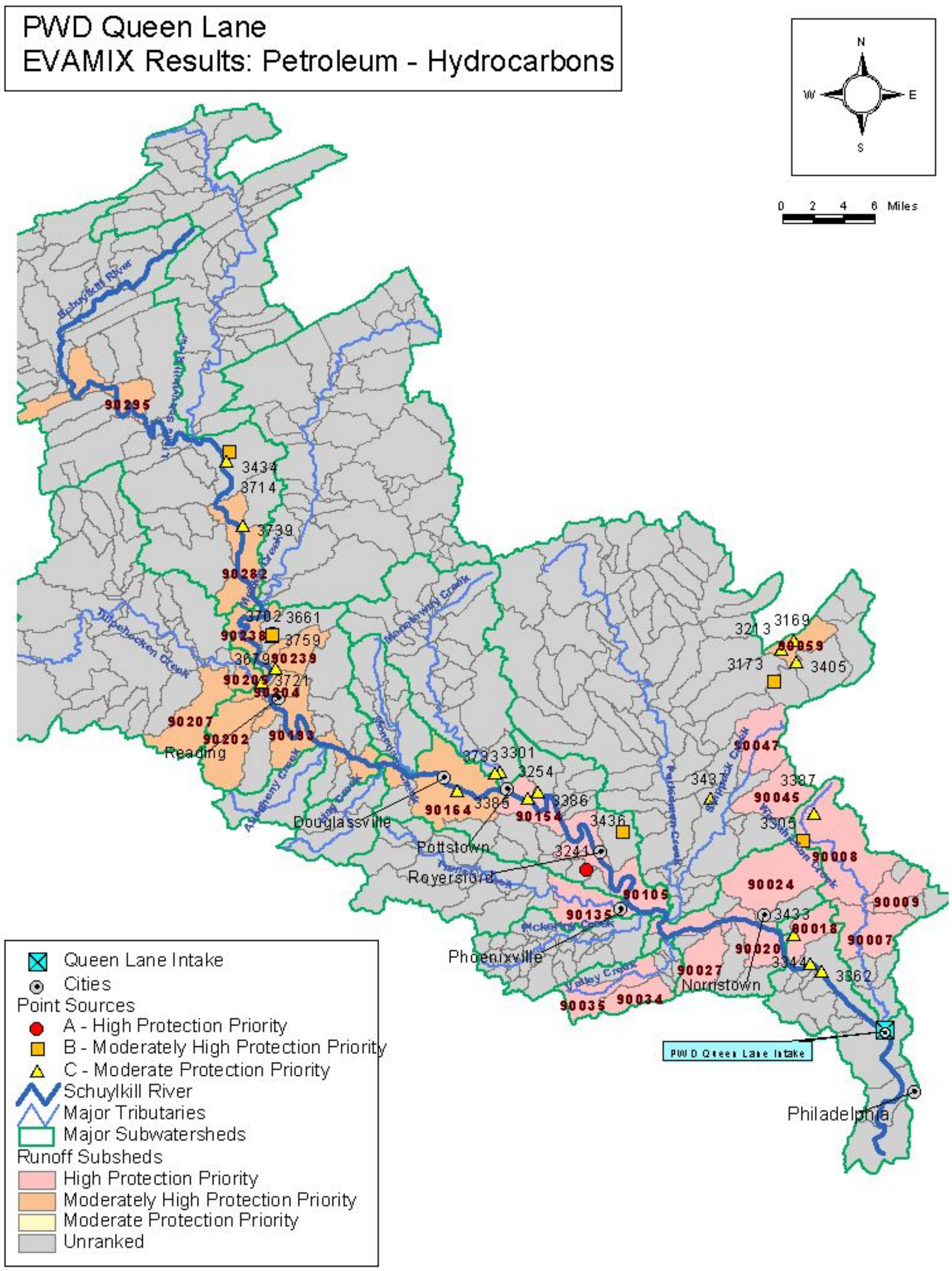
There were a limited number of significant sources of petroleum hydrocarbons, as shown in Table 3.2.4-8. Only aboveground storage tanks containing fuel, or stormwater runoff were identified as significant potential sources of petroleum hydrocarbon loading. Most of the high priority sites are either fuel storage facilities (with a low probability of release but potentially very high concentrations), or stormwater runoff with lower concentrations but frequent occurrence. All of the potentially significant sources of AST identified were in the Zone B or 5 to 25-hour time of travel range. Several non-point source runoff subwatersheds in the Wissahickon Creek and Lower Schuylkill River were identified as potentially significant sources of high protection priority. Figure 3.2.4-12 identifies the priority point sources and subwatersheds for petroleum hydrocarbons in the Schuylkill River Watershed. Much of the downstream portion of the Schuylkill (downstream of Pottstown) and the tributaries are high priority subwatersheds.

Table 3.2.4-8 Contaminant Category Ranking for Petroleum Hydrocarbons

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3702	BERKS FUEL STORAGE CO INC	AST	Laurel Run	Zone B	33.6	741240.0	Highest-A
3241	PLOTTS OIL BULK PLT	AST	Stony Run	Zone B	15.0	312247.4	Highest-A
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	2.7	Highest-A
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	4.5	1.6	Highest-A
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	1.5	Highest-A
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	2.5	Highest-A
90027	Trout Creek-027	NP	Trout Creek	Zone A	8.0	1.8	Highest-A
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	3.2	Highest-A
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	1.8	Highest-A
90105	Schuylkill River-105	NP	Schuylkill River	Zone B	10.5	1.2	Highest-A
90035	Valley Creek-035	NP	Valley Creek	Zone B	11.1	1.1	Highest-A
90135	French Creek-135	NP	French Creek	Zone B	12.1	1.0	Highest-A
90034	Little Valley Creek-034	NP	Little Valley Creek	Zone B	12.2	1.3	Highest-A
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	15.0	1.3	Highest-A
90045	Towamencin Creek-045	NP	Towamencin Creek	Zone B	16.0	1.1	Highest-A
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	1.1	Highest-A
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	1.2	Moderately High-B
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	2.1	Moderately High-B
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	1.1	Moderately High-B
3759	COLUMBIA PETRO	AST	Laurel Run	Zone B	33.6	234977.3	Moderately High-B
3305	REIT FUEL OIL CO BLUE BELL	AST	Stony Creek	Zone B	10.0	185310.0	Moderately High-B
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	31.0	1.3	Moderately High-B
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	31.0	1.6	Moderately High-B
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	2.1	Moderately High-B
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	1.3	Moderately High-B
90239	Bernhart Creek-239	NP	Bernhart Creek	Zone B	32.5	1.1	Moderately High-B
3436	OEH LERT Bros. Fuel Oil	AST	Mingo Creek	Zone B	15.5	185310.0	Moderately High-B
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	1.0	Moderately High-B
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	0.9	Moderately High-B
3173	FARM AND HOME OIL CO. INC.	AST	Mill Creek	Zone B	26.7	185310.0	Moderately High-B
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	0.9	Moderately High-B
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	42.3	188135.2	Moderately High-B
3437	ROBERT MARSHALL INC	AST	Skippack Creek	Zone B	15.5	85242.6	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3301	FARM & HOME OIL CO	AST	Manatawny Creek	Zone B	21.4	92655.0	Moderate-C
3733	COLUMBIA PETRO CORP	AST	Schuylkill River	Zone B	21.9	92655.0	Moderate-C
3433	JAY GRESS INC	AST	Plymouth Creek	Zone B	5.5	55593.0	Moderate-C
3213	HESTON S SWARTLEY TRANS CO INC	AST	East Branch Perkiomen Creek	Zone B	26.1	92655.0	Moderate-C
3362	LONZA INC.	AST	Schuylkill River	Zone A	3.0	9265.5	Moderate-C
3344	QUAKER CHEMICAL CORP.	AST	Schuylkill River	Zone A	3.5	9265.5	Moderate-C
3739	SANTILLI OIL CO INC	AST	Pigeon Creek	Flood Plain	39.2	69120.6	Moderate-C
3721	GOSHERTS QUALITY FUELS	AST	Schuylkill River	Flood Plain	31.5	46327.5	Moderate-C
3387	DE WALKER & SON INC	AST	Wissahickon Creek	Zone B	14.4	46327.5	Moderate-C
3254	OCCIDENTAL CHEMICAL CORP.	AST	Sprogles Run	Zone B	19.0	42621.3	Moderate-C
3386	EDWARD J SWEENEY & SONS	AST	Schuylkill River	Zone B	19.5	29279.0	Moderate-C
3169	M & S OIL	AST	East Branch Perkiomen Creek	Zone B	26.7	18531.0	Moderate-C
3385	WALTER F SCHWAB CO	AST	Manatawny Creek	Zone B	21.4	4632.8	Moderate-C
3405	WH KNEAS LUMBER CO	AST	East Branch Perkiomen Creek	Zone B	26.1	4632.8	Moderate-C
3661	KOCH MATERIALS CO.	AST	Laurel Run	Zone B	33.6	18531.0	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	32.5	4632.8	Moderate-C
3714	ES SAVAGE INC	AST	Schuylkill River	Zone B	42.3	9265.5	Moderate-C

Figure 3.2.4-12 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Petroleum Hydrocarbons in Schuylkill River Watershed



Phosphorus

Table 3.2.4-9 shows the ranking of sites for phosphorus loading. Like nitrates, the high protection priority category (category A) is dominated by NPDES dischargers, primarily wastewater treatment plants. Most of the loading from these sites appears to be relatively low, and is not likely to cause a cumulative impact that would cause significant water quality impairment at the intake. There are a few very large industrial sites that are also included in the high category, primarily due to the high potential concentrations should a spill occur. Moderately high priority sites are a mixture of NPDES sites and TRI sites. The NPS subwatersheds fell into category C. A large majority of the potentially significant sources were located in the drainage areas along the main stem Schuylkill River. Figures 3.2.4-13 and 3.2.4-14 illustrate the priority point sources and subwatersheds (moderate priority only) for phosphorous in the Lower and Upper Schuylkill River watersheds.

Table 3.2.4-9 Contaminant Category Ranking for Phosphorus

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	32.5	2316.38	Highest-A
2434	RICHARDSAPEX INC.	TRI	Schuylkill River	Zone A	1.0	892.00	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	0.93	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	0.93	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	0.93	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/ WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	0.93	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	0.93	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	0.93	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	0.93	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	0.93	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	0.93	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	0.93	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.16	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.15	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.15	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	0.93	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	0.93	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	13.15	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.15	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.15	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	4.20	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	0.93	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	0.93	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.15	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	0.93	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	3.44	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.15	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.15	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	5.70	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	0.93	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.15	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.15	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.93	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	0.93	Moderately High-B
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	0.93	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	0.93	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.15	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	0.93	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.15	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.93	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.15	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.15	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	0.93	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.15	Moderately High-B
2225	HANDY & HARMAN TUBE CO INC	TRI	Stony Creek	Zone B	8.5	176.28	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	0.93	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	0.93	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.15	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.15	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	0.93	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	0.93	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.15	Moderately High-B
2184	FREEDOM TEXTILE CHEMICALS CO.	TRI	Schuylkill River	Flood Plain	3.5	40.19	Moderately High-B
2191	LONZA INC.	TRI	Schuylkill River	Flood Plain	4.5	3.53	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.15	Moderately High-B
2158	NAMICO INC.	TRI	Schuylkill River	Flood Plain	1.0	7.58	Moderately High-B
2171	SIMPSON PAPER CO.	TRI	Schuylkill River	Flood Plain	2.5	14.10	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	0.65	Moderate-C
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.15	Moderate-C
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	1.25	Moderate-C
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	1.56	Moderate-C
2199	RESCO PRODS. INC.	TRI	Schuylkill River	Zone A	5.0	11.54	Moderate-C
2228	HENKEL CORP.	TRI	Wissahickon	Zone B	10.6	35.26	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
			Creek				
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	3.5	4.87	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.15	Moderate-C
2218	LEHIGH VALLEY DAIRIES INC.	TRI	Sandy Run	Flood Plain	12.5	21.15	Moderate-C
2179	ALEX C. FERGUSSON INC.	TRI	Valley Creek	Zone B	13.8	17.63	Moderate-C
90047	Skippack Creek-047	NP	Skippack Creek	Zone B	17.0	0.62	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	13.8	3.70	Moderate-C
2244	SERMATECH INTL. INC.	TRI	Mingo Creek	Zone B	16.5	14.46	Moderate-C
2249	TUSCAN LEHIGH DAIRIES L.P.	TRI	Towamencin Creek	Zone B	18.5	3.53	Moderate-C
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	26.2	15.87	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	0.63	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	0.93	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	0.71	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	26.1	0.67	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	26.8	0.77	Moderate-C
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Flood Plain	33.0	6.70	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	27.3	1.12	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	29.2	0.83	Moderate-C
2324	ATOFINA CHEMICALS INC.	TRI	Schuylkill River	Zone B	25.7	2.64	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	0.88	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	0.70	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	34.6	1.27	Moderate-C
2395	EAGLE CHEMICAL CO.	TRI	Schuylkill River	Zone B	33.0	21.15	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	1.77	Moderate-C

Figure 3.2.4-13 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Phosphorus in the Lower Schuylkill River Watershed

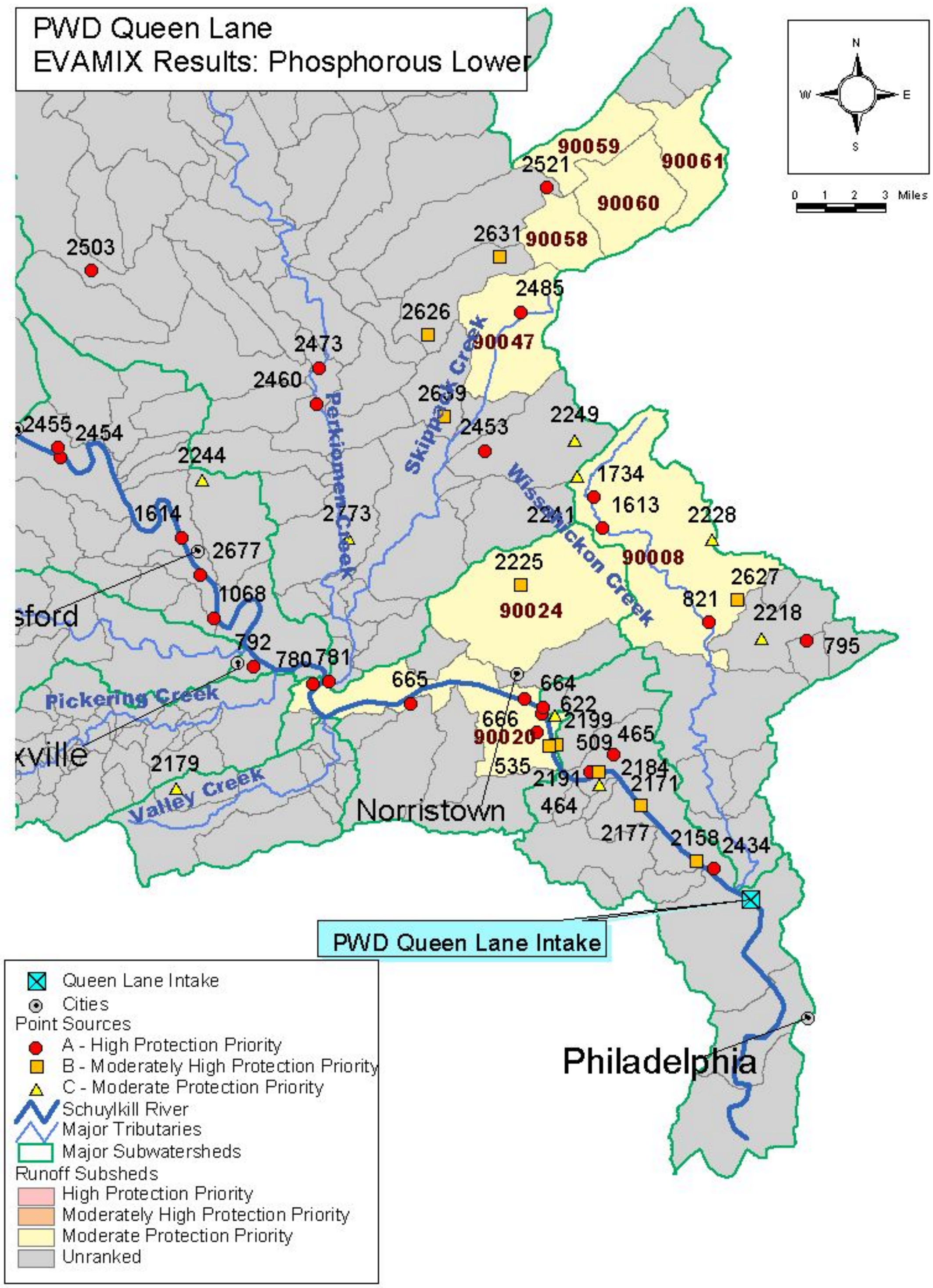
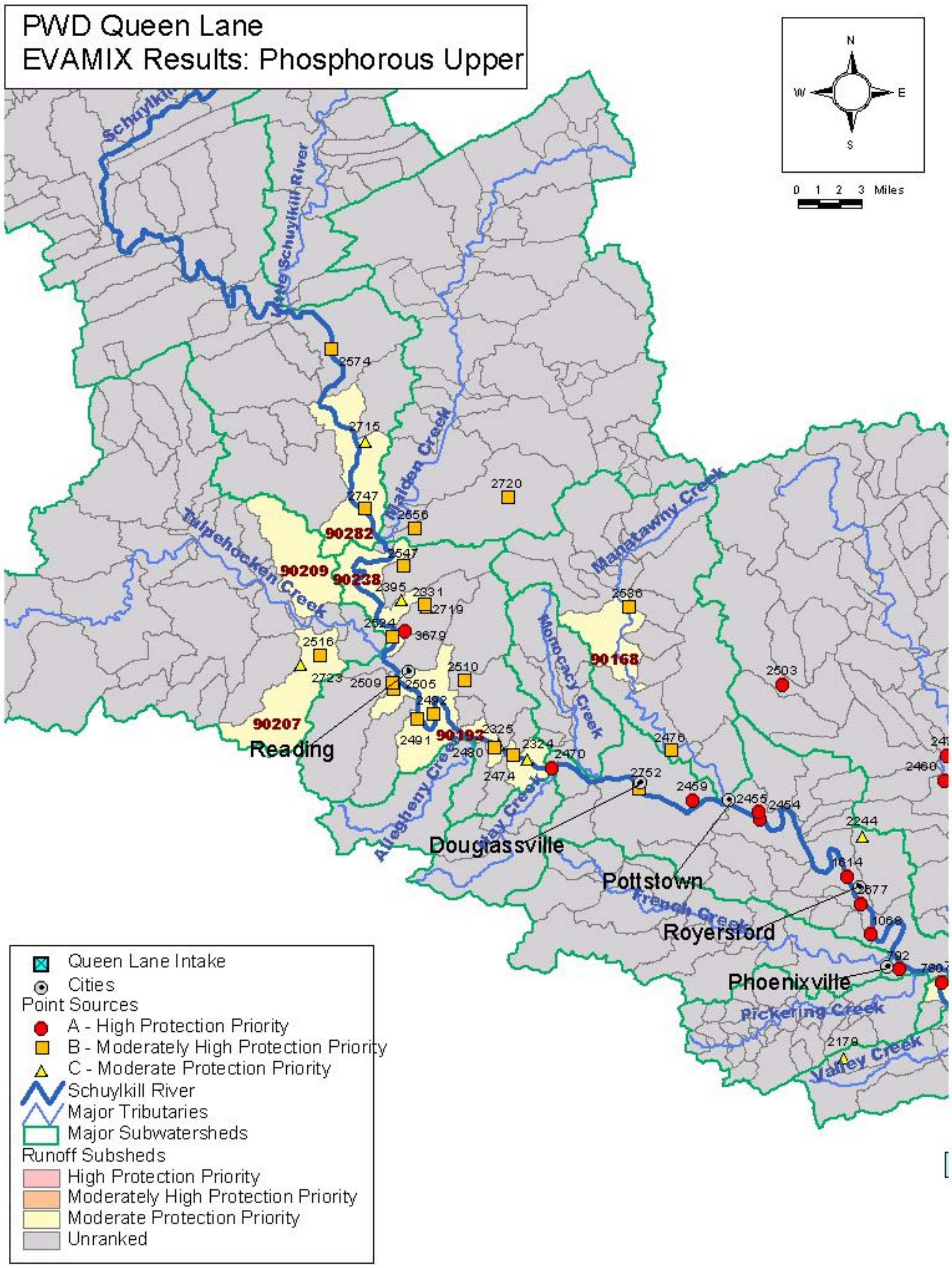


Figure 3.2.4-14 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Phosphorus in the Upper Schuylkill River Watershed



Disinfection By-Product Precursors (Total Organic Carbon)

Table 3.2.4-10 provides the results of the ranking of potential sources of TOC. In this case, all of the high protection priority sites (category A) are NPDES discharges from wastewater treatment plants. With the exception of some of the largest treatment plants, the results suggest that stormwater runoff is also a potential source of TOC with loads similar to the smaller NPDES sites. TRI and AST sites were mostly screened out, with only a few found in the moderate priority category (category C). Figures 3.2.4-15 and 3.2.4-16 illustrate the priority point sources and subwatersheds for total organic carbon in the Lower and Upper Schuylkill River watersheds. Moderately high priority subwatersheds are mainly located in the Wissahickon Creek area.

Table 3.2.4-10 Contaminant Category Ranking for Total Organic Carbon (Disinfection By-product Surrogate)

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	143.04	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	18.07	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	14.97	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	20.80	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/ WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	10.43	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	6.42	Highest-A
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	6.98	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	12.69	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	8.63	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	9.59	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	6.20	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	3.52	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	5.16	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	6.28	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	9.36	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	4.45	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.17	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.17	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.17	Highest-A
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	5.78	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	1.71	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	1.71	Highest-A
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	9.58	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.17	Highest-A
2460	SCHWENKSVILLE	NPDES	Perkiomen Creek	Flood Plain	16.1	0.17	Highest-A

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
	BOROUGH AUTH						
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.17	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	0.71	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	0.41	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.17	Highest-A
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	1.71	Highest-A
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	1.71	Moderately High-B
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.17	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	1.71	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.53	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.17	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	1.71	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.17	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.17	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.17	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.17	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	1.15	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.17	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	1.71	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.17	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.17	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	1.71	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.17	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	1.71	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.17	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.17	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.17	Moderately High-B
90020	Schuylkill River-020	NP	Schuylkill River	Zone A	4.5	1.27	Moderately High-B
90018	Plymouth Creek-018	NP	Plymouth Creek	Zone A	4.5	0.74	Moderately High-B
90007	Wissahickon Creek-007	NP	Wissahickon Creek	Zone A	4.9	0.90	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	2.10	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	1.52	Moderately High-B
3158	CROMBY GENERATING STATION	AST	Schuylkill River	Flood Plain	13.5	10.30	Moderately High-B
90027	Trout Creek-027	NP	Trout Creek	Zone A	8.0	0.88	Moderately High-B
90009	Sandy Run-009	NP	Sandy Run	Zone A	8.7	0.94	Moderately High-B
2171	SIMPSON PAPER CO.	TRI	Schuylkill River	Flood Plain	2.5	0.10	Moderately High-B
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.17	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	11.1	0.75	Moderate-C
90154	Schuylkill River-154	NP	Schuylkill River	Zone B	15.0	0.69	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	0.73	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	1.71	Moderate-C
2229	AJAX/ACORN STAMPING & MFG INC.	TRI	Perkiomen Creek	Zone B	13.5	0.24	Moderate-C
2251	POTTSTOWN PRECISION CASTING	TRI	Schuylkill River	Flood Plain	21.4	0.87	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2236	COLORCON INC	TRI	Wissahickon Creek	Zone B	13.8	0.20	Moderate-C
2241	MERCK & CO INC	TRI	Wissahickon Creek	Zone B	13.8	0.02	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	1.10	Moderate-C
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	23.6	0.24	Moderate-C
2268	MOYER PACKING CO.	TRI	Skippack Creek	Zone B	18.0	0.47	Moderate-C
2267	HATFIELD QUALITY MEATS INC.	TRI	Skippack Creek	Zone B	17.5	0.13	Moderate-C
90059	East Branch Perkiomen Creek-059	NP	East Branch Perkiomen Creek	Zone B	26.1	0.78	Moderate-C
2249	TUSCAN LEHIGH DAIRIES L.P.	TRI	Towamencin Creek	Zone B	18.5	0.00	Moderate-C
2337	CITY OF READING WASTEWATER TREATMENT PLANT	TRI	Schuylkill River	Flood Plain	29.1	0.94	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	1.14	Moderate-C
90202	Wyomissing Creek-202	NP	Wyomissing Creek	Zone B	31.0	0.80	Moderate-C
90204	Schuylkill River-204	NP	Schuylkill River	Zone B	31.0	0.77	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	0.67	Moderate-C
90207	Cacoosing Creek-207	NP	Cacoosing Creek	Zone B	33.9	0.69	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	1.04	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	37.1	0.83	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	37.6	0.79	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	40.7	1.02	Moderate-C
90287	Mill Creek-287	NP	Mill Creek	Zone B	40.7	0.69	Moderate-C
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	1.08	Moderate-C
2329	GIORGIO FOODS INC.	TRI	Willow Creek	Zone B	38.1	0.003	Moderate-C
90292	Bear Creek-292	NP	Bear Creek	Zone B	47.2	0.77	Moderate-C
90294	Pine Creek-294	NP	Pine Creek	Zone B	47.6	0.91	Moderate-C
2378	MID ATLANTIC CANNERS ASSOC.	TRI	Schuylkill River	Zone B	41.8	0.00	Moderate-C

Figure 3.2.4-15 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for TOC in the Lower Schuylkill River Watershed

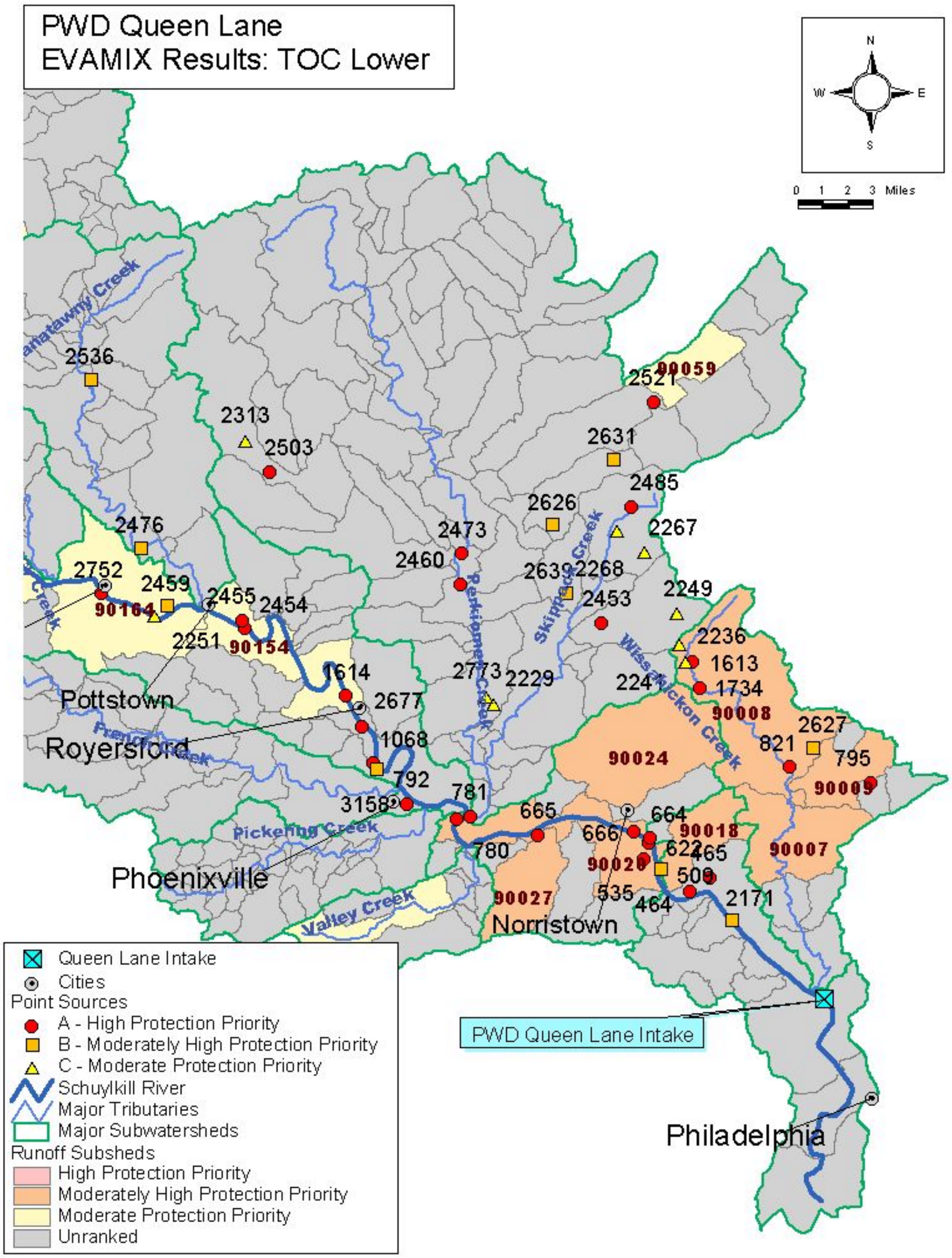
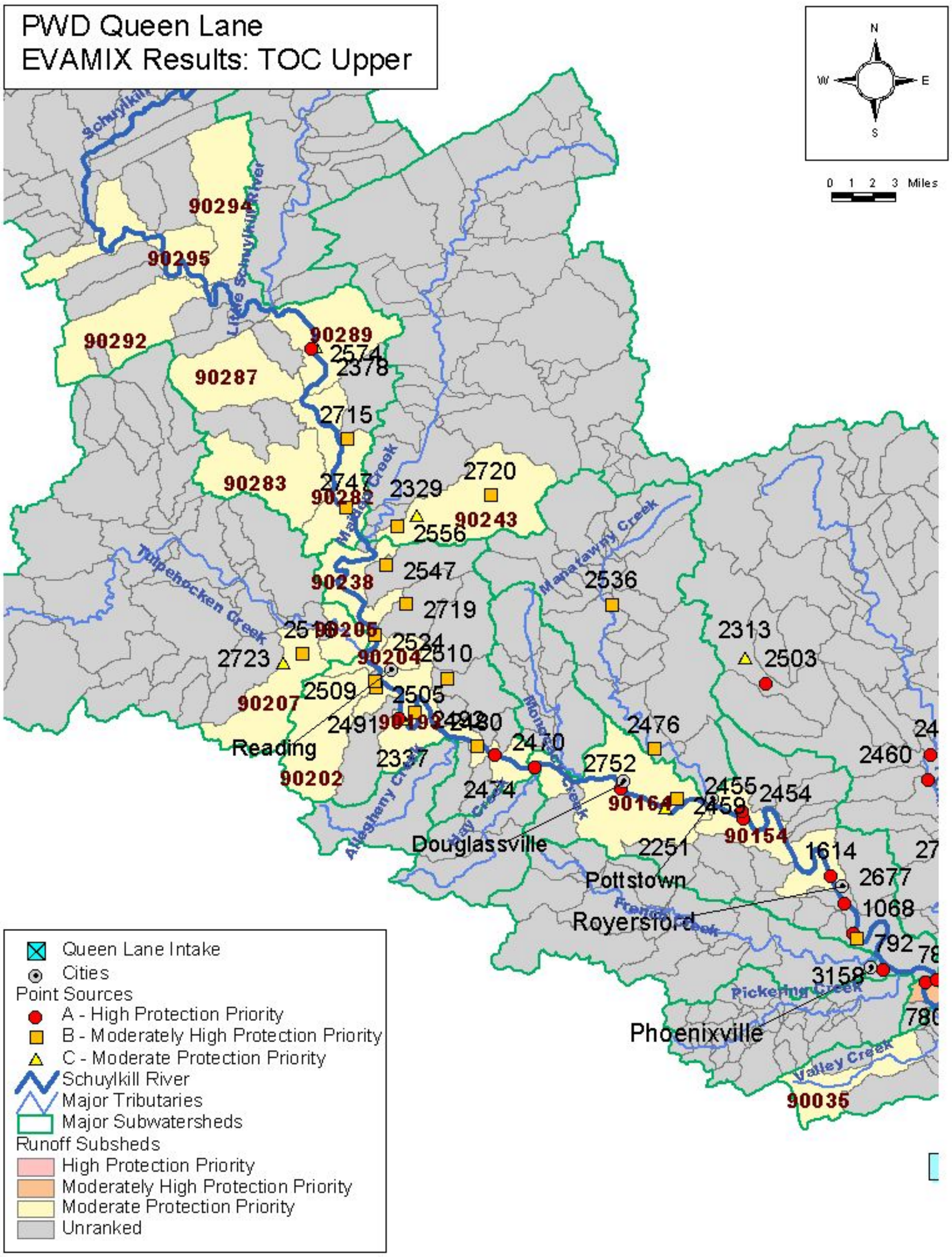


Figure 3.2.4-16 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for TOC in the Upper Schuylkill River Watershed



Turbidity (Total Suspended Solids)

Turbidity was analyzed using TSS as a surrogate. Table 3.2.4-11 provides the results of the final ranking of sites. Only NPDES discharges were identified as highest priority sources of TSS. The stormwater runoff (NPS sites) tend to show higher loading with less frequency. The NPDES sites generally have lower rates of TSS loading, however, at a more constant discharge. Loading rates from both sources appear high enough to cause concern for cumulative impacts at the intake. Figure 3.2.4-17 identifies the priority point sources and subwatersheds for total suspended solids in the Schuylkill River Watershed. Only one subwatershed, in the Wissahickon Creek area, is a moderately high priority.

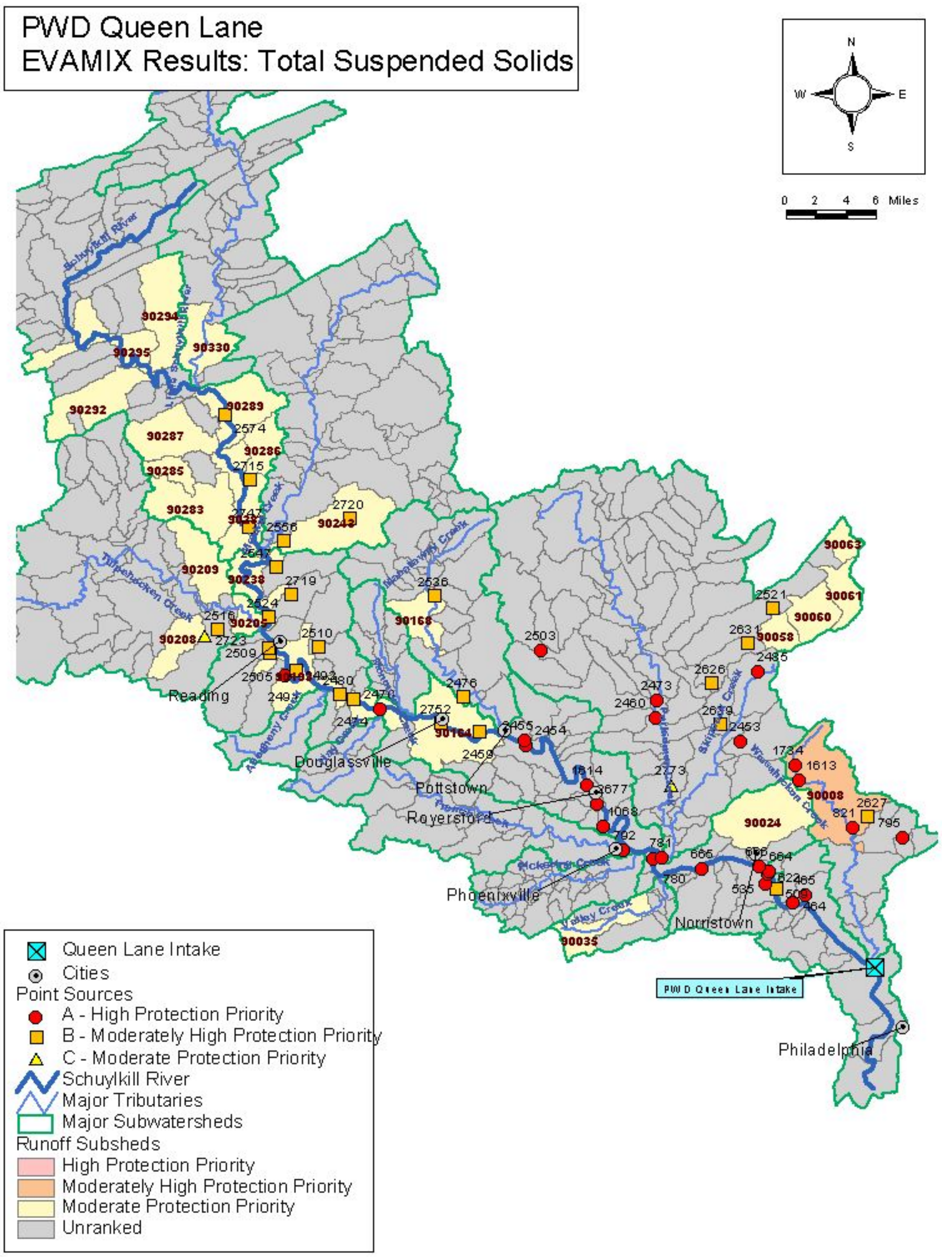
Table 3.2.4-11 Contaminant Category Ranking for Total Suspended Solids (TSS)

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
666	NORRISTOWN MUN WASTE AUTH	NPDES	Schuylkill River	Flood Plain	5.5	891.44	Highest-A
781	MONTGOMERY COUNTY SEW AUTH	NPDES	Perkiomen Creek	Flood Plain	10.5	16.00	Highest-A
465	WHITEMARSH TWP SEW AUTH	NPDES	Schuylkill River	Zone A	3.5	1.67	Highest-A
664	EAST NORRISTOWN/PLYMOUTH/ WHITPAIN JOINT SEWER AUTHORITY	NPDES	Schuylkill River	Flood Plain	5.5	11.78	Highest-A
464	CONSHOHOCKEN SEW TREAT. PLT.	NPDES	Schuylkill River	Zone A	3.5	9.19	Highest-A
821	AMBLER BORO	NPDES	Wissahickon Creek	Zone A	8.7	12.22	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	7.53	Highest-A
2491	READING CITY	NPDES	Schuylkill River	Zone B	29.5	61.48	Highest-A
795	ABINGTON TWP COMM-WWTR TRTMT P	NPDES	Sandy Run	Zone A	11.3	6.08	Highest-A
535	UPPER MERION TWP. AUTH-MATSUNK WPCC	NPDES	Schuylkill River	Zone B	5.0	2.22	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	25.32	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	2.32	Highest-A
780	VALLEY FORGE SEWER AUTHORITY	NPDES	Schuylkill River	Zone B	10.0	11.12	Highest-A
1734	BOROUGH OF NORTH WALES	NPDES	Wissahickon Creek	Flood Plain	13.2	0.03	Highest-A
622	BRIDGEPORT BORO	NPDES	Schuylkill River	Flood Plain	5.5	0.03	Highest-A
2473	LOWER FREDERICK TOWNSHIP TRT P	NPDES	Perkiomen Creek	Flood Plain	16.6	0.03	Highest-A
792	PHOENIXVILL BORO STP	NPDES	Schuylkill River	Zone B	11.5	1.16	Highest-A
2503	BERKS MONTGOMERY MUNICIPAL AUTH	NPDES	Swamp Creek	Flood Plain	23.1	1.02	Highest-A
2453	UPPER GWYNEDD-TOWAMENCIN MUN	NPDES	Towamencin Creek	Zone B	16.5	1.55	Highest-A
2460	SCHWENKSVILLE BOROUGH AUTH	NPDES	Perkiomen Creek	Flood Plain	16.1	0.03	Highest-A
2677	SPRING CITY BOROUGH SEWAGE PLANT	NPDES	Schuylkill River	Flood Plain	14.5	0.03	Highest-A
1614	LIMERICK TWP MUN AUTH	NPDES	Schuylkill River	Flood Plain	15.0	0.52	Highest-A
1068	PECO ENERGY CO-CROMBY GENERATING	NPDES	Schuylkill River	Flood Plain	13.5	0.03	Highest-A
2470	BIRDSBORO BORO MUN AUTH	NPDES	Schuylkill River	Flood Plain	24.8	1.19	Highest-A
2485	BOROUGH OF SOUDERTON	NPDES	Skippack Creek	Zone B	18.5	1.14	Highest-A
2454	NORTH COVENTRY MUN AUTH STP	NPDES	Schuylkill River	Flood Plain	19.5	0.03	Highest-A
2521	PENN RIDGE WASTE WATER TREATMENT AUTHORITY	NPDES	East Branch Perkiomen Creek	Flood Plain	25.4	2.75	Moderately High-B
2459	STANLEY G. FLAGG & CO.	NPDES	Schuylkill River	Zone B	20.9	0.03	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
	INC						
2474	EXETER TOWNSHIP WWTR TRTMT PLT	NPDES	Schuylkill River	Flood Plain	25.7	4.00	Moderately High-B
2627	UPPER DUBLIN TWP	NPDES	Wissahickon Creek	Zone B	8.7	0.03	Moderately High-B
2492	GPU GENERATION INC TITUS GENERATING STATION	NPDES	Schuylkill River	Zone B	28.6	1.98	Moderately High-B
2476	ALLEGHENY E. CONF. ASSOC. 7TH DAY ADVENTISTS	NPDES	Manatawny Creek	Flood Plain	23.1	0.03	Moderately High-B
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	0.06	Moderately High-B
2752	120 OLD PHILADELPHI	NPDES	Schuylkill River	Flood Plain	22.8	0.98	Moderately High-B
2509	WYOMISSING VALLEY JOINT MUN AU	NPDES	Wyomissing Creek	Zone B	31.0	2.69	Moderately High-B
2639	LOWER SALFORD TWP AUTH	NPDES	West Branch Skippack Creek	Flood Plain	16.5	0.03	Moderately High-B
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.14	Moderately High-B
2626	LOWER SALFORD TWP AUTH	NPDES	Indian Creek	Zone B	20.5	0.03	Moderately High-B
2747	LEESPORT BOROUGH AUTHORITY	NPDES	Schuylkill River	Flood Plain	37.1	0.03	Moderately High-B
2536	OLEY TOWNSHIP MUN AUTH	NPDES	Manatawny Creek	Flood Plain	29.8	0.03	Moderately High-B
2510	ANTIETEM VALLEY MUNICIPAL AUTHORITY	NPDES	Antietam Creek	Zone B	28.6	0.26	Moderately High-B
2631	TELFORD BORO AUTHORITY	NPDES	Indian Creek	Zone B	23.6	0.03	Moderately High-B
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	0.14	Moderately High-B
2574	HAMBURG MUN AUTH	NPDES	Schuylkill River	Zone B	41.8	2.50	Moderately High-B
2505	BALDWIN HARDWARE MFG CORP	NPDES	Schuylkill River	Zone B	30.0	0.03	Moderately High-B
2556	MAIDENCREEK TOWNSHIP AUTHORITY	NPDES	Willow Creek	Zone B	37.6	0.03	Moderately High-B
509	LUKENS STEEL CO	NPDES	Schuylkill River	Zone A	4.5	0.54	Moderately High-B
2516	SPRING TWP MUN AUTH	NPDES	Cacoosing Creek	Zone B	35.3	0.35	Moderately High-B
2719	GENERAL BATTERY CORP. READING SMELTER DIV.	NPDES	Bernhart Creek	Flood Plain	33.0	0.03	Moderately High-B
2720	FLEETWOOD BORO AUTH	NPDES	Willow Creek	Zone B	40.7	0.06	Moderately High-B
2715	BRUSH WELLMAN INC.	NPDES	Schuylkill River	Zone B	38.7	0.03	Moderately High-B
90008	Wissahickon Creek-008	NP	Wissahickon Creek	Zone A	8.1	10.80	Moderately High-B
90024	Stony Creek-024	NP	Stony Creek	Zone A	7.0	7.69	Moderate-C
2773	GRATERFORD STATE CORRECTIONAL INSTITUTE	NPDES	Perkiomen Creek	Zone B	13.5	0.03	Moderate-C
90035	Valley Creek-035	NP	Valley Creek	Zone B	11.1	4.64	Moderate-C
90164	Schuylkill River-164	NP	Schuylkill River	Zone B	20.5	4.46	Moderate-C
2723	SINKING SPRING BORO MUN AUTH	NPDES	Cacoosing Creek	Flood Plain	36.0	0.51	Moderate-C
90193	Schuylkill River-193	NP	Schuylkill River	Zone B	25.2	4.77	Moderate-C
90060	Pleasant Spring Creek-060	NP	Pleasant Spring Creek	Zone B	27.3	8.03	Moderate-C
90058	Mill Creek-058	NP	Mill Creek	Zone B	26.1	4.38	Moderate-C
90168	Manatawny Creek-168	NP	Manatawny Creek	Zone B	26.8	4.82	Moderate-C
90061	Morris Run-061	NP	Morris Run	Zone B	29.2	6.40	Moderate-C
90063	East Branch Perkiomen Creek-063	NP	East Branch Perkiomen Creek	Zone B	29.8	4.28	Moderate-C
90238	Schuylkill River-238	NP	Schuylkill River	Zone B	31.5	6.76	Moderate-C
90205	Tulpehocken Creek-205	NP	Tulpehocken Creek	Zone B	31.5	4.47	Moderate-C
90209	Plum Creek-209	NP	Plum Creek	Zone B	34.6	11.02	Moderate-C
90282	Schuylkill River-282	NP	Schuylkill River	Zone B	36.1	13.34	Moderate-C
90283	Irish Creek-283	NP	Irish Creek	Zone B	37.6	15.75	Moderate-C
90243	Willow Creek-243	NP	Willow Creek	Zone B	37.1	7.23	Moderate-C
90208	Little Cacoosing Creek-208	NP	Little Cacoosing Creek	Zone B	36.7	4.62	Moderate-C
90286	Pigeon Creek-286	NP	Pigeon Creek	Zone B	39.2	7.96	Moderate-C
90289	Schuylkill River-289	NP	Schuylkill River	Zone B	40.7	10.45	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
90287	Mill Creek-287	NP	Mill Creek	Zone B	40.7	10.26	Moderate-C
90285	Lesher Run-285	NP	Lesher Run	Zone B	40.2	5.36	Moderate-C
90330	Little Schuylkill River-330	NP	Little Schuylkill River	Zone B	45.1	5.39	Moderate-C
90295	Schuylkill River-295	NP	Schuylkill River	Zone B	47.1	8.86	Moderate-C
90294	Pine Creek-294	NP	Pine Creek	Zone B	47.6	9.21	Moderate-C
90292	Bear Creek-292	NP	Bear Creek	Zone B	47.2	4.86	Moderate-C

Figure 3.2.4-17 Priority Point Sources and Subwatersheds for PWD's Queen Lane Intake for Total Suspended Solids in the Schuylkill River Watershed



VOCs

Table 3.2.4-12 shows the results of the ranking of VOC sites. In this case, the only significant potential sources of VOCs are storage tanks (ASTs), industrial sites from the TRI database, RCRA sites, or wastewater treatment plants. The high priority category is a mixture of AST, TRI, and NPDES sites. The medium and low priority categories are primarily AST and RCRA sites. The NPDES sites appear to load VOCs at a very low rate, and are not likely to cause water quality impairment at the intake. The AST, and TRI sites would require a spill to cause water quality impairment, but resulting concentrations would be very high. RCRA sites were difficult to assess for potential loading. Figure 3.2.4-18 identifies the priority point sources and subwatersheds for VOCs in the Schuylkill River Watershed.

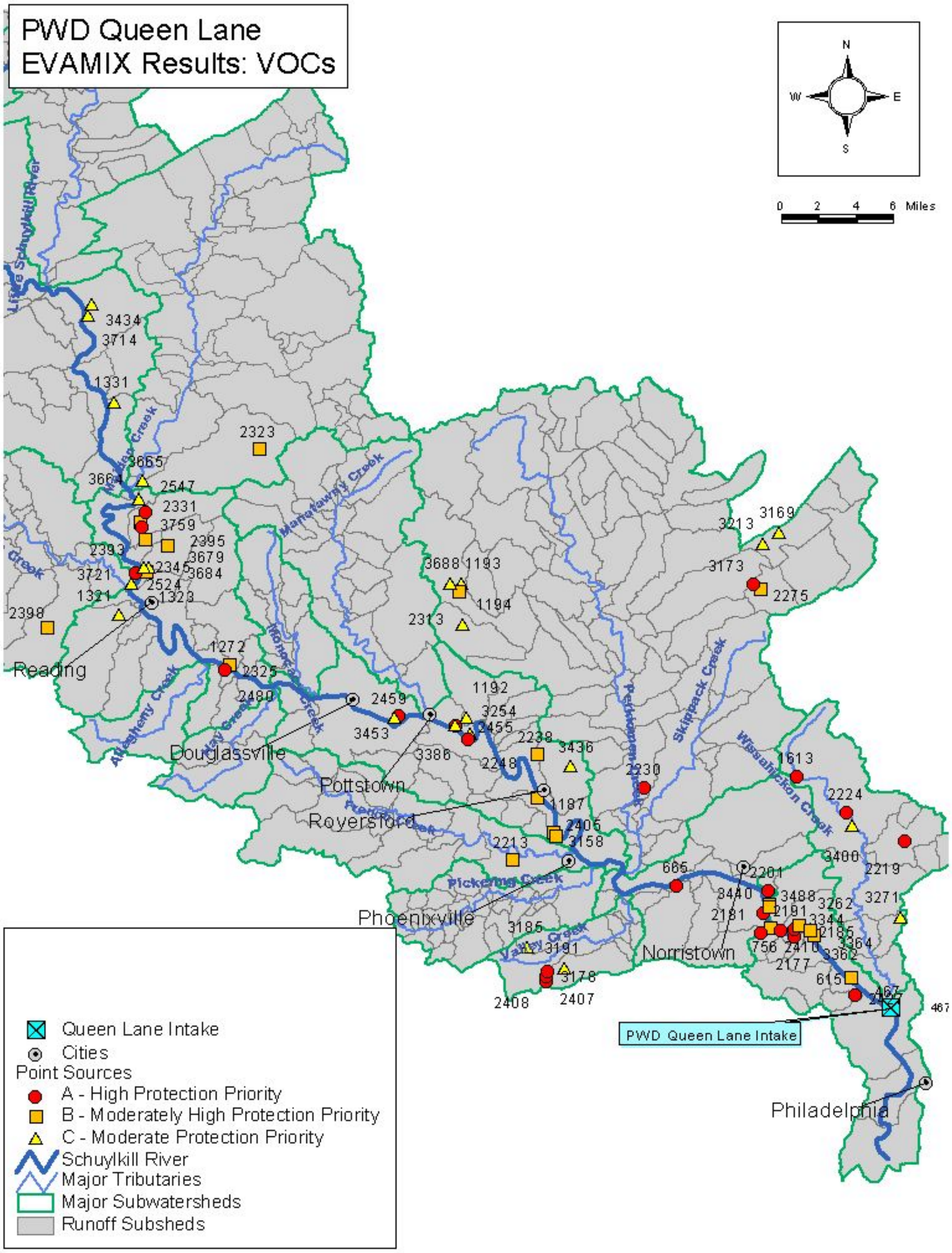
Table 3.2.4-12 Contaminant Category Ranking for VOCs

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3759	COLUMBIA PETRO	AST	Laurel Run	Zone B	33.6	18869025	Highest-A
3178	MALVERN TERM	AST	Little Valley Creek	Zone B	14.4	15566041	Highest-A
1613	UPPER GWYNEDD TWP	NPDES	Wissahickon Creek	Flood Plain	12.5	1.13	Highest-A
665	UPPER MERION MUN UTILITY AUTH	NPDES	Trout Creek	Zone A	8.0	1.11	Highest-A
2455	POTTSTOWN BORO	NPDES	Schuylkill River	Zone B	19.5	26.27	Highest-A
2480	CROMPTON & KNOWLES CORP GIBRALTAR PLT	NPDES	Schuylkill River	Flood Plain	26.2	2.79	Highest-A
2459	STANLEY G. FLAGG & CO. INC	NPDES	Schuylkill River	Zone B	20.9	0.67	Highest-A
3262	COOPERS CREEK CHEMICAL CORP.	AST	Schuylkill River	Zone A	3.0	4169475	Highest-A
2547	NGK METALS CORP.	NPDES	Laurel Run	Zone B	34.1	0.00	Highest-A
2524	CARPENTER TECHNOLOGY CORP	NPDES	Schuylkill River	Zone B	31.5	4.14	Highest-A
2219	HONEYWELL INC. PROCESS CONTROL DIV.	TRI	Sandy Run	Zone A	12.5	1270592	Highest-A
2410	ASHLAND CHEMICAL CO DIV ASHLAND OIL INC	TRI	Schuylkill River	Flood Plain	4.0	46200	Highest-A
2191	LONZA INC.	TRI	Schuylkill River	Flood Plain	4.5	15206	Highest-A
2185	FINNAREN & HALEY INC.	TRI	Schuylkill River	Flood Plain	3.5	2179	Highest-A
2181	COOPERS CREEK CHEMICAL CORP.	TRI	Gulph Creek	Zone A	4.5	64484	Highest-A
2201	SPRAY PRODS. CORP.	TRI	Plymouth Creek	Zone A	5.5	2077	Highest-A
2248	OCCIDENTAL CHEMICAL CORP.	TRI	Schuylkill River	Flood Plain	19.0	55978	Highest-A
2224	RHONE-POULENC AG CO.	TRI	Wissahickon Creek	Flood Plain	10.0	4654	Highest-A
2427	STEVENSON, W. N. CO.	TRI	Schuylkill River	Zone B	1.0	6143	Highest-A
2177	QUAKER CHEMICAL CORP.	TRI	Schuylkill River	Zone B	3.5	3234	Highest-A
2230	SUPERIOR TUBE CO.	TRI	Perkiomen Creek	Zone B	13.5	4992	Highest-A
3173	FARM AND HOME OIL CO. INC.	AST	Mill Creek	Zone B	26.7	3706200	Highest-A
2407	MOBIL OIL MALVERN TERMINAL	TRI	Little Valley Creek	Zone B	14.4	258926	Highest-A
2408	SUNOCO INC. (R&M) MALVERN TERMINAL	TRI	Little Valley Creek	Zone B	14.4	174141	Highest-A
2405	CROMBY GENERATING STATION	TRI	Schuylkill River	Zone B	13.5	50770	Moderately High-B

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
2313	CABOT PERFORMANCE MATERIALS	TRI	Swamp Creek	Zone B	23.6	34067	Moderately High-B
2213	PIERCE & STEVENS CHEMICAL CORP	TRI	French Creek	Zone B	14.4	2822	Moderately High-B
2331	LUCENT TECHNOLOGIES	TRI	Bernhart Creek	Flood Plain	33.0	1392	Moderately High-B
2238	STANLEY TOOLS ROYERSFORD PLANT	TRI	Schuylkill River	Zone B	15.5	1416	Moderately High-B
2325	CROMPTON & KNOWLES CORP GIBRALTAR PLT	TRI	Schuylkill River	Zone B	26.2	5978	Moderately High-B
756	PENN MED TECHNOLOGY	RCRA	Gulph Creek	Flood Plain	4.5	0.00	Moderately High-B
2345	GLIDDEN CO THE	TRI	Bernhart Creek	Zone B	32.5	33436	Moderately High-B
467	EVER READY CLEANERS	RCRA	Schuylkill River	Flood Plain	0.0	0.00	Moderately High-B
2275	FRES-CO SYSTEM USA INC.	TRI	Mill Creek	Zone B	26.7	3304	Moderately High-B
1187	SPRING CITY FOUNDRY	RCRA	Schuylkill River	Flood Plain	14.5	0.00	Moderately High-B
615	CONTAINER CORP OF AMERICA	RCRA	Schuylkill River	Flood Plain	1.5	0.00	Moderately High-B
2393	CARLOS R. LEFFLER INC.TUCKERTON FACILITY	TRI	Laurel Run	Zone B	33.6	177694	Moderately High-B
2395	EAGLE CHEMICAL CO.	TRI	Schuylkill River	Zone B	33.0	1523	Moderately High-B
2398	SUNOCO INC. (R&M) MONTELLO TERMINAL	TRI	Cacoosing Creek	Zone B	37.4	128448	Moderately High-B
3362	LONZA INC.	AST	Schuylkill River	Zone A	3.0	370620	Moderately High-B
3364	SCHUYLKILL PRINTING PLANT	AST	Schuylkill River	Zone A	3.0	277965	Moderately High-B
2323	GARDEN STATE TANNING - FLEETWOOD	TRI	Willow Creek	Zone B	41.2	2509	Moderately High-B
3344	QUAKER CHEMICAL CORP.	AST	Schuylkill River	Zone A	3.5	277965	Moderately High-B
3488	MONTGOMERY CHEM	AST	Plymouth Creek	Zone A	5.0	315027	Moderately High-B
3440	MONTGOMERY CNTY RESOURCE RECOVERY FAC	AST	Plymouth Creek	Zone A	5.0	277965	Moderately High-B
3158	CROMBY GENERATING STATION	AST	Schuylkill River	Flood Plain	13.5	444744	Moderately High-B
3400	ROTELLE INC	AST	Wissahickon Creek	Zone A	9.4	281671	Moderate-C
3271	METLAB CO	AST	Cresheim Creek	Zone B	4.3	325868	Moderate-C
3185	HCI EAST FALLS CORP	AST	Valley Creek	Zone B	13.8	555930	Moderate-C
3191	WORTHINGTON STEEL CO.	AST	Little Valley Creek	Zone B	13.8	296496	Moderate-C
3436	OEH LERT Bros. Fuel Oil	AST	Mingo Creek	Zone B	15.5	370620	Moderate-C
3386	EDWARD J SWEENEY & SONS	AST	Schuylkill River	Zone B	19.5	555930	Moderate-C
3254	OCCIDENTAL CHEMICAL CORP.	AST	Sprogles Run	Zone B	19.0	370620	Moderate-C
3721	GOSHERTS QUALITY FUELS	AST	Schuylkill River	Flood Plain	31.5	370620	Moderate-C
3453	PAM OIL INC	AST	Schuylkill River	Zone B	21.4	315824	Moderate-C
3688	BOYERTOWN OIL CO INC	AST	Swamp Creek	Zone B	24.2	277965	Moderate-C
3213	HESTON S SWARTLEY TRANS CO INC	AST	East Branch Perkiomen Creek	Zone B	26.1	370620	Moderate-C
3169	M & S OIL	AST	East Branch Perkiomen Creek	Zone B	26.7	370620	Moderate-C
1194	BOYERTOWN SANITARY DISPOSAL CO	RCRA	Minister Creek	Flood Plain	23.1	0.35	Moderate-C
1193	CABOT PERFORMANCE MATERIALS	RCRA	Swamp Creek	Flood Plain	24.2	2.78	Moderate-C

Source ID	Source Name	Database Used	Subwatershed	Zone	Time of Travel	Relative Impact (%)	Priority
3684	CARPENTER TECHNOLOGY CORP	AST	Bernhart Creek	Zone B	32.5	370620	Moderate-C
3679	GLIDDEN CO THE	AST	Bernhart Creek	Zone B	32.5	333558	Moderate-C
1192	OCCIDENTAL CHEMICAL CORP.	RCRA	Schuylkill River	Zone B	19.0	5.84	Moderate-C
3665	TEXTILE CHEM EK1	AST	Willow Creek	Zone B	37.1	555930	Moderate-C
3664	TEXTILE CHEMICAL CO INC	AST	Schuylkill River	Zone B	35.1	370620	Moderate-C
1321	BALDWIN HARDWARE MFG CORP	RCRA	Wyomissing Creek	Flood Plain	31.4	0.24	Moderate-C
3434	MOYER & SON INC	AST	Schuylkill River	Zone B	42.3	555930	Moderate-C
1272	CROMPTON & KNOWLES CORP GIBRALTAR PLT	RCRA	Schuylkill River	Zone B	26.2	76.16	Moderate-C
3714	ES SAVAGE INC	AST	Schuylkill River	Zone B	42.3	370620	Moderate-C
1323	CARPENTER TECHNOLOGY CORP	RCRA	Bernhart Creek	Zone B	32.5	19.55	Moderate-C
1331	BRUSH WELLMAN INC.	RCRA	Schuylkill River	Zone B	38.7	62.71	Moderate-C

Figure 3.2.4-18 Priority Point Sources and Subwatersheds for PWD's Belmont Intake for VOCs in the Schuylkill River Watershed



3.2.4.3 Narrative Results

Potentially Significant CERCLA Sources

Twenty-two of the 378 CERCLA sites in the watershed are on the National Priority List (NPL) for clean up by the USEPA. Approximately 274 of those CERCLA sites fall within the Zone A and B (5 to 25-hour times of travel) from the Belmont Intake during extreme high flow conditions. Only 27 of those 274 sites are within the Zone A (5-hour time of travel) from the Queen Lane Intake. Of those 27 sites in Zone A, 6 are within the floodplain. Overall, 18 sites are within the floodplain of Zone A and B from the Queen Lane Intake. It is very difficult to quantify the types and extent of pollution at a CERCLA site as well as their ability to migrate and impact a surface water supply. Therefore, a simple screening process was developed to determine which CERCLA sites may be a potentially significant source of contamination to the water supply. Sites that were considered significant needed to meet one or several of the following characteristics:

- The site is a National Priority List Site and considered contaminated and to be of concern by the USEPA;
- The site is within Zone A of the intake;
- The site is within the floodplain;
- The site is not currently being cleaned up by USEPA; or
- The site was identified by stakeholders as contaminated and of concern to the local community.

The priority ranking of the sites used the following criteria:

- A site met multiple criteria from above;
- A site was closer to the intake than another;
- A site had a higher surface water migration score than another site or overall migration score according to rankings provided at www.scorecard.org.

Using these criteria, 22 NPL sites were identified within the watershed. Two of the NPL sites reside within the floodplain, 18 fall within the Zone A and B of the Queen Lane intake. NPL sites are considered to be significant due to their history of contamination and local environmental impacts that require cleanup by the USEPA. As shown in Table 3.2.4-13, Montgomery, Chester, Berks, and Bucks counties are the top four counties in Pennsylvania when ranked by the number of NPL sites within them. Table 3.2.4-14 is a summary list of the most frequently detected chemicals at NPL sites in several counties within the Schuylkill River Watershed. As shown, the most common contaminants at these sites are volatile organic compounds and metal compounds.

Table 3.2.4-13 County Rankings in PA for Number of NPL Sites

Rank	County	Number of Superfund Sites
1	MONTGOMERY	16
2	CHESTER	12
3	BERKS	8
4	BUCKS	7
5	ADAMS	4
	ALLEGHENY	4
	LANCASTER	4
	LEHIGH	4
	MERCER	4
	MONROE	4
	YORK	4
6	DELAWARE	3
	SCHUYLKILL	3

Source www.scorecard.org

Table 3.2.4-14 Most Frequently Detected Chemicals at NPL Sites in Various Counties Draining Into the Schuylkill River Watershed

Contaminant	County
TCE	Berks
Diethanolamine	Berks
1,1-Trichlorethane	Bucks
Zinc	Bucks
Trichlorethylene	Chester
Nickel Compounds	Chester
Vinyl Chloride	Lehigh
Copper	Lehigh
TCE	Montgomery
Copper	Montgomery
Methyl Isobutyl Ketone	Philadelphia
Nickel Compounds	Philadelphia
Mercury	Schuylkill
Barium Compounds	Schuylkill

Source www.scorecard.org

In addition to NPL sites there were another 18 CERCLA sites in the floodplain upstream of the intake. These sites and the other CERCLA sites identified by stakeholders as potentially significant sources of concern were examined for significance.

The final ranking of the NPL sites is provided in Table 3.2.4-15. The rankings identified 18 NPL sites and 3 additional CERCLA sites that are considered to be potentially significant sources of contamination. Three of the sites were located within the Zone A (5-hour) travel time to the Queen Lane Intake. All remaining sites are located in Zone B (<25-hour). The sites of protection priority C are sites that have been cleaned up, contained, or are being utilized by businesses again and should represent little threat to the environment.

As mentioned earlier, there is no way to adequately quantify all of these sites for proper comparison in the overall EVAMIX prioritization rankings. However, based on the limited information available it appears that the CERCLA sites would potentially rank very low compared to other potentially significant sources in the watershed from the combined ranking.

Table 3.2.4-15 Potentially Significant CERCLA Sources for the Queen Lane WTP Intake

Rank	Zone	Site Name	Chemicals	Floodplain	NPL Status
A	A	TYSONS DUMP	VOCs		NPL
A	B	DOUGLASVILLE DISPOSAL SITE	VOCs, metals	YES	NPL
A	B	MOYERS LANDFILL	VOCs, metals		NPL
A	B	BERKS LANDFILL	VOCs, metals		NPL
A	B	OCCIDENTAL CHEMICAL CORP.	VOCs	YES	NPL
A	B	FOOTE MINERAL CO	VOCs, metals		NPL
B	B	RECTICON/ALLIED STEEL CORP	VOCs		NPL
B	B	BROWN'S BATTERY BREAKING	metals	YES	NPL
B	B	NORTH PENN – AREA 1	VOCs		NPL
B	B	NORTH PENN – AREA 7	VOCs		NPL
B	B	MALVERN TCE	VOCs		NPL
B	B	SALFORD QUARRY	VOCs, metals		Proposed
B	B	CRATER RESOURCES/KEYSTONE COKE/ALAN WOOD	VOCs, metals		NPL
B	A	MIQUON LANDFILL	Herbicides/Pesticides, metals		NOT ON NPL
B	A	POTTSTOWN INDUSTRIES COMPLEX	Unknown		NOT ON NPL
B	B	PHOENIXVILLE PIPE & TUBE LP STEEL CORP	Unknown		NOT ON NPL
C	B	HENDERSON RD SUPERFUND SITE	VOCs, metals		NPL
C	B	STANLEY KESSLER	VOCs		NPL
C	B	KIMBERTON SITE	VOCs, metals		NPL
C	B	COMMODORE SEMICONDUCTOR GROUP	VOCs		NPL
C	B	NORTH PENN – AREA 12	VOCs		NPL

Spills and Accidents

As mentioned in previous sections, the Schuylkill River is a major transportation corridor for railroads and trucking. In addition, there are several major petroleum pipelines located within the watershed. The volumes of chemicals transported by these means are quite significant. A tanker truck can normally hold about 5,000 gallons of a chemical. A railroad tanker car can normally hold about 14,000 gallons of a chemical. A pipeline, if it breaks and spills contaminants for an hour or more can spill between 1,000 to 10,000 gallons of a chemical, depending on its size.

Assuming that there was an accident and the entire or even partial contents of these sources were spilled into the river, estimates show that the impacts on downstream local water supplies could be severe even up to 100 miles downriver. Assuming the pipeline, railroad tanker car, or a tanker truck spilled benzene even ten miles upriver, only ten gallons of benzene would need to make it to the river during a normal flow day for concentrations in the river to potentially cause significant impacts on water quality. This would either require the plant to stop withdrawing water or special treatment of the water with carbon.

Under more extreme conditions, up to 100 gallons of benzene would need to be spilled for a similar impact. These estimates do not take into account the loss of benzene due to holding in pockets in the river or binding to sediments and other material as it flows downstream. Therefore, higher concentrations of 1,000 gallons of benzene spilled from an accident would most likely have a severe impact on water quality at the intake even if it was spilled during a rain event 100 miles upriver.

In terms of their overall priority compared to the other sources provided in the combined ranking, spills and accidents can have one of the greatest relative impacts on water quality and require some moderate level of protection priority. An early warning system on the Schuylkill River such as present on the Ohio River would help to prevent such severe impacts in the event of a spill.

Radionuclides

The presence of the Limerick Nuclear Generating Station upriver requires monitoring for the presence of radionuclides in the finished drinking water. To date, special monitoring has only detected Gross Beta radionuclides at levels far below the regulated limits in the finished water from Schuylkill River sources. No other types of radionuclides have been detected.

Regardless of the lack of observed impact from these sources, they were still identified. There were only two sources of radionuclides identified in the Schuylkill River Watershed. They are the Limerick Nuclear Generating Station and the Unitech Laundry Facility. The Limerick NGS does not directly discharge any waters into the Schuylkill River from its process and radionuclides are only considered to potentially enter the river through airborne deposition. The Unitech Laundry located in Royersford, cleans the uniforms from the operations at the Limerick NGS. It currently discharges its wastewater to the local sewage treatment plant but may be treating and discharging its process water to the river directly. This was mainly the result of issues associated with radionucludes in the bio-solids from the local sewage treatment plant that were to be used for land application.

Given that current water quality data does not suggest any radionuclide issues with these sources and the current controls and monitoring in place to protect against them, these sources would be considered a medium protection priority and would tend to fair lower than other sources identified in the combined ranking.

3.2.5 Qualitative Loading Analysis

Key Points

- **Quantitative contaminant loading analyses are difficult to implement, as it is not possible to accurately characterize all of the factors affecting potential contaminant releases and transport.**
- **Qualitative contaminant loading analyses can provide useful order-of-magnitude assessments that will help to identify potentially significant major loads.**
- **Non-point sources associated with stormwater runoff were identified as significant sources of salts, *Cryptosporidium*, fecal coliform, nitrates, petroleum hydrocarbons, phosphorus, disinfection by-products, and total suspended solids.**

3.2.5.1 Method

Performing a quantitative pollutant loading analysis requires a substantial investment in data collection. For example, for sites that actually discharge wastewater to the river on a continuous or intermittent basis, accurate data on discharge rates and concentrations of contaminants in the discharge water are required. For sites that store chemicals, accurate data on the amount and type of chemical stored are required, and a series of assumptions must be made about the probability of leaks or spills occurring. The analysis must also account for natural sources of certain contaminants and a calibrated non-point source or runoff-loading model is needed to add stormwater-related loadings to the calculations. For this reason, a quantitative contaminant loading analysis goes well beyond the scope of this study, and the data collected are not sufficiently accurate to allow a quantitative analysis to be performed.

Despite the limitations that the data impose, a more qualitative analysis of contaminant loading is still valuable, and can provide important insight into the relative magnitude of the impacts that the major contaminant sources might have on the water quality within the watershed. The approach to performing the analysis is summarized by the following steps.

Step 1: Loading Estimates

- For sites that have continuous or intermittent discharges, estimates of annual contaminant loading for each contaminant category are calculated by multiplying median discharge concentration times average annual discharge rate.

- For sites that simply store or use chemicals onsite, there is no logical way to estimate point loading because contaminants are only released through spills or leaks. An extreme estimate of potential loading can be made by assuming stored chemicals in the largest tank onsite are released through a catastrophic tank failure and are all spilled to the surface water.

- For non-point source pollutant loading, estimates for each contaminant category were provided by the SWMM model results on an annual basis.

Step 2: Loading Magnitude Comparisons
The loading estimates produced in step one are of widely varying accuracy. The SWMM model stormwater loads may be generally accurate, however, they are based on Event Mean Concentrations that may or may not be representative of local conditions within the watershed. The loading estimates for point source dischargers range from accurate for dischargers who regularly monitor their discharges and report results (usually the larger sources), to highly speculative where data had to be filled in for both concentration and discharge rate (many of the smaller dischargers). The loading estimates for sites that store or use chemicals are not based on data, and represent a speculation on potential leaking or spilling that probably overestimates loading by a considerable margin.

Despite the disparity in accuracy, the total annual loads can be contrasted with each other, and general conclusions about the magnitude of each type of source drawn. These estimates will also be compared to estimates of contaminant loads from natural or more regional sources (e.g. acid mine drainage) where information or data are available. The intent is not to calculate actual estimates of loading rate, but to better understand which sources are most likely to be major sources, and which appear to be minor sources.

Step 3: Reality Check
Because of the highly speculative nature of the loading estimates, annual average contaminant loads can be summed, and divided by annual average flow rates in the river to estimate an in stream concentration. The calculated concentration can be compared to in stream sampling data and conclusions drawn about the degree of overestimation or underestimation that the loading estimates appear to represent.

3.2.5.2 Results

Only a general, qualitative analysis of contaminant loading can be made with the sketchy data available for this analysis. A cumulative loading analysis goes well beyond the scope of this analysis and is not attempted here. The qualitative loading analysis is based on the loading estimates produced by the database in support of the evaluation of sites, and only provides an indication of the relative importance of each potential source.

Loading Estimates
Using the database, order of magnitude estimates of loads from each type of source can be made. These are discussed here in a general sense for the sites in the major databases.

Each source is rated according to the relative impact that the source might have on ambient river concentrations.

- *Low*: if the sites do not appear to contribute enough load to even register as a portion of the ambient concentration. Generally, each of these sites if discharging or spilling to the river, would only change the concentration at the intake by less than one percent.

- *Medium*: if the sites could be contributing a low percentage of the actual ambient concentrations. Generally, each of these sites, if discharging or spilling to the river, would change the concentration at the intake from 1 to 25%.

- *High*: if the sites could or are one of the major contributors of this contaminant. Generally, each of these sites, if discharging or spilling to the river, would change concentrations at the intake by more than 25%.

A distinction is made between sources that are contributing and those that could, but only if spills or leaks occur.

Table 3.2.5-1 provides a summary of the estimated combined contributions by the various source types under either normal or abnormal (such as the primary storage tank spilling all its contents) conditions. The table also provides comments on whether the indicated, cumulative sources appear to drive or influence water quality when compared to water quality data. "Yes" indicates that current water quality day corroborates the indicated source contributions. "Partial" indicates that current water quality data only partially corroborates the source contributions. "No" indicates that no real correspondence exists between the source contributions and water quality data.

Table 3.2.5-1 Qualitative Combined Contributions to River Water Quality

Contaminant	NPDES (dischargers)	NPS (runoff)	TRI (toxic facilities)	AST (storage tanks)	Matches with Reality?
Salts	Low	Low	Low-Medium*	Medium*	Yes
Cryptosporidium	Low	Low	Low	Low	Partial
Fecal coliforms	Low	Medium	Low	Low	Yes
Nitrate	Medium-High	Low	Medium-High*	Low	Yes
Metals	Medium	Medium	High*	High*	Partial
Phosphorus	Low-Medium	Medium	Medium	High*	Yes
Petroleum Hydrocarbons	Low	Medium	Low	High*	No
Disinfection-by-Products	Medium-High	Medium	Low	Low	Partial
Turbidity	Medium-High	Medium	Low	Low	Partial
Volatile Organic Compounds	Low-Medium	Low	High*	High*	Yes

** Abnormal and highly unlikely situation would require the simultaneous release of contaminants from all facilities or storage tanks.*

As shown, estimates for salts, fecal coliforms, nitrate, phosphorus, and volatile organic compounds appear to match well with current water quality data observations. However, the estimate for petroleum hydrocarbons does not match. Petroleum hydrocarbons are rarely, if ever, measured at the intake. Some categories, such as metals, only show partial matches. Source contributions for metals, such as lead and copper, do generally match water quality. However, source contributions do not correlate with iron and manganese intake levels, which are greatly influenced by acid mine drainage. Therefore, the qualitative loading analysis, which is based on conservative assumptions, only provides some very general indications about the impacts of various sources. This analysis requires further refinement as part of a true cumulative analysis for a TMDL in order to provide more accurate predictions.

Salts

NPDES (permitted dischargers): Low

Permanent discharges, but at very low concentrations.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of salts during the winter, but does not appear to be a significant concern.

TRI (generators/handlers): Low - Medium

Sites could contribute minor amounts, but only do so through spill or leaks.

AST (aboveground tanks): Medium (potential only)

Not a significant source unless a spill occurs.

Comparison of the loading results to actual seasonal trends in water quality data (section 2.1.5) shows that the results of both analyses indicate that NPS (stormwater) runoff is the main source of salts in the watershed. The qualitative loading results further indicate that the cumulative impact of these sources especially from developed areas may be significant. In addition, long-term trends appear to suggest that the cumulative impacts are significant and the source of the increasing concentrations in the river.

Cryptosporidium

NPDES (permitted dischargers): Low

These are one of only two sources, however, the loading rate is relatively low, and does not result in significant concentrations in the ambient water under normal circumstances.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of *Cryptosporidium* from certain land uses, and is probably responsible for almost all the background levels found in the river.

TRI (generators/handlers): Low

Not a source

AST (aboveground tanks): Low

Not a source.

Comparison of the qualitative loading data with actual water quality data from research studies conducted by PWD, suggest that the elevated concentrations observed during storm events are most likely due to storm water runoff from developed areas and pasture lands. However, during non-rainfall periods, it appears that NPDES discharges in particular from wastewater treatment plants are the main source of daily concentrations observed in the Schuylkill River. Therefore, efforts to reduce mean daily concentrations of *Cryptosporidium* in the river should focus on reducing the impacts from wastewater discharge, while efforts to reduce peak concentrations should focus on mitigating stormwater runoff from pastures and developed areas.

Fecal Coliform

NPDES (permitted dischargers): Low

These sites are one of only two sources, however, the loading rate is relatively low, and does not result in significant concentrations in the ambient water under normal circumstances.

NPS (stormwater runoff loading): Medium

Stormwater runoff is a major source and is probably responsible for almost all the background levels found in the river. This is usually seen in the extreme variability of fecal counts responding to rainfall events.

TRI (generators/handlers): Low

Not a source

AST (aboveground tanks): Low

Not a source.

Comparison of the qualitative loading data with actual water quality data suggests that the elevated concentrations observed during storm events are most likely due to stormwater runoff from developed areas and pasture lands. However, during non-rainfall periods, it appears that coliforms can originate from a number of sources including wastewater discharges, leaking septic tanks, leaking sewers, "wildcat" or illegal sewage discharges, geese, and livestock.

Metals

NPDES (permitted dischargers): Medium

NPDES discharges may account for some of the metal concentration found at the intake. The amounts, cumulatively, could represent a low but significant percent of total metal loading for certain metals.

NPS (stormwater runoff loading): Medium

Stormwater runoff can be a significant source of metals during storm events, with runoff often contributing copper, zinc, cadmium, and other metals at relatively low concentrations to the water.

TRI (generators/handlers): High (potential only)

Sites could contribute major amounts of metal to the river, but only do so through spill or leaks. The amounts stored, if spilled, could cause order of magnitude exceedances of the drinking water standards at the intake for short periods of time.

AST (aboveground tanks): High (potential only)

Sites could contribute major amounts of metal to the river, but only do so through spill or leaks. The amounts stored, if spilled, could cause order of magnitude exceedances of the drinking water standards at the intake for short periods of time.

Though the qualitative analysis suggests that TRI and AST sites have the potential for the greatest cumulative impacts, it would require numerous simultaneous catastrophes in the watershed for this to occur. Based on analysis of long-term trends, it appears that concentrations of metals are increasing in the river. Also water quality data suggests most metals increase during storm events. The only metal that does not always increase during rain events is Manganese. In section 1.4.6.1, it was shown that concentrations measured from acid mine drainage discharges can actually be responsible for everyday concentrations of Iron and Manganese observed in the Schuylkill River. Also, spatial analyses in section 3.1.5 also observed a decrease in metals concentrations with distance downriver. Therefore, though it is estimated qualitatively that NPDES discharges appear to have a medium impact on metal concentrations in the river, it is more likely that stormwater runoff and acid mine drainage are the driving factors cumulatively influencing water quality trends in the river.

Nitrates

NPDES (permitted dischargers): Medium - High

Permitted discharges of wastewater contribute a steady load of nitrates to the river, but do not result in concentrations that approach the drinking water standard.

NPS (stormwater runoff loading): Low

Stormwater runoff can be a source of nitrate, especially runoff from agricultural lands, however, in general, loading is not significant.

TRI (generators/handlers): Medium – High (potential only)

Generally not a source, although a few sites appear to have the potential to be a temporary source of high concentrations if a spill were to occur.

AST (aboveground tanks): Low

Not a significant source.

Analysis of observed nitrate concentrations in sections 3.1.5 and 1.5 show that nitrate and ammonia concentrations are decreasing in the river. Also, seasonal fluctuations in nitrate concentrations appear to be dominated by biological activity in the river. However, analysis of impairment data in section 3.1.5.4 suggests that nutrients are one of the top three leading causes of impairments in the lower half of the Schuylkill River Watershed. Upon further examination, these impairments may be more related to phosphorus than nitrate. Overall, the combined information suggests that improvements by wastewater discharge and reduced agricultural runoff have benefited the watershed, but the cumulative impacts of nitrate from both point and non-point sources combined may still play a significant role in determining stream health.

Petroleum Hydrocarbons

NPDES (permitted dischargers): Low

Not a significant source.

NPS (stormwater runoff loading): Medium

Stormwater runoff is a source of petroleum hydrocarbons during storm events, particularly from urban areas. Measurable concentrations at the intake are possible as a result of stormwater runoff.

TRI (generators/handlers): Low

Not a source.

AST (aboveground tanks): High (potential only)

This is only a source if spilled or leaked. The amounts stored at many sites, however, mean that a spill could have significant impact, with very high concentrations occurring following a spill.

As observed, petroleum hydrocarbons from non-point source runoff and above ground storage tanks were considered to have the greatest potential qualitative impacts. Petroleum hydrocarbon impacts are typically observed from spills caused by accidents or releases. The impacts of hydrocarbons from storm water runoff have not been observed in either water quality data or stream impairment descriptions to date.

Therefore, the observed cumulative impact of various sources on hydrocarbons is low, but the observed impact from an individual source during an accident can be significant.

Phosphorus

NPDES (permitted dischargers): Low - Medium

Wastewater discharges are a source of phosphorus, but at amounts that are not likely to have a large effect on ambient concentrations at the intake.

NPS (stormwater runoff loading): Medium

Stormwater runoff can be a major source of phosphorus in runoff from residential and agricultural areas. Concentrations may occasionally be high, causing a measurable impact at the intake.

TRI (generators/handlers): Medium (potential only)

Some sites could contribute significant amounts, but only do so through spill or leaks.

AST (aboveground tanks): High (potential only)

Generally not a source unless a major spill occurs.

Analysis of observed orthophosphate concentrations in sections 3.1.5 and 1.5 show that orthophosphate concentrations are increasing in the river. Seasonally, orthophosphate concentrations also appear their greatest during spring when runoff and rainfall occurs. In addition, analysis of impairment data in section 3.1.5.4 suggests that nutrients are one of the top three leading causes of impairments in the lower half of the Schuylkill River Watershed. Upon further examination, these impairments may be more related to phosphorus than nitrate. Overall, the combined information suggests that the cumulative release of phosphorus from non-point sources may be the most significant contribution for control.

Disinfection By-Product (Total Organic Carbon)

NPDES (permitted dischargers): Medium - High

Wastewater discharges are one of the major sources of TOC, and can be having a measurable impact on concentrations at the intake.

NPS (stormwater runoff loading): Medium

Stormwater runoff is a major source of TOC during storm events, and contribution can come for a variety of land uses, including parkland and wooded areas.

TRI (generators/handlers): Low

Sites could contribute minor amounts, but only do so through spill or leaks.

AST (aboveground tanks): Low

Not a significant source.

Total organic carbon can come from many sources including agriculture, decaying leaves and algae, and sewage discharge. However, the nature of the organic matter from those sources can be significantly different and have significantly different impacts on the formation of disinfection-by-products when they react with chlorine. Water quality data in section 1.4 suggests that TOC has increased in the river over the past decade. Since the population in the watershed has not changed significantly in the past decade, it is doubtful that NPDES discharges are the influencing cumulative source related to this increase. However, during this period, developed land throughout the watershed has increased. These observations suggest that the combined impact from the many non-point sources in the watershed may be driving the increasing concentrations observed in the river.

Turbidity (Total Suspended Solids)

NPDES (permitted dischargers): Medium - High

Wastewater discharges are a major source of TSS, and probably have a measurable impact at the intake.

NPS (stormwater runoff loading): Medium

Stormwater runoff is the major source of TSS during storm events, and can cause large increases in concentration for periods of time during and after a storm. The heaviest loading comes from disturbed construction sites and agricultural areas.

TRI (generators/handlers): Low

Not a source.

AST (aboveground tanks): Low

Not a source.

Though the qualitative analysis suggests that NPDES discharges can be a controlling source of turbidity, water quality data suggests otherwise. In fact, data shows that non-point source runoff tends to control turbidity due to its increased values during the wetter seasons. NPDES discharges may contribute to the daily non-rain event turbidity levels, but water quality data to date does not clearly suggest any impact on turbidity from dry weather discharges.

VOCs

NPDES (permitted dischargers): Low - Medium

Generally not a significant source of VOCs, however can contribute to loads depending on mix of industry.

NPS (stormwater runoff loading): Low

Not a significant source.

TRI (generators/handlers): High (potential only)

Sites could contribute significant amounts, but only through spill or leaks. A spill would result in orders of magnitude increase above drinking water standards.

AST (aboveground tanks): High (potential only)

Sites could contribute significant amounts, but only through spill or leaks. A spill would result in orders of magnitude increase above drinking water standards.

As observed, volatile organic compounds toxic release facilities and aboveground storage tanks were considered to have the greatest potential qualitative impacts. Analysis of the limited VOC data does not suggest any impacts from particular point sources or facilities. Past experiences tend to suggest that individual sources, such as accidents and spills that release benzene or toluene, are most likely to impact the water supply. Therefore, the observed cumulative impact and likelihood from various sources of VOCs is low, but the observed impact from an individual source during an accident can be significant.

3.2.6 Watershed Protection and Restoration Activities

Key Points

- **Restoration activities within the Lower Schuylkill River Watershed and the Wissahickon Creek Watershed are within Zone A of the Philadelphia Water Department's Queen Lane Intake.**
- **The Lower Schuylkill River Watershed was awarded $5,837,791 in grant funding over the past seven years.**
- **Over 50% of the grants funded restoration projects within the watershed.**
- **The Wissahickon Creek Watershed was awarded $1,124,625 in grants over the past seven years.**
- **Nearly 40% of the Wissahickon Creek grant funds are being used to fund urban stormwater best management demonstration projects.**

In order to gain an understanding of the current levels of environmental stewardship and awareness within watersheds, a compilation of grants and restoration projects was completed. State, Federal and private grant sources identified the levels of funding that they provided through various programs to respective watersheds from 1995 to 2001.

These programs include the Pennsylvania Department of Environmental Protection's (PA-DEP) 319 Non-point Source Program and the Growing Greener Program, the Pennsylvania Department of Conservation and Natural Resource's (PA-DCNR) Rivers Conservation Plan Program, and Pennsylvania's Coastal Zone Management Program. Also included were Pennsylvania's Natural Resource and Conservation Service's (NRCS) Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Watershed Protection and Flood Prevention Act (PL-566) Program, and the Environmental Quality Incentives Program (EQIP). In addition, private sources of funding were also compiled, including the William Penn Foundation, the Pew Charitable Trusts and The Pennsylvania League of Women's Voters. Additional sources of funding included federal funds via the Army Corps of Engineers (USACOE), the United States Environmental Protection Agency (EPA), the United States Fish and Wildlife Service (FWS), and the National Science Foundation (NSF).

Restoration activities within the Lower Schuylkill River Watershed and the Wissahickon Creek Watershed are within the Zone A limit of PWD's Queen Lane Intake. The Lower Schuylkill ranked first out of 17 subwatersheds for total dollars spent with $5,837,791, which corresponds to $83,913.68/ square mile. The Wissahickon Creek Watershed ranked fifth out of 17 subsheds with a total of $1,124,625, which corresponds to $17,674.44/square mile.

Figure 3.2.6-1 summarizes the distribution of grant dollars for the lower Schuylkill River Watershed by project type. Over 50% of the grant funds were allocated for restoration projects in the watershed.

Figure 3.2.6-1 Distribution of Lower Schuylkill River Watershed Grants by Project Type

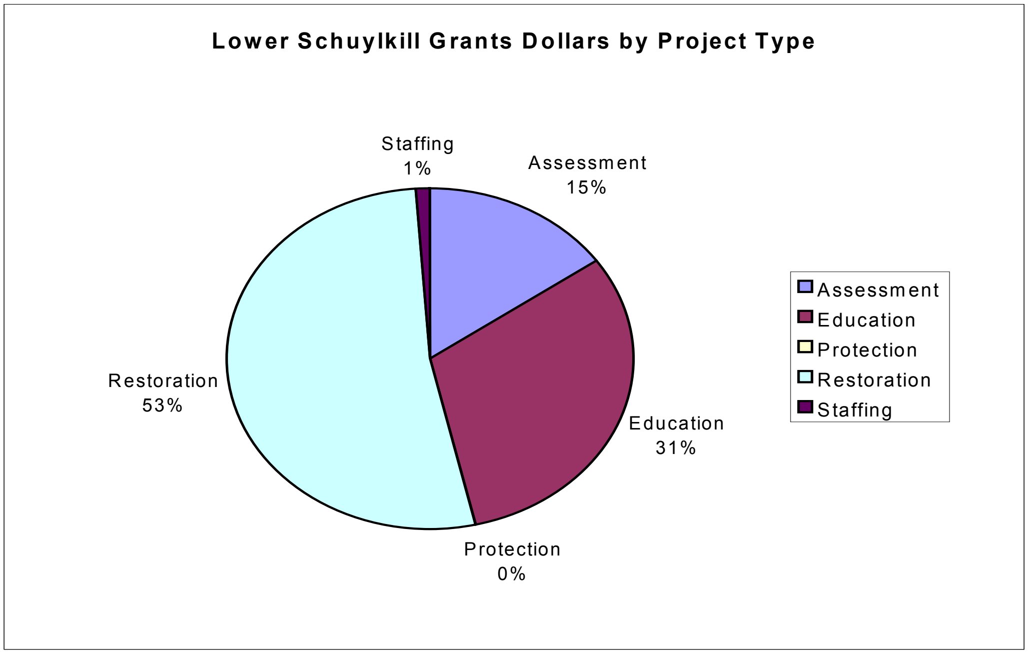


Table 3.2.6-1 lists the grants received within the Lower Schuylkill River Watershed from 1995-2001. The largest project funded was the Fairmount Water Works, receiving approximately 33% of the total funding for the watershed. The Fairmount Water Works will serve as the educational center for the region in terms of water resources and the connection between anthropogenic activities and environmental sustainability.

Table 3.2.6-1 Projects Receiving Grants in the Lower Schuylkill River Watershed from 1995-2001

Grant	Awardee	Project Description	Source	Year
$30,000	Philadelphia Urban Resource Partnership	Hire a director	PA DEP 319	1995
$50,000	Philadelphia Water Department	Waterworks exhibits	PA CZM	1995
$30,000	Philadelphia Urban Resource Partnership	Hire a director	PA DEP 319	1996
$3,600	Friends of the Manayunk Canal	Towpath map	DELEP	1997
$21,238	Fairmount Park Commission	Footbridge, observation deck	PA CZM	1998
$11,600	Pennsylvania Environmental Council	Environmental education	PA CZM	1998
$7,389	Schuylkill River Keeper	Riparian planting		1998
$27,500	Lower Merion Conservancy	Headquarters renovation	WPF	1999

Grant	Awardee	Project Description	Source	Year
$2,956	Manayunk Development Corporation	Environmental education	PA LoWV	1999
$7,200	Montgomery County Lands Trust	Land preservation	WPF	1999
$3,000	Philadelphia Water Department	Riparian buffer restoration	PA LoWV	1999
$3,000	Philadelphia Water Department	Riparian planting	DELEP	1999
$66,000	Schuylkill River Development Council	Bridge restoration	WPF	1999
$144,540	Schuylkill River Development Council	Riparian parkland	WPF	1999
$2,200	Manayunk Development Corporation	Towpath tour	DELEP	1999
$55,300	Villanova University	Wetland restoration; urban bmps	PA DEP 319	1999
$150,000	Bryn Mawr College	Stormwater wetland	PA GG	2000
$25,300	Fairmount Park Commission	Lake restoration	PA GG	2000
$20,000	Friends of the Manayunk Canal	Restoration Plan	PA GG	2000
$1,100,000	Fund for the Fairmount Water Works	Restoration and education	WPF	2000
$56,415	Manayunk Development Corporation	NPS pollution education	PA GG	2000
$2,906	Manayunk Development Corporation	Environmental education	PA LoWV	2000
$750,000	Philadelphia Water Department	Fairmount Water Works	PA GG	2000
$3,000	Philadelphia Water Department	Riparian buffer restoration	PA LoWV	2000
$200,000	Philadelphia Water Department	Stormwater bmps at a school	PA GG	2000
$11,000	Riverbend Environmental Education Center	Watershed models; education	PA GG	2000
$2,910	John Bartram Association	Fishing on the Schuylkill	DELEP	2000
$550,000	Schuylkill Center for Env Education	Environmental education, trails	WPF	2000
$797,500	Schuylkill River Development Council	Masterplan for tidal Schuylkill	WPF	2000
$3,500	Schuylkill River Keeper	Riparian planting		2000
$55,000	University City District	Clark park revitalization plan	WPF	2000
$85,020	Upper Merion Township	Streambank restoration	PA GG	2000
$10,120	Villanova University	Stormwater bmps on campus	PA GG	2000
$25,000	Riverbend Env Education Center	Develop a master site plan	PA GG	2001
$120,000	Lower Merion Township	Develop Rolling Hill Park trail	PA GG	2001
$350,000	Fairmount Park Commission	Develop East Fairmount Park	PA GG	2001
$240,000	Philadelphia Water Department	Fairmount Water Works	PA GG	2001
$59,112	Villanova University	detention basin into wetland	PA GG	2000
$85,500	Villanova University	Porous concrete demonstration	PA GG	2001
$385,000	Bryn Mawr College	Ashbridge Memorial Park	PA GG	2001
$34,985	The Miquon School	Crayfish Creek restoration	PA GG	2001
$250,000	University of Pennsylvania	Public stormwater management	PA GG	2001

Figure 3.2.6-2 summarizes the distribution of grant dollars for the Wissahickon Creek Watershed by project type. Seventy-five percent of the funds were allocated for restoration projects.

Figure 3.2.6-2 Distribution of Wissahickon Creek Watershed Grants by Project Type

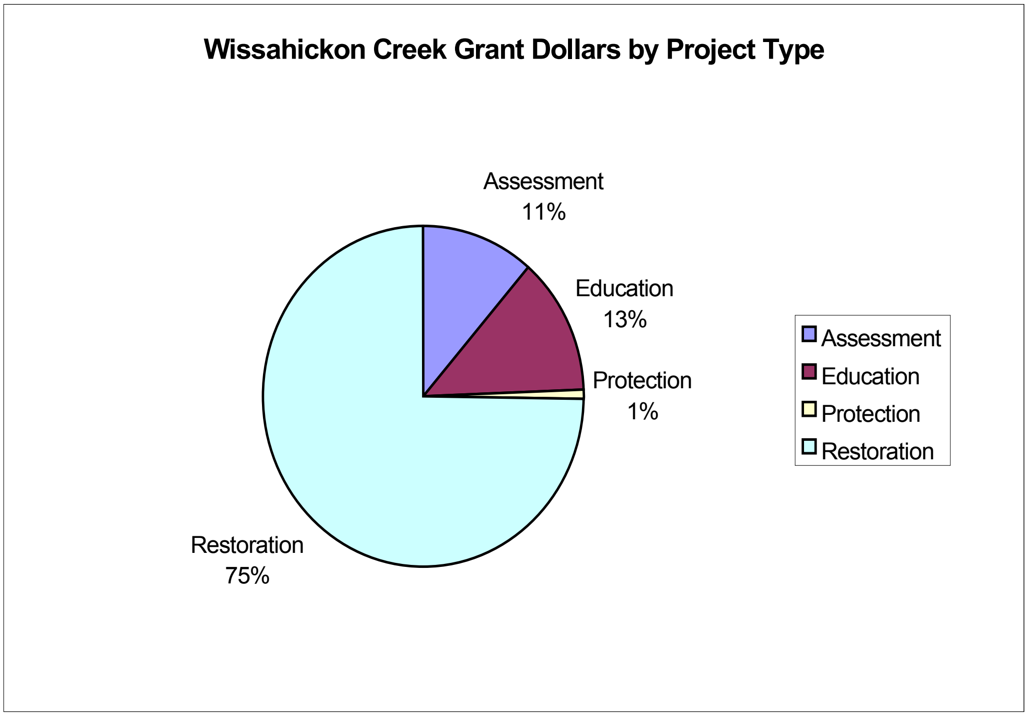


Table 3.2.6-2 shows the grants awarded within the Wissahickon Creek Watershed. The majority of grant dollars (39%) within the Wissahickon have gone to the Morris Arboretum (University of Pennsylvania) for demonstration projects for urban stormwater best management practices.

Table 3.2.6-2 Projects Receiving Grants in the Wissahickon Creek Watershed from 1995-2001

Grant	Awardee	Project Description	Source	Year
$76,250	Morris Arboretum	Urban bmps	PA DEP 319	1997
$108,750	Morris Arboretum	Urban bmps	PA DEP 319	1998
$115,273	Schuylkill River Keeper	Streambank stabilization		1998
$30,000	Lower Gwynedd Township	Urban bmps retrofits	PA WRAP	1999
$8,400	Montgomery County Land Trust	Land preservation	WPF	1999
$127,101	Morris Arboretum	Urban bmps	PA DEP 319	1999
$33,426	Schuylkill River Keeper	Streambank restoration		1999
$4,626	Schuylkill River Keeper	Streambank restoration		1999
$5,004	Schuylkill River Keeper	Streambank restoration		1999
$20,000	Wissahickon Valley W.A.	Water quality monitoring	PA DEP 319	1999
$24,515	Alliance for a Sustainable Future	Stormwater quality monitoring	PA GG	2000
$75,560	Alliance for a Sustainable Future	Stormwater quality monitoring	PA GG	2000
$20,633	Center in the Park	Educational curriculum	PA GG	2000
$3,300	Bioblitz with NLREEP: FPC	Streambank restoration	DELEP	2000
$4,035	Schuylkill River Keeper	Streambank restoration		2000
$3,038	Schuylkill River Keeper	Streambank restoration		2000
$3,000	Stroud Water Research Center	Water quality monitoring	PA LOWV	2000
$126,500	Morris Arboretum	Environmental education	WPF	2000
$26,000	Wissahickon Restoration Volunteers	Streambank restoration	PA GG	2000
$53,500	Wissahickon Valley W.A.	Streambank restoration	PA GG	2000
$5,714	Stroud Water Research Center	Macroinvertebrate analysis	WYO & WPF	1995-2000
$100,000	Ambler Borough	DAF	PA GG	2001
$150,000	Philadelphia Water Department	Stormwater treatment wetland	PA GG	2001

3.2.7 Public Participation Process

Key Points

- **Public kick-off meetings, Technical Advisory Group meetings, media articles and a Website were some of the methods used to involve the public in the Source Water Assessment Program (SWAP).**
- **A Technical Advisory Group (TAG) was established to facilitate communication among stakeholders, and to gather information about the watershed.**
- **The TAG meets quarterly to assist the Source Water Assessment Partnership in the SWAP process.**
- **Sixteen people attended the two public kick-off meetings held to introduce the SWAP.**
- **SWAP project information is available through the project Website, www.schuylkillswa.org.**

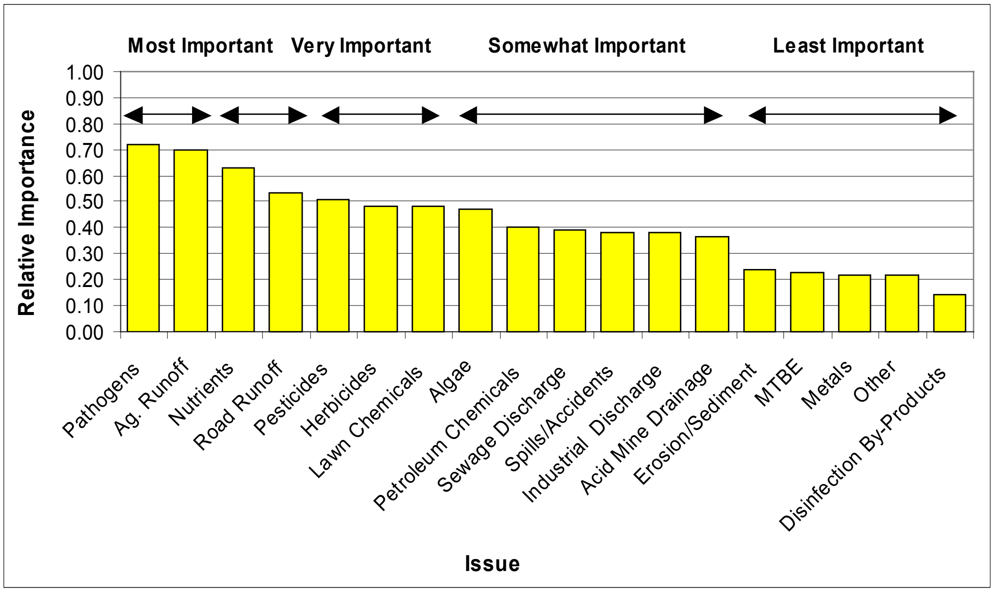
The involvement of the public in the Schuylkill Source Water Assessments included several avenues to provide opportunities for stakeholder and public involvement. These included:

- Public Kickoff Meetings
- Public Wrap-up Meetings
- Technical Advisory Group Meetings
- Legal Notices
- Newspaper Articles
- SWAP Website

Overall, these avenues appear to have been successful at reaching the public and stakeholders. Two public meetings resulted in 16 attendees, six advisory group meetings resulted in 161 attendees, 3 legal notices/ advertisements were published, 5 newspaper articles were published about the project, and the website has been accessed 521 times to date. Public Wrap-up meetings discussing the results of the project are anticipated for Spring 2002.

One of the important goals of gathering stakeholder input was to determine the perceived importance of various water quality issues so that comparisons could be conducted once the assessment was completed. According to the stakeholder input, the 17 water quality issues that were ranked fell into five general priority bins going from most important to least important (see Figure 3.2.7-1). Overall, pathogens, agricultural runoff, and nutrients were of greatest concern by stakeholders. Erosion and sedimentation control, metals, and disinfection-by-product precursors were considered the least important.

Figure 3.2.7-1 Ranking of Water Quality Issues by Stakeholders



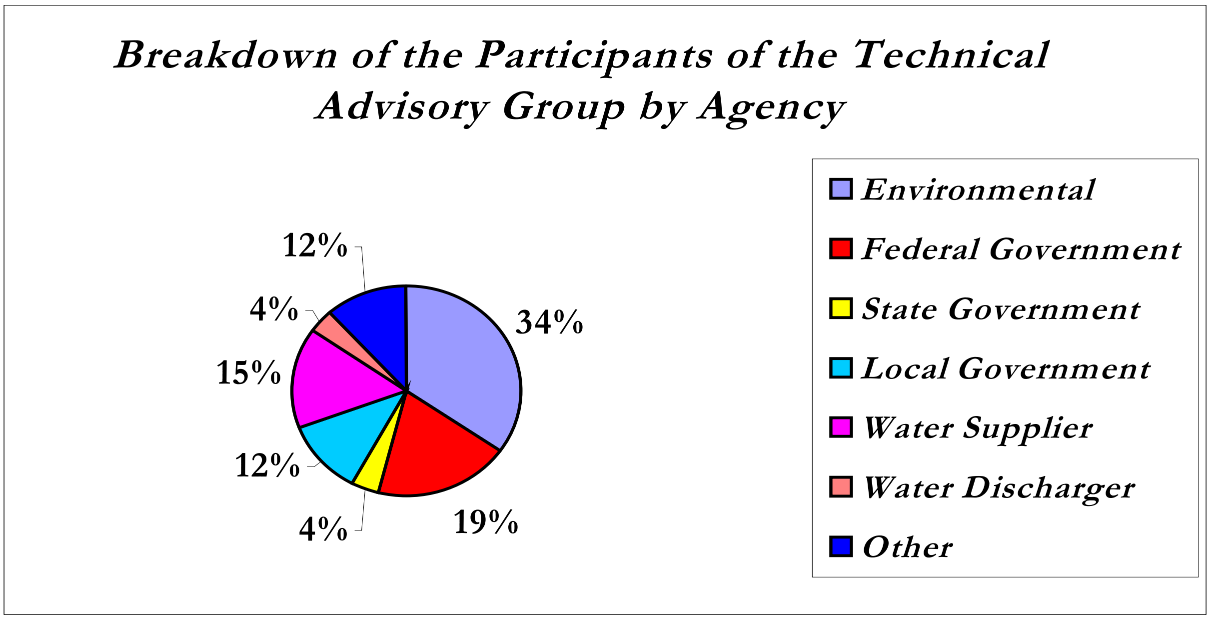
3.2.7.1 Advisory Groups

In order to better facilitate communication among the Source Water Assessment Partnership and the regions of the Schuylkill River Watershed to be assessed, an open Technical Advisory Group (TAG) was formed. This TAG was developed by the partnership as a way to closely interact with the stakeholders, and in turn, gather integral information about each region of the Schuylkill River Watershed. All of the 200 stakeholders were invited by the partnership to participate. Meeting quarterly, it is the primary responsibility of the TAG to inject public interest into the SWA process. Moreover, others duties of this group include:

- Sharing information with stakeholders;
- Verifying the information put forth by the partnership;
- Providing input on the assessment techniques and criteria used by the partnership;
- Offering general information regarding the areas local to each TAG;
- Participating in public outreach and education;
- Describing current protection activities;
- Identifying "potential" sources of contamination and preservation, and
- Assisting in the development of summary reports.

Technical Advisory Group Participants
Composed of watershed organizations, public interest groups, dischargers, suppliers, and local government agencies, the TAG offers a broad variety of perspectives and visions. Figure 3.2.7-2 is illustrative of the various types of agencies participating in the Technical Advisory Group.

Figure 3.2.7-2 Technical Advisory Group Breakdown



The following is a summation of some of the TAG's participants:

It is the mission of the ***Department of Environmental Protection (DEP)*** to protect the air, land, and water of Pennsylvania from pollution and to provide for the health and safety of its citizens through a cleaner environment. DEP works as partners with individuals, organizations, governments, and businesses for the prevention of pollution and the restoration of natural resources and achieves these goals via public service, protection, teamwork, communication, and pollution prevention. DEP is the state agency largely responsible for administering Pennsylvania's environmental laws and regulations. Its responsibilities include: reducing air pollution; making sure that our drinking water is safe; protecting water quality in our rivers and streams; making sure waste is handled properly; managing the Commonwealth's recycling programs and helping citizens prevent pollution and comply with the Commonwealth's environmental regulations. DEP is committed to general environmental education and encouraging effective public involvement in setting environmental policy.

Incorporated in 1969, the ***Western Berks Water Authority*** supplies water to the Borough of Wyomissing from its water treatment plant located on the Tulpehocken Creek, thereby meeting all of the water needs of the residents of Wyomissing, West Reading, and Shillington. The Authority also supplies water to Mohnton and Lincoln Park, as well as portions of Cumru Township, and small quantities to the Citizens Utility Water Company, the Blue Marsh Lake Park and the fire companies. The Authority's present water system facilities include a complete water treatment plant with a capacity of supplying up to eight million gallons of water per day. Aligns with the Borough of Wyomissing's mission to provide services identified with the tradition of excellent living in Wyomissing.

PennFuture is an organization that takes pride in defending the environment. In achieving it mission of defending nature, PennFuture effectively resists those who attack it and rallies against those who fail to do their duty to protect it. By combating global warming, smog, acid rain, and illness and advocating the increase of desperately needed funding for farmland preservation, among other things, PennFuture is making great strides in assuring that polluters and their allies no longer decide the fate of the environment and the economy. Comments and concerns may be voiced to Brenna Herpmann at (800) 321-7775. PennFuture's mailing address is 212 Locust Street, Suite 410, Harrisburg, PA 17101.

In order to share the responsibility of managing the water resources of the Delaware River Basin, the ***Delaware River Basin Commission (DRBC)*** was formed by the signatory parties of the Delaware River Basin Compact (Delaware, New Jersey, New York, Pennsylvania, and the United States). Since its inception on October 27, 1961, the very day that Compact became law, DRBC has been a pacesetter in environmental protection. As mentioned in its mission statement, DRBC focuses mainly on protecting, enhancing, and developing the water resources of the Delaware River Basin for the benefit of present and future generations. In achieving their mission, DRBC has developed such programs as water pollution abatement, water supply allocation, regulatory review (permitting), water conservation initiatives, regional planning, drought management, and flood control. Questions, comments, and concerns may be forwarded to Jon Zangwill via e-mail, zangwill@drbc.state.nj.us or telephone, (609) 883-9500 x 307. DRBC's mailing address is 25 State Police Drive, West Trenton, NJ 08628.

The ***Schuylkill River Greenway Association*** is a membership organization that has been working with citizens, community groups, and a host of other partners for close to 25 years. The primary objective of the Association is to promote the advocacy of river resources and open space. In 1995, with the designation of the Schuylkill River Corridor as Pennsylvania's seventh Heritage Park, the association expanded its mission to include such focal points as the conservation of the historic and cultural resources within the watershed as well as the economic development of such resources. Inquiries may be voiced to Executive Director Dixie Swenson via telephone, (610) 372-3916 or e-mail, srga@ptd.net. The Schuylkill River Greenway Association's mailing address is 960 Old Mill Road, Wyomissing, PA 19610-2522.

Clean Water Action (CWA) is a national citizens' organization that works toward the following goals: affordable water, prevention of health-threatening pollution, creation of environmentally safe jobs and businesses, and the empowerment of people to make democracy work. In addition, CWA organizes grass roots groups, coalitions, and campaigns with the common interest of protecting health and quality of life, so that they may better promote environmental well being within a community. The mailing address of the CWA National Office is 4455 Connecticut Avenue NW – Suite A300, Washington, DC 20008-2328 (Telephone: (202) 895-0420). The mailing address of the CWA Philadelphia Office is 1201 Chestnut Street, #602, Philadelphia, PA 19107. All inquires may be directed to Bob Wendelgass at the Philadelphia Office via e-mail, bwendelgass@cleanwater.org or telephone, (215) 640-8800.

Since its inception in 1950, the ***Montgomery County Planning Commission (MCPC)*** has made great strides in promoting order and development while also preserving the elements of the Montgomery County Watershed that define the community's quality of life. The MCPC is an advisory body on the following subjects: land transportation of all types, the environment, water and sewer service, parks and open space, farmland preservation, stormwater management, site design, housing, zoning, development patterns, and the demographic trends within Montgomery County. MCPC is composed of 9 member-appointed Board Members as well as a professional staff of 44, all of who provide support to municipal governments via innovative solutions to the challenges at hand. All questions, comments, and concerns may be voiced to MCPC Director, Kenneth B. Hughes via telephone, (610) 278-3722. The MCPC mailing address is P.O. Box 311, Norristown, PA 19404-0311.

The mission of the ***Schuylkill Riverkeeper Program*** is to protect and restore the Schuylkill River, its tributaries and habitats, through advocacy, enforcement, and citizen action. The Riverkeeper is a field office of the Delaware Riverkeeper Network and collaborates with the Patrick Center for Environmental Research at the Academy of Natural Sciences. The primary focus of the Riverkeeper Program is to identify and restore degraded streambanks throughout the Schuylkill River Watershed while also working with landowners in order to address the effects of sediment and nutrient pollution on waterways, all of which is encompassed within the Schuylkill Riverkeeper's Streambank Restoration Project. All inquiries may directed to Chari Towne via telephone, (610) 469-6005 or e-mail, srk@worldlynx.net. The mailing address of the Schuylkill Riverkeeper Program is P.O. Box 459, St. Peters, PA 19470-0459.

The ***Berks County Conservancy***, a non-profit organization established in 1974, is dedicated to preserving Berks County's unique Cultural and Environmental Heritage for the benefit of future generations. In order to achieve this, the conservancy has focused its efforts on the preservation of agricultural land and open space, the protection of the quality of the streams and ground water of Berks County, and the preservation of historic landmarks and scenic landscapes, all of which contribute to a sustainable future for the Berks County Community. Simply put, protecting water, habitat, and the natural environment are conservancy priorities. Questions may be forwarded to Joseph Hoffman, Director of Environmental Management, via telephone, (610) 372-4992. Berks County Conservancy's mailing address is 960 Old Mill Road, Wyomissing, PA 19610.

It is the mission of the ***Nature Conservancy*** to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters needed to survive. Since its inception in 1951, the Nature Conservancy, the world's largest private international conservation group, has formed partnerships with communities, businesses, and individuals in order to pave the road for the protection of millions of acres of valuable lands and waters worldwide. It is the commitment of the Nature Conservancy to expand the boundaries of conservation in order to save the Earth's last great places for future generations. All questions, comments, and concerns may be directed to Randy Gray, State Director, via telephone, (610) 834-1323 x116. The Nature Conservancy's mailing address is 1100 East Hector Street, Suite 470, Conshohocken, PA 19428.

Formed in September 1995 when the Lower Merion-Narberth Watershed Association merged into the Lower Merion Preservation Trust, the ***Lower Merion Conservancy*** has since acted to protect the Lower Merion area's natural and historic resources, open space, and watersheds for residents and future generations by promoting collective responsibility for these resources via education, advocacy, and research. Questions and concerns may be voiced to Executive Director Mike Weilbacher at (610) 645-9030. The mailing address of the conservancy is 1301 Rose Glen Road, Gladwyne, PA 19035.

The ***Natural Lands Trust*** is a nonprofit regional land trust that is committed to working with the region's communities to protect old-growth forests, diverse wildflower meadows, and dynamic wetlands. Through acquisition, conservation, easements, planning, and education, this organization encourages others to ensure the preservation of natural and cultural resources for many generations to come. Questions may be forwarded to Andy Pitz at (610) 353-5587. The mailing address of the Trust is 1031 Palmer's Mill Road, Media, PA 19063.

Incepted in 1964, the ***Perkiomen Watershed Conservancy*** has since been dedicated to protecting and conserving the natural resources within the Perkiomen Creek Watershed. This nonprofit organization reaches out to the surrounding community via environmental education and land conservation and protection. Questions, comments, and concerns may be forwarded to Executive Director Tish Ryan at (610) 287-9383. The mailing address of the conservancy is 1 Skippack Pike, P.O. Box 55, Schwenksville, PA 19473.

It is the mission of the ***Pennsylvania Environmental Council (PEC)*** to improve the quality of life for all Pennsylvanians. In doing so, PEC enhances the commonwealth's natural and man-made environments by integrating the advocacy, education, and implementation of both community and regional action programs. Director of Watersheds Programs Ann Smith will be accepting questions, concerns, and comments at (215) 563-0250. The mailing address of the PEC is 117 South 17th Street, Suite 2300, Philadelphia, PA 19103-5022.

Technical Advisory Group Meetings
Six TAG meetings were held as of September 2001. The following table outlines the date, location, and number of attendees of each meeting.

Table 3.2.7-1 Summary of Technical Advisory Group Meeting Dates and Locations

Meeting	Date	Location	Number of Attendees
1	October 25, 2001	DEP Offices Conshohocken, PA	47
2	January 17, 2001	DEP Offices Conshohocken, PA	29
3	April 4, 2001	DEP Offices Conshohocken, PA	24
4	May 9, 2001	DEP Offices Conshohocken, PA	28
5	June 13, 2001	DEP Offices Conshohocken, PA	19
6	September 24, 2001	DEP Offices Conshohocken, PA	14
			Total Attendees 161

These meetings were, in essence, discussion forums in which local stakeholders were enabled to voice their concerns and share their opinions of the project. The following is a summation of the minutes from the first five meetings:

MEETING 1

This meeting acted as an introduction to the Schuylkill River Watershed as well as to the Source Water Assessment. The watershed of the Schuylkill River was described as a significant, industrial, agricultural, and commercial corridor, a home to three million people in Pennsylvania in which 40% of the land is forested, 48% is agricultural, and 12% is developed. The region was cited as a source of heritage, history, culture, and recreation.

The specific aspects of the Schuylkill River Watershed as a drinking water supply are as follows:

- 58 surface water intakes
- 47 intakes for systems serving < 10,000
- 265 MGD withdrawn on average from the river and its tributaries
  serves over 1.8 million people

The Source Water Assessment was explained to be a multi-phase process. The process identifies potential or existing sources of contamination, evaluates the vulnerability/susceptibility of a water supply to contaminant sources, and determines protection priorities and activities for the water supply. The ultimate goal of a SWA was specified as developing local sources of water protection initiatives and educating the public about the source of their drinking water and its challenges. The SWA was depicted as an iterative and continuous process of assessing, planning, and implementing.

Utilities and stakeholders were encouraged to take an interest in the SWAs because the program was based on federal regulations mandated by Congress. Responding to requests by the public to know more about their water supply and how to protect it, Congress included provisions for a SWA within the Safe Drinking Water Act Reauthorization of 1996. It is the goal of Congress to have 50% of the United States population enveloped under Source Water Protection Plans by 2005.

The SWAs were said to benefit the stakeholders present at the meeting because stakeholders of the TAG would be directly involved by:

- Identifying sources of contamination and areas for protection;
- Having their organization highlighted for interested persons to contact/join;
- Determining potential linkages between their efforts and protection efforts;
- Increasing potential funding opportunities by incorporating projects into approved SWA plans.

The Schuylkill River SWA area to be covered was said to be comprised of 42 surface water intakes, 3 PADEP regions, 2,000 square miles of area, 130 miles of river, and 10 counties. The organization of the SWA was described as two distinct, but linked phases.

Phase I is inclusive of:

- 7 intakes
- 4 water systems
- 73% of the population
- 80% of river withdrawal for drinking water supplies
- bottom of the watershed
- industrial/urban/suburban issues

Phase II includes:

- 35 intakes
- 14 water systems
- 27% of the population
- 20% of withdrawal

- headwaters to middle of river
- rural, mining, agricultural, suburban issues

A schedule and timeline were presented in which Phase I, which began in July 2000, was marked for completion by December 2001. Phase II is scheduled to begin in July 2001 and end in July 2003.

MEETING 2

It is at this meeting that Phase I of the SWA was further discussed. Of particular focus was the Stakeholder Survey, a document that was sent to stakeholders prior to the meeting, which noted key contaminant issues, and asked that the recipients rank those issues on a relative scale of zero to one, with one being of the highest priority. Those stakeholders who responded to the survey included one municipal water supplier, one federal agency, and nine not-for-profit agencies. These respondents ranked pathogens and agricultural runoff as those issues having the highest priority with a ranking of approximately 0.7. On the opposite end of the scale, disinfection by-products were ranked as having the lowest priority with a score of 0.2.

The water quality of the Schuylkill River was also discussed. Parameters affecting water treatment were identified. When discussing contaminant source issues, it was determined that contaminant issues will vary with each perspective. For instance, the outlook of a fisherman will be significantly different from that of the upstream water suppliers and likewise, the downstream water suppliers will have a differing perspective than that of the stakeholders. Table 3.2.7-2 outlines the parameters of concern from both a drinking water perspective and a finished water quality perspective.

Table 3.2.7-2 Parameters of Concern from a Drinking Water and a Finished Water Quality Perspective

Drinking Water Perspective	Finished Water Quality Perspective
• Algae – clogs filters • Alkalinity & pH – affect coagulation • Turbidity – impacts coagulant & residual management costs • Metals – require additional chemicals for removal	• Algae – may cause taste & odor episodes • Salts – not removed by treatment & affect those on low sodium diets • *Cryptosporidium* – resistant to chlorine & may affect immune compromised sub-populations • Total Organic Carbon & Bromide – affect disinfection by-product formation

Water quality data, spanning a period of 30 years (1970 – 2000), for dozens of locations in the Schuylkill River Watershed had been compiled from several organizations. Of this data, conductivity, nutrients, metals, salts, and dissolved oxygen were identified as the most frequently monitored parameters, with pesticides, herbicides, and pathogens making up those parameters that are less frequently monitored.

MEETING 3

It was at this meeting that the four main sources of contaminant source compilation were established:

- Right to Know Network (www.rtk.net)
- Envirofacts (www.epa.gov/enviro)
- Efacts (www.dep.state.pa.us/dep/efacts/resources)
- ESRI Business MapPro

Within the RTK and Envirofacts systems, four Federal databases were accessed: PCS (Permit Compliance System), RCRIS (Resource Conservation and Recovery Act Information System), CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Act Information System), and TRI (Toxic Release Inventory). In order to populate the databases, data was downloaded from RTK by county and then "clipped" in RTK for the purpose of eliminating those data points outside of the watershed boundaries. Missing "x-y" coordinates were filled in by geocoding in ArcView and cross-referencing the same facility with other databases and Envirofacts. Facility data was then further cross-referenced with Envirofacts. Quality and contaminant data was populated via Envirofacts.

A second keynote feature of this meeting was the discussion of the process used to evaluate and prioritize the most critical sources within the Schuylkill River Watershed. It was determined that this process must be:

- Inclusive of all potential sources
- Equitably applied everywhere within the watershed
- Logical and well founded
- Reproducible and defensible

In order to satisfy this need, EVAMIX was introduced. This is a computerized matrix based evaluation method and ranking tool that uses a pair-by-pair comparison of each source against each other source via a criterion. This method is capable of performing hundreds of comparisons and calculations while handling units properly, as well as quantitative and qualitative criteria. This method results in a single number or "appraisal score," which is the single number that encompasses all of the data included in the criteria as well as the criteria weights. This number is also representative of the relative rank of Source A against all other sources, which in turn provides a strong foundation for assigning priorities to each particular source. The primary use of EVAMIX is decision support; via this system, it is possible to evaluate alternatives, prioritize options, organize data to facilitate decisions, formalize and document the decision process, and act as evidence in defense of the decision made.

It was determined that the results gathered from the EVAMIX matrix will be further reviewed and "reality checked." Any results for high-ranking sources will be added to other sources outside the scope of the analysis, e.g., highway spills, pipeline breaks, etc. All high-ranking sources will be flagged for follow-up data collection in a later phase in order to verify results. Zones were broken down into categories A, B, and C and calculated using the Geographical Information System (GIS) and river time travel estimates. The zone delineation is as follows, beginning with an area wide inventory:

- Zone A: critical segment, all potential sources
- Zone B: second segment, all significant sources
- Zone C: remainder, just area wide inventory

The goal of the Schuylkill Source Water Assessment was again cited as gaining an understanding of which sources within the Schuylkill River Watershed are most significant and which are not as critical. In doing so, a better understanding of present water quality concerns as well as a sharper focus on the most critical sites will be provided. This, in turn, will lead to a more limited number of high priority sites within the Schuylkill River Watershed.

MEETING 4

A main topic of this meeting was the population of missing data. The Schuylkill River Approach offers controlled screening for point sources as well as for non-point sources which will allow for an end result of a limited number of high priority sites, i.e., approximately 50 sites per intake. Missing information including flow, quantity, chemical group, and SIC code matching PADEP activity were identified.

Another keynote point of this meeting is significance screening, which aids in the development of the best estimate of quantity, concentration at the release point, as well as the dilution at the intake. The steps to be taken regarding this approach are as follows:

- Development of the best estimate of the worst case release (quantity)
- Calculation of concentration at the release point
- Calculation of dilution at the intake
- Comparison to "Threshold Impact"

When too little data is available, screening will be conducted using the number of releases, the amount stored, the chemical stored, and the location relative to the floodplain. Other steps include choosing a Threshold Value in terms of Drinking Water Standards and Ambient Mean Concentrations, determining a background concentration, calculating discharge in order to increase concentration by ten percent of ambient or of standard at the intake, and calculating the amount of spill of pure contaminant where appropriate.

Table 3.2.7-3 outlines the contaminant categories suggested at this meeting as well as their potential fields, for the purpose of populating the databases.

Table 3.2.7-3 Suggested Contaminant Categories and their Potential Fields

Suggested Contaminant Categories	Potential Fields
Fecal Coliform	• Possible Threshold: 200 count/100ml • Threshold Type: Contact Recreational Water Standard • Discharge Volume to Exceed Threshold: 100 MGD of wastewater die off at 2000 count/100 ml • Spill size to Exceed Threshold: Not Applicable
Turbidity (TSS)	• Possible Threshold: 10 mg/l • Threshold Type: Ambient Concentration • Discharge Volume to Double Threshold: 5 MGD at 200 mg/l (average wastewater) • Spill Size to Double Threshold: 10,000 lb of silt runoff in one day
Nutrients (Phosphorous)	• Possible Threshold: 0.12 mg/l • Threshold Type: Ambient • Discharge Volume to Exceed Threshold: 5 MGD to raise by 10% • Spill Size to Exceed Threshold: 110 lb of pure Phosphorous in one day
VOC (total)	• Possible Threshold: 5 parts per billion (ug/l) • Threshold Type: Drinking Water Standard for Benzene • Discharge Volume to Exceed Threshold: Not Applicable • Spill Size to Exceed Threshold: < 5 gallons per day of pure product
Metals (Pb as indicator)	• Possible Threshold: 0.015 mg/l • Threshold Type: Drinking water treatment trigger value • Discharge Volume to Exceed Threshold: approx. 1.5 MGD of industrial wastewater at 10 mg/l • Spill Size to Exceed Threshold: approx. 15 lb per day
Cryptosporidium/Giardia	• Possible Threshold: 1 oocyst per liter • Threshold Type: Drinking Water Guideline Value • Discharge Volume to Exceed Threshold: 10 oocysts per liter
Nitrates	• Possible Threshold: 10 mg/l • Threshold Type: Drinking Water Standard • Discharge Volume to Exceed Threshold: > 50 MGD • Spill Size to Exceed Threshold: 10,000 lb
DPB Precursors (TOC)	• Possible Threshold: 2.7 mg/l • Threshold Type: Ambient Median Value • Discharge Volume to Raise Threshold by 10%: 4 MGD of wastewater at 100 mg/l • Spill Size to Exceed Threshold: approx. 2000 lb per day
Petroleum Hydrocarbons (TPH)	• No Identified Possible Threshold • Threshold Type: Ambient (data sparse) • Discharge Volume to Exceed Threshold: Not yet determined
Salts (Chloride as indicator)	• Possible Threshold: 250 mg/l • Type of Threshold: Drinking Water Standard • Discharge Volume to Exceed Threshold: 1 MGD of brine (sea water) • Spill Size to Exceed Threshold: 200,000 lb of salt per day

Meeting 5

The primary focus of this meeting was on Source Priority Ranking. In essence, three questions needed to be answered:

- Are criteria missing?
- Are the qualitative scores properly defined?
- Are the criteria priorities (weighting factors) satisfactory to the group?

It was at this meeting that the diverse group including water suppliers, stakeholders, and dischargers reached a consensus on the criteria and the weighting factors to be used for the ranking sources. The group also agreed that the nine criteria of Relative Impact at Intake, Time of Travel, Existing Removal Capacity, Impact on Treatment, Potential Health Impacts, Potential for Release/Controls, Potential for Release Frequency, Violation Type/Frequency, and Location were sufficient to complete the ranking criteria. It was agreed upon that no other criteria were missing. Weighting factors and qualitative definitions were determined for the criteria being used to rank sources across all contaminant categories as well as within the six individual categories, thus answering the three primary questions posed. The following two tables (Table 3.2.7-4 and Table 3.2.7-5) outline the actual criteria, criteria type, and the percentages agreed upon for both the nine contaminant categories and the 6 individual contaminant categories at this fifth meeting of the SWA. Figures 3.2.7-3 and 3.2.7-4 graphically depict this breakdown.

Table 3.2.7-4 Consensus Weighting Values for Nine Criteria

Criteria	Type	Weight (%)
Relative Impact at Intake	Intake Related	12
Time of Travel	River Flow Related	5
Existing Removal Capacity	Intake Related	10
Impact on Treatment	Intake Related	10
Potential Health Impacts	User Related	20
Potential for Release/Controls	Source Related	14
Potential for Release/Frequency	Source Related	14
Violation Type/Frequency	Source Related	10
Location	River Flow Related	5

(*To be used in the EVAMIX analysis across contaminant categories)*

Figure 3.2.7-3 Breakdown of Criteria Type for Contaminant Groups

<u>Contaminant Categories</u>
Source Related Factors: 38%
Intake Related Factors: 32%
User Related: 20%
River Flow Related: 10%

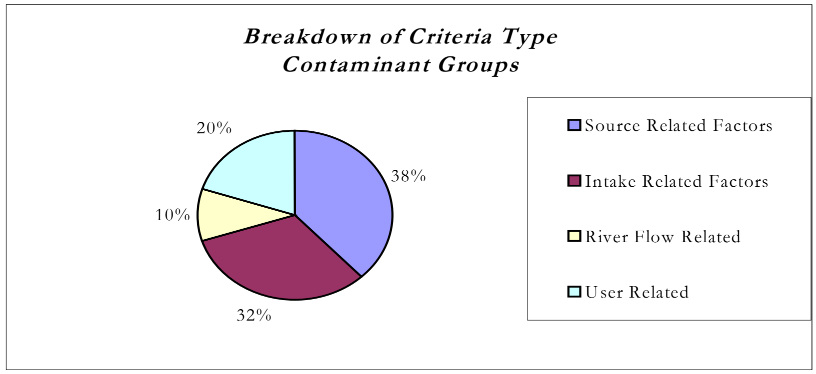


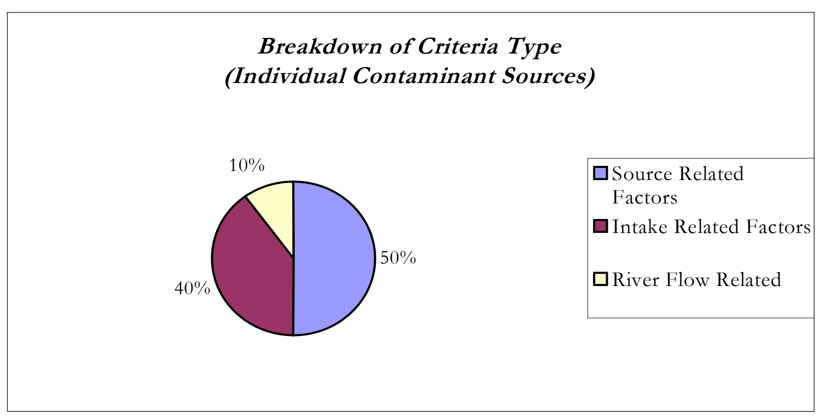
Table 3.2.7-5 Consensus Weighting Values for Six Criteria

Criteria	Type	Weight (%)
Relative Impact at Intake	Intake Related	40
Time of Travel	River Flow Related	5
Potential for Release/Controls	Source Related	20
Potential for Release/Frequency	Source Related	15
Violation Type/Frequency	Source Related	15
Location	River Flow Related	5

(To be used in the EVAMIX analysis within individual contaminant categories)

Figure 3.2.7-4 Breakdown of Criteria Type for Individual Contaminant Sources

<u>Individual Contaminant Categories</u>
Source Related Factors: 50%
Intake Related Factors: 40%
River Flow Related: 10%



3.2.7.2 Public Meetings

In an attempt to better educate the public about the importance of the Source Water Assessment Program (SWAP), two public kick-off meetings were conducted. Each public kick-off meeting utilized the following general approach in order to generate public interest:

- Press releases produced by the Philadelphia Water Department and the local stakeholders were sent to the local media and newspapers;
- Legal notices were sent to the local media and newspapers; and
- Advertisements were published in the Pennsylvania Department of Environmental Protection (PADEP)'s *Update*.

Hosted by local watershed organizations in order to promote a sense of credibility as well as to establish a connection with local residents, these meetings were, in essence, informational forums where members of the public were able to voice their concerns as well as share their visions for the project. Table 3.2.7-6 outlines the host, location, date, and number of attendees for each of the four aforementioned public meetings.

Table 3.7.2-6 Public Kickoff Meetings Held for PWD's Intakes

Meeting	Host(s)	Location	Date	Number of Attendees
1	Wissahickon Valley Watershed Association	Wissahickon Valley Watershed Association Ambler, PA	2/20/01	8
2	Schuylkill Environmental Education Center	Schuylkill Environmental Education Center Philadelphia, PA	3/14/01	8
				Total Attendees 16

A standard meeting agenda was developed and followed at each meeting. This agenda was composed of an introduction and an explanation of the purpose of the meeting. Another component of this agenda was an overview of Source Water Assessments, which included a brief yet thorough description of the SWAP as well as the areas to be assessed, i.e., the Schuylkill River Watershed. In addition, a discussion of contaminant source issues and water quality concerns was a keynote feature of the agenda. Finally, each meeting was concluded with an exercise in identification of potential contaminant sources, in which the attendees were asked to identify local sites that may impact the water supply. Questions, concerns, and comments were addressed as they were raised.

Prior to these kick-off meetings, several avenues were pursued in an attempt to notify the public. Letters produced by the Philadelphia Water Department, local stakeholders, and watershed groups specifying the location and directions, date, time and nature of the meetings were mailed to numerous stakeholders, including many of the businesses, government agencies, and environmental organizations located within or affected by the

Schuylkill River Watershed. The information contained in these letters was also posted on the SWAP website, www.schuylkillswa.org. In order to further generate public interest, various watershed groups and local stakeholders posted flyers throughout their respective areas and sent press releases to their local newspapers. Additionally, many of those local newspapers featured articles describing the nature of the meetings as well as the outcome, where applicable (Please see Figures A&B in the attached Appendix). Legal notices detailing the location, time, and date of each meeting were printed in the newspapers local to each area with which the SWAP is affiliated for the purpose of opening the meetings to everyone within the watershed. Table 3.2.7-7 is illustrative of the publications in which the legal notices appeared, the dates of publication, and the general areas reached.

Table 3.2.7-7 Legal Notices Published for Public Kickoff Meetings

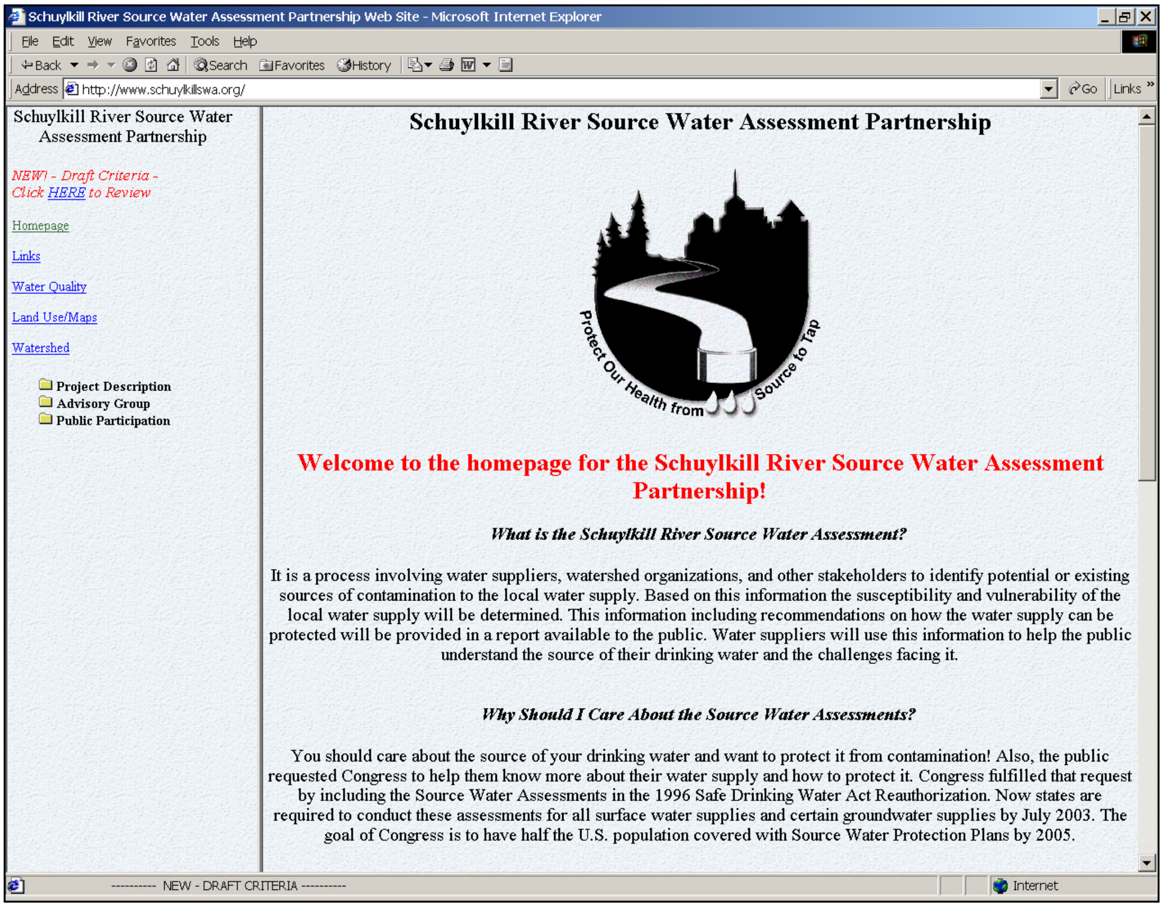
Date of Notice	Publication Name	Area Reached
2/14/01	The Ambler Gazette	Ambler, PA
3/12/01	The Philadelphia Daily News	Philadelphia, PA
3/12/01	The Philadelphia Inquirer	Philadelphia, PA

3.2.7.3 Website

A website was developed for the project (*www.schuylkillswa.org*) in order to provide a location where information about the project could be easily accessed by the public and stakeholders (see Figure 3.2.7-5). Though this was a task beyond the scope of the contract, it was considered to be a necessary form of information delivery. Most importantly, the website was considered to be the best way of providing the advisory group meeting information, meeting handouts, and meeting minutes without producing a significant burden of production on staff, given that there are over 200 stakeholders to mail information to on a quarterly basis at minimum.

The website was set up to provide general information about the purpose of the SWAPs and who to contact for information. It also provided links to information about public meetings, advisory group meetings, meeting materials, general watershed information, limited maps, watershed organizations, and general water quality information. Another special feature was an on-line stakeholder survey that stakeholders could fill out information about their water quality issues.

Figure 3.2.7-5 Picture of Schuylkill River SWAP Website (*www.schuylkillswa.org*)



3.2.8 PWD-Queen Lane Conclusions and Recommendations

The following discusses the findings of the assessment, and provides recommendations for projects and initiatives that are general for the entire watershed, regional, and intake specific. It also attempts to provide some specific examples of the best management practices that could be employed on some of the recommended projects.

Overall, the following activities were identified as having high priority for protection efforts to address:

- Sanitary Sewer Overflows of raw sewage from sewer collection systems, sewage lift stations, and manholes from upstream communities due to infiltration and inflow of stormwater into the sewer system or lack of wastewater treatment capacity.

- Combined Sewer Overflows from upstream communities such as Bridgeport and Norristown

- Communities discharging untreated sewage without proper sewage treatment such as New Philadelphia.

- Urban, residential, and agricultural runoff from various areas of the watershed, mostly located along the mainstem of the Schuylkill River from Reading to Philadelphia

- Discharges from municipal and industrial sources such as sewage treatment plants and chemical manufacturing facilities

- Acid Mine Drainage from Schuylkill County

- Spill and accidents from cars, tanker trucks, railroad cars, pipelines, tire piles, and fires at industrial facilities near the river and its tributaries

Table 3.2.8-1 summarizes the protection priorities assigned to the various types of sources overall and for each contaminant category. As shown, non-point sources and municipal or industrial discharges had the greatest overall priority compared to other sources.

It is important to note that just because an activity is given a high priority, that does not mean that any individual site is in violation of current environmental laws and regulations or negatively impacts the water quality at the facility. An activity with a high ranking means that it has the potential to negatively impact water supply quality under certain conditions.

Table 3.2.8-1 Summary of Protection Priority of Various Types of Potential Contaminant Sources

(A-C = significant protection priority, D-F = lower protection priority)

Contaminant Group	Permitted Municipal and Industrial Dischargers (NPDES)	Urban, Residential, and Agricultural Runoff	Industrial Facilities with Toxic Chemical Releases (TRI)	Hazardous Waste Facilities (RCRA)	AST (above ground storage tanks)	CERCLA (landfills, brownfields, etc.)	Overflows/ Discharges From Sewers	Acid Mine Drainage	Spills & Accidents
Overall (combined)	A-C	A-C	C	D-F	C	C	A	A	A
Chloride	D-F	A-C	A-C	D-F	A	C	D-F	D-F	A
Cryptosporidium	A-C	C	D-F	D-F	D-F	D-F	A	D-F	A
Fecal Coliforms	A-C	A-C	D-F	D-F	D-F	D-F	A	D-F	A
Metals	A-C	B-C	A-C	B-C	C	C	N/A	A	A
Nitrate	A-C	B-C	A-C	D-F	D-F	D-F	C	D-F	A
Petroleum Hydrocarbons	D-F	A-B	D-F	D-F	A-C	A	D-F	D-F	A
Phosphorus	A-C	C	A-C	D-F	A	D-F	C	D-F	A
Disinfection By Products	A-C	B-C	B-C	D-F	B	C	D-F	D-F	C
Turbidity	A-C	B-C	D-F	D-F	D-F	D-F	D-F	D-F	C
Volatile Organic Compounds	A	D-F	A-B	B-C	A-C	C	D-F	D-F	A
Herbicides/Pesticides	N/A	A	N/A	B-C	D-F	C	N/A	D-F	A
Radionuclides	A*	D-F	D-F	D-F	D-F	D-F	D-F	D-F	C

**only two locations*
Note: if only one source fell into a protection priority, that rank was given to the type of source for a given contaminant group
Just because an activity is given a high priority does not mean that any individual site is in violation of current environmental laws and regulations. An activity with a high ranking means that it possibly can have a high potential to have negative impacts on water supply quality under certain conditions.

Geographically, most of the priority point sources for the Queen Lane Intake are located within priority non-point source watersheds. In fact, over 82 percent of the point sources fell within priority non-point source watershed areas. Over 90 percent of the high protection priority point sources fell within priority non-point source watershed areas. Therefore, it appears that in general protection and restoration efforts should be focused in those areas.

Tables 3.2.8-2 and 3.2.8-3 provide summaries of the protection priorities of point and non-point sources in various watershed areas. Overall, the primary protection areas in which to focus in order to protect and improve PWD's protection efforts include the mainstem areas of the Schuylkill River between Reading and Philadelphia, the Wissahickon Creek, and Perkiomen Creek. The Valley Creek, French Creek, and Tulpehocken Creeks appear to have secondary protection priority. However other parts of the watershed may need limited attention for contaminant specific issues (i.e. metals and acid mine drainage).

In reality however, water quality data and dye studies of the Wissahickon Creek show that its impacts are quite significant on source water quality and potentially significant sources in this watershed should be given extremely high priority. Under various conditions dye studies have shown that 11-28 percent of the water supply withdrawn by the Queen Lane intake originates from the Wissahickon Creek.

Table 3.2.8-2 Summary of Protection Priority Ranking of Various Mainstem Schuylkill Areas for Point and Non-point Sources

	Protection Priority			
River Segment	**A High**	**B Moderately High**	**C Moderate**	**D-F Low**
Philadelphia – Conshohocken	N & P			
Conshohocken – Norristown	N & P			
Norristown to Valley Forge	N & P			
Valley Forge to Phoenixville	N & P			
Phoenixville to Royersford	P			N
Royersford to Pottstown	P	N & P	P	
Pottstown to Douglassville	P	N & P	P	
Douglassville to Reading	P	N & P	P	
Reading to Leesport	P	N & P	P	
Upper Schuylkill	P*	P		N
Little Schuylkill River	P*			N

** untreated sewage communities and acid mine drainage only*
Note : N – Non-point source runoff, P- Point sources

Table 3.2.8-3 Summary of Protection Priority Ranking of Various Tributaries for Point and Non-point Sources

	Protection Priority			
Tributary / Watershed	**A High**	**B Moderately High**	**C Moderate**	**D-F Low**
Wissahickon	N & P		P	
Perkiomen Creek	P	N & P	P	
Valley Creek		N	P	
Pickering Creek				N & P
French Creek				N & P
Manatawny Creek		N & P		
Monocacy Creek				N & P
Hay Creek				N & P
Allegheny Creek				N & P
Tulpehocken Creek			N & P	
Maiden Creek				N & P

Note : N – Non-point source runoff, P- Point sources

3.2.8.1 General Recommendations

Based on the results of the susceptibility analysis, water quality data, and stream impairments, it is clear that the impacts from stormwater runoff need to be addressed for the communities along the mainstem of the Schuylkill River from Reading to Philadelphia. Efforts to reduce these impacts require:

- Development of incentives for upstream communities to mitigate stormwater runoff;
- Education of township officials along the protection priority corridor about stormwater impacts;
- Preservation of existing greenspace along the Schuylkill River in the protection area;
- Acquisition of conservation easements or adjustment of zoning areas or local ordinances to reduce stormwater impacts from future development in the protection priority corridor between Philadelphia and Reading;
- Enforcement of the Phase II stormwater regulations for townships in the protection priority corridor between Philadelphia and Reading;
- Enforcement of compliance requirements for industries and municipalities discharging wastewater into the protection priority corridor between Philadelphia and Reading;
- Development and support of watershed or local community/environmental organizations to restore and protect various segments of the protection priority corridor between Philadelphia and Reading;

- Ensure that TMDL process and requirements along the Schuylkill River include components to address drinking water impacts;

- Development of special State or Federal legislation that provides funding and authority for water supply protection efforts in the protection priority corridor between Philadelphia and Reading.

- Include *Cryptosporidium* impacts in the permitting process for wastewater dischargers upstream of drinking water intakes.

In addition, the following actions are recommended for protection efforts in the Wissahickon Creek Watershed:

- Development of regulatory and financial incentives for enhanced wastewater discharge for pathogen removal and inactivation to address *Cryptosporidium* impacts;

- Development of incentives and controls for mitigation of stormwater runoff impacts. This includes requiring that current TMDL efforts in the watershed include specific components to address drinking water issues and concerns. This will provide an example of how the Safe Drinking Water Act and Clean Water Act should be integrated.

- Conduct an examination of current zonings and ordinances with the Montgomery County Planning Commission, Montgomery County Conservation District, and local townships to determine ways they can be enhanced to address current and future stormwater impacts. Identify areas where innovative techniques and incentives can be used to mitigate stormwater impacts and assist in the development and implementation of these efforts.

- Support of existing greenways, riparian corridor areas, and future riparian corridor easement and acquisition being conducted by the Wissahickon Valley Watershed Association and Montgomery County;

- Encourage and support the development of an Act 167 Stormwater Management Plan for the Wissahickon Creek.

The Philadelphia Suburban Water Company already works with numerous stakeholders to protect its water supply in the Perkiomen Creek. Therefore, it is recommended that any protection efforts be coordinated with the Philadelphia Suburban Water Company environmental initiatives and programs in the Perkiomen Creek Watershed.

In addition to the previous specific geographic recommendations, the following general efforts are recommended:

- Emergency Response Planning activities should be focused on priority AST, TRI, and RCRA facilities since they have been shown to have the greatest relative impact on water quality. Efforts should also be initiated to collect more detailed data on these sites for reprioritization. Also, state authorities should be encouraged to implement a 2 hour notice requirement for downstream users from spills instead of allowing 24 hour requirement since most spills can make it to a number of intakes in less than a day under various conditions.

- Given the potential catastrophic impacts from spills and accidents, an early warning system similar to that on the Ohio River should be installed along the mainstem Schuylkill River to provide water suppliers warning and accurate real time data when spills and accidents occur. It is recommended that USGS should be involved in the implementation of the early warning system.

- Long-term protection efforts by PWD should be focused on enhancing wastewater discharges and mitigating stormwater runoff. These will have the greatest overall impacts on improving source water quality.

- Sources of pathogens appear to be the sources of greatest priority to PWD when examined in the overall rankings. Therefore, these sources should be addressed accordingly.

- Given the significant amount of activity in the watershed by various organizations, protection efforts should be coordinated in such a way as to support and enhance existing efforts in the watershed.

- A corporate environmental stewardship program should be developed to educate, provide incentives, and engage businesses in water supply protection and stormwater mitigation.

- A workshop should be sponsored by PADEP to educate golf courses about the benefits of joining the environmental certification program by the Audubon Society.

- Special mechanisms and funding should be developed to allow the distribution of monies to support or initiate specific initiatives outside the City of Philadelphia that will protect or restore the water supply. This may involve development of a quasi-governmental or non-profit organization that can raise funds and distribute them to various organizations conducting protection activities beneficial to PWD. This organization may also need the ability acquire conservation easements or land in sensitive areas to maintain protected areas.

- Efforts should be made to encourage PADEP and DRBC to address and prioritize the impacts of CSOs and untreated discharges of raw sewage upstream of drinking water intakes. Similar efforts should also be allocated for mitigation of acid mine drainage impacts.

3.2.8.2 Regional Recommendations

There are several regional recommendations based on the results of the study and stakeholder input. These include the following:

- Development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection. This would include a special matching source water protection grant fund for the Schuylkill River Watershed that members would contribute to the state for matching. The watershed council including representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and fund projects with the most value to water supply protection.

- Development of a coordinated regional protection plan that will be adopted by water suppliers, planning commissions, and municipalities for establishment and protection of sensitive and high priority protection areas to the multiple and overlapping water supply areas between Reading and Philadelphia.

- Enforcement of rigorous and regular revision and implementation of ACT 537 Sewage Facilities Management Plans in Montgomery, Chester, Berks, and Schuylkill Counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 plan with emphasis on monitoring and measuring progress towards addressing identified problems.

Recommendation #1 – A Watershed Coalition and Local Source Water Protection Grant Funding Process

The development of a regional watershed coalition or council for improved coordination of watershed activities and grant funding between watershed organizations, public agencies, municipalities, and planning commissions for water supply protection is strongly needed in the watershed. The goal is to develop a partnership of state, public, and private organizations to specifically address and implement source water protection projects. Conceptually members of the coalition would be required to pay a membership fee to a state matching fund account. The membership fee would be based on the size of the organization and type of organization. For example, large water suppliers would be required to pay the largest membership fees (several thousand dollars) while small water suppliers would only be required a token $50-$100 fee. Planning commissions, public agencies, or environmental organizations would need to be determined.

The membership fee would be placed in a special state fund that is matched by that state for implementation of source water protection projects. Requests for proposals would be distributed to watershed organizations and other stakeholders to implement protection projects. Suggested locations and types of projects based on the results of the Source Water Assessments and regional source water protection plan will be recommended depending on the area of the project. Representatives from PADEP, water suppliers, counties, Schuylkill Riverkeeper, and other organizations would then review the grant applications and recommend funding to projects with the most value to water supply protection.

For example, if the membership raised $100,000 and was matched by PADEP into this special fund, a total of $200,000 would be available for projects. This could fund four to five specific protection projects a year such as parking lot BMPs, streambank restoration, riparian buffer plantings, streambank fencing, detention pond retrofits, etc. This would result in potentially 20 coordinated and focused source water protection projects being implemented in high protection priority areas over four years. This positive interaction with local community organizations would also raise awareness of source water protection issues and increase public awareness and potentially spur other project partnerships between private, public, and community organizations beyond the confines of the grant process and the watershed coalition.

Recommendation #2 - A Regional Source Water Protection Plan For Protection of the Source Water Protection Priority Corridor from Philadelphia to Reading

The same high priority protection areas along the mainstem Schuylkill River from the SWAs of PWD's intakes overlaps significantly with the protection priority areas from SWAs for the Pennsylvania American Water Company – Norristown, Philadelphia Suburban Water Company, Phoenixville Boro, Citizen's Utilities – Royersford, and Pottstown Boro water supply intakes. Therefore, the development of a regional source water protection plan for these intakes would provide the necessary coordination of source water protection projects to prevent duplication, overlap, and conflicting source water protection efforts. This plan would designate "home" areas where each water supplier would lead specific localized efforts and "team" areas where all water suppliers shared interest and need to coordinate and organize efforts accordingly.

This protection corridor also warrants special assistance, as evidenced by stream impairments and recreational water quality issues. The runoff and point sources in this corridor impact the water supplies for the over 1.3 million people that receive drinking water from these sources in the Berks, Chester, Montgomery, and Philadelphia county area. Given that many industries also withdraw water for electric generation and the majority of persons in the watershed reside in or near the protection corridor and conduct recreation in or along it, the benefits to aquatic life, recreation, industry, and quality of life for citizens in general are significant and cannot be ignored. The protection priority corridor is also coincidentally the location of significant efforts for greenway creation and recreational trails. In this case, the desire for increased recreational opportunities and greenways coincides with a desire for greenways to protect water supplies and represents a significant opportunity for numerous stakeholders to benefit.

Priority for funding of Growing Greener and DCNR grants for projects in the protection priority area should be given to projects that address sustainable mitigation of stormwater impacts and restoration or preservation of areas. In addition, agricultural land within the protection priority corridor would also be given easier access and higher priority for USDA funding such as EQIP or CRP to keep sensitive land areas out of production to protect local streams. PADEP and USDA could designate farms within the priority protection area as high priority for development of nutrient management plans. Townships located within the priority protection area should also be required to adopt uniform ordinances to address stormwater impacts from current and future activities.

Recommendation #3 – Rigorous Enforcement of Act 537 Sewage Facilities Management Plan Revision and Implementation
A number of the sewage related issues identified during the assessment were related to the operation, maintenance, and planning of sewer systems in the watershed. Therefore, rigorous enforcement of ACT 537 Sewage Facilities Management Plan revisions and implementation is required throughout Montgomery, Chester, Berks, and Schuylkill Counties. In addition, the sewage facility related issues from the SWAs should be incorporated into the ACT 537 Plan with emphasis on monitoring and measuring progress towards addressing identified problems. The ACT 537 already has many components in it designed to assist counties with addressing sewer overflow problems and be linked or integrated with Phase II stormwater compliance for municipalities since many overflows are stormwater related.

3.2.8.3 Intake Specific Recommendations: Example Project List and Best Management Practices

There are numerous specific projects that can be implemented throughout the watershed to protect and improve water supplies. The following list of projects provides a project title and location, potential project partners, and a general description of the components that could be incorporated into the protection project.

It may not be possible to implement all of the projects listed due to numerous unforeseen and unknown issues. Therefore, the list should be used as a resource to brainstorm and provide techniques for other projects that may be just as effective and valuable for source water protection. Specific descriptions and pictures of technologies and techniques that have been used locally or nationally to address a specific issue are provided in section 3.2.8.4 so that the reader can envision the mentioned technologies.

Some specific projects or initiatives include:

1. Stormwater Treatment Wetland at Maple Avenue, Ambler

2. Office Center & Business Parking Lot Runoff BMPs in Abington & Fort Washington

3. Residential runoff BMPs in Flourtown, Oreland, Fort Washington Abington, and Rosyln

4. Montgomeryville Mall parking lot BMPs and infiltration swales at Knapp Park to protect headwaters of Wissahickon Creek in Montgomeryville/Lansdale area

5. Improved urban runoff BMPs to protect the Wissahickon Creek headwaters in the Lansdale/Upper Gwynedd area
6. Acquisition, Riparian Buffer, and Water Quantity Addition During Low Flows from Coorsons Quarry/Lorraine Run in Whitemarsh Township
7. Extension of Riparian Buffer/Green Ribbon Preserve from Fort Washington State Park in Ambler to Lansdale
8. Chestnut Hill College roof and parking lot stormwater BMPs
9. Urban Runoff BMPs in Chestnut Hill, Germantown, and Andorra
10. Philadelphia University roof and parking lot runoff stormwater BMPS
11. Agricultural BMPS and educational program at Saul Agricultural High School
12. Venice Island and Manayunk Canal Development/Redevelopment Ordinances, Runoff Controls, and Best Management Practices
13. Lower Merion Township Riparian Buffer Protection & Stormwater Mitigation
14. Alternative Road Salt Technology Initiative
15. Mitigation of Illegal Sewage Discharges and Failing Septic Systems and Parkland Creation At River Road
16. Innovative Stormwater Controls for Redevelopment of Waterfront Properties in Conshohocken, Norristown, Bridgeport, and Pottstown Business & Industrial Parks
17. Best Management Practices at City and Suburban Golf Courses
18. Corporate Environmental Stewardship Program

Wissahickon Creek Projects & Initiatives

<u>1. Stormwater Treatment Wetland at Maple Ave. in Ambler and Stormwater Detention Pond Retrofitting</u>

Location: Ambler Borough

Partners: Wissahickon Valley Watershed Association, Temple University Ambler Campus, Ambler Borough, Lower Gwynedd, Whitpain, Upper Dublin Township

Description: A study should be conducted to examine the feasibility of converting the abandoned pond on Maple Ave. into a stormwater treatment wetland or augmenations to retain more stormwater runoff. If feasible, then implementation plans should be developed and funding sources identified. Additional investigations of the conversion of existing detention basins into infiltration basins or stormwater treatment wetlands in the tri-township area around near Ambler should also be investigated. A similar project is being conducted by the Perkiomen Watershed Conservancy in the Perkiomen Creek Watershed through a growing greener grant.

2. Office Center & Business Parking Lot Runoff BMPs in Abington/Fort Washington

Location: Fort Washington area, Sandy Run watershed

Partners: Fort Washington Office Center, businesses, Abington, Upper Dublin, and Springfield Township

Description: A series of coordinated stormwater controls should be implemented to reduce and treat stormwater runoff from the large impervious parking areas in the watersheds. This could include special infiltration swales and infiltration basins in and around the office center or simple retrofits of the detention basins.

3. Residential Runoff BMPs in Flourtown, Oreland, Fort Washington, Abington, and Roslyn

Location: Flourtown, Oreland, Fort Washington, Abington, and Roslyn

Partners: Abington, Upper Dublin, Springfield Township, Fort Washington State Park, and the Wissahickon Valley Watershed Association

Implement a series of coordinated stormwater controls to reduce and treat stormwater runoff from the large impervious parking areas in the watersheds. This could include special infiltration swales and infiltration basins in and around the office center or simple retrofits of the detention basins. In addition, the township should work with the local country clubs along the Sandy Run and Wissahickon to determine if stormwater control projects can be implemented on township or bordering country club properties. For example redirecting a portion of the runoff from the densely packed residential neighborhoods near the country clubs and township parklands into small treatment wetlands, detention ponds, infiltration swales, or combinations of these techniques could reduce stormwater runoff issues in the area. Examples of open space available for such projects which could include educational and open space enhancements include Roslyn Park, Ardsley Park, Burn Brae Park, Penbryn Park, and the many country clubs in the area as well as portions of Fort Washington State Park provide available space for potential opportunities.

4. Montgomeryville Mall parking lot BMPs and infiltration swales at Knapp Park to protect Wissahickon Creek headwaters

Knapp Park could be utilized in order to better retain and infiltrate stormwater from the Montgomeryville Mall if BMPs cannot be implemented on mall property to improve infilration and water quality. This would help aid in temperature shocks to biologicals as well as reduce pollutant loadings from parking lot runoff and stream erosion.

5. Urban Runoff BMPs to protect the Wissahickon Creek Headwaters in Lansdale/ Upper Gwynedd

Location: Lansdale and Upper Gwynedd

Description: A demonstration project that includes a series of BMPs such as redirecting urban stormwater runoff from an area of Lansdale into infiltration basins or swales should be implemented.

6. Riparian Buffer Acquisition and Water Quantity Addition During Low Flows from Coorsons Quarry/Lorraine Run in Whitemarsh Township

Partners: Philadelphia Cricket Club, Whitemarsh Twp, and Fort Washington State Park

Description: Measurements have shown that currently the Coorson's Quarry discharges several million gallons of water per day into Lorraine Run and ultimately the Wissahickon Creek. This is a significant dry weather flow that is necessary in diluting the impacts of wastewater discharge at the headwaters of the stream especially during drought periods. Without this flow, the relative percentage of wastewater discharge to flow would increase dramatically during low or stable flow periods. The quantity of the groundwater discharge in this area is necessary for not only dilution, but biological communities. The loss of this discharge would only exacerbate the "flashiness" of the stream and increase streambank erosion. Since the future of the quarry is not known, efforts should be made to determine the longevity of the quarry and purchase the property and water rights or withdrawal permits from the quarry to continue to maintain the discharge rates. This may be done by individual organizations or even a combination of DCNR/Fort Washington State Park, the Philadelphia Cricket Club, and Whitemarsh Township. Even simply developing an agreement with the quarry to the water rights for the site upon sale to any future owner could be helpful.

7. Extension of Riparian Buffer/Green Ribbon Preserve from Fort Washington State Park in Ambler to Lansdale

Partners WVWA & DCNR

Description: Continued support for acquisition of land through purchase and easements to complete the riparian buffer along the Wissahickon Creek.

8. Chestnut Hill College roof and parking lot stormwater BMPs

Location: Chestnut Hill College, Philadelphia

Partners: Chestnut Hill College, PWD, and Morris Arboretum

Description: A number of the stormwater BMPs that have been initiated at Morris Arboretum such as porous pavement, streambank stabilization, and infiltration swales should be implemented at the adjacent property at Chestnut Hill College. This could be part of an environmental curriculum at the college where students monitor the effectiveness of these practices. These practices include, but are not limited to rain barrels on small buildings, porous pavement, infiltration swales, riparian filter strips, etc.

9. Urban Runoff BMPs in Chestnut Hill, Germantown, and Andorra

Partners: Philadelphia Water Department, Fairmount Park Commission, Andorra Shopping Center, Summit Park Apartments, Henry on the Park Apartments, Andorra Civic Association, etc.

Location: Andorra, Germantown, Chestnut Hill

Description: The project would include a series of BMPs to reduce parking lot and roof runoff while encouraging infiltration into the groundwater table. These include tree shading/cover for large parking areas with infiltration swales in parking medians. Parking curb islands converted into infiltration swales and the placement of medians with trees and infiltration swales in large steeply sloped parking areas to slow down runoff and reduce temperature impacts during summer. The development of an interconnected rain gardens to withhold and treat roof runoff from the large apartment complexes is also recommended. Installation of treatment wetlands or additional infiltration basins below these large areas would also be useful. Installation of “greenscape” rooftops for large commercial facilities could also be explored.

<u>10. Philadelphia University roof and parking lot runoff stormwater BMPS</u>

Location: Philadelphia University

Partners: United States Army Corps of Engineers, Fairmount Park Commission, Philadelphia Water Department, and Philadelphia University

Description: The stormwater runoff from the university complex can be reduced through a number of improved practices including examination of detention pond utilization, development of infiltration swales, and other techniques. Students involved in environmental service learning projects and environmental programs could participate in design, implementation, and monitoring effectiveness of any stormwater BMPs that are installed or operated.

<u>11. Agricultural BMPS and educational program at Saul Agricultural School</u>

Partners: USDA, Philadelphia School District, Philadelphia Water Department

Description: Develop an educational program that includes the development and implementation of a good environmental practices plan with school students and faculty at Saul Agricultural High School. This includes developing grass filter strips and infiltration swales to capture runoff and remove pollutants from pastureland and barnyard runoff.

Mainstem Schuylkill River Projects

<u>1. Extension of the Belmont Intake Protection Area Meadow</u>

Location: West River Drive, Fairmount Park

Partners: Philadelphia Water Department, Fairmount Park Commission

Description: This project would extend the current demonstration meadow at the Belmont Intake and extend it approximately 0.25 miles upstream to the Strawberry Mansion Bridge. This would provide a riparian buffer to reduce runoff and erosion impacts near the intake as well as deter geese. The area would have interpretive and educational signing included to educate park users about the source of their water.

<u>2. Venice Island and Manayunk Canal Development/Redevelopment Ordinances, Runoff Controls, and Best Management Practices</u>

Location: Venice Island / Manayunk Canal

Partners: Manayunk Development Corporation, Philadelphia Planning Commission, Developers, Philadelphia Streets Department, Philadelphia Water Department, Fairmount Park Commission

Description: The development of a focused stormwater plan for this highly developed area should include special ordinances should be developed for the Manayunk / Venice Island Area that require the installation of appropriate technologies to treat and/or reduce the amount or intensity of runoff from parking lots and rooftops prior to discharge into the Manayunk Canal or Schuylkill River. It would also include a program of several focused public/private partnership projects to reduce and/or treat stormwater runoff from parking lots and rooftops. This could include the use of rainbarrels, development of raingardens on vacant lots, infiltration swales or ditches in parking lots, and planting of trees in parking lots to reduce temperature impacts.

<u>3. Lower Merion Township Riparian Buffer Protection & Stormwater Mitigation</u>

Location: Saw Mill Run, Mill Creek, and Gulley Run.

Partners: Lower Merion Township, Lower Merion Conservancy, Philadelphia Water Department, Philadelphia Country Club

Description: Develop ordinances preventing mowing of streambank areas while identifying partners for streambank plantings to reduce erosion or demonstrate aesthetically pleasing alternatives to mowed streambanks. A series of projects to reduce stormwater runoff could be implemented in areas of high impervious cover that have no runoff controls such as detention basins. In these areas projects such as infiltration ditches and swales for ground runoff or rain barrels for roof runoff should be piloted.

<u>4. Alternative Road Salt Technology Initiative</u>

Location(s): West River Drive, Kelly Drive, Chestnut Hill, Manayunk, Belmont, City Line Avenue, Lower Merion Township

Partners: Manayunk Development Corporation, Philadelphia Streets Department, Philadelphia Water Department, Pennsylvania Department of Environmental Protection, Lower Merion Township

Another component would also include testing alternative technologies to reduce the amount of salt applied to roads and parking lots in the area during the winter while maintaining safety. This could include finding funding sources to acquire special "fogging" machines that put down light mists of salt water on a road that require less salt application on an area.

<u>5. Mitigation of Illegal Sewage Discharges and Failing Septic Systems and Greenspace Creation At River Road</u>

Location: River Road, Philadelphia

Partner: Federal Emergency Management Agency, The State of Pennsylvania, The City of Philadelphia, and Schuylkill Environmental Education Center

Description: Failing septic systems or illegal sewage discharges into the river upriver from floodplain properties on River Road, jeopardize the recreational water quality of the Schuylkill River and the entrance to the Manayunk Canal. A long term program of acquisition of the properties to link the Schuylkill Environmental Education Center and Fairmount Park area along the canal to the Philadelphia City limits would eliminate these discharges and reduce future issues with floodplain development in the area.

6. Innovative Stormwater Controls for Redevelopment of Waterfront Properties in Conshohocken, Norristown, Bridgeport, and Pottstown Business & Industrial Parks

Location: Riverfront Areas along Conshohocken, Norristown, Bridgeport, and Pottstown

Partners: Municipalities, Montgomery County Planning Commission, Philadelphia Water Department, Pennsylvania American Water Company, Philadelphia Suburban Water Company, Montgomery County Conservation District

Description: This project includes installation of new technologies to treat and/or reduce the amount or intensity of runoff from parking lots and rooftops prior to discharge into the Schuylkill River. It would also include a program of several focused public/private partnership projects to reduce and/or treat stormwater runoff from parking lots and rooftops. This could include the use of rainbarrels, development of raingardens on vacant lots, infiltration swales or ditches in parking lots, pervious pavement, conversion of detention basins into treatment wetlands, and planting of trees in parking lots to reduce temperature impacts and reduce rainfall that reaches the pavement. These technologies could be implemented upon initial construction/redevelopment or be added to currently redeveloped areas in such a way as to improve aesthetics.

7. Encouraging Best Management Practices at City and Suburban Golf Courses

Location(s): Walnut Lane Golf Course, Philadelphia Country Club, and Eagle Lodge Country Club

Partners: Philadelphia Water Department, Lower Merion Township, Whitemarsh Township, Philadelphia Department of Recreation, Riverbend Environmental Education Center, Schuylkill Environmental Education Center, Philadelphia Country Club, and Eagle Lodge Country Club

Description: The three golf courses mentioned are located in high priority areas for source water protection. The owners, managers, and members of the golf course need to be educated about the importance of their property and how significant it is to the protection of the water supply. Also, efforts should be made to inventory and examine the environmental practices of the golf courses to identify improvements that can be made over time. One specific way is to encourage the golf courses to obtain Audubon certification that requires such a process and certain levels of success. Since the two country clubs are located nearby two very active environmental centers with good education programs and members of both the country clubs may also be members of the environmental centers, they should be involved in the process to maximize education opportunities and build neighborhood public-private environmental relationships.

8. A Corporate Environmental Stewardship Program

Project Partners: PWD, Partnership for the Delaware Estuary, Chester County Water Resources Authority, Schuylkill Environmental Education Center, Schuylkill Riverkeeper

Description: A program that engages, educates, and rewards businesses for participating in and completing various levels of source water protection should be established. The goals of this program include the following:

- Increase businesses awareness about the water supply and runoff impacts
- Provide opportunities for businesses to engage in piloting, demonstrating, or implementing various activities to reduce runoff from their location or other location(s) identified by stakeholders

3.2.8.4 Data Needs

Based on the various analyses that were conducted to identify specific sources of contamination, their location, and other characteristics, the following data gaps and information needs were identified.

Study of Cryptosporidium Presence in Wastewater Effluents

The national guidance documents for the SWAPs and DEP's own SWAP process has very specific interests in identifying and ranking sources of *Cryptosporidium*. However, the information, data, and tools were not available at the local level for an accurate analysis of this information. Preliminary studies by the Philadelphia Water Department, Philadelphia Suburban Water Company, and the PADEP have detected *Cryptosporidium* frequently at elevated levels in raw and treated sewage. The potential contribution of the pathogen *Cryptosporidium* from wastewater discharges, unsewered communities, and illicit discharges upstream of drinking water supplies is necessary to understand the daily impacts they have on pathogen challenges to the water treatment plants downstream. This could lead to strategies to reduce routine levels or viability of *Cryptosporidium* from discharges and better protect water supplies. Over the past three years, the Water Environment Research Federation has been conducting a research method to accurately detect and quantify levels of *Cryptosporidium* in wastewater. This study is almost complete and it is recommended that local studies that are conducted use this new method.

Shared GIS Information

Compilation and housing of up to date GIS information for upstream municipalities including sewer and stormsewer infrastructure characteristics (sewersheds, outfalls), zoning areas, ACT 167 information, preserved or potentially preserved agricultural land, county and township parklands, lands with conservation easements. Better information on abandoned or historical industrial sites and brownfields is also needed. Suggested partners interested in housing this information include the Delaware River Basin Commission.

3.2.8.5 Selection of Best Management Practices in Proposed Protection Projects

Selection of best management practices (BMPs) requires the careful weighting of various factors including capital and operational costs, land consumption, and effectiveness. This section describes the various costs and choices when selecting any bmps.

There are two types of BMPs that can be employed to address stormwater runoff, structural and non-structural. Structural practices usually involve the construction of some control structure or device. Non-structural practices usually involve activities that include changing public behavior and land use practices through education, training, and legal requirements. A comprehensive list of these practices is provided below in Tables 3.2.8-4 and 3.2.8-5.

Table 3.2.8-4 Structural BMPs for Stormwater Control

Ponds
Dry extended detention ponds
Wet ponds
Infiltration practices
Infiltration basin
Infiltration trench
Porous pavement
Filtration practices
Bio-retention
Sand and organic filters
Vegetative practices
Storm water wetland
Grassed swales
Grassed filter strip
Runoff pretreatment practices
Catch basins/Catch basin insert
In-line storage
Manufactured products for storm water inlets

Table 3.2.8-5 Nonstructural BMPs for Stormwater Control

Experimental practices
Alum injection
On-lot Treatment
On-Lot treatment
Better site design
Buffer zones
Open space design
Urban forestry
Conservation easements
Infrastructure planning
Narrower residential streets
Eliminating curbs and gutters
Green parking
Alternative turnarounds
Alternative pavers
BMP inspection and maintenance
Ordinances for post-construction runoff
Zoning

Employment and selection of the various structural bmp techniques and technologies requires additional familiarity with the pros and cons of the technologies, site selection and design issues, operation and maintenance and costs. Tables 3.2.8-6 and 3.2.8-7 provide examples of estimates of capital and maintenance costs of various structural bmps. Table 3.2.8-8 provides estimated land consumption for various structural bmps. Table 3.2.8-9 provides a description of the various contaminants non-structural bmps can address. Tables 3.2.8-10 through 14 provide data on the effectiveness of pollutant removal by various bmps. These tables are taken directly from EPA's website at **URL:** http://www.epa.gov/ost/stormwater/usw_d.pdf .

Table 3.2.8-6 Base Costs of Typical Applications of Storm Water BMPs

BMP Type	Typical Cost ($/BMP)	Application	Data Source
Retention Basin	$100,000	50-Acre Residential Site (Impervious Cover = 35%)	Adapted from Brown and Schueler (1997b)
Wetland	$125,000	50-Acre Residential Site (Impervious Cover = 35%)	Adapted from Brown and Schueler (1997b)
Infiltration Trench	$45,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from SWRPC (1991)
Infiltration Basin	$15,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from SWRPC (1991)
Sand Filter	$35,000-$70,000[2,3]	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from Brown and Schueler (1997b)
Bioretention	$60,000	5-Acre Commercial Site (Impervious Cover = 65%)	Adapted from Brown and Schueler (1997b)
Grass Swale	$3,500	5-Acre Residential Site (Impervious Cover = 35%)	Adapted from SWRPC (1991)
Filter Strip	$0-$9,000[3]	5-Acre Residential Site (Impervious Cover = 35%)	Adapted from SWRPC (1991)

1. Base costs do not include land costs.
2. Total capital costs can typically be determined by increasing these costs by approximately 30%.
3. A range is given to account for design variations.

Source: *http://www.epa.gov/ost/stormwater/usw_d.pdf*

Table 3.2.8-7 Operation and Maintanence Cost Estimates

BMP	Annual Maintenance Cost (% of Construction Cost)	Source(s)
Retention Basins and Constructed Wetlands	3%-6%	Wiegand et al, 1986 Schueler, 1987 SWRPC, 1991
Detention Basins[1]	<1%	Livingston et al, 1997; Brown and Schueler, 1997b
Constructed Wetlands[1]	2%	Livingston et al, 1997; Brown and Schueler, 1997b
Infiltration Trench	5%-20%	Schueler, 1987 SWRPC, 1991
Infiltration Basin[1]	1%-3%	Livingston et al, 1997; SWRPC, 1991
	5%-10%	Wiegand et al, 1986; Schueler, 1987; SWRPC, 1991
Sand Filters[1]	11%-13%	Livingston et al, 1997; Brown and Schueler, 1997b
Swales	5%-7%	SWRPC, 1991
Bioretention	5%-7%	(Assumes the same as swales)
Filter strips	$320/acre (maintained)	SWRPC, 1991

1. Livingston et al (1997) reported maintenance costs from the maintenance budgets of several cities, and percentages were derived from costs in other studies

Table 3.2.8-8 Land Consumption of Various BMPs

BMP Type	Land consumption (% of Impervious Area)
Retention Basin	2-3%
Constructed Wetland	3-5%
Infiltration Trench	2-3%
Infiltration Basin	2-3%
Porous Pavement	0%
Sand Filters	0%-3%
Bioretention	5%
Swales	10%-20%
Filter Strips	100%

Note: Represents the amount of land needed as a percent of the impervious area that drains to the practice to achieve effective treatment.
Source: Claytor and Schueler, 1996

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 3.2.8-9 Non-Structural BMPs Suited to Controlling Various Pollutants Pollutant Appropriate BMPs

	BMPS
Solids	Street Sweeping Land Use Modifications
Oxygen-Demanding Substances	Street Sweeping Education: Storm Drain Stenciling Land Use Modifications Education: Pet Scoop Ordinance Illicit Connections Eliminated
Nitrogen and Phosphorus	Street Sweeping Education: Pet Scoop Ordinance Land Use Modifications Proper Materials Handling Illicit Connections Eliminated Education: Lawn Care Materials Storage and Recycling
Pathogens	Illicit Connections Eliminated Land Use Modifications Education: Pet Scoop Ordinance
Petroleum Hydrocarbons	Street Sweeping Education: Storm Drain Stenciling Proper Materials Handling Illicit Connections Eliminated Materials Storage and Recycling Land Use Modifications
Metals	Street Sweeping Education: Storm Drain Stenciling Proper Materials Handling Illicit Connections Eliminated Materials Storage and Recycling Land Use Modifications
Synthetic Organic Compounds	Illicit Connections Eliminated Education: Storm Drain Stenciling Proper Materials Handling Education: Lawn Care Materials Storage and Recycling Land Use Modifications
Temperature	Land Use Modifications
pH	Illicit Connections Eliminated Proper Materials Handling Materials Storage and Recycling Land Use Modifications

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 3.2.8-10 Structural BMP Expected Pollutant Removal Efficiency

BMP Type	Typical Pollutant Removal (percent)				
	Suspended Solids	**Nitrogen**	**Phosphorus**	**Pathogens**	**Metals**
Dry Detention Basins	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Retention Basins	50 - 80	30 - 65	30 - 65	< 30	50 - 80
Constructed Wetlands	50 - 80	< 30	15 - 45	< 30	50 - 80
Infiltration Basins	50 - 80	50 - 80	50 - 80	65 - 100	50 - 80
Infiltration Trenches/ Dry Wells	50 - 80	50 - 80	15 - 45	65 - 100	50 - 80
Porous Pavement	65 - 100	65 - 100	30 - 65	65 - 100	65 - 100
Grassed Swales	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Vegetated Filter Strips	50 - 80	50 - 80	50 - 80	< 30	30 - 65
Surface Sand Filters	50 - 80	< 30	50 - 80	< 30	50 - 80
Other Media Filters	65 - 100	15 - 45	< 30	< 30	50 - 80

Source: Adapted from US EPA, 1993c.

Table 3.2.8-11 Pollutant Removal by Infiltration Practices

Parameter	Median or Average Removal Efficiency (percent)	Number of Observations
Total Phosphorus	65	5
Ammonia-Nitrogen	83	3
Nitrate	82	3
Total Nitrogen	83	2
Suspended Solids	89	2
Organic Carbon	82	1
Lead	98	1
Zinc	99	1

Source: Brown and Schueler, 1997a

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 3.2.8-12 Pollutant Removal by Retention Basins

Parameter	Median or Average Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	34	-12	90	20
Total Phosphorus	46	0	91	44
Ammonia-Nitrogen	23	-107	83	14
Nitrate	23	-85	97	27
Organic Nitrogen	23	2	34	6
Total Nitrogen	30	-12	85	24
Suspended Solids	70	-33	99	43
Bacteria	74	-6	99	10
Organic Carbon	35	-30	90	29
Cadmium	47	-25	54	5
Chromium	49	25	62	5
Copper	55	10	90	18
Lead	67	-97	95	34
Zinc	51	-38	96	32

Source: Brown and Schueler, 1997a

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 3.2.8-13 Pollutant Removal Efficiency of Constructed Wetland Systems

Parameter	Median Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	23	-30	78	12
Ortho-Phosphate	28	-109	93	7
Total Phosphorus	46	-120	97	37
Ammonia-Nitrogen	33	-86	62	15
Nitrate	46	4	95	18
Organic Nitrogen	7	-36	39	7
Total Nitrogen	24	-20	83	11
Suspended Solids	76	-300	98	26
Bacteria	78	55	97	3
Organic Carbon	28	-31	93	15
Cadmium	69	-80	80	6
Chromium	73	38	98	3
Copper	39	2	84	10
Lead	63	23	94	17
Zinc	54	-74	90	16

Sources: Strecker at al (1992); Organic Carbon, Bacteria and Metals from Brown and Schueler, 1997a

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

Table 3.2.8-14 Pollutant Removal Efficiency of Open Channel Vegetated Systems

Parameter	Average or Median Removal Efficiency (percent)	Range of Removals (percent)		Number of Observations
		Low	High	
Soluble Phosphorus	11	-45	72	8
Total Phosphorus	15	-100	99	18
Ammonia-Nitrogen	3	-19	78	4
Nitrate	11	-100	99	13
Organic Nitrogen	39	11	86	3
Total Nitrogen	11	-100	99	10
Suspended Solids	66	-100	99	18
Bacteria	-25	-100	0	5
Organic Carbon	23	-100	99	11
Cadmium	49	20	80	6
Chromium	47	14	88	5
Copper	41	-35	89	15
Lead	50	-100	99	19
Zinc	49	-100	99	19

Source: Brown and Schueler, 1997a

Source: http://www.epa.gov/ost/stormwater/usw_d.pdf

3.2.8.6 Descriptions and Pictures of Technologies for Stormwater Control

Though many technologies are recommended for use of best management practices, not everyone can envision how they would look and operate. The following section provides descriptions and pictures of these technologies. More detailed information such as design criteria, pros and cons to construction and operation, technical fact sheets, effectiveness, and various diagrams are also provided on EPA's websites at the following URLs.

http://www.epa.gov/npdes/menuofbmps/post.htm

http://www.epa.gov/ost/stormwater/usw_c.pdf

The following descriptions have been taken from these websites to provide the reader with descriptions of the following BMP technologies and techniques:

- Infiltration trenches
- Bio-retention areas
- Stormwater wetlands
- Infiltration basins
- Wet ponds
- Dry extended detention ponds
- Grass filter strips
- Grass swales
- Green parking
- Porous pavement
- Sand and organic filters
- Catch basins and inserts
- Storm water inlet products
- Log veins and coir fabric for streambank restoration

Bio-retention Areas
Post-construction Storm Water Management
in New Development and Redevelopment

Bioretention areas can be used in parking areas to collect and treat storm water (Source: University of Maryland, 2000)

Description

Bio-retention areas are landscaping features adapted to provide on-site treatment of storm water runoff. They are commonly located in parking lot islands or within small pockets of residential land uses. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems. During storms, runoff ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. Typically, the filtered runoff is collected in a perforated under-drain and returned to the storm drain system.

Infiltration Basin
Postconstruction Storm Water Management
in New Development and Redevelopment

Infiltration basins are designed to collect storm water from impervious areas and provide pollutant removal benefits through detention and filtration

Description

An infiltration basin is a shallow impoundment that is designed to infiltrate storm water into the ground water. This practice is believed to have a high pollutant removal efficiency and can also help recharge the ground water, thus restoring low flows to stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Storm Water Wetland
Post-construction Storm Water Management in New Development and Redevelopment


A storm water wetland detains storm water, removes pollutants, and provides habitat and aesthetic benefits (Source: The Bioengineering Group, Inc., no date)

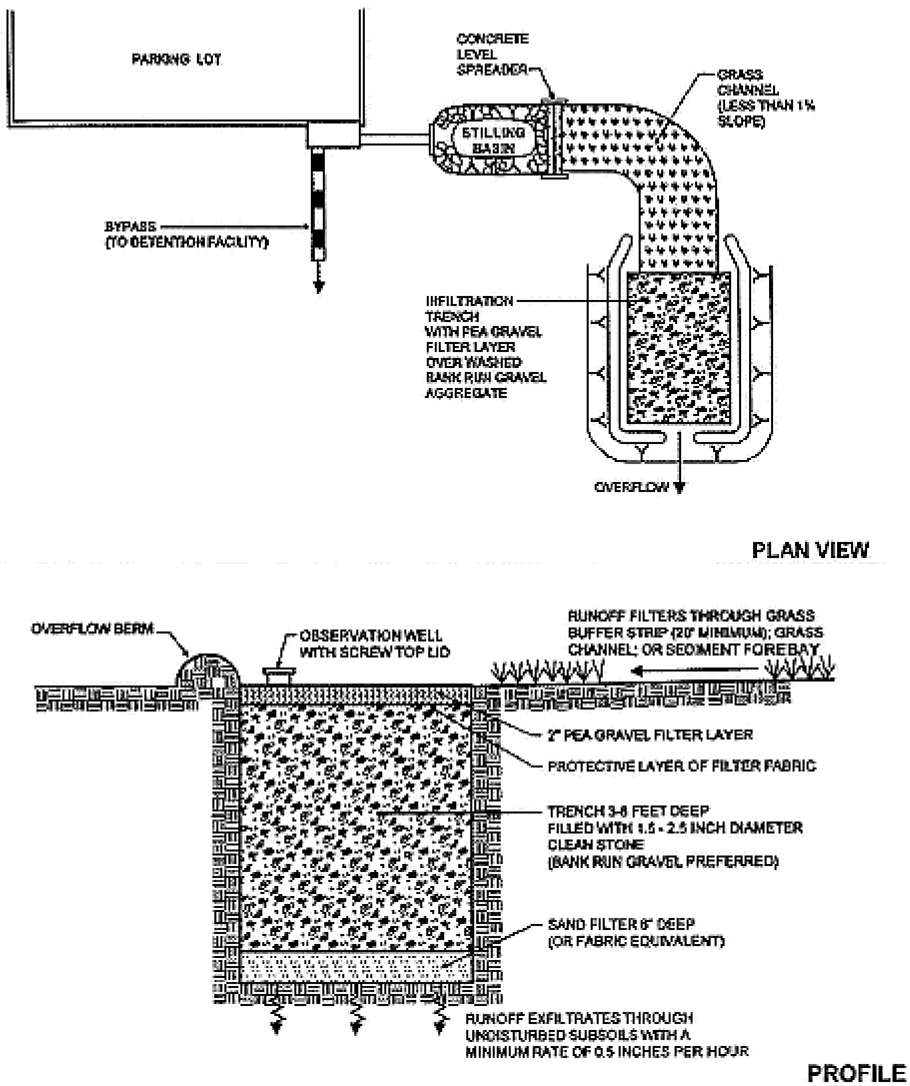
Description

Storm water wetlands (a.k.a. constructed wetlands) are structural practices similar to wet ponds (see Wet Pond fact sheet) that incorporate wetland plants into the design. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake within the practice. Wetlands are among the most effective storm water practices in terms of pollutant removal and they also offer aesthetic value. Although natural wetlands can sometimes be used to treat storm water runoff that has been properly pretreated, storm water wetlands are fundamentally different from natural wetland systems. Storm water wetlands are designed specifically for the purpose of treating storm water runoff, and typically have less biodiversity than natural wetlands in terms of both plant and animal life. Several design variations of the storm water wetland exist, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland.

A distinction should be made between using a constructed wetland for storm water management and diverting storm water into a natural wetland. The latter practice is not recommended because altering the hydrology of the existing wetland with additional storm water can degrade the resource and result in plant die-off and the destruction of wildlife habitat. In all circumstances, natural wetlands should be protected from the adverse effects of development, including impacts from increased storm water runoff. This is especially important because natural wetlands provide storm water and flood control benefits on a regional scale.

Infiltration Trench
Post-construction Storm Water Management
in New Development and Redevelopment
Description

An infiltration trench (a.k.a. infiltration galley) is a rock-filled trench with no outlet that receives storm water runoff. Storm water runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. There, runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. The primary pollutant removal mechanism of this practice is filtering through the soil.



A schematic of an infiltration trench (Source: MDE, 2000)

Grassed Filter Strip
Post-construction Storm Water Management
in New Development and Redevelopment

Grassed filter strips protect water quality by filtering pollutants before they reach the water (Source: USDA, 1997)

Description

Grassed filter strips (vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice, and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal. One challenge associated with filter strips, however, is that it is difficult to maintain sheet flow, so the practice may be "short circuited" by concentrated flows, receiving little or no treatment.

Grassed Swales
Post-construction Storm Water Management
in New Development and Redevelopment

Grassed swales can be used along roadsides and parking lots to collect and treat storm water runoff

Description

The term swale (a.k.a.grassed channel, dry swale, wet swale, bio-filter) refers to a series of vegetated, open channel management practices designed specifically to treat and attenuate storm water runoff for a specified water quality volume. As storm water runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Variations of the grassed swale include the grassed channel, dry swale, and wet swale. The specific design features and methods of treatment differ in each of these designs, but all are improvements on the traditional drainage ditch. These designs incorporate modified geometry and other features for use of the swale as a treatment and conveyance practice.

Wet Ponds
Post-construction Storm Water Management in New Development and Redevelopment

The primary functions of a wet pond are to detain storm water and facilitate pollutant removal through settling and biological uptake

Description

Wet ponds (a.k.a. storm water ponds, retention ponds, wet extended detention ponds) are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Ponds treat incoming storm water runoff by settling and algal uptake. The primary removal mechanism is settling as storm water runoff resides in this pool, and pollutant uptake, particularly of nutrients, also occurs through biological activity in the pond. Wet ponds are among the most cost-effective and widely used storm water practices. While there are several different versions of the wet pond design, the most common modification is the extended detention wet pond, where storage is provided above the permanent pool in order to detain storm water runoff in order to provide settling.

Dry Extended Detention Pond
Post-construction Storm Water Management in New Development and Redevelopment

A dry extended detention pond is designed to temporarily detain runoff during storm events

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the storm water runoff from a water quality design storm for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. However, they are often designed with small pools at the inlet and outlet of the basin. They can also be used to provide flood control by including additional flood detention storage.

Porous Pavement
Post-construction Storm Water Management in New Development and Redevelopment


A porous pavement parking lot (Source: Invisible Structures, no date)

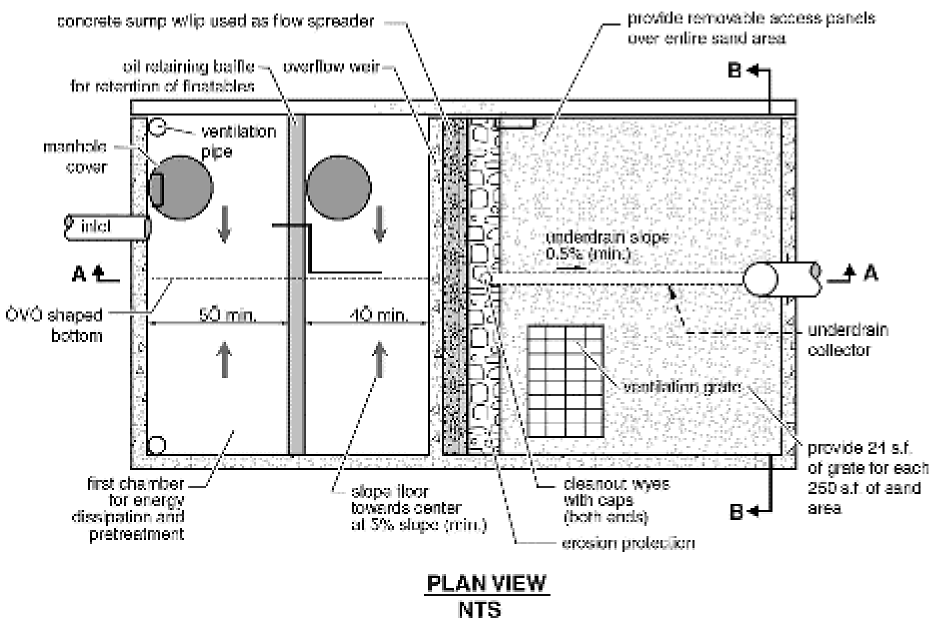
Description
Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot storm water to infiltrate directly and receive water quality treatment. There are a few porous pavement options, including porous asphalt, pervious concrete, and grass pavers. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous gridded systems with open areas designed to allow grass to grow within the void areas. Other alternative paving surfaces can help reduce the runoff from paved areas but do not incorporate the stone trench for temporary storage below the pavement (see Green Parking fact sheet). While porous pavement has the potential to be a highly effective treatment practice, maintenance has been a concern in past applications of the practice.

Green Parking
Post-construction Storm Water Management in New Development and Redevelopment


A green parking lot at the Orange Bowl in Miami, Florida (Source: Invisible Structures, no date)

Description
Green parking refers to several techniques applied together to reduce the contribution of parking lots to the total impervious cover in a lot. From a storm water perspective, application of green parking techniques in the right combination can dramatically reduce impervious cover and, consequently, the amount of storm water runoff. Green parking lot techniques include setting maximums for the number of parking lots created, minimizing the dimensions of parking lot spaces, utilizing alternative pavers in overflow parking areas, using bioretention areas to treat storm water, encouraging shared parking, and providing economic incentives for structured parking.

Sand and Organic Filters
Postconstruction Storm Water Management
in New Development and Redevelopment



Schematic of a sand filter (Source: King County, Washington, 2000)

Description

Sand filters are usually two-chambered storm water practices; the first is a settling chamber, and the second is a filter bed filled with sand or another filtering media. As storm water flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as storm water flows through the filtering medium. There are several modifications of the basic sand filter design, including the surface sand filter, underground sand filter, perimeter sand filter, organic media filter, and Multi-Chamber Treatment Train. All of these filtering practices operate on the same basic principle. Modifications to the traditional surface sand filter were made primarily to fit sand filters into more challenging design sites (e.g., underground and perimeter filters) or to improve pollutant removal (e.g., organic media filter).

Catch Basins/Catch Basin Inserts
Post-construction Storm Water Management in New Development and Redevelopment

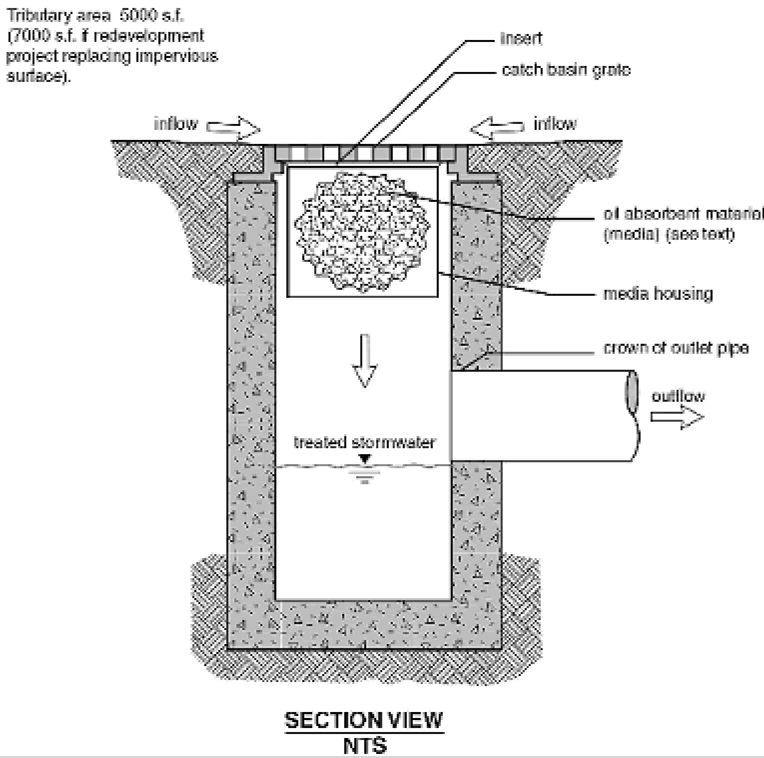
A worker inserts a catch basin insert for oil and grease, trash, debris, and sediment removal from storm water as it enters the storm drainage system (Source: AbTech Industries, 2001)

Description

A catch basin (a.k.a. storm drain inlet, curb inlet) is an inlet to the storm drain system that typically includes a grate or curb inlet and a sump to capture sediment, debris, and associated pollutants. They are also used in combined sewer overflow (CSO) watersheds to capture floatables and settle some solids. Catch basins act as pretreatment for other treatment practices by capturing large sediments. The performance of catch basins at removing sediment and other pollutants depends on the design of the catch basin (e.g., the size of the sump) and maintenance procedures to retain the storage available in the sump to capture sediment.

Catch basin efficiency can be improved using inserts, which can be designed to remove oil and grease, trash, debris, and sediment. Some inserts are designed to drop directly into existing catch basins, while others may require extensive retrofit construction.

Manufactured Products for Storm Water Inlets
Post-construction Storm Water Management
in New Development and Redevelopment



The typical design of a catch basin insert is a set of filters that are specifically chosen to address the pollutants expected at that site (Source: King County, Washington, 2000)

Description

A variety of products for storm water inlets known as swirl separators, or hydrodynamic structures, have been widely applied in recent years. Swirl separators are modifications of the traditional oil-grit separator and include an internal component that creates a swirling motion as storm water flows through a cylindrical chamber. The concept behind these designs is that sediments settle out as storm water moves in this swirling path. Additional compartments or chambers are sometimes present to trap oil and other floatables. There are several different types of proprietary separators, each of which incorporates slightly different design variations, such as off-line application. Another common manufactured product is the catch basin insert. These products are discussed briefly in the Catch Basin fact sheet.

Examples of Materials Used in a Streambank Restoration and Protection: Log veins redirect streamflow back to the center channel or slow side stream velocities protecting the streambank. The coir fabric stabilizes the streambank and allows new plantings such as tall warm seasoned grasses time to grow. Over time the coir fabric biodegrades back into the soil.

Conversion of Detention Ponds and Construction of Treatment Wetlands: A typical detention pond that is mowed has little water quality benefit and can be converted into something more beneficial. Treatment wetlands can be aesthetically pleasing and ecologically diverse. Both of the areas shown above are located in the Philadelphia Region.

3.2.9 PWD-Queen Lane Intake Public Summary

Introduction

As part of the requirements of the 1996 Safe Drinking Water Act Reauthorization, the Pennsylvania Department of Environmental Protection (PADEP) has been conducting assessments of all potentially significant sources of contamination to all public drinking water sources. The Philadelphia Water Department has prepared this Source Water Assessment Public Summary to provide information to support local and state efforts to protect the quality of the City of Philadelphia's drinking water sources. The information in this summary pertains to the water supply area for the Philadelphia Water Department's Queen Lane Water Treatment Plant. The water withdrawn for the Queen Lane Water Treatment Plant is treated and meets all state and federal regulations for safety and quality before being distributed to West Philadelphia. The assessment conducted for the Queen Lane Water Treatment Plant is of the "source" (river water) rather than "tap" (drinking) water. Information on "tap" (drinking) water quality is available from the Philadelphia Water Department's Annual Consumer Confidence Report that can be obtained by calling 215-685-6300 or www.phila.gov.

What is the Source of Your Drinking Water?

The source of water for the Philadelphia Water Department – Queen Lane Water Treatment Plant is surface water from the Schuylkill River. An average of 80 million gallons is withdrawn from the river per day. The water system serves approximately 350,000 customers in Philadelphia between the boundaries of the Schuylkill River and Broad Street (Route 611). The water supply intake is located in Fairmount Park section of Philadelphia. Approximately 1,900 square miles of land covering portions of 11 counties including large sections of Berks, Schuylkill, Montgomery, and Chester Counties drain into the river upstream from the intake. The land upstream of the intake is 47% forested/greenspace, 36 % agricultural, and 14 % developed. Approximately 3 million people live in the Schuylkill River Watershed.

Water Quality and Treatment Information

Water withdrawn from the Schuylkill River is coagulated, settled, filtered, and disinfected with chlorine prior to distribution to customers. Drinking water quality meets or exceeds all state or federal requirements. In addition, the Queen Lane Water Treatment Plant participates in the Partnership for Safe Water program. This program is an intensive voluntary program nationwide by water suppliers that strives for optimized water quality well beyond that required by state and federal agencies.

Evaluation of Significant Sources of Contamination

This assessment identifies and evaluates the possibility for contaminants to potentially enter the Schuylkill River upstream from the water intake prior to treatment. The contaminants addressed in this assessment include those regulated under the federal Safe Drinking Water Act as well as those PADEP has determined may present a concern to human health. These sources are then ranked to determine their protection priority to the water supplier. The protection priority is the level of importance and potential contamination a particular source represents the water supply. A description of the protection priority assigned to various types of sources upstream from the Belmont

Intake is provided in Table 3.2.9-1. Each type of source has a qualitative protection priority rating ranging from A to F. The "A" rating is considered a source of highest protection priority, while "F" is considered lowest protection priority. Sources with ratings between A and C are considered potentially significant sources for protection consideration. Sources with rating between D and F are considered to have less significance.

As indicated in Table 3.2.9-1, discharges of treated and untreated sewage upstream of the water intake were given the highest protection priority due to their potential to release pathogens and nutrients into the water supply. Polluted runoff from stormwater was also given a high protection priority due to the potential impacts of runoff from urban areas and agricultural lands that introduce pathogens, nutrients, and sediment into the water supply. Acid mine drainage was also considered a high protection priority due to the impacts it has on metals concentrations in the river.

Table 3.2.9-1 Summary of Protection Priorities for Various Upstream Sources

Source	Protection Priority	Description	Priority Area(s)	Contaminants
Treated Sewage	A - High	Wastewater discharges from wastewater treatment plants	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment, organic chemicals
Untreated Sewage	A - High	Combined and sanitary sewer overflows/discharges	Bridgeport, Norristown, & Schuylkill County	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients
Urban/Residential Runoff	A – C Moderate - High	Stormwater runoff from roads, parking lots, roofs	Reading to Philadelphia	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, metals, sediment
Agricultural Runoff	A-C Moderate - High	Stormwater runoff from croplands, pastures, livestock	Perkiomen Creek & Tulpehocken Creek	Pathogens, bacteria, viruses, *Cryptosporidium*, nutrients, sediment
Acid Mine Drainage	A - High	Discharge from abandoned coal mining areas	Schuylkill County	Metals
Industrial Facilities	A-C Moderate - High	Facilities that store or use hazardous chemicals	Reading to Philadelphia	Metals, nutrients, organic chemicals
Above Ground Storage Tanks	A-C Moderate - High	If storage tank spilled into river	Reading to Philadelphia	Petroleum hydrocarbons, metals, phosphorus
Landfills	C Moderate	Leaching of contaminants into streams	Reading to Philadelphia	Petroleum hydrocarbons, metals
Spills and Accidents	A-C Moderate - High	Car, truck, train, or pipeline accident spilling benzene	Watershed wide	Petroleum hydrocarbons, organic chemicals

Note: *Petroleum hydrocarbons include chemicals found in oils and greases. Organic chemicals include chemicals found in solvents, degreasers, varnishes, paints, gasoline, plastics, insect and weed killers.*

Ongoing Source Water Protection Activities

The Philadelphia Water Department (PWD) has an active source water protection program that works closely with state, federal, and local officials to address water quality issues. PWD also participates in various activities with upstream dischargers, businesses, communities, water suppliers, and watershed organizations that encourage communication, cooperation, education, protection, and restoration of the Schuylkill River and its tributaries.

Source Water Protection Needs

Overall, the primary areas to protect and improve PWD's water supply include the areas along the Schuylkill River between Reading and Philadelphia, the Wissahickon Creek, and Lower Perkiomen Creek. The Valley Creek, French Creek, and Tulpehocken Creeks appear to have secondary protection priority. In addition, other specific parts of the watershed may need limited attention for contaminant specific issues (i.e. acid mine drainage in Schuylkill County).

Based on these observations, the areas along the mainstem Schuylkill River between Reading and Philadelphia should be considered a priority protection corridor and have special protective regulations and legislation to restore and protect water quality. This includes development of initiatives to reduce or prevent pathogens such as *Cryptosporidium* from entering the river.

Long-term protection efforts should be focused on enhancing wastewater discharges and mitigating stormwater runoff from urban and residential areas. These will have the greatest overall impacts on improving source water quality and the Schuylkill River.

How to Obtain More Information

This Source Water Assessment Public Summary was completed in December 2001. Individuals interested in learning more about this water system and watershed can contact the Philadelphia Water Department at 215-685-6300 or access information from the Internet at www.phila.gov/departments/water or www.schuylkillswa.org.

How Do I Get Involved in Protecting the River and My Water Supply?

There are many ways you can help protect the river and your water supply. You can join a local watershed organization, join a citizens advisory committee, or write your state and local representatives or congressmen about your views and opinions on issues. Instead of joining organizations, you can also lend a hand when these various organizations conduct trash cleanup, stream restoration, tree planting activities, stenciling storm drains, or conducting stream monitoring. Even the smallest of things can help protect your stream, river, or water supply. Just simply calling the proper authorities when you see illegal dumping, dead fish, or other polluting activities can make a big difference (see Table 3.2.9-2). Below are a list of numbers to call for various situations and a list of websites to find more information about local watershed and environmental organizations in the area (see Table 3.2.9-3).

Table 3.2.9-2 Who to Call to Report Various Situations

Situation	Who To Call	Phone
Dead Fish	Fish & Boat Commission PADEP	717-626-0228 800-541-2050
Illegal Dumping & Related Pollution Activities	PADEP Environmental Police Unit	800-541-2050 215-685-6300
Sewage Spills	PADEP PWD	800-541-2050 215-685-6300
Oil & Gas Spills / Accidents	PADEP PWD	800-541-2050 215-685-6300

Table 3.2.9-3 Getting Involved: Places to go for More Information About Local Organizations

Information About	Phone Number	Website Address
Philadelphia Area Watershed Organizations	215-685-6300	www.schuylkillswa.org
Wissahickon Creek	215-646-8866	www.wvwa.org
Fairmount Park Friends Groups	215-685-0000	www.schuylkillswa.org
Schuylkill Riverkeeper	610-469-6005	email: srk@worldlynx.net
Perkiomen Watershed	610-287-9383	www.schuylkillswa.org
Tidal Schuylkill River	215.985.9393	www.srdc.net
Lower Merion Area	610-353-5587	www.schuylkillswa.org

List of Works Cited

Academy of Natural Sciences, The, Natural Lands Trust, and The Conservation Fund. 2001. The Conservation Fund Schuylkill River Conservation Plan.

Barber, Dana C. 1885. Report of a Sanitary Survey of the Schuylkill Valley

Biesecker, J.E., J.B. Lescinsky, and C.R. Wood. 1968. *Water Resources of the Schuylkill River Basin*: United States Department of the Interior Geological Survey.

Bollinger, J. E., L. J. Steinberg, M. J. Harrison, J. P. Crews, A. J. Englande, C. Velasco-Gonzales, L. E. White, and W. J. George. 1999. Comparative analysis of nutrient data in the lower Mississippi River. Water Research 33: 2627-2632.

Bricker, O. 1999. An overview of the factors involved in evaluating the geochemical effects of highway runoff on the environment. USGS open-file report 98-630.

Buckler, D. R., and G. E. Granato. 1999. Assessing biological effects from highway-runoff constituents. USGS open-file report 99-240.

Environmental Defense. Scorecard Homepage. 2001. Online. Internet. 19 September 2001. Available www.scorecard.org.

Environmental Protection Agency State Source Water Assessment and Protection Programs Guidance, August 1997, EPA 816-R-97-009, Office of Water 4606.

Exelon Nuclear, 2000, *Surface Water Stations near Limerick Generating Station* [1] -- data from Appendix A of LGS Annual Radiological Environmental Operating Report.

Gibson, Jane Mork. 1988. Philadelphia Museum of Art Bulletin, Vol. 84., Nos. 360 & 361.

Jaworski, N. A., and L. J. Hetling. 1996. Water quality trends of the mid-atlantic and northeast watersheds over the past 100 years. Conference proceedings, Watersheds '96. Pages 980-983.1998.

Jaworski, N. A., R. W. Howarth, and L. J. Hetling. 1997. Atmospheric deposition of nitrogen oxides onto the landscape contributes to coastal eutrophication in the northeast United States. Environmental Science and Technology. 31: 1995-2004.

Novotny, V, and H. Olem. 1994. Water quality: prevention, identification, and management of diffuse pollution. 1054 p. Van Nostrand Reinhold, New York.

Obolensky, Alexa. 2000. Final Report: Watershed Bromide Occurrence Study.

PADEP Southeast Regional Office, personal communication with Tom McCaffrey, 2001.

Reinhold, R. J. ed. 1998. Watershed management: practice, policies, and coordination. 391 p. Mc-Graw Hill, New York.

Schuylkill River Source Water Assessment Partnership. Schuylkill River Source Water Assessment Partnership Website. 14 June 2001. Online. Internet. 20 November 2001. **Available** www.schuylkillswa.org.

Solley, Wayne B., Robert R. Pierce, and Howard A. Perlman, 1995, Estimated Use of Water in the United States in 1995: U.S. Geological Survey Circular 1200.

Stamer, J.K., T.H. Yorke, and G.L. Pederson. 1985. Distribution and Transport of Trace Substances in the Schuylkill River Basin from Berne to Philadelphia, Pennsylvania. U.S. Geological Survey Water-Supply Paper 2256-A.

Toffey, William E. 1982. Philadelphia's River Resources. City of Philadelphia, Philadelphia City Planning Commission Technical Paper.

United States Department of Agriculture, Natural Resources Conservation Service, and Iowa State University Statistical Laboratory. 1997. Summary Report: 1997 National Resources Inventory.

United States Department of Agriculture, Natural Resources Conservation Service, and Iowa State University Statistical Laboratory. 2001. Summary Report: 2001 National Resources Inventory.

United States Environmental Protection Agency. EPA - Urban Storm Water BMP Study. 10 July 2001. Online. Internet. 26 October 2001. Available http://www.epa.gov/ost/stormwater/usw_d.pdf.

United States Environmental Protection Agency. Post-Construction Storm Water Management in New Development and Redevelopment. 5 May 2001. Online. Internet. 18 June 2001. Available http://www.epa.gov/npdes/menuofbmps/post.htm**.**

United States Environmental Protection Agency Safe Drinking Water is in our Hands, Existing Standards and Future Priorities. EPA document # EPA 815-F-98-007, September 1998.

Yorke, Thomas H., John K. Stamer, and Gary L. Pederson. 1985. Effects of Low-level Dams on the Distribution of Sediment, Trace Metals, and Organic Substances in the Lower Schuylkill River Basin, Pennsylvania: U.S. Geological Survey Water-supply Paper 2256-B.

List of Acronyms

ACCESS	Microsoft Access Database software
AMD	Acid Mine Drainage
AST	Aboveground Storage Tank
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CFS	Cubic Feet per Second
COWAMP	Pennsylvania's Comprehensive Water Quality Management
CRP	Conservation Reserve Program
CSO	Combined Sewer Overflow
CSX	CSX Transportation Rail Company
CWA	Clean Water Act
CWA	Clean Water Action
DBP	Disinfection by-product Precursor
DCNR	Department of Conservation and Natural Resources
DMR	Discharge Monitoring Report
DRBC	Delaware River Basin Commission
DVRPC	Delaware Valley Regional Planning Commission
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
EVAMIX	Mixed Data Multi-criteria Evaluation Software Program
FHWA	Federal Highway Administration
FWS	Fish and Wildlife Service
GIS	Geographic Information System
GPD	Gallons Per Day
LQG	Large Quantity Generators
MCPC	Montgomery County Planning Commission
MGD	Millions of Gallons per Day
MSL	Mean Sea Level
MTBE	Methyl Tertiary Butyl Ether
NCDC	National Climatic Data Center
NLCD	National Land Cover Data Set
NPDES	National Pollutant Discharge Elimination System Permit Program
NPL	National Priority List
NPS	Non-Point Source
NRCS	Natural Resources Conservation Resources
NSF	National Science Foundation
NURP	National Urban Runoff Pollutants Study
PADEP	Pennsylvania Department of Environmental Protection
PAWC	Pennsylvania American Water Company
PCB	Polychlorinated Biphenols
PCS	Permit Compliance System
PEC	Pennsylvania Environmental Council
PECO	Pennsylvania Electric Company
PEMA	Pennsylvania Emergency Management Agency Program
PWD	Philadelphia Water Department

PWS	Public Water Supply
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Act Information System
RTK	Right To Know
SDWA	Safe Drinking Water Act
SOC	Synthetic Organic Compounds
SQG	Small Quantity Generators
SSO	Sanitary Sewer Overflow
STEPS	Student Technical Experience in Problem Solving
STORET	USEPA’s Environmental Data System of STORage and RETrieval
STP	Sewage Treatment Plant
SWA	Source Water Assessment
SWAP	Source Water Assessment Program
TAG	Technical Advisory Group
TDS	Total Dissolved Solids
TM	Thematic Mapper
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRI	Toxic Release Inventory
TS	Total Solids
TSS	Total Suspended Solids
USACE	US Army Corps of Engineers
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WHP	Wellhead Protection Program
WRP	Wetlands Reserve Program
WWTP	Wastewater Treatment Plant

APPENDIX

Figure A

River study calls for an engineer

As one of the municipalities covered in a study on Schuylkill River contamination, Abington officials say they need a professional to monitor the coming meetings.

By [illegible]
Staff Writer

Abington Township will likely hire a firm to monitor the findings of a study being conducted on possible contamination of the Schuylkill River Basin.

At a public works meeting Monday, the committee voted to recommend spending $10,000 from the wastewater account to contract with Environmental Engineering and Management Associates Inc. for engineering representation in connection with Schuylkill Source Water Assessment meetings.

"It is incumbent on us to protect our interests by following the project," said Robert Leber, superintendent of the Abington Wastewater Treatment Plant.

The Schuylkill Source Water Assessment is a combined effort of the state Department of Environmental Protection, Philadelphia Water Department, Philadelphia Suburban Co., and Pennsylvania American Water Co.

The group identifies surface water contaminants in the Schuylkill River Basin, which increases the expense of producing drinking water, and attempts to eliminate the sources of those contaminants. The group will also determine exactly where the contaminants originate.

Leber said Abington discharges all wastewater into the Schuylkill Basin from one pipe and at one point.

As a point source discharger, Abington township contributes two types of bacterial contaminates, giardia and cryptosporidium, which are not easily eliminated, he said.

Leber said the plant uses chlorine and ultraviolet radiation to kill any contaminants, but said some of these contaminants can filter into the basin.

A majority of drinking water in Abington is obtained from surface water which is collected, treated extensively and then piped into homes by Philadelphia Suburban Co., according to Leber. The water is treated again, after being used in the home, by the plant before being distributed back into the Schuylkill Basin.

He also said 40 percent of contaminants in the Schuylkill Basin are caused by point source discharges, while the other 60 percent are caused by non-point sources such as surface water runoff, septic systems, wildlife and decaying vegetation.

Leber said each new contaminant the treatment plant is required to eliminate will require construction of a new process.

He said representatives for Abington Township will monitor the source water assessment meetings and report the findings to the township. He said these efforts may result in new regulations for wastewater treatment plants.

"[Representatives will] report back on issues we may want to respond to, have input on, and after all of the conclusions, advise Abington whether to accept conclusions or ask for clarification," he said.

Leber said it is important for Abington to have representation at the meetings to make sure the findings are scientifically sound and the conclusions are balanced.

Figure A (con't)

GLENSIDE NEWS
GLENSIDE, PA
WEEKLY 2,843
MAR 7 2001
MUTUAL PRESS CLIPPING SERVICE

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See Engineer, page 11

Study calls for an engineer

■ Engineer, from Page 9

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Figure B

TimesHerald.com

Front Page

Water groups form SWAP to protect Schuylkill River

GARY PULEO, Times Herald Staff

March 26, 2001

PERKIOMEN -- It may not be as dramatic and immediate as an oil spill in waters off the Galapagos Islands, but the much more gradual and ongoing pollution of the Schuylkill River is just as insidious.

That's the premise behind the seemingly inevitable alliance between the Perkiomen Watershed Conservancy, the Philadelphia Water Department, Pennsylvania American Water Company and Philadelphia Suburban Water Company, which is being called the Schuylkill River Source Water Assessment Partnership (SWAP).

"Basically, we're looking into things as far as source water issues are concerned -- different pollutants that get into the streams and eventually into the Schuylkill River that impact drinking water, not only for Philadelphia, but everyone along the river who draws water from there," said Ted Radzinski, Perkiomen Watershed Conservancy director.

Nutrients like phosphorous are getting into the stream from agricultural runoff and lawn fertilization, said Radzinski, as well as waste from cows and horses, which changes the ecology of the stream.

"Another big issue is salt, this time of year, as we're seeing a definite rise in sodium in the water, as the salt from de-icing the roads eventually runs into the streams," he said. "And there's really no way to prevent that or treat it. Even people on low-sodium diets may be getting sodium from their drinking water.

"What the new SWAP study will do is determine methods of improving upon these problems and come up with recommendations of how the groups can minimize impact on the streams."

Preston Luitweiler, senior manager of water resources for Suburban Water Company, agreed, citing the 1996 Safe Drinking Water Act Amendments, which required states to do source-water assessments for all of the public water supplies within their states.

"The Environmental Protection Agency (EPA) and the Department of Environmental Protection (DEP) spent about a year working on providing some guidance for how the states should do their assessments," he said.

Though the assessments are being done all over the country, each state seems to be handling the job differently, Luiteiler said.

"What's a little different about the situation on the Schuylkill River is that a couple of water suppliers got together and decided it didn't make sense to have a consultant come in and ask for information and then do all of this work for him, when we could just do the project for our own intakes," said Luitweiler.

Figure B (Con't)

Luitweiler.

"On the Schuylkill River, there are a variety of issues at different portions of the watershed, because it is so large. At the upper part of the watershed, acid drainage is a big issue. By the time that water gets down to the Philadelphia Water Department and Philadelphia Suburban Water Company, it's no longer a major issue.

"In more developed areas, it's waste-water discharges and sanitary sewer overflows that are the issues," he said.

Where the watershed organizations come in, Luitweiler said, "is that we've had a longstanding relationship with PWC over the years and we recognize that it's important to have them as partners in this activity, because they bring knowledge of what's going on in the watershed and they bring an interested membership to the process, as well as dedication."

The utilities suggested to the DEP that an advisory committee be formed, consisting of representation from the conservationists, the county planning commissions, watershed organizations, water utilities, waste-water people – any group that might have an interest in the source-water assessment.

Quarterly *SWAP* meetings will be open to the public, hosted by different watershed organizations up and down the Schuylkill, such as PWC, the Schuylkill Center for Environmental Education, the Schuylkill River Keeper and the Pottstown-Schuylkill Alliance.

"It may take awhile for this concept to catch on and people to realize what's going on," said Luitweiler. "I think people are being bombarded with so much that's going on from these watersheds, all covering the same ground from a different perspective.

"So people may be having a hard time figuring out who all these players are and what they're doing here."

Reader Opinions

Be the first person to voice your opinion on this story!

Back to top

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Voice your opinion on this story

Figure C

Times Herald, 2/22/01

Group examining contamination in Schuylkill River

By MICHELLE MOWAD
Times Herald Staff

SCHWENKSVILLE — The Schuylkill River Source Water Assessment Partnership (SWAP) will hold a public meeting at 7 p.m. today at the Perkiomen Watershed Conservancy to discuss potential sources of contamination of the Schuylkill River and possible actions for water quality improvement.

The SWAP, composed of regulatory agencies, drinking water suppliers, grassroots watershed organizations and other interested parties, is a public-private initiative designed to explore and understand the environmental challenges that affect local streams.

In 1996, amendments were passed to the Federal Safe Drinking Water Act that require state agencies and water suppliers to survey drinking water sources for contaminants and make this information available to the public.

The Schuylkill River SWAP embraced and expanded this original mandate in its desire to make the water quality assessments an important tool in furthering the protection of drinking water quality while enhancing the natural environment of the river and the land surrounding it.

The SWAP is working with organizations such as the Perkiomen Watershed Conservancy, the hosts of today's meeting at 1 Skippack Pike, to foster public participation in this study.

The conservancy believes identifying existing and potential pollution sources is necessary to ensure the protection of drinking water supplies.

It works to protect and restore the Perkiomen Creek, its tributaries and habitats and offers local citizens opportunities to get involved in hands-on watershed protection efforts.

In other news, the conservancy has selected Ted Radzinski to serve as the new executive director.

Radzinski, of Limerick and formerly Collegeville and Royersford, is familiar with the explosive growth and development in the area. Its impact has significantly altered the Perkiomen Watershed, he said.

"We all impact the environment from taking showers to driving our cars, and watershed issues involve more than just water," said Radzinski. "I look forward to working to raise people's awareness of these issues and to expand the services that the conservancy provides."

Radzinski serves on the Limerick Parks and Recreation Committee and was involved with the planning of the Limerick Center for Sustainability and Watershed Education.

In the past, he worked on a national program for the Environmental Protection Agency, served as project manager for an environmental consulting firm and spent 12 years working for Peco Energy Co.

He presently serves as an adjunct associate professor at Temple University in the civil and environmental engineering department.

Radzinski has an undergraduate degree in mechanical engineering from Drexel University and master's degree in water resources and environmental engineering from Villanova University.

Figure D

Schuylkill water assessment meeting

The Schuylkill River Source Water Assessment Partnership (SWAP) is hosting a public meeting on March 14, at 7 p.m. at the Schuylkill Center for Environmental Education, 8480 Hagy's Mill Rd. in Roxborough, to discuss potential sources of contamination to the Schuylkill River.

The Schuylkill River SWAP is a public-private initiative designed to explore and understand the environmental challenges to the Schuylkill River watershed as a means to identify its existing and potential pollution sources to drinking water supplies. In 1986, amendments were passed to the federal Safe Drinking Water Act that required state agencies and water suppliers to survey drinking water [illegible] contaminants and to make the information available to the public.

The Partnership, composed of regulatory agencies, drinking water suppliers, watershed organizations and other interested stakeholders, embraced and expanded this original mandate in its desire to make the water quality assessments an important tool in furthering the protection of our drinking water quality while enhancing the natural environment of the river and the land surrounding it.

The SWAP wants to involve the public in this study to gain their knowledge about their local environment and to solicit the public's assistance in identifying [illegible] through [illegible]tion or changes in public behavior, to sustain the pollution prevention measures that are ultimately implemented. A report documenting the project will be available at its completion.

The public meeting is an opportunity for individuals and organizations to become involved and to add their vision to the project. For additional information, visit www.schuylkillswa.org or call 215-685-4944.

Career fair for

Figure E

READERS' VIEWS

The Mercury 4-3-01

Help win the war against trash

On Feb. 16 the Greater Pottstown Watershed Alliance and the Schuylkill Riverkeeper hosted a public meeting for the Schuylkill River Source Water Assessment Partnership. During the presentation photographs of pollution sources were shown. One was of a large pile of tires with a dead deer lying on the top, right next to the Schuylkill River. It was labeled North Coventry Township. Since several of us live in Norco we asked for the explicit location. It was on Route 724 between Scholl Road and the Union Township line. Never ones to let a good pile of trash wait for too long, we decided this area would be our first priority for the year.

On Saturday, March 24, 18 volunteers met at the site. Several were from North Coventry, several from Pottstown, the Pottsgroves, Phoenixville, Sanatoga and one from Bryn Mawr. One of the volunteers was a Philadelphia Suburban Water Co. watershed watchdog, and the person who took the photograph that started all this. To our surprise and delight, six of the volunteers were Americorps volunteers working in Sanatoga and took time out to come to our aid (thanks to a notice in The Mercury). These great young people hailed from California, Boston and Las Vegas among other places.

In just four hours, we filled up two of Norco's dump trucks. We picked up 40 tires (bringing our total to 1,116 tires cleaned up and recycled). The trash included furniture, mattresses, box springs, medical waste, house shingles, car parts, carpets, wire fencing, oil bottles along with thousands of cans and bottles. We also filled up two pickups with metal scraps, which we recycled. All this in just three-quarters of a mile!

We wondered how many passersby thought we were court ordered to clean up this trash, instead of being volunteers.

Our thanks go to Firestone in Pottstown and Sears at the Coventry Mall for taking these tires. Waste Management provided free dumping. Our old friends at Recycling Services Inc. took the truckloads of metals. Thanks to North Coventry for the use of its trucks and a Norco employee, for bringing them.

Thanks to the volunteers of Americorps.

To those of you who continue to litter and illegally dump your trash anywhere you want, we are tired of looking at it and tired of picking it up. We would rather be with our families, fishing, canoeing, and enjoying our beautiful waterways.

We need your help. We are a small group and can't possibly do it all. Call the police when you see someone littering. Pick up trash when you see it. Make sure your trash does not get blown out of the containers. And if you want to spend a fulfilling Saturday morning picking up other people's trash, call us, we would love to have you join us.

The Greater Pottstown Watershed Alliance Inc. is a non-profit group of local volunteers who hold monthly cleanups, monitor water quality parameters and promote watershed restoration efforts.

Anyone interested can call me at 610-326-3916.

BILL CANNON
GPWA

Figure F

Water groups form SWAP to protect Schuylkill River

Partnership to study remedies for pollution

By GARY PULEO
Special to The Mercury 7 19 01

PERKIOMEN – It may not be as dramatic and immediate as an oil spill in waters off the Galapagos Islands, but the much more gradual and ongoing pollution of the Schuylkill River is just as insidious.

That's the premise behind the seemingly inevitable alliance between the Perkiomen Watershed Conservancy, the Philadelphia Water Department, Pennsylvania American Water Company and Philadelphia Suburban Water Company, which is being called the Schuylkill River Source Water Assessment Partnership (SWAP).

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(SWAP from P1)

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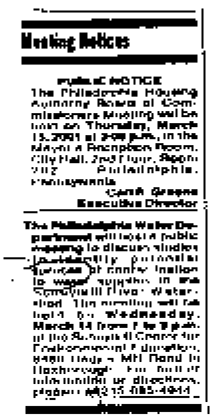
Figure G

Daily News
3/12/2001
p.55



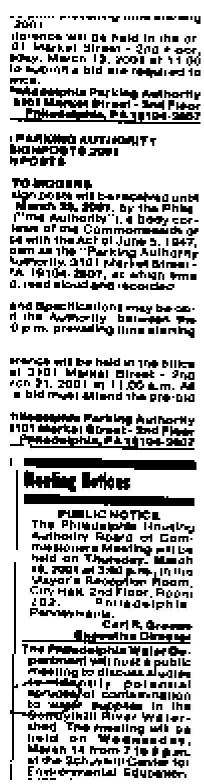
Meeting Notices

PUBLIC NOTICE
The Philadelphia Housing Authority Board of Commissioners Meeting will be held on Thursday, March 15, 2001 at 3:00 p.m. in the Mayor's Reception Room, City Hall, 2nd Floor, Room 202, Philadelphia, Pennsylvania.
Carl R. Greene
Executive Director

The Philadelphia Water Department will host a public meeting to discuss studies to identify potential sources of contamination to water supplies in the Schuylkill River Watershed. The meeting will be held on Wednesday, March 14 from 7 to 9 p.m. at the Schuylkill Center for Environmental Education, 8480 Hagy's Mill Road in Roxborough. For further information or directions, please call 215-685-4944.

Figure H

Inquirer
3/12/2001
p. A9



Philadelphia Parking Authority
3101 Market Street - 2nd Floor
Philadelphia, PA 19104-2807

PARKING AUTHORITY
SIGNPOSTS 2001

TO BIDDERS

Philadelphia Parking Authority
3101 Market Street - 2nd Floor
Philadelphia, PA 19104-2807

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Figure I

No. .... , ... Term, 20 ....

PROOF OF PUBLICATION NOTICE IN THE TIMES HERALD

Under Act No. 587, Approved May 16, 1929, P.L. 1784, as Last Amended by Act No. 320 of July 5, 1947

STATE OF PENNSYLVANIA)
) SS
COUNTY OF MONTGOMERY.)

William T. Murray, Publisher of THE TIMES HERALD, of the County and State aforesaid, being duly sworn, deposes and says that THE TIMES HERALD, a newspaper of general circulation published at Markley, Ann and Airy Streets, Borough of Norristown, County and State aforesaid, was established January 1, 1923, since which date THE TIMES HERALD has been regularly issued in said County, and that the printed notice or publication attached hereto, is exactly the same as was printed and published in the regular edition and issues of THE TIMES HERALD on the following dates, viz.: ....

.... 11 .... and the

.... 11 .... day of .... March .... A.D. 2001

Copy of Notice

here will be public meeting from 7 to 9pm on March 13, 2001 at the Perkiomen Watershed Conservancy in Schwenksville to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions please call 215-685-4944 or visit www.schuylkillswa.org

Affiant further deposes that he is an officer duly authorized by THE TIMES HERALD PUBLISHING COMPANY, INC., a corporation, publisher of THE TIMES HERALD, a newspaper of general circulation, to verify the foregoing statement under oath, and affiant is not interested in the subject matter of the aforesaid notice or advertisement, and that all allegations in the foregoing statements as to time, place and character of publications are true.

....

Sworn to and subscribed before me this 16th

day of .... March .... , 2001

....

Figure J

THE MERCURY

Publishers of The Mercury, The Penny Pincher and Real Estate Today

PROOF OF PUBLICATION OF NOTICE

Under Act No. 587, Approved May 6, 1929

STATE OF PENNSYLVANIA
COUNTY OF MONTGOMERY ss

Mary Ann Edleman, of The Mercury, of the County and State aforesaid, being duly sworn, deposes and says that THE MERCURY, a newspaper of general circulation published at 24 N. Hanover Street, Borough of Pottstown, County and State aforesaid, was established September 29, 1931 since which time, The Mercury has been regularly issued in said County, and that the printed notice of publication attached hereto is exactly the same as printed and published in the regular editions and issues of the said THE MERCURY on the following dates, viz.

February 22, 2001

Affiant further deposes that he/she is duly authorized by Dennis Pfeiffer, Publisher of said MERCURY, a newspaper of general circulation, to verify the foregoing statement under oath, and affiant is not interested in the subject matter of the aforesaid notice of advertisement, and that all allegations in the foregoing statements as to time, place and character of publication are true.

Mary Ann Edleman, Classified Manager

Sworn to and subscribed before me this 1st day of March, 2001

Notary Public

Drinking Water Supply Study

There will be a public meeting from 7 to 9pm on February 22, 2001 at the Perkiomen Watershed Conservancy in Schwenksville to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions please call 215-685-4944 or visit www.schuylkillswa.org.

Figure K

THE MERCURY

Publishers of The Mercury, The Penny Pincher and Real Estate Today

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STATE OF PENNSYLVANIA
COUNTY OF MONTGOMERY   SS.

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February 11, 2001

Affiant further deposes that he/she is duly authorized by Dennis Pfeiffer, Publisher of said MERCURY, a newspaper of general circulation, to verify the foregoing statement under oath, and affiant is not interested in the subject matter of the aforesaid notice of advertisement, and that all allegations in the foregoing statements as to time, place and character of publication are true.

Drinking Water Supply Study
There will be a public meeting from 7 to 9pm on February 15, 2001 at the Montgomery County Community College West Campus in Pottstown to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions please call 215-[illegible]-4844 or visit www.schuylkillriver.org.

Mary Ann Edleman
Mary Ann Edleman, Classified Manager

Sworn to and subscribed before me the 15th day of February, 20 01

Cindy L. [illegible]
Notary Public

Notarial [illegible]
Cindy [illegible] Public
Potts[illegible] County
My Commission [illegible] 2005
Member, Pennsylvania Association of Notaries

Figure L

Proof of Publication of Notice

THE AMBLER GAZETTE

State of Pennsylvania,
County of Montgomery *ss:*

Fred Behringer, Vice President of MONTGOMERY PUBLISHING/METROWEEK, a corporation of the County and State aforesaid, being duly sworn, deposes and says that THE AMBLER GAZETTE is a weekly newspaper published at Ambler, County and State aforesaid, which was established in the year 1879, since which date said newspaper has been regularly issued in said County, and that a copy of the printed notice of publication is attached hereto exactly as the same was printed and published in the regular editions and issues of the said weekly newspaper on the following dates, viz:

[illegible] Water Supply Study
[illegible] a public meeting [illegible] on February 22, 2001 [illegible] Valley Watershed Association in Ambler to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions please call 215-[illegible] or visit [illegible]

and the 14th day of Feb. A.D., 2001.

Affiant further deposes he is duly authorized by Montgomery Publishing/Metroweek, a corporation publisher of The Ambler Gazette, a weekly newspaper, to verify the foregoing statement under oath and also declares the affiant is not interested in the subject matter of the aforesaid notice or publication, and that all allegations in the foregoing statement as to time, place and character of publication are true.

[signature]

Vice President, Montgomery Publishing/
Metroweek, a Corporation

Sworn to and subscribed by me this 22nd day of February, 2001.

[signature]
Notary Public

My Commission Expires:

NOTARIAL SEAL
Lynn V. McGarvey, Notary Public
Upper Dublin Twp., Montgomery County
My Commission Expires Oct. 2, 2004

Figure M

No .... Term, 19 ....

Proof of Publication of Notice in the Reporter

Under Act No. 587, Approved May 10, 1929

Copy of notice or publication

LEGAL NOTICE
DRINKING WATER SUPPLY STUDY
There will be a public meeting from 7 to 9pm on February 20, 2001 at the Wissahickon Valley Watershed Association in Ambler to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions please call 215-685-4944 or visit www.schuylkillswa.org.

Lansdale, Pa.
Established 1870

State of Pennsylvania, } SS
County of Montgomery

Bernard N. DeAngelis, Assistant Treasurer of the GANNETT SATELLITE INFORMATION NETWORK, INC., a DELAWARE corporation, being duly sworn, deposes and says that THE REPORTER is a daily newspaper published at Lansdale, County and State aforesaid, which was established in the year 1870, since which date said daily newspaper has been regularly issued in said County, and that a copy of the printed notice or publication is attached hereto exactly as the same was printed and published in the regular editions and issues of the said daily newspaper on the following dates

viz

the 17th day of February A.D. 2001

Affiant further deposes he is an officer duly authorized by the GANNETT SATELLITE INFORMATION NETWORK, INC., a corporation, publisher of THE REPORTER, a daily newspaper, to verify the foregoing statement under oath and also declares that affiant is not interested in the subject matter of the aforesaid notice or publication, and that all allegations in the foregoing statement as to time, place and character of publication are true.

Bernard N. DeAngelis

Assistant Treasurer
Gannett Satellite Information Network, Inc.

FEB 19 2001

Sworn to and subscribed before me this date

Cynthia M. Stanton
Notary Public

Notarial Seal
Cynthia M. Stanton, Notary Public
Lansdale Boro, Montgomery County
My Commission Expires Nov 22, 2004
Member, Pennsylvania Association of Notaries

My Commission Expires:

Notarial Seal
Cynthia M. Stanton, Notary Public
Lansdale Boro, Montgomery County
My Commission Expires Nov 22, 2004
Member, Pennsylvania Association of Notaries

Statement of Advertising Costs

CAMP DRESSER & MCKEE INC
1500 ...
PHILADELPHIA, PA 19102

TO GANNETT SATELLITE INFORMATION NETWORK, INC.

For publishing the notice or advertisement attached hereto on the above stated date	$ 52.50
Notary Fee	$ 2.00
Total	$ 54.50

Publisher's Receipt for Advertising Costs

GANNETT SATELLITE INFORMATION NETWORK, INC., a corporation, publisher of THE REPORTER, a daily newspaper, hereby acknowledges receipt of the aforesaid advertising and publication, and certifies that the same have been duly paid

By

Figure N

No. .... Term, 20 ....

PROOF OF PUBLICATION NOTICE IN THE TIMES HERALD

Under Act No. 587, Approved May 16, 1929, P.L. 1784, as Last Amended by Act No. 520 of July 5, 1947

RECEIVED
FEB 27 2001
CAMP [illegible] KEE
PHILADELPHIA [illegible]

STATE OF PENNSYLVANIA)
) SS.
COUNTY OF MONTGOMERY.)

William T. Murray, Publisher of THE TIMES HERALD, of the County and State aforesaid, being duly sworn, deposes and says that THE TIMES HERALD, a newspaper of general circulation published at Markley, Ann and Airy Streets, Borough of Norristown, County and State aforesaid, was established January 1, 1923, since which date THE TIMES HERALD has been regularly issued in said County, and that the printed notice or publication attached hereto, is exactly the same as was printed and published in the regular edition and issues of THE TIMES HERALD on the following dates, viz.: .... th .... and the .... 19 .... day of .... February .... A.D. 20[illegible]

Copy of Notice

DRINKING WATER SUPPLY STUDY
There will be a public meeting from 7 to 9pm on February 22, 2001 at the Perkiomen Watershed Conservancy in Schwenksville to discuss a study underway to identify potential sources of contamination to water supplies in the Schuylkill River and its tributaries. For more information or directions, please call 215-[illegible]-4944 or visit www.schuylkillwaters.org

Affiant further deposes that he is an officer duly authorized by THE TIMES HERALD PUBLISHING COMPANY, INC., a corporation, publisher of THE TIMES HERALD, a newspaper of general circulation, to verify the foregoing statement under oath, and affiant is not interested in the subject matter of the aforesaid notice or advertisement, and that all allegations in the foregoing statements as to time, place and character of publications are true.

....
Publisher, The Times Herald

Sworn to and subscribed before me this ....22nd....

day of ....February........, 2001

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