ESTIMATES OF CONTAMINANT INPUTS TO THE DELAWARE ESTUARY

DELAWARE
ESTUARY PROGRAM

DELEP REPORT #95-03

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EXECUTIVE SUMMARY

A study was completed for the Delaware Estuary Program (DELEP) to develop loading estimates and identify principal sources of contaminants entering the Delaware River Estuary. Contaminants included in this study were those identified by the Program to be of interest because of concerns relating to the human consumption of contaminated fish, water column concentrations exceeding water quality criteria values, or high concentrations in estuarine sediments. Contaminants of interest included: the metals arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc; the chlorinated pesticides chlordane, DDT and its degradation products DDD and DDE, and dieldrin; PCBs and PAHs; and, the volatile organics 1,2 dichloroethane and tetrachloroethane.

Loading estimates were developed for point sources and three types of general nonpoint sources: atmospheric deposition, urban runoff, and runoff from agricultural lands. A model for estimating contaminant inputs to the estuary originating from groundwater infiltration was developed; however, estimates were not made because sufficient data were not found to characterize contaminant concentrations in groundwater.

Point source loadings were estimated using the National Coastal Pollution Discharge Inventory (NCPDI) data base developed by the National Oceanic and Atmospheric Administration (NOAA). Loading from the atmospheric deposition of contaminants onto the watershed were estimated using atmospheric deposition rates from the Chesapeake Bay Atmospheric Deposition Study (CBADS). Contaminant loadings due to urban runoff were estimated using the models and data produced by the USEPA's National Urban Runoff Program (NURP). Contaminant inputs from agricultural lands were estimated using historical information for crop types, pesticide application and degradation rates, and soil loss estimates.

Attempts were made to estimate contaminant loadings to the estuary resulting from the escape of contaminants from hazardous waste sites. Information from the USEPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) data base and supplemental information from Delaware, New Jersey, and Pennsylvania state agencies were used to identify sites contaminated with the chemicals of concern to the program. For some sites, additional information was available to identify the environmental media contaminated; however, quantitative estimates of the amount of contaminants reaching the estuary could not be developed due to the lack of appropriate characterization data.

Contaminant loading estimates were used to identify the relative magnitudes of point and nonpoint sources. Total loadings for arsenic, chromium, copper, lead and zinc were approximately 10^5 kg/year; a significant portion of these loadings originated from point sources discharging directly into the estuary. Urban runoff also contributes significantly to metal loadings to the bay. Agricultural runoff is a significant source of arsenic to the estuary because of the long-term use of inorganic and organic pesticides containing arsenic. Atmospheric deposition contributes a small proportion of the total loadings of the metals

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arsenic, chromium, copper, and lead. Total loading of mercury to the estuary is 10^4 kg/year. Urban runoff, point sources, and atmospheric deposition all contribute significant amounts of mercury.

The loading of chlorinated pesticides to the estuary are estimated to be 10^4 kg/year. The largest source for these chemicals is runoff from agricultural areas; however, data suggests that significant amounts of chlorinated pesticides enter through point sources. Point sources may include pesticides remaining at industrial sites that were previously used for the manufacture of pesticides. Although use of many chlorinated pesticides is now severely restricted, previous long-term use in agricultural areas, and slow degradation rates, has lead to the accumulation of these chemicals in soils that continue to erode into the estuary.

PCB loading to the estuary is estimated to be 10^2 kg/year. Sources include atmospheric deposition and point source discharges. Existing data suggest that hazardous waste sites may be a significant source of PCBs; however, no quantitative estimates could be made for this report.

Contaminant loading estimates were compared with estimates of the reservoir of contaminants in the sediments within the Delaware Estuary. Comparison of these two estimates suggest that sediments within the estuary are a likely source for a portion of the chlorinated pesticides and PCBs that are being detected in fish collected from the estuary. This finding suggests that management actions that concentrate on reducing contaminant loadings to the estuary may not be effective in immediately reducing contaminant concentrations in fish.

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ABBREVIATIONS

AVHRR	Advanced Very High Resolution Radiometry
BOD	Biochemical Oxygen Demand
CBADS	Chesapeake Bay Atmospheric Deposition Study
CCMP	Comprehensive Conservation Management Plan
CDA	Coastal Drainage Area
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CSO	Combined sewer overflow
DDD	Dichlorodiphenyl-dichloroethylene
DDE	Dichloro-diphenylethylene
DDT	Dichlorodiphenyl trichloroethylene
DELEP	Delaware Estuary Program
DMR	Discharge monitoring report
DRBC	Delaware River Basin Commission
EDA	Estuarine Drainage Area
EMAP	Environmental Monitoring and Assessment Program
FDA	Fluvial Drainage Area
MGD	Millions of gallons per day
NEI	National Estuarine Inventory
NCPDI	National Coastal Pollutant Discharge Inventory
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
ODES	Ocean Data Evaluation System
PADER	Pennsylvania Department of Environmental Resources
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCCMP	Preliminary Comprehensive Conservation Management Plan
PCS	Permit Compliance System
SIC	Standard industrial code
STAC	Science and Technical Advisory Committee
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	Volatile Organic Compounds
WWTP	Waste-water treatment plant

1.0 INTRODUCTION

Chemical contaminants are perceived by environmental managers and the general public to be a problem in many estuaries. The perception has been formed from widespread reports of contaminated fin- and shell-fish resources, beach closures, and unacceptable aesthetic conditions. An accurate assessment of the extent and magnitude of chemical contamination in the nation's estuaries is not yet available; however, the general consensus of the scientific community and estuarine managers is that while chemical contamination due to anthropogenic activities is widespread, concentrations resulting in direct impacts on estuarine biological resources, or of concern to human health, are limited to selected regions of estuaries adjacent to highly urban or industrial areas.

Chemical contaminants have been identified to be a concern in the Delaware River Estuary due to the long history of industrial activity in the area, a general finding that selected species of finfish contain chemical concentrations of concern to human health, and the occurrence of estuarine sediments found to be toxic to laboratory test organisms. In response to this concern, the Delaware Estuary Program (DELEP) sponsored a series of studies to determine the extent and magnitude of chemical contamination in the estuary and based in part on the results of those studies developed as toxics action plan. This toxics action plan is one of the principal chapters of the Comprehensive Conservation Management Plan (CCMP) developed by DELEP to improve the general environmental conditions in the estuary (DELEP 1994).

The estuary program is refining the toxics management strategy to include specific management options and suggestions for regulatory controls designed to effectively decrease the impact of chemical contaminants on biological resources and human health. The refined strategy will be presented in the final Comprehensive Conservation Management Plan (CCMP). The toxics management strategy depends upon information concerning the relative contribution of point source and nonpoint source loadings of chemical contaminants to the estuary. Further, the relative contribution of different classes of nonpoint source loadings needs to be identified to define specific and effective goals in the toxics management strategy.

The Delaware Estuary Program retained Versar, Inc. to develop estimates for the relative magnitude of contaminant loadings of point and nonpoint sources to the Delaware River Estuary. Our findings are presented in this report.

1.1 REPORT ORGANIZATION

The report is organized in eleven sections, beginning with this introduction. The second section presents background information on the contaminants of concern to the DELEP, outlines the general objectives of the report, and briefly describes the Delaware Estuary and its watershed. Section three of the report contains a description and an estimate of contaminant loadings from point sources. Sections four through seven describe loadings from nonpoint sources; section four describes contaminant inputs from atmospheric sources, section five describes loadings from urban runoff, section six contains descriptions and estimates of contaminant loadings from agricultural runoff, and section seven presents a discussion of contaminant inputs to the estuary from groundwater sources. Hazardous waste sites, landfills, and industrial sites as a potential source of contaminants to the estuary are discussed in section eight. Section nine presents an integrated picture of contaminant loadings to the Delaware River Estuary. These loading estimates are then compared to the reservoir of contaminants associated with the sediments within the estuary in section ten. Concluding statements are provided in section 11.0.

2.0 BACKGROUND

2.1 THE DELAWARE RIVER ESTUARY

The Delaware Estuary is one of the largest in the United States, rivaled only by the Chesapeake Bay and Long Island Sound. Extending 215 km (134 mi) from the mouth of the Delaware Bay at Liston Point, DE, to the head of tide at Trenton, NJ, the estuary has a total surface area of approximately 1989 km^2 (NOAA 1985), an average depth of 7.4 meters, and total a volume of nearly 14.7×10^9 m^3.

The Delaware Estuary is comprised of the Delaware Bay, a salinity transition zone, and the tidally influenced portion of the Delaware River. Delaware Bay is the portion of the estuary extending from the mouth of the bay to below Artificial Island (DRBC River km (Rkm) 80). The bay represents the drowned valley of the Delaware River formed after seaward flooding following the last glaciation. Sea level rise continues in the coastal Delaware area at a rate of about 6.2 cm/century (Belknap 1975). The mean depth of the bay is 9.7 m, but over 80% of the bay is less than 9 m deep. Deeper sections are located in the western portion of the bay, and the maximum depth is about 46 m. Unlike the Chesapeake Bay, the Delaware Bay is well-mixed with little long-term vertical stratification (Biggs 1978; Smullen et al. 1983). Salinities in this region range from those typical of marine water at the mouth, to brackish oligohaline water at the head of the bay (Figure 2-1).

The tidal riverine portion of the estuary begins south of Philadelphia, PA, near Marcus Hook, PA (Rkm 130), and runs to the rapids in Trenton, NJ (Rkm 216). Salinities in this region of the estuary are typically those of freshwater, but intrusions of brackish water from down river may occur during low river flow periods (Figure 2-1). During the last fifty years, the upstream extension of saline waters in the Delaware Estuary has increased (Smullen et al. 1983). Increased salinities may be due to a combination of rising sea level and upstream consumption and withdrawal of freshwater. Upstream progression of saline waters caused the city of Chester, PA, to abandon the river as a source of freshwater in 1951. Severe droughts continue to threaten other upstream municipal water supplies, including those to the city of Philadelphia, PA.

The transition zone is the region between the bay and tidal river portions of the estuary. This region is characterized as having low salinity and high turbidity. Concentrations of suspended solids are typically highest in the transition zone region.

The hydrodynamics of all three regions of the estuary are driven by the tides. The horizontal advection on each tidal cycle is approximately 10 km. The effect of this tidal excursion is the rapid dispersion of contaminants entering the estuary. The vertical tidal range increases from 1.3 m at the mouth of the bay to 2.5 m at the head of tide at Trenton. Channel modifications and the diversion of freshwater have caused the current tidal range at Trenton to be nearly twice that of 1890 (Hires et al. 1984; DiLorenzo et al. 1992). The increased tidal range almost certainly has increased bank erosion rates in the upper portion of the estuary, potentially increasing input rates for contaminants bound in marsh sediments.

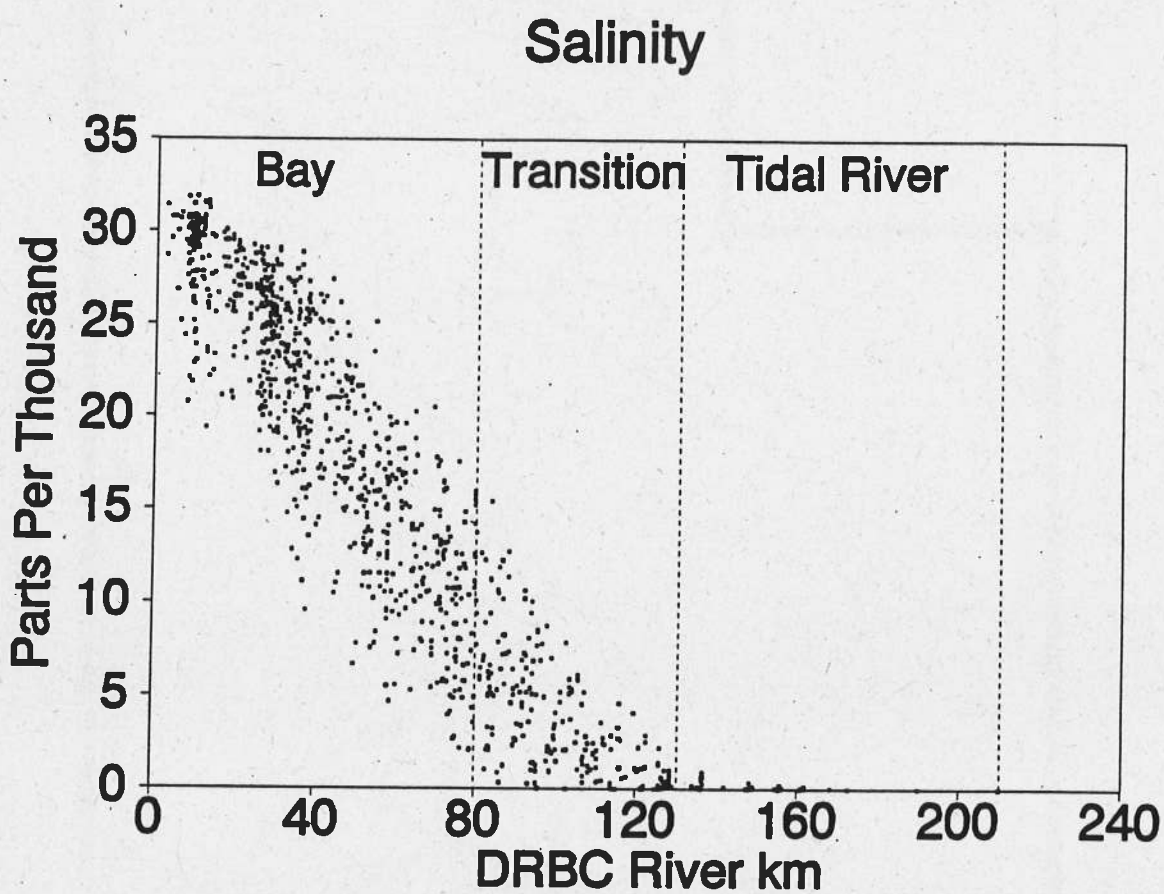

Figure 2-1. Salinity distribution in the Delaware Estuary. Data from Culberson (1988) and Lebo et al. (1990).

2.2 THE DELAWARE RIVER WATERSHED

The Delaware River Estuary receives drainage and runoff from a watershed that has a surface area of 34,836 km^2 (NOAA 1985) (Figure 2-2). By area, the watershed is 17.5 times the area of the estuary. In comparison, the watershed of the Chesapeake Bay is 14.5 times the area of the Chesapeake Bay. The approximate similarity of the watershed to estuary ratio for the two estuaries will make it possible to use Chesapeake Bay data to complete some of the nonpoint contaminant loading estimates presented in subsequent sections.

The main sources of freshwater to the estuary are the Delaware and Schuylkill Rivers. Together, these rivers drain 65% of the Delaware River Basin (Bauersfeld et al. 1989; Kolva et al. 1989). The long-term average freshwater flow to the estuary from the Delaware River

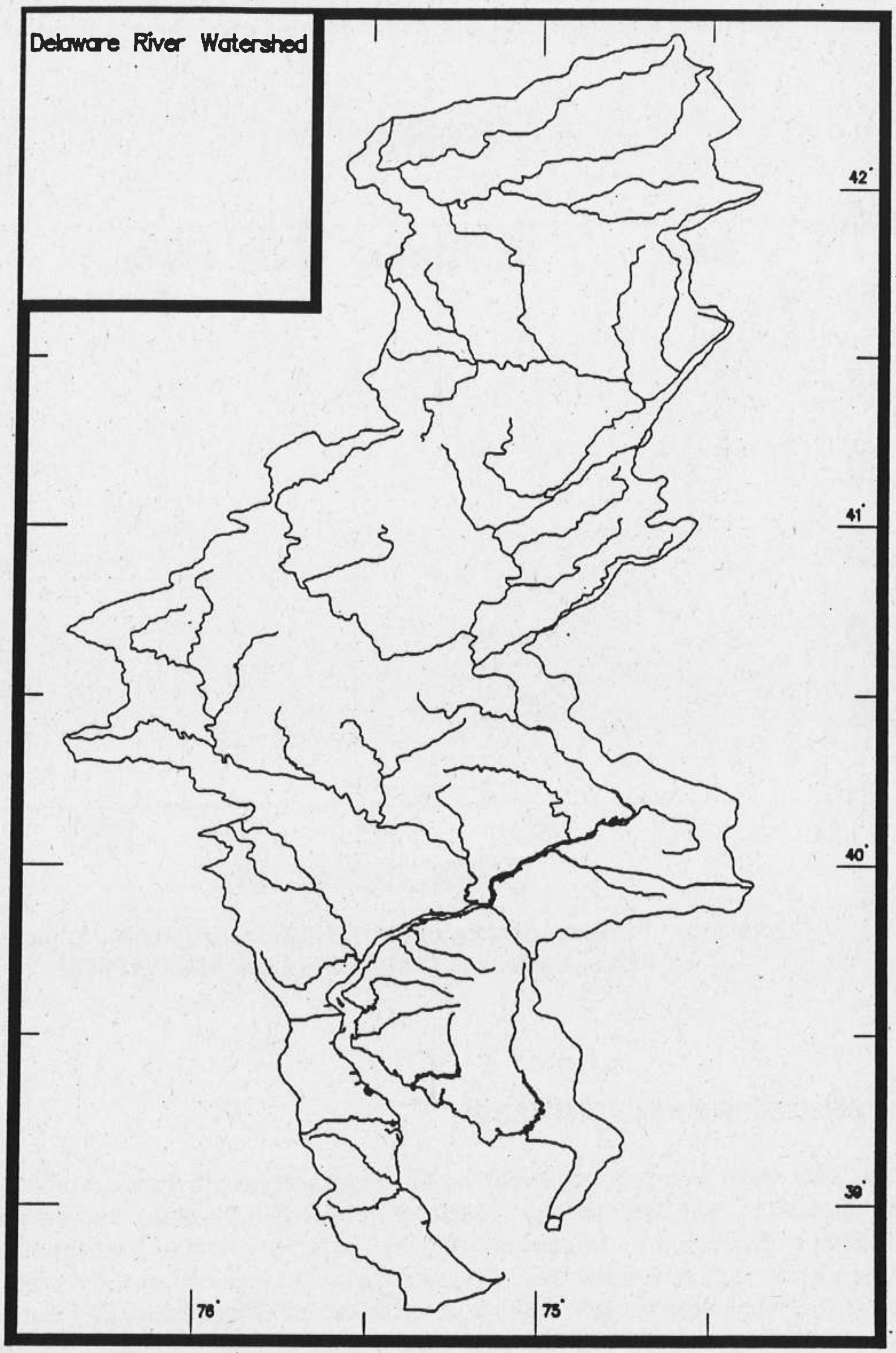

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Figure 2-2. Delaware River Watershed showing the major rivers and streams.

measured at Trenton, NJ, is approximately 330 m^3/sec; long-term average flow from the Schuylkill measured at Philadelphia is 83 m^3/sec. These two sources account for about 74% of the total surface water flow to the estuary estimated to be 560 m^3/sec (NOAA 1985). The combined flows of the Maurice, Leipsic, Cohansy, Smyrna, Salem, and Christina Rivers contribute an additional 1-2 m^3/sec. Flow is highest in March and April and lowest in August and September (Figure 2-3). The seasonal changes in freshwater flow to the estuary are driven by precipitation patterns. These patterns are potentially important since they may affect the seasonal input of contaminants from urban and agricultural runoff. Average flushing time for water in the estuary is 90-100 days (average = 100, range = 60 to 120 days, Ketchum 1952; average = 90 days, Sharp 1983).

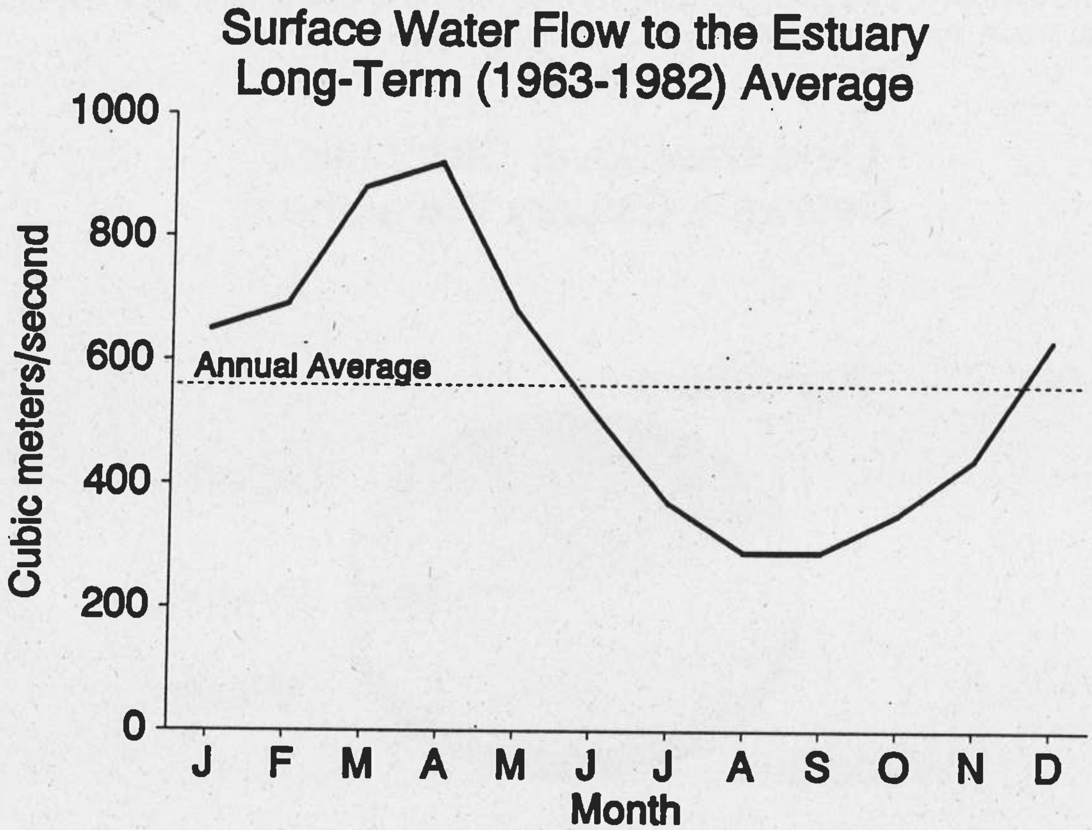

Figure 2-3. Seasonal distribution of surface-water flow to the estuary. Data taken from NOAA (1985).

The Delaware Estuary Watershed spans five physiographic provinces. The Appalachian Valley and Ridge Province is in the northern part of the watershed. The Highlands and Piedmont Provinces are downstream. Immediately surrounding the estuary are the Inner Coastal Plain and the Outer Coastal Plain Provinces.

Land use distribution within the watershed was recently determined using Advanced Very High Resolution Radiometer (AVHRR) imagery (Evans et al. 1993). Approximately 50%

of the surface area of the watershed is forested (Figure 2-4), and most of the forests are distributed in the upper portions of the watershed in Pennsylvania and New York. Agriculture constitutes 31% of the land use within the estuary and is concentrated in the lower Delaware portion of the watershed in the Delmarva Peninsula, in southern New Jersey, and in Pennsylvania. The third largest land use category is urban, accounting for nearly 14% of the watershed. The proportion of this land use category is increasing due to intense population growth. Growth rates exceeding 20% were observed in 10 of 22 counties in the Delaware River Basin region between 1970 to 1990 (Culliton et al. 1990). Urban areas are concentrated in the region between Trenton, NJ, and Wilmington, DE. Generally, these urban areas border the tidally influenced region of the Delaware River and the Schuylkill River valley. Other land-use/cover categories account for less than 5% of the total area and include wetlands, water, open and brush regions, and barren areas.

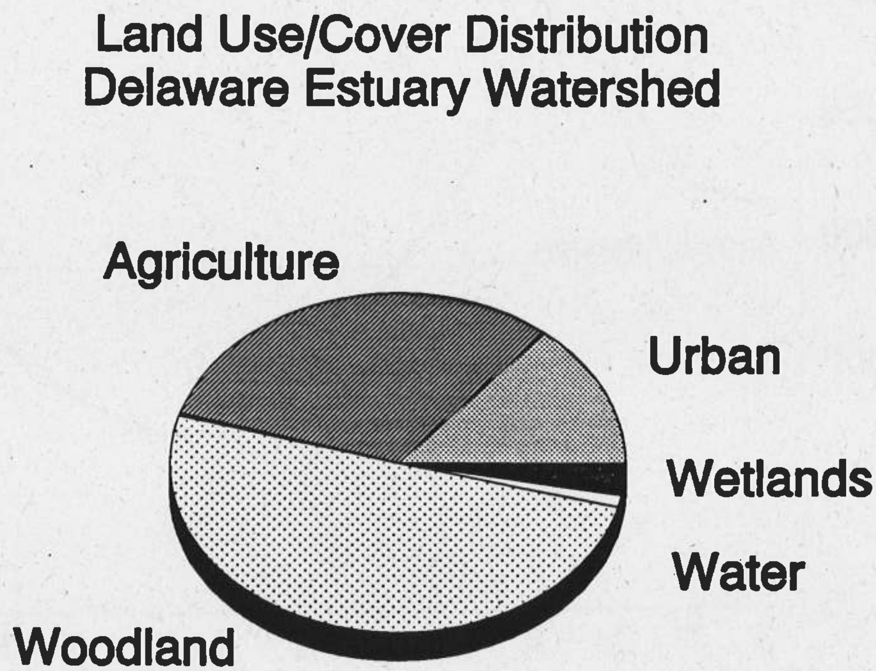

Figure 2-4. **Land use/cover distribution in the Delaware Estuary Watershed (taken from Evans et al. 1993).**

2.3 CONTAMINANT HISTORY

The Delaware Estuary supports one of the world's largest freshwater ports (Philadelphia Planning Commission 1982; Sharp 1986), one of the world's greatest concentrations of industry, and the second largest complex of oil-refining and petrochemical plants in the country (Council on Environmental Quality 1975). Approximately 70% of the oil arriving at the nation's east coast ports (over one billion barrels) moves through the combined Ports of Philadelphia, which includes berths in all three states in the region. This activity, combined with multiple point source inputs and approximately 300 combined sewer overflows that discharge directly into the estuary, has resulted in long-term impacts on the quality of water and sediments in the estuary.

Historically, the most polluted region of the bay has been between Marcus Hook, PA, and Philadelphia, PA, extending to Trenton, NJ. Albert (1988) completed a review of water quality history in the region. Conditions were worst during the 1940's when anoxia and hypoxia extended from Wilmington to Trenton, massive fish kills were common, and waters were mephitic and corroded the paint on ships berthed in the river. The region between Marcus Hook, and Philadelphia, PA, became known as a "dead zone," in which grossly depleted oxygen concentrations effectively obstructed the migration of anadromous fish through the estuary.

Conditions within the estuary have improved dramatically since the 1940's and 1950's due, in part, to the establishment of the Delaware River Basin Commission (DRBC) – a federal, multistate, regulatory agency with broad responsibility for all facets of water resource management. Water quality improved because this agency adopted higher water quality standards at a time when federal funds became available to build or improve publicly owned treatment facilities. Water quality, particularly dissolved oxygen concentrations, has improved greatly (Albert 1988); however, water quality is still not adequate to support fishable/swimmable classifications along the entire reach of the estuary (Marino et al. 1992).

Bacterial contamination is responsible for the estuary not meeting federal criteria for fishable and for swimmable water between the Pennsylvania-Delaware state line (river km 127) and just south of Peenypack Creek (river km 174). Generally, the water quality criteria for toxic substances are exceeded infrequently (McNair 1991). Highest contaminant concentration in the water and in sediments generally occur in the highly urbanized region of the estuary between Wilmington, DE and Trenton, NJ (McNair 1991; Costa and Sauer 1994).

2.4 CONTAMINANTS OF CONCERN

Efforts to complete loading estimates were focused on the contaminants of concern identified by the Toxics Subcommittee of the DELEP's Science and Technical Advisory Committee (STAC) (Table 2-1). The specified chlorinated pesticides (DDT, dieldrin, and chlordane) are of concern due to the occurrence of elevated concentrations of these contaminants in fish tissues. The New Jersey Department of Environmental Protection (NJDEP) and the Pennsylvania Department of Environmental Resources (PADER) have issued fish consumption advisories as a result of the elevated concentrations. Recent data (1990) collected by DRBC indicates contaminant concentrations exceed a 10^{-6} risk level in several fish species found in the Delaware River Estuary.

Table 2-1. Contaminants of concern
Chlorinated Pesticides
DDT (DDT, DDD, DDE)
Dieldrin
Chlordane
Polychlorinated Biphenyls (PCBs)
Metals
Lead
Copper
Mercury
Arsenic
Chromium
Silver
Volatile Organic Compounds
1,2, - Dichloroethane
Tetrachloroethane

Polychlorinated biphenyls (PCBs) are of concern because NJDEP and PADER have issued fish consumption advisories due to elevated concentrations in fish tissues (Belton et al. 1982; DRBC 1988; USFWS 1993; Greene and Miller 1994). Fish consumption advisories for the Delaware Estuary are summarized in Table 2-2.

Another reason for chlorinated pesticides and PCBs being treated as contaminants of concern is their potential effects on avian raptor populations. Elevated concentrations of PCBs, DDT, and chlordane have been measured in peregrine falcon eggs collected from nesting sites surrounding the estuary (Jarman et al. 1993). Evidence of eggshell thinning (a known result of exposure to chlorinated pesticides) continues to be found (Steidl et al. 1991), and the reproductive success of ospreys and bald eagles in the Delaware estuary region is low compared to other regions (Clark 1991; Niles et al. 1991).

The metals lead, copper, mercury, arsenic, chromium, and silver were also identified to be contaminants of concern. Monitoring data have demonstrated that water column concentrations of these chemicals approach and possibly exceed chronic water quality criteria values.

Volatile organic compounds (VOCs) also were identified as contaminants of concern. The compounds 1,2 - dichloroethane and tetrachloroethane have been specifically identified. Concentrations of these contaminants can exceed the water quality criteria established to predict human health against carcinogenic effects.

Polycyclic aromatic hydrocarbons (PAHs) were not initially identified by the DELEP STAC Toxics Subcommittee to be of primary concern. Based upon the sediment contaminants characterization study sponsored by DELEP (Costa and Sauer 1994), zinc and PAHs were added to the list of contaminants of concern in the Delaware Estuary.

Table 2-2. Fish consumption advisories for Delaware River and Bay. (taken from DELEP 1994).

Issuing Agency	Fish Species	Areal Extent	Pollutants of Concern	Advisory
PADER/PADH	White perch, Channel catfish, American eel	Yardle to PA/ DE Line	PCBs, Chlordane	Do not eat
NJDEP/NJDOH	Channel catfish	I-276 bridge to Birch Creek	PCBs, Chlordane	Do not eat
NJDEP/NJDOH	American eel	Statewide	PCBs, DDT, Chlordane	No more than 1 meal/week and no consumption for high risk groups*
NJDEP/NJDOH	Bluefish > 24" or > 6 lbs	Statewide	PCBs, DDT, Chlordane	No more than 1 meal/week and no consumption for high risk groups*
DNREC/ DEDHSS	Striped bass, White perch, Channel catfish, White catfish	DE State Line to the C&D Canal	PCBs	Do not eat
DNREC/ DEDHSS	Striped bass, Channel catfish, White catfish	C&D Canal to Cape Henlopen	PCBs	Adults: no more than five 8 oz. meals per year; Children: no more than three 4 oz. meals per year

* Pregnant women, nursing mothers, women of child-bearing age, young children

Additional information for each of the contaminants of concern is provided below. This information includes descriptions of the historic and current use of these contaminants. Additional information is provided to help understand the fate, behavior, and biological reactivity of contaminants in the environment.

2.5 CONTAMINANT CHARACTERIZATION

An understanding of the fate, behavior, and biological reactivity of the contaminants of concern is useful to complete contaminant loading estimates and evaluate model results. Contaminants behavior can be described using the following characteristics:

- Volatility - the degree to which a contaminant can evaporate. For organics, Henry's constant is typically used as a measure of the partitioning between the atmosphere and water. For metals, volatility is expressed is relative terms.

- Solubility - the degree to which a contaminant dissolves in a liquid solution. Solubility is typically expressed in terms of a volume specific weight (e.g., mg/liter)

- Adsorption - Adsorption is the affinity for a contaminant to bound onto particles. Contaminants can bind to soil, submerged sediments, and suspended particles in the water column. A measure of adsorption is the octanol-water partition coefficient (K_{ow}). Typically, the value for the partition coefficient is expressed in logarithmic form (log K_{ow}). This coefficient also is an indirect measure of the potential for bioaccumulation.

- Persistence - Organic chemicals can be degraded due to hydrolysis, photolysis, biological metabolism, and other processes. Persistence can be expressed in terms of half-life (the time it takes for half the amount to degrade) and is defined for a specific set of environmental conditions. Half-lifes are not reported for total metals; however, metals can transition between various forms, thus affecting biological reactivity and toxicity (e.g., methylation and demethylation reactions for mercury and tin)

- Bioconcentration - Certain contaminants have the ability to accumulate in biological tissues reaching concentrations exceeding contaminant concentrations in the surrounding media. Bioconcentration factors are expressed as a dimensionless number and typically a range of values is given to represent bioconcentration factors for multiple species. .

Characteristics for each of the contaminants of concern to the Delaware Estuary Program are given below. The range of values for some characteristics largely reflect the variety of conditions for which these characteristics were determined. Much of the material compiled for this section of the report were taken from Callahan et al. (1979), Weast (1978), and USEPA (1994a).

2.5.1 Dichlorodiphenyltrichloroethylane (DDT)

DDT was first synthesized in 1874 and was used as an insecticide starting in 1939 (McEwen and Stephenson 1979). DDT was applied to crops and to surface waters, swamps, and marshes to control disease carrying insects, particularly mosquitoes carrying malaria. Production of this chemical peaked in 1963. Use of DDT was restricted in 1972 because subsequent studies found it acts as a carcinogen, has detrimental effects to avian fauna, and its effectiveness decreased due to the resistance developed by over 150 insect species.

DDT has a low solubility and a high tendency to sorb to soil particles, making transport via erosion and streamflow a major pathway. It is also moderately volatile and may sorb onto particles in the atmosphere and thus become widely dispersed. DDT and its breakdown products DDD and DDA are the compounds most likely to be encountered in estuarine sediments. DDT degrades to DDE by the loss of one molecule of hydrochloric acid; DDE degrades to DDD by the loss of two more molecules of HCl. Degradation is slow, contributing to the great persistence of DDT and its breakdown products in the environment.

DDT and Metabolites			
	DDT	DDE	DDD
Volatility (Henry's constant atm m^3/mole)	2×10^{-5}	6.8×10^{-5}	4×10^{-6}
Water Solubility (mg/l)		0.04	
Octanol-Water Partition Coefficient (log K_{ow})	6.38	7.0	5.9
Persistence (half-life in days)	5,694	365	5,834
Bioconcentration factor		1.8×10^5	

BCFs for DDE are about 180,000 based on experimental data and 53,500 based on calculations. DDT is particularly toxic to insects, though DDE is not as toxic. Subacute effects include egg shell thinning in birds and reduced reproductive capabilities. DDT is a carcinogen. DDE is a probable human carcinogen, and may be a weak mutagen in animals, but no data appear to indicate that it is a teratogen.

2.5.2 Dieldrin

Dieldrin is a chlorinated hydrocarbon widely used from 1950 to 1974 on cotton, corn, and citrus crops for the control of soil-dwelling insects, especially termites. Dieldrin was also used to control locusts and tropical disease carrying insects, as a wood preservative, for termite control in electrical cables and buildings, and for moth proofing woolen clothes and carpets. Use of dieldrin on food products was suspended in 1974. All uses except as a termiticide, dipping nonfood roots and tops, and certain mothproofing were banned in 1985. Dieldrin is also a breakdown product of the pesticide aldrin. Products containing dieldrin were imported to the U.S. until 1985.

Dieldrin sorbs readily to soil particles that may enter the estuary and accumulate in bottom sediments. Dieldrin is broken down by hydrolysis (with a resultant half-life of about 10.5 years), photolysis (half-life of 2 months), and biotransformation. One epoxide breakdown product is more toxic to some insects than dieldrin itself. Dieldrin has a high potential for bioaccumulation. BCF for fish is 4,670. Sublethal effects include irreversible starvation, liver damage, immunological suppression, decreased fertility, and postnatal mortality. Dieldrin is a carcinogen for some mammals and mutagen in cell cultures.

Dieldrin	
Volatility (Henry's constant atm m^3/mole)	2×10^{-5}
Water Solubility (mg/l)	0.186
Octanol-Water Partition Coefficient (log K_{ow})	5.34
Persistence (half-life in days)	>3650
Bioconcentration factor	4,670

2.5.3 Chlordane

Chlordane is a chlorinated hydrocarbon first registered as a pesticide in 1948 and previously used on corn, grapes, strawberries, and other crops for the control of ants, cutworms, grasshoppers, and other insects prior to 1980. Technical chlordane (the common commercial form) is composed of a mixture of about 45 chlorinated hydrocarbon compounds (64 to 67% chlorine). Major components are *cis*- and *trans*-chlordane, chlordane isomers, heptachlor, and *cis*- and *trans*-nonachlor (NOAA 1990). Underground termite control has been the only permitted use since 1987.

Because of its low solubility and high tendency to sorb to soil particles, the most likely pathway leading from soil application to ground or surface water is through soil erosion, though some dissolution occurs. Half-life in soils has been estimated to be from 0.5 to 10 years in different soils. Atmospheric transport (from aerial applications, wind erosion of soil, and volatilization from water and soil) distributes chlordane globally.

For many species, little bioaccumulation occurs and levels in tissue are close to levels in ambient particulates. Microorganisms and animals can metabolize chlordane. Marine mammals metabolize chlordane much more slowly than carnivorous birds and fish-eating mammals. Biomagnification through marine food chains to marine mammals (porpoises and dolphins) has been observed. Chlordane has been implicated in the deaths of fish-eating birds.

Chlordane	
Volatility (Henry's constant atm m^3/mole)	5×10^{-5}
Water Solubility (mg/l)	0.056-1.85
Octanol-Water Partition Coefficient (log K_{ow})	5.5
Persistence (half-life in days)	1,386
Bioconcentration factor	14,000

2.5.4 Polychlorinated Biphenyls (PCBs)

PCBs are organic compounds composed of biphenyl with one to ten chlorine atoms forming 10 congener groups with 209 possible isomers. Polychlorinated biphenyls (PCBs) were first manufactured in 1929 and rapidly became used in the electric power and electronics industry as dielectric materials in transformers and capacitors. Between 1929 and 1989, total world production of PCBs (excluding the Soviet Union) was 3.4 billion pounds. Use of PCBs in the United States was banned in 1976; however, world production continued at 36 million pounds per year from 1980-1984 and 22 million pounds per year, 1984-1989. Approximately 30 to 70 percent of all PCBs remain in use. As much as 30 percent may reside in landfills, storage, or in the sediments of lakes, rivers and estuaries. Global budgets of PCBs are sufficiently imprecise that the fate of as much as 30 percent of all PCBs (approximately 4.5×10^8 kg) may be unknown (Thomas and Colburn 1992).

PCBs (Aroclor 1254)	
Volatility (Henry's constant atm m^3/mole)	2.8×10^{-3}
Water Solubility (mg/l)	0.01 - 0.05
Octanol-Water Partition Coefficient (log K_{ow})	6
Persistence (half-life in days)	Varies
Bioconcentration factor	$10^4 - 10^6$

PCBs are generally stable, insoluble in water, but soluble in fatty tissues; therefore, PCBs tend to bioaccumulate in biota and are bioconcentrated by trophic transfers. PCBs mimic hormones and are a powerful disruptor of the endocrine system that governs reproduction. Bacterial degradation of some PCBs does occur.

PCBs may be taken up by animals and stored in lipids, and depuration is slow. Bioconcentration factors are high and depend on the degree of chlorination. For marine organisms, BCFs are 85,000 for oysters; 340,000 and 51,000 for rotifer lipids and dry tissue; 21,000 for whole pinfish; and 27,800 for whole spot. BCFs for fathead minnows are 10,000.

Lethality of PCBs continues beyond acute exposure. Sublethal symptoms include decreased algal growth and aquatic organisms in general, reductions in photo-synthesis, reproductive toxicity or failure in fish and echinoderms, low survival of fish and echinoderm embryos, liver carcinomas, anemia, and skeletal deformities. Adverse avian effects occur in growth, reproduction, metabolism and behavior. PCBs also have mutagenic, carcinogenic, and teratogenic properties.

2.5.5 Lead

Although naturally occurring, native lead is rare. Due to resistance to corrosion, lead was commonly used in piping until information concerning its toxicity at low concentrations became available. As a component of solder, lead continues to present a potential risk to human health even where pipes are copper. Use of tetraethyl lead as an antiknock compound in gasoline caused great amounts of lead to be released into the environment. Due to the phase-out of lead in gasolines beginning in the early 1970's, the release of lead into the atmosphere has decreased (USEPA 1991; Figure 10-2) and some decreases have been shown in the concentration of lead in the surface sediments of estuaries (Alexander et al. 1993). Other anthropogenic sources of lead include manufacture of storage batteries, pigments, alloys, ammunition, spent shot, and sewage sludge.

Lead	
Volatility	low
Water Solubility (mg/l)	Insoluble
Octanol-Water Partition Coefficient (log K_{ow})	
Persistence (half-life in days)	Not applicable
Bioconcentration factor	10^2 - 10^3

Lead enters estuaries from point sources, urban and highway runoff, and atmospheric deposition. In surface waters, lead occurs in dissolved labile, dissolved bound (to colloids and complexes), and particulate forms. Lead is often found in sediments due to past accumulation, and thus can be a continual source through sediment release if sufficiently disturbed.

Lead bioconcentration factors (BCFs) for saltwater bivalve mollusks and algae range from 17.5 for a 56-day exposure of hard clams to 2,570 for a 130-day exposure of blue mussels. Freshwater fish BCFs range from 42 to 124 for brook and rainbow trout, and freshwater invertebrate BCFs range from 499 to 1,700. BCFs for marine algae vary from 13,000 to 82,000. Lead is toxic to all phyla of aquatic biota. Toxicity depends in part on the form of lead present. Saltwater algae may be especially sensitive to lead toxicity. Lead is also acutely toxic to saltwater invertebrates and fish. The range of toxicity is large - the most sensitive genus reported by the USEPA (1984) is *Fundulus* which was 85 times more sensitive than the least sensitive genus (*Mya*). Sublethal symptoms in fish include spinal deformities, decreased reproduction, increased mucus production (that may lead to asphyxiation), anemia, degeneration of the caudal fin, neural destruction, decreased swimming abilities, muscular atrophy, paralysis, renal pathology, retardation of sexual maturity, altered blood chemistry, and others. Lead inhibits chlorophyll formation in plants.

2.5.6 Copper

The element copper occurs naturally as various sulfide and oxide ores as well as in the native, unbound state. Manufacture of various products for the electrical industries accounts for most of its current use in the industrial world. Additional amounts are used in the manufacture of brass (an alloy containing primarily copper and zinc) and bronze (an alloy containing primarily copper and tin). The United States produces 1,560 x 10^6 kg Cu per year (1970: USDOI 1970); this is 26% of all world production.

The fate of copper in aquatic environments is dependent upon pH, Eh, the concentration of organic matter, availability of precipitating iron and manganese oxides, biological activity, and competition with other heavy metals (Callahan et al. 1979). Its affinity to hydrous iron and manganese oxides, clays, carbonate minerals, and organic matter means that copper is particle reactive and is readily removed from the dissolved phase. Subsequent sedimentation of copper laden particles causes copper to accumulate in sediments.

Copper is an essential nutrient and is accumulated by all plants and animals. Biological complexation and bioaccumulation are major determinants of the distribution and occurrence of copper in the environment; however, these processes are secondary to physicochemical sorption processes. At high concentrations, copper is toxic especially in the divalent ion form.

Copper	
Volatility (Henry's constant atm m^3/mole)	Low
Water Solubility (mg/l)	Varies with speciation
Octanol-water Partition Coefficient (log K_{ow})	
Persistence (half-life in days)	Not applicable
Bioconcentration factor	10^1 - 10^4

2.5.7 Mercury

Mercury is naturally present in the environment and is a component of more than 25 different minerals. Natural outgassing contributes 10^7 to 10^8 kg Hg to the atmosphere annually. Mercury is used in the production of batteries, electric switches, mercury vapor lamps, and other electronic devices. It is also used as a catalyst in the production of urethane polymers and as a fungicide and preservative in water-based paints. General use as a bactericide or fungicide was greatly restricted after August 1978. Use in latex paint was further restricted in November 1992. Other sources of lead include release to the atmosphere from fossil fuel combustion, municipal waste incinerators, lamps, and re-emission from land sources. Terrestrial sources include chloralkali plants, pesticides (no longer produced), and other industrial uses.

Pathways of lead to the estuary may begin with its deposition to land following atmospheric release. Surface water pathways include movement with sediments and water, and movement as a bioaccumulated element in fish and other organisms. Bio-transport is a significant pathway, as the mass of mercury in fish in a water body may equal the mass of mercury in the water itself (USEPA 1984). Mercury typically enters the estuary as inorganic mercury from atmospheric deposition, natural sources, and point source discharges, to be converted to methyl mercury by bacteria. In the estuary, forms commonly found include organic (methyl) mercury in living organisms, methyl mercury in sediments, and inorganic Hg(II) in water and sediments.

The uptake of mercury is relatively fast and depuration (release) relatively slow. Biological half-life in fish may be 2 to 3 years and may be due mostly to growth dilution rather than loss of mercury. Bioaccumulation is dependent on environmental factors including temperature. Bioconcentration factors in saltwater organisms range from 853 to 10,920 for algae and 10,000 to 40,000 for oysters. BCFs for freshwater fish range from about 10,000 to 81,700.

Mercury	
Volatility (Henry's constant atm m^3/mole) (HgO form)	6.97 x 10^{-3}
Water Solubility (mg/l)	0.056
Octanol-Water Partition Coefficient (K_{ow})	1.9 - 2.5
Persistence (half-life in days)	Not applicable
Bioconcentration factor (inorganic/organic forms)	1800-5000/ 10,000-81,700

Acute and chronic toxicity symptoms depend mainly on the form of mercury. Acute toxicity and immobilization may occur if high concentrations are encountered. Sublethal effects include changes in behavior of invertebrates and birds, growth reduction of algae and fish, embryo-larval mortality and teratogenesis of fish and amphibia, enzymatic changes, and impaired spermatogenesis of fish.

2.5.8 Arsenic

Arsenic is a rare but ubiquitous element in the earth's crust; average crust concentrations are approximately 5 ppm. The largest use of arsenic in the world is for the manufacture of various inorganic and organic pesticides. Arsenic compounds are also used in the manufacture of fireworks, infrared lenses, and as a decoloring agent. Compared to its use in various compounds, the use of metallic arsenic is relatively small and limited to metallurgical applications. Lead shot commonly contains about 1% arsenic to improve the roundness of the molten drops during manufacture. Metal bearings commonly contain up to 3% arsenic to improve thermal and mechanical properties. Other lead alloys used in batteries and cable sheathing may also contain small amounts of arsenic.

The fate of arsenic in the aquatic environmental depends mainly on pH and Eh. Arsenic is extremely mobile and cycle between the water column and sediments. This cycling is often mediated by biological activity and transformations. Vertical profiles of arsenic concentrations in the oceans show arsenic concentrations increasing with depth below the photic zone, suggesting biological uptake removed arsenic from surface waters and was regenerated at depth. Coprecipitation and sorption with hydrous oxides of iron may be the prevalent process for the removal of dissolved arsenic from estuarine waters. Sediments and ultimately the oceans are the primary sinks for arsenic in the aquatic environment.

Arsenic is considered to be extremely toxic. It can be bioaccumulated; however, concentrations measured in aquatic organisms are generally low. Fats generally contain more arsenic than other tissues although fish muscle tissue can also accumulate arsenic.

Arsenic	
Volatility (Henry's constant atm m^3/mole)	Low (but may be significant in reducing environments due to formation of arsine (AsH_3)
Water Solubility (mg/l)	Varies with speciation
Octanol-water Partition Coefficient (log K_{ow})	
Persistence (half-life in days)	Not applicable
Bioconcentration factor	$10^2 - 10^3$

2.5.9 Chromium

Chromium is naturally occurring and used to harden steel, in the manufacture of stainless steel, and in many steel alloys. Its principal use is in the electroplating industry where chromium plating is used to prevent corrosion. Added to glass, chromium produces an emerald green color. It is also used as a catalyst in the chemical industry. Other typical sources of chromium release include atmospheric sources such as coal combustion, municipal waste incineration, cement production, and cooling towers. Surface water discharge sources include electroplating and metal finishing industries, waste-water treatment plants, iron and steel foundries, inorganic chemical plants, tanneries, textile manufacturing, urban and residential runoff, and phosphate fertilizers.

Chromium	
Volatility	low
Water Solubility (mg/l)	Insoluble
Octanol-Water Partition Coefficient (log K_{ow})	
Persistence (half-life in days)	Not applicable
Bioconcentration factor	$10^2 - 10^3$

Cr(VI) tends to be the dominant species in saltwater. It is stable as chromate, dichromate, and hydrochromate and is mobile within the aquatic environment. Cr(III) forms stable complexes and may be removed from the water through scavaging by colloidal iron, flocculation with other colloids, and adsorption onto suspended sediments. Cr concentrations tend to be highest in small grain sediments (NOAA 1991).

For saltwater species, Cr(VI) bioconcentration factors for a polychaete, mussel, oyster, and bivalve species ranged from 125 to 260,000. Molluscan bioaccumulation depends on body weight and salinity. Rainbow trout BCFs are less than 3, and the BCF of a freshwater algal community was 8,500. Cr(II) BCFs for blue mussel, soft-shell clam, and oyster ranged from 86 to 153. There is little evidence of biomagnification through marine food chains.

Acute and sublethal toxicity symptoms depend on the form of chromium - Cr(III), Cr(VI), or organo-chromium. Toxicity to birds and mammals is largely due to Cr(VI), but not Cr(II) or Cr(III). Cr(VI) decreases marine algal growth, causes decreased feeding and reproduction and abnormalities in larval development in polychaetes, and abnormal larval development in echinoderms. Chromium also causes teratogenic effects in bird eggs, and affects survival, reproduction and blood chemistry of adult ducks. In mammals, chromium causes mutations and malignancies, affects blood and serum chemistry, and causes skin ulceration, irritative dermatitis, ulcerations in mucus membranes, kidney and liver lesions.

2.5.10 Silver

Silver is a rare element with an average crustal concentration of 0.1 ppm. It is a considered a precious metal with value second only to platinum and gold. It is also a noble metal because it cannot be easily changed to an oxide form through exposure to air or oxygen. This property makes silver ideal as an electrical conductor and applications in the electronics industry is one of the principal uses of silver. Additional uses include the manufacture of light sensitive compounds (e.g., silver bromide) for use in photography (30% of total use in 1980), alloys used in soldering, coatings and electroplating, medical prosthetics, and other metallurgical applications.

Silver is found in several chemical forms in aquatic environments: aquated cations, metal-inorganic complexes, and metal-organic complexes. Adsorption and precipitation effectively transform dissolved silver species to particulate forms that subsequently settle out of the water and become part of the sediment environment. Adsorption onto manganese dioxide and organic matter, and precipitation with halides, are probably the dominant controls on the mobility of silver in the aquatic environment (Callahan et al. 1979).

Silver can be bioaccumulated by aquatic organisms resulting in concentrations that can be three orders of magnitude greater than concentrations in the surrounding water. Silver is considered toxic to most aquatic species and is probably second only to mercury in terms of its relative toxicity ranking among the heavy metals.

Silver	
Volatility (Henry's constant atm m^3/mole)	Low
Water Solubility (mg/l)	Insoluble
Octanol-water Partition Coefficient (log K_{ow})	
Persistence (half-life in days)	Not applicable
Bioconcentration factor	10^2 - 10^3

2.5.11 1,2, - Dichloroethane

Dichloroethane, also called methylene chloride, is extensively used as a solvent, especially in paint-stripping formulations. The widespread use of this chemical has resulted in the contamination of groundwater and other drinking water supplies. Due to its volatility, significant amounts of dichloroethane have been detected in the troposphere and aerial transport is thought to be a significant process contributing to the widespread distribution of this chemical in the environment.

Dichloroethane is very soluble in water where the primary removal mechanism is evaporation. Oxidation and hydrolysis are not important processes affecting removal from aquatic systems. The bioaccumulation of this chemical is thought to be small.

Dichloroethane (Methylene Chloride)	
Volatility (Henry's constant atm m^3/mole)	High
Water Solubility (mg/l)	13,200 to 20,000
Octanol-water Partition Coefficient (K_{ow})	10-20
Persistence (half-life in days)	<0.04
Bioconcentration factor	10^2 - 10^3

2.5.12 Tetrachloroethane

Tetrachloroethane exists as two isomers: 1,1,2,2-tetrachloroethane and 1,1,1,2-tetrachloroethane. The first isomer, also called acetylene tetrachloride, is used mainly in the manufacturing of chlorinated solvents, especially trichloroethylene and tetrachloroethylene. Minor uses include as a solvent and as an insecticide, particularly against the greenhouse white fly. The second isomer has no commercial application.

The manufacture of large amounts of 1,1,2,2-tetrachloroethane has lead to its widespread distribution in the environment. It is commonly found contaminant of groundwater and drinking water supplies. As for other volatile organic compounds, evaporation is the dominant process removing this organic from the aquatic environment. Hydrolysis, oxidation, and adsorption are minor processes affecting the concentration of tetrachloroethane in the aquatic environment.

Tetrachloroethane can probably bioaccumulate in biological tissues but few measurements have been made to provide an estimate for a bioconcentration factor (BCF). The octanol/water partition coefficient (K_{OW}) suggests that bioaccumulation is possible, but is probably small. Tetrachloroethane is considered to be highly toxic.

Tetrachloroethane (1,1,2,2-tetrachloroethane)	
Volatility (Henry's constant atm m^3/mole)	5×10^{-5}
Water Solubility (mg/l)	2,900
Octanol-water Partition Coefficient (log K_{ow})	2.4
Persistence (half-life in days)	180
Bioconcentration factor	10^2 - 10^3

2.6 LOADING ESTIMATES

The contaminant loading estimates presented in this report were constructed using general models designed to give order of magnitude estimates for loadings from point sources and nonpoint sources including atmospheric deposition, urban runoff, agricultural runoff, and groundwater infiltration. These estimates were used to identify contaminant sources that significantly contribute to total loading to the estuary. Management and regulatory control focused on these sources will be most effective in reducing overall contaminant loading to the estuary. The information on the relative contribution to total loading of each source of chemical contamination will also be useful in helping to establish priorities for future research efforts, should refinement of these estimates be required in the future.

The contaminant sources addressed (point sources, atmospheric deposition, urban runoff, agricultural runoff, and groundwater infiltration) represent the major sources of contaminants to estuaries like the Delaware.

Another potentially major source are hazardous waste sites and landfills. Attempts were made to estimate contaminant releases from these sites and estimate loadings to the estuary that result from these releases.

A source of contaminants not considered in this report was the boating industry. Boat paints typically contain inorganic and organic anti-fouling additives that accumulate in the sediments surrounding marinas. Butyltin compounds, for example, are a concern due to their extreme toxicity to invertebrates. Current regulations, however, limits the application of paints containing butyltins to large boats only, reducing concerns for this class of compounds.

Boat motor exhaust can contribute lead, PAHs, and other contaminants to the estuary. The sediments in marina areas generally have elevated concentrations of lead and PAHs due to boating activities. Marinas also represent a potential source of copper arsenate because of the widespread use of treated wood in the construction of docks and pilings.

3.0 CONTAMINANT LOADINGS FROM POINT SOURCES

3.1 INTRODUCTION TO POINT SOURCES

Contaminants from point sources originate from facilities that discharge effluents directly into the estuary and indirectly into the lakes, streams, and rivers that drain into the estuary. Point sources include, waste-water treatment plants (WWTP), industrial facilities, and power plants. Facilities discharging effluents into surface waters through pipes, ditches, canals, or similar conveyances are generally considered to be point sources. The discharge of these effluents is regulated by the USEPA and cooperative state agencies as part of the Clean Water Act.

Contaminant loadings from point sources have been responsible for most cases of the extreme contamination of surface waters documented in the environmental literature (mercury pollution in Minimata Bay; kepone in the James River; petroleum hydrocarbons in the Cuyahoga River, OH). The extremely poor water quality conditions in the Delaware River during the 1940's and 1950's are generally attributed to organic and toxic loadings from inadequate waste-water treatment. A concerted effort by the federally commissioned Delaware River Basin Commission and funding through a federal construction grants program improved the quality of effluents from point sources and brought about significant improvements in the water quality of the Delaware River Estuary (Albert 1988).

3.2 METHODS FOR ESTIMATING POINT SOURCE LOADINGS

Estimates for contaminant loadings from point sources were made using NOAA's National Coastal Pollutant Discharge Inventory (NCPDI) data base. The data base was developed from the USEPA's Permit Compliance System (PCS) data base and information collected from selected facilities having permits issued as part of the National Pollution Discharge Elimination System (NPDES). The Strategic Environmental Assessment Division of NOAA developed this data base specifically to estimate loadings of chemical contaminants to estuarine and coastal drainage basins or areas. As defined by NOAA (Pacheco et al. 1993), the estuarine drainage area (EDA) is "that portion of an entire watershed that most directly affects the estuary and is delineated by the USGS hydrologic cataloging units and the head of tide." NOAA compiles information for 102 EDAs as part of the National Estuarine Inventory (NEI). NOAA's coastal drainage areas (CDAs) correspond to "that component of an entire watershed that is not part of the 102 EDAs in the NEI, but drains into an estuary or coastal water." USGS hydrologic cataloging units and the head of tide are also used to delineate the spatial extent of CDAs.

The NCPDI data base for the Delaware Estuary includes facilities located in the USGS hydrologic cataloging units listed in Table 3-1. This includes the EDA and selected upstream regions. All facilities located in the area defined by the Lower Delaware Cataloging Unit (020402) appear to included in the NCPDI data base. Only a portion of the facilities in the

Upper Delaware Cataloging Unit (020401) are included in the data base; therefore, the data base includes facilities located in portions of the watershed above the head of tide, particularly in Pennsylvania.

Table 3-1. Location of point source facilities included in NOAA's NCPDI data base for the Delaware Estuary.

Hydrologic Cataloging Unit	Description	Number of Facilities	
		Major	Minor
020402	Lower Delaware		
02040201	Crosswicks-Neshaminy, NJ-PA	26	106
02040202	Lower Delaware, NJ-PA	56	272
02040203	Schuylkill, PA	48	390
02040205	Brandywine-Christina, DE-MD-PA	20	135
02040206	Cohansey-Maurice, NJ	15	68
02040207	Broadkill-Smyrna, DE	5	13
020401	Upper Delaware		
02040101	Upper Delaware, NY-PA	0	5
02040102	East Branch Delaware, NY	1	2
02040104	Middle Delaware, Mongaup, Brodhead, NJ-NY-PA	1	17
02040105	Middle Delaware, Musconetcong, NJ-PA	10	153
02040106	Lehigh, PA	7	86
	Other	1	16
	Totals	190	1263

NOAA has compiled contaminant loading estimates for each facility in the USEPA's PCS data base using the procedures outlined in Pacheco et al. (1993). Loading estimates were based upon PCS data for calendar year 1991. Loading estimates for each facility were taken directly from the monthly discharge monitoring reports (DMRs). The DMRs include information for those contaminants and parameters for which monitoring is required and specifically included as part of the discharge permits issued by the USEPA and cooperating state agencies; however, facilities are not required to measure all contaminants, even when those contaminants are likely to be present in effluents. NOAA estimated loadings for contaminants not specifically included as part of the DMRs filed by each facility. Estimates were compiled by determining a typical contaminant concentration for each type of discharge, based upon the facility's standard industrial code (SIC). Typical contaminant concentrations for waste-water treatment plants were determined by the level of treatment of that facility (primary, secondary, or tertiary). For municipal wastewater treatment plants, typical pollutant concentrations were obtained from a 1982 report (USEPA 1982) and may not reflect current effluent concentrations.

Estimates of contaminant loadings to the estuary from point sources were made for the present study by summing mass loadings (kg/year) discharged from each facility in the Delaware Estuary EDA. Separate estimates were made for those facilities that discharge effluents directly into the estuary vs. those facilities that discharge effluents into tributaries that enter the estuary.

3.3 CONTAMINANT LOADINGS FROM POINT SOURCES

NOAA's NCPDI data base contains entries for 190 major and 1263 minor facilities that are potential point sources of contaminant inputs to the Delaware River Estuary (Table 3-1). These facilities include waste-water treatment facilities, industrial facilities, and power plants.

Total loadings to the EDA from point sources are summarized in Figure 3-1. Loadings for metals range from a low of 0.8×10^3 kg of mercury per year to a high of 1×10^6 kg of iron. Arsenic and cadmium point source inputs are approximately 10^4 kg per year, whereas chromium, copper, lead, and zinc inputs are approximately 10^5 kg per year. Total flow from all point sources combined averages 275.8 m^3/sec; this is equivalent to 49% of the long-term average flow of fresh-water into the Delaware River Estuary. These point sources discharge 43.8×10^6 kg of particles (measured as total suspended solids (TSS)) into the estuary.

Estimates for total contaminant loadings to the estuary were calculated for both major and minor facilities. Most (91%) of the total flow from point source dischargers originated from major facilities (Figure 3-2). Over 90% of the total annual loading of arsenic, cadmium, chromium, copper, iron, lead, and zinc, from point sources originated from the major facilities. Major facilities were also responsible for the most (88%) of point source loadings of mercury.

Figures 3-3 through 3-8 show the locations of the major facilities discharging into the Delaware estuarine drainage area. The geographic locations of each facility were taken directly from the NCPDI data base. No attempts were made to validate the locational data provided; however, NOAA completed a careful review of the locational information for each of the major facilities included in the data base. The locations of waste-water treatment plants (Figures 3-3 and 3-4), industrial facilities (Figures 3-5 and 3-6), and power plants (Figures 3-7 and 3-8) are shown separately, and details are provided for the highly populated area of the watershed between Wilmington, DE, and Trenton, NJ. These figures also show the size of each facility based upon the average flow in millions of gallons per day (MGD).

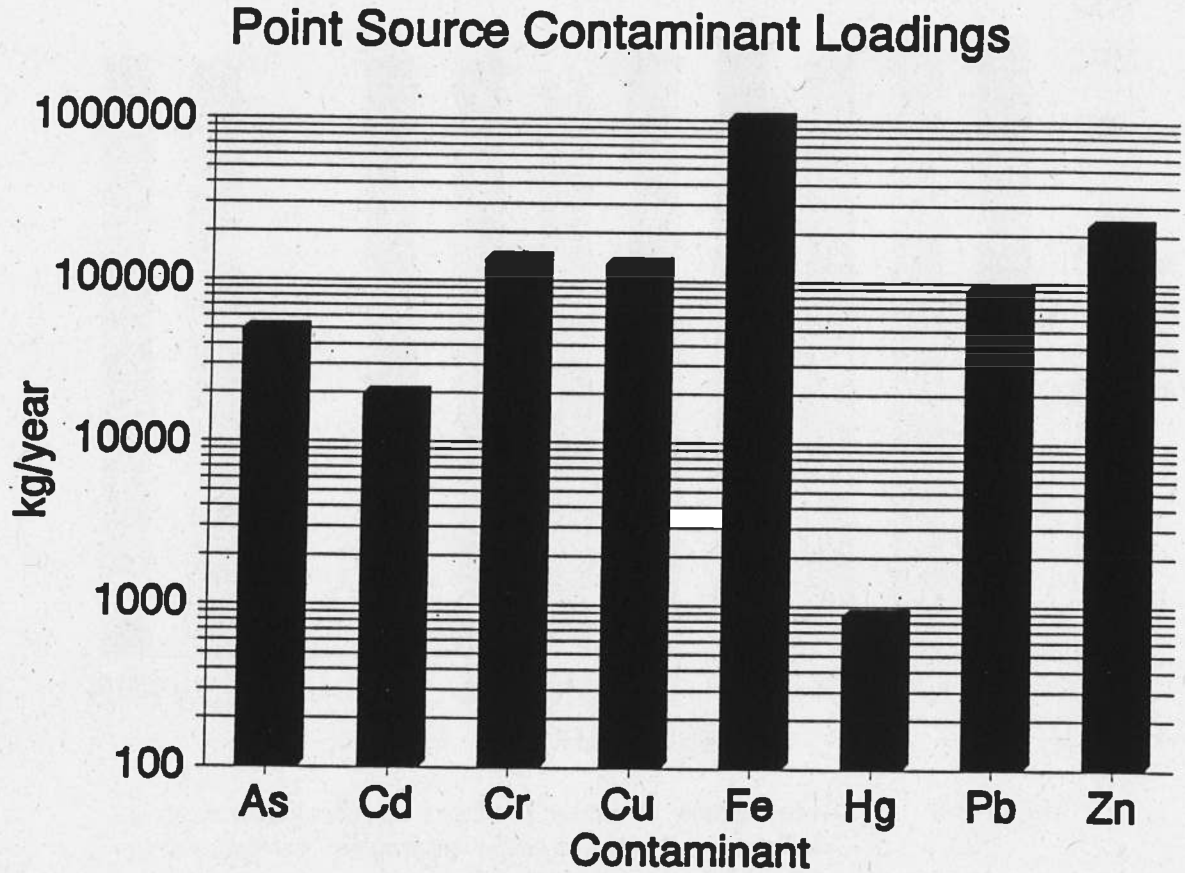

Figure 3-1. **Contaminant loadings from point sources estimated using NOAA's NCPDI Data Base.**

The contribution of waste-water treatment plants, industrial facilities, and power plants to total contaminant loadings from point sources is contaminant dependent (Figure 3-9). Inputs from waste-water treatment plants dominate loading estimates for many metals. Over 80% of all arsenic and iron, 78% of all cadmium, 71% of all lead and 65% of all zinc from point sources originate from waste-water treatment plants. Approximately half of all chromium and mercury originates from waste-water treatment plants; industrial facilities contribute most of the remainder. Inputs from industrial facilities dominate the loading estimate for copper; 49% of point source loadings of copper originates from industrial facilities. With the exception of copper, discharges from power plants contribute less than 5% to total metal loadings from point sources. Approximately 12% of all copper from point sources originates from power plants. The discharges from power plants are responsible for 65% of the total flow from point sources into the Delaware River Estuary.

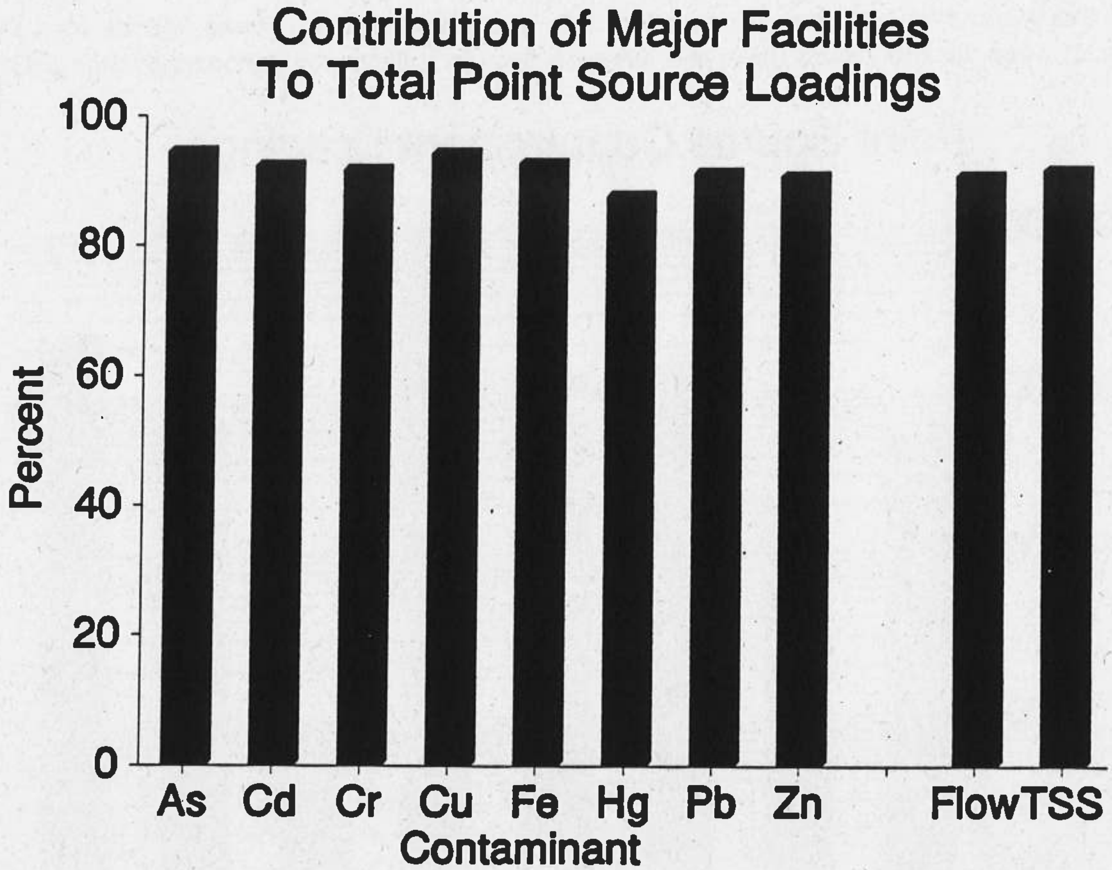

Figure 3-2. **Contribution of major facilities to total point source loadings. Total loadings estimated by summing major and minor facilities.**

Generally, facilities discharging directly into the Delaware Estuary contribute more contaminants than facilities discharging into the section of the Delaware River upstream of Trenton and to other tributaries entering the estuary (Figure 3-10). This pattern reflects the concentration of urban land use, industrial activity, and human population with the Wilmington to Trenton corridor. Point source inputs of zinc depart from this pattern with approximately equal amounts from facilities directly discharging into the estuary and those facilities discharging into tributaries and upstream.

The NCPDI contains information for both annual and seasonal contaminant loadings. Loading estimates for most metals (arsenic, cadmium, chromium, iron, mercury, lead, and zinc) do not indicate significant seasonal loading patterns. Loading estimates for copper, however, show seasonal differences (Figure 3-11). Loadings are highest in summer and spring, accounting for 66% of the annual input of copper. Point source loading of copper is lowest in the fall and winter.

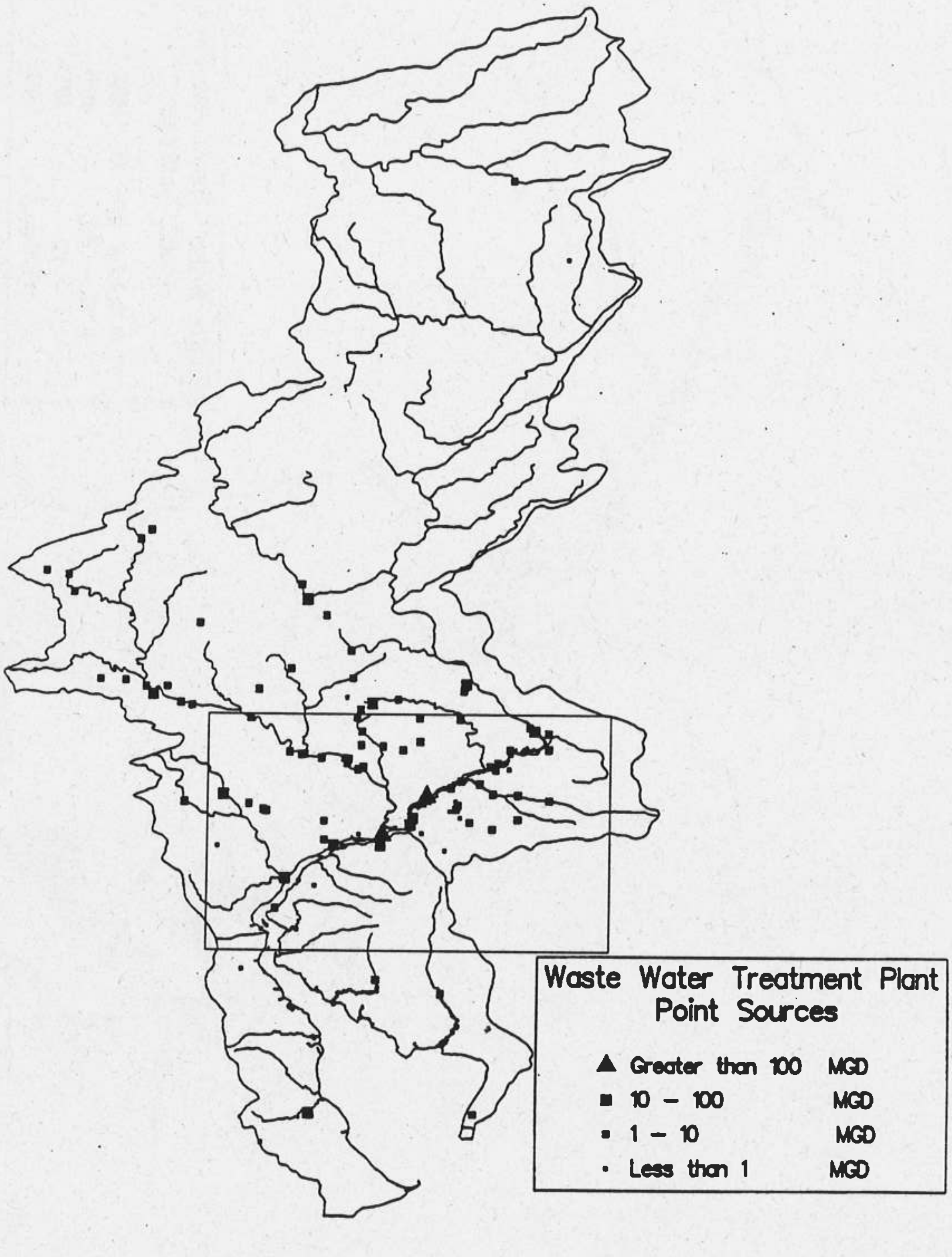

Figure 3-3. Location of major waste-water treatment plants in the Delaware watershed estuarine drainage area. Data taken from NOAA's NCPDI data base.

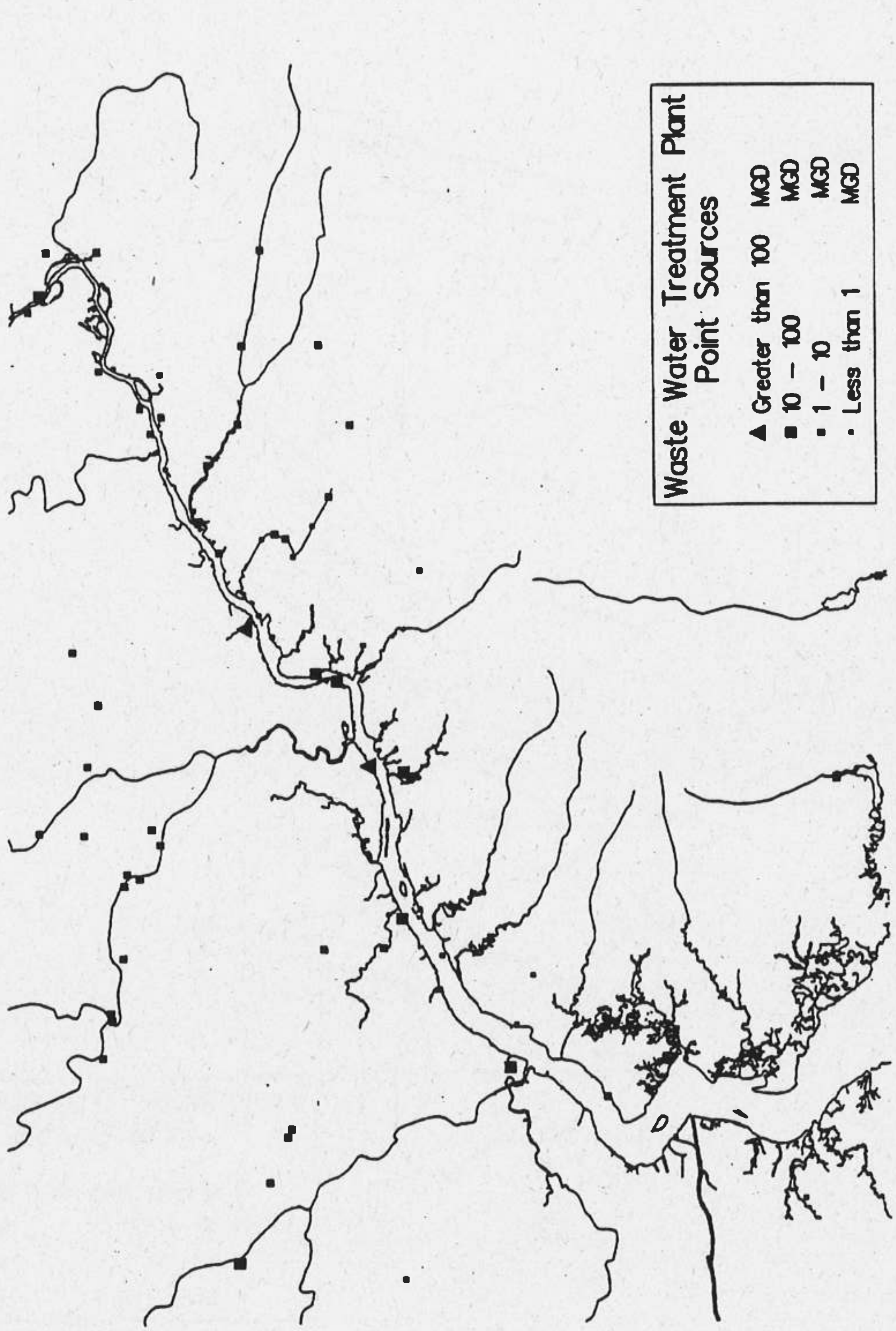

Figure 3-4. **Location of major waste-water treatment plants in the Delaware Watershed estuarine drainage (area detail). Data taken from NOAA's NCPDI data base.**

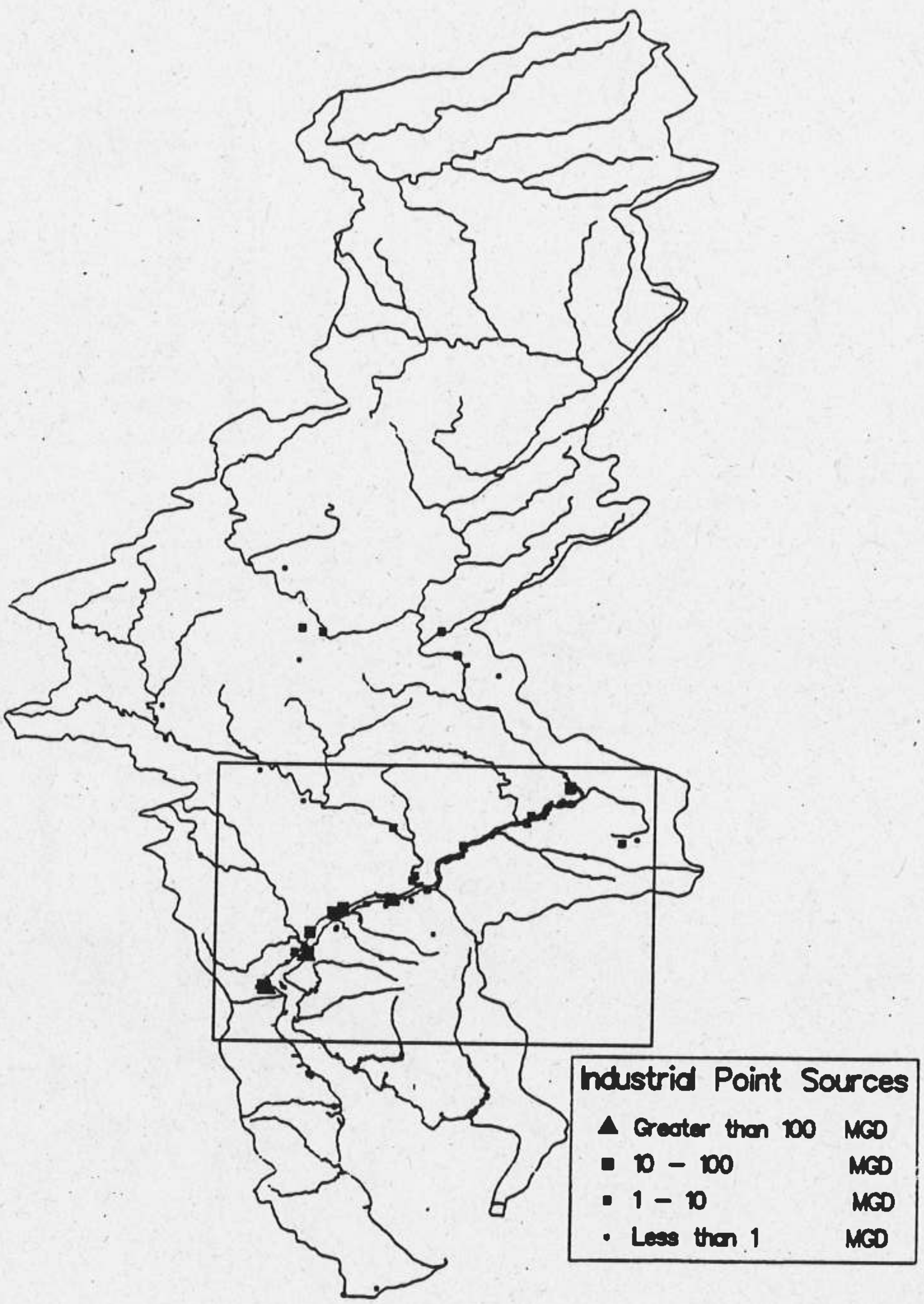

Figure 3-5. **Location of major industrial facilities discharging into the Delaware watershed estuarine drainage area. Data taken from NOAA's NCPDI data base.**

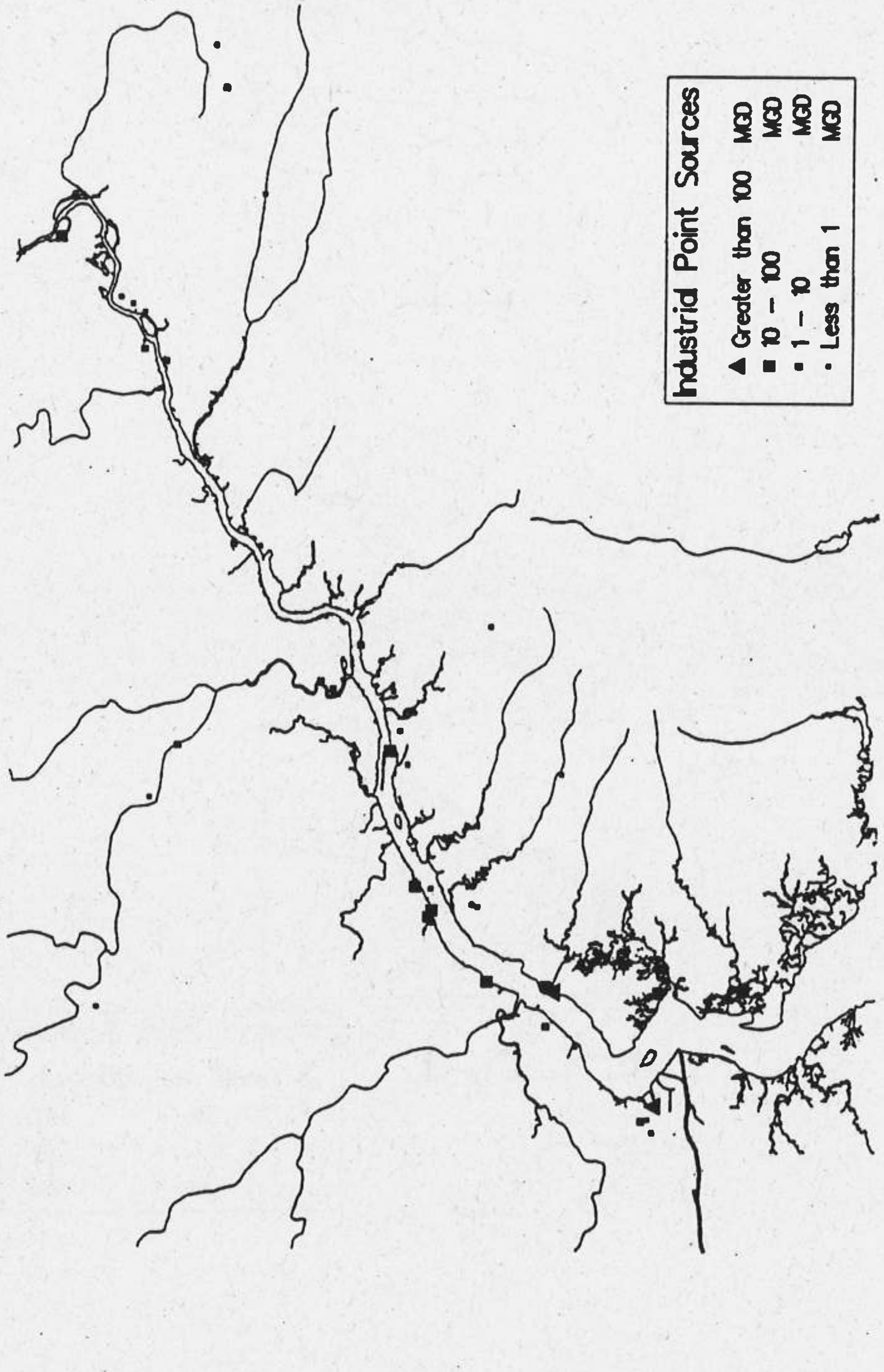

Figure 3-6. Location of major industrial facilities discharging into the Delaware watershed estuarine drainage area. Data taken from NOAA's NCPDI data base.

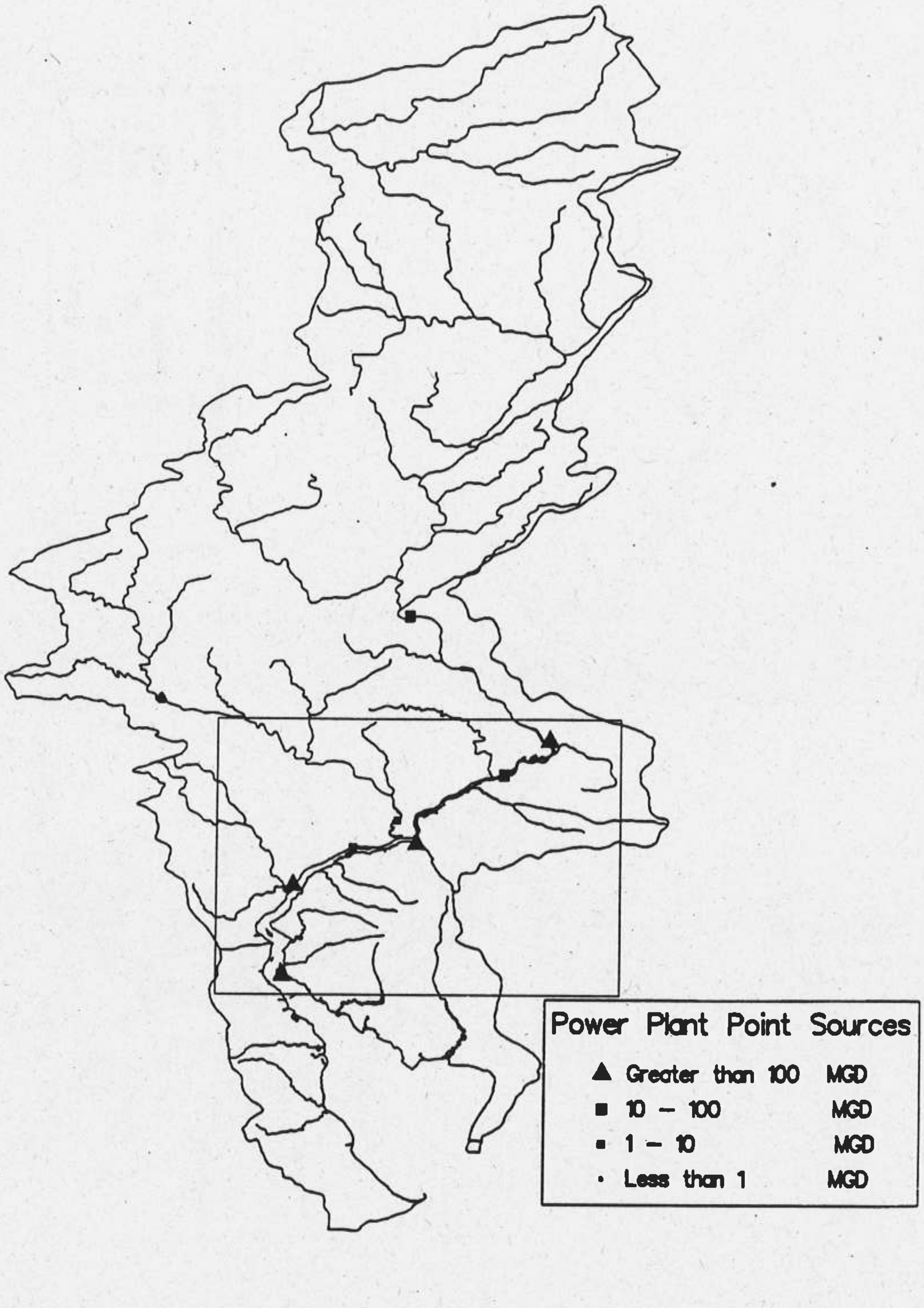

Figure 3-7. **Location of power plants discharging into the Delaware watershed estuarine drainage area. Data taken from NOAA's NCPDI data base.**

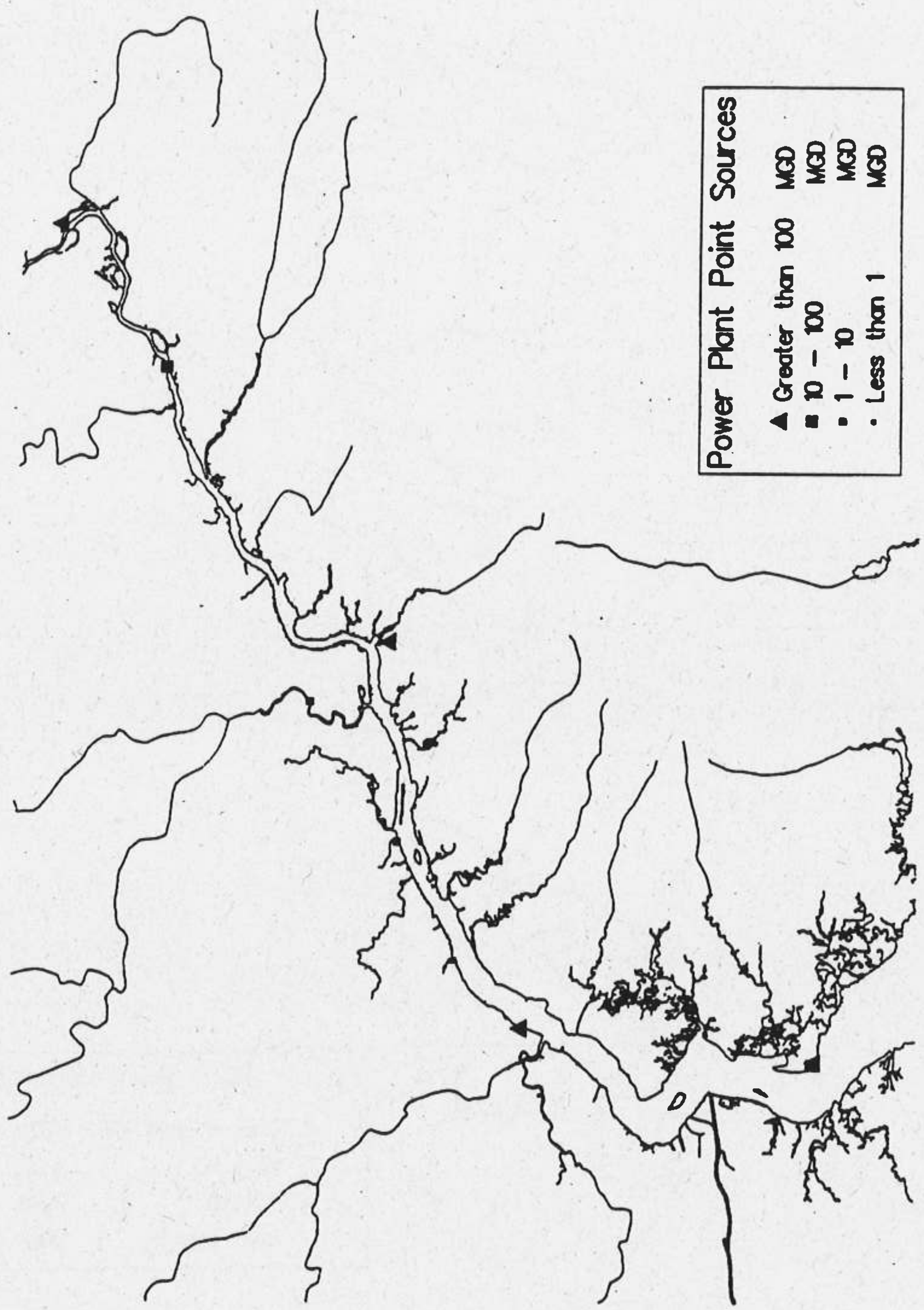

Figure 3-8. Location of power plants discharging into the Delaware watershed estuarine drainage area (area detail). Data taken from NOAA's NCPDI data base.

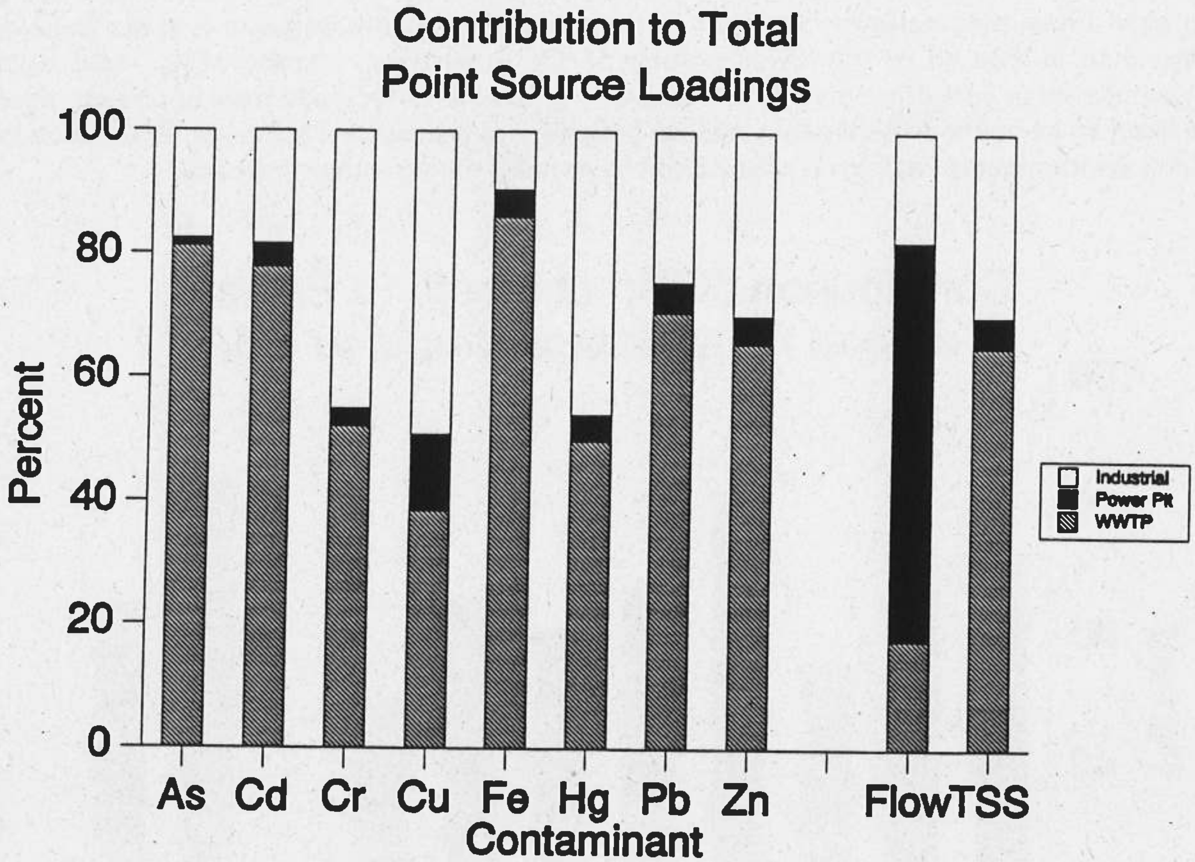

Figure 3-9. Contribution of waste-water treatment plants (WWTP), power plants, and industrial facilities to contaminant loadings from point sources

3.4 DISCUSSION OF POINT SOURCE CONTAMINANT LOADINGS

The estimates for contaminant loadings to the Delaware Estuary from point sources are entirely based upon NOAA's NCPDI data base. Two limitations exist in using this data base. The first limitation is that the NCPDI data base may not reflect contaminant loadings to the estuary proper. The calculated loading rates for particle reactive contaminants may be overestimates of the true loading rates because physico-chemical processes affecting chemical fate and behavior may prevent contaminants discharged into tributaries from reaching the estuary. The NCPDI data base includes facilities located above the head of tide, particularly in Pennsylvania. For contaminants that are not strongly reactive with suspended particles or sediments, and contaminants that have dissolved forms, the NCPDI data base may yield underestimates for contaminant loadings. The uncertainties introduced by these factors cannot be estimated; however, it is likely that the estimates provided here are close to or slightly overestimates of the amount of contaminants entering the estuary from point sources. Loadings from point source facilities in the upstream portion of the watershed are likely to be small in comparison to loadings from the lower upstream because point source loadings are strongly driven by population density and most (ca 80%) of the population in the Delaware watershed is located in the lower portion of the watershed. Additionally, most of the contaminants of concern are particle reactive. Contaminants released from upstream regions are likely to be bound to sediments in close proximity to discharges; however, these sediment bound contaminants may be washed into the estuary during extreme floods.

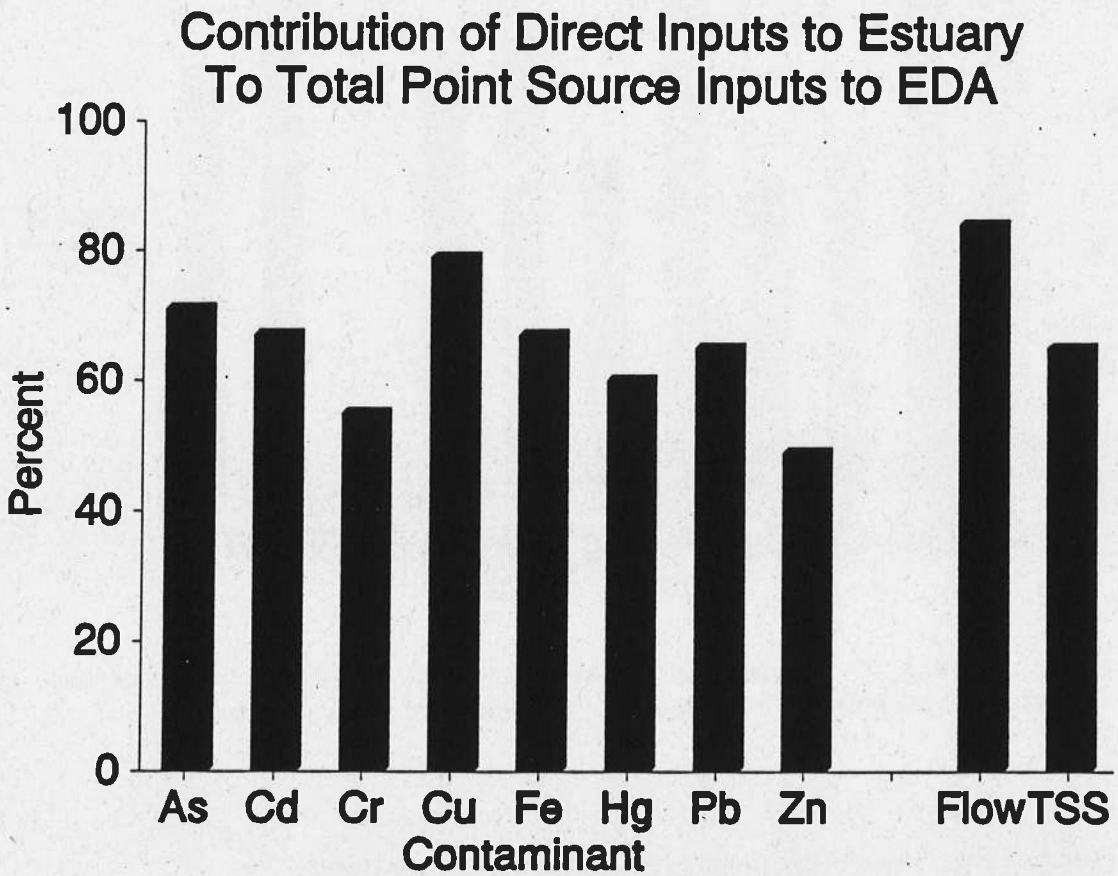

Figure 3-10. **Contribution of facilities discharging directly into the estuary to total loadings from all point sources within the EDA.**

The second limitation of the NCPDI data base is that reliable estimates could be made for only a small number of contaminants and parameters. These include flow, biochemical oxygen demand (BOD), total suspended solids, total nitrogen, total phosphorus, oil and grease, fecal coliform bacteria, and the metals arsenic, cadmium, chromium, copper, iron, lead, mercury, and zinc. The estimates for metals, flow and total suspended solids were included in this report. This list reflects the parameters and contaminants most frequently included in discharge permits. Although the USEPA's PCS data base includes the capability to monitor more than 1,600 parameters and contaminants, most facilities are not required to monitor these parameters. The background files compiled by NOAA during the compilation of the NCPDI data base include information for 647 of the more than 1,600 parameters included in the PCS data base; however, information for most of these parameters was so rarely found that loading estimates could not be reliably developed.

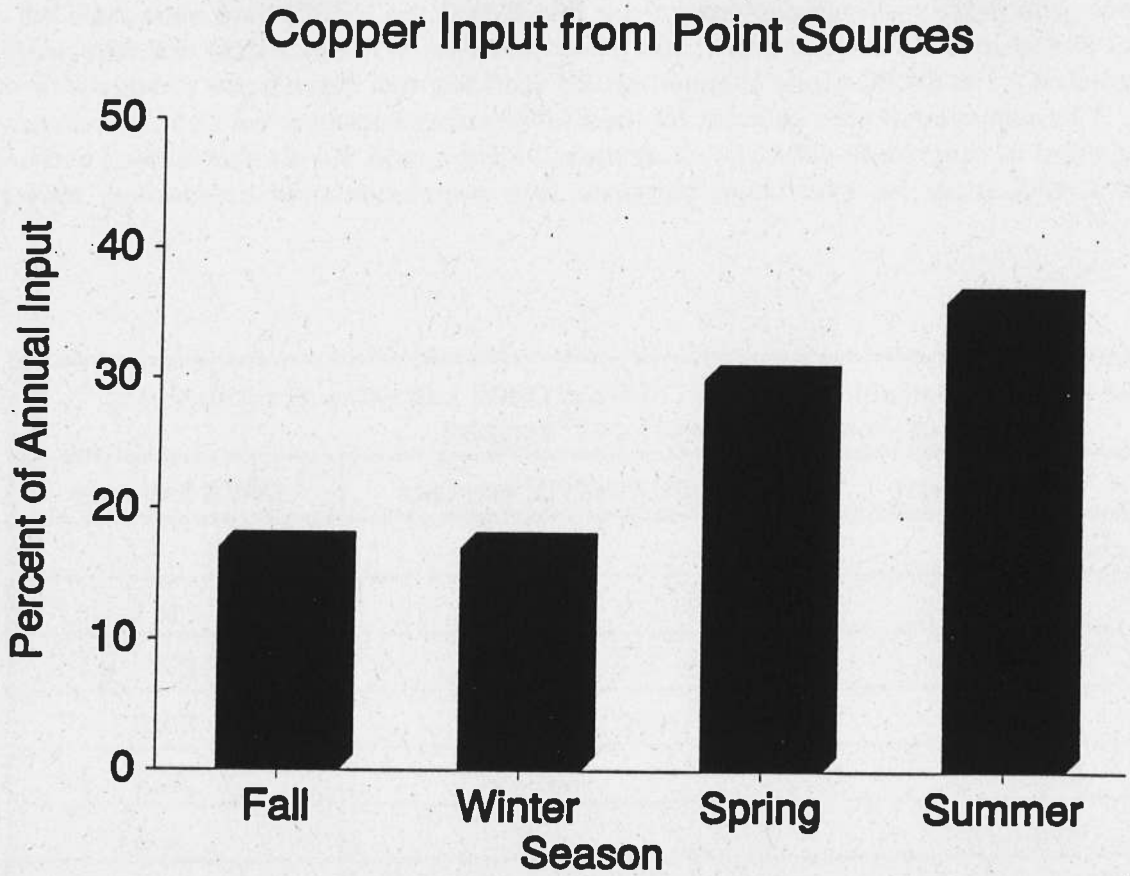

Figure 3-11. **Seasonal input of copper from point sources.**

The NCPDI data base contained data used to calculate a loading estimate for total chlorinated pesticides. This estimate is 2.2×10^3 kg/year. The estimate is for all chlorinated pesticides and is not limited to the chlorinated pesticides focused upon in this report (chlordane, DDT, DDD, DDE, dieldrin). Approximately 98% of this loading originates from major facilities, and 63% originates from industrial facilities. This number should be used with caution since it is based upon concentrations reported from a small number of facilities.

The loading estimates derived from NOAA's NCPDI data base were compared to point source toxic loading estimates completed by DRBC (Fikslin personal communication). These estimates were made from direct measurements of contaminant concentrations in 83 point sources discharging into the tidal Delaware River. The DRBC study was not limited to these contaminants reported in the facility monthly discharge monitoring reports; therefore, loading estimates were available for additional contaminants using the DRBC study.

The NCPDI and DRBC loading estimates are in fairly good agreement (Table 3-2). For arsenic, copper, lead, mercury, and zinc, the NCPDI estimates were higher than the DRBC estimates. The most probable explanation for this is that the NCPDI data base included all point source facilities (190 major and 1,263 minor facilities) in the estuarine drainage area of the watershed. The DRBC study focused on 83 facilities that discharged directly into the estuary. This explanation may account for most differences between the two studies; however, the order of magnitude difference in arsenic loadings, and the greater loading estimate from the DRBC study for chromium, suggests that a more detailed comparison may be warranted.

Table 3-2. Comparison of NOAA-NCPDI and DRBC estimates of contaminant loadings from point-sources (10^3 kg/year)

Contaminant	NOAA-NCPDI Estimate	DRBC Estimate
Metals		
Arsenic	49.2	5.1
Chromium	135	187
Copper	126	89.8
Lead	89	26.8
Mercury	0.9	0.21
Silver	N.E.	14.9
Zinc	225	169
Chlorinated Pesticides		
DDD	N.E.	3.1
Volatile Organics		
1,2 Dichloroethane	N.E.	18.2
Tetrachloroethane	N.E.	12.4

No discharges of PCBs were reported in the NCPDI data base for point source facilities. Further, using standard analytical techniques (minimum detection limit: 65 ng/l), no PCBs were detected for those wastewater discharges included in DRBC's survey of facilities discharging to the tidal river portion of the estuary. Discharges of significant amounts of PCBs through point sources are unlikely because persistent and toxic chemicals such as PCBs are closely regulated by the USEPA and cooperative states. Additionally, since federal statutes severely restrict the use of PCBs, the discharge of these chemicals due to current use in industrial facilities is likely to be negligible.

Despite existing regulation and control, PCB concentrations have been found in effluents from some municipal treatment facilities. PCB concentrations in effluents from four municipal treatment facilities in the New York City area were recently measured for a study funded by the USEPA's Office of Water (Battelle 1993). Average PCB effluent concentrations were 39 ng/l (10^{-9} g/l). This concentration value, and flow from all wastewater treatment facilities in the NCPDI data base (1.5×10^{12} liters/yr), were used to calculate a PCB loading estimate for the Delaware. The estimate of the amount of PCBs entering the Delaware Estuary from point sources using the New York City data is 58.6 kg/year. This estimate is likely to be an upper limit for the Delaware because the Hudson River-New York Harbor region is affected by elevated levels of PCBs and DRBCs study detected no discharges of PCBs.

3.5 SUMMARY OF POINT SOURCE LOADINGS

A summary of loading estimates for contaminants from point sources is presented in Table 3-3. Major findings are summarized below.

- Most of the contaminant loadings from point sources originate from the 190 major facilities; the 1263 minor facilities generally contribute less than 10% of the total.

- Waste-water treatment plants and industrial facilities contribute the most to total contaminant loadings from point sources; power plants are important only in terms of flow.

- Point source loadings for the metals of concern are approximately 10^5 to 10^6 kg/year.

- The point source loading estimate for chlorinated pesticides is approximately 10^3 kg/year.

Table 3-3. Summary of contaminant loadings from point sources (10^3 kg/year).

Contaminant	Comments	Loading Estimate
Metals		
Arsenic	Used NCPDI data base	49
Chromium	Used NCPDI data base	135
Copper	Used NCPDI data base	126
Lead	Used NCPDI data base	89
Mercury	Used NCPDI data base	1
Silver	Estimate from DRBC study	15
Zinc	Used NCPDI database	225
Polynuclear Aromatic Hydrocarbons (PAHs)		
PAHs	Insufficient data to complete estimate	N.E.
Chlorinated Pesticides		
Chlordane	Insufficient data to complete estimate	N.E.
DDT (Total)	Estimate for DDD only from DRBC study	3
Dieldrin	Insufficient data to complete estimate	N.E.
Total	Estimate made for total chlorinated pesticides only	2
PCBs		
PCB (Total)	Estimated from NCPDI flow data and concentration data from Battelle (1993)	0.06
Volatile Organics		
1,2 Dichloroethane	Estimate from DRBC study	18
Tetrachloroethane	Estimate from DRBC study	12

N.E. = No estimate

4.0 CONTAMINANT LOADINGS FROM ATMOSPHERIC SOURCES

4.1 INTRODUCTION AND DEFINITIONS

The atmosphere is a source of contaminants originating from mobile sources such as cars, trucks, and other transportation; stationary sources such as industrial facilities and incinerators; aerial spraying; wind erosion of particles; and degassing from diffuse land sources. Contaminant concentrations in air reflect local sources and far-field sources that are, in some cases, thousands of miles away.

Atmospheric transport and deposition is considered an important pathway for the transfer of PCB congeners from land to natural waters (Holsen et al. 1991). Data from studies of the PCBs entering Lakes Superior, Huron, and Michigan show that between 55 and 90% of all PCB inputs originate in the atmosphere (Strachan et al. 1989). Although PCBs have very low vapor pressures, they can be emitted to the atmosphere by scrubbing of air during PCB manufacture, vapor exhaust from steam jet ejectors, evaporation from PCB spills or spills of PCB-contaminated oil, evaporation from plant waste-water, and high-temperature incineration (Versar 1976).

Metals such as chromium, copper, nickel, and mercury are emitted to the air primarily as products of fossil-fuel combustion, especially high-temperature processes such as smelting. Metals may also be emitted through plating and other surface coating processes and through motor vehicle exhaust. Metals are transported and deposited at various rates and distances depending on their chemical state and physical characteristics.

Volatile organic compounds (VOCs), including priority pollutants such as 1,2-dichloroethane and tetrachloroethane, are emitted in great quantities from various manufacturing and cleaning operations. Many of the dry cleaning operations that regularly use volatile organic compounds are small and not included in the USEPA's Toxic Release Inventory (TRI) – a program designed to track and quantify contaminant emissions to the air, surface waters, and ground (USGAO 1992).

Polycyclic aromatic hydrocarbons (PAHs) in the atmosphere originate from fossil fuels, waste incineration, coal gasification and liquification processes, petroleum cracking, and the production of coke, carbon black, coal tar pitch, and asphalt (Hangebrauck et al. 1967). Mobile sources (primarily automobiles) are a major source of atmospheric PAHs in the United States, accounting for as much as 36% of the total emissions of PAHs into the atmosphere (Boesten and Leistra 1983). PAHs in the atmosphere are adsorbed onto airborne particles such as soot and fly ash and are subsequently transported by wind. Transport distances are a function of wind speed, atmospheric height, and particle diameter (McVeety and Hites 1988). Generally, PAH concentrations decrease dramatically with an increase in distance from urban sources (Windsor and Hites 1979).

4.2 METHODS FOR ESTIMATING ATMOSPHERIC LOADINGS

Two principal approaches are used to estimate atmospheric deposition. The first is to measure wet and dry deposition at various sites in the region of interest and then calculate an average deposition rate. This method assumes that the sampling sites are representative of the region of interest and that the time period for sampling is representative of the annual deposition rate that is being estimated. Additional problems are presented because the measured deposition rates are small (typically ng/m^2/day) and easily contaminated by field and laboratory operations.

The second approach used to estimate atmospheric deposition is to model the transfer of contaminants from the air using measured contaminant concentrations in air and model coefficients for contaminant transfer upon impaction.

Although estimates have been made for the atmospheric deposition of nutrients (Skudlark and Church 1993), no estimates for the atmospheric deposition of contaminants were found for use in this study. Additionally, a suite of sites at which measurements were available for both dry and wet atmospheric deposition could not be identified. Consequently, atmospheric loadings were estimated using the average deposition fluxes calculated as part of the Chesapeake Bay Atmospheric Deposition Study (CBADS) (Baker et al. 1992).

The justification for applying deposition rates from the Chesapeake study to the present Delaware study is that the two estuaries border each other and lie in the same general area of the country. Also, land use within the watersheds is approximately similar. Land use will affect both the production of atmospheric contaminants (input from land to air) and the transport to the estuary of contaminants deposited in the watershed. Urban areas, for example, constitute 14% of the land area in the Delaware watershed (Evans et al. 1993) and 11% of the land area in the Chesapeake watershed (USEPA 1994b).

The CBADS deposition rates (Table 4-1) are based on weekly aerosol and precipitation samples collected at two stations in the Chesapeake Bay watershed over a one year period (June 1990 through July 1991). Deposition fluxes were available for the trace metals arsenic, cadmium, chromium, copper, iron, nickel, lead, and zinc. Loading estimates were also available for PCBs. Loading estimates for PAHs were computed from the CBADS data by summing the average deposition fluxes for each of 14 individual PAHs sampled. Atmospheric deposition rates for mercury were not provided by the CBADS study; these were estimated using the average deposition fluxes taken from Galloway et al. (1982). The mercury deposition flux (1.5×10^3 μg/m^2/yr) was derived from general urban bulk deposition rates reported in the literature and based upon a study of deposition of airborne mercury near point sources (Lockeretz 1974).

The deposition rates derived above were used to calculate 1) direct deposition of contaminants to the estuary and 2) contaminant loadings to the estuary resulting from deposition of contaminants to the Delaware River Estuary Watershed. To calculate direct deposition to the estuary, the average deposition fluxes for each contaminant (μg/m^2/yr) were multiplied by the total area of the estuary (1,989 km^2: from NOAA 1985). Contaminant deposition to the watershed was calculated in a similar manner. The average deposition fluxes for each contaminant were multiplied by the total area of the watershed (34,836 km^2: from NOAA 1987). A transfer coefficient of 0.1 was used to estimate the amount of contaminant deposition that was transported from the watershed to the estuary. This transfer coefficient has been used by others to estimate nonpoint source nutrient loadings (Skudlark and Church 1993).

Table 4-1. Atmospheric deposition rates for contaminants ($\mu g/m^2/yr$). Taken from the Chesapeake Bay Atmospheric Deposition Study (Baker et al. 1992).

	Wet[a]	Dry[b]	Total[c]
Arsenic	49	100 ± 50	150
Cadmium	48	21 ± 10	69
Chromium	88	200 ± 96	290
Copper	260	400 ± 190	660
Iron	10,400	65,000 ± 31,000	75,000
Nickel	257	540 ± 250	800
Lead	556	690 ± 320	1,250
Zinc	1,335	2,000 ± 960	3,300
PCBs	2.7	2.5 ± 1.2	5
PAHs	82	249	331

Notes: [a] Wet deposition average fluxes, volume weighted from a) biweekly collections at the western shore site (organics), and b) weekly collections averaged again at both eastern and western shore sites (trace elements).

[b] Dry deposition average fluxes, averaged for a) daily (Tuesday) sampling at only the western shore site (organics), and b) weekly integrated collections averaged at both the eastern and western shore sites (trace elements). The error represents the largest uncertainty which is the assumed dry deposition velocities (see text for details).

[c] Simple sum of wet and dry fluxes.

4.3 ATMOSPHERIC LOADING ESTIMATES

Estimates for contaminant loadings resulting from atmospheric deposition are provided in Table 4-2. Estimates for the direct deposition of contaminants onto the surface of the estuary range from 10 to 10^4 kg/yr depending on the specific contaminant of concern (Figure 4-1). The atmospheric loading estimate for PCBs is 10 kg/yr. Direct deposition of metals and PAHs to the estuary range from 10^2 to 10^4 kg/yr. Iron and zinc had the highest deposition rates.

Table 4-2. Estimates for contaminant loadings from atmospheric deposition. Estimates provided for direct deposition to estuary, indirect input resulting from deposition on the watershed, and total input from atmospheric deposition.

Contaminant	Deposition Rate $\mu g/m^2/yr$	Direct to Estuary kg/yr	From Watershed kg/yr	Total
Arsenic	150	298	493	791
Cadmium	69	137	227	364
Chromium	290	577	953	1,529
Copper	660	1,313	2,168	3,481
Mercury	1,500	2,983	4,927	7,910
Nickel	800	1,591	2,628	4,219
Lead	1,250	2,486	4,106	6,592
Zinc	3,300	6,564	10,839	17,403
PCB	5	10	16	26
PAH	331	658	1,087	1,745

Atmospheric inputs of contaminants resulting from deposition in the entire watershed and transfer to the estuary are generally a factor of two higher than the estimates for direct deposition onto the surface of the estuary (Figure 4-2).

Except for mercury, contaminant loadings from atmospheric sources are generally two to three orders of magnitude less than contaminant loadings from point sources. Loading rates for mercury from atmospheric sources and point sources are approximately equal.

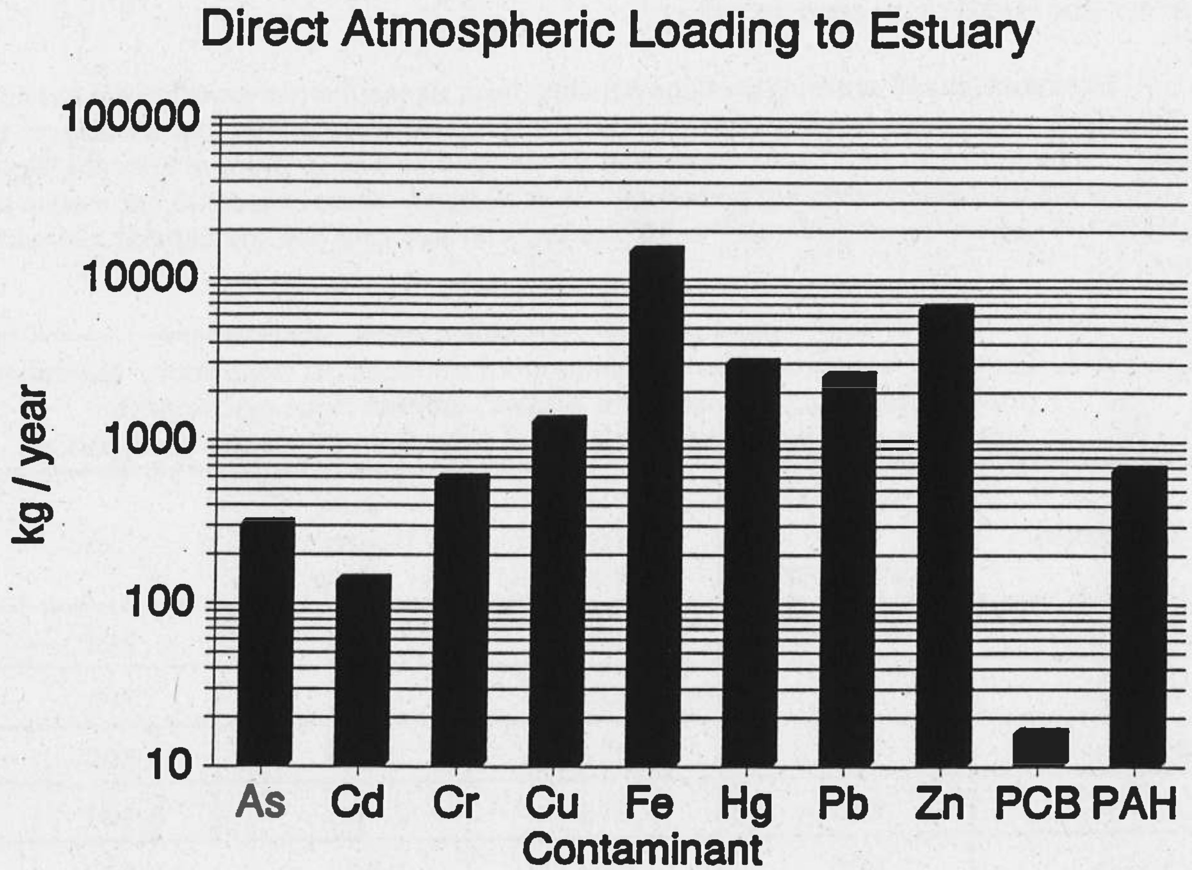

Figure 4-1. **Estimated direct inputs to estuary of contaminant loadings from atmospheric deposition.**

4.4 DISCUSSION OF ATMOSPHERIC LOADING ESTIMATES

The use of the deposition rates from the Chesapeake Bay study to estimate contaminant loading rates for the Delaware Estuary introduces an unknown error. To evaluate this potential error, the Chesapeake and Delaware watersheds were compared to identify differences that may influence the atmospheric deposition rates of toxics. Population density is different in the two watersheds. NOAA (1987) contains population density estimates for the estuarine drainage areas (EDA) of each watershed. The population density of the Delaware EDA is 1,082 individuals/mi^2, compared to a density of 404 individuals/mi^2 for the Chesapeake EDA. This difference may cause the use of the CBADS deposition rates to underestimate atmospheric inputs of contaminants to the Delaware Estuary since atmospheric inputs from mobile sources are likely to be strongly related to population density. Where industrial activities are similar, atmospheric inputs from stationary sources are also likely to be related to population.

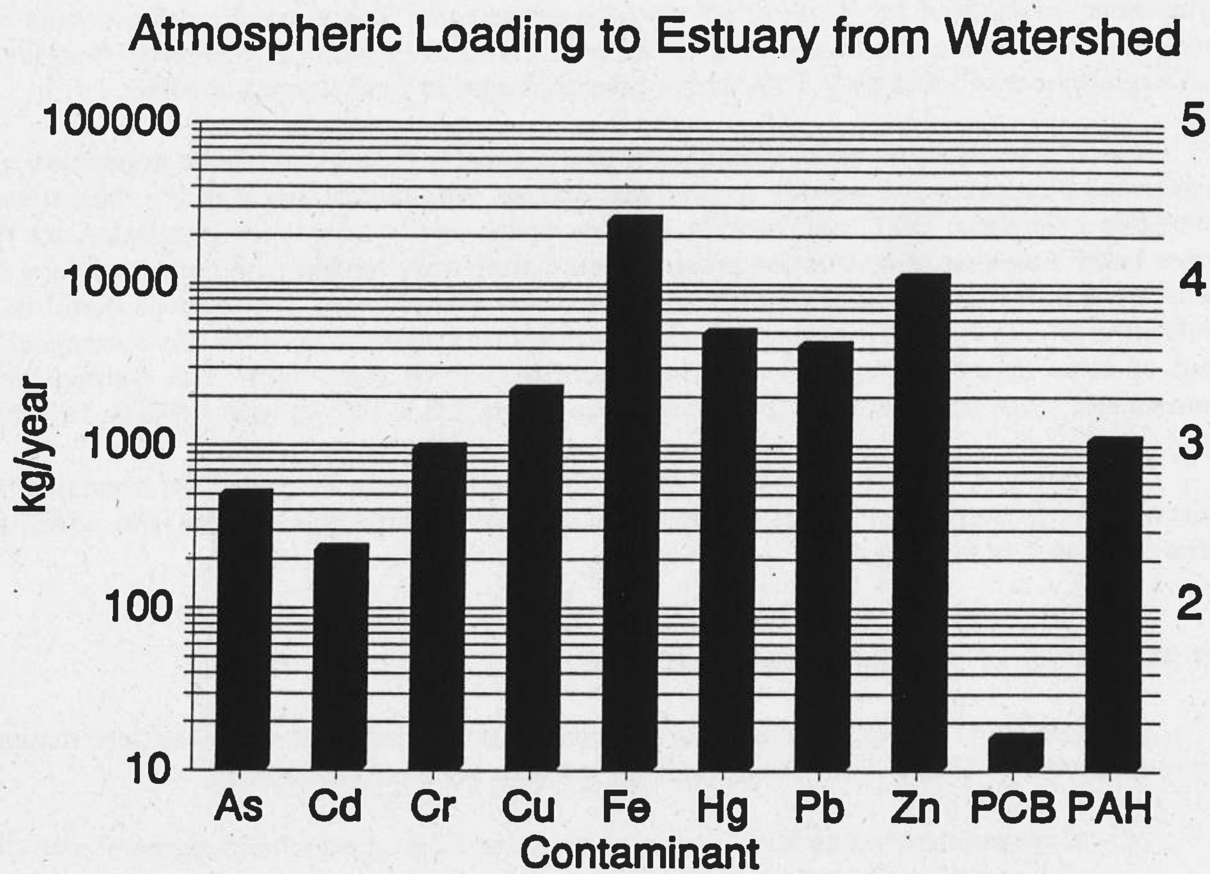

Figure 4-2. **Atmospheric loading of contaminants to estuary from the entire Delaware Estuary watershed.**

The long-range transport of contaminants from western sources is another factor potentially influencing deposition rates in the Delaware and Chesapeake watersheds. These far-field sources may have greater influence on the Chesapeake Bay watershed than on the Delaware watershed due to the topography separating the two watersheds in the Appalachian and Highland geographic provinces. If this is true, using deposition rates from the Chesapeake Bay may overestimate atmospheric deposition to the Delaware Estuary.

The atmospheric deposition estimates provided here indicate that except for mercury, contaminant inputs from point sources are significantly greater than contaminant inputs from atmospheric sources. Although the method used to estimate atmospheric loadings is simplistic, using a loading model of greater complexity or having deposition data from the Delaware Estuary watershed would not likely result in different loading rates that would change this overall conclusion.

Potential sources of the mercury entering the estuary through atmospheric deposition are many. Versar, Inc. (1994) inventoried air emissions in Maryland for the Power Plant Research Program of the Maryland Department of Natural Resources. Municipal waste incineration accounted for 54% of all mercury emissions. The second largest source of emissions was latex paint, accounting for 25% of the total emission of mercury. Coal-fired power plants contributed only 13% of the total emission of mercury in Maryland.

No information that estimates loading to the estuary from atmospheric deposition for chlorinated pesticides and volatile organic compounds was found. Input of the chlorinated pesticides chlordane, DDT, and dieldrin is likely to be small since these pesticides are no longer used; however, construction projects that disturb soils having high concentrations of these chemicals may cause significant releases to the atmosphere. It should be noted that while atmospheric input of previously used agrochemicals is likely to be small, the atmospheric input of other agrochemicals still in widespread use may be significant. For example, the atmospheric input of alachlor to the Chesapeake Bay is 2.5×10^3 kg/year (USEPA 1994b).

The input of volatile organic compounds to the Delaware Estuary from atmospheric sources is likely to be significant; however, no deposition rates were found with which to make estimates of loading rates.

4.5 SUMMARY OF ATMOSPHERIC LOADINGS

A summary of loading estimates for contaminants originating from atmospheric deposition is presented in Table 4-3. Major findings are also summarized below.

- Contaminant inputs to the estuary resulting from atmospheric deposition to the watershed are approximately twice inputs resulting from direct deposition to the estuary.
- The loading estimate for the metals of concern is approximately 10^2 to 10^4 kg/year.
- Loading estimate for PAHs is equivalent to those for metals.
- The loading estimates for PCBs from atmospheric deposition is approximately 10^1 kg/year.

Table 4-3. Summary of contaminant loadings from atmospheric sources to the Delaware Estuary (10^3 kg/year). Includes direct deposition to estuary and indirect inputs resulting from deposition in the watershed.

Contaminant	Comments	Loading Estimate
Metals		
Arsenic	Estimate using CBAD deposition rates	0.8
Chromium	Estimate using CBAD deposition rates	1.5
Copper	Estimate using CBAD deposition rates	3.5
Lead	Estimate using CBAD deposition rates	6.6
Mercury	Estimate from average deposition rates	7.9
Silver	Insufficient data to complete estimate	N.E.
Zinc	Estimate using CBAD deposition rates	17
Polycyclic Aromatic Hydrocarbons (PAH)		
PAH	Estimate using CBAD deposition rates	1.7
Chlorinated Pesticides		
Chlordane	Insufficient data to complete estimate	N.E.
DDT (Total)	Insufficient data to complete estimate	N.E.
Dieldrin	Insufficient data to complete estimate	N.E.
PCBs		
PCB (Total)	Estimate using CBAD deposition rates	0.03
Volatile Organics		
1,2 Dichloroethane	Insufficient data to complete estimate	N.E.
Tetrachloroethane	Insufficient data to complete estimate	N.E.

N.E. = No estimate

5.0 CONTAMINANT LOADINGS FROM URBAN RUNOFF

5.1 INTRODUCTION TO URBAN RUNOFF

Nonpoint source pollution from terrestrial runoff is influenced heavily by land use and population density. Runoff rates are usually much higher in urban areas due to impervious surfaces such as pavement and roofs (USEPA 1985). Sources of potentially toxic substances in urban runoff include products from incomplete combustion of fossil fuels, metal alloy corrosion, automobiles, pesticide use, manufacturing, and atmospheric deposition (USEPA 1994). The runoff quality and quantity are a function of several parameters, including land use activity, percent imperviousness, rainfall, automobile traffic density, and atmospheric sources (USEPA 1994).

Urban runoff may be collected in separate sewers or combined sewers. The latter collect both runoff and sanitary waste-water (USEPA 1985). During a large runoff event, storm flow may exceed sanitary flows by one or more orders of magnitude. Combined sewer overflows are discharged directly to receiving waters to avoid flooding; these overflows discharge high levels of pollutants since they contain the combination of runoff, raw sanitary sewage, and scoured waste-water solids previously deposited in sewers (USEPA 1985). This section includes loading estimates from urban areas without including the effects of combined sewer overflows.

Estimates for contaminant loadings to the Delaware Estuary resulting from urban runoff were derived from data collected by the USEPA's National Urban Runoff Program (NURP) (USEPA 1983). This program was designed to assess urban runoff water quality problems on a national scale. The following study parameters were included in the NURP study: particulates, oxygen-consuming constituents, nutrients, and the heavy metals copper, lead, and zinc. Only the data for the heavy metals are relevant to this study.

Twenty-eight sites representing urban areas throughout the country were sampled as part of NURP; none of these sites were located in the Delaware River watershed. The closest sites were Baltimore, MD, and Washington, DC, to the south, Long Island and Rochester, NY, to the north, and Detroit, MI, to the west.

5.2 METHODS FOR ESTIMATING LOADINGS FROM URBAN RUNOFF

Using the pollutant data collected for the NURP, Tasker and Driver (1988) developed the USGS Regression Models that may be used to estimate mean annual loadings in urban areas. These regression models accounted for 20 to 65 percent of the total variation in observed loads measured at the 28 NURP sites. Since no site-specific data were available for the Delaware River area, these regression models were used to estimate metal loadings to the estuary. The following site-specific variables were needed to apply the models: drainage area, land uses, imperviousness of the drainage basin to infiltration, mean annual rainfall, and mean minimum January temperature. Tasker and Driver (1988) developed associated methods to calculate 90% confidence values for the loading estimates completed for the Delaware Estuary.

The input data required for the regression models were assembled for each county in the Delaware watershed. Land use data for the 13 counties bordering the estuary were derived from NOAA (1987) resulting in seven urban land use categories (Table 5-1). The total urban drainage area (DA) is the sum of the urban land use types within each county. The impervious fraction of each land use type was estimated by comparing the land use description provided by NOAA with the average percent impervious values described for different land uses from USEPA (1985). The average impervious fraction (IA) for the urban area in each county was estimated by weighting the fractions for each land use type by the drainage area of that type.

Table 5-1. Urban land use in the 13 counties bordering the Delaware Estuary.

Urban Land Use Category	Impervious Fraction	Land Area (km^2)
Urban and built-up residential	0.52	1455
Commercial services	0.85	310
Industrial	0.72	113
Transportation and Communication	1	134
Industrial and commercial complex	0.65	25
Mixed urban and built-up	0.65	20
Other urban built-up	0.1	115
Total urban land use		2173

Mean annual rainfall (MAR) and mean minimum January temperature (MJT) were calculated for three stations in or near the Delaware Estuary (Dover, DE, Philadelphia, PA, and Hightstown, NJ) from meteorological data available for 1950 through 1990. The meteorological data from Dover, DE, were applied for Kent, Cumberland, Sussex, and Cape May counties. The values from Philadelphia were applied to New Castle, Burlington, Camden, Gloucester, Salem, Bucks, Delaware, and Philadelphia counties. Data from the Hightstown, NJ, weather station were used in calculations completed for Mercer county.

The USGS Regression Models developed by Tasker and Driver (1988) used the generalized-least-squares (GLS) method to estimate parameters of the regression model rather than the ordinary-least-squares (OLS) method since the variance of the response variables was not equal and the response variables are not independent. The authors also applied a bias

correction factor (BCF) to the equation to make the prediction equations approximately unbiased since a linear model was fitted to the logarithms of the loads. The equation for the general model to estimate contaminant loadings from urban runoff is presented below. The equation is in the general form:

$$W = 10^{[a + b*SQRT(DA) + c*IA + d*MAR + e*MJT + f*X2]} BCF$$

where
W = mean load associated with a runoff event (lbs/event)
DA = drainage area (mi^2)
IA = imperviousness (fraction)
MAR = mean annual rainfall (inches)
MJT = mean minimum January temperature (°F)
BCF = bias correction factor
X2 = land use indicator

Equation parameters a through f are regression coefficients that are specific to the contaminant of interest. Coefficient values for specific contaminants are given in Table 5-2. The variable X2 is a land use indicator that is 1 if commercial land use exceeds 75 percent of the total contributing drainage area and zero otherwise. This indicator was not significant for the metals estimated using this model.

Table 5-2. Values for coefficients in the USGS Regression Models used to estimate loadings from urban runoff.

	Copper	Lead	Zinc
a	-1.4824	-1.9679	-1.6302
b	1.8281	1.9037	2.0392
c	0	0.0070	0.0070
d	0	0.0128	0
e	-0.0141	0	0
f	0	0	0
BCF	1.403	1.365	1.322

The regression was originally scaled for areas between 0.01 and 0.85 square miles (0.03 to 2.2 km^2); therefore, it was necessary to complete the regression calculations for areas within that range. The average of the areas used to develop the original regression models was 0.17 square miles (0.44 km^2); a scale factor of 380 was applied to the urban areas of each county before using the above equation. The result was then scaled up to obtain a result for the actual area in each county. The mean loading per event was then converted to an average annual load by multiplying by the average number of storms per year. Tasker and Driver (1988) reported 42 storms per year for Washington, DC, and 39 for Baltimore, MD. The Washington, DC, value of 42 was used for the calculations urban loadings for the Delaware Estuary.

The average imperviousness fraction for the urban land use numbers was an estimated number and may not accurately reflect the actual imperviousness of the urban area in the Delaware Estuary watershed. A sensitivity analysis was completed by changing the value of IA by 30% higher or lower and rerunning the regression models. This analysis revealed that loading results are relatively insensitive to IA, since changing its value by 30% higher or lower resulted in less than a 0.5% difference in total loading estimates to the estuary for those constituents for which IA was a significant predictor (Pb and Zn).

Tasker and Driver (1988) also presented a method for calculating the 90% confidence intervals for the loading estimates based on their regression analyses. The confidence interval ranges are likely to be larger than reported here for two main reasons. First, the original regression analyses were based on monitoring conducted at small sites within urban areas (less than 1 square mile) for which land uses were probably much better known than for the county-wide estimates presented here. Second, the data are based on measurements made in the late 1970's and early 1980's. Factors that may affect metals released to the urban environment and available for runoff may have changed since that time (for instance, lead may have decreased due to the phase-out of leaded gasoline since that time).

To estimate loadings for other pollutants of concern to the Delaware Estuary Program, The Simple Method (Schueler, 1987 as cited in USEPA 1992) was used. This method was developed to provide estimates of pollutant loadings with limited available data. This method has been used to estimate pollutant loadings from urban runoff to the Chesapeake Bay (USEPA 1994). The following is the basic equation for the Simple Method:

$$Li = P * Pj * Rv * C * A * 0.1030$$

where Li = contaminant loading (kg/year)
P = average annual rainfall (inches)
Pj = unitless correction factor to account for storms that produce no runoff
Rv = runoff coefficient (dimensionless)
(Rv = 0.05 + 0.009 * PI; PI = percent imperviousness)
C = flow-weighted mean pollutant concentration (mg/liter)
A = area of development (acres)

For the Delaware Estuary, average annual rainfall (P) is about 40 to 42 inches (102 to 107 cm). Pj is 0.9 for the Washington, DC, area. This value was used for the Chesapeake Bay watershed toxics study (USEPA 1994) and was used in the present study. PI for the urban portions of the Delaware Estuary is approximately 58% and the area of development is 537,600 acres (2176 km^2).

The NURP study (USEPA 1983) provided the only available stormwater data in which priority pollutants were sampled at 20 of the 28 sites in the program. A total of 121 urban runoff samples were analyzed. Metals were the most prevalent priority pollutants detected in these urban runoff samples. Copper, lead, and zinc were found in at least 91% of the samples. Organic contaminants were detected less frequently and at lower concentrations than inorganic contaminants. Sixty-three of 106 organic were detected. The most commonly found organic contaminant was the plasticizer bis (2-ethlyhexyl) phthalate (detected in 22% of all samples), followed by the pesticide alpha-hexachlorocyclohexane (alpha-BHC), found in 20% of all samples. PCBs were found only in one sample at one site. Of the 123 priority pollutants, 43 were not detected in any of the 121 urban runoff samples. Contaminant concentrations from the NURP study are presented along with loading estimates using these concentrations in Table 5-3. Where a range of concentrations was provided, the geometric mean of the minimum and maximum values was used.

Using an alternative to the Simple Method above, loadings to the Delaware Estuary were computed as follows:

$$LA = CC * ARV * 3600(10*SD) * NOS * ULA$$

where

LA	=	contaminant loading estimate (kg/year)
CC	=	contaminant concentration (μg/liter)
ARV	=	average runoff volume per storm (liters/sec/km^2)
SD	=	average storm duration (hours)
NOS	=	average number of storms per year
ULA	=	area of urban land use (km^2)

The average runoff volume per storm for the Northeast region of the country was between 5 and 7 cfs per square mile (54.6 to 71.5 liters/sec/km^2); the average number of storms per year for Washington, DC, is 42; and the average storm duration is 6 hours (USEPA 1983). An average runoff volume per storm event of 6 cfs per square mile (65.6 liters/sec/km^2) was assumed, as was an average runoff duration of ten times the storm duration. Loading estimates calculated using this alternate method are presented in Table 5-3.

5.3 URBAN RUNOFF LOADING ESTIMATES

The mean annual loading estimates for contaminant inputs to the Delaware Estuary from the urban runoff regression models are presented in Table 5-4. The upper and lower 90% confidence intervals generated using the approach developed by Tasker and Driver (1988) are also presented. Estimates for copper and zinc are approximately one order of magnitude less than the loading estimates developed for point source contaminant inputs. The urban runoff loading estimate for lead is equivalent to the estimate for lead from point sources given the large confidence interval.

Table 5-3. Summary of Delaware Basin urban runoff pollutant loadings based on Simple Method and urban runoff concentrations from NURP priority pollutant samples for eastern seaboard states (USEPA 1983).

Pollutant	Range of Detected Concentrations (μg/liter)	Geometric Mean Concentration (μg/liter)	Mean Loadings based on Detected Concentrations (kg/year)	
			Simple Method	Alternate Simple Method
I. PESTICIDES				
Aldrin	0.002 - 0.1	0.014	17	18
Alpha-Hexachlorocyclohexane	0.0027 - 0.1	0.016	20	21
Beta-Hexachlorocyclohexane	0.018 - 0.1	0.042	51	55
Gamma-Hexachlorocyclohexane	0.007 - 0.1	0.026	32	34
Delta-Hexachlorocyclohexane	0.004 - 0.1	0.020	24	26
Chlordane	0.01 - 10	0.316	379	408
DDT	0.1	0.100	120	129
Alpha-Endosulfan	0.008 - 0.2	0.040	48	52
Heptachlor	0.01 - 0.1	0.032	38	41
Heptachlor Epoxide	0.003 - 0.1	0.017	21	22
Isophorone	10	10.000	12000	12900

Table 5-3. Continued.

Pollutant	Range of Detected Concentrations (µg/liter)	Geometric Mean Concentration (µg/liter)	Mean Loadings based on Detected Concentrations (kg/year)	
			Simple Method	Alternate Simple Method
II. METALS AND INORGANICS				
Antimony	2.6 - 23	7.733	9280	9976
Arsenic	1 - 50.5	7.106	8528	9167
Beryllium	1 - 49	7.000	8400	9030
Cadmium	0.1 - 14	1.183	1420	1526
Chromium	1 - 190	13.784	16541	17781
Copper	1 - 100	10.000	12000	12900
Cyanides	2 - 300	24.495	29394	31598
Lead	6 - 460	52.536	63043	67771
Mercury	0.6 - 1.2	0.849	1018	1095
Nickel	1 - 182	13.491	16189	17403
Selenium	2 - 77	12.410	14892	16008
Silver	0.2 - 0.8	0.400	480	516
Thallium	1 - 14	3.742	4490	4827
Zinc	10 - 2400	154.919	185903	199846
III. PCBs				
PCB-1260	0.030	0.03	36	39

Table 5-3. Continued.

Pollutant	Range of Detected Concentrations (µg/liter)	Geometric Mean Concentration (µg/liter)	Mean Loadings based on Detected Concentrations (kg/year)	
			Simple Method	Alternate Simple Method
IV. HALOGENATED ALIPHATICS				
Methane, dichloro-	5 - 14.5	8.515	10218	10984
Methane, trichloro-	0.2 - 12	1.549	1859	1998
Methane, tetrachloro-	1 - 2	1.414	1697	1824
Methane, trichlorofluoro-	0.6 - 27	4.025	4830	5192
Ethane-1,1 dichloro-	1.5 - 3	2.121	2546	2737
Ethane, 1,1,1-trichloro-	1.6 - 10	4.000	4800	5160
Ethane, 1,1,2,2-tetrachloro-	2 - 3	2.449	2939	3160
Ethene, trichloro-	0.3 - 12	1.897	2277	2448
Ethene, tetrachloro-	1 - 43	6.557	7869	8459
V. MONOCYCLIC AROMATICS				
Benzene	1 - 13	3.606	4327	4651
Benzene, chloro-	1 - 10	3.162	3795	4079
Benzene, ethyl-	1 - 2	1.414	1697	1824
Toluene	3 - 9	5.196	6235	6703

Table 5-3. Continued.

Pollutant	Range of Detected Concentrations (μg/liter)	Geometric Mean Concentration (μg/liter)	Mean Loadings based on Detected Concentrations (kg/year)	
			Simple Method	Alternate Simple Method
VI. PHENOLS AND CRESOLS				
Phenol	1 - 13	3.606	4327	4651
Phenol, pentachloro-	1 - 115	10.724	12869	13834
Phenol, 2-nitro-	1	1.000	1200	1290
Phenol, 4-nitro-	1 - 37	6.083	7299	7847
Phenol, 2,4-dimethyl-	1 - 10	3.162	3795	4079
m-Cresol, p-chloro-	1.5	1.500	1800	1935
VII. PHTHALATE ESTERS				
Phthalate, dimethyl	1	1.000	1200	1290
Phthalate, diethyl	1 - 10	3.162	3795	4079
Phthalate, di-n-butyl	0.5 - 11	2.345	2814	3025
Phthalate, di-n-octyl	0.4 - 2	0.894	1073	1154
Phthalate, bis(2-ethylhexyl)	4 - 62	15.748	18898	20315
Phthalate, butyl benzyl	1 - 10	3.162	3795	4079

Table 5-3. Continued.

Pollutant	Range of Detected Concentrations (μg/liter)	Geometric Mean Concentration (μg/liter)	Mean Loadings based on Detected Concentrations (kg/year)	
			Simple Method	Alternate Simple Method
VIII. POLYCYCLIC AROMATIC HYDROCARBONS				
Anthracene	1 - 10	3.162	3795	4079
Benzo (a) anthracene	1 - 10	3.162	3795	4079
Benzo (k) fluoranthene	4 - 14	7.483	8980	9653
Benzo (a) pyrene	1 - 10	3.162	3795	4079
Chrysene	0.67 - 10	2.588	3106	3339
Fluoranthene	0.3 - 21	2.510	3012	3238
Naphthalene	0.8 - 2.3	1.356	1628	1750
Phenanthrene	0.3 -10	1.732	2078	2234
Pyrene	0.3 - 16	2.191	2629	2826

Table 5-4. Total loadings (kg/yr) of three metals to the Delaware Estuary from urban areas of counties adjacent to the estuary. Estimated using USGS regression models.

		90% Confidence Interval	
Metal	Loading	Lower	Upper
Copper	23963	3688	79130
Lead	30954	5354	96003
Zinc	22009	4396	63057

The loading estimates for copper and lead generated using the NURP concentration data were within the confidence limits of the estimates using the USGS Regression Models (Table 5-3). The loading estimates for zinc using the NURP concentration data were approximately seven times higher than the estimate based on the regression models.

The loading estimates for other metals, pesticides, and other organic contaminants are presented in Table 5-3. Metal loadings were generally an order of magnitude greater than any other contaminant except for pentachlorophenol (PCP), and bis (2-ethylhexyl) phthalate. PAH input from urban areas was of the same order of magnitude as the loading from metals (10^4 kg/yr).

5.4 URBAN RUNOFF LOADING SUMMARY

A summary of estimates of contaminant loadings from urban runoff is presented in Table 5-5. Major findings are summarized below.

- The NURP regression model and simple method gave similar estimates for loadings of copper and lead from urban runoff. Estimates are approximately 3 x 10^4 kg/year.
- Urban runoff loading estimates for the metals of concern to DELEP are generally 10^3 to 10^4 kg/year except of zinc for which the estimate was 10^5 kg/year.
- The loading estimate for PAHs is approximately 10^4 kg/year.
- Loading estimates for chlorinated pesticides are approximately 10^2 kg/year.
- The input of PCBs from urban runoff is considered insignificant.
- The input of volatile organics from urban runoff is estimated to be 10^3 kg/year.

Table 5-5. Summary of contaminant loadings from urban runoff (10^3 kg/yr).

Contaminant	Comments	Loading Estimate
Metals		
Arsenic	Estimated using Simple Method and NURP concentration data.	10
Chromium	Estimated using Simple Method and NURP concentration data.	18
Copper	Estimated using USGS regression method	24
Lead	Estimated using USGS regression method	31
Mercury	Estimated using Simple Method and NURP concentration data.	1
Silver	Insufficent data available to complete estimate	N.E.
Zinc	Estimated using simple method and NURP concentration data	186
Polycyclic Aromatic Hydrocarbons (PAHs)		
PAH	Estimated using simple method and NURP concentration data	33
Chlorinated Pesticides		
Chlordane	Estimated using Simple Method and NURP concentration data.	0.1
DDT (Total)	Estimated using Simple Method and NURP concentration data.	0.1
Dieldrin	Insufficent data available to complete estimate	N.E.
PCBs		
PCB (Total)	Estimated using Simple Method and NURP concentration data.	0
Volatile Organics		
1,2 Dichloroethane	Estimated using Simple Method and NURP concentration data.	5
Tetrachloroethane	Estimated using Simple Method and NURP concentration data.	3

N.E. = No estimate

6.0 CONTAMINANT LOADINGS FROM AGRICULTURAL RUNOFF

6.1 INTRODUCTION AND DEFINITIONS

Agriculture accounts for 31% of the land use in the Delaware River watershed (Evans et al. 1993) and 39% of the land use in the 13 counties immediately adjacent to the estuary. Estimates of nonpoint contaminant inputs from agricultural lands focused on chlorinated pesticide loadings. Even though some of these chemicals are no longer used in agricultural practices (DDT and chlordane, for example), loadings continue due to years of use and slow degradation rates. For example, during the 1960's, fruit and vegetable farms were treated with 3 lb (1.4 kg) or more per acre per year of DDT and related insecticides. Rates 2 to 20 times this are mentioned in literature describing practices in the late 1940's and 1950's. DDT decays slowly in the soil (estimates are a 15-year half-life, or a decay fraction of only 0.05 per year). Hence, over a 20- to 30-year application period, significant amounts of these chemicals can accumulate and persist in the soil and appreciable amounts of contaminants can be released into the estuary and the tributaries that feed the estuary decades later.

The region surrounding the Delaware Estuary, especially the lower estuary, contains significant land used for agriculture devoted to fruits and vegetables. These areas were focused upon as potential nonpoint sources of contaminant loadings to the estuary. Loadings originating from lands planted with other crops would be expected to have impacts an order of magnitude or more smaller due to lower application rates or smaller acreage.

Several mechanisms can transport contaminants from areas of historical treatment to the estuary sediments. Water and wind erosion of soil particles to which the pesticides have bound is probably the predominant mechanism. Soil erosion rates of 10 tons per acre per year have been measured in areas of the Delaware watershed and, although high, are not regarded as unusual (USDA 1992; R. Baldwin, pers. comm.). The base erosion rates will be exacerbated by disturbance, for example, plowing. Fruit orchards are likely to be fairly stable unless disturbed. Construction in old vegetable farms or orchards that were heavily treated with chlorinated pesticides is a particularly suspect category for increasing loadings since higher erosion rates are often experienced during construction. While most sediment runoff from construction sites is controlled today, wind transport of contaminated dust to the estuary and runoff from sites directly into streams, are still active loading mechanisms. Construction sites, for example, may experience erosion rates of 40-100 tons/acre (R. Baldwin, pers. comm.).

6.2 METHODS FOR CONTAMINANT INPUTS FROM AGRICULTURAL RUNOFF

Estimating the loadings of contaminants from agricultural sources is necessarily inferential. The source areas are large and diffuse, and direct measurements would be prohibitive. In addition, historical applications of persistent agrochemicals are not well documented.

Some information on application rates was obtained by national statistical surveys of pesticide usage in 1964 and 1971 (USDA 1968; USDA 1974). This information, coupled with a crude fate model, can give order-of-magnitude estimates of current loadings due to the reservoir of these chemicals in the soil. A second approach is to estimate loadings more directly based on soil residue measurements and soil erosion rates. There are limited data to support this approach; consequently, the latter approach was used as a partial validation of the first.

The fates of contaminants diffusely applied over large land areas can be complex. There can be drift over wide areas during aerial application, uptake by plants and animals, adsorption to soil particles, vaporization and redeposition, leaching to groundwater, and transport to remote areas and aquatic environments by erosion. A simplified compartment model (Figure 6-1) was used to obtain an order-of-magnitude estimate of the agricultural reservoir of pesticide residues and their release rates. This simplified model is optimized for materials, such as persistent chlorinated hydrocarbon pesticides that reach the soil fairly quickly, are adsorbed to soil particles, do not go into solution readily, and are transported to other environments with soil. Other fate and transport mechanisms are assumed to be small.

This model is applied by determining application, degradation, and release rates for the contaminant of concern. Estimates of the historical application rates are made in Sections 6.2.1 through 6.2.3 below. The loading model section (6.2.4) describes several different realistic assumptions made for these parameters and demonstrates how the model is used. The size of the agricultural soil reservoir and the rate of release for the Delaware Estuary are estimated by running the model iteratively for the period of interest. These estimates are presented in Section 6.3.

In the second method, measured concentrations of soil contaminants were used. The concentrations were multiplied by a soil erosion rate and the amount of cropland to determine the contaminant release to the environment.

6.2.1 Estimation of Chemical Application Rates

The first step in estimating nonpoint loadings from agricultural lands is to ascertain how much may have been applied. In agricultural areas, chlorinated pesticides such as DDT were typically applied by spraying, often over broad areas from the air. This application method creates the potential for significant deposition on soil, to which the pesticide components could bind to form a long-term reservoir. Some pesticides were applied directly to or mixed into the soil.

Early use of pesticides is not well documented. A brief historical background is given in *INSECTS - The Yearbook of Agriculture*, (Bowen and Hall 1952). Some chlorinated insecticides such as p-dichlorobenzene have been used since the early part of this century. DDT, one of the contaminants of concern in the Delaware River Estuary, was first described in 1874. DDT's insecticidal value was discovered about 1939, and it was introduced into the U.S. in 1942. U.S. production of DDT for use by the armed forces began in 1943, and DDT became available as a civilian insecticide at the end of the war. Production and use increased rapidly: 37 million pounds of DDT were manufactured in 1953 and 124 million pounds in 1959. By 1964, U.S. farmers were using 100 million pounds of chlorinated hydrocarbons as insecticides alone, including 33 million pounds of DDT. After it was documented that DDT and related compounds caused eggshell thinning in avian fauna, thus threatening their reproduction and survival, use of DDT in the United States was banned in 1972.

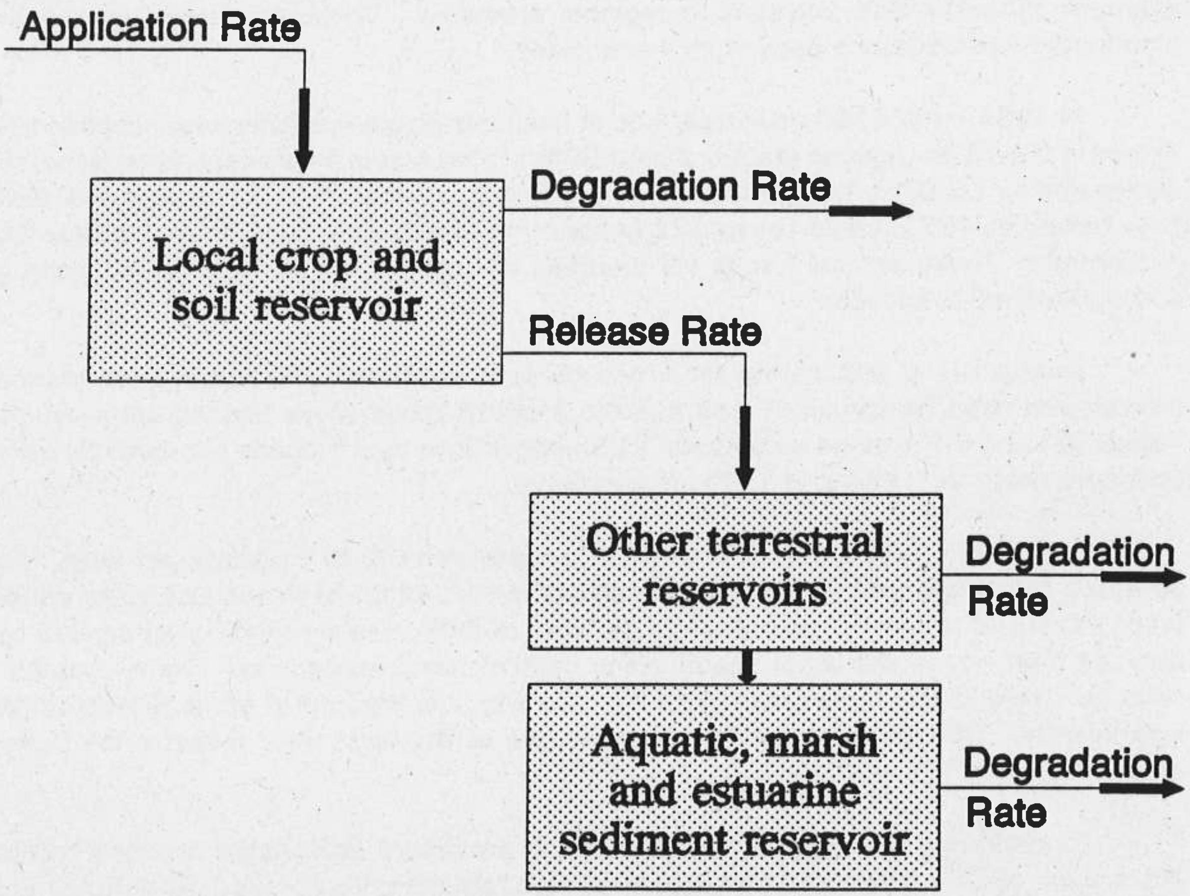

Figure 6-1. Simple model of pesticides in the environment.

Manufacture and use of DDT during the 30 years from 1942 to 1972 is the only known source of this material and its derivatives in the environment. Early work on residues in soils (Boswell 1952) mentions application rates as high as 3000 pounds per acre (1 pound/acre is equivalent to 112 kg/km^2). It is not clear whether this was purely for testing purposes; however, the comment is made that "normal use" for peach orchards was about 25 pounds/acre (p.288), with as much as 50 to 60 pounds/acre/year or more being used in other orchards (p. 294). Field crops were considered to receive "relatively small amounts" of 1 to 5 pounds per acre of DDT per year. Field crops with particular insect problems, such as corn, peas, beets, and cotton, may have received amounts up to 10 pounds per acre

(p. 293). An amount of 2 to 5 pounds per acre per crop was recommended for truck crops, noting that some parts of the country where two or three such crops are grown annually could incur loadings of 6 to 15 pounds per acre per year, or more from generous farmers.

Quantitative estimates for the pesticide application rates typical of the late 1950's were not located, but national statistical surveys were conducted in 1964 and 1971 (USDA 1968; USDA 1974). These surveys allow crude estimates of application rates using national averages proportionally adjusted to regional practices. These estimates were limited to chlorinated hydrocarbons applied as insecticides.

In 1964, nearly 100 million pounds of chlorinated hydrocarbons were applied as insecticides in the 48 contiguous states. About 90% of that amount was applied to crops, roughly distributed as 1/3 DDT, 1/3 Toxaphene, and 1/3 other substances. DDT usage had been more than halved by 1971, while Toxaphene usage remained roughly constant and others declined moderately. These general trends are modified by region-specific mixtures of crops, pests, and agricultural practices.

Average U.S. application rates can be estimated from the surveys on quantities of insecticides used on specific crops and the acres of those crops treated with insecticides. Tables 6-1 and 6-2 provide an average (U.S.) application rate (pounds per acre) for each crop and insecticide for 1964 and 1971, respectively.

In the mid-1960's the average rates ranged from 0.5 to 5 pounds per acre. It should be noted that fruits and vegetables, which are important crops in the Delaware watershed, were treated at rates of 2 to 5 pounds per acre of DDT, and that DDT was applied to more acreage than any of the other chemicals in each of these categories. The application rates were generally in the same range in 1971, however, the amount of acreage treated dropped significantly. DDT in particular had become one of the least used insecticides in terms of acres treated.

In summary, the early agricultural use of persistent chlorinated hydrocarbon insecticides, such as DDT, appears to have been at high rates that could lead to significant accumulations in a short time. Later usage is likely to have been at similar rates for vegetables while fruit orchard application rates appear to have dropped by an order of magnitude (though still remaining at the high end of the range). Shorter-lived and hopefully more benign chemicals replaced DDT in the late 1960's and early 1970's. These trends and application rates are used below to estimate the (nonpoint) residual reservoir of persistent chlorinated hydrocarbons in the Delaware Watershed.

6.2.2 Regional Characteristics of Application Rates

The regional data are not sufficient to calculate more specific application rates or acreages, but they are useful to guide the use of the national average rates listed above. The published surveys provide statistics on pesticide usage in the Northeast (which includes the

Table 6-1. Historical chlorinated pesticide application rates, U.S. averages for 1964 (lb/acre/yr). One pound/acre is equivalent to 112 kg/km^2.

	Corn	Cotton	Soybeans	Tobacco	Other Field	Irish Potatoes	Other Vegetables	Citrus	Apples	Other Fruits	Total
DDT	0.59	3.42	0.79	2.12	1.47	1.34	3.00		5.42	2.20	2.84
TDE		3.13		3.55			2.83		2.43	3.42	3.31
BHC and Lindane	0.02	0.85		0.89	0.07		3.02		1.23	0.15	0.54
Aldrin	0.90	1.06	0.74	1.59	0.77		0.66			0.40	0.90
Dieldrin	0.51		0.53	0.51	0.27	0.47	0.82	0.92	0.85	0.73	0.45
Endrin		1.56	0.19	1.01	0.24	0.43	2.00		1.00		1.32
Heptachlor	0.77			1.41	0.61						0.75
Toxaphene	1.31	5.37	1.85	2.98	2.41		4.01				4.26
Other	0.44	6.21	0.10	1.16	1.18	0.61	1.77	1.09	2.70	2.01	2.72
Total	0.86	3.91	1.25	2.31	1.37	0.86	2.80	1.04	3.26	1.32	2.18

Table 6-2. Historical chlorinated pesticide application rates, U.S. averages for 1971 (lb/acre/yr). One pound/acre is equivalent to 112 kg/km^2.

	Corn	Cotton	Wheat	Other Grain	Soybeans	Tobacco	Peanuts	Other Field	Alfalfa	Other Hay	Irish Potatoes	Other Vegetables	Citrus	Apples	Other Fruit	Total
Lindane	2.00			0	0.11	0		0.09			0.17	1.20			1.46	1.20
Strobane		12.00														12.00
TDE					0	4.76		0.17				3.85		1.00	3.00	3.81
DDT	1.00	5.52	0.56	0.35	0.80	1.17	2.82	0.96		1.00	2.03	4.85	2.50		2.00	4.51
Methoxychlor	1.64		0.50				5.67	3.51	1.04	0.83	7.00	1.67		1.17	0.86	1.29
Endrin	0.40	4.08	0.28	0.25	0.40		0	3.14			1.67	1.00		0.22	0.70	2.19
Heptachlor	0.58								0.21	0.50		3.40				0.59
Dieldrin		0.37				0.14		2.36	0			0.52	0.88	1.25	0.46	0.67
Aldrin	1.03			1.18	1.22			0.79	1.00				3.18		3.00	1.03
Chlordane	1.58			0.53		2.00		1.81		0.67	0.60	2.29	1.80	37.30	1.75	2.09
Endosulfan				1.00	0.94	1.14		0.60			0.67	2.02		1.40	0.71	1.07
Toxaphene	1.30	8.58	1.04	1.19	1.60	10.30	2.87	1.39	1.13	1.39	3.02	3.59	4.50		8.29	5.87
Other	0.78					5.00				0.14		1.43	1.00	0.22	5.07	2.01
Total	0.98	6.97	0.63	0.77	1.37	2.81	2.95	1.71	1.02	0.69	1.08	2.53	1.93	3.88	1.36	2.81

states encompassing the Delaware Watershed) for 1964 and 1971 (USDA 1968; USDA 1974).

The majority, by weight, of the pesticides used in the northeast were applied to fruits and vegetables (90% in 1964 and 88% in 1971). Application rates for DDT and related chemicals tend to be highest for these crop categories. The average DDT application rates for all crops in the Northeast were 2.71 lb/acre (304 kg/km^2) in 1964 and 16 lb/acre (1792 kg/km^2) in 1971, consistent with use primarily on fruits and vegetables. As in the nation as a whole, the acreage treated with DDT had dropped markedly by 1971. In distinct contrast with the rest of the country, however, Toxaphene was little used in either year.

Another important inference is that chlorinated hydrocarbons formed a much smaller part of the total insecticide pool in the Northeast than in the nation. In both years, approximately 22% by weight of the insecticides used in the Northeast were chlorinated hydrocarbons, vs. approximately 60% in both years for the whole country. In particular, only about 25% of the pesticides applied to fruits and vegetables in the Northeast could have been chlorinated hydrocarbons.

The chlorinated pesticides that are the focus of this study are generally no longer used due to their long-term persistence in the environment and concerns about their effects on ecological health. New generation pesticides are much less persistent (typically less than 100 days) and have a smaller potential to impact biological resources in estuarine environments (Pait et al. 1992). Statistics were available describing the use of these new generation pesticides in the Delaware River Estuary Watershed (Table 6-3). These application rates are presented as background material for this chapter. No attempts have been made to estimate the fraction of the amounts applied that potentially enter the estuary.

6.2.3 Agricultural Practices

To estimate loadings in the Delaware watershed, the crop area to which chemicals were applied must be known. This information may be determined on a county basis using the Census of Agriculture reports compiled by USDA.

Tables 6-4 and 6-5 include the Census of Agriculture acreages for vegetables and orchards for the period 1945-1987. This summary does not include information for two potentially important crop types, Irish potatoes and berries; therefore, estimates based upon Tables 6-4 and 6-5 will be conservative. County-level data was not available prior to 1964, therefore a complete picture of local crop type trends could not be constructed.

The data for 1969 are the most complete in the period of interest. These data were used as first-order estimates of the agricultural land exposed to pesticide treatment in the area immediately adjacent to the estuary. This is most likely a conservative estimate, since the general state trends show a continuing overall reduction in the amount of land in these crops,

Table 6-3. Application rates (10^3 kg/yr) of selected pesticides in the Delaware River estuary watershed (from Pait et al. 1992)

Pesticide Name, (Pesticide Class)* Common or Trade Names	kg of Active Ingredient Applied Per Year
Acifluorfen (H) -- Blazer, Tackle	4.3
Alachlor (H) -- Alanex, Lasso	145.5
Atrazine (H) -- Aatrex	99.2
Benbsulide (H) -- Betasan, Prefan	14.5
Butylate	13.1
Cyanazine (H) -- Bladex	35.7
2,4-D (H) -- Agrotect, Chloroxone	13.7
Fluometuron (H) -- Cotoran, Meturon	0
Linuron (H) -- Lorox	36.5
Metolachlor (H) -- Codal, Dual	74.3
Molinate (H) -- Ordram	0
Propanil (H) -- Propanex, Riselect	0
Simazine (H) -- Cekusan, Princep	11.9
Thiobencarb (H) -- Benthiocarb, Bolera	0
Trifluralin (H) -- Treflan, Triflurex	6.9
Vernolate (H) -- Surpass, Vernam	1.7
Carbaryl (I) -- Carbamine, Sevin	19.6
Carbofuran (I) -- Furadan, Yaltax	35.2
Chlorpyrifos (I) -- Dursban, Lorsban	8.0
Diazinon (I) -- Diazide, Spectracide	3.5
Disulfoton (I) -- Di-Syston, Solvirex	3.8
Endosulfan (I) -- Cyclodan, Thiodan	13.1
Ethoprop (I) -- Mocap	1.1
Fenvalerate (I) -- Pydrin	2.0
Malathion (I) -- Cythion, For-mal	3.7
Methamidophos (I) -- Monitor	3.2
Methyl Parathion (I) -- Fosferno	10.7
Parathion (I) -- Phoskil	13.7
Permethrin (I) -- Ambush, Pounce	4.2
Phorate (I) -- Rampart, Thimet	4.5
Profenofos (I) -- Curacon, Polycron	0
Terbufos (I) -- Contraven, Counter	11.7
Chlorothalonil (F) -- Bravo, Daconil	31.3
Metiram (F) -- Carbatene, Polyram	6.2
PCNB (F) -- Terraclor	0

* Pesticide class codes: H = herbicide, I = insecticide, F = fungicide

Table 6-4. Estimate of agricultural lands planted with vegetables for counties bordering the Delaware Estuary, 1945-1987 (acres).

County	1945	1950	1954	1959	1964	1969	1974	1978	1982	1987
Delaware	46018	38767	40033	42135	43805	39234	33721	35561	36845	43036
Kent					10060	11436	14169	16638	16747	21360
New Castle					4954	3581	1910	1077	1212	1562
Sussex					28791	24217	17643	17845	18886	20114
Pennsylvania	154793	101361	96154	72648	62473	56205				
Bucks						3879	2877	3627		
Delaware						459	313	218		
Philadelphia						63	0			
New Jersey	176387	143590	145879	126580	115296			72990	70746	72521
Burlington					8874	7349	6532	5977	5750	4634
Camden					1994	2071	1843	2343	2083	1924
Cape May					4156	3893	3078	2099	1941	1470
Cumberland					30147	30154	24334	17906	18292	19963
Gloucester					23086	22661	15995	11020	9839	10566
Mercer					1077	734	808	872	820	793
Salem					24957	26077	21490	13635	12824	13730
Other (non,DRB)					21005			19138	19197	19441

Table 6-5. Estimate of agricultural lands planted with orchards for counties bordering the Delaware Estuary, 1945-1987 (acres).

County	1945	1950	1954	1959	1964	1969	1974	1978	1982	1987
Delaware	11108	5892	2118	1755	1730	1526	1218	1086	1289	
Kent					737	675	641	628		
New Castle					223	126	63	34	44	
Sussex					770	725	514	424		
Pennsylvania	191693	148479	114397	94461	87556			70928	68124	66537
Bucks						747	549	467	489	495
Delaware						249	205	140	124	75
Philadelphia						4	0			
New Jersey	41499	33785	28559	25860	27851			22004	22632	20924
Burlington					2840	2431	2021	2275	1489	1262
Camden					2569	2818	2016	2037	2089	2011
Cape May					48	25	12	63	162	
Cumberland					1772	1768	1552	1318	1422	1435
Gloucester					10021	10980	10042	8705	9868	8923
Mercer					381	327	93	167	197	127
Salem					264	118	58	340		
Other (non,DRB)					9956			7099		

starting as early as 1945. In addition, these estimates do not account for crop rotation which would have moderated local soil residues, but would not have changed the net loading to the watershed.

6.2.4 Loading Model

The previous sections provide enough data to develop a crude chlorinated hydrocarbon pesticide loading model. It was assumed that initial application rates were high in 1947 (50 lb/acre for orchards and 5 lb/acre for vegetables) and decreased linearly to zero in 1972. This follows the general DDT pattern and results in average rates, over time, of 25 lb/acre and 2.5 lb/acre. These average numbers are consistent with the (Northeast) regional application rates (combined for all crops) reported for the mid- to late-1960's. The higher initial rates are consistent with reports from the 1950's and, at worst, can be taken as accounting for the fact that much more acreage may have been treated then than we will account for using 1969 land use statistics. This is a conservative model in the sense that it will tend to allow more time for *in situ* decay of the accumulated residue than if applications peaked later (e.g., around 1960).

Formally, the application rate (R) (lb/acre/year) may be expressed as a function of the year as follows:

ORCHARDS: $R = -2(Y-47) + 50$
VEGETABLES: $R = -0.2(Y-47) + 5$

where Y is the last two digits of the year of interest. As an example, the application rate for orchards in 1964 was :[-2 (64-47) + 50] = 16 lb/acre. Since the acreage of orchards (1969 total) in the 13 counties bordering the Delaware Estuary was 20,993 acres, the total amount of chlorinated hydrocarbons applied is estimated to have been 336,000 lb (152×10^3 kg). The corresponding application rate for vegetables was 1.6 lb/acre. Agricultural lands planted with vegetables (1969) were 136,574 acres; thus, the total amount of chlorinated hydrocarbons applied to vegetables was approximately 216,000 lb (98×10^3 kg).

The total, 554,000 lbs, is about 1/3 of the total chlorinated hydrocarbon insecticides applied in the Northeast in that year (1964). Although the distribution of crop types throughout the Northeast or the state-specific pesticide applications quantities are not known, this total is certainly a plausible order-of-magnitude number for the portion used in the Delaware Estuary watershed.

In the simulation, annual application rates (R) are applied to a hypothetical acre of land each year between 1947 and 1972, and then set to zero from 1972 to 1994. It is assumed that the entire amount is added to the accumulated amount already in the soil, and that a fixed percentage (5%) of this accumulated reservoir degrades in place each year. Based on the soil erosion rates reported for the Delaware River watershed (10 tons/acre/year), another 5% of the accumulated reservoir is removed (by erosion or to groundwater) each year and thereby released to the environment in a way that could migrate to the estuary sediments (see

Figure 6-1). No explicit modeling of the migration, or further degradation of this released material is done in this simple model. Thus, the model will depict the soil reservoir and current releases well (given that the assumptions are correct), but may overestimate the amount actually accumulated in the estuary sediments.

In an alternate, "baseline" simulation, it was assumed that chlorinated hydrocarbon pesticides were applied at a constant but small rate throughout the period: 1 lb/acre/year (112 kg/km^2/yr) for vegetables and 5 lb/acre/year (560 kg/km^2/yr) for orchards. These rates are below those reported or recommended, and, therefore, can be expected to give a lower bound estimate if the degradation and release rates are realistic.

6.3 LOADING ESTIMATES FOR CHLORINATED PESTICIDES

The loadings model provides estimates for the amounts of chlorinated pesticides currently associated with soils and the release rate of chlorinated pesticides (Table 6-6). For comparison, Table 6-7 gives loadings based on a FY 1969 study of pesticide residues in soils (Wiersma et al. 1972). This study surveyed cropland soils, but did not delineate the data by crop type. Therefore, the average concentration was multiplied by the total 1969 cropland in the counties bordering the estuary. A soil erosion rate of 10 tons/acre/year is assumed. This rate is consistent with reported rates in detailed assessments of nonpoint source pollution elsewhere in the Delaware watershed (Tulpehocken Creek Watershed: USDA 1992).

Table 6-6. Soil reservoir and release rate of chlorinated pesticides. Model estimates provided for 1994.

Crop Class	1994 Soil Reservoir (kg)	1994 Release Rate (kg/yr)
Historical Trend Simulation		
Orchards	126×10^3	6.3×10^3
Vegetables	82×10^3	4.1×10^3
Total	208×10^3	10.4×10^3
Baseline Simulation		
Orchards	38×10^3	1.9×10^3
Vegetables	51×10^3	2.5×10^3
Total	90×10^3	4.4×10^3

The number of samples from each state represented in Table 6-7 is small; further, it is unknown if the fruit and vegetable areas in the Delaware EDA were specifically sampled. If such areas were sampled, estimates are likely to be closer to the high end of the reported ranges detected than to the means. Nonetheless, the chlorinated hydrocarbon pesticide total

(3286 lb or 1490 kg) is the same order of magnitude as the baseline simulation. A similar number (3152 lb or 1430 kg) results if it is assumed that soils in fruit and vegetable areas have a concentration of 1 ppm and then the amount released from the standard 1969 acreage for these areas is calculated. Given the statistical uncertainties in applying these data to estimate loadings, and the persistence of these materials in the environment, the estimates provided with the second method are partial validation of the order of magnitude of the estimates provided by the loading model.

Table 6-7. Pesticide residues in soils (1969) and loadings estimates for the Delaware Estuarine Drainage Area (EDA).

		Delaware	New Jersey	Pennsylvania	Totals
Cropland Area (EDA Counties)	Acres	422,984	260,850	84,709	768,543
Number of samples		3	5	29	37
Chemical					
Arsenic	range (ppm)	0.95 - 5.88	4.55 - 17.21	2.96 - 64.94	
	mean (ppm)	4.0	12.0	11.0	
	loading (lb)	33838	62604	18635	115077
DDE	range (ppm)	-	0.18 - 0.66	0.01 - 1.60	
	mean (ppm)	-	0.17	0.07	
	loading (lb)		886	118	1004
DDT	range (ppm)	-	0.05 - 1.45	0.01 - 3.66	
	mean (ppm)	-	0.30	0.15	
	loading (lb)		1565	254	1819
Dieldrin	range (ppm)	-	0.05 - 0.21	0.01 - 0.14	
	mean (ppm)	-	0.05	0.02	
	loading (lb)		260	33	293
Chlordane	range (ppm)	-	-	0.02 - 0.92	
	mean (ppm)	-	-	0.07	
	loading (lb)			118	118
Lindane	range (ppm)	-	0.03	-	
	mean (ppm)	-	0.01	-	
	loading (lb)		52		52

Note: Dashes represent no reported data or a level less than 0.01 ppm.

The loading model should be regarded as a best-guess estimate, recalling that it was based on average statistics for the Northeast region. However, it cannot be determined whether agriculture in the counties of concern was different from the average; i.e., there is a chance that all of the DDT applied was used here, as well as a chance that none of it was. The ratio of acres treated with chlorinated hydrocarbon insecticides to the total acres planted in a given crop is unknown. Another factor to consider is the possibility that DDT and its relatives were used first in the Northeast at the high rates mentioned in the reports from the 1950's. This would have resulted in soil residues that affected plant health or generated resistant pests by the mid-1960's. Therefore, farmers would have already turned to mixes of other chemicals to control pests, but the potential toxics reservoir could be quite large.

6.4 LOADING ESTIMATES FOR OTHER AGRICULTURAL CONTAMINANTS

In addition to the chlorinated pesticides, a number of other agrochemicals contain contaminants of concern that may enter the Delaware Estuary in the runoff from agricultural areas. The contaminants of concern in these agrochemicals are mainly metals. Information about them is incomplete, and estimating an integrated historical accumulation difficult.

Inorganic fungicides include copper sulfates, other copper and zinc salts, and mercury compounds. Table 6-8 provides estimates for the amounts of these compounds used in the northeast United States during 1964 and 1971. In that region of the country, these fungicides were used primarily on fruit and potatoes.

Table 6-8. Estimates of the amount of inorganic fungicides used in the Northeast United States in 1964 and 1971 (10^3 kg/yr).

	1964	1971
Copper sulfates	50	32
Other copper compounds	31	30
Zinc salts	52	NR
Mercury compounds	NR	0

NR = Not reported

Herbicides containing contaminants of concern include sodium, calcium, and zinc arsenites and a variety of organic arsenicals. Combined, there were 1239 x 10^3 lb (562 x 10^3 kg) used in the United States in 1964. In the Northeast, these herbicides were used on fruit and vegetables. Further details concerning individual arsenites were not available and the arsenicals were not used in this region of the country in 1964 or 1971.

Insecticides containing contaminants of concern include lead, calcium, magnesium, and manganese arsenates. In 1964, there were 7156 x 10^3 lb (3246 x 10^3 kg) of these chemicals used in the United States. Further details concerning the use of individual arsenates were not available.

In addition to the fungicides, herbicides, and insecticides mentioned above, arsenic acid was used as a defoliant and desiccant and zinc phosphides were used as rodenticides.

The only element for which a reliable loading estimate may be made is arsenic. That estimate is based upon the soil survey data reported above. It is probable that copper and zinc were also used significantly. At the present time, however, it is not possible to estimate with any confidence the amounts of these materials available in the environment, how they compare to naturally present amounts, or to what extent they may contribute to nonpoint source loadings to the estuary.

6.5 DISCUSSION OF AGRICULTURAL RUNOFF LOADINGS

The agricultural statistics imply that if there is a toxics problem from persistent chlorinated hydrocarbons in the agricultural areas of the Delaware watershed, it will probably be found in areas where fruits and vegetables are grown. Several million pounds of persistent chlorinated pesticides were probably applied to these regions between 1947 and 1972. The baseline simulation suggests 6 x 10^6 lb (2.7 x 10^6 kg); the historical trend simulation gives over 22 x 10^6 lb (2.7 x 10^6 kg). As a result of the slow decay and release of this material to the environment, 2 to 3 % of the original material is still likely to be found in agricultural soils. This remaining amount (200 to 500 x 10^3 lb) (91 to 227 x 10^3 kg) would be sufficient to provide aggregate releases of thousands of pounds to the environment each year.

This assessment reinforces a conclusion of a 1975 report on DDT prepared for Congress by EPA (USEPA 1975): "Continued long-term contamination of aquatic sites from agricultural soils can be anticipated since localized flash flooding of fresh plowed fields can never be controlled and such events can lead to significant losses of particulate matter."

The estimates provided here do not include related disturbed areas that may have received considerable inputs of pesticides, including wetlands (mosquito control), suburban lawns and gardens, and forests. Wiersma et al. (1972a) found particularly high residues in lawn areas in urban regions. Forest pest control efforts relied heavily on DDT during the 1950's and 1960's (USEPA 1975).

Other contaminants of interest to the Delaware Estuary Program (PCBs, metals, and volatile organic compounds) are generally not used in agricultural areas in quantities that result in soil concentrations high enough to represent significant amounts in agricultural runoff. The exception is arsenic, which has been widely used as a component of inorganic insecticides. Arsenic (Table 6-7) has been detected in high concentrations throughout the Delaware watershed. Soil erosion in agricultural areas could supply the Delaware Estuary with approximately 115,000 lb (52.2 x 10^3 kg) of arsenic per year.

6.6 SUMMARY OF LOADINGS FROM AGRICULTURAL RUNOFF

A summary of loading estimates for contaminants originating from agricultural runoff is presented in Table 6-9. Major findings are also summarized below:

- The potential soil reservoir of chlorinated pesticides in the 13 counties adjacent to the Delaware River Estuary is 10^4 to 10^5 kg.
- The release rate of chlorinated pesticides from agricultural lands is approximately 10^4 kg/year.
- The release rate of arsenic from agricultural lands is approximately 10^4 kg/year.

Table 6-9. Summary of contaminant loadings from agricultural runoff (10^3 kg/year).

Contaminant	Comments	Loading Estimate
Metals		
Arsenic	Estimated using soil residue data.	52.2
Chromium	Insufficient data to complete estimate.	N.E.
Copper	Insufficient data to complete estimate. Potentially significant.	N.E.
Lead	Insufficient data to complete estimate. Potentially significant.	N.E.
Mercury	Insufficient data to complete estimate.	N.E.
Silver	Insufficient data to complete estimate.	N.E.
Chlorinated Pesticides		
Chlordane		N.E.
DDT (Total)	Baseline simulation model used to complete estimate.	4.4
Dieldrin	Estimated using soil residue data.	0.1
Total chlorinated pesticides		4.4
PCBs		
PCB (Total)	Insufficient data to complete estimate.	N.E.
Volatile Organics		
1,2 Dichloroethane	Insufficient data to complete estimate.	N.E.
Tetrachloroethane	Insufficient data to complete estimate.	N.E.

N.E. = No estimate

7.0 CONTAMINANT LOADINGS FROM GROUNDWATER

7.1 INTRODUCTION AND DEFINITIONS

Urban and agricultural runoff as sources of nonpoint contaminant inputs to the Delaware River Estuary are driven mainly by precipitation events. Yet only 5% of precipitation results in terrestrial runoff (NJDEP 1987). Of the approximately 100 cm of precipitation that falls annually in the Delaware River watershed, approximately 50% is returned to the atmosphere via evaporation and transpiration. The remaining 45% contributes to the recharge of groundwater (Figure 7-1).

No estimates of the total amount of groundwater entering the estuary could be found; however, estimates are available for the contribution of groundwater to tributaries of the estuary. These estimates indicate that groundwater is an important source of water to the estuary; 67 to 89% of the base flow (flow between storm events) of streams in the southern, coastal plains portion of the estuary is due to discharge from groundwater sources (Havens et al. 1980). This groundwater discharge tends to moderate the flows in the tributaries of the coastal plains, with the aquifer acting as a sponge during periods of high precipitation and contributing to base flow during low precipitation periods (See Figure 7-2). Groundwater discharge is also a significant part of the base flow of streams in the northern reaches of the watershed; however, groundwater discharges become more variable as the sands, gravels, silts, and clays of the coastal plain region are replaced by the mudstone, sandstone, and igneous rocks of the Piedmont region, and the sedimentary strata of the Appalachian Valley and Ridge region.

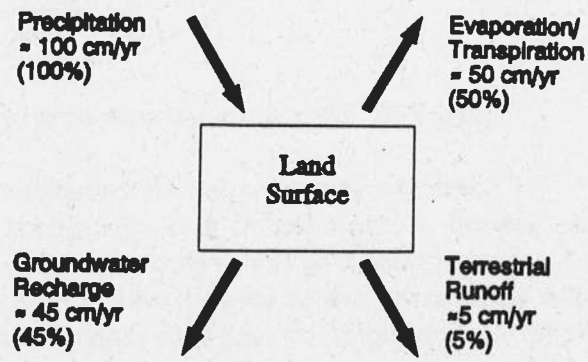

Figure 7-1. Precipitation budget for Delaware Estuary Watershed.

In addition to being an important source of water to the estuary, groundwater is a valuable resource to the population living in the Delaware Estuary region. Roughly half of the New Jersey population derives its drinking water from groundwater sources drawing approximately 600 million gallons per day (NJDEP 1988). Water withdrawal from groundwater sources can potentially change the hydrologic conditions surrounding the estuary. For example, the water demands of the Camden, NJ, area have withdrawn so much water that the flow of water from the Potomac-Raritan-Magothy aquifer to the estuary has reversed. Prior to water withdrawals, the flow from this aquifer to the Delaware Estuary and its tributaries was approximately 50 MGD. Since the estuary is now a source of water to the aquifer, this aquifer is not a source of contaminants for the estuary.

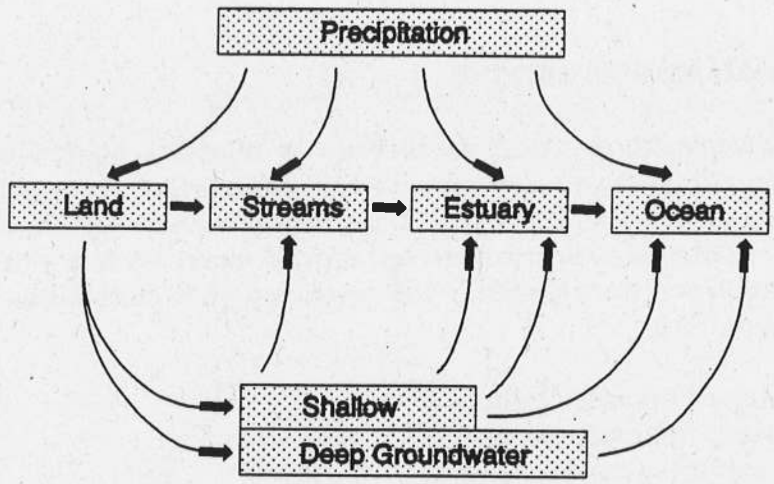

Figure 7-2. Conceptual model of groundwater hydrology.

Chemical contamination of groundwater originates from septic systems, landfills, underground storage tanks, and agricultural application of pesticides and fertilizers. In a recent study of drinking water throughout the country, the USEPA found that over 10 percent of the community water system wells and over 4 percent of rural domestic wells contained at least one pesticide or pesticide degradation product (USEPA 1990). In a separate study conducted in New Jersey, 7 out of 66 wells (11%) were found contaminated with the agrochemicals DDD (a degradation product of DDT), dieldrin, lindane, atrazine, and simazine. A subsequent study in 1988 showed that pesticide residues were found in 22 of 120 wells (18%) sampled in the coastal plains region of New Jersey. Alachlor, atrazine, aldicarb metabolites, carbofuran, chloroform, and dieldrin were the most frequently detected pesticides ranging in concentration from 0.01 to 13 μg/liter (Louis and Vowinkel 1988).

7.2 ESTIMATING GROUNDWATER CONTAMINANT LOADINGS

Attempts were made to apply a simple model to estimate contaminant loadings due to groundwater infiltration. The model used is stated as:

$$\text{loading (kg/yr)} = \text{groundwater flow (liters/yr)} \times \text{concentration } (\mu\text{g/liter}) / 10^9$$

No estimate of groundwater infiltration into the Delaware was found. This is not especially surprising since the focus of most groundwater studies is on identifying the location and size of aquifers, and estimating the flow an aquifer can potentially provide for drinking water consumption or irrigation. Studies concerning water exchange between the estuary and surrounding aquifers are usually focused on transport from the estuary to the aquifer (Phillips 1987) because exchange in this direction can contaminant public drinking supplies through the introduction of salts.

A crude estimate of groundwater flow was constructed by assuming that groundwater flow was in steady state equilibrium with groundwater recharge. Groundwater recharge can be calculated knowing the average precipitation rate (100 cm/yr), the proportion of precipitation that contributes to groundwater recharge (45%), and the area of the watershed (34,836 km^2). Using this information, a groundwater flow was estimated to be 15.7×10^9 m^3/yr. Most of this flow is through shallow aquifers that contribute directly to the tributaries that drain into the estuary (see Figure 7-2) since total freshwater flow is approximately 17×10^9 m^3/yr (560 m^3/sec). These numbers agree well with previous statements that the contribution of groundwater to the base flow of streams is large; the estimates provided here suggest as much as 90%.

Contaminant concentrations in groundwater were available from the USGS water resources data yearbooks. These concentrations are based upon direct measurements of contaminant concentrations in well water and presented in the water yearbooks by county. The groundwater measurements most frequently focus on inorganic salts and metals; data for organics and pesticides are available less frequently.

Using the USGS monitoring data to estimate groundwater contaminant inputs to the estuary presents two problems. First, it is not known how representative these data are of contaminant concentrations in the groundwater that enters the estuary. Monitoring wells are not randomly located and generally avoid areas known to be contaminated by releases from hazardous waste sites. The chemical concentration of groundwater is likely to be highly variable, even within the same aquifer and is reflective of local chemical sources and comparatively slow mixing rates.

The second problem is that the detection limits used in the USGS groundwater monitoring studies are typically high. For the contaminants of interest to DELEP, concentrations for most monitoring sites are reported as less than the detection limit. Chemical concentration data reported as less than a detection limit require some interpretation and judgement because actual concentrations can be between zero and the detection limit. If values reported as less than the detection limit are interpreted to be zero, then the average contaminant concentration in groundwater will be underestimated. If values reported as less than the detection limit are interpreted to be equal to the detection limit, or assumed to be equal to half the detection limit as has been done for some other contaminant studies, then the average contaminant concentration in groundwater could be overestimated. Small changes in the average concentration will significantly affect loading estimates since groundwater flow is very large (15.7×10^9 m^3/yr).

7.3 CONCLUSIONS

Estimates of groundwater flow into the estuary and groundwater contaminant concentrations were uncertain and could not be independently verified; therefore, estimates for contaminant loadings from groundwater infiltration were not calculated for this report. The omission of groundwater contaminant loading estimates from this report does not imply that this is an insignificant source of contaminants. On the contrary, groundwater is likely to be a significant source of contaminants to the estuary because:

- A large proportion (67-89%) of the base flow of streams is attributed to groundwater sources (Havens et al. 1980)

- Agrochemicals have been detected in a wells surrounding the estuary and in the New Jersey coastal plains region (Louis and Vowinkel 1988)

Contaminants from shallow aquifers contribute most to the concentrations measured in the rivers and streams in the watershed. These shallow aquifers generally have turnover times of 30 to 100 or more years. These long turnover times, and slow transport within the aquifer (meters/day), suggest that as contaminants in the overlying soils are transported deeper into the ground, concentrations within the aquifer will increase. If this occurs, the importance of groundwater as a source of contaminants to the estuary may increase.

8.0 OTHER SOURCES OF CONTAMINANTS

Loading estimates for contaminants entering the estuary from point sources and three general types of nonpoint sources (atmospheric deposition, urban runoff, and runoff from agricultural lands) were presented in previous sections of this report. Except for the point source loading estimates, these estimates were made from general models that do not link contaminant loadings to specific sites; however, commercial, industrial, and military sites, as well as landfills, represent sites potentially contributing contaminants to the estuary through what are considered nonpoint sources. For example, sites containing contaminated soils can contribute to contaminant loadings through terrestrial runoff and groundwater. Contaminants at these sites that are exposed to the air to evaporate and subsequently increase contaminant loadings to the estuary by increasing atmospheric deposition of contaminants. The spread of contaminants from any one site typically represents a very localized problem; however, in some cases contaminants from a particular site may be transported widely and affect contaminant concentrations over large geographic areas. The contamination of New Bedford Harbor and Buzzards bay due to PCB laden runoff from a site in New Bedford, MA (Weaver 1984) is one example of contamination from a single site affecting a large area.

The USEPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) was used a source of information for specific hazardous waste sites. CERCLIS is used to store and track information about hazardous waste sites included in the USEPA's Superfund Program. Most of the information included in the CERCLIS data base is focused on tracking the status of individual sites with respect to cleanup and remediation actions and legal proceedings; however, the data base also contains chemical characterization data.

CERCLIS sites receive a preliminary site inspection to evaluate the extent and severity of contamination and potential risks to ecological resources and human health. Based upon preliminary inspections, more detailed studies may be initiated to further evaluate risks to the environmental and human health. A hazard ranking system (HRS) is used to identify sites posing the most serious risks. The HRS uses numeric scores for a number of factors relating to the probability that contaminants will be released from a site, the relative toxicity of the contaminants present, and presence of sensitive ecological resources, and the potential to adversely affect human populations surrounding the site. Sites with the highest rankings are included in the USEPA's National Priority List (NPL) of hazardous waste sites.

Portions of the CERCLIS data base were obtained from staff within EPA Regions II and III. This was supplemented with information was obtained from the 1991 USEPA publications for the national priority list sites for Delaware, New jersey, and Pennsylvania (USEPA 1991a,b,c). Additional information for both NPL and non-NPL sites was obtained from USEPA, DNREC, NJDEPE, and PADER project managers for specific sites. The information was used to identify hazardous waste sites within the Delaware Estuary watershed. Information about the sites within the watershed was used to identify those sites at which contaminants of interest to DELEP were known to exist. For those sites known to be contaminated with PCBs and chlorinated pesticides, additional effort was made to locate additional information concerning the amount of contaminants present, media contaminated, the volume of contaminated media, and average contaminant concentrations. Information to characterize contaminants were not available for most sites in the CERCLIS data base. in general, more information was available for the NPL sites than for non-NPL sites reflecting the additional studies the sites posing the most risks have received. The site specific chemical characterization data were useful to identify sites that potentially contribute to contaminants to the estuary. For the vast number of sites, little information exists to quantify the transport of contaminants away from a site, and still less information exists to quantify the transport of contaminants into the estuary.

8.1 CERCLIS DATA BASE OVERVIEW

There are 1,550 CERCLIS sites in the Delaware Estuary watershed (Figure 8-1). The highest concentration of these sites is in the highly industrialized, urban corridor between Wilmington, DE and Trenton, NJ (Figure 8-2). The location and concentration of the CERCLIS sites reflects population density and historical distribution of industrial and manufacturing sites.

It is likely that those sites closest to the estuaries and its major tributaries have the highest potential to contribute significantly to contaminant loadings to the estuary. Of the 1,550 CERCLIS sites, 61% (938) are in the 13 counties immediately adjacent to the estuary. Three of those counties (New Castle, DE, Bucks, PA, and Philadelphia, PA) each have more than 100 CERCLIS hazardous waste sites.

CERCLIS sites that have been designated as NPL sites also have the potential to contribute significantly to contaminant loadings to the estuary due to the severity of chemical contamination. Of the 1,550 CERCLIS sites in the watershed, 127 are NPL sites (Figure 8-3). Recommendations have been made to add an additional three sites to the NPL list and the decision on one site is pending. Twelve sites included in the CERCLIS data base are former NPL sites and were deleted from the list because of remediation activities. As is for CERCLIS sites in general, NPL sites are concentrated in the highly urbanized corridor between Wilmington, DE and Trenton, NJ (Figure 8-4). Of the 127 NPL sites, 52% (66 sites) are located in the 13 counties immediately adjacent to the estuary.

8.2 CERCLIS SITES CONTAMINATED WITH PCBS AND CHLORINATED PESTICIDES

CERCLIS sites contaminated by PCBs and chlorinated pesticides were given special attention in this report. Of the 127 sites designated as NPL sites, 24 were identified to be contaminated with PCBs or chlorinated pesticides with many sites being contaminated with both. These sites are identified in Table 8-1 along with 23 non-NPL sites known to be contaminated with PCBs or chlorinated pesticides. This table provides also includes

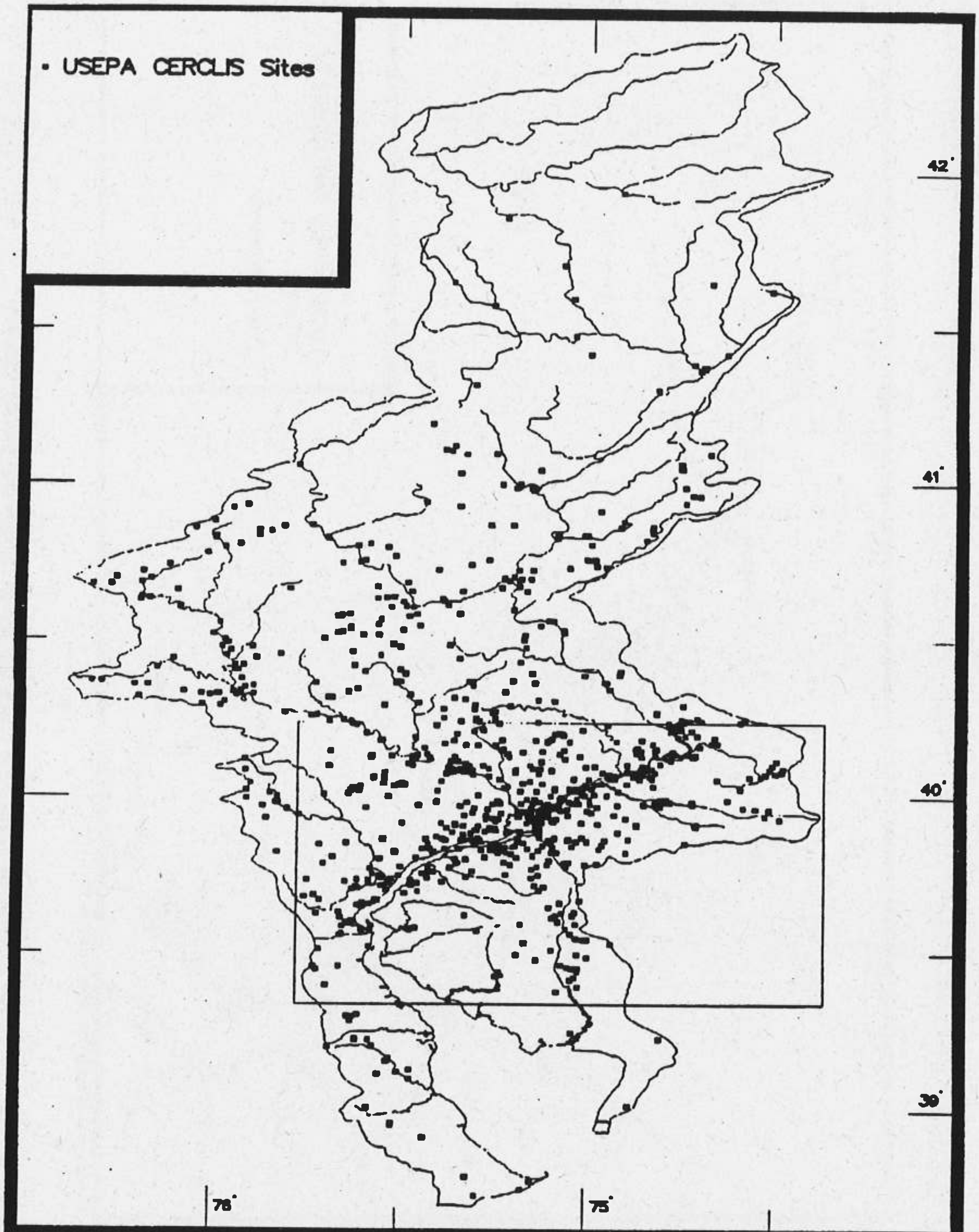

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Figure 8-1. Location of USEPA CERCLIS sites within the Delaware River Watershed

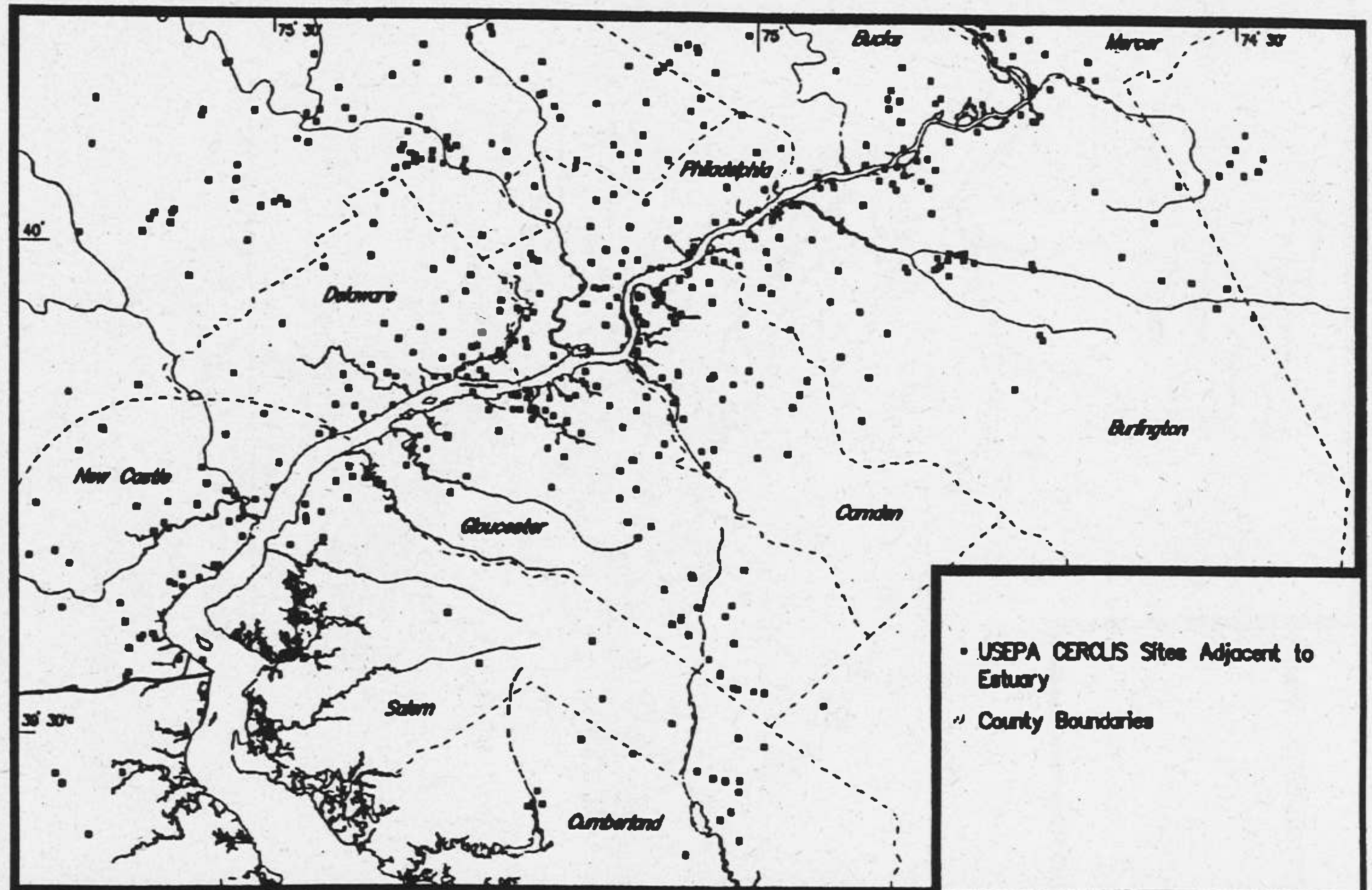


Figure 8-2. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary

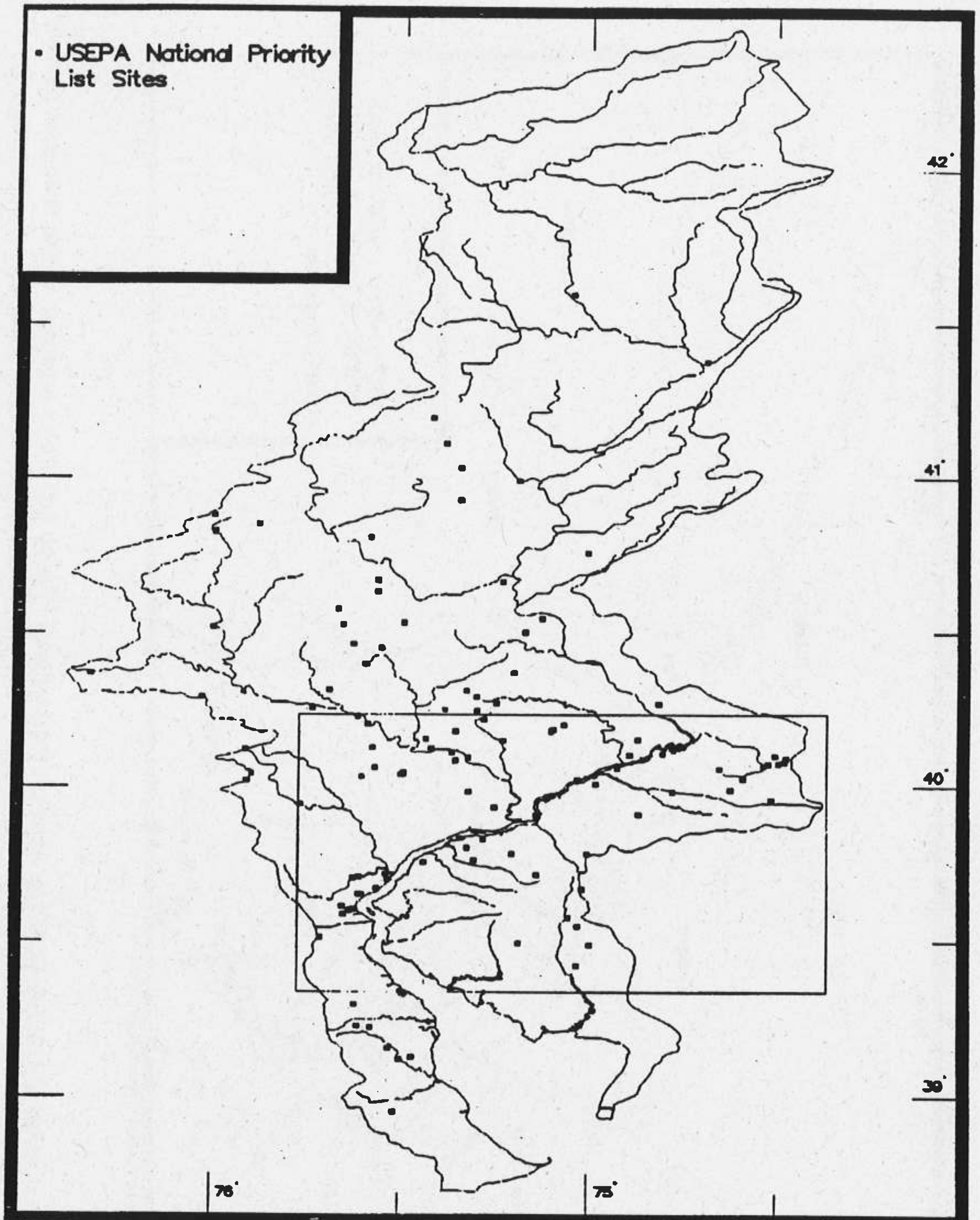


Figure 8-3. Location of USEPA CERCLIS sites on the National Priority List (NPL) within the Delaware River Watershed

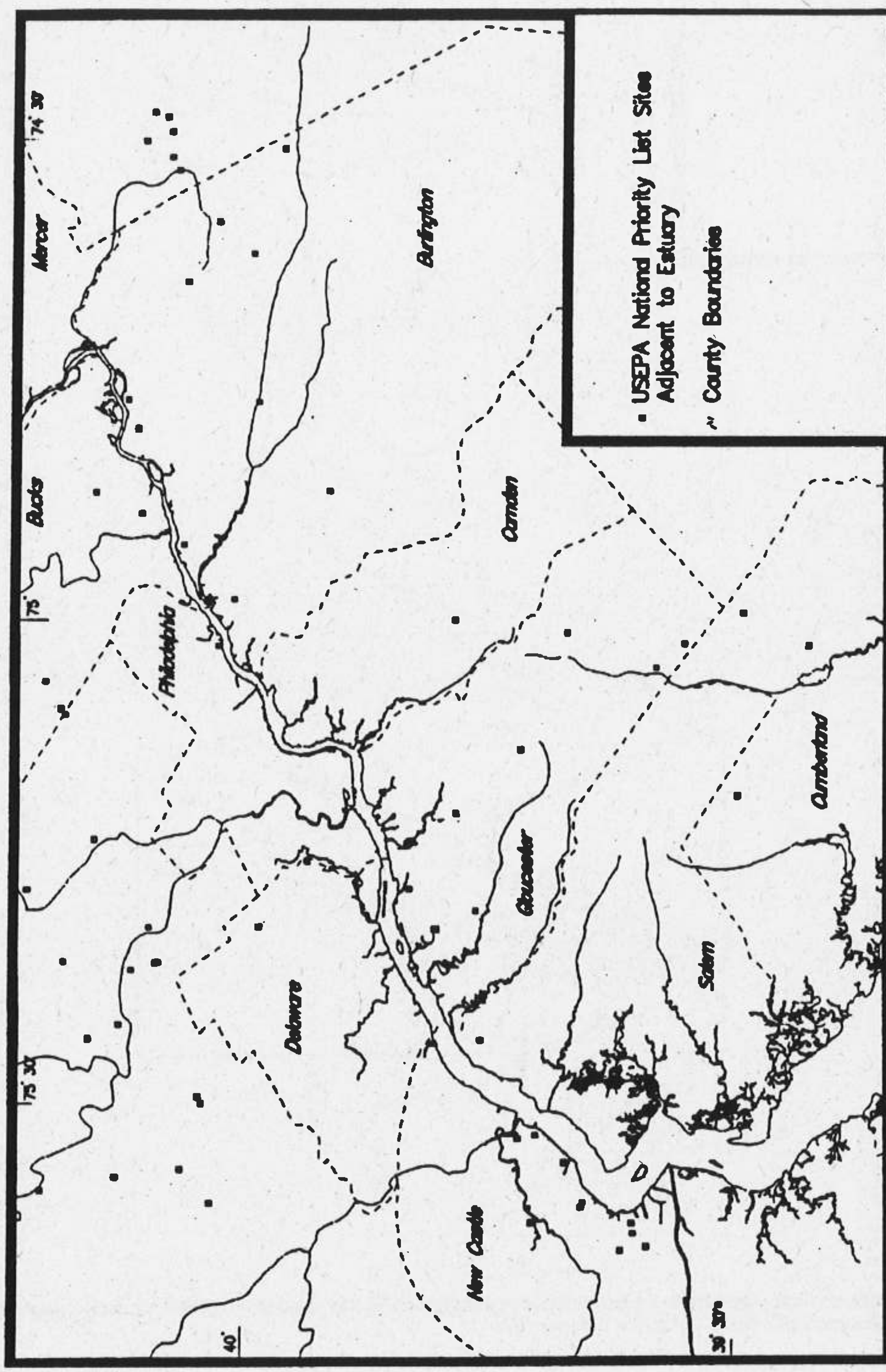


Figure 8-4. Location of USEPA CERCLIS sites on the National Priority List (NPL) adjacent to the Delaware Estuary

Table 8-1. Sites within the Delaware Estuary watershed where the USEPA CERCLIS data base indicates contamination with PCBs and/or chlorinated pesticides.

EPAID	SITE	STATE	COUNTY	NPL CODE[a]	MEDIA AFFECTED[b]
3DED980704951	Wildcat Landfill	DE	New Castle	F	GW and Soil
DED000605972	DE Sand and Gravel	DE	New Castle	F	SW
DED058980442	New Castle Spill	DE	New Castle	F	Soil
DED980713093	Harvey & Knott Drum Site	DE	New Castle	F	Soil
NJD000565531	Cosden Chem. Coatings	NJ	Burlington	F	Soil
NJD073732257	Roebling Steel Co.	NJ	Burlington	F	Soil
NJD980529085	Ellis Property	NJ	Burlington	F	Soil
NJD980529887	Vineland State School	NJ	Cumberland	F	Soil
NJD053292652	Bridgep. Rental & Oil Svs.	NJ	Gloucester	F	GW, SW, Soil
NJD980530109	Goose Farm	NJ	Ocean	F	Soil
NJD980532808	Pijak Farm	NJ	Ocean	F	Soil
NJD980532816	Spence Farm	NJ	Ocean	F	Soil
NJD980532824	Wilson Farm	NJ	Ocean	F	Soil
PAD002384865	Douglassville Disposal	PA	Berks	F	GW, SW, Soil
PAD981035009	Croydon TCE Spill	PA	Bucks	F	Soil (off site)

Table 8-1. Continued.

EPAID	SITE	STATE	COUNTY	NPL CODE[a]	MEDIA AFFECTED[b]
PAD014353445	Malvern TCE Site	PA	Chester	F	Soil
PAD980537773	William Dick Lagoons	PA	Chester	F	Soil
PAD980692594	Paoli Rail Yard	PA	Chester	F	SW, Soil
PAD980829527	Welsh Landfill	PA	Chester	F	Soil
PAD980539407	Wade (ABM)	PA	Delaware	D	Soil
PAD009862939	Henderson Road Site	PA	Montgomery	F	Soil
PAD980508766	Moyers Landfill	PA	Montgomery	F	(Fish)
PAD046557096	Metal Bank of America	PA	Philadelphia	F	GW, SW, Soils
PAD981939200	Publicker Site	PA	Philadelphia	F	Soils
PAD980830533	Eastern Diversified Metals	PA	Schuylkill	F	Soil
NJD980582142	Pulverizing Svs.	NJ	Burlington	N	GW, SW, Soil
NJD986570992	Franklin Burn	NJ	Gloucester	N	Soil
PAD980253355	Vulcanized Rubber	PA	Bucks	N	Soil
PAD981736507	Bensalem drum dump	PA	Bucks	N	Soil
PAD981939184	Houston Junkyard	PA	Bucks	N	Soil
PAD981735913	Texas Eastern Pipeline	PA	Chester	N	Soil
PA6143515447	Tinicum Natl. Env. Ctr.	PA	Delaware	N	Soil

Table 8-1. Continued.

EPAID	SITE	STATE	COUNTY	NPL CODE[a]	MEDIA AFFECTED[b]
PAD987323458	East Tenth St. Site	PA	Delaware	N	Soil
PAD980550958	Apache Waste Oil	PA	Montgomery	N	Soil
PAD981939051	Alderfer Landfill	PA	Montgomery	N	Soil
PAD981939390	Miquon Landfill	PA	Montgomery	N	Soil
PA0210000931	Tacony Wareho-use	PA	Philadelphia	N	Soil
PAD981737166	Metal Bank of America	PA	Philadelphia	N	Soil
PAD981939267	American St. Tannery	PA	Philadelphia	N	Soil
PAD982364036	Belfield Avenue Site	PA	Philadelphia	N	Soil
PAD982366296	Front St. Tanker	PA	Chester	N	Soil
PAD987379187	O'Brien Machinery	PA	Chester	N	Soil
PAD987277175	Old Barrett Bldg. Site	PA	Philadelphia	N	Soil
PAD987400561	ORFA Manuf. Co.	PA	Philadelphia	N	Soil
PAD987279890	Penrose Drum Site	PA	Philadelphia	N	Soil
NJD001700707	Monsan-to Chem. Co.	NJ	Gloucester	N	GW, SW, Soil
NJD98187731	Walton Farm	NJ	Burlington	N	GW, SW, Soil

(a) NPL Codes: F = present sites in the final NPL; D = sites deleted from the NPL; N = sites not included in the NPL.
(b) Media affected codes: SW = surface water; GW = groundwater

information for the location of the site, NPL status, and environmental media that are site is not affected by the contaminants present. The locations of sites contaminated with PCBs are shown in Figures 8-5 and 8-6. The locations of sites contaminated with chlorinated pesticides are shown in Figures 8-7 and 8-8.

8.2.1 Site Descriptions

Information describing the sites contaminated with PCBs and chlorinated pesticides is summarized below. Site descriptions are not limited to NPL or CERCLIS sites. Information was obtained from the 1991 USEPA publications for national priority list sites for Delaware, New Jersey, and Pennsylvania (USEPA 1991a; USEPA 1991b; USEPA 1991c), and from project managers of the specific sites from various agencies, including USEPA, DNREC, NJDEPE, and PADER, during telephone interviews. Information was not obtained for several sites due to difficulties with tracking data and contacting project managers. Site descriptions are presented alphabetically by state and then by site name using the registered CERCLIS data base site name.

Delaware Sand & Gravel Site (EPAID: DED000605972). The site is located in New Castle County, Delaware. Between 1968 and 1976, the site was used to landfill household and construction wastes and at least 7,000 drums containing industrial liquids and sludges. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Surveys of the site indicate that PCBs are concentrated in the Drum Disposal and Ridge areas. It is estimated that about 10% of the several thousand drums within the Drum area currently contain PCBs. PCB contamination in the Ridge area is found only in the uppermost 5 feet of soil. USEPA officials estimate that approximately 500 cubic yards of soil within the Ridge area is contaminated with PCBs at extremely low levels. The most recent sampling data indicate that metals (Cd, Cr, Hg, Fe, and Zn) and VOCs are the contaminants of concern in local groundwater. Sampling of fish tissue and bone from local fish found no detectable levels of PCBs, but did find lead at high levels in the bones. USEPA remedial actions are ongoing at the Drum area, where a slurry wall has been constructed, surface water is being pumped and treated, and drum removal is taking place. USEPA officials have indicated that this site is not a significant contributor of PCBs and chlorinated pesticides to the Delaware Estuary, but metals such as lead remain contaminants of concern.

Harvey & Knott Drum Site (EPAID: DED980713093). The site is located in New Castle County, Delaware. This site was used as an open dump and burning area between 1963 and 1969 on a portion of its 20 acres. The site was added to the USEPA NPL list in 1982; its current NPL indicator is F. Initial sampling at the site indicated that soils and sediment samples were contaminated with PCBs, VOCs, and metals. Soils flushing was initially prescribed, but was not found to be warranted after subsequent site sampling. Remediation for the site was completed in 1993, part of which included capping and re-vegetating the site. PCBs are no longer showing up in soils samples at the site or directly off the site,

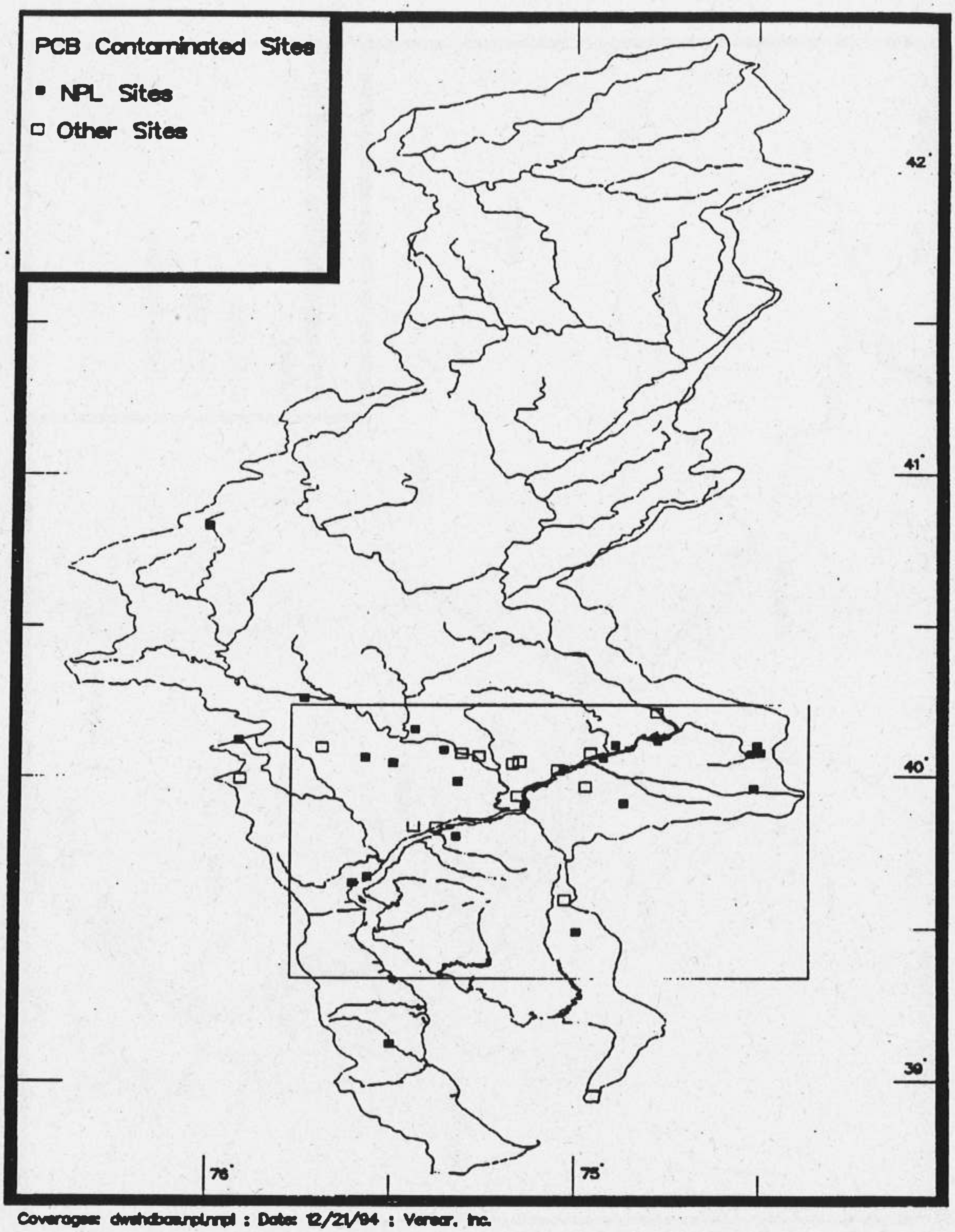


Figure 8-5. Location of USEPA CERCLIS sites contaminated with PCBs

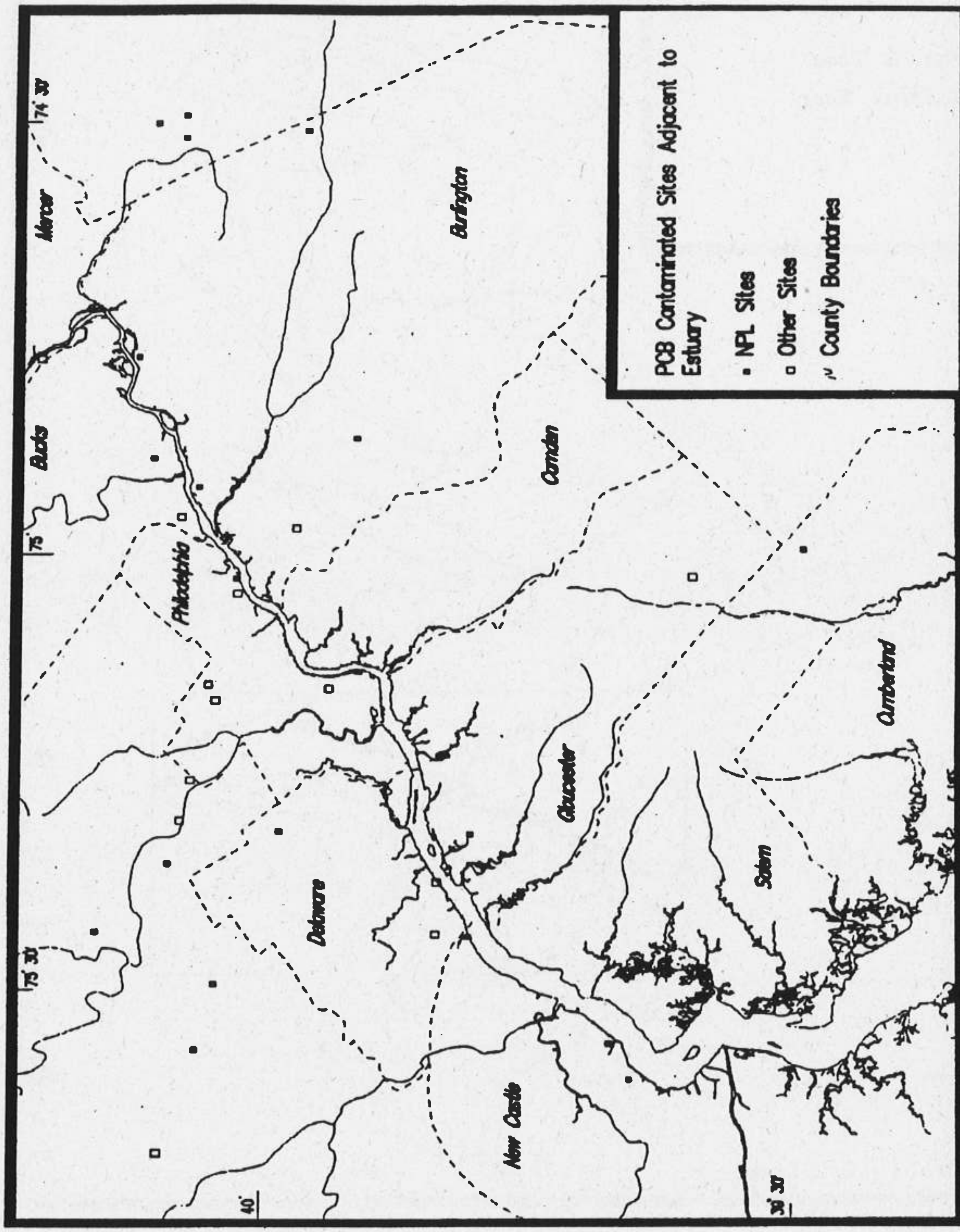


Figure 8-6. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with PCBs

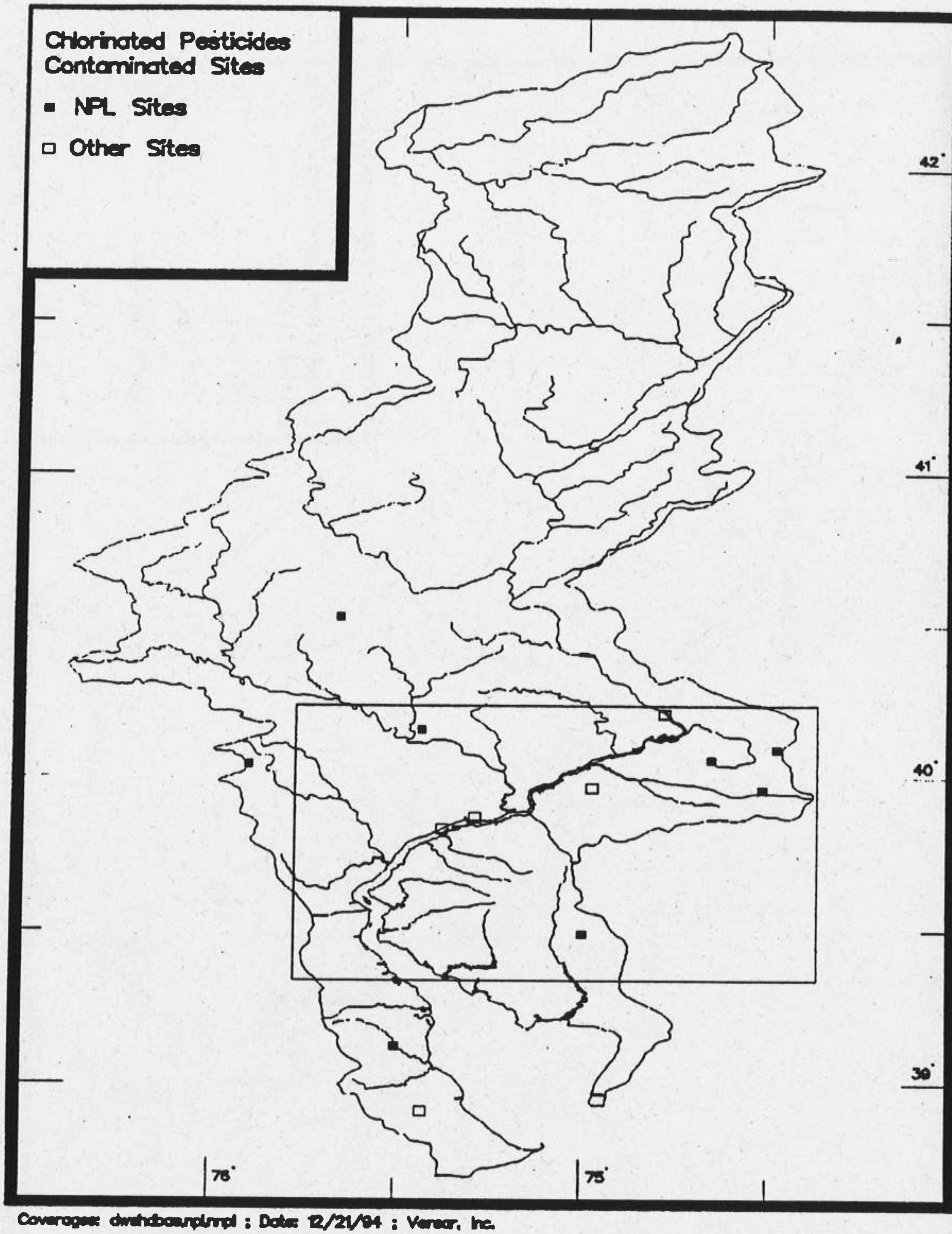


Figure 8-7. Location of USEPA CERCLIS sites contaminated with chlorinated pesticides

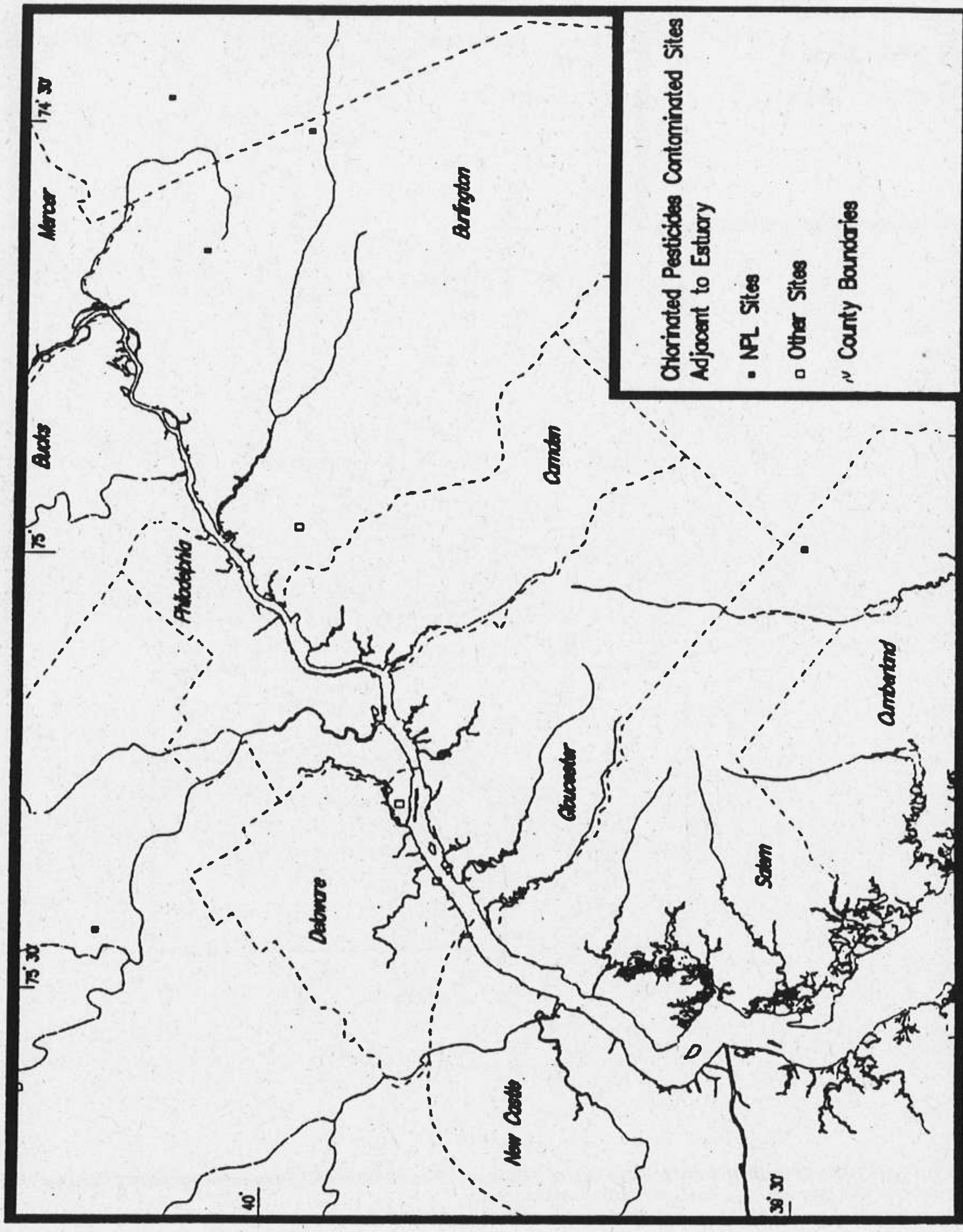


Figure 8-8. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with chlorinated pesticides

although lead and VOCs are still contaminants of concern in the groundwater and surface water at the site. USEPA officials have indicated that this site is not a significant contributor of PCBs and chlorinated pesticides to the Delaware Estuary, but metals such as lead and VOCs remain contaminants of concern.

New Castle Spill Site (EPAID: DED058980442). The site is located in New Castle County, Delaware. The Witco Chemical Company used this 6-acre site from 1954 until recently to process materials used in the production of plastic foam and spent solvents. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Preliminary sampling at the site indicated that various VOCs (particularly TCE) contaminate the groundwater. Soils on the site are contaminated with VOCs, PCBs, creosote, and other materials. We have no additional information at this time.

Wildcat Landfill Site (EPAID: DED980704951). The site is located in Kent County, Delaware, adjacent to the St. Jones River in Dover. Approximately 44 acres of the 84-acre site was used from 1962 to 1973 as a municipal and industrial waste landfill. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. USEPA remediation at the site has been completed. We have no additional information at this time.

Bridgeport Rental & Oil Services Site (EPAID: NJD053292652). The site is located in Gloucester County, New Jersey, approximately 2 miles south of the Delaware River, near Bridgeport. On the site is a former tank farm consisting of about 100 tanks, process vessels, drums, and a 13-acre waste oil and wastewater lagoon. Wastes still exist in the lagoon and in some of the storage tanks. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial sampling indicated that the lagoon contains approximately 2.5 million gallons of oil that is contaminated with PCBs, 60,000 cubic yards of PCB-contaminated sediments and sludge, and 70 million gallons of contaminated wastewater. Cedar Swamp, a freshwater tidal wetland is directly to the east of the site, and leads to Little Timber Creek, a tributary to the Delaware River. Sampling from 1991 by USEPA indicated that PBCs and VOCs have contaminated site groundwater, and that sediments and sludges from the lagoon contain PCBs and metals (Pb, Cd, Cr, and Ba). PCB-laden oil residues have also been found in the surface water of the lagoon. Numerous attempts to contact USEPA project managers for updated site information were unsuccessful. It is unclear whether this site remains a major contributor of PCBs to the Delaware Estuary.

Cosden Chemical Coatings Site (EPAID: NJD000565531). The site is located in Burlington County, New Jersey. The Cosden Chemical Coatings Corporation used the 6.5-acre site for an industrial coatings production facility from the early 1940s to 1989. Drums of materials have accumulated on the site. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. In the initial sampling of the site in 1988, EPA found the soil and groundwater to be contaminated with VOCs, and the soil with metals (Cr, Pb, Zn, and Cu), and PCBs. In their current pre-design investigation (to be completed December 1994), USEPA is conducting sampling to determine the movement of contaminants in site groundwater. In the investigation, they are particularly interested in which direction(s) the groundwater is moving. According to a USEPA official, the initial part of the investigation has indicated that groundwater may flow in two directions at the site, with a much stronger flow to the southeast, away from the Delaware River. The USEPA official said that the initial part of this investigation has shown that VOCs and metals are the contaminants of concern in site groundwater. The official also indicated that PCBs are present in some site soils, but none have been detected in the groundwater. Furthermore, there is no surface water source near the site. After release of the pre-design investigation, remedial activities at the site will likely include buildings and underground storage tank removal, and pumping and treating groundwater. The USEPA official concluded that due to the lack of PCBs in site groundwater (the groundwater also appears to move away from the Delaware River) and the absence of site surface water, it is not likely that the site is a significant contributor of PCBs to the Delaware Estuary.

Ellis Property Site (EPAID: NJD980529085). The site is located in Burlington County, New Jersey, in Evesham Township. The 36-acre site was formerly used as a drum recycling operation. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial sampling data indicate that a small area of soil was contaminated with PCBs. According to a USEPA official, approximately 60 cubic yards of contaminated soils currently exist at the site. No PCBs were detected in groundwater and surface water samples from the site. The VOCs (TCEs) and metals (Cr and Pb) are the contaminants of concern at the site, and have been detected in groundwater and surface water samples. The site is several miles from the Delaware River. The USEPA official emphasized that due to the small original amount of contamination at the site, the apparent success of the remedial action, and the distance of the site from the Delaware River, the Ellis Property Site is not a significant contributor of PCBs to the Delaware Estuary.

Franklin Burn Site (EPAID: NJD986570992). The site is located in Gloucester County, New Jersey, in Franklin Township. The site consists of seven separate parcels of land (which were formerly considered seven separate subsites). The Franklin Burn sites were part of an operation over a number of years in which fires were set to burn away plastic coatings from insulated wire and possibly other electrical components for the recovery and re-sale of copper. The site was added to the USEPA CERCLIS list in 1989; its current NPL indicator is N. Information about the site was obtained from a USEPA fact sheet, dated June 1994. Initial sampling by NJDEPE and USEPA indicated that ash piles contained high levels of metals (Sb, Ar, Ba, Cd, Cr, Cu, Pb, Se, and Ze), dioxins, furans, and VOCs. USEPA removal/remedial actions removed the contaminated ash and soils from the seven sites. Groundwater sampling from September 1992 in 29 wells throughout the seven subsites possessed no PCBs, VOCs, or pesticides above federal or state maximum contaminant levels. Metals (Sb, Be, Cr, and Pb), however, were detected at above maximum contaminant levels in 4 of the 29 samples. A USEPA official indicated that metals are the contaminants of concern at the Franklin Burn site, not PCBs, dioxins, or pesticides. The USEPA official concluded that due to the small original quantities of PCBs, dioxins, and pesticides at the site, the apparent success of the ongoing remedial actions (only minimal quantities of these contaminants have been found in post-remedial groundwater and soils), the site is not a significant contributor of PCBs and pesticides to the Delaware Estuary.

Goose Farm Site (EPAID: NJD980530109). The site is located in Ocean County, New Jersey. the 1.5 acre farm was used as a hazardous waste disposal area from the mid-1940s to the mid-1970s. Initial sampling at the site found groundwater contaminated with VOCs and arsenic, and soils contaminated with VOCs, PCBs, phenols, arsenic, and zinc. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. In a remedial action in 1988, most of the liquid and soil hazardous wastes were removed from the site, and a groundwater treatment system was installed. In 1989, the PRP excavated PCB-contaminated soils and re-graded the area. Due to the very small amount of existing PCB contamination (soils), and the distance of the site from the Delaware Estuary, it is not likely that the Goose Farm site is a significant contributor of PCBs to the estuary. We have no additional information at this time.

Monsanto Chemical Company Site (EPAID: NJD001700707). The site is located in Gloucester County, New Jersey, near Bridgeport, adjacent to the Delaware River. The 461-acre site has been used since 1961 to manufacture plasticizers, flame retardants, and related chemicals, it is still in operation. The site was added to the USEPA CERCLIS list in 1983; its current NPL indicator is N. The USEPA RCRA/HSWA was recently issued, permitting a remedial investigation to begin soon. Initial sampling at the site found that both groundwater and soils were contaminated with PCBs and VOCs (benzylchlorides). According to a USEPA officials, an area of the site called PDA#1, approximately 150 feet from the Delaware River, is the only important source of PCBs (other smaller areas exist, but are much more minor in scope). As part of several pre-remedial actions, a slurry wall was installed in 1983, and a groundwater pumping and treatment system (specifically designed for removal of PCBs) was installed in 1986. Initial investigations of the groundwater showed no PCB contamination, but additional monitoring will have to be performed under the HSWA permit. The USEPA official stressed that there is no conclusive proof to date that PCBs have gotten into the Delaware River from the Monsanto site, and therefore it is unclear whether the Monsanto site is currently a significant source of PCB contamination to the Delaware Estuary. A large part of the area of the site was historically constructed from dredged materials from the Delaware River (by the Corps of Engineers). Delaware River sediment sampling in the vicinity of the site is contaminated with PCBs, but their source is not documented. At least some of this contamination may be the result of the considerable past Corps of Engineers dredge disposal activities in the area. Several remedial actions are to be taken under HSWA, including the final capping of PDA#1, and long-term groundwater monitoring.

Pijak Farm Site (EPAID: NJD980532808). The 87-acre site is located in Ocean County, New Jersey, near New Egypt. The site was used as an industrial dump from 1963 to 1970, where drums of chemicals were disposed of in a natural ditch and were covered with soil. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial investigations indicated that groundwater was contaminated with VOCs (benzene and phthalates), and sediments and surface waters of the adjacent Crosswicks Creek were contaminated with VOCs and DDT. On-site soils were contaminated with VOCs and PCBs. To date, all contaminated surface materials and soils have been removed from the site. All USEPA cleanup goals have been met, and the site continues to be monitored to assure the effectiveness of the remediation. Due to the apparent success of the remedial actions at the site, and its distance from the Delaware Estuary, it is not likely that the Pijak Farm Site is currently a significant contributor of PCBs or pesticides to the estuary. We have no additional information at this time.

Pulverizing Services Site (EPAID: NJD980582142). The site is located in Burlington County, New Jersey. The site was used for a number of years for mixing and packaging various pesticides. While in operation, off-specification batches of pesticides were routinely disposed of on the site in unlined ditches (no drums). The site was added to the USEPA CERCLIS list in 1987; its current NPL indicator is N. The site is drained by a ditch on the north side of the site, which flows into an unnamed creek, and another ditch to the southwest of the site that drains to Pensauken Creek. According to a USEPA official, the site is located on the top of a ridge that is relatively high topographically for the area. Preliminary investigations have indicated that the groundwater under the site may flow in two directions. Initial soils sampling of the site by USEPA in late 1989 found high levels of DDT, DDE, DDD, and BHC (all chlorinated pesticides). Sediment from the two ditches exhibited levels of DDD at 21 μg/Kg, as well as elevated levels of Malathion and phenols, and low levels of VOCs. Groundwater from six monitoring wells on the site were found to contain Sevin (levels as high as 14,500 μg/L), Malathion, BHC, DDT, Dieldrin, Endrin, numerous VOCs, and metals (Cr, Pb, and Cd). Stormwater, from USEPA preliminary sampling (prior to the 1989 sampling) of the two ditches on site exhibited DDT at 3 μg/L, BHC at 20 μg/L, and Lindane at 20 μg/L. Some soils removal has taken place as part of the initial USEPA remedial investigations. The USEPA official indicated that as part of ongoing Phase II remedial investigations, soils, groundwater, sediment, and surface water samples will be taken by the end of December 1994. Results of the USEPA Phase II sampling will not be released until late spring of 1995. These sampling results will be used to determine more precisely which areas of the site will undergo soils removal and other actions. Owing to the elevated levels of chlorinated pesticides in the soils, sediment, groundwater, and possibly surface water, and its proximity to the Delaware River, there is potential for the Pulverizing Services site to be a contributor of these contaminants to the Delaware Estuary.

Roebling Steel Site (EPAID: NJD073732257). The site is located in Burlington County, New Jersey, immediately adjacent to the Delaware River in Florence. The 206-acre site was used for 75 years as a manufacturing plant for steel and wire products. Most recently, portions of the site were used for polymer reclamation operations, storage of insulated products, and refurbishment of refrigerated trailers and shipping containers. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial sampling at the site found that PCBs are present in site soils (the sources from leaking transformers and previous dust control practices). Soils at the site and adjacent to the site are also contaminated with various metals, notably lead. Groundwater under the site is contaminated with metals (Cr, Pb, Cd, Ni, Zn, and Cu). A USEPA official indicated that metals are the contaminants of concern at the site, not PCBs. Sediment and surface water data from 1991 for Crafts Creek and the Delaware River near the site indicates that, of 55 total samples, 3 sediment samples possessed PCBs (all three in considerable quantities), and 5 sediment samples possessed DDE and DDT (all in small quantities). None of the 1991 surface water samples contained PCBs or chlorinated pesticides. Groundwater data from 1991 also indicate that no PCBs or chlorinated pesticides were detected in any of the many samples analyzed. Considering that the amounts of PCBs and chlorinated pesticides detected in the sediment samples throughout the total area of the site were small, and that none of either were detected in groundwater samples, it is unlikely that the Roebling Steel site is currently a major contributor of PCBs or chlorinated pesticides to the Delaware Estuary.

Spence Farm (EPAID: NJD980532816). The 20-acre site is located in Ocean County, New Jersey, near New Egypt. From the 1950s to the 1970s, the site was used as a hazardous waste dump where chemical wastes were stored in drums or dumped on the ground. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial investigations indicated that groundwater and sediments of Crosswicks Creek are contaminated with VOCs and metals (Zn, Cr, and Hg). Soils were contaminated with VOCs and PCBs. Groundwater at the site flows toward tributaries to Crosswicks Creek, allowing for groundwater contamination to migrate to surface water. In 1990, the PRP completed soil and material removal, although additional site soils may still be contaminated with PCBs. Site groundwater has now been determined by USEPA to be clean. Due to the apparent success of the remedial actions at the site, and its distance from the Delaware Estuary, it is not likely that the Spence Farm Site is currently a significant contributor of PCBs to the estuary. We have no additional information at this time.

Vineland State School Site (EPAID: NJD980529887). The site is located in Cumberland County, New Jersey, in Vineland. Parts of the 195-acre site was used for disposing incinerator and hazardous wastes generated at the school. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial state sampling reports indicated that groundwater contained low levels of DDT and dieldrin, VOCs, and metals (Pb and Hg), and that soils in some areas contained PCBs, metals, polycyclic aromatic hydrocarbons and pesticides. The state concluded in these investigations that the very low levels of contamination in the soil and groundwater do not pose a threat to human health or the environment. According to a USEPA official, a remedial action in 1989 removed all PCB and pesticide-contaminated soils from the site. Pesticides and PCBs are no longer contaminants of concern at the site. There is ongoing groundwater monitoring of the main landfill area for VOCs only (not for PCBs or pesticides). The USEPA official also indicated that some of the original reports of pesticide and other contamination of the site were exaggerated. No further remedial actions are currently planned for the site. It is not likely that the Vineland State School remains a significant contributor of PCBs or pesticides to the Delaware River estuary.

Walton Farm Site (EPAID: NJD981877731). The site is located in Burlington County, New Jersey, in Delran Township, immediately adjacent to Rancocas Creek (a main tributary to the Delaware River). Approximately one acre of the 37-acre Walton site was used for a number of years as a pesticide dump by the Potentially Responsible Party (PRP). The site was added to the USEPA CERCLIS list in 1991; its current NPL indicator is N. Initial site investigations indicated that DDT, DDD, and DDE were the contaminants of concern at the site. Several metals (particularly As), additional pesticides, and semi-VOC compounds also contaminated the site. As part of the remediation prescribed for the site, approximately 10,000 cubic yards of materials were removed and the area has been back-filled and re-vegetated. In June 1992, the disposal area was confirmed to be below the removal action level specified in the Administration Order on Consent originally signed by USEPA and the PRP in 1991. Although Rancocas Creek sediment is still contaminated with DDT, the PRPs considered the cleanup cost impractical to obtain. The site is not listed on NPL, and sediment cleanup falls outside the scope of the removal program. This part of the cleanup was therefore referred by USEPA to NJDEPE for action. No further action has taken place at the site. Although virtually no contaminants remain on the Walton Farm site, it is unclear whether sediments from Rancocas Creek adjacent to the Walton Farm Site continue to contaminate the Delaware River and the Delaware Estuary. The most current sediment sampling data (1992) suggest that some high concentrations exist in Rancocas Creek adjacent to the site.

ABM Eddystone (Wade) Site (EPAID: PAD980693766). The site is located in Delaware County, Pennsylvania, directly adjacent to the Delaware River in Chester. This site was used as a rubber recycling facility from about 1950 to the early 1970s, and was than converted to an illegal industrial waste storage and disposal facility. It was added to the USEPA NPL list in 1983, and was deleted from the list in 1989; its current NPL indicator is N. Initial sampling at the site found that groundwater and soils were contaminated with metals (As, Cr, Hg, and Pb), PCBs, plastic resins, and VOCs. Several emergency cleanups and remedial actions have included removal of drums and scraping of soil to the water table. PADER is providing groundwater sampling for the site (30 years of monitoring required by USEPA). Current sampling data indicate that most of the site contaminants have been reduced by two to three levels of magnitude, although some VOCs and semi-VOCs are still contaminants of concern. USEPA officials indicated that it is their opinion that this site is currently not a significant contributor to the Delaware Estuary in terms of PCBs and chlorinated pesticides, due to effective USEPA remedial actions. Some residual contaminants still exist in the soil, but they are at extremely low levels.

Alderfer Landfill Site (EPAID: PAD981939051). The site is located in Montgomery County, Pennsylvania. No additional information available.

American Street Tannery Site (EPAID: PAD981939267). The site is located in Philadelphia County, Pennsylvania, about 1 mile from the Delaware River, in the City of Philadelphia. The site was used for a leather tanning operation for many years. It was added to the USEPA CERCLIS list in 1987; its current NPL indicator is N. Contamination was discovered at the site following an emergency cleanup after the burning of a site building. Initial sampling at the site after the burning found that VOCs and PCBs were present in the soils. As part of USEPA remedial actions the building site was cleaned up and the surrounding soils were removed. According to a USEPA official, no records of groundwater or surface water contamination exist for the site (although he indicated that some contamination could have gotten into surface waters through the city sewers at this urban site), and that the site is not a significant contributor of either PCBs or chlorinated pesticides to the Delaware Estuary.

Apache Waste Oil Site (EPAID: PAD980550958). The site is located in Montgomery County, Pennsylvania. No additional information available.

Belfield Avenue Site (EPAID: PAD982364036). The site is located in Philadelphia County, Pennsylvania, in the City of Philadelphia. The small, urban site was used for a number of years for storage of drums of hazardous materials. It was added to the USEPA CERCLIS list in 1987; its current NPL indicator is N. Following a fire at the site several years ago, initial sampling at the site found the surrounding soils to be contaminated with small quantities of PCBs and dioxin. As part of an emergency action, USEPA placed the drums in an impermeable on-site concrete vault. In a remedial action that took place in November 1994, the small quantity of drums existing within the vault were removed, and building debris and site soils were removed. According to a USEPA official, there is no existing documentation of either groundwater or surface water for the area of the site, but that the site is not a significant contributor of either PCBs or chlorinated pesticides to the Delaware Estuary. No further remedial or other actions are currently planned for the site.

Bensalem Drum Dump Site (EPAID: PAD981736507). The site is located in Bucks County, Pennsylvania. No additional information available.

Berks Landfill Site (EPAID: PAD000651810). The site is located in Berks County, Pennsylvania. The site, which consists of an eastern 43-acre and a western 17-acre landfill, opened in the 1950s, and is currently still in operation. It was added to the USEPA NPL list in 1989; its current NPL indicator is F. Initial sampling at the site indicated that groundwater in the vicinity of the landfill is contaminated with various VOCs and manganese; lead and PCBs were also identified in on-site soils. According to a USEPA official, however, results of the most recent sampling indicate that no PCBs are present in groundwater and surface water at the site. Only one of numerous soils samples was found to contain PCBs (no chlorinated pesticides were detected in any of the sampling), which were detected at less than 1 PPM. The USEPA official also indicated that VOCs are the primary contaminants of concern for the site, and that the site is not a significant contributor of either PCBs or chlorinated pesticides to the Delaware Estuary. No further remedial or other actions are currently planned for the site.

Croydon TCE Spill Site (EPAID: PAD981035009). The site is located in Bucks County, Pennsylvania, between Croydon and Bristol. The site is a four-square-mile residential area that also includes a small industrial complex and numerous small businesses. The site was added to the USEPA NPL list in 1986; its current NPL indicator is F. In 1985, USEPA identified a plume of VOC-contaminated groundwater (TCE) that appeared to be associated with the site. In addition, TCE and other VOCs were detected in eight residential wells. Low concentrations of PCBs were also found in off-site soils (none were found on the site). VOCs were also detected in Hog Run Creek, a tributary of the Delaware River. Remedial cleanup activities were completed in 1993. Due to the lack of documentation of any history of PCB contamination at the Croyden Spill site, it was likely never a significant contributor of PCBs to the Delaware Estuary. We have no additional information at this time.

Douglassville Disposal (EPAID: PAD002384865). The 50-acre site is located in Berks County, Pennsylvania, about 4 miles north of Pottstown. A waste oil and recycling facility operated on the site from 1941 to 1972, where waste oil sludge was placed in on-site lagoons. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial investigations by USEPA found that various metals (Pb, Cr, etc.), VOCs, polycyclic aromatic hydrocarbons, and PCBs have been found in on-site groundwater, surface water (Schuylkill River), and soils. Studies have detected PCBs in fish from the Schuylkill River near the site. In 1982, drums and contaminated surface soils were removed by a PRP. Sludge materials from the former site lagoons was removed, and they were filled in and re-vegetated. Recent USEPA investigations have shown that groundwater contaminants in the groundwater do not exceed background levels and do not require cleanup actions. Owing to its distant location from the Delaware Estuary, and the apparent success of the remedial actions the Douglassville Disposal Site is not likely a significant contributor of PCBs to the estuary. We have no additional information at this time.

East Tenth Street Site (EPAID: PAD987323458). The site is located in Delaware County, Pennsylvania. No additional information available.

Eastern Diversified Metals Site (EPAID: PAD980830533). The site is located in Schuylkill County, Pennsylvania. The 25-acre site was used from 1966 to 1977 as a disposal area for waste wire insulation material from a copper wire recycling operation. During this time, the company disposed of approximately 150 million pounds of "fluff" (waste insulation material). The site was added to the USEPA NPL list in 1989; its current NPL indicator is F. Initial investigations detected various VOCs and manganese in the groundwater, and metals (Cu, Pb, Mn, Zn), PCBs, and VOCs in on-site leachate and sediments. According to USEPA, dioxin, PCBs, and lead are the principal contaminants in the main fluff pile. In 1974, the PRP installed a wastewater treatment plant, diversion ditches, and an interceptor trench that diverts shallow groundwater to the treatment plant. Although the extent of PCB and dioxin contamination at the site is extensive, it is unlikely that the site is a major contributor of these contaminants to the Delaware Estuary, due to its considerable distance from the estuary (the site is drained by a tributary to the Little Schuylkill River). We have no additional information at this time.

Front Street Tanker Site (EPAID: PAD982366296). The site is located in Chester County, Pennsylvania, in the City of Chester. It was added to the USEPA CERCLIS list in 1988; its current NPL indicator is N. Although the current CERCLIS data base indicates that polybrominated biphenyls were found at the site during initial sampling, a USEPA official indicated that this record was incorrect; only several fluorinated contaminants were ever found at the site, at very low levels. The PADER took the lead in the removal of a small amount of contaminated soils at the site. The USEPA official also indicated that, due to the small size of the site and the low post-remedial level of contamination, no other remedial actions are currently planned. The USEPA official concluded that the site is not a significant contributor of either PCBs or chlorinated pesticides to the Delaware Estuary.

Henderson Road Site (EPAID: PAD009862939). The site is located in Montgomery County, Pennsylvania, in Upper Merion Township. O'Hara Sanitation has used the site since 1975 for waste storage, waste recycling, vehicle maintenance and parking, and office facilities. A deep injection well also lies beneath the maintenance garage. Other areas of concern include a pond and a landfill about 200 feet to the east of the well, as well as about 21,000 cubic yards of trash and cinder fill on adjacent properties. The site was added to the USEPA NPL list in 1984; its current NPL indicator is F. Initial investigations indicated that groundwater is contaminated with VOCs, various heavy metals, and cyanide. Additional data from the PADER indicate that some areas of site soils are contaminated with PCBs. The USEPA determined that immediate actions were not required at the Henderson Road site. Initial groundwater cleanup actions have commenced while the final remedy for groundwater contamination is being designed. We have no additional information at this time.

Houston Junkyard Site (EPAID: PAD981939184). The site is located in Bucks County, Pennsylvania. No additional information available.

Malvern TCE Spill Site (EPAID: PAD014353445). The 2-acre site is located in Chester County, Pennsylvania, in Malvern. The site is a federally regulated hazardous waste facility. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. From 1952 to 1976, the site operated as a solvent reclamation facility, where drums of waste were dumped into pits. Initial investigations found that groundwater under the site was contaminated with VOCs (specifically TCE), and that site soils were contaminated with PCBs. In a remedial action, all buried drums and some of the contaminated soil have been removed from the site. After adding the site to the NPL, USEPA performed a preliminary evaluation and determined that due to early remedial actions to remove contaminated drums and soils, no further immediate actions were necessary. Owing to the small amount of original PCB contamination, the apparent success of the remedial actions, and the distance of the site from the Delaware River, it is likely that this site was never a significant contributor of PCBs to the Delaware Estuary. We have no additional information at this time.

Metal Bank of America Site (EPAID: PAD046557096). The site is located in Philadelphia County, Pennsylvania, in the City of Philadelphia. The site is immediately adjacent to the Delaware River. According to the 1994 NOAA aquatic ecological risk assessment report for the site written in support of USEPA Region 3, the site was used for a transfer salvage operation from 1968 to 1973, where PCB-contaminated oil was stored in an underground storage tank. The site was added to the USEPA CERCLIS list in 1983; its current NPL indicator is F. The USEPA and NOAA estimated that between 44,000 and 175,000 liters of PCB-contaminated oil infiltrated the ground beneath the site due to rupture of the tank. About 16,000 liters of the contaminated oil have been recovered to date (primarily from pumping of oil-contaminated groundwater - no more will be recovered). USEPA has indicated that while the method is not entirely effective, it has helped to reduce the levels of contamination while permanent treatment alternatives are being studied. Numerous remedial actions have taken place at the site. PCBs remain the primary contaminant of concern at the site, because of their presence at elevated concentrations in groundwater, non-aqueous phase layer (NAPL or leachate), and sediment. The other contaminants found in site sediments include PAHs, phalates, cadmium, and DDT. The NOAA report concludes that only PCBs were considered a contaminant of concern for surface water, and only for a 15-meter-wide band of the Delaware River next to the site (due to the considerable dilution factor of the river). High concentrations of PCBs have been measured in the site leachate (NAPL), but no leachate has been found since 1991; it is not clear whether the leachate still occurs. Sediments also exhibit high concentrations of PCBs, but only in a relatively small area of the river immediately adjacent to the site (samples were conducted upriver and downriver of the site). Additionally, the NOAA report states that the mobility of PCBs in sediment is generally quite low, and that without disturbance of the sediment, PCBs (even under low rates of sedimentation) do not reach the overlying water via diffusion. Therefore, inputs of PCBs to the Delaware River from the site appear to be primarily from groundwater. These concentrations of PCBs become highly diluted in the river and are transported to the Delaware Estuary. From the data, it appears that the Metal Bank site has been a significant contributor of PCBs to the Delaware Estuary for many years, and continues to be at least a moderate contributor through its groundwater.

Miquon Landfill Site (EPAID: PAD981939390). The site is located in Montgomery County, Pennsylvania. No additional information available.

Moyers Landfill Site (EPAID: PAD980508766). The site is located in Montgomery County, Pennsylvania, in Collegeville. The 44-acre landfill accepted an unknown quantity of municipal, sewage, and industrial wastes from 1940 to 1981. The site was added to the USEPA NPL list in 1983; its current NPL indicator is F. Initial sampling indicated that on-site and off-site groundwater, surface runoff, and soils are contaminated with heavy metals VOCs. In addition, PCBs were thought to have been disposed of at the site (no formal documentation).

PCBs have been detected in trout in the surrounding streams. Cleanup activities began at the site in 1989. In December 1994, the site was capped, and final cleanup was concluded. A USEPA official indicated that the most recent PADER investigations (1992) sampled contaminants in leachate from trenches dug at the site. No PCBs, chlorinated pesticides, or VOCs were detected in any of the leachate samples. Low concentrations of metals were detected in the samples. Additionally, the USEPA official also indicated that no PCBs or chlorinated pesticides were detected in any of the most recent groundwater samples (1993). Metals remain the contaminant of concern at the site. Small quantities of PCBs were detected in soils samples at the site. Post-remedial groundwater and leachate sampling will take place once a month at the site as part of ongoing remediation. Owing to the uncertainty of the original extent of PCB contamination, which appears to have been minimal, the apparent lack of PCBs in site leachate and groundwater, combined with the distance of the site from the Delaware River, it is likely that this site was never a significant contributor of PCBs to the Delaware Estuary.

O'Brien Machinery Site (EPAID: PAD987379187). The site is located in Chester County, Pennsylvania. No additional information available.

Old Barrett Building Site (EPAID: PAD987277175). The site is located in Philadelphia County, Pennsylvania, in the City of Philadelphia. It was initially used for a number of years as a roofing tar operation. The site was also intermittently used for an operation that removed copper from electric transformers. It was added to the USEPA CERCLIS list in 1989; its current NPL indicator is N. A USEPA official indicated that a very small quantity of PBC-contaminated oils were dumped directly on the ground, and that the extent of contamination at the site was found to be small. The responsible party hired a private contractor to remove the contaminated soils, a building, and a concrete building pad. The USEPA official also indicated that he knows of no existing groundwater or surface water sampling data for the site. Owing to the small original amount of contamination at the site and the apparent success of the remedial action, the USEPA official concluded that the site is not a significant contributor of PCBs to the Delaware Estuary.

ORFA Manufacturing Company Site (EPAID: PAD987400561). The site is located in Philadelphia County, Pennsylvania, in the City of Philadelphia. It was used as the site of an explosives manufacturing facility for a number of years. The site was added to the USEPA CERCLIS list in 1988; its current NPL indicator is N. Although the current CERCLIS data base indicates that polychlorinated biphenyls were found at the site during initial sampling, a USEPA official indicated that this record was incorrect; only a small quantity of materials related to the manufacture of explosives were found at the site, including various VOCs, several metals (Pb and Se), and cyanide. The PADER took the lead in remediation of the site, which included removal of contaminated soils. No additional remediation is planned for the site. The USEPA official concluded that the site was never a contributor of PCBs to the Delaware Estuary.

Paoli Rail Yard Site (EPAID: PAD980692594). The site is located in Chester County, Pennsylvania, in Paoli. The 28-acre site has been operated by the Southeastern Pennsylvania Transportation Authority for over 30 years as an electric train repair facility and commuter rail station. The routine maintenance and repair of railroad cars involved electrical equipment containing PCBs. The site was added to the USEPA NPL list in 1990; its current NPL indicator is F. Initial sampling efforts indicated that levels of PCBs were very high in on-site soils, and that Valley Creek (a tributary to the Schuylkill River that flows near the site) sediments were also contaminated. The most recent sampling event at the site took place about 5 years ago. The sampling data indicated that the levels of PCBs were still very high at the site, but that Valley Creek sediment samples contained only moderate amounts (about 10 ppm maximum). No PCBs have been detected in local groundwater. Some remediation, in the form of soils removal, has taken place at the site, but remediation is has not been completed. A USEPA official responsible for the project stated that although there is contamination of Valley Creek sediments, it was his opinion that almost none of the PCBs migrate to the Delaware River Estuary. This is due to the fact that Valley Creek is only a tributary to the Schuylkill River, not the Delaware River, and that the estuary is a long distance from the site. Additional soils and sediment sampling will be conducted at the site in 1995.

Penrose Drum Site (EPAID: PAD987279890). The site is located in Philadelphia County, Pennsylvania. No additional information available.

Publicker/Cuyahoga Wrecking Plant Site (EPAID: PAD981939200). The site is located in Philadelphia County, Pennsylvania, directly adjacent to the Delaware River. The 37-acre site possessed an alcohol distillation process plant from 1912 to 1985. Beginning in the late 1970s, the company used some of its empty tanks to store fuel oils for other companies. The site was added to the USEPA NPL list in 1989; its current NPL indicator is F. A USEPA official confirmed that as of 1988, all transformers were removed from the site, and stabilization of the site was completed in 1989. According to the USEPA official, VOCs and metals are the contaminants of concern at the site. The USEPA official indicated that groundwater sampling by USEPA found no PCBs in any site groundwater. Other groundwater monitoring results indicate that site groundwater is contaminated with VOCs and metals. A small quantity of PCBs currently remain in the soil and sediment at the site; the soils are also contaminated with VOCs and metals. It is not clear whether the Publicker site was formerly a primary source of PCB contamination to the Delaware Estuary, but it probably is not currently. Site groundwater was apparently never contaminated with PCBs, and only small quantities remain in site soils and sediment.

Tacony Warehouse Site (EPAID: PA0210000931). The site is located in Philadelphia County, Pennsylvania. No additional information available.

Texas Eastern Pipeline Site (EPAID: PAD981735913). The site is located in Chester County, Pennsylvania. No additional information available.

Tinicum National Environmental Center (EPAID: PA6143515447). The site is located in Delaware County, Pennsylvania. No additional information available.

Vulcanized Rubber Site (EPAID: PAD980253355). The site is located in Bucks County, Pennsylvania. No additional information available.

8.2.2 Summary of PCB and chlorinated pesticide inputs from CERCLIS sites

Based upon the information in the CERCLIS data base and comments received from the project managers responsible for specific hazardous waste sites, the following conclusions may be made:

- The apparent relative original scope of PCB and chlorinated pesticide contamination at many of the CERCLIS sites was small. For several sites there was never conclusive data found to indicate that PCBs or chlorinated pesticides ever existed at the sites.

- Remediation has been completed at many of the sites for which information was obtained. Project managers for these remediated sites indicated that the current scope of PCBs or chlorinated pesticide contamination at most of these sites is minimal and that qualitative evaluations suggested that the input of contaminants into the estuary was minimal. It should be noted that "successful" remediation reflects site-specific criteria that may not ensure that water quality criteria are met, or that contaminants no longer enter the estuary.

- Existing PCB and chlorinated pesticide contamination at most of the sites affected soils, not surface water or groundwater.

- Some studies (such as Fisher et al. 1983) have indicated that once PCBs are locked into river sediment adjacent to a site, they essentially are not re-transported into the surface water above that sediment (unless the sediment is disturbed, as in dredging). In addition, the higher-chlorinated biphenyls may remain in the sediments closer to the source (Phillips 1986). Sediment sampling upriver and downriver (Delaware River) from the Metal Bank of America site (EPAID: PAD046557096) suggested that PCB concentrations in sediment decline sharply with distance from the source (NOAA 1994).

- From this review and telephone interviews with project managers, we conclude that the most problem sites within the watershed with regard to PCBs and pesticides include:

  -- ABM Eddystone site (EPAID: PAD980693766), due to close proximity to the Delaware River in Chester, PA and its prior use as an illegal waste storage and disposal facility.

-- Bridgeport Rental & Oil Services Site (EPAID: NJD053292652), due to the apparent extent of the existing PCB contamination and its relatively close proximity to the Delaware River.

-- Metal Bank of America Site (EPAID: PAD046557096), owing to the presence of PCBs at elevated concentrations in groundwater, non-aqueous phase layer (NAPL or leachate), and sediment. The chlorinated pesticide DDT was also found in low concentrations in site sediments.

-- Monsanto Chemical Company Site (EPAID: NJD001700707), where at least a small quantities of PCBs are found in Delaware River sediment adjacent to the site, and a former disposal site (soon to undergo final remediation) exists approximately 150 feet from the river.

-- Paoli Rail Yard Site (EPAID: PAD980692594), which still possess relatively high levels of soils and off site sediment PCB contamination. It is unclear, however, if Valley Creek is too far up the watershed to contribute significant quantities of PCBs to the Delaware Estuary.

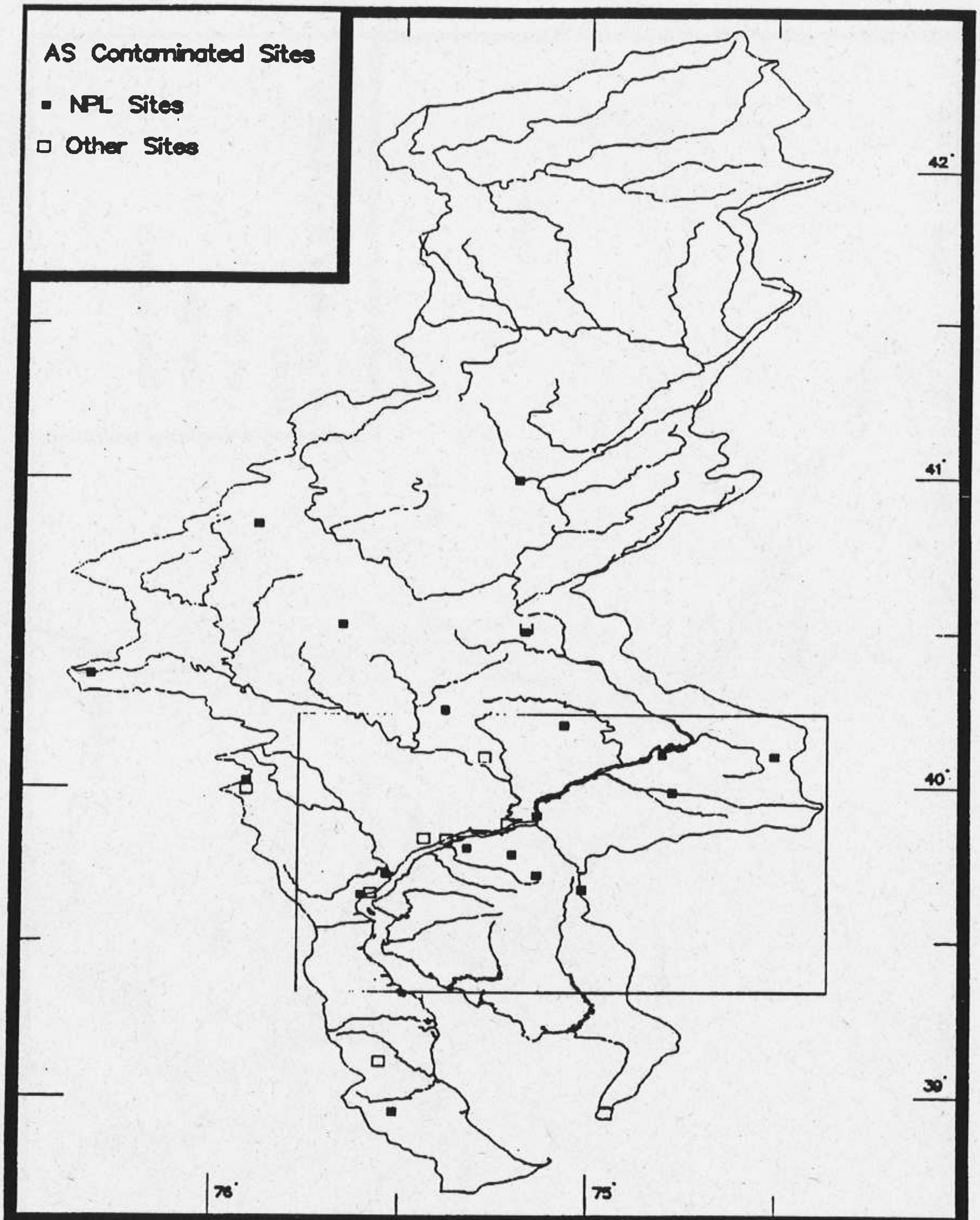
-- Pulverizing Services Site (EPAID: NJD980582142), due to high levels of chlorinated pesticide contamination of soils, groundwater, surface water, and sediment. The site is also adjacent to Pensauken Creek, a tributary to the Delaware River.

-- Roebling Steel Site (EPAID: NJD073732257), where three sediment samples (out of 55 total) from Crafts Creek and the Delaware River exhibited relatively high levels of PCBs, is probably only a minor contributor of PCBs to the estuary.

-- Walton Farm Site (EPAID: NJD981877731), due to the existing high levels of chlorinated pesticide contamination in Rancocas Creek sediments. There are no current plans to remediate the sediment contamination. The original source of the pesticides at the site (the dump), however, has been removed.

8.3 SITES CONTAMINATED WITH OTHER CONTAMINANTS OF INTEREST

The USEPA's CERCLIS data base was also used to identify sites where other contaminants of interest to DELEP were found. The location of these sites are shown in the series of figures that follow. The location of CERCLIS sites with evidence of arsenic contamination are shown in Figures 8-9 and 8-10. Copper contaminated sites are located in Figures 8-11 and 8-12. Chromium contaminated sites are located in Figures 8-13 and 8-14. Lead contaminated sites are located in Figure 8-15 and 8-16. The location of sites with evidence of mercury contamination are located in Figures 8-17 and 8-18. Sites with evidence of polynuclear aromatic hydrocarbon contamination are shown in Figures 8-19 and 8-20. Sites with evidence of contamination due to volatile organic compounds (VOCs) are shown in Figures 8-21 and 8-22. These sites are included in the list of all CERCLIS sites provided in an appendix to this report.



Coverages: dwshdbasnplnnpl ; Date: 12/21/94 ; Versar, Inc.

Figure 8-9. Location of USEPA CERCLIS sites contaminated with arsenic

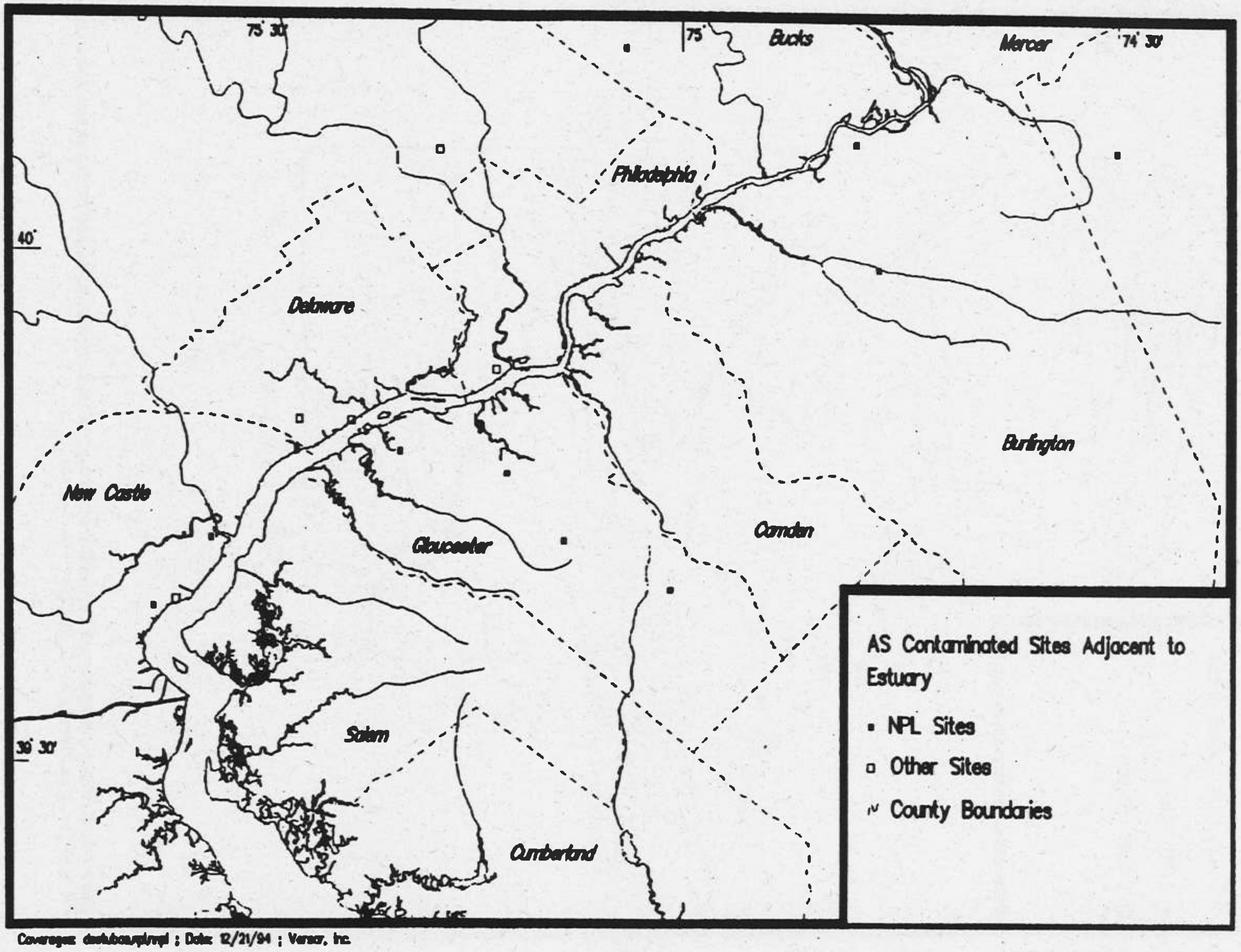
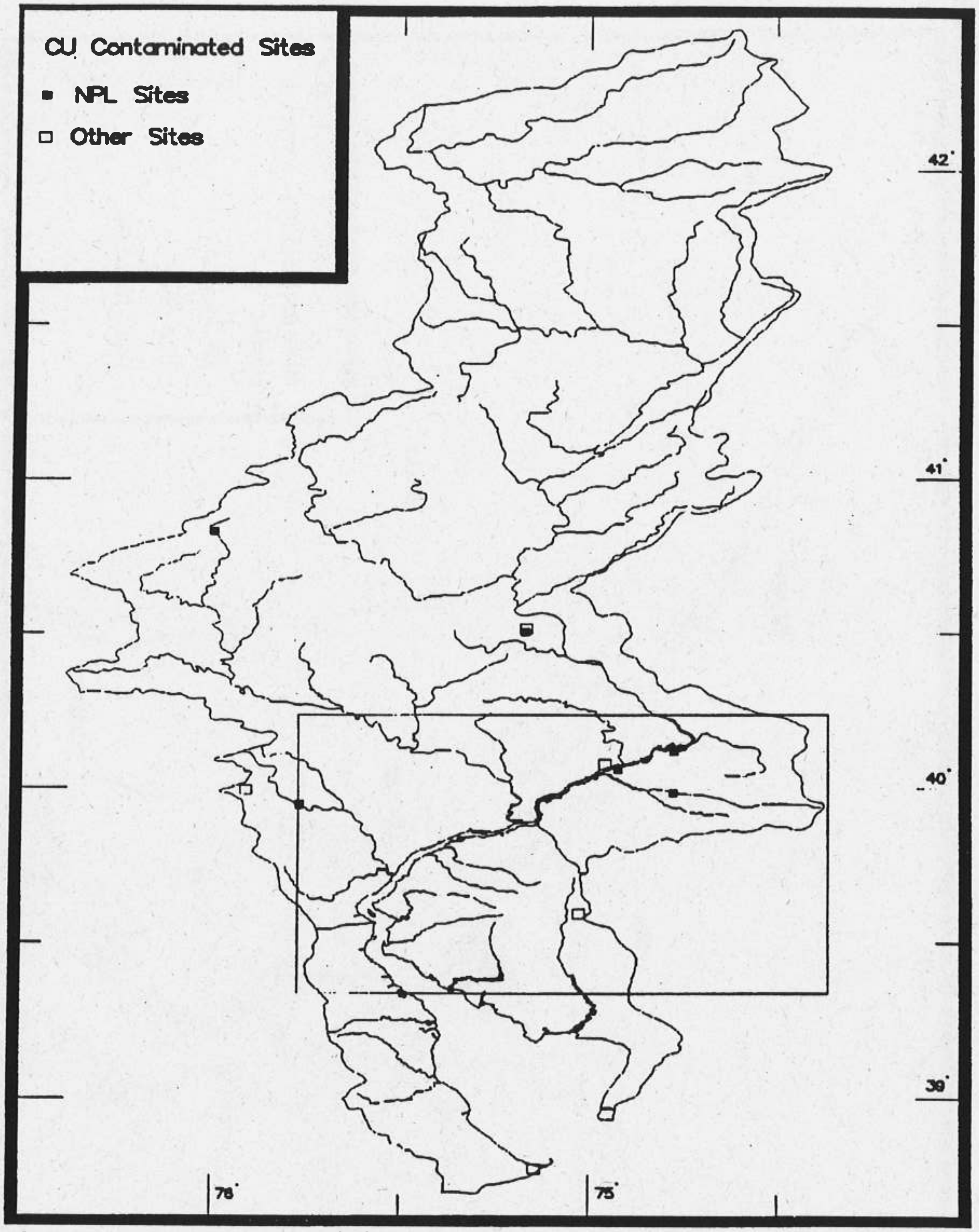


Figure 8-10. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with arsenic



Coverages: dwshdbas,npl,nmpl ; Date: 12/21/94 ; Versar, Inc.

Figure 8-11. Location of USEPA CERCLIS sites contaminated with copper

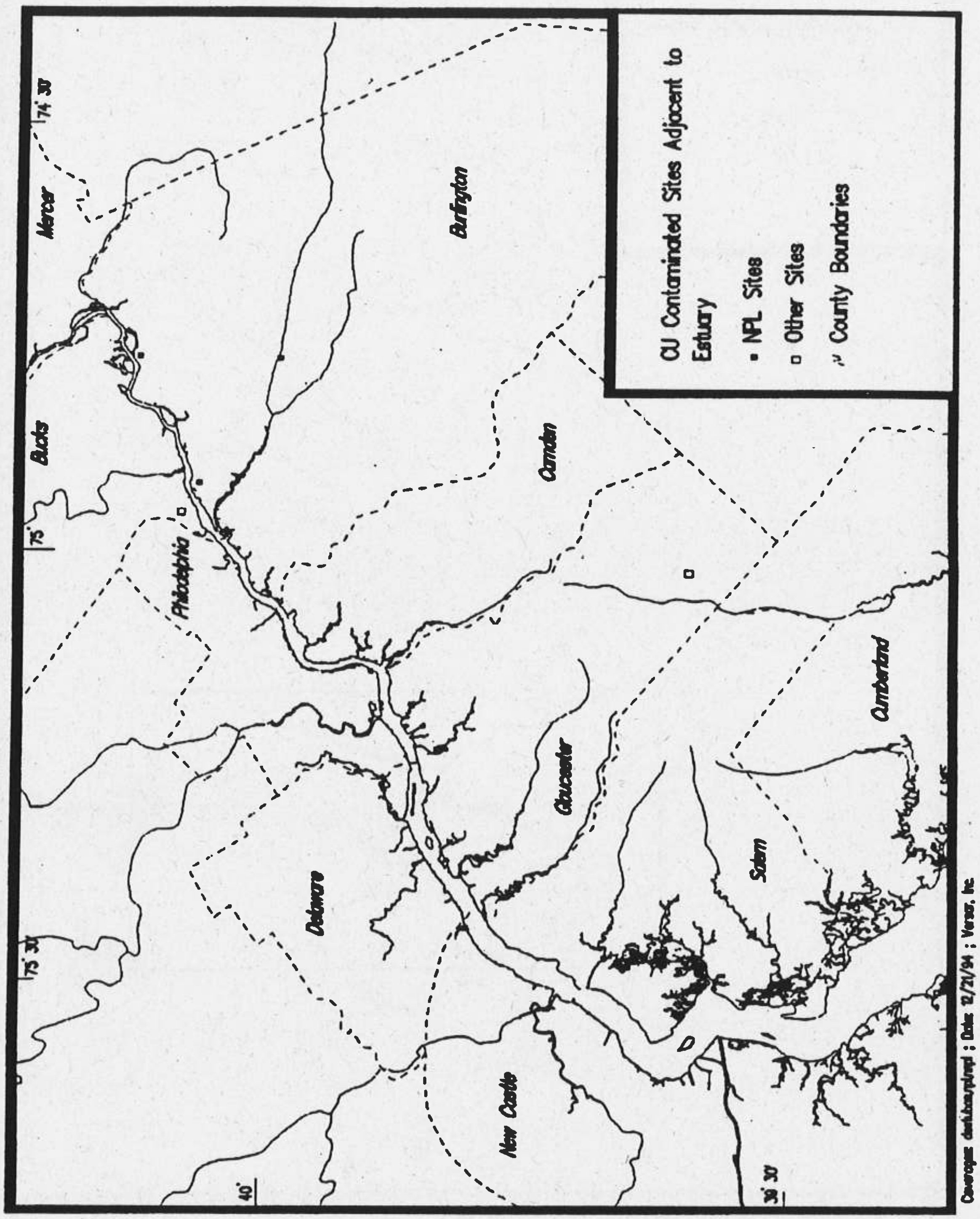


Figure 8-12. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with copper

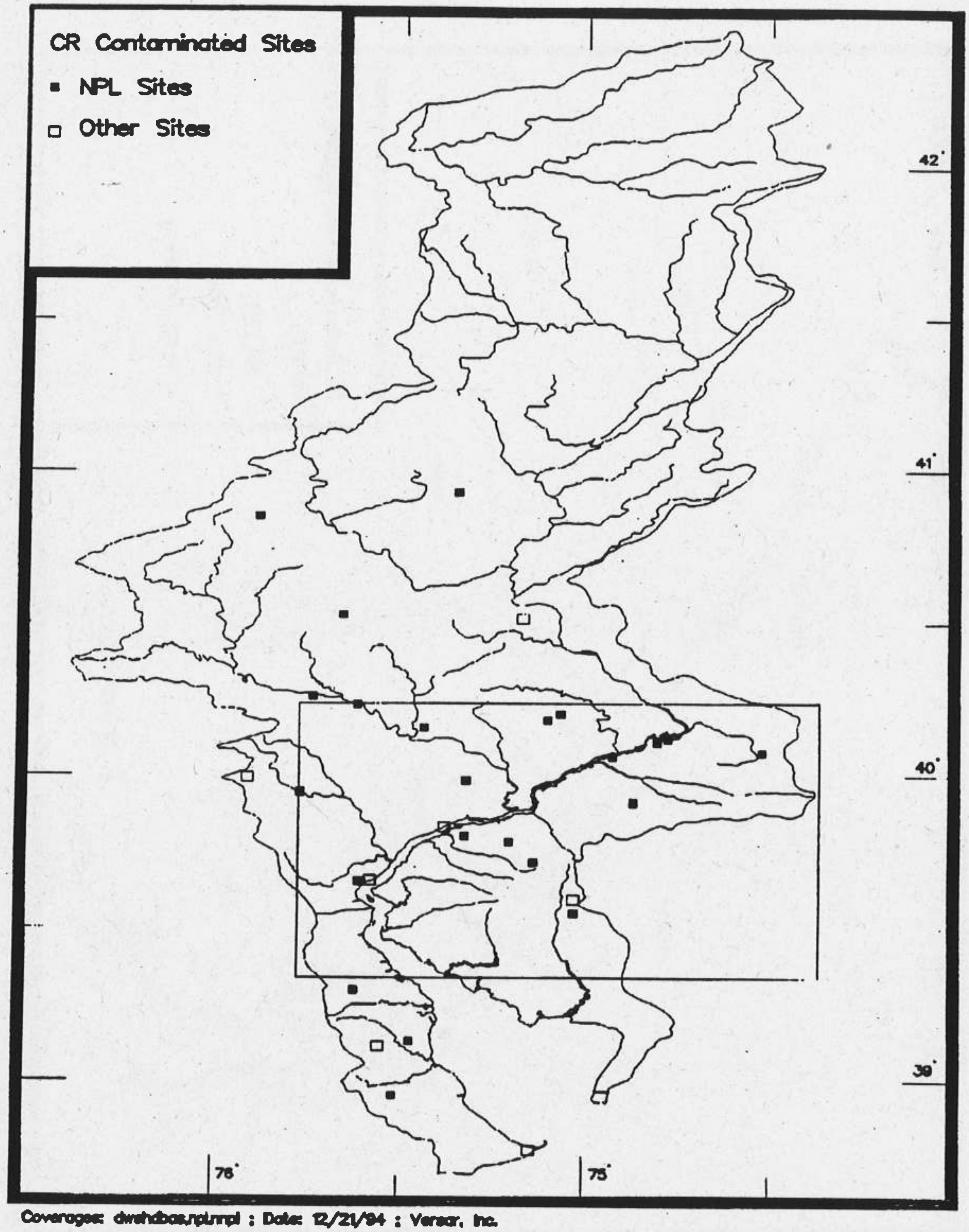


Figure 8-13. Location of USEPA CERCLIS sites contaminated with chromium

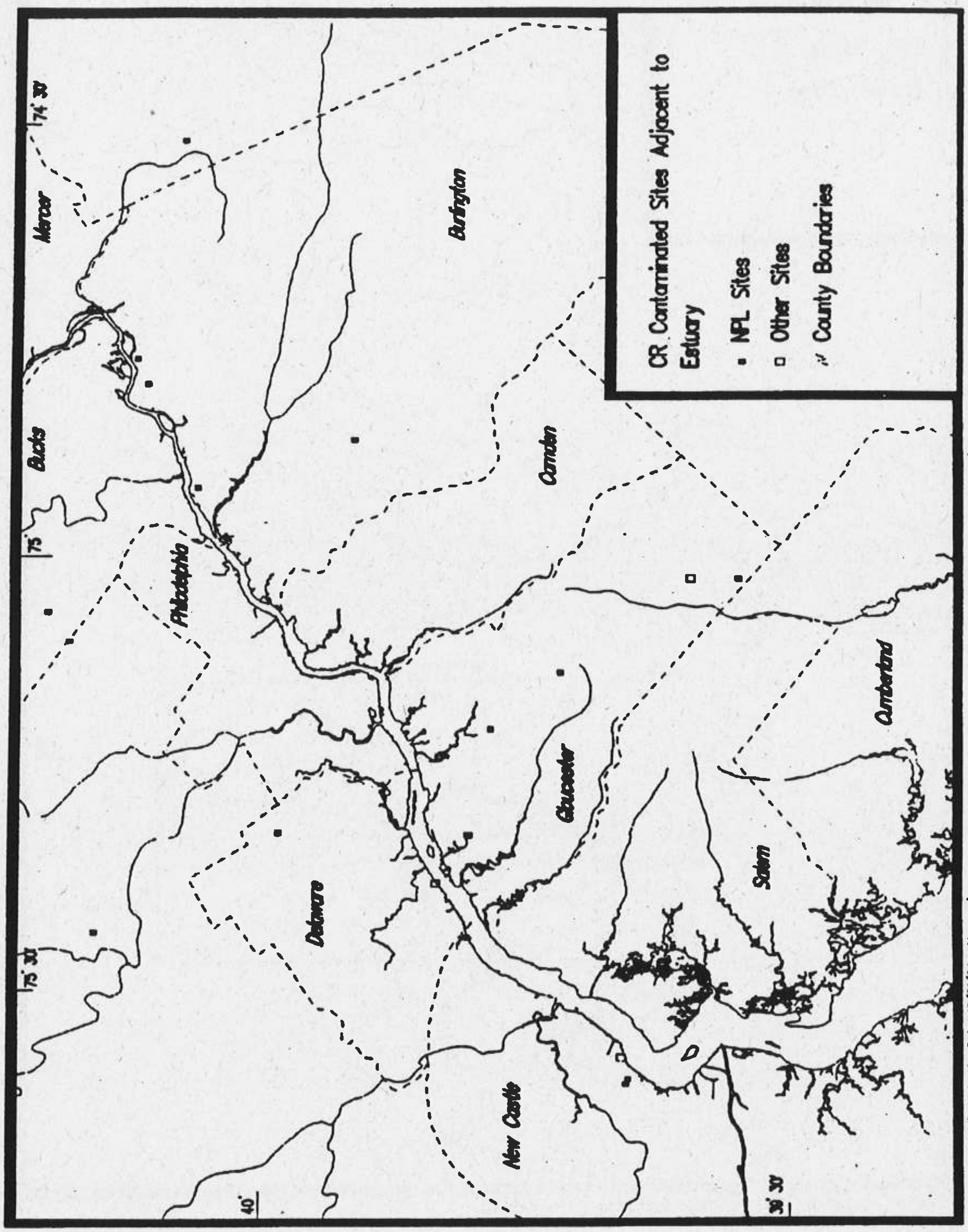


Figure 8-14. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with chromium

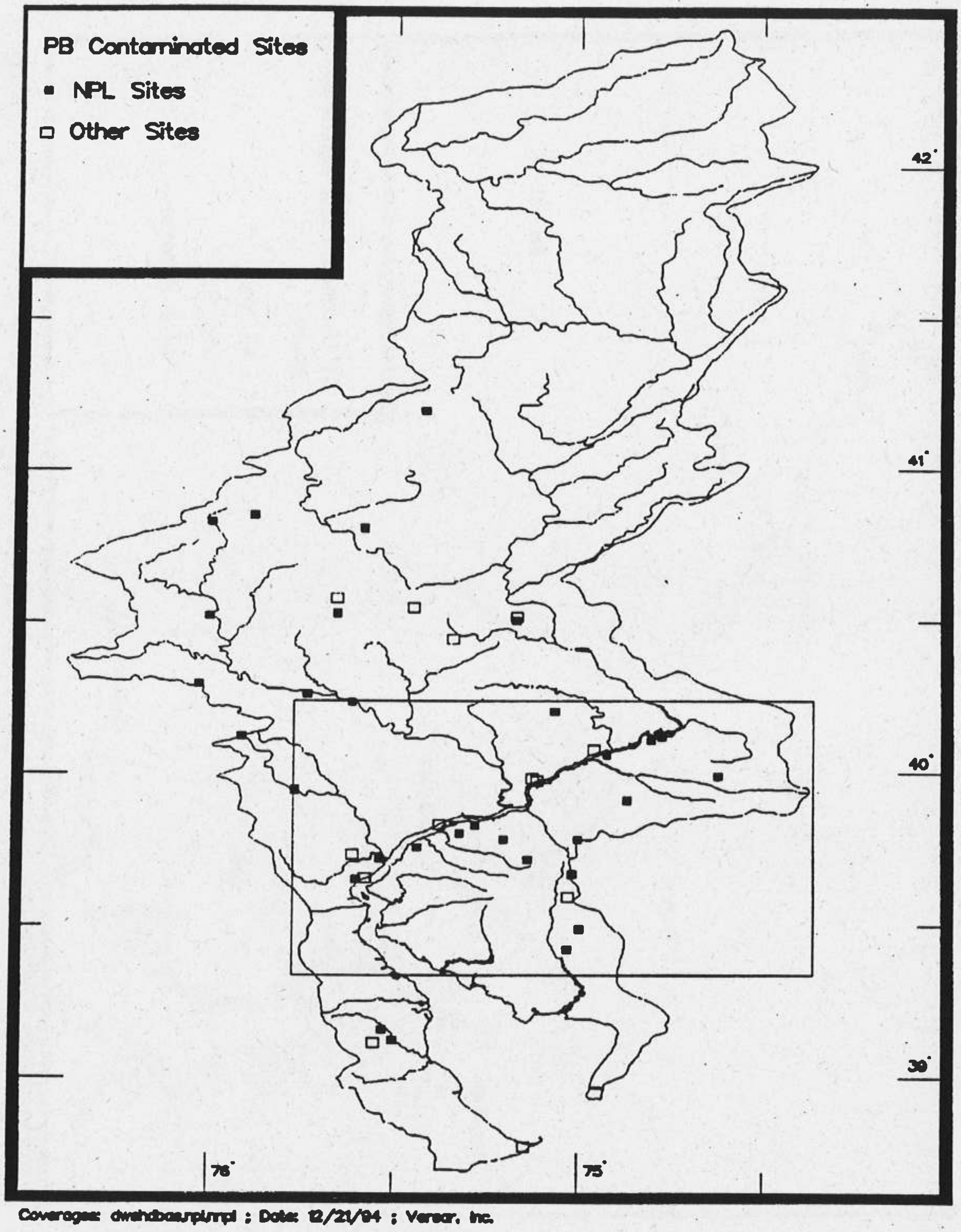


Figure 8-15. Location of USEPA CERCLIS sites contaminated with lead

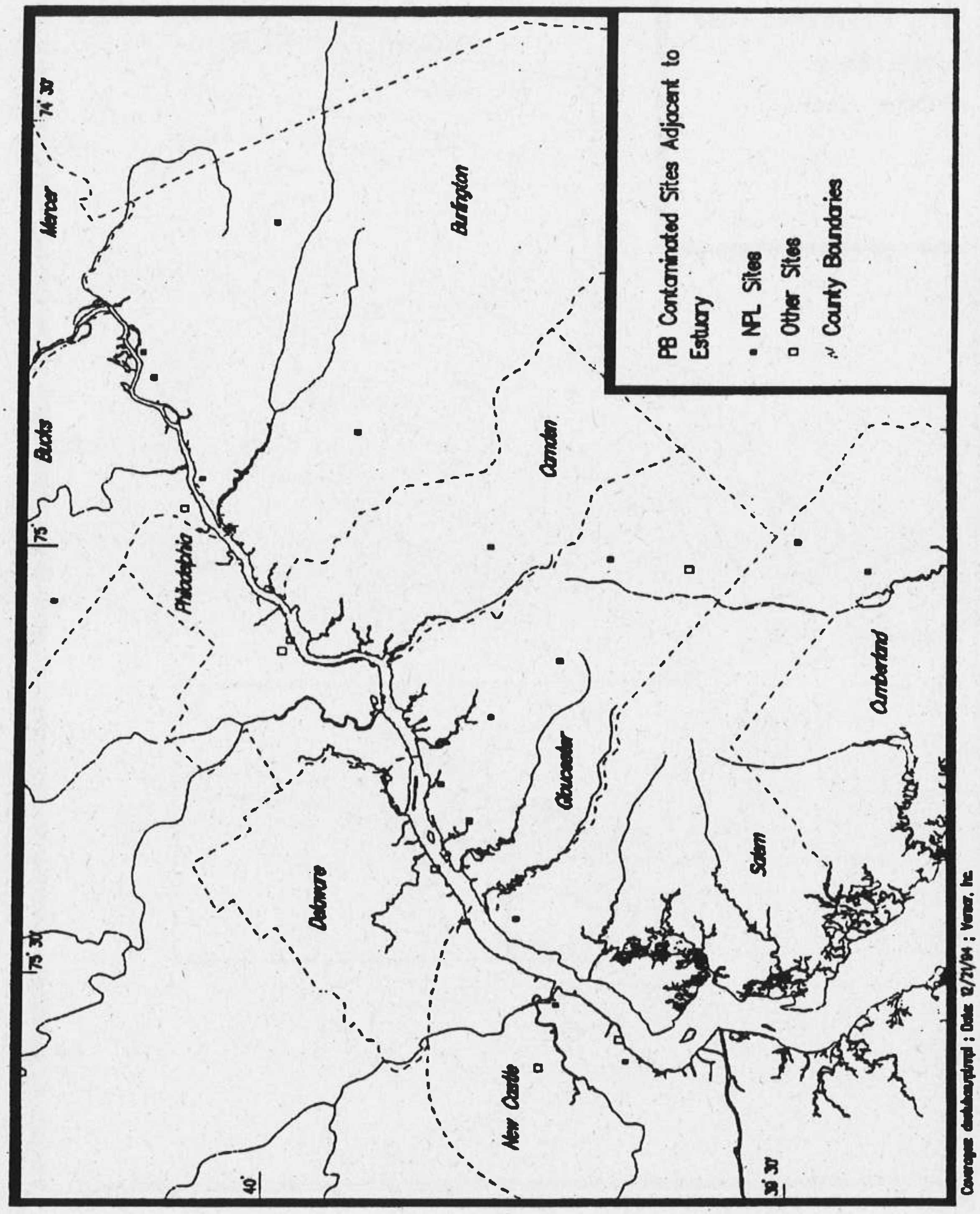


Figure 8-16. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with lead

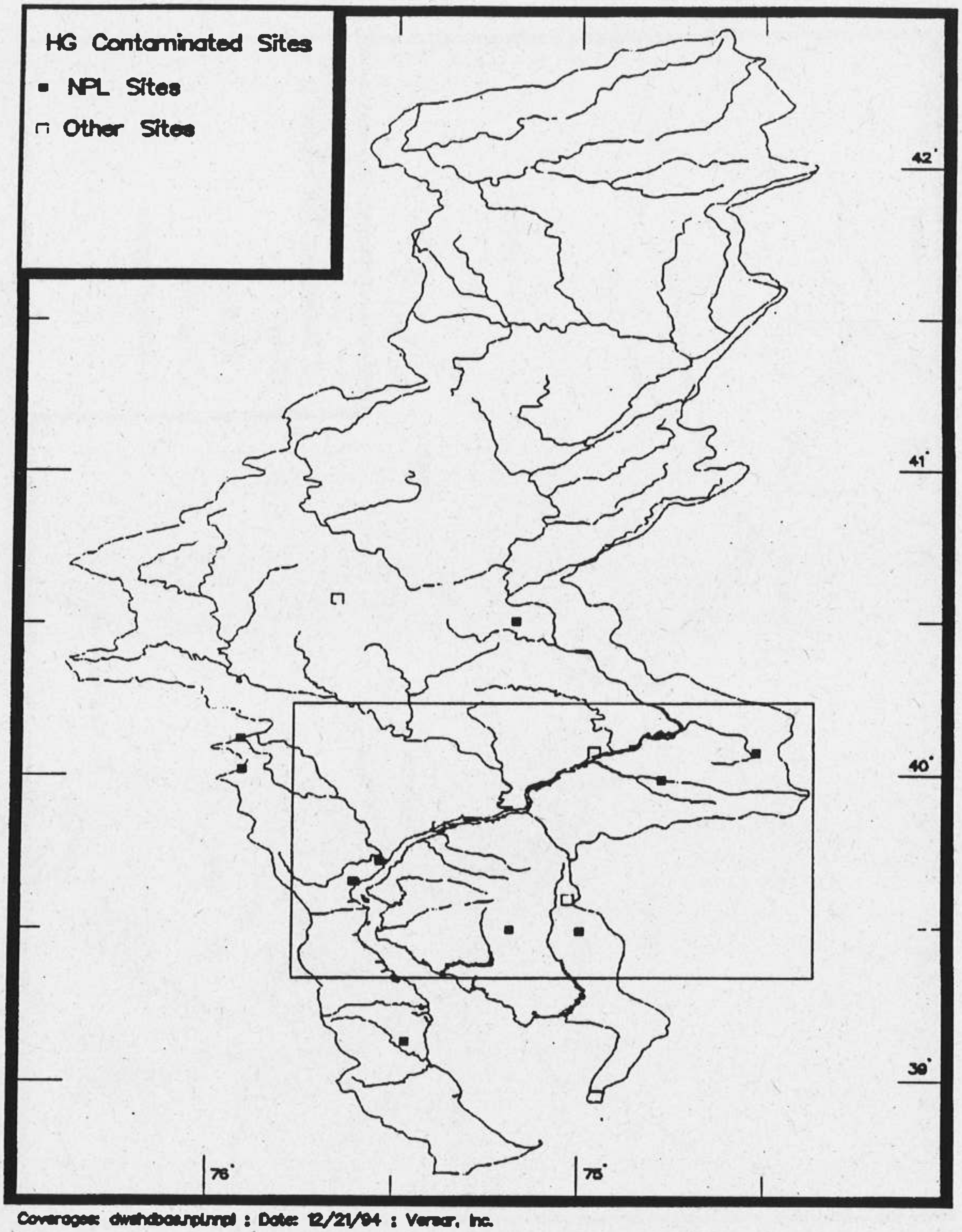


Figure 8-17. Location of USEPA CERCLIS sites contaminated with mercury

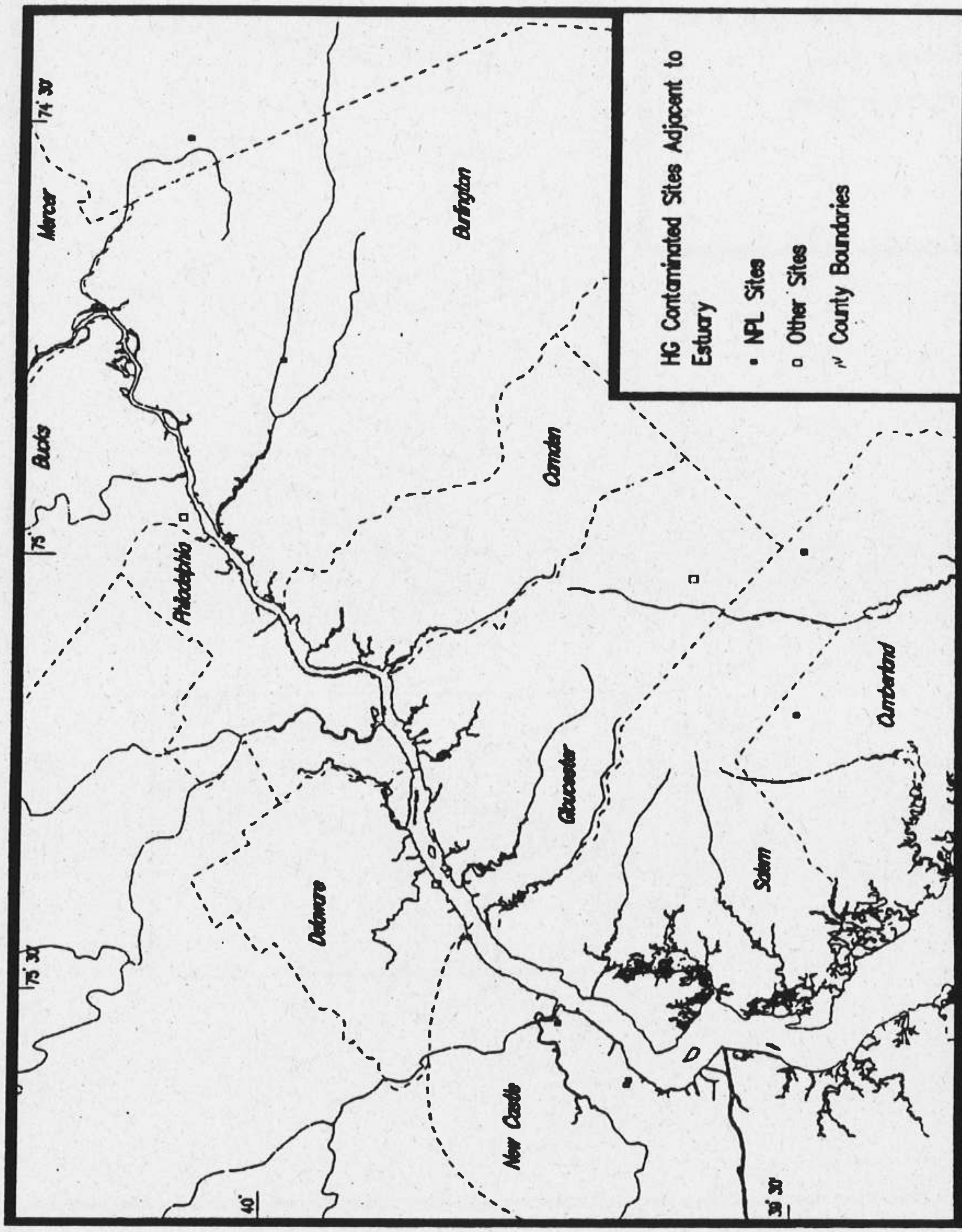


Figure 8-18. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with mercury

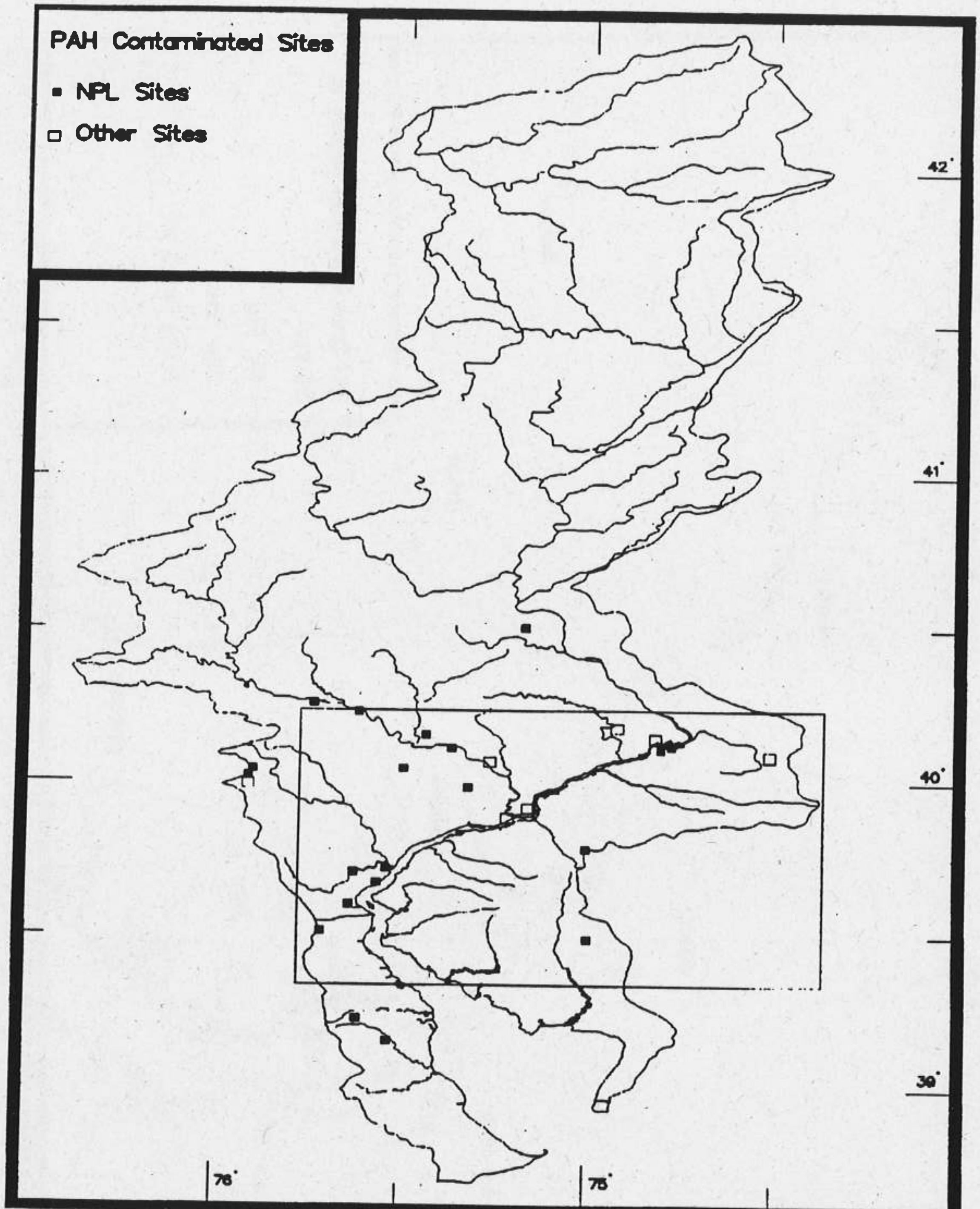


Figure 8-19. Location of USEPA CERCLIS sites contaminated with polycyclic aromatic hydrocarbons

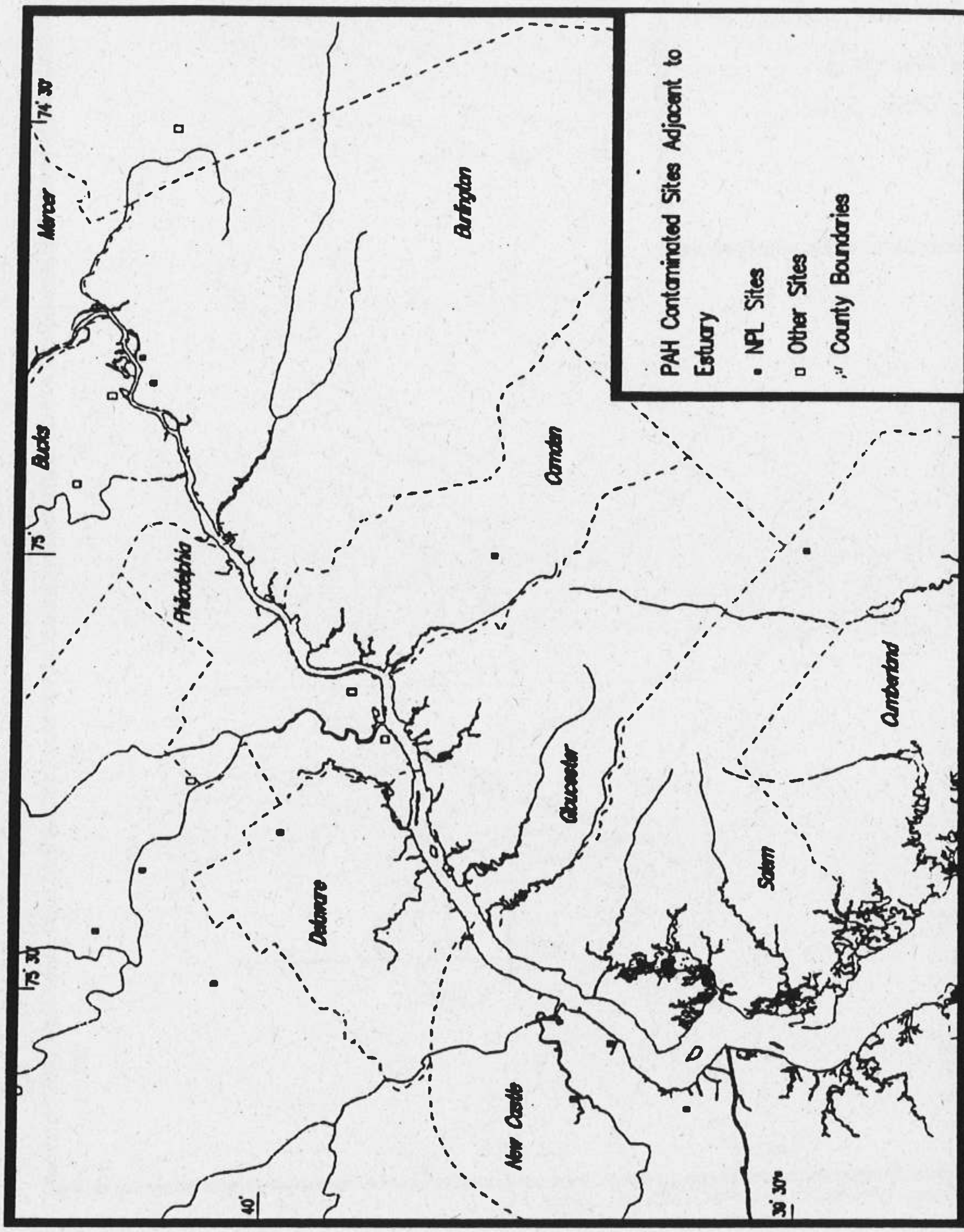


Figure 8-20. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with polycyclic aromatic hydrocarbons

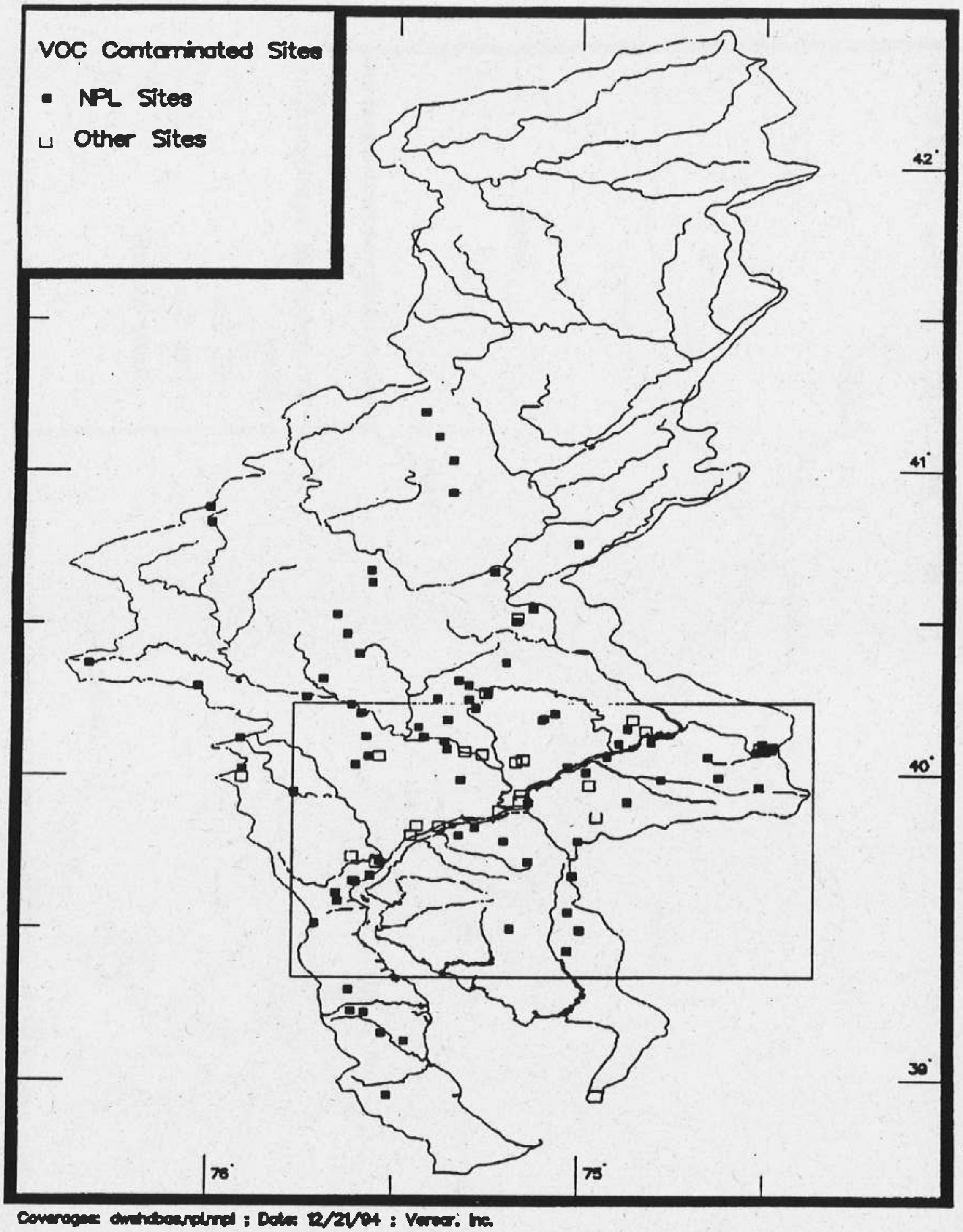


Figure 8-21. Location of USEPA CERCLIS sites contaminated with volatile organic compounds

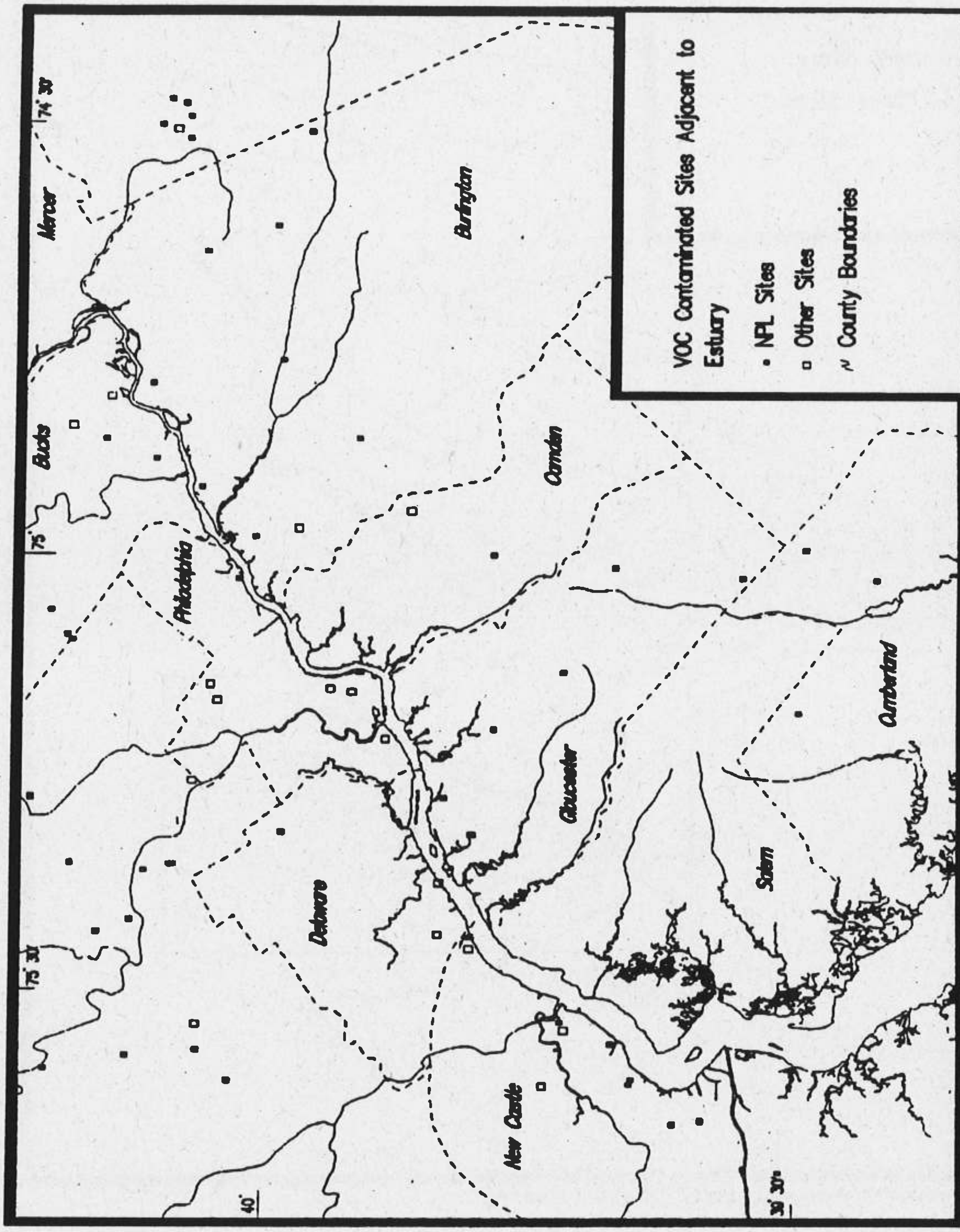


Figure 8-22. Location of USEPA CERCLIS sites adjacent to the Delaware Estuary and contaminated with volatile organic compounds

9.0 INTEGRATED ASSESSMENT OF CONTAMINANT LOADINGS

An estimate of the total amount of specific contaminants entering the Delaware River estuary was calculated from the sum of loading estimates for point sources, atmospheric deposition, urban runoff, and runoff from agricultural sources. The available data were not adequate to develop an estimate of contaminants entering the estuary through groundwater infiltration. Additionally, there was not sufficient information to estimate contaminant inputs from specific industrial, manufacturing, or hazardous waste sites within the watershed, except for inputs from point sources discharging directly into the estuary and its tributaries.

9.1 ARSENIC

Approximately 112 x 10^3 kg of arsenic enters the Delaware Estuary annually. The largest sources of arsenic (Figure 9-1) are point sources (44%) and runoff from agricultural lands (47%). Extensive use of inorganic and organic arsenic compounds in the 1950's and 1960's increased soil concentrations of arsenic and contributes to current loadings from agricultural areas. Urban runoff contributes less than 10% to the total arsenic input. Atmospheric deposition is an insignificant source of arsenic to the estuary.

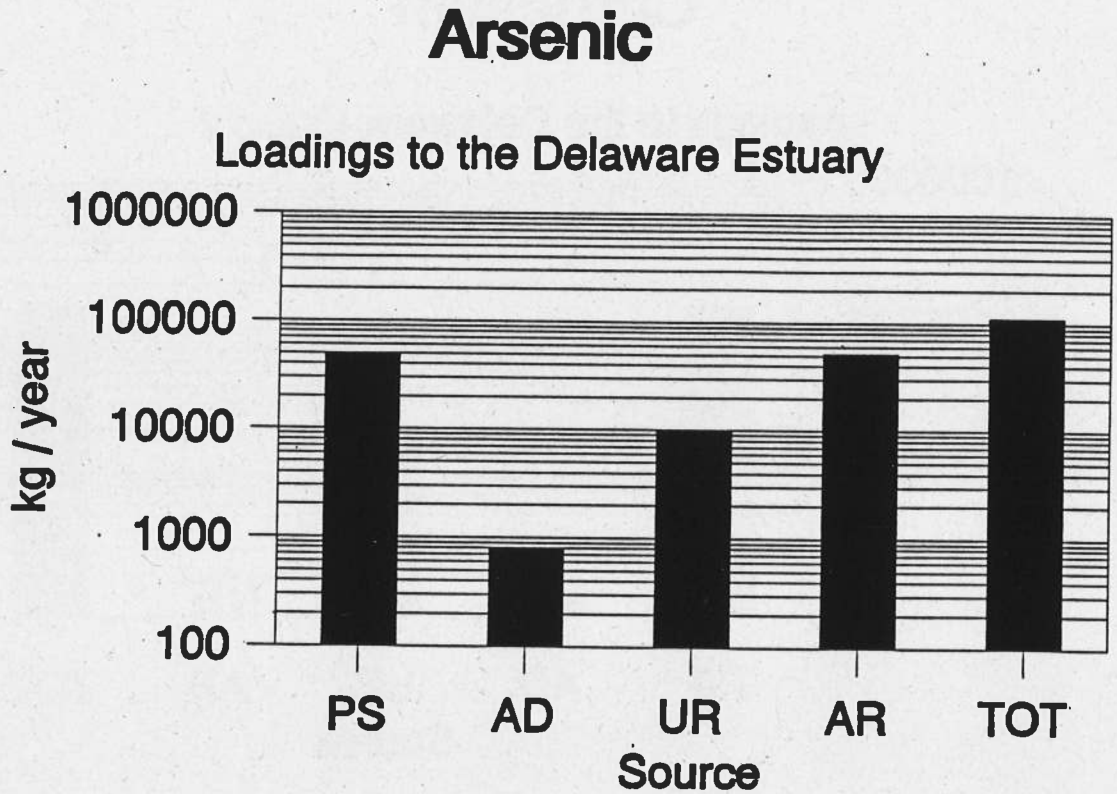


Figure 9-1. Arsenic loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.2 CHROMIUM

The Delaware Estuary receives approximately 154 x 10^3 kg of chromium annually. Most of the chromium (88%) originates from point sources (Figure 9-2). Urban runoff accounts for most of the remaining chromium entering the estuary. Atmospheric deposition is an insignificant source to chromium to the estuary. No estimate could be made for the amount of chromium entering the estuary as a result of runoff from agricultural lands.

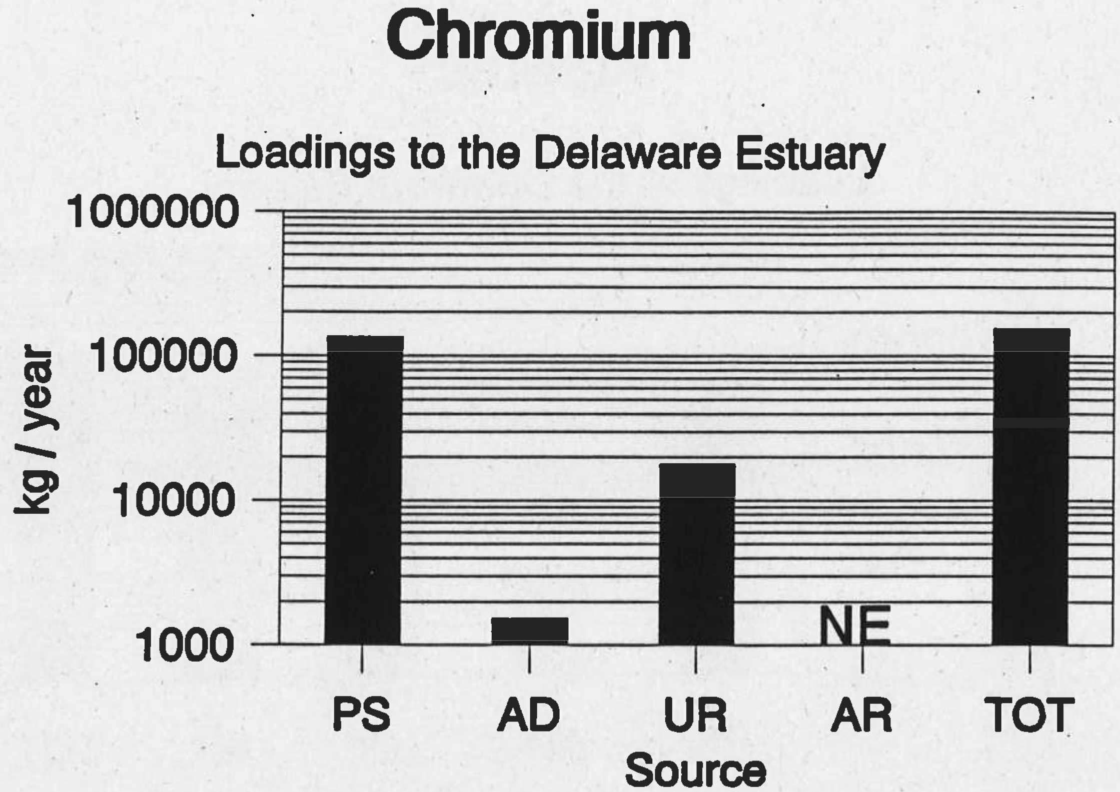


Figure 9-2. Chromium loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.3 COPPER

Approximately 153 x 10^3 kg of copper enters the estuary annually. The principal source of the copper is point sources, representing 82% of total copper loading (Figure 9-3). Urban runoff accounts for most of the remaining copper entering the estuary (16%) and copper from atmospheric deposition accounts for 2% of total copper loading. No estimate could be made for the amount of chromium entering the estuary as a result of runoff from agricultural lands.

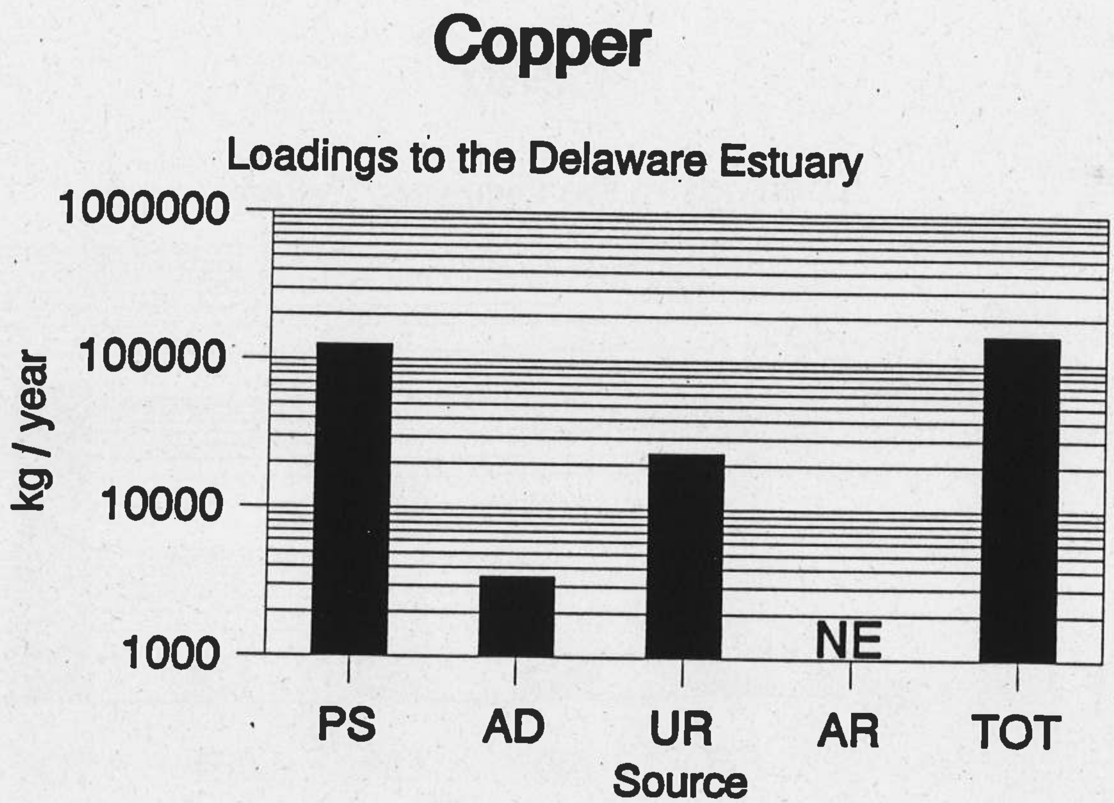


Figure 9-3. Copper loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.4 LEAD

The estuary receives approximately 126 x 10^3 kg of lead annually. The majority (70%) of the lead enters the estuary through point sources (Figure 9-4). Lead in urban runoff accounts for 24% of the total lead loading to the estuary. This is consistent with the view that old plumbing, old paint, and deposits remaining from the widespread use of leaded gasolines contribute most to environmental lead concentrations. Atmospheric deposition accounts for 5% of the total lead loading estimate. No estimate could be made for the amount of lead entering the estuary as a result of runoff from agricultural lands.

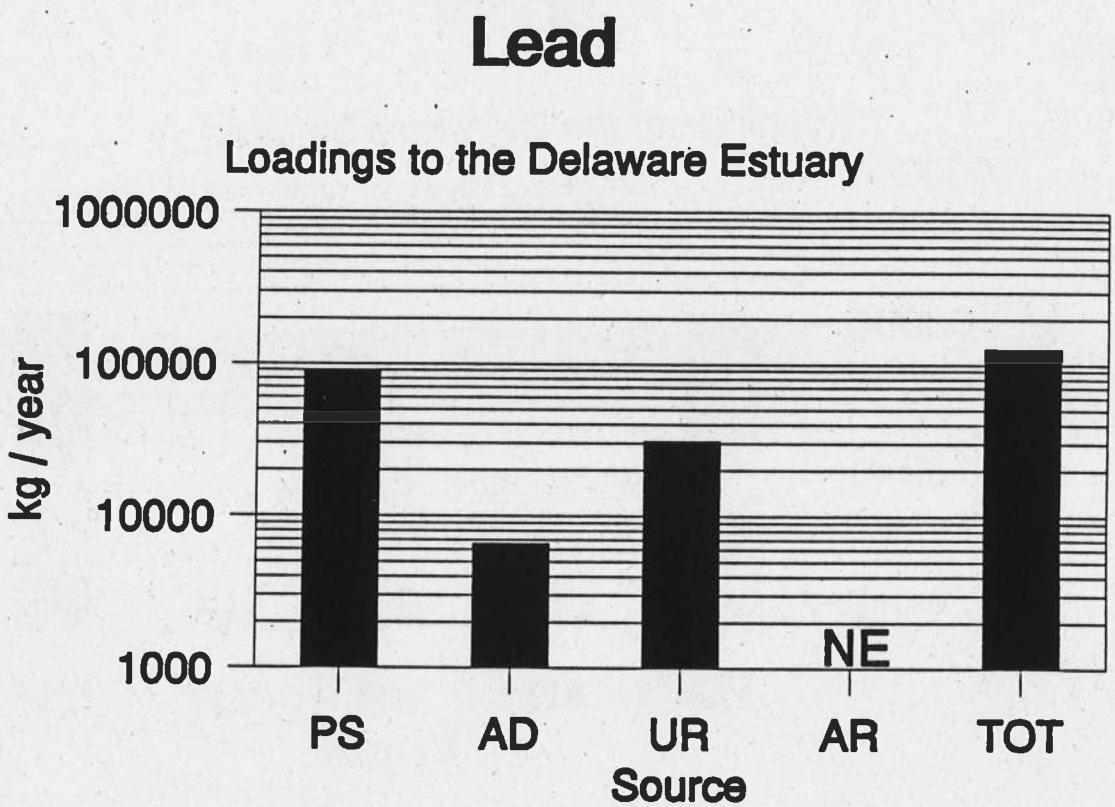


Figure 9-4. Lead loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.5 MERCURY

The annual input of mercury to the Delaware Estuary is approximately 9.9×10^3 kg. This is two orders of magnitude less that the loading rates for other metals. The route through which most (80%) of the mercury enters is atmospheric deposition. Urban runoff accounts for 11% and point sources account for 9% of the total mercury loading estimate. Loading rates for mercury from agricultural runoff could not be estimated using the data available.

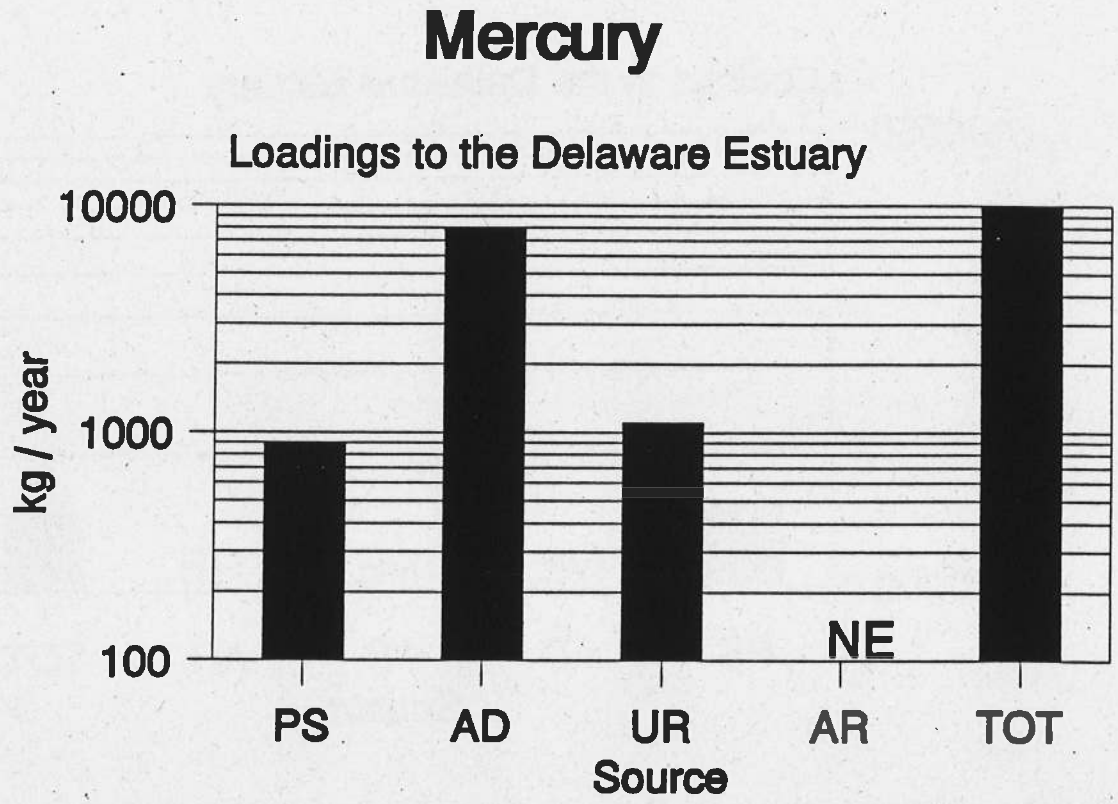


Figure 9-5. Mercury loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.6 SILVER

Quantitative estimates of the amount of silver entering the estuary could be developed for point sources only. Approximately 15 x 10^3 kg of silver enters the estuary through this route (Figure 9-6).

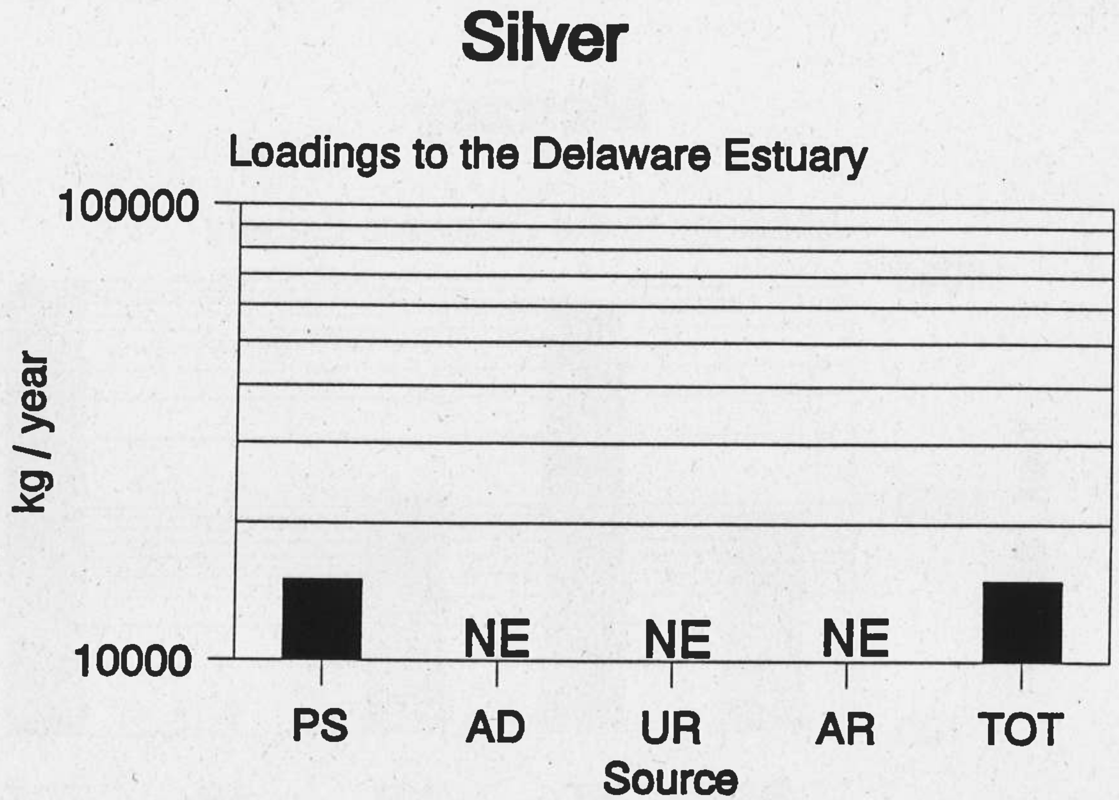


Figure 9-6. Silver loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.7 ZINC

Approximately 429 x 10^3 kg of zinc enters the estuary annually. This is the largest amount of any of the metals of concern to the Delaware Estuary Program. The largest sources of zinc are represented by point sources (53%) and urban runoff (43%) (Figure 9-7). Atmospheric deposition is a source for approximately 4% of the total amount of zinc entering the estuary. No estimate could be made for the amount of zinc entering the estuary in the runoff from agricultural lands.

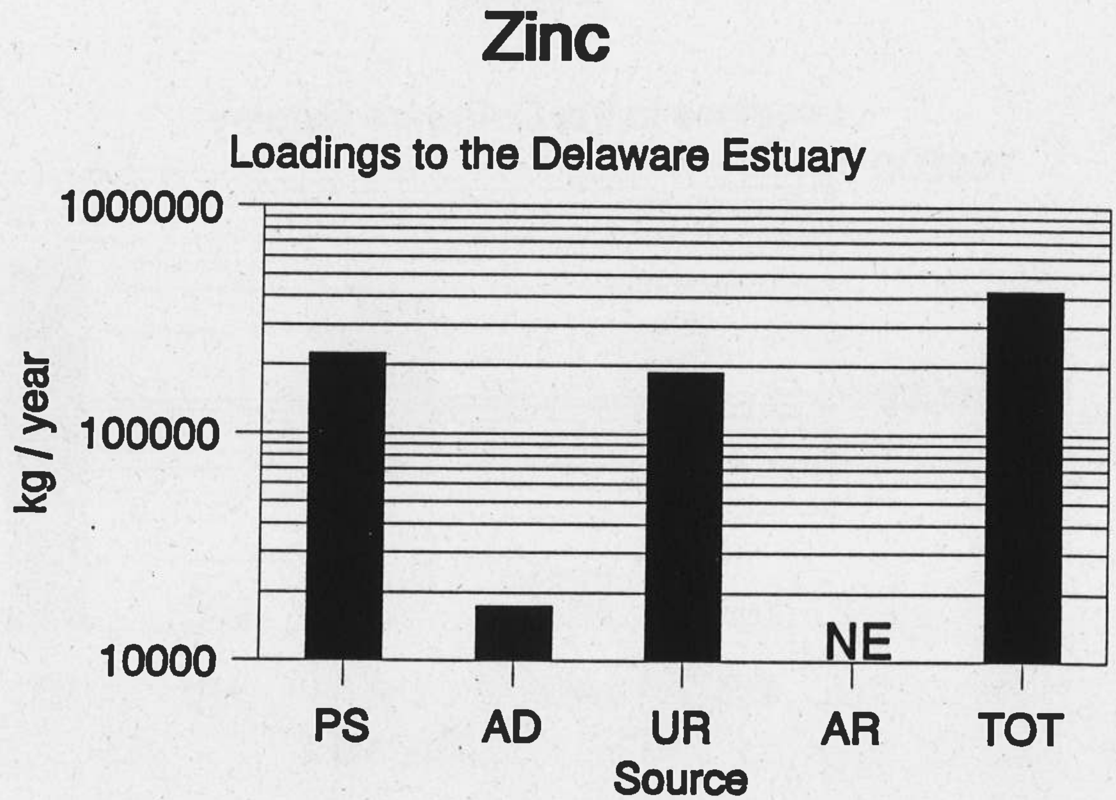


Figure 9-7. Zinc loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.8 POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

Loading estimates for polycyclic aromatic hydrocarbons could be made for atmospheric deposition and urban runoff only. No estimates could be made for PAH inputs from point sources or agricultural runoff based on the data available for this report. Approximately 35 x 10^3 kg of PAHs enter the estuary via atmospheric deposition and urban runoff (Figure 9-8). Urban runoff accounts for 95% of the total.

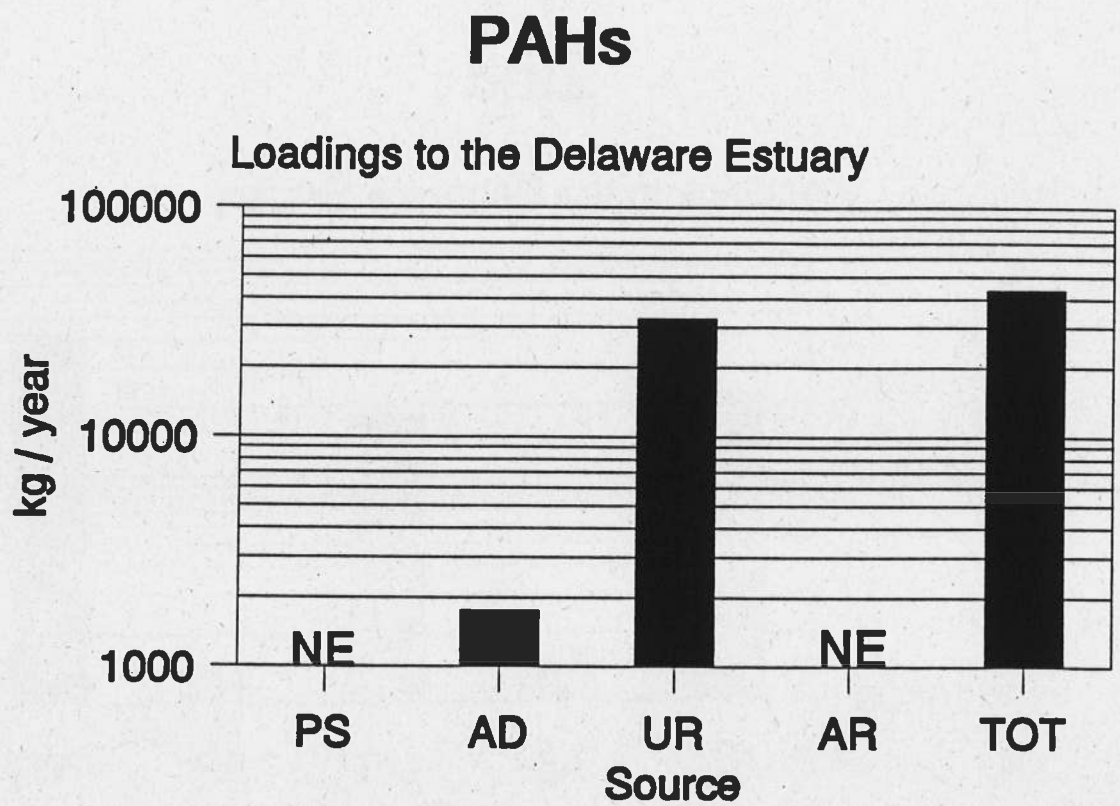


Figure 9-8. PAH loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.9 CHLORINATED PESTICIDES

The Delaware Estuary receives approximately 7.9×10^3 kg of chlorinated pesticides annually. The largest sources of these pesticides is runoff from agricultural areas (Figure 9-9). Chlorinated pesticides were previously added to these areas in large amounts. The slow degradation rates of these pesticides has caused them to persist in the environment and continue to enter the estuary, despite severe restrictions on their current use. The second largest source of chlorinated pesticides to the estuary appears to be point sources. This finding may be a result of the urbanization of areas previously used for agriculture. No estimates could be made of the input of chlorinated pesticides to the estuary as a result of atmospheric deposition or urban runoff.

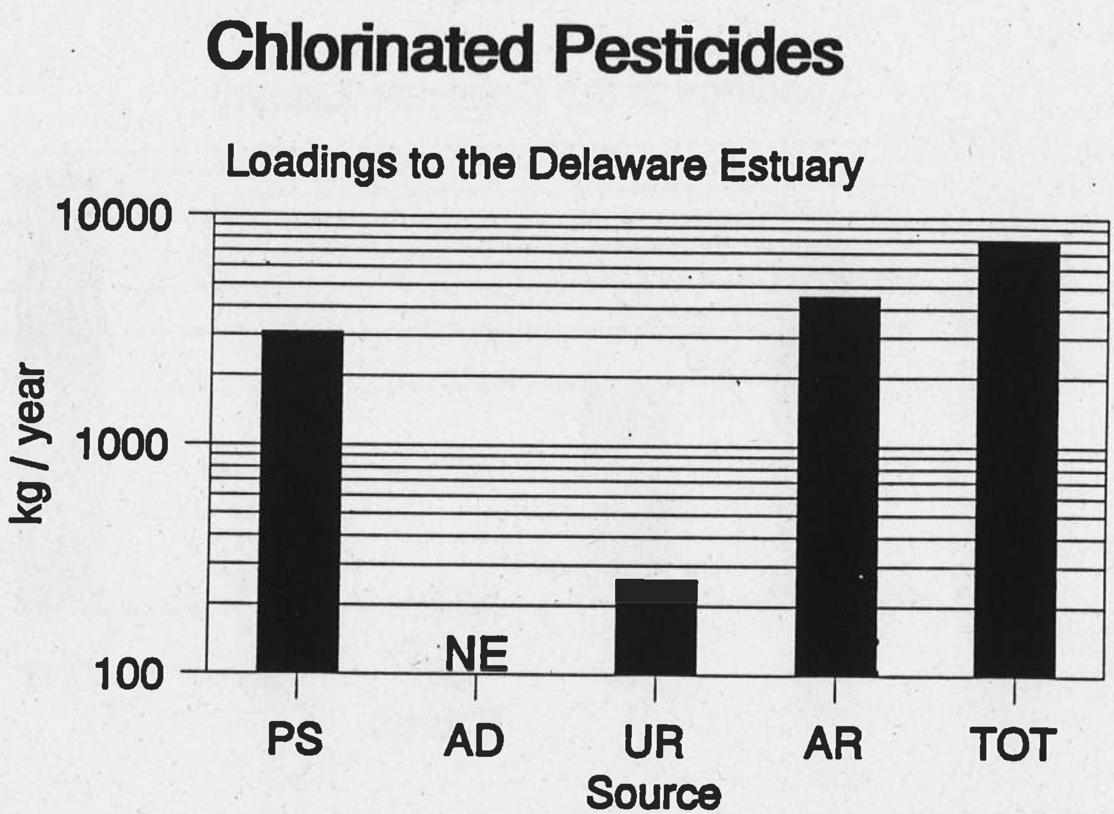


Figure 9-9. Chlorinated Pesticide loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.10 POLYCHLORINATED BIPHENYLS (PCB)

Loading estimates were possible for point sources, atmospheric deposition, and urban runoff (Figure 9-10). Existing data were not adequate to complete estimates for the amount of PCBs entering the estuary from agricultural runoff. Estimates indicate that the estuary receives at least 0.089 x 10^3 kg of PCBs annually (89 kg/yr). PCBs from point sources account for 66% of the total PCB estimate with the remaining entering as a result of atmospheric deposition. Existing models indicated that only insignificant amounts of PCBs enter the estuary as a result of urban runoff.

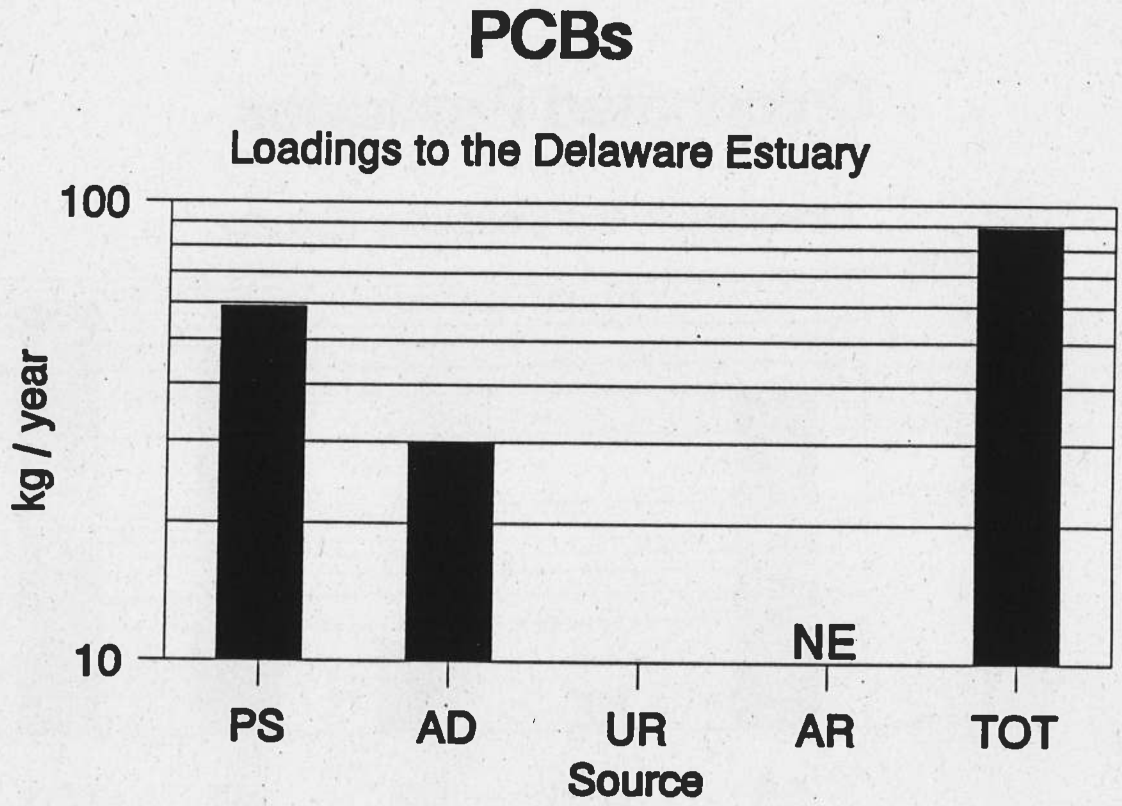


Figure 9-10. PCB loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.11 1,2 DICHLOROETHANE

Based upon estimates for point sources and urban runoff, approximately 23 x 10^3 kg of 1,2-dichloroethane enter the estuary annually (Figure 9-11). Point sources account for 78% of the total dichloroethane loading estimate. No estimate could be made of the amount of dichloroethane entering the estuary as a result of atmospheric deposition and agricultural runoff. Although not estimated, it is likely that atmospheric deposition is a significant route by which this volatile organic compound enters the estuary because it is highly volatile and soluble in water.

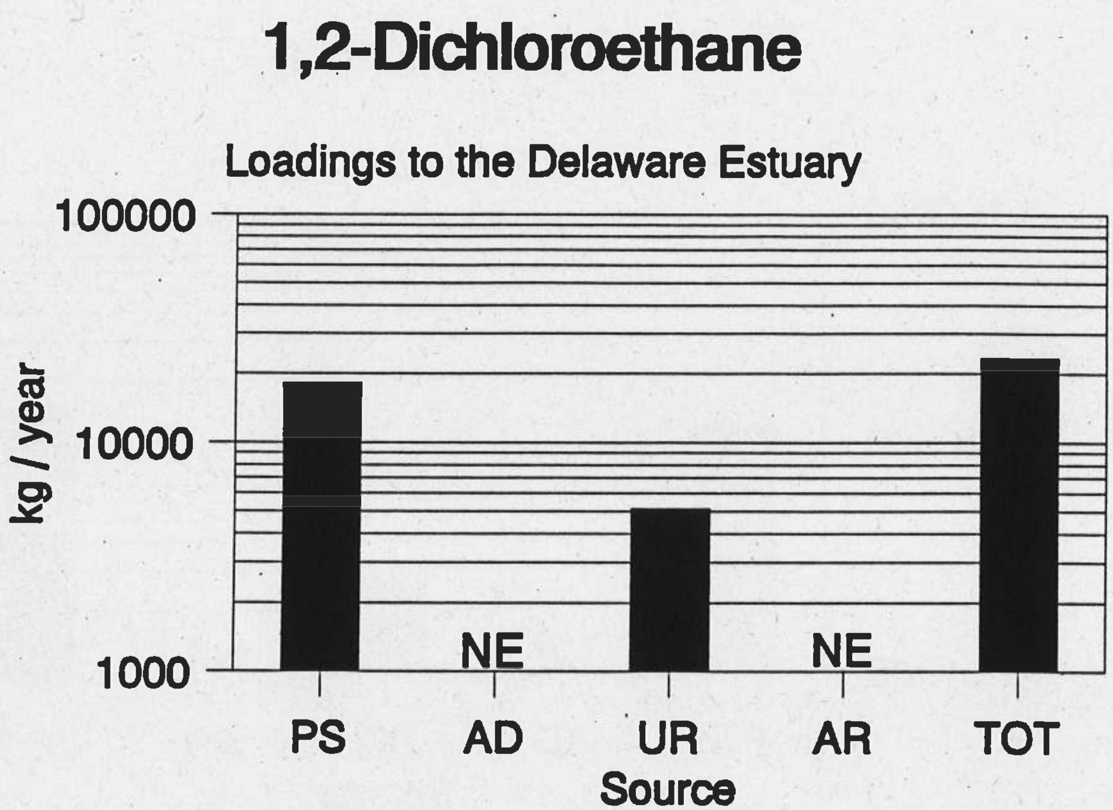


Figure 9-11. 1,2-Dichloroethane loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

9.12 TETRACHLOROETHANE

Loading estimates for the volatile organic compound tetrachloroethane could be completed for point source inputs and inputs from urban runoff. Approximately 15 x 10^3 kg enters the estuary annually with 80% entering through point source discharges (Figure 9-12). No estimate could be made of the amount of tetrachloroethane entering the estuary as a result of atmospheric deposition and agricultural runoff. Direct atmospheric deposition to the estuary is likely to be a significant by which this compound enters the estuary because of its high volatility and solubility in water.

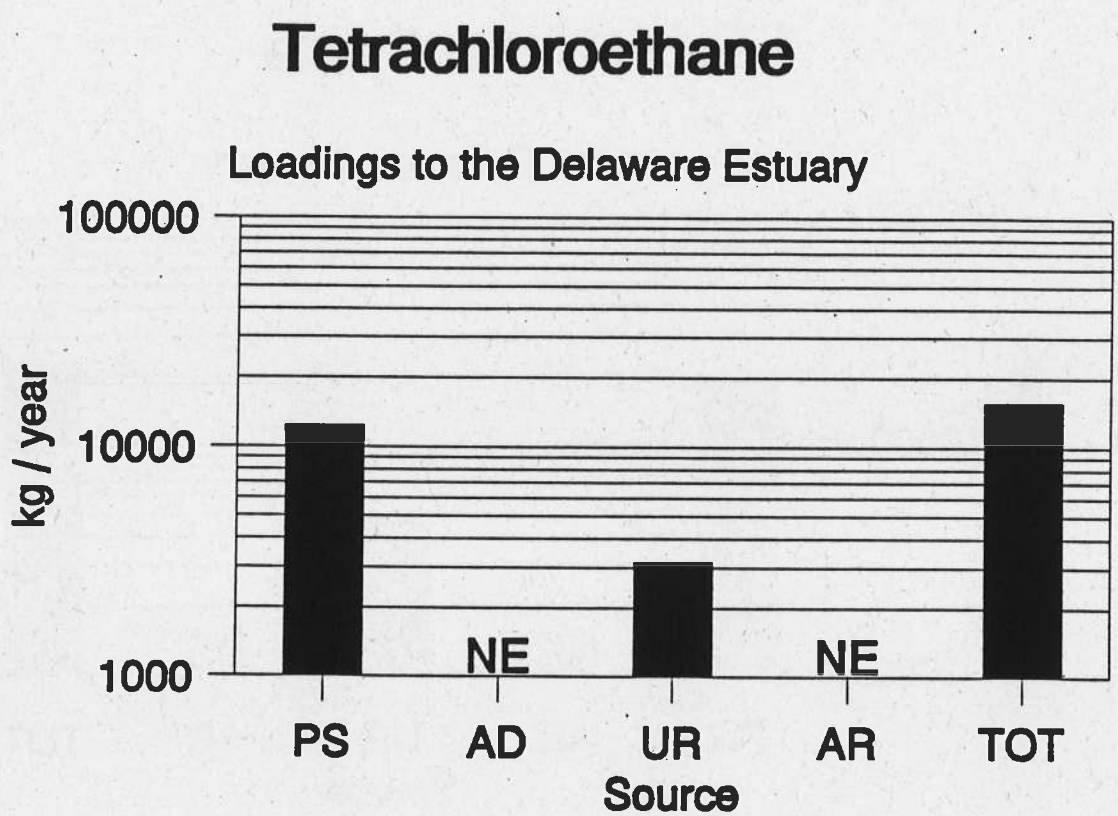


Figure 9-12. Tetrachloroethane loadings to the Delaware Estuary. Legend: PS = Point Sources, AD = Atmospheric Deposition, UR = Urban Runoff, and AR = Agricultural Runoff.

10.0 VERIFICATION OF LOADINGS WITH SEDIMENT RESERVOIR

10.1 INTRODUCTION

The contaminants of concern to the Delaware Estuary Program are generally reactive and become adsorbed to the surfaces of particles. Sediment-water partitioning coefficients for the contaminants of concern to the Delaware Estuary Program are generally high, indicating that the sediments of the estuary will trap these contaminants. Because the sediments within the estuary are a sink for most of these contaminants, the amount of contaminants in the sediments should exceed the total annual contaminant loading rate from point and non-point sources, unless there is a net transport of sediment out of the estuary, or chemical degradation of organic contaminants.

The amount of contaminants sequestered in the sediment of the Delaware River Estuary was estimated. This estimate was compared with the loading estimates presented in previous chapters as a first-order verification of the estimated loading rates.

Sediment contaminant reservoirs were estimated using data from the USEPA's Environmental Monitoring and Assessment Program (EMAP) (Weisberg et al. 1993), NOAA's National Status and Trends Program (NS&T) NOAA (1991), the USEPA's STORET and ODES data bases, and the recent study of sediment contaminants completed by Arthur D. Little, Inc. (ADL) for the Delaware Estuary Program (Costa and Sauer 1993). The EMAP, NS&T, and ADL studies used similar collection and analytical methods to measure contaminant concentrations; these data were considered to be of high quality. Methods used to collect the data in the ODES and STORET data bases were more variable. Figure 10-1 shows the locations of sampling stations for these programs.

10.2 METHODS

Sediment concentration data were used to estimate contaminant reservoirs using the methods outlined in this section. Contaminant reservoirs were estimated for seven segments of the estuary. The segments are described in Table 10-1 and shown in Figure 10-1. The sediment sample sites within each segment were identified, and the estuarine area within each segment was calculated.

Using data from the sampling stations within each segment, an average sediment concentration was calculated for each segment. Stations within each segment were equally weighted for the calculation. Sediment concentrations (μg or ng contaminant/g dry weight sediment) were then converted to areal estimates of contaminant storage. To complete this calculation, the average water content (by volume) of sediments was assumed to be 50%,

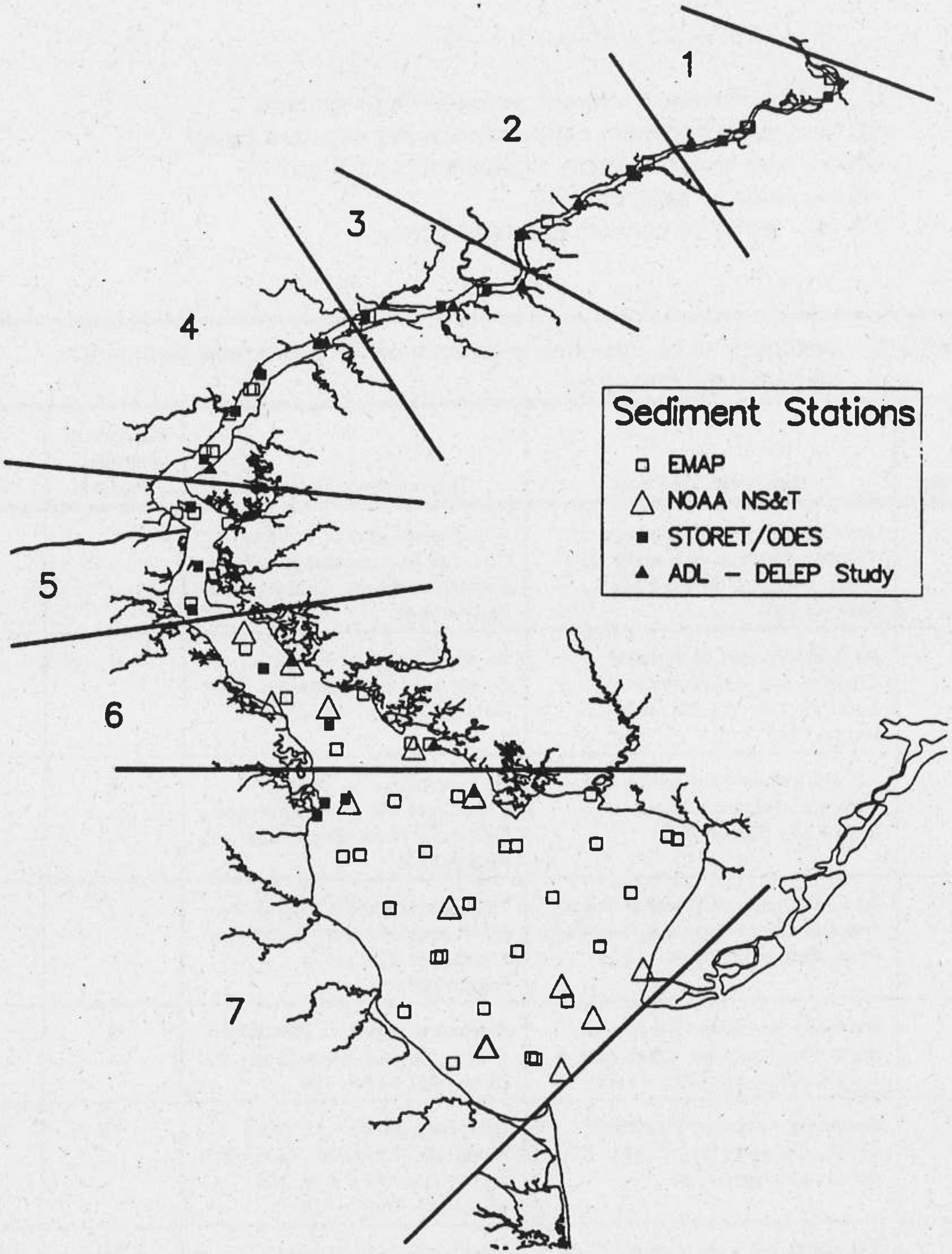


Figure 10-1. **Location of sampling stations for which sediment contaminant concentration data were available.**

and the average density of dry sediments was assumed to be as 2.5 g/cm^3. The following equation was used:

$$CS = SC \times DN \times AR \times 10$$

where
- CS = contaminant storage estimate (kg/segment)
- SC = mean sediment concentration per segment (μg/g)
- DN = dry weight density of sediments (2.5 g/cm^3)
- AR = area of segment (kg)
- 10 = factor to convert to proper units.

Table 10-1. Descriptions of estuarine segments used to estimate sediment contaminant reservoirs

Segment	Upstream Terminus	Downstream Terminus	Number of Sampling Stations	Area (km^2)
1	Just south of upstream end of Trenton Channel and north of Moon Channel (Rmi=132; Rkm=212)	At seaward end of Beverly Channel and upstream end of Enterprise Range (Rmi=114.5; Rkm=184)	4	14.15
2	At seaward end of Beverly Channel and upstream end of Enterprise Range (Rmi=114.5; Rkm=184)	At confluence of Newton Creek with the Delaware River (Rmi=97; Rkm=156)	4	25.51
3	At confluence of Newton Creek with the Delaware River (Rmi=97; Rkm=156)	At confluence of Chester Creek and Old Canal with the Delaware River (Rmi=83; Rkm=133)	5	31.63
4	At confluence of Chester Creek and Old Canal with the Delaware River (Rmi=83; Rkm=133)	Between Gambles Gut to the north and Red Lion Creek to the South (Rmi=63; Rkm=101)	7	67.90
5	Between Gambles Gut to the north and Red Lion Creek to the South (Rmi=63; Rkm=101)	Boundary between Blackbird Creek, DE and Hope Creek, NJ (Rmi=49; Rkm=79)	3	95.44
6	Boundary between Blackbird Creek, DE and Hope Creek, NJ (Rmi=49; Rkm=79)	Boundary between Leipsic River, DE (Rmi=34; Rkm=55) and Fortescue Creek, NJ (Rmi=28; Rkm=45)	12	261.85
7	Boundary between Leipsic River, DE (Rmi=34; Rkm=55) and Fortescue Creek, NJ (Rmi=28; Rkm=45)	Mouth of the Delaware Estuary (Rmi=0; Rkm=0)	35	1484.14

Sediment contaminant concentrations reflect recent deposition of particulates from the overlying water column, nearbed transport of particles, and mixing of surface sediments with deeper sediment through bioturbation. The measured sediment concentrations corresponded to homogenized samples representing the top 2 cm of sediments. In anoxic areas devoid of bioturbation, 2 cm may represent 2 to 10 years of contaminant deposition, depending upon deposition rates. Bioturbation can extend to 10 cm or more, thus causing surface sediments to reflect decades of contaminant inputs.

To reflect sediment inputs during the past 40 years, the estimate for contaminant storage in the top 2 cm was multiplied by 10. This calculation assumes that the average sedimentation rate during the past 40 years was approximately 0.5 cm/year and that the concentrations in the top 2 cm are similar to concentrations in the top 20 cm. The assumed sedimentation rate may reflect average conditions but is not meant to reflect specific regions of the estuary. Similarly, the assumption that bulk sediment contaminant concentrations are similar in the top 20 cm may be a good approximation for some contaminants; however, this assumption is not correct for contaminants that have declined in use significantly due to regulatory controls. For example, the gradual removal of tetraethyl lead from gasolines has significantly decreased atmospheric emissions of lead in the United States (USEPA 1991; Figure 10-2), and the restrictions on the use of PCBs have decreased PCB emissions. Despite whatever inaccuracies may be included in the above assumptions, the appropriate factor to extrapolate from contaminant concentrations in the top 2 cm to the amount of contaminants deposited during the past 40 years probably is no more than a factor of two different than 10.

10.3 SEDIMENT CONTAMINANT CONCENTRATIONS

Tables 10-2 and 10-3 present mean sediment contaminant concentrations for each segment of the estuary. Concentrations of most contaminants (i.e., Figure 10-3 for PCBs) are highest in the upper three segments of the estuary in the highly industrialized region between Wilmington, DE, and Trenton, NJ. This region receives the largest contaminant input from point sources. Contaminant loading from urban runoff is also highest in this region. Nonpoint contaminant inputs from landfills and industrial sites probably are highest in this region of the estuary because of the high concentration of hazardous waste sites listed in the USEPA's Superfund data base (CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System) and the number of those sites that are part of the National Priority List (NPL; See Section 8). Estimates of contaminant inputs from the Superfund and NPL sites were not completed separately since a large amount of site-specific data would be needed to complete those estimates and these data are not readily available for most sites.

The pattern of highest sediment concentrations occurring in the upper portion of the estuary is strongest for the pesticides DDT, chlordane, dieldrin, and PCBs. Most metals show the same pattern. The highest mean concentration of DDT occurs in Segment 1 (Figure 10-4) suggesting a significant upstream source of DDT. This is partially supported by the finding of highest concentrations of the DDT degradation compounds DDD and DDE downstream in Segment 2 of the estuary.

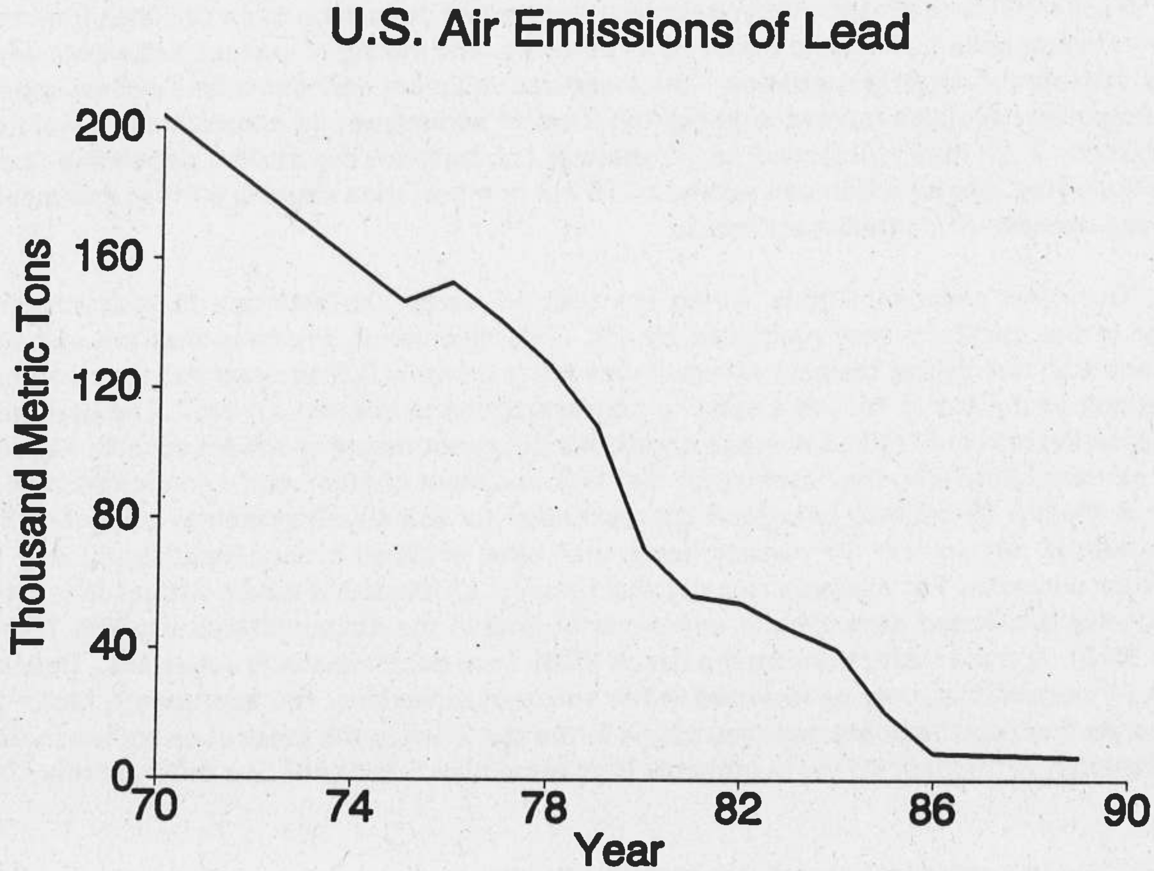


Figure 10-2. U.S. emissions of lead to air (USEPA 1991).

Table 10-2. Average contaminant concentrations in sediments of the Delaware River Estuary: Metals (ug/g dry weight sediment).

	As	Cd	Cr	Cu	Pb	Hg	Ag	Zn
Segment 1	3.90	2.75	45.1	42.9	47.87	0.09	0.20	435.7
Segment 2	0	0.43	36.3	42.5	24.47	0.16	0	367.0
Segment 3	1.78	0.07	42.7	25.0	28.64	0.18	0.01	193.9
Segment 4	2.15	0.15	48.1	23.1	25.35	0.20	0.01	174.1
Segment 5	.	0.3	68.5	20.5	33.21	0.21	0	170.7
Segment 6	4.84	0.18	44.5	9.87	16.38	0.07	0.07	97.2
Segment 7	6.34	0.34	33.6	6.40	16.72	0.06	0.06	64.5

Table 10-3. Average contaminant concentrations in sediments of the Delaware River Estuary: Organics (ng/g dry weight sediment).

	DDT	DDD	DDE	Chlordane	Dieldrin	PCBs	1,2 Dichloroethane	Tetrachloroethane
Segment 1	13.2	10.3	18.9		1.0	53.9	N.D.	N.D.
Segment 2	0	35.4	37.3		3.3	136.1	N.D.	N.D.
Segment 3	0.1	0	0		1.0	106.9	N.D.	N.D.
Segment 4	0.2	1.5	1.8		0.4	42.3	N.D.	N.D.
Segment 5	0.3	0.1	0.3		0.1	8.9	N.D.	N.D.
Segment 6	0.4	2.2	2.4		0.3	16.3	N.D.	N.D.
Segment 7	0.4	0.7	1.5		0.2	7.7	N.D.	N.D.

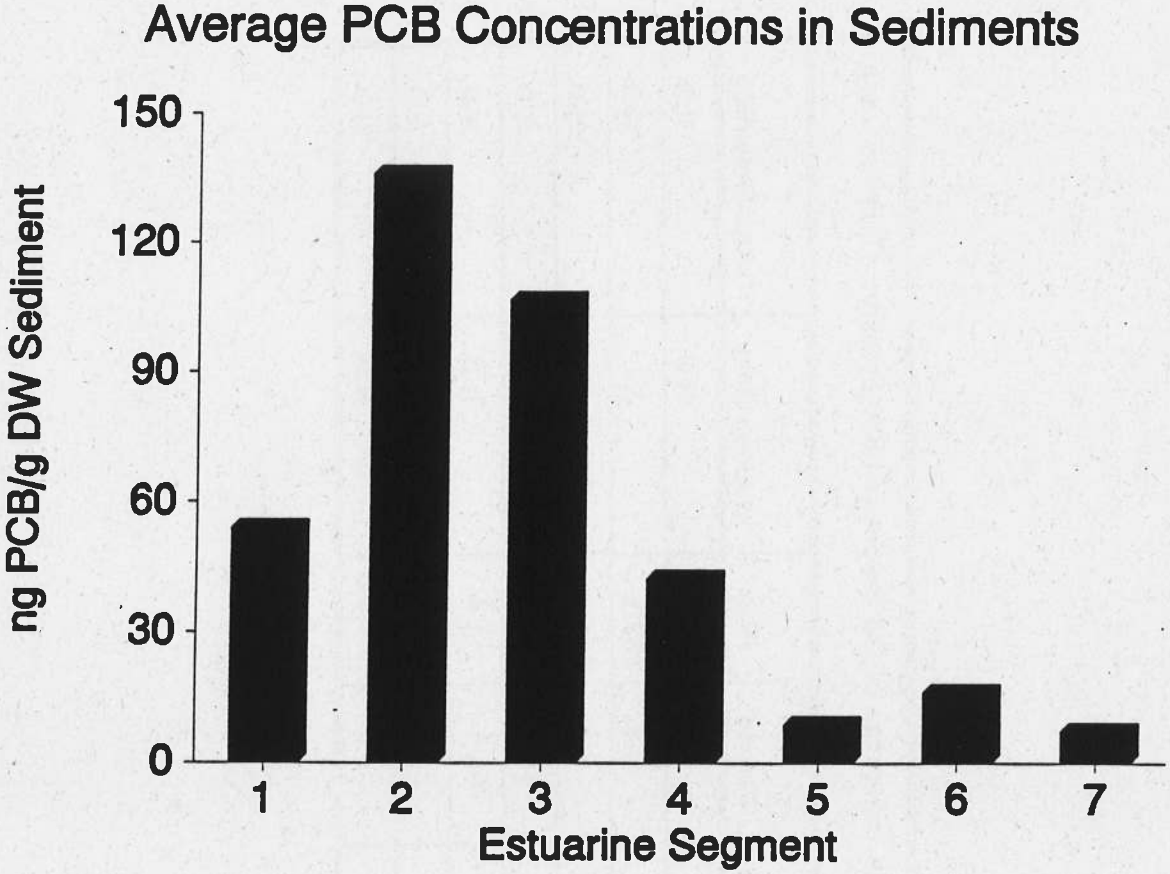


Figure 10-3. Mean concentration of PCBs in Delaware Estuary sediments.

Arsenic concentrations in sediments showed a spatial pattern different than that shown for most other contaminants. The highest concentration of arsenic was found in the lower bay segment. A potential cause of this is former industrial activity on the Maurice River. Between 1949 and the late 1980's, the Vineland Chemical Company manufactured organic herbicides containing arsenic at a site adjacent to the Maurice River, just north of Millville, NJ. As a result of plant operations and the storage of by-product arsenic salts, the subsurface soils, groundwater, and the Maurice River system downstream of the site were contaminated with arsenic (Ficklin et al. 1993). Downstream transport was significant in that Union Lake, a reservoir approximately seven miles from the site, is contaminated with arsenic. It is conceivable that large amounts of arsenic was transported further downstream and out into the estuary. Arsenic as As(III) and As(V) is mobile and sensitive to redox conditions within the sediments. Core data suggest that arsenic is diffusing out of Union Lake sediments into the overlying water (Ficklin et al. 1993).

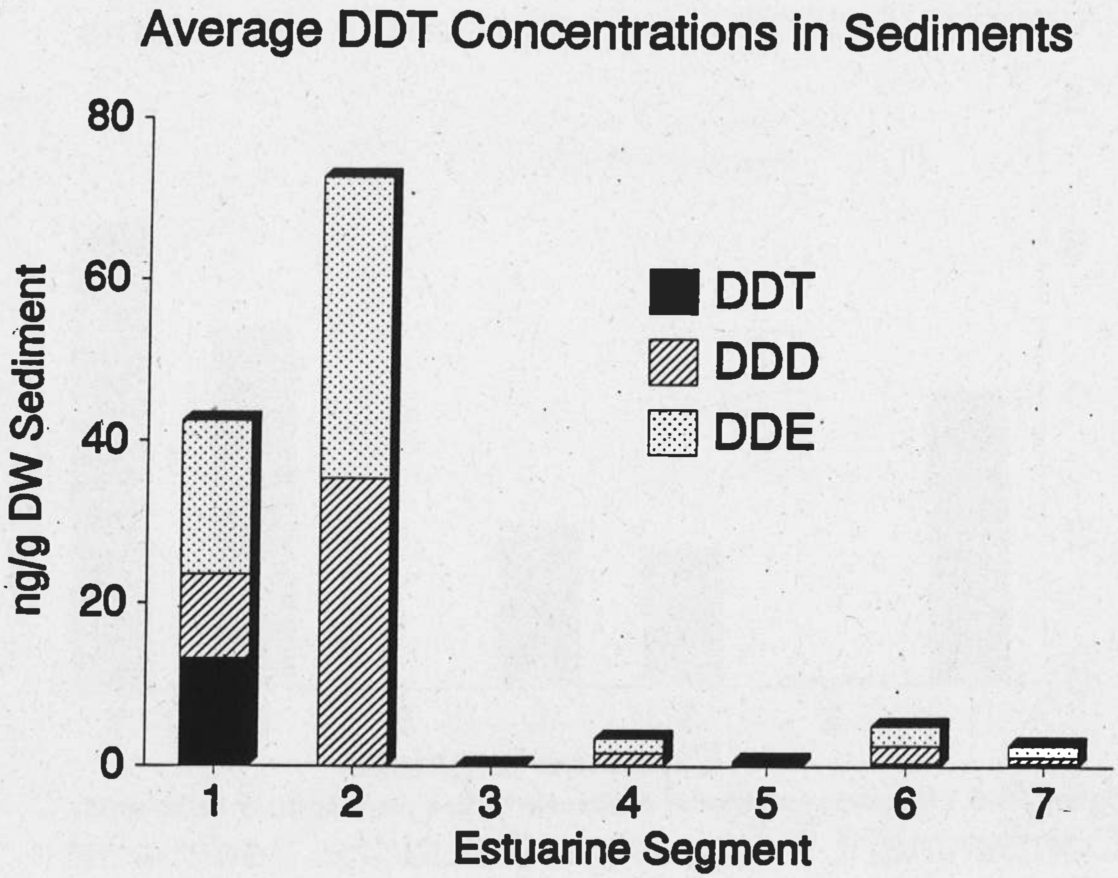


Figure 10-4. Mean concentrations of DDT, DDD, and DDE in Delaware Estuary sediments.

10.4 SEDIMENT CONTAMINANT RESERVOIRS

Estimates of the reservoir of contaminants in the sediments of the Delaware River Estuary are shown in Figures 10-5 and 10-7. Although highest sediment concentrations of most chemicals were found in the upper portion of the estuary, the largest contaminant reservoirs were found in the estuarine segments of the lower bay. This is due to the significantly larger areas of the lower bay segments compared to the area of the segments in the upper estuary. Segment 7 contained more than 50% of the entire sediment reservoir of metals in the estuary and at least 40% of the reservoir of chlorinated pesticides and PCBs.

For most contaminants, the reservoirs of contaminants in the sediments of the Delaware Estuary were larger than the estimated total contaminant loadings to the estuary (Table 10-4). Reservoir and loading estimates for mercury and PCBs were approximately equal. These findings generally support the loading estimates developed in previous chapters; however, loading estimates for chlorinated pesticides were approximately 36 times greater than the sediment reservoir estimate, suggesting that either estimate may need to be revised.

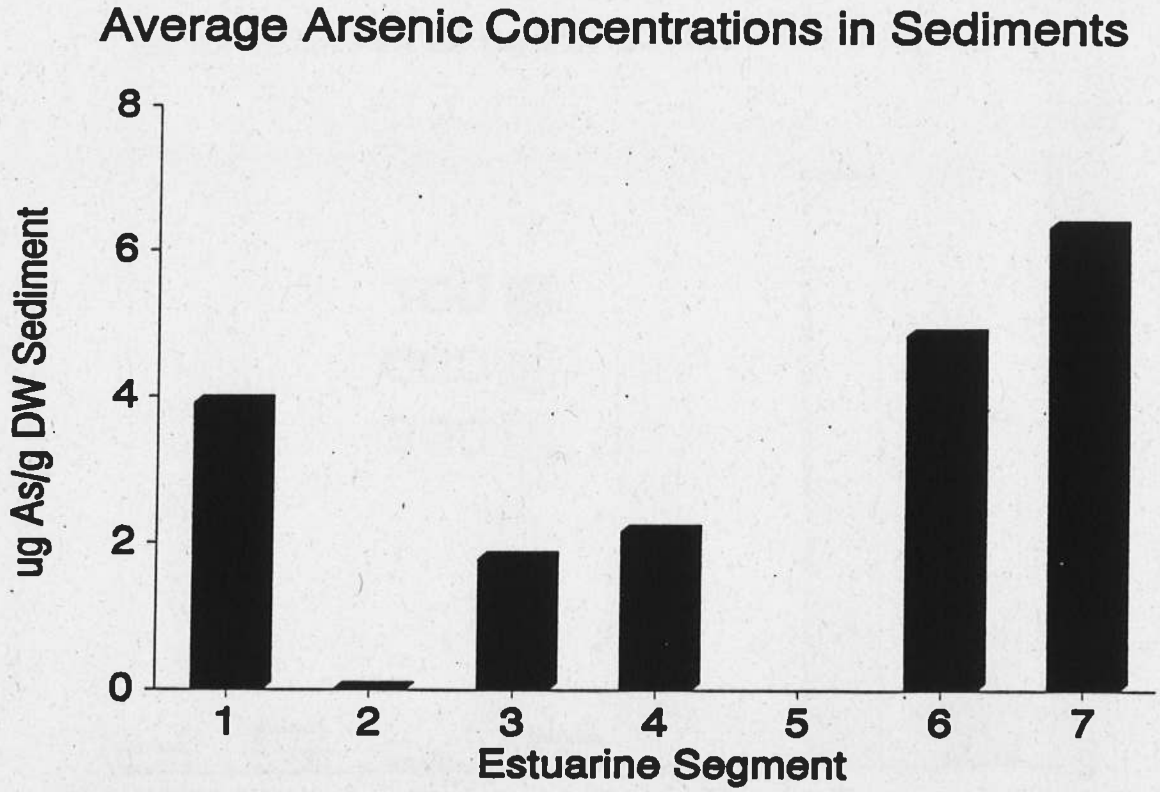


Figure 10-5. Mean concentration of arsenic in Delaware Estuary sediments.

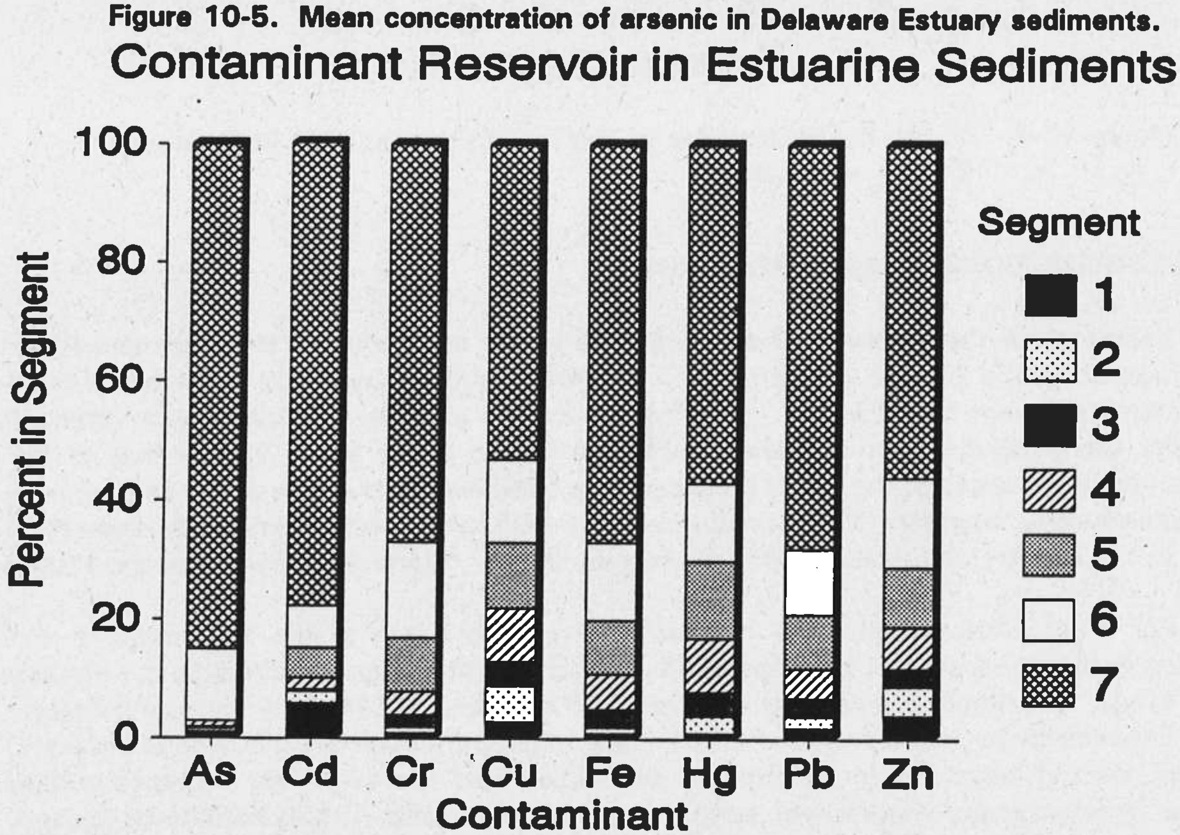


Figure 10-6. Contaminant reservoirs in estuarine sediments - metals.

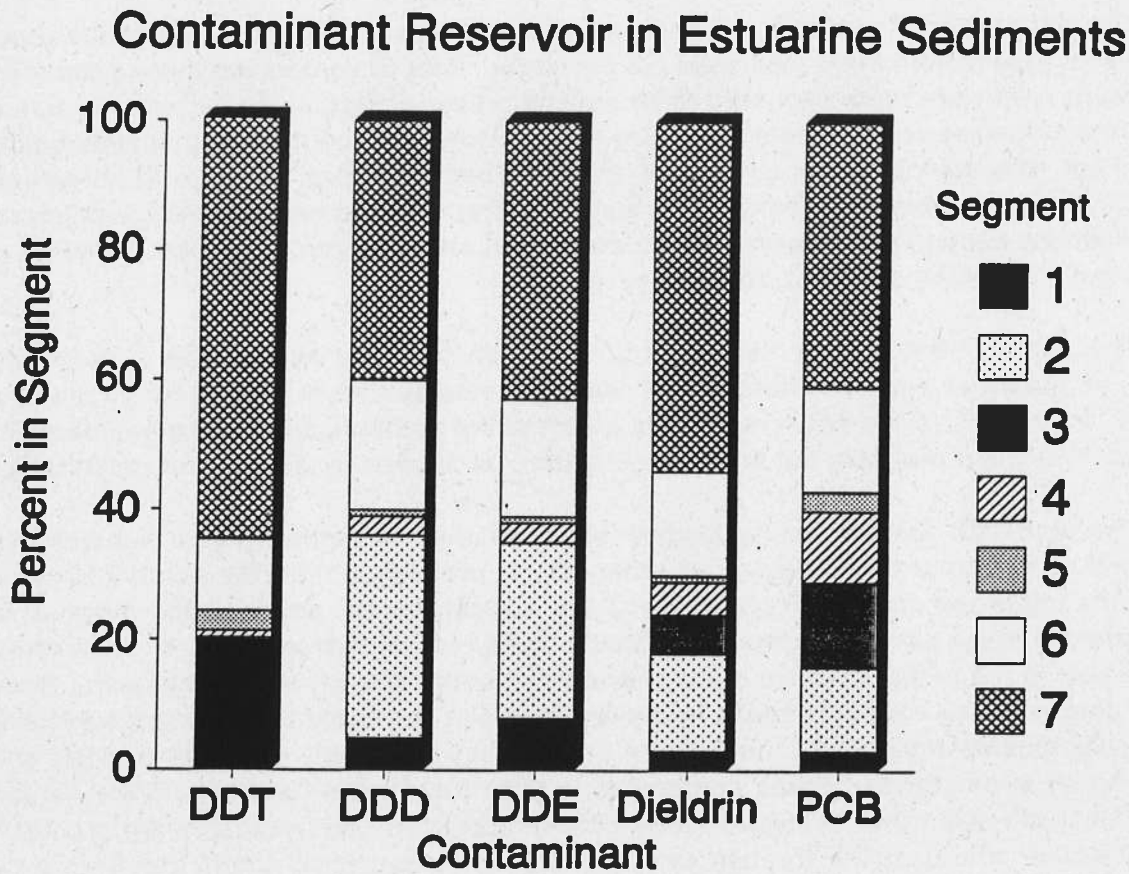


Figure 10-7. Contaminant reservoirs in estuarine sediments - chlorinated pesticides and PCBs.

Table 10-4. Comparison of contaminant reservoirs in estuarine sediments with contaminant loading estimates (10^3 kg).

	Sediment Reservoir	Loading Estimate
Metals		
Arsenic	272	112
Chromium	1853	154
Copper	453	153
Lead	904	126
Mercury	3.8	9.9
Chlorinated Pesticides		
Total	0.18	7.9
PCBs		
Total	0.7	0.09

The comparison of contaminant loading and reservoir estimates raises a question about why the sediment contaminant reservoirs are not larger. Prior to completing these estimates, contaminant reservoirs were expected to be several orders of magnitude larger than annual loading rates because the sediment reservoirs reflect decades of contaminant accumulation. Contaminant reservoirs in this study, however, were not more than an order of magnitude larger than estimated annual loadings. This suggests that the contaminant loading estimates or the sediment contaminant reservoir estimates are in error, or that significant amounts of contaminants are being removed from the estuary.

The contaminant loading estimates probably do not fully explain the discrepancy. Sources of potential error in contaminant loading estimates were described in previous chapters. In general, these errors may have affected the contaminant loading estimates by factors of 2 to 5 but probably did not change loading estimates by an order of magnitude.

The approach for estimating loading assumed that all contaminants in urban and agricultural runoff enter the estuary. All urban runoff probably enters the estuary because most of the urbanized areas in the watershed are adjacent to the estuary, and most urban runoff enters through combined sewer overflows and direct discharges. The fraction of the contaminants in the runoff from agricultural lands that enters the estuary is unknown. Some of these contaminants may be trapped in the sediments of the streams entering the estuary. These contaminants may reach the estuary only during infrequent episodes of high flow brought on by large storms. Some contaminants from runoff may never reach the estuary because of dams and other obstacles. Chemical degradation rates probably are greater in streams, further affecting the fraction of contaminants in terrestrial runoff that enters the estuary.

The estimates of the reservoir of contaminants in sediments are also probably not a large factor in explaining the discrepancy. These estimates are based on 71 stations in the estuary, and the location of many of the stations were determined by a probablistic sampling design developed specifically to complete the type of areally weighted estimates made here. The sediment contaminant reservoir estimates for the three segments in the tidal river portion of the estuary are less reliable because the number of sampling stations is fewest in those segments (see Table 10-1); however, increasing the number of stations in these segments probably would not increase the estimates substantially because the contaminant inventory is driven by the large areas of the lower segments. For the same reason, increased sampling focused on finding contaminant "hot-spots" would not significantly increase the estimates of contaminant reservoirs.

Contaminants may be removed from the estuary through two mechanisms. Contaminants may be transported downstream on particles in the water column or along the sediment surface (saltation). Contaminants associated with suspended particles may be transported down bay and removed to offshore regions because surface flows are generally seaward (Pape and Garvine 1982). Near-bottom transport of sediments probably does not remove contaminants from the estuary because near-bottom currents are generally directed onshore and into the mouth of the bay. Subtidal circulation in the bay, however, is strongly driven by winds

(Martin 1978). The effect of large, infrequent storms on the net transport of sediments and associated contaminants cannot be assessed using the information available.

The other mechanism for removing contaminants from the estuary is the physical removal of sediments by dredging. The U.S. Army Corps of Engineers supervises the removal of approximately 5 million cubic yards of sediment from the estuary annually to maintain a channel from Trenton to the sea. An additional 1 million cubic yards of sediment is removed per year from the mouth of the Christina River at the Wilmington Marine Terminal. Dredging activities in the Schuylkill River account for another 0.4 million cubic yards of sediment. In all, 6.4 million cubic yards of sediment (4.9×10^6 m^3) is removed annually and taken to onshore, dike-enclosed disposal sites.

The amount of contaminants removed by dredging operations can be estimated. For this estimate, the wet weight density of sediments was assumed to be 1.5 g/cm^3, and the water content of the sediments was assumed to be 50%. Based on these assumptions, the 4.9×10^6 m^3 of sediment is equivalent to approximately 3.67×10^{12} g of dry sediment. The amount of contaminants in the dredged sediments was estimated using the areally weighted, mean concentration of contaminants in the surface sediments of estuarine segments 1, 2, and 3 (see Figure 10-1). These estimates are presented in Table 10-5.

Table 10-5. Estimates for contaminants removed by dredging operations

Contaminant	Amount Removed (10^3 kg/year)
Metals	
Arsenic	5.7
Cadmium	2.7
Chromium	150
Copper	128
Lead	114
Mercury	0.55
Silver	0.15
Zinc	1115
Chlorinated Pesticides	
DDT	0.01
DDD	0.05
DDE	0.06
Dieldrin	0.006
PCBs	
Total	0.39

The amount of arsenic, cadmium, and total DDT removed by dredging is generally less than 1% of the estimated loadings and reservoirs of those contaminants. For other contaminants, especially chromium, copper, lead, and PCBs, the amount removed by dredging is a large proportion of the estimated loadings and estuarine sediment reservoirs. Based upon these estimates, dredging alone cannot explain why sediment reservoirs of contaminants are not orders of magnitude higher than estimated loadings.

11.0 CONCLUSIONS

Contaminant inputs to the Delaware River Estuary have decreased in recent decades due to improvements in the control and treatment of point sources (Albert 1988), reductions in the emissions of atmospheric contaminants (USEPA 1991d), and strict regulation on the manufacture and use of persistent toxic chemicals, such as chlorinated pesticides and PCB. Despite reductions, the estuary continues to receive significant amounts of potentially toxic contaminants. Based upon the present study, and limited to the contaminants of concern to the Delaware Estuary Program, the estuary receives 10^6 kg of contaminants annually. This is most likely a minimum estimate. Contaminants entering the estuary through groundwater infiltration and originating from hazardous waste sites contribute additional amounts that are not included in the loading estimates included in this report.

The contaminant loading estimates in this report are based upon simple modeling approaches and provide first-order estimates of contaminant loading rates. More detailed information about the watershed and activities within the watershed would be needed before more complex models could be applied. The usefulness of the first-order estimates is to provide environmental resource managers with an indication of the relative importance of various sources of contaminants. Armed with this information, managers are better prepared to make decisions concerning which contaminant sources should be studied in greater detail. Additionally, this information can be used to develop more effective management options for the control of contaminant inputs by focusing action and further study on the largest or most uncertain sources. For example, based upon the results presented, proposed regulatory controls and management options should focus on point sources to meet the goal of reducing the input of metals to the estuary.

The Toxics Task Force of the Delaware Estuary Program's Science and Technical Advisory Committee sponsored this study based on concerns about chlorinated pesticide and PCB concentrations in fish that were sufficiently elevated to prompt fish consumption advisories to be issued by the states bordering the estuary. At the time this study was initiated, the principal sources for the chlorinated pesticides and PCB were unknown and point source discharges were not thought to be major contributors to the estuary.

This study was able to identify significant sources for chlorinated pesticides (agricultural runoff and point source inputs) and PCB (point source discharges and atmospheric deposition). The study also identified hazardous waste sites containing these contaminants and from which significant amounts of contaminants were escaping, potentially entering the estuary (Chapter 8). Based upon this study, it is not known if these are the source of the chlorinated pesticides and PCB that are currently being accumulated by the fish in the Delaware Estuary. Direct measures of contaminant concentrations in surface sediments (Costa and Sauer 1994; Weisberg et al. 1993), and estimates of the amount of contaminants stored in the sediments (Chapter 10) suggest that the sediments within the estuary may be a significant source of the contaminants currently being measured in fish tissues. Additional research is recommended to define the relative contribution of new contaminants (those that continue to enter the estuary) vs. old contaminants (those that are stored in the sediments). This type of research, coupled with knowing more about the mechanisms affecting the uptake of contaminants by fish, would help with the development of effective management options focusing on the control of chemical contamination of fishery resources.

12.0 REFERENCES

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APPENDIX

INVENTORY OF HAZARDOUS WASTE SITES

APPENDIX

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Introduction

This appendix is an inventory of hazardous waste sites that are potential sources of contaminants to the Delaware Estuary. The inventory was compiled primarily from the USEPA's CERCLIS data base; state agencies responsible for the management of hazardous waste sites and landfills in the Delaware Estuary watershed provided additional information.

The first table of the appendix is a list of the hazardous waste sites in the USEPA's National Priority List (NPL). Sites are ordered by state and by county within state. The table provides the USEPA identification number, the site name, state, county, a code identifying the site's status on the NPL, a code identifying the type of hazardous waste site, and a list of the contaminants present at the site. The NPL codes identify:

F - Present sites on the final NPL
R - Sites recommended to be added as NPL sites
D - Sites deleted from the NPL sites due to remediation actions or recommendations from additional site characterization studies
P - Sites pending administrative action
S - Pre-proposal sites.
N - Sites not identified as an NPL

The codes identifying the type of hazardous waste sites are:

N - Military related
L - Landfill
I - Industrial waste treatment
B - Chemical Plant
A - Abandoned
M - Manufacturing Plant
O - Other
H - Housing area or farm
P - Pure lagoons
G - Groundwater
F - Federal facility
W - Wells

The second table in the appendix provides similar information for all non-NPL sites. This table includes hazardous waste sites tracked by the states but not included in the CERCLIS data base.

The chemical contaminants identified at specific sites include the metals arsenic, cadmium, chromium, copper, lead, mercury, and silver, chlorinated pesticides as a class, dieldrin, PCBs, and volatile organic compounds (VOCs). This list includes the contaminants of concern to the Delaware Estuary Program. PAHs were also included in the hazardous waste site characterization information presented in the two tables.

Appendix Table 1

National Priority List Sites

Appendix Table 1. CERCLIS National Priority List Hazardous Waste Sites.

EPA ID	SITE	COUNTY	NPL CODE	SITE CODE	GW	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	VOC
DE8570024010	DOVER AIR FORCE BASE	Kent	F	N	1	1						1	1			1		1
DED980693550	DOVER GAS LIGHT CO	Kent	F	A	1					1					1			1
DED980704860	COKER'S SANITATION SERVICE LANDFILLS	Kent	F	L	1					1								1
DED980704951	WILDCAT LANDFILL	Kent	F	L	1	1	1		1						1			
DED980705545	TYLER REFRIGERATION PIT	Kent	F	M	1								1					1
DED980705727	KENT CTY LANDFILL	Kent	R		1						1		1					1
DED980714141	CHEM-SOLV INC	Kent	F	A	1													1
DED000605972	DELAWARE SAND & GRAVEL	New Castle	F	L	1	1	1				1	1	1		1	1		1
DED000606079	TYBOUTS CORNER LANDFILL	New Castle	F	L	1	1												1
DED041212473	STANDARD CHLORINE CO	New Castle	F		1	1				1								
DED058980442	NEW CASTLE SPILL SITE	New Castle	F	I	1	1	1			1								1
DED980494496	ARMY CREEK LANDFILL	New Castle	F	L	1	1						1	1			1		1
DED980494603	PIGEON POINT LANDFILL	New Castle	R	L														
DED980551667	DELAWARE CITY PVC PLANT	New Castle	F	B	1													1
DED980552244	KOPPERS CO FACILITIES SITE	New Castle	F							1								
DED980555122	E.I. DU PONT, NEWPORT	New Castle	F	L	1	1												
DED980704894	OLD BRINE SLUDGE LANDFILL	New Castle	R	L														
DED980705255	NEW CASTLE STEEL PLANT	New Castle	D	M	1	1					1	1	1		1			
DED980713093	HARVEY & KNOTT DRUM SITE	New Castle	F	I	1	1	1				1	1			1			1
DED980830954	HALBY CHEMICAL	New Castle	F		1	1				1	1	1			1	1		1
DED981035520	SEALAND LTD	New Castle	F	A	1					1								1
DED043958388	NCR CORP, MILLSBORO	Sussex	F		1	1							1					1
DED980494637	SUSSEX CO LANDFILL #5	Sussex	F	L	1													1
NJ0570024018	MCGUIRE AFB #1	Burlington	S	N														
NJ2210020275	FORT DIX LANDFILL	Burlington	F	N	1	1						1			1			1
NJD000565531	COSDEN CHEMICAL COATINGS CORPORATION	Burlington	F	B	1		1						1	1	1			1
NJD002493054	KAUFFMAN & MINTEER INC	Burlington	F	M					1									1
NJD048044325	LANDFILL & DEVELOPMENT CO	Burlington	F	L	1	1					1	1		1		1	1	1
NJD073732257	ROEBLING STEEL CO	Burlington	F	M	1		1			1		1	1	1	1			
NJD980505382	LANG PROPERTY	Burlington	F	I	1	1	1		1									1
NJD980529085	ELLIS PROPERTY	Burlington	F	H	1	1	1						1		1			1
NJD980529143	FLORENCE LAND RECONTOURING INC. LF	Burlington	F	L	1					1	1		1		1			1

Appendix Table 1. CERCLIS National Priority List Hazardous Waste Sites.

EPA ID	SITE	COUNTY	NPL CODE	SITE CODE	GW	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	VOC
NJD980761357	TABERNACLE DRUM DUMP	Burlington	F	H	1		1					1	1		1			1
NJD980761365	EWAN PROPERTY	Burlington	F	H	1								1					1
NJD980785638	CINNAMINSON GROUND WATER CONTAMINATI	Burlington	F	G	1													1
NJD980505341	KING OF PRUSSIA	Camden	F	P	1	1			1				1					1
NJD980529192	GEMS LANDFILL	Camden	F	L	1					1		1			1			1
NJD980761381	COOPER ROAD SITE	Camden	D	I														1
NJD002362705	NASCOLITE CORP	Cumberland	F	M	1										1			1
NJD002385664	VINELAND CHEMICAL CO INC	Cumberland	F	B	1	1					1	1			1			1
NJD980529887	VINELAND STATE SCHOOL	Cumberland	F	O	1		1	1	1	1					1	1		1
NJD980761399	UPPER DEERFIELD TOWNSHIP SLF	Cumberland	F	L	1											1		1
NJD002349058	HERCULES INC	Gloucester	F	O	1										1			1
NJD002365930	SHIELD ALLOY CORP	Gloucester	F	M	1	1							1					1
NJD043584101	MATLACK INC	Gloucester	R															
NJD047321443	CHEMICAL LEAMAN TANK LINES INC	Gloucester	F	M	1	1					1		1					1
NJD053292652	BRIDGEPORT RENTAL & OIL SERV	Gloucester	F	I	1	1	1					1	1		1			1
NJD980505366	HELEN KRAMER LF	Gloucester	F	L	1	1					1	1	1		1			1
NJD980505416	LIPARI LANDFILL	Gloucester	F	L	1	1					1		1		1		1	1
NJD986620649	FRANKLIN BURN SITE #3	Gloucester	S	O														
NJ9170022694	US NAVAL AIR PROPULSION CTR	Mercer	S	N														
NJD980532832	FRIEDMAN PROPERTY	Monmouth	D	I	1					1								1
NJ2570026268	BOMARC/MCQUIRE MSL	Ocean	S	F														
NJD980530109	GOOSE FARM	Ocean	F	I	1	1	1				1							1
NJD980532808	PIJAK FARM	Ocean	F	A	1	1	1											1
NJD980532816	SPENCE FARM	Ocean	F	A	1	1	1						1			1		1
NJD980532824	WILSON FARM	Ocean	F	A	1	1			1									1
NJD980532840	HOPKINS FARM	Ocean	F	I	1													1
NJD061843249	NL INDUSTRIES INC.	Salem	F	M	1	1						1			1			
NJD981179047	POHATCONG VALLEY GROUNDWATER CONTAMINATI	Warren	F	G	1													1
NYD010968014	CARROL & DUBIES SEWAGE DISPOSAL	Orange	F	I														
NYD980528475	CORTESE LF	Sullivan	F	L														
PAD000651810	BERKS LANDFILL	Berks	F	L	1	1									1			1
PAD002360444	CRYO-CHEM INC	Berks	F	M	1	1												1

Appendix Table 1. CERCLIS National Priority List Hazardous Waste Sites.

EPA ID	SITE	COUNTY	NPL CODE	SITE CODE	GW	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	VOC
PAD002384865	DOUGLASSVILLE DISPOSAL	Berks	F	I	1	1	1			1			1		1			1
PAD061105128	BALLY GROUND WATER CONTAMINATION	Berks	F	W	1	1												1
PAD980508832	DORNEY ROAD SITE	Berks	F	L	1	1			1		1		1		1			1
PAD980691794	BERKS SAND PIT	Berks	F	I	1	1												1
PAD980831812	BROWN'S BATTERY BREAKING	Berks	F	M	1	1									1			
PAD981740061	CROSSLEY FARMS/HEREFORD GW	Berks	F	W														
PA6170024545	USN NAVAL AIR DEV CENTER	Bucks	F	F	1						1		1		1			1
PAD002345817	FISCHER & PORTER	Bucks	F	M	1													1
PAD047726161	BOARHEAD FARMS	Bucks	F	H	1	1												1
PAD051395499	REVERE CHEMICAL CO	Bucks	F	B	1	1				1	1	1		1	1	1		1
PAD091637975	ROHM AND HAAS LANDFILL	Bucks	R															1
PAD981035009	CROYDON TCE SPILL	Bucks	F	W	1	1	1											1
PAD981740004	DUBLIN WATER SUPPLY	Bucks	F	M	1													1
PAD002395887	PALMERTON ZINC PILE	Carbon	F	M	1	1						1			1			
PAD073613663	TONOLLI CORP	Carbon	F	A	1	1					1	1	1		1			
PAD000441337	STRASBURG LANDFILL	Chester	F	L	1	1						1	1	1	1			1
PAD002353969	RECTICON/ALLIED STEEL	Chester	F	M	1													1
PAD004351003	AIW FRANK	Chester	F	H	1													1
PAD014353445	MALVERN TCE SITE	Chester	F	O	1		1											1
PAD077087989	FOOTE MINERAL CO.	Chester	F	T														
PAD980537773	WILLIAM DICK LAGOONS	Chester	F	P	1				1	1								
PAD980539985	BLOSENSKI LANDFILL	Chester	F	L	1	1				1	1					1		1
PAD980691703	KIMBERTON SITE	Chester	F	B	1	1												1
PAD980692594	PAOLI RAIL YARD	Chester	F	O		1	1			1								
PAD980829527	WELSH LANDFILL	Chester	F	L	1		1					1			1	1		1
PAD002338010	HAVERTOWN PCP SITE	Delaware	F	M	1	1	+1?			1			1					1
PAD980539407	WADE (ABM)	Delaware	D	I	1		1		1		1		1		1	1		1
PAD980830921	LANSDOWNE RADIATION SITE	Delaware	D	R														
PAD987341716	AUSTIN AVENUE RADIATION SITE	Delaware	F	R														
PAD003005014	WHITMOYER LABS INC	Lebanon	F	B	1	1					1							1
PAD079160842	NOVAK SANITARY LANDFILL	Lehigh	F	L	1													1
PAD980537716	HELEVA LANDFILL	Lehigh	F	L	1													1

Appendix Table 1. CERCLIS National Priority List Hazardous Waste Sites.

EPA ID	SITE	COUNTY	NPL CODE	SITE CODE	GW	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	VOC
PAD980692719	VOORTMAN FARM	Lehigh	D	O											1			
PAD980829261	REESER'S LANDFILL	Lehigh	D	L	1										1	1		
PAD980829329	HEBELKA AUTO SALVAGE YARD	Lehigh	F	O														
PAD981033285	RODALE MANUFACTURING CO, INC	Lehigh	F	M														
PA5213820892	USA TOBYHANNA ARMY DEPOT	Monroe	F	F	1										1			1
PAD980691760	BRODHEAD CREEK	Monroe	F	B	1	1					1							
PAD981034630	ROUTE 940 DRUM DUMP	Monroe	F	L	1													1
PAD981034705	BUTZ LANDFILL	Monroe	F		1													1
PAD000436436	AMBLER ASBESTOS PILES	Montgomery	F	T	1	1												
PAD002342475	NORTH PENN-AREA 2	Montgomery	F	M	1													1
PAD002498632	NORTH PENN-AREA 7	Montgomery	F	M	1													1
PAD009862939	HENDERSON ROAD SITE	Montgomery	F	I	1		1											1
PAD014269971	STANLEY KESSLER	Montgomery	F	M	1													1
PAD039017694	RAYMARK	Montgomery	F	M	1								1					1
PAD057152365	NORTH PENN-AREA 12	Montgomery	F	M	1													1
PAD093730174	COMMODORE SEMICONDUCTOR GROUP	Montgomery	F	M	1													1
PAD096834494	NORTH PENN-AREA 1	Montgomery	F	M	1													1
PAD980229298	OCCIDENTAL CHEM/FIRESTONE	Montgomery	F	M	1	1				1			1		1			1
PAD980419097	CRATER RESOURCES/KEYSTONE COKE/ALAN WOOD	Montgomery	F	M														
PAD980508766	MOYERS LANDFILL	Montgomery	F	L	1	1	1		1	1		1	1					1
PAD980692024	TYSON DUMP #1	Montgomery	F	I	1	1				1								1
PAD980692693	NORTH PENN-AREA 5	Montgomery	F	M	1													1
PAD980693204	SALFORD QUARRY	Montgomery	R	T	1						1							1
PAD980926976	NORTH PENN-AREA 6	Montgomery	F	M	1													1
PAD002390748	HELLERTOWN MANUFACTURING CO	Northampton	F	M	1								1					1
PAD980508493	INDUSTRIAL LANE SITE	Northampton	F	L	1													1
PAD046557096	METAL BANKS	Philadelphia	F	M	1	1	1											1
PAD980552913	ENTERPRISE AVE	Philadelphia	D	L						1	1							1
PAD981939200	PUBLICKER/CUYAHOGA WRCKNG PLNT	Philadelphia	F	B	1		1				1							1
PAD980712616	MCADOO ASSOCIATES	Schuylkill	F	I	1													1
PAD980830533	EASTERN DIVERSIFIED METALS	Schuylkill	F	M	1	1	1							1	1			1

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EPA ID	SITE	COUNTY	NPL CODE	SITE CODE	GW	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	VOC

Appendix Table 2

Non-National Priority List Sites

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
DED984075424	DELAWARE RIVER DRUMS				V															
DED984075416	INDIAN RIVER INLET CYLINDER				V															
DED984066530	ALL RITE BUBBISH INC. 11 (OLD)	Kent	39.0083	75.5783	G															
DED067400192	ALL RITE BUBBISH REMOVAL INC 1 (NEW)	Kent	39.0083	75.5783	G															
DED981040587	ARTIS DRIVE SITE	Kent	39.1583	75.5233																
DED984072306	BOMBAY HOOK NAT'L WILDLIFE REFUGE	Kent	39.3017	75.6067																
DED980705735	BORDEN CHEM CO SMYRNA	Kent	39.2833	75.6250																
DED980537781	CAMDEL METALS	Kent	39.1150	75.5500																
DED984072553	CHEMDECON TRAILER	Kent	39.1650	75.5217	O															
DED980704910	CHESWOLD LANDFILL	Kent	39.2050	75.5667																
DED981736630	CITY OF DOVER-PUBLIC WORKS	Kent	39.1650	75.5217																
DED980918940	CLAYTON TWP L/F	Kent	39.2972	75.6333																
DED981045917	COKER SAND PIT	Kent	39.1650	75.5217																
DED980704878	COKERS LANDFILL #2	Kent	39.2250	75.6111																
DED980494504	COKERS LANDFILL #3	Kent	39.2222	75.6111																
DED984066175	DELAWARE BAY DRUM	Kent	39.1150	75.5500	V							1		1		1		1		
DED981114663	DELAWARE CORRECTIONAL CENTER	Kent	39.3017	75.6067																
DED057231185	DELAWARE HOSP FOR THE CHRONICALLY ILL	Kent	39.3017	75.6067																
DED075518050	DELAWARE STATE COLLEGE DUMP	Kent	39.1650	75.5217																
DED984074765	DINAHS CORNER	Kent	39.1650	75.5217																
DED984075689	DOVER POWER PLANT	Kent	39.1650	75.5217	O															
DED981037385	DUCK CREEK POND DUMP	Kent	39.3017	75.6067																
DED099979700	EASTERN DISPOSAL RUBBLE PIT	Kent	39.1650	75.5217																
DED981108640	ENNIS DUMP	Kent	39.3017	75.6067																
DED981736697	FRAZIER'S PIT	Kent	39.1650	75.5217																
DED000119438	GRIGCO WASTE OIL RECYCLING CO	Kent	39.1650	75.5217																
DED011963675	HOLY CROSS LANDFILL	Kent	39.1650	75.5217																
DED980705073	KENT CTY LANDFILL	Kent	39.1000	75.4667																
DED981039506	KENTON LANDFILL	Kent	39.2000	75.6833																
DED981115207	LEBANON ROAD LANDFILL	Kent	39.1650	75.5217																
DED084761162	LITTON IND	Kent	39.3017	75.6067																
DED984076026	MAYS BODY SHOP	Kent	39.1650	75.5217																
DED981109358	MILL STREET DUMP	Kent	39.3017	75.6067																
DED011006335	PARADEE OIL - DOVER SITE	Kent	39.1650	75.5217	L															

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DED981039621	PEARSONS CORNER DRUM SITE	Kent	39.1650	75.5217																
DED980705016	PORTERS LANDFILL	Kent	38.9583	75.5125																
DED984066662	PUGH DUMP	Kent	39.1650	75.5217	G															
DED069026193	SCOTT PAPER CO-DOVER PLT	Kent	39.1650	75.5217																
DED981038417	SILVER LAKE PARK FILL AREA	Kent	39.1650	75.5217																
DED981736762	SIMPSON LUMBER COMPANY DUMP	Kent	39.1650	75.5217																
DED981736010	SKULL PROPERTY	Kent	39.1650	75.5217																
DED984066191	SMYRNA COAL GAS	Kent	39.3017	75.6067	O															
DED981736580	SQUARE CLUB LODGE LANDFILL	Kent	39.1650	75.5217																
DED043581057	TEAL CONSTRUCTION CO LANDFILL	Kent	39.1650	75.5217																
DED982363996	VEPCO INDUSTRIAL PRK	Kent	39.1150	75.5500	G															
DED984066332	WILMINGTON SUBURBAN WATER CO.-CHRISTIANA	Kent	39.1650	75.5217	O															
DED984076133	WYOMING DUMP	Kent	39.1150	75.5500																
DED002342376	ABEX CORP (AMSCO)	New Castle	39.7150	75.5467																
DED058980509	AIR PROD & CHEM INC	New Castle	39.5961	75.6383																
DED981038714	AIRPORT PROPERTY SITE	New Castle	39.7150	75.5467																
DED984075481	AIRPORT ROAD ASBESTOS	New Castle	39.7150	75.5467	A	1	1													
DED054717939	ALLIED CHEM CORP DELAWARE WORKS	New Castle	39.8050	75.4533																
DED984071118	ALLIED CHEMICAL DRUM	New Castle	39.8050	75.4533	B															
DED075511154	AMERICAN HOECHST CORP	New Castle	39.5750	75.5983																
DED061805487	AMETEK, INC.	New Castle	39.7300	75.6417	M															
DED981038654	AMOCO ASBESTOS LANDFILL	New Castle	39.7150	75.5467																
DED060804580	AMOCO POLYMER PLANT	New Castle	39.7150	75.5467																
DED982364333	AMTRACK WILMINGTON RAILYARD	New Castle	39.7417	75.5417	O															
DED984075432	AMTRAK WILMINGTON REFUELING FACILITY	New Castle	39.7500	75.5000																
DED980555585	APPLIED TECHNOLOGY INC	New Castle	39.7467	75.5500	O															
DED981739469	ATLANTIC AVE DRUM SITE	New Castle	39.8050	75.4533	A															1
DED011028438	ATLANTIC AVIATION	New Castle	39.7150	75.5467																
DED984066167	AUGUSTINE BEACH / DEL. RIVER	New Castle	39.5217	75.5767	V															
DED981114606	BEECHER'S LOT	New Castle	39.6267	75.7183																
DED984066340	BELL PROPERTY DISPOSAL PIT	New Castle	39.7150	75.5467	G															
DED981038151	BREAD & CHEESE	New Castle	39.7350	75.6100																
DED982367351	BROOKSIDE DUMP	New Castle	39.6800	75.7517																
DED984075747	BUDD METAL	New Castle	39.7417	75.5417																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
DED981035108	CADMUS FILL	New Castle	39.7500	75.5000																
DED980705909	CAPITOL RECOVERY	New Castle	39.7544	75.5694																
DED011021342	CASTLE FORD	New Castle	39.7150	75.5467	G															
DED981114549	CATTAFI	New Castle	39.8250	75.5100																
DED980705602	CHAPMANS RD	New Castle	39.6800	75.7517																
DED002359818	CHICAGO BRIDGE & IRON CO	New Castle	39.6706	75.5578																
DED982367534	CHRISTIANA MALL SITE	New Castle	39.6267	75.7183	O															
DED002357408	CHRYSLER ASSEMBLY PLT	New Castle	39.6800	75.7517																
DED980830400	CIBA- GEIGY SEEP	New Castle	39.7350	75.6100	O															
DED073750796	CITY OF WILMINGTON MARINE TERMINAL	New Castle	39.7417	75.5417																
DED981034226	CLAYVILLE DUMP	New Castle	39.6800	75.7517																
DED054734918	CONTAINER CORP	New Castle	39.7467	75.5467																
DED002329316	CURTIS PAPER COMPANY	New Castle	39.6800	75.7517	G															
DED981034739	DEEMERS BEACH DUMPSITE	New Castle	39.7150	75.5467																
DED054578166	DEL CHAPEL PLACE	New Castle	39.6800	75.7517																
DED009800616	DELAWARE CONTRACTING CO	New Castle	39.7150	75.5467																
DED981044837	DELAWARE STATE HIGHWAY DEPARTMENT	New Castle	39.4483	75.7183																
DED981105026	DELAWARE WOOD PRESERVER CO	New Castle	39.8250	75.5100																
DED000621409	DELMARVA POWER & LIGHT - DELAWARE CITY	New Castle	39.5750	75.5983																
DED981044779	DELMARVA POWER & LIGHT - EDGEMOOR	New Castle	39.8033	75.5500																
DED980705198	DENTON LANDFILL	New Castle	39.7150	75.5467																
DED000800292	DUPONT & CO RESTON PRODUCTS	New Castle	39.6717	75.7100																
DED980705842	DUPONT CHERRY ISLAND LANDFILL	New Castle	39.7500	75.5000																
DED003930807	DUPONT EXPERIMENTAL STA	New Castle	39.7708	75.5750																
DED042263764	DUPONT GLASGOW BARROW PLT	New Castle	39.7150	75.5467																
DED064370992	DUPONT HASKELL LABS	New Castle	39.6800	75.7517																
DED123606303	ELECTRIC HOSE & RUBBER RECON	New Castle	39.7500	75.5000	O															
DED000800284	ER/ABANDONED OFF-SHORE DRUM	New Castle	39.7750	75.4950	A															
DED069009884	FIBRE PROCESSING	New Castle	39.7417	75.5417																
DED980919328	FIRST STATE STEEL DRUM CO	New Castle	39.6317	75.6583																
DED073760167	FMC CORP	New Castle	39.6844	75.7250																
DED004321212	FORBES STEEL AND WIRE CORPORATION	New Castle	39.7417	75.5417																
DED066036753	GATES ENGINEERING CO INC	New Castle	39.7467	75.5467																
DED002329738	GETTY REFINNING & MARKETING CO	New Castle	39.5961	75.6231																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
DED981736259	GLASGOW DRIVE DUMP	New Castle	39.6267	75.7183																
DED980690978	GLASGOW SITE	New Castle	39.5733	75.7783																
DED980705677	GLOBE UNION INC	New Castle	39.4583	75.7250																
DED002331536	GORE, W L & ASSOC. INC., - NEWARK	New Castle	39.6800	75.7517																
DED980705436	HARRY WOOD LANDFILL	New Castle	39.6611	75.5958																
DED980705131	HARVEY KNOTT LANDFILL	New Castle	39.5750	75.7639																
DED984072249	HEALTHWAYS INC.	New Castle	39.4600	75.6567																
DED069024016	HELIX ASSOCIATES, INC.	New Castle	39.6717	75.7100	M															
DED001315647	HERCULES RESEARCH CENTER	New Castle	39.7300	75.6417																
DED075516989	HIGH VOLTAGE MAINTENANCE SITE	New Castle	39.7417	75.5417																
DED984073197	HOMALITE, INC	New Castle	39.7350	75.6100																
DED002342020	ICI AMERICAS INC ATLAS PT SITE	New Castle	39.7150	75.5467																
DED980705784	INDUSTRIAL PROD	New Castle	39.6486	75.5944																
DED981108095	JULIANO SITE	New Castle	39.8033	75.5500																
DED981736317	KRIEGER'S LANDFILL	New Castle	39.7150	75.5467	L															
DED981040645	KRUSE PLAYGROUND SITE	New Castle	39.7417	75.5417																
DED981104029	LUDLOW INDUSTRIAL PARK DRUM SITE	New Castle	39.7500	75.5000																
DED981940786	MAGNOLIA SWAMP	New Castle	39.6800	75.7517	O															
DED982367476	MECO DRIVE SITE	New Castle	39.7350	75.6100	O															
DED984071126	MERCAPTAN AIR RELEASE	New Castle	39.5750	75.5983	O															
DED984075127	MICUCIO BROTHERS	New Castle	39.4483	75.7183	L															
DED984066233	MIDDLETOWN LANDFILL	New Castle	39.4483	75.7183	O															
DED984066316	MIDDLETOWN SEWER PLANT DUMP	New Castle	39.4483	75.7183	G															
DED981038771	MILL RD LANDFILL	New Castle	39.6800	75.7517																
DED981037005	MINQUADALE GRAVEL PIT	New Castle	39.7150	75.5467																
DED002334639	MOTOR WHEEL SITE	New Castle	39.6800	75.7517	G															
DED981034853	MT PLEASANT RAILROAD DUMP	New Castle	39.4483	75.7183																
DED981736440	NEW CASTLE ABANDONED CONTAINER SITE	New Castle	39.7150	75.5467	O															1
DED981939333	NEW CASTLE GAS COMPANY	New Castle	39.7150	75.5467																
DED084780592	NEWARK CONCRETE CO	New Castle	39.6717	75.7100																
DED980705792	NEWARK HOUSING AUTH LANDFILL	New Castle	39.7331	75.7436																
DED980705487	NEWARK LANDFILL	New Castle	39.6800	75.7517																
DED984074781	NEWARK MUNITIONS STORAGE SITE	New Castle	39.6717	75.7100																
DED980705313	NEWPORT CY LANDFILL	New Castle	39.7139	75.6139																

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DED984066696	NEWPORT DRUM SITE	New Castle	39.7350	75.6100	A															
DED002336915	NORTH AMERICAN SMELTING COMPANY	New Castle	39.7467	75.5467	O											1				1
DED002337863	NVF COMPANY NEWARK	New Castle	39.6800	75.7517	G															
DED981037138	NVF STATE LINE LANDFILL	New Castle	39.8100	75.6767																
DED002337806	NVF(YORKLYN)	New Castle	39.8083	75.6750																
DED980705859	O & T REALTY	New Castle	39.7322	75.5803																
DED002290203	OLIN CORP - SUNOLIN CHEM	New Castle	39.8050	75.4533																
DED981038474	PARKWAY GRAVEL CO	New Castle	39.6267	75.7183																
DED984066217	PETTINARO TRANSFORMER SITE	New Castle	39.7750	75.4950	G															
DED002276764	PHOENIX STEEL CORP	New Castle	39.8050	75.4533																
DED011018611	PORTER CHEVROLET	New Castle	39.6800	75.7517																
DED982366882	RAINTREE VILLAGE	New Castle	39.6800	75.7517	H															
DED980918049	REEVIS & REEVIS CLAY PIT	New Castle	39.7867	75.7000																
DED981940844	ROBSCOTT MANOR	New Castle	39.6800	75.7517																
DED984067041	ROGERS CORNER DUMP	New Castle	39.7467	75.5467																
DED984066225	SALEM CHURCH-MUDDY RUN DUMP	New Castle	39.6267	75.7183	G															
DED069877611	SES INC	New Castle	39.6800	75.7517																
DED981034671	SHELPOT CREEK DUMP	New Castle	39.7500	75.5000																
DED981035058	SIXTEENTH STREET QUARRY	New Castle	39.7500	75.5000																
DED053301560	SPATZ FIBERGLASS	New Castle	39.8100	75.6767																
DED984075341	STARR ROAD ABANDONED DRUM	New Castle	39.6800	75.7517	A															
DED981038532	STATE HIGHWAY BORROW PIT	New Castle	39.5617	75.6500																
DED981036940	SUMMIT LANDFILL	New Castle	39.4483	75.7183																
DED981038656	TAYLOR LANDFILL	New Castle	39.6267	75.7183																
DED002379675	TEXACO INC CLAYMONT TERM	New Castle	39.9833	75.8333																
DED984066241	THEIL, MARY (ESTATE OF)	New Castle	39.7500	75.5000																
DED980705917	TIMKO BROTHERS LANDFILL	New Castle	39.7322	75.5799																
DED980831077	TISDEL PROPERTY	New Castle	39.7331	75.5803																
DED981736648	TOWNSEND DUMP-GREARS CORNERS DUMP	New Castle	39.3967	75.6917	O															
DE0960009611	USA CORPS OF ENGR CANAL SITE	New Castle	39.5569	75.6528																
DE0572824274	USAF (TENANT) WILMINGTON AIRPORT SITE	New Castle	39.7417	75.5417																
DED981034796	WHITTINGTON SAND AND GRAVEL	New Castle	39.6267	75.7183																
DED981102825	WILMINGTON COAL GAS CO	New Castle	39.7417	75.5417																
DED980705610	WILMINGTON MUN SEWAGE SYSTEM	New Castle	39.7375	75.5194																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
DED073754830	WILMINGTON SUBURBAN WATER CO.	New Castle	39.8050	75.4533	G															
DE3690590002	WILMINGTON TRAIN YARD	New Castle	39.7467	75.5467																
DED011022035	WILSON CONTRACTING CO LANDFILL	New Castle	39.7150	75.5467																
DED981940968	WINDY HILLS	New Castle	39.6800	75.7517																
DED984066290	ASSAWOMAN BAY	Sussex	38.7733	75.1417	V								1	1	1	1				
DED053269270	BARCROFT CO	Sussex	38.7800	75.1050																
DED984074179	BROADKILL BEACH DRUM	Sussex	38.7867	75.3133	O															
DED984066738	CARPENTER LANDFILL	Sussex	38.9117	75.4283	G															
DED981736853	DONOVAN SITE	Sussex	38.7733	75.1417																
DED984066597	DRAPER JONES SITE	Sussex	38.9117	75.4283	N															
DED984066654	HARRINGTON, ELLA SITE	Sussex	38.9117	75.4283	G															
DED984075374	HERBICIDE SPILL	Sussex	38.9117	75.4283						1										
DED981039563	HUDSON PIT	Sussex	38.7500	75.1667																
DED981736739	JACKSON PIT	Sussex	38.7733	75.1417																
DED984066720	LARRY LONG SITE	Sussex	38.7733	75.1417	G															
DED984066209	LEWES COAL GAS	Sussex	38.7733	75.1417	O															
DED984066639	LIN LEIGH INC.	Sussex	38.7867	75.3133	O															
DED984066589	LOWE LACKLOVE SITE	Sussex	38.7733	75.1417	O															
DED981736796	METCALF PIT	Sussex	38.7733	75.1417																
DED982366544	MILTON DUMP	Sussex	38.7867	75.3133	O															
DED984073096	MILTON MAINTENANCE YARD	Sussex	38.7867	75.3133																
DED984066829	SCARBOROUGH PIT	Sussex	38.9117	75.4283																
DED981111313	SUSSEX COUNTY LANDFILL #3 - ANGOLA	Sussex	38.7267	75.2883																
DED981104979	SUSSEX LUMBER CO	Sussex	38.7733	75.1417																
DE6170057040	USN NAVAL FACILITY-LEWES	Sussex	38.7733	75.1417	O															
DED984066621	WELLS SITE, J.	Sussex	38.7733	75.1417	O															
DED002348787	WILKERSON TERRACE SITE	Sussex	38.9117	75.4283	G															
NJD980769335	NASH PROPERTY	Atlantic	39.5529	74.8616																
NJD048620090	SCOTT PAPER CO	Atlantic	39.5302	74.9323																
NJD980530133	AEROHAVEN AIRPORT	Burlington	39.8223	74.8934																
NJD002366621	AIRCO SPECIAL GASES	Burlington	39.9933	74.9917																
NJD067363101	AKZO CHEMICALS, INC.	Burlington	39.9567	74.9987																
NJD981082985	ALLAN'S PIT	Burlington	39.8435	74.7200																
NJD011300803	ATLANTIC WOOD INDUSTRIES	Burlington	39.9814	74.8103																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD981082993	BEVERLY MUNICIPAL LF	Burlington	40.0663	74.9240																
NJD980504880	BIG HILL SLF	Burlington	39.9054	74.7038																
NJD980529572	BIRMINGHAM RD DUMP	Burlington	39.9633	74.7149																
NJD981083009	BOB DRAYTON INC	Burlington	39.9107	74.7069																
NJD980504906	BOGS DITCH	Burlington	40.0593	74.9380																
NJD980769368	BORDENTOWN CITY MUNICIPAL DUMP	Burlington	40.1276	74.7114																
NJD000557843	BORDENTOWN LANDFILL	Burlington	40.1332	74.7065																
NJD061284717	BORDENTOWN LDFL SCA SERVICE	Burlington	40.1279	74.7149																
NJD966600468	BURLINGTON ARMY PLANT	Burlington	40.0783	74.8692																
NJD980771794	BURLINGTON CITY DUMP	Burlington	40.0724	74.8496																
NJD980530505	BURLINGTON CLAY & ENGINEERING CO	Burlington	40.0666	74.8310																
NJD980504989	BURLINGTON CLAY & ENGINEERING CO	Burlington	40.0641	74.8610																
NJD980769061	BURLINGTON CO HWY DEPT	Burlington	39.9885	74.8141																
NJD980771786	BURLINGTON TWP LF	Burlington	40.0575	74.8571																
NJD981560949	BUSTERS JUNKYARD	Burlington	39.9867	74.5783																
NJD980769244	CREEK-TURN CERAMICS	Burlington	39.9799	74.8128																
NJD047318043	DETREX CHEMICAL INDUSTRIES, INC.	Burlington	40.0944	75.0022																
NJD085696686	DOWELL SCHLUMBERGER INCORPORATED	Burlington	39.9863	74.8033																
NJD002340610	EAGLE DYEING & FINISHING	Burlington	39.9935	74.8018																
NJD002361665	ELECTRONIC PARTS SPECIALTY CO	Burlington	39.9706	74.8023																
NJD980771802	EVESHAM TOWNSHIP LANDFILL	Burlington	39.8659	74.8864																
NJD981877796	GIBERSON PROPERTY	Burlington	39.8106	74.7153																
NJD981084650	GRAVEL PIT RT. 541	Burlington	40.0596	74.8239																
NJD981084676	HANCOCK LANE GRAVEL PIT	Burlington	40.0344	74.8205																
NJD011136884	HERCULES INC	Burlington	40.0776	74.8169																
NJD001519107	HOEGANAES CORP	Burlington	40.0254	74.9857																
NJD054726373	HOLLY CHEMICAL CO.	Burlington	39.9933	74.7850	A															
NJD071450068	JET PULVERIZER CO	Burlington	39.9776	74.9899																
NJD002300051	JOHNSON & TOWERS	Burlington	39.9333	74.8950	O															
NJD980769137	MAPLE SHADE TWP SITE	Burlington	39.9510	74.9862																
NJD071455331	MARATHON INDUSTRIES INC	Burlington	39.9785	74.8482																
NJD048606897	METHODE ELECTRONICS	Burlington	40.0417	74.6917																
NJD981084700	MOUNT HOLLY MUNICIPAL LANDFILL	Burlington	39.9864	74.7860																
NJD981083090	MT. HOLLY GAS WORKS	Burlington	39.9929	74.7891																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD002352029	NATIONAL CASEIN	Burlington	40.0115	75.0099																
NJD980769152	NIXON'S STORE	Burlington	39.8271	74.6053																
NJD981178353	NOBLE OIL COMPANY	Burlington	39.8541	74.7334																
NJD043973122	OCCIDENTAL CHEMICALS & PLASTICS CORP	Burlington	40.0872	74.8361																
NJD980769160	PALMYRA BORO SITE	Burlington	39.9944	75.0234																
NJD980772560	PAUL'S TANK CLEANING	Burlington	39.9769	74.8174																
NJD980505614	PEMBERTON TWP LF	Burlington	39.9386	74.5208																
NJD980769178	PERRY INDUSTRIES	Burlington	39.9748	74.8452																
NJD981490220	POINSETT PROPERTY	Burlington	39.9644	74.5489																
NJD980582142	PULVERIZING SERVICES	Burlington	39.9880	74.9695	B	1	1	1		1										1
NJD002342434	RCA CORP MSR	Burlington	39.9755	74.9172																
NJD981082951	REED AVENUE SITE	Burlington	40.0409	74.9858																
NJD980769186	REIMER STREET SITE	Burlington	39.9921	74.7943																
NJD980755714	RIVERSIDE METAL CORPORATION	Burlington	40.0407	74.9584																
NJD981083132	RIVERTON GAS WORKS	Burlington	40.0063	75.0030																
NJD094341625	SANITARY LF INC	Burlington	40.0084	74.9784																
NJD981084783	SHAMONG TOWNSHIP LANDFILL I	Burlington	39.8067	74.7812																
NJD981084791	SHAMONG TOWNSHIP LANDFILL II	Burlington	39.7955	74.7753																
NJD980769202	STAVOLA OIL COMPANY	Burlington	39.9778	74.8152																
NJD041762840	STEPAN CHEMICAL	Burlington	40.1350	74.7273																
NJD002339406	SYBRON CHEMICAL DIVISION	Burlington	39.9774	74.7130																
NJD981084536	TABERNACLE TWP MUNICIPAL LANDFILL	Burlington	39.8220	74.7275																
NJD001890185	TENNECO POLYMERS, INC	Burlington	40.0870	74.8750																
NJD002265528	THOMASON PRESS	Burlington	39.9433	74.9250																
NJD981084809	TOOLEY'S GARAGE	Burlington	40.0890	74.8248																
NJD095275269	TROFE INCINERATION SITE	Burlington	39.9333	74.8950																
NJD981185291	UNCLE PROPERTY	Burlington	39.9297	74.4819																
NJD002347565	US PIPE & FOUNDRY CO	Burlington	40.0813	74.8560																
NJD981877731	WALTON'S FARM	Burlington	40.0161	74.9142	H															
NJD002345247	YATES INDUSTRIES PLANTS 1 & 2	Burlington	40.1609	74.6963																
NJD071455141	ADVANCED CHEMICAL TECHNOLOGY	Camden	39.9486	75.0992																
NJD002338267	ALUMINUM SHAPES INC.	Camden	39.9567	75.0883																
NJD000312371	AMSPEC CHEMICAL CO	Camden	39.8878	75.1251																
NJD980528749	ATLANTIC INDUSTRIAL TANK MAINTENANCE	Camden	39.9264	75.1246																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD980779599	BELL HARBOR INC	Camden	39.8542	75.0936																
NJD071462279	BORDEN CHEMICAL PRINTING	Camden	39.9183	75.1167																
NJD000305524	BUZBY SLF	Camden	39.8478	74.9570																
NJD981083017	CAMDEN COKE PLANT	Camden	39.9313	75.1299																
NJD980769079	CAMDEN FIRE DEPARTMENT	Camden	39.9447	75.1242																
NJD981083025	CAMDEN GAS WORKS	Camden	39.9342	75.1276																
NJD986620995	CAMDEN RADIATION SITES	Camden	39.9011	75.1239																
NJD001288042	CAMPBELL SOUP CO.(CAMPBELL PLACE)	Camden	39.9467	75.1217																
NJD003951951	CAMPBELL SOUP CO.(MARKET PLACE)	Camden	39.9467	75.1217																
NJD043274471	CITGO PETROLEUM	Camden	39.9567	75.0683																
NJD070280904	CLASSIC CHEMICAL	Camden	39.9421	75.1022																
NJD002355105	CLEMENT 'COVERALL' COMPANY	Camden	39.9467	75.1217																
NJD980769095	CONRAIL-PAVONIA ENGINE YARD	Camden	39.9479	75.1006																
NJD980774467	CRESCENT LIGHTING, INC.	Camden	39.8661	75.0467																
NJD002266732	CURTIS-YOUNG CORP	Camden	39.9793	75.0201																
NJD986570901	DELAWARE RIVER	Camden	39.7750	75.0533	V															
NJD005440342	DESOTO, INCORPORATED	Camden	39.9850	75.0456																
NJD069016954	ELCO CORP. VARICIRQUITS	Camden	39.9567	75.0683																
NJD980529028	ERLTON LF	Camden	39.9194	75.0133																
NJD002493757	ETCHED CIRCUITS INC	Camden	39.9141	74.9673																
NJD980505127	FAZZIO LANDFILL	Camden	39.8637	75.0998																
NJD002263822	FINNESSY BODY WORKS	Camden	39.9203	75.0664																
NJD002352300	FLAGS, INC.	Camden	39.8700	75.0836																
NJD980536577	FLOWEN OIL DELAWARE VALLEY CORP.	Camden	39.9436	75.1000																
NJD986578169	FOGARTY INDUSTRIES	Camden	39.8667	75.0833																
NJD986634723	FRONT STREET WAREHOUSE	Camden	39.9183	75.1167																
NJD002347664	G & W NATURAL RESOURCES	Camden	39.8667	75.0833																
NJD043292606	GAF CORPORATION	Camden	39.8667	75.0833																
NJD002514750	GEORGIA PACIFIC CORPORATION	Camden	39.9567	75.0683																
NJD000591289	GLOUCESTER CITY JR. SR. H. S	Camden	39.8667	75.0833	V.															
NJD981083058	GLOUCESTER GAS WORKS	Camden	39.8912	75.1260																
NJD000310417	GROW GROUP INC/DE VOE MARINE COATING CO.	Camden	39.9567	75.0683																
NJ1470035295	GSA NILE MISSILE BATTERY	Camden	39.7750	75.0533																
NJD000600734	HARLEIGH CEMETERY	Camden	39.9266	75.0905																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD980527956	HARRISON AVE LF	Camden	39.9514	75.1058																
NJD980642888	KELBROS INC.	Camden	39.9467	75.1217																
NJD045796976	KEUFFEL & ESSER	Camden	39.9467	75.1217																
NJD087098380	KRAMER CHEMICALS	Camden	39.9183	75.1167																
NJD981490279	LANGSTON DIV-MOLINS MACHINE CO.	Camden	39.9188	75.1188																
NJD014623854	MARTIN AARON INC.	Camden	39.9208	75.1203																
NJD981877566	MERCHANTVILLE PENNSAUKEN WELL #1	Camden	39.9822	75.0367																
NJD001700830	MONSANTO CO	Camden	39.9380	75.1087																
NJD002350015	OWENS-CORNING FIBERGLASS CORP	Camden	39.8633	75.0498																
NJD980532972	OWENS-CORNING FIBERGLASS CORP	Camden	39.8429	75.0375																
NJD980530380	OWENS-CORNING FIBERGLASS CORP	Camden	39.8576	74.9984																
NJD075544858	PINE VALLEY GOLF CLUB	Camden	39.7868	74.9700																
NJD075475871	PINE VALLEY PRECISION INC	Camden	39.9293	75.0803																
NJD000606079	PURE STREAM INC	Camden	39.7897	75.0587																
NJD002342517	RCA CORP /CAMDEN PLANT	Camden	39.9479	75.1260																
NJD980530752	REVES & HYATT SUNOCO STATION	Camden	39.8871	74.9145																
NJD002488989	S W ELECTRONIC & MFR CORP.	Camden	39.8717	75.0100																
NJ3210420920	SFC NV BRITTON USAR CENTER	Camden	39.9533	75.1033																
NJD002356475	SGL MODERN HARD CHROME SERVICE	Camden	39.9811	75.0511																
NJD980417976	SHERWIN-WILLIAMS	Camden	39.8347	74.9646																
NJD986626570	STE-LAR TEXTILE	Camden	39.9183	75.1167																
NJD069047967	TEXACO USA	Camden	39.9728	75.0725																
NJD002357945	ULTIMATE SCREW MACHINE PRODUCTS CO	Camden	39.8578	75.0261																
NJD044546846	UNDERWATER TECHNICS INC.	Camden	39.9609	75.0966																
NJD986570893	UNION STREET ASBESTOS SITE	Camden	39.9567	75.0683																
NJD098159130	UNITED STEEL & WIRE CO., INC.	Camden	39.9567	75.0683																
NJD986610541	URBAN CASTING CO	Camden	39.7906	75.0461																
NJD982530073	VANGUARD VINYL SIDIN	Camden	39.8911	75.1266	A															
NJD086423886	VINELAND CONSTRUCTION	Camden	39.9636	75.0814																
NJD085695542	W B SAUNDERS CO	Camden	39.9412	75.0482																
NJD000575266	WARD SAND AND MATERIALS	Camden	39.9567	75.0683																
NJD981677772	FOUNDATIONS & STRUCTURES SLF	Cape May	39.2275	74.8011																
NJD048592026	MAR-TEE CONTRACTORS (SCA SERVICES)	Cape May	39.0158	74.8828																
NJD981143035	WILDWOOD PUMP STATION	Cape May	38.9986	74.8536																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD038009684	ABBOTTS MANUFACTURING CO	Cumberland	39.4272	75.2242																
NJD096854229	AIRCRAFT PAINTING INC	Cumberland	39.4419	75.0208																
NJD000574491	AIRWORK CORP	Cumberland	39.3772	75.0753																
NJD980530927	BRIDGETON CITY LF	Cumberland	39.4250	75.2392																
NJD981084635	BRIDGETON COAL GAS	Cumberland	39.4253	75.2375																
NJD981178346	CASIE ECOLOGY OIL SALVAGE	Cumberland	39.4625	75.0839																
NJD980530539	CITY OF VINELAND LF	Cumberland	39.4522	75.0344																
NJD980530547	CITY OF VINELAND LF	Cumberland	39.4531	75.0347																
NJD982531436	DONNA ESTATES	Cumberland	39.4800	75.1300																
NJD002372415	FRINTON LAB	Cumberland	39.4531	75.0197																
NJD980769558	GAMMA INDUSTRIES	Cumberland	39.2476	75.0342																
NJD986649762	GARRISON ROAD WELL CONTAMINATION	Cumberland	39.4558	75.0472																
NJD000820167	KERR GLASS MANUFACTURING CORP	Cumberland	39.3919	75.0197																
NJD980504963	MAPLEWOOD ROAD SITE	Cumberland	39.5711	74.8698																
NJD981084692	MILLVILLE COAL GAS SITE	Cumberland	39.4131	75.0397																
NJD002342087	OI KIMBLE STS INC	Cumberland	39.4972	75.0208																
NJD002342053	OWENS-ILLINOIS INC PLANT #14	Cumberland	39.4408	75.2292																
NJD986603660	QUINTON TWP SWDA	Cumberland	39.4283	75.2333																
NJD044552354	A & B DRUM COMPANY	Gloucester	39.7967	75.0972																
NJD986593762	ABANDON DRUM	Gloucester	39.6167	75.0800	H															
NJD002373579	AIR PRODUCTS & CHEMICAL INC	Gloucester	39.8301	75.2542																
NJD981084585	ALMO ANTI POLLUTION SERVICES	Gloucester	39.6600	75.0684																
NJD980769665	AMADEI LF	Gloucester	39.7683	75.1433																
NJD077091569	ASSOCIATED PACKAGING	Gloucester	39.7683	75.1433																
NJD043278787	B. P. OIL INC	Gloucester	39.8477	75.2378																
NJD084779388	BARON BLAKESLEE DIVISION, PUREX CORP.	Gloucester	39.8417	75.1967																
NJD051406346	CBS RECORDS	Gloucester	39.7495	75.1266																
NJD980769400	CLAYTON BORO GARAGE	Gloucester	39.6468	75.0974																
NJD990753162	COASTAL EAGLE POINT OIL	Gloucester	39.8543	75.1675																
NJD980769418	COHAWKIN ROAD SITE	Gloucester	39.7910	75.2181																
NJD980206957	COLONIAL PIPELINE	Gloucester	39.8236	75.2122																
NJD085689495	CONTINENTAL VANGUARD.	Gloucester	39.8717	75.1250																
NJD002491116	DEPTFORD PLATING COMPANY, INC	Gloucester	39.8298	75.1268																
NJD980684437	E.I. DUPONT DE NEMOURS	Gloucester	39.8475	75.2958																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU.	PB	HG	AG	TOTAL METAL	VOC
NJD980530695	E.I. DUPONT PAULSBORO WORKS	Gloucester	39.8417	75.2395																
NJD030306732	EAST COAST POLLUTION CONTROL, INC	Gloucester	39.6594	75.0678																
NJD986639557	EDWARDS & EASTLACK PROPERTIES	Gloucester	39.6167	75.0600																
NJD069043370	EM DIAGNOSTIC SYSTEMS	Gloucester	39.8083	75.2694																
NJD980769723	ESSEX CHEMICAL PLANT SITE	Gloucester	39.8468	75.2363																
NJD009448432	FMC CORP	Gloucester	39.6191	75.0798																
NJD986628451	FOSTER FARM	Gloucester	39.8414	74.6764																
NJD986570992	FRANKLIN BURN SITE	Gloucester	39.5933	75.0256	O			1					1	1	1	1	1	1		
NJD986571016	FRANKLIN BURN SITE #2	Gloucester	39.6311	75.0278	O															
NJD986620656	FRANKLIN BURN SITE #4	Gloucester	39.5767	75.0517	O															
NJD986620664	FRANKLIN BURN SITE #5	Gloucester	39.5767	75.0517	O															
NJD986633543	FRANKLIN BURN SITE #6	Gloucester	39.6167	75.0600	O															
NJD986641637	FRANKLIN BURN SITE #7	Gloucester	39.6167	75.0600	O															
NJD980505374	FRANKLIN TWP LF	Gloucester	39.6120	75.0694																
NJD980505622	FRANKLIN TWP LF	Gloucester	39.5624	75.0390																
NJD051390383	GARMENT BAR CO., INC.	Gloucester	39.8717	75.1250																
NJD980769640	GLASSBORO LAB PACK DUMP	Gloucester	39.7002	75.1246																
NJD071630131	GRACE WR & COMPANY INCORPORATED	Gloucester	39.8350	75.1550																
NJD980529234	HAUTO METALLURGICAL DRUM	Gloucester	39.7121	75.1111																
NJD980505226	HENRY HARRIS LF	Gloucester	39.7511	75.2144																
NJD000831578	INDUSTRIAL STEEL DRUM CO INC	Gloucester	39.5606	75.0394																
NJD980769434	JEM LANDFILL	Gloucester	39.8350	75.1550																
NJD046556486	KINSLEY'S LANDFILL, INC.	Gloucester	39.7845	75.1033																
NJD067362087	LILLY INDUSTRIAL COATING	Gloucester	39.8174	75.1992																
NJD980529374	MAC SANITARY LF INC	Gloucester	39.8383	75.0682																
NJD085693505	MANTUA METAL PROD CO INC	Gloucester	39.8128	75.1406																
NJD980769681	MARSHALL SERVICE	Gloucester	39.5466	75.0213																
NJD980769442	MARTEL PROPERTY	Gloucester	39.8442	75.1159																
NJD014725410	MARVIN JONAS INC	Gloucester	39.7792	75.1300																
NJD002342426	MOBIL OIL LF	Gloucester	39.8450	75.2551																
NJD980769699	MONROE TWP MUNICIPAL WELL #4 & #5	Gloucester	39.6897	74.9904																
NJD001700707	MONSANTO CO	Gloucester	39.8031	75.3503	B															
NJD981083108	MUNICIPAL WELL CONTAMINATION	Gloucester	39.6524	74.4997																
NJD079463392	NALCO CHEMICAL COMPANY, INC.	Gloucester	39.8169	75.1988																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD980505515	NATIONAL PARK LANDFILL	Gloucester	39.8601	75.1830																
NJD980769632	NEW JERSEY STATE D.O.T. YARD	Gloucester	39.8014	75.3218																
NJD980505556	NEWFIELD LF	Gloucester	39.5443	75.0048																
NJD980769715	NJ TURNPIKE MM 16.7	Gloucester	39.8064	75.1838																
NJD000246801	NORTHERN FINES CHEM	Gloucester	41.1203	74.5874																
NJD000560094	OIL RECOVERY CO INC	Gloucester	39.6611	75.0684																
NJD981877582	PAULSBORO COAL GAS SITE	Gloucester	39.8300	75.2467																
NJD067394825	PEABODY CLEAN INDUSTRY INC	Gloucester	39.8500	75.2414																
NJD002360188	PIONEER METAL FINISHING INC	Gloucester	39.6205	75.0349																
NJD071454276	PITCCO - PRICKETTS' INDUSTRIAL TANK CLNG	Gloucester	39.8234	75.0916																
NJD002330322	POLYREZ CO INC	Gloucester	39.8693	75.1797																
NJD002331973	PRIDE ELECTRO PLATING	Gloucester	39.8717	75.1250																
NJD980529697	REDKOLE FARM	Gloucester	39.7733	75.3636																
NJD053288239	ROLLINS ENVIRONMENTAL SERVICES NJ INC	Gloucester	39.7893	75.3432																
NJD980505713	ROUTE 534 SITE	Gloucester	39.8222	75.0778																
NJD089039626	SAFETY KLEEN CORP/CLAYTON SOLVENT CTR	Gloucester	39.6619	75.0693																
NJD981490311	SCHALICK RESIDENCE	Gloucester	39.5108	75.0897																
NJD002482602	SHELL CHEM	Gloucester	39.8291	75.2204																
NJD982178790	STARTING GATE/LAIL PROPERTY	Gloucester	39.8197	75.2348																
NJD002349751	STRUTHERS-DUNN INC	Gloucester	39.7403	75.1440																
NJD981082977	SWEDESBORO COAL GAS	Gloucester	39.7448	75.3190																
NJD048620496	TABLICAPS INC	Gloucester	39.6269	75.0631																
NJD065367264	TIMBERLANE WELDING & SERVICES INC	Gloucester	39.8291	75.2369																
NJD986629327	UNICORN INDUSTRIES	Gloucester	39.5431	74.9942																
NJD980505838	WEST DEPTFORD MUN DP	Gloucester	39.8449	75.1899																
NJD980769657	WILLIAMSTOWN ROAD LANDFILL	Gloucester	39.6008	75.0723																
NJD980532964	WINNER CHEM INC	Gloucester	39.8442	75.2490																
NJD981084833	WOODBURY GAS WORKS	Gloucester	30.8179	75.1529																
NJD982187387	ELIZABETHTOWN GAS CO-FORMER GAS PLANT	Hunterdon	40.3642	74.9468																
NJD980589923	LEHIGH FLUID POWER, INCORPORATED	Hunterdon	40.3908	74.9122																
NJD980772750	OLD RIVER ROAD	Hunterdon	40.3421	74.9386																
NJD982273310	PINKERTON DUMP SITE	Hunterdon	40.5267	75.0617																
NJD980766786	PLESSEY CERAMICS	Hunterdon	40.5314	75.0638																
NJD980237200	RIEGAL PROD	Hunterdon	40.5624	75.0699																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
NJD982268708	TEXAS EASTERN GAS PIPELINE CO	Hunterdon	40.4017	74.9103																
NJD986648129	200 WOLVERTON STREET	Mercer	40.2250	74.7667																
NJD053276218	ALL SERVICE METAL TREATING COMPANY	Mercer	40.2364	74.7792																
NJD002366441	AMERICAN STANDARD INC	Mercer	40.2469	74.7459																
NJD986579480	BCS ASSOCIATES	Mercer	40.1967	74.7017																
NJD986581098	BLAKELY LAUNDRY COMPANY INC	Mercer	40.2917	74.7417	A															
NJD981082886	BRUNSWICK AVE GAS WORKS	Mercer	40.2318	74.7551																
NJD051411809	C.K. BLAUTH LUMBER/SUPPLY	Mercer	40.1702	74.6482																
NJD986639102	CHAMPALE LAB	Mercer	40.1950	74.7350	A															
NJD080796782	CONGOLEUM PLANT	Mercer	40.2508	74.7028																
NJD980505051	DUCK ISLAND SANITARY LF	Mercer	40.1906	74.7541																
NJD070262611	DURABOND PRODUCTS COMPANY	Mercer	40.2163	74.7467																
NJD980529119	EUGENE PARKS	Mercer	40.1709	74.6633																
NJD092338722	FINA OIL AND CHEMICAL CO - COSDEN DIV.	Mercer	40.2467	74.5759																
NJD002357242	GENERAL ELECTRIC CO	Mercer	40.2416	74.7228																
NJD002353951	GMC FISHER BODY DIVISION	Mercer	40.2668	74.8122																
NJD002346286	GOULD STORAGE BATTERY CORP	Mercer	40.2281	74.7714																
NJD075484139	HYDROCARBON RESEARCH INC	Mercer	40.2448	74.7373																
NJD069000818	INTER-STATE WASTE REMOVAL INC	Mercer	40.2113	74.7182																
NJD981084684	JACOBSTOWN RD. SITE	Mercer	40.0633	74.5611																
NJD980210009	MONSANTO CO	Mercer	40.1688	74.6564																
NJD000316778	PRINCETON BIOMEDICS	Mercer	40.2383	74.5867																
NJD086425402	SATURN CHEMICAL INC	Mercer	40.2393	74.7434																
NJD002294163	STOKES MOLDED PRODUCTS	Mercer	40.2128	74.7453																
NJ9210420999	STRYKER USAR CENTER	Mercer	40.2433	74.6917																
NJD980266801	THIOKOL CHEM CORP/ PANELYTE DIV	Mercer	40.2391	74.7378																
NJD986603959	TITAN LIGHTING FACILITY	Mercer	40.1950	74.7350	A															
NJD002349942	TRANSAMERICA DELAVEL DELROYD DIVISION	Mercer	40.2421	74.7310																
NJD077076347	TRENTON DRUM CO	Mercer	40.2385	74.7445	A															
NJD981083140	TRENTON GAS PLANT 1	Mercer	40.2158	74.7641																
NJD011802790	TRENTON LEHIGH COAL & OIL	Mercer	40.2362	74.7489																
NJD981877590	U.S. STEEL CORP/WIRE ROPE DIV	Mercer	40.2131	74.7586																
NJD092338326	WESTERN ELECTRIC	Mercer	40.3606	74.7289																
NJD980653919	JONES LIQUOR STORE	Monmouth	40.1154	74.4911																

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NJD002330496	PRODELIN INC	Monmouth	40.2532	74.4381																
NJD986601292	SOUTH BRUNSWICK ASPHALT	Ocean	39.9936	74.2797																
NJD980417257	AGWAY COUNTY FOODS	Salem	39.5938	75.1724																
NJD980771471	ALDINE ABANDONED DRUMS	Salem	39.5706	75.2890																
NJD002365615	ANCHOR HOCKING CORPORATION PLANT #6	Salem	39.5758	75.4703																
NJD048585269	BF GOODRICH CHEM GROUP	Salem	39.7716	75.4223																
NJD000554659	BROWNING-FERRIS IND	Salem	39.7614	75.4186																
NJD011881174	C.R. WARNER, INC.	Salem	39.6372	25.3194																
NJD002363703	DELKOTE, INC	Salem	39.7167	75.4667																
NJD002365730	E.I. DUPONT DE NEMOURS	Salem	39.6913	75.4837																
NJD002365490	E.I. DUPONT DE NEMOURS	Salem	39.7249	75.4506																
NJD064344575	GANES CHEMICAL INC	Salem	40.6356	75.5378																
NJD981877681	GAYNOR GLASS WORKS	Salem	39.5742	75.5742																
NJD980771695	KURTZ RESIDENCE	Salem	39.6218	75.3216																
NJD002349256	MANNINGTON MILLS INC	Salem	39.5807	75.4553																
NJD980530919	OLDMANS TWP SANITARY LF	Salem	39.7284	75.3831																
NJ3210022270	PEDRICKTOWN SUPPORT FACILITY	Salem	39.7600	75.4067																
NJD981084742	PENNS GROVE COAL GAS	Salem	39.7328	75.4682																
NJD980771869	PITTSGROVE TWP LF	Salem	39.5356	75.1617																
NJD981084775	SALEM COAL GAS	Salem	39.5773	75.4678																
NJD980771778	TOMAH PRODUCTS INC. / NO - STRIP	Salem	39.7394	75.4242																
NJD980505812	UPPER PENNS NECK SLF	Salem	39.6988	75.4492																
NJD011037496	XERXES FIBERGLASS INC	Salem	39.7206	75.4677																
NJD980771513	CHARLOTTE URANIUM MINE	Sussex	40.9393	74.7369																
NJD980529200	GREEN ACRES LF	Sussex	39.9906	74.2049																
NJD980771661	HAMM'S SLF	Sussex	41.0969	74.6706																
NJD980773881	MKY CORPORATION	Sussex	40.9883	74.7383	B															
NJD986627396	MKY WOLF LAKE SITE	Sussex	40.9606	74.6983																
NJD980530745	MYKROY CERAMICS	Sussex	40.9638	74.7183																
NJD981084726	NEWTON COAL GAS SITE 1	Sussex	41.0491	74.7464																
NJD981083124	NEWTON COAL GAS SITE 2	Sussex	41.0607	74.7514																
NJD980529457	NEWTON SANITARY LANDFILL	Sussex	41.0641	74.7484																
NJD002397065	SCHNEIDER & MARQUAD INC	Sussex	41.0517	74.7517																
NJD980528699	ALPHA BOROUGH SANITARY LANDFILL	Warren	40.6722	75.1829																

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NJD980504823	ALPHA QUARRY	Warren	40.6563	75.1628																
NJD059282061	ALUMITEK DIVISION TRANSISTOR	Warren	40.8633	74.0153																
NJD003000049	BASF WYANDOTTE CORP	Warren	40.7583	74.9817																
NJD002167799	BATES MANUFACTURING CO	Warren	30.9989	59.0011																
NJD059284208	BELL & HOWELL	Warren	40.6956	75.1510																
NJD980755300	BELVIEW RD TRUCK AREA	Warren	40.7217	75.1459																
NJD981562622	CASTLE CREEK FABRICS	Warren	40.7558	74.9981																
NJD002397701	CELANESE PLASTICS & SPECIALTIES	Warren	40.8341	75.0803																
NJD002394955	CRAMER PLATING & ANODIZING CO, INC	Warren	40.8373	75.0074																
NJD045133485	ELASTIMOLD DIV AMERACE CORP	Warren	40.8200	74.8433																
NJD002395713	FASCO FINISHING CO.,	Warren	40.6867	75.1833	B															
NJD059283242	GEORGIA-PACIFIC CORP/POLMER MAT'LS DIV	Warren	40.8332	75.0789																
NJD980771356	GETTY PIPELINE	Warren	40.7348	74.9503																
NJD980530646	HARMONY TWP LF	Warren	40.6867	75.1833																
NJD980505259	HIGH POINT SANITARY LANDFILL	Warren	40.7314	75.0498																
NJD980529267	HOFFMAN - LA ROCHE - RQT	Warren	40.8350	75.0017																
NJD042321042	HOFFMAN - LA ROCHE INC	Warren	40.8250	75.0617																
NJD098260136	INDEPENDENCE TWP	Warren	40.8616	74.9114																
NJD082988056	INMONT CORP	Warren	40.8344	75.0793																
NJD001213487	J T BAKER CHEM CO	Warren	40.7025	75.1986																
NJD980530653	LOPATCONG TWP LF	Warren	40.7218	75.1841																
NJD003001757	M AND M MARS INC	Warren	40.8842	74.8253																
NJD056823735	OXFORD TEXTILE FINISHING	Warren	40.8053	74.9901																
NJD982187395	PHILLIPSBURG COAL GAS SITE	Warren	40.6965	75.1786																
NJD986579472	PLANAR FARM	Warren	40.9133	74.9667																
NJD080787025	RYMON FARM	Warren	40.7282	75.0491																
NJD981490352	SOUTH LINCOLN AVENUE SITE	Warren	40.7367	74.9772																
NJD092225721	SOUTHLAND CORP	Warren	40.8780	74.9043																
NJD049467887	USR OPTONIX INC.	Warren	40.8533	74.8267																
NJD980771455	VICTORIA LANE SITE	Warren	40.8423	74.8250																
NJD981083157	WASHINGTON COAL GAS	Warren	40.7539	74.9793																
NYD084337298	C & D BATTERIES DIV /ELTRA CORP	Orange	41.4189	74.6266																
NYD981183379	COACHMAN CARTING	Orange	41.3733	74.6883	A															
NYD980531537	ORANGE & ROCKLAND OTIL /PORT JERVIS	Orange	41.3770	74.6922																

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NYD980507032	MAMAKATING LF	Sullivan	41.6215	74.5102																
NYD980534762	MONTICELLO LF	Sullivan	41.6448	74.6710																
NYD986870808	ROSCOE WOOD PRODUCTS	Sullivan	41.9350	74.9150																
PAD981034242	ADAMS LABORATORIES, INC	Berks	40.3283	75.8933																
PAD055631584	ADELPHIA KITCHENS INC	Berks	40.3267	75.9917																
PAD071203103	AGWAY, INC	Berks	40.4433	75.8850																
PAD987284320	ALGONQUIN CHEMICAL	Berks	40.5550	75.9850	B															
PAD987347572	ALUMINIUM ALLOYS INC	Berks	40.3267	76.0333																
PAD002329365	AMERICAN COLOR & CHEMICAL CORP	Berks	40.3517	75.8933																
PAD072831415	ARROW INTERNATIONAL INC	Berks	40.3283	75.9867	O															
PAD000428441	ATLAS MINERAL & CHEMICAL	Berks	40.5250	75.6678																
PAD002350833	BALDWIN HARDWARE MFG CO	Berks	40.3233	75.9406																
PAD006129654	BERKMONT IND-UNICAST DIV	Berks	40.3333	75.6383																
PAD982367658	BERKS CO FIRE TRAINING SCHOOL	Berks	40.3333	76.0600	O															
PAD981107337	BERKS COUNTY PRISON DUMP	Berks	40.4500	75.9667																
PAD002332344	BIRDSBORO CORP NICHOLAS GUGLIELMO	Berks	40.2683	75.8067																
PAD002347540	BIRDSBORO SLAG CO	Berks	40.2683	75.8067																
PAD980508394	BOYERTOWN LANDFILL	Berks	40.3333	75.6383																
PAD037672052	BOYERTOWN SCRAP	Berks	40.3167	75.6831	A															
PAD002387835	BRUSH WELLMAN INC	Berks	40.4900	75.9817																
PAD044540136	CABOT-WROUGHT PROD - DIV OF CABOT CORP	Berks	40.4033	75.9333																
PAD002281723	CALORIC CORP	Berks	40.5050	75.7017																
PAD002344315	CARPENTER TECHNOLOGY CORP	Berks	40.3367	75.9283																
PAD980508675	CLEMENTS LANDFILL	Berks	40.4667	75.9556																
PAD987348885	COLE PROPERTY	Berks	40.3767	75.9250	H															
PAD000800193	CONTINENTAL CAN CO USA PLANT 479	Berks	40.4183	75.9217	O															
PAD980707632	CRISTMANS IND WASTES LANDFILL	Berks	40.5500	75.5583																
PAD002917466	CROMPTON & KNOWLES CORP GIBRALTAR PLT	Berks	40.2683	75.8067																
PAD002343630	DANA CORP. PARISH DIVISION	Berks	40.3483	75.9167	O															
PAD981105075	DOUGLASS-EARL TCE	Berks	40.3333	75.6383																
PAD982367732	DUTCH VALLEY DINER	Berks	40.5017	75.9700	G															
PAD069785632	ELTRA CORP PRESTALITE BATT DIV	Berks	40.3767	75.9250	O															
PAD981034309	EMPIRE STEEL CASTINGS LANDFILL	Berks	40.3283	75.8933																
PAD071207757	F R & S LANDFILL	Berks	40.2683	75.8067																

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PAD021446521	FR & S #3 INDUSTRIAL WASTE SITE	Berks	40.3483	75.9167																
PAD990753089	GENERAL BATTERY CORP	Berks	40.3767	75.9250																
PAD010556603	GULF OIL SINKING SPRINGS	Berks	40.3167	76.2003																
PAD987329075	HAMBURG FIELD HOUSE	Berks	40.5550	75.9850	H															
PAD987332541	HAMBURG PLAYGROUND SITE	Berks	40.5550	75.9850	H															
PAD982367674	HAZY'S MOBILE HOME PRK	Berks	40.5550	75.9850	O															
PAD002270304	HOFFMANN IND INC	Berks	40.3225	76.0100																
PAD980692727	KAWECKI BERYLCO	Berks	40.3450	75.6133																
PAD097153399	KIWI BRANDS INC.	Berks	40.2617	75.7217	O															
PAD987343118	KUNKEL - R.I.	Berks	40.4800	75.9783																
PAD987347192	MOHRSVILLE LEAD	Berks	40.4800	75.9783	H															
PAD980539035	NATIONAL GYPSUM CO EVANSVILLE PLT	Berks	40.4800	75.8967																
PAD987266574	NEVERSINK MOUNTAIN	Berks	40.3367	75.9283	O															
PAD981110174	ORCHARD ROAD DRUM BURIAL SITE	Berks	40.4550	75.8200																
PAD002338721	PRIZER PAINTER STOVE WORKS, INC	Berks	40.3283	75.9283																
PAD980831010	READING INDUSTRIES PLT #4	Berks	40.3767	75.9250																
PAD002342145	READING INDUSTRIES-PLT 1	Berks	40.4192	75.9433																
PAD987277803	READING RAILYARD DUMP	Berks	40.2883	75.9817	G															
PAD987277989	RIC'S MARINE	Berks	40.4383	76.1083	L															
PAD981033459	RYELAND ROAD ARSENIC SITE	Berks	40.3542	76.1767	O															
PAD987332822	SUN PIPELINE	Berks	40.5017	75.9700	O															
PAD981735970	TEXAS EASTERN PIPELINE-BECHTELSVILLE STA	Berks	40.4183	75.6228																
PAD981937519	TEXAS EASTERN PIPELINE-BERNVILLE STA	Berks	40.4092	76.1508																
PAD981104920	TILDEN TWP FILL	Berks	40.5550	75.9850																
PAD980539159	UGI CORP GAS MFG PLT	Berks	40.3350	75.9483																
PAD980536912	UGI CORP GAS MFG PLT	Berks	40.3333	75.6383																
PAD981939127	WERNERSVILLE FIRE TRAINING PIT	Berks	40.3333	76.0800																
PAD000443705	WESTERN BERKS REFUSE AUTHORITY LANDFILL	Berks	40.2683	75.8067																
PAD980539092	WESTERN BERKS REFUSE AUTHORITY LANDFILL	Berks	40.3033	75.9717																
PAD002363156	WOLF DYE & BLEACH	Berks	40.5017	75.9700																
PAD064197896	WYOMISSING CORP PAPER DIV	Berks	40.4050	75.9433																
PAD981034002	3M CO-TAPE DIV	Bucks	40.1261	74.8525																
PAD042266171	A & E MFG CO INC	Bucks	40.1400	74.8650																
PAD077060358	ABAR CORP	Bucks	40.2033	75.0733																

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PAD987268174	ACRO-MATIC, INC	Bucks	40.2383	75.1300	G															
PAD980692545	ALLEN LUKINS	Bucks	40.3708	75.5083																
PAD177276342	AMERICAN COPPER PRODUCTS	Bucks	40.6833	76.1967																
PAD055066823	AMERICAN INDUSTRIES CO	Bucks	40.1400	74.8650																
PAD002342236	AMETEK-US GAUGE DIV	Bucks	40.3542	75.3042																
PAD981109911	ARROW CARTING LANDFILL	Bucks	40.5633	75.1033																
PAD053277752	AVERY INT'L CORP - FASSON DIV.	Bucks	40.4417	75.3417	O															
PAD054732557	AYDIN ELECTRO FAB	Bucks	40.0767	74.9567	O															
PAD987397163	BEDMINSTER BURIED DRUM	Bucks	40.4300	75.1783																
PAD162700686	BENS AUTO BODY	Bucks	40.3100	75.1300	O															
PAD981736507	BENSALEM DRUM DUMP	Bucks	40.0767	74.9567	A			1					1		1	1	1			
PAD987388360	BENSALEM PARK SITE	Bucks	40.0767	74.9567																
PAD987266491	BENSALEM POWER CO	Bucks	40.0767	74.9567	O															
PAD000824805	BETZ LABORATORIES INC	Bucks	40.1783	74.9200	O															
PAD009722265	BETZ-LABS - NEW BOILER PLT	Bucks	40.1783	74.9200																
PAD980555015	BRINTECH CORP/DIV GARRY ELECTR	Bucks	40.1783	74.9200	O															
PAD053817516	BRISTOL BOROUGH WATER WORKS	Bucks	40.1000	74.8500																
PAD075521641	BRISTOL MUNICIPAL TOWNSHIP AUTH	Bucks	40.0824	74.8893																
PAD987336666	BUCKS COUNTY FIRE TRAINING CENTER	Bucks	40.3100	75.1300																
PAD980508444	CAMERON-SABA TRACT	Bucks	40.0069	74.9444																
PAD000799338	CARTEX INC	Bucks	40.1817	74.8517																
PAD002494037	CARTEX PLANT	Bucks	40.2100	74.7750																
PAD987396058	CENTER SCHOOL ROAD SITE (DEREWAL)	Bucks	40.3667	75.3050																
PAD000862821	CHALFONT BOROUGH WATER DIS	Bucks	40.2900	75.2050																
PAD980693220	CHALFONT CORP	Bucks	40.2000	75.0833																
PAD002323848	CHEM-FAB CORP	Bucks	40.3100	75.1300																
PAD064361926	CHILDERS PRODUCTS INC.	Bucks	40.1683	74.8217	O															
PAD000731166	CONRAIL MORRISVILLE LAGOONS	Bucks	40.2100	74.7750																
PAD981737075	CORCO CHEMICAL	Bucks	40.1000	74.8500																
PAD002359659	CORCO CHEMICAL CORP	Bucks	40.1817	74.8517																
PAD003916798	CRANE CO. CHEMPUMP DIV.	Bucks	40.2383	75.1300																1
PAD069880029	CRC CHEMICAL INC	Bucks	40.2033	75.0733	O															
PAD987391323	CROYDON PLASTICS	Bucks	40.0767	74.9567																
PAD057153009	DAILY AND AYDIN CO	Bucks	40.3883	75.0067																

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PAD981939689	DCI PLATING	Bucks	40.3950	75.1467																
PAD981736101	DELAWARE SCRAP AND IRON	Bucks	40.1000	74.8500																
PAD002506210	DIGILOG CIRCUITS LOG	Bucks	40.3950	75.1467	O															
PAD987285889	DILLON ROAD LANDFILL	Bucks	40.3100	75.1300																
PAD980693287	DOYLESTOWN BORO PUBLIC WATER SUPPLY	Bucks	40.3100	75.1300																
PAD982364218	DOYLESTOWN GROUND WATER	Bucks	40.3100	75.1300	W															
PAD980706675	DUPONT DELAWARE RIV PLT	Bucks	40.0694	74.9389																
PAD981738925	DURHAM TWP SOLVENT SPILL	Bucks	40.5967	75.1967	A															
PAD005831938	DURNAN & GOOD, INC	Bucks	40.5633	75.1033	O															
PAD981939085	EDGELY ROAD SITE	Bucks	40.1000	74.8500																
PAD981034580	EPPINGER & RUSSELL CO	Bucks	40.0767	74.9567																
PAD981736622	FENNEL ROAD DRUM SITE	Bucks	40.4417	75.3417	A															
PAD981947351	FIORE-DEFLAVIS, INCORPORATION	Bucks	40.2383	75.1300																
PAD002375186	FURLONG MANUFACTURING	Bucks	40.3050	75.0867																
PAD099079303	GELCO TRUCK LEASING	Bucks	40.0767	74.9567																
PAD981034457	GENERAL CRUSHED STONE CO	Bucks	40.3667	75.3050																
PAD981739345	GREENTOP MOBILE HOME PARK	Bucks	40.3978	79.3322																
PAD980508592	GROWS SANITARY LF	Bucks	40.1453	74.7672																
PAD981034069	HASKINS RESEARCH	Bucks	40.1750	75.0450																
PAD981737018	HAYNES TRUCKING	Bucks	40.1000	74.8500																
PAD981114986	HERALD PRODUCTS SITE - HSCA	Bucks	40.1783	74.9200							1									
PAD980832760	HERMAN MOYER PROPERTY	Bucks	40.4847	75.3678																
PAD980538847	HILLTOWN QUARRY	Bucks	40.3333	75.2183																
PAD981939184	HOUSTON JUNKYARD	Bucks	40.2100	74.7750	O			1		1										
PAD987367455	I-95 SULFURIC ACID LEAK	Bucks	40.0767	74.9567	O															
PAD002395325	INTERNATIONAL TELE & TELEG	Bucks	40.6900	75.2100																
PAD982367617	INTERSTATE ASPHALT (OLD)	Bucks	40.4417	75.3417	P															
PAD981044787	JACKSONVILLE INDUSTRIAL PARK	Bucks	40.2033	75.0733																
PAD981034523	KEY RESEARCH & DEVELOPMENT CO	Bucks	40.1783	74.9200																
PAD981736416	KEYSTONE AIRCRAFT CO	Bucks	40.1000	74.8500																
PAD047319389	LENAPE MFG CO	Bucks	40.3667	75.3050																
PAD981940836	LESTER STYER	Bucks	40.3667	75.3150																
PAD002273852	LIVINGSTON AND CO	Bucks	40.2283	74.9433																
PAD002387603	LYNN ELECTRONICS CORP	Bucks	40.1783	74.9200																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD060493582	MACK TRUCKS INC.	Bucks	40.5167	75.5567																
PAD981947534	MAGNAFLUX QUALITY	Bucks	40.1783	74.9200																
PAD981103815	MAGNOLIA GARDENS (HAYES)	Bucks	40.1000	74.8500																
PAD004961579	MAYCO CORPORATION	Bucks	40.1000	74.8500																
PAD058985771	MCADOO & ALLEN WELTING CO INC	Bucks	40.4417	75.3417																
PAD987323540	MEADOWOOD CONDO	Bucks	40.2033	75.0733	H															
PAD004006839	MERIT METAL PRODUCTS CORP	Bucks	40.2383	75.1300																
PAD980552145	MONACH CIRCUIT INDUSTRIES INC	Bucks	40.1400	74.8650	O															
PAD981103831	MORNINGSIDE IND PARK - DEMO SITE	Bucks	40.2100	74.7750																
PAD981102833	MORRISVILLE/PENNWOOD CROSSNG TRAILER PRK	Bucks	40.2100	74.7750																
PAD981736564	MUSKRAT ROAD DRUM SITE	Bucks	40.3667	75.3150																
PAD046565941	NATIONAL CAN CORPORATION	Bucks	40.2100	74.7750	O															
PAD002505550	NATIONAL SOLVENTS INC	Bucks	40.1508	74.8111																
PAD987391901	NEWTOWN PESTICIDE DRUMS BURIAL SITE	Bucks	40.2283	74.9433	H															
PAD987268695	NOCKAMIXON TWP RTE 563 SITE	Bucks	40.4767	75.1633	G															
PAD096225061	NORTH PENN POLISHING & PLATING	Bucks	40.3667	75.3150																
PAD981045206	NORTHAMPTON INDUSTRIAL PARK	Bucks	40.2133	75.0100																
PAD002262020	NORTHEAST PAINT & VARNISH CO	Bucks	40.1400	74.8650	O															
PAD980693022	NUCLEAR RESEARCH CORP	Bucks	40.1750	75.0450																
PAD987279361	OLD PLASTI-SEAL CORP	Bucks	40.1350	75.0700																
PAD981105042	PATTERSON PARCHMENT	Bucks	40.0767	74.9567																
PAD002371987	PENN ENGINEERING & MFG CO	Bucks	40.3633	75.1383	O															
PAD043584531	PENN JERSEY INDUSTRIAL WASTE	Bucks	40.0767	74.9567	O															
PAD014512388	PENN RARE METALS	Bucks	40.5167	75.1667								1	1	1	1	1				1
PAD980693436	PENNSBURY COATINGS CO	Bucks	40.2033	75.0733																
PAD002290823	PENNWALT CORP-CORNWELL HEIGHTS	Bucks	40.0700	74.9400																
PAD981939291	PENROSE DUMP	Bucks	40.2383	75.1300																
PAD987277126	PLEASANT VALLEY	Bucks	40.4417	75.3417	G															
PAD987282829	PP & L EAST PALMERTON SUBSTATION	Bucks	40.8000	75.6150																
PAD987280021	PP & L SIEGFRIED SUBSTATION	Bucks	40.6833	75.4817																
PAD014557805	PRECISION FINISHING INC	Bucks	40.3667	75.3150																
PAD054717475	PRINTED CIRCUITS SITE	Bucks	40.1000	74.8500	M															
PAD073739005	PRIOR COATED METALS	Bucks	40.2100	74.7750	O															
PAD987324225	QUAKERTOWN/KRUPPS FOUNDRY - HSCA	Bucks	40.4417	75.3417									1			1				

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PAD980693634	QUALITY RESEARCH LABS INC	Bucks	40.0767	74.9567																
PAD980538961	R C A SERVICE CO	Bucks	40.3667	75.3150																
PAD002369015	REMMEY WOOD PRODUCTS INC	Bucks	40.1750	75.0450																
PAD061836710	RICHBORO MANUFACTURING CO	Bucks	40.2133	75.0100																
PAD057142002	ROBERTSON - AMERICAN CORP	Bucks	40.2100	74.7750																
PAD000798470	ROHM & HAAS CO EXPERIMENTAL FARM	Bucks	40.2283	74.9433																
PAD981736689	RTE 13 DRUM DUMP	Bucks	40.1000	74.8500	A															
PAD065716813	SAFETY-KLEEN CORP (2-139-01)	Bucks	40.1000	74.8500	O															
PAD980693600	SEIDEL WATER CO	Bucks	40.3650	75.3067																
PAD987285616	SELLERSVILLE INACTIVE LANDFILL	Bucks	40.3667	75.3150	V															
PAD980692891	SHANGRILLA SOD FARM	Bucks	40.3667	75.3050																
PAD987277480	SOLEBURY NICOTINE SITE	Bucks	40.3100	75.1300	G															
PAD980508683	ST MICHAEL'S DUMP	Bucks	40.1458	74.8172							1									1
PAD002336410	STAUFFER CHEM CO	Bucks	40.2100	74.7750																
PAD980690507	STORYBOOK HOMES/MANFRED DEREWAL	Bucks	40.1958	75.0625																
PAD054731260	SUPERIOR ZINC	Bucks	40.1472	74.8544																
PAD981940778	T AND B/ANSLEY CORP	Bucks	40.3667	75.3050																
PAD980539209	THIOKOL BRISTOL	Bucks	40.1583	74.8625																
PAD057136661	THOMPSON NISSAN	Bucks	40.3100	75.1300	G															
PAD987336658	TOLLBROTHERS - SABO	Bucks	40.1783	74.9200																
PAD987270196	TROILO CONSTRUCTION CO. LANDFILL	Bucks	40.2100	74.7750	G															
PAD982363160	TROWBRIDGE ESTATES MERCURY	Bucks	40.0767	74.9567																
PAD981040413	TULLYTOWN TANK DUMP	Bucks	40.1000	74.8500																
PAD987393360	TUSCARORA OIL	Bucks	40.3650	74.9533	O															
PAD980538904	UGI CORP GAS MFG PLT	Bucks	40.3667	75.3050																
PAD981034358	UNION MILLS PAPER MFG CO	Bucks	40.3650	74.9533																
PAD002375376	UNITED STATES STEEL CORP	Bucks	40.1817	74.8517																
PAD980253355	VULCANIZED RUBBER CO	Bucks	40.2100	74.7750	M			1												
PAD980706824	WATSON JOHNSON LANDFILL	Bucks	40.3667	75.5000																
PAD987379195	WESTMINISTER APARTMENTS	Bucks	40.2383	75.1300	H															
PAD987291747	WESTMORELAND TUBULAR PRODUCTS - HSCA	Bucks	40.1400	74.8650																
PAD981034085	WHIPPANY PAPER CO, INC FILL	Bucks	40.5967	75.1967																
PAD002272615	WONDER CHEMICAL	Bucks	40.1817	74.8517																
PAD981034184	WONDER CHEMICAL CORP	Bucks	40.1000	74.8500																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD980832463	BANKS TWP LANDFILL	Carbon	40.9203	75.9517																
PAD981104854	BEAVER MEADOWS FILL	Carbon	40.9300	75.9117																
PAD981939679	COXEVILLE STRIPPING HOLE	Carbon	40.9300	75.9117																
PAD982367302	EAST PENN TWP FILL	Carbon	40.8283	75.6967	G															
PAD980832521	JIM THORPE LANDFILL	Carbon	42.8806	75.7403																
PAD981110356	LANSFORD BORO LANDFILL	Carbon	40.8486	75.8489																
PAD002399186	LEHIGHTON ELECTRONICS INC	Carbon	40.8283	75.6967	O															
PAD987281508	NESQUEHONING LEAKING RAILCAR	Carbon	40.8633	75.8150																
PAD980539829	PENN PWR & LGT LEHIGHTON GAS PLT	Carbon	40.8283	75.6967																
PAD980554877	PENN PWR & LGT MAUCH CHUNK PLT	Carbon	40.8683	75.7383																
PAD987285301	SEMANOFF PROPERTY	Carbon	40.8283	75.6967																
PAD002390284	SILBERLANE MFG - LANSFORD PLT	Carbon	40.8350	75.8817																
PAD981939028	ALLISTER CO. SITE	Chester	40.0100	75.6361																
PAD002353290	AMERICAN INKS & COATING CORP	Chester	40.1033	75.4767	O															
PAD981033764	AUTOCAR TRUCKS DIV	Chester	40.0283	75.6233																
PAD981033869	B-J DEVELOPERS, INC-SEWAGE PLT	Chester	39.9817	75.8250																
PAD081868309	BISHOP TUBE CO	Chester	40.0417	75.5417																
PAD981939620	BLOSENSKI FARM	Chester	40.0833	75.9117																
PAD069006716	C & F CHEMICAL	Chester	39.9650	75.5883	B															
PAD987317823	CHEMICAL LEAMAN LAGOONS	Chester	40.0133	75.8467																
PAD987347556	CHEMICAL LEAMAN TANK LINES INC	Chester	40.0283	75.6233																
PAD981739527	CHURCH FARM SCHOOL SITE	Chester	40.0283	75.6233																
PAD000414730	COATSVILLE LANDFILL	Chester	39.9986	75.8267																
PAD980830038	COCKERHAM SEPTIC TANK CLEANERS	Chester	40.0183	75.6072																
PAD981033822	CONRAD-PYLE CO	Chester	39.8233	75.8250																
PAD064375470	DELAWARE CONTAINER CORP	Chester	39.9817	75.8250																
PAD982363814	DIMATTEO LANDFILL	Chester	39.9650	75.5883	O															
PAD987347150	DORLANS MILL PAPER CO. DUMP	Chester	40.0133	75.8467																
PAD981033897	DOWNINGTOWN PAPER CO	Chester	40.0083	75.7000																
PAD021962008	DUPONT COATESVILLE	Chester	39.9817	75.8250																
PAD000796367	DUPONT E I DENEMOURS	Chester	39.9650	75.5883	O															
PAD987269396	EAST BRADFORD TOWNSHIP LANDFILL	Chester	40.0083	75.7000	H															
PAD048037600	EAST FALLS CHEM CO	Chester	40.0400	75.5000																
PAD981033954	EXTON PAPER MANUFACTURING	Chester	40.0283	75.6233																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD002373090	EXTON PAPER MFRS	Chester	39.9817	75.8000																
PAD980427348	EXTON PAPERS MFRS INC	Chester	39.9817	75.8250																
PAD002329456	FOOTE MINERAL - EXTON	Chester	40.0219	75.6283																
PAD987346939	FORMER DELAWARE CONTAINER LOCATION	Chester	39.9650	75.5883																
PAD980829931	FROG HOLLOW ROAD SITE	Chester	40.1433	75.6833																
PAD987327145	HICKORY HILL ROAD OIL SPILL	Chester	39.9650	75.5883	O															
PAD981034028	HIGHWAY MATERIALS, INC	Chester	40.0283	75.6233																
PAD987366802	HOFFMAN CIRCLE	Chester	40.0083	75.7000	V															
PAD040839052	HOLLINGSWORTH SOLDERLESS TERM CO	Chester	40.0400	75.5000																
PAD980832406	HOOPER LANDFILL	Chester	40.0625	75.5392																
PAD002331635	JAMES SPRING & WIRE CO. INC	Chester	40.0400	75.5000	O															1
PAD087362327	JOHNSON MATTHEY INC W WHITELAND SITE	Chester	39.9650	75.5883																
PAD987276363	KARDON PARK	Chester	40.0083	75.7000	G															
PAD981939440	KENNETT SQUARE GAS	Chester	39.8467	75.7117																
PAD980692776	KENNETT SQUARE JUNK YARD	Chester	39.8417	75.2167																
PAD046566806	KEYSTONE MUSHROOM	Chester	39.9700	75.8650																
PAD987346657	KIMBERLEA LANDFILL	Chester	40.1317	75.5733																
PAD000605972	KNICKERBOCKER LANDFILL	Chester	40.0400	75.5000																
PAD980550545	LANCHESTER CORP STABILIZED DISP SITE	Chester	40.0833	75.9117																
PAD002326908	LUKENS STEEL CO	Chester	39.9817	75.8250																
PAD981033517	LUKENS STEEL CO(SLAG STORAGE AREA)	Chester	39.9817	75.8250																
PAD981110539	MATHEY - BISHOP PIT #1	Chester	40.0356	75.5142																
PAD002271039	METALLURGICAL PRODUCTS CO	Chester	39.9650	75.5883																
PAD073591273	MID COUNTY MUSTANG	Chester	40.0283	75.6233																
PAD982363871	MODENA YARD	Chester	39.9817	75.8250	O															
PAD980508758	MOUNTAINTOP LANDFILL	Chester	40.0833	75.9117																
PAD002324978	NATIONAL ROLLING MILLS INC	Chester	40.0400	75.5000																
PAD107214116	NATIONAL VULCANIZED FIBER	Chester	39.8467	75.7117	O															
PAD987379167	O'BRIEN MACHINERY	Chester	40.0083	75.7000	M															
PAD981033269	ORGANIC RECYCLING, INC PILOT PLT	Chester	39.9650	75.5883																
PAD981103906	PAOLI CONSTRUCTION CO	Chester	40.0383	75.4867																
PAD981110893	PARKESBURG FILL	Chester	39.9817	75.8250																
PAD980692842	PENN GENERAL PAPER CO	Chester	39.9328	75.8567																
PAD981938939	PERRY PHILLIPS LANDFILL	Chester	39.9817	75.8250																

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PAD002276756	PHOENIX STEEL CORP	Chester	40.1317	75.5200																
PAD980716302	RESOURCE TECHNOLOGY SER INC	Chester	40.0400	75.5000																
PAD044065035	REYNOLDS METALS CO DOWNINGTOWN PLT	Chester	40.0083	75.7000																
PAD981034390	ROBERTS PACKING CO	Chester	40.1317	75.5733																
PAD099081812	SAFETY KLEEN CORP 2-139-09	Chester	40.0400	75.5000	O															
PAD987329786	SALVATION ARMY	Chester	39.9650	75.5883	O															
PAD047331095	SCM SPECIALTY COATING DIV	Chester	40.1317	75.5200																
PAD980830095	SHIP ROAD SITE	Chester	40.0283	75.6058																
PAD002381697	SONOBOND CORPORATION	Chester	39.9650	75.5883	O															
PAD981104755	SOUTH COATESVILLE FILL	Chester	39.9817	75.8250																
PAD981104631	SPRING CITY BOROUGH FILL	Chester	40.1800	75.5500																
PAD981103880	STOLTZFUS DEMOLITION SITE	Chester	39.9817	75.8250																
PAD987277100	STRUNK FARM SITE	Chester	39.9617	75.8000	G															
PAD981735913	TEXAS EASTERN PIPELINE-PHOENIXVILL	Chester	40.0972	75.6872																
PAD039018866	TOTAL RECOVERY INC	Chester	40.0767	75.5383				1												
PAD070265119	TURCO COATINGS	Chester	40.1317	75.5200	M															
PAD987280096	VALLEY FORGE ARMY HOSPITAL	Chester	40.1317	75.5200																
PAD987271699	VALLEY FORGE MOUNTAIN NIKE BASE	Chester	39.9817	75.8250	O															
PA9141733080	VALLEY FORGE NATIONAL HISTORIC PARK	Chester	40.1000	75.4650																
PAD002327484	VISHAY INTERTECHNOLOGY	Chester	40.0400	75.5000																
PAD069048254	WYETH LABORATORIES	Chester	40.1483	75.0800																
PAD980554679	ABM DISPOSAL	Delaware	39.8700	75.2683																
PAD990823742	ALLIED CHEMICAL DELAWARE VLY WKS	Delaware	39.8350	75.4367																
PAD987277852	ALLOY METAL WIRE WORKS	Delaware	39.8833	75.3067	M															
PAD987394244	APARTMENT OIL SPILL	Delaware	39.9133	75.3500	H															
PAD046538211	ARCO CHEMICAL CO RESEARCH & ENG CTR	Delaware	39.9867	75.4000	O															
PAD071612683	ARCO PETROLEUM PROD - MARCUS HOOK	Delaware	39.8350	75.4367																
PAD981033699	AURO-MANUFACTURING CO, INC	Delaware	39.8967	75.2583																
PAD987285079	BALDWIN DEFIANCE	Delaware	39.8950	75.2917	O															
PAD980539340	BALT & OHIO R R CO TRAIN DERAILMENT	Delaware	39.8633	75.3750																
PAD980550982	BALT & OHIO RR CO THE	Delaware	39.9083	75.2867																
PAD987368564	BALTIMORE PIKE AND PAPER MILL ROADS	Delaware	39.9017	75.3717	A															
PAD096837356	BOEING VERTOL CO	Delaware	39.9083	75.3267																
PAD981033640	BRYTON CHEMICAL CO	Delaware	39.8350	75.4367																

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PAD980539977	CHEM CLEAR INC - CHESTER	Delaware	39.8333	75.4167																
PAD084201524	CHEM CLEAR INC - WAYNE	Delaware	40.0500	75.3867																
PAD031436561	CHESTER CITY EXPLOSION SITE	Delaware	39.8533	75.6400	O															
PAD987329778	CHESTER PARK OIL SPILL	Delaware	39.8633	75.3750	O															
PAD980693162	CLEARVIEW LANDFILL	Delaware	39.9033	75.2561																
PAD002358133	COLUMBIA RESEARCH LABORATORY	Delaware	39.8633	75.3350																
PAD002343200	CONGOLEUM CORP	Delaware	39.8350	75.4367	O															
PAD987380714	CORK INDUSTRIES, INC.	Delaware	39.8967	75.2583	O															
PAD981033228	CURTIS PUBLISHING CO	Delaware	39.9000	75.2517																
PAD980552590	DARBY CREEK TANK FARM	Delaware	39.9083	75.2867																
PAD981109507	DELAWARE CO BOTTLING WORKS - BOILERS	Delaware	39.8350	75.4367																
PAD980707715	DELAWARE CONTAINER INC	Delaware	39.9500	75.3033																
PAD982367484	DELAWARE COUNTY INCINERATOR PLT #2	Delaware	39.9167	75.3867	O															
PAD982367427	DELAWARE COUNTY INCINERATOR PLT #3	Delaware	39.9167	75.3867	O															
PAD982367542	DELAWARE INCINERATOR FILL #1 PLT	Delaware	39.9167	75.3867	O															
PAD002365906	DELCO PLATING SITE	Delaware	39.8833	75.3067	M															
PAD002385409	DELMONT LABORATORIES, INC	Delaware	39.9133	75.3500																
PAD980706162	EAST COAST CHEMICAL DISPOSAL INC.	Delaware	39.8350	75.4367	O															
PAD987323458	EAST TENTH STREET SITE	Delaware	39.8350	75.4367	M			1				1							1	1
PAD987269941	EDDYSTONE AVE TRAILER SITE	Delaware	39.8633	75.3350	O															
PAD987390721	FOLCROFT COURT APARTMENTS	Delaware	39.8967	75.2583	H															
PAD980508576	FOLCROFT DUMP	Delaware	39.8897	75.2689																
PAD039047071	FORD MOTOR CO CHESTER ASSEMBLY PLT	Delaware	39.8633	75.3750																
PAD987350071	FRANKLIN PRINTING CO	Delaware	39.9300	75.2683																
PAD980253231	FREEBORN ASPHALT PLANT(DIFRANCESCO)	Delaware	39.9867	75.2983																
PAD982366298	FRONT STREET TANKER	Delaware	39.8667	75.3833	A															
PAD981736382	GRADYVILLE MIDNIGHT DUMPING	Delaware	39.9750	75.4483	A															
PAD987270402	HARRY MILLER PROPERTY	Delaware	39.9167	75.4917	O															
PAD987271335	HARRY MILLER PROPERTY 2	Delaware	39.9167	75.4917	G															
PAD980832752	HAVERFORD TWP LANDFILL	Delaware	39.9722	75.3361																
PAD981947419	HUMPHREY'S EXTERMINATING CO	Delaware	39.9083	75.2867																
PAD098160906	I U CONVERSION SYST MARCUS HOOK FAC	Delaware	39.8350	75.4367																
PAD987368022	I-95 REST AREA-LOWER CHICHESTER	Delaware	39.8350	75.4367	O															
PAD987387586	IMMANUEL LUTHERAN CHURCH	Delaware	39.8933	75.2967	H															

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD987356755	J. B. EURELL	Delaware	39.9333	75.2500	M															
PAD987387057	LANCASTER COACH WORKS	Delaware	40.0500	75.3867																
PAD981736747	LANSDOWNE SITE #2	Delaware	39.9333	75.2500																
PAD000647354	LAUREL PIPE LINE CO BOOTH STA	Delaware	39.8350	75.4367																
PAD013975495	LITTON SYSTEMS INC	Delaware	39.9300	75.2683	O															
PAD980693840	MAYER LANDFILL	Delaware	39.8875	75.3569																
PAD044545695	METRO CONTAINER CORP	Delaware	39.8633	75.3750	O															
PAD000793414	MIKE'S SUNOCO SERVICE STATION	Delaware	39.9817	75.2633																
PAD980508733	MOCK DUMP-FORMERLY CONCORD TWP LANDFILL	Delaware	39.8664	75.5417																
PAD049630502	MONROE CHEMICAL	Delaware	39.8633	75.3750																
PAD981033582	MPA DISTRIBUTORS-HARDEE'S	Delaware	39.9083	75.2867																
PAD987277811	NAYLORS RUN	Delaware	39.9667	75.2983	G															
PAD987348893	NIXON CLENERS	Delaware	39.8633	75.3750	O															
PAD980552129	NL IND INC NICKEL SMELTING PLT	Delaware	39.8633	75.3217																
PAD085711525	NOR PRO BAKERY	Delaware	39.8833	75.3067																
PAD981039266	PAPER PRODUCTS	Delaware	39.9417	75.3250																
PAD980539084	PENN IND CHEM CO	Delaware	39.8633	75.3750																
PAD981109572	PERKINS	Delaware	39.8633	75.3750																
PAD002296143	PHILA CHEWING GUM CORP	Delaware	39.9667	75.2983																
PAD980706758	PHILADELPHIA ELECTRIC CO.	Delaware	39.8633	75.3750																
PAD987336997	PHILADELPHIA SEA PLANE BASE	Delaware	39.8633	75.3017	O															
PAD987341989	PROSPECT PARK	Delaware	39.8833	75.3067	M															
PAD081871717	RECLAMATION RESOURCES INC	Delaware	39.8350	75.4367																
PAD987334687	ROSATI CONTRACTOR SITE	Delaware	39.8950	75.2917	O															
PAD000647446	S P P C #2 TANK FARM	Delaware	39.8650	75.4283																
PAD980550594	S P P C MARCUS HOOK REF	Delaware	39.8350	75.4367																
PAD987387578	SALT SERVICE	Delaware	39.8817	75.3267	A															
PAD000796504	SCOTT PAPER	Delaware	39.8633	75.3017																
PAD001267879	SCOTT PAPER CO	Delaware	39.8633	75.3017																
PAD002274991	SCOTT PAPER CO	Delaware	39.8633	75.3750																
PAD000796512	SCOTT PAPER CO./CHESTER	Delaware	39.8633	75.3750																
PAD002480002	SENTRY PAINT & CHEMICAL CO	Delaware	39.9083	75.2867																
PAD981109937	SINCLAIR REFINING CO	Delaware	39.8350	75.4367																
PAD980832695	SPRINGFIELD TWP BULK WASTE LANDFILL	Delaware	39.9417	75.3250																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD981033202	SUN OIL CO.-PHILLIPS ISLAND FILL	Delaware	39.8350	75.4367																
PAD987369808	SUN OIL SPILL	Delaware	39.9750	75.4483	O															
PAD980706907	SUN OIL/READ-BOYD FARM	Delaware	39.8508	75.4225																
PAD002479657	SUN SHIP INC	Delaware	39.8667	75.3833																
PAD071451611	SWEENEY LANDFILL	Delaware	39.8750	75.4000																
PAD160960605	TINICUM INDUSTRIAL PARK	Delaware	39.8700	75.2883																
PA6143515447	TINICUM NATIONAL ENVIRONMENTAL CTR	Delaware	39.8700	75.2883	L				1											
PAD980509020	VERMICULITE DUMP	Delaware	39.8250	75.4083																
PAD987372091	WIDNER UNIVERSITY-PENNSYLVANIA CAMPUS	Delaware	39.8633	75.3750	O															
PAD987360708	YEADON MYSTERY OIL	Delaware	39.9333	75.2500	H															
PAD061690871	QUAKER ALLOY	Lebanon	40.3661	76.2983																
PAD981939135	VALLEY DISPOSAL, INC. DISPOSAL	Lebanon	40.3550	76.2117																
PAD002391969	ALLENTOWN PAINT MFG CO INC	Lehigh	40.5833	75.4567	O															
PAD980539100	CARLISLE ST DUMP	Lehigh	40.5833	75.4567																
PAD053081909	CHAIN BIKE CORP	Lehigh	40.5833	75.4567	O															
PAD982363808	EGYPT CENTRAL QUARRY	Lehigh	40.6217	75.4933	O															
PAD981736952	ENAMELSTRIP SITE FACILITY	Lehigh	40.6033	75.5250																
PAD981104540	FOGELSVILLE SITE	Lehigh	40.6033	75.4667																
PAD003001732	GENERAL ELECTRIC CO	Lehigh	40.5783	75.4764																
PAD047354267	GULF & WESTERN-BONNEY FORGE DIV	Lehigh	40.5833	75.4567																
PAD002399210	HIGH QUALITY POLISHING & PLATING	Lehigh	40.4883	75.5200	A															
PAD982363921	HINKLE INCINERATOR	Lehigh	40.5667	75.5517	L															
PAD980706931	IMC CHEM SEIPLE PLT	Lehigh	40.6386	75.5167																
PAD987276938	KAYAL'S SERVICE STATION	Lehigh	40.6217	75.4933	G															
PAD045137247	KEYSTONE LAMP MFG CORP	Lehigh	40.7500	75.6083	O															
PAD982364226	LEBANON CHEMICAL	Lehigh	40.6033	75.4667	M															
PAD981104698	LEHIGH CNTY AUTH SHREDDED WASTE LANDFILL	Lehigh	40.5667	75.5517																
PAD082028879	LEHIGH SALVAGE OIL INC	Lehigh	40.6033	75.5250																
PAD980832091	LYNN TWP LANDFILL	Lehigh	40.6631	75.7958																
PAD000604173	MACK TRUCKS INC	Lehigh	40.5833	75.4567																
PAD042321117	MACK TRUCKS, INC	Lehigh	40.5833	75.4567	O															
PAD047353172	OLIN CORP	Lehigh	40.5833	75.6350																
PAD000765388	PA POWER & LIGHT CO MARTINS CREEK	Lehigh	40.6033	75.4667																
PAD987281441	PP & L SOUTH WHITEHALL SUBSTATION	Lehigh	40.6033	75.5250																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD987281425	PP & L WESCOSVILLE SUBSTATION	Lehigh	40.5167	75.6000																
PAD056602923	PRIOR COATED METALS	Lehigh	40.5833	75.4567																
PAD987378221	QUEEN CITY BUSINESS CENTER	Lehigh	40.6033	75.4667																
PAD980552020	SAFETY-KLEEN CORP 2-007-01	Lehigh	40.6033	75.5250																
PAD987265293	SHELLHAMMER QUARRY	Lehigh	40.7500	75.6083																
PAD982367591	TEXACO AUTO CENTER	Lehigh	40.7450	75.6567																
PAD980538748	UGI CORP GAS MFG PLT - ALLENTOWN	Lehigh	40.6083	75.4850																
PAD980538839	UGI CORP GAS MFG PLT - CATASAUQUA	Lehigh	40.6550	75.4700																
PAD987272259	VALLEY IRON AND STEEL	Lehigh	40.6083	75.4850	G															
PAD981033343	VOLNEY FELT CO	Lehigh	40.4800	75.5000																
PAD987285244	WALBERT CONTRACTING SERVICE	Lehigh	40.5383	75.6333																
PAD002393460	WHITEHALL CEMENT	Lehigh	40.6217	75.4933																
PAD987279809	WHITEHALL LAB	Lehigh	40.6217	75.4933																
PAD981103740	WIFAND, EA LANDFILL	Lehigh	40.6217	75.4933																
PAD987277951	AGMAR ESTATES/FREDERICK W. SHEAMAN	Luzerne	41.0600	75.7767	G															
PAD982363905	MID ATLANTIC COAST DELIVERY SYSTEM	Luzerne	41.0600	75.7767	G															
PAD981033624	PERCY A BROWN & CO	Luzerne	40.6033	75.4667																
PAD981114788	CHESTNUTHILL TWP LF	Monroe	40.9417	75.4350																
PAD000736975	DIVERSY WYANDOTE CORP	Monroe	40.9983	75.1817																
PAD003038544	DRACKETT INC	Monroe	40.9983	75.1817																
PAD987392271	FAIRVIEW WATER COMPANY	Monroe	41.1217	75.3583	G															
PAD059262459	GENERAL ELECTRIC CO CARBON PRODUCTS OPER	Monroe	40.9983	75.1817	O															
PAD003037504	HEICO IND	Monroe	40.9864	75.1508																
PAD982363962	HOPKINS LANDFILL	Monroe	40.9867	75.1933	J															
PAD981033681	MERRELL-NATIONAL LAB SAN FILL	Monroe	41.0950	75.3283																
PAD982367062	POCONO MANOR LANDFILL	Monroe	41.1067	75.3667	O															
PAD982367120	POCOTRAN-EAST TRANSFER STATION	Monroe	41.0967	75.2467	O															
PAD980829139	REDMOND FINISHING CO INC	Monroe	40.9900	75.1875																
PAD980832265	RICHARD HAMMOND DEMOLITION SITE	Monroe	40.9961	75.2300																
PAD981033590	RONSON CORP	Monroe	40.9800	75.1467																
PAD982367609	STROUD TWP LANDFILL	Monroe	40.9867	75.1933	G															
PAD987365426	VILLAGE OF REEDERS GW	Monroe	40.9867	75.1933	G															
PAD987266442	WILLIE HARPER PROPERTY	Monroe	41.0433	75.1283	O															
PAD002356392	A STEIERT & SON, INC	Montgomery	40.2783	75.3000																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD981033277	ABC INSERT CO INC (LAGOON)	Montgomery	40.1517	75.2233																
PAD024398661	ABINGTON TWP INC	Montgomery	40.1100	75.1200																
PAD990823684	AIRCO WELDING PRODUCTS	Montgomery	40.0917	75.3375																
PAD981105018	ALAN WOOD STEEL	Montgomery	40.1000	75.2767																
PAD981939051	ALDERFER LANDFILL - HSCA	Montgomery	39.9939	75.9083	L			1			1	1		1	1					1
PAD002348324	AMCHEM PROD INC	Montgomery	40.1664	75.2428																
PAD009224961	AMERICAN ELECTRONIC LAB, INC	Montgomery	40.2483	75.2450	O															
PAD002347003	AMERICAN OLEAN TILE CO INC	Montgomery	40.2400	75.2867																
PAD002298440	ANDALE CORP	Montgomery	40.2400	75.2867																
PAD980832570	ANDERSON ROAD SITE	Montgomery	40.0900	75.3600																
PAD980550958	APACHE WASTE OIL	Montgomery	40.0767	75.3067	A			1												1
PAD981730365	ASHLEY BOROUGH DUMP	Montgomery	41.2217	75.8747																
PAD980692990	ASPHALT PAVING & SUPPLY	Montgomery	40.1061	75.3225																
PAD987394871	AUDUBON PESTICIDE	Montgomery	40.1650	75.3217	W															
PAD046553939	AUDUBON WATER CO	Montgomery	40.1350	75.4267																
PAD981034325	BEAVERBRIGHT CHEMICALS, INC	Montgomery	40.2783	75.3000																
PAD002345965	BECHTEL DAIRIES	Montgomery	40.1817	75.5467																
PAD981035728	BEIDLER ROAD SITE	Montgomery	40.0900	75.3600	A															
PAD980830004	BETH AYRES RECLAMATION CO	Montgomery	40.1350	75.0700																
PAD002390961	BETHLEHEM APPARATUS COMP. INC	Montgomery	40.5867	75.3417																
PAD981034887	BORIT ASBESTOS TAILINGS PILE	Montgomery	40.1517	75.2233																
PAD053299202	BRENAHAN, EJ INC - MCCARTER 5000TH PLT	Montgomery	40.2467	75.6500																
PAD002482628	BROOKS INSTRUMENT DIVISION	Montgomery	40.2783	75.3000	O															
PAD053285557	C & D CHARTER POWER SYSTEMS	Montgomery	40.0716	75.3036																
PAD980831101	CALEY ROAD	Montgomery	40.0183	75.3978																
PAD002285039	CHAIN LINK FENCE CO.	Montgomery	40.2483	75.2450	O															
PAD002387298	CHANCELLOR PRESS INC	Montgomery	40.0833	75.3383																
PAD981034077	CHEMICAL CONCENTRATES DIV	Montgomery	40.1383	75.2117																
PAD980831390	CHEMICAL ROAD ASBESTOS PILE	Montgomery	40.1000	75.2767								1								
PAD980927099	CHLORINE RELEASE	Montgomery	40.1000	75.1500																
PAD987270709	CHRISTIAN OESTERLE PROPERTY	Montgomery	40.1817	75.5467	G															
PAD069780310	COLEBROOKEDALE LANDFILL	Montgomery	40.3625	75.7250																
PAD002377489	COLORCON INC	Montgomery	40.2083	75.3000																
PAD000731158	COLWELL LANE SITE	Montgomery	40.1000	75.2767	L															

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD980693055	COMBUSTION EQUIPMENT ASSOC	Montgomery	40.1267	75.3517																
PAD084361835	CONVERSION SYSTEMS INC	Montgomery	40.1800	75.1350	O															
PAD084362940	CONVERSION SYSTEMS INC RESEARCH LAB	Montgomery	40.1800	75.1350	O															
PAD002343820	COOPERS CREEK CHEM	Montgomery	40.0792	75.3267																
PAD981034515	CORROSION REACTION CONSULTANTS	Montgomery	40.1417	75.1683																
PAD002277978	CRYSTAL SOAP & CHEMICAL	Montgomery	40.2400	75.2867																
PAD002344711	DANA CORP., SPICER UNIV. JOINT DIV.	Montgomery	40.2395	75.6300																
PAD058998675	DANELLA BROTHERS DEMO SITE	Montgomery	40.1000	75.2767																
PAD000440941	DECK QUARRY	Montgomery	40.1000	75.2767																
PA7120507341	DEPT OF AGRICULTURE-EASTERN RESEARCH CTR	Montgomery	40.0767	75.1900	F															
PAD148707441	DOEHLER-JARVIS/FARLEY INDUSTRIES	Montgomery	40.2408	75.6881																
PAD981104730	DOMINO SALVAGE INC	Montgomery	40.0917	75.2617																
PAD073734501	DOMINO SALVAGE LANDFILL	Montgomery	40.0767	75.3067																
PAD981035660	E CUMBERLAND STREET SITE	Montgomery	40.1000	75.2767																
PAD987355070	EAM CORPORATION	Montgomery	40.2267	75.4017																
PAD980693113	EASTERN MATERIALS	Montgomery	40.1433	75.1167																
PAD000431957	EATON LABORATORIES INC.	Montgomery	40.2400	75.2867	O															
PAD045137130	EISENHARDT MILLS, INC	Montgomery	40.4050	75.5000																
PAD073744609	ELWOOD IVINS STEEL TUBE WORKS	Montgomery	40.1800	75.1350																
PAD981033905	ESS ELL CORP	Montgomery	40.1517	75.2233																
PAD092665492	EVANSBURG WATER CO	Montgomery	40.1817	75.5467																
PAD000650770	EXTRACORPOREAL MEDICAL SPECIALISTS	Montgomery	40.0767	75.3067																
PAD980692958	FAIRVIEW VILLAGE	Montgomery	40.1683	75.3783																
PAD980631218	FIELD HOUSE	Montgomery	40.0925	75.3694																
PAD020083747	FLECK INDUSTRIES	Montgomery	40.1433	75.1167																
PAD021048004	FORMS INC	Montgomery	40.1433	75.1167																
PAD002331254	FREDERICKS COMPANY	Montgomery	40.1208	75.0569																
PAD987378213	FREDS AUTO JUNKYARD	Montgomery	40.0833	75.3383																
PAD057130148	G & W H CORSON, INC	Montgomery	40.3883	75.0067																
PAD981033525	GBG, INCORP-E GREENVILLE IND	Montgomery	40.4050	75.5000																
PAD001680719	GENERAL ELECTRIC CO SPACE DIV	Montgomery	40.0900	75.3600	O															
PAD987346632	GENERAL SCIENCES LABORATORY	Montgomery	40.3167	75.3550	O															
PAD980537963	GIBBONS WASTE OIL	Montgomery	40.2467	75.6500																
PAD980830517	GINO'S QUARRY	Montgomery	40.0772	75.3639																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD099081986	GLASGOW INC- MCCOY QUARRY	Montgomery	40.0833	75.3500																
PAD980829857	GLASGOW LANDFILL	Montgomery	40.0983	75.3667																
PAD002334696	GOODRICH BF CO	Montgomery	40.1208	75.4572																
PAD980831457	GRAVERS ROAD ASBESTOS SITE	Montgomery	40.1000	75.2767								1								
PAD075504795	GREEN, TWEED CO INC	Montgomery	4.0234	75.2767	O															
PAD980555197	GREENE, TWEED & CO INC	Montgomery	40.2400	75.3367	O															
PAD001367606	GULF OIL CORP	Montgomery	40.2400	75.2867																
PAD981109929	GULPH MILLS SITE	Montgomery	40.0767	75.3067																
PAD987369535	HALE PUMPS CO.	Montgomery	40.0767	75.3067	M															
PAD002335222	HANDY & HARMAN TUBE CO INC	Montgomery	40.1133	75.3433																
PAD987272242	HART INDUSTRIES	Montgomery	40.1433	75.1167	O															
PAD002356632	HATFIELD PACKING CO INCIN	Montgomery	41.5633	75.7583																
PAD980830848	HATFIELD SITE	Montgomery	40.2833	75.3000																
PAD075498733	HATFIELD TWNSHIP MUN AUTHORITY	Montgomery	40.2700	75.2517																
PAD002386761	HONEYWELL INC. PROCESS CONTROL DIV.	Montgomery	40.1383	75.2117	O															
PAD987377397	ICI AMERICAS-MONTGOMERY	Montgomery	40.1650	75.3217																
PAD048618094	KELLETT AIRCRAT CORP	Montgomery	40.1433	75.1167																
PAD981033962	KEYSTONE FILTER MEDIA CO	Montgomery	40.1133	75.3433																
PAD002378818	KEYSTONE GREY IRON FOUNDRY CO	Montgomery	40.2467	75.6500																
PAD980550925	KEYSTONE SAN MONT CO	Montgomery	40.0767	75.3067																
PAD053306015	KNOLL INTERNATIONAL	Montgomery	40.4050	75.5000																
PAD084766369	KOPPERS CO INC.	Montgomery	40.0833	75.3383																
PAD981033947	KORVETTE, EJ INC	Montgomery	40.0900	75.1433																
PAD981034440	KRYLON INC	Montgomery	40.1267	75.3517																
PAD981939687	KULPSVILLE QUARRY	Montgomery	40.2400	75.3367	G															
PAD981034200	LANCKO ENGINEERING	Montgomery	40.1383	75.2117																
PAD002371581	LANSDALE FINISHERS INC	Montgomery	40.2400	75.2867	O															
PAD002371573	LANSDALE PORCELAIN ENAMEL CORP	Montgomery	40.2400	75.2867																
PAD982367799	LEE RD CHEMICAL DUMP	Montgomery	40.3250	75.4733	H															
PAD980693139	LEEDS & NORTHRUP ANALYTICAL BLDG	Montgomery	40.2400	75.2867																
PAD002277952	LEEDS & NORTHRUP MAIN BLDG	Montgomery	40.2117	75.2767																
PAD987277142	LIMERICK ACID DUMP	Montgomery	40.1817	75.5467	O															
PAD987285269	LIMERICK-ROYERSFORD AMUSEMENT	Montgomery	40.1817	75.5467																
PAD987332814	LINFIELD INDUSTRIAL PARK	Montgomery	40.1817	75.5467	M															

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD071456644	LOWER MERION TWP INC	Montgomery	40.0067	75.2867																
PAD000900167	LUKENS STEEL CO ALAN WOOD STEEL IMPDMT	Montgomery	40.0978	75.3133																
PAD067394502	MAACO ENTERPRISES	Montgomery	40.0750	75.3750																
PAD987349115	MATTHEWS SITE	Montgomery	40.2600	75.3833	H															
PAD002347102	MCNEIL LABS	Montgomery	40.1261	75.2058																
PAD000731471	MCNEIL PHARMACEUTICAL	Montgomery	40.1833	75.2250	I															
PAD002387926	MERCK & CO INC	Montgomery	40.2083	75.3000																
PAD987347184	MET-PRO CORP.	Montgomery	40.2400	75.3367																
PAD981939390	MIQUON LANDFILL	Montgomery	40.0667	75.2600				1			1									1
PAD980250799	NATIONAL GYPSUM CO W CONSHOCKEN PLT	Montgomery	40.0767	75.3067																
PAD987347176	NICE BEARING DIV. OF SKF INDUSTRIES	Montgomery	40.2400	75.3367																
PAD002336774	NICOLETTE INDUSTRIES	Montgomery	40.1267	75.3517																
PAD987355120	NORTH PENN AREA 10	Montgomery	40.2267	75.4017																
PAD987355096	NORTH PENN AREA 8	Montgomery	40.2267	75.4017																
PAD987355112	NORTH PENN AREA 9	Montgomery	40.2267	75.4017																
PAD044534808	NORTH PENN WATER AUTHORITY	Montgomery	40.2400	75.2867																
PAD014198154	NU LIFE CLEANERS	Montgomery	40.1750	75.1050																
PAD980831739	O'HARA LANDFILL	Montgomery	40.0808	75.3556																
PAD980829949	PASQUALE LANDFILL	Montgomery	40.0778	75.3639																
PAD987352200	PECO LOTS # 5,7,8 & 9	Montgomery	40.2467	75.6500																
PAD987355062	PECORA CORPORATION	Montgomery	40.2267	75.4017																
PAD002354108	PENCO PRODUCTS	Montgomery	40.1333	75.4533																
PAD049321219	PENN CAN CO	Montgomery	40.1800	75.1350																
PAD987347168	PENN FISHING TACKEL CO	Montgomery	40.2400	75.3367																
PAD075538033	PENNWALT TECHNOLOGICAL CENTER	Montgomery	40.0900	75.3600																
PAD002375483	PETER J SALMON CO	Montgomery	40.1000	75.1500																
PAD980831655	PHILADELPHIA ELECTRIC CO SITE	Montgomery	40.0833	75.3042																
PAD002278224	PHILADELPHIA RESINS CORP	Montgomery	41.6500	75.3667	O															
PAD980692347	PHILADELPHIA TEXTILE FINISHERS, INC	Montgomery	40.1267	75.3517																
PAD987266459	PILLSBURY CO	Montgomery	40.4050	75.5000	O															
PAD002265213	PLASTI - SEAL CORP	Montgomery	40.1350	75.0700																
PAD002334373	PLUMMER PRECISION OPTICS	Montgomery	40.3933	75.4867	O															
PAD981736804	POTTSTOWN ABANDONED TRAILER SITE	Montgomery	40.2467	75.6500	A															
PAD064351026	POTTSTOWN DISP SER	Montgomery	40.2467	75.6500																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD981736816	POTTSTOWN DRUM SITE	Montgomery	40.2467	75.6500																
PAD987347531	POTTSTOWN INDUSTRIES COMPLEX	Montgomery	40.1517	75.2233																
PAD981104524	POTTSTOWN SANITARY LANDFILL	Montgomery	40.2467	75.6500																
PAD980509012	PRESTON HECKLER UPPER ST RD	Montgomery	40.2333	75.2333																
PAD981936459	PROSOCK FARM SITE	Montgomery	40.1267	75.3517																
PAD981040553	QUARRY ASBESTOS SITE	Montgomery	40.1000	75.2767																
PAD980551048	RECLAMATION RESOURCES INC	Montgomery	40.2700	75.2517																1
PAD000765644	RECLAMATION RESOURCES INC	Montgomery	40.0833	75.3383																
PAD002351761	REILLY WHITEMAN WALTON CO	Montgomery	40.0767	75.3067																
PAD980555809	RESOURCE TECHNOLOGY CORPORATION	Montgomery	40.1000	75.2767	O															
PAD980550479	RESOURCE TECHNOLOGY SER INC	Montgomery	40.0767	75.3067																
PAD987394913	ROBERTS & MANDER STOVE COMPANY	Montgomery	40.1750	75.1050	M															
PAD981034143	ROBINSON-HALPERN CO	Montgomery	40.0767	75.3067																
PAD981034010	ROLLE MANUFACTURING CO, INC	Montgomery	40.2400	75.2867																
PAD981034135	ROMA KOTE PAINT CO	Montgomery	40.1267	75.3517																
PAD987371564	ROUTE 202 FUEL TANKER INCIDENT	Montgomery	40.0900	75.3600	O															
PAD981736867	ROUTE 563 DRUM SITE	Montgomery	40.3000	75.4500	A															
PAD987347200	SARATOGA ROAD	Montgomery	40.0900	75.3600	H															
PAD002345767	SELAS CORPORATION	Montgomery	40.1417	75.1683																
PAD987327137	SIMPSON PAPER	Montgomery	40.0667	75.2600	O															
PAD056166214	SMITH, KLINE & FRENCH LAB	Montgomery																		
PAD002276331	SOLID STATE SCIENTIFIC INC	Montgomery	40.2483	75.2450	O															
PAD002314607	SPERRY UNIVAC	Montgomery	40.1650	75.2900																
PAD000765800	SPRAGUE ELECTRIC COMPANY	Montgomery	40.1433	75.1167	O															
PAD042716084	SPRAY PROD CORP	Montgomery	40.1267	75.3517	O															
PAD002344117	STANDARD PRESSED STEEL	Montgomery	40.0917	75.1250																
PAD987355104	STATIC INCORPORATED	Montgomery	40.2267	75.4017																
PAD987368188	STOCKTON AQUIFER	Montgomery	40.1750	75.1050	G															
PAD987276516	STORK RESIDENCE	Montgomery	40.2400	75.2867	G															
PAD021976790	SUPERIOR TUBE CO	Montgomery	40.1133	75.3433																
PAD002353407	SUPERIOR TUBE COMPANY	Montgomery	40.1267	75.3517	O															
PAD981936947	SWEENEY-POLLOCK LANDFILL	Montgomery	40.2341	75.6257																
PAD046557682	SYNTHANE TAYLOR CORP	Montgomery	40.1294	75.4669																
PAD002351070	TECH ALLOY	Montgomery	40.1900	75.4563																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD000441907	TELEFLEX IND	Montgomery	40.2400	75.2867																
PAD981034267	THERMAL RESEARCH ENG CORP	Montgomery	40.0767	75.3067																
PAD980538854	TRAILMOBILES W PT PLT	Montgomery	40.2083	75.3000																
PAD002370005	TUBE METHODS INC	Montgomery	40.0833	75.3383	O															
PAD980692061	TYSON DUMP #2	Montgomery	40.0900	75.3600																
PAD002344463	UNIFORM TUBES INC	Montgomery	40.1900	75.4583																
PAD000769547	UNION CARBIDE CORP AG PROD	Montgomery	40.1517	75.2233																
PAD981104458	UPPER DUBLIN TWP LANDFILL	Montgomery	40.1383	75.2117																
PAD981034945	UPPER DUBLIN/WHITPAIN TWP ASBESTOS SITE	Montgomery	40.1383	75.2117																
PAD980830723	UPPER FREDRICK TWP SPRAYFIELD	Montgomery	40.2917	75.5417																
PAD981103765	UPPER MERION TWP LANDFILL	Montgomery	40.0833	75.3383																
PAD987277837	USN NAVAL AIR STATION - WILLOW GROVE	Montgomery	40.1433	75.1167	O															
PAD981034333	VALLEY FORGE BREWING CO	Montgomery	40.1267	75.3517																
PAD043576222	VALLEY FORGE CORPORATE CENTER WATER CO	Montgomery	40.0900	75.3600																
PAD980692362	VARIETY CLUB CAMP	Montgomery	40.2000	75.3467																
PAD987377405	VOLKSWAGEN SITE/DENTAL EZ	Montgomery	40.1650	75.3217																
PAD987355088	W.M. YOKUM MACHINE CO.	Montgomery	40.2267	75.4017																
PAD085690592	WASTE CONVERSION	Montgomery	40.2783	75.3000																
PAD061817276	WASTE EQUIP SYST DIV HOBART CORP	Montgomery	40.1750	75.1050																
PAD980692909	WASTE TECHNIQUES CORP	Montgomery	40.0978	75.3228																
PAD987332574	WELSH VILLAGE	Montgomery	40.2483	75.2450																
PAD001306992	WEYERHAEUSER PAPER CO	Montgomery	40.0667	75.2600																
PAD981034382	WHITE PIGMENT CORP	Montgomery	40.0900	75.3600																
PAD980538797	WHITEMARSH MDWS	Montgomery	40.0767	75.3067																
PAD982366841	WHITEMARSH TWP DRUM DUMP	Montgomery	40.1000	75.2767	O															
PAD987266558	WHITES ROAD PARK	Montgomery	40.2400	75.2867	H															
PAD002348126	WILLIAM H RASER	Montgomery	40.1383	75.2117																
PAD053295089	WOOD IND PROD CO	Montgomery	40.0767	75.3067																
PAD980540025	ALLIED CHEM CORP BETHLEHEM TAR PLT	Northampton	40.6100	75.3717																
PAD002399265	AMERICAN NICKELOID CO	Northampton	40.7567	75.5950																
PAD043394683	ASHLAND CHEMICAL CO	Northampton	40.6972	75.2222																
PAD980198386	BANGOR BOROUGH INCINERATOR	Northampton	40.8683	75.2006																
PAD990824161	BETHLEHEM STL CORP BETHLEHEM LANDFILL	Northampton	40.6100	75.3717																
PAD980539076	CASTLE RECYCLING CORP	Northampton	40.7400	75.3117																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD099427908	CHEMICAL LEAMAN TANK LINES	Northampton	40.7400	75.3117																
PAD980830350	CHERRYVILLE SITE	Northampton	40.7667	75.5150																
PAD980692818	CITY OF BETHLEHEM	Northampton	40.6100	75.3717																
PAD980829147	CUNARD LOWER PROPERTY	Northampton	40.6833	75.4817																
PAD981110117	EASTON - MORGAN RIDGE	Northampton	40.6900	75.2100																
PAD987269966	EASTON COMPRESSOR STATION	Northampton	40.6900	75.2100	G															
PAD980832430	EASTON PLANT	Northampton	40.6900	75.2100																
PAD981939945	FUEL STORAGE AREA	Northampton	40.6833	75.4817	A															
PAD067091439	GRAND CTL SAN LANDFILL	Northampton	40.8667	75.2600																
PAD981103914	HA-RA INC - FERNWOOD DEMO SITE	Northampton	40.7400	75.3117																
PAD980829915	HANOVER TWP SITE	Northampton	40.6550	75.3350																
PAD059285676	HERCEG LANDFILL	Northampton	40.7400	75.3117																
PAD038419156	JAMES RIVER CORP OF VIRGINIA	Northampton	40.6900	75.2100	O															
PAD987265319	LONE STAR CEMENT DUMP	Northampton	40.7400	75.3117																
PAD002389237	LONE STAR IND INC	Northampton	40.7400	75.3117																
PAD981939457	NORTHAMPTON FUEL	Northampton	40.6833	75.4817																
PAD000798454	P P G INDUSTRIES INC STOCKERTOWN	Northampton	40.7567	75.2650																
PAD073615916	PALMER TWP PROCESSING & RECYCLING	Northampton	40.6900	75.2100																
PAD080874282	PENN FOAM CORP	Northampton	40.6900	75.2100	O															
PAD980693543	PENN GYPSUM	Northampton	40.6833	75.4817																
PAD980550347	PENN PWR & LGT E HAYNES QUARRY	Northampton	40.7967	75.5350																
PAD980537591	PENNWALT CORP EASTON PLT	Northampton	40.6900	75.2100																
PAD987281482	PP & L LOCK HAVEN SUBSTATION	Northampton	40.7400	75.3117																
PAD987281474	PP & L NAZARETH SUBSTATION	Northampton	40.7400	75.3117																
PAD987282837	PP & L QUARRY SUBSTATION	Northampton	40.5667	75.5517																
PAD987357043	PP & L SENECA SUBSTATION	Northampton	40.6233	75.3633																
PAD002388916	REICHARD COULSON INC	Northampton	40.6333	75.3875																
PAD987280005	RT. 22 & 33 HCL TANKER SPILL	Northampton	40.6100	75.3717	O															
PAD987283488	SAVAGE INDUSTRIES - HSCA	Northampton	40.7250	75.3983																
PAD980538953	UGI CORP GAS MFG PLT	Northampton	40.6900	75.2100																
PAD980538771	UGI CORP GAS MFG PLT - BETHLEHEM	Northampton	40.6550	75.3350																
PAD980539019	UGI CORP GAS MFG PLT - HELLERTOWN	Northampton	40.5867	75.3417																
PAD980538896	UGI CORP GAS MFG PLT - W. EASTON	Northampton	40.6900	75.2100																
PAD980538805	UGI CORP MFG PLT - NAZARETH	Northampton	40.7400	75.3117																

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD980829618	WALNUTPORT DUMP	Northampton	40.7567	75.5950																-
PAD048613368	2314 N. AMERICAN STREET	Philadelphia	39.9867	75.1467	O															
PAD987339710	60TH AND ESSINGTON AVENUE	Philadelphia	39.9550	75.1833	O															
PAD987332848	70TH AND KINGSESSIN TRAILER	Philadelphia	39.9233	75.2400	A															
PAD987387669	ABBOTT PLATING COMPANY	Philadelphia	39.9750	75.1117	M															
PAD980692123	ABM-58TH ST	Philadelphia	39.9483	75.2267																
PAD014624654	ACE SERVICE CORP	Philadelphia	39.9167	75.1583	O															
PAD982363863	ADELPHIA STEEL	Philadelphia	40.0583	75.0333	O															
PAD987277829	AERNAL WAREHOUSE	Philadelphia	40.0233	75.0450	G															
PAD002312791	ALLIED CHEM CORP FIBERS & PLASTICS	Philadelphia	39.9983	75.0667																
PAD981939267	AMERICAN STREET TANNERY	Philadelphia	39.9367	75.1550	A			1												1
PAD987349123	AMTRAK 30TH STREET	Philadelphia	39.9550	75.1833	O															
PAD980539563	ANZON INC	Philadelphia	39.9833	75.1250	B											1				
PAD002289700	ARCO PETROLEUM PROD CO	Philadelphia	39.9383	75.1817																
PAD980552251	ASHLAND CHEMICAL COMPANY	Philadelphia	39.9167	75.1583	B															
PAD980692750	B & P MOTOR EXPRESS PHILA TERMINAL	Philadelphia	39.9750	75.1117																
PAD987285400	BARCLAY STREET ABANDONED DRUMS	Philadelphia	39.9550	75.1700	A															
PAD987343910	BARTRAM AVENUE DRUMS	Philadelphia	39.8933	75.2400	O															
PAD987323441	BATH & KINGSTON DRUM DUMP	Philadelphia	39.9750	75.1117	A															
PAD002282713	BECK ENGRAVING COMPANY THE	Philadelphia	39.9450	75.1467	O															
PAD982364036	BELFIELD AVENUE SITE	Philadelphia	40.0433	75.1683	M			1												1
PAD980508402	BRIDESBURG DUMP	Philadelphia	39.9833	75.2333																
PAD987327152	BRIDGE STREET CHEMICAL SPILL	Philadelphia	39.9550	75.1833	O															
PAD069020691	BRUDER M A & SONS INC	Philadelphia	39.9483	75.2267	O															
PAD980508469	BUDD CO DUMP	Philadelphia	40.1317	75.0167																
PAD980539688	CASSAR EDWARD H	Philadelphia	39.9750	75.1117																
PAD987318318	CELOTEX CORP	Philadelphia	39.9383	75.1783	O															
PAD980555312	CHEVRON USA INC SRTF	Philadelphia	39.9550	75.1833	O															
PAD982367070	CLIFF RD & PAOLI AVE SITE	Philadelphia	40.0567	75.2317	O															
PAD987390523	COLEMAN COMPANY	Philadelphia	40.0167	75.1333	O															
PAD077098770	COMMUNITY COLLEGE OF PHILADELPHIA	Philadelphia	39.9550	75.1833	O															
PAD030298400	CONRAIL	Philadelphia	39.9550	75.1833																
PAD987388568	CONTAINER RECYCLER INC.	Philadelphia	39.9167	75.1583	O						1									1
PAD981939275	CROCE INDUSTRIES	Philadelphia	40.0567	74.9933																

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PA0971590005	DEFENSE PERSONNEL SUPPORT	Philadelphia	39.9550	75.1833	O															
PAD987323433	DELAWARE AVE. TRANSFORMER OIL SPILL	Philadelphia	39.9667	75.1467	A															
PAD987277225	DELAWARE RIVER DRUM REMOVAL	Philadelphia	39.9983	75.0667	V															
PAD987320199	DELAWARE VALLEY RECYCLING INC.	Philadelphia	39.8933	75.2400	O															
PAD987390036	DEPT OF STREETS PIER LEAK	Philadelphia	39.9667	75.1467	O															
PAD054733597	DODGE FOUNDRY CO	Philadelphia	40.0233	75.0450																
PAD987366499	DRUM LOCATION 1-13-92	Philadelphia	39.9667	75.1467	A															
PAD002277655	DWORKIN ELECTROPLATERS INC	Philadelphia	39.9750	75.1117																
PAD987271194	E. Z. CHEMICAL	Philadelphia	39.9667	75.1467	B															
PAD987394921	ELLEN KNUTSEN CUMENE SPILL	Philadelphia	39.9750	75.1117	V															
PAD002274009	ELLISCO CO	Philadelphia	40.0167	75.1333																
PAD981936962	END PROPERTY	Philadelphia	40.0833	75.1889																
PAD980826685	ESSSINGTON AVE	Philadelphia	39.9450	75.1467																
PAD002268944	FALKENSTEIN ELECTROPLATING	Philadelphia	39.9933	75.1383	M															
PAD077078210	FRANKFORD ARSENAL	Philadelphia	39.9983	75.0667																
PAD981044894	GENERAL ELECTRIC CO	Philadelphia	40.0233	75.0450																
PAD002316305	GENERAL ELECTRIC CO - RSD	Philadelphia	39.9550	75.1833	O															
PAD046558037	GENERAL ELECTRIC CO.-BREAKER PLANT	Philadelphia	39.9233	75.2400	O															
PAD075527804	GENERAL ELECTRIC SKEATS LABORATORY	Philadelphia	39.9014	75.2417																
PAD002269090	GILBERT SPRUANCE CO.	Philadelphia	39.9750	75.1117	O															
PAD980692982	GLOBE SOLVENTS	Philadelphia	40.0750	75.1267																
PAD075486217	HALPERN & STEIN INC	Philadelphia	39.9800	75.1733																
PAD981103922	HARROWGATE INCINERATOR RESOURCE RECOVERY	Philadelphia	40.0250	75.0833																
PAD987283520	HENSHELL CORPORATION	Philadelphia	39.9933	75.1583	O															
PAD987393964	HIGH CHEMICAL INC.	Philadelphia	39.9800	75.1417	M															
PAD982367914	HOUSTON PLAYGROUND	Philadelphia	40.0567	75.2317	O															
PAD002275022	HOWARD REFRIGERATOR CO INC	Philadelphia	40.0567	74.9933																
PAD070263023	IMPERIAL METAL & CHEMICAL CO.	Philadelphia	39.9750	75.1117	O															
PAD980832547	INDEPENDENT WIRING	Philadelphia	40.0167	75.1333																
PAD987327194	INNOVATIVE PRINTING AND LITHOGRAPHY	Philadelphia	40.1317	75.0167	M															
PAD980538615	INTERN PAPER CO A M COLLINS	Philadelphia	39.9800	75.1417																
PAD002282002	INTERNATIONAL PAPER CO LIQUID PKG.	Philadelphia	40.1317	75.0167	O															
PAD981736911	JUNIATA PARK DISPOSAL AREA	Philadelphia	40.0250	75.0833																
PAD982367252	KENDRICK RECREATION CNTR	Philadelphia	40.0567	75.2317	O															

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EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD000432542	KERR-MC GEE CHEMICAL	Philadelphia	39.9261	75.1417																
PAD982364416	KOMAK/ONTARIO ST	Philadelphia	40.0167	75.1333	O															
PAD987347549	LAUREL PRODUCTS	Philadelphia	40.0583	75.0333																
PAD982367849	LIGHTMAN DRUM SITE	Philadelphia	40.0567	75.2317	O															
PAD982367195	LIVEZEY ST SITE	Philadelphia	40.0567	75.2317	O															
PAD011201662	LOWER ALLEN TOWNSHIP SITE	Philadelphia	39.9550	75.1583	O															
PAD982367724	MANAYUNK CANAL ASH DISPOSAL SITE	Philadelphia	40.0567	75.2317	O															
PAD987279336	MANHEIM LAUNDRY/BULL MARKET	Philadelphia	40.0433	75.1683																
PAD980538672	MARTIN MARIETTA CORP	Philadelphia	39.9750	75.1117																
PAD981034317	MASTER MANUFACTURING CO	Philadelphia	39.9933	75.1383																
PAD987392289	MAX LEVY AUTOGRAPH INC.	Philadelphia	40.0433	75.1683	O															
PAD002277077	MC CLOSKY VARNISH CO	Philadelphia	40.0583	75.0333																
PAD981106099	MCDONNELL DOUGLAS PESTICIDE	Philadelphia	39.9983	75.0667	O															
PAD002279008	MCFADDEN, LAWRENCE CO	Philadelphia	40.0583	75.0333																
PAD987322534	MERIT PRODUCTS SITE	Philadelphia	39.9933	75.1583	A															
PAD987367307	MERRICK STREET SITE	Philadelphia	40.0567	75.2317																
PAD981737166	METAL BANK OF AMERICA	Philadelphia	40.0500	75.1500				1												1
PAD987394939	MUSIC ANNEX RADIATION	Philadelphia	39.9550	75.1833	H															
PA5170090018	NAVAL AVIATION SUPPLY OFFICE (ASO)	Philadelphia	40.0850	75.0933																
PAD981034572	NEWCO-RRI, PHILADELPHIA	Philadelphia	39.8933	75.2400																
PAD980539381	NL IND INC TATHAM BROTHERS	Philadelphia	39.9450	75.1467																
PAD980539746	NL IND INC THOMAS SPARKS CO	Philadelphia	39.9367	75.1550																
PAD980538557	NL IND INC WESTERN WHITE LEAD	Philadelphia	39.9550	75.1833																
PAD981740046	NOROC ENTERPRISES	Philadelphia	4.0028	75.1333	G															
PAD981103849	NORTHEAST INCINERATOR	Philadelphia	39.9983	75.0667																
PAD980693253	ODONNELL STEEL DRUM	Philadelphia	39.9292	75.2333																
PAD987277175	OLD BARRETT BUILDING	Philadelphia	39.9383	75.1783	A															
PAD987317831	OLD CARDO SITE	Philadelphia	40.0983	74.9767																
PAD987400561	ORFA MANUFACTURING COMPANY	Philadelphia	39.9483	75.2267	A															
PAD982367138	PARKER AVE & SILVERWOOD ST SITE	Philadelphia	40.0567	75.2317	O															
PAD980706972	PASSYUNK TOWN GAS	Philadelphia	39.9550	75.1833																
PAD987366846	PECO UNDERGROUND LINE	Philadelphia	39.9167	75.1583	O															
PAD987358611	PENN PETROLEUM COMPANY	Philadelphia	39.9450	75.1467	M															
PAD980539324	PHILA CITY DUMP	Philadelphia	39.9550	75.1833																

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PAD980693071	PHILA NW INCINERATOR	Philadelphia	40.0300	75.2183																
PAD980692743	PHILA POLICE ACADEMY	Philadelphia	40.0361	75.0014																
PAD980693360	PHILA REDEVELOPMENT AUTH	Philadelphia	39.9833	75.1250																
PAD987266129	PHILADELPHIA INTERNATIONAL AIRPORT	Philadelphia	39.8933	75.2400	O															
PAD987339728	PHILADELPHIA MSO DRUM SITE	Philadelphia	39.9367	75.1550	O															
PAD980713291	PHILADELPHIA SLUDGE LAGOONS	Philadelphia	39.9983	75.0667																
PAD987332830	PIER 12 GASOLINE SPILL	Philadelphia	39.9450	75.1467	O															
PAD987327129	PINE OIL	Philadelphia	39.9550	75.1583	O															
PAD980707095	POINT BREEZE TOWN GAS	Philadelphia	39.9550	75.1833																
PAD987369632	PUBLIC STORAGE	Philadelphia	40.0233	75.0450	O															
PAD980538490	PUREX CORP FELS PLT	Philadelphia	39.9233	75.2400																
PAD086789144	PUREX CORP FRANKLIN PROD DIV	Philadelphia	39.9817	75.2283																
PAD987277498	PUROLITE CHEMICAL	Philadelphia	39.9800	75.1417	O															
PAD987329380	QUALITY CONTAINER ABANDONED DRUMS	Philadelphia	39.9750	75.1117	O											1				
PAD982367781	QUARRY ASH DISPOSAL SITE	Philadelphia	40.0567	75.2317	O															
PAD001739966	QUICKWAY INC	Philadelphia	39.9919	75.0714																
PAD987399185	READING TERMINAL	Philadelphia	39.9550	75.1583	C															
PAD980539621	REMINGTON RAND UNIVAC	Philadelphia	39.9933	75.1583																
PAD002310043	RICCIARDI & SONS CO INC AL	Philadelphia	39.9667	75.1467																
PAD980829758	RICHMOND STREET SITE	Philadelphia	39.9764	75.1014																
PAD980707038	RICHMOND TOWN GAS	Philadelphia	39.9550	75.1833																
PAD002282341	RIVERSIDE IND CENTER BANK & LANDFILL	Philadelphia	40.0583	75.0333																
PAD077883346	ROHM & HAAS - PHILA PLT	Philadelphia	40.0014	75.5281	B															
PAD980829741	ROXBOROUGH CINDER	Philadelphia	40.0042	75.0944																
PAD987270162	RUSCOMBMANOR QUARRY	Philadelphia	40.0417	75.1167	O															
PAD982364234	SABLE DIAMONDS/US METAL & COINS	Philadelphia	39.9450	75.1467	O															
PAD987366507	SANSOM STREET JEWELRY FIRE	Philadelphia	39.9550	75.1583	O															
PAD987353596	SANTIAGO JUNK YARD	Philadelphia	40.0167	75.1333	O															
PAD980692966	SCHIAVO BROTHERS	Philadelphia	39.8933	75.2400																
PAD987390739	SCHUYLKILL PARK	Philadelphia	39.9533	75.1650	H															
PAD980918924	SEPTA - POWELTON RAILYARD	Philadelphia	39.9550	75.1833																
PAD982364150	SEPTA - ROBERTS AVE YARD RAILYARD	Philadelphia	40.0167	75.1333	O															
PAD987367463	SEPTA SITE	Philadelphia	39.9550	75.1833	O															
PAD982367906	SHAWMONT AVE DUMPSITE	Philadelphia	40.0567	75.2317	O															

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD000000190	SKF IND INC SPEC BEARING DIV	Philadelphia	40.0250	75.0833																
PAD981738800	SOLLY AVE MIDNIGHT DUMP SITE	Philadelphia	40.0850	75.0933																
PAD987336989	SOUTH WEST PHILADELPHIA SLUDGE SPILL	Philadelphia	39.8933	75.2400	O															
PAD981103898	SOUTHEAST INCINERATOR	Philadelphia	39.9167	75.1583																
PAD982367146	SOUTHWEST PHILA. ABONDONED TRAILER SITE	Philadelphia	39.9767	75.2500																
PAD987327087	SOVEREIGN OIL SPILL	Philadelphia	39.9800	75.1417	M															
PAD982364283	SPEEDY MUFFLER	Philadelphia	39.9933	75.1383	O															
PAD980832745	ST RD AT PENNYPACK CR	Philadelphia	40.0314	75.0100																
PAD987362564	SUGARHOUSE REALTY, INC.	Philadelphia	39.9833	75.1250	A															
PAD980551907	SUN COMPANY CHEMICAL PAINT FIRE	Philadelphia	40.0167	75.1750	B															
PAD980919179	TACONY CRUCIBLE PROPERTY	Philadelphia	40.0233	75.0450																
PA0210000931	TACONY WAREHOUSE	Philadelphia	40.0233	75.0450				1												
PAD980828032	TERMINAL AVENUE/SWANSON CREEK SITE	Philadelphia	40.0767	75.1900																
PAD987268646	THOMPSON ST TRAILER SITE	Philadelphia	39.9833	75.1250	O															
PAD987387594	TIDEWATER GRAIN PIER	Philadelphia	39.9383	75.1817	V															
PAD987270972	TIOGA STREET SITE	Philadelphia	39.9750	75.1117	O															
PAD987348869	TULIP STREET	Philadelphia	40.0233	75.0450	B															
PAD982367666	UMBRIA ST ASH DISPOSAL SITE	Philadelphia	40.0567	75.2317	O															
PAD087098653	UNITANK TERMINAL SERVICE	Philadelphia	39.9750	75.1117	O															
PA4170022418	USN PHILA NAVAL SHIPYARD	Philadelphia	39.8900	75.1750																
PAD002373900	WESTINGHOUSE LANDFILL POND	Philadelphia	39.8639	75.2833																
PAD981034507	WETHERILL & CO, INC	Philadelphia	39.9483	75.2267																
PAD987399177	WYNDMOOR PESTICIDE RELEASE	Philadelphia	40.0767	75.1900	H															
PAD980830301	WYNNFIELD AREA SITE	Philadelphia	39.9889	75.2361																
PAD981034846	CROWN INDUSTRIAL	Pike	41.4767	75.0383																
PAD981110091	MILFORD BORO LANDFILL	Pike	41.3042	74.8133																
PAD987282845	PP & L BLOOMING GROVE SUBSTATION	Pike	41.3217	75.3050																
PAD987396769	TRI- STATE CANOE & CAMPGROUND - HSCA	Pike	41.3683	74.7000																
PAD981940729	VANDOR CO	Pike	41.4200	74.9967																
PAD981110067	WESTFALL TWP LANDFILL	Pike	41.3889	74.7175																
PAD098742893	AGMET CORP	Schuylkill	40.8569	76.0539																
PAD069778967	AIR PRODUCTS & CHEMICAL INC	Schuylkill	40.7967	75.9717	O															
PAD980197750	ALSTATE - SCHUYLKILL CO - ASPHALT	Schuylkill	40.6383	76.1950																
PAD105448534	ALSTATE - SCHUYLKILL CO - CRESSONA	Schuylkill	40.6383	76.1950																

Appendix Table 2. CERCLIS Non-NPL Hazardous Waste Sites.

EPA ID	SITE	COUNTY	LAT	LONG	SITE CODE	GS	SW	PCB	DIEL-DRIN	PEST	PAH	AS	CD	CR	CU	PB	HG	AG	TOTAL METAL	VOC
PAD002376937	ATKINSON IND INC	Schuylkill	40.6583	76.1000																
PAD071203046	ATLAS POWDER CO REYNOLDS PLT	Schuylkill	40.7967	75.9717	O															
PAD981045990	BLYTH TWP LANDFILL	Schuylkill	40.7392	76.1219																
PAD982367187	BRANCH TWP LANDFILL #1	Schuylkill	40.6767	76.2767	O															
PAD982367245	BRANCH TWP LANDFILL #2	Schuylkill	40.6833	76.1967	O															
PAD981045875	COALDALE LANDFILL	Schuylkill	40.8047	75.9328																
PAD096262522	CRESSONA ALUMINUM CO	Schuylkill	40.6383	76.1950																
PAD981110685	CRESSONA BOROUGH LANDFILL	Schuylkill	40.6261	76.1983																
PAD980707517	EAST MINES ST CLAIR LANDFILL	Schuylkill	40.7161	76.1917																
PAD081621096	GLASWELD INTERNATIONAL INC	Schuylkill	40.6928	76.1706																
PAD987390507	HOMETOWN VILLAGE WELLS	Schuylkill	40.7967	75.9717																
PAD000797928	ICI AMERICAS INC.	Schuylkill	40.7967	75.9717	O															
PAD980707574	JOHN FRY LANDFILL	Schuylkill	40.6672	76.3481																
PAD981114770	LEEDS FOUNDRY - ST CLAIR	Schuylkill	40.7183	76.1917																
PAD981038904	MINERSVILLE BORO L/F	Schuylkill	40.6989	76.2636																
PAD987324001	NAFINGERS JUNKYARD	Schuylkill	40.6033	76.0917																
PAD987266434	ORWIGSBURG DISPOSAL	Schuylkill	40.6583	76.1000	O															
PAD980537831	PENN PWR & LGT TAMAQUA GAS PLT	Schuylkill	40.7967	75.9717																
PAD987378254	POTTSVILLE AREA SCHOOL DISTRICT	Schuylkill	40.6833	76.1967																
PAD981037617	POTTSVILLE GAS PLANT	Schuylkill	40.6833	76.1967																
PAD981104670	SCHUYLKILL HAVEN LANDFILL	Schuylkill	40.6300	76.1733																
PAD987327186	SCULPS HILL AIRSTRIP	Schuylkill	40.6033	76.0917	O															
PAD981045800	TAMAQUA BORO LANDFILL	Schuylkill	40.7758	76.0189																
PAD980918650	WASCOGG	Schuylkill	40.6750	76.3250																
PAD053905816	DAMASCUS TWP DISPOSAL SITE	Wayne	41.7033	75.0717																
PAD054151923	MANCHESTER TWP DISPOSAL SITE	Wayne	41.8550	75.2250																
PAD980539704	PENN PWR & LGT HONESDALE GAS PLT	Wayne	41.5733	75.2583																
PAD043872035	SANDY SHORE CO & FOWLER OIL CO DEMO	Wayne	41.5733	75.2583																