Environmental Risk Study

For

City of Chester, Pennsylvania

Conducted by the U.S.Environmental Protection Agency

Region III

in conjunction with the

Pennsylvania Department of Environmental Resources

May, 1995

Draft Report

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The U.S. Environmental Protection Agency wishes to acknowledge the cooperation and support efforts of the Pennsylvania Department of Environmental Resources(PADER), the PADER Region I Office, the Pennsylvania Department of Health, Bureau of Epidemiology, the Delaware County Commissioners, Chester City Council, Mayor Barbara Bohannon-Shepard, Chester Citizens Concerned for Quality Living, Public Interest Law Center of Philadelphia, Delaware Valley Toxics Coalition, and Pacific Environmental Services Inc.

CHESTER RISK PROJECT
TECHNICAL SUPPORT DOCUMENT

EXTERNAL REVIEW DRAFT, VERSION 1.0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, REGION III

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EXECUTIVE SUMMARY

The Chester Risk Assessment Project was part of an initiative by the United States Environmental Protection Agency (USEPA) Region III and agencies of the Commonwealth of Pennsylvania to study environmental risks, health, and regulatory issues in the Chester, Pennsylvania area. Although the original intent of the study was to provide a complete "cumulative risk study," utilizing exposure data for all environmental media and exposure pathways, the actual report is more of an aggregated risk study due to the largely unknown nature of the interrelated exposures.

The city of Chester is located approximately 15 miles southwest of the city of Philadelphia along the Delaware River. According to the 1990 United States Census, 41,856 persons reside in Chester, which has an area of 4.8 square miles. Surrounding communities also examined in development of this report include Eddystone, Trainer, Marcus Hook, and Linwood. The area contains a mixture of commercial, residential, and industrial uses. Often, industrial facilities and major highways are situated very close to residences.

A key element in the project scope called for environmental risks to be quantitated wherever possible, and supplemented with qualitative information. Chemical data were gathered from existing sources. The scope of this project did not include collection of new data specifically designed for a Chester risk assessment. Instead the workgroup performed an examination of available data which yielded the following observations:

- The data had been collected for different programs and different agencies. These data were not originally designed to support a quantitative risk assessment of the Chester area.

- The databases were of varying quality, and certain chemicals and media had not been tested. However, even with the limited data, many data sets were available to be used to generate estimated risks.

- Modeling of air data from point sources was performed prior to the air risk assessment. Therefore, point source air risks are based on projected data rather than data actually collected in the field. The lead (Pb) data, area sources of volatile organic compound (VOC) emissions, Resource Conservation and Recovery Act (RCRA) site information, and Toxic Release Inventory (TRI) data did not involve the types of environmental data conducive to quantitative risk assessment.

The findings of the report include:

- Over 60% of children's blood lead samples were above the Center for Disease Control (CDC) recommended threshold action level of 10 ug/dL.

- Both cancer and non-cancer risks from the pollution sources at locations in the city of Chester exceed levels which USEPA believes are acceptable. Air emissions from facilities in and around Chester provide a component of the cancer and non-cancer risk to the citizens of Chester.

- The potential health risk from regularly eating contaminated fish from streams in Chester and the Delaware River is unacceptably high.

- Drinking water in Chester appears to be typical of supplies in other cities through out the country.

In response to these findings, the USEPA Region III recommends that:

- the lead paint education and abatement program in the city of Chester should be aggressively enhanced,

- sources of air emissions which impact the areas of the city with unacceptably high risk should be targeted for compliance inspections and any necessary enforcement action,

- a voluntary emission reduction program should be instituted to obtain additional emissions reductions from facilities which provide the most emissions in the areas of highest risk,

- enhanced public education programs regarding the reasons behind the existing state mandated fishing ban should be implemented.

In addition, while fugitive dust emissions have not shown to be a significant component of risk in the City, a program to minimize fugitive emissions from dirt piles and streets should be instituted to alleviate this nuisance.

There was limited ability to assess noise and odor complaints for the city within the timeframe of the study. It is recommended that follow-up continue in the form of a noise and odor monitoring program in areas most likely to suffer from these nuisances. If significant levels are found, a noise and/or odor reduction program should be implemented in those areas.

1.0 OBJECTIVE

The Chester Risk Project was part of a larger initiative by the United States Environmental Protection Agency (USEPA) Region III and agencies of the Commonwealth of Pennsylvania to study environmental risks, health, and regulatory issues in the Chester, Pennsylvania area. This initiative was the result of potential concerns from the perspective of environmental risk because of factors such as a high concentration of industry and the proximity of residences to industrial and high-traffic areas. Members of the community contacted USEPA with concerns about their health and environment. Additionally, factors such as the economic status of the area and the presence of a significant minority population raised potential concerns with respect to environmental justice.

This report contains the technical findings and supporting documentation for the environmental risk portion of the Chester study. The USEPA Region III Toxicologists' Quality Circle was tasked to perform a risk assessment of the Chester, Pennsylvania area. The scope of the risk assessment was defined as follows:

- Environmental risks should be quantitated wherever possible, and supplemented with qualitative information.
- The study should be performed in 180 days. Within the scope of the 180-day study, new environmental sampling would not be conducted, and the study should rely on existing data.
- The assessment should take into account multiple sources and potential sources of environmental risk. As far as possible, the sum of these risks should be evaluated.
- Within the scope of the 180-day study, it was not possible to perform a "control city" evaluation or a comparative study. However, relevant data currently available for the rest of the Region (Pennsylvania, Maryland, Delaware, Virginia, West Virginia, District of Columbia) or nation would be incorporated wherever possible.
- As far as possible, the concerns of the Chester area community should be considered in the study.
- Technical guidance for the performance of risk assessment should be followed.

2.0 ENVIRONMENTAL SETTING AND BACKGROUND INFORMATION

The city of Chester is located approximately 15 miles southwest of the city of Philadelphia along the Delaware River (see Fig. 2-1). According to the 1990 United States Census, 41,856 persons reside in Chester, which has an area of 4.8 square miles. Approximately 75% of the population is reported to consist of people of color (65% African-American). Surrounding communities also examined in development of this report include Eddystone, Trainer, Marcus Hook, and Linwood. Major routes transecting Chester include Interstate 95, which runs northeast to southwest through the city, and US Route 13, which parallels Interstate 95 to the east. US Route 322 bisects Chester from northwest to southeast and leads to the Commodore Barry Bridge over the Delaware River to New Jersey.

Drinking water for the City of Chester is supplied by the Chester Water Authority (CWA) and Philadelphia Suburban Water Company (PSWC). CWA is supplied with surface water from the Octoraro Reservoir in Lancaster County and from the Susquehanna River near the Peach Bottom nuclear plant. CWA's surface water intakes are well outside the study area and do not receive drainage from the city. The PSWC is supplied with surface water and groundwater from six surface water sources and 39 wells. The closest surface intake is located on Crum Creek about eight miles north of the city of Chester. There are no PSWC wells in the Chester City area.

Large sources of surface water in the city of Chester include Chester Creek and the Delaware River. All streams in the Chester vicinity ultimately drain into the Delaware River in a dendritic pattern. The Delaware River is a protected waterway for the maintenance and propagation of fish species that are indigenous to a warm-water habitat. Additional uses for the river include as a passageway for migratory fish, potable water supply, livestock water supply, irrigation, water contact sports, and navigation. Wetland areas front along the Delaware River in the Chester city area. The short nose sturgeon (Ancipenser brevirostrum) is a federally protected species with a habitat that includes the Delaware River within the study area. In addition, two federally listed endangered birds are expected to be found as transient species in the project area. They are the bald eagle (Haliaeetus leucocephalus) and the peregrine falcon (Falco peregrinus). There are no listed critical habitats for these species in the study area.

The hydrogeologic conditions beneath the study area are highly dynamic in nature. Water levels are influenced by tides and high rates of infiltration from storms. Shallow groundwater will generally flow from topographic highs to lows and discharge

into Chester Creek and the Delaware River. Groundwater flow in the underlying crystalline bedrock is restricted to fractures and joints.

The regional climate is moderate and humid due to the low topographic relief and proximity to the Atlantic Coast. As a result, the southeastern part of Pennsylvania is more humid and has more precipitation than western Pennsylvania. The mean annual temperature for Philadelphia, Pennsylvania, the closest reporting station, is 54.3°F. Average monthly temperatures range from 31.2°F in January to 76.5°F in July. The average annual precipitation is 41.38 inches, which is evenly distributed throughout the year.

3.0 PRINCIPLES OF RISK ASSESSMENT AND BASIC ASSUMPTIONS

Examination of available data yielded the following observations: The data had been collected for different programs and different agencies and were not originally designed to support a quantitative risk assessment of the Chester area. The databases were of varying quality, and certain chemicals and media had not been tested. However, with the limited data available, it was possible for many data sets to be used to generate estimated risks.

The following principles and procedures were used for the generation of quantitative risks. Modeling of air data from point sources preceded the air risk assessment, such that point source air risks are based on projected data rather than data actually collected in the field. The lead data, area sources of volatile organic compound (VOC) emissions, Resource Conservation and Recovery Act (RCRA) site information, and Toxic Release Inventory (TRI) data did not involve the types of environmental data conducive to quantitative risk assessment, and they were evaluated as described in Section 4.

3.1 INTRODUCTION

In a risk assessment, the hazards posed by chemicals detected by chemical analysis are evaluated. Potential risks may exist when there are chemicals present in media and receptors which have access to the chemicals. This constitutes a complete exposure pathway.

The following steps form a basic framework that the quantitative assessments in this document followed wherever possible. Special evaluations (i.e., lead, TRI data) were performed for those data sets which did not lend themselves to this type of analysis.

To evaluate risks, several steps are taken. First, the data

are assessed for usability and comparability. Data may then undergo statistical manipulations for use in the quantitative risk assessment. An initial screening step occurs during data evaluation for the purposes of narrowing down the list of chemicals that are quantitatively assessed. Using conservative assumptions, the chemical concentrations that would correspond to the lower end of the target screening risk range are calculated. These concentrations are called risk-based concentrations, or RBCs, and are compared to the site data during the data evaluation stage to rule out chemicals that will not contribute significantly to risks at the site.

Exposure pathways are then determined. The receptors that may be exposed are also chosen. Both current and future land uses must be considered. Using site-specific or default assumptions, estimated exposure doses are calculated for each receptor.

Once the amount of exposure each receptor receives has been calculated, that amount or dose is compared with values designed to assess the safety or toxicity of a chemical. This step, which is called risk characterization, helps the risk assessor determine the likelihood of adverse effects occurring for that exposure scenario.

Finally, the uncertainty of the risk analysis is described, either quantitatively, qualitatively, or both. This step helps give a more complete picture of environmental risks, and helps risk managers weigh their options in addressing potential hazards.

The following sections give a detailed explanation of how these steps were performed for the Chester area project.

3.2 DATA EVALUATION

Chemical data were gathered from existing sources. The scope of this project did not include collection of new data specifically designed for a Chester risk assessment. The data sources and data quality are discussed in detail in Section 4.

3.2.1 Chemicals of Potential Concern

The data were examined in order to determine chemicals of potential concern (COPCs). COPCs are defined as those substances that are potentially related to the risk source being studied and whose data are of sufficient quality for use in the risk assessment. It is appropriate to select COPCs for each medium of concern.

Data were often screened using RBCs. RBCs were used to

determine whether, if included in the risk assessment, the chemical would be likely to contribute significantly to the risk. The screening concentrations were based on the following exposure assumptions for soil and sediment:

For carcinogens, residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days/year, divided into lifetime segments of 6 years at 15 kg body weight, ingesting 200 mg/day of soil, and 24 years at 70 kg, ingesting 100 mg/day.

For noncarcinogens, a six-year childhood exposure was assumed, with a 15-kg child consuming 200 mg/day of soil, 350 days per year. For noncarcinogens, the child-only scenario is more conservative than the adult scenario.

For leachate, the screening parameters included an exposure frequency of 7 days/year for a 70-kilogram adult for 30 years. The ingestion rate was 10 mL/event for liquid leachate and 100 mg/event for solid leachate samples.

Chemicals that are essential nutrients and common minerals (calcium, iron, magnesium, potassium, and sodium) were not selected as COPCs.

The RBCs for drinking water were derived as follows:

For carcinogens, residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days/year, divided into lifetime segments of 6 years at 15 kg body weight consuming 1 L/day and 24 years at 70 kg consuming 2 L/day. For noncarcinogens, the thirty-year adult-only scenario was used. For volatile chemicals (those with a Henry's Law constant greater than 1E-5 atm-m^3/mol), a volatilization factor of 0.5 L/m^3 and an inhalation rate of 20 m^3/day were assumed.

Several different types of surface water samples were obtained. They included samples from constantly flowing streams, large bodies of water such as the Delaware River, intermittent streams, drainage ditches, and areas of ponded water.

Unfiltered inorganic results were used for surface water in the assessment of human health effects, because any direct contact would occur with the water in its unfiltered state, including any suspended sediments.

Stream surface water COPCs were selected by comparing results to RBCs. The surface water RBCs were derived using the following assumptions: 30-year exposure (simplified as 6 years at 15 kg and 24 years at 70 kg) during swimming, with incidental ingestion of 50 mL/hour of surface water, with each swimming

event lasting 2.6 hours and occurring 7 times/year, based primarily on suggested inputs from USEPA, 1989a.

Modeled air concentrations were compared to risk-based concentrations (RBCs). The RBCs were based on the following exposure assumptions: Residential exposure was assumed to occur during both childhood and adulthood for a total of 30 years, 350 days/year, divided into lifetime segments of 6 years at 15 kg body weight, inhaling 12 m^3 of air per day, and 24 years at 70 kg, inhaling 20 m^3/day (30 years of adulthood for noncarcinogens). For air criteria pollutants, comparisons were made to National Ambient Air Quality Standards (NAAQS) instead of RfDs.

Fish tissue samples were compared with RBCs for fish tissue. Consumption was assumed to occur by adults for a total of 30 years, 350 days/year, ingesting 54 g of fish per day. This corresponds to a fish consumption rate of approximately 3/4 lb. of locally caught fish per week.

Using these assumptions, the RBCs were calculated at target risks of Hazard Quotient (HQ) = 0.1 (one-tenth the expected no-effects dose) and cancer risk = 1E-6 (probability of excess cancer cases 1 in 1,000,000). Calculation of HQs and estimated cancer risks is discussed in detail in Section 3.4.

3.2.2 Exposure Point Concentrations

Use of the 95% upper confidence limit (UCL) on the mean was considered for exposure point concentrations. However, several issues arose. Some data sets contained too few samples for the derivation of a UCL. Some very large data sets were not available in electronic format, making it doubtful that UCL calculations could be performed within the time constraints of the study. Some databases were clear in identifying positive results and maximums, but interpretation of detection limits was difficult. For other data sets, only averages were reported.

The detailed assessment of each data set (see Section 4) includes a discussion of exposure point concentration and whether maximum or average concentration was selected. The results for each assessment must be placed in the context of whether it represents estimated worst-case or average exposure.

3.3 EXPOSURE PATHWAYS

3.3.1 Receptors

Several factors determine what receptors may be exposed to the COPCs. It is expected that adult and child residents could be exposed to air, surface soil, sediment, and leachate. It is

anticipated that local residents could be exposed to surface water and sediment through recreational use. Public water supply results were obtained, and adults and children served by these supplies would be the potential receptors of concern for that water. People were observed fishing in the Delaware River, and it was assumed that the fish consumption pathway would also be complete.

3.3.2 Estimating Exposure

Exposure estimations are calculated for each receptor and each medium. Exposures from direct contact with soil and sediment can occur via incidental ingestion and dermal contact. Fugitive dust emissions and emissions of volatile organics from surface soils may contribute to inhalation exposure, although these pathways are usually much less significant than ingestion and dermal exposure.

Incidental ingestion of soil and sediment is estimated as shown in Table 3-1. Leachate risks were not quantitated because the sample concentrations did not exceed the screening RBCs (see Section 4.5).

Dermal exposure to soil and sediment is assessed as shown in Table 3-2.

There are generally three routes of exposure to chemicals in drinking water: ingestion, dermal exposure, and inhalation. The greatest exposures are assumed to occur from the activities of drinking and bathing or showering.

Ingestion exposure is estimated as shown in Table 3-3. Dermal exposure to water is estimated as shown in Table 3-4. Inhalation exposure through showering is generally assumed to occur for adults only and is estimated as shown in Table 3-5. For adults, the exposure from inhalation and ingestion comprises the bulk of the risk, and these two routes were quantitated. Because children are expected to bathe rather than shower, ingestion and dermal exposure were quantitated for children.

The equations used for surface water exposure are the same used to evaluate ingestion and dermal exposure to groundwater. However, the inputs vary and are shown on Tables 3-3 and 3-4.

The equations used for exposure to air contaminants are shown in Table 3-6.

The fish tissue ingestion equation was the same as that used for soil ingestion. Some of the input parameters differ from those of soil exposure and are shown on Table 3-1.

3.4 RISK CHARACTERIZATION

3.4.1 Toxicological Parameters

Once exposure has been estimated in terms of a dose for each receptor, further assessment must be done to determine the risk associated with that dose. This is commonly done with the use of dose-response parameters.

Dose-response parameters are based on scientific studies. They attempt to correlate a given dose with its effect on a receptor. Noncarcinogenic (non-cancer) effects are generally assumed to have a threshold; that is, a level below which exposure can occur without adverse effects. Carcinogenic (cancer-causing) effects are assumed by USEPA to have no threshold; that is, any exposure may potentially cause the cellular changes that lead to uncontrolled cell proliferation. Therefore, the two effects, carcinogenic and noncarcinogenic, are evaluated differently.

The dose-response parameters for the COPCs in the Chester area are shown on Tables 3-7 and 3-8. The following hierarchy was followed in selecting these numbers: parameters from USEPA's Integrated Risk Information System (IRIS), parameters from Health Effects Assessment Summary Tables (HEAST), numbers withdrawn from IRIS or HEAST but not yet substituted, numbers from USEPA's Environmental Criteria and Assessment Office (ECAO), numbers from other sources. Section 5.0 includes further discussion of the sources of these numbers and the uncertainty associated with them. Dose-response parameters used in the TRI assessment are shown on Table 4-28.

This section addresses the quantitative toxicity of the COPCs. Appendix I includes Toxicological Profiles for each COPC, which contain descriptions of the properties and potential effects of the COPCs.

3.4.1.1 Noncarcinogenic Dose-Response Parameters

Concentrations of chemicals at which no adverse effects have been observed, or which were the lowest levels at which adverse effects were observed, may be used to estimate a Reference Dose (RfD) for human exposure. The No-Observed-Adverse-Effects-Levels (NOAELs) or Lowest-Observed-Adverse-Effects-Levels (LOAELs) are typically reported from animal data. Other experimental factors, such as the route of administration of the chemical, may contribute to difficulties comparing these data to human exposures. Therefore, USEPA develops RfDs for human exposure by multiplying the NOAEL or LOAEL by uncertainty factors and modifying factors. The uncertainty factors are applied to account for variation in the general population, extrapolation

from animal data to humans, extrapolation from short-term studies to assessing chronic exposure, differences between NOAELs vs. LOAELs, and any other sources of uncertainty. RfDs are available for ingestion and inhalation exposures. At this time, dermal doses are assessed by comparison to adjusted oral RfDs (USEPA, 1989a).

To evaluate human noncarcinogenic risk, the exposure dose is divided by the RfD. If the dose is less than the RfD, this quotient, referred to as the Hazard Quotient (HQ), will be less than 1, and adverse effects would not be anticipated. Because RfDs are set below expected toxic doses, it is difficult to determine at what dose toxicity would be expected to occur. Therefore, although exceedance of RfDs does not necessarily mean that toxic effects will be expected, it is prudent for exposures to result in HQs less than 1.

When more than one chemical is present in the medium of exposure, the combined effects of these chemicals must be considered. Chemicals may act synergistically, where the combined effect is much greater than would be expected when each of their effects is considered individually. They may act antagonistically, where the combined effect is less than would be expected when considering the chemicals individually. Chemicals may also act additively, where the combined effect is equal to the sum of the individual effects. With the present state of knowledge, chemicals in mixtures are assumed to act additively unless there is evidence to the contrary. Therefore, HQs may be added for a total Hazard Index (HI). When the chemicals act on the same target organs via similar mechanisms, it is also desirable for the HI to be less than 1. Therefore, for all HIs greater than 1, an assessment of the mechanisms of toxicity will be made to determine whether an unacceptable risk exists from a combination of chemicals.

RfDs have not been developed for all chemicals. Where they are unavailable, substitute values may be used. For example, a provisional allowable daily intake (ADI) may be estimated using the Layton method, which involves multiplying animal data (usually an LD50, or dose lethal to 50 percent of an experimental population) by a conservative factor (Layton, 1987). For carcinogens, noncarcinogenic effects usually occur at much higher levels than unacceptable carcinogenic risks. In such cases, where the RfD is not available, only carcinogenic effects were assessed.

3.4.1.2 Carcinogenic Dose-Response Parameters

USEPA assigns a "weight-of-evidence" to carcinogens to evaluate the likelihood that the agent is a human carcinogen. The weight-of-evidence classifications are defined below:

Group A	Human carcinogen
Group B	Probable human carcinogen; B1 indicates that limited human data are available; B2 indicates that there is sufficient evidence in animals and inadequate or no evidence in humans
Group C	Possible human carcinogen
Group D	Not classifiable as to human carcinogenicity
Group E	Evidence of noncarcinogenicity for humans

For the purposes of this risk assessment, carcinogenic effects were assessed for Groups A, B, and C carcinogens.

The parameter that relates exposure dose to carcinogenic response is the slope factor. The slope factor is used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a carcinogen. Slope factors are derived from scientific study data, to which a variety of mathematical models may be applied. For each slope factor, the Integrated Risk Information System (IRIS) database includes a summary of the information used to derive that chemical's slope factor.

To estimate carcinogenic risk, the following equation is used:

$$CR = 1 - \exp(-CSF \times D)$$

CR = Estimated cancer risk
CSF = Cancer slope factor (1/mg/kg/day)
D = Exposure dose (mg/kg/day)

3.4.1.3 Other Parameters and Criteria

For drinking water, in addition to estimations of risk as described above, comparisons to drinking water criteria may be made. Under the Safe Drinking Water Act, public water suppliers are required to meet National Primary Drinking Water Regulations (NPDWRs), which may take the form of Maximum Contaminant Levels (MCLs) or Action Levels.

This is not a risk estimation method, since MCLs are based on both human health information and available technology. In some cases, MCLs may be well below levels expected to be associated with significant human health risks. In other cases, there may be evidence that MCLs may not be as protective as desired, but the regulations have not been changed yet because of the lengthy process involved in changing these numbers or because no cost-effective technology currently exists for treatment of the chemical in water. Some chemicals are unavoidable by-products of the chlorination process necessary for the

disinfection of public water supplies. Potential risks associated with these unavoidable chemicals are balanced by the benefits of removing pathogenic organisms from public water supplies.

MCL Goals (MCLGs) are not required to be met by public water supplies. They are health-based numbers, and MCLs are set as close to MCLGs as possible. For known and suspected human carcinogens, the MCLGs are set at zero.

Secondary MCLs (SMCLs) are not health-based. They are designed to prevent unpleasant aesthetic effects in water such as offensive taste or odor, corrosivity or staining of plumbing fixtures.

3.4.1.4 Adjustment of Dose-Response Parameters

In accordance with USEPA, 1989a, Appendix A, the dose-response parameters had to be adjusted when the estimated dose was dermally absorbed, but the original parameter was based on oral intake. This was done by adjusting the orally administered parameter by the oral absorption percentage (preferably for the same route, vehicle, and species as the critical study on which the parameter was based) to give an absorbed parameter. The following absorption factors were obtained from USEPA IRIS and ECAO:

Arsenic: 95%
1,2-Dichloroethene: 100%
Nickel: 4.3%
Tetrachloroethene: 100%
Vinyl chloride: 100%
Beryllium: 1%
Manganese: 3-4% from food, 100% from water
Cadmium: 5% from water, 2.5% from food
Copper: 60%
Zinc: 25%
Mercury: 15%
Polychlorinated biphenyls (PCBs): 89%

All other absorption factors for this adjustment were assumed to be 100% if no other number was available. As can be seen from the factors for other volatile compounds, this is expected to be realistic for volatile compounds, and less so for semi-volatiles, pesticides, and metals.

3.5 UNCERTAINTY ANALYSIS

Uncertainty will be discussed in Section 4 for each data set and calculation. However, this section includes general uncertainties common to all the data sets.

Uncertainty associated with the assessment of risk may be associated with exposure estimation, toxicity assessment, and in risk characterization. The policy of the USEPA is to be protective of human health and the environment. In accordance with this policy, exposure estimates and the parameters used in the characterization of the exposures are of a conservative nature whenever possible. These conservative parameters are designed to insure that all estimates are protective and that all sensitive subpopulations are considered. Some of these exposure parameters may be overestimates of the actual exposures experienced by receptors.

The use of default parameters may lead to an overestimation of risk, since these values are conservative for the purpose of protecting sensitive receptors in risk evaluation. There are also uncertainties associated with chemical-specific input parameters such as permeability constants.

Agency guidance assumes that the concentrations of contaminants identified will remain the same over time. Since the contaminant concentrations may decrease over time, the exposures of receptors and subsequent risks calculated may be overestimates for future exposure. This could also result in underestimation if further releases were to occur.

Uncertainty associated with toxicity characterization may be due to factors including extrapolation from subchronic to chronic data, intraspecies extrapolation, interspecies variability, lack of certain types of data, data limitations, and other relevant modifying factors. All of these factors are taken into account when evaluating the toxicity of the contaminants in question. Toxicity factors may be based upon cases such as the extrapolation of data obtained from animal studies in which short-term exposure to very high concentrations of contaminants produced some carcinogenic effects to possible human effects produced by low-dose long-term exposures.

The evaluation of the uncertainty associated with toxicity also includes an assessment of the certainty with respect to RfD values and the safety factors built into the toxicity values used for the evaluation of contaminants. It should be noted that in applying the Agency's RfD methodology, arguments may be made for various RfD values within a factor of 2 or 3 of the current RfD value. Additionally, the RfD computation methodology derives a number with inherent uncertainty that may span an order of magnitude. The IRIS database includes information related to the uncertainty factors and the confidence in the RfD values for a given contaminant.

Uncertainty associated with the characterization of risk is related to the uncertainty of the exposure and toxicity

characterizations. It is noted that risk is a function of the intake of a contaminant as based on the exposure scenario and the toxicity of the contaminant to which the receptor has been exposed. It is acknowledged that the default exposure parameters are conservative and therefore probably overestimate the actual exposure. The uncertainty associated with RfDs and other toxicity data values is based upon the methodology used to derive the data values, the quality of the data derived from the various studies used to assess the toxicity of the contaminant, and the margins of safety built into these values.

No special subpopulations (other than children, which are considered to be part of almost every residential population) were identified. While certain subpopulations such as subsistence fishers, children with pica, and persons with respiratory diseases may exist within the study area, there was little or no available information that could be incorporated within the framework of the 180-day study.

4.0 SPECIFIC MEDIA AND DATA SETS ASSESSED

This section consists of the results of the quantitative risk assessments for specific data sets. Qualitative discussions of risk and comparative information are also included, wherever possible. Evaluation of environmental data sets (area sources, blood lead, RCRA, and TRI data) that did not lend themselves to standard quantitative risk assessment but contained information relevant to the Chester area environment are also included.

4.1 GROUNDWATER AND DRINKING WATER

This study investigated the drinking water quality of both private and public well users in the City of Chester and surrounding municipalities including Marcus Hook Borough, Trainer Borough, Chester City, Chester Township, Linwood, Upland Borough and Eddystone Borough. The potability of the groundwater in the study area and potential risk to private well users was evaluated by qualitative assessment of the existing monitoring well data from Comprehensive Environmental Response, Compensation, and Liabilities Information System (CERCLIS) and Resource Conservation and Recovery Act (RCRA) sites. Environmental equity issues that would require further study were identified where appropriate with respect to the data obtained to date.

4.1.1 Data Sources

4.1.1.1 PADER Finished Water Data

Hard copies of finished water data were obtained from the Pennsylvania Department of Environmental Resources (PADER) for the time period between 1980 and 1994. The monitoring data are

collected for regulated contaminants as indicated by the Safe Drinking Water Act (1986) (SDWA) and amendments thereafter (USEPA, 1994d). Data for organics, inorganics, radionuclides and other parameters (e.g., pH, hardness, etc.) were available. Several limitations were noted including inconsistent reporting of data parameters by the sampling laboratory (i.e., the use of different names for the same parameter), the use of different methods of reporting concentrations, errors in data recording, errors in identification of sample type (raw vs. finished water), and the use of different labels for similar sampling locations.

This database was used to assess the drinking water quality of residents in the study area; their water is supplied by the Chester Water Authority and Philadelphia Suburban Water Company. The data from the Coatesville Water Authority and the Philadelphia Water Department were used for comparative purposes. All of the data were confirmed with the individual laboratories serving each of the Water Companies to the fullest extent possible.

When appropriate, the potential human health risks due to contaminants in the drinking water were assessed. The data from 1989-1993 were used for risk purposes because this time period appeared to be the most consistent regulatory period with respect to the monitoring of currently regulated contaminants. The monitoring data for 1994 were incomplete and were not used. Only data from sampling points labelled as "distribution entry point," "distribution sample," "plant tap," and "finished water" were assessed.

Note that all of the data used in assessing risk from contaminants detected in the finished water distributed by the Philadelphia Water Department (e.g., described as either high service, gravity or effluent from the Baxter, Queen Lane and Belmont Intakes) were from the Philadelphia Water Department, Annual Report, Bureau of Laboratory Services, Fiscal Year 1993. This Report was made available prior to receiving PADER's finished water data. However, the data were cross-referenced with the data from PADER received at a later date.

Note also that only the monitoring data for trihalomethanes (THMs) from the Coatesville Water Authority were used for comparative analysis of the THM levels with other water supplies (discussed further in Section 4.1.4, below). These data were made available by the Coatesville Water Authority for 1993.

4.1.1.2 United States Geological Survey (USGS) Water Resources Division, Groundwater Site Inventory (GWSI)

The data from the Groundwater Site Inventory (GWSI) database are limited to sites visited during the conduct of a hydrologic

investigation. At the time of entry into the database, the site data are verified. Data in the GWSI are reviewed for correctness and revised where errors are detected. The geohydrologic unit identifier may not conform to the latest geologic mapping, although efforts are made to update this information periodically. The database also contains chemical data for private wells when made available through a hydrologic investigation. However, no chemical data were available. This database was used only to determine the number and location of private wells in the study area.

4.1.1.3 Pennsylvania Bureau of Topographic and Geologic Survey

The data from the water well inventory for drillers include many wells that do not have field location verification. No records exist in the database for water wells that would have been drilled previous to 1966. Drillers are currently required by law to provide well records for all water wells that they drill, but there is no field compliance monitoring system in place. Therefore, information on all wells drilled since 1966 may not be available.

This database was used only to determine the number and location of private wells in the study area. There are currently no chemical data accessible in this database.

4.1.1.4 USGS Files of Well Driller Reports

USGS files of well driller reports include well locations that have been field verified. The information in the reports is the same as that contained in the GWSI but presented in a hard copy format. These reports may contain more information than the GWSI database.

These reports were used as confirmation of the data reported in the GWSI only to ascertain the number and location of private wells in the study area. No chemical data were available.

4.1.1.5 1990 United States Census

The 1990 US Census of Population and Housing, United States Department of Commerce, Economic and Statistics Administration, Bureau of the Census STF 3A, File 29, Tables H22-H33, was another source of groundwater data. The data in column H22-H33 "Source of Water" were obtained from both occupied and vacant housing units in the study area. A well that supplied greater than 5 housing units was assumed to be a public well and those that supplied fewer than 5 housing units were assumed to be private wells. Private wells were broken down into two categories, drilled and dug wells. The category "other source" includes water obtained from springs, creeks, rivers, lakes, cisterns,

etc., but it is not clear whether these sources supply private or public wells. Therefore, this data set was not used. The data are estimates of the actual figures that would have been obtained from a complete count if one had been made and, as such, are subject to both sampling and non-sampling errors.

This database was used only to determine the number and location of private wells in the study area. There are currently no chemical data available in the database.

4.1.1.6 Hazardous Waste CERCLIS and RCRA National Corrective Action Prioritization System (NCAPS)

These databases contain administrative information on Superfund and RCRA sites in the Region. They are described further in Sections 4.3 and 4.4.

These databases were used to determine the number of CERCLIS and RCRA Corrective action sites in the study area with known or suspected groundwater contamination. The data obtained from CERCLIS and RCRA sites were also used to qualitatively assess the potential risk of drinking groundwater in the study area by private well users (if any).

4.1.1.7 Geographical Information Systems (GIS)

GIS allows for the mapping of data onto USGS maps. The GIS was used to illustrate a number of data sets using a variety of data layers. Several layers of data were overlain onto a map of the study area as follows:

1. A map showing the number of estimated private wells by census tract/block numbering.

2. A map showing the number of estimated private wells by census tract/block numbering overlain with the location of individual private wells retrieved from the USGS database and the Pennsylvania Bureau of Topographic and Geologic Survey database.

3. Same as above with an overlay of the Superfund sites showing potential risk areas.

All other data sets were presented in a graphic format (see text).

4.1.1.8 Federal Reporting Data System (FRDS)

The FRDS database maintains information on public water supplies (PWSs) with MCL and monitoring violations for each state

in the Region. The data may be retrieved by county and by zip code.

This database was used to determine the number of MCL violations and the parameters violated from 1989-1994 for the Chester Water Authority, the Philadelphia Suburban Water Company, and the Philadelphia Water Department.

4.1.2 Screening Data Analysis

The chemicals of potential concern (COPCs) in finished water (regulated contaminants only) from the PWSs in the study area were selected by comparison with RBCs for residential use of drinking water, as described in Section 3.2.1. COPCs were selected for each year from 1989-1993.

4.1.3 Risk Assessment Data Analysis

Exposure point concentrations were the average concentration reported for each contaminant detected in the finished water for the entire system for each year. The data sets were reported as averages for each year for at least one of the systems under investigation (e.g. the Philadelphia Water Department). A Reasonable Maximum Exposure (RME) concentration, as recommended in USEPA, 1989a was not calculated. Averages were used for consistency's sake. The limitations of some of the data sets included only averages being reported.

Exposure was estimated for use of the finished water. The calculations and inputs presented in Tables 3-3, 3-4, and 3-5 were used for ingestion, inhalation and dermal contact with contaminants in drinking water. Note that the monitoring well data were assessed qualitatively for risk associated with the use of private wells. There were no chemical data available for private wells.

The Dermal Exposure Guidance document (USEPA, 1992d) was used to assess dermal risk. Contaminant-specific dermal exposure parameters [e.g., permeability constant (Kp) values] were obtained from this guidance. Where appropriate, a Kp value was calculated for some contaminants that lack a value based on the contaminant-specific octanol-water partition coefficient (Kow) and molecular weight. Contaminant-specific Kows were obtained from USEPA, 1986a or Howard, 1989.

Risk was calculated using the exposure doses as described in Section 3.4. The detailed calculations are included in Appendix II. No toxicity criteria have been developed for total THMs; therefore, the criteria for chloroform were used as a surrogate.

This is a conservative assumption because chloroform has the highest Cancer Slope Factor of the four regulated THMs. Toxicity profiles for each COPC are provided in Appendix I.

Risks were characterized for two exposure scenarios. In the first, a risk was calculated for an exposure duration of one year for each year during 1989-1993. In the second, risks were calculated for an exposure duration of 30 years based on the 1993 data only. This was done because of the uncertainty associated with exposure duration to chemicals in finished water. Typically, exposure point concentrations are assumed to remain constant for the entire exposure duration. However, contaminants may appear in the finished water at an unknown frequency, and this variability was observed in the five-year data set. Contamination varies over time and could vary significantly within a time period of one year. Certainly, significant variation in contaminant levels are expected to occur over a 30-year exposure period. Finished water is expected to be free of contamination but may, in fact, contain contaminants at concentrations below the MCL. These contaminant concentrations may pose a certain amount of risk at levels that are "permissible" in finished water.

4.1.4 Results and Discussion

4.1.4.1 Private Well Investigation

The census tract data obtained in 1990 involved a random door-to-door survey of the housing units (both vacant and occupied) in the study area (see Table 4-1). An assessment of the data indicated that less than 1% of the housing units in the study area may obtain their drinking water source from private wells. According to the local health department, the entire population of Chester is connected to a PWS. However, the health department had no data on which to base this conclusion (Gross, 1994). There are an estimated 61 private wells in the study area, of which approximately 31 are believed to be dug wells and approximately 30 are believed to be drilled wells. The data are estimates of the actual figures that would have been obtained from a complete count (USDOC, 1990). Therefore, the exact number of private wells in the study area is largely unknown.

The location of these potential wells are indicated in Figure 4-1 by the census tract/block numbering areas. Most of these private wells may be concentrated in the City of Chester area although there are wells apparently also situated in Trainer Borough, Chester Township and Eddystone Borough (Figure 4-1). Efforts to obtain locational information for any of the 61 private wells identified on the census tract have been hampered primarily because of those regulations which protect individual

rights to privacy. It should be noted that information retrieval from the census tract is quite limited mostly because the quality and quantity of the data input into the database are limited.

Data from other sources (e.g., the USGS GWSI and the Pennsylvania Bureau of Topographic and Geological Survey Databases) were retrieved in an effort to verify the existence and to obtain locational and chemical data for the private wells indicated in the census tract data of 1990. These databases were found to contain very little in the form of locational information and no chemical data. Locational information (e.g., in the form of longitudinal and latitudinal coordinates) was found for three possible private wells (Figure 4-2), although field verification has not been possible because no addresses were associated with the locational data. Only names were reported for those wells which are believed to be owned by private residents.

The addresses for the names of the people retrieved in the databases (and confirmed in the USGS Well Driller Reports) were cross-referenced with a telephone directory. None of the persons contacted said that they were using the wells for potable sources (Rundell, 1994). Some of the wells were in commercial establishments, not private residences. This effort indicates that there may be some private wells in the area (which may not be currently used), and that further investigation may be necessary. This is especially so in view of the fact that groundwater in the study area is of poor quality (see below).

4.1.4.2 Groundwater Quality in the Study Area

Monitoring wells were installed as part of hazardous waste site investigations in the study area. These wells are not used for human consumption, but as indicators of groundwater quality. Based on the monitoring data collected from several CERCLIS sites in the study area, groundwater in the study area may be impacted by a number of hazardous waste sources. Significant levels of organic and inorganic contaminants were detected in monitoring wells which are indicative of potential groundwater contamination (Table 4-2). Contaminant-specific monitoring well data from RCRA sites currently undergoing corrective action were not available for analysis at the time of this study. The fact that the existing groundwater in the study area appears to be highly contaminated with anthropogenic sources of pollution is critical for those who may be currently utilizing groundwater for their drinking water sources (e.g., for private well users). Figure 4-3 shows potentially affected groundwater areas from CERCLIS sites in Chester City and Linwood, Marcus Hook and Trainer boroughs. Until the quality of groundwater in private wells can be ascertained, it may be prudent to avoid exposure to the groundwater in the study area.

It should be noted that this analysis is hampered by the fact that the vertical and horizontal extent of contamination (e.g., the groundwater flow of contaminants in the vertical and horizontal planes) are not known.

4.1.4.3 Public Water Supply

Drinking water quality from public water sources in the study area was investigated because greater than 99% of the population is expected to obtain their drinking water from a public supply. The study area is served by the Chester Water Authority except for Eddystone, which is served by the Philadelphia Suburban Water Company. It should be noted that Philadelphia Suburban Water Company purchases water for Eddystone from the Chester Water Authority. This water undergoes no additional treatment; therefore, the actual source of drinking water for Eddystone is the Chester Water Authority.

Finished water data obtained from PADER and in some cases from the water company itself were analyzed and the potential risk from reported contaminants were assessed as described above. Contaminants were categorized as originating from water treatment (i.e., those that occur as byproducts of chlorination, fluoridation, or other intentional treatment) and non-treatment-related (i.e., pollutant and naturally occurring chemicals). The data indicate that both types of chemicals have existed and could continue to exist in the finished water of citizens in the study area. In all cases, however, reported contaminant levels for the time period studied are lower than enforceable MCLs; therefore, the PWS for the study area is in compliance with the National Primary Drinking Water Regulations. The low levels of contaminants that were measured were primarily by-products of the disinfection process or treatment-related contamination.

Tables 4-3, 4-4, and 4-5 summarize risks for the 1-year and 30-year exposure scenarios for the PWSs. The supporting information for these calculations was presented in Section 3; the detailed calculations are shown in Appendix II.

<u>Potential Risk from Treatment-Related Sources</u>

Total Trihalomethanes

There were several THMs (chloroform, bromodichloromethane and dibromochloromethane) detected in finished water in this study at levels above their respective RBCs (Tables 4-6, 4-7, 4-8). The data are consistent with Region-wide results. Violations for the PWSs under study are shown in Tables 4-9, 4-10, and 4-11. Note that these violations are primarily associated with treatment performance techniques and/or late reporting problems, and that no actual exceedances of MCLs were

noted. Several MCL violations for THMs have been found in PWSs across the Region. THMs were also found in most PWSs nationwide (Olson, 1993).

THMs are degradation products of the disinfection process which eliminates disease-causing microbial pathogens from drinking water. THMs are formed in the drinking water during the reaction between chlorine (an effective and widely used disinfectant) and organic matter already in the water. Chronic exposure to high levels of THMs in PWSs may result in an increased risk of developing toxic effects from ingestion and/or inhalation of these contaminants in the water. Chlorinated drinking water has been associated with certain types of rectal, colon and bladder cancers and with liver damage in studies conducted in Louisiana and Wisconsin and in laboratory studies (Amdur et al, 1993). Significant risks may exist even at levels below the MCL for THMs of 100 ug/L. Risk estimates for THMs range as high as 1E-4 (cancer risk) and 1 (non-cancer risk) for the Chester study area PWSs. It may be noted that a lower MCL of 80 ug/L for total THMs (TTHM) has been recently proposed by USEPA (USEPA, 1994e). The intent of this proposed rule is to reduce TTHM levels and potential health risks in finished water without increasing risks of health effects associated with microbial pathogens. Many PWSs are preparing for the anticipated new rule by replacing the chlorine in the disinfection process with other disinfectants (e.g., chlorine dioxide, chlorite, chlorate, and chloramine) (Calabrese et al, 1989). This change has generally led to a decrease in the levels of TTHM.

Coliforms

Coliforms represent a group of bacteria used as indicators of fecal coliform. Coliform bacteria are normally found in the intestinal flora of humans. Their presence may indicate that water is contaminated with fecal matter that may contain other disease-causing organisms from infected individuals. Some of these disease-causing organisms may be enteric bacteria (bacteria that live within the intestinal tract of mammals) that can cause typhoid fever, cholera and dysentery; viruses, such as the hepatitis virus; and protozoans, such as Giardia lamblia, which can cause dysentery in exposed individuals (USEPA, 1993a). The chlorination process is designed to eliminate these microbial pathogens (see Figure 4-4). The recently proposed MCL for TTHM of 80 ug/L is accompanied by other proposed risks that are balanced against risks due to these pathogens (USEPA, 1994e).

Treatment system design failure may also lead to the introduction of disease-causing organisms in drinking water. In March, 1993, in Milwaukee, there was a surface water treatment system failure when changing over to a new system design to fulfill the surface water treatment rule promulgated by the SDWA

in 1989. Apparently failure in the coagulation/sedimentation process led to the introduction of a small parasite, Cryptosporidium, in the distribution system, causing residents to become ill, primarily with stomach and intestinal disorders (Rice, 1993).

Several finished water samples from the Chester Water Authority, Philadelphia Suburban Water Company and the Philadelphia Water Department were found to have had positive total coliform results in the time period between 1989 and 1993. Results for fecal coliform were negative, and current data from the FRDS database indicate that this MCL parameter has not been recently violated. However, there have been reported monitoring violations for the Surface Water Treatment Rule (SWTR) in FRDS due to the failure of the PWSs to meet the proper treatment performance required under the SWTR or due to the failure of the PWSs to submit monitoring results as scheduled (Tables 4-9, 4-10, and 4-11). These monitoring violations have resulted in enforcement action within a reasonable time frame.

The new rule for surface water promulgated in June, 1989 requires that all surface water be filtered prior to distribution and that all groundwater under the influence of surface water be filtered as well (USEPA, 1989d; USEPA, 1993a). Samples positive for total coliforms are tested for fecal coliforms. This new rule may lower the frequency of MCL violations for this parameter.

Inorganics

Fluoride was detected in finished water from the Chester Water Authority and the Philadelphia Water Department but was not present at levels of concern. Fluoride is typically added to the finished water of PWSs for the prevention of dental caries (Note: the Philadelphia Suburban Water Company does not add fluoride to their finished water). Therefore, fluoride was not considered in the total risk estimate calculated. It should be noted that fluoride has very low toxicity and at high levels is associated with dental mottling (a cosmetic effect also known as dental fluorosis). If the levels exceed 20 mg/day (far in excess of the expected dose from the level allowed in finished public water) and exposure is continuous (e.g., for a 20 year period), fluoride may be associated with the development of crippling skeletal fluorosis (USEPA, 1994c).

Potential Risk from Non-Treatment-Related Sources

Several contaminants in finished water may be attributed to non-treatment-related sources. These contaminants include metals and volatile organic compounds.

Inorganics

Inorganics were detected infrequently in the Chester Water Authority, the Philadelphia Suburban Water Company and the Philadelphia Water Department finished water. No metals were present at levels of concern. The only inorganics detected that were of potential concern to human health based on their respective RBCs are fluoride and nitrite. Nitrite was detected only in the Chester Water Authority in 1989 and 1993 does not represent a significant noncancer risk to those exposed (HI < 1). Fluoride was discussed under treatment-related issues.

Metals such as lead have just begun to be monitored at the tap (USEPA, 1991b). Therefore, there are limited monitoring data on lead to determine if the lead levels in drinking water of PWSs in Chester are safe. The low lead levels reported in the PWSs serving the Chester study area were not of concern based on the Action Level for lead of 15 ug/L. However, a periodic assessment of the monitoring data is recommended before a final assessment is made. Note that there were some monitoring violations reported for the Chester Water Authority and the Philadelphia Water Department (Tables 4-9, 4-10 and 4-11), which resulted in enforcement action.

In other parts of Region III, which includes Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia, the following chemicals were found at levels that exceeded MCLs in PWSs: barium, cadmium, chromium, fluoride, lead, mercury, selenium and the inorganic compound nitrate.

Overall, nitrate appears to be a Regional concern, with Lancaster County having the greatest number of MCL violations for that parameter in Pennsylvania. Currently, the PWSs serving the Chester study area do not appear to be impacted with high levels of nitrate at this time, although low levels of nitrate that did not exceed the RBC were detected in finished water.

Metals are common in metal plating facilities, foundries, smelters, etc. They tend to leach into groundwater with changes in the physical and chemical characteristics of soils. Most metals, e.g., lead compounds, however, are expected to come from corrosion of plumbing materials in the water distribution system (e.g., corrosion by-products) (USEPA, 1991b).

Metals and other inorganics (e.g., nitrite and nitrate) have varying degrees of toxicity as indicated in the toxicity profiles found for each metal and/or inorganic compound detected in finished water in the Region (Appendix I). Most exposure to metals (e.g., arsenic and beryllium) is associated with lung disease and lung cancer mostly in occupational settings from inhalation. Other metals like fluoride are associated with

erosion of tooth enamel, skin cancer (e.g., arsenic) and central nervous system failure (e.g., thallium).

Volatile Organic Compounds

Volatile organic compounds (VOCs) were detected at trace levels in PWSs serving the Chester area. Those that exceeded their respective RBCs were carbon tetrachloride and tetrachloroethene.

Trace levels of carbon tetrachloride were also detected in finished water from the Philadelphia Water Department, not used as a drinking water source in the Chester study area.

Overall significant increased cancer risk and noncancer risk are not expected from exposure to VOCs in finished water in the study area at the levels reported between 1989-1993 (see Tables 4-3, 4-4, and 4-5).

In the Region in general, a significant number of MCL violations for VOCs such as trichloroethene (TCE) and TCE derivatives such as vinyl chloride were detected in PWSs in Pennsylvania. These were limited primarily to Berks and Montgomery Counties. In the State's Water Quality Report submitted by Pennsylvania in 1992, other organics (e.g., unregulated contaminants at levels of potential concern such as cis-1,3-dichloropropene) are noted in PWSs [305(b) Reports] that may be of concern. Data from the Chester Water Authority and the Philadelphia Water Department also indicate the presence of unregulated contaminants such as cis-1,3-dichloropropene. The data may be biased towards Pennsylvania showing the greatest number of violations in the Region, however. Pennsylvania has the largest number of PWSs of all the States and better reporting systems in FRDS. The reporting schedules for MCL violations of VOCs for large and small PWSs differ. Although they both have to report at the same frequency, their starting monitoring dates differ. Large systems started monitoring by 1/88, while small systems started monitoring by 1/91.

Sources of VOCs include dry cleaners, underground storage tanks, landfills, etc., all of which were ranked as the major sources of drinking water contamination in Region III [305(b) Reports].

VOCs have varying degrees of toxicity ranging from non-cancer effects such as neurological disorders and kidney failure to cancer effects such as liver cancer. VOCs in drinking water and their toxic effects are summarized in ENR, 1988. The toxicity profiles for those VOCs of concern in this study are summarized in Appendix I.

Pesticides

There were no pesticides detected in finished water in the study area during the time period investigated.

It is still questionable whether pesticides pose a risk to drinking water supplies (USEPA, 1986b). Over 250 pesticides have been detected in the groundwater of at least 42 States in the nation, of which only 24% of the wells tested had detections (Weber, 1993). Ongoing studies conducted in Region III of the Delmarva Peninsula (USGS 1989, 1992 and 1993) measured only trace levels of pesticides: atrazine, cyanazine, simazine, alachlor, metolachlor, and dicamba. Most detections correlated with the intensive use of these herbicides in three widely distributed and commonly rotated crops--corn, soybean, and small grain--particularly if grown in well-drained soils. Most pesticides were detected in the upper aquifer (10 m) above the water table. The presence of trace levels of pesticides in groundwater suggest that pesticides can leach into groundwater and affect drinking water, especially in shallow aquifers, suggesting that the levels of pesticides should be monitored.

The need for continued monitoring of pesticides in groundwater has also been indicated when studying the Region as a whole. The detection of highly toxic pesticides 2,4,5-trichlorophenoxyacetic acid, endrin, ethylene dibromide, lindane, methoxychlor and toxaphene were reported to be found in PWSs in Pennsylvania at levels above the MCL. Upcoming Regional studies in Jefferson and Lancaster Counties in Pennsylvania will demonstrate to states how GIS can be used for the development of their Pesticide in Groundwater State Management Plans to protect their groundwater from pesticides (Weber, 1993).

Radionuclides

Radon monitoring finished water data were not available for the PWSs serving the Chester study area. It is not known if radon in drinking water is a concern for residents in the study area at this time.

An MCL for radon of 300 pCi/L has been proposed by USEPA. The chief hazard of radon exposure is caused by the action of alpha-emitting short-lived daughters of radon (e.g., ^{218}Po and ^{214}Po), which are solids and deposit on the bronchial airways during inhalation and exhalation, resulting in lung cancer. Although risks from exposure through the ingestion route are possible, there are currently no studies available for review. Radon ingested in water is absorbed into the bloodstream from the small intestine and circulates to the lungs, from which it is exhaled. Radon is also distributed to other body organs such as the stomach, intestine, liver, muscle, body fat and other

tissues. Therefore, the approach to assessing the risk of ingested radon is to determine the individual organ doses of radiation based on radon (USDWSD, 1991).

Radionuclides (gross alpha, gross beta particles and radium 226/228) detected in finished water in PWSs serving the Chester study area did not represent a significant concern based on the RBCs of these contaminants.

Regional studies on the levels of radionuclides in drinking water supplies are not available or accessible for the most part. Radionuclides (e.g., gross alpha and beta; combined radium 226/228) have been detected infrequently in the Region. Both Pennsylvania and Virginia had greater MCL violations for this parameter than Delaware, Maryland, West Virginia, suggesting that radionuclides in drinking water in Region III should continue to be monitored.

According to a nationwide study done in 1993 (Olson, 1993), about 49 million people drink water containing significant levels of radioactive radon, and millions more drink water contaminated with radium, uranium, and other radioactive substances. Yet most of these contaminants still are not regulated in drinking water, although some have proposed MCLs.

Comparison of Risk Levels of Finished Water Supplies

In order to compare the potential risk from contaminants in finished water of Chester residents with other communities, a comparative analysis was done of the risk levels from contaminants in finished water from the Chester Water Authority, the Philadelphia Suburban Water Company, and the Philadelphia Water Department. Figures 4-5 and 4-6 show a comparison of cancer and non-cancer risk levels for the finished water supplies. In this analysis the risk levels (for all sources of contamination including treatment-related sources) for the Chester Water Authority (serving the study area) were compared with those of the Philadelphia Suburban Water Company and the Philadelphia Water Department. An exposure duration of 30 years (90th percentile of time spent at one residence) was assumed. All risk levels were either at or below a Hazard Index of 1 and a cancer risk level of 1E-4). It is apparent from this figure that most of the risk (>90%) is due to "treatment process" residuals, i.e., THMs.

A comparative analysis of the risk levels from THMs for the Chester Water Authority, Coatesville Water Authority, Philadelphia Suburban Water Company and the Philadelphia Water Department during 1993 (Figures 4-7 and 4-8) indicates that the risk levels for THMs are largely within the acceptable risk ranges. Although the cancer risk levels are approaching 1E-4,

the risk levels are below the risk levels for THMs at the MCL of 100 ug/L.

A comparative analysis of the annual risk levels from all of the reported contaminants during 1989-1993 for the Chester Water Authority, the Philadelphia Suburban Water Company and the Philadelphia Water Department indicates cancer risk levels (<1E-4) and hazard indices (<1) generally lower than the risks based on 30-year exposure (Figures 4-9 and 4-10). It should be noted that these risk levels were calculated assuming an exposure duration of 1 year only. The actual risk levels could be higher if the contaminants remain in finished water over a lifetime. Risk estimates could be as high as or higher than those risks calculated using an exposure duration of 30 years.

4.1.5 Uncertainty Analysis

Uncertainty associated with the analytical data used to assess risk for the Chester Project may be characterized as being associated with exposure estimation, toxicity assessment, and risk characterization. General uncertainties common to all quantitative assessments were summarized in Section 3.5.

There are uncertainties associated with the exposure parameters used in this study. The exposure duration used in calculating the risk may have overestimated the actual exposures experienced by the receptors at their residences. It is difficult to determine the frequency at which contaminants appear for each system and their duration over a lifetime since these data are not available. Therefore, it was assumed that the type and concentrations of contaminants will remain the same over time (i.e., are static). Since the contaminant concentrations may vary over time, the potential risk to receptors may also vary. Consequently, averaging risks over a 30-year lifetime may not be appropriate. This was taken into consideration by assuming a minimum exposure duration of one year and a maximum exposure duration of 30 years (for 1993 data only).

On the other hand, the actual risk levels for the contaminants detected in finished water from the PWSs may be underestimated because only average values were considered in the risk assessment. This was necessary in order to be consistent in the risk methodologies used for comparative purposes, since some of the finished water data were available as averages only. Therefore, the actual risk may be higher if the maximum concentrations or the 95% UCL of the mean were used.

There are other uncertainties inherent in the risk estimates related to data quality. There were variations seen in the manner in which the data were reported from one PWS to another

and from one laboratory to another. In addition, there were a few errors in data recording on the state compliance forms. While attempts were made to verify all suspect data, the possibility of additional undetected errors cannot be ruled out.

Data assessment is further complicated by the fact that PWSs typically receive water from different sources and from different locations at different times. TTHM levels, for example, are generally higher in water derived from surface sources. For example, the Chester Water Authority uses two surface sources, the Octorara Reservoir and the Susquehanna River. It is difficult to determine which sources of water were mixed. This makes it difficult to establish trends in contaminant levels from the different contributing sources.

Some contaminants were detected infrequently (e.g., tetrachloroethene and carbon tetrachloride) and thus may be considered to be outliers. However, because of the small database and the different monitoring times for each of the regulated contaminants, it is possible that those contaminants designated as outliers appear at a higher frequency over a resident's exposure duration (estimated to be 30 years by the USEPA).

There are significant data gaps associated with the private well data. The current data are equivocal with regard to the number of wells in the area. The census tract data of 1990 report that approximately 61 private wells may be found in the City of Chester area. Other data sources from USGS GWSI and the Pennsylvania Bureau of Topographic and Geologic Survey indicate that there are only about 3 potential private wells in the study area. Conversation with some of the users indicates that the wells are not being used for potable sources and/or are owned by private businesses and not residences. This has not been verified.

There are currently no chemical data available from which to assess risk for potential private well users. Hence, it is not known whether residents that may be on private wells are drinking contaminated water. The state and municipal health departments are not aware of any private wells in the area. The USEPA has no jurisdiction over private wells and has only limited if any data on private wells from Superfund sites.

The qualitative risk for contaminants in monitoring wells emanating from CERCLIS sites in the study area and assumed to be in private wells in the study area are probably overestimated by virtue of the fact that the vertical and horizontal extent of contamination are largely unknown. It is not known if residents that may be on private wells are receiving the contamination that was detected at these monitoring points.

In some cases, toxicity information for some contaminants were not available. In these cases, conservative default values were used. For example, there are currently no toxicity criteria available for TTHM. The toxicity criteria for the most toxic THM, chloroform, was used to be conservative.

Dermal toxicity criteria are not readily available. Oral toxicity criteria were used. No adjustments were deemed necessary because this route represents a minor percentage of the total risk and the appropriate absorption factors needed to make the adjustments are not consistently available. It is expected that the potential risks from the inhalation and the oral routes will significantly outweigh the potential risks from the dermal route. For VOCs, the absorption is very close to 100% in any case.

There are uncertainties associated with the level of protectiveness of the MCLs. While most MCLs are protective of human health, many are based on the technical and economic feasibility of treating down to health-based levels in addition to human health consideration. This is the apparent case with TTHM. This poses a question as to whether drinking contaminated finished water is an environmental equity issue or an economic issue. When considering TTHM in finished water, one must weigh the risk of potential cancer and non-cancer effects due to ingestion of TTHM with that of drinking water with high levels of coliform and potentially deadly disease-causing microorganisms which can pose a more immediate health threat.

As stated previously, the duration of the exposure to contaminants in finished water may vary over time. It is difficult to determine the frequency at which COPCs will occur in finished water in the future. Since contaminants may appear at levels below their respective MCLs and no further treatment is deemed necessary, there is potential for significant risk if the MCLs are not protective.

4.2 LEAD

4.2.1 Introduction

4.2.1.1 Lead in the Environment

Inorganic lead is an ingredient in solder, paints and ceramic glazes, glass, storage batteries, plastics, and electronic devices. Processes such as mining, smelting, combustion (of coal, oil, or municipal waste), battery manufacture, welding, and spray coating emit lead to the air. Automobiles once produced 90% of all US lead emissions, but this source has been largely eliminated by the removal of tetraethyl lead from gasoline. Human activity has distributed lead widely

in the environment. Workers and the general population have many opportunities for significant exposure.

Lead is volatile only at high temperatures, so most emissions take the form of lead dust rather than gas. Dispersal depends on wind speed and direction. The dust particles tend to deposit quickly, usually within ten miles of the source. Over time, lead accumulates in soil near sources of air emissions. Once in soil lead tends to stay there, attached to organic molecules or in the form of insoluble salts.

4.2.1.2 Lead Exposure

People can be exposed to lead by five important routes: from air, food, drinking water (and beverages), soil and dust, and across the placenta before birth. Lead absorption through the skin is not significant.

- People may inhale lead-bearing dust before it is deposited. Small dust particles (less than 4 ten-thousandths of an inch in diameter) are deposited in the lungs and absorbed into the body.

- Lead can be ingested with food. Food gets contaminated by lead particles deposited onto crops, lead-bearing pesticides, or cans made with leaded solder. Garden vegetables grown in lead-bearing soils may have high lead levels.

- Drinking water may contain substantial amounts of lead. Some US water supplies have high lead levels at the source, especially if the water is naturally acidic. More often, lead leaches from pipes and solder at a rate which depends on the acidity, hardness, and temperature of the water. Absorption of lead in food and water ranges from about 15% in adults to over 50% in small children. Unabsorbed lead is excreted in feces.

- People may be exposed to lead by incidental ingestion of soil and house dust. Lead in house dust comes from outdoor soil, deposition from air, and small particles of deteriorated lead paint. Adults pick up small amounts of soil and dust on the hands, and ingest it when they eat or smoke. Children get higher lead doses from soil and dust than adults do, for two reasons. First, children ingest a larger amount of soil and dust as part of their normal mouthing behavior. Second, ingested lead reaches a higher concentration in tissues because the small size of the child's body allows for less dilution.

Absorption of lead ingested with soil and dust depends on

particle size, chemical species of lead, and concentration. Lead which is dissolved in the gastrointestinal tract is more easily taken into the body. Larger soil particles dissolve more slowly, and less lead is absorbed. Lead sulfides are less soluble than lead oxides or acetates, so absorption of sulfides is thought to be less. Where lead levels in soil and dust are very high, a smaller percentage of lead appears to be absorbed. Lead at mining sites, where lead sulfide is found in large particles at high concentrations, tends to be less readily absorbed. Lead absorption in areas contaminated by more soluble lead species in smaller particles tends to be higher.

- Lead readily crosses the placenta, and distributes into the tissues of the growing fetus.

4.2.1.3 Movement of Lead in the Body

Once lead is absorbed into the body, half is eliminated in bile or urine within a few weeks. Of the remaining half, 95% goes into bone and the rest into soft tissues (internal organs, blood, etc.). Soft-tissue lead has an elimination half-life of a few weeks, but lead in bone persists for many years. Slow leaching of bone lead can keep soft-tissue lead levels high, even after exposure stops. Accelerated bone loss caused by aging or pregnancy may lead to even higher soft-tissue levels for short periods, placing pregnant women, fetuses, and older people at high risk. Lead levels in soft tissue are important, because it is soft tissue that sustains the most damage from lead. USEPA uses blood lead concentrations as a measure of internal lead dose.

4.2.1.4 Toxic Effects of Lead

Lead affects several organ systems, including the nervous, hematopoietic (blood-forming), circulatory, urinary, and reproductive systems. Nervous effects include irritability, short attention span, muscular tremors, memory loss, and tingling in the extremities. In addition to these overt symptoms, children suffer significant losses in motor skills and cognitive ability. Children with blood lead levels at or above 10 micrograms per deciliter (ug/dL) have significantly lower Intelligence Quotient (IQ) scores. The IQ loss increases in proportion to blood lead.

Lead blocks an important step in the synthesis of heme, a critical part of hemoglobin (the oxygen-carrying molecule in red blood cells). At high blood lead levels, this effect results in anemia. Inhibition of heme synthesis is detected early by the buildup of erythrocyte protoporphyrin (EP, a partially assembled heme molecule), or decreased activity of ALA-D (the enzyme that

controls the blocked step) in the blood. Lead causes lesions in the proximal tubules of the kidney, resulting in impaired kidney function. In animal studies, lead also creates kidney tumors. USEPA has classified it as a probable human carcinogen on the basis of this evidence. Evidence for lead-induced cancer in humans is inconclusive.

Other toxic effects of lead include increased blood pressure and decreased sperm production in adult males, decreased serum vitamin D in children, decreased birth weights in newborns, increased spontaneous abortion rates in women.

The toxic effect which USEPA uses as the basis of regulatory actions for lead is decreased IQ in children. USEPA uses this effect because it occurs at lower blood lead concentrations than do other toxic effects.

4.2.1.5 The USEPA Three City Study

The Superfund Amendments and Reauthorization Act of 1986 (SARA) authorized USEPA to conduct a detailed study (the "Three City Study") of environmental lead levels and blood lead concentrations in children in three urban areas. The purpose of the study was to determine whether abatement of lead in soil could reduce blood lead levels in inner city children. In 1987, USEPA established criteria for site selection, and selected Boston, Baltimore, and Cincinnati as the study sites. In order to determine the effects of intervention, it was first necessary to establish baseline environmental and blood lead levels for these urban areas, before intervention took place.

This baseline information is also useful for comparison with other urban areas in which no abatement has occurred. It is important to note that the study was designed to assess the effects of reducing soil lead levels; identifying sources of environmental lead was not a study objective. Before abatement, average surface soil lead levels ranged from 505 mg/kg in Cincinnati to 2620 mg/kg in Boston. In Baltimore, of these three cities the nearest and perhaps most similar to Chester, the average surface soil lead was 571 mg/kg. Pre-abatement geometric mean blood lead levels were 12.6 ug/dL in Boston, 12.5 ug/dL in Baltimore, and 11.7 ug/dL in Cincinnati. Seventy-one percent of children exceeded the Centers for Disease Control's criterion of 10 ug/dL in Boston, versus 59% in Baltimore and 52% in Cincinnati.

4.2.2 Data Source

Paper records of over 10,000 blood lead measurements for children in the Chester area, taken between 1989 and 1992, were obtained from the City of Chester. Names, addresses, and blood

lead measurements were entered into a computer database. Age and sex were not reported, nor was information available about how the children were chosen for blood lead sampling. Some children were sampled 10 times or more during the 5-year period covered by the data, and some were sampled only once. Also, many of the children lived at more than one address during this period.

Lead concentration data for the media to which children are exposed--air, tap water, soil, dust, and food--were extremely scarce. Although water data from the city's water treatment plant were analyzed as part of this study, water supplies typically have very low lead levels at the source. Lead solder and lead pipes in the distribution system, especially in private homes, contribute most of the lead found at the tap. Measurements of lead levels at taps in private homes were not available.

Lead measurements in soil on residential lots and in dust in the interiors of homes were also unavailable. It is believed that most cases of childhood lead poisoning are caused by elevated lead levels in interior dust which children ingest as part of normal mouthing behavior. Thus, the lack of these concentration data makes it very difficult to determine whether high blood lead levels resulted from exterior soils or contributions of paint to interior dust.

Quantitative information about lead concentrations in air, tap water, residential soil, interior dust, and food were for the most part unavailable. Municipal water supply data were examined, but were considered unrepresentative of lead concentrations at the tap because they did not include the contribution of the water distribution system. Residential soil and dust data were not found. Site investigation reports for nine sites in Chester which USEPA evaluated for potential inclusion on the Superfund list were examined. Lead concentration data in these reports were limited, and it could not be determined whether significant off-site releases could have occurred.

4.2.3 Data Analysis

To enhance the analysis of trends and improve the reliability of the database, analysis was restricted to children whose blood lead was measured two times or more. Data were separated by year to analyze for temporal trends. Spatial trends were analyzed by averaging blood lead measurements for each residence, including multiple measurements of the same child and measurements of siblings. Summary statistics and graphs were prepared using a desktop personal computer running Lotus 123 version 4. Maps were prepared by the USEPA Information Resources Management Branch, using their minicomputer-based GIS.

USEPA's Integrated Exposure/Uptake/Biokinetic (IEUBK) model (USEPA, 1994f) was used to predict blood lead levels for a population of children aged 1 through 6 exposed to national average lead concentrations in air, tap water, soil, dust, and food. This prediction was compared to the blood lead data for Chester. The IEUBK model was then run iteratively, with different additional amounts of lead exposure, until a close match was found between the modeled results and the Chester data. This amount of additional lead intake needed for the model's predictions to match the observations serves to estimate whether mean lead intake in Chester exceeded national averages.

This lack of concentration data in environmental media forced the lead analysis to concentrate on a description of children's blood lead. The blood lead data served as: (1) as a surrogate for exposure, (2) as a basis of comparison with other intensively studied urban areas, and (3) as a basis for estimating total lead intake by Chester children, compared with national averages. However, it must be emphasized that this analysis cannot estimate the relative contributions of potential lead sources, or even identify these potential sources (except for those generic to urban areas, such as auto emissions, paint, etc.).

4.2.4 Results and Discussion

Results of USEPA's ambient air modeling exercise (Section 4.7 and Appendix III) suggest that ambient levels of lead are in compliance with national standards. Since these standards were developed with the IEUBK model, it is unlikely that lead levels in air had a substantial impact of children's blood lead.

Site investigation reports for Chester area properties investigated as potential Superfund sites (see Section 4.4) were examined to determine if substantial lead releases could have occurred. Of these, three (Delaware County Incinerator, ABM Wade, and East 10th Street) appeared to have high on-site lead levels in one or more media. One site (Delaware County Incinerator) may have released significant quantities of lead off-site during the past operation of the incinerator. However, it is important to note that this evaluation was completely qualitative, and was based on extremely limited data. These data cannot be extrapolated to predict lead content of soils in surrounding areas.

Blood lead levels over the five years for which data were available (Table 4-12) showed a geometric mean concentration of 14.2 ug/dL, which is between 1.4 and 2.5 ug/dL higher than the blood lead levels observed in USEPA's Three City Study. Sixty-eight percent of the children in Chester exceeded 10 ug/dL, similar to Boston (71%) but substantially worse than Baltimore or

Cincinnati (59% and 51%, respectively). There are several significant uncertainties about the Chester blood statistics. First, the process by which the Chester children were selected for blood lead measurement was not recorded. However, the sample was unlikely to be random, and the degree to which the sampled individuals represent the entire population in Chester is unknown. Second, the ages of the children were not provided, so direct comparison with data from the Three City Study (which included only children of specific ages) may be misleading.

To analyze temporal trends, the blood data were separated into years (Table 4-13). Geometric mean blood lead concentration declined from a high of 18.0 ug/dL in 1990 to 11.9 ug/dL in 1993. The percentage of children exceeding 10 ug/dL declined from 79% in 1990 to 61% in 1992; the percentage above 50 ug/dL declined even more dramatically, from 6.2% in 1989 to 0.22% in 1993.

Frequency distributions by year (Fig. 4-11) show a substantial decrease in the number of observations above 20 ug/dL, and a trend for most of the population to be concentrated in the range 5 and 30 ug/dL in the later years. Fig. 4-12 shows substantial decreases in the percentage of children exceeding 10, 15, 25, and 50 ug/dL. Little change occurred between 1989 and 1991, but later data show significant declines in incidence of high blood lead levels. The decreases in observations above 25 and 50 ug/dL are especially large. Fig. 4-13 shows that the decrease in geometric mean blood lead levels between 1991 and 1992 was statistically significant. Fig. 4-13 also indicates that the 10th percentile of blood lead remained fairly stable during the five-year period, but the 90th percentile blood lead level decreased from 50 to 25 ug/dL.

Fig. 4-14 shows the prediction of blood lead distribution for a population of children exposed to national default lead levels, plus typical urban soil and dust lead concentrations of 500 mg/kg. The predicted geometric mean blood lead level was 6.6, with 25.7% of the population above 10 ug/dL. Postulating 130 ug/day additional lead intake produced the closest fit with the blood lead distribution observed in Chester children. This suggests that the lead intake among area children may exceed national averages by about 130 ug/day. This should be used as a rough estimate only. It is important to note that the IEUBK model's predictions would be appropriate for a randomly selected population of children 6 years of age and less (see Fig. 4-15). The Chester children were probably not randomly selected, and the data may have included children of other ages.

Two maps of mean blood lead were prepared. Fig. 4-16 shows the location of each address at which a child resided at the time of a blood lead measurement. All blood lead values for each address were averaged. Points are color-coded by range of blood

lead. Fig. 4-17 shows the average blood lead level observed at homes within areas 100 meters square. The areas are color-coded for range of blood lead. These maps fail to reveal any geographic trends in blood lead levels, which appear to be randomly distributed through the city. This inability to find trends can be interpreted two ways: (1) blood lead levels tend to be similar throughout Chester, or (2) geographic trends do exist, but could not be detected with the limited, non-random database available.

4.2.5 Uncertainty Analysis

Several major sources of uncertainty have influenced the interpretation of the blood lead data.

The paper records of blood lead from the city of Chester did not include age or sex of the children or information on how they were selected for sampling. Because of these uncertainties, it is possible that these data may not be truly representative of blood lead levels among small children in Chester. USEPA cannot predict whether the actual blood lead levels in the community would have been over- or underestimated due to this effect.

Different children were sampled different numbers of times. Children with very high blood lead levels may have been sampled more often than those with lower levels. Restricting the data analysis to children measured more than once may have reduced potential errors from this effect, but it is still possible that community blood lead levels were overestimated.

Maps showing area distribution of blood lead were prepared by averaging all blood lead readings obtained at each residence. Because blood lead does not change immediately upon changed exposure, showing blood lead by residence may have obscured real geographical differences.

Lead concentration data for air, tap water, soil, dust, and food were essentially unavailable. This lack of information made it impossible to draw even tentative conclusions about sources of lead exposure to children.

USEPA's IEUBK model is most effective when used in combination with a large database of measured blood lead and lead concentrations in residential soil, dust, and tap water. The model was not intended to be used in the way described in this chapter. Accordingly, the estimate of an excess 130 ug/day lead intake in Chester children, when compared with national averages, should be considered a range-finding exercise only.

4.3 RCRA TSDF FACILITIES

4.3.1 Data Source

In USEPA Region III, 605 Resource Conservation and Recovery Act (RCRA) Treatment, Storage and Disposal facilities (TSDFs) were ranked by the RCRA National Prioritization System. USEPA has established this ranking system to ensure that corrective actions are initiated in a timely manner at RCRA facilities with the highest priority. It is an internal USEPA management tool. Facilities are scored and ranked based on the information about toxicant releases to environmental media, toxicities of contaminants, proximity to residents and sensitive environments, waste quantity, etc. As a result of the prioritization system, the facilities are categorized as "High", "Medium", and "Low" as indicated below. Corrective action will be required under the authority of the 1984 Hazardous and Solid Waste Amendments (HSWA). The HSWA corrective action applies to releases to any media from any waste management units. Subpart F in HSWA requires groundwater remediation at a regulated unit. A regulated unit is defined as any surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982.

The corrective action program is incorporated into a facility permit or enforcement actions with consent or unilateral orders. The TSDF facilities were screened for inclusion in the Chester risk study.

4.3.2 Data Analysis, Results and Discussion

In the State of Pennsylvania, there are 378 TSDFs. Eight facilities are identified in the Chester study area. They are listed below, with their priority rankings.

1. Sun Refining Company (High).
2. PECO, also known as Chem Clear (High).
3. BP Oil Company (High).
4. Congoleum Corporation (High).
5. Scott Paper (Medium).
6. Enviro Safe, also known as Marcus Hook Processing (Medium).
7. Witco Corporation (Low).
8. East Coast Chemical Disposal (Low).

Four facilities (Sun Refining Co., BP Oil Co., PECO, and Congoleum Corp.) were given a high Agency priority. Sun Refinery Co. stabilized its wastes on site, and BP Oil Co. excavated contaminated media and disposed of it off site. Additionally, both facilities currently conduct groundwater monitoring and evaluation to determine whether hazardous waste is

actually entering groundwater. The data available so far are for groundwater quality evaluation such as total organic carbon (TOC), TOX, pH, salinity, etc. For long-term corrective actions, these facilities are subject to USEPA's HSWA permit requirements for complete site investigation to define the nature and extent of contamination. Based on the investigation results, cleanup activities will be implemented. The draft permits for these facilities will be prepared in Fiscal Year 1995 (FY 95).

For Congoleum Corp., it is anticipated that this facility will be subject to initial corrective action activities during FY 95.

The PECO facility is inactive. The facility is currently engaged in corrective action activities in the early sampling stage of a RCRA Facility Investigation (RFI), pursuant to a USEPA Enforcement Consent Order. In a response to USEPA's request for information concerning all releases of hazardous wastes at or from the facility, dated April 27, 1992, PECO reported that there were 54 individual incidents of releases at the facility that occurred from 1981 to 1983. The total quantity of released hazardous wastes and/or hazardous constituents was reported to be approximately 57,000-62,000 gallons. These releases consisted of treated, semi-treated, and untreated waste water, sludge material, oil, and water mixtures, polymer, hexavalent chromium mixtures, or unknown contents from hazardous waste storage tanks and hazardous waste receiving pits. Analysis of spilled materials listed in the September 16, 1983 Hazardous Spill Report revealed that these spilled materials contained cadmium, chromium, copper, nickel, lead and zinc. In addition, arsenic and mercury were detected in soil where the spill occurred.

Enviro Safe, ranked as Medium, has completed an RFI. Based on the findings of the RFI, USEPA concluded that the site poses no adverse risk to human health and environment. Therefore, no further action is warranted at Enviro Safe.

Based on a file search, the potential compounds of concern in the study area for all sites are:

In groundwater:	trichloroethene, phenanthrene, lead, and other metals
In surface water:	phenanthrene, methyl chloride, chromium, and lead
In soil:	phenanthrene, toluene, arsenic and other metals
In air:	asbestos, naphthalene, and toluene

In addition to the above, benzene, toluene, ethylbenzene, and xylene would generally be considered chemicals of potential concern at refineries such as Sun Refining Co. and BP Oil.

There are no completed quantitative data available for the above RCRA facilities, with the exception of Enviro Safe. Only qualitative descriptions of waste types and impacted media are available at this time. Therefore, the RCRA facilities could not be quantitatively assessed and were handled qualitatively in this report.

4.4 CERCLIS FACILITIES: SURFACE SOIL AND LEACHATE

4.4.1 Data Source

Under CERCLA/SARA (Comprehensive Environmental Response, Compensation, and Liabilities Act/Superfund Reauthorization and Amendments Act), potential hazardous waste sites undergo preliminary investigations to determine whether they are candidates for the National Priorities List (NPL) ("Superfund" list). The data from these site assessments are kept on file at the Regional office of USEPA. Information for sites that undergo preliminary investigations, removal actions, and NPL listing is compiled on the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database.

The CERCLIS database was reviewed to identify sites located in the Chester Risk Project study area (Chester City, Chester Township, Eddystone, Linwood, Lower Chichester Township, Marcus Hook, and Trainer). Based upon this review, a total of 36 sites, with various levels of USEPA involvement, were identified. The files for each of these sites were evaluated, and potentially usable analytical data were available for eight sites, as indicated below:

Chester City:	Scott Paper Company (PAD002274991) ABM Wade (PAD980539407)
Chester Township:	Delaware Incinerator Fill #1 (PAD982367542)
Eddystone:	Monroe Chemical (PAD049630502)
Marcus Hook:	Air Products & Chemical Inc. (PAD002346732) East Tenth Street Site, a.k.a. FMC Site (PAD987323458) Vermiculite Dump (PAD980509020)
Trainer:	Metro Container Corp. (PAD04454895)

For these sites, all relevant information from the files, including analytical results, sample location maps, sample descriptions and site histories, were copied. For the remaining

28 sites without potentially usable data, either (1) analytical data were not generated, (2) samples were collected from sealed drums or from the interior of buildings, (3) the data were of questionable quality, (4) sample media or locations could not be determined, (5) the data were reported in obviously incorrect units, or (6) the file (for two sites) was unavailable.

For the facilities evaluated during this study (i.e., those with usable analytical data), site-specific information is presented in Table 4-14.

4.4.2 Screening Data Analysis

Analytical results for the eight sites in the study area with usable data were screened for the purpose of identifying chemicals of potential concern (COPCs). To accomplish this task, RBCs were used, as described in Section 3.2.1.

Unlike the soil exposure pathway, for aqueous and solid leachate, default screening values for determining COPCs are not provided in Region III technical guidance. Therefore, risk-based screening equations for aqueous and solid leachate were derived as described in Section 3.2.1.

Based upon the application of Region III technical guidance for selecting COPCs, seven of the eight sites with usable analytical data were retained for further evaluation, as presented in Table 4-15.

4.4.3 Risk Assessment Data Analysis

None of the leachate samples assessed contained chemicals in excess of screening RBCs. However, in several instances, soil constituents were observed at concentrations of potential concern. To quantify the doses associated with residential exposure (child and adult) to contaminants in surface soil, standard equations and default exposure parameters were applied, as presented in Tables 3-1 and 3-2. With regard to routes of exposure, inadvertent soil ingestion was considered for all COPCs, while dermal exposure was quantified for PCBs only. For the sake of simplicity and protectiveness, and due to the general lack of high-quality data, the maximum reported concentration of each COPC at each site was used in the dose calculations. Estimated doses for the COPCs at each site are presented in Tables 4-16 and 4-17.

4.4.4 Results and Discussion

To predict the risks associated with exposure to surface soil under a residential scenario, toxicity criteria for the COPCs must be considered. Quantitative risks (Hazard Indices and

cancer risks) were estimated as described in Sections 3.3 and 3.4.

Generally, the Superfund program defines unacceptable risk as follows:

- individual or cumulative carcinogenic risks that exceed the upper bound (1E-4) of the established range (1E-6 to 1E-4) for acceptable cancer risk

- HQs in excess of 1.0, or cumulative HQs -- referred to as the Hazard Index (HI) -- in excess of 1.0 for similar target organs

Individual risk estimates are presented in Tables 4-18 and 4-19, while cumulative risk for each receptor at each site is presented in Table 4-20. As demonstrated in Tables 4-18 through 4-20, unacceptable risks (carcinogenic and non-carcinogenic) may exist at the following sites in the study area: Vermiculite Dump, ABM Wade, Air Products & Chemicals, Inc., and East Tenth Street Site, a.k.a. FMC Site. The risks are also displayed on Figures 4-18, 4-19, 4-20, and 4-21. The ABM Wade soil risks represent historical conditions. Records indicate that remedial action, including soil removal, has since been performed.

The percent contribution to overall risk from each COPC is provided in Table 4-21.

4.4.5 Uncertainty Analysis

In addition to the generic uncertainties, including the use of conservative exposure assumptions that accompany most quantitative risk assessments (discussed in Section 3.5), a few issues related specifically to this evaluation are presented below:

- A possible weakness in the data relates to those sites where removal actions were conducted, but sampling results represent pre-removal conditions.

- Some data may be antiquated; in these instances, current environmental conditions may not be accurately characterized by the reported analytical results. Such data are identified with qualifying statements where this is known.

- Many of the CERCLIS sites evaluated for this study are located in industrial or commercial areas, making residential exposure improbable.

4.5 SURFACE WATER, SEDIMENT, AND FISH TISSUE

4.5.1 Data Sources

Three main data sources were used for surface water, sediment, and fish tissue data: the STORET database, CERCLIS files, and the National Study of Chemical Residues in Fish.

4.5.1.1 STORET

Surface water, sediment, and fish tissue data from areas sampled in Region III are stored on the STORET database. STORET is a computerized management information system residing on USEPA's computer at Research Triangle Park, NC. States, federal, and local governments supply and retrieve the information. The information is used to detect changes in pollution levels, demonstrate effects of pollution abatement programs, aid in basin planning and management, prepare data for permit processing, meet reporting requirements, and monitor water quality and toxic substances. Over 130,000,000 parametric observations for over 700,000 sampling sites throughout the United States are contained within STORET. Data quality varies between reporting agencies and is indicated by self-reported "remark codes." The remark codes indicate whether the sample is a composite, whether the reported result is believed to be biased high or low, whether the value is believed to be estimated, etc.

The Region III Toxicologists' Quality Circle agreed to use only ambient, not effluent, data from this source. A summary of all STORET data for Delaware County was examined. The STORET locations were mapped (Fig. 4-22). The map showed that all county stations except three were in or near the study area, with approximately four locations appearing to be in Chester city. All except the three remote stations (422094, WQN0159, and 332052) were retained on the assumption that Chester or general study area residents could have access to and come in contact with these stations for recreational or fishing purposes.

4.5.1.2 CERCLIS

The CERCLIS database was described in Section 4.4. Five CERCLIS sites in the Chester study area had surface water and/or sediment data. These sites underwent data quality review in accordance with the Quality Assurance Plans under which the work was authorized.

4.5.1.3 National Study of Chemical Residues

The National Study of Chemical Residues in Fish was performed by USEPA to study fish tissue contamination nationwide (USEPA, 1992b). This study began as an outgrowth of the National Dioxin Study, which found notable concentrations of dioxins in fish tissue. It involved the collection of fish tissue from over

300 stations nationwide.

One station from this study was located within the Chester study area, and these fish tissue results were used for the Chester risk assessment. Analytical data were obtained in accordance with the analytical procedures and quality assurance plans cited in the national study.

4.5.1.4 Data Quality

None of these data were originally collected for the purposes of conducting a cumulative risk assessment of the Chester area. The STORET data are basically generated to monitor certain chemicals in certain water bodies, often in relation to state discharge permits or evaluation of water quality. Water quality can include health and diversity of aquatic organisms, presence of harmful bacteria and microorganisms, etc., and is often not targeted to toxic chemicals. However, several toxic chemicals are regularly monitored, and these results were retrieved.

The site assessment and removal data are collected in likely "worst-case" spots on hazardous waste sites in order to determine whether chemical contamination exists at the site in harmful amounts and whether it is attributable to the site. The data are used to characterize a small area and provided the only source of sediment data available, except for one STORET sediment result.

The National Chemical Residue study was designed to identify chemicals that accumulate in fish tissue in areas most likely to be contaminated (i.e., urban and industrial areas, areas downstream of facilities that commonly use bioconcentrating chemicals).

All three of these data sets are biased toward detecting contamination; the sampling designs involved targeting areas where pollution is suspected or expected. The sampling designs were not random. Some "background" or "upstream" samples were obtained for site assessments. Such samples are designed to be unaffected by the site in question but may be affected by other environmental sources.

The STORET fish tissue samples were all composites. They were identified as fillet of white perch with skin, channel catfish fillet, American eel (no viscera, head, or skin), edible portion of blue claw crab, or fillet with skin of the white sucker. The fish tissue sample from the National Chemical Residue study was the fillet of a brown bullhead (bottom feeder). Since all samples were considered to represent edible portions of edible fish, they were used as such in the dose estimations.

Fish tissue concentrations reported for wet weight were used. Where dry weight concentrations were available, these were only used if percent moisture was also available and the concentration could be converted. When both dry and wet weight concentrations were available for the same chemical, the wet weight was used preferentially.

Data gaps include chemicals not analyzed for (such as most organics in surface water), locations not sampled, and media not sampled (such as sediment in most locations). Area-specific exposure parameters (such as consumption rates of locally-caught fish) were also unknown. People were observed fishing in the Delaware River during a study area visit in September, indicating that at least occasional and perhaps subsistence fishing are possible exposure pathways.

4.5.2 Screening Data Analysis

The goal of this assessment was to estimate a risk for each station location. Therefore, a preliminary screening was performed to rule out chemicals that would not contribute significantly to the risk, and to focus on chemicals that would comprise the bulk of the risk. Data were screened using RBCs as described in Section 3.2.1. Inorganic data less than 10 ug/l from STORET, rejected, non-detect, "B" CERCLIS data (attributed to blank contamination), and "K" STORET data (less than detection limit), were not used. This screening was used to select COPCs at each location. Thallium in water was screened using the Maximum Contaminant Level (MCL) because no RfD is available. This screening approach is consistent with Region III's method of performing risk assessments at hazardous waste sites.

One assessment of the ABM Wade site involved groundwater-to-surface water modeling to predict Delaware River concentrations based on groundwater samples. The predicted concentrations were less than 0.1 ug/l for each chemical, and none of the modeled results exceeded the human health-based screening RBCs for surface water.

4.5.3 Risk Assessment Data Analysis

The maximum positive concentration for each chemical of concern was used in risk assessment. This results in a "high-end" exposure scenario. Because of the limitations on time and available data, only this estimate was performed. Ideally, "central tendency" and "reasonable maximum exposures" might also be used. However, it would be recommended that if such effort were undertaken, the data should be derived from a sampling program designed specifically for a cumulative risk assessment of Chester.

Five stations had no COPCs. In order to derive risks for these stations, estimated risks for all positively detected chemicals at these locations were derived.

For surface water, risks to potential swimmers via ingestion and dermal contact were estimated. For fish tissue, risks to people potentially consuming fish tissue were estimated. For sediment, risks to potential swimmers via ingestion and dermal contact were estimated. For all routes, both adults and children were considered. Exposure estimations are calculated for each receptor and each medium. The equations and input parameters were presented in Tables 3-1 through 3-4. Quantitative risks (Hazard Indices and cancer risks) were estimated as discussed in Sections 3.3 and 3.4.

Risk addresses the quantitative toxicity of the chemicals. Appendix I includes Toxicological Profiles for each chemical, which contain descriptions of their properties and potential effects.

No RfD or cancer slope factor (CSF) has been established for lead. Lead was assessed separately under this project (see Section 4.2).

4.5.4 Results and Discussion

Table 4-22 presents the COPCs and their maximum concentrations at each station.

Table 4-23 presents the risks associated with direct contact with surface water at each location. It can be seen that the Hazard Indices for each location are less than 1, indicating that significant adverse noncancer health effects due to contact with surface water at the reported concentrations are not expected. Estimated cancer risks are at or below 1E-6 for all locations except the Delaware County Incinerator Landfill #1 (3.9E-5). The cancer risk at this site was based on arsenic and beryllium in a drainage ditch water sample taken adjacent to the landfills. The water sample was reported as "greenish brown" and is likely to have contained high amounts of suspended solids. The feasibility of people actually swimming in a drainage ditch depends upon its depth and width, seasons of flow, and may also depend upon its aesthetic appeal.

Table 4-24 presents the risks associated with direct contact with sediment at each location. It can be seen that the Hazard Indices for each location are less than 1, indicating that significant adverse noncancer health effects due to contact with sediment at the reported concentrations are not expected. Estimated cancer risks were all below 1E-5. Risks were between 1E-6 and 1E-5 at the Monroe Chemical site (stream sediment

upstream of the site, due to arsenic), East 10th Street site [polycyclic aromatic hydrocarbons (PAHs) in sediment taken at outfalls to Marcus Hook Creek], Delaware County Incinerator Landfill #1 (due to arsenic and beryllium in drainage pipe inlets and drainage ditch sediment), and ABM Wade (due to arsenic in Delaware River sediment). The drainage pipe inlets and outfalls are probably not likely to be used for recreation such as swimming. It can be seen that arsenic contributes the majority of the cancer risk. Beryllium and PAHs also contribute notably to cancer risk. Arsenic and beryllium are metals that are found both naturally occurring in the environment and as the result of anthropogenic activities. PAHs result from the incomplete combustion of organic material and are also found from both natural and anthropogenic sources.

Table 4-25 presents the risks associated with fish consumption at each station. It can be seen that the HI at every station exceeds 1, except for the adult receptor at station 3096. This is due to chlordane and dieldrin at WQF00511-000.6; chlordane at WQN0182; chlordane, DDT, arsenic, copper, cadmium, and oxychlordane at WQF00002-084.9; chlordane, DDT, and oxychlordane at WQF00002-81.8; mercury and alpha-chlordane at DELFISH-07; and a combination of chlordane, dieldrin, and mercury at 3096. The cancer risks at every station exceed 1E-4. This is due to dieldrin at WQF00511-000.6; PCBs and chlordane at WQN0182; chlordane, arsenic, and PCBs at WQF00002-084.9; chlordane, DDE, and PCBs at WQF00002-81.8; PCBs, DDE, and alpha-chlordane at DELFISH-07; and PCBs and dioxins at 3096. It is currently unknown whether locally-caught fish is a regular part of the diet of citizens of Chester and the surrounding area. Therefore, this exposure pathway may or may not be complete.

Table 4-26 summarizes the total risks at each location and the chemicals that contribute the greatest portion to the total risk.

Figures 4-23, 4-24, and 4-25 also display this information.

4.5.5 Comparative Risks and Additional Information

An analysis of the National Study of Chemical Residues in Fish shows that the PCB concentrations at station 3096 are not atypical for southeastern Pennsylvania/northern Delaware. Of 15 fish samples in that area, all but one showed comparable or higher concentrations of PCBs. However, fish tissue samples from other areas in Region III, notably central Pennsylvania and central and western Virginia, had lower PCBs than southeastern Pennsylvania. A similar pattern was observed for dioxins, mercury, and dieldrin. It seems that station 3096 was typical of southeastern Pennsylvania. In general, southeastern Pennsylvania

had chemical concentrations comparable to or higher than the rest of the Region, although certain other areas of Region III reported high concentrations of particular chemicals (i.e., PCBs and dioxins in West Virginia, DDE in eastern Pennsylvania).

Nationally, station 3096 was in the lowest category for dioxins (concentration from 0 to 1 pg/g), along with 29 other sites in the nation. Seventy sites in the nation had dioxin and furan concentrations higher than station 3096.

Nationwide, 362 sites were tested for organic compounds in fish tissue and 374 were tested for mercury. The Chester area fish tissue sample concentrations were greater than the national mean and median for 3 locations for DDE (with 2 more exceeding the median only); 3 locations for PCBs; one location for dieldrin (with 2 more exceeding the median only); and 2 locations for oxychlordane. One Chester area mercury sample exceeded the national median concentration. (National means were calculated using 1/2 the detection limit for non-detects).

The Commonwealth of Pennsylvania conducts water quality assesments [called "305(b) Reports"] of surface water. The Chester study area is in Subbasin 3 of the Lower Delaware Basin. This subbasin includes all of Philadelphia and Delaware Counties. The subbasin consists of the Schuylkill River basin as well as other tributaries to the lower Delaware, including Brandywine, Chester, Ridley, Crum, and Darby Creeks. The 1994 305(b) report included an assessment of 1182.5 of the 2825.6 stream miles in this subbasin. The assessment examines whether the water quality is such that the stream supports its use as designated by the Commonwealth of Pennsylvania (i.e., drinking water, swimming and other recreation, propagation of aquatic species, etc.). Approximately 59% of the assessed stream miles fully supported their designated uses. Approximately 29% partially supported designated uses, leaving 12% not capable of supporting their designated uses. The four major sources of this degradation were considered by the state to be agriculture, resource extraction (i.e., mining), industrial point sources, and municipal point sources. Industrial point sources were particularly mentioned with respect to the Schuylkill River. Municipal point source impacts were reported to be concentrated in the heavily populated areas of the subbasin, including Chester Creek.

Other sources of degradation include unknown sources, other nonpoint sources, other point sources, natural sources, hydromodification, urban runoff, atmospheric deposition, combined sewer overflows, and onsite wastewater systems.

Fish consumption advisories are in place for the Delaware River and estuary from Yardley, Pennsylvania, to the Pennsylvania/Delaware state line for white perch, channel

catfish, and American eel, due to PCBs and chlordane.

4.5.6 Uncertainty Analysis

Along with the sources of uncertainty discussed in Section 3.5, the following uncertainty is important in evaluation of this data set.

Aluminum (oral RfD), mirex (oral CSF), t-nonachlor (oral RfD and CSF), and pentachloroanisole (oral RfD and CSF) have no toxicity values listed for them in IRIS or the Health Effects Assessment Summary Tables (HEAST). Interim toxicity values have been used for these constituents [either withdrawn IRIS or HEAST values, numbers from the Environmental Criteria and Assessment Office (ECAO), or, in the case of aluminum, a 1987 OHEA document]. The oral CSF for arsenic was based on exposure to water, and the application of this number to exposure via soil may not be strictly appropriate. t-Nonachlor was addressed using parameters for heptachlor. The CSFs for PAHs were derived relative to that of benzo[a]pyrene.

Chromium was assumed to be hexavalent, since the analytical techniques did not differentiate between trivalent and hexavalent chromium and hexavalent is generally more toxic. However, this in all probability results in overestimate of risks from chromium.

Some exposures could not be assessed at all because of lack of any sort of toxicity criteria (dermal exposure to sediment PAHs). USEPA ECAO determined that it is not appropriate to apply the oral CSF to dermal effects from PAHs since they may act locally. Therefore, dermal carcinogenic risk from these PAHs may only be addressed qualitatively at this time.

There was additional uncertainty associated with the adjustment of oral dose-response parameters for dermally absorbed doses. As noted, when absorption factors were not available, the chemical was assumed to be 100% absorbed during the RfD or CSF study. While this is likely to be realistic for volatile compounds, the assumption could be underprotective for chemicals absorbed less than 100%.

As noted earlier, surface water and sediment risks are likely to be overestimated where the samples were obtained from outfalls and drainage ditches.

It is likely that most of the general population of Chester does not consume locally-caught fish. However, subpopulations may exist consisting of occasional fishers or possibly even subsistence fishers. Subsistence fishers could have risks higher than those quantitated herein.

This risk assessment, which utilized existing data that were targeted at likely areas of contamination, can only be used to identify where risks are "high" or "of potential concern," but cannot necessarily identify "low-risk" locations because of data gaps. Data gaps include chemicals not analyzed for, chemicals whose detection limits exceeded RBCs, chemicals without dose-response parameters or other properties necessary for risk quantitation, and locations and media not sampled.

4.6 TOXIC RELEASE INVENTORY (TRI)

4.6.1 Data Source

The TRI database contains information about chemical releases from industrial manufacturers and processors (primary Standard Industrial Classification (SIC) codes 20-39) to environmental media. Since 1987, facilities meeting established thresholds have been required to report release data according to section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA).

4.6.2 Data Analysis

Region III has developed a method for evaluating these releases in terms of their relative toxicity. This method is documented in the Chemical Indexing System for the Toxic Chemical Release Inventory Part I: Chronic Index (USEPA, 1993d). The Chemical Indexing analysis provided in the present report displays the 1992 TRI data in terms of the Chronic Index (toxicity-weighted releases) and Residual Mass (non-weighted releases) for Region III, highlighting TRI facilities in Delaware County, Pennsylvania.

The Regional maps (Figures 4-26, 4-27, and 4-28) show TRI releases in terms of the Chronic Index, including non-carcinogenic and/or carcinogenic index dose. Those releases which do not have an associated toxicity factor are combined according to the amount of the release and are termed Residual Mass. The resultant Chronic Indices and Residual Mass values are summed for each facility and for each 8 x 8 mile geographic grid area in Region III. Combining the facility Chronic Indices within a geographic grid gives an indication of the potential for cumulative hazard from TRI facilities within a given geographic area.

After aggregation, the grids are ranked from lowest to highest, and represented by the 10 percentiles indicated in the map keys. The green coded maps represent a combination of the highest ranking Chronic Index grids and the highest ranking Residual Mass grids.

For the reporting year 1992, the calculated Chronic Indices account for more than 85% of the total TRI mass released in Region III.

Table 4-27 shows the top six TRI facilities in the Chronic Index and Residual Mass ranking. In addition, a summary and complete tabular output of the chemical releases reported for each TRI category is provided (see Tables 4-28 and 4-29).

It is important to point out that it is not the purpose of this analysis to formulate comparisons of potential risk due to exposure to various chemicals. An assessment of these parameters may be performed during Phase II of this process, using site specific exposure data and demographic information. The intent of this analysis is to provide an estimate of relative hazard for screening purposes. In addition, since this analysis focuses only on release data obtained from the TRI database, it is subject to the requirements under which this reporting occurs. In this respect, both the quantitative ranking as well as qualitative evaluation contained in this report must be considered equally.

4.6.3 Results and Discussion

In Delaware County, 28 facilities were subject to TRI reporting under EPCRA for the reporting year (RY) 1992. A summarized priority listing of these facilities is included in Table 4-27 and a complete listing is provided in Tables 4-28 and 4-29. Table 4-27 shows a quantitative summary of the facilities which ranked in the top 90th percentile - 95% confidence of the 28 facilities subject to reporting under EPCRA. This analysis should be viewed in conjunction with the qualitative evaluation included in this report.

It has not been determined whether these releases were continuous for the entire year or if they reflect one-time accidental releases or spills. In addition, the proximity of these releases relative to potentially exposed populations has not been established. The determination of a potential health threat of the volumes released depends on the proximity of the stack to residential areas, the surrounding terrain and the meteorological conditions. Furthermore, should it be determined that additional analysis is required at any site listed in this report, documentation which identifies these release as continuous or intermittent should be obtained prior to the analysis.

4.6.3.1 Sun Refining & Marketing Co., Marcus Hook

According to the TRI database, Sun Refining & Marketing filed 21 Form R's for the RY1992. Ethylene oxide, benzene and

methyl tert-butyl ether (MTBE) pose the greatest potential threat. These compounds are reported to be released from fugitive and point sources to the air medium. The reader is referred to pages 3, 6 and 9 of Table 4-28 for more complete information regarding the amounts and relative toxicity of these releases.

The toxicity factors for both ethylene oxide and MTBE were obtained from secondary sources (USEPA, 1993b; USEPA, 1990b). While these toxicity factors have received some form of peer review within individual USEPA programs, the data are not recognized as Agency-wide consensus information. Ethylene oxide is considered to be a Group B1 carcinogen causing point-of-entry tumors (stomach) after chronic gavage in rats. MTBE has been documented by the Office of Drinking Water to possess non-carcinogenic effects. The noncarcinogenic toxicity factor (oral RfD) is derived from laboratory rat inhalation experiments which documented a slight reduction in lung weights and increasing depth of anesthesia with increasing dose. The carcinogenic and noncarcinogenic toxicity factors for benzene, whose effects include carcinogenicity (Group A) and leukemia, are derived from USEPA-approved oral toxicity data (USEPA, 1994c) and possess Agency-wide agreement.

Inhalation data for these chemicals are available from secondary USEPA sources. The relative toxicity rank using inhalation data is similar to that provided for the oral assessment. The target organ effects from inhalation exposure include central nervous system impairment (MTBE) and leukemia (benzene and ethylene oxide).

4.6.3.2 Witco Corp, Trainer

This facility filed three Form R reports during the RY1992 indicating releases of 2-methoxyethanol and methanol from fugitive and point sources to the air medium. The reader is referred to pages 3, 6 and 9 of Table 4-28 for more detail. Of greatest concern for potential health effects are the fugitive and stack releases of 2-methoxyethanol to the air medium. This compound has been determined to cause testicular effects in inhalation studies in laboratory rabbits.

4.6.3.3 Scott Paper, Chester

Scott Paper has filed 4 Form R reports for RY1992. Three of the four chemicals--chloroform, hydrochloric acid and sulfuric acid--are of concern from a health perspective. The relatively high volume of stack emissions of these compounds may be significant due to the acute irritating effects of these compounds via the inhalation route (see pages 3, 6 and 9 of Table 4-28). Effects of acids and chloroform include irritation of the

mucous membranes including eyes and respiratory tract, persistent cough, degeneration and ulceration of the nasal epithelium (Sittig, 1985). The proximity of this facility to the Sun Refining and Marketing Co. in Marcus Hook should be considered to determine potential contributory risks to exposed populations.

4.6.3.4 Foamex, L.P., Eddystone

While this company submitted three Form R reports for RY1992, only one compound is of concern from a health perspective. Dichloromethane (DCM; also known as methylene chloride) was reported to be released from fugitive sources to the air medium. Detailed TRI release information may be found on pages 3, 6 and 9 of Table 4-28. This compound possesses both carcinogenic and non-carcinogenic effects. The USEPA-approved toxicity factors are derived from IRIS (USEPA, 1994c), and the compound has been shown to produce liver toxicity in laboratory rats exposed to DCM in drinking water. DCM is also classified by the USEPA as a Group B2 carcinogen, and inhalation exposure of mice to DCM has been shown to produce tumors.

4.6.3.5 Boeing Defense and Space Group, Ridley Park

Boeing Defense and Space Group filed six Form R reports for the RY1992. The chemicals included methyl isobutyl ketone, acetone, trichloroethylene, toluene, methyl ethyl ketone and sulfuric acid (see pages 2, 5, and 8 of Table 4-28. While most of these chemicals (except trichloroethylene) are less toxic than some of the others mentioned above, the volumes and combination of these chemicals released from stacks to the air may contribute to a significant health risk. As mentioned previously, however, the determination of a potential health threat of the volumes released depends on the proximity of the stack to residential areas, the surrounding terrain and the meteorological conditions.

4.6.3.6 Epsilon Prods.

Three facilities released chemicals for which oral toxicity values were unavailable. Of these, Epsilon Prods. released the largest volumes of chemicals. The company filed 2 Form R reports for the RY1992. Ethylene and propylene were released from fugitive and stack sources. Most significant is the release of 53,000 lbs./year of propylene from fugitive sources. The National Toxicology Program (NTP) has tested the carcinogenicity of propylene by the inhalation route and found no evidence of carcinogenicity in rats or mice (NTP). Sittig, 1985, reports that propylene is a mild toxicant, producing narcosis and irregular heartbeat during acute exposure. Sun Oil also reported similar releases to air of ethylene and propylene at 46,000 and 45,000 lbs./year, respectively.

4.7 AIR

4.7.1 Modeled Air Concentrations

4.7.1.1 Data Source

Estimated air concentrations for 699 chemicals were provided for approximately 1400 locations in Chester City. Of the pollutants assessed, 640 are gaseous in nature, while 59 exist as particulate matter. A detailed description of the air modeling process for this project is presented in Appendix III of this report.

4.7.1.2 Point Source Data Analysis

Although emission contributions from many sources were modeled, only the total concentration of each pollutant at each location was considered in risk calculations. The general VOC source category included an assumption about the presence of creosote/coal tar. There were indications that this assumption was not valid for the industries concerned (see discussion of Prime Sources, below), and creosote was therefore not included in the quantitative risk assessment. Of the 699 chemicals evaluated, 122 have toxicity values in the form of RfDs or CSFs. Five of the modeled chemicals are criteria pollutants, and are regulated under the authority of the Clean Air Act via the National Ambient Air Quality Standards (NAAQS).

For chemicals with RfDs or CSFs, modeling results were screened using RBCs as described in Section 3.2.1. to identify chemicals of potential concern (COPCs). Accordingly, inhalation under a standard residential exposure scenario was considered. In instances where both an RfD and a CSF exist for a given COPC, only the most sensitive endpoint (cancer or non-cancer) was evaluated. Based upon the application of Region III technical Guidance, 15 COPCs were identified in Chester City air. COPCs and their associated toxicity criteria are presented in Tables 4-30 and 3-8.

Estimated criteria pollutant concentrations were compared to the NAAQS. (This approach for evaluating potential threats is similar to the methodology employed for assessing non-cancer threats posed by chemicals with RfDs.) For the purpose of this report, all criteria pollutants were retained for evaluation. The criteria pollutants assessed for this project, and their associated NAAQS, are presented in Table 4-31.

4.7.1.3 Point Source Results and Discussion

To evaluate the carcinogenic risks or the non-cancer threats associated with exposure, the ratio between the screening RBC and

the predicted air concentration was calculated for each COPC possessing a CSF or an RfD. These risks are representative of the calculation shown in Table 3-6.

For gasoline and diesel, carcinogenic risks were assessed based upon respective unit risks for these compounds, as determined by a recent USEPA investigation (USEPA, 1993c).

For the criteria pollutants, predicted concentrations at each grid location were compared to NAAQSs. (Note that the concentrations of lead predicted by the model represent annual average levels, rather than quarterly concentrations. Although annual average levels of lead were compared to the quarterly standard, inaccuracies related to such a comparison are insignificant in the context of this study.)

Individual Risks

At various locations in Chester, several chemicals were predicted to exist in air at concentrations of potential concern. Chromium VI was determined to contribute the most to carcinogenic risk at any given location, while hydrogen chloride presents the greatest non-cancer threat. A summary of the highest individual risks in Chester City is presented in Table 4-32 for carcinogenic COPCs, and in Table 4-33 for COPCs with non-cancer endpoints.

None of the predicted concentrations of criteria pollutants in Chester exceeded NAAQSs, as illustrated in Table 4-34.

Cumulative Risks

Cumulative carcinogenic risks and non-cancer threats are predicted to exceed benchmarks at several locations in Chester City. The range of aggregate carcinogenic risks in Chester as a result of inhalation is estimated to be 1.1E-5 to 6.6E-5. For non-cancer endpoints, the range of HIs is predicted to be 1.0 to 3.8. The risks are also displayed on Figures 4-29, 4-30, 4-31, 4-32, 4-33, and 4-34.

To evaluate the cumulative impacts related to the criteria pollutants, the ratios between the modeled concentrations at each location to the NAAQS were calculated. Then, for each grid point in Chester City, ratio values for individual criteria pollutants were summed. (This approach for evaluating potential threats is similar to the methodology employed for assessing non-cancer threats posed by chemicals with RfDs.) Cumulative values for the criteria pollutants were estimated to range from 0.6 to 1.6. This is illustrated on Fig. 4-35.

It is possible to discuss the culpability of various sources of air pollution to these risks. As outlined in the section on

air quality modeling, a large number of sources was modeled, the sources vary dramatically in their contribution to both carcinogenic risk and noncarcinogenic hazards.

In order to compare the contributions of the various sources to air pollution in Chester, it was first necessary to develop a means of comparison. The examination of risks at the location of the most exposed individual, MEI, (a common practice in Superfund and other programs) is not appropriate in the case of Chester for a number of reasons.

First, the air quality analysis is inadequate to support such comparisons. For many types of sources, emission rates were calculated by estimating the emission rate of total respirable particulate or total volatile organic compounds (VOC) and multiplying this emission rate by the weight fractions of the various constituent chemicals. The weight fractions were generally derived from source profiles found in USEPA's SPECIATE database which is used for emissions inventory development for ozone modeling. The difficulty in applying these source profiles to Chester is that, while the profiles are meant to be representative of the average source of a given type, they are not representative of many typical sources.

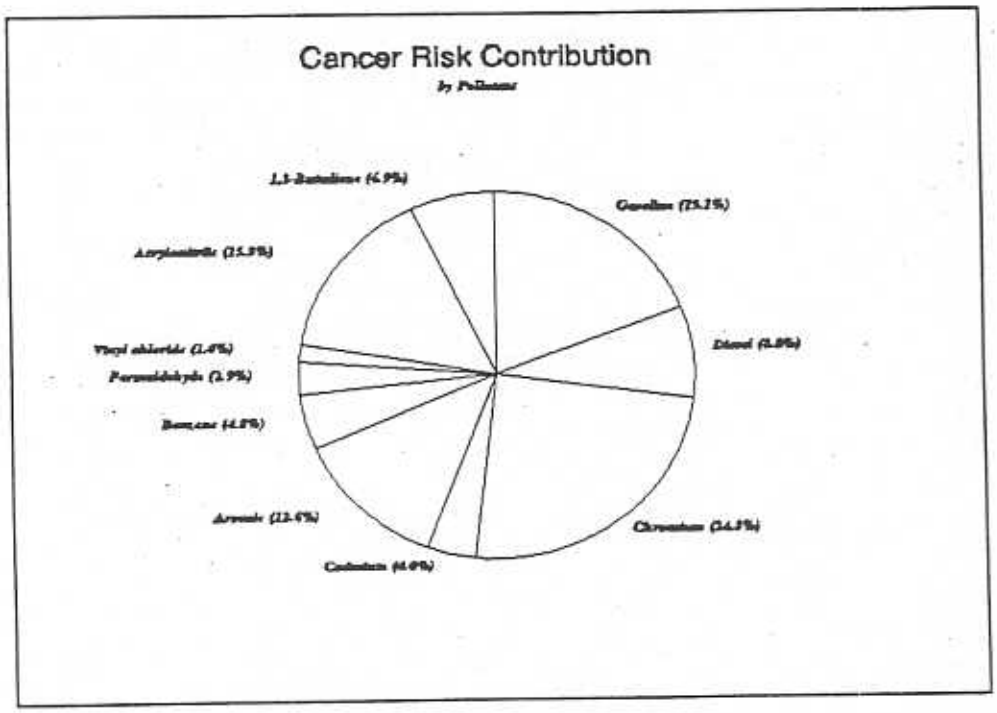
For example, Prime Sources, Incorporated, was initially predicted to be the primary cause of increased cancer risk due to air pollution at the location of the MEI. This original interpretation was corrected upon discovery of the following information. Prime's VOC-related emission rates were calculated by multiplying the state-identified classification ("organic solvent evaporation-- miscellaneous") profile to the State's estimate of Prime's VOC emissions. In an initial step of the analysis, this profile reflected estimates that 12.5% of emissions from such activities are creosote. Prime, however, was a manufacturer of cocoa products, and may not have used creosote at all. (Additionally, this company is reported to have ceased operations.) Risks related to creosote exposure have been deleted from the analysis because the 12.5% assumption may not apply to specific individual facilities.

Second, risk at the location of the MEI is probably not the best way of identifying the most important sources. A source may have highly localized impacts, yet not have a large effect on the city as a whole.

The sources that pose the greatest risk or hazard to the greatest number of people are probably those that are most important to identify. Pursuant to this philosophy, sources were identified that caused the greatest risk or hazard averaged over the city as a whole. As noted in the discussion on air quality modeling, estimates of air toxic concentrations and total risk

were accomplished at 1392 receptors (locations) in and near the city of Chester. [Some of these receptors were just outside of the city (within 200 meters of the boundary). This does not substantively affect the results of the analysis.] The risks posed by the fifteen chemicals of potential concern were calculated and averaged over the entire city.

Point sources accounted for roughly 40 percent of environmental carcinogenic risk in Chester and more than half of the sub-chronic risk. PQ, Delcora, and Sun each contribute roughly one quarter of the long-term cancer risk. PQ emits chromium and arsenic, Delcora emits those and other heavy metals, and Sun emits many organic species. DuPont and Westinghouse account for approximately 80 percent of the non-cancer risk. The culpability of major point sources to long-term and short-term risk throughout the city is listed in Table 4-35. The contribution of each pollutant of concern to carcinogenic risk is shown in the pie chart below.



4.7.1.4 Point Source Uncertainties Analysis

In addition to the generic uncertainties discussed in Section 3.5, including the use of conservative exposure assumptions, that accompany most quantitative risk assessments, a few issues related specifically to this evaluation are presented below:

- For pollutants with RfDs and CSFs, either carcinogenic risks or non-cancer endpoints were evaluated, but not both. In instances where a chemical has both carcinogenic and non-cancer potential, because of the exclusion of the less sensitive endpoint, systemic effects may be slightly under-estimated.

- When totaling HQs to arrive at an HI for each location, target organs were not considered. Therefore, the assumption of additivity for non-cancer endpoints may be overly conservative for pollutants with differing target organs.

- The unit risks used in calculations involving gasoline and diesel are based on investigations and literature searches performed by the USEPA in USEPA, 1993c. These values have not been verified by the Science Advisory Board, and should be considered provisional.

Although this analysis has certain limitations (especially the use of SPECIATE and the generalization of some modeling inputs), it is useful in identifying facilities for further study and enhanced focus (enforcement, emissions control). See Appendix III of this report and Section 5 of the Air Toxic Emissions Inventory and Dispersion Modeling for Chester, Pennsylvania for a description of emissions/modeling uncertainty.

4.7.1.5 Mobile Source Data Analysis (Truck Route Modeling)

Systems Applications International (SAI), working as a subcontractor to Pacific Environmental Services (PES), analyzed particulate matter (PM-10) and hydrocarbon (expressed as total organic gases or TOG) impacts of the heavy duty diesel truck traffic associated with the Delaware County Resource Recovery Facility (DCRRF) for a portion of the truck route along Second Street between Thurlow and Montgomery Streets. SAI's analysis is summarized below; SAI's final report is included in the PES report as Appendix J.

Emission estimates were accomplished for TOG and PM-10 using the MOBILE5a and PART5 emission estimation models, respectively. The models were driven by roadway geometry and signalization data for obtained from the Pennsylvania Department of Transportation

(PENNDOT). Estimates of 1991 average daily traffic volumes for Second and Flower Streets were obtained from projections included in the application for the solid waste permit for the DCRRF (Valley Forge Laboratories, 1985). The traffic volume for Jeffrey Street was obtained from traffic count data provided by PENNDOT.

After they estimated emissions rates, the contractor applied the CAL3QHC and ISCST2 dispersion models. The CAL3QHC model was used to estimate maximum hourly concentrations under the worst case microscale modeling conditions, and the ISCST2 model was used to estimate the annual average hourly concentrations for distances up to 500 meters from Second Street. Conditions for 1991 were modeled since this was the most recent year for which traffic data along the corridor could be obtained. Hourly surface meteorology data for Philadelphia International Airport for 1991 were used as inputs to the ISCST2 modeling. The methodology used with each model is discussed in detail in Appendix J of the PES report.

4.7.1.6 Results and Discussion

Hourly Averages

The results of CAL3QHC modeling are presented in Table 4-36. CAL3QHC was used to model the worst-case hourly average conditions with and without the DCRRF truck traffic. As evidenced by Table 4-36, the truck contribution to the predicted emission levels is more significant for PM-10 than for TOG. This can be attributed to the fact that truck PM-10 emission factors are significantly larger than the fleet average, whereas TOG emission factors of the trucks are similar or below the fleet average. For the intersection of Jeffrey and Second Streets, the truck contribution to transportation-caused ambient PM-10 near the intersections is estimated at 50 percent, and at Flower and Second Streets is over 60 percent.

Table 4-37 shows the location of the receptors with the 10 highest concentrations for the modeling that included the DCRRF trucks. The highest concentrations occur at the receptors located at the corners of the intersection. This indicates below capacity roadway operation (i.e., the queue is being cleared in each signal cycle).

Annual Averages

The annual average concentrations predicted by ISCST2 are presented in Table 4-38. The results for the two cases (with and without the DCRRF trucks) are shown for the two cross sections perpendicular to Second Street. The cross sections illustrate the concentration of emissions as a function of distance from

Second Street. The concentration data in Table 4-38 are presented in Figures 4-39 through 4-42. As was seen with CAL3QHC, the truck contribution to PM-10 emissions is more significant than the contribution to TOG emissions. The annual average concentrations are significantly below the worst-case concentrations predicted by CAL3QHC.

Table 4-39 shows the location of the receptors measuring the six highest concentrations for the modeling that included the DCRRF trucks. The highest annual average concentrations occur at the receptors located nearest Second Street.

Note that the ISCST2 results are best used for obtaining the annual contribution to ambient pollutant concentrations from trucks associated with the DCRRF. These concentrations do not reflect the additional emissions from traffic on cross streets to Second Street in the section modeled.

These emissions contribute to overall exposure. However, since dose-response parameters are usually chemical-specific, it is difficult to relate total PM-10 or total gases to a quantitative risk. Therefore, it is merely noted here that vehicles pose an additional source of exposure to particulate and gaseous pollutants. The short-term PM-10 concentrations are below the 24-hour NAAQS for PM-10 of 150 ug/m^3.

4.7.1.7 Mobile Source Uncertainty Analysis

Factors contributing to uncertainty in the truck route modeling include:

- potential unrepresentativeness of the traffic data;
- potential dissimilarities between the Chester fleet and "typical" fleets described in the emissions estimation tools;
- uncertainties in the dispersion model algorithms; and
- representativeness of the meteorological data.

4.7.2 Area Source Emissions

County-wide estimated emissions were available for area sources of air contaminants. These data were not conducive to the performance of a quantitative risk assessment because of the difficulty in identifying individual chemicals and separating the Chester area out from the county. However, a qualitative/semi-quantitative assessment follows.

4.7.2.1 Definition of Area Sources

Sources of toxic air releases which are small when evaluated individually, but are significant when combined with other facilities of similar type, may be identified in a given geographic area. Volatile organic compounds (VOCs) are of particular concern because some are classified by USEPA as probable or possible human carcinogens. Also, they photochemically combine with oxides of nitrogen (NO_x) and carbon monoxide (CO) in the presence of sunlight to form ozone, which causes respiratory problems and plant damage.

4.7.2.2 Data Source

Information about area sources comes from two sources of data. Information about the location, industry type, and number of employees is available through Dun and Bradstreet. Information about the amount of VOCs released per employee per year is available in USEPA, 1991d. Combining these two databases gives an estimate of VOC emissions per facility per year.

4.7.2.3 Data Analysis

A list of facilities with Standard Industrial Classification (SIC) codes between 4000 and 9999 (which include businesses such as transportation services, gasoline service stations, automobile repair shops, and dry cleaners), and within the study area was retrieved from the Dun and Bradstreet (D&B) data base. [Facilities with SIC codes between 2000 and 3999 (manufacturing) are reported in the TRI data base and are evaluated in the Air Toxics Modeling portion of the study]. The information for each facility included the name of the facility, address, DUNS number, and SIC code. For each facility, the VOC emissions estimate, in lbs./year per employee, was determined, based on the SIC code. 248 facilities were found to have an SIC code with a corresponding VOC emissions estimate. The number of employees for each facility was then multiplied by the VOC estimate to arrive at a value for total emissions for that facility per year.

A grid system was established for the study area, with each grid square approximately one square kilometer (or about 1/2 mile by 1/2 mile), and the sum of the estimated emissions for each facility within a given grid square was calculated. The values for the grid system were assigned colors from red to blue, with grey indicating no facilities.

4.7.2.4 Results and Discussion

Fig. 4-36 shows the estimated emissions for all the grid squares in the study area.

Fig. 4-37 highlights the top 9 (15%) grid squares, which represent estimated annual releases of VOCs of over 40,000 pounds.

Fig. 4-38 shows the minority distribution of the study area with the 9 high squares indicated in cross-hatching. This indicates that grid squares 6, 7, and 8 are in an area with a very high percentage of minority population, indicating that the potential for impact to the minority community is greatest in these areas.

4.7.2.5 Uncertainty Analysis

There are several limitations to the approach used to estimate the VOC emissions for the area sources. First, the D&B data base does not contain every facility in the study area that releases VOCs. New businesses that have started since the last update of the data, and facilities which are not large enough to be included would be omitted. This is not likely to contribute significantly to the overall total of emissions, but could have an effect on the evaluation of a particular grid.

The estimates of VOC releases are based on studies of "typical" facilities and are not actual measures of the releases from the facilities in the study area. The actual type and amount of VOC releases is not available. The estimates are not identified for the specific SIC codes that were identified in the D&B database, so that approximate values were used instead of SIC code-specific ones.

4.7.2.6 Recommendations

Further investigation should be conducted to determine if actual releases are occurring, and which VOCs are from the facilities within grid squares 6, 7, and 8. This could be done through surveying the facilities listed in the D&B data base and/or conducting air monitoring for the specific VOCs that would be expected to be released from these facilities.

4.8 OTHER ENVIRONMENTAL CONCERNS

One of the study objectives was to be responsive to environmental concerns raised by the citizens in the study area. Some of these were issues for which USEPA had no available database and could therefore not assess with quantitative risk assessment. These issues included odors and noise and are addressed below.

4.8.1 Odors

4.8.1.1 Background Information

Odor is a very difficult sensory phenomenon to describe objectively. Many attempts and subsequently many descriptors have been utilized in trying to describe the human olfactory system and especially its variability, thresholds and the time duration aspect of the sensation.

At least three different odor thresholds have been identified: (1) the absolute perception threshold, (2) the recognition threshold, (3) the objectionability threshold (Verschueren, 1983). For our purposes in this discussion, the Threshold Odor Concentration will be considered to be 50% of the recognition threshold. This is the concentration at which 50% of odor receptors defined the odor as being representative of the chemical being studied.

It is key to understand that many odors may be perceived at concentrations as low as 1 part per billion (e.g. ammonia ethylacrylate, isopropylmercaptan), while still others can be detected as low as 1 part per trillion (e.g. n-butyric acid). The mere ability to sense an odor does not necessarily mean that it is harmful at threshold levels. On the other hand, some chemicals which are potentially harmful at low concentrations may not be perceived by most humans at levels which are significantly harmful. This certainly exacerbates individual fears and adds to stress associated with the perceived odors which people encounter.

Another physiologic process which adds to the confusion with odors is the fact that short-term perception of even low-concentration odors taxes the olfactory system in such a manner that it seems to adapt to or "shut down" the perception of the odor. This often leads to odor complaint data of reported short duration. The actual phenomenon may be an adaptation response where the odor is no longer perceptible although it still exists at a similar concentration. A typical investigator might record an event of short duration.

Instrumentation utilized for such an investigation would not be affected by the adaptation response but may have threshold sensitivities several orders of magnitude higher than the human sense of smell.

A major source of concern in the Chester neighborhoods are the odors which seem to emanate from the industries along the Delaware River coastline. It may be that individual small industrial or commercial operations could be sources of these emissions.

Although the incidence of odor complaints has been one of

the greatest concerns in Chester, the pervasiveness of odor could not be addressed quantitatively in the environmental risk assessment. This does not diminish the importance of odors to residents, nor is it meant to ignore or screen them out of the assessment. There were virtually no data available at the onset of the study related to odors. During the study, several meetings were held among the participating agencies and a workgroup was formed in order to define a monitoring effort to identify and quantify the perceived odors.

It was the conclusion of the workgroup that a short-term surveillance and analysis effort would not adequately identify odors, could not be used for quantification purposes, and would offer no assistance to identifying sources of the odors.

For purposes of this report, odors are being considered only as a source of further investigation. They are a nuisance which may add to the overall stress of residing in an urbanized environment. It is much like intrusive noise, unsightly vacant lots, and unwanted traffic through a neighborhood.

As of the date of this report, little data exist regarding odors in the city of Chester. The best sources of information related to odors is the Commonwealth of Pennsylvania's Department of Environmental Resources (PADER) log of odor complaints for the past few years. As part of the data log, complainants are asked to provide location and possible source of the odor. This time, date, location and possible source could be used to identify neighborhoods at risk from this obtrusive environmental concern. However, since the data provided to PADER are kept confidential, it is inappropriate to attempt to use GIS to map the complaint information in such a way as to infer sources of odors in neighborhoods.

The data do clearly show that the vast majority of complaints derive from the residential area contiguous to the industrialized river front in the western portion of Chester. Waste management facilities located in this area handle solid waste (trash), medical wastes, and sewage wastes.

4.8.1.2 Long-Term Odor Investigation

During the Chester study, it was decided that in order to provide an adequate depiction of the air emissions, pollutants and possibly odors, a long-term study was necessary. The USEPA Environmental Service Division, in conjunction with the PADER Bureau of Laboratories, began a year long study utilizing Summa canisters in December 1994. The field protocol for the study is presented in Appendix IV.

4.8.1.3 Short-Term Odor Investigation

It was decided that although a short-duration odor investigation could not be used for risk assessment purposes, it would be a useful tool in determining what chemicals are present during certain time periods and what evidence is present to identify emission sources.

During November 1994, for a continuous 120-hour time period, investigators patrolled the areas where significant complaint data had been compiled. The investigators logged odor/location information and were prepared to investigate odor complaints as they were received. In addition, during the evening and night-time hours, PADER's Mobile Analytic Unit was on site concentrating on the waste facility complex along the riverfront that is bordered by residential neighborhoods in the western side of the city. The investigation plan for this surveillance is included in Appendix V. The results of this study will be published at a future date by PADER.

4.8.2 Noise

4.8.2.1 Background Information

Many residents of Chester have complained that environmental noise diminishes the quality of life they experience in a home setting. They cite numerous sources of the noise and have requested help from the industrial community and the environmental agencies in reducing noise to acceptable, non-intrusive levels. Some of the sources identified include:

- truck traffic passing through residential areas
- industrial operating equipment
- aircraft over-flights
- music sources, such as car radios, home hi-fi
- train pass-by

Transportation noise sources are often cited as leading disruptions in residential neighborhoods. In the case of large trucks, the inherent low frequency engine and drive train noise are "felt" (pressure waves) as low frequency sounds often "exciting" structures or even individuals' body frames. These vibrations may be unsettling to sensitive individuals. In addition, any vehicle which has not been properly maintained can produce sound far in excess of the original equipment manufacturer levels, and may be in violation of state or local noise regulations.

Other transportation noise sources in Chester can include trains and aircraft over-flights. These are typically short in duration but high in amplitude, usually causing a temporary intrusive event.

Industrial noise sounds can have single or multiple sources and can be short or long in duration. Depending on the sound level (amplitude) and/or the quality (frequency or tone), the sound may vary from imperceptible to annoying or intrusive.

Residential sounds such as radios, televisions, hi-fi systems, barking dogs and even children playing may be sources of unwanted sound. There is great variability regarding the intrusiveness of these sounds.

As part of the Chester Risk Project, USEPA staff reviewed applicable environmental noise studies performed in the Chester area and performed a literature search for any applicable mitigation measures. This limited search found a Pre-Operational Noise Monitoring Study (Westinghouse, 1991) and a subsequent Noise Report Summary (Westinghouse, 1993).

In the study, environmental noise monitoring was performed at seven locations. This was considered to be background noise monitoring, at facility site locations, prior to final construction and operation of the Delaware County Resource Recovery facility. A total of three continuous 24-hour time periods were sampled including one weekend day and two weekdays. An additional four locations were sampled in the residential community in February 1991 in areas adjacent to the Resource Recovery facility.

Although there was some variability in the measured noise data due to short-duration transient events, the levels measured in and around the facility and in the residential neighborhoods are typical of urban residential settings and would be considered generally acceptable.

Comparing the 1990 data with a follow-up 1993 similar noise evaluation after the Resource Recovery facility was in operation, indicates that at several locations, sound levels L_{eq} (Energy Equivalent Sound Level) are similar to pre-operational levels. It is also noted in the 1993 report that reports of short-term intrusive sounds were logged by facility staff and follow-up investigations were attempted. These tests were designed to establish a time history of sound amplitude in order to discover plant operations possibly responsible for the noise disturbance. Additional, discrete narrow-band frequency analysis was also attempted in order to identify the offending sound. One-third octave band analysis as well as very narrow ($0.5H^3$) spectral measurements were taken. Suspected sources were cooling tower fans, roof ventilation fans, air compressors, and a vacuum truck.

No definitive source was identified in the report.

4.8.2.2 Noise Control Ordinance

A noise control ordinance for the City of Chester, Pennsylvania was passed on January 14, 1993. This ordinance applies to vehicles, appliances and equipment, and includes many of the "nuisance" type of unwanted sounds. The ordinance includes subjective aspects of noise as well as objective criteria limits for motorized vehicles and property line limit depending on land use zoning.

4.8.2.3 Control of Environmental Noise

Urbanization typically brings together the key ingredients of sustaining life in a city. Industry means jobs and a tax base, residents supply homes and workers for industry, and commercial businesses provide support to industry and residents. When these key elements are condensed into a tight geographical area, intrusions begin to occur. A workable plan of action to enable the synergism of community to function must be based on communication and cooperation. Where these attributes do not exist, intervention must then occur. In the case of noise, reasonable people can usually agree on action plans (or compromise actions) which satisfy all parties. When an impasse arises, local and in some cases state intervention must decide the course of action. This can occur by utilization of a noise control ordinance, civil litigation, or some other type of objective third-party dispute resolution.

4.9 EPIDEMIOLOGICAL ISSUES

A study of the existing public health status of the community and a specific epidemiological study to try to establish cause-and-effect links between environmental risks and health effects were beyond the scope of the environmental risk project. However, the state health department, as a preliminary exercise, looked at the mortality rate for certain diseases in the city as compared to the state and county. This exercise may be found in Appendix VI. This may give useful information regarding the existing health of the community, although it cannot be used to establish causes of the health conditions.