Fall 2006

Community-based evaluation of the air toxic provisions of title III of the 1990 clean air act amendments : risks, costs and benefits

Keith C. Silverman
New Jersey Institute of Technology

ABSTRACT

COMMUNITY-BASED EVALUATION OF THE AIR TOXICS PROVISIONS OF TITLE III OF THE 1990 CLEAN AIR ACT AMENDMENTS: RISKS, COSTS AND BENEFITS

by
Keith C. Silverman

Hazardous air pollutants (HAPs) are those pollutants that are known or suspected to cause cancer, serious health effects, or adverse environmental effects. People exposed to HAPs at sufficient concentrations and durations may have an increased risk of getting cancer or experiencing other health effects. The 1990 Amendments to the Clean Air Act (CAAA) directed the U.S. Environmental Protection Agency (USEPA) to use technology-based air pollution control measures to significantly reduce emissions of HAPs from major sources of air pollution, followed by a risk-based assessment to address any remaining or residual health risks.

This study retrospectively assessed the public health risk posed by 17 major source facilities, located in three counties in New Jersey, in 1990, the year the Clean Air Act was last amended. Air dispersion modeling, based on the physical characteristics and mass emission rates of the source facilities, was used to quantitatively and spatially estimate the community's exposure to HAPs. The estimated exposures were then used to evaluate the public health risk posed by source facilities individually and collectively. The risk results were used to assess what, if any, air pollution controls would be required for the source facilities by Title III of the CAAA. The economic benefits and costs of these pollution controls were also estimated.

The results suggest that the public health impact of the emissions was limited to the receptors in close proximity to the source facilities. No cumulative impacts were found in nearby residential neighborhoods even when source facilities were clustered together. The morbidity risks from non-carcinogenic pollutants were all below acceptable thresholds. The mortality risks from carcinogenic pollutants were all within the USEPA acceptable risk range. No source facility posed a cancer risk to the community greater than 1 in one hundred thousand, and only three source facilities presented a cancer risk greater than 1 in one million. The results suggest that the addition of technology-based air pollution controls results in relatively small reductions in community health risk and that the residual risk, after the additional controls, is minimal.

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A Dissertation
Submitted to the Faculty of
New Jersey Institute of Technology
and
Rutgers, The State University of New Jersey – Newark
in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Environmental Science

Department of Chemistry and Environmental Science

January 2007

APPROVAL PAGE

COMMUNITY-BASED EVALUATION OF THE AIR TOXICS PROVISIONS OF TITLE III OF THE 1990 CLEAN AIR ACT AMENDMENTS: RISKS, COSTS AND BENEFITS

Keith C. Silverman

Dr. Zeyuan Qiu, Dissertation Advisor — Date
Assistant Professor of Chemistry and Environmental Science, NJIT

Dr. Joseph W. Bozzelli, Committee Member — Date
Distinguished Professor, Department of Chemistry and Environmental Science, NJIT

Dr. Somenath Mitra, Committee Member — Date
Professor, Department of Chemistry and Environmental Science, NJIT

Dr. Edward V. Sargent, Committee Member — Date
Senior Director, Global Safety & the Environment, Merck & Co., Inc.

Dr. Joan G. Tell, Committee Member — Date
Senior Project Engineer, Global Safety & the Environment, Merck & Co., Inc.

Dr. Daniel J. Watts, Committee Member — Date
Executive Director, York Center for Environmental Engineering & Science, NJIT

BIOGRAPHICAL SKETCH

Author: Keith Charles Silverman

Degree: Doctor of Philosophy

Date: January 2007

Undergraduate and Graduate Education:

- Doctor of Philosophy in Environmental Science,
  New Jersey Institute of Technology and
  Rutgers, The State University of New Jersey, Newark, NJ, January 2007

- Master of Public Health in Environmental and Occupational Health,
  University of Medicine and Dentistry of New Jersey and
  Rutgers, The State University of New Jersey, Piscataway, NJ, May 1999

- Bachelor of Arts in Biology,
  Rutgers, The State University of New Jersey, New Brunswick, NJ, May 1989

Major: Environmental Science

Selected Presentations and Publications:

Silverman KC and Tell JG. (2002, December 8 – 11). Comparison of AERMOD, ISCST3, AERMOD-PRIME, and ISCST3-PRIME: Implications for Risk Assessment. Paper presented at the Society for Risk Analysis Annual Meeting, New Orleans, LA.

Naumann BD, Silverman KC, Dixit R, Faria EC and Sargent EV. (2001). Case Studies of Categorical Data-Derived Adjustment Factors. *Journal of Human and Ecological Risk Assessment*, 7(1), 61-105.

Silverman KC, Naumann BD, Holder DJ, Dixit R, Faria EC, Sargent EV and Gallo MA. (1999). Establishing Data-Derived Uncertainty Factors from Published Pharmaceutical Clinical Trial Data. *Journal of Human and Ecological Risk Assessment*, 5(5), 1059-1089.

ACKNOWLEDGEMENTS

Thanks to the many people who assisted and encouraged me in so many ways during my doctoral studies. In particular, my friends, Dr. Ellen Faria, Dr. Bruce Naumann, and Patricia Green, whose support, wisdom, and guidance have been instrumental over the years. I especially want to thank Dr. Edward Sargent, who has advised me throughout my masters and doctoral programs. Ed is not only a boss, a mentor, and a true friend, but he is also someone for whom I have the greatest respect and admiration. I have learned so much over the years from Ed about science, business, leadership, and family. I am truly grateful for the privilege of having worked with Ed. I also want to extend a big thanks to Dr. Joan Tell for all the support, guidance, and friendship she has given me over the years. Our scholarly debates have greatly shaped both my academic and professional development.

I am especially grateful to Dr. Zeyuan Qiu, my dissertation committee chairperson and friend. Zeyuan provided an educational experience that encouraged scientific and scholarly interaction and contributed greatly to my academic development. Not only did he always make time for me, but also he always read and responded to the drafts of each chapter quickly and with detailed comments and suggestions. I am also grateful to my committee members for their comments and suggestions. I have benefited greatly from their advice.

I want to thank my parents for their never-ending support and encouragement over the years, through all my endeavors. They have shown me the value of hard work and their confidence in my abilities and in me has impressed upon me the dedication and discipline to work hard. I also want to thank my parents and my sister, Kristen, for the

countless hours of childcare support they provided when my wife's schedule and mine were hectic.

I am very grateful for the support I received from two very inspirational and influential young women, my two daughters, Emily and Lauren. I am so proud of how these young women handled the missed dinners, the missed goodnight kisses, and the missed time with daddy. Their constant understanding and love was a big encouragement to me. Finally, I cannot even begin to express how grateful I am to my wife and my best friend, Kate. Kate has suffered more for this dissertation than anyone else has. She has been a constant source of loving encouragement, patience, wisdom, and support throughout this whole endeavor. Without Kate, this dissertation would have never been possible. So, thank you, Kate, for everything!

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ACCACA	Advisory Council on Clean Air Compliance Analysis
ADD	Average Daily Dose
AERMOD	American Meteorological Society / Environmental Protection Agency Regulatory Model
AERMET	AERMOD Meteorological Preprocessor
AERMIC	AMS/EPA Regulatory Model Improvement Committee
AMOS	Ample Margin of Safety
AMS	American Meteorological Society
ARB	Air Resources Board, Cal EPA
ATSDR	Agency for Toxic Substances & Disease Registry
BCA	Benefit and Cost Analysis
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
Cal EPA	California Environmental Protection Agency
CAPCOA	California Air Pollution Control Officers Association, Cal EPA
CFR	Code of Federal Regulations
COC	Chemical of Concern
COI	Cost of Illness
CPI	Consumer Price Index
CV	Contingent Valuation
DEM	Digital Elevation Model
DOQQ	Digital Ortho-QuarterQuad
EDF	Environmental Defense Fund
EPCRA	Emergency Planning and Community Right to Know Act
ESL	Effects Screening Level
FR	Federal Register
g/s	grams per second
GIS	Geographical Information System
HAP	Hazardous Air Pollutant
HEAST	Health Effects Assessment Summary Tables
HON	Hazardous Organic NESHAP
HI	Hazard Index
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
ISC	Industrial Source Complex Model
kg	kilogram
LADD	Lifetime Average Daily Dose
LICR	Lifetime Incremental Cancer Risk
LOAEL	Lowest-observed-adverse-effect-level
LULC	Land Use and Land Cover
MACT	Maximum Achievable Control Technology.
m^3	cubic meters
mb	millibars

MCL	Maximum Contaminant Level
MEI	Maximum Exposed Individual
MIR	Maximum Individual Risk
mg/m^3	milligrams per cubic meter
MON	Miscellaneous Organic NESAHP
MRL	Minimum Risk Level
µg	micrograms
$\mu g/m^3$	microgram per cubic meter
NAICS	North American Industrial Classification System
NAS	National Academy of Sciences
NATA	National Air Toxic Assessment
NCDC	National Climatic Data Center
NCEA	National Center for Exposure Assessment
NESHAP	National Emission Standards for Hazardous Air Pollutants.
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NJDEPE	New Jersey Department of Environmental Protection and Energy
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NRC	National Research Council
NRDC	National Resources Defense Council
NTI	National Toxics Inventory
NY	New York
OAQPS	Office of Air Quality Planning and Standards
OEHHA	Office of Environmental Health Hazard Assessments
OLDN	Organic Liquids Distribution (non-gasoline) NESHAP
OPRA	Open Public Records Act
OSHA	United States Occupational Safety & Health Administration
PBL	Planetary Boundary Layer
Pharm	Pharmaceutical NESHAP
PPI	Producer Price Index
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
REL	Reference Exposure Level
RfC	Reference Concentration
RfD	Reference Dose
SAB	Science Advisory Board
SARA	Superfund Amendments and Reauthorization Act
SCRAM	Support Center for Regulatory Air Models
SDTS	Spatial Data Transfer Standard
SDWA	Safe Drinking Water Act
SIC	Standard Industrial Classification
SF	Slope Factor
SOCMI	Synthetic Organic Chemical Manufacturing Industry
STF-1	Summary Tape File - 1
TCEQ	Texas Commission on Environmental Quality

THF	Tetrahydrofuran
TTN	Technology Transfer Network
TOU	Thermal Oxidizer Unit
tpy	Tons per year
TRI	Toxic Release Inventory
TRIF ID	TRI Facility Identification
UF	Uncertainty Factor
UR	Unit Risk
US	United States
USC	United States Code
USCB	United States Census Bureau
USDOL	United States Department of Labor
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VAPCCI	Vatavuk Air Pollution Control Cost Indexes
VOC	Volatile Organic Compound
VSL	Value of a Statistical Life
VSLY	Value of a Statistical Life Year
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION

1.1 General Background

Hazardous air pollutants (HAPs) are those air pollutants that are known or suspected to cause cancer, serious health effects, or adverse environmental effects. Examples of HAPs include benzene, methylene chloride, vinyl chloride, dioxin, and metal compounds. Section 112(b) of the Clean Air Act (CAA) lists the 188 HAPs (USEPA, 1990a). People exposed to HAPs at sufficient concentrations and durations may increase their chance of getting cancer or experiencing other serious health effects. These health effects include damage to the immune system, as well as neurological, respiratory, reproductive, developmental, and other health problems (National Research Council, 1994; USEPA, 1990a, 1990b, 2003e). Toxic air pollutants originate primarily from two types of sources: mobile sources and stationary sources. Mobile sources are further categorized as on-road mobile sources (e.g., cars, trucks, and buses) and non-road mobile sources (e.g., planes, trains, marine equipment, construction equipment, lawn and garden equipment, and emergency generators) (USEPA, 2003f). Stationary sources are further categorized as either major sources or area sources. A major source is any stationary source or group of stationary sources located within a contiguous area under common business control (e.g., an industrial facility) that emits or has the potential to emit (considering controls) in aggregate, 10 tons per year (tpy) or more of any one HAP or 25 tpy or more of any combination of HAP (Brownell, 2001; Martineau, 2004; USEPA, 1990a). Major sources may release pollutants from equipment leaks, when materials are transferred from one

location to another, or during discharge through stacks or vents.

Area sources are defined as any stationary source of HAPs that is not a major source (Martineau, 2004; USEPA, 1990a). Area sources are generally smaller size facilities (e.g., dry cleaners) that release lesser quantities of pollutants into the air. Area sources are defined as sources that emit less than 10 tpy of a single air toxic, or less than 25 tpy of a combination of air toxics. Though emissions from individual area sources are often relatively small, collectively their emissions can be of concern, particularly where large numbers of sources are located in heavily populated areas. Another type of area source is the home, where emissions originate from building materials and cleaning activities (Brownell, 2001; Martineau, 2004; USEPA, 1990a, 2003f). Motor vehicles and non-road vehicles are not considered area sources (Martineau, 2004).

Prior to the 1990 Amendments, the 1970 and 1977 versions of the CAA required the United States Environmental Protection Agency (USEPA) to list chemicals as HAPs and then set National Emission Standards for HAPs (NESHAPs) based on their specific health risks. The United States (U.S.) Congress directed the USEPA to set these health-based limits at a level that provided an ample margin of safety (AMOS) to protect public health [42 U.S.C. §7412(b)(1)(B) (1970)] (Martineau, 2004; USEPA, 1999c). This health-based approach to standard setting proved difficult and minimally effective in reducing emissions. From 1970 to 1990, the USEPA had listed only eight chemicals as HAPs and issued NESHAPs for only seven of the listed HAPs. In addition, these NESHAPs only covered a limited number of emission sources. The major difficulty in listing chemicals as HAPs was the risk assessment and risk management process necessary to set a NESHAP. The risk assessment was made difficult by the air dispersion

modeling and human health impact assessment necessary to establish a safe level of exposure. The risk management process attempted to balance the assessed risk against other elements, such as technological feasibility and cost, to reduce the exposure to a level that provided for an AMOS to protect public health (Andrews, 2000; Martineau, 2004).

A major blow to setting NESHAPs using the risk-based approach came in 1987. In a historic case, the National Resources Defense Council (NRDC) took the USEPA to court (*National Resources Defense Council v. EPA, 1987*) to challenge the USEPA's decision to consider cost and technical feasibility in setting the vinyl chloride NESHAP. The court concluded that the USEPA could not consider cost when establishing a safe level of exposure to a HAP but the USEPA could consider cost and technical feasibility when setting a level of exposure that provides for an AMOS to protect public health. Therefore, the court ruled in favor of the USEPA and concluded that consideration of cost, in establishing a NESHAP that provided for an AMOS, was acceptable (Martineau, 2004).

Because of all the difficulties the USEPA encountered while attempting to set risk-based NESHAPs, Congress decided to alter the approach when drafting the 1990 CAAA. In the 1990 Amendments, Congress directed the USEPA to use a two-step approach to control HAPs. The approach required the USEPA to first use a technology-based approach to significantly reduce emissions of HAPs from major sources of air pollution, followed by a risk-based approach to address any remaining or residual risks. The approach to setting technology-based standards involved establishing a list of emitters of HAPs then grouping the emitters on the list by industry. These groups

became known as source categories. Congress also included a list of 188 HAPs in the 1990 CAAA. The complete list of the HAPs can be found at 42 U.S.C. §7401 *et seg.* (1990) and in Appendix A of this study.

The technology-based standards of the 1990 CAAA required the maximum achievable control technology (MACT) be applied to HAP emission sources at industrial source facilities (Martineau, 2004; USEPA, 2000d). The MACT standard required the installation of air pollution controls that would result in the maximum degree of reduction that is achievable, considering cost, energy requirements, and any non-air quality health and environmental impacts (Brownell, 2001; Martineau, 2004). For new sources, the USEPA based the standard on the best controlled source in the source category. For existing sources, the USEPA based the standard on the average pollution control level achieved by the top performing existing sources in the source category (Brownell, 2001; Martineau, 2004). The USEPA has taken the position that it will not consider costs when setting the MACT standards (Martineau, 2004).

The MACT standards are considered the national emission standards for HAPs (i.e., the NESHAPs) for specific source categories. For example, the Pharmaceutical MACT standard regulates the HAP emissions from processes at pharmaceutical manufacturing operations that meet the criteria of a major source. The final rule for pharmaceutical production, published September 21, 1998, affected approximately 100 pharmaceutical production facilities nationwide and was expected to reduce air toxics emissions by 24,000 tons annually which equates to a 65 percent reduction from pre-MACT levels (USEPA, 2002c).

Section 112(f) of the CAA now requires the USEPA to complete a report to Congress that includes a discussion of methods the USEPA would use to evaluate the risks remaining after the application of MACT standards. This residual risk assessment must assess the MACT standards effectiveness at reducing the health and environmental risks posed by HAPs. After setting a MACT standard, the USEPA has eight years (nine years for the earliest standards) to examine the risk posed by continued emissions from source facilities and if necessary, to issue requirements for additional controls to reduce unacceptable residual risk (USEPA, 2000d). At the time of this study, the USEPA was still developing its strategy for assessing and reducing residual risks and still in the process of promulgating final residual risk standards.

In 1999, the USEPA published it's *Residual Risk Report to Congress*, in response to a requirement that Congress had put in the 1990 CAAA (USEPA, 1999c). The *Residual Risk Report to Congress* specifically references the benzene NESHAP which the USEPA issued shortly after the vinyl chloride decision. In the benzene NESHAP, the USEPA developed a two step regulatory framework. In the first step, the USEPA set an acceptable level of risk. In the second step, the USEPA established an AMOS, which made the NESHAP more stringent. The framework used to develop the benzene NESHAP is one potential framework for assessing residual risk (Martineau, 2004).

In June 2006, the USEPA issued a draft of the proposed rule for the *Hazardous Organic National Emissions Standards for Hazardous Air Pollutants (HON): Residual Risk* (USEPA, 2006e). The proposed rule reviewed the technology-based standards put in place and the estimated residual risks for the HON source category. As a result of this review, the USEPA proposed two options. The first option would impose no further

controls based on a proposal that the existing technology-based standards were protecting public health with an AMOS. The second option would require further reductions of organic HAPs by applying additional controls to emissions that are currently not controlled by the technology-based standard. Written comments on the proposed rule were being collected by the USEPA at the time of writing of this study. It is fairly certain that a quantitative human health risk assessment, that considers the effects of direct inhalation of emitted HAPs, will be a critical component of any residual risk rule. Besides the direct health risks, the overall residual risk may also consider indirect human risk from persistent and bioaccumulative pollutants and/or ecological risk. Residual risks greater than a specified threshold may require the emitting industry to implement further reductions in the emissions of HAPs (Brownell, 2001).

This study examined the impacts of uniformly applied technology-based standards for controlling air pollution. The first part of this study presents a methodology for assessing the health risk that industrial source facilities pose to the community. In this part, reported data on facility emissions were used in a quantitative human health risk assessment to evaluate the risk in 1990 from 17 major sources in NJ. The intent of this retrospective risk assessment was to evaluate the health risk that existed in 1990, the year the CAA was last amended and the MACT standards were established.

Quantitative human health risk assessments are commonly used as a tool to guide regulatory decision making and policy setting. A human health risk assessment that looks at the direct inhalation of vapor emissions requires critical pieces of information such as site-specific data on the physical characteristics of the emission sources, accurate estimates on the mass emission rate of the chemicals of concern (COC), good estimates

of toxicity, predictions of the spatial and temporal distributions of these emissions, and an estimate of human exposure. Air dispersion models are used in risk assessments to predict the fate and transport of pollutants in the atmosphere. Once emitted, pollutants mix with the existing air where physical processes, such as turbulence and chemical reactions, cause the pollutants to disperse and their concentrations to decrease. Air dispersion models predict the spatial and temporal distributions of pollutants using mathematical equations that describe the numerous and complex meteorological processes responsible for pollutant dispersion. As such, air dispersion models are widely used to meet federal and state air quality regulations (USEPA, 2001). Since human exposure is based on the air concentration of the pollutant, the concentration data predicted by an air dispersion model is a critical step in the risk assessment process.

As mentioned earlier, a quantitative human health risk assessment that considers the effects of direct inhalation of emitted HAPs is one component by which residual risk will be estimated. Residual risks, greater than a specified threshold, may require source facilities to implement further reductions in their emissions of HAPs. Therefore, if a human health risk assessment results in an overestimate of risk then unnecessary cost may be incurred to eliminate a risk that is already small. On the other hand, under-estimates of risk would have detrimental effects on public health and environment.

In the second part of this study the results of the quantitative risk assessment will be used in a benefit and cost analysis (BCA) of the MACT standards as they pertain to the source facilities in this study. The BCA part of this study considered the cost of the technology-based controls in relation to any benefits, in terms of protection of public health. As mentioned earlier, decisions involving safe levels of air pollution are to be

made solely on the basis of health and environmental effects, regardless of cost. However, the USEPA is allowed to consider cost and technical feasibility when deciding what level of air pollution constitutes an AMOS. This approach is similar to the Safe Drinking Water Act (SDWA), last amended in 1996, which allowed for the consideration of cost in setting Maximum Contaminant Levels (MCLs) (Kucera, 2001).

Regardless of whether or not economic factors are considered in setting public health and environmental policies, policymakers should be questioning if the dollars spent on complying with environmental regulations are having a positive impact. To shed light on this question, economists look to see if the marginal cost of attainment of a regulation is less than the marginal benefits produced through the regulation. Simply speaking, is society seeing an improvement in public health or in the environment for the money spent on the regulation? The answer to this question requires the benefits and costs of environmental policies to be measured or estimated and then compared. A positive net benefit would indicate that the public is getting a benefit for each dollar spent.

The BCA in this study estimated the human health benefits derived as a result of any air pollution controls added under the MACT standards. Any predicted reductions in adverse human health effects were assigned a monetary value. The change in adverse effects was assessed in terms of the magnitude decrease in morbidity (i.e., sickness) or mortality (i.e., death) as a result of the regulation. Placing a dollar value on public health or a human life can be quite controversial. To make the BCA meaningful and useful as a policy making tool, the dollar estimates must be accurate and at the same time practical. Various valuation methods have been developed and numerous studies have been

conducted to estimate the dollar value of public health and to determine society's willingness to pay (WTP) for risk reduction.

1.2 Statement of the Problem

Two prior cost and benefit studies of the CAA by the USEPA concluded the 1970 Act along with the Amendments of 1977 and 1990 were beneficial in improving the air quality of the United States. In both studies, the total implementation costs of CAA were justified by the total benefits obtained in human health and welfare. The first study, a retrospective study, showed the ratio of the benefits to costs for the period 1970 to 1990 was 42 to 1 (USEPA, 1997a). The second study, a prospective study, estimated the ratio for the period 1990 to 2010 to be approximately 4 to 1 (USEPA, 1999b).

However, these studies considered the aggregate costs and benefits of implementing the 1990 CAAA and did not evaluate each Title of the Act separately. The 1990 CAAA contained eleven Titles (USEPA, 1990b).

- Title I: Provisions for Attainment and Maintenance of National Ambient Air Quality Standards
- Title II: Provisions Relating to Mobile Sources
- Title III: Hazardous Air Pollutants
- Title IV: Acid Deposition Control
- Title V: Permits
- Title VI: Stratospheric Ozone Protection
- Title VII: Provisions Relating to Enforcement
- Title VIII: Miscellaneous Provisions
- Title IX: Clean Air Research

- Title X: Disadvantaged Business Concerns
- Title XI: Clean Air Employment Transition Assistance

The eleven titles of the CAA dealt with diverse air pollutants, ranging from the local pollutants such as the HAPs to the regional and global pollutants such as ozone, with very different policies. The aggregate BCA does not show the effectiveness and efficiency of the individual titles and has limited implications for the future air pollution control policy. The USEPA is currently planning its third BCA on the CAA. It is expected that the third study will evaluate the costs and benefits of the CAA as a whole as well as separately for individual titles. This study empirically evaluated Title III of the 1990 CAAA at a community level and filled two gaps identified in the USEPA's national level BCAs. First, it developed a methodology to evaluate Title III, which deals with the HAPs. Second, it addressed the costs and benefits of Title III at a much more detailed level than a national study would do.

In order to accomplish this, a methodology was devised to perform a community level human health risk assessment. The risk assessment looked at real source facilities using the emission information reported to the state environmental agency. The experiences and the information gained from this study can be used to supplement and refine the prior two USEPA BCA studies as well as future studies. The results of the benefit and cost section of this study will also aid policymakers in developing future policies that integrate technology-based standards with probability- or risk-based standards. The results of this study can be used to guide future decisions on residual risk and to configure future regulations that target pollution abatement to those pollutants that pose the greatest human health risk and subsequently maximize net benefits.

In order to consider the impact of only Title III, a facility-specific and community-specific human health risk assessment had to be performed. Community level risk assessment is an emerging science that requires detailed assessments of pollutant fate and human exposure. The USEPA recently released the *Air Toxics Risk Assessment Reference Library Volume 3, Community Scale Assessment* that is intended to serve as a technical resource these community scale, multi-source, air toxics risk assessments (USEPA, 2006c). However, the methodology presented in the USEPA guide still needs to be expanded on and improved. The methodology used in this study will be valuable for carrying out future community level risk assessments. Several of the lessons learned during this study were provided to the USEPA in the form of written comments during the public comment period on the peer review drafts of the above guide.

1.3 Hypothesis

Technology-based standards have been found to be effective in reducing air pollution. The hypothesis of this research is that the uniform application of air pollution controls to major sources of HAPs based primarily on industrial classification, while effective, may not provide a significantly positive net benefit. A more effective approach may be to use a risk-based framework that considers the impact of air pollutants on a community scale.

1.4 Objectives

This study addressed two of the gaps identified in the USEPA's reports to Congress on the benefits and costs of the CAA. The first gap addressed was that neither report presented any quantitative cost or benefit data on the HAPs. The USEPA cited the fact that essential data was lacking for the HAPs as the primary reason why the HAPs were not fully incorporated into either of the studies. This study made use of publicly available data on emissions and air dispersion modeling to quantitatively estimate the human health risk posed by several source facilities before the application of the MACT controls. The second gap addressed was that the USEPA's prospective study did not quantitatively take into account the impact of the MACT standards. This study quantitatively considered both the benefits and costs of the MACT standards on the communities and the source facilities in the study area.

Future reforms of the CAA may allow for the consideration of risks, benefits, and costs prior to the implementation of a reformed Act. Therefore, the third goal of this study was to aid future policymaking decisions on air pollution regulation by demonstrating how the public health effects posed by source facilities in a community can be used to study the benefits and costs associated with air pollution control regulation. In order to accomplish the goals of this study the following specific objectives were defined prior to undertaking the study.

Objective 1. Identify the community to be studied by identifying emitting industries (i.e., source facilities), of defined industrial classes, located in a defined geographical region, and which emitted greater than a threshold quantity of HAPS in 1990.

Objective 2. Perform a community level public health risk assessment using reported emissions data compiled from public records for the source facilities chosen in Objective 1. Carry out the risk assessment using the latest advances in air dispersion modeling and accepted risk assessment methodologies. Generate a spatial representation of the baseline public health risk in 1990 posed by the source facilities.

Objective 3. Estimate the air pollution controls the source facilities would need to apply to be compliant with the MACT standards. Confirm if any air pollution measures were undertaken through available public records.

Objective 4. Estimate the public health benefits that were attained or would be attained through the addition of the air pollution controls required by the MACT standards. Estimate the dollar value of any benefits from reductions in mortality and morbidity.

Objective 5. Estimate the cost to the source facilities of installing and operating the air pollution controls required under the MACT standards.

Objective 6. Perform a benefit and cost assessment of the MACT standards. Estimate the potential impact the residual risk standards may have on the source facilities and the community.

1.5 Procedure

The procedure used is this study is outlined below.

Study Design

- Identify the community or geographic area of interest.
- Identify the timeframe of interest.
- Identify source facilities.

Hazard Assessment

- Obtain and examine emissions reports for the source facilities.
- Build the study area and source facilities in the Geographic Information System (GIS).

Dose-Response Assessment

- Research the dose-response and toxicity data for the emitted chemicals.

Exposure Assessment

- Model all emission sources, from all source facilities, in the air dispersion model.

Risk Characterization

- Calculate the spatial and temporal distributions of human exposure.
- Estimate the baseline human health risk in 1990.
- Estimate any cumulative risk from source facilities located in proximity to one another.

Benefit and Cost Analysis

- Estimate the air pollution controls that would be required under Title III of the CAAA.
- Estimate the cost of the air pollution controls.
- Estimate the benefits in terms of reduced mortality and morbidity.

1.6 Assumptions

Two simplifying assumptions have been made in this study:

1. Health effects (morbidity) are the direct result of chronic inhalation of HAPs.

2. Cancer (mortality) is the direct result of chronic inhalation of HAPs. Furthermore, all cases of cancer are fatal and result in an individual dying.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

Title III of the 1990 CAAA included the provisions for (1) the establishment of technology-based emission standards for source categories and (2) the assessment of the residual risk to public health that remains after the application of the technology-based standards (USEPA, 1990b). Section 812 of Title VIII included provisions for analyzing the benefits and costs of the CAA. Section 812 amended Section 312 of the original CAA, which addressed economic impact analyses of the CAA. As part of the requirements of Section 812, the USEPA is required to periodically assess the effect of the CAA on the public health, economy, and environment of the United States. These analyses are commonly referred to as Section 812 reports. In performing such analyses, the USEPA was directed to consider the costs, benefits and other effects associated with compliance for each standard issued for a HAP, including any technology-based standard and/or risk-based standards (USEPA, 1990a).

In terms of the benefits, Section 812 directs the USEPA to consider all of the economic, public health, and environmental benefits (USEPA, 1990a). In terms of the costs, Section 812 directs the USEPA to consider the effects on employment, productivity, cost of living, economic growth, and the overall economy of the United States (USEPA, 1990a). The findings of the Section 812 analyses of costs and benefits must be reported to Congress. Section 812 required the USEPA to issue the first analyses

to Congress "not later than twelve months after the date of enactment of the Clean Air Act Amendments of 1990" (USEPA, 1990a). Subsequent reports to update the original report must be issued to Congress "not later than 24 months after the date of enactment of the Clean Air Act Amendments of 1990, and every 24 months thereafter" (USEPA, 1990a).

The USEPA has conducted and published two separate Section 812 reports to date (USEPA, 1997a, 1999b). The Section 812 reports have been responsible for much of the progress in the field of valuation of morbidity and mortality benefits and many of the methodologies for carrying out benefit and cost analyses of air pollution regulation. The idea to study the benefits and costs of Title III separately from the other Titles of the Act originated from critical reviews of the two existing Section 812 reports. The Section 812 reports and reviews were used as the starting point for the research done in this study, especially for the benefit and cost assessment part.

2.2 Uniform Emission Standards

The concepts of considering risk, benefits, and costs when setting environmental policy and regulations has been discussed for decades. The historical approach to air pollution control was based primarily on emissions standards, such as those required for the HAPs in both the 1970 CAA and the 1990 CAAA. These emission standards were commonly referred to as the command-and-control approach because they set a legally enforceable and uniform standard on the allowable concentration of a pollutant in ambient air over a specified measurement time (Tietenberg, 2000a). Some economists argue that the command-and-control approach is not cost effective because it assumes all emission

sources pose the same risk to human health. In addition, uniformly applied controls fail to consider variations in emission rates between sources, variations in pollutant fate between sources, and variations in costs to control emissions between sources (Marakovits & Considine, 1996; Nichols, 1982; Tietenberg, 2000a).

Nichols (1982) demonstrated the importance of considering exposure rather than simply reductions in emissions when evaluating the cost effectiveness of proposed regulations. The paper presented a case study of benzene emissions from maleic anhydride plants that were the focus of a proposed USEPA standard in April 1980. The proposed standard focused on maleic anhydride plants since estimates indicated that over half of the benzene emitted from chemical manufacturing came from a handful of maleic anhydride plants. In addition, these emissions emanated from a single process vent that could easily be controlled using any of several different air pollution control technologies. According to the CAA, any emission standard would need to ensure public health with an AMOS. The costs were estimated using industry supplied cost estimates, which have the potential to be over inflated. The benefits were estimated by performing air dispersion modeling and estimating the exposure pre- and post-air pollution control. The expected benefits, measured as a decrease in lifetime excess cancer risk, were assumed to be proportional to the decrease in exposure. The benefits were converted into dollars based on the assumption that a case of cancer was fatal and using a range of dollar values for what a life saved was worth. The concept of placing a dollar value on a life saved will be discussed later in this section. The case study found that the proposed emission standard did not yield positive net benefits even when relatively high estimates of the benefits were used in the analysis (Nichols, 1982).

A case study by Marakovits and Considine (1996) looked at the benefits and costs of emission-based standards compared to exposure-based standards for coke oven emissions. The hypothesis was that environmental health standards should be based on population exposure rather than on ambient air quality. The case study concluded that an environmental policy based on exposure can achieve the same level of protection of public health as do emission standards while at the same time reducing compliance costs by up to sixty percent (Marakovits & Considine, 1996).

Policy makers can use the information from these case studies to guide future regulations so that pollution abatement is targeted at those pollution sources that pose the greatest risk to human health and subsequently maximize net benefits. The case study presented by Nichols (1982) was used as a model for this study. However, Nichols (1982) only considered a single process vent from eight maleic anhydride plants located in the United States. The work in this study focused on 17 source facilities located in three counties in New Jersey. Furthermore, this study considered the emissions of all carcinogenic and all non-carcinogenic chemicals (regardless of whether or not they are classified as a HAP) emanating from all process vents on the source facility for which data was available in the public record. Using this methodology, this study predicted the complete exposure profile from each of the source facilities.

2.3 Ample Margin of Safety (AMOS)

Prior to the 1990 Amendments, the 1970 and 1977 versions of the CAA required the USEPA to list chemicals as HAPs and then set national emission standards for HAPs (NESHAPs) based on their specific health risks. Congress directed the USEPA to set the

health-based limits at a level that provided an AMOS to protect public health [42 U.S.C. §7412(b)(1)(B) (1970)] (Martineau, 2004; USEPA, 1999c). The major difficulty the USEPA encountered in listing chemicals as HAPs was the risk analysis and ambient air quality analysis necessary to determine the emission standard that would provide for an AMOS to protect the public health (Martineau, 2004). This was especially true for carcinogens. Carcinogenic and non-carcinogenic chemicals are evaluated separately in a human health risk assessment because the mechanisms by which carcinogens cause cancer are assumed to be fundamentally different from the mechanisms by which non-carcinogens cause illnesses (Martineau, 2004; National Research Council, 1994; Tietenberg, 2000a). The principal difference reflects the assumption that non-carcinogenic chemicals exhibit a threshold dose below which no adverse effects occur, whereas the general assumption held by most environmental agencies is that no such threshold exists for carcinogenic effects (National Research Council, 1994). Therefore, some environmentalists have argued that protecting public health with an AMOS requires eliminating all exposures to carcinogens and an emission standard of zero. Completely eliminating emissions is not always technically feasible nor necessarily a viable economic option (Martineau, 2004; Tietenberg, 2000a). The USEPA cites an acceptable range of 1 in ten thousand (1×10^{-4}) to 1 in one million (1×10^{-6}) for potential cancer risk. Cancer risks less than 1 in one million are referred to as *de minimis* risk (USEPA, 1989).

The acceptable range for carcinogens was determined prior to the 1990 CAAA, when the USEPA was tasked with setting NESHAPs for HAPs to protect public health with an AMOS. In 1987, the NRDC took the USEPA to court (*National Resources*

Defense Council v. EPA, 1987) to challenge the USEPA's decision to consider cost and technical feasibility in setting the vinyl chloride NESHAP. First, the court ruled that the USEPA must first determine a safe emissions level (i.e., one that represents an acceptable level of risk) and then add a margin of safety to account for uncertainties (Martineau, 2004). Second, the court ruled that the USEPA could not consider cost when establishing a safe level of exposure to a HAP but the USEPA could consider cost and technical feasibility when setting a level of exposure that provides for an AMOS to protect public health (Martineau, 2004). In response to the court's decision, the USEPA decided to base its regulatory decision primarily on a quantitative risk assessment and adopted an estimated lifetime cancer risk, from exposure to vinyl chloride, of less than 1 in ten thousand (1×10^{-4}) as an acceptable risk. The USEPA went forward with the view that the margin of safety should reduce the risk to no higher than 1 in one million (1×10^{-6}) (National Research Council, 1994).

The USEPA used this two step regulatory framework when they designed the benzene NESHAP. In the first step, the USEPA decided what an acceptable level of risk was. This was considered the safe level. It is important to realize that safe does not necessarily mean without risk. In the second step, the USEPA decided to make the regulation more stringent by applying an AMOS. The framework used to develop the benzene NESHAP is one potential framework for setting risk-based emission standards (Martineau, 2004). Even though the benzene NESHAP considers risk when determining what an AMOS is, it is still considered a uniformly applied emission standard because it sets a legally enforceable concentration of benzene in air.

2.4 Section 812 Analysis

The USEPA has conducted and published two Section 812 reports. The first report entitled, *The Benefits and Costs of the Clean Air Act, 1970 to 1990*, was published by the USEPA in 1997 (USEPA, 1997a). The second report entitled, *The Benefits and Costs of the Clean Air Act, 1990 to 2010*, was published by the USEPA in 1999 (USEPA, 1999b). Currently, the USEPA is in the planning stages for the third 812 analysis (USEPA, 2003d).

A USEPA Science Advisory Board (SAB) special council and others have reviewed and commented on both Section 812 reports (Krupnick & Morgenstern, 2002; USEPA, 1996, 1999a). A special council panel has also been convened to review the revised analytical plan for the USEPA's third Section 812 report, *The Benefits and Costs of the Clean Air Act, 1990 - 2020.* The panel expected to have the final analytical plan ready for March 2005 but as of the writing of this study the plan had not been finalized. Further information on the USEPA's third Section 812 report can be found on the SAB webpage on the USEPA's website.

The first USEPA report was a retrospective BCA that attempted to compare a baseline, based on a no emissions control scenario, to an emissions control scenario based on the provisions of both the 1970 CAA and the 1977 Amendments to the CAA. The findings of the study indicated that implementation of the provisions of the CAA from 1970 to 1990 significantly reduced air pollutant emissions. The report concluded that the direct benefits of the CAA from 1970 to 1990 included reduced incidence of a number of adverse human health effects, improvements in visibility, and avoided damage to agricultural crops. A key assumption made in the report was that increased air pollution

exposures have a causal relationship in terms of adverse health effects. The estimated economic value of the estimated benefits ranged from $5.6 to $49.4 trillion (in 1990 dollars) with a mean estimate of $22.2 trillion. The direct costs of implementing the CAA from 1970 to 1990, including annual compliance expenditures in the private sector and program implementation costs in the public sector, totaled $523 billion (in 1990 dollars). Thus, the retrospective analysis of the benefits and costs of implementing the CAA from 1970 to 1990 indicated that the mean estimate of total benefits over the period exceeded total costs by more than a factor of 42. Taking into account the aggregate uncertainty in the estimates, the ratio of benefits to costs ranged from approximately 10 to 100 times (USEPA, 1997a).

The Advisory Council on Clean Air Compliance Analysis (ACCACA) (hereafter, the Council), a special committee of the USEPA's SAB, reviewed the first USEPA report. The Council had several findings that stressed the importance of providing sound estimates of costs and benefits (USEPA, 1996). The most significant finding the Council had was with regard to uncertainty. The Council felt the use of a single point estimate for cost and benefit was not the most scientifically sound practice given the state of knowledge and could at worst be seriously misleading. The Council suggested that ranges or probabilities would be more helpful. The Council also commented on the controversies surrounding the use of contingent valuation (CV) within the economics profession and the impact this had on the estimation of critical benefit inputs such as morbidity and mortality (USEPA, 1996). In addition, the Council also recommended that the costs and benefits of the specific Titles of the CAA be studied in contrast to just looking at the aggregate benefits and costs. Other significant findings centered on

discount rates, cost estimates, the relation between peak and average emissions, and spatial estimates of air concentrations (USEPA, 1996).

The second USEPA Section 812 report was a prospective BCA aimed at estimating the future social benefits and costs of the CAAA from 1990 to 2010. According to the study, the economic value of the public health and environmental benefits during this time period exceeded the costs by a margin of 4 to 1. The direct benefits of implementing the provisions of the 1990 CAAA from 1990 to 2010 were estimated to be $71 billion in 2000 (in 1990 dollars) and $110 billion in 2010 (in 1990 dollars). The direct cost was estimated to be $19 billion in 2000 (in 1990 dollars) and $27 billion in 2010 (in 1990 dollars). Both estimates were the mean estimate. Thus, the prospective analysis of the benefits and costs of implementing the 1990 CAAA (Titles I through V) from 1990 to 2010 indicated that the mean estimate of total benefits over the period exceeded total costs by a margin of approximately 4 to 1 for both 2000 and 2010 (USEPA, 1999b).

The benefit for Title VI (stratospheric ozone depleting compounds) was estimated separately and found to be $530 billion (in 1990 dollars). This benefit estimate was not considered in the overall results because the benefits were estimated over 175 years (i.e., the time period from 1990 through 2165) (USEPA, 1999b). The data in the prospective study indicated that some titles delivered greater positive net benefits than others. A 1999 study by Smith and Ross (as cited in Krupnick and Morgenstern, 2002) disaggregated the benefits of the 1990 CAAA by title. The total benefit estimates in 2010 (in 1990 dollars) was approximately $110 billion. The study attributed approximately $26.6 billion (in 1990 dollars) of benefits to Title I (attainment and maintenance of

NAAQS), $15 billion to Title II (mobile sources), $1.9 billion to Title III (hazardous air pollutants), and $69.3 billion to Title IV (reducing acid rain precursors – SO_2 and NO_x) (Krupnick & Morgenstern, 2002). Therefore, Title III accounted for approximately 2 percent of the total benefits of implementing Titles I through IV.

The estimated costs (in 1990 dollars) for compliance in 2010 with Title I was predicted to be $14.5 billion, Title II was $9 billion, Title III was $840 million., Title IV was $2 billion, and Title V (permitting) was 300 million (USEPA, 1999b). The data indicate that the Title III provisions comprised only a small fraction of the total costs of implementing the provisions of the 1990 CAAA (i.e., $840 million out of $27 billion). Therefore, the cost of meeting the requirements of Title III was approximately 3 percent of the total costs of implementing Titles I through IV.

The prospective study used an approach that compared two distinct scenarios, a pre-CAAA scenario, and a post-CAAA scenario. The Pre-CAAA scenario takes the emissions and air pollution control situation as it existed in 1990 and sets this as the baseline. The Post-CAAA scenario considers the implementation of the 1990 CAAA. The study uses economic activity projections to estimate the Pre-CAAA and Post-CAAA emissions for the two target years, 2000 and 2010 (USEPA, 1999b).

With regards to Title III, the prospective study only considered the impacts of the 2- and 4- year MACT standards in the benefits and costs analyses (USEPA, 1999b). The 2-year MACT standards were the dry cleaning NESHAP and the hazardous organic NESHAP (HON). The 4-year MACT standards were NESHAPs for the followings source categories: aerospace; chromium electroplating; coke ovens; commercial sterilizers; degreasing organic cleaners; gasoline distribution (stage 1); hazardous waste

combustion; industrial cooling towers; magnetic tape surface coating; marine vessel loading operations; off-site waste and recovery operations; petroleum refineries; polymers and resins (I, II, & IV); printing and publishing surface coating; secondary lead smelters; shipbuilding and ship repair surface coating; and wood furniture surface coating. There are an additional twenty-one 7-year MACT standards and forty-seven 10-year MACT standards whose benefits and costs were not considered in the prospective study (USEPA, 1999b, 2006j). It is anticipated that the costs to implement Title III will rise when the full costs of implementation of all the MACT standards are considered. Furthermore, the benefits and costs of any residual risk standards were not considered in the prospective study. If a residual risk assessment indicates that emissions exceed a specified risk threshold after the technology-based controls have been instituted then additional air pollution controls will need to be installed.

The USEPA was unable to quantify the health effects associated with reductions in exposure to HAPs due to a lack of monitoring data, limited and inconsistent emission inventories, lack of scientific literature on the effects of HAPs, and limited air modeling. The USEPA identified this as a source of uncertainty with a likely major significance since it could potentially lead to an underestimate of the net benefits. Since the data was not available to do a quantitative risk assessment for the HAPs, the USEPA assumed an 80 percent rule effectiveness for all control measures under Title III (USEPA, 1999b). This assumption simply reduced the Pre-CAAA and Post-CAAA estimated values in 2000 and 2010 by 80 percent.

The Council also reviewed the second USEPA report and again the Council suggested that aggregate cost and benefits be broken down into individual titles. Other

findings of the Council included recommending that the USEPA revise its estimates for the value of a statistical life (VSL) and present cost effective results in terms of Net Cost per Life Saved as well as Net Cost per Life-Year Saved (USEPA, 1999a). A critical gap identified by the Council is that neither report presented any quantitative benefit and cost analyses or other data on specific HAPs. Instead, the focus was primarily on the criteria pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), ozone (O_3), and lead (Pb). The USEPA and the Council cited the fact that essential data were lacking for the HAPs and therefore, they were not fully incorporated into either of the studies (USEPA, 1997a, 1999a).

An independent review of the USEPA's first two studies emphasized the need to separate the costs and benefits of future analyses into specific titles and recommended focusing future studies on specific policy issues that have the potential to increase the net benefits of the CAA in the future (Krupnick & Morgenstern, 2002). For example, decreased mortality accounted for approximately 81% and 90% of the benefits in the first and second Section 812 reports, respectively. Since decreases in mortality are a major benefit associated with implementation of the CAA, it would be important to study the magnitude that the decreases in HAP emissions due to the provisions of Title III would have on mortality.

2.5 Human Health Risk Assessment

In 1983, the National Research Council (NRC) published a report entitled *Risk Assessment in the Federal Government: Managing the Process* which has become the foundation of risk assessment theory and practice (National Research Council, 1983).

The report is commonly referred to as the "Red Book" because of its bright red cover. The Red Book addresses the practice of risk assessment, how to improve the practice of risk assessment, and how to distinguish risk assessment from risk management. The Red Book's recommendations have helped shape risk policy and practices in government, academia, and industry (Johnson & Reisa, 2003). In 1984, the Administer of the USEPA, William Ruckelshaus, officially endorsed the framework for risk assessment and risk management presented in the Red Book as the primary framework to be used in USEPA decision making (Andrews, 2000; Ruckelshaus, 1983). In 1994, the NRC published *Science and Judgement in Risk Assessment* which expanded on the methodologies for carrying out risk assessments (National Research Council, 1994).

The Red Book defines risk as "the probability of injury, disease, or death under specific circumstances" and risk assessment as "the characterization of the potential adverse health effects of human exposure to environmental hazards" (National Research Council, 1983). The definitions combine two concepts: hazard and probability. This is one area that causes confusion when people discuss risk assessment (Andrews, 2000). People often simply assume that hazard equals risk. However, this is not a valid assumption; a hazard does not always pose a risk. In order for a hazard to cause an effect there must be some type of exposure to the hazard. In the risk assessment framework, the probability or likelihood of suffering an effect is based on the severity of the hazard and the magnitude of the exposure to the hazard.

The Red Book essentially codified the following four steps of a risk assessment (Johnson & Reisa, 2003; National Research Council, 1983, 1994). In each step, the

relevant and scientifically reliable information is evaluated and the related uncertainties are described (USEPA, 2000c).

- Hazard Identification: The determination of whether a particular chemical is or is not casually linked to particular health effects.
- Dose-Response Assessment: The determination of the relation between the magnitude of exposure and the probability of occurrence of the health effects in question.
- Exposure Assessment: The determination of the extent of human exposure before or after application of regulatory controls.
- Risk Characterization: The description of the nature and often the magnitude of human risk, including any uncertainty.

In this study, the hazard identification step involved identifying source facilities, determining the timeframe of interest, and researching the air emissions from these source facilities. The dose-response assessment step involved researching the toxicity data available for all the emitted chemicals and describing the relationship between the magnitude of exposure and the degree of the toxic effect. In the exposure assessment step, data on the emission sources and the mass emission rates were used in an air dispersion model to predict the spatial and temporal exposure distribution in the vicinity of the source facilities. The selection of the air dispersion model is discussed in the next section. The final step, the risk characterization step, combined the information from the previous three steps to predict a numerical estimate of mortality and morbidity. Risk characterization is the culminating step of the risk assessment process which communicates the key findings and the strengths and weaknesses of the assessment (USEPA, 2000c). In this study, the risk characterization was aided by the use of a Geographical Information System (GIS), which allowed for better analyses of the interactions between environmental exposure and public health.

The results of this study can be used by policy makers and regulators in choosing and justifying regulatory decisions (Andrews, 2000; National Research Council, 1994). William Ruckelshaus suggested that our laws need to reflect scientifically sound risk assessments. Ruckelshaus' belief was that "scientists assess the risk and find out what the problems are. The process of deciding what to do about the problems is risk management" (Ruckelshaus, 1983). The risk management process starts with the predicted health risks and then determines what the possible control options are. Risk management decisions may be influenced by factors such as the benefits and the costs of the various control options (Ruckelshaus, 1983). The main goal of the risk assessment is to prioritize the numerous environmental risks. This prioritization is then used during the risk management step to inform regulatory decision making and aid in the allocation of limited funds so that they go towards reducing the most serious risks (Russell & Gruber, 1987).

Travis et al. (1987) examined 132 federal regulatory decisions on environmental carcinogens from 1976 through 1985. The results revealed that every chemical with an individual lifetime excess cancer risk of 1 in ten thousand was regulated while only one chemical with a risk less than 1 in one million was regulated. Risk alone was the primary reason for regulating the chemicals that posed the highest risk. Regulatory decision making on the chemicals that posed a risk less than 1 in ten thousand was based on risk and cost effectiveness of the regulation (Travis et al. as cited in Andrews, 2000). The results of the Travis study also relate to the discussion on AMOS since the results support the earlier consideration that an excess cancer risk of 1 in ten thousand is a tolerable risk.

2.6 Air Dispersion Modeling

Air dispersion models are designed to predict the fate and transport of air emissions of pollutants in the atmosphere. Generally, emitted pollutants mix with the air where physical processes, such as turbulence, and chemical reactions cause the pollutant to disperse and the concentration to decrease. In some cases, chemical reactions involving the primary pollutants produce secondary pollutants, such as ozone. Air dispersion models predict the spatial and temporal ambient air concentrations of a chemical using mathematical equations that describe the numerous and complex meteorological processes that are responsible for dispersion. The calculations are based on user input such that the greater the accuracy in the model inputs the greater the accuracy of the modeling results. Data input includes actual meteorological data, source emission data in the form of a mass emission rate, dimensions of nearby structures, and actual local terrain information.

Most USEPA regulatory air dispersion modeling in the United States is conducted in accordance with the procedures outlined by the USEPA in the *Guideline on Air Quality Models* (hereafter, the *Guideline*) which provides federal guidance for all USEPA regulatory modeling performed in the U.S. (USEPA, 2005d). Currently, there are two air dispersion models commonly used in the United States to model gaseous pollutants over a short range: AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model) and ISC (Industrial Source Complex). The November 2005 revision to the *Guideline* replaced the widely used ISC model with AERMOD, a state-of-the-practice air dispersion model.

The ISC model was originally released in the early 1980's and has undergone several revisions of both the code and the algorithms used to model dispersion (Paine & Lew, 1997). The current version of the ISC model was released in 1995 (USEPA, 1995a). The ISC model is based on a simplistic understanding of atmospheric processes, while the newer AERMOD model incorporates what has been learned about air dispersion modeling in recent years to more accurately represent the current understanding of dispersion in the atmosphere (Trinity Consultants, 1999).

The ISC model is a Gaussian dispersion model that assumes any release from a source disperses in a steady-state manner from the time of release until the time it reaches the receptor. Gaussian dispersion models also assume that a normal distribution can characterize the horizontal and vertical spread of a plume (Trinity Consultants, 1999). The ISC model requires input data on source characteristics, receptor location, meteorological parameters, and topography.

The Gaussian dispersion models are based on a simplistic understanding of atmospheric processes. Therefore, in 1991, the American Meteorological Society (AMS) and the USEPA co-sponsored a committee called the AMS/EPA Regulatory Model Improvement Committee (AERMIC) that developed the AERMOD model. AERMOD incorporates many of the same algorithms as ISC but contains advanced algorithms for dispersion, plume rise, buoyancy and the handling of complex terrain. AERMOD, like ISC, is a steady-state model and is most useful for analyzing short-range pollutant transport within 20 kilometers of the source (Trinity Consultants, 1999; USEPA, 2002b). As such, AERMOD is considered by the USEPA and the scientific community to be a theoretically better model (USEPA, 2005d).

A review of the available literature found several studies by the USEPA and independent consultants that attempted to evaluate and validate AERMOD. The findings of many of these studies were presented at the USEPA's 7th Conference on Air Quality Modeling held in June 2000 in Washington, D.C. (USEPA, 2000e). The main justification for replacing ISC with AERMOD was that AERMOD incorporated many of the scientific advances made in the 1970's and 1980's in understanding turbulence and dispersion in the planetary boundary layer (PBL). The PBL is the turbulent region of the atmosphere where pollutants are emitted, transported, mixed, and dispersed (Weil, 2000). AERMOD's treatment of the PBL is therefore, considered more realistic. The AERMOD meteorological pre-processor (AERMET) makes use of the surface characteristics of the land surrounding the facility along with the hourly surface meteorological data to produce more realistic values of parameters that affect dispersion such as albedo, bowen ratio, and surface roughness. These parameters are discussed in further detail in Section 3.2.3.3 (Meteorological Data).

In this study, air dispersion modeling was carried out to determine the fate of the vapor phase emissions in the atmosphere and to estimate air concentrations of pollutants at specific ground level geographical receptor locations for defined averaging times. The air dispersion model used in this study was AERMOD.

2.7 Geographical Information Systems (GIS)

GIS can be a very powerful tool in risk assessment. It can be used to better illuminate the interaction between environmental pollution and public health (Jarup, 2004). GIS has been used in environmental justice assessments to study the geographic distribution of

industrial air emissions by income and race (Chakraborty, 2001; Dolinoy & Miranda, 2004; Maantay, 2002; Perlin et al., 1995). GIS allows analysis at several different geographical units of analysis, such as a census tract, the block group, a municipality, zip codes, or radius circles around a point of release (Chakraborty, 2001; Perlin et al., 1995).

GIS has been used to assess exposure to air pollution from traffic (Bellander et al., 2001); from fine particulate matter (Goswami et al., 2002; Levy et al., 2001); from products of combustion (Bellander et al., 2001; Levy et al., 2001); and from airborne dioxin (Poulstrup & Hansen, 2004). Several studies have demonstrated the integration of air dispersion modeling with GIS to assess geospatial trends in pollution and exposure (Balagopalan, 1999; Dent et al., 2000; Folgert & Metcalfe, 1997; Kinman et al., 1999). In several of the studies (Balagopalan, 1999; Dent et al., 2000; Dolinoy & Miranda, 2004; Kinman et al., 1999; Perlin et al., 1995), the air emissions data was extracted from the USEPA Toxic Release Inventory (TRI) database similar to what was done in this study. Two papers provided a review of the literature where GIS was used to organize and map health data, such as, disease rates and potential sources of environmental exposure (Nuckols et al., 2004; Rushton, 2003). Both reviews concluded that a new discipline, referred to as spatial epidemiology, will continue to enhance our understanding of the association between environmental contaminants and disease and will alert public health workers to disease clusters that require further attention.

Using GIS allows the risk assessor to leverage very high resolution geodata (e.g., digital orthophotos, digital terrain maps, and land-use land-cover data) during the hazard identification, the exposure assessment, and the risk characterization phases. During the risk characterization phase, GIS allows for realistic assessments of exposures and

exceedances. Using a GIS, the risk assessor can determine if the point of maximum concentration is located near a potential receptor of interest. If it is not, the risk assessor can perform a realistic survey of the community to locate the most probable receptor and the associated modeled concentration at that receptor.

2.8 Valuation of Benefits

There are several broad categories of benefits that can be evaluated when studying the effectiveness of air pollution reduction programs. Categories such as decreased destruction of buildings are indicators of economic activity because the repair of a building has a cost associated with it. Other indicators of economic activity include benefits to production or consumption (e.g., crops, forests, fisheries, or water supplies) and benefits to economic assets (e.g., reduced corrosion or increased property values). On the other hand, benefits such as increased visibility, decreased pollutant levels, and overall cleaner skies are welfare enhancing benefits that are not sold in markets and therefore, their value is not well defined (Davies & Mazurek, 1998). Other non-market benefits include: benefits to individuals, such as, reductions in mortality, reductions in morbidity or benefits to other environmental assets (e.g., recreation, visibility, or inherent value). It has been estimated that more than 90 percent of the environmental benefits of the CAA are due to non-market benefits and a majority of theses benefits are seen as decreases in mortality (Davies & Mazurek, 1998; Krupnick & Morgenstern, 2002).

In order to estimate the benefits of an air quality regulation, the changes in air quality must somehow be translated into improvements in human health. This is often difficult because the effects of air pollutants can range from minor and reversible effects

(e.g., eye irritation), to debilitating effects (e.g., aggravation of asthma or chronic bronchitis) and in the worse case, fatal effects (e.g., cancer). In order to compare the costs of implementing the CAA to the benefits gained as a result of the CAA's programs, a monetary value must be assigned to the human health benefits of decreased morbidity (i.e., chronic and debilitating health effects) and mortality (i.e., death) that are gained as a result of the regulation.

In the USEPA's prospective Section 812 study, the agency explained the assumptions used to derive the necessary monetary values of health effects (USEPA, 1999b). In that study a higher value was placed on mortality than on morbidity (Krupnick & Morgenstern, 2002). In order to do that, the USEPA looked at the WTP data gained from numerous studies in the literature and made valuation estimates on several different health effects. The WTP data is an individual's WTP to avoid sickness or death. In cases where the WTP data was lacking, the USEPA used data on the cost of treatment or the cost of illness (COI). However, the COI estimates generally underestimate the value of avoiding a health effect because they only consider direct costs and ignore utility benefits such as happiness derived from better health (USEPA, 1999b). In the prospective study, the values (in 1990 dollars) for morbidity due to respiratory illness from chronic bronchitis and chronic asthma were $260,000 per case and $25,000 per case, respectively. These values represent the people's WTP to avoid a case of chronic respiratory disease (USEPA, 1999b).

The USEPA retrospective and prospective Section 812 studies also estimated the benefit of mortality effects. Here the benefit is the avoidance of small increases in the risk of dying. By summing the individual WTP data to avoid small increases in the risk

of mortality over enough individuals the USEPA estimated the value of a single statistical death avoided (or life saved) as a result of regulatory action. This valuation was referred to as the Value of a Statistical Life (VSL). Both studies used a VSL of $4.8 million (in 1990 dollars) (USEPA, 1999b).

In addition to the VSL, the USEPA carried out another valuation calculation based on life-years lost and referred to this as the value of statistical life-year (VSLY) approach. The VSLY approach looks at the number of life years saved as opposed to the number of lives saved. Calculation of the VSLY takes into consideration the fact that older individuals have a shorter life expectancy than younger people do and as such, the VSLY prorates and discounts the VSL proportional to the life expectancy. Discounting means that the present value of a life saved today is worth more than the present value of a life saved in the future. In other words, a life saved today is worth more than a life saved tomorrow. The USEPA employed the VSLY approach by first estimating the age distribution of those lives projected to be saved by reducing air pollution. A life expectancy table is then used to calculate the life years saved for each statistical life within each age and gender cohort (USEPA, 1999b). If the discount rate increases, the present value of the benefit would decrease and the VSLY would increase. The VSLY can be multiplied by the number of years of remaining life expectancy for the affected population to derive the total benefit (USEPA, 1999b).

The VSLY methodology has the potential to negatively impact the elderly, who have fewer life years remaining and therefore, the estimated benefits would be less. The question then becomes should we spend as much to prevent mortality in older people as we do to prevent mortality in younger people? As expected, this was a highly

contentious issue since it created equity issues across age cohorts. The VSLY only considers age but if it were expanded to include other socio-economic parameters, it could potentially create numerous equity and ethical issues. The USEPA has since moved away from the use of the VSLY. The current practice is to apply the same VSL to all ages and all risks (Maguire, 2006).

Most economists agree that WTP is an accepted benefits metric for government and policymakers to use as a tool when evaluating policies that are meant to reduce risks to human health (Jones-Lee et al., 1985; Pratt & Zeckhauser, 1996). The fundamental principle of the WTP approach is that social decisions should reflect the individual preferences of those affected (i.e., consumer preferences) and therefore, different people will have different amounts they would be willing to pay for small reductions in their probability of dying. The WTP approach tends to focus on individual marginal rates of substitution of money in turn for a small decrease in the risk of death or injury (Jones-Lee et al., 1985). Studies indicate that individuals are usually willing to pay more for a specified reduction in risk, if the risk is concrete and concentrated. For example, people are willing to pay more to save an identified life than a hypothetical statistical life, and more willing to pay for remedies than for preventive measures (Pratt & Zeckhauser, 1996). Pratt and Zeckhauser also explored the rational choice theory that individuals go through when they are faced with life threatening risks. One problem with the valuation of health risks, that makes it different from consumer goods, is that any point estimate of a market price may not accurately reflect the vast level of interpersonal variation observed in the WTP approach (Rosen, 1981).

Viscusi (1993, 1995, 1996) pointed out that even if society wanted to provide a world free of risk, our economic resources are limited and do not allow for such an option. If policymakers do not place bounds on risk reduction efforts, then society will eventually end up with policies that cost more and more because of diminishing returns. Such practice would also divert resources from more productive or beneficial uses (Viscusi, 1995, 1996). If it is not practical to reduce risks to the lowest level, then what levels of risk and cost are acceptable? The major consideration here would be the level of risk reduction achievable for a given expenditure and the value that society places on that level risk reduction (Viscusi, 1993). Since the answers to these questions are not easily resolved, the common approach policymakers take is to regulate uniformly to an established level (i.e., the command and control approach). Consideration of costs and benefits may or may not enter into the decision making process. Consequently, a BCA can be a useful tool for regulators to use in determining the economic feasibility of a regulation.

2.9 National Scale Air Toxics Assessment

The National Scale Air Toxics Assessment (NATA) is the USEPA's ongoing comprehensive evaluation of toxic air pollutants in the United States. In 2002, the USEPA released the first NATA on 32 of the 188 listed HAPs using emissions data from the 1996 National Toxics Inventory (NTI). The assessment concluded that of the four main source types (i.e., area stationary, major stationary, on-road mobile, non-road mobile), no one source type was a dominant contributor to the estimated concentrations (USEPA, 2003g). In February 2006, the USEPA released the second NATA on 133 of

the 188 listed HAPs using air toxics emissions from the 1999 NTI. The USEPA has released a fact sheet which details the major findings (USEPA, 2006g). The following bullets were excerpted directly from the USEPA's technical fact sheet. In general the results showed:

- *From a national perspective, benzene is the most significant air toxic for which cancer risk could be estimated, contributing twenty-five percent of the average individual cancer risk. Based on the USEPA's national emissions inventory, the key sources for benzene are on-road (49%) and non-road mobile sources (19%), and open burning, prescribed fires and wildfires (14%).*

- *For most of the noncancer health effects the USEPA assessed (e.g., liver, kidney, developmental effects), the estimated exposures were below levels at which adverse health effects are expected. The USEPA's assessment indicates the potential for two types of noncancer effects: respiratory and neurological. Of these, respiratory health effects show a higher potential for adverse effects to the greatest number of people; considerably higher levels than neurological.*

- *The assessment estimates that in most of the country people have a lifetime cancer risk from air toxics between 1 and 25 in a million. This means that out of one million people, between 1 and 25 people have increased likelihood of contracting cancer as a result of breathing air toxics from outdoor sources, if they were exposed to 1999 levels over the course of their lifetime. The assessment estimates that most urban locations have air toxics lifetime cancer risk greater than 25 in a million. Risk in transportation corridors and some other locations are greater than 50 in a million. In contrast, one out of every three Americans (330,000 in a million) will contract cancer during a lifetime, when all causes (including exposure to air toxics) are taken into account. Based on these results, the risk of contracting cancer is increased less than 1% due to inhalation of air toxics from outdoor sources.*

- *Over 92% of the U.S. population have "hazard index" values for respiratory toxicity (a measure of the relative hazard for effects other than cancer) greater than 1.0 and over 17% of the U.S. population have "hazard index" values greater than 10. Because these exposures exceed the no-effect levels (1.0 or less) for effects to the respiratory system, this result suggests that some people may experience an increased risk of respiratory irritation or other adverse respiratory effects from exposure to air toxics.*

Based on the findings of the 2002 NATA, it appears that toxic air pollutants are a public health concern that requires further continued attention. It is important to realize that

both NATAs are meant to help regulatory agencies and communities understand the emerging air toxics issues and trends. They are not intended to be used for estimating risk at the local level, for quantifying benefits of reduced emissions, or for identifying localized hotspots (USEPA, 2006g). One interesting conclusion the USEPA makes in the 2006 NATA is that "the risk of contracting cancer is increased less than 1% due to inhalation of air toxics from outdoor sources". This finding suggests that reductions in HAPs may not lead to significant changes in actual mortality.

This study looked at the baseline risk in 1990 posed by 17 source facilities in NJ. Using the results of the risk assessment, this study estimated the magnitude change in mortality and morbidity, due to anticipated reductions in HAPs, which would be achieved through implementation of the provisions of Title III of the 1990 CAAA.

CHAPTER 3

DATA AND METHODS

3.1 Study Area and Source Facilities

New Jersey was the overall geographic area of interest for this study. Information on HAPs in NJ was reviewed in order to identify a specific geographic area for the study. The USEPA's Air Toxics website, which included information on the 2002 NATA was examined first (USEPA, 2003g). As part of the 2002 NATA initiative, the USEPA conducted a national-scale assessment of 32 air toxics based on 1996 emissions data. In addition to the 2002 NATA results, information on HAPs in NJ was obtained from the Environmental Defense Fund (EDF) Scorecard (EDF, 2003, 2005). Both the 2002 NATA and the EDF Scorecard defined stationary sources as stacks and vents located within industrial source facilities (e.g., chemical plants, oil refineries, power plants, and hazardous waste incinerators) that meet the classification of a major source as defined in Section 112 of the CAA. A major source is any stationary source or group of stationary sources located within a contiguous area under common business control (e.g., an industrial facility) that emits or has the potential to emit (considering controls) in aggregate, 10 tons per year (tpy) or more of any one HAP or 25 tpy or more of any combination of HAP (Brownell, 2001; Martineau, 2004; USEPA, 1990a). Area sources were defined as sources that generally have smaller emissions on an individual basis than major sources and are often too small or ubiquitous in nature to be inventoried as individual sources. Area sources include facilities that have air toxics emissions below the major source threshold as defined in Section 112 of the CAA and thus emit less than

10 tpy of a single HAP or less than 25 tpy of multiple HAPs (Brownell, 2001; Martineau, 2004; USEPA, 1990a).

The EDF Scorecard rankings for HAPs indicated that NJ, when compared to other states in the United States, ranked in the 90^{th} - 100^{th} percentile, as one of the dirtiest/worst states. The EDF Scorecard rankings were based on exposure estimates derived from the 1996 Toxic Release Inventory (TRI) data on emissions and accepted USEPA exposure estimates. Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA) of 1986 (also known as Title III of the Superfund Amendments and Reauthorization Act (SARA)) required source facilities to submit TRI reports to both the USEPA and their state agency. In addition, many states, including NJ, created their own TRI programs (USEPA, 2004c).

The EDF Scorecard results are meant to provide a perspective on the magnitude and sources of HAP problems (EDF, 2003). The EDF Scorecard indicated that the average individual's added cancer risk in NJ was 1,400 per million people for point sources and 46 per million people for area sources. The EDF Scorecard also reported a noncancer cumulative hazard quotient of 0.12 for point sources and 0.46 for area sources. The hazard quotient was defined as the increased probability of developing adverse but non-cancer health effects over a lifetime from exposure to the modeled ground level air concentrations of HAPs. Hazard quotients greater than one indicate an increased probability of suffering of a chronic disease (morbidity) as a result of exposure to a pollutant. According to the EDF Scorecard, NJ ranked in the highest 20% of all states for the number of people living in areas where the estimated cancer risk from HAPs was greater than 1 in ten thousand (EDF, 2005).

Building on the information learned from the review of the 2002 NATA and the EDF Scorecard, the USEPA's TRI database was used to obtain preliminary data on the emissions of HAPs in NJ. The USEPA compiles the TRI data each year into a database and makes the data publicly available on-line through the USEPA's TRI Explorer and the USEPA's Envirofacts. There are also non-governmental organizations (e.g., EDF) which make the data available on-line through their own data access tools (e.g., EDF's Scorecard). Detailed information on the TRI data and the potential uses for the data are available on-line from the USEPA's TRI website (USEPA, 2004b).

For this study the USEPA's TRI Explorer was used to query the TRI database. TRI Explorer is an on-line tool that allows the TRI database to be searched electronically (USEPA, 2004d). The first year that the TRI data was compiled was 1988 (Martineau, 2004), however the TRI database only contains data starting with the year 1989. TRI Explorer was originally designed to help communities identify source facilities and chemical releases that warrant further study and analysis and as such provided a fast and easy way to access the TRI data (USEPA, 2004b). In NJ, the Department of Environmental Protection (NJDEP) is responsible for the state program. The NJ TRI data is accessible on-line from the NJDEP (NJDEP, 2004b).

The first query of the TRI database was a report for all industries. An industry report was generated for all HAPs, for all industries in NJ. This query produced a downloadable data set that contained data on fugitive air emissions, stack air emissions, and total air emissions of HAPs in pounds. The query was run once a year from 1988 through 2001. The results from the first query indicated that industries in the Standard Industrial Classification (SIC) major group code of 28 were a significant source of air

pollution (Table 3.1). SIC code 28 represents chemicals and allied products (OSHA, 2005). The SIC system is a series of number codes that attempts to classify all business establishments by the types of products or services they provide. Establishments engaged in the same activity, whatever their size or type of ownership, are assigned the same SIC code. Within the manufacturing sector, chemicals and allied products are represented by the major group code 28. This major group includes establishments producing basic chemicals and establishments manufacturing products by predominantly chemical processes. Establishments classified in this major group produce three general classes of products: (1) basic chemicals, such as acids, alkalies, salts, and organic chemicals; (2) chemical products to be used in further manufacture, such as synthetic fibers, plastics materials, dry colors, and pigments; and (3) finished chemical products to be used for ultimate consumption, such as drugs, cosmetics, and soaps; or to be used as materials or supplies in other industries, such as paints, fertilizers, and explosives (OSHA, 2005). It should be noted that the SIC code has now been replaced by the North American Industrial Classification System (NAICS) (USCB, 2006a). Since the SIC code was in use in 1990 (the baseline year for this study) use of the SIC code was considered appropriate for this study.

As shown in Table 3.1, even though the annual quantity of HAPs emitted by all industries of SIC code 28 has decreased dramatically, they still ranked either first or second compared to all other SIC codes. From 1988 through 1997, the chemical industry (SIC code 28) ranked first in terms of overall pounds of HAPs emitted. Beginning in the 1998 reporting year, source facilities in the electric utilities industry category (SIC code 49) were required to report their emissions. Since 1998, the electric utilities

industry has ranked above the chemical industry in terms of pounds released (USEPA, 2004b).

Table 3.1 HAPs Released by All Industries of SIC Code 28 in NJ

TRI Year	Fugitive Air (pounds)	Stack Air (pounds)	Total Air Emissions (pounds)	NJ TRI Ranking by Total Air Emissions
1988	3,755,598	5,148,992	8,904,590	1
1989	2,759,608	4,979,370	7,738,978	1
1990	2,051,782	4,095,593	6,147,375	1
1991	1,618,667	3,802,936	5,421,603	1
1992	1,676,766	3,145,934	4,822,700	1
1993	1,271,132	1,958,265	3,229,397	1
1994	820,312	2,282,367	3,102,679	1
1995	767,615	2,792,110	3,559,725	1
1996	672,790	2,548,211	3,221,001	1
1997	702,354	2,690,541	3,392,895	1
1998	728,898	1,325,765	2,054,663	2
1999	667,919	1,791,611	2,459,530	2
2000	632,931	1,379,613	2,012,545	2
2001	543,243	1,002,706	1,545,949	2

Source: TRI database (USEPA, 2004b).

The second query of the TRI database was a report by geography. The report was generated for all HAPs, released by all industries of SIC code 28, in all counties, throughout NJ. This query was run in order to identify a specific geographic region for this study. The query was run annually per county in NJ to obtain data for 1988 to 2001, inclusive. The queries each produced a downloadable data set that contained data about on-site and off-site reported releases of HAPs in pounds. Table 3.2 shows that Essex County, Middlesex County, and Union County consistently ranked high in terms of the amount of HAPs emitted. Essex, Union, and Middlesex Counties are located in northern NJ. As shown in Figure 3.1, these three counties lie within a heavily urban and industrialized area of NJ and in close proximity to both New York City and the ports of NJ and New York (NY).

Table 3.2 HAPs Released by Industries of SIC Code 28 in NJ, by County

TRI Year	County	Fugitive Air (pounds)	Stack Air (pounds)	Total Air Emissions (pounds)	NJ TRI Ranking by Total Air Emissions
1988	Middlesex	1,049,050	1,071,428	2,120,478	1
1988	Essex	616,210	1,067,670	1,683,880	2
1988	Union	386,364	509,044	895,408	3
1989	Middlesex	872,055	1,008,091	1,880,146	1
1989	Essex	411,765	1,073,934	1,485,699	2
1989	Union	200,239	306,652	506,891	4
1990	Essex	239,696	695,534	935,230	2
1990	Middlesex	277,567	522,970	800,537	3
1990	Union	291,383	451,211	742,594	4
1991	Essex	195,965	795,450	991,415	1
1991	Middlesex	264,685	650,966	915,651	2
1991	Union	420,432	403,224	823,656	3
1992	Essex	150,243	1,036,524	1,186,767	1
1992	Union	343,185	324,447	667,632	3
1992	Middlesex	235,226	383,901	619,127	4
1993	Union	280,234	288,946	569,180	1
1993	Essex	149,495	397,245	546,740	2
1993	Middlesex	194,174	323,262	517,436	3
1994	Union	181,501	356,101	537,602	3
1994	Essex	116,933	412,620	529,553	4
1994	Middlesex	200,538	230,188	430,726	5
1995	Essex	114,009	444,903	558,912	4
1995	Union	214,790	329,094	543,884	5
1995	Middlesex	324,557	218,181	542,738	6
1996	Middlesex	212,740	353,240	565,980	3
1996	Union	224,469	296,989	521,458	5
1996	Essex	63,356	275,347	338,703	6
1997	Essex	60,109	431,324	491,433	4
1997	Middlesex	166,823	304,841	471,664	5
1997	Union	149,085	288,493	437,578	6
1998	Middlesex	179,090	286,049	465,139	2
1998	Union	202,411	232,234	434,645	3
1998	Essex	94,203	147,931	242,134	5
1999	Union	224,172	279,620	503,792	3
1999	Middlesex	123,281	202,684	325,965	4
1999	Essex	66,987	151,651	218,638	5
2000	Union	244,274	271,361	515,635	2
2000	Middlesex	142,570	195,872	338,442	4
2000	Essex	72,263	141,330	213,593	6
2001	Middlesex	199,369	199,860	399,229	3
2001	Union	172,684	209,175	381,859	4
2001	Essex	82,522	102,469	184,991	5

Source: TRI database (USEPA, 2004b).

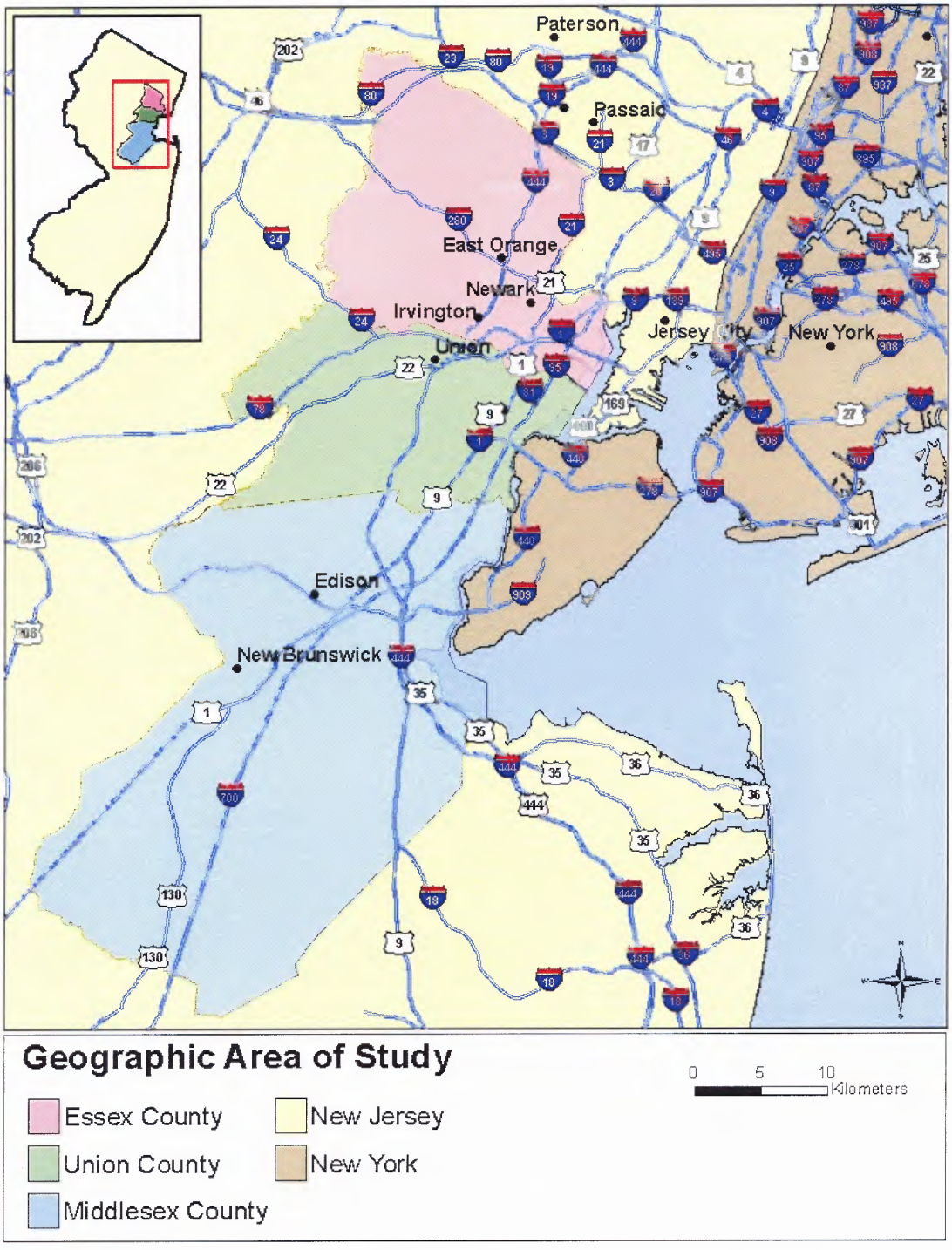

Figure 3.1 Geographic location of Essex, Union, and Middlesex Counties.

Source: County boundary shapefiles obtained from NJDEP (NJDEP, 2004a).

The third query of the TRI database was carried out for all source facilities of SIC code 28, for all HAPs, by specified county (i.e., Essex, Middlesex and Union), by year of interest. This query was run to identify the source facilities from which the air pollution emissions originated. This query was run 14 times per county, for each of the three counties, to obtain data for 1988 to 2001, inclusive. The queries each produced a downloadable data set that included on-site and off-site reported releases of HAPs in pounds. The downloaded data also contained information on the TRIF ID (the TRI facility identification number), the geographic coordinates of the facility (latitude and longitude), and specific information on pollutant releases (i.e., fugitives, stack, and total air releases).

As discussed previously, 1990 was selected as the baseline year for this study. The 1990 data was filtered to identify the source facilities that emitted greater than 10 tpy of a single HAP or 25 tpy of multiple HAPs. Facilities meeting the major source criteria in 1990 were selected as candidates for the MACT standards and therefore, were selected for inclusion in the study. Twenty (20) source facilities were initially selected for inclusion in the study. Seven source facilities were located in Essex County, eight in Middlesex County, and five in Union County.

In NJ, the Open Public Records Act (OPRA) mandates disclosure of governmental records and allows the public to access these records. An OPRA request was performed on all 20 source facilities to obtain the 1990 emission statements and air permits on file at the NJDEP. Information on NJ's OPRA and the forms needed to carry out the OPRA requests were accessed on-line from the NJDEP. The OPRA request was processed by the NJDEP and emissions statements for 17 of the 20 source facilities were

located. The three source facilities for which there was no information were ISP Van Dyk Inc. (Essex County), Ferro Corporation (Middlesex County) and Nutro Labs Inc. (Middlesex County). The initial OPRA request was followed up with a second OPRA request in order to locate information on the three missing source facilities. The second OPRA request was also unable to locate information on the three missing source facilities. The NJDEP could not provide any additional information on why there were no emissions statements for these source facilities for 1990. One possibility was that 1990 was the first reporting year and therefore, these source facilities may not have reported (D. Wong, NJDEP, personal communication, October 8, 2004). The emissions statements for 1991 and 1992 were also requested to check if they could be used to fill gaps in the 1990 data. The research into the 1991 and 1992 data revealed that the NJDEP did not collect data for 1991 and much of the data for 1992 was of low quality and with many missing data points (D. Wong, NJDEP, personal communication, October 8, 2004).

In conclusion, the 1990 data represented the best available data from the early years of reporting and therefore, was chosen for use in the study. Since no emissions statements for 1990 could be located for ISP Van Dyk Inc., Ferro Corporation, and Nutro Labs Inc. these three source facilities were dropped from the study. The 1990 emissions statements for the remaining 17 source facilities were then examined to determine the number of point sources and the HAPs emitted by each point source. Table 3.3 lists the 17 source facilities that were selected for inclusion in this study. Figure 3.2 shows the geographic location of the 17 source facilities in NJ.

Table 3.3 Source Facilities Identified in the Study Area

	Facility	City	County	TRIF ID
1.	Firmenich Inc.	Newark	Essex	07114CHMFL92896
2.	Hoechst Celanese Corporation	Newark	Essex	07105HCHST354DO
3.	Hoffmann-La Roche Inc.	Nutley	Essex	07110HFFMN340KI
4.	Penick Corporation	Newark	Essex	07114PNCKC158MT
5.	Sun Chemical Corporation	Newark	Essex	07105SNCHM185FO
6.	Troy Chemical Corporation	Newark	Essex	07105TRYCHONEAV
7.	Amerchol Corporation	Edison	Middlesex	08818MRCHL136TA
8.	Private Formulations Inc.	Edison	Middlesex	08818PRVTF460PL
9.	RBH Dispersions, Inc.	Bound Brook	Middlesex	08805RBHDSL5FAC
10.	Rhodia Inc.	New Brunswick	Middlesex	08901RHNPL298JE
11.	Staflex Products, Inc.	Carteret	Middlesex	07008STFLXMIDDL
12.	Union Carbide Corporation	Piscataway	Middlesex	08854NNCRB1RIVE
13.	Ciba-Geigy Corp.	Summit	Union	07901CBGGY556MO
14.	Exxon Corp.	Linden	Union	07036XXNCH1400P
15.	Merck & Co. Inc.	Rahway	Union	07065MRCKC126EL
16.	Schering Corporation	Kenilworth	Union	07033SCHRN2000G
17.	Schering Corporation	Union	Union	07083SCHRN1011M

Source: TRI database (USEPA, 2004b).

The SIC sub-codes (e.g., 28XX) for all 17 source facilities were compiled. The MACT regulations corresponding to those SIC sub-codes were obtained on-line from the USEPA's list of NESHAPs (USEPA, 2005e). The SIC sub-codes for the 17 source facilities were covered under four separate MACT standards. A list of the SIC codes and MACT standards are shown in Table 3.4. A detailed description of the applicable MACT standards is presented in Table 3.5.

Table 3.4 SIC Codes and Principle Products of the Study Facilities

Facility	Plant IDs	SIC Code(s)	Principle Products	MACT*
Firmenich, Inc.	06242	2869	Fragrance Raw Materials	3
Hoechst Celanese Corp.	05131	2869	Formaldehyde Solutions	3
Hoffman LaRoche Inc.	30374, 05004	2834	Pharmaceuticals	4
Penick Corp.	06265	2833	Pharmaceuticals	4
Sun Chemical Corp.	06262	2819	Synthetic Organic Chemicals	2
Troy Chemical Corp.	05459	2851	Specialty Chemicals	1
Amerchol Corp.	15343	2843	Cosmetic Intermediates	1
Private Formulations, Inc.	15579	2834	Pharmaceuticals	4
RBH Dispersions, Inc.	15678	2899, 2851	Pigment Dispersions	1
Rhodia Inc.	15101	2869	Industrial Organic Chemicals	3
Staflex Products, Inc	15074	2869	Esters	1
Union Carbide Corp.	15031	2833	Polyethylene	4
Ciba-Geigy Corp.	40017	2834, 2833	Pharmaceuticals	4
Exxon Corp.	40064, 40003, 40276	2869, 2911	Petrochemicals	3
Merck & Co., Inc.	40009	2833	Pharmaceuticals	4
Schering Corp. (Kenilworth)	40384	2834	Pharmaceuticals	4
Schering Corp. (Union)	40084	2834	Pharmaceuticals	4

* Refer to Table 3.5 for a description of the applicable MACT standards.

Table 3.5 MACT Standards Relevant to this Study

	MACT Standard	Description
1.	NESHAP: Miscellaneous Organic Chemical Manufacturing (Miscellaneous Organic NESHAP) (MON)	▪ 68 Fed. Reg. 63851, Nov. 11, 2003 ▪ Compliance date: Nov. 10, 2006 ▪ Facilities described by the SIC Codes 282, 283, 284, 285, 286, 287, 289, and 386 that are not already covered by a specific MACT rule. ▪ Applies to producers of specialty organic chemicals, explosives, certain polymers and resins, and certain pesticide intermediates.
2.	NESHAP: Hazardous Organic Air Pollutants From the Synthetic Organic Chemical Manufacturing Industry (Hazardous Organic NESHAP) (HON)	▪ 59 Fed. Reg. 19402, Apr. 22, 1994 ▪ Compliance date: May 12, 1999 ▪ NAICS Code 325 – Chemical Manufacturing (Includes SIC code 2819 – Industrial Inorganic Chemicals, Not Elsewhere Classified) ▪ To be subject to the HON, a chemical manufacturing process must be used to produce one or more of the 396 SOCMI chemicals listed in subpart F of the rule.
3.	NESHAP: Organic Liquids Distribution (Non-Gasoline) (Organic Liquids Distribution NESHAP) (OLDN)	▪ 69 Fed. Reg. 5038, Feb. 03, 2004 ▪ Compliance date: Feb. 03, 2007 ▪ Facilities described by the SIC Codes 2821, 2865, 2869, 2911, 4226, 4612, 5169, and 5171. ▪ Applies to new and existing organic liquids distribution (non-gasoline) operations, which are carried out at storage terminals, refineries, crude oil pipeline stations, and various manufacturing facilities.
4.	NESHAP: Pharmaceuticals Production (Pharm MACT)	▪ 63 Fed. Reg. 50280, Sept. 21, 1998 ▪ Compliance date: Sept. 21, 2001 ▪ Facilities described by the SIC codes 2833 and 2834. ▪ Producers of finished dosage forms of drugs, for example, tablets, capsules, solutions, that contain an active ingredient generally, but not necessarily, in association with inactive ingredients. ▪ Applies to producers of components whose intended primary use is to furnish pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment, or prevention of disease, or to affect the structure or any function of the body of humans or other animals.

Source: (USEPA, 2005e)

3.2 Estimation of the 1990 Baseline Health Risk

3.2.1 Hazard Identification

The emissions statements for all 17 source facilities were reviewed for content completeness. The emissions statement data were supplied by the NJDEP as Microsoft® Office Excel spreadsheets. Separate spreadsheets were obtained for all 17 source facilities. Within each spreadsheet there were seven individual worksheets labeled A1, A2, B1, C1, D1, E1, and F1. The worksheets contained the following information:

- A1 – plant level data
- A2 – process identification data for sources on record with the NJDEP
- B1 – process and emission information for fuel combustion
- C1 – process and emission information for VOC storage tanks
- D1 – process emission information for batch operations
- E1 – process and VOC emission information for surface coating operations
- F1 – process and emission information for other process types and pollutants

No supporting documentation, such as table descriptions or field descriptions, was received from the NJDEP along with the electronic files. Therefore, another OPRA request was filed with NJDEP, requesting a copy of the guidance document that was issued with either the collection of or the release of the emissions statements. The NJDEP was unable to locate a copy of the guidance document. The earliest guidance document that the NJDEP could locate was the *Guidance Document for the 1993 Emission Statement Report of Actual Emissions* (NJDEPE, 1994). This guidance document was used to determine the general information, table descriptions, and field descriptions for the seven worksheets.

A review of all the worksheets indicated that worksheets A1, A2, and D1 contained the most useful information. Worksheets B1, C1, E1, and F1 did not contain any information that was pertinent to this study. In most cases, worksheets B1, C1, E1, and F1 did not contain any data at all. The actual field values were then checked for consistency with the descriptions reported in the 1993 guidance document. The only deviation found was for the stack diameter field. The stack diameter, reported in the 1990 emissions statements, was in inches as opposed to feet in the 1993 guidance document. The field descriptions of the most relevant fields in worksheet A2 and D1 are listed in Appendix B.

Worksheets A1 and A2 contained the data the source facility had originally entered into parts 1 and 2 of form A of the 1990 New Jersey Department of Environmental Protection and Energy (NJDEPE) Emission Statement (NJDEPE, 1994). Worksheet D contained the data entered on form D. Form A was a multi-part form that was designed to tie together the whole emission statement. It included overview data about the source facility in part 1 and a list of sources that emitted air pollutants in part 2 (NJDEPE, 1994). Form D allowed source facilities to avoid having to report emissions on a source by source basis. Reporting on form D was done on a batch basis. The emissions from the batch were not apportioned to any individual source. If source facilities reported on form D for batch operations then the source facilities were required to identify on part 2 of form A every piece of equipment or emission control device associated with a batch operation (NJDEPE, 1994).

The emissions and point sources for each source facility were determined from worksheets A1, A2, and D1 as follows. First Table D1 (form D) was queried, using the

CHEM_NAME (chemical name) field, to create a list of all the chemicals emitted. The chemicals were checked against the list of 188 HAPs to determine which of the emitted chemicals were HAPs (USEPA, 1990a) (the list of HAPs can be found in Appendix A). If a chemical was determined to be a HAP it was automatically added to a list of COCs for the study. The review of the emissions data indicated that the source facilities emitted numerous chemicals that were not included on the USEPA's original HAP list. These non-HAP chemicals were temporarily added to the list of COCs. In order to evaluate whether the non-HAP COCs should be included in the study, the toxicity of the non-HAP COCs was assessed.

The toxicity information on the non-HAP COCs was researched. Section 3.2.2 (Toxicity Assessment) of this study describes the methodology used to research the available toxicity information. If no chronic toxicity values were available for a chemical, that chemical was dropped from the study. For many of the chemicals, chronic toxicity criteria were not available because the appropriate toxicity testing has not been conducted. This is due to the fact that testing is not usually done on chemicals whose exposure experience suggests a limited potential for long term risk (National Research Council, 1994). The toxicity assessment produced a final list of 102 COCs for which adequate toxicity information existed. The final list of COCs selected for evaluation in this study is listed in Table 3.6. The list of the 35 chemicals dropped from this study due to inadequate toxicity information is shown in Table 3.7. A review of the emissions reports indicated that the annual mass of these 35 chemicals was minimal and therefore, removing them from the study would not have a significant impact. Detailed information on the COCs is presented in Section 3.2.2 (Toxicity Assessment). It is important to note

that the CAA only regulates emissions of HAPs. In this study, the public health risk was assessed for both the HAPs and the non-HAP air pollutants. Including the non-HAP chemicals, as well as the HAPS, allowed for a complete assessment of public health risk imposed by the emitted chemicals.

Table 3.6 List of Chemicals of Concern

Acetic acid	Ethyl acrylate *	N-butyl acrylate
Acetic anhydride	Ethyl chloroformate	Nonanal
Acetone	Ethyl ether	N-propyl acetate
Acetonitrile *	Ethylene dichloride *	Oil
Acrylic acid *	Ethylene glycol *	Pelargonic acid
Acrylic momoner	Ethylene oxide *	Pentanal
Ammonia	Formaldehyde *	Phenol *
Benzaldehyde	Formic acid	Phosphoric acid
Benzene *	Glycerine	Phthalic anhydride *
Benzonitrile	Heptane	Propane
Bis (2-ethylhexyl) adipate	Hexane *	Propanol
Butane	Hydrazine *	Propargyl alcohol
Butanol	Hydrochloric acid *	Propionic acid
Butyl acetate	Hydroquinone *	Propylene glycol, methyl ester
Carbon disulfide *	Isobutane	Propylene oxide *
Chlorine *	Isobutyl alcohol	Pyridine
Chlorobenzene *	Isopentane	Styrene *
Chloroform *	Isopentyl alcohol	Styrene oxide *
Cyclohexane	Isopropanol	tert-butanol
Cyclohexanone	Isopropylamine	tert-butyl chloride
Di(2-ethylhexyl)phthalate *	Maleic anhydride *	Tetrachloroethane *
Diacetone alcohol	Methanol *	Tetrahydrofuran
Dibutyl phthalate *	Methyl acetate	Toluene *
Dichlorobenzene *	Methyl acrylate	Trichloroacetic acid
Diethylene glycol	Methyl amyl alcohol	Trichloroethane *
Diethylene triamine	Methyl bromide *	Tridecyl alcohol
Dimethyl carbamoyl chloride *	Methyl cyclohexane	Triethylamine *
Dimethyl sulfate *	Methyl ethyl ketone *	Triethylene glycol
Dimethylamine	Methyl formate	Trimethyl benzene
Dimethylformamide *	Methyl hydrazine *	Trimethyl borate
Dioxane *	Methyl isobutyl ketone	Vinyl acetate
Epichlorohydrin *	Methyl methacrylate	Vinyl chloride *
Ethanol	Methylene chloride *	Vinyl methyl ether
Ethyl acetate	Naphthalene *	Xylene *

Note: Compounds marked with an asterisk (*) are HAPs

Table 3.7 List of Chemicals Dropped from the Study

1,3-butylene glycol
1-Chloro-3-bromopropane
1-Chloro-3-methoxypropane
2-(1-hydroxypentyl)-cyclopentanone
2-ethylhexanol
2-ethylhexyl acrylate
2-pentylidene-cyclopentanone
3-amino-5-methyl-1H-pyrazole
5-methyl isoxazole
Amyl cinnamic aldehyde
Bromoacetyl bromide
Butoxymethanol
Butyl isocyanate
Butyl methyl ether
Caprolactone
Cyclopentanone
Dimethoxy propane
D-lactone
Ethyl trifluoroacetate
Gamma-butyrolactone
Heptanoic acid
Isobutylene
Isobutyraldehyde
Isophytol
Methoxymethanol
Methyl malonate
N-(1,1-dimethylethyl)-benzenemethanamine
N-ethyl pyrrolidone
Pentyl malonate
Peracetic acid
Phenylacetaldehyde
Phytadiene
Tocopherol
Trimethyl hydroquinone
Vitamin A acetate

Worksheet D1 (form D) also provided information on the stack identifier and the batch identifier the emissions were assigned to. The stack identifier and batch identifier were cross-referenced to worksheet A2 (part 2 of form A) which contained parameters on the equipment used in and the emission sources of each batch process. In all cases, the equipment and emission points listed in worksheet A2 were assigned to a batch process. The emission source parameters and the corresponding emission rates were necessary information required for the air dispersion modeling analysis to determine the ground-level concentration of COCs.

In several cases, there was no information on the physical parameters of the emission sources in worksheet A2. When no information was available, the emissions were transferred to a surrogate emission source located at the same facility. The emission source with the highest emission rate, and for which physical parameter information was available, was chosen as the surrogate. In other cases, information on an entire batch process was missing in worksheet A2. When the batch information was missing, the emissions were transferred to a surrogate emission source as described above. By doing so, all the emissions were captured in the modeling and health risk assessment.

The NJDEP emissions statements contained information on air pollution control devices and the efficiencies of these control devices. In some cases, the source facilities provided information on existing controls. Unfortunately, information on the codes used for the control devices could not determined because the 1990 guidance document could not be located and because the codes used in the 1993 guidance document did not correspond to the 1990 codes. Verbal guidance provided by the NJDEP indicated that the 1990 emissions, listed in the emissions statements, were the total tons per year of the

chemical, emitted from the batch process, after the use of any and all control devices. Appendix B lists the COCs, their emission rates, and the emission source parameters for the point sources for all 17 source facilities.

In this study, the batch operations were assumed to occur continuously throughout the year (i.e., 8,760 hours per year). This assumption was necessary in order to calculate the emission rate for the modeling, since information on the actual batch run time and the actual number of batches per year was not contained in the emissions statements. The emission rates reported in the emissions statements were converted from tons per year to grams per second (g/s) using Equation 3.1.

$$\frac{\text{grams}}{\text{second}} = \left(\frac{\text{tons}}{\text{year}}\right) \times \left(\frac{2000\,\text{pounds}}{\text{ton}}\right) \times \left(\frac{454\,\text{grams}}{\text{pound}}\right) \times \left(\frac{\text{year}}{8760\,\text{hours}}\right) \times \left(\frac{\text{hour}}{3600\,\text{seconds}}\right) \tag{3.1}$$

The emissions statements from the NJDEP did not contain any data on fugitive emissions from the source facilities. As mentioned earlier, the TRI database contained information on both point sources and fugitive emissions. Therefore, the TRI data was the only available source of information to obtain fugitive emissions for this study. The TRI data reflect any reductions in emissions due to the presence of air pollution control devices (N. Lopez, USEPA, personal communication, December 12, 2005). However, a review of the TRI data on fugitive emissions for 1990 did not specifically indicate if any pollution control devices were applied. Therefore, the TRI data for fugitive emissions was assumed to be the amount of fugitive emissions coming from a source facility. It is important to note that source facilities usually estimated fugitive emissions based on simple mass balance calculations and not on true measured values.

Like the point emissions, the fugitive emissions were assumed to occur continuously throughout the year (i.e., 8,760 hours per year). This assumption was

necessary since information on the actual number of tanks fills, tank empties, batch run times, and the actual number of batches per year was not contained in the TRI database for 1990. The emission rates reported in the TRI were converted from pounds per year to grams per second (g/s) using Equation 3.2.

$$\frac{\text{grams}}{\text{second}} = \left(\frac{\text{pounds}}{\text{year}}\right) \times \left(\frac{454\ \text{grams}}{\text{pound}}\right) \times \left(\frac{\text{year}}{8760\ \text{hours}}\right) \times \left(\frac{\text{hour}}{3600\ \text{seconds}}\right) \tag{3.2}$$

Appendix B also lists the COCs, their emission rates, and the emission source parameters for the fugitive sources for all 17 source facilities.

3.2.2 Toxicity Assessment

Toxicity (dose-response) is defined as the ability of a chemical to cause adverse effects at a defined dosage in biological systems. The purpose of the toxicity assessment was two-fold: (1) to identify the carcinogenic and non-carcinogenic effects that may arise from chronic direct inhalation exposure of humans to the COCs and (2) to provide an estimate of the quantitative relationship between the magnitude and duration of exposure and the probability or severity of adverse effects. These estimates of toxicity, commonly known as unit risk (UR) factors and reference concentrations (RfC), can be used to evaluate public exposure to the COCs. In this study only chronic, direct toxicity (both carcinogenic and non-carcinogenic) to humans from the inhalation exposure pathway was evaluated. The term carcinogenic refers to any chemical for which there is sufficient evidence that exposure may result in continuing cell division (i.e., cancer) in humans or animals. Conversely, the term non-carcinogenic refers to any chemical for which the carcinogenic evidence is negative or insufficient (National Research Council, 1994).

Exposure to some chemicals may result in both carcinogenic and non-carcinogenic effects.

Carcinogenic and non-carcinogenic endpoints were evaluated separately because the mechanisms by which chemicals cause cancer are assumed to be fundamentally different from the processes that cause non-carcinogenic effects. The principal difference is the assumption that non-carcinogenic chemicals exhibit a threshold dose below which no adverse effects occur, whereas the general assumption held by most environmental agencies is that no such threshold exists for carcinogenic effects (National Research Council, 1994).

The estimates of toxicity for chronic inhalation exposure are expressed differently for carcinogens and non-carcinogens. For carcinogenic effects, the toxicity estimate was expressed as the inhalation Unit Risk (UR) factor with units of 1 over microgram per cubic meter [$(\mu g/m^3)^{-1}$]. The UR is defined as the upper-bound excess lifetime cancer risk resulting from continuous exposure over a lifetime to an agent at a concentration of 1 $\mu g/m^3$ in air. UR can be interpreted as follows: if UR equals 2×10^{-6} then two excess cancer cases (upper-bound estimate) are expected to develop per million people if exposed daily for a lifetime to 1 microgram (μg) of the chemical in 1 cubic meter (m^3) of air (USEPA, 2005a). For non-carcinogenic health effects, the toxicity estimate was expressed as the reference dose concentration (RfC) with units of milligrams per cubic meter (mg/m^3). The RfC is an estimated concentration level (with uncertainty spanning perhaps an order of magnitude) under which a continuous inhalation exposure to the human population (including sensitive subgroups) is likely to cause an appreciable risk of deleterious effects during a lifetime. Therefore, exposure to a chemical below the RfC,

even over a long period of time, is not expected to have any negative effects on health. RfCs can be derived from a No Observed Adverse Effect Level (NOAEL), a Lowest Observed Adverse Effect Level (LOAEL), or a benchmark concentration. Uncertainty factors (UFs) are generally applied to the RfC to reflect limitations of the data (USEPA, 2005a). The UR and RfC were used as health benchmarks, to evaluate the potential health effects of the COCs in Section 3.2.3 (Exposure Assessment).

The exposure estimates used standard assumptions of body weight of 70 kilograms (kg) and inhalation rates of air of 20 cubic meters per day (m^3/day) for an adult. When exposures to children were assessed, the exposure estimates were corrected to account for differences in exposure between adults and children. This will be discussed in detail in Section 3.2.3 (Exposure Assessment).

Appendix C lists the chronic toxicity values selected for use in this study to evaluate the potential chronic risks associated with direct exposure to air emissions of the COCs. The chronic toxicity criteria used in this study were obtained from the sources listed below and in priority order.

- USEPA Office of Air Quality Planning and Standards (OAQPS) Dose-Response Assessment Tables, February 28, 2005 Version (USEPA, 2005b).
- USEPA Integrated Risk Information System (IRIS) computer database (July 2005). The IRIS database is maintained by the Office of Research and Development, National Center for Exposure Assessment (NCEA), Cincinnati, OH (USEPA, 2005a).
- USEPA Health Effects Assessment Summary Table (HEAST) (July 31, 1997 Edition). The HEAST table was originally produced by the USEPA Office of Emergency and Remedial Response, Washington, DC and is maintained by the Office of Research and Development, National Center for Exposure Assessment (NCEA), Cincinnati, OH (USEPA, 1997b).

- USEPA Region III Risk Based Concentration (RBC) Table (October 2005 Edition). The table is published by the USEPA Region III, Technical Support Section, Philadelphia, PA (USEPA, 2005c).

- New Jersey Department of Environmental Protection (NJDEP) Air Quality Permitting Program Table of Reference Concentrations for Inhalation and the Table of Unit Risk Factors for Inhalation (September 2005 Versions) (NJDEP, 2005).

- California EPA (Cal EPA) Toxicity Criteria Database (July 2005). The Cal EPA database is maintained by the Office of Environmental Health Hazard Assessment (OEHHA), Sacramento, CA (Cal EPA, 2005c). In addition to the database, the Cal EPA Air Resources Board (ARB) publishes a Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (April 25, 2005 Edition) (Cal EPA, 2005a).

- Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels (ESLs) Table, October 01, 2003 Version. The table is produced by TCEQ toxicologists (TCEQ, 2003).

The USEPA OAQPS has prepared toxicity tables for risk assessments of HAPs. The OAQPS has two separate tables available. One table provides values for long-term (chronic) inhalation and oral exposures, and the second table values for short-term (acute) inhalation exposures. The OAQPS table for chronic inhalation was used as the primary source of toxicity data in this study. The advantage to using the OAQPS table is that they draw from numerous sources of toxicity data for many of the 188 HAPs. In creating the table, the OAQPS toxicologists considered the available chronic dose-response toxicity assessments; evaluated their conceptual consistency with USEPA risk assessment guidelines; evaluated their level of peer review; evaluated any available chemical-specific information; and used professional judgment to derive a list of chronic inhalation toxicity values suitable for use in risk assessments. For the oral exposure pathway, the OAQPS table also lists chronic oral toxicity values for persistent and bioaccumulative substances likely to pose important non-inhalation risks when emitted from air sources. The OAQPS

states that the values in the table support hazard identification and dose-response assessment, as defined in the National Academy of Sciences (NAS) risk assessment paradigm, for estimating the risk of contracting cancer and the level of hazard associated with adverse health effects other than cancer (National Research Council, 1983, 1994).

It is important to note that values in these tables are single point estimates within a range of possible values. As such, these values incorporate a certain amount of uncertainty and variability. The OAQPS states the tables are generally appropriate for screening-level risk assessments, including assessments to select contaminants, exposure routes, or emission sources of potential concern, or to help set priorities for further research (USEPA, 2005b).

As mentioned earlier, the OAQPS table contained information on many of the HAPs. Since the OAQPS table only contained HAPs, the IRIS database was used as the primary source of toxicity information for the COCs that were either HAPs but not listed in the OAQPS table or COCs that are not classified as HAPs. IRIS is a database of human health effects that may result from exposure to various substances found in the environment. IRIS was initially developed for the USEPA staff in response to a growing demand for consistent information on chemical substances for use in risk assessments, decision-making, and regulatory activities. The toxicity values in the IRIS database have been subjected to extensive peer-review (USEPA, 2005a, 2005b). Many of the values in the OAQPS table are taken from the IRIS database.

The HEAST tables were used as an additional source of toxicity information for the COCs that were HAPs but not listed in the OAQPS table and the COCs that are not classified as HAPs. The HEAST tables are for use at both Superfund and Resource

Conservation and Recovery Act (RCRA) sites and provide a comprehensive listing of provisional risk assessment information relative to oral and inhalation routes of exposure for chemicals. Some of the values in the OAQPS table are taken from the HEAST tables.

The RBC table was used as an additional source of toxicity information for the COCs that were HAPs but not listed in the OAQPS table and the COCs that are not classified as HAPs. The RBC table lists toxicity values from several sources, including IRIS, HEAST, and provisional USEPA peer reviewed values and is therefore, an excellent source of toxicity information. The RBC table incorporates values from the following sources: (1) IRIS database; (2) HEAST and HEAST Alternate tables; (3) Agency for Toxic Substances and Disease Registry (ATSDR) chronic Minimum Risk Levels (MRLs); (4) USEPA NCEA provisional values; and (5) USEPA provisional peer-reviewed values.

The NJDEP table of Reference Concentrations for Inhalation and table of Unit Risk Factors for Inhalation were used as an additional source of toxicity information for the COCs that were HAPs but not listed in the OAQPS table and the COCs that are not classified as HAPs. The NJDEP Air Quality Permitting Program uses the UR factors and RfCs in these tables in the current risk screening process to evaluate potential health effects from source facilities seeking permits to emit air toxics in New Jersey (NJDEP, 2005).

If none of the above tables or databases produced toxicity values for the COCs, the next source of information consulted was the Cal EPA OEHHA, Toxicity Criteria Database and the Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values. The table is a quick look-up table of all cancer potency values and

noncancer acute and chronic Reference Exposure Levels (RELs) that are available for use in the California Air Toxics "Hot Spots" Program. The table includes cancer potency values and chronic noncancer RELs that have been approved by the OEHHA and the ARB, or are listed in the California Air Pollution Control Officers Association's (CAPCOA) *Risk Assessment Guidelines* (1993). Cancer potency factors are used to assess the cancer risk from carcinogens in the air and RELs are used to assess noncancer health impacts. A chronic REL is an airborne level of a chemical at or below which no adverse health effects are anticipated in individuals indefinitely exposed to that level. Cal EPA develops RELs using the best available published scientific data and based solely on health considerations (Cal EPA, 2005b).

For several COCs the above sources did not provide the required toxicity values. The last source used to locate toxicity information was the TCEQ ESLs. The ESLs are based on data concerning health effects, the potential for odors to be a nuisance, effects on vegetation, and corrosive effects. It is important to note that they are not ambient air standards. However, if predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health or welfare effects are not expected. If ambient levels of constituents in the air exceed the screening levels, it does not necessarily indicate a problem but rather, it triggers a review in more depth. There are two types of ESLs: short-term and long-term. Short-term ESLs are typically measurements for a one-hour averaging period and long-term ESLs are typically measurements for an annual averaging period. The long-term ESLs were used as sources of toxicity data in this study (TCEQ, 2003).

It should be noted that there has been some controversy centered on using the ESLs to determine adverse health levels (TCEQ, 2003). In response to this, the TCEQ has contracted an independent reviewer to do a scientific peer review of the ESL methodology. As of the writing of this study, the findings of their review of the ESL methodology had not been released. The decision to use the ESLs in this assessment was based on the fact that without a toxicity value a COC can not be quantitatively evaluated in the risk assessment. The decision was therefore, made to use the ESL data so that the greatest number of COCs could be included in this study.

3.2.3 Exposure Assessment

3.2.3.1 Geographic Information System (GIS). The GIS software used for this project was ArcGIS (ESRI, Redlands, CA, Version 9.1 for Windows). The base shapefiles for New Jersey were obtained from the NJDEP Bureau of Geographic Information Services website (NJDEP, 2004a). The shapefiles downloaded from the NJDEP and used in this study were:

- Aerial photographs (1995) (supplied as Digital Ortho-QuarterQuads (DOQQs))
- Land Use and Land Cover (LULC) (1986) (filenames: esslulc; unilulc; midlulc)
- State Boundary of New Jersey (filename: state)
- Counties of New Jersey (filename: stco)
- Municipalities of New Jersey (filename: muncoast)

The maps in this study were developed using NJDEP GIS digital data. However, this study and the maps in this study have not been verified by NJDEP and are not state-authorized.

The geographic (latitude and longitude) coordinates of the 17 source facilities in the study were converted to New Jersey State Plane projected coordinates and mapped in GIS. The publicly available software package, Corpscon (U.S. Army Corps of Engineers, Version 5.11.08 for Windows) was used to convert from geographic coordinates (latitude and longitude), NAD 83 into projected coordinates with the State Plane, NAD 83, New Jersey-2900 (U.S. Survey Feet) projection.

In order to verify the accuracy of the geographic coordinates supplied with the TRI data, a field survey was completed. During the field survey, the location and coordinates of all 17 source facilities were verified using a Magellan Meridian GPS unit with an accuracy of three meters or better. The field visit also found that one source facility (Hoechst Celanese Corp.) no longer physically existed. In addition, one of the source facilities (Rhodia Inc.) was no longer operating but the physical facility still existed. Street locations were confirmed using the ArcView extension StreetMAP (ESRI, Redlands, CA). The boundaries of the 17 source facilities were determined based on the results of the field survey and a review of the street level data and aerial photographs in the GIS. The accuracy of the source facility boundaries and property lines was not confirmed with the source facilities themselves. However, the resolution of the street level data and the NJDEP aerial photographs proved extremely helpful in determining the most probable boundaries of the source facilities.

In this study, the human health effects of the emitted COCs were derived from the exposure estimates based on the predicted ground-level air concentrations of the COCs. The air dispersion model was used to predict the ambient air concentrations of the COCs at specific spatial locations around each source facility. The exposure estimates were put

into the GIS for ease of analysis. Using the GIS allowed the results to be interpreted spatially. It also allowed the results for the individual source facilities to be overlaid on each other to estimate the overall cumulative exposure over the geographic area of study.

3.2.3.2 Air Dispersion Model. Air dispersion modeling was carried out to determine the fate of the vapor phase emissions in the atmosphere. The model estimated the average ground-level air concentration at defined geographical receptors during defined timeframes. The air dispersion model used in this study was AERMOD. The AERMOD model has three components:

- AERMET – the meteorological preprocessor
- AERMAP – the terrain data preprocessor
- AERMOD – the air dispersion model

The commercial software package, BREEZE® AERMOD GIS Pro (Trinity Consultants Inc., Dallas, TX, Version 5.1.0) was used for all modeling runs. The BREEZE® software incorporates USEPA Version 04300 of AERMOD. The basic model calculations performed by the BREEZE® software are identical to the calculations performed by the USEPA version of AERMOD that is available on the USEPA Support Center for Regulatory Air Models (SCRAM) web site for public distribution (USEPA, 2002d). The commercial package was chosen simply because the graphical user interface is user-friendly and makes application of the USEPA model easier.

The air dispersion model required input data on source characteristics, emission rates, receptor locations, meteorological parameters, and surrounding terrain elevations. The air dispersion modeling in this study was carried out in accordance with the procedures outlined by the USEPA in the *Guideline on Air Quality Models* which

provides guidance for all regulatory modeling performed in the United States (USEPA, 2005d). In practice, emissions emanating from stacks, vent boxes, and tank vents are modeled as point sources. Fugitive emissions from a tank or a group of tanks are modeled as area sources in which the emission rate is divided by the source area to obtain an area-weighted emission rate. Fugitive emissions from process pads and buildings are modeled as volume sources and assigned dimensions based on the building size in accordance with USEPA guidance (USEPA, 1995a). In this study, the emissions from point sources were modeled as point sources. The emissions statements from the NJDEP did not contain any data on the origin of the fugitive emissions. Therefore, all the fugitive emissions were assumed to emanate from the production buildings and as such, were modeled as volume sources.

Once emitted, pollutants mix with the existing air where turbulence causes the concentration of the pollutants to decrease. Buildings and structures in the vicinity of a stack can affect wind flow which sometimes causes turbulence to develop on the lee side of a building. The turbulence can effect the ground-level concentrations of the emitted pollutant on the lee side of a building and downwind from a building. This phenomenon is known as building downwash (Venkatram & Thé, 2003). Downwash can have important ramifications in the field of air dispersion modeling (USEPA, 1995b). For example, the plume can get caught in the turbulence on the lee side of a building causing concentrations next to a building to be relatively high. The plume may also be carried downwind and dispersed more rapidly by the turbulence (Venkatram & Thé, 2003).

The building downwash algorithms in AERMOD are designed to determine the extent of building downwash occurring. A separate building profile program should be

run for all point emission sources prior to execution of the air dispersion model to determine whether a stack is potentially subject to wake effects from the surrounding structures. The information is then used as an input by the air dispersion model. Since no information about the buildings and structures located on the 17 source facilities was available through the public records, no buildings or structures were included in this study. Therefore, the building profile program was not run prior to the air dispersion modeling runs. Since industrial facilities contain numerous buildings and supporting structures (e.g., sheds and pipe racks) it was assumed that these buildings would cause turbulence. It was further assumed that this turbulence would lead to increased ground-level concentrations within the facility and decreased concentrations downwind of the facility.

The emissions statements from the NJDEP did not contain any data on the geographical locations of the point source and fugitive emissions. Information on the geographical locations of the emissions sources is a required parameter in the air dispersion model. Therefore, assumptions had to be made on where the emissions probably emanated from the source facility. Information gained from the field visits to the source facility and the aerial photographs in the GIS were used to determine possible locations of production buildings or tank farms at the source facility. For example, if the roof of a building contained numerous vents it was assumed to be a production building. The locations selected as the most probable areas for point source emissions and fugitive emissions at all 17 source facilities were digitized and converted into shapefiles using the GIS. Figure 3.3 depicts an example of one of the source facilities in the study. In the example, several buildings were identified to be potential production buildings. The

emissions from the source facility were assumed to emanate from the identified area. Next, a shapefile of the area was digitized in the GIS. The shapefiles were then imported into the air dispersion modeling software and the point sources and volume sources were arbitrarily assigned to geographical locations within the shapefile boundary.

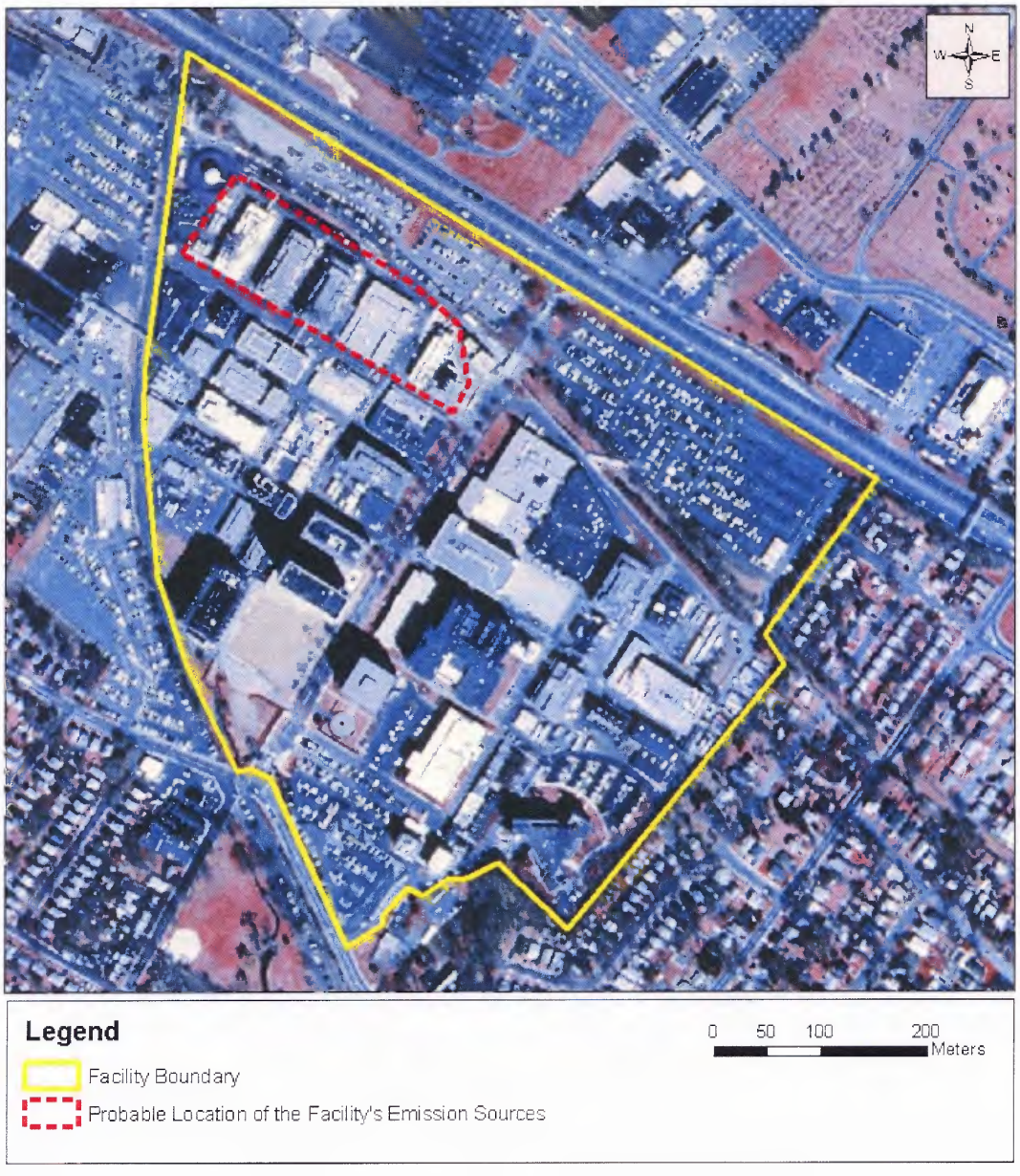

Figure 3.3 Probable location of a facility's emission sources.

Source: Aerial photograph obtained from NJDEP (NJDEP, 2004a).

The air dispersion model required the Universal Transverse Mercator (UTM) coordinates, the release height above ground, and the base elevation above mean sea level for all emission sources. For point sources, the model also required data on mass emission rate, stack gas temperature, stack gas vertical velocity, and stack diameter. The additional inputs required for volume sources were mass emission rate, initial lateral dimension, and initial vertical dimension.

The volume sources were assigned dimensions based on building size in accordance with USEPA guidance (USEPA, 1995a). The initial lateral dimension of the volume source was entered as the length of the digitized volume source divided by 4.3. The length of the building was determined using the aerial photographs in the GIS. Since no information on the height of the buildings was available, some assumptions had to be made. It was assumed that a default building was 6 meters (19.7 feet) high and therefore, the release height (i.e., the center of the building) was assumed to be 3 meters (9.8 feet) above ground level. The initial vertical dimension was calculated using the regulatory standard equation of initial vertical dimension (6 meters) divided by 2.15, which equaled 2.79 meters (9.2 feet). A release height of 3 meters and an initial vertical dimension of 2.79 meters were used for all volume sources modeled.

Reported emission rates were used for all point and volume sources in all modeling runs. Point sources and volume sources at each source facility were grouped into a single "source group" in the air dispersion modeling software. The Breeze® software has a "source groups" option that allows the user to model aggregate contributions from individual emission sources. Each source facility was modeled as an individual source group. The software also allowed several source groups to be modeled

in a single modeling run. This allowed the source groups to be modeled individually and collectively (Trinity Consultants, 2004). Refer to Appendix B for a detailed description of all sources, source parameters, and mass emission rates used in the model. All source facilities except for the Ciba-Geigy Corp. and the Schering Corp. (Union) source facilities contained both point and volume sources. Since there were no fugitive emissions listed in the TRI for the Ciba-Geigy Corp. and the Schering Corp. (Union) source facilities, no volume sources were modeled for those facilities.

All modeling runs used the annual averaging time option. USEPA regulatory default options were chosen for all other model options. The USEPA version of AERMOD only allows one pollutant to be modeled at a time. However, the BREEZE® version of AERMOD has a special add-in, AERMOD-MSP, that allows multiple pollutants to be modeled in a single run (Trinity Consultants, 2004).

All air dispersion modeling output was collected in standard text format files that contained geographical locations ('X' and 'Y' coordinates) for each receptor as well as a modeled air concentration at that receptor. The height for all modeled receptors was ground level (i.e., 'Z' = 0). The modeled air concentrations were expressed as micrograms per cubic meter ($\mu g/m^3$). The maximum annual concentrations from the modeling runs were used in the exposure assessment step.

3.2.3.3 Meteorological Data. Five years of AERMOD formatted metrological data for Newark International Airport, covering the time period 1991 through 1995, was purchased from Trinity Consultants, Inc. The data was comprised of hourly surface air data recorded at Newark International Airport (Call sign EWR, WBAN Station ID 14734). The WBAN Station ID number is a five digit station identifier assigned by the National Climatic Data Center (NCDC) for digital data storage and general station identification purposes (NOAA, 2005). The Newark International Airport weather station is located in Newark, NJ, Essex County. The elevation of the station at ground level is 2.1 meters (7 feet) above mean sea level. The anemometer height is 9.1 meters (30 feet) above ground level. The latitude and longitude of the station is 40° 43' N and 74° 10' W (NOAA, 2005). The hourly surface data contained information on pressure, temperature, cloud cover, ceiling height, wind speed, wind direction, humidity, and precipitation.

The upper air data required for the air dispersion modeling was obtained from the Atlantic City Airport upper air station (Call sign ACY, WBAN Station ID 93755) for all years except 1995. In late 1994, the upper air station was moved from Atlantic City Airport in Atlantic County, NJ to Brookhaven National Laboratory in Suffolk County, NY (Call Sign OCX, WBAN Station ID 94703). The upper air data for 1995 was obtained from the Atlantic City Airport upper air station. This change in location was not anticipated to have any effect on the analysis since the upper air data contains information on pressure, temperature, wind direction, and wind speed at higher altitudes.

Upper air data is taken every twelve hours from weather balloons which measure upper air conditions over a particular location. The upper air data contained vertical

measurements of various upper air parameters collected at various pressures. The upper air measurements are in units of pressure instead of height. Pressure decreases exponentially in the atmosphere as height increases, reaching zero pressure in space. The standard unit for pressure is millibars (mb). The atmospheric pressure at sea level is approximately 1015 mb (UNISYS, 2005).

The raw meteorological data was processed for use in AERMOD using the AERMOD Meteorological preprocessor (AERMET) (Breeze® AERMET, Trinity Consultants Inc., Dallas, TX, Version 4.1.0). AERMET is a three stage meteorological preprocessor. The first two stages involve merging the surface air data and the upper air data into a single file called a merge file (Trinity Consultants, 2004). Since this study involved multiple sites, the best option was to obtain a single merge file (preprocessed through stage two) from a commercial vendor. The benefit of purchasing the merge files from a commercial source was the professional preparation and quality analysis of the data by a professional meteorologist. The quality analysis process identified such issues as missing data, out of range values, and data inconsistencies, and then repaired the data with accepted default values. The Newark International Airport data was supplied in merge format. The merge file was later combined with the various site-specific land use parameters in stage three of AERMET.

The Auer land use method was used to determine the site-specific land use parameters for each of the 17 source facilities. According to the Auer method, a circle with a radius of three kilometers was drawn around the center of each facility in the GIS and the circular area was divided into twelve sectors of thirty degrees each, starting with sector one which was centered on zero degrees (i.e., due north). The land use within each

sector was then classified as either water, urban, deciduous forest, coniferous forest, or grassland, consistent with USEPA guidance (Auer, 1978; USEPA, 1998). The aerial extent of each land use classification, in square meters and as a percentage of the total sector area, was determined using the LULC shapefiles for NJ (obtained from the NJDEP) in the GIS.

GIS analyses indicated that urban was the primary land use in the three kilometer circles for all the 17 facilities. Since all 17 source facilities had the same land use classification, there was no need to create site-specific land use characteristics for each source facility. The land use classifications for the entire study area are shown in Figure 3.4. A single meteorological file was created in AERMET using the Newark International Airport merge file and the land use parameters characteristic of urban areas (USEPA, 2004e). The parameters were taken from Tables 4-1 to 4-3 in Paine (1987), as specified in the *Revised Draft User's Guide for the AERMOD Meteorological Preprocessor (AERMET)* (USEPA, 1998). These tables list typical values of the albedo, Bowen ratio, and surface roughness length as a function of season and land use type. The parameters were incorporated into AERMET using a single sector, as shown in Table 3.8. The input file and summary file from the AERMET run was included in Appendix D. The AERMET processed data was then imported into the air dispersion modeling software.

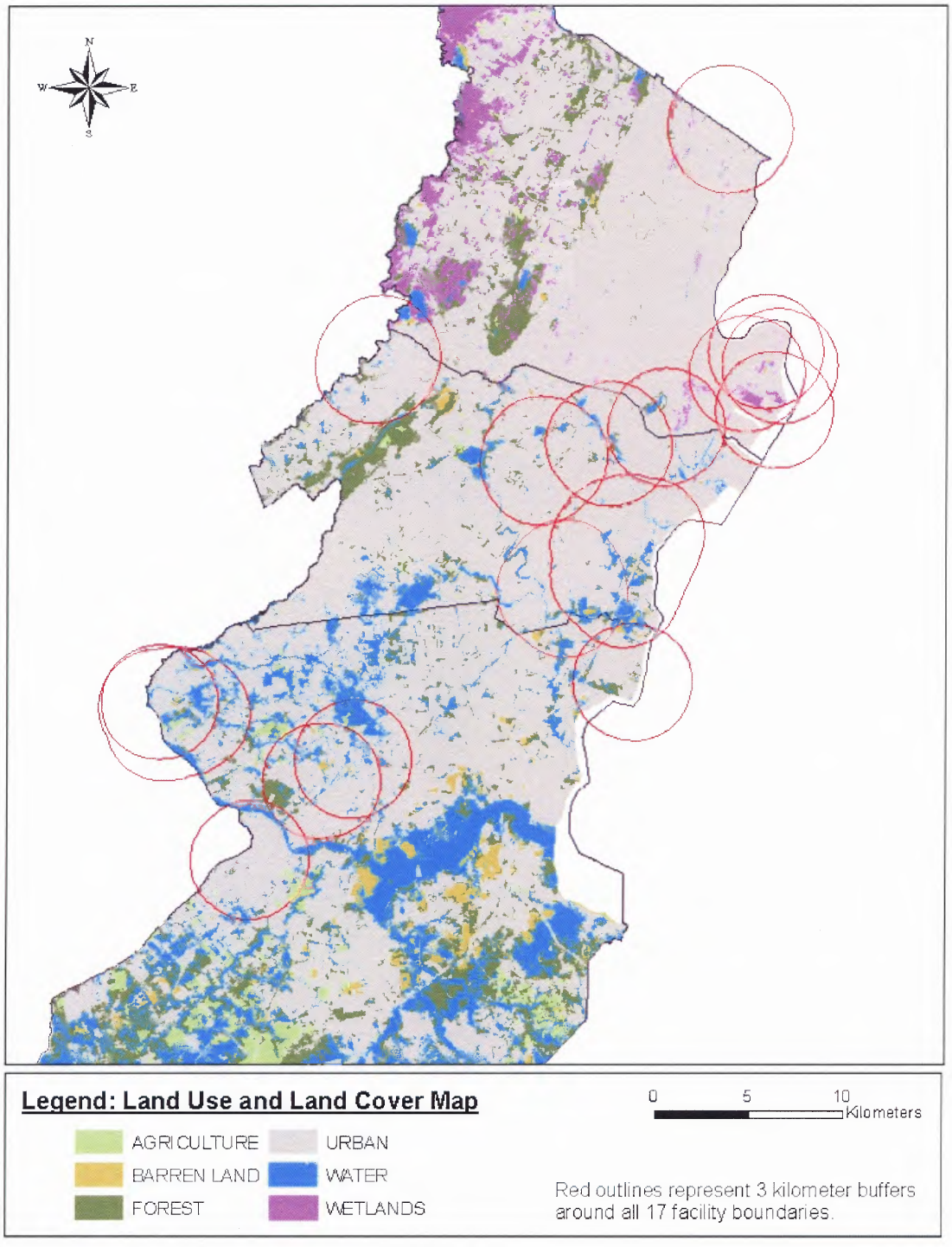

Figure 3.4 Land use characteristics surrounding the source facilities.

Source: County boundary and land use and land cover shapefiles obtained from NJDEP (NJDEP, 2004a).

Table 3.8 Site-Specific Land Use Parameters Used in AERMET

Frequency [1]	Albedo [2]	Bowen Ratio [3]	Roughness [4] (meters)
Winter	0.35	1.75	1.00
Spring	0.14	1.00	1.00
Summer	0.16	2.00	1.00
Autumn	0.18	2.00	1.00

Notes:

1) The four seasons are based on the emergence and growth of vegetation.

2) The albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. Typical values range from 0.1 for thick deciduous forests to 0.90 for fresh snow.

3) The Bowen ratio is the ratio of the sensible heat flux to the latent heat flux and is used for determining planetary boundary layer parameters for convective conditions. The daytime Bowen ratio, an indicator of surface moisture, stays fairly constant during the day. Midday values of the Bowen ratio range from 0.1 over water to 10.0 over desert.

4) The surface roughness length is related to the height of obstacles to the wind flow and is, in principle, the height at which the mean horizontal wind speed is zero. Typical values range from less than 0.001 m over a calm water surface to 1 m or more over a forest or urban area.

Source: (USEPA, 1998)

3.2.3.4 Digital Elevation Models (DEMs). A digital elevation model (DEM) is a digital file consisting of an array of terrain elevations for defined ground positions at regularly spaced horizontal intervals and referenced horizontally either to a projected coordinate system (UTM) or to a geographic (latitude and longitude) coordinate system. The DEM data files used in this study were 7.5-minute DEM files. Each 7.5-minute DEM data file corresponded to a single 1:24,000 scale United States Geological Survey (USGS) topographic map quadrangle of the United States. The 7.5-minute DEM data file consisted of an array of elevations referenced horizontally in the UTM coordinate system, with a uniform horizontal spacing of 10 or 30 meters (USEPA, 2003c). The geographic area for which DEMs were required was determined in the GIS by selecting all USGS quadrangles that were within five miles of any of the 17 source facilities. DEM data was obtained for the following USGS quadrangles: Paterson-NJ, Hackensack-NJ, Morristown-NJ, Caldwell-NJ, Orange-NJ, Weehawkin-NJ-NY, Bernardsville-NJ, Chatham-NJ, Roselle-NJ, Elizabeth-NJ-NY, Jersey City-NJ-NY, Bound Brook-NJ, Plainfield-NJ, Perth Amboy-NJ-NY, Arthur Kill-NJ-NY, Monmouth Junction-NJ, New Brunswick-NJ, South Amboy-NJ-NY, and Keyport-NJ-NY.

The 7.5-minute DEM data files, with uniform spacing intervals of 10 meters (i.e., 10 meter resolution), were downloaded from an on-line spatial data warehouse (Internet: www.geocomm.com) in Spatial Data Standard Transfer (SDTS) format. The DEM data files were converted from SDTS format into native format, the format required by the air dispersion modeling software. The SDTS files were downloaded in UNIX compression format (file type: *.TAR.GZ) and were un-compressed using the shareware version of WIN-ZIP®. Once the files were un-compressed, the public domain program "sdts2dem"

was used to translate the USGS DEM data files from SDTS format to native format (Internet: http://www.cs.arizona.edu/topovista/sdts2dem/). The processed DEM data files were imported into the air dispersion modeling software. As shown in Figure 3.5, the terrain in the study area was relatively consistent with elevations ranging from 0 to 60 meters (0 to 200 feet) above mean sea level.

3.2.3.5 Receptor Grids. In order to spatially model the ambient air concentrations of the emitted COCs, the air dispersion modeling software required a receptor grid layer be created. The GIS was used to create receptor grids that adequately captured the emissions from all 17 source facilities in the study. As presented in Figure 3.4, the three kilometer buffers drawn around each facility boundary suggested four spatial clusters of source facilities. As shown in Figure 3.6, four unique receptor grids were created in the GIS. The boundary of these receptor grids encompassed all the geographical area covered by the three kilometer buffers in each of the four clusters of source facilities. The four receptor grids were named North Essex, East Union, West Union, and South Middlesex.

The North Essex and West Union receptor grids each contained a single source facility. The East Union receptor grid contained ten source facilities and the South Middlesex receptor grid contained five source facilities. The North Essex and West Union receptor grids were both created with 70 points in the X direction (east – west), 70 points in the Y direction (north – south), and with 100 meter (328 feet) spacing between the points. The East Union receptor grid was created with 79 points in the X direction , 98 points in the Y direction, and with 250 meter (820 feet) spacing between the points. The South Middlesex receptor grid was created with 69 points in the X direction, 60 points in the Y direction, and with 250 meter (820 feet) spacing between the points. The use of 100 meter spacing was not practical with the East Union and South Middlesex receptor grids due to the large geographic area that needed to be covered. The North Essex and West Union grids contained 4,900 receptors, the East Union grid contained 7,742 receptors, and the Lower Middlesex grid contained 4,140 receptors.

Once the receptor grids were finalized in the GIS, they were digitized in the air dispersion modeling software as a uniform Cartesian grid. A uniform Cartesian grid is comprised of an array of points identified by their X (east – west) and Y (north – south) coordinates. The receptor grid had a series of parameters associated with it that were used to define it, such as receptor elevation and receptor height (Trinity Consultants, 2004). The height of all receptors in this study was set at ground level. The uniform Cartesian receptor grid was converted into individual discrete receptors in the air dispersion model.

In addition to the discrete receptors, the air dispersion modeling software allows for the creation of discrete boundary receptors. Boundary receptors were placed along the entire boundary of a source facility and allowed for modeling impacts at the property boundary (Trinity Consultants, 2004). The boundaries of all 17 source facilities were digitized in the GIS and imported into the air dispersion modeling software. Discrete boundary receptors were placed along the source facility boundary at 30 meter (98 feet) intervals.

Use of uniform receptor grids resulted in receptors that were located within the property boundaries of several source facilities. The air dispersion model calculates the impacts at all receptors. However, for most regulatory uses, the impacts at on-site receptors are usually excluded because the regulations focus on the ambient environment beyond the facility fenceline (Trinity Consultants, 2004). Therefore, all on-site receptors were automatically removed by selecting the "remove on-site receptors" option in the air dispersion modeling software.

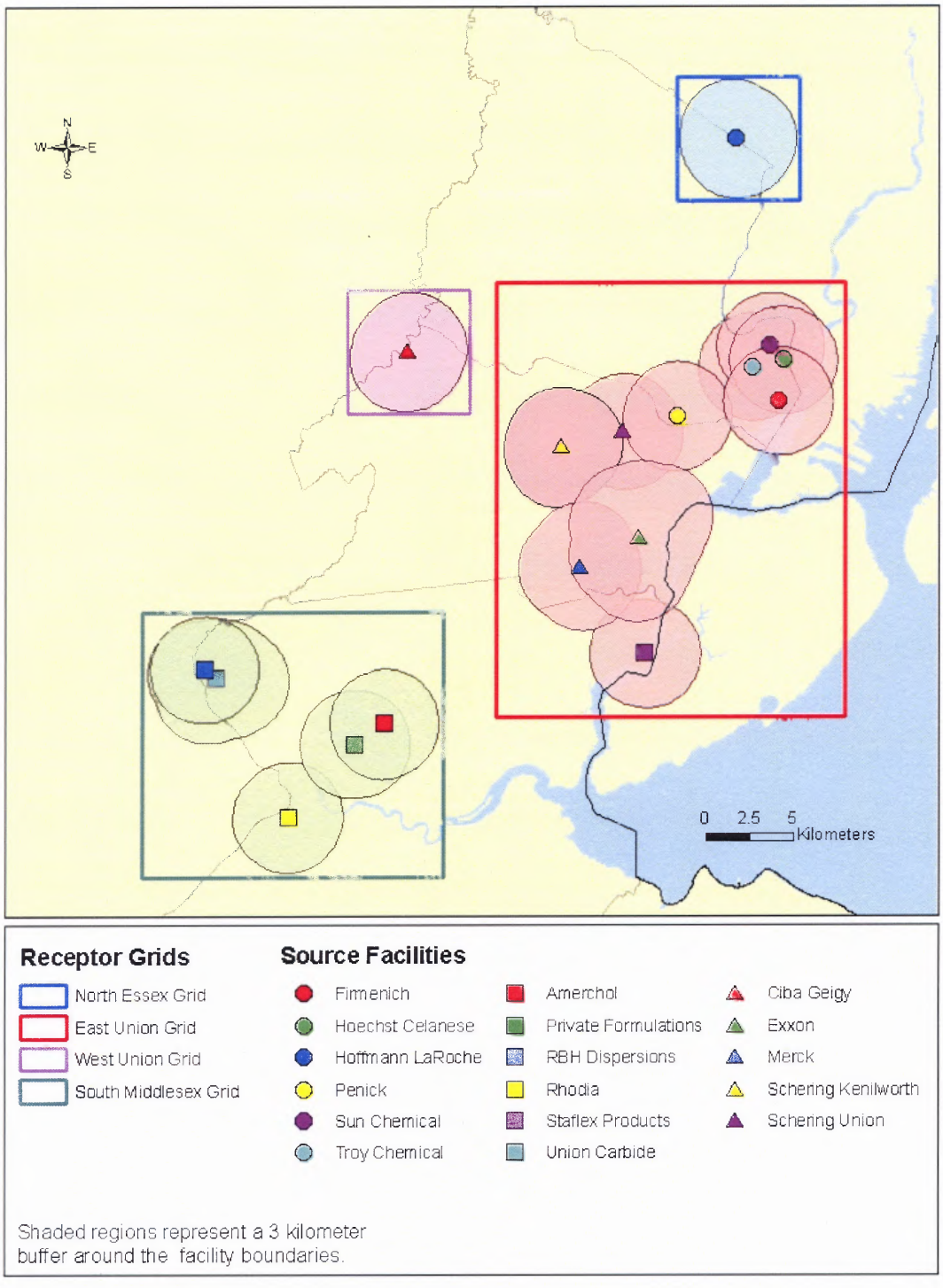

Figure 3.6 Boundaries of the receptor grids used in the air dispersion model.

Source: County boundary shapefiles obtained from NJDEP (NJDEP, 2004a).

3.2.4 Risk Characterization

The risk assessment evaluated the direct risk from inhalation of vapors using standard risk equations and assumptions (USEPA, 1989) and the maximum ground-level air concentrations predicted by the air dispersion model. The USEPA exposure assumptions result in different risk characterizations for adults and children because of varying body weights, exposure times, and inhalation rates. Specifically a Hazard Index (HI) and a Lifetime Incremental Cancer Risk (LICR) were calculated at all receptors for the COCs emitted by the 17 source facilities.

The HI is a measure of the potential for non-carcinogenic adverse effects following exposure to a chemical (USEPA, 1989, 1999c). The HI was calculated using the equation shown below.

$$HI = \frac{C_{air} \times IR_{air} \times EF \times ED}{BW \times RfD_i \times AT_{nc} \times 365 \frac{days}{yr}} \tag{3.3}$$

where:

Parameter	Description	Value	Units
HI	Hazard Index	chemical specific	
C_{air}	Air concentration at receptor	chemical specific	mg/m^3
IR_{air}	Inhalation rate of air (adult/child)	20 / 7.2	m^3/day
EF	Exposure frequency	365	days/year
ED	Exposure duration (adult/child)	25 / 6	year
BW	Body weight (adult/child)	70 / 15	kg
RfD_i	Inhalation reference dose	chemical specific	mg/kg-day
AT_{nc}	Averaging Time - non-carcinogens (adult/child)	25 / 6	year

Equation 3.3 is the relationship between the Average Daily Dose (ADD) and the Reference Dose (RfD) for a particular chemical. The RfD is a measure of the lowest daily dose of a chemical to a human that results in no adverse health effects. Therefore, as long as the ADD is less than the RfD than no adverse health effects are expected. The

RfC described in Section 3.2.2 (Toxicity Assessment) is simply the RfD adjusted for exposure, as such:

$$\mathrm{RfC\,(mg/m^3)} = \mathrm{RfD_{inh}\ (mg/kg/day)} \times \mathrm{bodyweight\ (kg)} \times \frac{1}{\mathrm{inhalation\ rate\ (m^3/day)}} \qquad (3.4)$$

When calculating the HI, the exposure duration and the averaging time are equal. Therefore, Equation 3.3 can be simplified and expressed as:

$$\mathrm{HI} = \mathrm{C_{air}\,(mg/m^3)} \,/\, \mathrm{RfC\,(mg/m^3)} \qquad (3.5)$$

where C_{air} is the ambient air concentration of the chemical predicted by the air dispersion modeling software. A HI of 1 or less for the inhalation pathway typically indicates that exposure to that chemical will not result in any potential adverse health effects from that particular pathway of exposure (USEPA, 1989).

In order to account for exposures to multiple pollutants, regulatory agencies often set the HI goal below 1 for individual chemicals. The HIs for individual chemicals are then summed to calculate the Hazard Quotient (HQ). The cumulative HQ represents the health risk from exposure to multiple pollutants. If the HQ is less than the threshold value of 1 then the individual would not suffer negative health impacts from exposure to all the emitted chemicals (National Research Council, 1994). In this study, a HI was calculated for each COC and a cumulative HQ was calculated for all COCs emitted by all source facilities.

The LICR is defined as the upper-bound probability of developing cancer as a result of continuous exposure to a chemical at the estimated concentration over a 70 year period. This 70 year period is assumed to be the average human lifespan. The predicted

LICR focuses on the additional risk of cancer predicted from the exposure to a chemical (USEPA, 1999c). The LICR was calculated using the equation shown below.

$$LICR = \frac{C_{air} \times EF \times ED \times SF_i \times IR_{air}}{BW \times AT_c \times 365 \frac{days}{yr}} \tag{3.6}$$

where:

Parameter	Description	Value	Units
LICR	Lifetime Incremental Cancer Risk	chemical specific	--
C_{air}	Air concentration at receptor	chemical specific	mg/m^3
EF	Exposure frequency	365	days/year
ED	Exposure duration (adult / child)	70 / 6	yea
SF_i	Inhalation slope factor	chemical specific	$(mg/kg\text{-}day)^{-1}$
IR_{air}	Inhalation rate of air (adult / child)	20 / 7.2	m^3/day
BW	Body weight (adult / child)	70 / 15	kg
AT_c	Averaging time – carcinogens (adult / child)	70 / 6	year

Equation 3.6 is the relationship between the Lifetime Average Daily Dose (LADD) and the cancer Slope Factor (SF) for a chemical (USEPA, 1989). The Unit Risk (UR) factor described in Section 3.2.2 (Toxicity Assessment) is simply the cancer SF adjusted for exposure, as such:

$$UR_{inh}\left(\frac{1}{\mu g/m^3}\right) = SF_{inh}(mg/kg/day)^{-1} \times \frac{1}{\text{body weight (kg)}} \times \text{inhalation rate}\left(m^3/d\right) \times \frac{1}{1000(\mu g/mg)} \tag{3.7}$$

The UR factor is the upper-bound estimate of the lifetime incremental cancer risk as the result of continuous exposure over a lifetime to an ambient air concentration of one microgram per cubic meter ($\mu g/m^3$) of a chemical. Therefore, for carcinogens, the LICR evaluates the degree to which a receptor may have an increased likelihood of developing cancer over a lifetime due to exposure to a chemical. The LADD differs from the ADD in that it assumes a person is exposed continuously to the exposure concentration throughout their lifetime. The inherent assumption for carcinogens is that there is no

threshold dose for carcinogenic effects. Therefore, any exposure to a carcinogen has the potential to cause an effect and as such, all exposures are averaged over the entire lifetime of an individual. The LADD may be adjusted to account for varying exposure durations but the averaging time stays constant at a lifetime. With the ADD, the exposure duration and the averaging times are equal. Equation 3.6 in can be simplified and expressed as:

$$LICR = C_{air}\ (\mu g/m^3) \times UR\ (\mu g/m^3)^{-1} \tag{3.8}$$

where C_{air} is the ambient air concentration of the chemical predicted by the air dispersion modeling software. LICRs are expressed as a unitless probability and are represented in scientific notation as a negative exponent of 10. For example, the probability of developing cancer of one chance in 10,000 is written as 1×10^{-4}. For the great majority of HAPs, the LICR provides an upper-bound prediction of cancer risk as a result of a lifetime of exposure to a level of chemical. In reality, the actual risk may be lower than the predicted risk (USEPA, 1999c). The USEPA cites an acceptable range of 1 in ten thousand (1×10^{-4}) to 1 in one million (1×10^{-6}) for potential cancer risk. Cancer risks less than 1 in one million are considered *de minimis* risk (Martineau, 2004; USEPA, 1989, 1999c).

The risk characterization in this study was a deterministic and simplistic estimate of risk and hazard. In reality, there is variability in the effects seen as a result of exposure. Therefore, a distribution of risk or hazard would be a more realistic representation. This is why the USEPA SAB recommended, in their comments on the prospective Section 812 study, that a probabilistic assessment be used to account for uncertainty and variability, (USEPA, 1999a, 1999c).

In this study, the HI and LICR were estimated for all receptors using the maximum modeled annual average air concentration of the COC, from a source group, at that receptor. The LICR and HI were calculated for each receptor using the exposure calculations for adults and children described in Section 3.2.3 (Exposure Assessment). The LICRs for the individual COCs were summed to derive a cumulative LICR from all COCs. The HI for the individual COC was summed to derive a cumulative HQ for all COCs. The receptors that represented the maximum cumulative LICR and HQ for each source facility were selected. These points of maximum cumulative LICR and HI represented the maximum exposed individual (MEI). The MEI is the receptor where the maximum value occurs, regardless of whether there is a person there or not (USEPA, 2004a). The maximum cumulative LICR values less than the *de minimus* cancer risk of 1 in one million and the maximum cumulative HQ values less than the hazard no-effect level of 1 were considered to be acceptable and were not investigated further in the study. The source facilities that had a maximum cumulative LICR value greater than 1 in one million or a maximum cumulative HQ value greater than 1 were chosen for further investigation in the study.

The data was the imported into the GIS so that the receptor that represented the maximum individual risk (MIR) could be selected. The MIR was a concept included in the benzene NESHAP (USEPA, 1999c). The MIR represents the point of highest estimated LICR or HI to a receptor in areas where people are believed to occupy (USEPA, 2004a). For example, a MIR would not be located in the middle of a stream or in a parking lot. The MIR can be considered equivalent to the term "individual most exposed" which is used in Section 112(f) of the CAA on residual risk (USEPA, 1999c).

To identify the MIR precisely, it is necessary to know detailed information about the locations of actual people in the study area. The GIS is an extremely useful tool in identifying the MIR.

Population assessments were used to estimate the populations exposed to various risk levels in the study area (USEPA, 1999c, 2004a, 2006c, 2006e). This was done by summing up the populations that have predicted LICRs or HQs above a given risk threshold. The LICR multiplied by the population was used to predict the excess cancer cases in the exposed population (ECR, 2005) This 70 year population risk estimate is sometimes divided by 70 to obtain an upper-bound prediction of the number of cancer cases per year (ECR, 2005; USEPA, 1999c).

3.3 Estimation of Human Health Benefits

3.3.1 Air Pollution Controls Required by the MACT Standard

This part of the study assesses the air pollution controls the source facilities would apply to be compliant with the MACT standards. As mentioned previously, the USEPA has specific MACT standards that apply to specific source categories. The MACT standards relevant to this study are described in Table 3.5. An OPRA request was filed with the NJDEP requesting information to help determine if the 17 source facilities in this study had notified the NJDEP of their intent to be covered under the MACT standards. Under the CAA, source facilities are required to notify the NJDEP of their status under MACT. An additional OPRA request was submitted to the NJDEP requesting information and records on the source facilities that had notified the NJDEP of their status under MACT. The information obtained during the record reviews was used to determine what (if any) MACT controls the source facilities may have installed since the baseline year of 1990.

Using actual information on the reported MACT source category and/or the MACT controls installed at each facility, the magnitude decrease in toxic emissions was estimated. If no data could be located then assumptions about the most probable MACT controls applied at each facility had to be made. Since data may not always be available on the effectiveness of the installed controls, it may need to be estimated (USEPA, 1999b). The USEPA has several implementation tools available from the Technology Transfer Network (TTN) website to aid in estimating what MACT controls would be required for a facility. This study evaluated all the emitted COCs not just the HAPs. It is important to note that if the risk happens to be driven by a non-HAP COC, installing MACT controls does not necessarily mean that the non-HAP emissions will be controlled.

As discussed earlier, the USEPA uses a risk range of 1 in ten thousand to 1 in one million as a level of acceptable risk (i.e., 1×10^{-4} to 1×10^{-6}). Since the USEPA is still in the process of promulgating the final residual risk standards, there is no risk threshold against which residual risk can be definitively evaluated. In this study, the lower bound of the acceptable risk range (1×10^{-6}) was chosen so that the goal of protecting public health with an AMOS would be met. If a source facility's predicted post-MACT risk level was less than 1 in one million then there was no need for additional air pollution controls or reductions in risk. If a facility's predicted post-MACT risk exceeded 1 in one million, then the emission reductions the facility would need to take to meet 1 in one million was assessed and the cost for any additional air pollution controls was also estimated.

3.3.2 Economic Valuation of Human Health Benefits

Translation of health benefits into dollar value is the most contentious aspect of a benefit and cost analysis (Davies & Mazurek, 1998). The difficulty arises in attempting to place a dollar value on a good, such as health, that is not sold in markets. The contention arises due to the large interpersonal variability people exhibit when asked to place a value on a reduction in risk, an improvement in health, or a human life. Health benefits can be expressed in terms of the lessening of effects of a chronic disease (morbidity) or preventing a premature death (mortality). When estimating morbidity benefits, economists consider empirical criteria such as loss of income while a person is sick and/or the medical costs incurred to treat the illness. In addition, psychological aspects such as the unpleasantness of being sick should also factor into the overall estimate of the benefits (Portney, 2000). Mortality benefits are usually measured by a person's WTP for an air quality improvement that reduces the probability of dying (Portney, 2000). Obviously, the WTP is affected by how the probability is defined and the magnitude of the reduction in probability. The WTP to prevent mortality is the VSL and it represents the value of preventing one case of premature mortality.

There are two broad classifications of economic methods used to estimate environmental values and health benefits: direct and indirect methods. Both the direct and indirect methods can be based on observable behavior (i.e., revealed preference studies) or behavior that takes place when a person is presented with a survey about a hypothetical situation (i.e., stated preference studies) (Tietenberg, 2000b).

The direct observable method infers the value from actual observable choices in a real market. For example, the economic loss of crop injury from a drought can be

directly calculated using market prices. The direct observable method is not useful in estimating a value for incremental changes in human health since health is not sold in markets. The direct hypothetical method, also known as contingent valuation or stated preference studies, makes use of the personal choices a consumer makes in a hypothetical situation. The choices a person makes are used to estimate the person's WTP for an environmental or health benefit that does not have a market value. Several indirect observable methods can also be used in the valuation of health benefits. These methods, commonly referred to as revealed preference methods, are the revealed choice method, the hedonic property value method, the hedonic wage method, and the averting behavior method. All these methods infer a value estimate by studying related real markets (Smith & Huang, 1995; Tietenberg, 2000b; Tsuge et al., 2002; Viscusi, 1993). A common indirect and hypothetical method used to estimate the value of health benefits is the contingent valuation method. This method uses a sample survey designed around a hypothetical model to estimate people's WTP for the health benefit (Viscusi, 1993).

In this study, the post-MACT health benefits were estimated by the reduction in emissions the MACT controls would produce. The post-MACT health benefits were then compared to the baseline 1990 pre-MACT results. The benefit of the regulation was estimated by analyzing reductions in mortality and morbidity. In this study, mortality was measured by the LICR due to exposure to the COCs. Morbidity was represented by the increased possibility of developing chronic health effects and was measured by the HI and HQ. The HI assessed the possibility of increased incidence of a chronic disease for a particular COC and the HQ assessed the probability of increased incidence of a chronic disease cumulatively from all COCs. In this study, the *de minimus* risk threshold is 1 in

one million for the LICR. There was no need to quantify the health benefits gained by lowering the LICR below the *de minimus* levels. Similarly, if the predicted HQ was below 1 there was no need to quantify the health benefits gained by lowering the HQ below the acceptable threshold.

Benefit transfer is the valuation method used by the USEPA in its prospective Section 812 study to derive monetary values of health effects. Benefit transfer is the application of existing information available from research, to new contexts for which information is not available (Rosenberger & Loomis, 2001). The existing information can be on a place, an observed behavior, or a hypothetical scenario. The new context can be another related place, a related benefit, or a policy for which there is little or no data available on the economic value. Benefit transfer provides a means by which a value can be estimated in the new context using existing information about the value for similar context (Rosenberger & Loomis, 2001). In this study, the monetary value of the health benefit was based on the WTP data in the literature. This WTP data was estimated through stated preference and revealed preference methods.

In the prospective Section 812 study, the USEPA used WTP data to estimate the value of avoiding several morbidity effects. For example, the mean value of avoiding incidence (in 1990 dollars) of morbidity due to respiratory illness from chronic bronchitis and chronic asthma was estimated at $260,000 per case and $25,000 per case, respectively (USEPA, 1999b). In the same prospective study, the USEPA used $4.8 million (in 1990 dollars) as the VSL (USEPA, 1999b). This VSL was based on twenty-six relevant studies available at that time in the literature. Five of the twenty-six studies were contingent valuation studies and the remainder were hedonic wage studies (USEPA,

1999b). Therefore, the VSL was estimated using primarily hedonic wage studies (USEPA, 1999b).

The mortality benefits were calculated by multiplying the VSL by the estimated number of deaths prevented. Morbidity effects were calculated in a similar fashion by combining the estimates of the reduction in the number of cases of a disease prevented, the reduction in lost work days, and the value of each effect. The USEPA has also developed economic guidelines for its regulatory impact analyses. The guideline recommends a VSL of $6.2 million (in 2000 dollars) (USEPA, 2000a).

Recently, Viscusi and Aldy (2003) critically reviewed thirty years of scientific work on the VSL. The review is a meta-analysis of sixty mortality studies and forty morbidity studies using several valuation methodologies, namely contingent valuation studies, hedonic wage studies, hedonic housing price studies, and averting behavior studies. The review discussed the advantages and limitations of the various valuation methodologies and considered VSL estimates from both the United States and abroad. They found the estimates of the VSL, using the hedonic wage model, ranged from $4 to $9 million in 2000 dollars in the United States. Canadian estimates ranged from $2 to $6 million in 2000 U.S. dollars and were in line with U.S. estimates. However, in England the VSL estimates ranged from $18 million to as high as $68 million in 2000 U.S. dollars. The English numbers were primarily based on CV studies, which might account for the wide disparity between England and the United States. The review suggested using a median estimate VSL of $7 million in 2000 dollars (Viscusi & Aldy, 2003).

In order to estimate the benefits, it was also necessary to determine the number of individuals exposed to levels of COCs that exceeded the safe threshold levels. The

affected population was estimated using 1990 Census information available electronically at the block group level. The block group level was the highest resolution data available for the 1990 Census. Digital boundary files for the 1990 Census block groups were available on-line as shapefiles from the United States Census Bureau (USCB) (USCB, 2005).

The 1990 Census block groups that had receptors with a LICR greater than 1 in one million or a HQ greater than 1 were selected in the GIS. The populations of the selected block groups were found in the Summary Tape File (STF-1) for the 1990 Census which was available on-line from the USCB (USCB, 2006b). The numbers of individuals in each block group were summed to derive the total number of people residing in the affected area. The total population impacted was an overestimate since the population of the entire block group was included in the assessment regardless of the percentage of the block group that actually exceeded the thresholds. The total population impacted (at a LICR greater than 1 in one million or HQ greater than 1) was assumed to be the number of incidences of mortality or morbidity that could be reduced. The benefits were calculated by multiplying the number of reduced incidences of morbidity or mortality by the estimated WTP values of avoiding the health effects.

This study only looked at the benefits and costs of Title III of the 1990 CAAA. As in the prospective Section 812 study by the USEPA, minor and reversible effects and acute duration exposures were not addressed as benefits in this study. In addition, environmental benefits such as improvements in ecosystem health, improvements in visibility, or benefits to agriculture were not considered in the calculation of benefits. Environmental benefits are more accurately reflected in Titles I, II, IV, and VI of the

1990 CAA Amendments. In addition, acute health effects possibly attributable to short term upsets or meteorological disturbances were not considered within the scope of this study.

Several USEPA guidance documents were consulted during the process of benefit estimation. They are the *Guidelines for Preparing Economic Analysis* (USEPA, 2000a), the *Handbook for Non-Cancer Health Effects Valuation* (USEPA, 2000b), the *Children's Health Valuation Handbook* (USEPA, 2003a), and the *Cost of Illness Handbook* which is an on-going project that is provided on-line by the USEPA (USEPA, 2006d). In addition, a USEPA National Center for Environmental Research project on valuation for environmental policy included numerous helpful references pertaining to valuation of mortality and morbidity (USEPA, 2003b).

3.3.3 Normalization of Costs and Benefits

The benefit and cost estimates presented throughout this study were normalized to the base year 2003 and are expressed in 2003 U.S. dollars. Normalization of costs and benefits were necessary to ensure all costs and benefits were comparable. For example, the USEPA used a VSL of $4.8 million (in 1990 dollars) in its retrospective study and a VSL of $6 million (in 1998 dollars) in its prospective study. The VSLs were actually equivalent in both studies after the adjustment for inflation. One method of normalizing is to adjust the dollar values to a base year using a price index (USEPA, 2000a).

The benefit and cost estimates presented throughout this study were all normalized to 2003 dollars based on the latest price indices by U.S. Department of Labor (USDOL), Bureau of Labor Statistics. The USDOL publishes a variety of price indices tailored to specific sectors and/or industries. The most recognizable indices are the

Consumer Price Index (CPI) and the Producer Price Index (PPI). The CPI is the most widely used measure of inflation and is called the cost of living index. The CPI is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. The CPI can be used as a deflator of the value of the dollar to aid in determining a consumer's purchasing power at different time periods. As prices increase, the purchasing power of the consumer could decline if the total income of the consumer stays the same. CPIs are available for major groups of consumer expenditures (e.g., food and beverages, housing, apparel, transportation, medical care, recreation, education and communications, and other goods and services), for items within each major group, and for special categories such as services (USDOL, 2003a). CPIs are available on-line from the USDOL (USDOL, 2003a).

The PPI is a family of indices that measures the average change over time in selling prices received by domestic producers for their goods and services (USDOL, 1997). The USDOL PPI data contains over 500 industry price indices in combination with over 10,000 specific product line and product category sub-indices. PPIs are available on-line from the USDOL (USDOL, 2003c). In 1994, the USEPA created a series of custom indices, referred to as the Vatavuk Air Pollution Control Cost Indexes (VAPCCI), that specifically focused on eleven environmental pollution control devices (USEPA, 2000a). In 2005, the USEPA stopped supporting the VAPCCI due to changes in the data collected by the USDOL, Bureau of Labor Statistics (USEPA, 2006h).

In this study, the MACT control costs in a given year were adjusted for inflation, to the cost in 2003 dollars, by multiplying the control cost by a ratio of the PPIs in both years as reported by the USDOL, as shown in Equation 3.9.

$$\frac{\text{Control Cost}_{\text{year}}}{\text{Price Index}_{\text{year}}} = \frac{\text{Control Cost}_{\text{base year}}}{\text{Price Index}_{\text{base year}}} \quad (3.9)$$

This methodology is described in the USDOL guidance document, *Escalation and Producer Price Indexes* (USDOL, 1991) and the USEPA guidance document, *Guidelines for Preparing Economic Analyses* (USEPA, 2000a).

A review of the available industry specific PPIs did not locate a PPI specific to the pollution abatement industry (USDOL, 2003c). Therefore, the PPI database was queried using the following selections: the industry was set to special industry machinery (code #3559) with the product set to chemical manufacturing machinery, equipment and parts (code #1) (query code PDU3559#1). This query produced a table of annual PPI data from 1990 to 2003, which is shown in Table 3.9. The industry classifications used in the PPI were based on the SIC system. SIC code 3559 describes Special Industry Machinery, Not Elsewhere Classified. The product code designated specific products manufactured within the specified industry. A second query was carried out using a generic, aggregate index for total manufacturing industries (query code PCUOMFG#) (USDOL, 2003c). The overall change in the aggregate index was less than the change in the specific index because it included the effects of all industries, some of which are volatile and may have decreased the overall index. For this study, the cost of the pollution abatement equipment was adjusted using the data for the chemical manufacturing machinery, equipment, and parts index, since this index was considered more relevant.

Table 3.9 Selected Annual Producer Price Indices

Year	Chemical Manufacturing PPI [1]	Total Manufacturing PPI [2]
1990	130.4	114.5
1991	133.9	115.9
1992	137.9	117.4
1993	142.0	119.1
1994	144.9	120.7
1995	150.4	124.2
1996	152.5	127.1
1997	158.7	127.5
1998	161.8	126.2
1999	165.8	128.3
2000	168.5	133.5
2001	168.5	134.6
2002	165.7	133.7
2003	163.3	137.1

Notes:

1) Series Id: PDU3559#1
   Industry: Special industry machinery, n.e.c.
   Product: Chemical manufacturing machinery, equipment and parts.

2) Series ID: PDUOMFG#
   Industry : Total manufacturing industries
   Product : Total manufacturing industries

Source: (USDOL, 2003c).

The benefits in a given year were adjusted for inflation to 2003 dollars, using the CPIs as reported by the USDOL, in a similar manner, as shown in Equation 3.10.

$$\frac{\text{Benefits}_{\text{year}}}{\text{Price Index}_{\text{year}}} = \frac{\text{Benefits}_{\text{base year}}}{\text{Price Index}_{\text{base year}}} \tag{3.10}$$

This methodology was described in the U.S. Department of Labor (USDOL) guidance, *How to Use the CPI Index for Escalation* (USDOL, 2003b).

CPI data were obtained for the aggregate index for *U.S. Medical Care* and *U.S. All Items* over the time frame 1990 to 2003. The CPI data are shown in Table 3.10. The benefits in this study were normalized using the CPI relating to the aggregate index for *U.S. Medical Care*. The CPI relating to the aggregate index for *U.S. Medical Care* was considered more relevant since the goal was to standardize the value of health effects.

Table 3.10 Selected Annual Consumer Price Indices

Year	Annual CPI [1] U.S. Medical Care	Annual CPI [2] U.S. All Items
1990	162.8	130.7
1991	177.0	136.2
1992	190.1	140.3
1993	201.4	1445
1994	211.0	148.2
1995	220.5	152.4
1996	228.2	156.9
1997	234.6	160.5
1998	242.1	163.0
1999	250.6	166.6
2000	260.8	172.2
2001	272.8	177.1
2002	285.6	179.9
2003	297.1	184.0

Notes:

1) Series Id: CUUR0000SAM
   Area: U.S. city average
   Item: Medical care

2) Series ID: CUUR0000SA0
   Area: U.S. city average
   Item: All items

Source: (USDOL, 2003a).

3.4 Estimation of Cost Data for Air Pollution Controls

In this part of the study, the cost of the air pollution control equipment that the source facility would incur or had incurred due to the MACT standards was estimated. First, the *Pharmaceutical MACT Rule Assistant*, a USEPA on-line tool, was run to determine the compliance options available under the Pharmaceuticals MACT standard for the source facilities (USEPA, 2006f). The following information on compliance options was obtained from the *Pharmaceutical MACT Rule Assistant*. The Pharmaceuticals MACT has specific standards, test methods, and initial compliance requirements for each of the four source categories: process vents, storage tanks, equipment leaks, and wastewater. In addition, there are specific monitoring, reporting, and recordkeeping requirements associated with the individual compliance options. The pharmaceutical MACT specifies air emissions standards (1) across all process vents within a process and (2) for large individual process vents that meet a certain flowrate threshold.

There are several compliance options existing source facilities can undertake to demonstrate compliance across all process vents within a process.

- Set annual mass limits for all vents within a process. In order for a source facility to choose this option, the emission rate must be less than 900 kilograms per year (< 2000 pounds per year) for each vent and less than 1,800 kilograms per year for the entire facility (< 4000 pounds per year).
- Reduce emissions from all vents within a process, which exceed a minimum flow rate, by 93 percent.
- Add a combustion control device (e.g., a thermal incinerator) at each outlet.

Compliance with the second air emission standard (the individual vent standard) requires that each individual vent, which exceeds a minimum flow rate, must reduce uncontrolled emissions by 98 percent.

The USEPA regulations also provide for an alternative option (the pollution prevention option) to meet the emission standards. The pollution prevention option allows the source facilities to incorporate pollution prevention initiatives instead of traditional end-of-pipe controls. After initial compliance with the emission standards is demonstrated, the source facility must conduct periodic monitoring and reporting to confirm on-going compliance. Similar information on air emission standards was obtained for the HON, MON, and the OLDN (Table 3.5).

Based on the review of the MACT standards, the traditional end-of-pipe controls that would be applied to the source facilities in this study were thermal incineration with a post-incineration wet scrubber. Detailed information on these two air pollution control technologies was obtained from the USEPA's Technology Transfer Network (TTN), Clean Air Technology Center (USEPA, 2006a, 2006b, 2006h). According to the USEPA, the thermal incinerator unit is also referred to as a thermal oxidizer unit (TOU) and the control of volatile organic chemicals (VOCs) is based on destruction by thermal oxidation (USEPA, 2006b). VOC destruction efficiency depends upon design criteria (e.g., chamber temperature, residence time, inlet VOC concentration, compound type, and degree of mixing). Typical thermal incinerator design efficiencies range from 98 to 99.99 percent and above depending on system design and characteristics of the waste stream. If the waste stream contains halogen- or sulfur-containing compounds then hydrogen chloride, hydrogen fluoride, sulfur dioxide, and other highly corrosive acid gases may form. In that case, installation of a post-oxidation acid gas treatment system (i.e., a wet scrubber) is required for control of the acid gases (USEPA, 2006b). Wet scrubbers are used to control inorganic gases and are commonly referred to as acid gas

scrubbers. They remove air pollutants by inertial or diffusional impaction, reaction with a sorbent or reagent slurry, or absorption into a liquid solvent. Control efficiencies range from 95 to 99 percent depending on the type of reagent used and the scrubber design (USEPA, 2006a).

The former Innovative Strategies and Economics Group of the USEPA (now known as the OAQPS – Air Benefit and Cost Group) have developed methodologies for estimating the costs of air pollution regulations. Their findings are available on-line at the USEPA TTN webpage and include cost methodology manuals as well as spreadsheets for estimating capital and annual costs (USEPA, 2006i). The USEPA fact sheets contained the costs of both the thermal incinerator (USEPA, 2006b) and the wet scrubber (USEPA, 2006a). The costs were adapted from USEPA cost estimating spreadsheets and the USEPA *Air Pollution Control Cost Manual, 5th Edition* (EPA 453/B-96-011). The costs in the fact sheets are referenced to the volumetric flow rate of the treated waste stream. According to the fact sheets, thermal incineration has an annualized cost of $400 to $3,300 per short ton (i.e., 2,000 pounds) of VOCs ($440 to $3,600 per metric ton). The wet scrubber has an annualized cost of $45 to $860 per short ton of VOCs ($50 to $950 per metric ton).

The USEPA *Air Pollution Control Cost Manual* details the engineering information and cost information and is an accepted standard in the field of environmental pollution control sizing and costing. The estimating procedures used in the *Manual* are nominally accurate to within plus or minus 30 percent and are referred to as "study" estimates. The *Manual* is useful for estimating costs intended for use in regulatory development because the estimating procedures do not require detailed site-

specific information. The detailed information necessary for site-specific level analyses are usually proprietary and not readily available to the regulator. In addition, detailed analyses are usually very costly to carry out. Therefore, the cost estimates in the *Manual* offer sufficient detail for regulatory analysis purposes (USEPA, 2002a).

The annualized cost reflected the total capital investment and the total annual operation and maintenance cost for the air pollution control device. The total capital investment captures the total direct and total indirect costs of the air pollution control equipment plus any additional costs for land or off-site facilities. The total direct and total indirect costs comprise the majority of the costs for air pollution control equipment. The total direct costs include the costs required to purchase the equipment needed for the control system (purchased equipment costs); the costs of labor and materials for installing that equipment (direct installation costs); the costs for site preparation and buildings; and certain other costs (indirect installation costs). Indirect installation costs include engineering costs, construction and field expenses, contractor fees, start-up and performance test costs, and contingencies (USEPA, 2002a).

Once routine operations begin, the total annual cost occurs. Routine operation of the control device does not begin until the system is working within its design parameters. The total annual cost is comprised of the direct costs, indirect costs, and any recovery credits for materials or energy. The direct costs are the costs for raw materials, energy, utilities, and waste treatment and disposal. The indirect costs are for labor, maintenance materials, and repair parts. The indirect costs are comprised of costs for administration, overhead, property taxes, insurance, and capital recovery (USEPA, 2002a).

As mentioned earlier, the risk was calculated using actual emissions from the source facilities expressed in pounds per year of COCs emitted. The costs of the air pollution control were converted to an abatement cost per pound of COC emitted. The cost, of the MACT air pollution controls for a source facility, was calculated by multiplying the abatement cost for the COCs (in terms of pounds emitted) by the actual amount of all COCs emitted in pounds per year.

3.5 Benefit and Cost Assessment

The final part of the study compared the public health benefits gained through the additional MACT air pollution controls to the implementation cost of installing and operating and maintaining the additional controls. The benefits and costs of the air pollution control devices occur over an extended period of time. Consequently, the benefit and cost assessment must capture the future effects of current decisions.

The USEPA's prospective Section 812 study indicated that the Title III provisions of the 1990 CAAA comprised only a small fraction ($840 million out of $27 billion, in 1990 dollars) of the total costs of implementing the provisions of the CAA. However, the implementation costs of meeting the requirements of Title III only reflected the public costs incurred to the federal and state regulatory agencies. These public costs did not take into account the private costs of implementing the MACT standards incurred by the source facilities. Therefore, it is anticipated that the total costs of implementing Title III will be substantially higher when the private costs of MACT implementation are considered.

The results of the quantitative risk assessment were used as the basis for a benefit and cost comparison of the MACT standards. Title III of CAA would be efficient if

MACT standards were maximizing the net social benefits to society (i.e., maximizing social welfare). The net social benefit to society is equal to the sum of the gains (benefits) minus the losses (costs) to society from policies that change prices and quantities (Figure 3.7). In this study, the primary recipient of the benefits was the community and the primary bearer of the costs was the source facilities. The costs were the private costs to the source facilities for implementing the MACT controls. The public costs to society to administer and enforce Title III were not considered. Therefore, the net benefit in this study was calculated as the benefits to society minus the private costs to the source facilities from implementing the MACT standards as outlined in Title III of the 1990 CAAA.

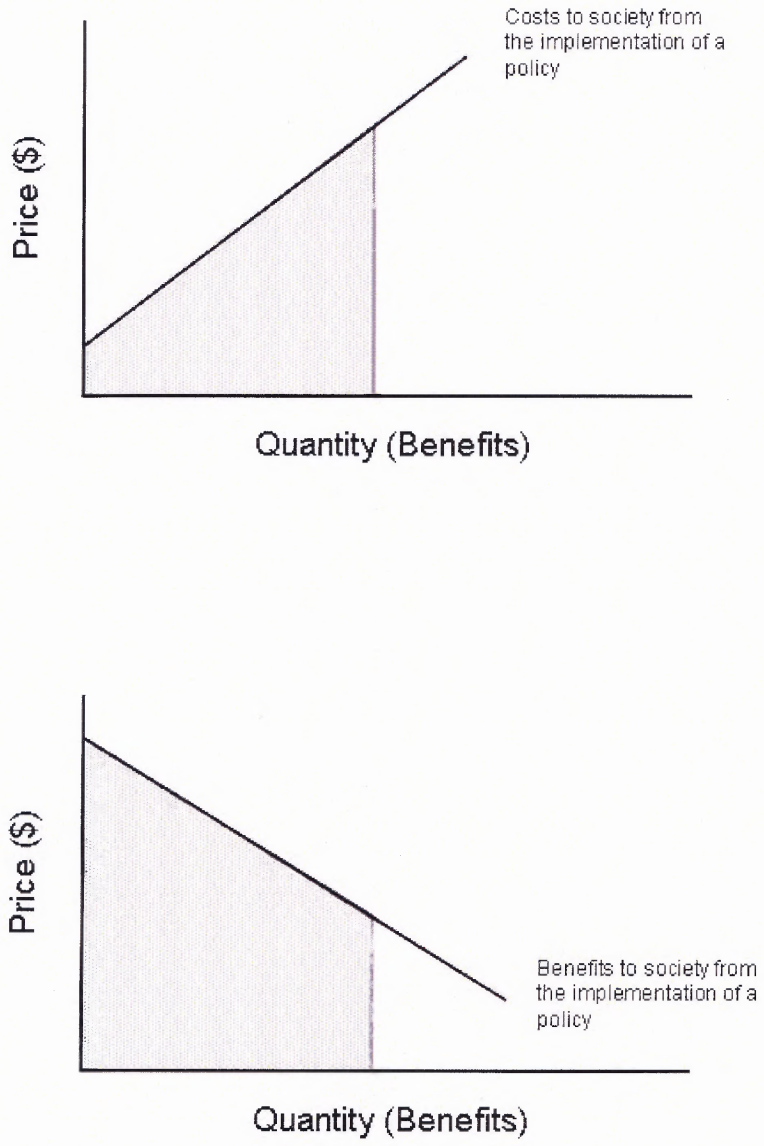

Figure 3.7 Components of the net social benefit.

CHAPTER 4

RESULTS, ANALYSIS, AND UNCERTAINITIES

4.1 Air Dispersion Modeling

The air dispersion model (AERMOD) was run four times, one time for each of the four receptor grids in the study (North Essex, East Union, West Union, and South Middlesex). Each of the four model runs simultaneously modeled all of the emission sources at all the source facilities located within the boundaries of each receptor grid. The AERMOD-MSP option in the BREEZE® software automatically created a batch file that ran each of the four modeling runs 102 times, one time for each of the COCs. The final number of modeling runs done for this study was 408 runs (i.e., 4 receptor grids × 102 COCs). The total number of receptors modeled were 4,900 in both the North Essex and West Union grids; 7,742 in the East Union grid; and 4,140 in the Lower Middlesex grid.

All air dispersion modeling output was collected in standard text format files that contained geographical coordinates ('X' and 'Y') for every receptor as well as a modeled air concentration for every COC at that receptor. The height for all modeled receptors was ground level (i.e., 'Z' = 0). The modeled air concentrations were expressed as micrograms per cubic meter ($\mu g/m^3$). Appendix E contains the model input for the modeling runs. The modeling generated 408 output files, which is one file for each COC for each of the four receptor grids.

The output files included a summary table of the ten highest, maximum annual average air concentrations of a COC, for all source groups modeled. A source group was

comprised of all the emissions sources located at a source facility. Appendix F contains several example output files. The LICR and the HI were calculated for every receptor using the maximum annual average air concentration for that receptor. The maximum annual average air concentrations for each COC considered the impact from all the emission sources located at a facility. The LICR and HI were calculated for each receptor using the exposure calculations for adults and children described in Section 3.2.3 (Exposure Assessment). The LICRs for the individual COCs were summed to derive a cumulative LICR from all COCs, emitted from all emission sources located at a source facility. The HIs for the individual COCs were summed to derive a cumulative HQ from all COCs, emitted from all emission sources located at a source facility. An analysis of all the individual LICRs and HIs and the cumulative LICRs and HQs was conducted in the GIS. The following quality assurance checks were performed on the data and the results.

- Confirmed that all the COCs listed in Appendix B were modeled and that the correct emission rates were used. This was accomplished by checking all emission rates for all the emission sources against the output files from the air dispersion modeling.
- Confirmed the toxicity values used in the exposure assessment were up to date and correct.
- Confirmed the correct annual average air concentrations were imported into the GIS.
- Confirmed the exposure assessment calculations were correct.
- Confirmed the dispersion coefficients, derived from the air dispersion modeling, were within the expected range for the source parameters and the emission rates modeled. This check was completed for one source facility and verified by comparing the modeled values against values reported in an air permit on file at the NJDEP.
- Confirmed that the COCs modeled all appeared in the final GIS analysis.

4. 2 Risk Characterization

The risk assessment evaluated the risk from direct inhalation of vapors using standard risk equations and assumptions (USEPA, 1989), site-specific COCs and their emission rates, and the maximum, ground level, annual average air concentration predicted by the air dispersion model. Specifically, a HI and a LICR were calculated for all the COCs emitted by the 17 source facilities in this study.

4.2.1 Individual Facility Risk

The receptors that represented the maximum cumulative LICR and HQ for each source facility were selected and are presented in Table 4.1. These receptors represent the MEI. The maximum cumulative LICR values less than the *de minimus* cancer risk of 1 in one million (1×10^{-6}) and the maximum cumulative HQ values less than the HQ no-effect level of 1 were considered to be acceptable and were not investigated further in the study. The source facilities that had a maximum cumulative LICR value greater than 1 in one million or a maximum cumulative HQ value greater than 1 were chosen for further investigation in the study.

Table 4.1 Maximum Cumulative LICRs and HQs for the 17 Source Facilities

Facility	Receptor Grid	HQ		LICR	
		Adult	Child	Adult	Child
Hoffman LaRoche Inc.	NE	0.9	1.6 *	2.9E-05 *	4.9E-05 *
Ciba-Geigy Corp.	WU	0.8	1.4 *	2.6E-07	4.3E-07
Exxon Corp.	EU	0.2	0.3	0.0E+00	0.0E+00
Firmenich, Inc.	EU	0.0	0.1	3.0E-11	5.0E-11
Hoechst Celanese Corp.	EU	0.5	0.8	1.6E-05 *	2.7E-05 *
Merck & Co., Inc.	EU	0.1	0.2	9.2E-06 *	1.5E-05 *
Penick Corp.	EU	0.5	0.8	0.0E+00	0.0E+00
Schering Corp. (Kenilworth)	EU	0.0	0.0	0.0E+00	0.0E+00
Schering Corp. (Union)	EU	0.0	0.0	0.0E+00	0.0E+00
Staflex Products, Inc	EU	0.0	0.0	1.6E-07	2.6E-07
Sun Chemical Corp.	EU	0.1	0.1	0.0E+00	0.0E+00
Troy Chemical Corp.	EU	0.1	0.1	0.0E+00	0.0E+00
Amerchol Corp.	SM	5.8 *	9.8 *	3.6E-05 *	6.1E-05 *
Private Formulations, Inc.	SM	0.0	0.0	0.0E+00	0.0E+00
RBH Dispersions, Inc.	SM	0.1	0.2	0.0E+00	0.0E+00
Rhodia Inc.	SM	0.1	0.1	1.5E-10	2.6E-10
Union Carbide Corp.	SM	0.4	0.6	3.2E-06 *	5.4E-06 *

Notes:
1) Receptor Grids: NE = North Essex, EU = East Union, WU = West Union, SM = South Middlesex
2) Source facilities that had receptors with a LICR value greater than 1 in one million (1×10^{-6}) or a HQ value greater than 1 are shown with an asterisk (*).

The source facilities chosen for further investigation were Hoechst Celanese Corp., Hoffman LaRoche Inc., Amerchol Corp., Union Carbide Corp., Merck & Co., Inc., and Ciba-Geigy Corp. In all cases the calculated health risks were worst for children. Children are often considered a sensitive population within the general population. Therefore, the general population risk, for both adults and children in this study, was estimated using the LICRs estimated for children. The assumption was that other less sensitive groups would be protected since the population risk was estimated using the most sensitive group.

The next step in the analysis was to determine if the LICR exceeded 1 in one million or the HQ exceeded 1 at the MIR. This analysis involved locating the MIR for each source facility in the GIS. For this analysis, the MIR was considered a residential receptor. The Amerchol Corp., the Ciba-Geigy Corp., and the Hoechst Celanese source facilities were examined using the aerial photographs obtained from the NJDEP. The examination found that all of the HQs were less than 1 and all of the cumulative LICRs were less than 1 in one million at all residential receptors. Therefore, the health risk posed by the emissions in 1990, from these three source facilities, was considered acceptable to the surrounding community.

The Hoffman LaRoche Inc. facility was further examined using the aerial photographs obtained from the NJDEP. The examination determined that the HQ did not exceed 1 for any residential receptors and therefore, the hazard posed by the non-carcinogenic COCs from this source facility was considered to be acceptable. The maximum cumulative LICR value did not exceed 1 in ten thousand (1×10^{-4}) at any receptor. Spatial examination of the LICR distribution showed that the cumulative LICR

did not exceed 1 in one hundred thousand (1×10^{-5}) for any residential receptors. The LICR for the receptors, near the source facility, fell between 1 in one hundred thousand (1×10^{-5}) and 1 in one million (1×10^{-6}). The distribution of the carcinogenic risk posed to children is presented in Figure 4.1.

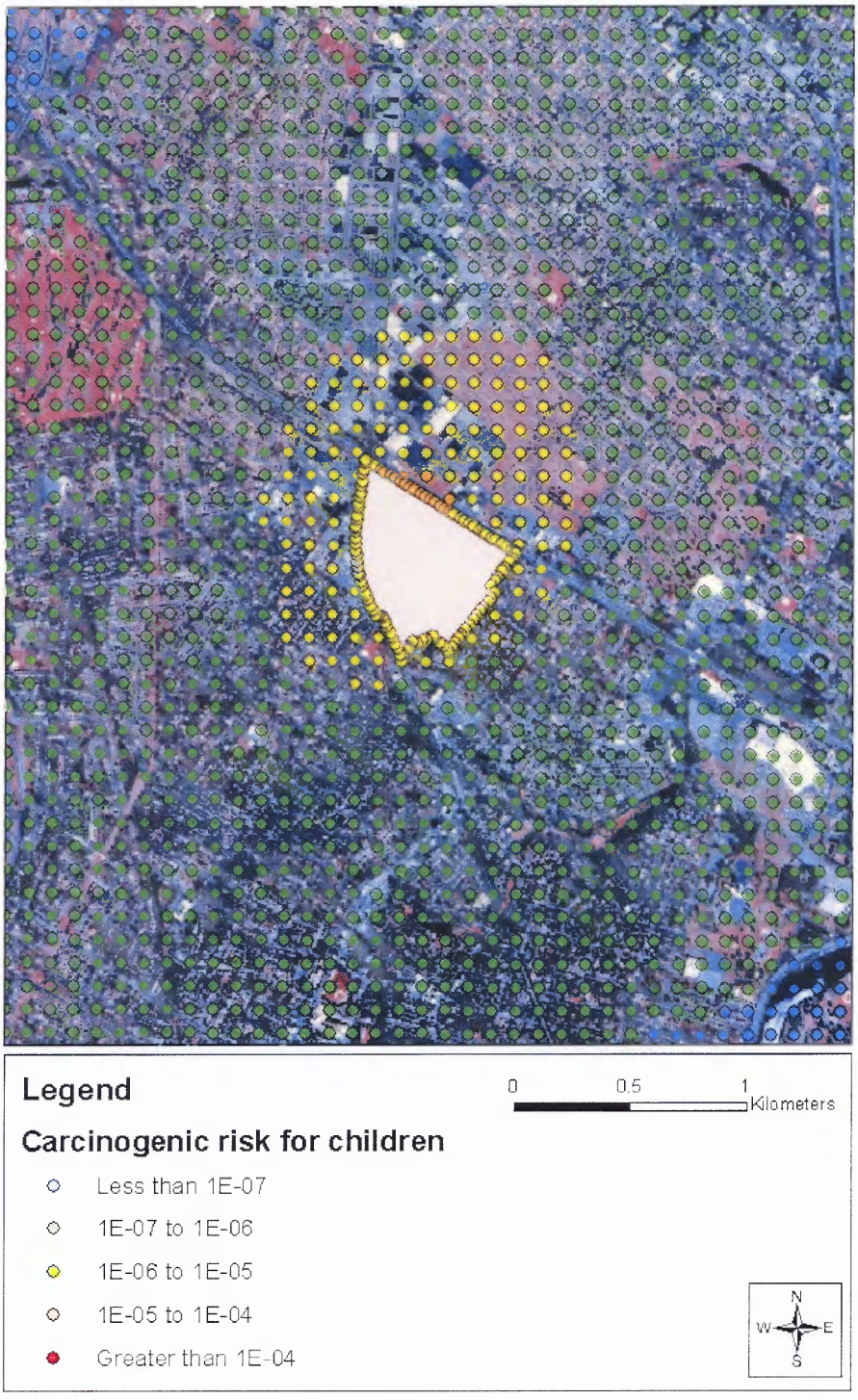

Figure 4.1 Carcinogenic risk to children in 1990 (Hoffman LaRoche Inc.).

Source: Aerial photograph obtained from NJDEP (NJDEP, 2004a).

A population analysis was therefore, carried out on the source facility using 1990 Census information available electronically at the block group level. Digital boundary files for the 1990 Census block groups were available as shapefiles on-line from the USCB (USCB, 2005). The 1990 Census block groups that fell within the 1×10^{-5} to 1×10^{-6} isopleths were selected in the GIS and are presented in Figure 4.2. Each block group is associated with a unique identifier, called the GEOID. Information on the selected GEOIDs was queried in the 1990 detailed Summary Tape File (STF-1) for the 1990 Census. The STF-1 file was available on-line from the USCB (USCB, 2006b). The STF-1 file contained information on the number of individuals in each of the impacted block groups (Figure 4.2) as well as additional information such as age, sex, and race.

The number of individuals in each block group was then summed to derive the number of people residing in the area of impact. This assessment of the number of people potentially impacted was conservative since a block group was included in the assessment as long as the block group was impacted to any extent. Since some groups were impacted more than others, the total potentially impacted population was overestimated. The total number of potentially impacted people was 9,008.

The Merck & Co., Inc. facility was further examined using the aerial photographs obtained from the NJDEP. The examination determined that the HQ did not exceed 1 near any residential receptors and therefore, the hazard posed by the non-carcinogenic COCs from this source facility was considered to be acceptable. The maximum cumulative LICR value did not exceed 1 in ten thousand (1×10^{-4}) at any receptor. Spatial examination of the LICR distribution showed that the cumulative LICR did not exceed 1 in one hundred thousand (1×10^{-5}) for any residential receptors. The LICR for the receptors, in the vicinity of the source facility, fell between 1 in one hundred thousand (1×10^{-5}) and 1 in one million (1×10^{-6}). The distribution of the carcinogenic risk posed to children is presented in Figure 4.3.

A similar population analysis was performed on the source facility using 1990 Census information at the block group level. The 1990 Census block groups that fell within the 1×10^{-5} to 1×10^{-6} range were selected and are presented in Figure 4.4. The number of individuals in each block group was then summed to derive the number of people residing in the area of impact. The total number of potentially impacted people was 14,949.

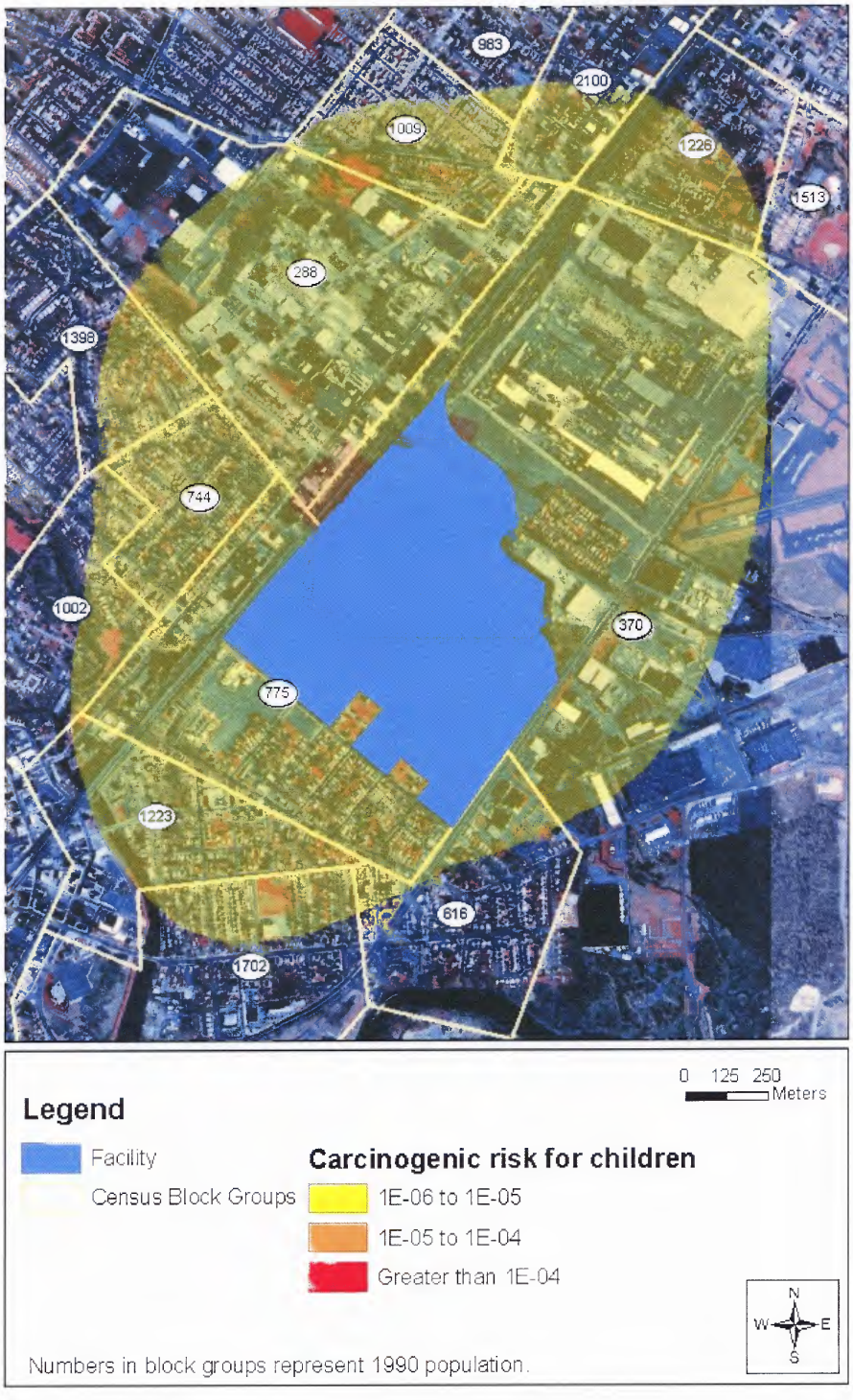

Figure 4.4 1990 Census block tracts of interest (Merck & Co., Inc.).

Source: Aerial photograph obtained from NJDEP (NJDEP, 2004a).

The Union Carbide Corp. facility was further examined using the aerial photographs obtained from the NJDEP. The examination determined that the HQ did not exceed 1 near any residential receptors and therefore, the hazard posed by the non-carcinogenic COCs from this source facility was considered to be acceptable. The maximum cumulative LICR value did not exceed 1 in one hundred thousand (1×10^{-5}) at any receptor. The LICR for the receptors, near the source facility, fell between 1 in one hundred thousand (1×10^{-5}) and 1 in one million (1×10^{-6}). The distribution of the carcinogenic risk posed to children is presented in Figure 4.5.

A similar population analysis was performed on the facility using 1990 Census information at the block group level. The 1990 Census block groups that fell within the 1×10^{-5} to 1×10^{-6} range were selected and are presented in Figure 4.6. The number of individuals in each block group was then summed to derive the number of people residing in the area of impact. The total number of people that potentially were impacted was 7,676 people.

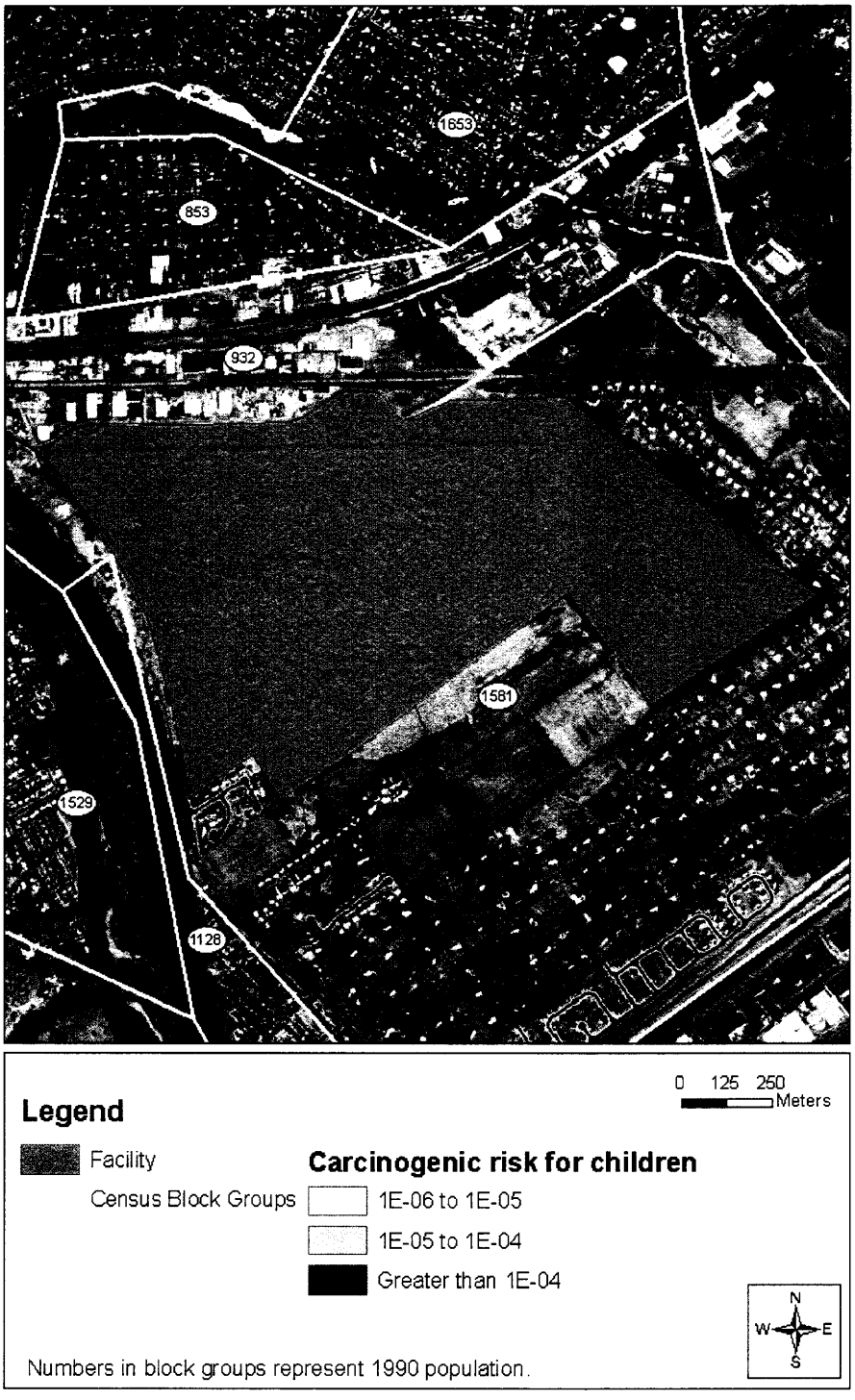

Figure 4.6 1990 Census block tracts of interest (Union Carbide Corp.).

Source: Aerial photograph obtained from NJDEP (NJDEP, 2004a).

The cumulative LICR values were analyzed for the Hoffman LaRoche, Merck, and Union Carbide source facilities to determine what COCs were responsible for the LICR. The individual COCs responsible for the LICRs are shown in Table 4.2. The risk drivers for the Hoffman LaRoche source facility were methyl hydrazine, tetrahydrofuran, and methylene chloride. The risk drivers for the Merck source facility were tetrahydrofuran, benzene, and methylene chloride. The risk drivers for the Union Carbide source facility were vinyl chloride and methylene chloride. All the risk drivers were HAPs except for tetrahydrofuran (THF).

In this assessment, it was assumed that the provisional USEPA cancer slope factor for THF is valid and therefore, it was assessed as a carcinogen. However, it should be noted that THF is not yet considered a carcinogen by the USEPA. Including THF, a non-HAP, and treating it as a carcinogen (using the provisional cancer slope factor) make this assessment a conservative one.

Table 4.2 COCs Driving Carcinogenic Risk in Children

	Carcinogenic Risk for Children		
COC	**Hoffman LaRoche Inc.**	**Merck & Co., Inc.**	**Union Carbide Corp.**
Benzene	1.8E-08	4.3E-06	---
Epichlorohydrin	---	---	1.2E-07
Ethyl acrylate	---	---	1.2E-07
Formaldehyde	8.8E-10	2.3E-11	1.4E-09
Methyl hydrazine	3.1E-05	---	---
Methylene chloride	1.6E-06	6.6E-07	1.4E-06
Tetrachloroethane	---	9.8E-08	---
Tetrahydrofuran	1.8E-05	1.3E-05	1.7E-08
Vinyl chloride	---	---	4.3E-06
Total LICR	**5.1E-05**	**1.8E-05**	**5.9E-06**

4.2.2 Cumulative Risk

The cumulative or additive risk posed by the emissions from multiple source facilities was also studied in the GIS. As shown in Figure 3.2, several source facilities were located in close proximity to each other. Analysis of the maximum cumulative LICRs and HQs in the GIS showed that no source facility had a significant spatial impact beyond their immediate boundary. In no case did a LICR greater than 1 in one million or a HQ greater than 1 from one source facility spatially intersect a LICR greater than 1 in one million or a HQ greater than 1 from another source facility. Therefore, there was no cumulative risk to calculate in this study.

4.2.3 Benefit and Cost Assessment

The Hoffman LaRoche, Merck, and Union Carbide source facilities were chosen for the benefits and costs comparison. In each case the lifetime excess probability of cancer (as measured by the cumulative LICR for children) at the MIR exceeded the *de minimus* threshold of 1 in one million (1×10^{-6}). However, in no case did the MIR exceed the acceptable risk threshold of 1 in one hundred thousand (1×10^{-5}). In order to predict the excess cancers, the population estimated to be exposed to risk levels above 1 in one million was multiplied by the maximum potential risk level of 1×10^{-5}. In reality, the risk distribution in the impacted population ranges from a maximum of 1×10^{-5} to less than 1×10^{-6}. The 1×10^{-5} risk level was used in order to be practical and conservative. As presented in Table 4.3, the predicted excess cancer cases were less than one for all the source facilities. It is important to note that the specific person whose probability of developing cancer due to the additional controls cannot be identified or predicted. The

results indicated that implementation of the MACT standards at these three source facilities would result in relatively small changes in mortality risks, even from the HAPs.

Table 4.3 Risk Estimates Due to COC Exposure

Facility	Maximum LICR [1]	Estimated Size of Population Exposed to a Risk Greater than 1×10^{-6}	Estimated Excess Cancers [2]	Estimated Cancers per Year [3]
Hoffman LaRoche	1.0×10^{-5}	14,949	0.15	0.002
Merck	1.0×10^{-5}	9,008	0.09	0.001
Union Carbide	1.0×10^{-5}	7,676	0.08	0.001

Notes:
1) The Maximum LICR is the highest lifetime excess risk of developing cancer for the exposed population.
2) Estimated Excess Cancers = Maximum LICR × Number of people in the exposed population.
3) Estimated Cancers per Year = Estimated Excess Cancers ÷ 70 years

Reference: (ECR, 2005; USEPA, 1999c)

The VSL used in this study was based on the VSL value the USEPA cites in its *Guidelines for Preparing Economic Analyses* (USEPA, 2000a) and the VSL estimate provided by Viscusi & Aldy (2003). The USEPA guideline recommends a VSL of $6.2 million in 2000 dollars. Viscusi & Aldy (2003) suggests a median estimated VSL of $7 million in 2000 dollars. A VSL value of $7 million (in 2000 dollars) was chosen for use in this study. The VSL was normalized to 2003 dollars using the CPI data from Section 3.3.3 (Normalization of Costs and Benefits). Since the CPI was 260.8 in 2000 and 297.1 in 2003, the VSL was normalized to $7,980,000 in 2003 dollars. Therefore, the benefit to society was $7.98 million dollars for this study.

The next step in the benefit and cost comparison was to estimate the costs the three source facilities might have incurred to install the air pollution controls in compliance with the MACT standards. An important assumption was that all three source facilities would continue to operate under the MACT standards. An OPRA request was submitted to the NJDEP to find out if the three source facilities had notified the NJDEP that their facility would be subject to the provisions of one or more of the MACT standards listed in Table 3.5. A file review of the MACT notification records indicated that Hoffman LaRoche Inc. and Merck & Co., Inc. had both notified the NJDEP their facilities were subject to both the Pharmaceuticals NESHAP and the Hazardous Organic Air Pollutants from the Synthetic Organic Chemical Manufacturing Industry NESHAP (HON). No information was located on the Union Carbide source facility. Since no information could be located on the Union Carbide source facility, it was dropped from the benefit and cost comparison.

The file review also revealed that five source facilities, that did not show unacceptable risk in 1990, had also registered with the NJDEP that they were subject to a MACT standard(s). The source facilities and the MACT standard(s) they are subject to are as follows: Sun Chemical Corp. (MON); Ferro Corp. (HON); Rhodia (MON); Conoco Phillips (formerly Exxon Bayway) (HON and OLDN); and Schering (Union) (Pharm MACT and HON). The data are summarized in Table 4.4.

Table 4.4 MACT Facilities on Record with NJDEP

Facility	MACT Standard
Hoffman LaRoche Inc.	Pharm MACT and HON
Merck & Co., Inc.	Pharm MACT and HON
Exxon Corp.	HON and OLDN
Ferro Corp.	HON
Rhodia Inc.	MON
Schering Corp. (Union)	Pharm MACT and HON
Sun Chemical Corp.	MON

Note: Refer to Table 3.5 for a description of the MACT standards.

The file review revealed that Merck & Co., Inc. had installed a thermal incineration unit and a post-incineration scrubber. Several file reviews were also made of the actual air permits for the Merck source facility. These file reviews involved extensive volumes of information and were difficult to process without an intimate knowledge of the source facility. The option of reviewing the air permits for the Hoffman LaRoche source facility was dropped since the above review did not produce useable information. A thorough review of the emissions statements used in Section 3.2.1 (Hazard Identification) and information in the MACT notifications on file at the NJDEP indicated that the Hoffman LaRoche source facility had installed air pollution controls similar to the Merck source facility.

The compliance date of the HON was May 12, 1999 and the Pharmaceuticals MACT was Sept. 21, 2001. For this study, the assumption was made that the earliest year a source facility would have been compliant was 1998. Cost data was taken from the USEPA air pollution control technology fact sheets on the thermal incinerator (USEPA, 2006b) and the wet scrubber (USEPA, 2006a). According to the fact sheets, thermal incineration has an annualized cost of $400 to $3,300 per short ton (i.e., 2,000 pounds) of VOCs ($440 to $3,600 per metric ton). The wet scrubber has an annualized cost of $45 to $860 per short ton of VOCs ($50 to $950 per metric ton). The annual cost data for the TOU and the wet scrubber were adjusted for each year of operation using the PPI data in Section 3.3.3 (Normalization of Costs and Benefits).

The annual tons per year of point source emissions for the Hoffman LaRoche and Merck source facilities were calculated based on the emissions information provided in the emissions statements from the NJDEP. The annual tons per year of emissions were

then used to calculate the annual cost of the TOU and the TOU scrubber. The assumption was made that all HAP and non-HAP emissions, from all the point sources at the source facility, vent through the TOU and TOU scrubber. Since the MACT standards only address the HAPs, there is no requirement for a source facility to vent all its non-HAP VOC emissions through the TOU and TOU scrubber.

The total annual emissions, from point sources at the Hoffman LaRoche source facility, were 453.1 tons. The total annual emissions, from point sources at the Merck source facility, were 652.2 tons. The normalized data, for the range of control costs, were used to calculate the annual operating cost for the TOU and the TOU scrubber from 1998 through 2003. Since emissions statements were not available from the early 1990's (refer to Section 3.2.1 (Hazard Identification) and the TRI database only tracks emissions post air pollution control devices, there was no data available to estimate the emissions going to the air pollution control devices post 1990. Therefore, the assumption was made that the tons per year produced by the two source facilities remained constant throughout the years. The cost data is presented in Table 4.5.

Table 4.5 Cost Estimate for MACT Controls at Two Facilities

Year	Hoffman LaRoche Inc.			Merck & Co., Inc.		
	Emissions (tpy)	Cost (low range)	Cost (high range)	Emissions (tpy)	Cost (low range)	Cost (high range)
1998	453.1	$196,893	$1,840,613	652.2	$283,392	$2,649,235
1999	453.1	$201,760	$1,886,117	652.2	$290,398	$2,714,729
2000	453.1	$205,046	$1,916,832	652.2	$295,127	$2,758,938
2001	453.1	$205,046	$1,916,832	652.2	$295,127	$2,758,938
2002	453.1	$201,638	$1,884,979	652.2	$290,223	$2,713,092
2003	453.1	$198,718	$1,857,677	652.2	$286,019	$2,673,795
Total		**$1,209,100**	**$11,303,050**		**$1,740,284**	**$16,268,726**

Note: All costs are expressed in 2003 dollars.

The total benefits obtained were calculated as the number of excess cancers (or the number of reduced deaths) × $7,980,000 (the VSL). Therefore, the total benefits derived from the addition of the MACT air pollution controls was $1,192,930 for the Hoffman LaRoche source facility and $718,838 for the Merck source facility. The total cost for the Hoffman LaRoche source facility for the first six years of operation ranged from a $1,209,100 to $11,303,050. The calculated net benefits for the Hoffman LaRoche source facility ranged from a negative net benefit of $16,170 to a negative net benefit of $10,110,119. This equaled a benefit to cost ratio that ranged from 1 to 0.1. The total cost for the Merck source facility for the first six years of operation ranged from $1,740,284 to $16,268,726. The calculated net benefits for the Merck source facility range from a negative net benefit of $1,021,446 to a negative net benefit of $15,549,888. This equaled a benefit to cost ratio that ranged from and 0.4 to 0.04. The benefit and cost comparisons suggest that the incremental cost to install, operate, and maintain the MACT controls exceeds the benefits of the controls.

4.3 Variability and Uncertainty

A key component of the risk characterization step is a discussion on variability and uncertainty (USEPA, 2000c). Variability arises from true heterogeneity in characteristics such as dose-response differences within a population and spatial and temporal differences in exposure levels throughout the exposed population. Emission sources differ from each other in terms of their physical characteristics and their mass emission rates. This variability means individual exposure, dose, and risk can vary widely in a large population (USEPA, 2000c). This study attempted to minimize variability by using the high-end or upper-bound estimates when estimating the public health risk to the

The toxicity assessment and exposure assessment steps made use of the most current knowledge about the toxicity of the emitted COCs and the latest advances in air dispersion modeling. Still, the estimation of human risk is always subject to much uncertainty. The emissions in this study were modeled using a constant emission rate throughout the year. In reality, emissions vary temporally in terms of rate and release characteristics such as temperature. The predictions of concentration by the air dispersion model are dependent on numerous meteorological factors and data on the terrain surrounding the modeled source facilities. In order to address this variability and uncertainty, five years of meteorological data were used to capture the true meteorological patterns. Standard risk assessment equations and default assumptions, such as body weight, inhalation rate, exposure duration, and exposure frequency, were used to assess exposure in the study. In reality, distributions of these parameters would more accurately reflect the variability seen in a heterogeneous population.

In estimating the health effects, a causal relationship must be assumed between direct exposure to an atmospheric pollutant and adverse health effects. In reality, a human being is exposed to many different environmental stressors and to different combinations and levels of environmental stressors. Predictions of health effects become even more complicated when one considers the many components of variability that are observed after exposure, such as biological variability. Biological variability can be subdivided into inter-individual and intra-individual variability. Intra-individual variability reflects the physiological differences and responses that occur within an individual over time and inter-individual variability reflects the differences between individuals. These inter-individual and intra-individual variabilities may cause some

individuals or groups to be more susceptible to the effects of chemicals (Grassman et al., 1998; National Research Council, 1994). To address this, safety factors are incorporated into the toxicity estimates for non-carcinogens to account for inter-individual and intra-individual variability. For carcinogenic effects, the toxicity estimate was defined as an upper bound, approximating a 95 percent confidence limit, on the increased cancer risk from a lifetime of exposure. This study used the most current knowledge about the toxicity of the emitted COCs. For example, the chemical THF is currently considered a non-HAP and a non-carcinogen by the USEPA. However, the USEPA NCEA has released a provisional cancer slope factor for THF. In this assessment, it was assumed that the provisional USEPA cancer slope factor for THF was valid and therefore, it was assessed as a carcinogen. Including THF was done to be protective of public health. Lastly, the health status of exposed individuals has been shown to play a role in disease initiation and progression.

The risk characterization step was performed using point estimates for the toxicity values and point estimates for all the exposure assessment parameters. In reality, distributions of these parameters would more accurately reflect the variability seen in a heterogeneous population. Use of a probabilistic approach would move away from the worst case assumptions used in deterministic estimations and offer a more realistic distribution of risk or hazard. Regardless, the use of point estimates in this study was appropriate for assessing risk since policymakers have essentially adopted a bright line approach when dealing with toxicity, hazard, and risk. The use of point estimates is easily understood by policymakers, risk managers, and the public because the risk assessment results in bright lines between acceptable and unacceptable. In addition, there

is currently no framework to design regulations based on probabilistic assessments. The NRC and the SAB have both recommended the use of probabilistic assessments to account for uncertainty and variability (National Research Council, 1994; USEPA, 1999a).

The benefit and cost comparison also used point estimates of the benefits and costs. The benefits were estimated using a central tendency estimate for the VSL that was based on numerous VSL studies. Valuation decisions regarding the VSL are contentious, even among economists and many assumptions went into the hedonic wage and contingent valuation studies used to derive the VSL. The cost assessment used high and low end estimates of cost derived from USEPA cost estimating guidance. These estimates have a reported accuracy of plus or minus thirty percent.

Lastly, this study did not attempt to include the impact of benefits and costs that could not be monetized or were extremely difficult to monetize. For example, omission of public environmental effects and public sentiment could potentially lead to an underestimation of social benefits, although the impact that HAPs have on these social benefits was not anticipated to be large in this study. In general, the primary concern with the HAPs is their effects on human health. The ecological effects of the emissions were also not considered in this study. The valuation of ecological benefits is an on-going and emerging science and the SAB is currently debating methodologies to address ecological valuation. The ecological effects of the HAPs were not anticipated to be large in this study. Since none of the emitted COCs were classified as persistent or bioaccumulative chemicals, the indirect risk that HAPs may pose through the food chain was deemed not relevant to this study.

Considering the numerous sources of variability and uncertainty, this study used the best available data to provide a comprehensive and detailed analysis of the public health risk posed by the 17 source facilities in 1990.

exposed population. The benefit and cost assessment used a central tendency estimate for the VSL and a high- and low-end range of cost estimates.

Uncertainty arises from lack of knowledge about factors such as adverse effects, emission rates, and pollutant levels in the environment. Generally, risk assessments are affected by several categories of uncertainty. One type of uncertainty is measurement uncertainty which refers to the error that accompanies scientific measurements. This type of uncertainty was associated with the economic models used to estimate the VSL and the estimation of the costs of air pollution control. There are also uncertainties associated with the use of scientific models, such as the dose-response models used to estimate toxicity factors and the air dispersion model used to predict the ambient air concentrations of the emitted COCs (USEPA, 2000c). Many of the uncertainties identified with this study are the same ones that surrounded the two prior USEPA Section 812 studies.

The hazard identification step of the risk assessment made use of source facility reported emissions data in 1990 that were available in the public records. A detailed emissions reporting procedure was relatively new to the source facilities and the NJDEP in the early 1990s and as such, the statements were often returned to the NJDEP lacking data. The emissions data supplied by the source facilities were usually based on engineering assumptions and other scientific modeling tools rather than actual monitoring of emissions. In cases where the data was incomplete or missing, assumptions had to be made or default assumptions needed to be used. Considering all this, the data reported by the source facilities were still the most comprehensive and detailed data available and therefore, were the most appropriate to use in the study.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The CAA Amendments of 1990 required the USEPA to regulate the emissions of all HAPs through technology-based standards. The mandate led to the creation of the technology-based MACT standards. This study examined the risks, benefits, and costs of using technology-based standards in a highly industrialized area in New Jersey. In the first part of this study, a quantitative human health risk assessment was carried out to evaluate the public health risk posed by 17 source facilities in 1990, the year the CAA was last amended. The risk evaluated all emissions of HAP and non-HAP pollutants from the source facility. Therefore, the assessment provided a picture of the risk from the VOCs emitted from the source facility. If a source facility posed a cancer risk to the community greater than 1 in one million, than the source facility was carried forward into the second part of the study, a comparison of benefits and costs.

Three source facilities out of 17 were carried forward into the benefit and cost comparison. These facilities were examined to determine the level and type of air pollution controls that would need to be installed to meet the requirements of the MACT standards. In all three case studies, it was predicted that the source facility would be required to install a thermal oxidizing unit and a scrubber. The thermal oxidizing unit would be for control of combustible VOCs. The scrubber would be for control of any acid gases generated during the combustion process in the thermal oxidizing unit. In order to estimate the benefits, two simplifying assumptions had to be made in this study: First, health effects (i.e., morbidity) are the direct result of chronic

inhalation of VOCs. Secondly, cancer (i.e., mortality) is the direct result of chronic inhalation of VOCs and in addition, all cases of cancer are assumed fatal.

The benefits of the air pollution controls were estimated by calculating the annual reduction in human health risk and subsequently deaths, which would be predicted from the reductions in emissions of VOCs due to the controls. A VSL of $7.98 million in 2003 dollars was used in this study to assign a value to the reduction in predicted deaths. The annualized cost to control the emissions of VOCs from the source facilities was estimated using USEPA cost estimation fact sheets. The costs were presented as a range of dollars spent per ton of VOC reduced.

The 1 in one million risk threshold was chosen because Congress directed the USEPA, in the 1970 CAA, to set health-based limits at a level that provided an ample margin of safety (AMOS) to protect public health [42 U.S.C. §7412(b)(1)(B) (1970)]. The USEPA cites an acceptable range of 1 in ten thousand to 1 in one million for potential cancer risk to the MEI. Cancer risks less than 1 in one million are referred to as *de minimis* risk (USEPA, 1989) and do not require any additional risk reduction measures. The acceptable range for carcinogen risk was determined when the USEPA set the NESHAP for vinyl chloride (National Research Council, 1994).

To date, the USEPA has carried out two benefit and cost analyses (i.e., Section 812 analyses) of the CAA. This study addressed some of the gaps identified in the previous studies and presented a flexible methodology for evaluating the risks, benefits, and costs of air pollution regulations at a community level. This study demonstrated that a quantitative public health risk assessment and a quantitative benefit and cost comparison of Title III (i.e., the HAPs) of the 1990 CAAA could be designed and carried

out on a community level. The fact that this was not done in the prior two USEPA Section 812 analyses was identified as a gap in those studies. However, it was discovered that a large level of effort was required to design and carry out a study of this magnitude. This finding suggests that it might not be practical to perform a similar study on a national level. The approach demonstrated in this study suggests it is suitable for modeling exposures from single source facilities as well as cumulative exposure from multiple source facilities in a community. The community level, public health risk assessment carried out in this study parallels and supports the methodology recently developed by the USEPA in its *Air Toxics Risk Assessment Reference Library – Volume 3* for conducting air toxics analyses at the facility and community levels.

The emission source parameters and the mass emission rates contained in the 1990 emission reports were limited and not very detailed. Regardless, this study used publicly available data as inputs for air dispersion modeling. The USEPA had cited the fact that essential data was lacking for the HAPs as the primary reason the HAPs were not fully incorporated into either of the prior USEPA Section 812 analyses. In the future, researchers will have an easier time performing similar risk assessments due to the improved quality of the information submitted being submitted currently and the ease of which the information can be accessed electronically.

The publicly available emissions statements contained information on the HAPs as well as non-HAPs. This study considered the human health effect of both HAPs and non-HAPs and therefore, provided a more complete representation of the health risks posed by the source facilities. Interestingly, the study concluded that the risk drivers for the community were predominantly HAPs. In fact, the only non-HAP pollutant that was

identified as a risk driver in this study was tetrahydrofuran (THF). This suggests that a human health risk assessment that only considers HAP emissions would be a good predictor of risk to the community yet simpler to carry out. If the risk assessment indicated the potential for hot spots than a more detailed and comprehensive risk assessment could be performed on the source facility. Decreasing the number of chemicals included in the risk assessment would decrease its size and allow for the incorporation of a greater number of industrial source categories and/or a greater number of source facilities into the assessment. This approach would help address the earlier observation that the magnitude of this study suggests that it may not be practical to perform a similar study on a national level. If a risk assessment considering just the HAPs indicates hot spots in the community than a more complete assessment of the aggregate risk faced by a community could be undertaken.

This study suggests that the spatial impact of HAP emissions from the 17 source facilities was limited to the receptors in close proximity to the source facilities. In addition, no cumulative or additive impacts were predicted even when source facilities were located in close proximity to each other. The latter supports the finding that receptors in close proximity to a source facility are the most affected. This suggests that receptors in close proximity to multiple industrial facilities may be a priority for future studies.

The MIR represents the point of highest estimated LICR or HI to a receptor in a community. The health risk in 1990, from non-carcinogenic air pollutants, emanating from all 17 source facilities, was within acceptable levels at the MIR. The baseline health risk in 1990, from carcinogenic air pollutants, emanating from all 17 source

facilities, was within the USEPA acceptable risk range of 1 in ten thousand to 1 in one million excess risk at the MIR. No source facility presented a risk to the community greater than 1 in one hundred thousand at the MIR and only three source facilities posed a risk greater than 1 in one million at the MIR. In all cases, the MIR was located in close proximity to the source facility. These findings suggest that the technology-based air pollution control standards (i.e., MACT) required under Title III of the 1990 CAAA result in relatively small changes in an individuals' morbidity and mortality risks for the source facility types and the geographic region evaluated in this study.

The predicted net benefits for two of the source facilities, that posed a risk between 1 in one hundred thousand and 1 in one million to the community, were both negative. The net benefits for the third source facility could not be predicted due to a lack of information. The calculated net benefits for the one source facility ranged from negative $16,000 to negative $10.1 million and the second source facility ranged from negative $1 million to negative $15.5 million. The benefit and cost comparison suggested that the incremental cost to install and operate and maintain the MACT controls exceeded the benefits of the controls for the source facility types and the geographic region evaluated in this study.

The only health benefits considered in this study were benefits derived from reductions in direct inhalation of air pollutants. However, VOCs in the atmosphere can react with nitrogen oxides, oxygen, and sunlight to produce photochemical smog. Ozone, along with nitric acid and partially oxidized VOCs, are the major constituents of photochemical smog and are referred to as secondary pollutants (Baird, 1999). No attempt was made to estimate any health benefits derived from a reduction in the

formation of secondary pollutants, such as ozone. The assessment of ozone formation would require a detailed analysis of the VOCs emitted to determine their relative reactivity factor, additional modeling specifically designed to treat the formation, fate, and transport of ozone in the atmosphere, and a dose-response assessment of the health effects of ozone. Exposure to ozone has been shown to produce transient irritation of the respiratory system (Baird, 1999). The results of this study suggested that the spatial impact of the VOC emissions occurred in close proximity to the source facilities therefore, any impact to the community from the formation of secondary pollutants was assumed not to be significant. Nonetheless, a quantitative assessment of how reductions in VOC emissions affect secondary pollutants could be the subject of future work in this area. If an improvement in health effects were predicted, because of the decrease in ozone formation, the benefits would need to be included in the calculation of the overall health benefits and the benefit-cost comparison would need to be reevaluated.

This study focused on the human health benefits, in terms of reduced morbidity and mortality, due to direct inhalation of air pollutants. The study did not attempt to include the impact of benefits and costs that could not be monetized or were extremely difficult to monetize. However, one could envision several potential non-market benefits. For example, the study did not consider any welfare effects attributable to a reduction in VOCs. As mentioned earlier, one of the components of photochemical smog is nitric acid. Sulfuric acid and nitric acid are the two predominant acids in acid rain (Baird, 1999). Therefore, one could envision that a reduction in VOC emissions could potentially lead to benefits for biological organisms, the environment, and inanimate objects such as buildings. In addition, no benefits were assigned to the positive public

sentiment that usually accompanies policies that reduce pollution. The omission of benefits derived from reductions in secondary pollutants was not anticipated to be large in this study since in general, the primary concern with the HAPs is their effects on human health.

Another potential benefit, not assessed in this study, is the reduction in emissions seen as an indirect result of the pending implementation of the 1990 CAAA. As shown in Table 3.1, the annual quantity of HAPs emitted by all industries of SIC code 28 in New Jersey decreased from 8.9 million pounds in 1988 to 1.6 million pounds in 2001. One potential reason for the reductions was the increased levels of air pollution control installed since 1988. One could envision that a potential source facility may have undertaken several initiatives to decrease emissions in order to remain below the emissions threshold for a major source and therefore, avoid having to install additional air pollution controls. For example, source facilities may have reduced HAPs by applying cleaner chemistry, substituting for HAPs in the manufacturing process, applying better operation and maintenance procedures, and/or reducing output all in an effort to decrease emissions.

All of the un-captured benefits discussed above have the potential to influence the benefit and cost comparison. However, the goal of this study was not to consider all of the benefits and costs of the MACT regulations but rather to focus on the major risks and benefits to the community and the major costs to industry of the regulation. It was interesting to discover that none of the baseline risks in 1990 were unacceptable (i.e., greater than 1 in ten thousand) and that only three of the source facilities posed a risk greater than the *de minimus* risk level of 1 in one million. The results indicate that in this

study, application of the MACT standards at the source facilities is not expected to show a large reduction in risk for the community. Caution should be used in extrapolating the results of this study to other source facilities, in other industrial source classifications, located in other communities throughout the nation. A better option would be to use the methodology presented in this study to assess how well a regulation is working in other communities throughout the nation.

The results of this study indicate that, the provisions set forth in Title III of the 1990 CAAA, may not produce positive net benefits in a community. However, several benefits were not captured in this study and capturing these benefits, in future studies may change the outcome of the benefit and cost comparison. There are scientific, economic, social, and regulatory reasons for desiring health effective and cost effective air pollution regulations. Therefore, future policymaking decisions on air pollution regulations should consider the approach used in this study, or a similar approach, to assess the public health benefits to the community gained because of the regulation as well as the costs associated with implementing the regulation. Developing a regulatory framework that accounts for risks, benefits and costs at a community level would allow for increased economic efficiency. For example, a regulation may call for universal and uniform controls in all cases, except where an assessment of risk could demonstrate an alternate control strategy. This framework could potentially allow resources to be conserved. These saved resources could then be reallocated to other uses more beneficial to public health.

Future Work

In order to address all the gaps identified in the prior two Section 812 analyses of the CAA the following work is recommended:

- The risk characterization in this study was a deterministic and simplistic estimate of risk and hazard. In reality, a probabilistic assessment that accounts for uncertainty and variability would produce a distribution of risk or hazard that would be a more realistic representation.

- Expand the methodology used in this study to include a greater number of facilities, of a particular source type, and over a wider geographic area.

- Expand the methodology used in this study to capture a greater number of benefits in the benefit and cost assessment.

These studies will facilitate the development of a regulatory framework that will allow for designing regulations that consider risks, benefits, and costs at a community level.

APPENDIX A

THE LIST OF HAZARDOUS AIR POLLUTANTS

The U.S. Congress included a list of 189 HAPs in the 1990 Amendments to the Clean Air Act. The complete list of the HAPs can be found at 42 U.S.C. §7401 *et seg.* (1990). Table A.1 lists the HAPs.

Table A.1 List of Hazardous Air Pollutants

CAS No.	Chemical Name	CAS No.	Chemical Name
75070	Acetaldehyde	111422	Diethanolamine
60355	Acetamide	121697	N,N-Diethyl aniline & N,N-Dimethyl aniline
75058	Acetonitrile	64675	Diethyl sulfate
98862	Acetophenone	119904	3,3-Dimethoxybenzidine
53963	2-Acetylaminofluorene	60117	Dimethyl aminoazobenzene
107028	Acrolein	119937	3,3'-Dimethyl benzidine
79061	Acrylamide	79447	Dimethyl carbamoyl chloride
79107	Acrylic acid	68122	Dimethyl formamide
107131	Acrylonitrile	57147	1,1-Dimethyl hydrazine
107051	Allyl chloride	131113	Dimethyl phthalate
92671	4-Aminobiphenyl	77781	Dimethyl sulfate
62533	Aniline	534521	4,6-Dinitro-o-cresol, and salts
90040	o-Anisidine	51285	2,4-Dinitrophenol
1332214	Asbestos	121142	2,4-Dinitrotoluene
71432	Benzene	123911	1,4-Dioxane (1,4-Diethyleneoxide)
92875	Benzidine	122667	1,2-Diphenylhydrazine
98077	Benzotrichloride	106898	Epichlorohydrin (l-Chloro-2,3-epoxypropane)
100447	Benzyl chloride	106887	1,2-Epoxybutane
92524	Biphenyl	140885	Ethyl acrylate
117817	Bis(2-ethylhexyl)phthalate (DEHP)	100414	Ethyl benzene
542881	Bis(chloromethyl)ether	51796	Ethyl carbamate (Urethane)
75252	Bromoform	75003	Ethyl chloride (Chloroethane)
106990	1,3-Butadiene	106934	Ethylene dibromide (Dibromoethane)
156627	Calcium cyanamide	107062	Ethylene dichloride (1,2-Dichloroethane)
133062	Captan	107211	Ethylene glycol
63252	Carbaryl	151564	Ethylene imine (Aziridine)
75150	Carbon disulfide	75218	Ethylene oxide
56235	Carbon tetrachloride	96457	Ethylene thiourea
463581	Carbonyl sulfide	75343	Ethylidene dichloride (1,1-Dichloroethane)
120809	Catechol	50000	Formaldehyde
133904	Chloramben	76448	Heptachlor
57749	Chlordane	118741	Hexachlorobenzene
7782505	Chlorine	87683	Hexachlorobutadiene
79118	Chloroacetic acid	77474	Hexachlorocyclopentadiene
532274	2-Chloroacetophenone	67721	Hexachloroethane
108907	Chlorobenzene	822060	Hexamethylene-1,6-diisocyanate
510156	Chlorobenzilate	680319	Hexamethylphosphoramide
67663	Chloroform	110543	Hexane
107302	Chloromethyl methyl ether	302012	Hydrazine
126998	Chloroprene	7647010	Hydrochloric acid
1319773	Cresols/Cresylic acid (isomers and mixture)	7664393	Hydrogen fluoride (Hydrofluoric acid)
95487	o-Cresol	123319	Hydroquinone
108394	m-Cresol	78591	Isophorone
106445	p-Cresol	58899	Lindane (all isomers)
98828	Cumene	108316	Maleic anhydride
94757	2,4-D, salts and esters	67561	Methanol
3547044	DDE	72435	Methoxychlor
334883	Diazomethane	74839	Methyl bromide (Bromomethane)
132649	Dibenzofurans	74873	Methyl chloride (Chloromethane)

Table A.1 List of Hazardous Air Pollutants (Continued)

CAS No.	Chemical Name	CAS No.	Chemical Name
96128	1,2-Dibromo-3-chloropropane	71556	Methyl chloroform (1,1,1-Trichloroethane)
84742	Dibutylphthalate	78933	Methyl ethyl ketone (2-Butanone)
106467	1,4-Dichlorobenzene(p)	108883	Toluene
91941	3,3-Dichlorobenzidene	95807	2,4-Toluene diamine
111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	584849	2,4-Toluene diisocyanate
542756	1,3-Dichloropropene	95534	o-Toluidine
62737	Dichlorvos	8001352	Toxaphene (chlorinated camphene)
1634044	Methyl tert butyl ether	120821	1,2,4-Trichlorobenzene
101144	4,4-Methylene bis(2-chloroaniline)	79005	1,1,2-Trichloroethane
75092	Methylene chloride (Dichloromethane)	79016	Trichloroethylene
101688	Methylene diphenyl diisocyanate (MDI)	60344	Methyl hydrazine
101779	4,4¬-Methylenedianiline	74884	Methyl iodide (Iodomethane)
91203	Naphthalene	95954	2,4,5-Trichlorophenol
98953	Nitrobenzene	88062	2,4,6-Trichlorophenol
92933	4-Nitrobiphenyl	121448	Triethylamine
100027	4-Nitrophenol	1582098	Trifluralin
79469	2-Nitropropane	540841	2,2,4-Trimethylpentane
684935	N-Nitroso-N-methylurea	108054	Vinyl acetate
62759	N-Nitrosodimethylamine	593602	Vinyl bromide
59892	N-Nitrosomorpholine	108101	Methyl isobutyl ketone (Hexone)
56382	Parathion	624839	Methyl isocyanate
82688	Pentachloronitrobenzene (Quintobenzene)	80626	Methyl methacrylate
87865	Pentachlorophenol	75014	Vinyl chloride
108952	Phenol	75354	Vinylidene chloride (1,1-Dichloroethylene)
106503	p-Phenylenediamine	1330207	Xylenes (isomers and mixture)
75445	Phosgene	95476	o-Xylenes
7803512	Phosphine	108383	m-Xylenes
7723140	Phosphorus	106423	p-Xylenes
85449	Phthalic anhydride		Antimony Compounds
1336363	Polychlorinated biphenyls (Aroclors)		Arsenic Compounds (inorganic including
1120714	1,3-Propane sultone		Beryllium Compounds
57578	beta-Propiolactone		Cadmium Compounds
123386	Propionaldehyde		Chromium Compounds
114261	Propoxur (Baygon)		Cobalt Compounds
78875	Propylene dichloride (1,2-Dichloropropane)		Coke Oven Emissions
75569	Propylene oxide		Cyanide Compounds1
75558	1,2-Propylenimine (2-Methyl aziridine)		Glycol ethers2
91225	Quinoline		Lead Compounds
106514	Quinone		Manganese Compounds
100425	Styrene		Mercury Compounds
96093	Styrene oxide		Fine mineral fibers3
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin		Nickel Compounds
79345	1,1,2,2-Tetrachloroethane		Polycylic Organic Matter4
127184	Tetrachloroethylene (Perchloroethylene)		Radionuclides (including radon)5
7550450	Titanium tetrachloride		Selenium Compounds

APPENDIX B

SOURCE INFORMATION FOR ALL FACILITIES

The information provided in this appendix is presented by source facility in the order shown below. Information is provided on the point emissions sources, the fugitive emissions sources, and the mass emission rates.

	Facility	City	County
1.	Firmenich Inc.	Newark	Essex
2.	Hoechst Celanese Corporation	Newark	Essex
3.	Hoffmann-La Roche Inc.	Nutley	Essex
4.	Penick Corporation	Newark	Essex
5.	Sun Chemical Corporation	Newark	Essex
6.	Troy Chemical Corporation	Newark	Essex
7.	Amerchol Corporation	Edison	Middlesex
8.	Private Formulations Inc.	Edison	Middlesex
9.	RBH Dispersions, Inc.	Bound Brook	Middlesex
10.	Rhodia Inc.	New Brunswick	Middlesex
11.	Staflex Products, Inc.	Carteret	Middlesex
12.	Union Carbide Corporation	Piscataway	Middlesex
13.	Ciba-Geigy Corp.	Summit	Union
14.	Exxon Corp.	Linden	Union
15.	Merck & Co. Inc.	Rahway	Union
16.	Schering Corporation	Kenilworth	Union
17.	Schering Corporation	Union	Union

The emissions statement data were supplied by the NJDEP as Microsoft® Office Excel spreadsheets. Separate spreadsheets were obtained for all 17 source facilities. Within each spreadsheet there were seven individual worksheets labeled A1, A2, B1, C1, D1, E1, and F1. The worksheets contained the following information:

- A1 – plant level data
- A2 – process identification data for sources on record with the NJDEP
- B1 – process and emission information for fuel combustion
- C1 – process and emission information for VOC storage tanks
- D1 – process emission information for batch operations
- E1 – process and VOC emission information for surface coating operations
- F1 – process and emission information for other process types and pollutants

The descriptions of the field headers for worksheet A1 are listed below. All the information for each facility was obtained from the NJDEP facility emissions statements unless otherwise specified.

PLANT_ID	NJDEP identifier for a facility.
PLANT_NAME	Facility name.
LOCATION	Facility address.
PLANT_CITY	City in which facility is located.
SIC	SIC code on record with the NJDEP.
SECOND_SIC	Secondary SIC code(s) on record with the NJDEP.
PRIN_PROD	General and brief description of facility's activities.
VOC_TON_YR	Tons per year of VOCs emitted.

The descriptions of the field headers for worksheets A2 and D2, for the point emission sources, are listed below. All the information for each facility was obtained from the NJDEP facility emissions statements unless otherwise specified.

MODEL_ID	Unique identifier assigned to all point emission sources modeled in this study.
STACK_ID	NJDEP identifier for a point source.
SR_DESCR	Brief description of the source.
HEIGHT	Stack height above ground level in units of feet.
DIAMETER	Average diameter of the stack in units of inches.
TEMP	Average temperature of the exhaust gas in units of degrees Fahrenheit.
VOLUME	Average exhaust flow rate in units of actual cubic feet per minute.
CHEM_NAME	Name of the chemical emitted.
TPY_HC	Tons per year of a chemical emitted.
g/s	Grams per second of a chemical emitted. The grams per second were calculated from the TPY_HC field. Refer to Equation 3.1 in Section 3.2.1 (Hazard Identification).
FULL_ID	Unique identifier for each emission. The FULL_ID is a concatenation of the PLANT_ID ("P"), the STACK_ID ("T"), and the SOURCE_ID ("O"). The FULL_ID is a 10 digit number in the form PPPPPTTTOO.
EFFICIENCY	The combined overall efficiency (%) of all control devices present on the source.

The descriptions of the field headers for the fugitive emission sources are listed below. All the information for each facility was obtained from the USEPA and State of NJ TRI databases unless specified otherwise.

CHEM_NAME	Name of the chemical emitted.

REL_EST_AMT	Estimated amount of chemical released in pounds per year.
g/s	Field for the grams per second of a chemical emitted. The grams per second were calculated from the REL_EST_AMT field. Refer to Equation 3.2 in Section 3.2.1 (Hazard Identification).
REL_CODE	Description of the basis for estimating the release.
TRI_FAC_ID	TRI Facility Identification code.

Table B.1 Source Facility: Firmenich, Inc.

PLANT_ID	06242
PLANT_NAME	Firmenich, Inc.
LOCATION	928-964 Doremus Avenue
PLANT_CITY	Newark
SIC	2869
SECOND_SIC	-
PRIN_PROD	Fragrance raw materials
VOC_TON_YR	15.8
TRIF ID	07114CHMFL92896

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_FM_01	001	REACTOR	50	2	95	1
E_FM_02	002	DISTILLATION SYSTEM	50	2	70	1
E_FM_03	038	REACTOR	55	2	50	1
E_FM_04	053	REACTORS	55	3	86	3
E_FM_05	071	DISTILLATION SYSTEM	55	10	85	3
E_FM_06	074	DISTILLATION SYSTEM	55	10	85	2

Table B.1 Source Facility: Firmenich, Inc. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_FM_01	001	BENZALDEHYDE	1.4E-05	0624200101	0
E_FM_01	001	METHANOL	9.0E-04	0624200101	0
E_FM_02	002	BENZALDEHYDE	3.1E-04	0624200201	0
E_FM_03	038	PENTANAL	3.8E-04	0624203801	0
E_FM_04	053	METHANOL	1.3E-01	0624205303	0
E_FM_05	071	NONANAL	7.0E-04	0624207101	0
E_FM_05	071	XYLENE	1.2E-06	0624207101	0
E_FM_06	074	BENZALDEHYDE	1.2E-03	0624207401	0
E_FM_06	074	XYLENE	2.9E-06	0624207401	0

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_FM_V01	21.9	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_FM_V01	DIMETHYL SULFATE	7.2E-05	Other Approaches
E_FM_V01	FORMALDEHYDE	7.2E-05	Other Approaches
E_FM_V01	METHANOL	3.6E-03	Other Approaches
E_FM_V01	PHOSPHORIC ACID	7.2E-05	Other Approaches
E_FM_V01	STYRENE OXIDE	7.2E-05	N/A
E_FM_V01	XYLENE (MIXED ISOMERS)	3.9E-02	Other Approaches

Table B.2 Source Facility: Hoechst Celanese, Inc.

PLANT_ID	05131
PLANT_NAME	Hoechst Celanese Chemical Group, Inc.
LOCATION	354 Doremus Avenue
PLANT_CITY	Newark
SIC	2869
SECOND_SIC	-
PRIN_PROD	Formaldehyde solutions
VOC_TON_YR	745.9
TRIF ID	07105HCHST354DO

POINT SOURCE

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_HC_01	051	LIQUID TRANSFER	37	13	60	3000
E_HC_02	052	LIQUID TRANSFER	37	13	60	3000

Table B.2 Source Facility: Hoechst Celanese, Inc. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_HC_01	051	ACETONE	4.2E-03	0513105101	90
E_HC_01	051	ACRYLIC ACID	1.0E-04	0513105101	90
E_HC_01	051	BUTANOL	4.4E-04	0513105101	90
E_HC_01	051	BUTYL ACETATE	1.7E-03	0513105101	90
E_HC_01	051	ETHYL ACRYLATE	4.5E-03	0513105101	90
E_HC_01	051	FORMALDEHYDE	4.0E-05	0513105101	0
E_HC_01	051	ISOBUTYL ALCOHOL	4.8E-04	0513105101	90
E_HC_01	051	MEK	9.3E-03	0513105101	90
E_HC_01	051	METHANOL	1.1E-02	0513105101	90
E_HC_01	051	METHYL ACRYLATE	5.3E-03	0513105101	90
E_HC_01	051	N-BUTYL ACRYLATE	4.2E-04	0513105101	90
E_HC_01	051	N-PROPYL ACETATE	1.2E-03	0513105101	90
E_HC_01	051	VINYL ACETATE	4.1E-02	0513105101	90
E_HC_02	052	ACETIC ACID	1.8E-03	0513105201	90
E_HC_02	052	BUTANOL	5.9E-04	0513105201	90
E_HC_02	052	ETHYL ACETATE	9.4E-03	0513105201	90
E_HC_02	052	FORMALDEHYDE	2.6E-02	0513105201	90
E_HC_02	052	FORMIC ACID	4.6E-04	0513105201	90
E_HC_02	052	ISOPROPAL ALCOHOL	1.1E-03	0513105201	90
E_HC_02	052	METHANOL	3.8E-04	0513105201	0
E_HC_02	052	PROPIONIC ACID	7.2E-06	0513105201	90

Table B.2 Source Facility: Hoechst Celanese, Inc. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_HC_V01	23.2	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_HC_V01	ACETONE	3.73E-03	Other Approaches
E_HC_V01	BUTYL ACRYLATE	6.08E-03	Other Approaches
E_HC_V01	ETHYL ACRYLATE	8.77E-03	Other Approaches
E_HC_V01	ETHYLENE GLYCOL	2.70E-02	Other Approaches
E_HC_V01	FORMALDEHYDE	5.01E-02	Other Approaches
E_HC_V01	METHANOL	6.28E-02	Other Approaches
E_HC_V01	METHYL ACRYLATE	8.67E-03	Other Approaches
E_HC_V01	METHYL ETHYL KETONE	4.20E-03	Other Approaches
E_HC_V01	METHYL ISOBUTYL KETONE	3.82E-03	Other Approaches
E_HC_V01	N-BUTYL ALCOHOL	1.77E-02	Other Approaches
E_HC_V01	VINYL ACETATE	1.04E-01	Other Approaches

Note: butyl and ethyl acrylate were summed together for modeling

Table B.3 Source Facility: Hoffman LaRoche, Inc.

PLANT_ID	30374
PLANT_NAME	Hoffman LaRoche, Inc.
LOCATION	RTE. 3 (also 340 Kingsland Street)
PLANT_CITY	Clifton (also Nutley)
SIC	2834
SECOND_SIC	-
PRIN_PROD	Pharmaceuticals
VOC_TON_YR	820.5
TRIF ID	07110HFFMN340KI

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_HR_01	008	REACTOR	65	1	81	4
E_HR_02	009	REACTORS	65	2	104	7
E_HR_03	456	REACTORS	10	80	70	1300
E_HR_04	457	REACTORS	120	80	70	3000
E_HR_05	458	SEPARATOR	45	1	47	11
E_HR_06	460, 465, UNKNOWN SOURCES	STRIPPER	20	40	70	100

Table B.3 Source Facility: Hoffman LaRoche, Inc. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_HR_01	008	TETRAHYDROFURAN	1.4E-03	3037400802	0
E_HR_01	008	TOLUENE	3.7E-04	3037400801	0
E_HR_02	009	ISOPROPYL ALCOHOL	2.5E-03	3037400907	95
E_HR_02	009	METHANOL	9.0E-05	3037400904	93
E_HR_02	009	METHYL BROMIDE	2.1E-02	3037400906	99
E_HR_02	009	TOLUENE	1.8E-04	3037400905	0
E_HR_03	456	ETHANOL	3.9E-03	3037445615	0
E_HR_03	456	METHANOL	1.9E-02	3037445615	88
E_HR_03	456	TOLUENE	1.9E-02	3037445615	85
E_HR_04	457	ACETONE	6.5E-03	3037445710	95.4
E_HR_04	457	METHANOL	2.7E-03	3037445710	95.4
E_HR_04	457	TOLUENE	6.5E-03	3037445710	95.4
E_HR_05	458	ETHANOL	3.0E-05	3037445801	0
E_HR_05	458	METHANOL	6.0E-05	3037445801	0
E_HR_05	458	TOLUENE	2.2E-05	3037445801	0
E_HR_06	718	ACETIC ACID	5.9E-02	0500471803	0
E_HR_06	893	ACETIC ANHYDRIDE	8.3E-02	0500489302	0
E_HR_06	A15	ACETONE	1.5E+00	30374A1521	0
E_HR_06	514	ACETONITRILE	2.5E-03	3037451401	0
E_HR_06	113	BENZENE	4.3E-05	3037411304	0
E_HR_06	349	BUTANOL	6.1E-04	3037434901	62.5
E_HR_06	A13	CHLOROFORM	6.3E-02	30374A1381	0
E_HR_06	A04	CYCLOHEXANE	5.7E-02	30374A0482	0
E_HR_06	A27	DIMETHYL FORMAMIDE	9.1E-03	30374A2712	0
E_HR_06	928	ETHANOL	6.3E-02	0500492801	0
E_HR_06	501	ETHYL CHLOROFORMATE	1.2E-03	3037450105	95
E_HR_06	465	ETHYL ETHER	1.4E-02	3037446502	37
E_HR_06	115	ETHYLENE GLYCOL	1.1E-02	0500411501	0
E_HR_06	626	FORMALDEHYDE	3.0E-03	0500462602	90
E_HR_06	A05	ISOPROPYL ALCOHOL	4.4E-01	30374A0511	0
E_HR_06	A14	METHANOL	1.0E+00	30374A1431	20
E_HR_06	A03	METHYL ETHYL KETONE	2.2E-02	30374A0332	0
E_HR_06	283	METHYL FORMATE	6.5E-04	3037428301	0
E_HR_06	898	METHYLHYDRAZINE	1.2E-04	0500489801	33.33
E_HR_06	855	N-HEPTANE	1.3E+00	0500485501	99

Table B.3 Source Facility: Hoffman LaRoche, Inc. (Continued)

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_HR_06	A05	N-HEXANE	1.2E+00	30374A0501	89
E_HR_06	868	PHENOL	4.6E-06	3037486807	0
E_HR_06	928	PYRIDINE	3.4E-02	0500492801	0
E_HR_06	222	TERT-BUTYL CHLORIDE	6.1E-04	0500422201	90.38
E_HR_06	725	TETRAHYDROFURAN	1.7E-01	0500472501	0
E_HR_06	A27	TOLUENE	7.0E+00	30374A2712	0
E_HR_06	725	TRIETHYLAMINE	1.1E-03	0500472501	0
E_HR_06	330	OIL	8.8E-03	0500433001	90

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_HR_V01	62	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_HR_V01	ACETONE	2.9E-01	Other Approaches
E_HR_V01	CHLOROFORM	3.6E-03	Other Approaches
E_HR_V01	DICHLOROMETHANE	1.8E-01	Other Approaches
E_HR_V01	METHANOL	2.4E-01	Other Approaches
E_HR_V01	NAPHTHALENE	7.2E-05	Published Emission Factors
E_HR_V01	TOLUENE	1.9E-01	Other Approaches

Table B.4 Source Facility: Penick Corp.

PLANT_ID	06265
PLANT_NAME	Penick Corporation
LOCATION	158 Mount Olivet Avenue
PLANT_CITY	Newark
SIC	2833
SECOND_SIC	-
PRIN_PROD	Bulk pharmaceuticals
VOC_TON_YR	53.6
TRIF ID	07114PNCKC158MT

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_PK_01	016, 013, 014, 015, 019	SOLVENT RECOVERY SYSTEM	50	2	70	5
E_PK_02	020	CONCENTRATOR	60	2	86	1
E_PK_03	022, 023, 026, 027, 028	DRYER, TANK	24	2	70	1
E_PK_04	029, 005, 007, 018	REACTOR, DRYER, TANK	30	2	80	2
E_PK_05	041	REACTOR	60	5	70	1
E_PK_06	042, 047	REACTOR	60	5	70	3
E_PK_07	049, 052, 057, 058	TANKS	12	3	60	2
E_PK_08	070	REACTOR	60	1	70	40
E_PK_09	072	REACTOR	60	5	80	3
E_PK_10	076, 075, 077, 078, 079, 080	CRYSTALLIZER	50	3	70	4
E_PK_11	082, 083, 084	TANKS	60	3	90	1
E_PK_12	087, 094, 095, 096, 101	TANKS	25	2	70	3
E_PK_13	102	CENTRIFUGE	15	3	70	5
E_PK_14	103, 105, 109, 110	BUILDING VENTILATION	60	20	70	2000
E_PK_15	111, 113	TANK	60	2	70	3

Table B.4 Source Facility: Penick Corp. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_PK_01	019	METHANOL	1.2E-02	0626501902	0
E_PK_02	020	BUTANOL	8.0E-03	0626502001	0
E_PK_03	028	BUTANOL	1.2E-03	0626502801	0
E_PK_04	029	ETHANOL	1.8E-02	0626502901	0
E_PK_05	041	TOLUENE	3.8E-01	0626504111	0
E_PK_06	047	BUTANOL	5.4E-03	0626504701	0
E_PK_07	058	METHANOL	4.7E-03	0626505801	0
E_PK_08	070	ETHANOL	5.6E-04	0626507009	0
E_PK_08	070	TOLUENE	1.3E-02	0626507009	0
E_PK_09	072	BUTANOL	3.9E-03	0626507212	0
E_PK_10	080	METHANOL	1.6E-01	0626508001	0
E_PK_11	084	ETHANOL	1.7E-04	0626508401	0
E_PK_11	084	METHANOL	2.3E-03	0626508401	0
E_PK_11	084	TOLUENE	1.3E-03	0626508401	0
E_PK_12	096	BUTANOL	4.2E-03	0626509601	0
E_PK_12	096	ETHANOL	3.1E-03	0626509601	0
E_PK_12	087	ISOPROPANOL	4.2E-03	0626508701	0
E_PK_12	101	TOLUENE	2.2E-02	0626510101	0
E_PK_13	102	ISOPROPANOL	6.7E-04	0626510201	0
E_PK_13	102	TOLUENE	1.6E-03	0626510201	0
E_PK_14	110	BUTANOL	9.4E-04	0626511002	0
E_PK_14	109	ETHANOL	9.7E-04	0626510901	0
E_PK_14	109	ISOPROPANOL	9.0E-05	0626510901	0
E_PK_14	109	METHANOL	3.9E-04	0626510901	0
E_PK_14	109	TOLUENE	1.5E-03	0626510901	0
E_PK_15	113	ETHANOL	7.2E-04	0626511301	0
E_PK_15	113	METHANOL	2.5E-04	0626511301	0
E_PK_15	113	TOLUENE	2.0E-03	0626511301	0

Table B.4 Source Facility: Penick Corp. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_PK_V01	11.4	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_PK_V01	AMMONIA	9.4E-02	Published Emission Factors
E_PK_V01	HYDROCHLORIC ACID	7.2E-05	Published Emission Factors
E_PK_V01	METHANOL	4.2E-01	Published Emission Factors
E_PK_V01	N-BUTYL ALCOHOL	4.2E-01	Published Emission Factors
E_PK_V01	PHOSPHORIC ACID	7.2E-05	N/A
E_PK_V01	TOLUENE	4.2E-01	Published Emission Factors

Table B.5 Source Facility: Sun Chemical Corp.

PLANT_ID	06262
PLANT_NAME	Sun Chemical Corporation - Pigments Division
LOCATION	185 Foundry Street
PLANT_CITY	Newark
SIC	2819
SECOND_SIC	-
PRIN_PROD	Manufacturers of synthetic organic chemicals
VOC_TON_YR	65.7
TRIF ID	07105SNCHM185FO

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_SC_01	001	REACTOR	35	2	120	15
E_SC_02	003	DRYER VENT OVENS	40	17	321	6488
E_SC_03	004	FILTER PRESS	8	30	100	2000
E_SC_04	005	REACTOR	6	30	100	6000
E_SC_05	006	FILTER PRESS	20	20	80	2077
E_SC_06	011	EXHAUST FAN	12	10	70	6329 (1)

Note: (1) Volume in table exceeded AERMOD's range of acceptable values. Default volume of 5000 used in study.

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_SC_01	001	METHANOL	5.9E-02	0626200101	0
E_SC_02	003	METHANOL	7.5E-02	0626200302	95
E_SC_02	003	NAPHTA	5.5E-02	0626200302	0
E_SC_03	004	METHANOL	8.6E-02	0626200403	0
E_SC_04	A02	METHANOL	4.1E-01	06262A0201	0
E_SC_05	006	METHANOL	2.2E-01	0626200601	0
E_SC_05	006	NAPHTA	3.9E-02	0626200601	0
E_SC_06	011	METHANOL	3.3E-02	0626201101	0

Table B.5 Source Facility: Sun Chemical Corp. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_SC_V01	14.9	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_SC_V01	METHANOL	6.2E-01	Other Approaches
E_SC_V01	PHOSPHORIC ACID	7.2E-05	Other Approaches

Table B.6 Source Facility: Troy Chemical Corp.

PLANT_ID	05459
PLANT_NAME	Troy Chemical Corp.
LOCATION	One Avenue L
PLANT_CITY	Newark
SIC	2851
SECOND_SIC	-
PRIN_PROD	Specialty chemicals
VOC_TON_YR	15.3
TRIF ID	07105TRYCHONEAV

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
E_TC_01	017	REACTOR	20	8	70	600
E_TC_02	034	METHANOL RECOVERY SYSTEM	30	1	70	3
E_TC_03	036	REACTOR	40	2	70	100 (1)
E_TC_04	058	REACTOR	18	2	175	40
E_TC_05	060	TANK	25	2	70	3
E_TC_06	062	TANK	22	2	70	3
E_TC_07	068	REACTOR	20	5	100	300
E_TC_08	069	REACTOR	25	15	120	100
E_TC_09	070	REACTOR	25	2	70	3
E_TC_10	071	TANK	30	2	50	10
E_TC_11	074, 073	TANK	20	2	70	7
E_TC_12	077	METHANOL RECOVERY SYSTEM	30	2	90	3

Note: (1) Volume in table exceeded AERMOD's range of acceptable values. Default volume of 5000 used in study.

Table B.6 Source Facility: Troy Chemical Corp. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
E_TC_01	017	METHANOL	6.7E-02	0545901702	99
E_TC_02	034	METHANOL	1.6E-02	0545903401	95
E_TC_03	036	DIETHYLENE TRIAMINE	1.3E-03	0545903601	99
E_TC_03	036	NAPTHA	3.6E-03	0545903601	99
E_TC_04	058	NAPHTHA	1.4E-02	0545905801	50
E_TC_05	060	METHANOL	6.4E-03	0545906001	50
E_TC_06	062	METHANOL	6.6E-03	0545906201	50
E_TC_07	068	PROPARGYL ALCOHOL	3.5E-03	0545906802	90
E_TC_08	069	METHANOL	5.6E-04	0545906902	90
E_TC_08	069	PROPARGYL ALCOHOL	5.2E-04	0545906901	90
E_TC_09	070	METHANOL	1.7E-01	0545907001	20
E_TC_10	086	METHANOL	3.5E-02	0545908601	0
E_TC_11	073	METHANOL	9.0E-02	0545907301	99
E_TC_11	074	NAPHTHA	6.6E-04	0545907401	20
E_TC_12	077	METHANOL	1.5E-03	0545907701	99

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
E_TC_V01	20.5	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
E_TC_V01	1 2 4-TRIMETHYLBENZENE	3.6E-03	Other Approaches
E_TC_V01	METHANOL	2.7E-01	Other Approaches
E_TC_V01	STYRENE	7.2E-05	Other Approaches

Table B.7 Source Facility: Amerchol Corp.

PLANT_ID	15343
PLANT_NAME	Amerchol Corp.
LOCATION	136 Talmadge Road
PLANT_CITY	Edison
SIC	2843
SECOND_SIC	-
PRIN_PROD	Cosmetic intermediates
VOC_TON_YR	76.8
TRIF ID	08818MRCHL136TA

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_AMER_01	13, 16	REACTOR	25	2	180	1
M_AMER_02	15	REACTOR	27	2	295	11
M_AMER_03	18	TANK	22	1	70	1
M_AMER_04	19, 20, 28	TANK & TANK VENTS	25	2	188	1
M_AMER_05	29	REACTOR	25	2	180	1
M_AMER_06	31	REACTOR	25	2	221	1
M_AMER_07	32	REACTOR	25	1	194	2
M_AMER_08	33	REACTOR	25	2	140	1
M_AMER_09	38, 39, 46	SETTLING TANK	26	2	70	7
M_AMER_10	41, 42, 43, 44, 45, 47, 51	TANK VENT	28	1	130	1
M_AMER_11	54	REACTOR	27	2	70	250

Table B.7 Source Facility: Amerchol Corp. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_AMER_01	016	ISOPROPANOL	0.182429	1534301601	95
M_AMER_02	015	METHANOL	130.720443	1534301501	99.9
M_AMER_03	018	ACETIC ACID	0.007123	1534301801	0
M_AMER_03	018	ACETIC ANHYDRIDE	0.000980	1534301801	0
M_AMER_03	018	HEPTANE	0.015401	1534301801	95
M_AMER_04	020	MINERAL SPIRITS	0.003788	1534302001	0
M_AMER_04	028	TOLUENE	0.883737	1534302801	95
M_AMER_05	029	ISOPROPANOL	0.091215	1534302901	95
M_AMER_06	031	ACETIC ACID	0.007107	1534303101	0
M_AMER_06	031	ACETIC ANHYDRIDE	0.000980	1534303101	0
M_AMER_07	032	MINERAL SPIRITS	0.001894	1534303201	0
M_AMER_07	032	TOLUENE	0.404139	1534303201	95
M_AMER_08	033	ACETIC ACID	0.000016	1534303301	0
M_AMER_08	033	HEPTANE	0.015401	1534303301	95
M_AMER_09	046	MINERAL SPIRITS	0.011747	1534304601	0
M_AMER_10	051	MINERAL SPIRITS	0.013258	1534305101	0
M_AMER_10	051	TOLUENE	2.828972	1534305101	95
M_AMER_11	054	METHANOL	130.720443	1534305401	99.9

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_AMER_V01	22.8	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_AMER_V01	ETHYLENE OXIDE	2.3E-03	Other Approaches
M_AMER_V01	METHANOL	7.8E-02	Other Approaches
M_AMER_V01	PROPYLENE OXIDE	1.0E-01	Other Approaches
M_AMER_V01	TOLUENE	5.4E-01	Other Approaches

Table B.8 Source Facility: Private Formulations, Inc.

PLANT_ID	15579
PLANT_NAME	Private Formulations, Inc.
LOCATION	460 Plainfield Avenue
PLANT_CITY	Edison
SIC	2834
SECOND_SIC	
PRIN_PROD	Over the counter pharmaceuticals
VOC_TON_YR	22.2
TRIF ID	08818PRVTF460PL

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_PRFM_01	1	DRYING	30	20	100	7500
M_PRFM_02	17	MIXING TANK	30	10	70	7600

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_PRFM_01	001	METHANOL	4.9E-02	1557900101	99
M_PRFM_02	A01	METHANOL	3.7E-01	15579A0101	0

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_RRFM_V01	45.4	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_RRFM_V01	METHANOL	3.6E-03	Other Approaches

Table B.9 Source Facility: RBH Dispersions, Inc.

PLANT_ID	15678
PLANT_NAME	RBH Dispersions, Inc.
LOCATION	L-5 Factory Lane
PLANT_CITY	Middlesex
SIC	2899
SECOND_SIC	2851
PRIN_PROD	Pigment dispersions
VOC_TON_YR	32.4
TRIF ID	08805RBHDSL5FAC

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_RBH_01	10, 14, 15, 16, 18, 22, 25, 32, 33, 34, 35	MILL (Average)	28	14	71.5	3000
M_RBH_02	26, 27, 28	MIXING TANK (Average)	17	20	75	3000
M_RBH_03	002	STORAGE TANK	17	2	70	57
M_RBH_04	017	MIXING TANK	17	20	75	3000
M_RBH_05	020	BLDG.	17	10	80	5000
M_RBH_06	030	COWLES	30	6	70	1600
M_RBH_07	031	TANK	25	20	70	7200

Table B.9 Source Facility: RBH Dispersions, Inc. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_RBH_01	034	ACETONE	0.008004	1567803401	0
M_RBH_01	018	BUTANOL	0.002541	1567801804	0
M_RBH_01	034	BUTYL ACETATE	0.009390	1567803404	0
M_RBH_01	018	CYCLOHEXANONE	0.000345	1567801804	0
M_RBH_01	034	ETHYL ACETATE	0.007545	1567803404	0
M_RBH_01	034	ETHYL ALCOHOL	0.005438	1567803404	0
M_RBH_01	018	ISPOROPYL ALCOHOL	0.339136	1567801801	0
M_RBH_01	036	METHOXY 2 PROPANOL	0.001254	1567803601	0
M_RBH_01	036	METHYL ETHYL KETONE	0.068463	1567803601	0
M_RBH_01	034	METHYL ISOBUTYL KETONE	0.008628	1567803401	0
M_RBH_01	018	METHYL METHACRYLATE	0.001216	1567801804	0
M_RBH_01	036	PROPANOL	0.003419	1567803601	0
M_RBH_01	018	SOLVESSO 100	0.000583	1567801804	0
M_RBH_01	036	TOLUENE	0.022657	1567803601	0
M_RBH_01	018	XYLENE	0.003803	1567801804	0
M_RBH_02	026	ACETONE	0.000003	1567802602	0
M_RBH_02	028	BUTANOL	0.000051	1567802801	0
M_RBH_02	026	BUTYL ACETATE	0.000003	1567802602	0
M_RBH_02	026	ISOPROPYL ALCOHOL	0.000270	1567802603	0
M_RBH_02	026	METHOXY 2 PROPANOL	0.000002	1567802602	0
M_RBH_02	028	METHYL ETHYL KETONE	0.002098	1567802801	0
M_RBH_02	026	METHYL ISOBUTYL KETONE	0.000003	1567802602	0
M_RBH_02	026	PROPANOL	0.000018	1567802602	0
M_RBH_02	027	SOLVESSO 100	0.000144	1567802701	0
M_RBH_02	028	TOLUENE	0.000104	1567802801	0
M_RBH_02	028	XYLENE	0.000076	1567802801	0
M_RBH_03	002	METHOXY 2 PROPANOL	0.000029	1567800201	0
M_RBH_03	002	METHYL ETHYL KETONE	0.000173	1567800201	0
M_RBH_03	002	PROPANOL	0.000288	1567800201	0
M_RBH_03	002	TOLUENE	0.000058	1567800201	0
M_RBH_04	017	BUTANOL	0.000211	1567801702	0
M_RBH_04	017	BUTYL ACETATE	0.000235	1567801702	0
M_RBH_04	017	CYCLOHEXANONE	0.000006	1567801702	0
M_RBH_04	017	ETHYL ACETATE	0.000705	1567801702	0

Table B.9 Source Facility: RBH Dispersions, Inc. (Continued)

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_RBH_04	017	ETHYL ALCOHOL	0.000362	1567801702	0
M_RBH_04	017	ISOPROPYL ALCOHOL	0.000352	1567801702	0
M_RBH_04	017	METHOXY 2 PROPANOL	0.000176	1567801702	0
M_RBH_04	017	METHYL ETHYL KETONE	0.000622	1567801702	0
M_RBH_04	017	METHYL ISOBUTYL KETONE	0.000006	1567801702	0
M_RBH_04	017	METHYL METHACRYLATE	0.000235	1567801702	0
M_RBH_04	017	SOLVESSO 100	0.000110	1567801702	0
M_RBH_04	017	TOLUENE	0.001533	1567801702	0
M_RBH_04	017	XYLENE	0.000369	1567801702	0
M_RBH_05	020	BUTANOL	0.000511	1567802001	0
M_RBH_05	020	BUTYL ACETATE	0.000365	1567802001	0
M_RBH_05	020	CYCLOHEXANONE	0.000009	1567802001	0
M_RBH_05	020	ETHYL ACETATE	0.001094	1567802001	0
M_RBH_05	020	ETHYL ALCOHOL	0.000802	1567802001	0
M_RBH_05	020	ISOPROPYL ALCOHOL	0.000438	1567802001	0
M_RBH_05	020	METHYL ETHYL KETONE	0.000967	1567802001	0
M_RBH_05	020	METHYL ISOBUTYL KETONE	0.000009	1567802001	0
M_RBH_05	020	METHYOXY 2 PROPANOL	0.000274	1567802001	0
M_RBH_05	020	SOLVESSO 100	0.000171	1567802001	0
M_RBH_05	020	TOLUENE	0.002198	1567802001	0
M_RBH_05	020	XYLENE	0.000937	1567802001	0
M_RBH_06	030	BUTYL ACETATE	0.000396	1567803003	0
M_RBH_06	030	CYCLOHEXANONE	0.000317	1567803003	0
M_RBH_06	030	ETHYL ACETATE	0.001189	1567803003	0
M_RBH_06	030	ETHYL ALCOHOL	0.001114	1567803004	0
M_RBH_06	030	ISOPROPYL ALCOHOL	0.000476	1567803003	0
M_RBH_06	030	METHYL ETHYL KETONE	0.004435	1567803003	0
M_RBH_06	030	METHY ISOBUTYL KETONE	0.000317	1567803003	0
M_RBH_06	030	TOLUENE	0.002768	1567803004	0
M_RBH_07	031	BUTYL ALCOHOL	0.002073	1567803101	0
M_RBH_07	031	BUTYL ACETATE	0.021260	1567803103	0
M_RBH_07	031	ETHYL ACETATE	0.070000	1567803103	0
M_RBH_07	031	ETHYL ALCOHOL	0.051334	1567803103	0
M_RBH_07	031	ISOPROPYL ALCOHOL	0.028000	1567803103	0
M_RBH_07	031	TOLUENE	0.060667	1567803103	0

Table B.9 Source Facility: RBH Dispersions, Inc. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_RBH_V01	10.6	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_RBH_V01	METHYL ETHYL KETONE	7.2E-02	Published Emission Factors
M_RBH_V01	METHYL METHACRYLATE	3.6E-03	Other Approaches
M_RBH_V01	TOLUENE	3.5E-02	Published Emission Factors
M_RBH_V01	XYLENE (MIXED ISOMERS)	2.5E-02	Published Emission Factors

Table B.10 Source Facility: Rhone-Poulenc, LP.

PLANT_ID	15101
PLANT_NAME	Rhone-Poulenc Specialty Chemicals, LP.
LOCATION	298 Jersey Avenue
PLANT_CITY	New Brunswick
SIC	2869
SECOND_SIC	
PRIN_PROD	Industrial organic chemicals
VOC_TON_YR	19.8
TRIF ID	08901RHNPL298JE

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_RHOD_01	006	REACTOR	41	2	120	3
M_RHOD_02	007	REACTOR	42	3	120	25
M_RHOD_03	010	SCRUBBER	45	13	70	2520
M_RHOD_04	044	TANK	41	2	70	4
M_RHOD_05	045	TANK	40	2	105	25

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_RHOD_01	006	FORMALDEHYDE	3.60E-04	1510100601	0
M_RHOD_01	006	PHENOL	3.60E-04	1510100601	0
M_RHOD_02	007	FORMALDEHYDE	3.60E-04	1510100701	0
M_RHOD_02	007	PHENOL	3.60E-04	1510100701	0
M_RHOD_03	010	METHANOL	1.01E-02	1510101001	90
M_RHOD_04	044	FORMALDEHYDE	3.17E-04	1510104401	0
M_RHOD_04	044	PHENOL	3.17E-04	1510104401	0
M_RHOD_05	045	FORMALDEHYDE	0.00E+00	1510104501	0
M_RHOD_05	045	PHENOL	0.00E+00	1510104501	0
M_RHOD_05	055	TOLUENE	7.92E-04	1510105501	0

Table B.10 Source Facility: Rhone-Poulenc, LP. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_RHOD_V01	10.2	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_RHOD_V01	METHANOL	3.0E-01	Published Emission Factors
M_RHOD_V01	PHENOL	3.6E-03	Published Emission Factors
M_RHOD_V01	TOLUENE	1.6E-01	Published Emission Factors

Table B.11 Source Facility: Staflex, Inc.

PLANT_ID	15074
PLANT_NAME	Staflex Specialty Esters, Inc.
LOCATION	Middlesex Avenue
PLANT_CITY	Carterte
SIC	2869
SECOND_SIC	
PRIN_PROD	Esters
VOC_TON_YR	32.8
TRIF ID	07008STFLXMIDDL

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_SF_01	150	REACTOR	20	3	70	19
M_SF_02	151	REACTOR VENT	20	2	70	8

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_SF_01	150	BUTANOL	1.8E-04	1507415001	0
M_SF_01	150	ISOPROPYL ALCOHOL	1.0E-03	1507415001	0
M_SF_02	151	BUTANOL	9.4E-04	1507415101	0
M_SF_02	151	BUTYL ACETATE	1.4E-04	1507415101	0
M_SF_02	151	METHANOL	1.1E-04	1507415101	0
M_SF_02	151	METHYL AMYL ALCOHOL	3.5E-04	1507415101	0
M_SF_02	151	TRIDECYL ALCOHOL	5.7E-05	1507415101	0

Table B.11 Source Facility: Staflex, Inc. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_SF_V01	53.5	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_SF_V01	BIS(2-ETHYLHEXYL) ADIPATE	4.2E-04	Other Approaches
M_SF_V01	CERTAIN GLYCOL ETHERS	1.2E-03	Other Approaches
M_SF_V01	DI(2-ETHYLHEXYL) PHTHALATE	4.4E-03	Other Approaches
M_SF_V01	DIBUTYL PHTHALATE	2.3E-04	Other Approaches
M_SF_V01	MALEIC ANHYDRIDE	1.7E-04	Other Approaches
M_SF_V01	METHANOL	8.6E-04	Other Approaches
M_SF_V01	N-BUTYL ALCOHOL	2.4E-02	Other Approaches
M_SF_V01	PHTHALIC ANHYDRIDE	7.2E-05	Other Approaches

Table B.12 Source Facility: Union Carbide Corp.

PLANT_ID	15031
PLANT_NAME	Union Carbide Chemicals & Plastics Corporation
LOCATION	One River Road
PLANT_CITY	Bound Brook
SIC	2833
SECOND_SIC	
PRIN_PROD	Polyethylene
VOC_TON_YR	559.7
TRIF ID	08854NNCRB1RIVE

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
M_UC_01	016	REACTOR	40	10	77	10
M_UC_02	069	REACTOR	15	15	160	125
M_UC_03	125	EVAPORATOR	50	3	125	1
M_UC_04	138	REACTOR	38	60	70	1
M_UC_05	139	MIX TANK	25	10	80	20
M_UC_06	147	REACTOR	30	3	1500	2
M_UC_07	171	REACTOR & TANK	20	3	70	5
M_UC_08	181	VACUUM DRYER	35	2	77	65
M_UC_09	184	CONFIDENTIAL	30	3	80	5
M_UC_10	198	DRYING UNIT	4	2	70	2
M_UC_11	218	EXTRUDER	35	20	1500	85
M_UC_12	223	FLUID BED DRYER	37	10	140	2500
M_UC_13	226, 227, 228	SEPARATOR & SIEVE	50	2	70	0
M_UC_14	229	DRYING OVEN	30	12	158	1456

Table B.12 Source Facility: Union Carbide Corp. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_UC_01	016	ACETONE	1.2E-04	1503101601	60.00
M_UC_01	016	N-BUTANOL	6.1E-04	1503101601	99.90
M_UC_01	016	TOLUENE	3.1E-04	1503101601	97.00
M_UC_01	016	TRIETHYLAMINE	1.2E-05	1503101601	99.00
M_UC_02	069	ACETONE	4.0E-03	1503106901	99.90
M_UC_02	069	VINYL ACETATE	8.5E-04	1503106901	99.90
M_UC_02	069	VINYL CHLORIDE	8.0E-02	1503106901	99.90
M_UC_03	125	BUTANOL	1.1E+01	1503112501	99.90
M_UC_03	A01	ETHANOL	3.1E-01	15031A0101	99.90
M_UC_03	A01	TOLUENE	2.1E+01	15031A0101	99.90
M_UC_03	A01	VINYL METHYL ETHER	4.2E-01	15031A0101	99.90
M_UC_04	138	BUTANOL	2.1E-02	1503113801	99.00
M_UC_04	138	EPICHLOROHYDRIN	1.4E-02	1503113801	99.00
M_UC_04	138	TOLUENE	1.6E-01	1503113801	99.00
M_UC_05	139	BUTANOL	1.1E-03	1503113901	99.00
M_UC_05	139	ETHANOL	1.1E-03	1503113901	99.00
M_UC_05	139	HEPTANE	6.1E-03	1503113901	99.00
M_UC_05	139	HEXANE	1.1E-03	1503113901	99.00
M_UC_05	139	ISOPENTANE	1.1E-03	1503113901	99.00
M_UC_05	139	PROPANOL	1.1E-03	1503113901	99.00
M_UC_05	139	TETRAHYDROFURAN	1.1E-03	1503113901	99.00
M_UC_05	139	XYLENE	6.1E-03	1503113901	99.00
M_UC_06	147	PROPANE	9.6E-02	1503114701	99.00
M_UC_07	171	METHYLENE CHLORIDE	1.7E-02	1503117101	99.90
M_UC_08	181	ACETONE	2.4E-04	1503118101	99.00
M_UC_09	184	ACETONE	3.5E-04	1503118401	99.90
M_UC_09	184	DIETHYLENE GLYCOL	1.7E-03	1503118401	99.90
M_UC_09	184	ETHYL ACRYLATE	1.7E-03	1503118401	99.90
M_UC_10	198	BUTANOL	5.2E-06	1503119801	0.00
M_UC_10	198	TOLUENE	4.1E-05	1503119801	0.00
M_UC_11	218	PROPANE	7.6E-03	1503121803	99.00
M_UC_12	223	ACETONE	4.3E-04	1503122301	0.00
M_UC_12	223	ISOPROPANOL	1.7E-05	1503122301	0.00
M_UC_12	223	METHANOL	8.6E-05	1503122301	0.00

Table B.12 Source Facility: Union Carbide Corp. (Continued)

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
M_UC_12	223	METHYL ACETATE	3.5E-04	1503122301	0.00
M_UC_12	223	VINYL ACETATE	4.3E-05	1503122301	0.00
M_UC_13	228	METHYLENECHLORIDE	6.0E-03	1503122801	0.00
M_UC_14	229	METHYLENE CHLORIDE	2.5E-01	1503122901	0.00

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
M_UC_V01	49	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
M_UC_V01	ACETONE	2.0E-02	Other Approaches
M_UC_V01	CERTAIN GLYCOL ETHERS	7.4E-02	Other Approaches
M_UC_V01	DICHLOROMETHANE	5.9E-02	Other Approaches
M_UC_V01	EPICHLOROHYDRIN	1.2E-04	Other Approaches
M_UC_V01	FORMALDEHYDE	4.0E-02	Other Approaches
M_UC_V01	N-BUTYL ALCOHOL	3.7E-02	Other Approaches
M_UC_V01	PHENOL	1.0E-01	Other Approaches
M_UC_V01	PHOSPHORIC ACID	1.9E-03	Other Approaches
M_UC_V01	TOLUENE	3.1E-02	Other Approaches

Table B.13 Source Facility: Ciba-Geigy Corp.

PLANT_ID	40017
PLANT_NAME	Ciba-Geigy Corporation
LOCATION	556 Morris Avenue
PLANT_CITY	Summit
SIC	2834
SECOND_SIC	2833
PRIN_PROD	Pharmaceuticals
VOC_TON_YR	244.8
TRIF ID	07901CBGGY556MO

Table B.13 Source Facility: Ciba-Geigy Corp. (Continued)

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
U_CG_01	058	REACTOR AND SCRUBBER	30	40	50	15
U_CG_02	069, 015	REACTOR	30	2	70	5
U_CG_03	100, 030, 101, 104, 105, 106, 107	REACTORS	30	2	70	15
U_CG_04	119	REACTORS	30	1	70	5
U_CG_05	121, 122, 123, 124, 125, 126, 127, 129, 130	REACTORS	30	2	70	3
U_CG_06	132	EVAPORATOR, DEGREASERS, TANKS	20	3	70	483 (1)
U_CG_07	133	REACTOR	35	2	100	5
U_CG_08	136	REACTOR	30	2	70	3
U_CG_09	137	MIXER	25	8	75	750
U_CG_10	138	CENTRIFUGE	30	2	60	15
U_CG_11	140	REACTORS	30	1	32	1
U_CG_12	141	REACTORS	30	2	70	30
U_CG_13	142	REACTORS	20	5	450	15
U_CG_14	144	REACTOR	25	2	70	1
U_CG_15	146	GENERAL EXHAUST VENT	42	20	70	7200
U_CG_16	147	REACTORS EXHAUST VENT	34	25	70	3680
U_CG_17	148	GENERAL EXHAUST VENT	42	20	70	7200
U_CG_18	152, 153, 154, 155, 167	REACTOR	30	2	70	1
U_CG_19	176	TANK VENT	40	3	70	483 (2)
U_CG_20	180	TANK VENT	25	4	70	500

Notes:

(1) Volume adjusted from 600 ACFM to 483 ACFM so Velocity would be <= 50 m/s

(2) Volume adjusted from 680 ACFM to 483 ACFM so Velocity would be <= 50 m/s

Table B.13 Source Facility: Ciba-Geigy Corp. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_CG_01	058	ETHANOL	8.4E-04	4001705808	83
U_CG_01	058	DIOXANE	4.0E-06	4001705808	0
U_CG_01	058	ISOPROPANOL	1.8E-03	4001705808	75
U_CG_01	058	METHYLENE CHLORIDE	1.6E-03	4001705808	0
U_CG_01	058	HEXANE	1.5E-03	4001705808	66
U_CG_01	058	TOLUENE	1.4E-04	4001705808	50
U_CG_02	069	ACETIC ACID GLACIAL	8.9E-05	4001706901	
U_CG_02	069	BUTANOL	1.8E-05	4001706901	90
U_CG_02	069	HEXANE	8.9E-03	4001706901	66
U_CG_03	167	ACETONE	4.2E-01	4001716701	60
U_CG_03	107	ETHANOL	4.1E-03	4001710703	83
U_CG_03	167	ISOPROPYLAMINE	2.3E+00	4001716701	98
U_CG_03	105	METHANOL	1.3E-04	4001710501	57
U_CG_03	107	TOLUENE	1.1E-02	4001710703	79
U_CG_04	119	ACETIC ACID GLACIAL	4.3E-04	4001711902	0
U_CG_04	119	ETHANOL	1.9E-03	4001711902	83
U_CG_04	119	DIOXANE	8.1E-06	4001711902	0
U_CG_04	119	ISOPROPYL ALCOHOL	5.8E-07	4001711902	75
U_CG_04	119	METHANOL	1.2E-06	4001711902	83
U_CG_04	119	METHYLENE CHLORIDE	4.1E-03	4001711902	0
U_CG_05	130	ACETONE	4.5E-03	4001713001	80
U_CG_05	123	ETHANOL	1.2E-04	4001712302	
U_CG_05	130	ETHYL ACETATE	4.6E-03	4001713001	80
U_CG_05	123	DIMETHYLFORMAMIDE	3.5E-03	4001712301	
U_CG_05	123	TOLUENE	3.3E-03	4001712302	
U_CG_06	132	TOLUENE	8.0E-03	4001713207	0
U_CG_07	133	METHANOL	1.3E-04	4001713301	83
U_CG_07	133	METHYL CYCLOHEXANE	1.0E-03	4001713301	81
U_CG_07	133	TOLUENE	1.3E-03	4001713301	0
U_CG_08	136	ACETIC ACID GLACIAL	4.3E-04	4001713602	0
U_CG_08	136	ETHANOL	1.9E-03	4001713602	83
U_CG_08	136	DIOXANE	8.1E-06	4001713602	0
U_CG_08	136	ISOPROPYL ALCOHOL	2.9E-07	4001713601	75
U_CG_08	136	METHANOL	5.8E-07	4001713601	83

Table B.13 Source Facility: Ciba-Geigy Corp. (Continued)

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_CG_08	136	METHYLENE CHLORIDE	4.1E-03	4001713602	0
U_CG_09	137	ETHANOL	8.5E-03	4001713701	95
U_CG_10	138	ACETONE	3.8E-02	4001713801	60
U_CG_10	138	ETHANOL	5.9E-04	4001713801	83
U_CG_10	138	ISOPROPYLAMINE	2.1E-01	4001713801	98
U_CG_10	138	METHANOL	1.3E-04	4001713801	57
U_CG_10	138	TOLUENE	1.6E-03	4001713801	79
U_CG_11	140	DIMETHYLAMINE	3.6E-03	4001714002	
U_CG_11	140	METHANOL	7.4E-03	4001714002	
U_CG_12	141	ACETONE	7.6E-02	4001714102	60
U_CG_12	141	ISOPROPYL ALCOHOL	3.6E-03	4001714102	75
U_CG_12	141	ISOPROPYLAMINE	4.2E-01	4001714102	98
U_CG_13	142	DIMETHYLFORMAMIDE	1.4E-05	4001714201	
U_CG_14	144	ETHANOL	1.3E-04	4001714402	83
U_CG_14	144	ETHYL ACETATE	3.1E-04	4001714402	95
U_CG_15	146	ACETONE	1.1E+00	4001714628	60
U_CG_15	146	ETHANOL	1.4E-02	4001714624	83
U_CG_15	146	DIMETHYLAMINE	5.0E-02	4001714628	
U_CG_15	146	ISOPROPYLAMINE	5.9E+00	4001714628	98
U_CG_15	146	METHANOL	1.0E-01	4001714628	
U_CG_15	146	TOLUENE	3.8E-02	4001714624	79
U_CG_16	147	ACETONE	8.9E-02	4001714741	80
U_CG_16	147	ETHANOL	1.7E-03	4001714741	
U_CG_16	147	ETHYL ACETATE	5.7E-02	4001714741	80
U_CG_16	147	DIMETHYLFORMAMIDE	4.8E-02	4001714741	
U_CG_16	147	TOLUENE	6.3E-02	4001714741	
U_CG_17	A03	ACETIC ACID GLACIAL	4.1E-03	40017A0301	0
U_CG_17	A04	ACETONE	3.8E-02	40017A0401	60
U_CG_17	A04	ETHANOL	1.5E-02	40017A0401	83
U_CG_17	148	DIOXANE	6.0E-05	4001714815	0
U_CG_17	A02	ISOPROPYL ALCOHOL	3.2E-02	40017A0202	75
U_CG_17	A04	ISOPROPYLAMINE	2.1E-01	40017A0401	98
U_CG_17	A01	METHANOL	4.2E-03	40017A0102	83
U_CG_17	A01	METHYL CYCLOHEXANE	1.8E-02	40017A0102	81
U_CG_17	148	METHYLENE CHLORIDE	3.1E-02	4001714815	0

Table B.13 Source Facility: Ciba-Geigy Corp. (Continued)

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_CG_17	148	BUTANOL	1.3E-04	4001714815	90
U_CG_17	A02	HEXANE	9.2E-02	40017A0202	66
U_CG_17	A04	TOLUENE	3.5E-02	40017A0401	79
U_CG_18	155	METHANOL	1.8E-04	4001715501	
U_CG_18	155	METHYLENE CHLORIDE	9.9E-03	4001715501	
U_CG_19	176	ETHANOL	1.2E-06	4001717601	
U_CG_19	176	ISOPROPYL ALCOHOL	1.2E-06	4001717601	
U_CG_19	176	METHANOL	1.1E-05	4001717601	
U_CG_19	176	METHYLENE CHLORIDE	9.5E-05	4001717601	
U_CG_20	180	ETHANOL	1.7E-06	4001718001	
U_CG_20	180	ISOPROPYL ALCOHOL	1.7E-06	4001718001	
U_CG_20	180	METHANOL	1.7E-05	4001718001	
U_CG_20	180	METHYLENE CHLORIDE	1.5E-04	4001718001	

FUGITIVE SOURCE

No fugitive emissions were reported in the TRI for 1990.

FUGITIVE SOURCE EMISSIONS

No fugitive emissions were reported in the TRI for 1990.

Table B.14 Source Facility: Exxon Corp.

PLANT_ID	40064, 40003, 40276
PLANT_NAME	Exxon – Bayway Chemical Plant / Bayway Refinery,
LOCATION	1400 Park Avenue
PLANT_CITY	Linden
SIC	2869
SECOND_SIC	2911,8731
PRIN_PROD	Petrochemicals
VOC_TON_YR	2303.4
TRIF ID	07036XXNCH1400P

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
U_BW_01	084	REACTOR	60	25	1600	3400
U_BW_02	256	REACTOR	40	2	115	8
U_BW_03	299	REACTOR	70	3	100	55

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_BW_01	084	ACETIC ACID	2.0E+00	4006408402	99.9
U_BW_01	A02	HEXANE	7.0E+00	40276A0201	10
U_BW_01	084	PHENOL	1.8E+00	4006408401	99.9
U_BW_02	256	HEXANE	4.6E+00	4006425601	99.9
U_BW_02	256	PHENOL	1.8E+00	4006425601	99.9
U_BW_03	299	ACETIC ACID	2.0E+00	4006429901	99.9
U_BW_03	299	HEXANE	2.0E+00	4006429901	99.9

Table B.14 Source Facility: Exxon Corp. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
U_BW_V01	110	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
U_BW_V01	AMMONIA	1.3E+00	Other Approaches
U_BW_V01	CHLORINE	1.4E-03	Other Approaches
U_BW_V01	CYCLOHEXANE	1.7E-02	Other Approaches
U_BW_V01	ETHYLENE GLYCOL	3.6E-03	Other Approaches
U_BW_V01	HYDROCHLORIC ACID	1.1E-01	Other Approaches
U_BW_V01	MALEIC ANHYDRIDE	1.4E-03	Other Approaches
U_BW_V01	NAPHTHALENE	1.4E-05	Other Approaches
U_BW_V01	PHENOL	1.7E-03	Other Approaches
U_BW_V01	SEC-BUTYL ALCOHOL	4.3E-03	Other Approaches
U_BW_V01	TOLUENE	1.4E-05	Other Approaches
U_BW_V01	XYLENE (MIXED ISOMERS)	1.7E-04	Other Approaches

Table B.15 Source Facility: Merck & Co., Inc.

PLANT_ID	40009
PLANT_NAME	Merck & Co., Inc.
LOCATION	126 East Lincoln Avenue
PLANT_CITY	Rahway
SIC	2833
SECOND_SIC	Pharmaceuticals
PRIN_PROD	
VOC_TON_YR	1188
	07065MRCKC126EL

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
U_MK_01	899	REACTORS	55	20	70	3000
U_MK_02	919	UNKNOWN SOURCES	94	15	104	6000

Table B.15 Source Facility: Merck & Co., Inc. (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_MK_01	A01	ACETIC ACID	1.6E-03	40009A0180	0
U_MK_01	899	ACETIC ANHYDRIDE	1.2E-03	4000989918	0
U_MK_01	A01	ACETONE	9.8E-01	40009A0189	0
U_MK_01	A01	CHLOROBENZENE	1.8E-01	40009A0174	0
U_MK_01	A01	DIMETHYLFORMAMIDE	2.7E-02	40009A0180	0
U_MK_01	A01	ETHANOL	1.9E-01	40009A0179	78.2
U_MK_01	A01	ETHYL ACETATE	1.5E+00	40009A0185	10.4
U_MK_01	A01	FORMALDEHYDE	5.6E-04	40009A0180	0
U_MK_01	A01	HEXANE	3.7E-01	40009A0197	3.2
U_MK_01	A01	ISOPROPANOL	3.0E-01	40009A0179	92.5
U_MK_01	A01	MEK	7.6E-02	40009A0179	0
U_MK_01	A10	METHANOL	5.9E+00	40009A1062	0
U_MK_01	A01	TETRAHYDROFURAN	8.7E-01	40009A0195	0
U_MK_01	A01	TOLUENE	2.7E-01	40009A0197	77
U_MK_02	919	ACETIC ANHYDRIDE	1.7E-05	4000991908	0
U_MK_02	919	ACETONE	5.7E+00	4000991967	0
U_MK_02	919	CHLOROFORM	2.8E-03	4000991935	99
U_MK_02	919	ETHANOL	2.9E-03	4000991931	69.9
U_MK_02	919	ISOPENTYL ALCOHOL	6.0E-01	4000991954	0
U_MK_02	919	ISOPROPANOL	1.1E+00	4000991967	0
U_MK_02	919	METHANOL	7.8E-01	4000991967	0

Table B.15 Source Facility: Merck & Co., Inc. (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
U_MK_V01	108	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE
U_MK_V01	1 1 2 2-TETRACHLOROETHANE	2.4E-04	Data Monitoring Or Measurements
U_MK_V01	1 2-DICHLOROBENZENE	1.9E-02	Published Emission Factors
U_MK_V01	ACETONE	1.9E-01	Data Monitoring Or Measurements
U_MK_V01	ACETONITRILE	1.1E-01	Published Emission Factors
U_MK_V01	AMMONIA	1.9E-01	Published Emission Factors
U_MK_V01	BENZENE	7.8E-02	Data Monitoring Or Measurements
U_MK_V01	CARBON DISULFIDE	1.3E-01	Published Emission Factors
U_MK_V01	CHLOROFORM	2.7E-02	Published Emission Factors
U_MK_V01	DICHLOROMETHANE	2.0E-01	Data Monitoring Or Measurements
U_MK_V01	HYDROCHLORIC ACID	3.5E-01	Published Emission Factors
U_MK_V01	METHANOL	7.9E-01	Data Monitoring Or Measurements
U_MK_V01	METHYL ETHYL KETONE	3.5E-03	Published Emission Factors
U_MK_V01	TOLUENE	1.7E-01	Published Emission Factors

Table B.16 Source Facility: Schering Corp. (Kenilworth)

PLANT_ID	40384
PLANT_NAME	Schering Corporation
LOCATION	2000 Galloping Hill Road
PLANT_CITY	Kenilworth
SIC	2834
SECOND_SIC	Pharmaceuticals
PRIN_PROD	
VOC_TON_YR	2775.3
TRIF ID	07033SCHRN2000G

POINT SOURCE

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
U_SPK_01	006	COATING PANS	26	30	80	9999
U_SPK_02	009	DRYER	29	9	195	3300
U_SPK_03	028	TANK	22	10	72	800
U_SPK_04	029, 030, 031, 032, 033, 034, A01	DRYER	66	34	113	9000
U_SPK_05	041, 042	DRYER	26	13	120	2000
U_SPK_06	047, 048	DRYER	80	10	175	4800
U_SPK_07	051	MIXER	64	36	70	9999
U_SPK_08	052, 060	AEROSOL FILLING MACHINE	84	6	70	350

Table B.16 Source Facility: Schering Corp. (Kenilworth) (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_SPK_01	006	ETHANOL	1.8E-02	4038400608	0
U_SPK_01	006	ISOPROPANOL	1.9E-04	4038400608	0
U_SPK_01	006	METHANOL	7.6E-04	4038400608	0
U_SPK_02	009	ETHANOL	1.3E-02	4038400901	95
U_SPK_02	009	METHANOL	6.9E-04	4038400901	95
U_SPK_03	028	ETHANOL	1.7E-02	4038402802	0
U_SPK_03	028	HEXANE	7.4E-04	4038402802	0
U_SPK_03	028	METHANOL	9.3E-04	4038402802	0
U_SPK_03	028	NAPTHA	1.9E-04	4038402802	0
U_SPK_04	A01	ETHANOL	6.6E-01	40384A0103	95
U_SPK_04	A01	METHANOL	3.5E-02	40384A0103	95
U_SPK_05	042	ETHANOL	3.6E-02	4038404201	0
U_SPK_05	042	ISOPROPANOL	3.8E-04	4038404201	0
U_SPK_05	042	METHANOL	1.5E-03	4038404201	0
U_SPK_06	048	ETHANOL	4.8E-02	4038404801	0
U_SPK_06	048	METHANOL	2.5E-03	4038404801	0
U_SPK_07	051	ETHANOL	4.4E-02	4038405105	0
U_SPK_07	051	METHANOL	2.3E-03	4038405105	0
U_SPK_08	060	ISOBUTANE	5.5E-03	4038406001	0
U_SPK_08	060	N-BUTANE	3.7E-04	4038406001	0
U_SPK_08	060	PROPANE	1.5E-03	4038406001	0

Table B.17 Source Facility: Schering Corp. (Union)

PLANT_ID	40084
PLANT_NAME	Schering Corporation
LOCATION	1011 Morris Avenue
PLANT_CITY	Union
SIC	2834
SECOND_SIC	Pharmaceuticals
PRIN_PROD	
VOC_TON_YR	183.7
TRIF ID	07083SCHRN1011M

POINT SOURCES

MODEL_ID	STACK_ID	SR_DESCR	HEIGHT	DIAMETER	TEMP	VOLUME
U_SPU_01	069	REACTOR	50	3	100	150
U_SPU_02	076	REACTOR	40	30	70	7000
U_SPU_03	082	REACTOR	25	3	70	1
U_SPU_04	083	TANK	41	10	70	1400
U_SPU_05	086	TANK	5	25	40	1
U_SPU_06	094, 095, 096, 107	DRYER	32	10	200	1500
U_SPU_07	145	DRYER	52	8	190	1250

Table B.17 Source Facility: Schering Corp. (Union) (Continued)

POINT SOURCE EMISSIONS

MODEL_ID	STACK_ID	CHEM_NAME	g/s	FULL_ID	EFFICIENCY
U_SPU_01	069	ACETONE	2.6E-06	4008406902	95
U_SPU_01	069	METHANOL	1.8E-05	4008406902	95
U_SPU_01	069	TOLUENE	1.3E-05	4008406902	95
U_SPU_01	069	TRIMETHYL BORATE	2.6E-06	4008406902	95
U_SPU_02	076	ACETIC ACID	9.9E-05	4008407617	0
U_SPU_02	076	BENZONITRILE	2.2E-05	4008407621	0
U_SPU_02	A02	BUTANOL	3.7E-02	40084A0201	0
U_SPU_02	A01	ETHYL ACETATE	3.0E-02	40084A0101	0
U_SPU_02	076	ETHYLENE GLYCOL	9.0E-05	4008407621	0
U_SPU_02	076	GYLCERINE	9.2E-05	4008407607	0
U_SPU_02	A01	HEPTANE	2.9E-02	40084A0103	0
U_SPU_02	A01	ISOPROPANOL	7.3E-02	40084A0103	0
U_SPU_02	076	METHANOL	2.5E-03	4008407615	0
U_SPU_02	A02	TOLUENE	5.0E-02	40084A0201	0
U_SPU_03	082	BUTANOL	7.2E-04	4008408201	0
U_SPU_03	082	METHANOL	7.2E-06	4008408201	0
U_SPU_04	083	TICHLOROACETIC ACID	2.0E-06	4008408301	0
U_SPU_05	086	ETHANOL	6.9E-05	4008408601	0
U_SPU_06	107	BUTANOL	1.3E-02	4008410701	0
U_SPU_06	107	HEPTANE	2.8E-02	4008410701	0
U_SPU_06	096	ISOPROPANOL	3.5E-02	4008409601	0
U_SPU_06	107	METHANOL	2.3E-03	4008410701	0
U_SPU_06	107	TOLUENE	2.1E-02	4008410701	0
U_SPU_07	145	ACETONE	2.6E-06	4008414501	95
U_SPU_07	145	BUTANOL	8.8E-05	4008414501	95
U_SPU_07	145	METHANOL	1.8E-05	4008414501	95
U_SPU_07	145	TOLUENE	1.3E-05	4008414501	95
U_SPU_07	145	TRIMETHYL BORATE	2.6E-06	4008414501	95

Table B.17 Source Facility: Schering Corp. (Union) (Continued)

FUGITIVE SOURCE

No fugitive emissions were reported in the TRI for 1990

FUGITIVE SOURCE EMISSIONS

No fugitive emissions were reported in the TRI for 1990

Table B.16 Source Facility: Schering Corp. (Kenilworth) (Continued)

FUGITIVE SOURCE

MODEL_ID	Initial Lateral Dimension (meters)	Initial Vertical Dimension (meters)	Release Height (meters)
U_SPK_V01	25.6	2.79	3

FUGITIVE SOURCE EMISSIONS

MODEL_ID	CHEM_NAME	g/s	REL_CODE	TRI_FAC_ID
U_SPK_V01	1 1 1-TRICHLOROETHANE	2.0E-02	Other Approaches	07033SCHRN2000G

APPENDIX C

CHRONIC TOXICITY CRITERIA

Table C.1 lists the chronic toxicity values selected for use in this study. The chronic toxicity values used in this study were obtained from the sources listed below and in priority order. Details on the sources can be found in Section 3.2.2 (Toxicity Assessment).

- USEPA Office of Air Quality Planning and Standards (OAQPS) Dose-Response Assessment Tables, February 28, 2005 Version (USEPA, 2005b).
- USEPA Integrated Risk Information System (IRIS) computer database (USEPA, 2005a).
- USEPA Health Effects Assessment Summary Table (HEAST), July 31, 1997 Edition (USEPA, 1997b).
- USEPA Region III Risk Based Concentration (RBC) Table, October 2005 Edition (USEPA, 2005c).
- New Jersey Department of Environmental Protection (NJDEP) Air Quality Permitting Program Table of Reference Concentrations for Inhalation and the Table of Unit Risk Factors for Inhalation, September 2005 Versions (NJDEP, 2005).
- California EPA (Cal EPA) Toxicity Criteria Database (Cal EPA, 2005c) and the Cal EPA Air Resources Board (ARB) Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, April 25, 2005 Edition (Cal EPA, 2005a).
- Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels (ESLs) Table, October 01, 2003 Version (TCEQ, 2003).

Table C.1 Chronic Toxicity Criteria

Sources:

ASTDR	ATSDR chronic Minimum Risk Levels (MRLs).
CAL	California EPA value.
Conv. Oral.	Value converted from an oral toxicity value.
EPA-P	USEPA provisional peer-reviewed values.
EPA-NCEA-P	USEPA National Center for Exposure Assessment (NCEA) provisional values.
ESL-LT	Effects Screening Levels (ESLs) – Long Term.
HEAST	Health Effects Assessment Summary Table.
HEAST-ALT	Health Effects Assessment Summary Table, Alternate table.
IRIS	USEPA Integrated Risk Information System (IRIS) on-line database.
P-CAL	California EPA provisional value.

References:

OAQPS	USEPA Office of Air Quality Planning and Standards (OAQPS), Prioritized Chronic Dose-Response Values tables.
IRIS	USEPA Integrated Risk Information System (IRIS) on-line database.
R3RBC	USEPA Region 3 Risk Based Concentrations (RBC) table.
TCEQ	Texas Commission on Environmental Quality (TCEQ), Effects Screening Levels (ESLs) table.

Chemical of Concern	CAS No.	HAP	RfC (mg/m^3)	Source	Reference	UR $(\mu g/m^3)^{-1}$	Source	Reference
Acetic acid	64-19-7	N	2.50E-01	ESL-LT	TCEQ	--	--	--
Acetic anhydride	108-24-7	N	2.00E-01	ESL-LT	TCEQ	--	--	--
Acetone	67-64-1	N	3.15E+00	Conv. Oral, IRIS	R3 RBC	--	--	--
Acetonitrile	75-05-8	Y	6.00E-02	IRIS	OAQPS	--	--	--
Acrylic acid	79-10-7	Y	1.00E-03	IRIS	OAQPS	--	--	--
Acrylic momoner	79-06-1	Y	7.00E-04	P-CAL EPA	OAQPS	1.30E-03	IRIS	OAQPS
Ammonia	7664-41-7	N	1.00E-01	IRIS	R3 RBC	--	--	--
Benzaldehyde	100-52-7	N	3.50E-01	Conv. Oral, IRIS	R3 RBC	--	--	--
Benzene	71-43-2	Y	3.00E-02	IRIS	OAQPS	7.80E-06	IRIS	OAQPS
Benzonitrile	100-47-0	N	5.00E-01	ESL-LT	TCEQ	--	--	--
Bis(2-ethylhexyl)adipate	103-23-1	N	2.10E+00	Conv. Oral, IRIS	R3 RBC	3.43E-07	Conv. Oral, IRIS	R3 RBC
Butane	106-97-8	N	1.90E+01	ESL-LT	TCEQ	--	--	--
Butanol	71-36-3	N	3.50E-01	Conv. Oral, IRIS	R3 RBC	--	--	--
Butyl acetate	123-86-4	N	1.85E+00	ESL-LT	TCEQ	--	--	--
Carbon disulfide	75-15-0	Y	7.00E-01	IRIS	OAQPS	--	--	--

Table C.1 Chronic Toxicity Criteria (Continued)

Chemical of Concern	CAS No.	HAP	RfC (mg/m^3)	Source	Reference	UR $(\mu g/m^3)^{-1}$	Source	Reference
Chlorine	7782-50-5	Y	2.00E-04	CAL	OAQPS	--	--	--
Chlorobenzene	108-90-7	Y	1.00E+00	CAL EPA	OAQPS	--	--	--
Chloroform	67-66-3	Y	9.80E-02	ATSDR	OAQPS	--	--	--
Cyclohexane	110-82-7	N	6.00E+00	IRIS	IRIS	--	--	--
Cyclohexanone	108-94-1	N	1.75E+01	Conv. Oral, IRIS	R3 RBC	--	--	--
Di(2-ethylhexyl)phthalate	117-81-7	Y	1.00E-02	P-CAL	OAQPS	2.40E-06	CAL	OAQPS
Diacetone alcohol	123-42-2	N	1.33E+00	ESL-LT	TCEQ	--	--	--
Dibutyl phthalate	84-74-2	Y	3.50E-01	Conv. Oral, IRIS	R3 RBC	--	--	--
Dichlorobenzene	95-50-1	N	1.40E-01	HEAST	R3 RBC	--	--	--
Diethylene glycol	111-46-6	N	2.20E+00	ESL-LT	TCEQ	--	--	--
Diethylene triamine	111-40-0	N	4.00E-02	ESL-LT	TCEQ	--	--	--
Dimethyl carbamoyl chloride	79-44-7	Y	--	--	--	3.70E-03	TCD	CAL EPA
Dimethyl sulfate	77-78-1	Y	5.00E-03	ESL-LT	TCEQ	--	--	--
Dimethylamine	124-40-3	N	4.00E-02	ESL-LT	TCEQ	--	--	--
Dimethylformamide	68-12-2	Y	3.00E-02	IRIS	OAQPS	--	--	--
Dioxane	123-91-1	Y	3.60E+00	D-ATSDR	OAQPS	3.10E-06	Conv. Oral	OAQPS
Epichlorohydrin	106-89-8	Y	1.00E-03	IRIS	OAQPS	1.20E-06	IRIS	OAQPS
Ethanol	64-17-5	N	1.80E+01	ESL-LT	TCEQ	--	--	--
Ethyl acetate	141-78-6	N	3.15E+00	Conv. Oral, IRIS	R3 RBC	--	--	--
Ethyl acrylate	140-88-5	Y	--	--	--	1.40E-05	Conv. Oral	OAQPS
Ethyl chloroformate	541-41-3	N	5.00E-03	ESL-LT	TCEQ	--	--	--
Ethyl ether	60-29-7	N	7.00E-01	Conv. Oral, IRIS	R3 RBC	--	--	--
Ethylene dichloride	107-06-2	Y	2.40E+00	ATSDR	OAQPS	2.60E-05	IRIS	OAQPS
Ethylene glycol	107-21-1	Y	4.00E-01	CAL EPA	OAQPS	--	--	--
Ethylene oxide	75-21-8	Y	3.00E-02	CAL	OAQPS	8.80E-05	CAL	OAQPS
Formaldehyde	50-00-0	Y	9.80E-03	ATSDR	OAQPS	5.50E-09	OAQPS	OAQPS

Table C.1 Chronic Toxicity Criteria (Continued)

Chemical of Concern	CAS No.	HAP	RfC (mg/m^3)	Source	Reference	UR $(\mu g/m^3)^{-1}$	Source	Reference
Formic acid	64-18-6	N	9.00E-02	ESL-LT	TCEQ	--	--	--
Glycerine	56-81-5	N	5.00E-02	ESL-LT	TCEQ	--	--	--
Heptane	142-82-5	N	3.50E+00	ESL-LT	TCEQ	--	--	--
Hexane	110-54-3	Y	2.00E-01	IRIS	OAQPS	--	--	--
Hydrazine	302-01-2	Y	2.00E-04	CAL EPA	OAQPS	4.90E-03	IRIS	OAQPS
Hydrochloric acid	7647-01-0	Y	2.00E-02	IRIS	OAQPS	--	--	--
Hydroquinone	123-31-9	Y	1.40E-01	Conv. Oral, P-EPA	R3 RBC	1.60E-05	Conv. Oral, P-EPA	R3 RBC
Isobutane	75-28-5	N	4.80E+00	ESL-LT	TCEQ	--	--	--
Isobutyl alcohol	78-83-1	N	1.05E+00	Conv. Oral, IRIS	R3 RBC	--	--	--
Isopentane	78-78-4	N	3.50E+00	ESL-LT	TCEQ	--	--	--
Isopentyl alcohol	123-51-3	N	1.50E-01	ESL-LT	TCEQ	--	--	--
Isopropanol	67-63-0	N	7.85E+00	ESL-LT	TCEQ	--	--	--
Isopropylamine	75-31-0	N	1.20E-01	ESL-LT	TCEQ	--	--	--
Maleic anhydride	108-31-6	Y	7.00E-04	CAL	OAQPS	--	--	--
Methanol	67-56-1	Y	4.00E+00	CAL EPA	OAQPS	--	--	--
Methyl acetate	79-20-9	N	3.50E+00	Conv. Oral, HEAST	R3 RBC	--	--	--
Methyl acrylate	96-33-3	N	1.05E-01	Conv. Oral, HEAST-Alt	R3 RBC	--	--	--
Methyl amyl alcohol	108-11-2	N	2.90E-01	ESL-LT	TCEQ	--	--	--
Methyl bromide	74-83-9	Y	5.00E-03	IRIS	OAQPS	--	--	--
Methyl cyclohexane	108-87-2	N	3.01E+00	HEAST	R3 RBC	--	--	--
Methyl ethyl ketone	78-93-3	Y	5.00E+00	IRIS	OAQPS	--	--	--
Methyl formate	107-31-3	N	2.50E+00	ESL-LT	TCEQ	--	--	--
Methyl hydrazine	60-34-4	Y	2.00E-04	CAL EPA	OAQPS	4.90E-03	IRIS	OAQPS
Methyl isobutyl ketone	108-10-1	Y	3.00E+00	IRIS	OAQPS	--	--	--
Methyl methacrylate	80-62-6	Y	7.00E-01	IRIS	OAQPS	--	--	--
Methylene chloride	75-09-2	Y	1.00E+00	ATSDR	OAQPS	4.70E-07	IRIS	OAQPS

Table C.1 Chronic Toxicity Criteria (Continued)

Chemical of Concern	CAS No.	HAP	RfC (mg/m^3)	Source	Reference	UR $(\mu g/m^3)^{-1}$	Source	Reference
Naphtha	64742-95-6	N	1.25E+00	ESL-LT	TCEQ	--	--	--
n-butyl acrylate	141-32-2	N	1.80E-01	ESL-LT	TCEQ	--	--	--
Nonanal	124-19-6	N	1.50E+00	ESL-LT	TCEQ	--	--	--
n-propyl acetate	109-60-4	N	6.30E-01	ESL-LT	TCEQ	--	--	--
Oil	8012-95-1	N	5.00E-02	ESL-LT	TCEQ	--	--	--
Pelargonic acid	112-05-0	N	5.00E-03	ESL-LT	TCEQ	--	--	--
Pentanal	110-62-3	N	1.00E-01	ESL-LT	TCEQ	--	--	--
Phenol	108-95-2	Y	2.00E-01	CAL EPA	OAQPS	--	--	--
Phosphoric acid	7664-38-2	N	1.00E-02	IRIS	R3 RBC	--	--	--
Phthalic anhydride	85-44-9	Y	2.00E-02	CAL	OAQPS	--	--	--
Propane	74-98-6	N	1.80E+01	ESL-LT	TCEQ	--	--	--
Propanol	71-23-8	N	4.90E+00	ESL-LT	TCEQ	--	--	--
Propargyl alcohol	107-19-7	N	2.00E-02	ESL-LT	TCEQ	--	--	--
Propionic acid	79-09-4	N	1.00E-01	ESL-LT	TCEQ	--	--	--
Propylene glycol, methyl ester	107-98-2	N	2.00E+00	IRIS	R3 RBC	--	--	--
Propylene oxide	75-56-9	Y	3.00E-02	IRIS	OAQPS	3.70E-06	IRIS	OAQPS
Pyridine	110-86-1	N	7.00E-02	ESL-LT	TCEQ	--	--	--
Styrene	100-42-5	Y	1.00E+00	IRIS	OAQPS	--	--	--
Styrene oxide	96-09-3	Y	6.00E-03	P-CAL	OAQPS	--	--	--
tert-Butanol	75-65-0	N	6.20E-01	ESL-LT	TCEQ	--	--	--
tert-Butyl chloride	507-20-0	N	4.40E+00	ESL-LT	TCEQ	--	--	--
Tetrachloroethane	79-34-5	Y	--	--	--	5.80E-05	IRIS	OAQPS
Tetrahydrofuran	109-99-9	N	3.01E-01	EPA-NCEA-P	R3 RBC	1.94E-06	EPA-NCEA-P	R3 RBC
Toluene	108-88-3	Y	4.00E-01	IRIS	OAQPS	--	--	--
Trichloroacetic acid	76-03-9	N	7.00E-02	ESL-LT	TCEQ	--	--	--
Trichloroethane	71-55-6	Y	1.00E+00	CAL	OAQPS	--	--	--

Table C.1 Chronic Toxicity Criteria (Continued)

Chemical of Concern	CAS No.	HAP	RfC (mg/m^3)	Source	Reference	UR $(\mu g/m^3)^{-1}$	Source	Reference
Tridecyl alcohol	112-70-9	N	2.70E+00	ESL-LT	TCEQ	--	--	--
Triethylamine	121-44-8	Y	7.00E-03	IRIS	OAQPS	--	--	--
Triethylene glycol	112-27-6	N	1.00E-01	ESL-LT	TCEQ	--	--	--
Trimethyl benzene	95-63-6	N	5.95E-03	EPA-P	R3 RBC	--	--	--
Trimethyl borate	121-43-7	N	1.30E-02	ESL-LT	TCEQ	--	--	--
Vinyl acetate	108-05-4	Y	2.00E-01	IRIS	OAQPS	--	--	--
Vinyl chloride	75-01-4	Y	1.00E-01	IRIS	OAQPS	8.80E-06	IRIS	OAQPS
Vinyl methyl ether	107-25-5	N	9.70E+00	ESL-LT	TCEQ	--	--	--
Xylene	1330-20-7	Y	1.00E-01	IRIS	OAQPS	--	--	--

APPENDIX D

AERMET INPUT FILE AND SUMMARY FILE

Appendix D contains the input file to and summary file from AERMET. The meteorological data processed through AERMET was imported into the air dispersion modeling software and used in all modeling runs.

D.1 AERMET Input File

```
** BREEZE AERMET v4.0.7 - C:\Documents and
Settings\SILVERMK\Desktop\KCS\Dissertation\MetData\EWR91-95.amt
** Trinity Consultants, Dallas, TX

JOB
     MESSAGES  C:\DOCUME~1\SILVERMK\Desktop\KCS\DISSER~4\MetData\EWR91-95.MSG
     REPORT  C:\DOCUME~1\SILVERMK\Desktop\KCS\DISSER~4\MetData\EWR91-95.RPT
     CHK_SYNTAX

METPREP
     DATA  C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.MRG
     MODEL  AERMOD
     LOCATION  FACILITY 40.43N 74.1W 5
     NWS_HGT  WIND 9.1
     XDATES  91/01/01 95/12/31
     METHOD  WIND_DIR RANDOM
     METHOD  REFLEVEL SUBNWS
     FREQ_SECT  SEASONAL 1
     SECTOR  1 0 360
     SITE_CHAR  1 1 0.35 1.75 1.00
     SITE_CHAR  2 1 0.14 1.00 1.00
     SITE_CHAR  3 1 0.16 2.00 1.00
     SITE_CHAR  4 1 0.18 2.00 1.00
     OUTPUT  C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.SFC
     PROFILE  C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.PFL

**BREEZE
**     TYPE  4
```

D.2 AERMET Summary File

```
**************************************************************************
***  Stage 3 - Estimate Boundary Layer Parameters
**************************************************************************

        AERMET, A Meteorological Processor for the AERMOD Dispersion Model
                                Version  03273

                     Data Processed on  2-JUL-05 at 23:24:19

              ********************************************************
              ***         AERMET Setup Finished Successfully         ***
              ********************************************************

    1.  Input/Output Files

        C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.RPT
OPENED SUCCESSFULLY
        C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.MSG
OPENED SUCCESSFULLY
        C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.MRG
OPENED SUCCESSFULLY
        C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.SFC
OPENED SUCCESSFULLY
        C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-95.PFL
OPENED SUCCESSFULLY

    2.  Dispersion Model for which Data Are Processed

          AERMOD

    3.  Processing Options

           Process        Scheme         Description
           -------        ------         -----------
        WIND DIRECTION    RANDOM     NWS wind directions are RANDOMIZED
        SBL PROCESSING    UCALST     The default (Holtslag method is used)
        REFERENCE LEVEL   SUBNWS     NWS data ARE SUBSTITUTED for on-site   data

    4.  Locations of Meteorological Data

         Data            Site      Longitude    Latitude
        Pathway           ID       (degrees)    (degrees)
        -------          ----      ---------    ---------
        UPPERAIR      00093755        74.67W       39.75N
        SURFACE          14734        74.17W        40.7N
        ONSITE               0

        ****************************************
        * Longitude and Latitude for Processing *
        *          74.10      40.43             *
        ****************************************

    5.  Surface Characteristics

                  Wind Sector                    Bowen    Roughness
          Month   Start    End      Albedo      Ratio    Length (m)
          ------------------------------------------------------------
            1        0.   360.      0.3500     1.7500      1.0000
            2        0.   360.      0.3500     1.7500      1.0000
            3        0.   360.      0.1400     1.0000      1.0000
            4        0.   360.      0.1400     1.0000      1.0000
            5        0.   360.      0.1400     1.0000      1.0000
            6        0.   360.      0.1600     2.0000      1.0000
            7        0.   360.      0.1600     2.0000      1.0000
            8        0.   360.      0.1600     2.0000      1.0000
            9        0.   360.      0.1800     2.0000      1.0000
```

```
          10        0.  360.    0.1800    2.0000    1.0000
          11        0.  360.    0.1800    2.0000    1.0000
          12        0.  360.    0.3500    1.7500    1.0000

   6.  Input File(s) for   AERMOD

         Surface Meteorology:  C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-
95.SFC
         Profile Data       :  C:\DOCUME~1\SILVERMK\DESKTOP\KCS\DISSER~4\METDATA\EWR91-
95.PFL

 The number of calms encountered is:    935
```

APPENDIX E

AERMOD INPUT FILES

The air dispersion model (AERMOD) was run four times, one time for each of the four receptor grids in the study (North Essex, East Union, West Union, and South Middlesex). Each model run simultaneously modeled all of the emission sources, located on all the source facilities, within the boundaries of the respective receptor grid. The AERMOD-MSP option in the BREEZE® software automatically created a batch file that ran each of the four modeling runs 102 times, one time for each of the COCs. The final number of modeling runs done for this study was 408 runs (i.e., 4 receptor grids × 102 COCs). The total number of receptors modeled were 4,900 in both the North Essex and West Union grids; 7,742 in the East Union grid; and 4,140 in the Lower Middlesex grid. This appendix contains abbreviated versions of all four AERMOD input files (i.e., NE_Run1.dat, EU_Run1.dat, WU_Run1.dat, SM_Run1.dat). To abbreviate the original input file, the 'X' and 'Y' coordinates of the individual receptors were omitted.

E.1 AERMOD Input Files

```
** BREEZE AERMOD GIS Pro v5.1.0 - C:\KCS\AERMOD\NE_Run1.dat
** Trinity Consultants

** PRIME

CO STARTING
CO TITLEONE North Essex
CO TITLETWO Run 1: 16-DEC-2005
CO MODELOPT DFAULT CONC
CO AVERTIME ANNUAL
CO POLLUTID ALL_POLL
CO RUNORNOT RUN
CO FINISHED

SO STARTING
SO ELEVUNIT METERS
SO LOCATION SRC60 POINT 571024.8 4520821.4 41
** SRCDESCR E_HR_01
SO LOCATION SRC61 POINT 571024.8 4520802.7 40
** SRCDESCR E_HR_02
SO LOCATION SRC62 POINT 571024.8 4520784.0 40
** SRCDESCR E_HR_03
SO LOCATION SRC63 POINT 571024.8 4520763.9 39
** SRCDESCR E_HR_04
SO LOCATION SRC64 POINT 571124.6 4520772.4 40
** SRCDESCR E_HR_05
SO LOCATION SRC65 POINT 571124.6 4520755.5 40
** SRCDESCR E_HR_06
SO LOCATION SRC144 VOLUME 571072.85 4520765.55 40
** SRCDESCR E_HR_V01
SO SRCPARAM SRC60 0.000000E+00 19.812 300.3722 3.725601 0.0254
SO SRCPARAM SRC61 0.000000E+00 19.812 313.15 1.62995 0.0508
SO SRCPARAM SRC62 0.000000E+00 3.048 294.2611 0.1891907 2.032
SO SRCPARAM SRC63 0.000000E+00 36.576 294.2611 0.4365938 2.032
SO SRCPARAM SRC64 0.000000E+00 13.716 281.4833 10.2454 0.0254
SO SRCPARAM SRC65 5.900000E-02 6.096 294.2611 5.821251E-02 1.016
SO SRCPARAM SRC144 0.000000E+00 3 62 2.79
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT METERS
(Listing of receptors has been omitted for brevity, please refer to Section 3.2.3.5 (Receptor Grids) for
details on receptor spacing)
RE FINISHED

ME STARTING
ME SURFFILE C:\KCS\EWR91-95.SFC
ME PROFFILE C:\KCS\EWR91-95.PFL
ME PROFBASE 9 METERS
ME SURFDATA 14734 1991
ME UAIRDATA 00093755 1991
ME STARTEND 1991 01 01 1 1995 12 31 24
ME FINISHED

OU STARTING
OU FINISHED

** OUTFILE C:\KCS\AERMOD\NE_Run1.lst
** RAWFILE C:\KCS\AERMOD\NE_Run1.RAW
** RAWFMT 2
** TERRFILE C:\KCS\MOSAIC.DEM 2 2 1 18 9.999972 531660 4469240 531660 4539020 584570
4539020 584570 4469240
** HILLBOUN 567460.9 4516833.7 574959.4 4524210.3

** POLLUTNT IDN 01 ACETIC_ACID X
** POLLUTNT NAM 01 Acetic acid
** POLLUTNT IDN 02 ACETIC_ANH X
** POLLUTNT NAM 02 Acetic anhydride
** POLLUTNT IDN 03 ACETONE X
** POLLUTNT NAM 03 Acetone
** POLLUTNT IDN 04 ACETONITRILE X
** POLLUTNT NAM 04 Acetonitrile
** POLLUTNT IDN 05 ACRYLIC_ACID X
** POLLUTNT NAM 05 Acrylic acid
** POLLUTNT IDN 06 ACRYLIC_MONO X
** POLLUTNT NAM 06 Acrylic monomer
** POLLUTNT IDN 07 BENZALDEHYDE X
** POLLUTNT NAM 07 Benzaldehyde
** POLLUTNT IDN 08 BENZENE X
** POLLUTNT NAM 08 Benzene
** POLLUTNT IDN 09 BENZONITRILE X
** POLLUTNT NAM 09 Benzonitrile
** POLLUTNT IDN 10 BUTANE X
** POLLUTNT NAM 10 Butane
** POLLUTNT IDN 11 BUTANOL X
** POLLUTNT NAM 11 Butanol
** POLLUTNT IDN 12 BUTYL_ACETATE X
```

```
** POLLUTNT NAM 12 Butyl acetate
** POLLUTNT IDN 13 CHLOROBENZENE X
** POLLUTNT NAM 13 Chlorobenzene
** POLLUTNT IDN 14 CHLOROFORM X
** POLLUTNT NAM 14 Chloroform
** POLLUTNT IDN 15 CYCLOHEXANE X
** POLLUTNT NAM 15 Cyclohexane
** POLLUTNT IDN 16 CYCLOHEXANONE X
** POLLUTNT NAM 16 Cyclohexanone
** POLLUTNT IDN 17 DIACETONE_ALCOHOL X
** POLLUTNT NAM 17 Diacetone alcohol
** POLLUTNT IDN 18 DIETHYLENE_GLYCOL X
** POLLUTNT NAM 18 Diethylene glycol
** POLLUTNT IDN 19 DIETHYLENE_TRIAMINE X
** POLLUTNT NAM 19 Diethylene triamine
** POLLUTNT IDN 20 DIMETHYL_CC X
** POLLUTNT NAM 20 Dimethyl carbonyl chloride
** POLLUTNT IDN 21 DIMETHYLAMINE X
** POLLUTNT NAM 21 Dimethylamine
** POLLUTNT IDN 22 DIMETHYLFORMAMIDE X
** POLLUTNT NAM 22 Dimethylformamide
** POLLUTNT IDN 23 DIOXANE X
** POLLUTNT NAM 23 Dioxane
** POLLUTNT IDN 24 EPICHLOROHYDRIN X
** POLLUTNT NAM 24 Epichlorohydrin
** POLLUTNT IDN 25 ETHANOL X
** POLLUTNT NAM 25 Ethanol
** POLLUTNT IDN 26 ETHYL_ACETATE X
** POLLUTNT NAM 26 Ethyl acetate
** POLLUTNT IDN 27 ETHYL_ACRYLATE X
** POLLUTNT NAM 27 Ethyl acrylate
** POLLUTNT IDN 28 ETHYL_CHLOROFORMATE X
** POLLUTNT NAM 28 Ethyl chloroformate
** POLLUTNT IDN 29 ETHYL_ETHER X
** POLLUTNT NAM 29 Ethyl ether
** POLLUTNT IDN 30 ETHYLENE_DICHLORIDE X
** POLLUTNT NAM 30 Ethylene dichloride
** POLLUTNT IDN 31 ETHYLENE_GLYCOL X
** POLLUTNT NAM 31 Ethylene glycol
** POLLUTNT IDN 32 FORMALDEHYDE X
** POLLUTNT NAM 32 Formaldehyde
** POLLUTNT IDN 33 FORMIC_ACID X
** POLLUTNT NAM 33 Formic acid
** POLLUTNT IDN 34 GLYCERINE X
** POLLUTNT NAM 34 Glycerine
** POLLUTNT IDN 35 HEPTANE X
** POLLUTNT NAM 35 Heptane
** POLLUTNT IDN 36 HEXANE X
** POLLUTNT NAM 36 Hexane
** POLLUTNT IDN 37 HYDRAZINE X
** POLLUTNT NAM 37 Hydrazine
** POLLUTNT IDN 38 HYDROCHLORIC X
** POLLUTNT NAM 38 Hydrochloric acid
** POLLUTNT IDN 39 HYDROQUINONE X
** POLLUTNT NAM 39 Hydroquinone
** POLLUTNT IDN 40 ISOBUTANE X
** POLLUTNT NAM 40 Isobutane
** POLLUTNT IDN 41 ISOBUTYL_ALCOHOL X
** POLLUTNT NAM 41 Isobutyl alcohol
** POLLUTNT IDN 42 ISOPENTANE X
** POLLUTNT NAM 42 Isopentane
** POLLUTNT IDN 43 ISOPENTYL_ALCOHOL X
** POLLUTNT NAM 43 Isopentyl alcohol
** POLLUTNT IDN 44 ISOPROPANOL X
** POLLUTNT NAM 44 Isopropanol
** POLLUTNT IDN 45 ISOPROPYLAMINE X
** POLLUTNT NAM 45 Isopropylamine
** POLLUTNT IDN 46 METHANOL X
** POLLUTNT NAM 46 Methanol
** POLLUTNT IDN 47 METHYL_ACETATE X
** POLLUTNT NAM 47 Methyl acetate
** POLLUTNT IDN 48 METHYL_ACRYLATE X
** POLLUTNT NAM 48 Methyl acrylate
** POLLUTNT IDN 49 METHYL_AMYL_ALCOHOL X
** POLLUTNT NAM 49 Methyl amyl alcohol
** POLLUTNT IDN 50 METHYL_BROMIDE X
** POLLUTNT NAM 50 Methyl bromide
** POLLUTNT IDN 51 METHYL_CYCLOHEXANE X
** POLLUTNT NAM 51 Methyl cyclohexane
** POLLUTNT IDN 52 MEK X
** POLLUTNT NAM 52 Methyl ethyl ketone
** POLLUTNT IDN 53 METHYL_FORMATE X
** POLLUTNT NAM 53 Methyl formate
** POLLUTNT IDN 54 METHYL_HYDRAZINE X
** POLLUTNT NAM 54 Methyl hydrazine
** POLLUTNT IDN 55 METHYL_ISOBUTYL_KETONE X
** POLLUTNT NAM 55 Methyl isobutyl ketone
** POLLUTNT IDN 56 METHYL_METHACRYLATE X
```

E.1 AERMOD Input Files (Continued)

** POLLUTNT NAM 56 Methyl methacrylate
** POLLUTNT IDN 57 METHYLENE_CL X
** POLLUTNT NAM 57 Methylene chloride
** POLLUTNT IDN 58 NAPHTHA X
** POLLUTNT NAM 58 Naphtha
** POLLUTNT IDN 59 N-BUTYL_ACRYLATE X
** POLLUTNT NAM 59 N-butyl acrylate
** POLLUTNT IDN 60 NONANAL X
** POLLUTNT NAM 60 Nonanal
** POLLUTNT IDN 61 N-PROPYL_ACETATE X
** POLLUTNT NAM 61 N-propyl acetate
** POLLUTNT IDN 62 OIL X
** POLLUTNT NAM 62 Oil
** POLLUTNT IDN 63 PELARGONIC_ACID X
** POLLUTNT NAM 63 Pelargonic acid
** POLLUTNT IDN 64 PENTANAL X
** POLLUTNT NAM 64 Pentanal
** POLLUTNT IDN 65 PHENOL X
** POLLUTNT NAM 65 Phenol
** POLLUTNT IDN 66 PHOSPHORIC_ACID X
** POLLUTNT NAM 66 Phosphoric acid
** POLLUTNT IDN 67 PROPANE X
** POLLUTNT NAM 67 Propane
** POLLUTNT IDN 68 PROPANOL X
** POLLUTNT NAM 68 Propanol
** POLLUTNT IDN 69 PROPARGYL_ALCOHOL X
** POLLUTNT NAM 69 Propargyl alcohol
** POLLUTNT IDN 70 PROPIONIC_ACID X
** POLLUTNT NAM 70 Propionic acid
** POLLUTNT IDN 71 PROPYLENE_GLYCOL X
** POLLUTNT NAM 71 Propylene glycol, methyl ester
** POLLUTNT IDN 72 PYRIDINE X
** POLLUTNT NAM 72 Pyridine
** POLLUTNT IDN 73 TERT-BUTANOL X
** POLLUTNT NAM 73 tert-butanol
** POLLUTNT IDN 74 TERT-BUTYL_CHLORIDE X
** POLLUTNT NAM 74 tert-butyl chloride
** POLLUTNT IDN 75 TETRAHYDROFURAN X
** POLLUTNT NAM 75 Tetrahydrofuran
** POLLUTNT IDN 76 TOLUENE X
** POLLUTNT NAM 76 Toluene
** POLLUTNT IDN 77 TRICHLOROACETIC X
** POLLUTNT NAM 77 Trichloroacetic acid
** POLLUTNT IDN 78 TRIDECYL X
** POLLUTNT NAM 78 Tridecyl alcohol
** POLLUTNT IDN 79 TRIETHYLAMINE X
** POLLUTNT NAM 79 Triethylamine
** POLLUTNT IDN 80 TRIETHYLENE X
** POLLUTNT NAM 80 Triethylene glycol
** POLLUTNT IDN 81 TRIMETHYL_BORATE X
** POLLUTNT NAM 81 Trimethyl borate
** POLLUTNT IDN 82 VINYL_ACETATE X
** POLLUTNT NAM 82 Vinyl acetate
** POLLUTNT IDN 83 VINYL_CHLORIDE X
** POLLUTNT NAM 83 Vinyl chloride
** POLLUTNT IDN 84 VINYL_METHYL_ETHER X
** POLLUTNT NAM 84 Vinyl methyl ether
** POLLUTNT IDN 85 XYLENE X
** POLLUTNT NAM 85 Xylene
** POLLUTNT IDN 86 AMMONIA X
** POLLUTNT NAM 86 Ammonia
** POLLUTNT IDN 87 BIS_2EH_ADIPATE X
** POLLUTNT NAM 87 Bis(2-ethylhexyl) adipate
** POLLUTNT IDN 88 CARBON_DISULFIDE X
** POLLUTNT NAM 88 Carbon disulfide
** POLLUTNT IDN 89 CHLORINE X
** POLLUTNT NAM 89 Chlorine
** POLLUTNT IDN 90 DI_2EH_PHTHALATE X
** POLLUTNT NAM 90 Di(2-ethylhexyl) phthalate
** POLLUTNT IDN 91 DICHLOROBENZENE X
** POLLUTNT NAM 91 Dichlorobenzene
** POLLUTNT IDN 92 DIBUTYL_PHTHALATE X
** POLLUTNT NAM 92 Dibutyl phthalate
** POLLUTNT IDN 93 DIMETHYL_SULFATE X
** POLLUTNT NAM 93 Dimethyl sulfate
** POLLUTNT IDN 94 ETHYLENE_OXIDE X
** POLLUTNT NAM 94 Ethylene oxide
** POLLUTNT IDN 95 MALEIC_ANH X
** POLLUTNT NAM 95 Maleic anhydride
** POLLUTNT IDN 96 PHTHALIC_ANH X
** POLLUTNT NAM 96 Phthalic anhydride
** POLLUTNT IDN 97 PROPYLENE_OXIDE X
** POLLUTNT NAM 97 Propylene oxide
** POLLUTNT IDN 98 STYRENE_OXIDE X
** POLLUTNT NAM 98 Styrene oxide
** POLLUTNT IDN 99 STYENE X
** POLLUTNT NAM 99 Styrene
** POLLUTNT IDN 100 TETRACHLORETHANE X

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT NAM  100  Tetrachloroethane
** POLLUTNT IDN  101  TRICHLOROETHANE  X
** POLLUTNT NAM  101  Trichloroethane
** POLLUTNT IDN  102  TRIMETHYL_BENZENE  X
** POLLUTNT NAM  102  Trimethyl benzene
** POLLUTNT EMS  SRC60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.400000E-03
** POLLUTNT EMS  SRC60 3.700000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC60 0 0 0 0 0 0
** POLLUTNT EMS  SRC61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC61 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.500000E-03 0 9.000000E-05
** POLLUTNT EMS  SRC61 0 0 0 2.100000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC61 0 0 0 0 0 0 0 0 1.800000E-04 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC61 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.900000E-03
** POLLUTNT EMS  SRC62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.900000E-02
** POLLUTNT EMS  SRC62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC62 0 0 1.900000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC62 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC63 0 0 6.500000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.700000E-03
** POLLUTNT EMS  SRC63 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC63 0 0 6.500000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC63 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.000000E-05
** POLLUTNT EMS  SRC64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.000000E-05
** POLLUTNT EMS  SRC64 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC64 0 0 2.200000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC64 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC65 5.900000E-02 8.300000E-02 1.500000E+00 2.500000E-03 0
** POLLUTNT EMS  SRC65 0 0 4.300000E-05 0 0 6.100000E-04 0 0 6.300000E-02 5.700000E-02
** POLLUTNT EMS  SRC65 0 0 0 0 0 0 9.100000E-03 0 0 6.300000E-02 0 0 1.200000E-03
** POLLUTNT EMS  SRC65 1.400000E-02 0 1.100000E-02 3.000000E-03 0 0 1.300000E+00
** POLLUTNT EMS  SRC65 1.200000E+00 0 0 0 0 0 0 0 4.400000E-01 0 1.000000E+00
** POLLUTNT EMS  SRC65 0 0 0 0 0 2.200000E-02 6.500000E-04 1.200000E-04 0 0
** POLLUTNT EMS  SRC65 0 0 0 0 0 8.800000E-03 0 0 4.600000E-06 0 0 0 0 0 0 3.400000E-02
** POLLUTNT EMS  SRC65 0 6.100000E-04 1.700000E-01 7.000000E+00 0 0 1.100000E-03
** POLLUTNT EMS  SRC65 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC144 0 0 2.900000E-01 0 0 0 0 0 0 0 0 0 0 3.600000E-03 0 0
** POLLUTNT EMS  SRC144 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC144 0 0 2.400000E-01 0 0 0 0 0 0 0 0 0 0 1.800000E-01 7.200000E-05
** POLLUTNT EMS  SRC144 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.900000E-01 0 0 0
** POLLUTNT EMS  SRC144 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
** BREEZE AERMOD GIS Pro v5.1.0 - C:\KCS\AERMOD\EU_Run1.dat
** Trinity Consultants

** PRIME

CO STARTING
CO TITLEONE  East Union
CO TITLETWO  Run 1: 19-DEC-2005
CO MODELOPT  DFAULT  CONC
CO AVERTIME  ANNUAL
CO POLLUTID  SEL_POLL
CO RUNORNOT  RUN
CO FINISHED

SO STARTING
SO ELEVUNIT  METERS
SO LOCATION  SRC66  POINT  566086.5  4490955.0  4
** SRCDESCR  M_SF_01
SO LOCATION  SRC67  POINT  566132.5  4490946.6  4
** SRCDESCR  M_SF_02
SO LOCATION  SRC68  POINT  562274.4  4496146.2  6
** SRCDESCR  U_MK_01
SO LOCATION  SRC69  POINT  562341.9  4496146.2  6
** SRCDESCR  U_MK_02
SO LOCATION  SRC70  POINT  565774.4  4498396.6  5
** SRCDESCR  U_BW_01
SO LOCATION  SRC71  POINT  566025.3  4498304.8  5
** SRCDESCR  U_BW_02
SO LOCATION  SRC72  POINT  566274.2  4498364.0  4
** SRCDESCR  U_BW_03
SO LOCATION  SRC73  POINT  561274.2  4503008.6  29
** SRCDESCR  U_SPK_01
SO LOCATION  SRC74  POINT  561288.2  4503007.1  29
** SRCDESCR  U_SPK_02
SO LOCATION  SRC75  POINT  561301.6  4503005.3  29
** SRCDESCR  U_SPK_03
SO LOCATION  SRC76  POINT  561314.4  4503003.5  29
** SRCDESCR  U_SPK_04
SO LOCATION  SRC77  POINT  561327.2  4503001.6  29
** SRCDESCR  U_SPK_05
SO LOCATION  SRC78  POINT  561271.8  4502994.3  29
** SRCDESCR  U_SPK_06
```

```
SO LOCATION SRC79 POINT 561286.1 4502992.8 29
** SRCDESCR U_SPK_07
SO LOCATION SRC80 POINT 561299.5 4502991.0 29
** SRCDESCR U_SPK_08
SO LOCATION SRC81 POINT 564627.5 4503896.2 12
** SRCDESCR U_SPU_01
SO LOCATION SRC82 POINT 564644.4 4503896.2 12
** SRCDESCR U_SPU_02
SO LOCATION SRC83 POINT 564661.8 4503896.2 12
** SRCDESCR U_SPU_03
SO LOCATION SRC84 POINT 564678.2 4503896.2 12
** SRCDESCR U_SPU_04
SO LOCATION SRC85 POINT 564695.6 4503896.2 12
** SRCDESCR U_SPU_05
SO LOCATION SRC86 POINT 564713.1 4503896.2 13
** SRCDESCR U_SPU_06
SO LOCATION SRC87 POINT 564731.6 4503896.2 12
** SRCDESCR U_SPU_07
SO LOCATION SRC88 POINT 573667.2 4505561.9 3
** SRCDESCR E_FM_01
SO LOCATION SRC89 POINT 573663.7 4505552.8 3
** SRCDESCR E_FM_02
SO LOCATION SRC90 POINT 573660.2 4505543.1 3
** SRCDESCR E_FM_03
SO LOCATION SRC91 POINT 573656.2 4505533.2 2
** SRCDESCR E_FM_04
SO LOCATION SRC92 POINT 573651.9 4505523.0 2
** SRCDESCR E_FM_05
SO LOCATION SRC93 POINT 573648.6 4505513.6 2
** SRCDESCR E_FM_06
SO LOCATION SRC94 POINT 572180.4 4507502.5 4
** SRCDESCR E_TC_01
SO LOCATION SRC95 POINT 572178.4 4507494.6 4
** SRCDESCR E_TC_02
SO LOCATION SRC96 POINT 572176.2 4507486.2 4
** SRCDESCR E_TC_03
SO LOCATION SRC97 POINT 572174.5 4507478.5 4
** SRCDESCR E_TC_04
SO LOCATION SRC98 POINT 572172.7 4507471.4 4
** SRCDESCR E_TC_05
SO LOCATION SRC99 POINT 572170.9 4507463.9 4
** SRCDESCR E_TC_06
SO LOCATION SRC100 POINT 572168.9 4507455.5 4
** SRCDESCR E_TC_07
SO LOCATION SRC101 POINT 572167.0 4507448.3 4
** SRCDESCR E_TC_08
SO LOCATION SRC102 POINT 572165.2 4507441.0 4
** SRCDESCR E_TC_09
SO LOCATION SRC103 POINT 572179.5 4507462.2 4
** SRCDESCR E_TC_10
SO LOCATION SRC104 POINT 572177.5 4507454.0 4
** SRCDESCR E_TC_11
SO LOCATION SRC105 POINT 572175.8 4507446.7 4
** SRCDESCR E_TC_12
SO LOCATION SRC106 POINT 573904.1 4507864.9 0
** SRCDESCR E_HC_01
SO LOCATION SRC107 POINT 573933.1 4507852.4 0
** SRCDESCR E_HC_02
SO LOCATION SRC108 POINT 573192.7 4508662.4 3
** SRCDESCR E_SC_01
SO LOCATION SRC109 POINT 573200.3 4508665.9 3
** SRCDESCR E_SC_02
SO LOCATION SRC110 POINT 573207.9 4508669.3 3
** SRCDESCR E_SC_03
SO LOCATION SRC111 POINT 573214.9 4508672.2 3
** SRCDESCR E_SC_04
SO LOCATION SRC112 POINT 573194.9 4508655.9 4
** SRCDESCR E_SC_05
SO LOCATION SRC113 POINT 573201.7 4508659.0 3
** SRCDESCR E_SC_06
SO LOCATION SRC114 POINT 567873.3 4504595.9 7
** SRCDESCR E_PK_01
SO LOCATION SRC115 POINT 567876.0 4504591.5 7
** SRCDESCR E_PK_02
SO LOCATION SRC116 POINT 567878.3 4504587.1 7
** SRCDESCR E_PK_03
SO LOCATION SRC117 POINT 567880.8 4504582.9 6
** SRCDESCR E_PK_04
SO LOCATION SRC118 POINT 567883.3 4504578.5 6
** SRCDESCR E_PK_05
SO LOCATION SRC119 POINT 567886.5 4504574.5 6
** SRCDESCR E_PK_06
SO LOCATION SRC120 POINT 567880.6 4504600.8 6
** SRCDESCR E_PK_07
SO LOCATION SRC121 POINT 567882.9 4504596.2 7
** SRCDESCR E_PK_08
SO LOCATION SRC122 POINT 567885.4 4504591.1 7
** SRCDESCR E_PK_09
```

```
SO LOCATION SRC123 POINT 567887.8 4504586.9 6
** SRCDESCR E_PK_10
SO LOCATION SRC124 POINT 567890.3 4504582.1 6
** SRCDESCR E_PK_11
SO LOCATION SRC125 POINT 567892.8 4504577.7 6
** SRCDESCR E_PK_12
SO LOCATION SRC126 POINT 567887.5 4504605.0 6
** SRCDESCR E_PK_13
SO LOCATION SRC127 POINT 567890.5 4504599.9 6
** SRCDESCR E_PK_14
SO LOCATION SRC128 POINT 567893.0 4504594.5 6
** SRCDESCR E_PK_15
SO LOCATION SRC134 VOLUME 566190.2 4490930.85 4
** SRCDESCR M_SF_V01
SO LOCATION SRC135 VOLUME 562389.45 4496233.7 6
** SRCDESCR U_MK_V01
SO LOCATION SRC136 VOLUME 566488.5 4498452.5 2
** SRCDESCR U_BW_V01
SO LOCATION SRC137 VOLUME 561335.05 4502968.4 29
** SRCDESCR U_SPK_V01
SO LOCATION SRC139 VOLUME 567900.25 4504607.7 6
** SRCDESCR E_PK_V01
SO LOCATION SRC140 VOLUME 573645.2 4505500.1 2
** SRCDESCR E_FM_V01
SO LOCATION SRC141 VOLUME 572192.45 4507441.85 4
** SRCDESCR E_TC_V01
SO LOCATION SRC142 VOLUME 573952.35 4507843.05 0
** SRCDESCR E_HC_V01
SO LOCATION SRC143 VOLUME 573223.1 4508657.3 4
** SRCDESCR E_SC_V01
SO SRCPARAM SRC66 0.000000E+00 6.096 294.26 1.966289 0.0762
SO SRCPARAM SRC67 0.000000E+00 6.096 294.26 1.8628 0.0508
SO SRCPARAM SRC68 1.600000E-03 16.764 294.26 6.985501 0.508
SO SRCPARAM SRC69 0.000000E+00 28.6512 313.15 24.83734 0.381
SO SRCPARAM SRC70 2.000000E+00 18.288 1144.26 5.066817 0.635
SO SRCPARAM SRC71 0.000000E+00 12.192 319.26 1.8628 0.0508
SO SRCPARAM SRC72 2.000000E+00 21.336 310.93 5.69189 0.0762
SO SRCPARAM SRC73 0.000000E+00 7.9248 299.82 10.34786 0.762
SO SRCPARAM SRC74 0.000000E+00 8.8392 363.71 37.94593 0.2286
SO SRCPARAM SRC75 0.000000E+00 6.7056 295.37 7.451201 0.254
SO SRCPARAM SRC76 0.000000E+00 20.1168 318.15 7.251386 0.8636
SO SRCPARAM SRC77 0.000000E+00 7.9248 322.04 11.02249 0.3302
SO SRCPARAM SRC78 0.000000E+00 24.384 352.59 44.70721 0.254
SO SRCPARAM SRC79 0.000000E+00 19.5072 294.26 7.186012 0.9144
SO SRCPARAM SRC80 0.000000E+00 25.6032 294.26 9.05528 0.1524
SO SRCPARAM SRC81 0.000000E+00 15.24 310.93 15.52334 0.0762
SO SRCPARAM SRC82 9.900000E-05 12.192 294.26 7.244223 0.762
SO SRCPARAM SRC83 0.000000E+00 7.62 294.26 0.1034889 0.0762
SO SRCPARAM SRC84 0.000000E+00 12.4968 294.26 13.0396 0.254
SO SRCPARAM SRC85 0.000000E+00 1.524 277.59 1.49024E-03 0.635
SO SRCPARAM SRC86 0.000000E+00 9.7536 366.48 13.971 0.254
SO SRCPARAM SRC87 0.000000E+00 15.8496 360.93 18.19141 0.2032
SO SRCPARAM SRC88 0.000000E+00 1.524 308.15 0.2328501 0.0508
SO SRCPARAM SRC89 0.000000E+00 1.524 294.26 0.2328501 0.0508
SO SRCPARAM SRC90 0.000000E+00 16.764 283.15 0.2328501 0.0508
SO SRCPARAM SRC91 0.000000E+00 16.764 303.15 0.3104667 0.0762
SO SRCPARAM SRC92 0.000000E+00 16.764 302.59 0.027942 0.254
SO SRCPARAM SRC93 0.000000E+00 16.764 302.59 0.018628 0.254
SO SRCPARAM SRC94 0.000000E+00 6.096 294.26 8.731877 0.2032
SO SRCPARAM SRC95 0.000000E+00 9.144 294.26 2.794201 0.0254
SO SRCPARAM SRC96 0.000000E+00 12.192 294.26 23.28501 0.0508
SO SRCPARAM SRC97 0.000000E+00 5.4864 352.59 9.314002 0.0508
SO SRCPARAM SRC98 0.000000E+00 7.62 294.26 0.6985502 0.0508
SO SRCPARAM SRC99 0.000000E+00 6.7056 294.26 0.6985502 0.0508
SO SRCPARAM SRC100 0.000000E+00 6.096 310.93 11.1768 0.127
SO SRCPARAM SRC101 0.000000E+00 7.62 322.04 0.4139556 0.381
SO SRCPARAM SRC102 0.000000E+00 7.62 294.26 0.6985502 0.0508
SO SRCPARAM SRC103 0.000000E+00 9.144 283.15 2.328501 0.0508
SO SRCPARAM SRC104 0.000000E+00 6.096 294.26 1.62995 0.0508
SO SRCPARAM SRC105 0.000000E+00 9.144 305.37 0.6985502 0.0508
SO SRCPARAM SRC106 0.000000E+00 11.2776 288.71 16.53373 0.3302
SO SRCPARAM SRC107 1.800000E-03 11.2776 288.71 16.53373 0.3302
SO SRCPARAM SRC108 0.000000E+00 10.668 322.04 3.492751 0.0508
SO SRCPARAM SRC109 0.000000E+00 12.192 433.71 20.90977 0.4318
SO SRCPARAM SRC110 0.000000E+00 2.4384 310.93 2.069778 0.762
SO SRCPARAM SRC111 0.000000E+00 1.8288 310.93 6.209334 0.762
SO SRCPARAM SRC112 0.000000E+00 6.096 299.82 4.836295 0.508
SO SRCPARAM SRC113 0.000000E+00 3.6576 294.26 46.57 0.254
SO SRCPARAM SRC114 0.000000E+00 15.24 294.26 1.16425 0.0508
SO SRCPARAM SRC115 0.000000E+00 18.288 303.15 0.2328501 0.0508
SO SRCPARAM SRC116 0.000000E+00 7.3152 294.26 0.2328501 0.0508
SO SRCPARAM SRC117 0.000000E+00 9.144 299.82 0.4657001 0.0508
SO SRCPARAM SRC118 0.000000E+00 18.288 294.26 3.725601E-02 0.127
SO SRCPARAM SRC119 0.000000E+00 18.288 294.26 0.111768 0.127
SO SRCPARAM SRC120 0.000000E+00 3.6576 288.71 0.2069778 0.0762
SO SRCPARAM SRC121 0.000000E+00 18.288 294.26 37.25601 0.0254
SO SRCPARAM SRC122 0.000000E+00 18.288 299.82 0.111768 0.127
SO SRCPARAM SRC123 0.000000E+00 1.524 294.26 0.4139557 0.0762
```

E.1 AERMOD Input Files (Continued)

```
SO SRCPARAM SRC124 0.000000E+00 18.288 305.37 0.1034889 0.0762
SO SRCPARAM SRC125 0.000000E+00 7.62 294.26 0.6985502 0.0508
SO SRCPARAM SRC126 0.000000E+00 4.572 294.26 0.5174446 0.0762
SO SRCPARAM SRC127 0.000000E+00 18.288 294.26 4.657001 0.508
SO SRCPARAM SRC128 0.000000E+00 18.288 294.26 0.6985502 0.0508
SO SRCPARAM SRC134 0.000000E+00 3 53.5 2.79
SO SRCPARAM SRC135 0.000000E+00 3 108 2.79
SO SRCPARAM SRC136 0.000000E+00 3 110 2.79
SO SRCPARAM SRC137 0.000000E+00 3 25.6 2.79
SO SRCPARAM SRC139 0.000000E+00 3 11.4 2.79
SO SRCPARAM SRC140 0.000000E+00 3 21.9 2.79
SO SRCPARAM SRC141 0.000000E+00 3 20.5 2.79
SO SRCPARAM SRC142 0.000000E+00 3 23.2 2.79
SO SRCPARAM SRC143 0.000000E+00 3 14.9 2.79
SO SRCGROUP STAYFLEX SRC66 SRC67 SRC134
SO SRCGROUP MERCK SRC68 SRC69 SRC135
SO SRCGROUP BAYWAY SRC70 SRC71 SRC72 SRC136
SO SRCGROUP SCHPLH_K SRC73 SRC74 SRC75 SRC76 SRC77 SRC78 SRC79 SRC80
SO SRCGROUP SCHPLH_K SRC137
SO SRCGROUP SCHPLH_U SRC81 SRC82 SRC83 SRC84 SRC85 SRC86 SRC87
SO SRCGROUP FIRMNICH SRC88 SRC89 SRC90 SRC91 SRC92 SRC93 SRC140
SO SRCGROUP TROYCHEM SRC94 SRC95 SRC96 SRC97 SRC98 SRC99 SRC100
SO SRCGROUP TROYCHEM SRC101 SRC102 SRC103 SRC104 SRC105 SRC141
SO SRCGROUP HOECHST SRC106 SRC107 SRC142
SO SRCGROUP SUNCHEM SRC108 SRC109 SRC110 SRC111 SRC112 SRC113 SRC143
SO SRCGROUP PENICK SRC114 SRC115 SRC116 SRC117 SRC118 SRC119 SRC120
SO SRCGROUP PENICK SRC121 SRC122 SRC123 SRC124 SRC125 SRC126 SRC127
SO SRCGROUP PENICK SRC128 SRC139
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT METERS
(Listing of receptors has been omitted for brevity, please refer to Section 3.2.3.5 (Receptor Grids) for
details on receptor spacing)
RE FINISHED

ME STARTING
ME SURFFILE C:\KCS\EWR91-95.SFC
ME PROFFILE C:\KCS\EWR91-95.PFL
ME PROFBASE 9 METERS
ME SURFDATA 14734 1991
ME UAIRDATA 00093755 1991
ME STARTEND 1991 01 01 1 1995 12 31 24
ME FINISHED

OU STARTING
OU FINISHED

** OUTFILE C:\KCS\AERMOD\EU_Run1.lst
** RAWFILE C:\KCS\AERMOD\EU_Run1.RAW
** RAWFMT 2
** TERRFILE C:\KCS\MOSAIC.DEM 2 2 1 18 9.999972 531660 4469240 531660 4539020 584570
4539020 584570 4469240
** HILLBOUN 556780.6 4486916 578099.2 4512734


** POLLUTNT IDN 01 ACETIC_ACID X
** POLLUTNT NAM 01 Acetic acid
** POLLUTNT IDN 02 ACETIC_ANH X
** POLLUTNT NAM 02 Acetic anhydride
** POLLUTNT IDN 03 ACETONE X
** POLLUTNT NAM 03 Acetone
** POLLUTNT IDN 04 ACETONITRILE X
** POLLUTNT NAM 04 Acetonitrile
** POLLUTNT IDN 05 ACRYLIC_ACID X
** POLLUTNT NAM 05 Acrylic acid
** POLLUTNT IDN 06 ACRYLIC_MONO X
** POLLUTNT NAM 06 Acrylic monomer
** POLLUTNT IDN 07 BENZALDEHYDE X
** POLLUTNT NAM 07 Benzaldehyde
** POLLUTNT IDN 08 BENZENE X
** POLLUTNT NAM 08 Benzene
** POLLUTNT IDN 09 BENZONITRILE X
** POLLUTNT NAM 09 Benzonitrile
** POLLUTNT IDN 10 BUTANE X
** POLLUTNT NAM 10 Butane
** POLLUTNT IDN 11 BUTANOL X
** POLLUTNT NAM 11 Butanol
** POLLUTNT IDN 12 BUTYL_ACETATE X
** POLLUTNT NAM 12 Butyl acetate
** POLLUTNT IDN 13 CHLOROBENZENE X
** POLLUTNT NAM 13 Chlorobenzene
** POLLUTNT IDN 14 CHLOROFORM X
** POLLUTNT NAM 14 Chloroform
** POLLUTNT IDN 15 CYCLOHEXANE X
** POLLUTNT NAM 15 Cyclohexane
** POLLUTNT IDN 16 CYCLOHEXANONE X
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** POLLUTNT NAM 16 Cyclohexanone
** POLLUTNT IDN 17 DIACETONE_ALCOHOL X
** POLLUTNT NAM 17 Diacetone alcohol
** POLLUTNT IDN 18 DIETHYLENE_GLYCOL X
** POLLUTNT NAM 18 Diethylene glycol
** POLLUTNT IDN 19 DIETHYLENE_TRIAMINE X
** POLLUTNT NAM 19 Diethylene triamine
** POLLUTNT IDN 20 DIMETHYL_CC X
** POLLUTNT NAM 20 Dimethyl carbonyl chloride
** POLLUTNT IDN 21 DIMETHYLAMINE X
** POLLUTNT NAM 21 Dimethylamine
** POLLUTNT IDN 22 DIMETHYLFORMAMIDE X
** POLLUTNT NAM 22 Dimethylformamide
** POLLUTNT IDN 23 DIOXANE X
** POLLUTNT NAM 23 Dioxane
** POLLUTNT IDN 24 EPICHLOROHYDRIN X
** POLLUTNT NAM 24 Epichlorohydrin
** POLLUTNT IDN 25 ETHANOL X
** POLLUTNT NAM 25 Ethanol
** POLLUTNT IDN 26 ETHYL_ACETATE X
** POLLUTNT NAM 26 Ethyl acetate
** POLLUTNT IDN 27 ETHYL_ACRYLATE X
** POLLUTNT NAM 27 Ethyl acrylate
** POLLUTNT IDN 28 ETHYL_CHLOROFORMATE X
** POLLUTNT NAM 28 Ethyl chloroformate
** POLLUTNT IDN 29 ETHYL_ETHER X
** POLLUTNT NAM 29 Ethyl ether
** POLLUTNT IDN 30 ETHYLENE_DICHLORIDE X
** POLLUTNT NAM 30 Ethylene dichloride
** POLLUTNT IDN 31 ETHYLENE_GLYCOL X
** POLLUTNT NAM 31 Ethylene glycol
** POLLUTNT IDN 32 FORMALDEHYDE X
** POLLUTNT NAM 32 Formaldehyde
** POLLUTNT IDN 33 FORMIC_ACID X
** POLLUTNT NAM 33 Formic acid
** POLLUTNT IDN 34 GLYCERINE X
** POLLUTNT NAM 34 Glycerine
** POLLUTNT IDN 35 HEPTANE X
** POLLUTNT NAM 35 Heptane
** POLLUTNT IDN 36 HEXANE X
** POLLUTNT NAM 36 Hexane
** POLLUTNT IDN 37 HYDRAZINE X
** POLLUTNT NAM 37 Hydrazine
** POLLUTNT IDN 38 HYDROCHLORIC X
** POLLUTNT NAM 38 Hydrochloric acid
** POLLUTNT IDN 39 HYDROQUINONE X
** POLLUTNT NAM 39 Hydroquinone
** POLLUTNT IDN 40 ISOBUTANE X
** POLLUTNT NAM 40 Isobutane
** POLLUTNT IDN 41 ISOBUTYL_ALCOHOL X
** POLLUTNT NAM 41 Isobutyl alcohol
** POLLUTNT IDN 42 ISOPENTANE X
** POLLUTNT NAM 42 Isopentane
** POLLUTNT IDN 43 ISOPENTYL_ALCOHOL X
** POLLUTNT NAM 43 Isopentyl alcohol
** POLLUTNT IDN 44 ISOPROPANOL X
** POLLUTNT NAM 44 Isopropanol
** POLLUTNT IDN 45 ISOPROPYLAMINE X
** POLLUTNT NAM 45 Isopropylamine
** POLLUTNT IDN 46 METHANOL X
** POLLUTNT NAM 46 Methanol
** POLLUTNT IDN 47 METHYL_ACETATE X
** POLLUTNT NAM 47 Methyl acetate
** POLLUTNT IDN 48 METHYL_ACRYLATE X
** POLLUTNT NAM 48 Methyl acrylate
** POLLUTNT IDN 49 METHYL_AMYL_ALCOHOL X
** POLLUTNT NAM 49 Methyl amyl alcohol
** POLLUTNT IDN 50 METHYL_BROMIDE X
** POLLUTNT NAM 50 Methyl bromide
** POLLUTNT IDN 51 METHYL_CYCLOHEXANE X
** POLLUTNT NAM 51 Methyl cyclohexane
** POLLUTNT IDN 52 MEK X
** POLLUTNT NAM 52 Methyl ethyl ketone
** POLLUTNT IDN 53 METHYL_FORMATE X
** POLLUTNT NAM 53 Methyl formate
** POLLUTNT IDN 54 METHYL_HYDRAZINE X
** POLLUTNT NAM 54 Methyl hydrazine
** POLLUTNT IDN 55 METHYL_ISOBUTYL_KETONE X
** POLLUTNT NAM 55 Methyl isobutyl ketone
** POLLUTNT IDN 56 METHYL_METHACRYLATE X
** POLLUTNT NAM 56 Methyl methacrylate
** POLLUTNT IDN 57 METHYLENE_CL X
** POLLUTNT NAM 57 Methylene chloride
** POLLUTNT IDN 58 NAPHTHA X
** POLLUTNT NAM 58 Naphtha
** POLLUTNT IDN 59 N-BUTYL_ACRYLATE X
** POLLUTNT NAM 59 N-butyl acrylate
** POLLUTNT IDN 60 NONANAL X
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT NAM 60 Nonanal
** POLLUTNT IDN 61 N-PROPYL_ACETATE X
** POLLUTNT NAM 61 N-propyl acetate
** POLLUTNT IDN 62 OIL X
** POLLUTNT NAM 62 Oil
** POLLUTNT IDN 63 PELARGONIC_ACID X
** POLLUTNT NAM 63 Pelargonic acid
** POLLUTNT IDN 64 PENTANAL X
** POLLUTNT NAM 64 Pentanal
** POLLUTNT IDN 65 PHENOL X
** POLLUTNT NAM 65 Phenol
** POLLUTNT IDN 66 PHOSPHORIC_ACID X
** POLLUTNT NAM 66 Phosphoric acid
** POLLUTNT IDN 67 PROPANE X
** POLLUTNT NAM 67 Propane
** POLLUTNT IDN 68 PROPANOL X
** POLLUTNT NAM 68 Propanol
** POLLUTNT IDN 69 PROPARGYL_ALCOHOL X
** POLLUTNT NAM 69 Propargyl alcohol
** POLLUTNT IDN 70 PROPIONIC_ACID X
** POLLUTNT NAM 70 Propionic acid
** POLLUTNT IDN 71 PROPYLENE_GLYCOL X
** POLLUTNT NAM 71 Propylene glycol, methyl ester
** POLLUTNT IDN 72 PYRIDINE X
** POLLUTNT NAM 72 Pyridine
** POLLUTNT IDN 73 TERT-BUTANOL X
** POLLUTNT NAM 73 tert-butanol
** POLLUTNT IDN 74 TERT-BUTYL_CHLORIDE X
** POLLUTNT NAM 74 tert-butyl chloride
** POLLUTNT IDN 75 TETRAHYDROFURAN X
** POLLUTNT NAM 75 Tetrahydrofuran
** POLLUTNT IDN 76 TOLUENE X
** POLLUTNT NAM 76 Toluene
** POLLUTNT IDN 77 TRICHLOROACETIC X
** POLLUTNT NAM 77 Trichloroacetic acid
** POLLUTNT IDN 78 TRIDECYL X
** POLLUTNT NAM 78 Tridecyl alcohol
** POLLUTNT IDN 79 TRIETHYLAMINE X
** POLLUTNT NAM 79 Triethylamine
** POLLUTNT IDN 80 TRIETHYLENE X
** POLLUTNT NAM 80 Triethylene glycol
** POLLUTNT IDN 81 TRIMETHYL_BORATE X
** POLLUTNT NAM 81 Trimethyl borate
** POLLUTNT IDN 82 VINYL_ACETATE X
** POLLUTNT NAM 82 Vinyl acetate
** POLLUTNT IDN 83 VINYL_CHLORIDE X
** POLLUTNT NAM 83 Vinyl chloride
** POLLUTNT IDN 84 VINYL_METHYL_ETHER X
** POLLUTNT NAM 84 Vinyl methyl ether
** POLLUTNT IDN 85 XYLENE X
** POLLUTNT NAM 85 Xylene
** POLLUTNT IDN 86 AMMONIA X
** POLLUTNT NAM 86 Ammonia
** POLLUTNT IDN 87 BIS_2EH_ADIPATE X
** POLLUTNT NAM 87 Bis(2-ethylhexyl) adipate
** POLLUTNT IDN 88 CARBON_DISULFIDE X
** POLLUTNT NAM 88 Carbon disulfide
** POLLUTNT IDN 89 CHLORINE X
** POLLUTNT NAM 89 Chlorine
** POLLUTNT IDN 90 DI_2EH_PHTHALATE X
** POLLUTNT NAM 90 Di(2-ethylhexyl) phthalate
** POLLUTNT IDN 91 DICHLOROBENZENE X
** POLLUTNT NAM 91 Dichlorobenzene
** POLLUTNT IDN 92 DIBUTYL_PHTHALATE X
** POLLUTNT NAM 92 Dibutyl phthalate
** POLLUTNT IDN 93 DIMETHYL_SULFATE X
** POLLUTNT NAM 93 Dimethyl sulfate
** POLLUTNT IDN 94 ETHYLENE_OXIDE X
** POLLUTNT NAM 94 Ethylene oxide
** POLLUTNT IDN 95 MALEIC_ANH X
** POLLUTNT NAM 95 Maleic anhydride
** POLLUTNT IDN 96 PHTHALIC_ANH X
** POLLUTNT NAM 96 Phthalic anhydride
** POLLUTNT IDN 97 PROPYLENE_OXIDE X
** POLLUTNT NAM 97 Propylene oxide
** POLLUTNT IDN 98 STYRENE_OXIDE X
** POLLUTNT NAM 98 Styrene oxide
** POLLUTNT IDN 99 STYENE X
** POLLUTNT NAM 99 Styrene
** POLLUTNT IDN 100 TETRACHLORETHANE X
** POLLUTNT NAM 100 Tetrachloroethane
** POLLUTNT IDN 101 TRICHLOROETHANE X
** POLLUTNT NAM 101 Trichloroethane
** POLLUTNT IDN 102 TRIMETHYL_BENZENE X
** POLLUTNT NAM 102 Trimethyl benzene
** POLLUTNT EMS SRC66 0 0 0 0 0 0 0 0 0 0 1.800000E-04 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E-03
** POLLUTNT EMS SRC66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

E.1 AERMOD Input Files (Continued)

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** POLLUTNT EMS  SRC66 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC66 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC67 0 0 0 0 0 0 0 0 0 0 9.400000E-04 1.400000E-04 0 0 0 0
** POLLUTNT EMS  SRC67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC67 0 0 1.100000E-04 0 0 3.500000E-04 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.700000E-05 0 0
** POLLUTNT EMS  SRC67 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC68 1.600000E-03 1.200000E-03 9.800000E-01 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC68 0 0 1.800000E-01 0 0 0 0 0 0 0 0 2.700000E-02 0 0 1.900000E-01
** POLLUTNT EMS  SRC68 1.500000E+00 0 0 0 0 0 0 0 0 0 3.700000E-01 0 0 0 0 0
** POLLUTNT EMS  SRC68 0 0 3.000000E-01 0 5.900000E+00 0 0 0 0 0 7.600000E-02
** POLLUTNT EMS  SRC68 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.700000E-01
** POLLUTNT EMS  SRC68 2.700000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC68 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC69 0 1.700000E-05 5.700000E+00 0 0 0 0 0 0 0 0 0 0 2.800000E-03
** POLLUTNT EMS  SRC69 0 0 0 0 0 0 0 0 0 0 2.900000E-03 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC69 0 0 0 0 0 0 0 6.000000E-01 1.100000E+00 0 7.800000E-01
** POLLUTNT EMS  SRC69 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC69 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC69 0 0 1.000000E+00
** POLLUTNT EMS  SRC70 2.000000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC70 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.000000E+00 0 0 0 0 0 0
** POLLUTNT EMS  SRC70 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E+00
** POLLUTNT EMS  SRC70 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC70 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC71 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC71 0 0 0 0 0 0 0 0 4.600000E+00 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC71 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E+00 0 0 0 0
** POLLUTNT EMS  SRC71 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC71 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC72 2.000000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC72 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.000000E+00 0 0 0 0 0 0
** POLLUTNT EMS  SRC72 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC72 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC72 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E-02
** POLLUTNT EMS  SRC73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.900000E-04 0 7.600000E-04
** POLLUTNT EMS  SRC73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC73 0 0 1.000000E+00
** POLLUTNT EMS  SRC74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-02
** POLLUTNT EMS  SRC74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.900000E-04
** POLLUTNT EMS  SRC74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC74 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC74 0 0 1.000000E+00
** POLLUTNT EMS  SRC75 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-02
** POLLUTNT EMS  SRC75 0 0 0 0 0 0 0 0 0 0 7.400000E-04 0 0 0 0 0 0 0 0 0 9.300000E-04
** POLLUTNT EMS  SRC75 0 0 0 0 0 0 0 0 0 0 0 1.900000E-04 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC75 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC75 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.600000E-01
** POLLUTNT EMS  SRC76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.500000E-02
** POLLUTNT EMS  SRC76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC76 0 0 1.000000E+00
** POLLUTNT EMS  SRC77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-02
** POLLUTNT EMS  SRC77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.800000E-04 0 1.500000E-03
** POLLUTNT EMS  SRC77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC77 0 0 1.000000E+00
** POLLUTNT EMS  SRC78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.800000E-02
** POLLUTNT EMS  SRC78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.500000E-03
** POLLUTNT EMS  SRC78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC78 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC78 0 0 1.000000E+00
** POLLUTNT EMS  SRC79 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.400000E-02
** POLLUTNT EMS  SRC79 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.300000E-03
** POLLUTNT EMS  SRC79 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC79 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC79 0 0 1.000000E+00
** POLLUTNT EMS  SRC80 0 0 0 0 0 0 0 0 0 3.700000E-04 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC80 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.500000E-03 0 0
** POLLUTNT EMS  SRC80 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.500000E-03
** POLLUTNT EMS  SRC80 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC80 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC81 0 0 2.600000E-06 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC81 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E-05
** POLLUTNT EMS  SRC81 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC81 0 0 1.300000E-05 0 0 0 0 2.600000E-06 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC81 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC82 9.900000E-05 0 0 0 0 0 0 2.200000E-05 0 3.700000E-02
** POLLUTNT EMS  SRC82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.000000E-02 0 0 0 0 9.000000E-05
** POLLUTNT EMS  SRC82 0 0 9.200000E-05 2.900000E-02 0 0 0 0 0 0 0 7.300000E-02
** POLLUTNT EMS  SRC82 0 2.500000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC82 0 0 0 0 0 0 0 0 0 0 5.000000E-02 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC83 0 0 0 0 0 0 0 0 0 0 0 7.200000E-04 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC83 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-06
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT EMS  SRC83 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC83 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC83 0 0 1.000000E+00
** POLLUTNT EMS  SRC84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.000000E-06
** POLLUTNT EMS  SRC84 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.900000E-05
** POLLUTNT EMS  SRC85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC85 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC86 0 0 0 0 0 0 0 0 0 0 1.300000E-02 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC86 0 0 0 0 0 0 0 0 0 0 0 0 0 2.800000E-02 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC86 0 3.500000E-02 0 2.300000E-03 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.100000E-02 0 0 0
** POLLUTNT EMS  SRC86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC87 0 0 2.600000E-06 0 0 0 0 0 0 0 8.800000E-05 0 0 0 0 0
** POLLUTNT EMS  SRC87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC87 0 0 1.800000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC87 0 0 0 0 0 0 0 0 0 0 0 1.300000E-05 0 0 0 0 2.600000E-06
** POLLUTNT EMS  SRC87 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC88 0 0 0 0 0 0 1.400000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC88 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.000000E-04
** POLLUTNT EMS  SRC88 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC88 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC88 0 0 1.000000E+00
** POLLUTNT EMS  SRC89 0 0 0 0 0 0 3.100000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC89 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC89 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC90 0 0 0 0 0 0 0 0 0 3.800000E-04 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC90 1.000000E+00
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** POLLUTNT EMS  SRC91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-01 0 0
** POLLUTNT EMS  SRC91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC91 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC91 1.000000E+00
** POLLUTNT EMS  SRC92 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC92 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC92 0 0 0 0 0 7.000000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
** POLLUTNT EMS  SRC92 0 0 0 0 0 0 0 0 0 1.200000E-06 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC92 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC93 0 0 0 0 0 0 1.200000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC93 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC93 0 0 0 0 0 0 0 0 0 2.900000E-06 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC93 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC94 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC94 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.700000E-02 0 0
** POLLUTNT EMS  SRC94 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC94 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.600000E-02 0 0
** POLLUTNT EMS  SRC95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC95 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC95 1.000000E+00
** POLLUTNT EMS  SRC96 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-03 0 0
** POLLUTNT EMS  SRC96 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC96 0 0 0 0 0 0 0 0 0 3.600000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC96 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC96 0 0 0 0 0 0 1.000000E+00
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** POLLUTNT EMS  SRC97 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC97 0 0 0 1.400000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC98 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC98 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.400000E-03 0 0
** POLLUTNT EMS  SRC98 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.500000E-03 0 0 0 0 0 0
** POLLUTNT EMS  SRC100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC100 1.000000E+00
** POLLUTNT EMS  SRC101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.600000E-04 0 0
```

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** POLLUTNT EMS  SRC101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.200000E-04
** POLLUTNT EMS  SRC101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC101 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.100000E-02 0 0
** POLLUTNT EMS  SRC102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC102 1.000000E+00
** POLLUTNT EMS  SRC103 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC104 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC104 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.000000E-02 0 0
** POLLUTNT EMS  SRC104 0 0 0 0 0 0 0 0 0 6.600000E-04 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC104 0 0 0 0 0 0 1.000000E+00
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** POLLUTNT EMS  SRC105 1.000000E+00
** POLLUTNT EMS  SRC106 0 0 4.200000E-03 0 1.000000E-04 0 0 0 0 0 4.400000E-04
** POLLUTNT EMS  SRC106 1.700000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.500000E-03
** POLLUTNT EMS  SRC106 0 0 0 0 4.000000E-05 0 0 0 0 0 0 0 0 4.800000E-04 0 0
** POLLUTNT EMS  SRC106 0 0 1.100000E-02 0 5.300000E-03 0 0 0 9.300000E-03 0
** POLLUTNT EMS  SRC106 0 0 0 0 0 4.200000E-04 0 1.200000E-03 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC106 0 0 0 0 0 0 0 0 0 0 0 0 0 4.100000E-02 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC106 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC107 1.800000E-03 0 0 0 0 0 0 0 0 0 5.900000E-04 0 0 0 0 0
** POLLUTNT EMS  SRC107 0 0 0 0 0 0 0 0 0 9.400000E-03 0 0 0 0 0 2.600000E-02
** POLLUTNT EMS  SRC107 4.600000E-04 0 0 0 0 0 0 0 0 0 0 1.100000E-03 0 3.800000E-04
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** POLLUTNT EMS  SRC108 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC109 0 0 0 0 0 0 0 0 0 5.500000E-02 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC112 0 0 0 0 0 0 0 0 0 3.900000E-02 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC112 0 0 0 0 0 0 1.000000E+00
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** POLLUTNT EMS  SRC113 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.300000E-02 0 0
** POLLUTNT EMS  SRC113 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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** POLLUTNT EMS  SRC115 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC115 1.000000E+00
** POLLUTNT EMS  SRC116 0 0 0 0 0 0 0 0 0 0 0 1.200000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC116 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC116 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC116 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC116 1.000000E+00
** POLLUTNT EMS  SRC117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E-02
** POLLUTNT EMS  SRC117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC118 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC118 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC118 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.800000E-01
```

```
** POLLUTNT EMS  SRC118 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC119 0 0 0 0 0 0 0 0 0 0 0 5.400000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC119 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC119 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC119 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC119 1.000000E+00
** POLLUTNT EMS  SRC120 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC120 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.700000E-03 0 0 0
** POLLUTNT EMS  SRC120 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC120 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC120 1.000000E+00
** POLLUTNT EMS  SRC121 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.600000E-04
** POLLUTNT EMS  SRC121 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC121 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-02
** POLLUTNT EMS  SRC121 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC122 0 0 0 0 0 0 0 0 0 0 0 3.900000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC122 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC122 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC122 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC122 1.000000E+00
** POLLUTNT EMS  SRC123 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC123 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.600000E-01 0 0
** POLLUTNT EMS  SRC123 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC123 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC123 1.000000E+00
** POLLUTNT EMS  SRC124 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-04
** POLLUTNT EMS  SRC124 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.300000E-03
** POLLUTNT EMS  SRC124 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC124 0 0 1.300000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC124 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC125 0 0 0 0 0 0 0 0 0 0 0 4.200000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC125 0 0 0 3.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC125 0 4.200000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC125 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.200000E-02 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC125 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC126 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC126 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.700000E-04 0 0 0 0
** POLLUTNT EMS  SRC126 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC126 1.600000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC126 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC127 0 0 0 0 0 0 0 0 0 0 0 9.400000E-04 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC127 0 0 0 9.700000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC127 0 9.000000E-05 0 3.900000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC127 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.500000E-03 0 0 0
** POLLUTNT EMS  SRC127 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-04
** POLLUTNT EMS  SRC128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.500000E-04
** POLLUTNT EMS  SRC128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC128 0 0 2.000000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC128 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC134 0 0 0 0 0 0 0 0 0 0 0 2.400000E-02 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC134 0 0 0 0 0 0 0 0 0 0 1.200000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC134 0 0 0 8.600000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC134 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.200000E-04
** POLLUTNT EMS  SRC134 0 0 4.400000E-03 0 2.300000E-04 0 0 1.700000E-04 7.200000E-05
** POLLUTNT EMS  SRC134 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC135 0 0 1.900000E-01 1.100000E-01 0 0 0 7.800000E-02 0 0
** POLLUTNT EMS  SRC135 0 0 0 2.700000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC135 0 0 0 0 0 0 3.500000E-01 0 0 0 0 0 0 0 7.900000E-01 0
** POLLUTNT EMS  SRC135 0 0 0 0 3.500000E-03 0 0 0 0 2.000000E-01 0 0 0 0 0 0
** POLLUTNT EMS  SRC135 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-01 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC135 0 1.900000E-01 0 1.300000E-01 0 0 1.900000E-02 0 0 0
** POLLUTNT EMS  SRC135 0 0 0 0 0 2.400000E-04 0 0 1.000000E+00
** POLLUTNT EMS  SRC136 0 0 0 0 0 0 0 0 0 0 0 4.300000E-03 0 0 0 1.700000E-02 0
** POLLUTNT EMS  SRC136 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03 0 0 0 0 0 0
** POLLUTNT EMS  SRC136 1.100000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.400000E-05
** POLLUTNT EMS  SRC136 0 0 0 0 0 0 1.700000E-03 0 0 0 0 0 0 0 0 0 1.400000E-05
** POLLUTNT EMS  SRC136 0 0 0 0 0 0 0 0 1.700000E-04 1.300000E+00 0 0 1.400000E-03
** POLLUTNT EMS  SRC136 0 0 0 0 0 1.400000E-03 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC137 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC137 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC137 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC137 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.000000E-02 0
** POLLUTNT EMS  SRC137 1.000000E+00
** POLLUTNT EMS  SRC139 0 0 0 0 0 0 0 0 0 0 0 4.200000E-01 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC139 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-05 0 0 0 0
** POLLUTNT EMS  SRC139 0 0 0 4.200000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC139 0 0 7.200000E-05 0 0 0 0 0 0 0 0 0 4.200000E-01 0 0 0
** POLLUTNT EMS  SRC139 0 0 0 0 0 0 9.400000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC139 0 0 1.000000E+00
** POLLUTNT EMS  SRC140 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC140 0 0 0 0 7.200000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03
** POLLUTNT EMS  SRC140 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-05 0
** POLLUTNT EMS  SRC140 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.900000E-02 0 0 0
** POLLUTNT EMS  SRC140 0 0 0 0 7.200000E-05 0 0 0 0 7.200000E-05 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC141 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC141 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.700000E-01 0 0
** POLLUTNT EMS  SRC141 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

```
** POLLUTNT EMS  SRC141 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-05
** POLLUTNT EMS  SRC141 0 0 3.600000E-03 1.000000E+00
** POLLUTNT EMS  SRC142 0 0 3.700000E-03 0 0 0 0 0 0 0 1.770000E-02 0 0 0 0 0
** POLLUTNT EMS  SRC142 0 0 0 0 0 0 0 0 0 0 0 1.500000E-02 0 0 0 2.700000E-02 5.010000E-02
** POLLUTNT EMS  SRC142 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.280000E-02 0 8.670000E-03
** POLLUTNT EMS  SRC142 0 0 0 4.200000E-03 0 0 3.800000E-03 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC142 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.040000E-01 0 0 0
** POLLUTNT EMS  SRC142 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC143 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC143 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.200000E-01 0 0
** POLLUTNT EMS  SRC143 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-05 0 0 0
** POLLUTNT EMS  SRC143 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC143 0 0 0 0 0 0 1.000000E+00


** BREEZE AERMOD GIS Pro v5.1.0 - C:\KCS\AERMOD\WU_Run1.dat
** Trinity Consultants

** PRIME

CO STARTING
CO TITLEONE  Western Union
CO TITLETWO  Run 1: 19-DEC-2005
CO MODELOPT  DFAULT  CONC
CO AVERTIME  ANNUAL
CO POLLUTID  SEL_POLL
CO RUNORNOT  RUN
CO FINISHED

SO STARTING
SO ELEVUNIT  METERS
SO LOCATION  SRC40  POINT  552279.6  4508206.5  72
** SRCDESCR  U_CG_01
SO LOCATION  SRC41  POINT  552279.6  4508218.4  71
** SRCDESCR  U_CG_02
SO LOCATION  SRC42  POINT  552279.6  4508229.4  71
** SRCDESCR  U_CG_03
SO LOCATION  SRC43  POINT  552279.6  4508239.9  71
** SRCDESCR  U_CG_04
SO LOCATION  SRC44  POINT  552279.6  4508249.2  71
** SRCDESCR  U_CG_05
SO LOCATION  SRC45  POINT  552279.6  4508258.5  71
** SRCDESCR  U_CG_06
SO LOCATION  SRC46  POINT  552279.6  4508267.8  70
** SRCDESCR  U_CG_07
SO LOCATION  SRC47  POINT  552279.6  4508278.0  70
** SRCDESCR  U_CG_08
SO LOCATION  SRC48  POINT  552292.3  4508278.0  70
** SRCDESCR  U_CG_09
SO LOCATION  SRC49  POINT  552304.6  4508278.0  70
** SRCDESCR  U_CG_10
SO LOCATION  SRC50  POINT  552315.6  4508278.0  70
** SRCDESCR  U_CG_11
SO LOCATION  SRC51  POINT  552329.1  4508278.0  70
** SRCDESCR  U_CG_12
SO LOCATION  SRC52  POINT  552343.1  4508278.0  70
** SRCDESCR  U_CG_13
SO LOCATION  SRC53  POINT  552355.3  4508278.0  70
** SRCDESCR  U_CG_14
SO LOCATION  SRC54  POINT  552366.7  4508278.0  70
** SRCDESCR  U_CG_15
SO LOCATION  SRC55  POINT  552379.4  4508278.0  70
** SRCDESCR  U_CG_16
SO LOCATION  SRC56  POINT  552379.4  4508289.8  70
** SRCDESCR  U_CG_17
SO LOCATION  SRC57  POINT  552379.4  4508300.4  69
** SRCDESCR  U_CG_18
SO LOCATION  SRC58  POINT  552379.4  4508312.7  69
** SRCDESCR  U_CG_19
SO LOCATION  SRC59  POINT  552379.4  4508324.9  69
** SRCDESCR  U_CG_20
SO SRCPARAM  SRC40  1.000000E+00  9.144  283.15  8.731876E-03  1.016
SO SRCPARAM  SRC41  1.000000E+00  9.144  294.26  1.16425  0.0508
SO SRCPARAM  SRC42  1.000000E+00  9.144  294.26  3.492751  0.0508
SO SRCPARAM  SRC43  1.000000E+00  9.144  294.26  4.657001  0.0254
SO SRCPARAM  SRC44  1.000000E+00  9.144  294.26  0.6985502  0.0508
SO SRCPARAM  SRC45  1.000000E+00  6.096  294.2611  50  0.0762
SO SRCPARAM  SRC46  1.000000E+00  10.668  310.9278  1.16425  0.0508
SO SRCPARAM  SRC47  1.000000E+00  9.144  294.2611  0.6985502  0.0508
SO SRCPARAM  SRC48  1.000000E+00  7.62  297.0389  10.91485  0.2032
SO SRCPARAM  SRC49  1.000000E+00  9.144  288.7111  3.492751  0.0508
SO SRCPARAM  SRC50  1.000000E+00  9.144  273.15  0.9314002  0.0254
SO SRCPARAM  SRC51  1.000000E+00  9.144  294.2611  6.985502  0.0508
SO SRCPARAM  SRC52  1.000000E+00  6.096  505.3722  0.5588401  0.127
SO SRCPARAM  SRC53  1.000000E+00  7.62  294.2611  0.2328501  0.0508
SO SRCPARAM  SRC54  1.000000E+00  12.8016  294.2611  16.7652  0.508
SO SRCPARAM  SRC55  1.000000E+00  10.3632  294.2611  5.484085  0.635
SO SRCPARAM  SRC56  1.000000E+00  12.8016  294.2611  16.7652  0.508
```

E.1 AERMOD Input Files (Continued)

```
SO SRCPARAM SRC57 1.000000E+00 9.144 294.2611 0.2328501 0.0508
SO SRCPARAM SRC58 1.000000E+00 12.192 294.26 50 0.0762
SO SRCPARAM SRC59 1.000000E+00 7.62 294.26 29.10626 0.1016
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT METERS
(Listing of receptors has been omitted for brevity, please refer to Section 3.2.3.5 (Receptor Grids) for
details on receptor spacing)
RE FINISHED

ME STARTING
ME SURFFILE C:\KCS\EWR91-95.SFC
ME PROFFILE C:\KCS\EWR91-95.PFL
ME PROFBASE 9 METERS
ME SURFDATA 14734 1991
ME UAIRDATA 00093755 1991
ME STARTEND 1991 01 01 1 1995 12 31 24
ME FINISHED

OU STARTING
OU FINISHED

** OUTFILE C:\KCS\AERMOD\WU_Run1.LST
** RAWFILE C:\KCS\AERMOD\WU_Run1.RAW
** RAWFMT 2
** TERRFILE C:\KCS\MOSAIC.DEM 2 2 1 18 9.999972 531660 4469240 531660 4539020 584570
4539020 584570 4469240
** HILLBOUN 548585.3 4504539.5 556083.8 4511885.6

** POLLUTNT IDN 01 ACETIC_ACID X
** POLLUTNT NAM 01 Acetic acid
** POLLUTNT IDN 02 ACETIC_ANH X
** POLLUTNT NAM 02 Acetic anhydride
** POLLUTNT IDN 03 ACETONE X
** POLLUTNT NAM 03 Acetone
** POLLUTNT IDN 04 ACETONITRILE X
** POLLUTNT NAM 04 Acetonitrile
** POLLUTNT IDN 05 ACRYLIC_ACID X
** POLLUTNT NAM 05 Acrylic acid
** POLLUTNT IDN 06 ACRYLIC_MONO X
** POLLUTNT NAM 06 Acrylic monomer
** POLLUTNT IDN 07 BENZALDEHYDE X
** POLLUTNT NAM 07 Benzaldehyde
** POLLUTNT IDN 08 BENZENE X
** POLLUTNT NAM 08 Benzene
** POLLUTNT IDN 09 BENZONITRILE X
** POLLUTNT NAM 09 Benzonitrile
** POLLUTNT IDN 10 BUTANE X
** POLLUTNT NAM 10 Butane
** POLLUTNT IDN 11 BUTANOL X
** POLLUTNT NAM 11 Butanol
** POLLUTNT IDN 12 BUTYL_ACETATE X
** POLLUTNT NAM 12 Butyl acetate
** POLLUTNT IDN 13 CHLOROBENZENE X
** POLLUTNT NAM 13 Chlorobenzene
** POLLUTNT IDN 14 CHLOROFORM X
** POLLUTNT NAM 14 Chloroform
** POLLUTNT IDN 15 CYCLOHEXANE X
** POLLUTNT NAM 15 Cyclohexane
** POLLUTNT IDN 16 CYCLOHEXANONE X
** POLLUTNT NAM 16 Cyclohexanone
** POLLUTNT IDN 17 DIACETONE_ALCOHOL X
** POLLUTNT NAM 17 Diacetone alcohol
** POLLUTNT IDN 18 DIETHYLENE_GLYCOL X
** POLLUTNT NAM 18 Diethylene glycol
** POLLUTNT IDN 19 DIETHYLENE_TRIAMINE X
** POLLUTNT NAM 19 Diethylene triamine
** POLLUTNT IDN 20 DIMETHYL_CC X
** POLLUTNT NAM 20 Dimethyl carbonyl chloride
** POLLUTNT IDN 21 DIMETHYLAMINE X
** POLLUTNT NAM 21 Dimethylamine
** POLLUTNT IDN 22 DIMETHYLFORMAMIDE X
** POLLUTNT NAM 22 Dimethylformamide
** POLLUTNT IDN 23 DIOXANE X
** POLLUTNT NAM 23 Dioxane
** POLLUTNT IDN 24 EPICHLOROHYDRIN X
** POLLUTNT NAM 24 Epichlorohydrin
** POLLUTNT IDN 25 ETHANOL X
** POLLUTNT NAM 25 Ethanol
** POLLUTNT IDN 26 ETHYL_ACETATE X
** POLLUTNT NAM 26 Ethyl acetate
** POLLUTNT IDN 27 ETHYL_ACRYLATE X
** POLLUTNT NAM 27 Ethyl acrylate
** POLLUTNT IDN 28 ETHYL_CHLOROFORMATE X
** POLLUTNT NAM 28 Ethyl chloroformate
** POLLUTNT IDN 29 ETHYL_ETHER X
```

```
** POLLUTNT NAM 29 Ethyl ether
** POLLUTNT IDN 30 ETHYLENE_DICHLORIDE X
** POLLUTNT NAM 30 Ethylene dichloride
** POLLUTNT IDN 31 ETHYLENE_GLYCOL X
** POLLUTNT NAM 31 Ethylene glycol
** POLLUTNT IDN 32 FORMALDEHYDE X
** POLLUTNT NAM 32 Formaldehyde
** POLLUTNT IDN 33 FORMIC_ACID X
** POLLUTNT NAM 33 Formic acid
** POLLUTNT IDN 34 GLYCERINE X
** POLLUTNT NAM 34 Glycerine
** POLLUTNT IDN 35 HEPTANE X
** POLLUTNT NAM 35 Heptane
** POLLUTNT IDN 36 HEXANE X
** POLLUTNT NAM 36 Hexane
** POLLUTNT IDN 37 HYDRAZINE X
** POLLUTNT NAM 37 Hydrazine
** POLLUTNT IDN 38 HYDROCHLORIC X
** POLLUTNT NAM 38 Hydrochloric acid
** POLLUTNT IDN 39 HYDROQUINONE X
** POLLUTNT NAM 39 Hydroquinone
** POLLUTNT IDN 40 ISOBUTANE X
** POLLUTNT NAM 40 Isobutane
** POLLUTNT IDN 41 ISOBUTYL_ALCOHOL X
** POLLUTNT NAM 41 Isobutyl alcohol
** POLLUTNT IDN 42 ISOPENTANE X
** POLLUTNT NAM 42 Isopentane
** POLLUTNT IDN 43 ISOPENTYL_ALCOHOL X
** POLLUTNT NAM 43 Isopentyl alcohol
** POLLUTNT IDN 44 ISOPROPANOL X
** POLLUTNT NAM 44 Isopropanol
** POLLUTNT IDN 45 ISOPROPYLAMINE X
** POLLUTNT NAM 45 Isopropylamine
** POLLUTNT IDN 46 METHANOL X
** POLLUTNT NAM 46 Methanol
** POLLUTNT IDN 47 METHYL_ACETATE X
** POLLUTNT NAM 47 Methyl acetate
** POLLUTNT IDN 48 METHYL_ACRYLATE X
** POLLUTNT NAM 48 Methyl acrylate
** POLLUTNT IDN 49 METHYL_AMYL_ALCOHOL X
** POLLUTNT NAM 49 Methyl amyl alcohol
** POLLUTNT IDN 50 METHYL_BROMIDE X
** POLLUTNT NAM 50 Methyl bromide
** POLLUTNT IDN 51 METHYL_CYCLOHEXANE X
** POLLUTNT NAM 51 Methyl cyclohexane
** POLLUTNT IDN 52 MEK X
** POLLUTNT NAM 52 Methyl ethyl ketone
** POLLUTNT IDN 53 METHYL_FORMATE X
** POLLUTNT NAM 53 Methyl formate
** POLLUTNT IDN 54 METHYL_HYDRAZINE X
** POLLUTNT NAM 54 Methyl hydrazine
** POLLUTNT IDN 55 METHYL_ISOBUTYL_KETONE X
** POLLUTNT NAM 55 Methyl isobutyl ketone
** POLLUTNT IDN 56 METHYL_METHACRYLATE X
** POLLUTNT NAM 56 Methyl methacrylate
** POLLUTNT IDN 57 METHYLENE_CL X
** POLLUTNT NAM 57 Methylene chloride
** POLLUTNT IDN 58 NAPHTHA X
** POLLUTNT NAM 58 Naphtha
** POLLUTNT IDN 59 N-BUTYL_ACRYLATE X
** POLLUTNT NAM 59 N-butyl acrylate
** POLLUTNT IDN 60 NONANAL X
** POLLUTNT NAM 60 Nonanal
** POLLUTNT IDN 61 N-PROPYL_ACETATE X
** POLLUTNT NAM 61 N-propyl acetate
** POLLUTNT IDN 62 OIL X
** POLLUTNT NAM 62 Oil
** POLLUTNT IDN 63 PELARGONIC_ACID X
** POLLUTNT NAM 63 Pelargonic acid
** POLLUTNT IDN 64 PENTANAL X
** POLLUTNT NAM 64 Pentanal
** POLLUTNT IDN 65 PHENOL X
** POLLUTNT NAM 65 Phenol
** POLLUTNT IDN 66 PHOSPHORIC_ACID X
** POLLUTNT NAM 66 Phosphoric acid
** POLLUTNT IDN 67 PROPANE X
** POLLUTNT NAM 67 Propane
** POLLUTNT IDN 68 PROPANOL X
** POLLUTNT NAM 68 Propanol
** POLLUTNT IDN 69 PROPARGYL_ALCOHOL X
** POLLUTNT NAM 69 Propargyl alcohol
** POLLUTNT IDN 70 PROPIONIC_ACID X
** POLLUTNT NAM 70 Propionic acid
** POLLUTNT IDN 71 PROPYLENE_GLYCOL X
** POLLUTNT NAM 71 Propylene glycol, methyl ester
** POLLUTNT IDN 72 PYRIDINE X
** POLLUTNT NAM 72 Pyridine
** POLLUTNT IDN 73 TERT-BUTANOL X
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT NAM 73 tert-butanol
** POLLUTNT IDN 74 TERT-BUTYL_CHLORIDE X
** POLLUTNT NAM 74 tert-butyl chloride
** POLLUTNT IDN 75 TETRAHYDROFURAN X
** POLLUTNT NAM 75 Tetrahydrofuran
** POLLUTNT IDN 76 TOLUENE X
** POLLUTNT NAM 76 Toluene
** POLLUTNT IDN 77 TRICHLOROACETIC X
** POLLUTNT NAM 77 Trichloroacetic acid
** POLLUTNT IDN 78 TRIDECYL X
** POLLUTNT NAM 78 Tridecyl alcohol
** POLLUTNT IDN 79 TRIETHYLAMINE X
** POLLUTNT NAM 79 Triethylamine
** POLLUTNT IDN 80 TRIETHYLENE X
** POLLUTNT NAM 80 Triethylene glycol
** POLLUTNT IDN 81 TRIMETHYL_BORATE X
** POLLUTNT NAM 81 Trimethyl borate
** POLLUTNT IDN 82 VINYL_ACETATE X
** POLLUTNT NAM 82 Vinyl acetate
** POLLUTNT IDN 83 VINYL_CHLORIDE X
** POLLUTNT NAM 83 Vinyl chloride
** POLLUTNT IDN 84 VINYL_METHYL_ETHER X
** POLLUTNT NAM 84 Vinyl methyl ether
** POLLUTNT IDN 85 XYLENE X
** POLLUTNT NAM 85 Xylene
** POLLUTNT IDN 86 AMMONIA X
** POLLUTNT NAM 86 Ammonia
** POLLUTNT IDN 87 BIS_2EH_ADIPATE X
** POLLUTNT NAM 87 Bis(2-ethylhexyl) adipate
** POLLUTNT IDN 88 CARBON_DISULFIDE X
** POLLUTNT NAM 88 Carbon disulfide
** POLLUTNT IDN 89 CHLORINE X
** POLLUTNT NAM 89 Chlorine
** POLLUTNT IDN 90 DI_2EH_PHTHALATE X
** POLLUTNT NAM 90 Di(2-ethylhexyl) phthalate
** POLLUTNT IDN 91 DICHLOROBENZENE X
** POLLUTNT NAM 91 Dichlorobenzene
** POLLUTNT IDN 92 DIBUTYL_PHTHALATE X
** POLLUTNT NAM 92 Dibutyl phthalate
** POLLUTNT IDN 93 DIMETHYL_SULFATE X
** POLLUTNT NAM 93 Dimethyl sulfate
** POLLUTNT IDN 94 ETHYLENE_OXIDE X
** POLLUTNT NAM 94 Ethylene oxide
** POLLUTNT IDN 95 MALEIC_ANH X
** POLLUTNT NAM 95 Maleic anhydride
** POLLUTNT IDN 96 PHTHALIC_ANH X
** POLLUTNT NAM 96 Phthalic anhydride
** POLLUTNT IDN 97 PROPYLENE_OXIDE X
** POLLUTNT NAM 97 Propylene oxide
** POLLUTNT IDN 98 STYRENE_OXIDE X
** POLLUTNT NAM 98 Styrene oxide
** POLLUTNT IDN 99 STYENE X
** POLLUTNT NAM 99 Styrene
** POLLUTNT IDN 100 TETRACHLORETHANE X
** POLLUTNT NAM 100 Tetrachloroethane
** POLLUTNT IDN 101 TRICHLOROETHANE X
** POLLUTNT NAM 101 Trichloroethane
** POLLUTNT IDN 102 TRIMETHYL_BENZENE X
** POLLUTNT NAM 102 Trimethyl benzene
** POLLUTNT IDN 103 UNIT_ER
** POLLUTNT NAM 103 Unit Emission Rate
** POLLUTNT EMS SRC40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.000000E-06
** POLLUTNT EMS SRC40 0 8.400000E-04 0 0 0 0 0 0 0 0 0 0 1.500000E-03 0 0 0
** POLLUTNT EMS SRC40 0 0 0 0 1.800000E-03 0 0 0 0 0 0 0 0 0 0 0 1.600000E-03
** POLLUTNT EMS SRC40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.400000E-04 0 0
** POLLUTNT EMS SRC40 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC41 8.900000E-05 0 0 0 0 0 0 0 0 1.800000E-05 0 0 0 0 0
** POLLUTNT EMS SRC41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.900000E-03 0
** POLLUTNT EMS SRC41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC41 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC42 0 0 4.200000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC42 0 0 0 4.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC42 0 0 2.300000E+00 1.300000E-04 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.100000E-02 0 0 0
** POLLUTNT EMS SRC42 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC43 4.300000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC43 0 8.100000E-06 0 1.900000E-03 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC43 0 0 0 0 0 0 5.800000E-07 0 1.200000E-06 0 0 0 0 0 0 0
** POLLUTNT EMS SRC43 0 0 0 4.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC43 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC43 0 1.000000E+00
** POLLUTNT EMS SRC44 0 0 4.500000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC44 3.500000E-03 0 0 1.200000E-04 4.600000E-03 0 0 0 0 0
** POLLUTNT EMS SRC44 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC44 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.300000E-03 0 0 0
** POLLUTNT EMS SRC44 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT EMS  SRC45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.000000E-03
** POLLUTNT EMS  SRC45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC46 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC46 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-04 0 0
** POLLUTNT EMS  SRC46 0 0 1.000000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC46 0 0 0 0 0 0 1.300000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC46 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC47 4.300000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC47 0 8.100000E-06 0 1.900000E-03 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC47 0 0 0 0 0 0 2.900000E-07 0 5.800000E-07 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC47 0 0 0 4.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC47 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC47 0 1.000000E+00
** POLLUTNT EMS  SRC48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8.500000E-03
** POLLUTNT EMS  SRC48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC48 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC49 0 0 3.800000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC49 0 0 0 5.900000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC49 0 0 2.100000E-01 1.300000E-04 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.600000E-03 0 0 0
** POLLUTNT EMS  SRC49 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03
** POLLUTNT EMS  SRC50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.400000E-03
** POLLUTNT EMS  SRC50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC50 0 0 1.000000E+00
** POLLUTNT EMS  SRC51 0 0 7.600000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC51 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03
** POLLUTNT EMS  SRC51 4.200000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC51 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC51 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC52 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.400000E-05
** POLLUTNT EMS  SRC52 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC52 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC52 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC53 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.300000E-04
** POLLUTNT EMS  SRC53 3.100000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC53 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC53 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC53 0 0 1.000000E+00
** POLLUTNT EMS  SRC54 0 0 1.100000E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.000000E-02
** POLLUTNT EMS  SRC54 0 0 0 1.400000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC54 0 0 5.900000E+00 1.000000E-01 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.800000E-02 0 0 0
** POLLUTNT EMS  SRC54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC55 0 0 8.900000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC55 4.800000E-02 0 0 1.700000E-03 5.700000E-02 0 0 0 0 0
** POLLUTNT EMS  SRC55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.300000E-02 0 0 0
** POLLUTNT EMS  SRC55 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC56 4.100000E-03 0 3.800000E-02 0 0 0 0 0 0 0 1.300000E-04
** POLLUTNT EMS  SRC56 0 0 0 0 0 0 0 0 0 0 0 6.000000E-05 0 1.500000E-02 0 0
** POLLUTNT EMS  SRC56 0 0 0 0 0 0 0 0 9.200000E-02 0 0 0 0 0 0 0 3.200000E-02
** POLLUTNT EMS  SRC56 2.100000E-01 4.200000E-03 0 0 0 0 1.800000E-02 0 0 0
** POLLUTNT EMS  SRC56 0 0 3.100000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC56 3.500000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC56 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.800000E-04 0 0
** POLLUTNT EMS  SRC57 0 0 0 0 0 0 0 0 9.900000E-03 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC57 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC57 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC58 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.200000E-06
** POLLUTNT EMS  SRC58 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.200000E-06 0 1.100000E-05
** POLLUTNT EMS  SRC58 0 0 0 0 0 0 0 0 0 0 0 9.500000E-05 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC58 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC58 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-06
** POLLUTNT EMS  SRC59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-06 0 1.700000E-05
** POLLUTNT EMS  SRC59 0 0 0 0 0 0 0 0 0 0 0 1.500000E-04 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC59 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC59 0 0 0 0 0 0 0 0 0 1.000000E+00


** BREEZE AERMOD GIS Pro v5.1.0 - C:\KCS\AERMOD\SM_Run1.dat
** Trinity Consultants

** PRIME

CO STARTING
CO TITLEONE  South Middlesex
CO TITLETWO  Run 1: 26-DEC-2005
CO MODELOPT  DFAULT  CONC
CO AVERTIME  ANNUAL
CO POLLUTID  SEL_POLL
CO RUNORNOT  RUN
```

E.1 AERMOD Input Files (Continued)

```
CO FINISHED

SO STARTING
SO ELEVUNIT METERS
SO LOCATION SRC1 POINT 551191.5 4486822.4 26
** SRCDESCR M_AMER_01
SO LOCATION SRC2 POINT 551193.5 4486810.1 26
** SRCDESCR M_AMER_02
SO LOCATION SRC3 POINT 551199.5 4486837.3 26
** SRCDESCR M_AMER_03
SO LOCATION SRC4 POINT 551203.9 4486823.8 26
** SRCDESCR M_AMER_04
SO LOCATION SRC5 POINT 551206.4 4486813.9 26
** SRCDESCR M_AMER_05
SO LOCATION SRC6 POINT 551215.9 4486823.2 26
** SRCDESCR M_AMER_06
SO LOCATION SRC7 POINT 551212.1 4486835.3 26
** SRCDESCR M_AMER_07
SO LOCATION SRC8 POINT 551209.3 4486845.2 25
** SRCDESCR M_AMER_08
SO LOCATION SRC9 POINT 551207.0 4486858.3 25
** SRCDESCR M_AMER_09
SO LOCATION SRC10 POINT 551202.8 4486874.0 25
** SRCDESCR M_AMER_10
SO LOCATION SRC11 POINT 551219.6 4486813.9 26
** SRCDESCR M_AMER_11
SO LOCATION SRC12 POINT 549415.7 4485705.5 31
** SRCDESCR M_PRFM_01
SO LOCATION SRC13 POINT 549438.7 4485706.4 30
** SRCDESCR M_PRFM_02
SO LOCATION SRC14 POINT 540879.9 4489921.3 17
** SRCDESCR M_RBH_01
SO LOCATION SRC15 POINT 540891.6 4489913.9 17
** SRCDESCR M_RBH_02
SO LOCATION SRC16 POINT 540880.4 4489912.6 16
** SRCDESCR M_RBH_03
SO LOCATION SRC17 POINT 540891.9 4489905.3 16
** SRCDESCR M_RBH_04
SO LOCATION SRC18 POINT 540881.0 4489903.5 16
** SRCDESCR M_RBH_05
SO LOCATION SRC19 POINT 540893.4 4489894.4 16
** SRCDESCR M_RBH_06
SO LOCATION SRC20 POINT 540881.7 4489893.2 16
** SRCDESCR M_RBH_07
SO LOCATION SRC21 POINT 545679.6 4481542.7 16
** SRCDESCR M_RHOD_01
SO LOCATION SRC22 POINT 545690.6 4481553.2 16
** SRCDESCR M_RHOD_02
SO LOCATION SRC23 POINT 545703.7 4481561.3 16
** SRCDESCR M_RHOD_03
SO LOCATION SRC24 POINT 545698.2 4481534.9 14
** SRCDESCR M_RHOD_04
SO LOCATION SRC25 POINT 545707.7 4481545.2 14
** SRCDESCR M_RHOD_05
SO LOCATION SRC26 POINT 541265.9 4489460.1 16
** SRCDESCR M_UC_01
SO LOCATION SRC27 POINT 541292.0 4489476.0 17
** SRCDESCR M_UC_02
SO LOCATION SRC28 POINT 541316.1 4489493.4 17
** SRCDESCR M_UC_03
SO LOCATION SRC29 POINT 541336.7 4489508.6 17
** SRCDESCR M_UC_04
SO LOCATION SRC30 POINT 541358.4 4489521.8 18
** SRCDESCR M_UC_05
SO LOCATION SRC31 POINT 541376.5 4489534.8 18
** SRCDESCR M_UC_06
SO LOCATION SRC32 POINT 541396.2 4489549.8 18
** SRCDESCR M_UC_07
SO LOCATION SRC33 POINT 541280.5 4489441.3 16
** SRCDESCR M_UC_08
SO LOCATION SRC34 POINT 541300.6 4489451.6 17
** SRCDESCR M_UC_09
SO LOCATION SRC35 POINT 541325.5 4489468.5 17
** SRCDESCR M_UC_10
SO LOCATION SRC36 POINT 541346.8 4489484.0 17
** SRCDESCR M_UC_11
SO LOCATION SRC37 POINT 541367.5 4489499.9 17
** SRCDESCR M_UC_12
SO LOCATION SRC38 POINT 541386.9 4489515.8 17
** SRCDESCR M_UC_13
SO LOCATION SRC39 POINT 541408.6 4489529.9 18
** SRCDESCR M_UC_14
SO LOCATION SRC129 VOLUME 540886.0 4489908.3 16
** SRCDESCR M_RBH_V01
SO LOCATION SRC130 VOLUME 541342.3 4489499.1 17
** SRCDESCR M_UC_V01
SO LOCATION SRC131 VOLUME 545688.5 4481550.8 16
** SRCDESCR M_RHOD_V01
```

E.1 AERMOD Input Files (Continued)

```
SO LOCATION SRC132 VOLUME 549428.8 4485672.4 30
** SRCDESCR M_PRFM_V01
SO LOCATION SRC133 VOLUME 551179.4 4486809.95 26
** SRCDESCR M_AMER_V01
SO SRCPARAM SRC1 0.000000E+00 7.62 355.3722 1.617014E-03 0.0508
SO SRCPARAM SRC2 0.000000E+00 8.2296 419.2611 1.778716E-02 0.0508
SO SRCPARAM SRC3 7.123000E-03 6.7056 294.2611 6.468057E-03 0.0254
SO SRCPARAM SRC4 0.000000E+00 7.62 359.8167 1.617014E-03 0.0508
SO SRCPARAM SRC5 0.000000E+00 7.62 355.3722 1.617014E-03 0.0508
SO SRCPARAM SRC6 7.107000E-03 7.62 378.15 1.617014E-03 0.0508
SO SRCPARAM SRC7 0.000000E+00 7.62 363.15 1.293611E-02 0.0254
SO SRCPARAM SRC8 0.000000E+00 7.62 333.15 1.617014E-03 0.0508
SO SRCPARAM SRC9 0.000000E+00 7.9248 294.2611 0.0113191 0.0508
SO SRCPARAM SRC10 0.000000E+00 8.5344 327.5945 6.468057E-03 0.0254
SO SRCPARAM SRC11 0.000000E+00 8.2296 294.2611 0.4042535 0.0508
SO SRCPARAM SRC12 0.000000E+00 9.144 310.9278 0.1212761 0.508
SO SRCPARAM SRC13 0.000000E+00 9.144 294.2611 0.4915723 0.254
SO SRCPARAM SRC14 0.000000E+00 8.5344 295.0945 9.900087E-02 0.3556
SO SRCPARAM SRC15 0.000000E+00 5.1816 297.0389 4.851042E-02 0.508
SO SRCPARAM SRC16 0.000000E+00 5.1816 294.2611 9.216981E-02 0.0508
SO SRCPARAM SRC17 0.000000E+00 5.1816 297.0389 4.851042E-02 0.508
SO SRCPARAM SRC18 0.000000E+00 5.1816 299.8167 0.3234028 0.254
SO SRCPARAM SRC19 0.000000E+00 9.144 294.2611 0.2874692 0.1524
SO SRCPARAM SRC20 0.000000E+00 7.62 294.2611 0.116425 0.508
SO SRCPARAM SRC21 0.000000E+00 12.4968 322.0389 4.851042E-03 0.0508
SO SRCPARAM SRC22 0.000000E+00 12.8016 322.0389 1.796683E-02 0.0762
SO SRCPARAM SRC23 0.000000E+00 13.716 294.2611 9.644677E-02 0.3302
SO SRCPARAM SRC24 0.000000E+00 12.4968 294.2611 6.468057E-03 0.0508
SO SRCPARAM SRC25 0.000000E+00 12.192 313.7056 4.042535E-02 0.0508
SO SRCPARAM SRC26 0.000000E+00 12.192 298.15 6.468056E-04 0.254
SO SRCPARAM SRC27 0.000000E+00 4.572 344.2611 3.593365E-03 0.381
SO SRCPARAM SRC28 0.000000E+00 15.24 324.8167 7.186731E-04 0.0762
SO SRCPARAM SRC29 0.000000E+00 11.5824 294.2611 1.796682E-06 1.524
SO SRCPARAM SRC30 0.000000E+00 7.62 299.8167 1.293611E-03 0.254
SO SRCPARAM SRC31 0.000000E+00 9.144 1088.706 1.437346E-03 0.0762
SO SRCPARAM SRC32 0.000000E+00 6.096 294.2611 3.593365E-03 0.0762
SO SRCPARAM SRC33 0.000000E+00 10.668 298.15 0.1051059 0.0508
SO SRCPARAM SRC34 0.000000E+00 9.144 299.8167 3.593365E-03 0.0762
SO SRCPARAM SRC35 0.000000E+00 1.2192 294.2611 3.234029E-03 0.0508
SO SRCPARAM SRC36 0.000000E+00 10.668 1088.706 1.374462E-03 0.508
SO SRCPARAM SRC37 0.000000E+00 11.2776 333.15 0.1617014 0.254
SO SRCPARAM SRC38 0.000000E+00 15.24 294.2611 1.617014E-05 0.0508
SO SRCPARAM SRC39 0.000000E+00 9.144 343.15 6.539924E-02 0.3048
SO SRCPARAM SRC129 0.000000E+00 3 10.6 2.79
SO SRCPARAM SRC130 0.000000E+00 3 49 2.79
SO SRCPARAM SRC131 0.000000E+00 3 10.2 2.79
SO SRCPARAM SRC132 0.000000E+00 3 45.4 2.79
SO SRCPARAM SRC133 0.000000E+00 3 22.8 2.79
SO SRCGROUP AMERCHOL SRC1 SRC2 SRC3 SRC4 SRC5 SRC6 SRC7 SRC8 SRC9
SO SRCGROUP AMERCHOL SRC10 SRC11 SRC133
SO SRCGROUP PRIVFORM SRC12 SRC13 SRC132
SO SRCGROUP RBH SRC14 SRC15 SRC16 SRC17 SRC18 SRC19 SRC20 SRC129
SO SRCGROUP RHODIA SRC21 SRC22 SRC23 SRC24 SRC25 SRC131
SO SRCGROUP UCARB SRC26 SRC27 SRC28 SRC29 SRC30 SRC31 SRC32 SRC33
SO SRCGROUP UCARB SRC34 SRC35 SRC36 SRC37 SRC38 SRC39 SRC130
SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE ELEVUNIT METERS
(Listing of receptors has been omitted for brevity, please refer to Section 3.2.3.5 (Receptor Grids) for
details on receptor spacing)
RE FINISHED

ME STARTING
ME SURFFILE C:\KCS\EWR91-95.SFC
ME PROFFILE C:\KCS\EWR91-95.PFL
ME PROFBASE 9 METERS
ME SURFDATA 14734 1991
ME UAIRDATA 00093755 1991
ME STARTEND 1991 01 01 1 1995 12 31 24
ME FINISHED

OU STARTING
OU FINISHED

** OUTFILE C:\KCS\AERMOD\SM_Run1.LST
** RAWFILE C:\KCS\AERMOD\SM_Run1.RAW
** RAWFMT 2
** TERRFILE C:\KCS\MOSAIC.DEM 2 2 1 18 9.999972 531660 4469240 531660 4539020 584570
4539020 584570 4469240
** HILLBOUN 536674.1 4477598 555049.4 4493627.6

** POLLUTNT IDN 01 ACETIC_ACID X
** POLLUTNT NAM 01 Acetic acid
** POLLUTNT IDN 02 ACETIC_ANH X
** POLLUTNT NAM 02 Acetic anhydride
** POLLUTNT IDN 03 ACETONE X
```

```
** POLLUTNT NAM 03 Acetone
** POLLUTNT IDN 04 ACETONITRILE X
** POLLUTNT NAM 04 Acetonitrile
** POLLUTNT IDN 05 ACRYLIC_ACID X
** POLLUTNT NAM 05 Acrylic acid
** POLLUTNT IDN 06 ACRYLIC_MONO X
** POLLUTNT NAM 06 Acrylic monomer
** POLLUTNT IDN 07 BENZALDEHYDE X
** POLLUTNT NAM 07 Benzaldehyde
** POLLUTNT IDN 08 BENZENE X
** POLLUTNT NAM 08 Benzene
** POLLUTNT IDN 09 BENZONITRILE X
** POLLUTNT NAM 09 Benzonitrile
** POLLUTNT IDN 10 BUTANE X
** POLLUTNT NAM 10 Butane
** POLLUTNT IDN 11 BUTANOL X
** POLLUTNT NAM 11 Butanol
** POLLUTNT IDN 12 BUTYL_ACETATE X
** POLLUTNT NAM 12 Butyl acetate
** POLLUTNT IDN 13 CHLOROBENZENE X
** POLLUTNT NAM 13 Chlorobenzene
** POLLUTNT IDN 14 CHLOROFORM X
** POLLUTNT NAM 14 Chloroform
** POLLUTNT IDN 15 CYCLOHEXANE X
** POLLUTNT NAM 15 Cyclohexane
** POLLUTNT IDN 16 CYCLOHEXANONE X
** POLLUTNT NAM 16 Cyclohexanone
** POLLUTNT IDN 17 DIACETONE_ALCOHOL X
** POLLUTNT NAM 17 Diacetone alcohol
** POLLUTNT IDN 18 DIETHYLENE_GLYCOL X
** POLLUTNT NAM 18 Diethylene glycol
** POLLUTNT IDN 19 DIETHYLENE_TRIAMINE X
** POLLUTNT NAM 19 Diethylene triamine
** POLLUTNT IDN 20 DIMETHYL_CC X
** POLLUTNT NAM 20 Dimethyl carbonyl chloride
** POLLUTNT IDN 21 DIMETHYLAMINE X
** POLLUTNT NAM 21 Dimethylamine
** POLLUTNT IDN 22 DIMETHYLFORMAMIDE X
** POLLUTNT NAM 22 Dimethylformamide
** POLLUTNT IDN 23 DIOXANE X
** POLLUTNT NAM 23 Dioxane
** POLLUTNT IDN 24 EPICHLOROHYDRIN X
** POLLUTNT NAM 24 Epichlorohydrin
** POLLUTNT IDN 25 ETHANOL X
** POLLUTNT NAM 25 Ethanol
** POLLUTNT IDN 26 ETHYL_ACETATE X
** POLLUTNT NAM 26 Ethyl acetate
** POLLUTNT IDN 27 ETHYL_ACRYLATE X
** POLLUTNT NAM 27 Ethyl acrylate
** POLLUTNT IDN 28 ETHYL_CHLOROFORMATE X
** POLLUTNT NAM 28 Ethyl chloroformate
** POLLUTNT IDN 29 ETHYL_ETHER X
** POLLUTNT NAM 29 Ethyl ether
** POLLUTNT IDN 30 ETHYLENE_DICHLORIDE X
** POLLUTNT NAM 30 Ethylene dichloride
** POLLUTNT IDN 31 ETHYLENE_GLYCOL X
** POLLUTNT NAM 31 Ethylene glycol
** POLLUTNT IDN 32 FORMALDEHYDE X
** POLLUTNT NAM 32 Formaldehyde
** POLLUTNT IDN 33 FORMIC_ACID X
** POLLUTNT NAM 33 Formic acid
** POLLUTNT IDN 34 GLYCERINE X
** POLLUTNT NAM 34 Glycerine
** POLLUTNT IDN 35 HEPTANE X
** POLLUTNT NAM 35 Heptane
** POLLUTNT IDN 36 HEXANE X
** POLLUTNT NAM 36 Hexane
** POLLUTNT IDN 37 HYDRAZINE X
** POLLUTNT NAM 37 Hydrazine
** POLLUTNT IDN 38 HYDROCHLORIC X
** POLLUTNT NAM 38 Hydrochloric acid
** POLLUTNT IDN 39 HYDROQUINONE X
** POLLUTNT NAM 39 Hydroquinone
** POLLUTNT IDN 40 ISOBUTANE X
** POLLUTNT NAM 40 Isobutane
** POLLUTNT IDN 41 ISOBUTYL_ALCOHOL X
** POLLUTNT NAM 41 Isobutyl alcohol
** POLLUTNT IDN 42 ISOPENTANE X
** POLLUTNT NAM 42 Isopentane
** POLLUTNT IDN 43 ISOPENTYL_ALCOHOL X
** POLLUTNT NAM 43 Isopentyl alcohol
** POLLUTNT IDN 44 ISOPROPANOL X
** POLLUTNT NAM 44 Isopropanol
** POLLUTNT IDN 45 ISOPROPYLAMINE X
** POLLUTNT NAM 45 Isopropylamine
** POLLUTNT IDN 46 METHANOL X
** POLLUTNT NAM 46 Methanol
** POLLUTNT IDN 47 METHYL_ACETATE X
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT NAM 47 Methyl acetate
** POLLUTNT IDN 48 METHYL_ACRYLATE X
** POLLUTNT NAM 48 Methyl acrylate
** POLLUTNT IDN 49 METHYL_AMYL_ALCOHOL X
** POLLUTNT NAM 49 Methyl amyl alcohol
** POLLUTNT IDN 50 METHYL_BROMIDE X
** POLLUTNT NAM 50 Methyl bromide
** POLLUTNT IDN 51 METHYL_CYCLOHEXANE X
** POLLUTNT NAM 51 Methyl cyclohexane
** POLLUTNT IDN 52 MEK X
** POLLUTNT NAM 52 Methyl ethyl ketone
** POLLUTNT IDN 53 METHYL_FORMATE X
** POLLUTNT NAM 53 Methyl formate
** POLLUTNT IDN 54 METHYL_HYDRAZINE X
** POLLUTNT NAM 54 Methyl hydrazine
** POLLUTNT IDN 55 METHYL_ISOBUTYL_KETONE X
** POLLUTNT NAM 55 Methyl isobutyl ketone
** POLLUTNT IDN 56 METHYL_METHACRYLATE X
** POLLUTNT NAM 56 Methyl methacrylate
** POLLUTNT IDN 57 METHYLENE_CL X
** POLLUTNT NAM 57 Methylene chloride
** POLLUTNT IDN 58 NAPHTHA X
** POLLUTNT NAM 58 Naphtha
** POLLUTNT IDN 59 N-BUTYL_ACRYLATE X
** POLLUTNT NAM 59 N-butyl acrylate
** POLLUTNT IDN 60 NONANAL X
** POLLUTNT NAM 60 Nonanal
** POLLUTNT IDN 61 N-PROPYL_ACETATE X
** POLLUTNT NAM 61 N-propyl acetate
** POLLUTNT IDN 62 OIL X
** POLLUTNT NAM 62 Oil
** POLLUTNT IDN 63 PELARGONIC_ACID X
** POLLUTNT NAM 63 Pelargonic acid
** POLLUTNT IDN 64 PENTANAL X
** POLLUTNT NAM 64 Pentanal
** POLLUTNT IDN 65 PHENOL X
** POLLUTNT NAM 65 Phenol
** POLLUTNT IDN 66 PHOSPHORIC_ACID X
** POLLUTNT NAM 66 Phosphoric acid
** POLLUTNT IDN 67 PROPANE X
** POLLUTNT NAM 67 Propane
** POLLUTNT IDN 68 PROPANOL X
** POLLUTNT NAM 68 Propanol
** POLLUTNT IDN 69 PROPARGYL_ALCOHOL X
** POLLUTNT NAM 69 Propargyl alcohol
** POLLUTNT IDN 70 PROPIONIC_ACID X
** POLLUTNT NAM 70 Propionic acid
** POLLUTNT IDN 71 PROPYLENE_GLYCOL X
** POLLUTNT NAM 71 Propylene glycol, methyl ester
** POLLUTNT IDN 72 PYRIDINE X
** POLLUTNT NAM 72 Pyridine
** POLLUTNT IDN 73 TERT-BUTANOL X
** POLLUTNT NAM 73 tert-butanol
** POLLUTNT IDN 74 TERT-BUTYL_CHLORIDE X
** POLLUTNT NAM 74 tert-butyl chloride
** POLLUTNT IDN 75 TETRAHYDROFURAN X
** POLLUTNT NAM 75 Tetrahydrofuran
** POLLUTNT IDN 76 TOLUENE X
** POLLUTNT NAM 76 Toluene
** POLLUTNT IDN 77 TRICHLOROACETIC X
** POLLUTNT NAM 77 Trichloroacetic acid
** POLLUTNT IDN 78 TRIDECYL X
** POLLUTNT NAM 78 Tridecyl alcohol
** POLLUTNT IDN 79 TRIETHYLAMINE X
** POLLUTNT NAM 79 Triethylamine
** POLLUTNT IDN 80 TRIETHYLENE X
** POLLUTNT NAM 80 Triethylene glycol
** POLLUTNT IDN 81 TRIMETHYL_BORATE X
** POLLUTNT NAM 81 Trimethyl borate
** POLLUTNT IDN 82 VINYL_ACETATE X
** POLLUTNT NAM 82 Vinyl acetate
** POLLUTNT IDN 83 VINYL_CHLORIDE X
** POLLUTNT NAM 83 Vinyl chloride
** POLLUTNT IDN 84 VINYL_METHYL_ETHER X
** POLLUTNT NAM 84 Vinyl methyl ether
** POLLUTNT IDN 85 XYLENE X
** POLLUTNT NAM 85 Xylene
** POLLUTNT IDN 86 AMMONIA X
** POLLUTNT NAM 86 Ammonia
** POLLUTNT IDN 87 BIS_2EH_ADIPATE X
** POLLUTNT NAM 87 Bis(2-ethylhexyl) adipate
** POLLUTNT IDN 88 CARBON_DISULFIDE X
** POLLUTNT NAM 88 Carbon disulfide
** POLLUTNT IDN 89 CHLORINE X
** POLLUTNT NAM 89 Chlorine
** POLLUTNT IDN 90 DI_2EH_PHTHALATE X
** POLLUTNT NAM 90 Di(2-ethylhexyl) phthalate
** POLLUTNT IDN 91 DICHLOROBENZENE X
```

E.1 AERMOD Input Files (Continued)

```
** POLLUTNT NAM 91 Dichlorobenzene
** POLLUTNT IDN 92 DIBUTYL_PHTHALATE X
** POLLUTNT NAM 92 Dibutyl phthalate
** POLLUTNT IDN 93 DIMETHYL_SULFATE X
** POLLUTNT NAM 93 Dimethyl sulfate
** POLLUTNT IDN 94 ETHYLENE_OXIDE X
** POLLUTNT NAM 94 Ethylene oxide
** POLLUTNT IDN 95 MALEIC_ANH X
** POLLUTNT NAM 95 Maleic anhydride
** POLLUTNT IDN 96 PHTHALIC_ANH X
** POLLUTNT NAM 96 Phthalic anhydride
** POLLUTNT IDN 97 PROPYLENE_OXIDE X
** POLLUTNT NAM 97 Propylene oxide
** POLLUTNT IDN 98 STYRENE_OXIDE X
** POLLUTNT NAM 98 Styrene oxide
** POLLUTNT IDN 99 STYENE X
** POLLUTNT NAM 99 Styrene
** POLLUTNT IDN 100 TETRACHLORETHANE X
** POLLUTNT NAM 100 Tetrachloroethane
** POLLUTNT IDN 101 TRICHLOROETHANE X
** POLLUTNT NAM 101 Trichloroethane
** POLLUTNT IDN 102 TRIMETHYL_BENZENE X
** POLLUTNT NAM 102 Trimethyl benzene
** POLLUTNT IDN 103 UNIT_ER
** POLLUTNT NAM 103 Unit Emission Rate
** POLLUTNT EMS SRC1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.824290E-01 0 0 0 0
** POLLUTNT EMS SRC1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC1 1.000000E+00
** POLLUTNT EMS SRC2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.307204E+02 0 0
** POLLUTNT EMS SRC2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC2 1.000000E+00
** POLLUTNT EMS SRC3 7.123000E-03 9.800000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.540100E-02 0 0
** POLLUTNT EMS SRC3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC3 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC4 0 0 0 3.788000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC4 8.837370E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC4 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9.121500E-02 0 0 0 0
** POLLUTNT EMS SRC5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC5 1.000000E+00
** POLLUTNT EMS SRC6 7.107000E-03 9.800000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC6 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC7 0 0 0 1.894000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC7 4.041390E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC7 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC8 0 0 0 0 1.600000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC8 0 0 0 0 0 0 0 0 0 0 0 0 0 1.540100E-02 0 0 0 0 0 0 0
** POLLUTNT EMS SRC8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC8 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC9 0 0 0 1.174700E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC9 1.000000E+00
** POLLUTNT EMS SRC10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC10 0 0 0 1.325800E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC10 2.828972E+00 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC10 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS SRC11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.307204E+02 0 0
** POLLUTNT EMS SRC11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC11 1.000000E+00
** POLLUTNT EMS SRC12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.900000E-02 0 0
** POLLUTNT EMS SRC12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC12 1.000000E+00
** POLLUTNT EMS SRC13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS SRC13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.700000E-01 0 0
** POLLUTNT EMS SRC13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

E.1 AERMOD Input Files (Continued)

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** POLLUTNT EMS  SRC13 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC13 1.000000E+00
** POLLUTNT EMS  SRC14 0 0 8.004000E-03 0 0 0 0 0 0 0 2.541000E-03 9.390000E-03
** POLLUTNT EMS  SRC14 0 0 0 3.450000E-04 0 0 0 0 0 0 0 0 5.438000E-03 7.545000E-03
** POLLUTNT EMS  SRC14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.391360E-01 0 0 0
** POLLUTNT EMS  SRC14 0 0 0 0 6.846300E-02 0 0 8.628000E-03 1.216000E-03 0
** POLLUTNT EMS  SRC14 5.830000E-04 0 0 0 0 0 0 0 0 0 3.419000E-03 0 0 1.254000E-03
** POLLUTNT EMS  SRC14 0 0 0 0 2.265700E-02 0 0 0 0 0 0 0 0 3.803000E-03 0 0
** POLLUTNT EMS  SRC14 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC15 0 0 0 0 0 0 0 0 0 0 5.100000E-05 3.000000E-06 0 0 0 0
** POLLUTNT EMS  SRC15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC15 2.700000E-04 0 0 0 0 0 0 0 2.098000E-03 0 0 3.000000E-06
** POLLUTNT EMS  SRC15 0 0 1.440000E-04 0 0 0 0 0 0 0 0 0 1.800000E-05 0 0 2.000000E-06
** POLLUTNT EMS  SRC15 0 0 0 0 1.040000E-04 0 0 0 0 0 0 0 0 7.600000E-05 0 0
** POLLUTNT EMS  SRC15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.730000E-04
** POLLUTNT EMS  SRC16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.880000E-04 0 0 2.900000E-05
** POLLUTNT EMS  SRC16 0 0 0 0 5.800000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC16 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC17 0 0 0 0 0 0 0 0 0 0 2.110000E-04 2.350000E-04 0 0 0 0
** POLLUTNT EMS  SRC17 0 0 0 0 0 0 0 0 3.620000E-04 7.050000E-04 0 0 0 0 0 0
** POLLUTNT EMS  SRC17 0 0 0 0 0 0 0 0 0 0 0 3.520000E-04 0 0 0 0 0 0 0 6.220000E-04
** POLLUTNT EMS  SRC17 0 0 6.000000E-06 2.350000E-04 0 1.100000E-04 0 0 0 0
** POLLUTNT EMS  SRC17 0 0 0 0 0 0 0 0 1.760000E-04 0 0 0 0 1.533000E-03 0 0
** POLLUTNT EMS  SRC17 0 0 0 0 0 0 3.690000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC17 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC18 0 0 0 0 0 0 0 0 0 0 5.110000E-04 3.650000E-04 0 0 0 9.000000E-06
** POLLUTNT EMS  SRC18 0 0 0 0 0 0 0 0 8.020000E-04 1.094000E-03 0 0 0 0 0 0
** POLLUTNT EMS  SRC18 0 0 0 0 0 0 0 0 0 0 0 4.380000E-04 0 0 0 0 0 0 0 9.670000E-04
** POLLUTNT EMS  SRC18 0 0 9.000000E-06 0 0 1.710000E-04 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC18 0 0 2.740000E-04 0 0 0 0 2.198000E-03 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC18 9.370000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC19 0 0 0 0 0 0 0 0 0 0 0 3.960000E-04 0 0 0 3.170000E-04
** POLLUTNT EMS  SRC19 0 0 0 0 0 0 0 0 1.114000E-03 1.189000E-03 0 0 0 0 0 0
** POLLUTNT EMS  SRC19 0 0 0 0 0 0 0 0 0 0 0 4.760000E-04 0 0 0 0 0 0 0 4.435000E-03
** POLLUTNT EMS  SRC19 0 0 3.170000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC19 0 0 2.768000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC19 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC20 0 0 0 0 0 0 0 0 0 0 2.073000E-03 2.126000E-02 0 0 0 0
** POLLUTNT EMS  SRC20 0 0 0 0 0 0 0 0 5.133400E-02 7.000000E-02 0 0 0 0 0 0
** POLLUTNT EMS  SRC20 0 0 0 0 0 0 0 0 0 0 0 2.800000E-02 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6.066700E-02
** POLLUTNT EMS  SRC20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC21 0 0 0 0 3.600000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-04 0 0 0 0
** POLLUTNT EMS  SRC21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC21 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC22 0 0 0 0 3.600000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-04 0 0 0 0
** POLLUTNT EMS  SRC22 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC22 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.010000E-02 0 0
** POLLUTNT EMS  SRC23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC23 1.000000E+00
** POLLUTNT EMS  SRC24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC24 0 0 0 0 3.170000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.170000E-04 0 0 0 0
** POLLUTNT EMS  SRC24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC24 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.920000E-04
** POLLUTNT EMS  SRC25 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC26 0 0 1.200000E-04 0 0 0 0 0 0 6.100000E-04 0 0 0 0 0
** POLLUTNT EMS  SRC26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC26 0 0 0 0 0 3.100000E-04 0 0 1.200000E-05 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC27 0 0 4.000000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC27 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC27 0 0 0 0 0 0 8.500000E-04 8.000000E-02 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC27 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC28 0 0 0 0 0 0 0 0 0 0 1.100000E+01 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC28 0 0 0 3.100000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC28 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC28 0 0 0 0 0 0 2.100000E+01 0 0 0 0 0 0 0 4.200000E-01 0
** POLLUTNT EMS  SRC28 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC29 0 0 0 0 0 0 0 0 0 0 2.100000E-02 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC29 0 0 1.400000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC29 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC29 0 0 0 0 0 0 1.600000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC29 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
```

```
** POLLUTNT EMS  SRC30 0 0 0 0 0 0 0 0 0 0 0 1.100000E-03 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC30 0 0 0 1.100000E-03 0 0 0 0 0 0 0 0 0 6.100000E-03 1.100000E-03
** POLLUTNT EMS  SRC30 0 0 0 0 0 1.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC30 0 0 0 0 0 0 0 0 0 0 0 1.100000E-03 0 0 0 0 0 0 1.100000E-03
** POLLUTNT EMS  SRC30 0 0 0 0 0 0 0 0 0 0 6.100000E-03 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC30 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC31 0 0 0 0 0 0 0 0 0 0 0 0 0 9.600000E-02 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC31 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC31 1.000000E+00
** POLLUTNT EMS  SRC32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC32 0 0 1.700000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC32 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC32 1.000000E+00
** POLLUTNT EMS  SRC33 0 0 2.400000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC33 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC33 1.000000E+00
** POLLUTNT EMS  SRC34 0 0 3.500000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-03
** POLLUTNT EMS  SRC34 0 0 0 0 0 0 0 0 1.700000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC34 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC34 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC34 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC35 0 0 0 0 0 0 0 0 0 0 0 5.200000E-06 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC35 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC35 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC35 4.100000E-05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC35 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC36 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC36 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC36 0 0 0 0 0 0 0 0 0 0 0 0 0 7.600000E-03 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC36 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC36 1.000000E+00
** POLLUTNT EMS  SRC37 0 0 4.300000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.700000E-05
** POLLUTNT EMS  SRC37 0 8.600000E-05 3.500000E-04 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4.300000E-05
** POLLUTNT EMS  SRC37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC38 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC38 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC38 0 0 6.000000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC38 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC38 1.000000E+00
** POLLUTNT EMS  SRC39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC39 0 0 2.500000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC39 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC39 1.000000E+00
** POLLUTNT EMS  SRC129 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC129 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.200000E-02
** POLLUTNT EMS  SRC129 0 0 0 3.600000E-03 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC129 0 0 3.500000E-02 0 0 0 0 0 0 0 0 2.500000E-02 0 0 0 0
** POLLUTNT EMS  SRC129 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC130 0 0 2.000000E-02 0 0 0 0 0 0 0 3.700000E-02 0 0 0 0 0
** POLLUTNT EMS  SRC130 0 0 0 0 0 0 0 1.200000E-04 0 0 0 0 0 0 7.400000E-02 4.000000E-02
** POLLUTNT EMS  SRC130 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5.900000E-02
** POLLUTNT EMS  SRC130 0 0 0 0 0 0 0 1.000000E-01 1.900000E-03 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC130 0 0 3.100000E-02 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC130 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC131 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC131 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.000000E-01 0 0
** POLLUTNT EMS  SRC131 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03 0 0 0 0
** POLLUTNT EMS  SRC131 0 0 0 0 0 0 1.600000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC131 0 0 0 0 0 0 0 0 0 0 0 0 0 1.000000E+00
** POLLUTNT EMS  SRC132 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC132 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3.600000E-03 0 0
** POLLUTNT EMS  SRC132 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC132 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC132 1.000000E+00
** POLLUTNT EMS  SRC133 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC133 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7.800000E-02 0 0
** POLLUTNT EMS  SRC133 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC133 5.400000E-01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
** POLLUTNT EMS  SRC133 0 0 0 0 0 0 1.000000E+00
```

APPENDIX F

EXAMPLE OF AERMOD OUTPUT FILES

The modeling runs generated 408 output files (i.e., 4 receptor grids × 102 COCs). All air dispersion modeling output was collected in standard text format files that contained geographical coordinates ('X' and 'Y') for every receptor as well as a modeled air concentration for every COC at that receptor. The height for all modeled receptors was ground level (i.e., 'Z' = 0). The modeled air concentrations were expressed as micrograms/cubic meter ($\mu g/m^3$). This Appendix contains abbreviated versions of the AERMOD output files for several COCs (benzene, formaldehyde, methylene chloride, methyl hydrazine, and tetrahydrofuran) emitted from the Hoffman LaRoche source facility. To abbreviate the original output file, pages 5 through 125 were omitted. These pages contained the 'X' and 'Y' coordinates for all the receptors modeled as well as the predicted concentration of the COC at each receptor.

F.1 Example of AERMOD Output Files: Benzene

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:37
 **MODELOPTs:                                                                                                      PAGE   1
 CONC                         DFAULT ELEV

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **Model Uses NO DRY DEPLETION.  DDPLETE =  F
 **Model Uses NO WET DEPLETION.  WDPLETE =  F
 **NO GAS DRY DEPOSITION Data Provided.

 **Model Uses RURAL Dispersion Only.

 **Model Uses Regulatory DEFAULT Options:
           1. Stack-tip Downwash.
           2. Model Accounts for ELEVated Terrain Effects.
           3. Use Calms Processing Routine.
           4. Use Missing Data Processing Routine.
           5. "Upper Bound" Values for Supersquat Buildings.
           6. No Exponential Decay

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates ANNUAL Averages Only

 **This Run Includes:     7 Source(s);      1 Source Group(s); and    4980 Receptor(s)

 **The Model Assumes A Pollutant Type of:  BENZENE

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
          Model Outputs Tables of ANNUAL Averages by Receptor
          Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours
```

F.1 Example of AERMOD Output Files: Benzene (Continued)

```
 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     9.00 ;  Decay Coef. =       0.0000 ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                              ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.4 MB of RAM.

 **Input Runstream File:          C:\KCS\AERMOD\NE_RUN1_BENZENE.DAT
 **Output Print File:             C:\KCS\AERMOD\NE_RUN1_BENZENE.LST


1 *** AERMOD - VERSION 04300 ***    ***  North Essex                                                    ***        12/16/05
                                    ***  Run 1: 16-DEC-2005                                             ***        10:44:37
 **MODELOPTs:                                                                                                    PAGE   2
 CONC                        DFAULT ELEV


                                                *** POINT SOURCE DATA ***

            NUMBER EMISSION RATE                          BASE     STACK    STACK     STACK     STACK    BUILDING  URBAN  EMISSION RATE
   SOURCE    PART.  (GRAMS/SEC)      X         Y         ELEV.    HEIGHT   TEMP.    EXIT VEL. DIAMETER  EXISTS    SOURCE SCALAR VARY
    ID       CATS.                 (METERS)  (METERS)  (METERS) (METERS) (DEG.K)  (M/SEC)   (METERS)                      BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC60        0   0.00000E+00  571024.8 4520821.5    41.0     19.81    300.37     3.73      0.03       NO        NO
   SRC61        0   0.00000E+00  571024.8 4520802.5    40.0     19.81    313.15     1.63      0.05       NO        NO
   SRC62        0   0.00000E+00  571024.8 4520784.0    40.0      3.05    294.26     0.19      2.03       NO        NO
   SRC63        0   0.00000E+00  571024.8 4520764.0    39.0     36.58    294.26     0.44      2.03       NO        NO
   SRC64        0   0.00000E+00  571124.6 4520772.5    40.0     13.72    281.48    10.25      0.03       NO        NO
   SRC65        0   0.43000E-04  571124.6 4520755.5    40.0      6.10    294.26     0.06      1.02       NO        NO
```

F.1 Example of AERMOD Output Files: Benzene (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:37
 **MODELOPTs:                                                                                                      PAGE   3
 CONC                         DFAULT ELEV


                                                    *** VOLUME SOURCE DATA ***

            NUMBER EMISSION RATE                          BASE    RELEASE    INIT.    INIT.   URBAN  EMISSION RATE
    SOURCE   PART.  (GRAMS/SEC)     X         Y          ELEV.   HEIGHT     SY       SZ      SOURCE  SCALAR VARY
     ID      CATS.                (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)          BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   SRC144       0   0.00000E+00  571072.9 4520765.5    40.0      3.00     62.00     2.79     NO

1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:37
 **MODELOPTs:                                                                                                      PAGE   4
 CONC                         DFAULT ELEV


                                                *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                                 SOURCE IDs


  ALL       SRC60    , SRC61    , SRC62    , SRC63    , SRC64    , SRC65    , SRC144   ,
```

(NOTE: Pages 5 - 125 have been omitted for brevity.)

F.1 Example of AERMOD Output Files: Benzene (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                    ***        12/16/05

                                     ***  Run 1: 16-DEC-2005                             ***        10:44:44
 **MODELOPTs:                                                                                       PAGE 126
 CONC                         DFAULT ELEV

                                        *** THE SUMMARY OF MAXIMUM ANNUAL (   5 YRS) RESULTS ***


                                     ** CONC OF BENZENE  IN MICROGRAMS/M**3                      **

                                                                                                  NETWORK
 GROUP ID                        AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       1ST HIGHEST VALUE IS       0.00137 AT (  571172.19,  4520842.00,     40.44,     40.44,      0.00)  DC
          2ND HIGHEST VALUE IS       0.00128 AT (  571197.75,  4520826.50,     39.91,     39.91,      0.00)  DC
          3RD HIGHEST VALUE IS       0.00125 AT (  571155.12,  4520852.50,     40.88,     40.88,      0.00)  DC
          4TH HIGHEST VALUE IS       0.00109 AT (  571214.81,  4520816.00,     39.40,     39.40,      0.00)  DC
          5TH HIGHEST VALUE IS       0.00096 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          6TH HIGHEST VALUE IS       0.00096 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          7TH HIGHEST VALUE IS       0.00080 AT (  571240.44,  4520800.00,     38.74,     38.74,      0.00)  DC
          8TH HIGHEST VALUE IS       0.00078 AT (  571112.44,  4520878.50,     41.50,     41.50,      0.00)  DC
          9TH HIGHEST VALUE IS       0.00064 AT (  571257.50,  4520790.00,     38.63,     38.63,      0.00)  DC
         10TH HIGHEST VALUE IS       0.00058 AT (  571124.69,  4520902.50,     40.63,     40.63,      0.00)  DC


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
```

F.1 Example of AERMOD Output Files: Benzene (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                  ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                           ***        10:44:44
 **MODELOPTs:                                                                                     PAGE 127
 CONC                        DFAULT ELEV


*** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            7 Warning Message(s)
 A Total of         1153 Informational Message(s)

 A Total of          935 Calm Hours Identified

 A Total of          218 Missing Hours Identified (  0.50 Percent)

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

F.2 Example of AERMOD Output Files: Formaldehyde

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:38
 **MODELOPTs:                                                                                                      PAGE   1
 CONC                         DFAULT ELEV

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **Model Uses NO DRY DEPLETION.  DDPLETE =  F
 **Model Uses NO WET DEPLETION.  WDPLETE =  F
 **NO GAS DRY DEPOSITION Data Provided.

 **Model Uses RURAL Dispersion Only.

 **Model Uses Regulatory DEFAULT Options:
           1. Stack-tip Downwash.
           2. Model Accounts for ELEVated Terrain Effects.
           3. Use Calms Processing Routine.
           4. Use Missing Data Processing Routine.
           5. "Upper Bound" Values for Supersquat Buildings.
           6. No Exponential Decay

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates ANNUAL Averages Only

 **This Run Includes:     7 Source(s);      1 Source Group(s); and    4980 Receptor(s)

 **The Model Assumes A Pollutant Type of:  FORMALDE

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
         Model Outputs Tables of ANNUAL Averages by Receptor
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours
```

F.2 Example of AERMOD Output Files: Formaldehyde (Continued)

```
 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     9.00 ;  Decay Coef. =       0.0000 ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                              ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.4 MB of RAM.

 **Input Runstream File:          C:\KCS\AERMOD\NE_RUN1_FORMALDE.DAT
 **Output Print File:             C:\KCS\AERMOD\NE_RUN1_FORMALDE.LST


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:38
 **MODELOPTs:                                                                                                      PAGE   2
 CONC                        DFAULT ELEV


                                                *** POINT SOURCE DATA ***

                NUMBER EMISSION RATE                          BASE     STACK    STACK     STACK     STACK    BUILDING  URBAN  EMISSION RATE
   SOURCE        PART.  (GRAMS/SEC)      X          Y        ELEV.    HEIGHT   TEMP.    EXIT VEL. DIAMETER  EXISTS    SOURCE SCALAR VARY
    ID           CATS.                (METERS)   (METERS)  (METERS) (METERS) (DEG.K)  (M/SEC)   (METERS)                      BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC60         0   0.00000E+00  571024.8 4520821.5    41.0     19.81    300.37     3.73      0.03      NO        NO
   SRC61         0   0.00000E+00  571024.8 4520802.5    40.0     19.81    313.15     1.63      0.05      NO        NO
   SRC62         0   0.00000E+00  571024.8 4520784.0    40.0      3.05    294.26     0.19      2.03      NO        NO
   SRC63         0   0.00000E+00  571024.8 4520764.0    39.0     36.58    294.26     0.44      2.03      NO        NO
   SRC64         0   0.00000E+00  571124.6 4520772.5    40.0     13.72    281.48    10.25      0.03      NO        NO
   SRC65         0   0.30000E-02  571124.6 4520755.5    40.0      6.10    294.26     0.06      1.02      NO        NO
```

F.2 Example of AERMOD Output Files: Formaldehyde (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                          ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                   ***        10:44:38
 **MODELOPTs:                                                                                             PAGE   3
 CONC                         DFAULT ELEV


                                                *** VOLUME SOURCE DATA ***

             NUMBER EMISSION RATE                      BASE    RELEASE    INIT.    INIT.   URBAN  EMISSION RATE
    SOURCE    PART.  (GRAMS/SEC)     X         Y      ELEV.   HEIGHT      SY       SZ     SOURCE  SCALAR VARY
     ID       CATS.                (METERS)  (METERS) (METERS) (METERS)  (METERS) (METERS)            BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC144        0   0.00000E+00  571072.9 4520765.5    40.0     3.00     62.00     2.79     NO


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                          ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                   ***        10:44:38
 **MODELOPTs:                                                                                             PAGE   4
 CONC                         DFAULT ELEV


                                           *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                                SOURCE IDs


  ALL       SRC60    , SRC61    , SRC62    , SRC63    , SRC64    , SRC65    , SRC144   ,
```

(NOTE: Pages 5 - 125 have been omitted for brevity.)

F.2 Example of AERMOD Output Files: Formaldehyde (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:44
 **MODELOPTs:                                                                                                      PAGE 126
 CONC                         DFAULT ELEV

                                          *** THE SUMMARY OF MAXIMUM ANNUAL (   5 YRS) RESULTS ***


                                       ** CONC OF FORMALDE IN MICROGRAMS/M**3                        **

                                                                                                        NETWORK
 GROUP ID                        AVERAGE CONC                RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 ALL      1ST HIGHEST VALUE IS       0.09560 AT (  571172.19,  4520842.00,     40.44,     40.44,      0.00)  DC
          2ND HIGHEST VALUE IS       0.08958 AT (  571197.75,  4520826.50,     39.91,     39.91,      0.00)  DC
          3RD HIGHEST VALUE IS       0.08717 AT (  571155.12,  4520852.50,     40.88,     40.88,      0.00)  DC
          4TH HIGHEST VALUE IS       0.07639 AT (  571214.81,  4520816.00,     39.40,     39.40,      0.00)  DC
          5TH HIGHEST VALUE IS       0.06695 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          6TH HIGHEST VALUE IS       0.06695 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          7TH HIGHEST VALUE IS       0.05550 AT (  571240.44,  4520800.00,     38.74,     38.74,      0.00)  DC
          8TH HIGHEST VALUE IS       0.05416 AT (  571112.44,  4520878.50,     41.50,     41.50,      0.00)  DC
          9TH HIGHEST VALUE IS       0.04435 AT (  571257.50,  4520790.00,     38.63,     38.63,      0.00)  DC
         10TH HIGHEST VALUE IS       0.04013 AT (  571124.69,  4520902.50,     40.63,     40.63,      0.00)  DC


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
```

F.2 Example of AERMOD Output Files: Formaldehyde (Continued)

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                             ***        10:44:44
 **MODELOPTs:                                                                                      PAGE 127
 CONC                         DFAULT ELEV


 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            7 Warning Message(s)
 A Total of         1153 Informational Message(s)

 A Total of          935 Calm Hours Identified

 A Total of          218 Missing Hours Identified (  0.50 Percent)

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

F.3 Example of AERMOD Output Files: Methylene chloride

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                     PAGE   1
 CONC                         DFAULT ELEV

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **Model Uses NO DRY DEPLETION.  DDPLETE =  F
 **Model Uses NO WET DEPLETION.  WDPLETE =  F
 **NO GAS DRY DEPOSITION Data Provided.

 **Model Uses RURAL Dispersion Only.

 **Model Uses Regulatory DEFAULT Options:
           1. Stack-tip Downwash.
           2. Model Accounts for ELEVated Terrain Effects.
           3. Use Calms Processing Routine.
           4. Use Missing Data Processing Routine.
           5. "Upper Bound" Values for Supersquat Buildings.
           6. No Exponential Decay

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates ANNUAL Averages Only

 **This Run Includes:     7 Source(s);      1 Source Group(s); and    4980 Receptor(s)

 **The Model Assumes A Pollutant Type of:  METHYLEN

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
          Model Outputs Tables of ANNUAL Averages by Receptor
          Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours
```

F.3 Example of AERMOD Output Files: Methylene chloride (Continued)

```
 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     9.00 ;  Decay Coef. =       0.0000 ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                              ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.4 MB of RAM.

 **Input Runstream File:          C:\KCS\AERMOD\NE_RUN1_METHYLEN.DAT
 **Output Print File:             C:\KCS\AERMOD\NE_RUN1_METHYLEN.LST


1 *** AERMOD - VERSION 04300 ***    ***  North Essex                                                    ***        12/16/05
                                    ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                     PAGE   2
 CONC                        DFAULT ELEV


                                                *** POINT SOURCE DATA ***

            NUMBER EMISSION RATE                          BASE     STACK    STACK     STACK     STACK    BUILDING  URBAN  EMISSION RATE
   SOURCE    PART.  (GRAMS/SEC)      X          Y         ELEV.    HEIGHT   TEMP.    EXIT VEL. DIAMETER   EXISTS   SOURCE  SCALAR VARY
    ID       CATS.                 (METERS)   (METERS)  (METERS) (METERS) (DEG.K)   (M/SEC)   (METERS)                        BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC60        0   0.00000E+00  571024.8 4520821.5    41.0     19.81    300.37     3.73      0.03      NO       NO
   SRC61        0   0.00000E+00  571024.8 4520802.5    40.0     19.81    313.15     1.63      0.05      NO       NO
   SRC62        0   0.00000E+00  571024.8 4520784.0    40.0      3.05    294.26     0.19      2.03      NO       NO
   SRC63        0   0.00000E+00  571024.8 4520764.0    39.0     36.58    294.26     0.44      2.03      NO       NO
   SRC64        0   0.00000E+00  571124.6 4520772.5    40.0     13.72    281.48    10.25      0.03      NO       NO
   SRC65        0   0.00000E+00  571124.6 4520755.5    40.0      6.10    294.26     0.06      1.02      NO       NO
```

F.3 Example of AERMOD Output Files: Methylene chloride (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                      PAGE   3
 CONC                         DFAULT ELEV


                                                    *** VOLUME SOURCE DATA ***

             NUMBER EMISSION RATE                          BASE    RELEASE    INIT.    INIT.   URBAN  EMISSION RATE
    SOURCE    PART.  (GRAMS/SEC)     X         Y          ELEV.   HEIGHT     SY       SZ      SOURCE  SCALAR VARY
     ID       CATS.                (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)          BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC144        0   0.18000E+00  571072.9 4520765.5    40.0      3.00     62.00     2.79     NO


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                      PAGE   4
 CONC                         DFAULT ELEV


                                                *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                                    SOURCE IDs


  ALL       SRC60    , SRC61    , SRC62    , SRC63    , SRC64    , SRC65    , SRC144   ,
```

(NOTE: Pages 5 - 125 have been omitted for brevity.)

F.3 Example of AERMOD Output Files: Methylene chloride (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                          ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                   ***        10:44:44
 **MODELOPTs:                                                                                             PAGE 126
 CONC                        DFAULT ELEV

                                        *** THE SUMMARY OF MAXIMUM ANNUAL (   5 YRS) RESULTS ***


                                     ** CONC OF METHYLEN IN MICROGRAMS/M**3                        **

                                                                                                    NETWORK
 GROUP ID                       AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 ALL      1ST HIGHEST VALUE IS      2.03936 AT (  571124.69,  4520902.50,     40.63,     40.63,      0.00)  DC
          2ND HIGHEST VALUE IS      1.90069 AT (  571197.75,  4520826.50,     39.91,     39.91,      0.00)  DC
          3RD HIGHEST VALUE IS      1.88924 AT (  571214.81,  4520816.00,     39.40,     39.40,      0.00)  DC
          4TH HIGHEST VALUE IS      1.82608 AT (  571069.81,  4520904.50,     40.02,     41.76,      0.00)  DC
          5TH HIGHEST VALUE IS      1.73331 AT (  571044.19,  4520920.00,     37.87,     39.32,      0.00)  DC
          6TH HIGHEST VALUE IS      1.62021 AT (  571240.44,  4520800.00,     38.74,     38.74,      0.00)  DC
          7TH HIGHEST VALUE IS      1.55944 AT (  571027.12,  4520930.50,     36.86,     36.86,      0.00)  DC
          8TH HIGHEST VALUE IS      1.53928 AT (  570940.50,  4520829.00,     36.32,     36.32,      0.00)  DC
          9TH HIGHEST VALUE IS      1.52928 AT (  570937.94,  4520809.50,     36.16,     36.16,      0.00)  DC
         10TH HIGHEST VALUE IS      1.49279 AT (  570934.12,  4520779.50,     36.10,     36.10,      0.00)  DC


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
```

F.3 Example of AERMOD Output Files: Methylene chloride (Continued)

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                             ***        10:44:44
 **MODELOPTs:                                                                                      PAGE 127
 CONC                         DFAULT ELEV


 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            7 Warning Message(s)
 A Total of         1153 Informational Message(s)

 A Total of          935 Calm Hours Identified

 A Total of          218 Missing Hours Identified (  0.50 Percent)

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

F.4 Example of AERMOD Output Files: Methyl hydrazine

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                     PAGE   1
 CONC                         DFAULT ELEV

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **Model Uses NO DRY DEPLETION.  DDPLETE =  F
 **Model Uses NO WET DEPLETION.  WDPLETE =  F
 **NO GAS DRY DEPOSITION Data Provided.

 **Model Uses RURAL Dispersion Only.

 **Model Uses Regulatory DEFAULT Options:
           1. Stack-tip Downwash.
           2. Model Accounts for ELEVated Terrain Effects.
           3. Use Calms Processing Routine.
           4. Use Missing Data Processing Routine.
           5. "Upper Bound" Values for Supersquat Buildings.
           6. No Exponential Decay

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates ANNUAL Averages Only

 **This Run Includes:     7 Source(s);      1 Source Group(s); and    4980 Receptor(s)

 **The Model Assumes A Pollutant Type of:  METHYL_H

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
         Model Outputs Tables of ANNUAL Averages by Receptor
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours
```

F.4 Example of AERMOD Output Files: Methyl hydrazine (Continued)

```
 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     9.00 ;  Decay Coef. =       0.0000 ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                             ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.4 MB of RAM.

 **Input Runstream File:          C:\KCS\AERMOD\NE_RUN1_METHYL_H.DAT
 **Output Print File:             C:\KCS\AERMOD\NE_RUN1_METHYL_H.LST

1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                      PAGE   2
 CONC                        DFAULT ELEV
```

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	URBAN SOURCE	EMISSION RATE SCALAR VARY BY
SRC60	0	0.00000E+00	571024.8	4520821.5	41.0	19.81	300.37	3.73	0.03	NO	NO	
SRC61	0	0.00000E+00	571024.8	4520802.5	40.0	19.81	313.15	1.63	0.05	NO	NO	
SRC62	0	0.00000E+00	571024.8	4520784.0	40.0	3.05	294.26	0.19	2.03	NO	NO	
SRC63	0	0.00000E+00	571024.8	4520764.0	39.0	36.58	294.26	0.44	2.03	NO	NO	
SRC64	0	0.00000E+00	571124.6	4520772.5	40.0	13.72	281.48	10.25	0.03	NO	NO	
SRC65	0	0.12000E-03	571124.6	4520755.5	40.0	6.10	294.26	0.06	1.02	NO	NO	

F.4 Example of AERMOD Output Files: Methyl hydrazine (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                      PAGE   3
 CONC                         DFAULT ELEV


                                                *** VOLUME SOURCE DATA ***

             NUMBER EMISSION RATE                          BASE    RELEASE    INIT.    INIT.   URBAN  EMISSION RATE
    SOURCE    PART.  (GRAMS/SEC)     X         Y          ELEV.   HEIGHT     SY       SZ      SOURCE  SCALAR VARY
     ID       CATS.                (METERS)  (METERS)  (METERS)  (METERS)  (METERS)  (METERS)          BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC144        0   0.00000E+00  571072.9 4520765.5    40.0      3.00     62.00     2.79      NO


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:40
 **MODELOPTs:                                                                                                      PAGE   4
 CONC                         DFAULT ELEV


                                           *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                                SOURCE IDs


  ALL       SRC60    , SRC61    , SRC62    , SRC63    , SRC64    , SRC65    , SRC144   ,
```

(NOTE: Pages 5 - 125 have been omitted for brevity.)

F.4 Example of AERMOD Output Files: Methyl hydrazine (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                          ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                   ***        10:44:44
 **MODELOPTs:                                                                                             PAGE 126
 CONC                        DFAULT ELEV

                                        *** THE SUMMARY OF MAXIMUM ANNUAL (   5 YRS) RESULTS ***


                                     ** CONC OF METHYL_H IN MICROGRAMS/M**3                      **

                                                                                                    NETWORK
 GROUP ID                        AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 ALL      1ST HIGHEST VALUE IS       0.00382 AT (  571172.19,  4520842.00,     40.44,     40.44,      0.00)  DC
          2ND HIGHEST VALUE IS       0.00358 AT (  571197.75,  4520826.50,     39.91,     39.91,      0.00)  DC
          3RD HIGHEST VALUE IS       0.00349 AT (  571155.12,  4520852.50,     40.88,     40.88,      0.00)  DC
          4TH HIGHEST VALUE IS       0.00306 AT (  571214.81,  4520816.00,     39.40,     39.40,      0.00)  DC
          5TH HIGHEST VALUE IS       0.00268 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          6TH HIGHEST VALUE IS       0.00268 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          7TH HIGHEST VALUE IS       0.00222 AT (  571240.44,  4520800.00,     38.74,     38.74,      0.00)  DC
          8TH HIGHEST VALUE IS       0.00217 AT (  571112.44,  4520878.50,     41.50,     41.50,      0.00)  DC
          9TH HIGHEST VALUE IS       0.00177 AT (  571257.50,  4520790.00,     38.63,     38.63,      0.00)  DC
         10TH HIGHEST VALUE IS       0.00161 AT (  571124.69,  4520902.50,     40.63,     40.63,      0.00)  DC


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
```

F.4 Example of AERMOD Output Files: Methyl hydrazine (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                             ***        10:44:44
 **MODELOPTs:                                                                                       PAGE 127
 CONC                        DFAULT ELEV


 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            7 Warning Message(s)
 A Total of         1153 Informational Message(s)

 A Total of          935 Calm Hours Identified

 A Total of          218 Missing Hours Identified (  0.50 Percent)

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

F.5 Example of AERMOD Output Files: Tetrahydrofuran

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                                             ***        10:44:42
 **MODELOPTs:                                                                                                     PAGE   1
 CONC                         DFAULT ELEV

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **Model Uses NO DRY DEPLETION.  DDPLETE =  F
 **Model Uses NO WET DEPLETION.  WDPLETE =  F
 **NO GAS DRY DEPOSITION Data Provided.

 **Model Uses RURAL Dispersion Only.

 **Model Uses Regulatory DEFAULT Options:
           1. Stack-tip Downwash.
           2. Model Accounts for ELEVated Terrain Effects.
           3. Use Calms Processing Routine.
           4. Use Missing Data Processing Routine.
           5. "Upper Bound" Values for Supersquat Buildings.
           6. No Exponential Decay

 **Model Assumes No FLAGPOLE Receptor Heights.

 **Model Calculates ANNUAL Averages Only

 **This Run Includes:     7 Source(s);      1 Source Group(s); and    4980 Receptor(s)

 **The Model Assumes A Pollutant Type of:  TETRAHYD

 **Model Set To Continue RUNning After the Setup Testing.

 **Output Options Selected:
          Model Outputs Tables of ANNUAL Averages by Receptor
          Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours
```

F.5 Example of AERMOD Output Files: Tetrahydrofuran (Continued)

```
 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     9.00 ;  Decay Coef. =       0.0000 ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                             ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =     1.4 MB of RAM.

 **Input Runstream File:          C:\KCS\AERMOD\NE_RUN1_TETRAHYD.DAT
 **Output Print File:             C:\KCS\AERMOD\NE_RUN1_TETRAHYD.LST


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:42
 **MODELOPTs:                                                                                                      PAGE   2
 CONC                        DFAULT ELEV


                                                *** POINT SOURCE DATA ***

            NUMBER EMISSION RATE                          BASE     STACK    STACK     STACK     STACK    BUILDING  URBAN  EMISSION RATE
   SOURCE    PART.  (GRAMS/SEC)      X          Y         ELEV.    HEIGHT   TEMP.    EXIT VEL. DIAMETER  EXISTS   SOURCE  SCALAR VARY
    ID       CATS.                 (METERS)   (METERS)  (METERS) (METERS) (DEG.K)  (M/SEC)   (METERS)                      BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC60        0   0.14000E-02  571024.8 4520821.5    41.0     19.81    300.37     3.73      0.03       NO       NO
   SRC61        0   0.00000E+00  571024.8 4520802.5    40.0     19.81    313.15     1.63      0.05       NO       NO
   SRC62        0   0.00000E+00  571024.8 4520784.0    40.0      3.05    294.26     0.19      2.03       NO       NO
   SRC63        0   0.00000E+00  571024.8 4520764.0    39.0     36.58    294.26     0.44      2.03       NO       NO
   SRC64        0   0.00000E+00  571124.6 4520772.5    40.0     13.72    281.48    10.25      0.03       NO       NO
   SRC65        0   0.17000E+00  571124.6 4520755.5    40.0      6.10    294.26     0.06      1.02       NO       NO
```

F.5 Example of AERMOD Output Files: Tetrahydrofuran (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:42
 **MODELOPTs:                                                                                                      PAGE   3
 CONC                         DFAULT ELEV


                                                  *** VOLUME SOURCE DATA ***

             NUMBER EMISSION RATE                          BASE    RELEASE    INIT.    INIT.   URBAN  EMISSION RATE
     SOURCE   PART.  (GRAMS/SEC)     X         Y          ELEV.   HEIGHT     SY       SZ      SOURCE  SCALAR VARY
      ID      CATS.                (METERS)  (METERS)  (METERS) (METERS)  (METERS) (METERS)            BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   SRC144        0   0.00000E+00  571072.9 4520765.5    40.0     3.00     62.00     2.79     NO


1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:42
 **MODELOPTs:                                                                                                      PAGE   4
 CONC                         DFAULT ELEV


                                              *** SOURCE IDs DEFINING SOURCE GROUPS ***

 GROUP ID                                                    SOURCE IDs


  ALL       SRC60    , SRC61    , SRC62    , SRC63    , SRC64    , SRC65    , SRC144   ,
```

(NOTE: Pages 5 - 125 have been omitted for brevity.)

F.5 Example of AERMOD Output Files: Tetrahydrofuran (Continued)

```
1 *** AERMOD - VERSION 04300 ***     ***  North Essex                                                    ***        12/16/05
                                     ***  Run 1: 16-DEC-2005                                             ***        10:44:44
 **MODELOPTs:                                                                                                      PAGE 126
 CONC                        DFAULT ELEV

                                        *** THE SUMMARY OF MAXIMUM ANNUAL (   5 YRS) RESULTS ***


                                     ** CONC OF TETRAHYD IN MICROGRAMS/M**3                        **

                                                                                                        NETWORK
 GROUP ID                        AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)   OF TYPE  GRID-ID
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 ALL      1ST HIGHEST VALUE IS       5.42555 AT (  571172.19,  4520842.00,     40.44,     40.44,      0.00)  DC
          2ND HIGHEST VALUE IS       5.08280 AT (  571197.75,  4520826.50,     39.91,     39.91,      0.00)  DC
          3RD HIGHEST VALUE IS       4.94930 AT (  571155.12,  4520852.50,     40.88,     40.88,      0.00)  DC
          4TH HIGHEST VALUE IS       4.33452 AT (  571214.81,  4520816.00,     39.40,     39.40,      0.00)  DC
          5TH HIGHEST VALUE IS       3.80536 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          6TH HIGHEST VALUE IS       3.80536 AT (  571129.50,  4520868.00,     41.48,     41.48,      0.00)  DC
          7TH HIGHEST VALUE IS       3.14955 AT (  571240.44,  4520800.00,     38.74,     38.74,      0.00)  DC
          8TH HIGHEST VALUE IS       3.08080 AT (  571112.44,  4520878.50,     41.50,     41.50,      0.00)  DC
          9TH HIGHEST VALUE IS       2.51757 AT (  571257.50,  4520790.00,     38.63,     38.63,      0.00)  DC
         10TH HIGHEST VALUE IS       2.28576 AT (  571124.69,  4520902.50,     40.63,     40.63,      0.00)  DC


  *** RECEPTOR TYPES:  GC = GRIDCART
                       GP = GRIDPOLR
                       DC = DISCCART
                       DP = DISCPOLR
```

F.5 Example of AERMOD Output Files: Tetrahydrofuran (Continued)

```
1 *** AERMOD - VERSION 04300 ***     *** North Essex                                    ***        12/16/05
                                     *** Run 1: 16-DEC-2005                             ***        10:44:44
 **MODELOPTs:                                                                                      PAGE 127
 CONC                          DFAULT ELEV


 *** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            7 Warning Message(s)
 A Total of         1153 Informational Message(s)

 A Total of          935 Calm Hours Identified

 A Total of          218 Missing Hours Identified (  0.50 Percent)

    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

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