United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

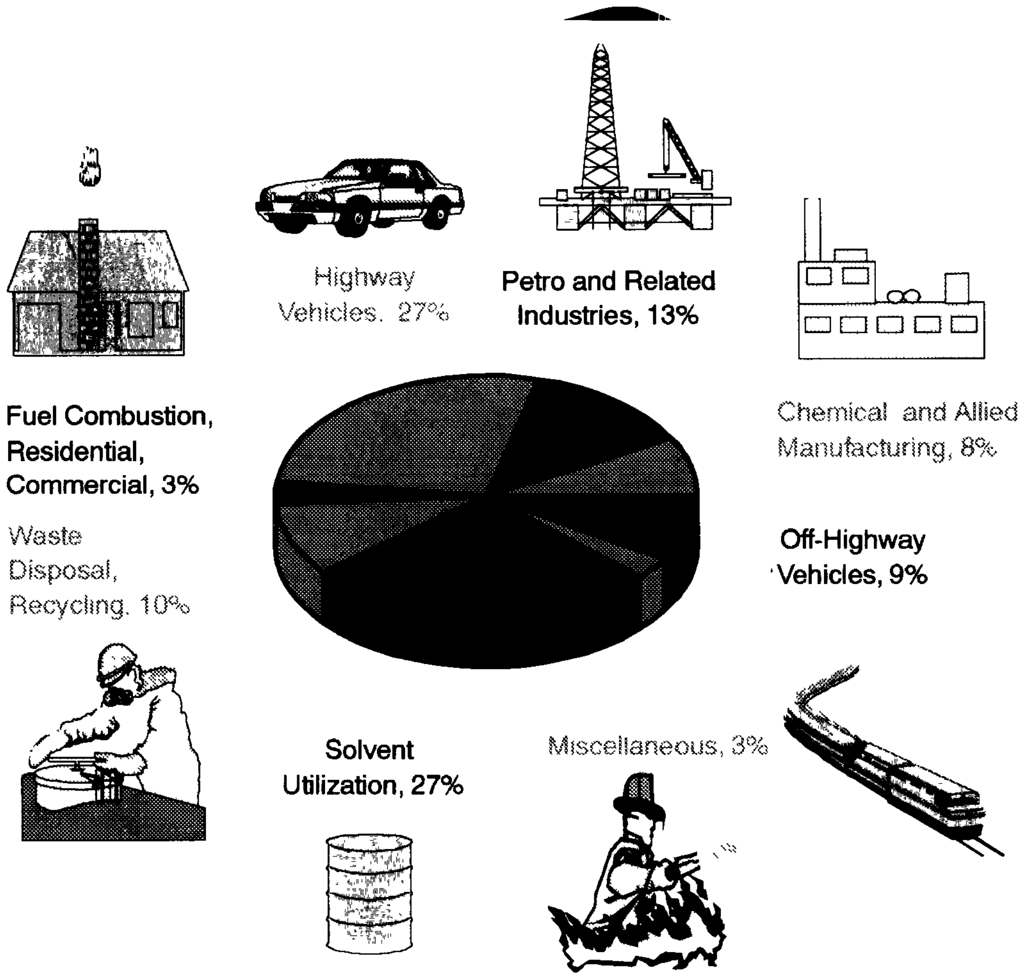
EPA-454/R-93-032
October 1993

Air

EPA

NATIONAL AIR POLLUTANT EMISSION TRENDS, 1900 - 1992

1992 VOC EMISSIONS BY SOURCE
22.7 MILLION SHORT TONS



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National Air Pollutant Emission Trends

1900 — 1992

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Publication No. EPA-454/R-93-032

FOREWORD

This document presents the most recent estimates of national and regional emissions of the criteria air pollutants. The emissions of each pollutant are estimated for many different source categories, which collectively account for all anthropogenic emissions. The report presents the total emissions from all 50 States and from each EPA region in the country. These estimates are updated annually.

This report is the third in a series that will track the changes in national emissions since passage of the Clean Air Act Amendments of 1990. The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities that cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. These reports will serve as a measure of our nation's progress in reducing air pollution emissions as a result of mandatory and voluntary controls and of continuous changes in national activity.

This report also reflects recent improvements in the way national and regional emissions are calculated. Improvement in estimation methods is an on-going effort, and it is expected that future reports will reflect this effort. Revisions to the *National Air Pollutant Emission Trends, 1900-1992,* (hereinafter referred to as *"Trends")* methodology include a change in the method used to estimate pre- and post-1985 emissions, incorporation of state-derived emission estimates, use of certain years for trends only, and use of other years as both trend and absolute indicators. Further details of these methodological changes are described in section 5 of this report. This year's report has limited coverage of biogenic, global warming gas, toxic, and international emissions. Preliminary estimates are presented for the years 1990 through 1992. Final estimates (including refinements to the data used to estimate emissions) will be presented in future reports.

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TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AFS	AIRS Facility Subsystem
AIRS	Aerometric Information Retrieval System
AMS	AIRS Area/Mobile Source Subsystem
ARCINFO	name of commercial Graphical Interface System (GIS) product
BEA	Bureau of Economic Analysis
CAAA	Clean Air Act Amendments
CCT	Clean Coal Technology
CE	control efficiency
CEC	European Commission
CEFIC	Conseil European de l'Industrie Chimique (European Chemical Industry Council)
CEUM	Coal and Electric Utility Model
CH_4	methane
CITEPA	Centre Interprofessionnel Technique d'Etudes de la Polution Atmopherique (currently, the main contractor for the CORINAIR program)
CO	carbon monoxide
CO_2	carbon dioxide
CORINAIR	CORINE AIR
CORINE	COoRdination d'INformation Environnementale
DGXI	Directorate General Environment, Nuclear Safety and Civil Protection
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
E-GAS	Economic Growth Analysis System
EEA	European Environment Agency
EFTA	European Free Trade Association
EIA	Energy Information Administration
EIB	Emission Inventory Branch
EMFAC7F	California on-road motor vehicle emission factor model
EPA	Environmental Protection Agency
ERCAM	Emission Reduction and Cost Analysis Model
EUROTRAC	EUROpean experiment on TRAnsport and transformation of environmentally relevant trace Constituents in the troposphere over Europe (a scientific research program)
FCCC	Framework Convention on Climate Change
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FTP	Federal Test Procedure
HAPs	hazardous air pollutants
HDDV	heavy-duty diesel vehicle
HDGV	heavy-duty gasoline vehicle

HPMS	Highway Performance Monitoring System
I/M	inspection and maintenance
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
LDDT	light-duty diesel truck
LDDV	light-duty diesel vehicle
LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LRTAP	long range transboundary air pollution
MC	motorcycle
MOBILE5	EPA's mobile source emission factor model
MVMA	Motor Vehicle Manufacturers Association
NAAQS	National Ambient Air Quality Standards
NACE	nomenclature generale des activites economiques de la Communaute europeenne
NADB	National Allowance Data Base
NAPAP	National Acid Precipitation Assessment Program
NCAR	National Center for Atmospheric Research
n.e.c.	not elsewhere classified
NEDS	National Emissions Data System
NESHAP	National Emission Standard for Hazardous Air Pollutants
NMHC	nonmethane hydrocarbons
NMOG	nonmethane organic gases
NMVOC	nonmethane VOC
NO_x	nitrogen oxides
NSPS	New Source Performance Standards
NSTU	Nomenclature of Statistical Territorial Units
OECD	Organisation for Economic Cooperation and Development
OMS	Office of Mobile Sources
Pb	lead
PHOXA	PHotochemical OXidants study (a scientific research program)
PM-10	particulate matter less than ten microns in aerodynamic diameter
POTW	publicly owned treatment works
QA/QC	quality assurance/quality control
RE	rule effectiveness
RIA	Regulatory Impact Analysis
ROM	Regional Oxidant Model
RVP	Reid vapor pressure
SCC	Source Classification Code
SEDS	State Energy Data System
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SO_2	sulfur dioxide
SRAB	Source Receptor Analysis Branch

TF	task force
TP	total particulates
tpy	tons per year
TRI	Toxic Release Inventory
TSDF	treatment storage and disposal facility
UAM	Urban Airshed Model
UNECE	United Nations Economic Commission for Europe
UNICE	UNion des Confederations de l'Industrie et des employeurs d'Europe (union of industrial and employers' confederations of Europe)
VMT	vehicle miles traveled
VOC	volatile organic compounds

ACKNOWLEDGEMENT

This report was prepared with the help of many people. The EPA wishes to acknowledge the assistance of Sharon Nizich, David Misenheimer, and David Mobley of the Emission Inventory Branch, as well as staff at E.H. Pechan & Associates, who assisted in preparing the emission estimates and producing this report: William Barnard, Andrew Bollman, Kirstin Brust, Patricia Carlson, Allan Dean, Michiel Doorn, Gerhard Gschwandtner, Diane Linderman, Teresa Lynch, Kathleen Manwaring, and Charles Monroe (Durham, North Carolina), and Janice Chen, Dianne Crocker, Maureen Mullen, Edward Pechan, Susan Rothschild, James Schornagel, Martha Schultz, Douglas Solomon, Gregory Stella, James Wilson, and Michael Wimberly (Springfield, Virginia). Appreciation is also extended to Laurel Schultz, William Frietsche, Dat Giap, Evelyn Sue Kimbrough, and Charles Mann of EPA in preparation of past *Trends* reports. The agency also wishes to acknowledge the data and information that were provided by numerous people from Government agencies and private institutions and organizations.

EXECUTIVE SUMMARY

This report presents the U.S. Environmental Protection Agency's (EPA) latest estimates of national and regional emissions for criteria air pollutants:[a] carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_x), fine particulate matter less than ten microns (PM-10), sulfur dioxide (SO_2), total particulate matter [TP (only in Appendix C)] and reactive volatile organic compounds (VOC). Estimates are presented for the years 1900 to 1992, with increasing detail in more recent years.

National emissions are estimated annually by the U.S. EPA based on statistical information about each source category, emission factor, and control efficiency. The estimates are made for over 450 individual source categories that include all major sources of anthropogenic emissions for the years 1900 through 1984.

> Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Differences in methodologies for allocating emissions among source categories could result in significant changes in the emission estimates, particularly at the more detailed source category level. <u>CAUTION SHOULD BE EXERCISED WHEN COMPARING TRENDS FOR TOTALS OF PRE- AND POST-1985 VALUES</u>.

Starting with 1985, the estimates are based on a modified National Acid Precipitation Assessment Program (NAPAP)[1] methodology. This will allow for the inclusion of emissions data compiled and submitted by individual state pollution control agencies. As these detailed source emissions data progressively replace the broader, economic-activity based emission estimates, the accuracy of the national and regional estimates should improve, but comparisons with previously published estimates must take into account this changing complexion of the data base. This change in methodology is only a *first* step, however, so caution should be used when using this report for comparative purposes. More details on the changing methodology are described in section 5. The emission estimates for individual source categories are aggregated to show the emission trends at the national and regional levels and by major source category.

ES.1 EMISSION SUMMARY

Table ES-1 and Figures ES-1 and ES-2 present national emissions of each pollutant in units of million tons[b] per year, except Pb, which is expressed in thousand tons per year. Table ES-1 shows emissions for every fifth year from 1900 to 1980, and for every year from 1982 to 1992. Table ES-2 shows the change in total national emissions of each pollutant since 1900, where available. The percentage change is shown for five time periods; 1900 to 1992, 1940 to 1992, 1970 to 1992, 1982 to 1992, and 1991 to 1992.

Since 1900[c], total national NO_x emissions have increased by 790 percent (approximately a factor of 9), SO_2 emission have increased approximately 130 percent, and VOC emissions have increased 195 percent. From 1970 to 1992, emissions of Pb show the greatest decrease (98 percent), followed by PM-10 [excluding fugitive dust (51 percent)], SO_2 (27 percent), CO (27 percent), and VOC (24 percent). NO_x emissions appear to have increased approximately 11 percent. Emissions of PM-10 and Pb show their greatest decrease in the 1970s, while emissions of the other pollutants show their greatest decrease in the 1980s.

The 1990, 1991, and 1992 emission estimates are preliminary and will be revised in the next report when final data from ozone State Implementation Plans (SIPs) are available. Using the methodology explained in section 5, it was estimated that from 1991 to 1992 coal consumption (a major source of SO_2) increased, as well as overall vehicular traffic (a major source of CO, NO_x, and VOC). Estimated industrial activity varied during this period; some source categories increased production, while others did not. Based on the preliminary emission estimates for 1992, Pb emissions have increased slightly from 1991, while emissions of all other pollutants have continued to decrease.

The following sections present a brief description of the changes in total national emissions of each pollutant from 1991 to 1992. Because of the small percentage change from 1991 to 1992, combined with the inherent error in the estimation procedure, the trend based on a 1-year change is not definitive. The data are presented in Table ES-1.

ES.2 EMISSIONS SUMMARY BY POLLUTANT

ES.2.1 Carbon Monoxide Emissions

Total national CO emissions in 1992 are estimated to be 87.18 million tons, as compared to 90.68 million tons in 1991. From 1991 to 1992, the total emissions from highway vehicles decreased by 3.54 million tons. This decrease is due in part to the replacement of older, less efficient automobiles with newer automobiles. CO emissions from residential wood combustion decreased by 0.42 million tons during this period.

ES.2.2 Nitrogen Oxide Emissions

Total national NO_x emissions in 1992 are estimated to be 23.15 million tons, as compared to 23.41 million tons in 1991. This change is due to a 3.08 percent decrease in NO_x emissions from highway vehicles as older, less efficient automobiles were replaced with newer automobiles. For the past 5 years, national emissions of NO_x have remained nearly constant despite increased vehicular traffic. As a point of comparison, the total national emissions in 1986 were 22.28 million tons.

ES.2.3 Reactive Volatile Organic Compound Emissions

Total VOC emissions in 1992 are estimated to be 22.73 million tons, as compared to 23.40 million tons in 1991. Highway vehicles continued to be a major source of VOC. Vehicle miles traveled (VMT) increased from 2,228 x 10^9 miles in 1991 to 2,272 x 10^9 miles traveled in 1992. As a result of continued replacement of older automobiles, total VOC emissions from gasoline-powered highway vehicles decreased by 11 percent from 1991 to 1992, according to EPA calculations.

The decrease in highway emissions from 1991 to 1992 was offset by an increase in off-highway emissions, from 2.06 million tons in 1991 to 2.13 million tons in 1992.

ES.2.4 Sulfur Dioxide Emissions

Total national emissions of SO_2 in 1992 are estimated to be 22.73 million tons, as compared to 22.77 million tons in 1991. The most significant changes in SO_2 emissions since 1991 appear to have occurred in the stationary fuel combustion sources (electric utilities, industrial, commercial/institutional, residential). Increased consumption of bituminous coal by electric utilities and industrial boilers in 1992 was negated by the decreased usage of other fuels (subbituminous coal, oil, gas) which yielded a net decrease in emissions from stationary fuel combustion sources.

ES.2.5 Lead Emissions

Total national lead emissions increased from 5.01 thousand tons in 1991 to 5.18 thousand tons in 1992. Historically, large decreases in lead emissions occurred prior to the 1980s after the introduction of unleaded gasoline. For example, in 1970, lead emissions from highway vehicles were 171.96 thousand tons, compared to 62.19 thousand tons in 1980. In contrast, total emissions of lead from highway vehicles in 1992 were only 1.38 thousand tons, a drop from the 1.52 thousand tons emitted from highway vehicles in 1991. The modest overall increase in lead emissions from 1991 to 1992 is related to general economic growth.

ES.2.6 Particulate Matter Emissions

Total national emissions of PM-10 from point and fugitive process sources are estimated to be 5.93 million tons in 1992. (Point and fugitive process source categories include all source categories except fugitive dust sources.) After fugitive dust, industrial processes are the largest contributor to emissions of PM-10. In 1991, industrial processes contributed 1.87 million tons, as compared to 1.94 million tons in 1992. The net effect of these changes was an increase in total national emissions of approximately 0.12 thousand tons from point and fugitive process sources.

Total national fugitive dust PM-10 emissions in 1992 are estimated to be 45.50 million tons, which is about 8 times the total emissions from point and fugitive process sources. The total PM-10 emissions from fugitive dust sources (agricultural tilling, construction, mining and quarrying, paved roads, unpaved roads, and wind erosion) for 1985 to 1992 ranges from 42.04 million tons in 1987 to 59.84 million tons in 1988. Decreased wind erosion is largely responsible for the decrease in total fugitive dust PM-10 emissions (49.54 to 45.50 million tons) from 1991 to 1992.

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[a] The Clean Air Act (CAA) requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards (NAAQS) are set at levels which, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. Regulated pollutants are therefore referred to as "criteria pollutants."

[b] Unless otherwise noted, all references to tons in this report are short tons.

[c] It should be noted that the historic emission estimates may not be as reliable as the more recent estimates as a result of increased uncertainty in early statistics and assumptions.

Table ES-1. Summary of of National Emission Estimates*

(million short tons)

YEAR	VOC	SO_2	NO_x	CO	PM-10	PM-10 (fugitive dust)**	Pb (thousand short tons)
1900***	7.76	9.99	2.61	NA	NA	NA	NA
1905***	8.12	13.96	3.31	NA	NA	NA	NA
1910***	8.40	17.28	4.10	NA	NA	NA	NA
1915***	9.05	20.29	4.67	NA	NA	NA	NA
1920***	9.29	21.14	5.16	NA	NA	NA	NA
1925***	13.36	23.26	7.30	NA	NA	NA	NA
1930***	18.32	21.11	8.02	NA	NA	NA	NA
1935***	16.20	16.98	6.64	NA	NA	NA	NA
1940	17.12	19.95	7.57	90.87	15.43	NA	NA
1945***	17.48	26.01	9.55	94.83	15.79	NA	NA
1950	20.86	22.38	10.40	98.79	16.16	NA	NA
1955***	22.18	20.88	11.56	101.28	15.03	NA	NA
1960	24.32	22.25	14.58	103.78	13.90	NA	NA
1965***	27.73	26.75	16.58	111.24	12.99	NA	NA
1970	29.74	31.33	20.86	118.70	12.08	NA	219.47
1975	25.14	28.12	22.30	102.11	7.25	NA	158.54
1980****	28.35	26.21	23.66	129.00	7.02	NA	74.96
1982	24.86	23.38	22.67	116.15	5.45	NA	57.67
1983	25.41	22.73	22.01	115.96	6.09	NA	49.23
1984	26.14	23.66	22.63	112.97	6.35	NA	42.22
1985	25.01	23.39	22.42	107.90	6.18	44.68	20.12
1986	25.35	22.48	22.28	104.89	5.81	49.90	7.30
1987	24.72	22.62	22.81	99.30	6.04	42.04	6.84
1988	25.02	23.09	23.63	99.07	6.44	59.84	6.46
1989	23.91	23.20	23.48	93.39	6.21	53.16	6.10
1990*****	23.67	22.82	23.56	92.38	6.08	44.77	5.63
1991*****	23.40	22.77	23.41	90.68	5.81	49.54	5.01
1992*****	22.73	22.73	23.15	87.18	5.93	45.50	5.18

NOTE(S):
- * NA denotes not available. 1.1 million short tons equals 1 million metric tons.
- ** Fugitive dust emissions not included in PM-10 estimates prior to 1985.
- *** NAPAP historical emissions[2,3]
- **** There is a change in methodology for determining highway vehicle and off-highway emission estimates.
- ***** 1990, 1991, and 1992 estimates are preliminary.

Table ES-2. Percent Change in National Emission Estimates*

Pollutant	1900 to 1992	1940 to 1992	1970 to 1992	1982 to 1992	1991 to 1992
VOC	193	33	-24	-2	-3
SO_2	128	14	-27	-1	-0
NO_x	787	206	11	0	-1
CO	NA	-4	-27	-29	-4
PM-10	NA	-62	-51	9	-7
Pb	NA	NA	-98	-52	3

NOTE(S): * NA denotes not available. 1992 estimates are preliminary; negative percent change indicates a decrease; PM-10 comparisons prior to 1991 are for nonfugitive dust emissions only.
There is a change in methodology for determining highway vehicle emission estimates in 1980.

Figure ES-1. Trend in National Emission Estimates, VOC, SO_2, NO_x, and PM-10

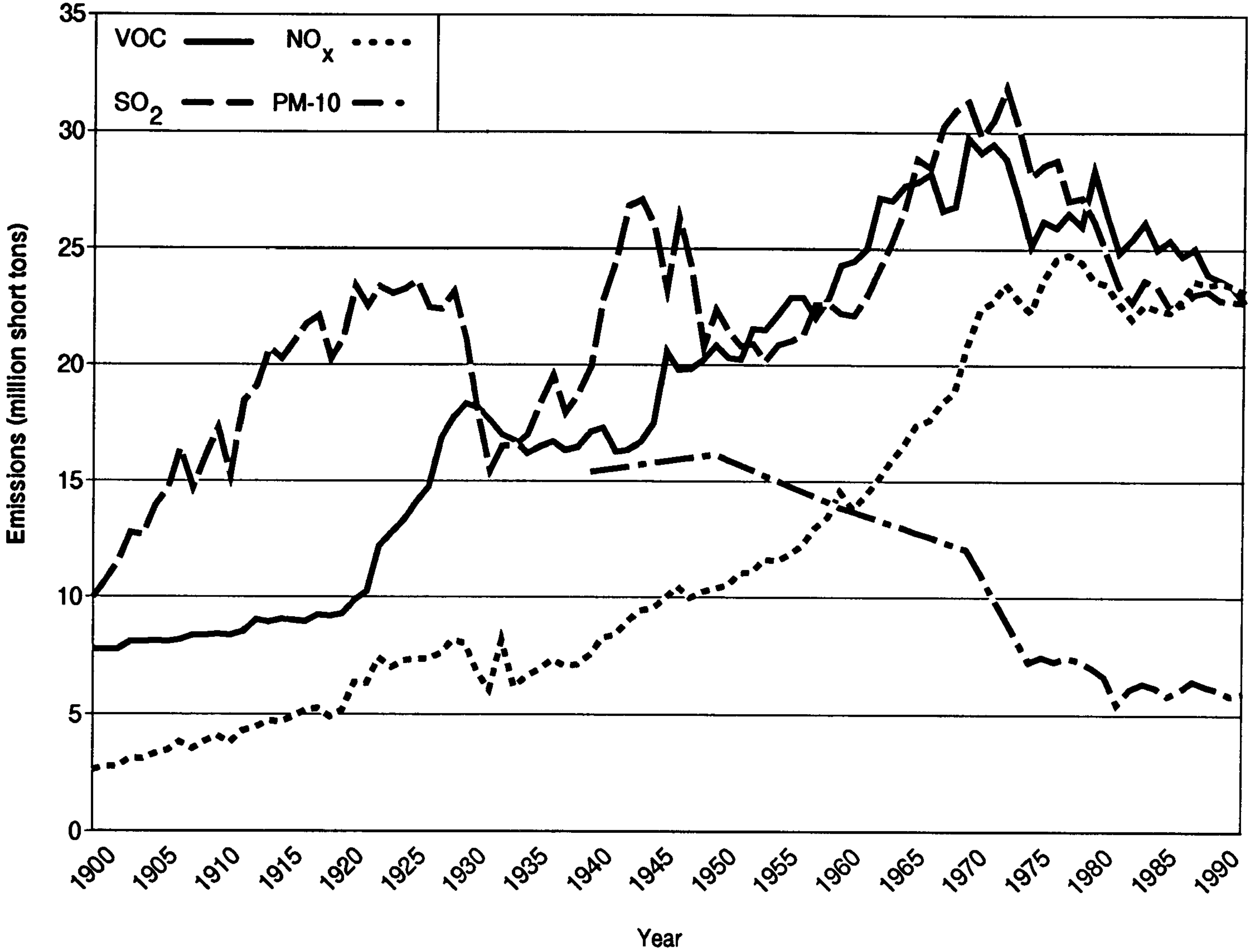
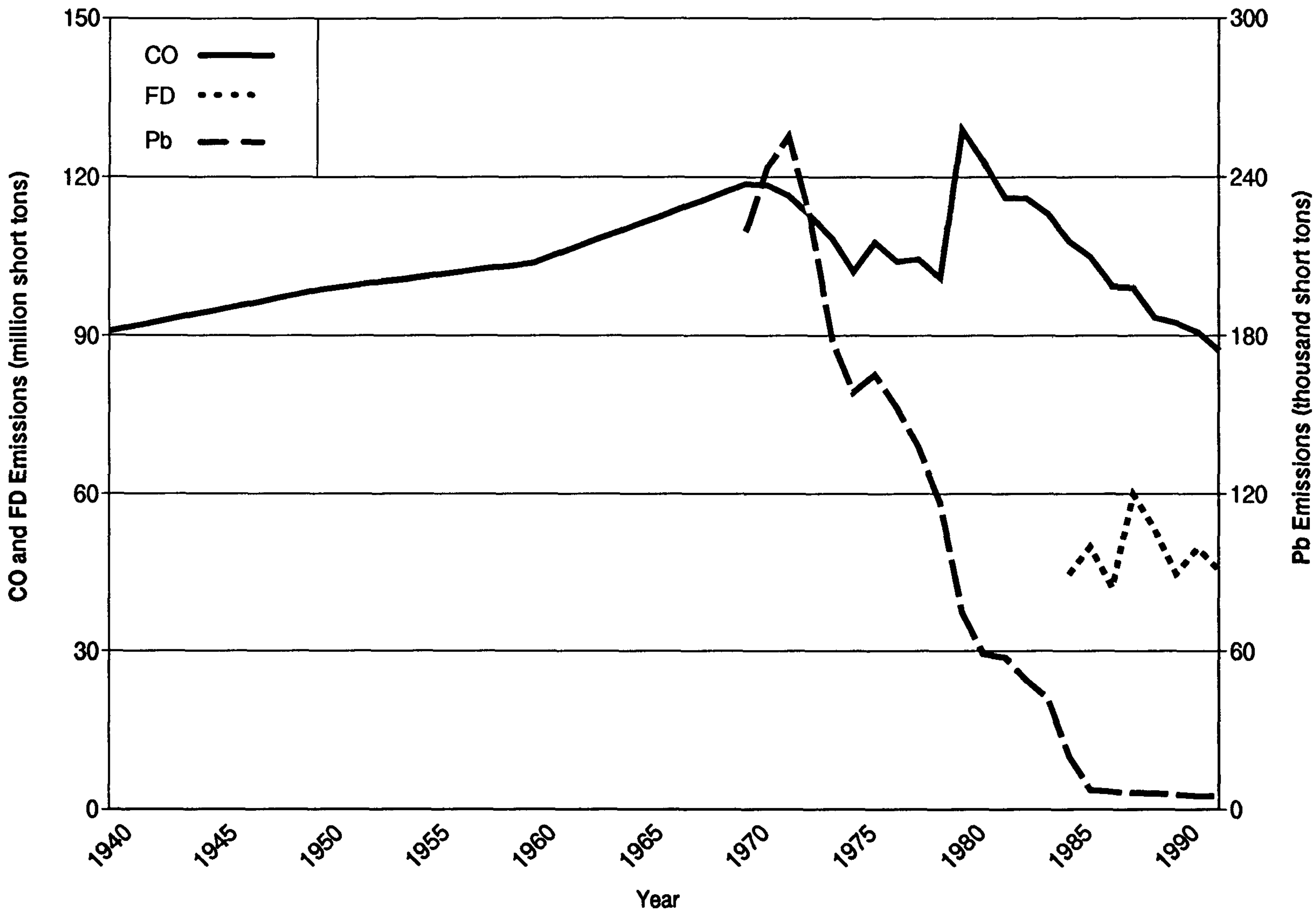


Figure ES-2. Trend in National Emission Estimates, CO*, FD, and Pb**



* The abrupt rise in emissions from 1979 to 1980 is due to changes in methods for calculating highway vehicle and off-highway emissions.

** FD = PM-10 fugitive dust emissions

SECTION 1.0

INTRODUCTION

This report presents the U.S. Environmental Protection Agency's (EPA) latest estimates of national and regional emissions for criteria air pollutants[d]: carbon monoxide (CO), lead (Pb), nitrogen oxides (NO_x), fine particulate matter less than ten microns (PM-10), sulfur dioxide (SO_2), total particulate matter [TP (only in Appendix C)], and reactive volatile organic compounds (VOC). Estimates are presented since 1900 with increasing detail in the later years.

This report contains information on the improved methodology for estimating emissions from 1985 to the present, and for calculating emissions from highway vehicles. A new set of categories is also being introduced in this year's report. The new methodology for estimating 1992 emissions allows emissions to be calculated by season as well as by state. International emissions from Europe and Canada are presented, as well as emissions from the Toxic Release Inventory (TRI). Finally, a phase-out of reporting TP emissions in favor of PM-10 has been initiated.

1.1 WHAT'S NEW

To date, each year the EPA has prepared national emission estimates for assessing historic trends in criteria pollutant emissions. While these estimates have been prepared using consistent methodologies and have been useful for evaluating emission changes from year to year, they have not provided an absolute indication of emissions for any given year. For this year's report, EPA set a goal of preparing emission trends that would also represent absolute emissions, particularly for the more recent years where better emissions data bases are available. To achieve this goal of absolute emissions, methodologies have been changed. The process is complex, however. A combination of methodologies has to be incorporated before the end result (one methodology) can be obtained. In this year's report, the reader will find four types of methodology covering four distinct periods : 1900 to 1939, 1940 to 1984, 1985, and 1986 to 1992 (see description of methods on the following page and in section 5). Since accuracy and availability of historical data is limited, this *Trends* report will not be revisiting the earlier years (pre-1970) through each year's analysis (some exceptions are discussed in section 5). However, numerous changes in current year totals will be apparent as state actual and state modeling data become available. Please note that methodologies within a given period will also vary, as more accurate data are loaded into the *Trends* data base.

States are currently finalizing a large emissions data base from calendar year 1990 to support Clean Air Act Amendments (CAAA) requirements for ozone and carbon monoxide nonattainment areas. Actions in revising the *Trends* methodology to achieve consistency with state emission inventories will be described in more detail in section 5. This change in methodology has allowed *Trends* to present emissions for the state and ozone nonattainment areas. It also allows for the display of emissions by season. This report will also expand its scope from national-level criteria pollutant emissions to international (Canadian and European), air toxics, and greenhouse gas emissions. *Trends* will also phase out the reporting of TP emissions, which will be replaced with PM-10, consistent with changes in the National Ambient Air Quality Standards (NAAQS).

1.1.1 Methodology Changes

Emission inventory data being submitted by the states in response to the CAAA will be used in numerous activities, one of which is modeling. The modeling community will incorporate emissions data into Regional Oxidant Model (ROM) and Urban Airshed Model (UAM) runs. Results obtained with urban models may be sensitive to assumptions made about pollution transported into the urban modeling domain. Thus, the EPA will be running the ROM to provide base and future year boundary conditions. For the base year, this entails multiple ROM runs covering approximately 180 episode days over a 5-year period (1987 to 1991). For the future base year modeling, the attainment years 1996, 1999, 2005, and 2007 will need to be modeled. To support the ROM runs, an emission inventory is needed for the regional modeling domain. Since the states are not required to develop or submit statewide emission inventories for all source categories, and since nonattainment area emission inventories are not required to be submitted and approved in a time frame to support the ROM runs, EPA developed *Regional Interim Emission Inventories (1987-1991), Volume I: Development Methodologies* (hereinafter referred to as "*Interim*")[4] for the 1987 to 1991 base years.

Within the current Aerometric Information Retrieval System (AIRS), the majority of the emissions data reported are for sources within a nonattainment area or for sources emitting greater than 100 tons per year, because this is the only information the states are required to report. However, for modeling analysis and trend evaluations, information on emissions from all sources (both within and outside of nonattainment areas) is required. Several projects are in progress or have been recently completed, that address parts of the problem described above. For instance, in an effort to compare inventories, a new listing of source categories (Tier 1) and subcategories (Tier 2) applicable to all criteria pollutants was developed. A third level of subcategories (Tier 3) that is pollutant specific was also developed, and Source Classification Codes (SCCs) were assigned to these subcategories. The Tier 1 and Tier 2 categories are listed in Table 1-1.

The U.S. EPA's Emission Inventory Branch (EIB) is developing procedures/criteria[5] for replacing *Interim* emissions data with ozone SIP-submitted data. Eventually, this will result in a 1990 Base Year Inventory that consists of state data for nonattainment areas and EPA-generated data for all other areas.

The EIB is also developing a data management and reporting system to manipulate the output from the above tasks. When all these tasks are completed, the EIB will be able to extract the most current state inventories from AIRS and supplement the gaps with EPA-generated attainment inventories. The EIB has already made several changes to the *Trends* methodology to make the transition smoother.

Efforts to revise the *Trends* methodology to achieve consistency with state emission inventories have begun by integrating the *Interim* methodology. The next step will be to integrate the state SIP emission inventories into *Trends*. In general, the *Trends* emissions will reflect the *Trends* methodology for 1900 through 1984, the 1985 National Acid Precipitation Assessment Program Emission Inventory (NAPAP)[1] methodology for 1985, and the *Interim* methodology for 1986 through 1992. Although there have been many changes to the *Trends* methodology, some methods have remained constant. For example, the 1900 through 1939 VOC, NO_x, and SO_2 emissions were extracted from the NAPAP historical emissions report.[2,3] In addition, all particulate and lead emissions (1940 to 1992), and all SO_2 (except 1980 electric utility emissions), NO_x, CO, and VOC emissions from 1940 to 1984 (except 1980 through 1984 transportation emissions) reported in *Trends* are based on the previous national "top-down" methodology. Section 5 describes modifications made to the previous *Trends*, 1985 NAPAP, and *Interim* Inventory methodologies to produce this report.

1.1.2 Highway Vehicle Emissions

The methodology for estimating highway vehicles has been modified from that used to produce previous estimates. The main differences are use of MOBILE5, inclusion of inspection and maintenance (I/M) programs, use of additional speed classes, and use of California's on-road motor vehicle emission factor model (to estimate California emissions). More details are described in section 5.

1.1.3 Temporal and Spatial Allocation

Starting with this year's report, state-level emissions for the current year are included. Multiple year trends will continue to be portrayed only at the regional and national levels. The trends in emissions will remain at the regional level for simplicity. Figure 1-1 is a map of the United States displaying the states in each U.S. EPA region. The top 30 plants in AIRS Facility Subsystem (AFS) are presented in section 2 for all six criteria pollutants.

Current year seasonal emissions for Tier 1 source categories will be presented beginning with this report.

1.1.4 Other Emission Inventories

In addition to presenting an update of the special biogenic VOC emission inventory reported in the last *Trends* report, greenhouse gas and air toxic emissions are presented. Emissions from Canada and Europe are also presented in this report.

1.1.5 Particulate Matter Emissions

On July 1, 1987, EPA published a final rule embodying an ambient air quality standard for PM-10 designed to replace the existing standard for particulates, commonly referred to as total particulate matter (TP). Starting with this year's report TP will be presented only in Appendix C. This report presents PM-10 emissions for years prior to 1985. These estimates are based on TP emissions and were developed by engineering judgment. The methodology is explained in section 5.

1.2 IN THIS REPORT

There have been some changes in the format of this year's report. These changes are intended to make the report more comprehensible and informative. The previous executive summary format has been divided into two parts: (1) the executive summary, which gives a quick look at the current year's emissions and (2) an introduction, section 1, which informs the reader of changes to the report and how the report is structured. Section 2 gives a detailed account of the current year emissions by pollutant, source category, state, nonattainment area, county, and season and by a listing of top-emitting facilities. Section 3 discusses the national trend in emissions from 1900 (where available) to the current year. (This section is a combination of last year's sections 2 and 5.) Section 4 presents the regional trends in emissions from 1985 through the current year. An explanation of the methodologies used to determine emissions for 1900 through 1939, 1940 through 1984, 1985, and 1986 through the current year is found in section 5. The seasonal and total emission projections for the nation are presented in section 6. (This section is a combination of last year's sections 6 and 7.) Section 7 presents biogenic emissions. Section 8 displays emission estimates from sources, noncriteria pollutants, or countries not traditionally part of the *Trends* report. These emissions were developed by EPA and other Government agencies.

As in last year's report, all emissions reported in tables and figures in the body of the report are in multiples of short tons. Tables and figures now appear at the end of each section in the order in which they are discussed. Appendix A contains tables for each of the criteria pollutants by Tier 3 source categories. If a zero is reported, the emissions are less than 0.5 thousand tons (or 0.5 tons for Pb). An "NA" means that the apportionment of the historic emission estimates to these subcategories was not possible. If a tier category does not appear, then emissions are not currently estimated for that category (either EPA thinks the emissions are zero or does not currently know how to estimate them with limited resources). The regional total emissions for each criteria pollutant are located in Appendix B. PM-10 fugitive dust emissions are also shown separately by region. Emissions of TP by Tier 3 source categories are presented in Appendix C. Some duplicate tables of the major source categories and subcategories for each criteria pollutant in metric tons are located in Appendix D of the report.

Emissions of NO_x are expressed as weight-equivalent nitrogen dioxide. Molecular weights associated with VOC emissions are more complex, since there is a wide range associated with the individual compounds emitted. Therefore, no equivalent molecular weight standard exists for VOC. The VOC emissions referred to in this report include reactive volatile organic compounds.

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[d] The Clean Air Act (CAA) requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and which are emitted from numerous and diverse stationary or mobile sources. For each pollutant, a "criteria" document must be compiled and published by the Administrator. The criteria are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards are set at levels which, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. Regulated pollutants are therefore referred to as "criteria pollutants."

Table 1-1. Major Source Categories

TIER 1	TIER 2
FUEL COMBUSTION-ELECTRIC UTILITIES	
	Coal
	Oil
	Gas
	Other
	Internal Combustion
FUEL COMBUSTION-INDUSTRIAL	
	Coal
	Oil
	Gas
	Other
	Internal Combustion
FUEL COMBUSTION-OTHER	
	Commercial / Institutional Coal
	Commercial / Institutional Oil
	Commercial / Institutional Gas
	Misc. Fuel Combustion (except residential)
	Residential Wood
	Residential Other
CHEMICAL & ALLIED PRODUCT MFG.	
	Organic Chemical Mfg.
	Inorganic Chemical Mfg.
	Polymer & Resin Mfg.
	Agricultural Chemical Mfg.
	Paint, Varnish, Lacquer, Enamel Mfg.
	Pharmaceutical Mfg.
	Other Chemical Mfg.
METALS PROCESSING	
	Nonferrous
	Ferrous
	Not elsewhere classified
PETROLEUM & RELATED INDUSTRIES	
	Oil & Gas Production
	Petroleum Refineries & Related Industries
	Asphalt Manufacturing
OTHER INDUSTRIAL PROCESSES	
	Agriculture, Food, & Kindred Products
	Textiles, Leather, & Apparel Products
	Wood, Pulp & Paper, & Publishing Products
	Rubber & Miscellaneous Plastic Products
	Mineral Products
	Machinery Products
	Electronic Equipment
	Transportation Equipment
	Construction
	Miscellaneous Industrial Processes
SOLVENT UTILIZATION	
	Degreasing
	Graphic Arts
	Dry Cleaning
	Surface Coating
	Other Industrial
	Nonindustrial

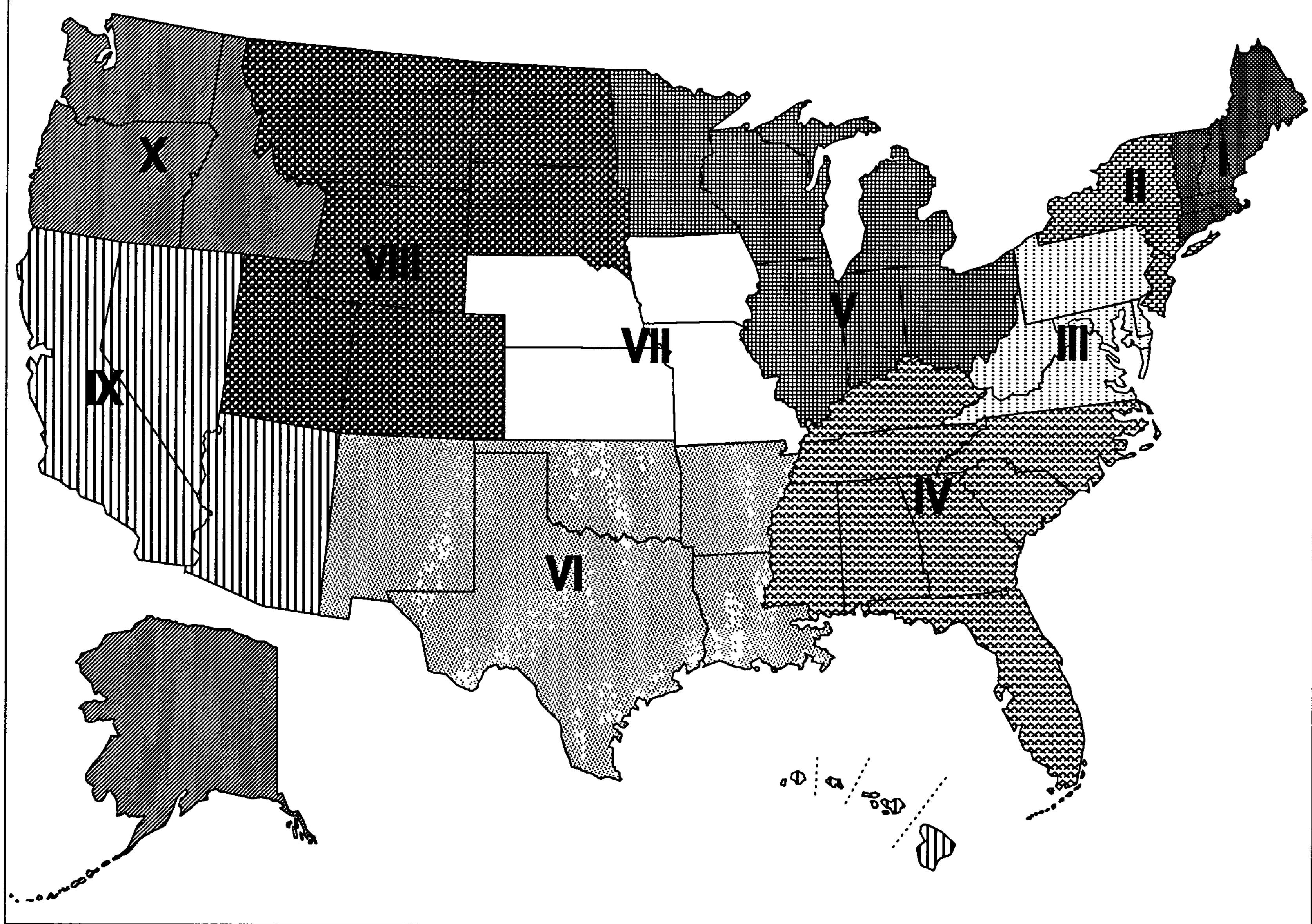
(continued)

Table 1-1 (continued)

TIER 1	TIER 2
STORAGE & TRANSPORT	
	Bulk Terminals & Plants
	Petroleum & Petroleum Product Storage
	Petroleum & Petroleum Product Transport
	Service Stations: Stage I
	Service Stations: Stage II
	Service Stations: Breathing & Emptying
	Organic Chemical Storage
	Organic Chemical Transport
	Inorganic Chemical Storage
	Inorganic Chemical Transport
	Bulk Materials Storage
	Bulk Materials Transport
WASTE DISPOSAL & RECYCLING	
	Incineration
	Open Burning
	Publicly owned treatment works
	Industrial Waste Water
	Treatment storage and disposal facility
	Landfills
	Other
HIGHWAY VEHICLES	
	Light-Duty Gas Vehicles & Motorcycles
	Light-Duty Gas Trucks
	Heavy-Duty Gas Vehicles
	Diesels
OFF-HIGHWAY	
	Nonroad Gasoline
	Nonroad Diesel
	Aircraft
	Marine Vessels
	Railroads
NATURAL SOURCES	
	Biogenic
	Geogenic
	Miscellaneous (lightning, freshwater, saltwater)
MISCELLANEOUS	
	Agriculture & Forestry
	Other Combustion (forest fires)
	Catastrophic / Accidental Releases
	Repair Shops
	Health Services
	Cooling Towers
	Fugitive Dust

NOTE(S): Refer to section 5.0 for a description of source categories. For the purposes of this report, forest fires are considered anthropogenic sources although some fires may be caused by nature.

Figure 1-1. EPA Administrative Regions



SECTION 2.0

SUMMARY OF 1992 EMISSIONS

Although the EPA has produced an annual estimate of emission trends since 1973, this report is the first in a series which will present emissions at the state, ozone nonattainment area, and seasonal level for CO, NO_x, VOC, and SO_2. There has also been a rearrangement of source categories. As a result of these changes, the report format has been changed. The more detailed information (state, county, nonattainment area, and seasonal emissions) will be presented for the current year of emissions. The source categories have changed from previous reports that stressed three major source categories (stationary fuel combustion, transportation, and industrial processes) to the tier structure of 14 major categories.

This report is the second in a series which will track the changes in the top-emitting sources of CO, NO_x, VOC, and SO_2 emissions and the first in a series which will track PM-10, Pb, and industrial SO_2. AIRS/AFS was used to determine the types of plants that emit large quantities of criteria pollutants. Emissions were extracted from AIRS/AFS using "Plant Emissions Report, AFP 634,"[11] excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error.

Note: Emission estimates used for this report were not quality assured/quality controlled (QA/QC) and represent the last year of update. When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change. Because these lists are based on several different extractions and some additional adjustments have been made, the data in tables in this report may not correspond precisely to the data currently in AIRS/AFS. However, this report has presented the top 30 sources based to the maximum extent possible, on AIRS/AFS.

The most common industries by pollutant contained in the list of top 30 emitting sources are defined in Table 2-1.

2.1 CARBON MONOXIDE EMISSIONS

The 1992 emissions of CO were calculated using one of three methodologies depending on the source category. All three methods are based on the *Interim* methodology (details are provided in section 5). Highway vehicle emissions for 1992 were estimated using the MOBILE5 emission factor model and VMT projected from the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS). The fossil-fuel steam electric utility emissions were derived by the same method as the 1991 electric utility emissions reported in the *Interim* report. Area source, solvents, and nonutility point emissions were projected from the 1990 *Interim* Inventory using the E-GAS model. By using this new methodology, *Trends* is now able to present CO emissions at the state, county, ozone nonattainment area, and seasonal levels.

2.1.1 Emissions by Source Category

As mentioned earlier, the source categories have changed from previous reports. There are now 14 first-level (Tier 1) categories. In Tier 1, the natural sources category contains minimal CO emissions and thus is not estimated for *Trends*. (Studies are currently underway, however, on isoprene oxidation, monoterpene, and other organic compound emissions.) Figure 2-1 presents a pie chart of the remaining 13 categories, three of which (solvent utilization, storage and transport, and electric utility fuel combustion) constitute less than 0.5 percent of the total and are combined with petroleum and related industries, industrial fuel combustion, other industrial processes, waste disposal and recycling, and chemical and allied chemical manufacturing in the "All Other" category. As the figure shows, highway vehicles are the major contributor to CO emissions. In 1992, they represented 63 percent of the total CO emissions. Of the total highway emissions, 69 percent are from light-duty gasoline-powered vehicles. Because there was a change of methodology (see section 5), motorcycle emissions are not estimated. The second major contributor to CO emissions are off-highway vehicles, which constitute approximately 17 percent of total CO emissions. These emissions result primarily from the gasoline consumption by construction, industrial and farm equipment, and recreational marine vessels. Table A-3, in Appendix A presents a complete breakdown of transportation emissions.

Table 2-2 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, constituted 93 percent of total CO emissions in 1992.

2.1.2 Spatial Emissions

The 1992 CO emissions were estimated at the county level and summed to the state level. These estimates are presented in Tables 2-3 and 2-4 and Figures 2-2 and 2-3.

2.1.2.1 State-level Emissions

Because the methodology for estimating emissions has changed for CO, the total state emissions can now be estimated. As mentioned earlier, these emissions are preliminary and may change in future reports. Table 2-3 presents the point, area, and total emissions estimated for each state in alphabetical order. Table 2-4 presents the same information, but in descending order by total emissions. The emissions for Alaska and Hawaii include only highway vehicle and fossil-fuel steam electric utility emissions. (A base year inventory similar to NAPAP was not available for these states.) The 10 States with the largest CO emissions in 1992 are presented in Figure 2-2. These States represent 48 percent of the total national CO emissions in 1992.

2.1.2.2 County-level Emissions

Figure 2-3 is a map of the 1992 CO emissions, in tons per square mile, for each county. As the map shows, the eastern third and west coast emit more CO than the western two-thirds of the continental United States.

2.1.3 Nonattainment Area vs. Total National Emissions

As a first step towards reporting nonattainment area emission estimates, Figure 2-4 presents a typical[c] serious and above ozone nonattainment area with 1992 CO emissions by major Tier 1 categories. The "All Other" category is defined in section 2.1.1. Figure 2-4 also presents a comparison between the 1992 CO typical serious and above ozone nonattainment area to the total national[f] Tier 1 major source category percentages. The ozone nonattainment emissions were determined by summing emissions from all counties in the three nonattainment areas. As shown in Figure 2-4, the nonattainment area percentages closely parallel the national percentages, with the exception of metals processing and off-highway sources, which constitute a larger percentage of the total emissions, and fuel combustion-other and miscellaneous (primarily forest fires) sources, which constitute a smaller percentage of the total emissions.

2.1.4 Emissions from Top 30 Emitters

This report is the second in a series which will track the top-emitting sources of CO. Figure 2-5 and Table 2-5 present the plant-level emissions of the top 30 largest point source emitters of CO. These emissions were extracted from AIRS/AFS using "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) The data presented in Table 2-5 and Figure 2-5 represent the latest updated year of record, as of November 19, 1993.

2.1.5 Seasonal Emissions

The seasonal emissions were estimated using three methodologies. Highway vehicle emissions were estimated for each month, and then summed to the four seasons. Electric utilities and area source emissions were temporally apportioned using state point and area factors obtained from the NAPAP methodology.[6] The point emissions were distributed to the seasons based on the 1985 NAPAP seasonal throughput percentages for each point. The seasons are defined as winter (December, January, February), spring (March, April, May), summer (June, July, August), and autumn (September, October, November).

As shown in Figure 2-6, most Tier 1 source categories emitted CO in approximately equal amounts all year, with three exceptions. The first exception is fuel combustion-other, which contributes 56 percent during the winter and only 2 percent in the summer. This difference is a result of more residential wood burning during the winter months. The second exception is off-highway sources, which emit less in the winter and more in the summer. The third exception is highway vehicles that emit greater amounts in cold weather (i.e., the winter).

2.2 NITROGEN OXIDE EMISSIONS

The 1992 emissions of NO_x were calculated using one of three methodologies, depending on the source category. All three methods are based on the *Interim* methodology (details are provided in section 5). Highway vehicle emissions for 1992 were estimated using the MOBILE5 emission factor model and VMT projected from the FHWA's HPMS. The fossil-fuel steam electric utility emissions were derived by the same method as the 1991 electric utility emissions reported in the *Interim* report. Area source, solvent, and nonutility point emissions were projected from the 1990 *Interim* Inventory using E-GAS. By using this new methodology, *Trends* is now able to present NO_x emissions at the state, county, ozone nonattainment area, and seasonal levels.

2.2.1 *Emissions by Source Category*

As mentioned earlier, the source categories in this report have changed from previous reports. There are now 14 first-level categories. Of these 14, natural source emissions of NO_x are considered minimal, and therefore are not estimated for *Trends*. Figure 2-7 presents a pie chart of the remaining 13 categories, four of which (solvent utilization, storage and transport, waste disposal and recycling, and metals processing) constitute less than 1 percent of the total and are combined with chemical and allied product manufacturing, other industrial processes, miscellaneous, and petroluem and related industries in the "All Other" category. As shown, highway vehicles and electric utility emissions each represent 32 percent of the total 1992 NO_x emissions. The emissions from electric utilities are made up of 90 percent coal, of which 68 percent are emissions from bituminous coal. As with CO emissions, light-duty gasoline-powered vehicles (47 percent) are the major contributor to 1992 highway vehicle NO_x emissions. Tables A-5 and A-6, in Appendix A, present a complete breakdown of electric utility and highway vehicle emissions, respectively.

Table 2-6 presents the point and area source split of the Tier 1 source categories. Area source emissions, including highway vehicles, contributed slightly more than half (55 percent) of the total NO_x emissions in 1992.

2.2.2 *Spatial Emissions*

The 1992 NO_x emissions were estimated at the county level and summed to the state level. These estimates are presented in Tables 2-7 and 2-8 and Figures 2-8 and 2-9.

2.2.2.1 *State-level Emissions*

Because the methodology for estimating emissions has changed for NO_x, the total state emissions can now be estimated. As mentioned earlier, these emissions are preliminary and may change in future reports. Table 2-7 presents the point, area, and total emissions estimated for each state, in alphabetical order. Table 2-8 presents the same information, but in descending order by total emissions. The emissions for Alaska and Hawaii include only highway vehicle and fossil-fuel steam electric utility emissions. (A base year inventory similar to NAPAP was not available for these states.) The 10 states with the largest NO_x emissions in 1992 are presented in Figure 2-8. These states represent 50 percent of the total national NO_x emissions in 1992.

2.2.2.2 *County-level Emissions*

Figure 2-9 is a map of the 1992 NO_x emissions, in tons per square mile, for each county. As the map shows, the eastern half and the west coast emit more NO_x than the western half of the continental United States.

2.2.3 *Nonattainment Area vs. Total National Emissions*

As a first step towards reporting nonattainment emission estimates, Figure 2-10 presents a typical[g] serious and above ozone nonattainment area with 1992 NO_x emissions by major Tier 1 categories. The "All Other" category is defined in section 2.2.1. Figure 2-10 also presents a comparison between the 1992 NO_x typical serious and above ozone nonattainment area to the total national[h] Tier 1 major source category percentages. The ozone nonattainment emissions were determined by summing emissions from all counties in the three nonattainment areas. As shown in Figure 2-10, the nonattainment area percentages closely parallel the national percentages, with the exceptions of fuel combustion-other, highway vehicles, and off-highway sources, which constitute a larger percentage of total emissions, and electric utility sources, which constitute a smaller percentage of total emissions.

2.2.4 Emissions from Top 30 Emitters

This report is the second in a series which will track the top emitting sources of NO_x. Figure 2-11 and Table 2-9 present the plant-level emissions of the top 30 point source emitters of NO_x. These emissions were extracted from AIRS/AFS using "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) The data presented in Table 2-9 and Figure 2-11 represent the latest updated year of record, as of November 19, 1993.

2.2.5 Seasonal Emissions

The seasonal emissions were estimated using one of three methodologies. Highway vehicle emissions were estimated for each month, and then summed to the seasonal total. Electric utilities and area source emissions were temporally apportioned by using state point and area factors obtained from the NAPAP methodology.[6] The point emissions were distributed to the seasons based on the 1985 NAPAP seasonal throughput percentages for each point. The seasons are defined as winter (December, January, February), spring (March, April, May), summer (June, July, August), and autumn (September, October, November).

As shown in Figure 2-12, in 1992 most Tier 1 source categories emitted NO_x in approximately equal amounts all year, with two exceptions: fuel combustion-other and off-highway emissions. The emissions from fuel combustion-other are 47 percent in the winter and 8 percent in the summer. The off-highway emissions are 21 percent in the winter and 28 percent in the summer.

2.3 REACTIVE VOLATILE ORGANIC COMPOUND EMISSIONS

The 1992 emissions of VOC were calculated using one of three methodologies, depending on the source category. All three methods are based on the *Interim* methodology (details are provided in section 5). Highway vehicle emissions for 1992 were estimated using the MOBILE5 emission factor model and VMT projected from the FHWA's HPMS. The fossil-fuel steam electric utility emissions were derived by the same method as the 1991 electric utility emissions reported in the *Interim* report. Area source, solvent, and nonutility point emissions were projected from the 1990 *Interim* Inventory using E-GAS. By using this new methodology, *Trends* is now able to present VOC emissions at the state, county, ozone nonattainment area, and seasonal levels.

2.3.1 Emissions by Source Category

As mentioned previously, the source categories in this report have changed from previous reports. There are now 14 first-level categories. Of these, biogenics, a subcategory of natural sources, are considered a major source of VOC emissions. Biogenic emission estimates for 1990 are included in section 7. More extensive studies are underway for this category, and results will be published in the 1994 *Trends* report. Figure 2-13 presents a pie chart of the remaining 13 categories. Two of the source categories (electric utility fuel combustion and metals processing) constituted less than 0.5 percent of the total emissions and are combined with chemical and allied products, petroleum and related industries, miscellaneous, other industrial processes, and fuel combustion (industrial, other). As shown, highway vehicles and solvent utilization both contributed 27 percent to the total 1992 VOC emissions. Light-duty gasoline-powered vehicles represent 66 percent of the highway vehicle 1992 VOC emissions. Surface coating represents 43 percent of the solvent utilization emissions. There are 26 subcategories of surface coating. Their contribution to surface coating emissions are presented in Figure 2-13. The emissions from these Tier 3 categories are presented in Table A-9, in Appendix A.

Table 2-10 presents the point and area split of the Tier 1 source categories. Area source emissions, including highway vehicles, constituted 82 percent of total VOC emissions in 1992.

2.3.2 Spatial Emissions

The 1992 VOC emissions were estimated at the county level and summed to the state level. These estimates are presented in Tables 2-11 and 2-12 and Figures 2-14 and 2-15.

2.3.2.1 State-level Emissions

Because the methodology for estimating emissions has changed for VOC, the total state emissions can now be estimated. As mentioned earlier, these emissions are preliminary and may change in future reports. Table 2-11 presents the point, area, and total emissions estimated for each state, in alphabetical order. Table 2-12 presents the same information, but in descending order by total emissions. The emissions for Alaska and Hawaii include only highway vehicle, fossil-fuel steam electric utility, and solvent emissions. (A base year inventory similar to NAPAP was not available for these states.) The 10 states with the largest VOC emissions in 1992 are presented in Figure 2-14. These states represent 51 percent of the total national VOC emissions in 1992.

2.3.2.2 County-level Emissions

Figure 2-15 is a map of the 1992 VOC emissions, in tons per square mile, for each county. As the map shows, the eastern half and the west coast emit more VOC than the western half of the continental United States.

2.3.3 Nonattainment Area vs. Total National Emissions

As a first step towards reporting nonattainment emission estimates, Figure 2-16 presents 1992 VOC emissions by major Tier 1 categories for "typical"[i] serious and above ozone nonattainment area . The "All Other" category is defined in section 2.3.1. Figure 2-16 also presents a comparison between the 1992 VOC typical serious and above ozone nonattainment area to the total national[j] Tier 1 major source category percentages. The ozone nonattainment emissions were determined by summing emissions from all counties in the three nonattainment areas. As the figure shows, the nonattainment area percentages closely parallel the national percentages. The sources contributing more to the total emissions in this typical nonattainment area are solvent utilization and highway vehicles. Waste disposal and recycling and storage and transport emissions contribute more to the national total than to the nonattainment area total.

2.3.4 Emissions from Top 30 Emitters

This report is the second in a series which will track the top-emitting sources of VOC. Figure 2-17 and Table 2-13 present the plant-level emissions of the top 30 point source emitters of VOC. These emissions were extracted from AIRS/AFS using "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) The data presented in Table 2-13 and Figure 2-17 represent the latest updated year of record, as of November 19, 1993.

2.3.5 Seasonal Emissions

The seasonal emissions were estimated using three methodologies. Highway vehicle emissions were estimated for each month, and then summed to the seasonal total. Electric utilities and area source emissions were temporally apportioned using state point and area factors obtained from the NAPAP methodology.[6] The point emissions were distributed to the seasons based on the 1985 NAPAP seasonal throughput percentages for each point. The seasons are defined as winter (December, January, February), spring (March, April, May), summer (June, July, August), and autumn (September, October, November).

As shown in Figure 2-18, in 1992, most Tier 1 source categories emitted VOCs in approximately equal amounts with three exceptions. The first exception is the other fuel combustion sources (primarily residential wood) which accounts for 56 percent of VOC emissions during the winter and 3 percent during the summer. Secondly, off-highway sources emit 19 percent during the winter and 31 percent in the summer. Thirdly, even though the highway vehicle VOC emissions are distributed 27 percent in the winter and 24 percent in the summer, the evaporative VOC emissions (23 percent of total highway emissions) are greater during the summer (30 percent) than the winter (20 percent). The seasonal percentage distribution of highway vehicle evaporative and exhaust emissions are:

Season	Exhaust (%)	Evaporative (%)
Spring	25	26
Summer	22	30
Autumn	24	24
Winter	29	20

2.4 SULFUR DIOXIDE EMISSIONS

The 1992 emissions of SO_2 were calculated using one of three methodologies, depending on the source category. All three methodologies are based on the *Interim* methodology (details are provided in section 5). Highway vehicle emissions for 1992 were estimated using VMT projected from the FHWA's HPMS and AP-42 emission factor. The fossil-fuel steam electric utility emissions were derived by the same method as the 1991 electric utility emissions reported in the *Interim* report. Area source, solvent, and nonutility point emissions were projected from the 1990 *Interim* Inventory using E-GAS. By using this new methodology, *Trends* is now able to present SO_2 emissions at the state, county, and seasonal level.

2.4.1 Emissions by Source Category

As mentioned earlier, the source categories have changed from previous reports. There are now 14 first-level categories. Of these 14, only the natural sources category is not currently estimated for *Trends*. (There are sulfur emissions from marine sources, but they are considered minor.) Figure 2-19 presents a pie chart of the remaining 13 categories, five of which (solvent utilization, storage and transport, waste disposal and recycling, off-highway, and miscellaneous) constitute less than 2 percent of the total and are combined with chemical and allied product manufacturing, petroluem and related industries, and other industrial processes in the "All Other" category. As shown, electric utilities are the major contributor to SO_2 emissions. In 1992 they represented 70 percent of the total SO_2 emissions. The second largest contributor is industrial fuel combustion, which produced 14 percent of the 1992 SO_2 emissions. The combustion of coal is 96 percent of the electric utility emissions. Bituminous coal combustion is 88 percent of the electric utility coal combustion emissions.

Table 2-14 presents the point and area source split of the Tier 1 source categories. Point source emissions, contributed 91 percent to the total SO_2 emissions in 1992.

2.4.2 Spatial Emissions

The 1992 SO_2 emissions were estimated at the county level and summed to the state level. These estimates are presented in Tables 2-15 and 2-16 and Figures 2-20 and 2-21.

2.4.2.1 State-level Emissions

Because the methodology for estimating emissions has changed for SO_2, the total state emissions can now be estimated. As mentioned previously, these emissions are preliminary and may change in future reports. Table 2-15 presents the point, area, and total emissions estimated for each state, in alphabetical order. Table 2-16 presents the same information, but in descending order by total emissions. The emissions for Alaska and Hawaii include only highway vehicle and fossil-fuel steam electric utility sources. (A base year inventory similar to NAPAP was not available for these states.) The 10 states with the largest SO_2 emissions in 1992 are presented in Figure 2-20. These states represent 59 percent of the total national SO_2 emissions in 1992.

2.4.2.2 County-level Emissions

Figure 2-21 is a map of the 1992 SO_2 emissions, in tons per square mile, for each county. The eastern half and the west coast emit more SO_2 than the western half of the continental United States.

2.4.3 Emissions from Top 30 Emitters

This report is the second in a series which will track the top-emitting sources of SO_2 and the first to track industrial SO_2. Figure 2-22 and Table 2-17 present, respectively, the geographic location and the plant-level emissions of the top 30 point source SO_2 emitters, all of which are electric utilities. Figure 2-23 and Table 2-18 present the corresponding information for the top 30 industrial point sources of SO_2 (i.e., excluding electric utilities). These emissions were extracted from AIRS/AFS using "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in

AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) The data presented in Tables 2-17 and 2-18 and Figures 2-22 and 2-23 represent the latest updated year of record, as of November 19, 1993.

2.4.4 Seasonal Emissions

The seasonal emissions were estimated using three methods. Highway vehicle emissions were estimated for each month, and then summed to each season. Electric utilities and area source emissions were temporally apportioned using state point and area factors obtained from the NAPAP methodology.[6] The point emissions were distributed to the seasons based on the 1985 NAPAP seasonal throughput percentages for each point. The seasons are defined as winter (December, January, February), spring (March, April, May), summer (June, July, August), and autumn (September, October, November).

As shown in Figure 2-24, in 1992, most Tier 1 source categories emitted SO_2 in approximately equal amounts all year. An exception is fuel combustion-other, which emits 42 percent during the winter and only 12 percent in the summer. This difference is a result of more residential fuel combustion in the winter than any other time of the year. Highway vehicles and solvent utilization emit less during the winter.

2.5 LEAD EMISSIONS

The 1992 emissions of Pb were estimated by the same methodology used to produce the 1991 emissions in the last report.[7] The 1992 emissions are based on extending the trend of the Pb emission estimates since 1986 (details are provided in section 5). This methodology makes estimating state and seasonal emissions very resource intensive; therefore, only national emission estimates are presented here.

2.5.1 Emissions by Source Category

As mentioned earlier, the source categories in this report have changed from previous reports. There are now 14 first-level categories. Of these categories, the following five are not estimated for Pb: solvent utilization, storage and transport, petroleum and related industries, natural sources, and miscellaneous. The remaining nine categories are presented in a pie chart in Figure 2-25. The "All Other" category includes chemical and allied product manufacturing, other industrial processes, and fuel combustion (electric utility and industrial). Metal processing, the major contributor of Pb emissions in 1992, represents 40 percent of the total emissions. Nonferrous metal processing represents 64 percent of the 1992 metals processing Pb emissions. Primary and secondary Pb products are responsible for 30 and 23 percent, respectively, of the nonferrous metals processing Pb emissions in 1992.

2.5.2 Emissions from Top 30 Emitters

This report is the first in a series which will track the top-emitting sources of Pb. Figure 2-26 and Table 2-19 present the plant-level emissions of the top 30 largest point source emitters of Pb. These emissions were extracted from AIRS/AFS using "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) Many of the sources located in and responsible for nonattainment problems are not included in Table 2-19 and Figure 2-26. Efforts are being made to include the emission data for nonattainment area sources into AIRS/AFS. As a result, the emission estimates listed in Table 2-19 and located on Figure 2-26 underestimate the national totals due to incomplete data. As an example, Tennessee has three Pb nonattainment areas; however, there are no Tennessee sources in Table 2-19 or Figure 2-26. The data presented in Table 2-19 and Figure 2-26 represent the latest update year of record, as of November 19, 1993. The states not shaded in Figure 2-26 currently contain no emissions data in AIRS/AFS.

2.6 PARTICULATE MATTER EMISSIONS

The 1992 emissions from particulate matter were estimated by the same methodology used to produce the 1991 emissions in the last report. The 1992 emissions are based on extending the trend of the PM-10 emission estimates from previous years (details are in section 5). This methodology makes estimating state and seasonal emissions very resource intensive; therefore, only national emission estimates are presented in this section.

2.6.1 Emissions by Source Category

As mentioned earlier, the source categories in this report have changed from previous reports. There are now 14 first-level categories. Of these categories, the following three are not estimated for PM-10: solvent utilization, storage and transport, and natural sources. Figure 2-27 presents a pie chart in which the remaining categories, with the exclusion of fugitive dust sources, have been combined in the "All Other" category. Fugitive dust sources constitute 99 percent of the 1992 total PM-10 emissions. Unpaved roads (33 percent) are the greatest contributor to 1992 PM-10 fugitive dust emissions. The remaining 5 categories are construction (23 percent), paved roads (17 percent), agricultural tilling (15 percent), wind erosion (10 percent), and mining and quarrying (1 percent).

2.6.2 Emissions from Top 30 Emitters

This report is the first in a series which will track the top-emitting sources of PM-10. Figure 2-28 and Table 2-20 present the plant-level emissions of the top 30 largest point source emitters of PM-10. These emissions were extracted from AIRS/AFS using the "Plant Emission Report, AFP 634," excluding plants listed as permanently closed. In addition, some adjustments were made for data that were obviously in error. (When a state is updating its inventory, the emissions are not in AIRS/AFS. Therefore, depending on the day the data are extracted, the list of top emitters may change.) Many of the sources located in and responsible for nonattainment problems are not included in Table 2-20 and Figure 2-28. Efforts are being made to include the emission data from nonattainment area sources into AIRS/AFS. As a result, the emission estimates listed in Table 2-20 and Figure 2-28 underestimate the national totals due to incomplete data. As an example, Montana has eight PM-10 nonattainment areas; however, there are no Montana sources in Table 2-20 or Figure 2-28. The data presented in Table 2-20 and Figure 2-28 represent the latest updated year of record, as of November 19, 1993. The states not shaded in Figure 2-28 had no emissions data reported in AIRS/AFS at the time of the extraction.

[e] The emissions from three serious or above ozone nonattainment areas were summed to produce a "typical" serious and above ozone nonattainment area.

[f] The national percentages in Figure 2-4 include the nonattainment area emissions.

[g] The emissions from three serious or above ozone nonattainment areas were summed to produce a "typical" serious and above ozone nonattainment area.

[h] The national percentages in Figure 2-10 include the nonattainment area emissions.

[i] The emissions from three serious or above ozone nonattainment areas were summed to produce a "typical" serious and above ozone nonattainment area.

[j] The national percentages in Figure 2-16 include the nonattainment area emissions.

Table 2-1. Predominant Industries in the Top 30 from AIRS/AFS

Pollutant	Industry	No. of Plants
CO	Steel mills	11
	Carbon black producers	9
	Aluminum plants	5
Pb	Primary and secondary smelting and refining of nonferrous metals	11
	Steel mills	5
NO_2	Electric utilities	30
PM-10	Electric utilities	6
	Steel mills	3
SO_2	Electric Utilities	30
Industrial SO_2	Petroleum refineries	7
	Primary smelting and refining of nonferrous metals	8
	Steel mills	3
VOC	Industrial organic and inorganic chemical plants	11
	Petroleum Refineries	5
	Steel mills	5

Table 2-2. CO 1992 National Point and Area Tier 1 Source Category Emissions

(thousand short tons)

Tier	Point	Area	Total	% Point	% Area	% Total
Fuel Combustion - electric utility	311	0	311	5.17	0	0.36
Fuel Combustion - industrial	473	241	714	7.85	0.30	0.82
Fuel Combustion - other	89	5,065	5,154	1.48	6.24	5.91
Chemical & Allied Product Mfg.	1,873	0	1,873	31.09	0	2.15
Metals Processing	1,978	0	1,978	32.83	0	2.27
Petroleum & Related Ind.	403	0	403	6.69	0	0.46
Other Industrial Processes	720	2	722	11.95	0.00	0.83
Solvent Utilization	2	0	2	0.03	0	0.00
Storage & Transport	100	0	100	1.66	0	0.12
Waste Disposal & Recycling	76	1,611	1,686	1.25	1.98	1.93
Highway Vehicles	0	55,288	55,288	0	68.13	63.42
Off-Highway	0	14,679	14,679	0	18.09	16.84
Miscellaneous	0	4,271	4,271	0	5.26	4.90
Total	6,026	81,157	87,183	100	100	100

Table 2-3. State CO 1992 Point, Area, and Total Emissions, by State

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Alabama	241	1,662	1,902	3.99	2.05	2.18
Alaska	0	80	80	0.00	0.10	0.09
Arizona	10	1,282	1,293	0.17	1.58	1.48
Arkansas	102	769	871	1.70	0.95	1.00
California	105	7,188	7,293	1.74	8.86	8.37
Colorado	8	1,156	1,164	0.14	1.42	1.34
Connecticut	6	846	852	0.09	1.04	0.98
Delaware	41	218	259	0.69	0.27	0.30
District of Columbia	2	108	110	0.03	0.13	0.13
Florida	78	4,249	4,327	1.29	5.24	4.96
Georgia	199	2,704	2,903	3.30	3.33	3.33
Hawaii	1	204	205	0.02	0.25	0.24
Idaho	5	1,111	1,116	0.08	1.37	1.28
Illinois	150	2,798	2,948	2.49	3.45	3.38
Indiana	613	2,008	2,621	10.17	2.47	3.01
Iowa	11	836	847	0.18	1.03	0.97
Kansas	71	847	918	1.18	1.04	1.05
Kentucky	78	1,302	1,379	1.29	1.60	1.58
Louisiana	757	1,724	2,481	12.56	2.12	2.85
Maine	17	525	542	0.28	0.65	0.62
Maryland	24	1,321	1,345	0.41	1.63	1.54
Massachusetts	15	1,731	1,746	0.25	2.13	2.00
Michigan	266	3,162	3,428	4.41	3.90	3.93
Minnesota	77	1,569	1,646	1.28	1.93	1.89
Mississippi	91	1,045	1,137	1.51	1.29	1.30
Missouri	143	1,977	2,120	2.38	2.44	2.43
Montana	37	800	837	0.62	0.99	0.96
Nebraska	3	484	487	0.05	0.60	0.56
Nevada	60	437	497	1.00	0.54	0.57
New Hampshire	16	383	399	0.27	0.47	0.46
New Jersey	8	2,038	2,046	0.14	2.51	2.35
New Mexico	23	755	778	0.38	0.93	0.89
New York	39	4,087	4,127	0.65	5.04	4.73
North Carolina	129	2,472	2,601	2.14	3.05	2.98
North Dakota	8	245	254	0.14	0.30	0.29
Ohio	334	3,334	3,669	5.55	4.11	4.21
Oklahoma	77	1,097	1,174	1.28	1.35	1.35
Oregon	24	1,288	1,312	0.40	1.59	1.50
Pennsylvania	257	3,463	3,720	4.26	4.27	4.27
Rhode Island	0	270	270	0.00	0.33	0.31
South Carolina	51	1,287	1,339	0.85	1.59	1.54
South Dakota	5	411	417	0.09	0.51	0.48
Tennessee	153	1,851	2,004	2.54	2.28	2.30
Texas	737	6,035	6,772	12.23	7.44	7.77
Utah	45	725	771	0.75	0.89	0.88
Vermont	0	241	241	0.00	0.30	0.28
Virginia	50	2,087	2,136	0.83	2.57	2.45
Washington	409	2,319	2,728	6.79	2.86	3.13
West Virginia	323	590	913	5.35	0.73	1.05
Wisconsin	68	1,789	1,857	1.13	2.20	2.13
Wyoming	56	246	302	0.93	0.30	0.35
National	6,026	81,157	87,183	100	100	100

Table 2-4. State CO 1992 Point, Area, and Total Emissions, by Total Emissions

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
California	105	7,188	7,293	1.74	8.86	8.37
Texas	737	6,035	6,772	12.23	7.44	7.77
Florida	78	4,249	4,327	1.29	5.24	4.96
New York	39	4,087	4,127	0.65	5.04	4.73
Pennsylvania	257	3,463	3,720	4.26	4.27	4.27
Ohio	334	3,334	3,669	5.55	4.11	4.21
Michigan	266	3,162	3,428	4.41	3.90	3.93
Illinois	150	2,798	2,948	2.49	3.45	3.38
Georgia	199	2,704	2,903	3.30	3.33	3.33
Washington	409	2,319	2,728	6.79	2.86	3.13
Indiana	613	2,008	2,621	10.17	2.47	3.01
North Carolina	129	2,472	2,601	2.14	3.05	2.98
Louisiana	757	1,724	2,481	12.56	2.12	2.85
Virginia	50	2,087	2,136	0.83	2.57	2.45
Missouri	143	1,977	2,120	2.38	2.44	2.43
New Jersey	8	2,038	2,046	0.14	2.51	2.35
Tennessee	153	1,851	2,004	2.54	2.28	2.30
Alabama	241	1,662	1,902	3.99	2.05	2.18
Wisconsin	68	1,789	1,857	1.13	2.20	2.13
Massachusetts	15	1,731	1,746	0.25	2.13	2.00
Minnesota	77	1,569	1,646	1.28	1.93	1.89
Kentucky	78	1,302	1,379	1.29	1.60	1.58
Maryland	24	1,321	1,345	0.41	1.63	1.54
South Carolina	51	1,287	1,339	0.85	1.59	1.54
Oregon	24	1,288	1,312	0.40	1.59	1.50
Arizona	10	1,282	1,293	0.17	1.58	1.48
Oklahoma	77	1,097	1,174	1.28	1.35	1.35
Colorado	8	1,156	1,164	0.14	1.42	1.34
Mississippi	91	1,045	1,137	1.51	1.29	1.30
Idaho	5	1,111	1,116	0.08	1.37	1.28
Kansas	71	847	918	1.18	1.04	1.05
West Virginia	323	590	913	5.35	0.73	1.05
Arkansas	102	769	871	1.70	0.95	1.00
Connecticut	6	846	852	0.09	1.04	0.98
Iowa	11	836	847	0.18	1.03	0.97
Montana	37	800	837	0.62	0.99	0.96
New Mexico	23	755	778	0.38	0.93	0.89
Utah	45	725	771	0.75	0.89	0.88
Maine	17	525	542	0.28	0.65	0.62
Nevada	60	437	497	1.00	0.54	0.57
Nebraska	3	484	487	0.05	0.60	0.56
South Dakota	5	411	417	0.09	0.51	0.48
New Hampshire	16	383	399	0.27	0.47	0.46
Wyoming	56	246	302	0.93	0.30	0.35
Rhode Island	0	270	270	0.00	0.33	0.31
Delaware	41	218	259	0.69	0.27	0.30
North Dakota	8	245	254	0.14	0.30	0.29
Vermont	0	241	241	0.00	0.30	0.28
Hawaii	1	204	205	0.02	0.25	0.24
District of Columbia	2	108	110	0.03	0.13	0.13
Alaska	0	80	80	0.00	0.10	0.09
National	6,026	81,157	87,183	100	100	100

Table 2-5. Top 30 CO Emitters in AIRS/AFS

U.S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	3	PA	USX CORPORATION - EDGAR THOMSON WORKS	288,469	90
2	3	WV	WEIRTON STEEL CORPORATION	212,044	90
3	5	OH	WHEELING PITTSBURGH STEEL STEUBENVILLE	185,571	90
4	5	IN	U S STEEL CO GARY WORKS PART 2	175,432	92
5	3	PA	SHENANGO IRON & COKE WORKS	133,651	90
6	3	PA	USX CORPORATION - CLAIRTON WORKS	125,152	90
7	5	IL	ACME STEEL COMPANY	100,507	92
8	6	LA	CABOT CORP CANL PLT PO BOX 598 FRAN	98,008	90
9	4	AL	GULF STATES STEEL	97,000	92
10	3	PA	BETHLEHEM STEEL CORP.	90,994	90
11	6	LA	COLUMBIAN CHEMICAL DRAWER 1149 FRAN	86,089	90
12	3	MD	BETHLEHEM STEEL	73,225	90
13	6	LA	CABOT CORP BOX 100 VILLE PLATTE 705	66,615	90
14	6	LA	DEGUSSA CARBON BLACK CO/POB 1328 NE	64,258	90
15	6	TX	CABOT CORPORATION	63,232	90
16	5	IN	ALCOA (ALUMINUM CO. OC AMERICA)	61,582	92
17	5	MN	ASHLAND PETROLEUM	59,264	90
18	6	OK	WITCO CORP, CONCARB DIVISION	56,796	91
19	6	TX	SID RICHARDSON CARBON AND GASOLINE	55,818	85
20	6	TX	PHILLIPS 66 COMPANY, DIV OF PHILLIPS	54,916	90
21	6	LA	ADDIS PLANT SID RICHARDSON RD	54,322	90
22	5	OH	ORMET CORPORATION	52,947	90
23	5	IN	LTV STEEL COMPANY	52,640	92
24	10	WA	ALUM CO OF AMERICA	52,200	92
25	7	MO	NORANDA ALUMINUM, INCORPORATED	50,808	89
26	5	OH	DEGUSSA CORPORATION	48,745	90
27	4	TN	E. I. DU PONT DE NEMOURS AND COMPANY	46,928	90
28	7	KS	COLUMBIAN CHEMICALS COMPANY	46,187	92
29	6	LA	EXXON CO USA REFINERY BOX 551 BATON	44,492	90
30	10	WA	INTALCO ALUMINUM	43,976	92

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. Plants in nonattainment areas include rule effectiveness and plants in attainment areas do not. The reader should use caution when comparing rankings.

Table 2-6. NO_x 1992 National Point and Area Tier 1 Source Category Emissions
(thousand short tons)

Tier	Point	Area	Total	% Point	% Area	% Total
Fuel Combustion - electric utility	7,468	0	7,468	71.93	0	32.26
Fuel Combustion - industrial	1,920	1,602	3,523	18.50	12.55	15.22
Fuel Combustion - other	99	635	734	0.95	4.97	3.17
Chemical & Allied Product Mfg.	401	0	401	3.86	0	1.73
Metals Processing	78	0	78	0.75	0	0.34
Petroleum & Related Ind.	94	0	94	0.91	0	0.41
Other Industrial Processes	296	5	301	2.85	0.04	1.30
Solvent Utilization	3	0	3	0.02	0	0.01
Storage & Transport	3	0	3	0.03	0	0.01
Waste Disposal & Recycling	20	63	82	0.19	0.49	0.36
Highway Vehicles	0	7,477	7,477	0	58.57	32.30
Off-Highway	0	2,852	2,852	0	22.34	12.32
Miscellaneous	0	133	133	0	1.04	0.58
Total	10,382	12,767	23,149	100	100	100

Table 2-7. State NO_x 1992 Point, Area, and Total Emissions, by State

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Alabama	284	247	531	2.73	1.94	2.29
Alaska	2	10	12	0.02	0.08	0.05
Arizona	137	249	386	1.32	1.95	1.67
Arkansas	106	151	257	1.02	1.19	1.11
California	299	1,150	1,449	2.88	9.01	6.26
Colorado	148	174	322	1.43	1.36	1.39
Connecticut	21	117	138	0.20	0.92	0.60
Delaware	31	31	62	0.30	0.25	0.27
District of Columbia	1	17	18	0.01	0.13	0.08
Florida	392	520	912	3.78	4.07	3.94
Georgia	313	378	691	3.02	2.96	2.98
Hawaii	12	21	33	0.11	0.17	0.14
Idaho	7	83	91	0.07	0.65	0.39
Illinois	442	448	889	4.25	3.51	3.84
Indiana	601	390	991	5.79	3.06	4.28
Iowa	150	150	300	1.45	1.17	1.30
Kansas	199	201	400	1.92	1.58	1.73
Kentucky	369	263	632	3.55	2.06	2.73
Louisiana	366	419	785	3.52	3.28	3.39
Maine	17	59	76	0.16	0.47	0.33
Maryland	117	203	320	1.13	1.59	1.38
Massachusetts	86	223	309	0.83	1.75	1.34
Michigan	349	436	785	3.36	3.41	3.39
Minnesota	179	201	380	1.72	1.57	1.64
Mississippi	105	187	292	1.01	1.47	1.26
Missouri	317	271	588	3.05	2.12	2.54
Montana	80	85	165	0.77	0.67	0.71
Nebraska	68	106	175	0.66	0.83	0.75
Nevada	69	68	137	0.67	0.53	0.59
New Hampshire	26	47	73	0.25	0.37	0.32
New Jersey	101	283	384	0.97	2.22	1.66
New Mexico	164	117	281	1.58	0.92	1.21
New York	226	535	761	2.18	4.19	3.29
North Carolina	237	346	583	2.28	2.71	2.52
North Dakota	133	53	185	1.28	0.41	0.80
Ohio	628	488	1,116	6.04	3.82	4.82
Oklahoma	205	225	430	1.97	1.77	1.86
Oregon	21	186	207	0.21	1.46	0.90
Pennsylvania	441	486	927	4.25	3.80	4.00
Rhode Island	1	32	33	0.01	0.25	0.14
South Carolina	119	174	292	1.14	1.36	1.26
South Dakota	22	43	65	0.22	0.34	0.28
Tennessee	296	252	547	2.85	1.97	2.36
Texas	1,374	1,498	2,872	13.23	11.73	12.41
Utah	130	98	228	1.25	0.77	0.99
Vermont	1	27	27	0.01	0.21	0.12
Virginia	137	315	451	1.32	2.46	1.95
Washington	108	265	373	1.04	2.08	1.61
West Virginia	342	103	446	3.30	0.81	1.92
Wisconsin	203	235	438	1.96	1.84	1.89
Wyoming	201	99	301	1.94	0.78	1.30
National	10,382	12,767	23,149	100	100	100

Table 2-8. State NO_x 1992 Point, Area, and Total Emissions, by Total Emissions

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Texas	1,374	1,498	2,872	13.23	11.73	12.41
California	299	1,150	1,449	2.88	9.01	6.26
Ohio	628	488	1,116	6.04	3.82	4.82
Indiana	601	390	991	5.79	3.06	4.28
Pennsylvania	441	486	927	4.25	3.80	4.00
Florida	392	520	912	3.78	4.07	3.94
Illinois	442	448	889	4.25	3.51	3.84
Louisiana	366	419	785	3.52	3.28	3.39
Michigan	349	436	785	3.36	3.41	3.39
New York	226	535	761	2.18	4.19	3.29
Georgia	313	378	691	3.02	2.96	2.98
Kentucky	369	263	632	3.55	2.06	2.73
Missouri	317	271	588	3.05	2.12	2.54
North Carolina	237	346	583	2.28	2.71	2.52
Tennessee	296	252	547	2.85	1.97	2.36
Alabama	284	247	531	2.73	1.94	2.29
Virginia	137	315	451	1.32	2.46	1.95
West Virginia	342	103	446	3.30	0.81	1.92
Wisconsin	203	235	438	1.96	1.84	1.89
Oklahoma	205	225	430	1.97	1.77	1.86
Kansas	199	201	400	1.92	1.58	1.73
Arizona	137	249	386	1.32	1.95	1.67
New Jersey	101	283	384	0.97	2.22	1.66
Minnesota	179	201	380	1.72	1.57	1.64
Washington	108	265	373	1.04	2.08	1.61
Colorado	148	174	322	1.43	1.36	1.39
Maryland	117	203	320	1.13	1.59	1.38
Massachusetts	86	223	309	0.83	1.75	1.34
Wyoming	201	99	301	1.94	0.78	1.30
Iowa	150	150	300	1.45	1.17	1.30
Mississippi	105	187	292	1.01	1.47	1.26
South Carolina	119	174	292	1.14	1.36	1.26
New Mexico	164	117	281	1.58	0.92	1.21
Arkansas	106	151	257	1.02	1.19	1.11
Utah	130	98	228	1.25	0.77	0.99
Oregon	21	186	207	0.21	1.46	0.90
North Dakota	133	53	185	1.28	0.41	0.80
Nebraska	68	106	175	0.66	0.83	0.75
Montana	80	85	165	0.77	0.67	0.71
Connecticut	21	117	138	0.20	0.92	0.60
Nevada	69	68	137	0.67	0.53	0.59
Idaho	7	83	91	0.07	0.65	0.39
Maine	17	59	76	0.16	0.47	0.33
New Hampshire	26	47	73	0.25	0.37	0.32
South Dakota	22	43	65	0.22	0.34	0.28
Delaware	31	31	62	0.30	0.25	0.27
Hawaii	12	21	33	0.11	0.17	0.14
Rhode Island	1	32	33	0.01	0.25	0.14
Vermont	1	27	27	0.01	0.21	0.12
District of Columbia	1	17	18	0.01	0.13	0.08
Alaska	2	10	12	0.02	0.08	0.05
National	10,382	12,767	23,149	100	100	100

Table 2-9. Top 30 NO_x Emitters in AIRS/AFS

U. S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	4	TN	TVA CUMBERLAND STEAM PLANT	106,928	90
2	4	KY	TVA- PARADISE A & B	97,787	90
3	5	OH	GENERAL JAMES M. GAVIN PLANT	86,748	90
4	5	OH	JAMES M STUART ELEC GENERATING STATION	76,905	90
5	5	IL	COM ED - POWERTON STATION	72,628	92
6	5	IN	INDIANA KENTUCKY ELECTRIC CORPORATION	70,705	90
7	5	IL	COM ED - KINCAID GENERATING STATION	64,984	92
8	5	IL	ILLINOIS POWER CO - BALDWIN POWER PLANT	63,213	92
9	4	GA	GA POWER CO BOWEN STM ELEC GEN STA	63,131	90
10	4	AL	ALA POWER CO-E C GASTON	62,359	92
11	3	PA	PENN POWER-MANSFIELD	57,914	90
12	5	OH	KYGER CREEK STATION OHIO VALLEY ELEC COR	57,462	90
13	5	IN	PSI - GIBSON	57,063	90
14	5	OH	OHIO EDISON COMPANY W H SAMMIS PLANT	54,153	90
15	7	MO	ASSOCIATED ELECTRIC	54,027	90
16	10	AK	GVEA ILLINOIS STREET	53,351	90
17	4	FL	FL PWR-CRYSTAL RIVER	52,832	90
18	4	AL	ALABAMA POWER CO-BARRY STEAM PLT	52,409	92
19	7	MO	ASSOC. ELECTRIC CO. - THOMAS HILL	51,452	90
20	3	WV	MONONGAHELA POWER - HARRISON	50,726	90
21	3	PA	PEN ELEC - HOMER CITY	49,124	90
22	4	NC	CP&L ROXBORO UNITS 1 2 3 4	46,668	88
23	3	PA	PEN ELEC - CONEMAUGH	46,478	90
24	5	IL	CENTRAL ILLINOIS PUBLIC SERVICE	46,386	92
25	3	PA	PEN ELEC - KEYSTONE	46,037	90
26	5	OH	MUSKINGUM RIVER PLANT	45,409	90
27	4	NC	DUKE POWER-BELEWS CR	44,071	89
28	4	FL	TAMPA ELEC-BIG BEND	43,857	90
29	4	GA	GA POWER CO BRANCH STM ELEC GEN STA	43,258	90
30	8	MT	MPC - COLSTRIP 1-4	42,382	92

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. Plants in nonattainment areas include rule effectiveness and plants in attainment areas do not. The reader should use caution when comparing rankings.

Table 2-10. VOC 1992 National Point and Area Tier 1 Source Category Emissions

(thousand short tons)

Tier	Point	Area	Total	% Point	% Area	% Total
Fuel Combustion - electric utility	32	0	32	0.78	0	0.14
Fuel Combustion - industrial	259	21	279	6.21	0.11	1.23
Fuel Combustion - other	10	384	394	0.23	2.07	1.73
Chemical & Allied Product Mfg.	1,303	456	1,758	31.25	2.46	7.74
Metals Processing	70	0	70	1.67	0	0.31
Petroleum & Related Ind.	304	411	715	7.29	2.22	3.15
Other Industrial Processes	397	78	475	9.52	0.42	2.09
Solvent Utilization	1,198	4,864	6,062	28.74	26.21	26.67
Storage & Transport	588	1,235	1,823	14.11	6.65	8.02
Waste Disposal & Recycling	8	2,306	2,314	0.19	12.43	10.18
Highway Vehicles	0	6,099	6,099	0	32.86	26.84
Off-Highway	0	2,127	2,127	0	11.46	9.36
Miscellaneous	1	576	577	0.02	3.11	2.54
Total	4,168	18,557	22,726	100	100	100

Table 2-11. State VOC 1992 Point, Area, and Total Emissions, by State
(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Alabama	204	374	579	4.90	2.02	2.55
Alaska	0	15	15	0.00	0.08	0.07
Arizona	2	243	245	0.05	1.31	1.08
Arkansas	37	185	222	0.88	0.99	0.97
California	98	1,872	1,970	2.36	10.09	8.67
Colorado	6	209	215	0.14	1.13	0.95
Connecticut	6	180	186	0.15	0.97	0.82
Delaware	13	101	114	0.32	0.54	0.50
District of Columbia	1	23	23	0.02	0.12	0.10
Florida	22	804	826	0.52	4.33	3.63
Georgia	50	579	629	1.21	3.12	2.77
Hawaii	0	42	42	0.00	0.23	0.19
Idaho	1	171	172	0.02	0.92	0.76
Illinois	297	636	932	7.12	3.42	4.10
Indiana	125	451	576	2.99	2.43	2.53
Iowa	11	205	216	0.27	1.10	0.95
Kansas	29	196	226	0.70	1.06	0.99
Kentucky	82	253	335	1.98	1.36	1.47
Louisiana	139	528	667	3.34	2.84	2.93
Maine	6	88	94	0.13	0.48	0.41
Maryland	23	249	272	0.55	1.34	1.20
Massachusetts	56	340	397	1.35	1.83	1.75
Michigan	103	638	742	2.48	3.44	3.26
Minnesota	57	321	378	1.36	1.73	1.66
Mississippi	59	245	304	1.41	1.32	1.34
Missouri	136	359	495	3.27	1.93	2.18
Montana	6	127	133	0.14	0.69	0.59
Nebraska	5	119	124	0.12	0.64	0.55
Nevada	1	82	82	0.02	0.44	0.36
New Hampshire	5	70	74	0.11	0.38	0.33
New Jersey	91	495	586	2.19	2.67	2.58
New Mexico	8	122	130	0.19	0.66	0.57
New York	152	810	963	3.65	4.37	4.24
North Carolina	192	556	748	4.61	3.00	3.29
North Dakota	2	73	75	0.04	0.39	0.33
Ohio	114	711	825	2.74	3.83	3.63
Oklahoma	24	250	274	0.57	1.35	1.21
Oregon	44	218	263	1.06	1.18	1.16
Pennsylvania	114	765	880	2.75	4.12	3.87
Rhode Island	11	59	69	0.25	0.32	0.30
South Carolina	31	665	696	0.73	3.58	3.06
South Dakota	8	81	89	0.19	0.44	0.39
Tennessee	171	380	552	4.11	2.05	2.43
Texas	1,182	1,819	3,001	28.36	9.80	13.21
Utah	9	122	131	0.22	0.66	0.58
Vermont	1	41	42	0.03	0.22	0.18
Virginia	144	435	579	3.46	2.34	2.55
Washington	47	399	445	1.12	2.15	1.96
West Virginia	104	461	565	2.50	2.48	2.49
Wisconsin	121	348	469	2.91	1.88	2.07
Wyoming	16	43	59	0.39	0.23	0.26
National	4,168	18,557	22,726	100	100	100

Table 2-12. State VOC 1992 Point, Area, and Total Emissions, by Total Emissions

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Texas	1,182	1,819	3,001	28.36	9.80	13.21
California	98	1,872	1,970	2.36	10.09	8.67
New York	152	810	963	3.65	4.37	4.24
Illinois	297	636	932	7.12	3.42	4.10
Pennsylvania	114	765	880	2.75	4.12	3.87
Florida	22	804	826	0.52	4.33	3.63
Ohio	114	711	825	2.74	3.83	3.63
North Carolina	192	556	748	4.61	3.00	3.29
Michigan	103	638	742	2.48	3.44	3.26
South Carolina	31	665	696	0.73	3.58	3.06
Louisiana	139	528	667	3.34	2.84	2.93
Georgia	50	579	629	1.21	3.12	2.77
New Jersey	91	495	586	2.19	2.67	2.58
Alabama	204	374	579	4.90	2.02	2.55
Virginia	144	435	579	3.46	2.34	2.55
Indiana	125	451	576	2.99	2.43	2.53
West Virginia	104	461	565	2.50	2.48	2.49
Tennessee	171	380	552	4.11	2.05	2.43
Missouri	136	359	495	3.27	1.93	2.18
Wisconsin	121	348	469	2.91	1.88	2.07
Washington	47	399	445	1.12	2.15	1.96
Massachusetts	56	340	397	1.35	1.83	1.75
Minnesota	57	321	378	1.36	1.73	1.66
Kentucky	82	253	335	1.98	1.36	1.47
Mississippi	59	245	304	1.41	1.32	1.34
Oklahoma	24	250	274	0.57	1.35	1.21
Maryland	23	249	272	0.55	1.34	1.20
Oregon	44	218	263	1.06	1.18	1.16
Arizona	2	243	245	0.05	1.31	1.08
Kansas	29	196	226	0.70	1.06	0.99
Arkansas	37	185	222	0.88	0.99	0.97
Iowa	11	205	216	0.27	1.10	0.95
Colorado	6	209	215	0.14	1.13	0.95
Connecticut	6	180	186	0.15	0.97	0.82
Idaho	1	171	172	0.02	0.92	0.76
Montana	6	127	133	0.14	0.69	0.59
Utah	9	122	131	0.22	0.66	0.58
New Mexico	8	122	130	0.19	0.66	0.57
Nebraska	5	119	124	0.12	0.64	0.55
Delaware	13	101	114	0.32	0.54	0.50
Maine	6	88	94	0.13	0.48	0.41
South Dakota	8	81	89	0.19	0.44	0.39
Nevada	1	82	82	0.02	0.44	0.36
North Dakota	2	73	75	0.04	0.39	0.33
New Hampshire	5	70	74	0.11	0.38	0.33
Rhode Island	11	59	69	0.25	0.32	0.30
Wyoming	16	43	59	0.39	0.23	0.26
Hawaii	0	42	42	0.00	0.23	0.19
Vermont	1	41	42	0.03	0.22	0.18
District of Columbia	1	23	23	0.02	0.12	0.10
Alaska	0	15	15	0.00	0.08	0.07
National	4,168	18,557	22,726	100	100	100

Table 2-13. Top 30 VOC Emitters in AIRS/AFS

U.S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	4	KY	AIR PRODUCTS & CHEMICALS, INC.	28,670	90
2	4	AL	COURTAULDS NO AMERICA INC	22,349	92
3	4	TN	EASTMAN, TENN. CO	19,283	92
4	5	OH	CHEMI-TROL CHEMICAL CO	17,190	90
5	5	OH	BP OIL COMPANY	15,337	90
6	5	OH	BP CHEMICALS INC.	12,583	90
7	3	WV	WHEELING-PITT (FOLLANSBEE)	10,644	90
8	4	KY	ASHLAND OIL CO	10,134	90
9	3	PA	LTV STEEL COMPANY - PITTSBURGH WORKS	9,425	90
10	5	OH	ARMCO STEEL COMPANY L.P.	9,006	90
11	6	TX	E.I.DU PONT DE NEMOURS & COMPANY INC	8,561	90
12	5	IL	ACME STEEL COMPANY-CHICAGO COKE PLANT	8,386	92
13	3	VA	HOECHST CELANESE CORP	8,003	90
14	5	MI	WEYERHAEUSER CO	7,959	90
15	4	NC	E I DUPONT COMPANY	7,944	87
16	3	PA	USX CORPORATION - CLAIRTON WORKS	7,706	90
17	5	IL	CL INDUSTRIES INC	7,504	92
18	5	OH	IMPRESSION COATING, INC.	7,486	90
19	6	LA	EXXON CO USA REFINERY BOX 551 BATON	7,416	90
20	3	PA	CONGOLEUM CORP.	7,105	90
21	6	TX	TEXAS EASTMAN DIVISION, EASTMAN CHEM	6,956	90
22	4	TN	EASTMAN, TENN. CO	6,955	92
23	7	MO	MODINE MFG. CO.	6,854	86
24	6	OK	CONOCO INC.	6,805	91
25	6	TX	SHELL OIL COMPANY	6,707	90
26	4	NC	CAPE INDUSTRIES	6,682	87
27	8	CO	CHEMICAL SYSTEMS TECHNOLOGY INC.	6,655	90
28	6	TX	MOBIL OIL CORPORATION	6,599	90
29	4	AL	AMOCO CHEMICALS CO	6,427	92
30	5	MI	GM TRUCK & BUS	6,223	85

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities. Plants in nonattainment areas include rule effectiveness and plants in attainment areas do not. The reader should use caution when comparing rankings.

Table 2-14. SO_2 1992 National Point and Area Tier 1 Source Category Emissions

(thousand short tons)

Tier	Point	Area	Total	% Point	% Area	% Total
Fuel Combustion - electric utility	15,841	0	15,841	76.76	0	69.69
Fuel Combustion - industrial	2,463	626	3,090	11.94	29.91	13.59
Fuel Combustion - other	197	391	589	0.96	18.68	2.59
Chemical & Allied Product Mfg.	419	0	419	2.03	0	1.84
Metals Processing	868	0	868	4.20	0	3.82
Petroleum & Related Ind.	411	0	411	1.99	0	1.81
Other Industrial Processes	395	2	397	1.91	0.09	1.74
Solvent Utilization	1	0	1	0.00	0	0.00
Storage & Transport	21	0	21	0.10	0	0.09
Waste Disposal & Recycling	21	15	36	0.10	0.73	0.16
Highway Vehicles	0	785	785	0	37.47	3.45
Off-Highway	0	271	271	0	12.91	1.19
Miscellaneous	0	4	4	0	0.21	0.02
Total	20,637	2,095	22,731	100	100	100

Table 2-15. State SO_2 1992 Point, Area, and Total Emissions, by State

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Alabama	705	71	776	3.41	3.41	3.41
Alaska	1	1	1	0.00	0.04	0.01
Arizona	541	22	563	2.62	1.04	2.48
Arkansas	89	24	113	0.43	1.14	0.50
California	71	188	259	0.34	8.99	1.14
Colorado	94	14	109	0.46	0.69	0.48
Connecticut	47	21	67	0.23	0.98	0.30
Delaware	88	5	94	0.43	0.26	0.41
District of Columbia	4	2	6	0.02	0.09	0.02
Florida	822	59	881	3.98	2.83	3.88
Georgia	867	33	901	4.20	1.60	3.96
Hawaii	23	2	25	0.11	0.09	0.11
Idaho	24	12	37	0.12	0.59	0.16
Illinois	1,208	38	1,246	5.85	1.81	5.48
Indiana	1,735	180	1,915	8.41	8.61	8.43
Iowa	256	19	276	1.24	0.93	1.21
Kansas	112	14	126	0.54	0.64	0.55
Kentucky	954	50	1,004	4.62	2.39	4.42
Louisiana	291	131	422	1.41	6.25	1.86
Maine	68	16	84	0.33	0.76	0.37
Maryland	301	56	357	1.46	2.68	1.57
Massachusetts	243	44	287	1.18	2.09	1.26
Michigan	481	40	521	2.33	1.90	2.29
Minnesota	118	19	138	0.57	0.91	0.60
Mississippi	160	79	239	0.77	3.76	1.05
Missouri	886	51	937	4.29	2.42	4.12
Montana	73	7	80	0.36	0.32	0.35
Nebraska	56	12	67	0.27	0.56	0.30
Nevada	60	8	68	0.29	0.39	0.30
New Hampshire	52	8	60	0.25	0.38	0.26
New Jersey	118	53	171	0.57	2.53	0.75
New Mexico	234	17	250	1.13	0.79	1.10
New York	515	100	615	2.50	4.75	2.70
North Carolina	488	61	549	2.36	2.92	2.42
North Dakota	229	22	250	1.11	1.04	1.10
Ohio	2,542	104	2,645	12.32	4.96	11.64
Oklahoma	140	23	163	0.68	1.10	0.72
Oregon	22	35	56	0.11	1.65	0.25
Pennsylvania	1,356	74	1,430	6.57	3.54	6.29
Rhode Island	2	5	8	0.01	0.26	0.03
South Carolina	243	20	263	1.18	0.97	1.16
South Dakota	33	6	39	0.16	0.30	0.17
Tennessee	960	31	991	4.65	1.48	4.36
Texas	1,097	147	1,244	5.32	7.02	5.47
Utah	55	19	75	0.27	0.93	0.33
Vermont	1	5	6	0.01	0.24	0.03
Virginia	315	56	371	1.53	2.69	1.63
Washington	140	36	175	0.68	1.70	0.77
West Virginia	1,196	12	1,208	5.80	0.59	5.32
Wisconsin	397	24	421	1.92	1.15	1.85
Wyoming	123	17	140	0.60	0.82	0.62
National	20,637	2,095	22,731	100	100	100

Table 2-16. State SO_2 1992 Point, Area, and Total Emissions, by Total Emissions

(thousand short tons)

State	Point	Area	Total	% Point	% Area	% Total
Ohio	2,542	104	2,645	12.32	4.96	11.64
Indiana	1,735	180	1,915	8.41	8.61	8.43
Pennsylvania	1,356	74	1,430	6.57	3.54	6.29
Illinois	1,208	38	1,246	5.85	1.81	5.48
Texas	1,097	147	1,244	5.32	7.02	5.47
West Virginia	1,196	12	1,208	5.80	0.59	5.32
Kentucky	954	50	1,004	4.62	2.39	4.42
Tennessee	960	31	991	4.65	1.48	4.36
Missouri	886	51	937	4.29	2.42	4.12
Georgia	867	33	901	4.20	1.60	3.96
Florida	822	59	881	3.98	2.83	3.88
Alabama	705	71	776	3.41	3.41	3.41
New York	515	100	615	2.50	4.75	2.70
Arizona	541	22	563	2.62	1.04	2.48
North Carolina	488	61	549	2.36	2.92	2.42
Michigan	481	40	521	2.33	1.90	2.29
Louisiana	291	131	422	1.41	6.25	1.86
Wisconsin	397	24	421	1.92	1.15	1.85
Virginia	315	56	371	1.53	2.69	1.63
Maryland	301	56	357	1.46	2.68	1.57
Massachusetts	243	44	287	1.18	2.09	1.26
Iowa	256	19	276	1.24	0.93	1.21
South Carolina	243	20	263	1.18	0.97	1.16
California	71	188	259	0.34	8.99	1.14
North Dakota	229	22	250	1.11	1.04	1.10
New Mexico	234	17	250	1.13	0.79	1.10
Mississippi	160	79	239	0.77	3.76	1.05
Washington	140	36	175	0.68	1.70	0.77
New Jersey	118	53	171	0.57	2.53	0.75
Oklahoma	140	23	163	0.68	1.10	0.72
Wyoming	123	17	140	0.60	0.82	0.62
Minnesota	118	19	138	0.57	0.91	0.60
Kansas	112	14	126	0.54	0.64	0.55
Arkansas	89	24	113	0.43	1.14	0.50
Colorado	94	14	109	0.46	0.69	0.48
Delaware	88	5	94	0.43	0.26	0.41
Maine	68	16	84	0.33	0.76	0.37
Montana	73	7	80	0.36	0.32	0.35
Utah	55	19	75	0.27	0.93	0.33
Nevada	60	8	68	0.29	0.39	0.30
Connecticut	47	21	67	0.23	0.98	0.30
Nebraska	56	12	67	0.27	0.56	0.30
New Hampshire	52	8	60	0.25	0.38	0.26
Oregon	22	35	56	0.11	1.65	0.25
South Dakota	33	6	39	0.16	0.30	0.17
Idaho	24	12	37	0.12	0.59	0.16
Hawaii	23	2	25	0.11	0.09	0.11
Rhode Island	2	5	8	0.01	0.26	0.03
District of Columbia	4	2	6	0.02	0.09	0.02
Vermont	1	5	6	0.01	0.24	0.03
Alaska	1	1	1	0.00	0.04	0.01
National	20,637	2,095	22,731	100	100	100

Table 2-17. Top 30 SO_2 Emitters in AIRS/AFS

U.S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	5	OH	GENERAL JAMES M. GAVIN PLANT	373,413	90
2	4	GA	GA POWER CO BOWEN STM ELEC GEN STA	305,302	90
3	5	IN	INDIANA KENTUCKY ELECTRIC CORPORATION	281,423	90
4	5	IN	PSI - GIBSON	273,037	90
5	7	MO	UNION ELECTRIC COMPANY - LABADIE PLANT	250,119	90
6	5	OH	KYGER CREEK STATION OHIO VALLEY ELEC COR	249,143	90
7	4	GA	GA POWER CO WANSLEY STM ELEC GEN STA	248,651	90
8	5	OH	MUSKINGUM RIVER PLANT	245,099	90
9	5	IL	ILLINOIS POWER CO - BALDWIN POWER PLANT	233,770	92
10	3	PA	PEN ELEC - CONEMAUGH	186,043	90
11	7	MO	ASSOCIATED ELECTRIC	176,535	90
12	5	OH	JAMES M STUART ELEC GENERATING STATION	173,828	90
13	5	OH	OHIO EDISON COMPANY W H SAMMIS PLANT	169,131	90
14	3	PA	WEST PENN-HATFIELD	161,733	90
15	4	AL	ALA POWER CO-E C GASTON	156,480	92
16	4	FL	TAMPA ELEC-BIG BEND	149,425	90
17	5	OH	CARDINAL OPERATING COMPANY	148,751	90
18	4	KY	TVA- PARADISE A & B	137,432	90
19	5	IL	CENTRAL ILLINOIS PUBLIC SERVICE	136,408	92
20	5	IN	ALCOA GENERATING CORP.	135,281	90
21	3	PA	PEN ELEC - KEYSTONE	134,775	90
22	3	PA	PP & L - MONTOUR	132,446	90
23	4	GA	GA POWER CO YATES STM ELEC GEN STA	129,844	90
24	5	OH	CEI - EASTLAKE	128,547	90
25	5	OH	COLUMBUS SOUTHERN POWER-CONESVILLE	128,227	90
26	3	PA	PP & L - BRUNNER ISLAND	119,560	90
27	4	AL	ALABAMA POWER-GORGAS	114,484	92
28	5	IL	COM ED - KINCAID GENERATING STATION	113,987	92
29	5	IN	PSI - CAYUGA	109,973	92
30	3	PA	PEN ELEC - HOMER CITY	108,456	90

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities.

Table 2-18. Top 30 Industrial SO_2 Emitters in AIRS/AFS

U.S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	6	TX	ALUMINUM COMPANY OF AMERICA	67,364	90
2	5	IL	UNO-VEN COMPANY	53,036	92
3	6	TX	ASARCO INCORPORATED	47,341	90
4	7	MO	ASARCO INCORPORATED	44,136	90
5	9	AZ	ASARCO INCORPORATED	42,664	90
6	8	ND	DAKOTA GASIFICATION COMPANY	40,477	92
7	5	IL	SHELL OIL CO WOOD RIVER MFG COMPLEX	40,063	92
8	6	NM	PHELPS DODGE MINING/HIDALGO SMELTER	34,592	91
9	5	OH	USS/KOBE STEEL CO. - LORAIN WORKS	34,467	90
10	5	OH	MEAD CORPORATION	33,921	90
11	4	FL	GULF PWR-L SMITH	33,846	90
12	3	DE	STAR ENTERPRISE, DELAWARE CITY PLANT	32,878	90
13	8	UT	KENNECOTT	30,037	90
14	5	OH	ARMCO STEEL COMPANY L.P.	29,132	90
15	6	NM	PHELPS DODGE/CHINO MINES	28,058	91
16	4	AL	EXXON CO USA	25,876	92
17	6	LA	AGRICO-UNCLE SAM PLANT UNCLE SAM LA	25,727	90
18	5	IL	MOBIL JOLIET REFINING CORP	24,824	92
19	5	OH	WHEELING PITTSBURGH STEEL STEUBENVILLE S	22,714	90
20	4	TN	TENN EASTMAN CO	19,236	92
21	4	NC	CHAMPION INT CORP	18,613	89
22	8	MT	ASARCO INCORPORATED	18,251	92
23	5	WI	FORT HOWARD CORPORATION	18,071	90
24	4	MS	SHELL WESTERN E & P	17,116	86
25	7	IA	ADM-CLINTON	17,017	85
26	6	LA	REYNOLDS METALS CO. BROOKLAWN DRIVE	16,628	90
27	6	TX	CHEVRON U. S. A. PRODUCTS COMPANY	15,500	90
28	5	IL	CLARK OIL & REFINING CORPORATION	14,791	92
29	6	TX	MOBIL OIL CORPORATION	14,625	90
30	9	AZ	PHELPS DODGE	14,222	85

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that there may be inaccuracies and incompleteness in the data, and the data may not accurately reflect the current emissions of facilities.

Table 2-19. Top 30 Pb Emitters in AIRS/AFS

U. S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	7	NE	AMERICAN MICROTRACE CO	296.40	92
2	7	MO	DOE RUN COMPANY	157.00	90
3	5	IL	CHEMETCO	78.11	92
4	5	IL	GRANITE CITY STEEL COMPANY	76.29	92
5	7	MO	ASARCO INCORPORATED	54.15	90
6	7	MO	DOE RUN COMPANY	52.60	90
7	6	TX	ASARCO INCORPORATED	33.75	90
8	7	NE	MAGNOLIA METAL CORP	23.60	92
9	8	MT	ASARCO INCORPORATED	22.91	92
10	5	IL	PILOT BATTERY INC	12.93	92
11	5	IL	TARACORP INDUSTRIES - HOYT PLANT	12.19	92
12	6	AR	SWEPCO-FLINT CREEK	12.00	92
13	5	IL	GOULD INC-METALS DIV	11.17	92
14	5	IL	ACME STEEL COMPANY	11.04	92
15	6	TX	NORTH STAR STEEL TEXAS, INCORPORATED	10.27	90
16	7	NE	MAGNUS/FARLY INC	9.64	92
17	4	SC	GASTON COPPER RECYCL	8.01	91
18	5	IN	IPALCO - STOUT	7.12	90
19	5	IL	NORTH CHICAGO REFINERS AND SMELTERS INC	6.61	92
20	5	IL	ILLINOIS POWER CO - BALDWIN POWER PLANT	6.11	92
21	5	IN	GENERAL BATTERY CORP.(EXIDE CORPORATION)	4.65	92
22	5	IN	BREMEN CASTINGS INC	4.49	90
23	5	IL	POWERLAB INC	3.85	92
24	3	PA	ALLEGHENY LUDLUM STEEL	3.45	90
25	5	IL	GM-POWERTRAIN DIVISION	3.41	92
26	3	PA	ARMCO STAINLESS AND ALLOY PRODUCTS	3.10	90
27	4	AL	SANDERS LEAD CO	3.00	92
28	9	NV	NEVADA CEMENT CO	3.00	90
29	6	TX	GENERAL MOTORS CORPORATION	2.89	90
30	5	IN	NOBLESVILLE CASTING	2.79	90

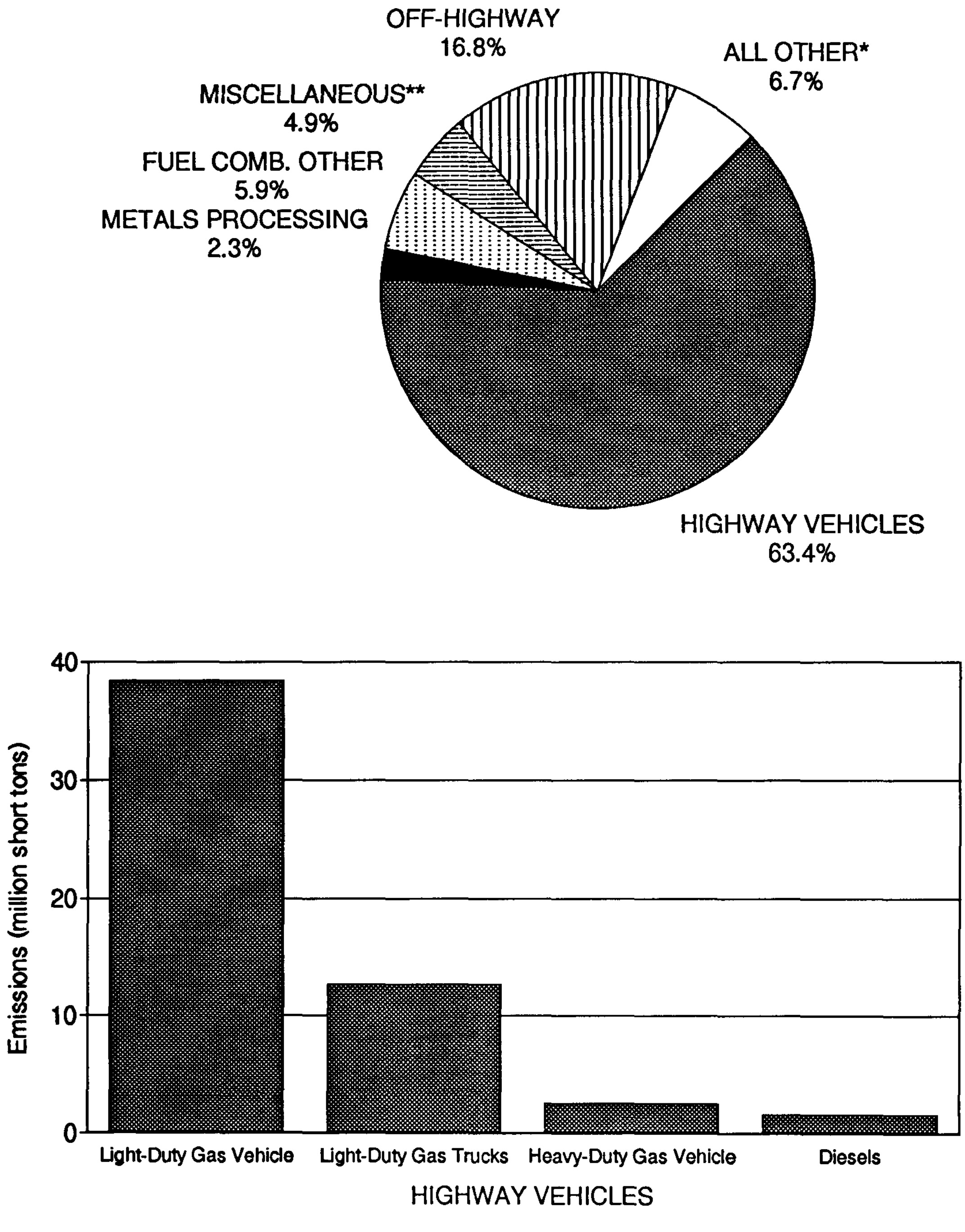
NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that most Pb estimates are UNDERESTIMATES due to incomplete data. The reader should use caution when comparing to data in other EPA reports, or when comparing rankings above.

Table 2-20. Top 30 PM-10 Emitters in AIRS/AFS

U.S. Rank	EPA Region	State	Plant Name	Emissions (tpy)	Year of Record
1	5	MN	LTV STEEL MINING CO	15,992	90
2	5	MN	US STEEL	15,295	90
3	7	MO	NEMO COAL, INC.	11,562	87
4	5	WI	CONSOLIDATED PAPERS INC-KRAFT DIV	10,508	90
5	7	NE	ASH GROVE CEMENT CO	10,246	92
6	1	ME	DRAGON PRODUCTS COMPANY, INC.	9,915	90
7	9	AZ	ASARCO	5,920	92
8	7	MO	EMPIRE DISTRICT ELEC	5,661	90
9	5	IL	NORTH CHICAGO REFINERS AND SMELTERS INC	4,607	92
10	5	IL	COUNTRYMARK COOPERATIVE, INC.	4,447	92
11	5	IL	BIG RIVER ZINC CORPORATION	4,321	92
12	8	ND	UPA/CPA: COAL CREEK STATION	4,212	92
13	8	WY	PACIFICORP - JIM BRIDGER	3,999	92
14	5	IL	PEABODY COAL CO MIDWEST DIVISION	3,371	92
15	7	MO	HARBISON-WALKER REFRACTORY	3,334	87
16	5	IL	ACME STEEL COMPANY-CHICAGO COKE PLANT	3,330	92
17	1	ME	S. D. WARREN CO. SCOTT PAPER CO	3,166	90
18	5	IN	CENTRAL SOYA COMPANY INC	3,129	90
19	1	CT	EXETER ENERGY CO	3,089	91
20	5	IL	ILLINOIS POWER CO - BALDWIN POWER PLANT	3,076	92
21	7	NE	ENDICOTT CLAY PRODUCTS	2,986	92
22	10	WA	PACIFIC POWER_& LIGHT CO.	2,791	92
23	5	IL	NORTHWEST WASTE TO ENERGY	2,737	92
24	3	PA	BETHLEHEM STEEL CORP.	2,701	90
25	7	MO	US ARMY ENGINEER CEN	2,648	87
26	3	PA	UNITED STATES STEEL CORP., THE	2,598	90
27	3	PA	PP & L - MONTOUR	2,585	90
28	5	IL	A E STALEY MANUFACTURING CO	2,568	92
29	7	MO	IMPERIAL PRODUCTS CO	2,461	90
30	5	IL	BUNGE CORPORATION	2,458	92

NOTE(S): These data were reported as found in AIRS/AFS. EPA recognizes that most PM-10 estimates are UNDERESTIMATES due to incomplete data. The reader should use caution when comparing to data in other EPA reports, or when comparing rankings above.

Figure 2-1. CO 1992 National Emissions by Source Categories



* ALL OTHER is defined in section 2.1.1

** Miscellaneous is primarily forest fire emissions.

Figure 2-2. Top 10 CO-Emitting States in 1992

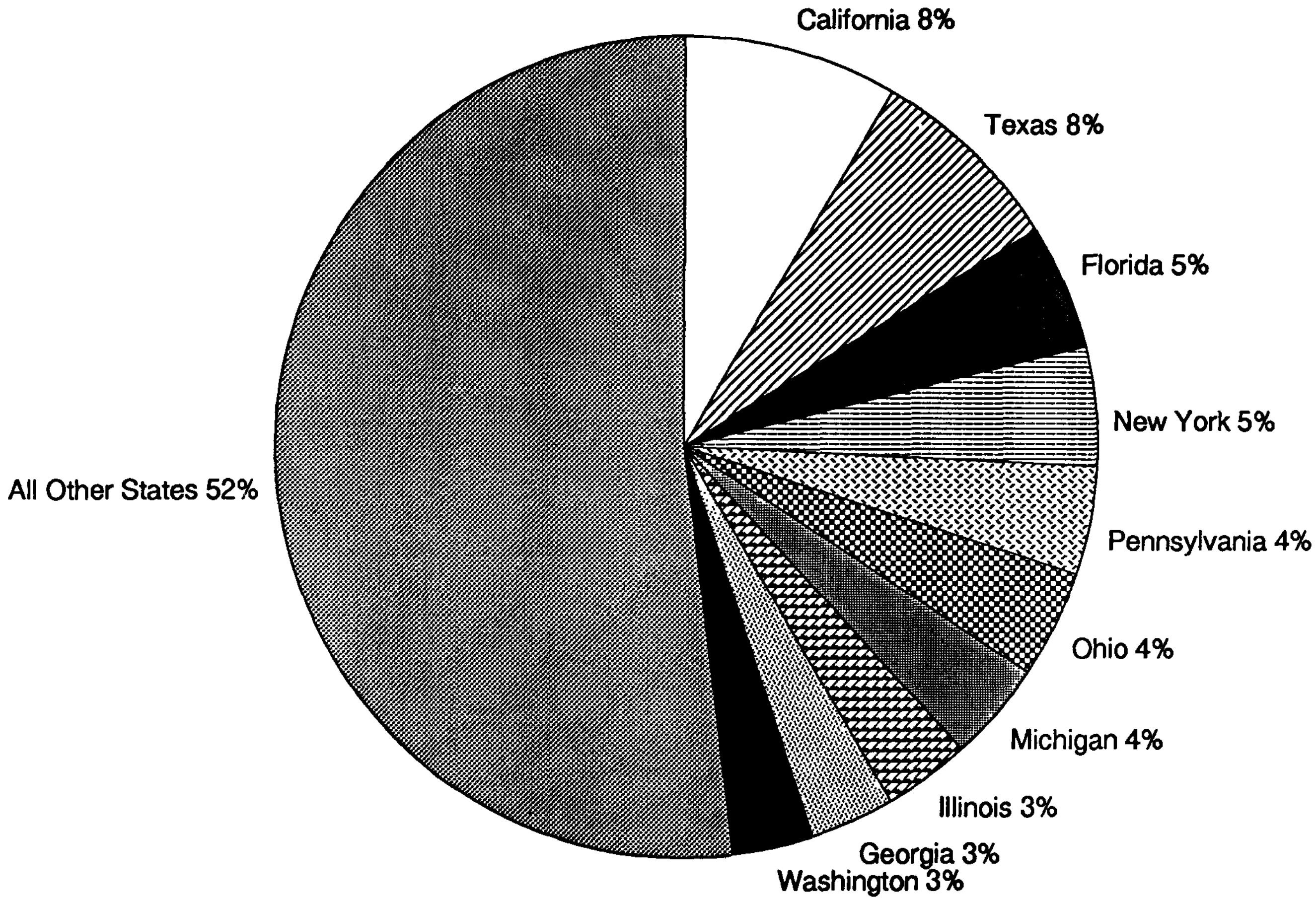


Figure 2-3. Density Map of 1992 CO County-level Emissions

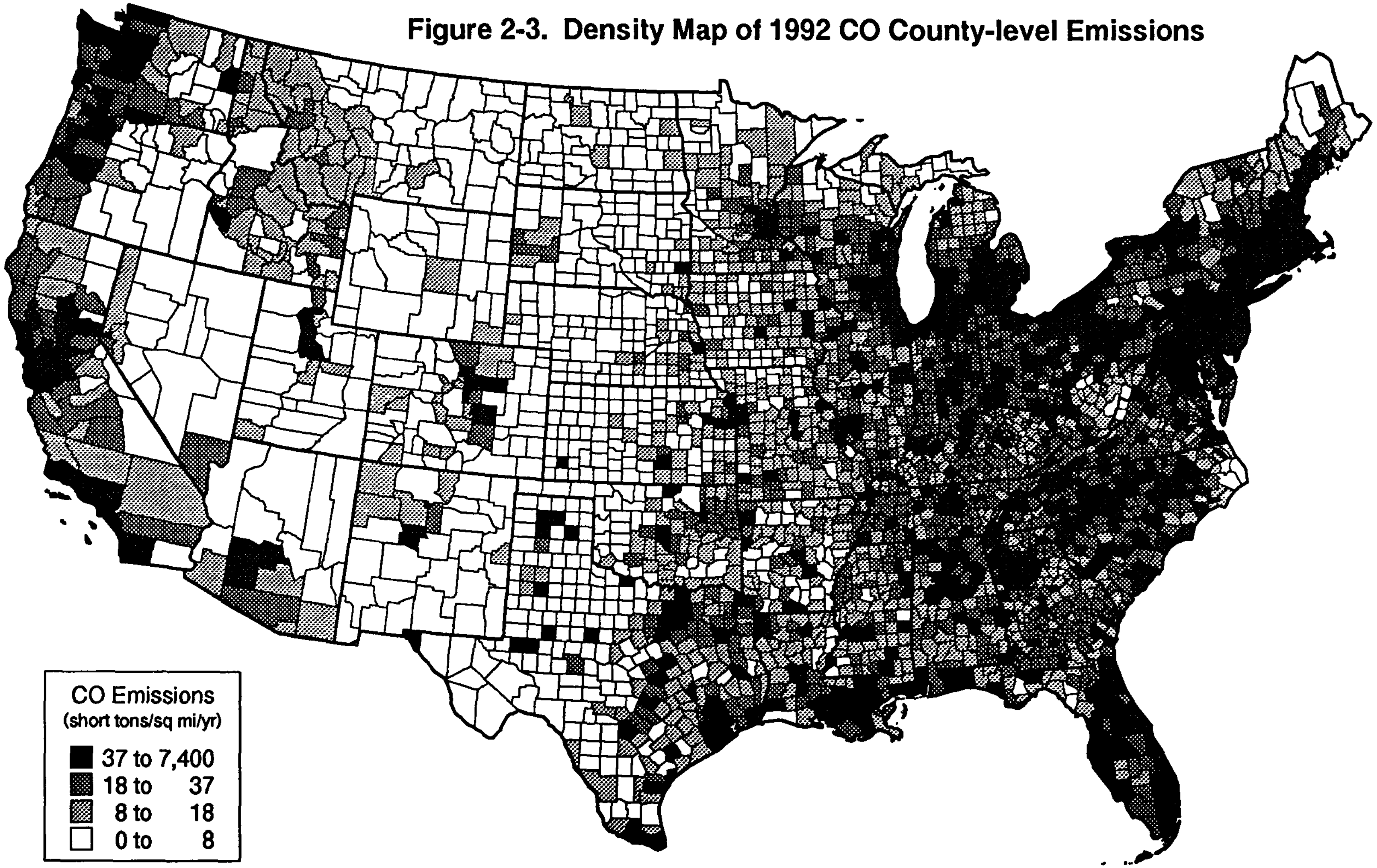
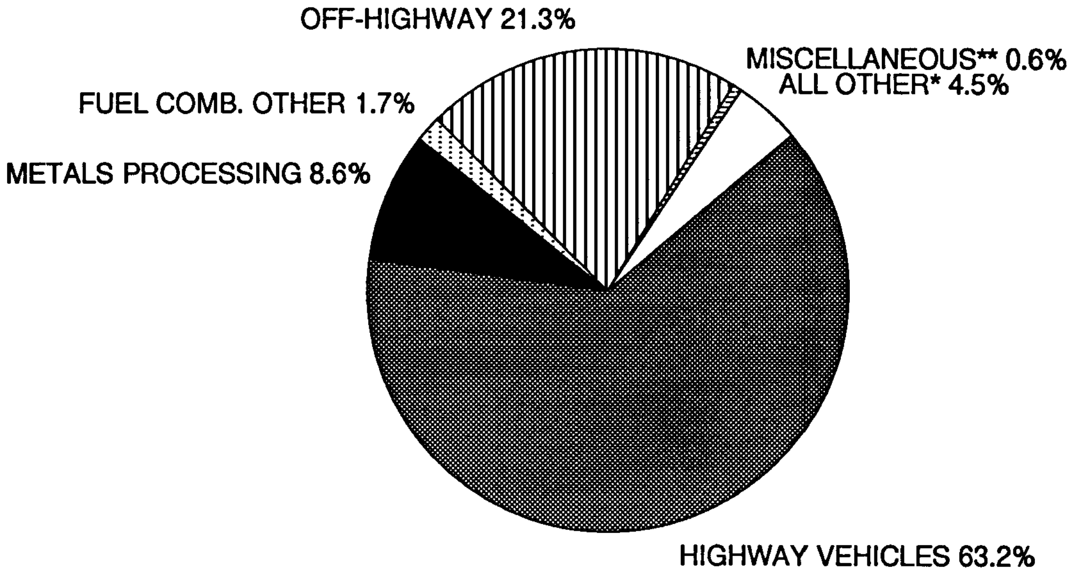
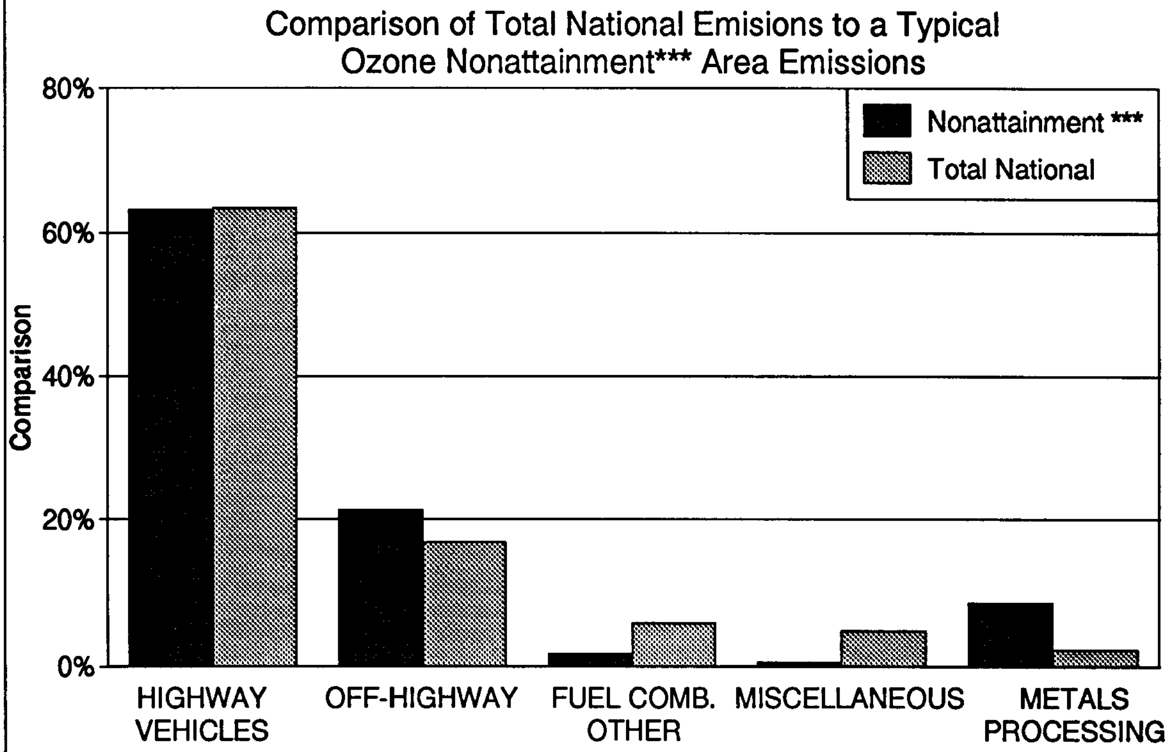


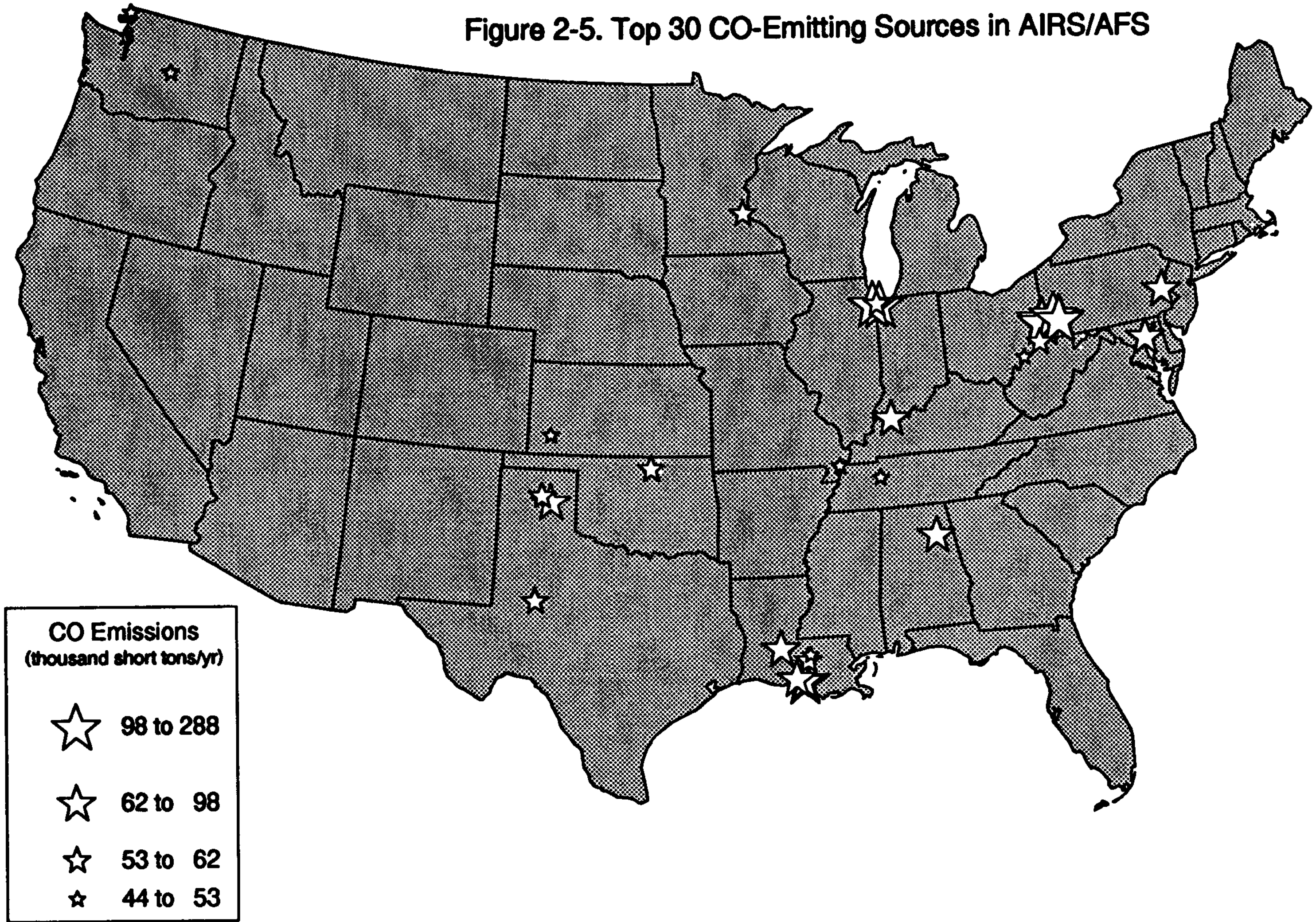
Figure 2-4. 1992 CO Emissions for a Typical Ozone Nonattainment* Area by Source Category**





* ALL OTHER is defined in section 2.1.1
** Miscellaneous is primarily forest fires
*** Nonattainment = serious and above

Figure 2-5. Top 30 CO-Emitting Sources in AIRS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

Figure 2-6. 1992 Seasonal CO Emissions by Tier 1 Source Category

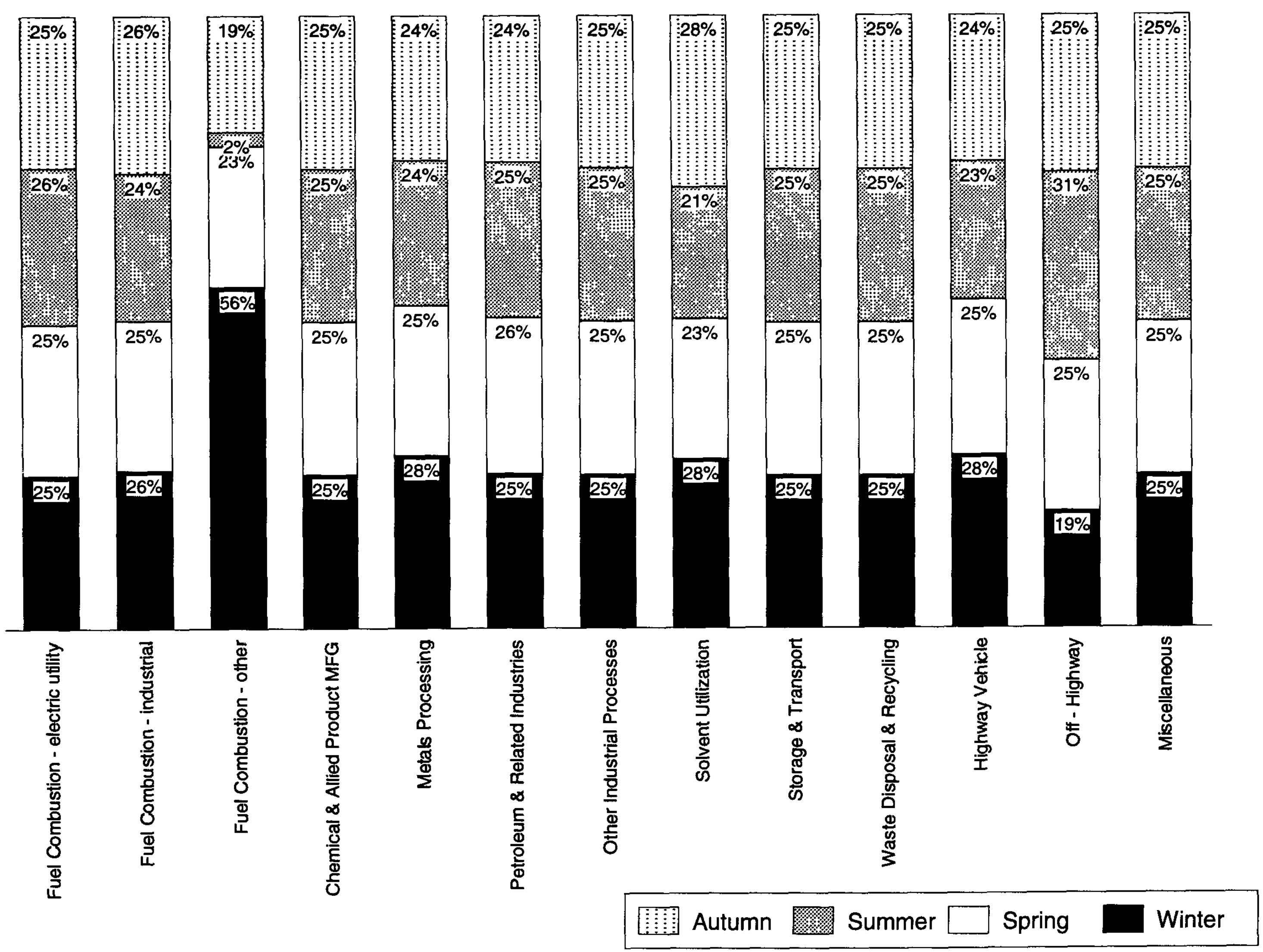
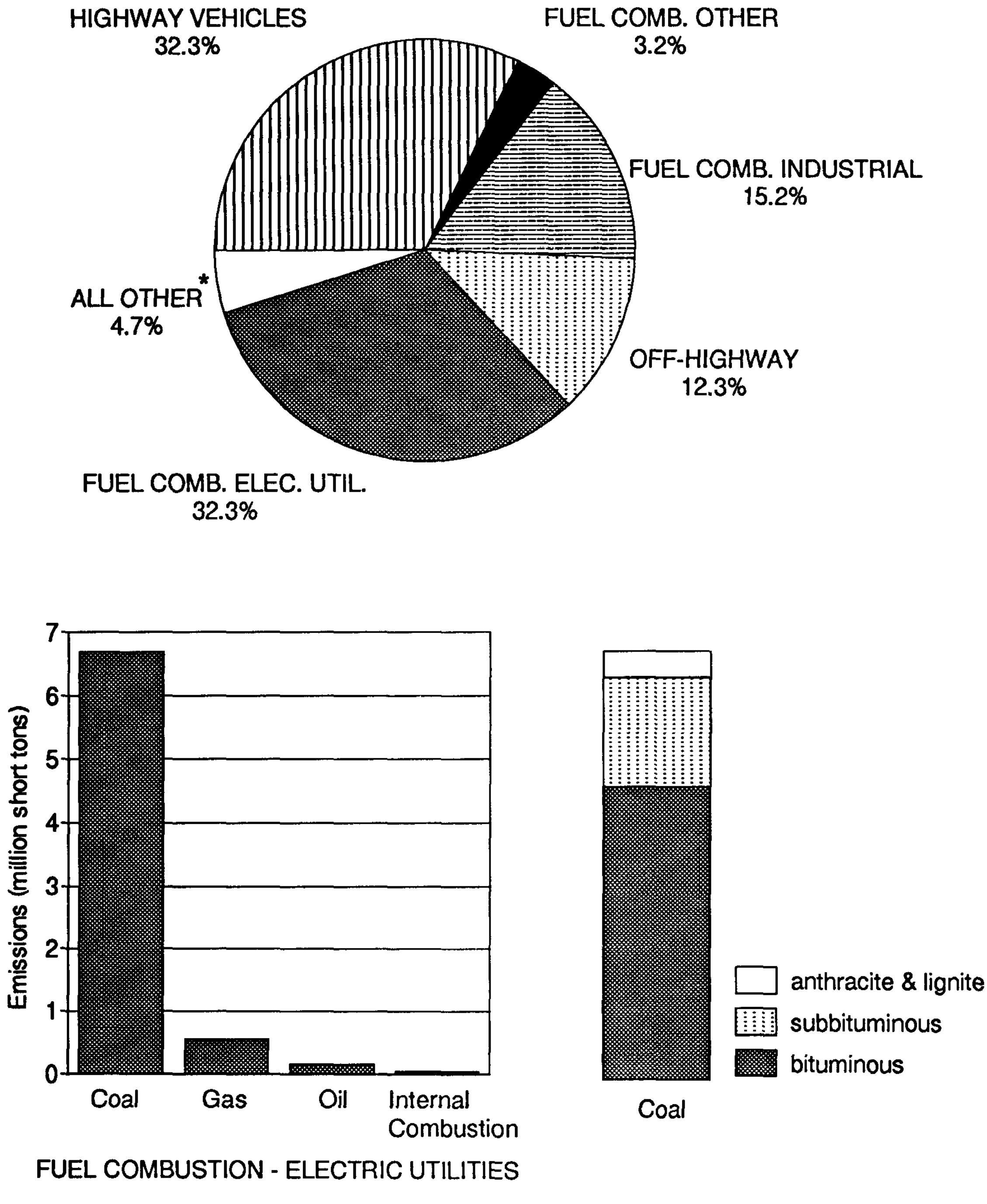


Figure 2-7. NO_x 1992 National Emissions by Source Categories



* ALL OTHER is defined in section 2.2.1

Figure 2-8. Top 10 NO_x-Emitting States in 1992

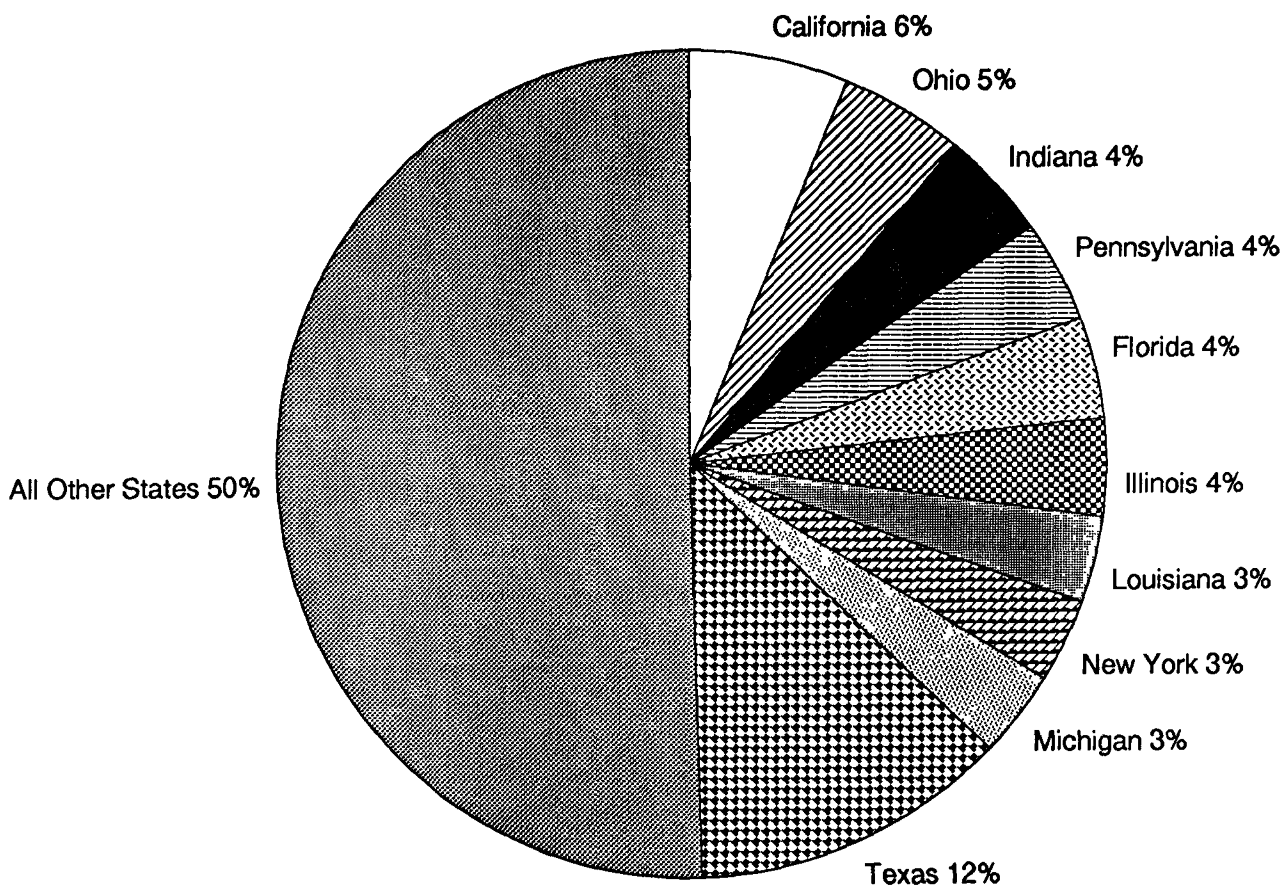


Figure 2-9. Density Map of 1992 NO_x County-level Emissions

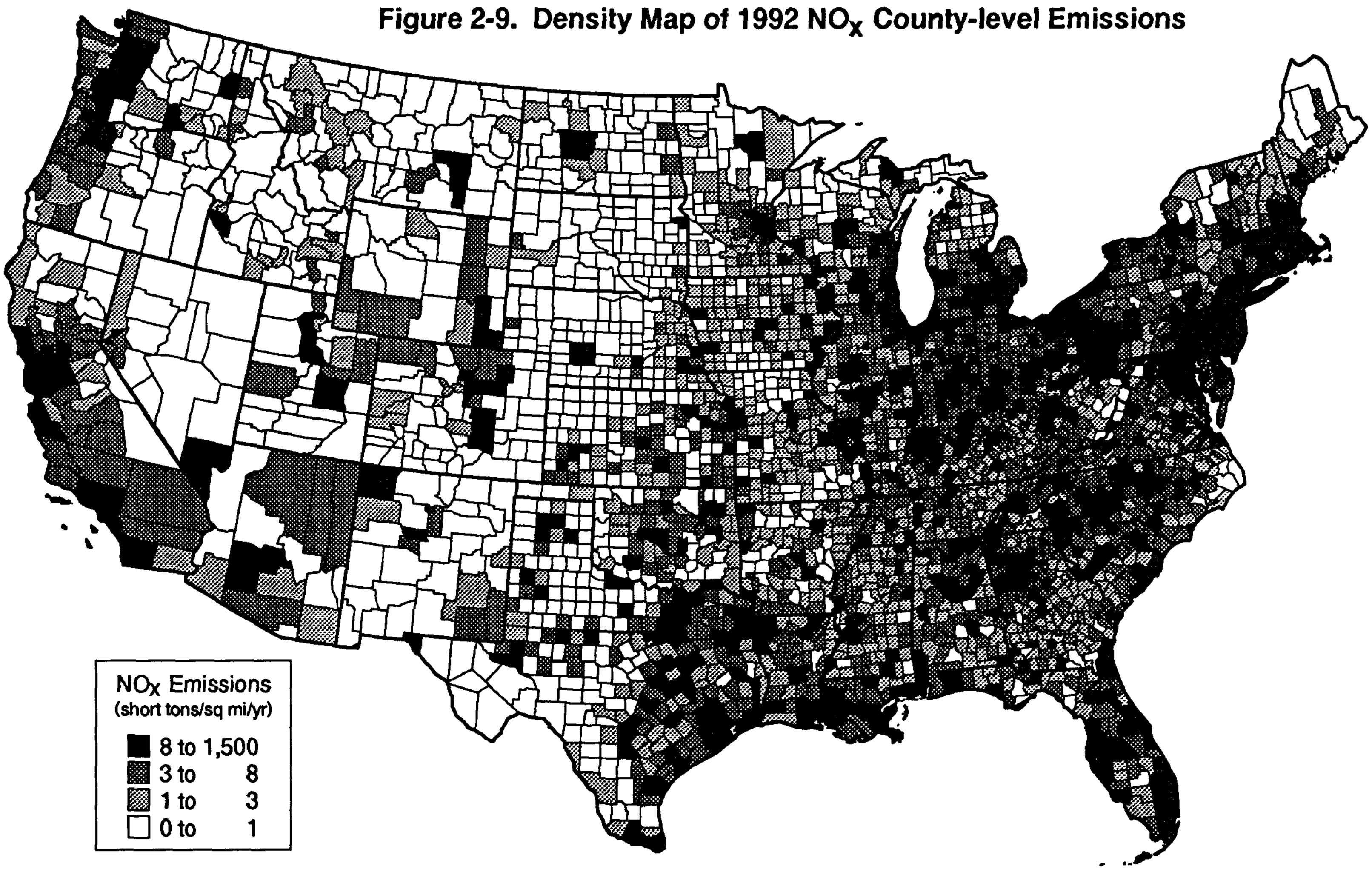
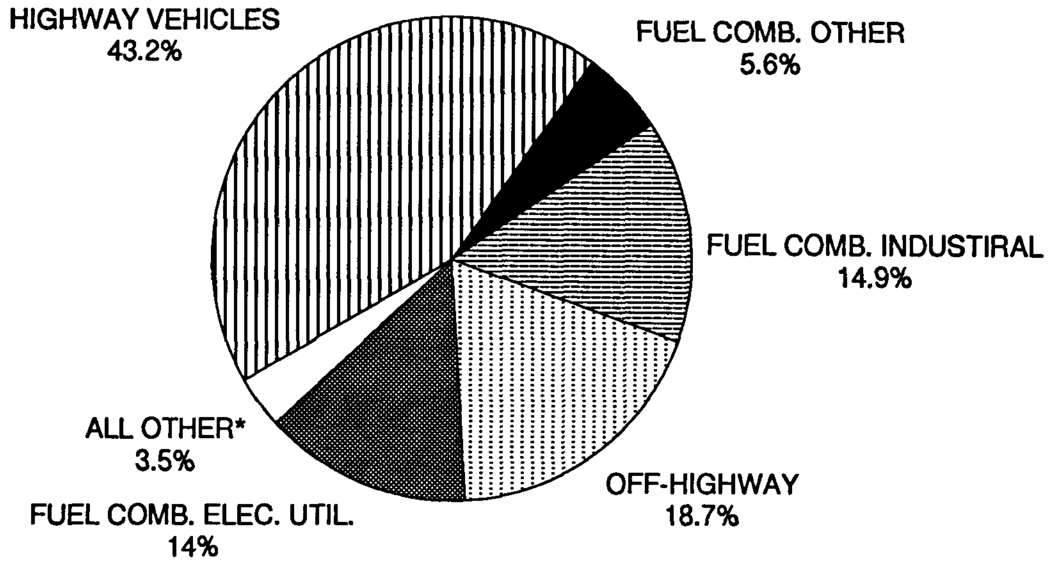
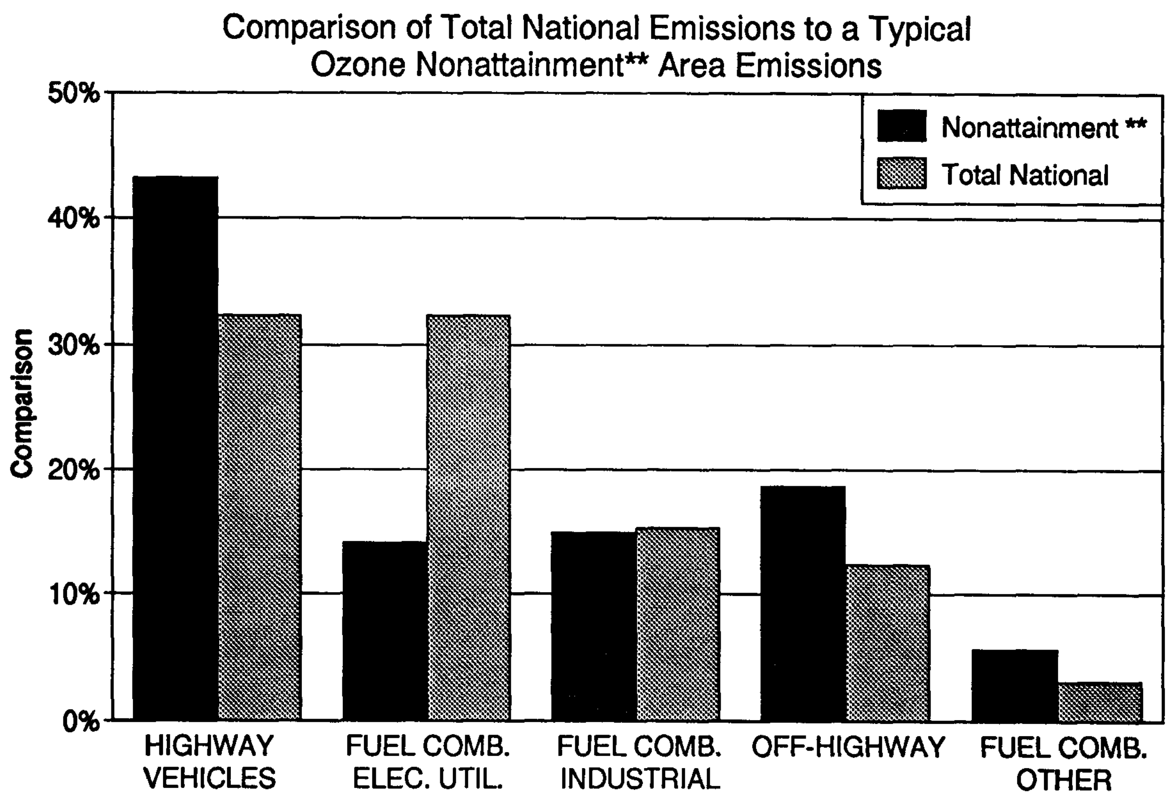


Figure 2-10. 1992 NO_x Emissions for a Typical Ozone Nonattainment Area by Source Category**

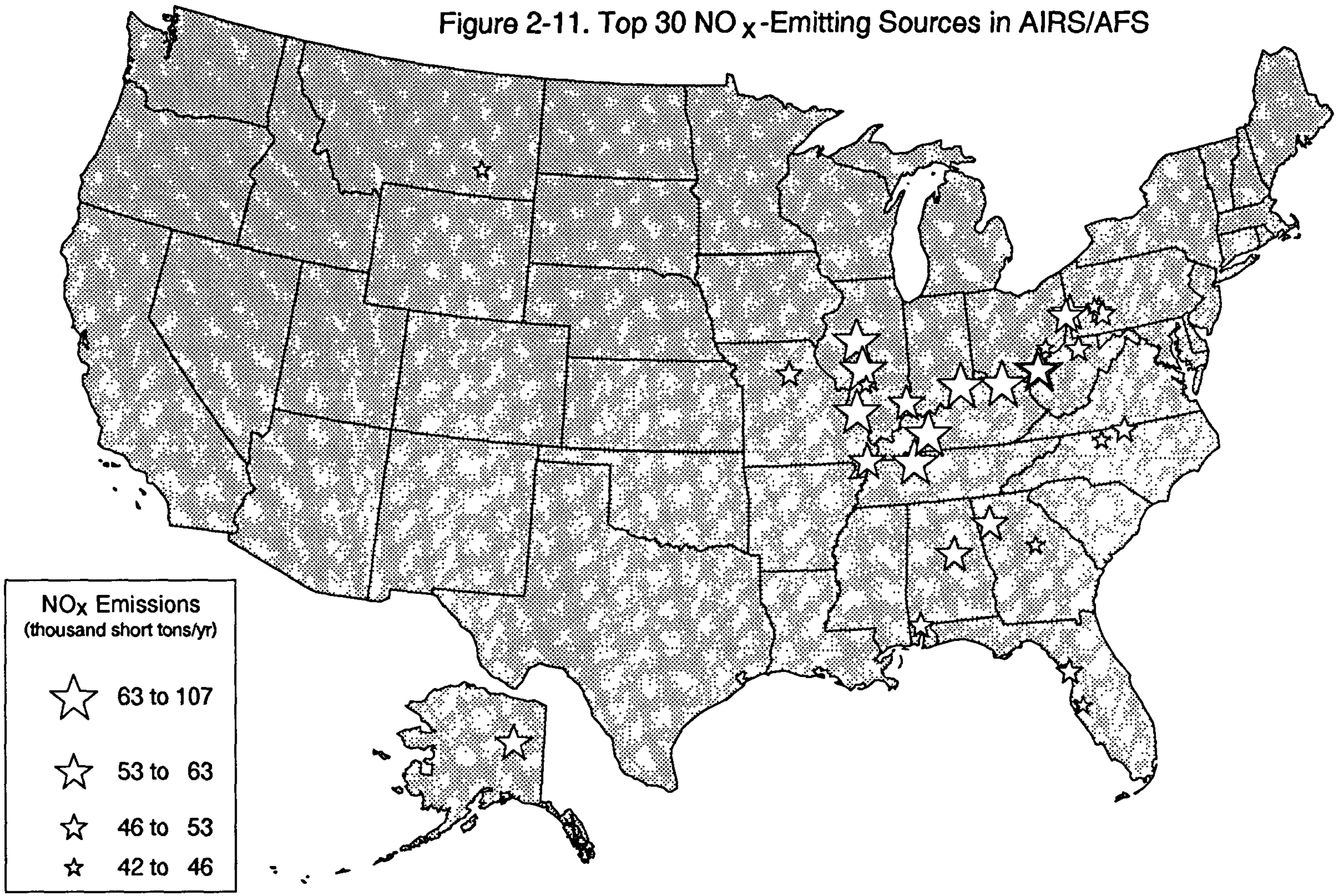




* ALL OTHER is defined in section 2.2.1

** Nonattainment = typical serious and above

Figure 2-11. Top 30 NO_X-Emitting Sources in AIRS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

Figure 2-12. 1992 Seasonal NO_x Emissions by Tier 1 Source Category

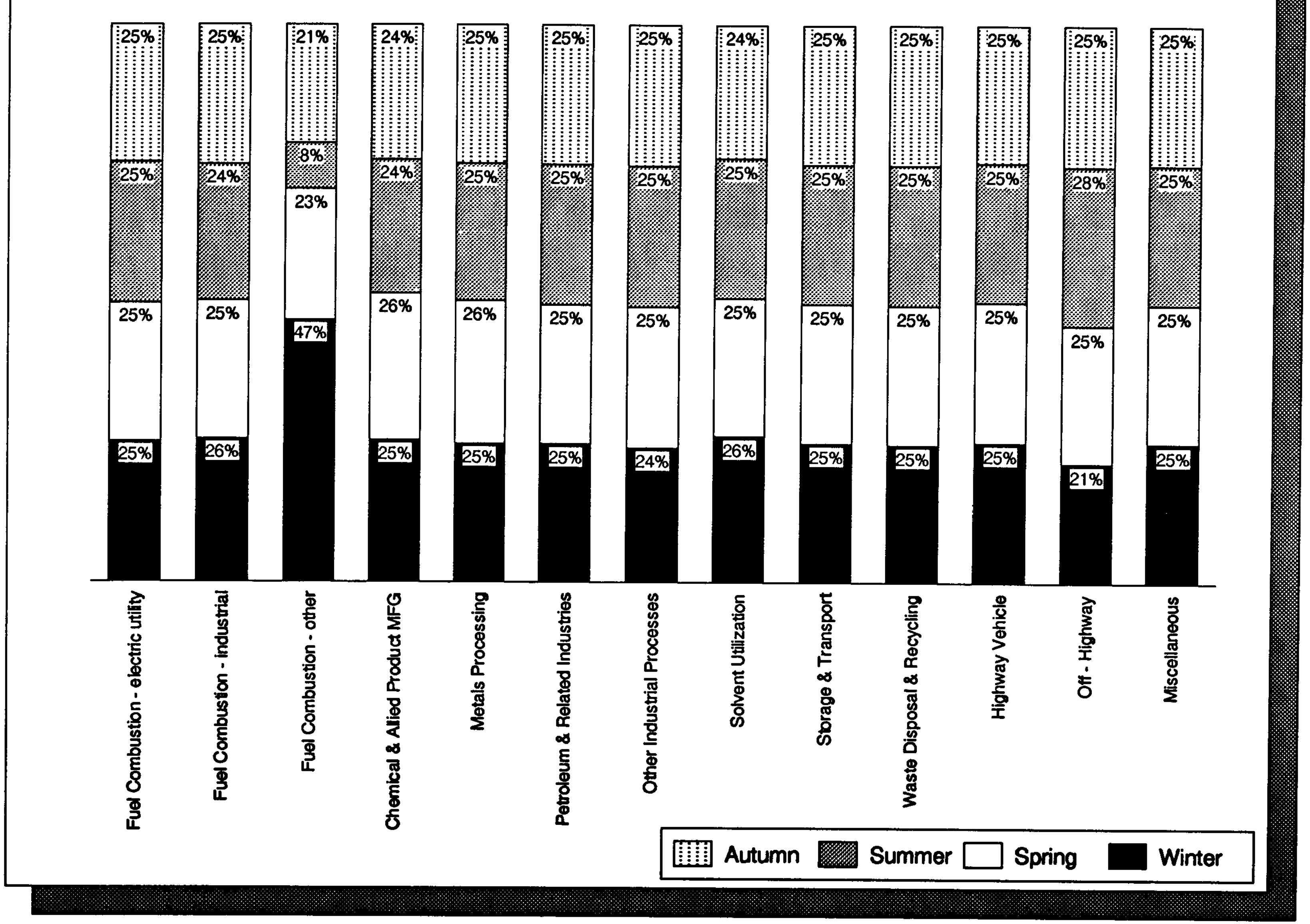
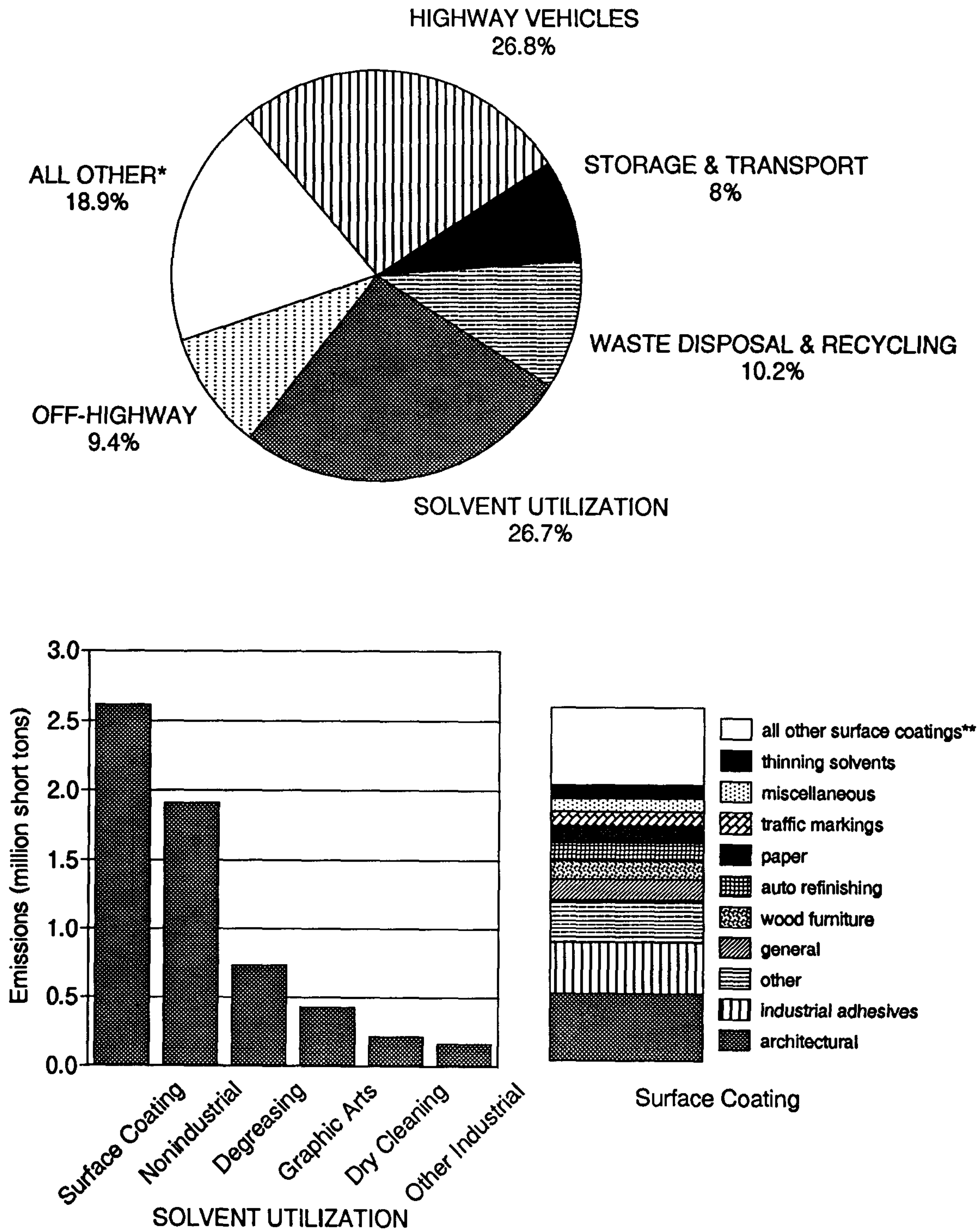


Figure 2-13. VOC 1992 National Emissions by Source Categories



* ALL OTHER is defined in section 2.3.1

** All other surface coatings are the remaining surface coating categories listed in Table A-9, Appendix A.

Figure 2-14. Top 10 VOC-Emitting States in 1992

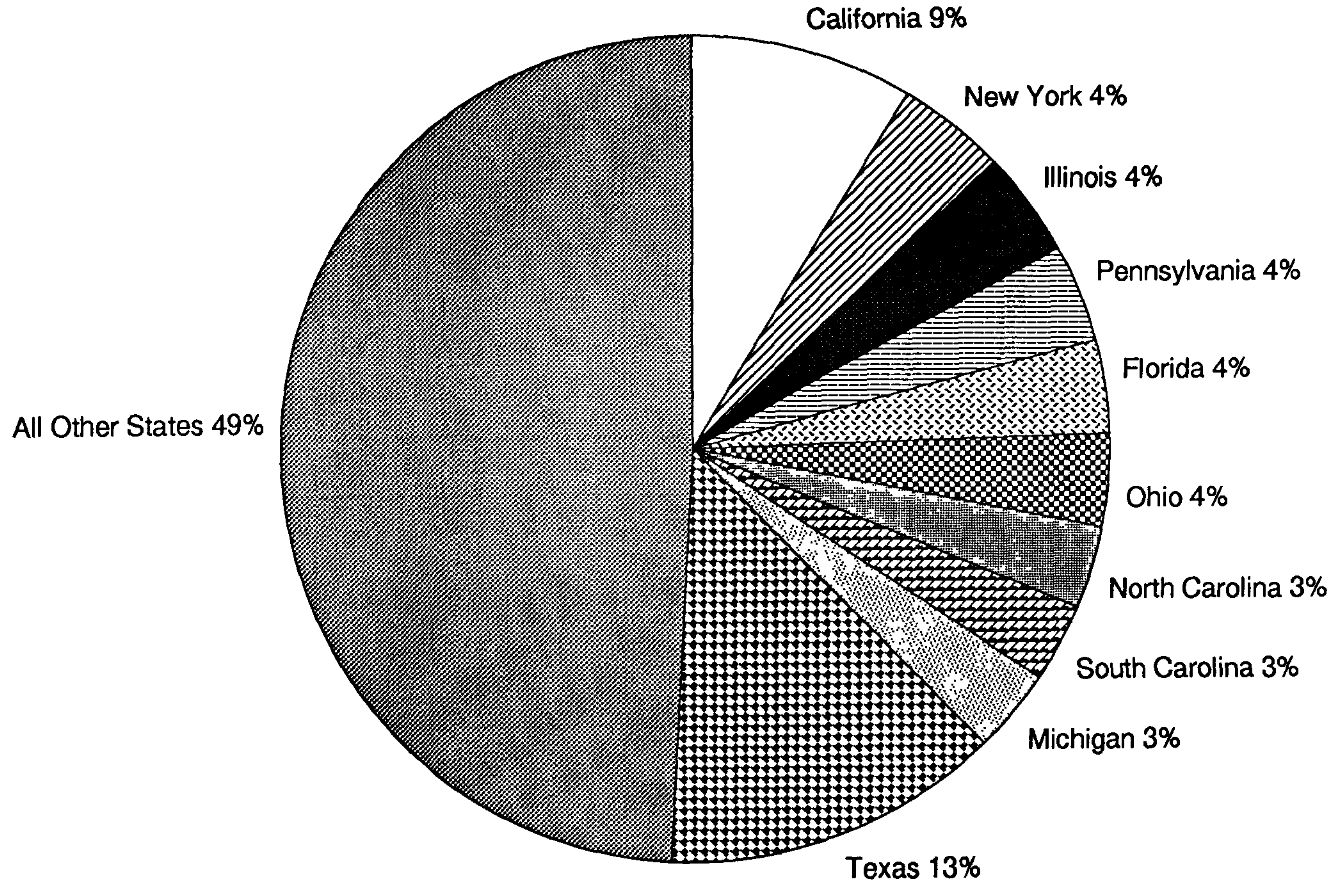


Figure 2-15. Density Map of 1992 VOC County-level Emissions

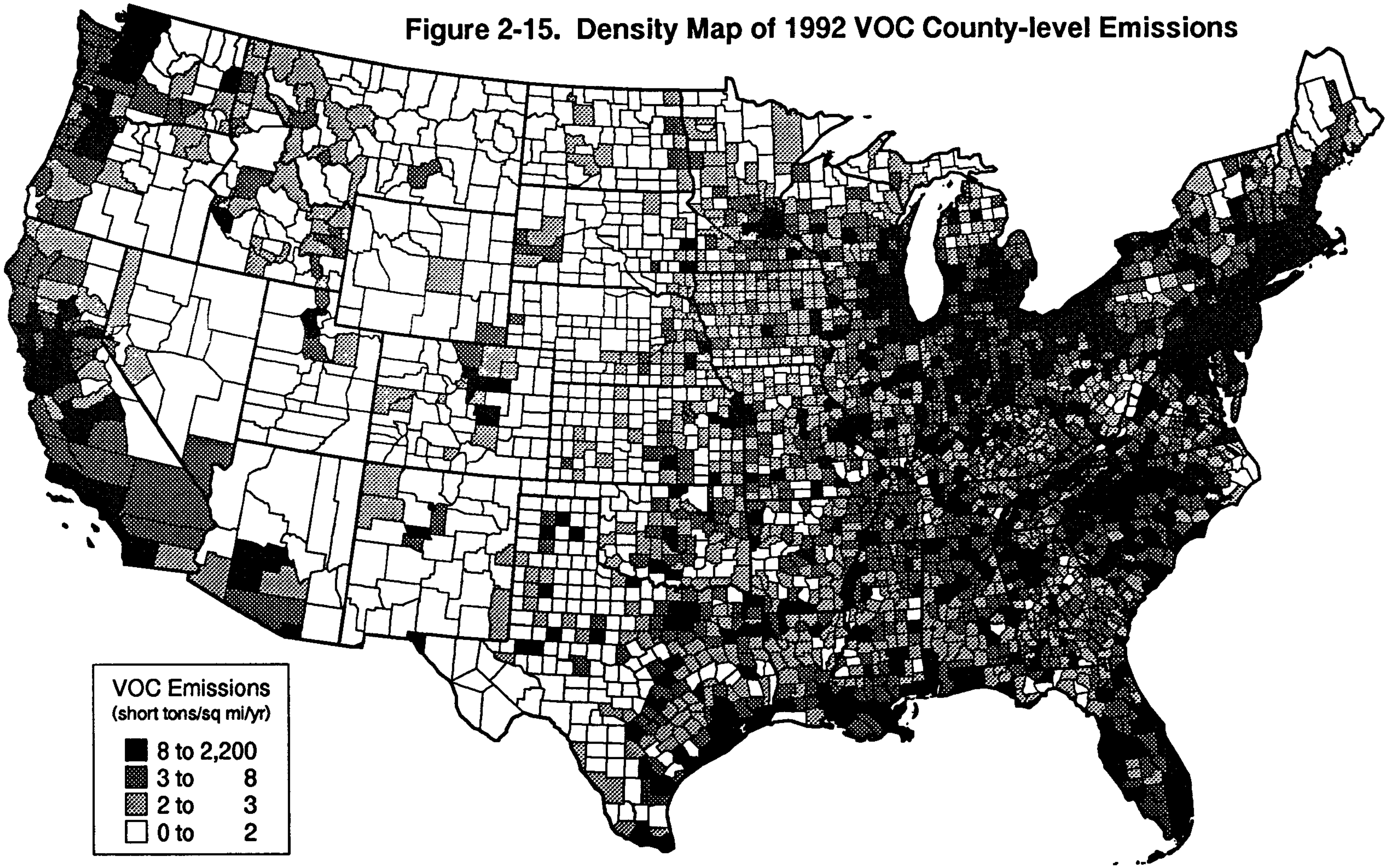
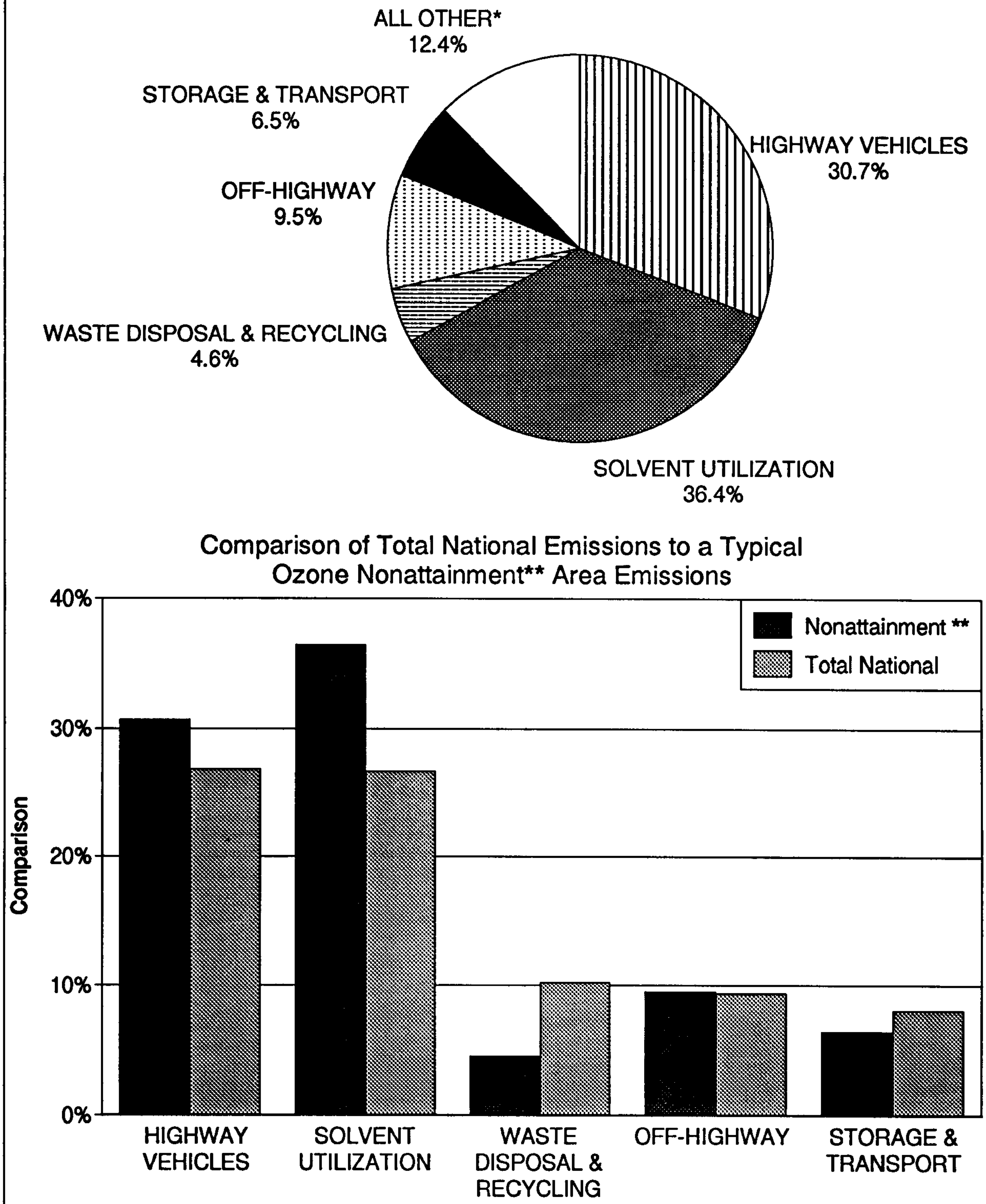


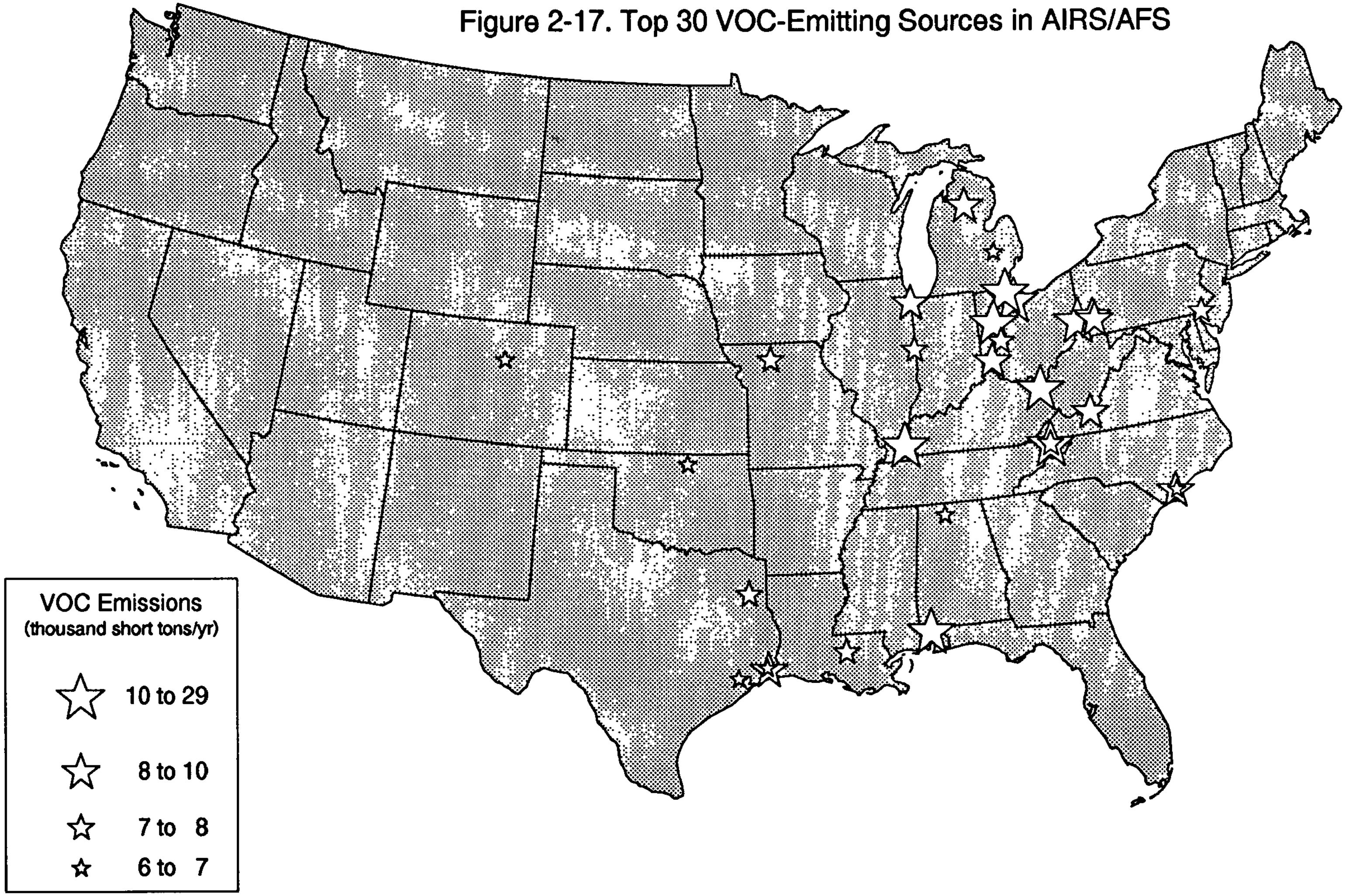
Figure 2-16. 1992 VOC Emissions for a Typical Nonattainment Area by Source Category**



* ALL OTHER is defined in section 2.3.1

** Nonattainment = serious and above

Figure 2-17. Top 30 VOC-Emitting Sources in AIRS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

Figure 2-18. 1992 Seasonal VOC Emissions by Tier 1 Source Category

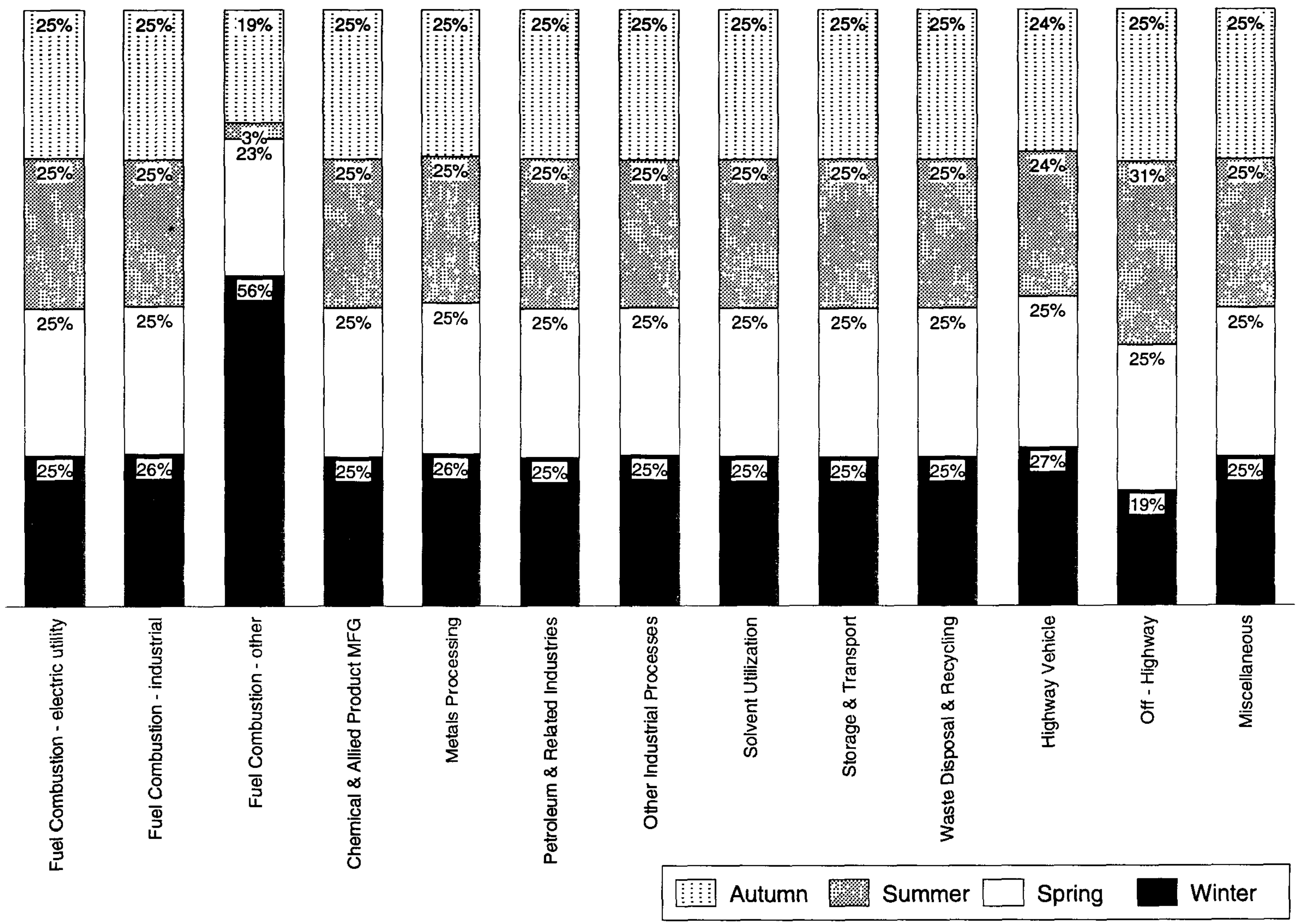
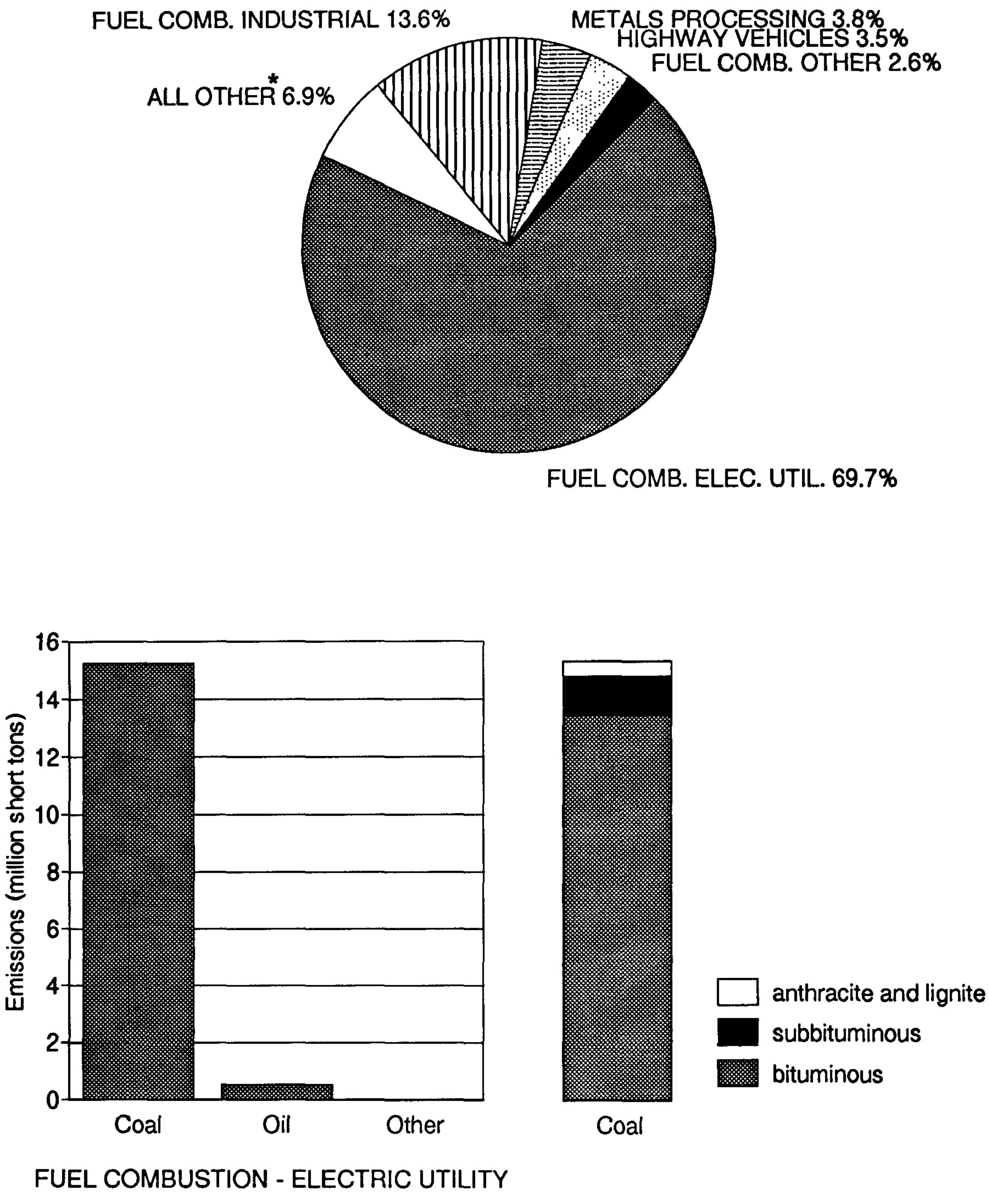


Figure 2-19. SO_2 1992 National Emissions by Source Categories



* ALL OTHER is defined in section 2.4.1

Figure 2-20. Top 10 SO_2 -Emitting States in 1992

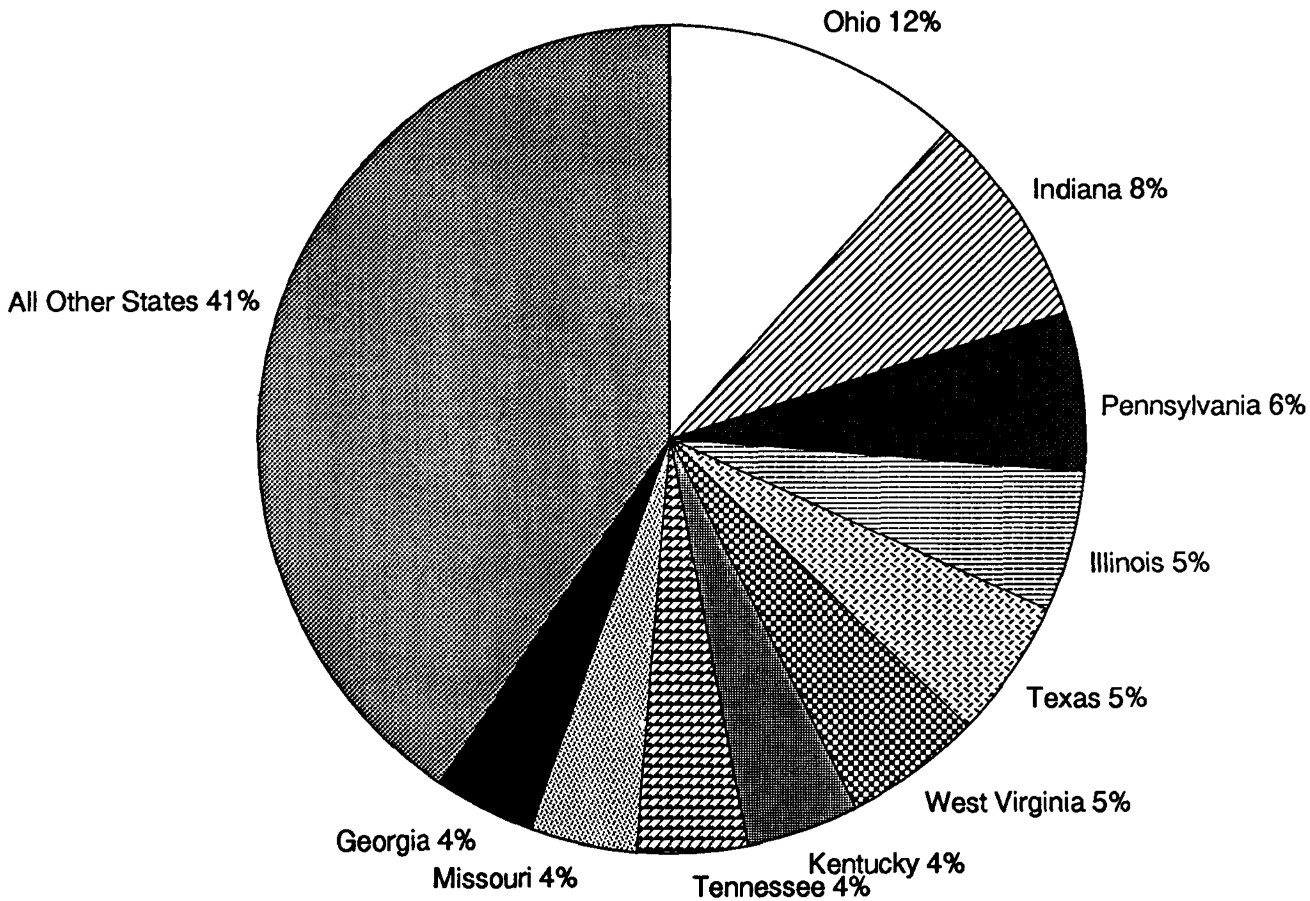


Figure 2-21. Density Map of 1992 SO_2 County-level Emissions

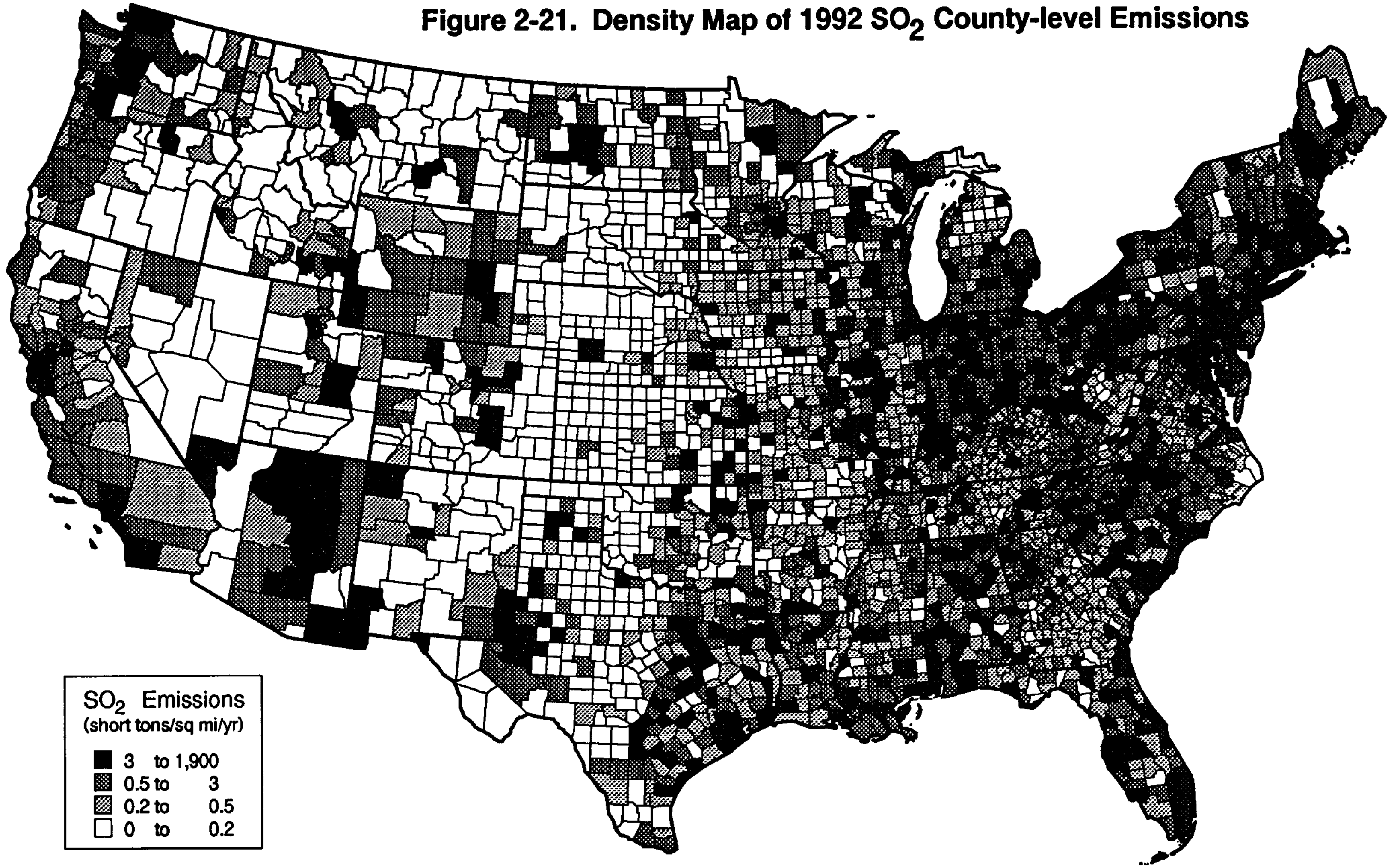
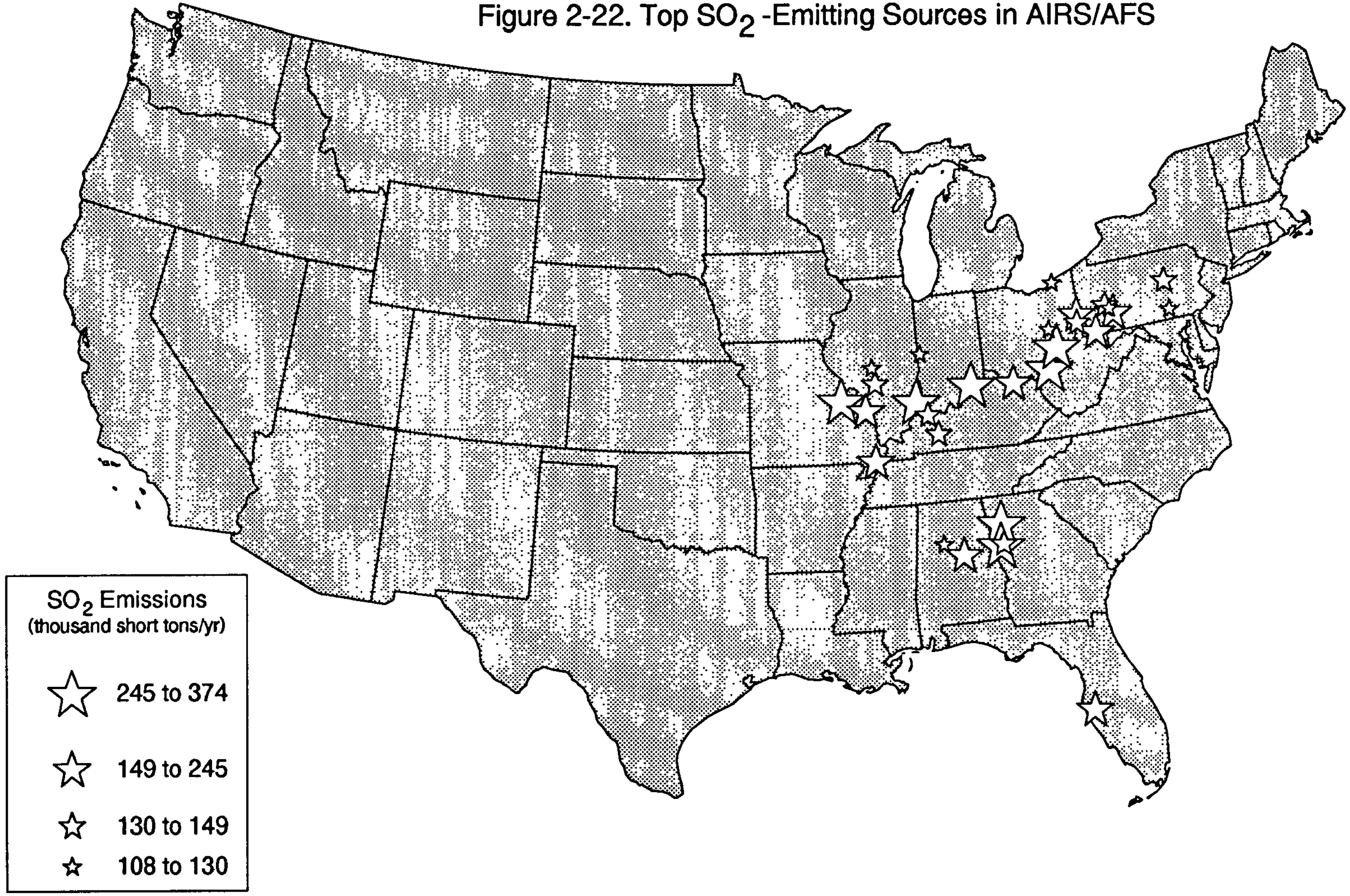
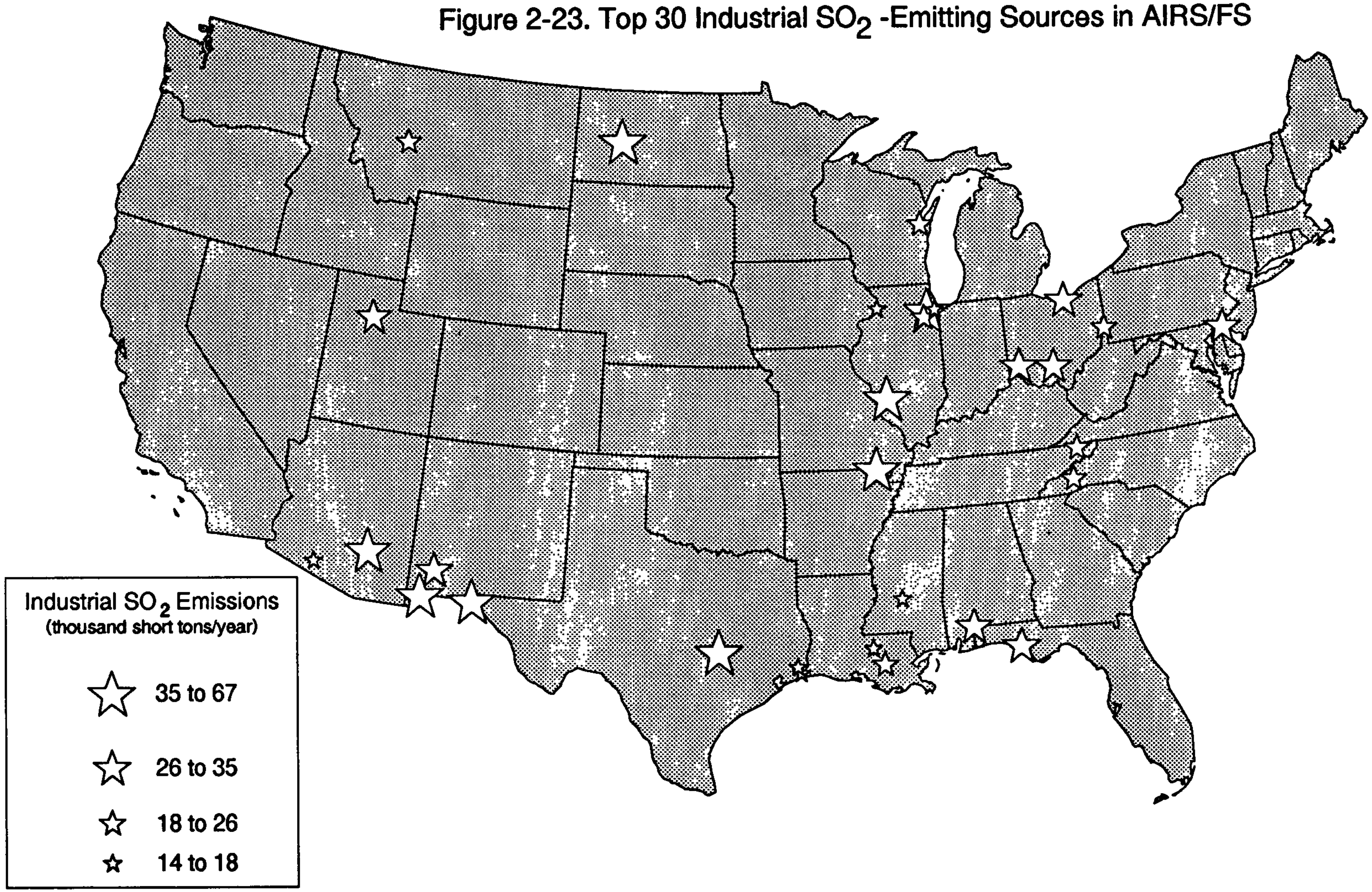


Figure 2-22. Top SO_2-Emitting Sources in AIRS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

Figure 2-23. Top 30 Industrial SO_2 -Emitting Sources in AIRS/FS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

Figure 2-24. 1992 Seasonal SO_2 Emissions by Tier 1 Source Category

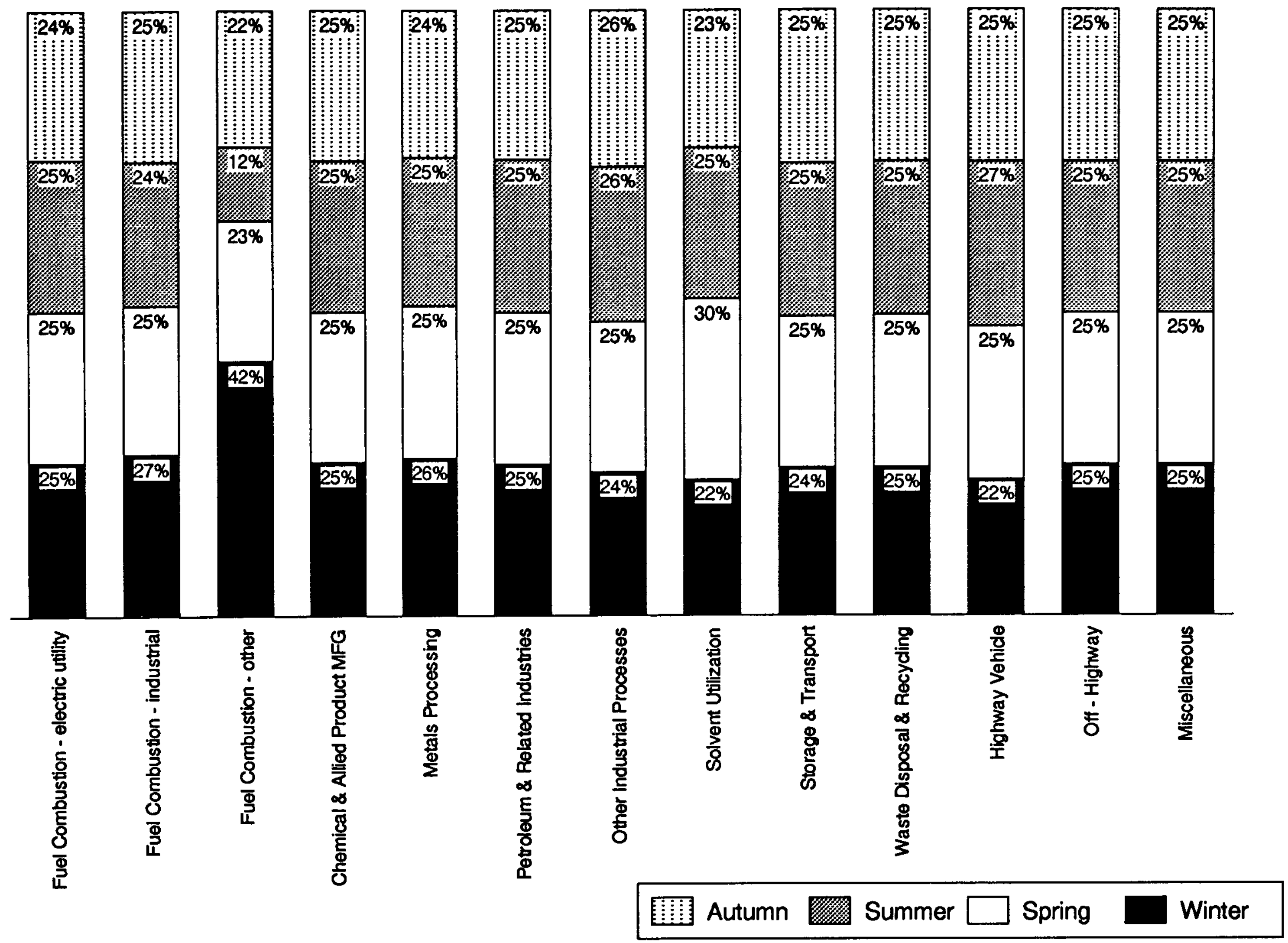
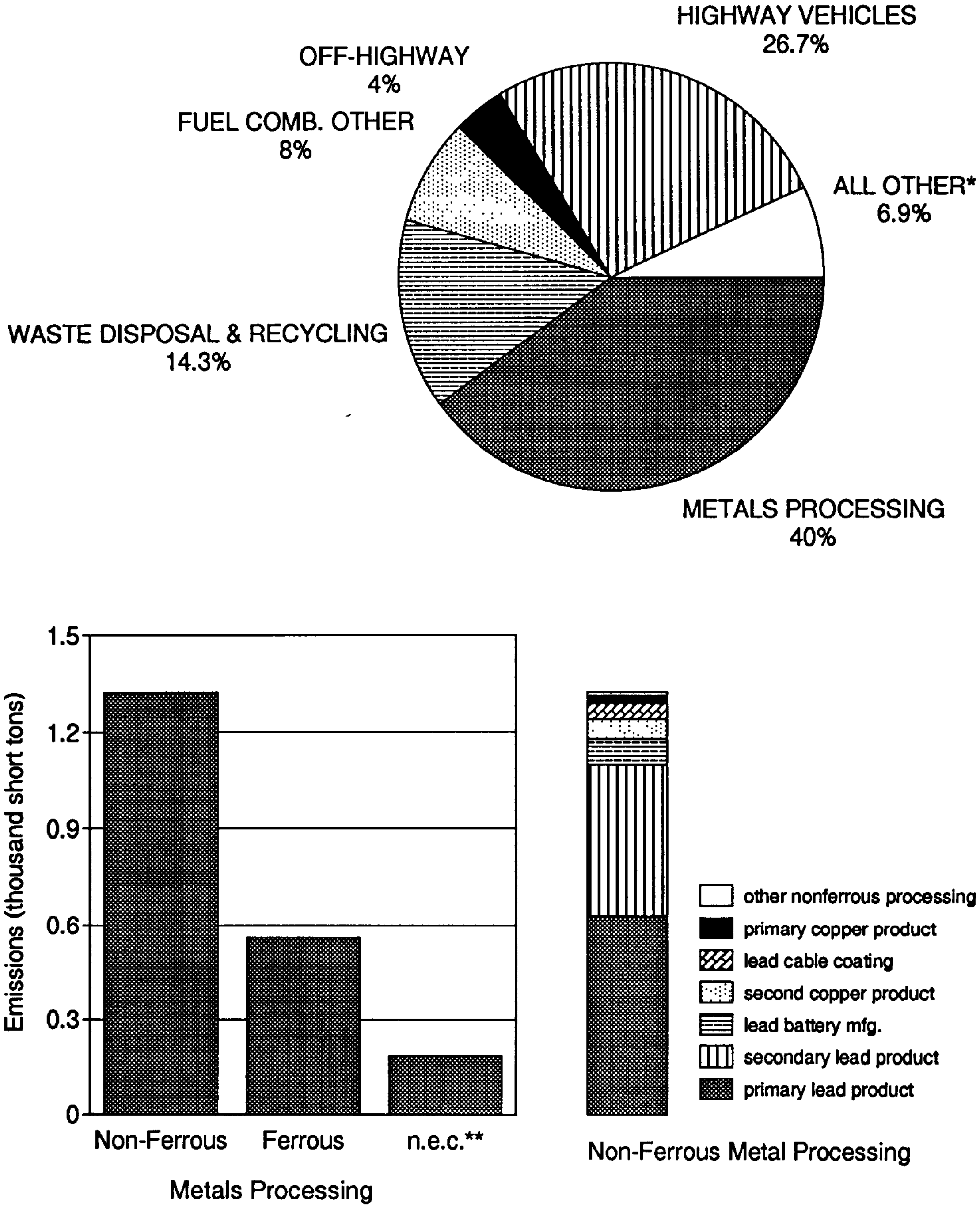
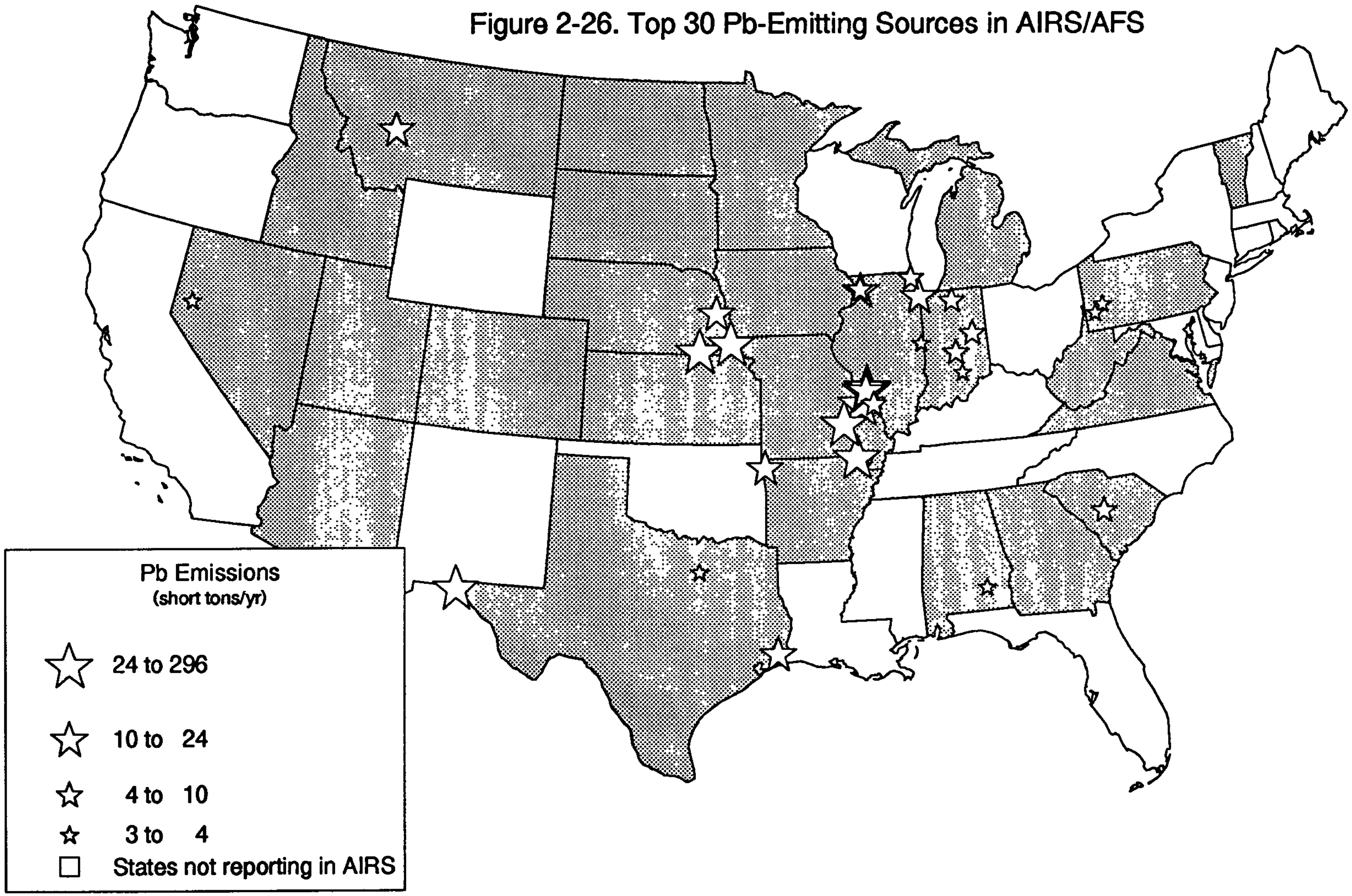


Figure 2-25. Pb 1992 National Emissions by Source Categories



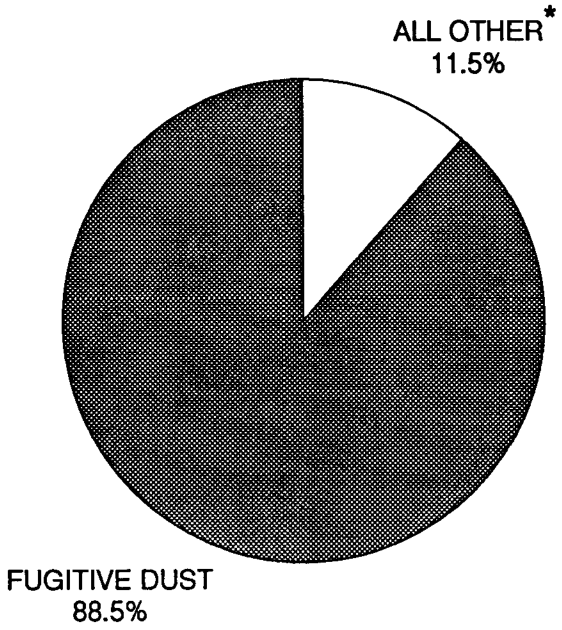
* ALL OTHER is defined in seciton 2.5.1
** not elsewhere classified.

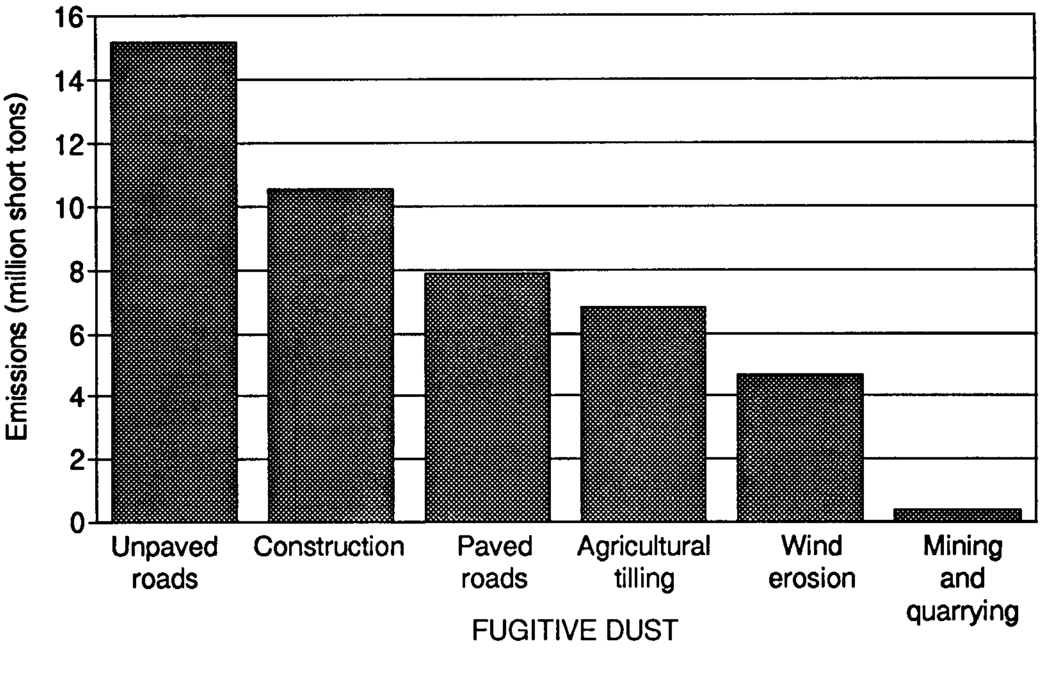
Figure 2-26. Top 30 Pb-Emitting Sources in AIRS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

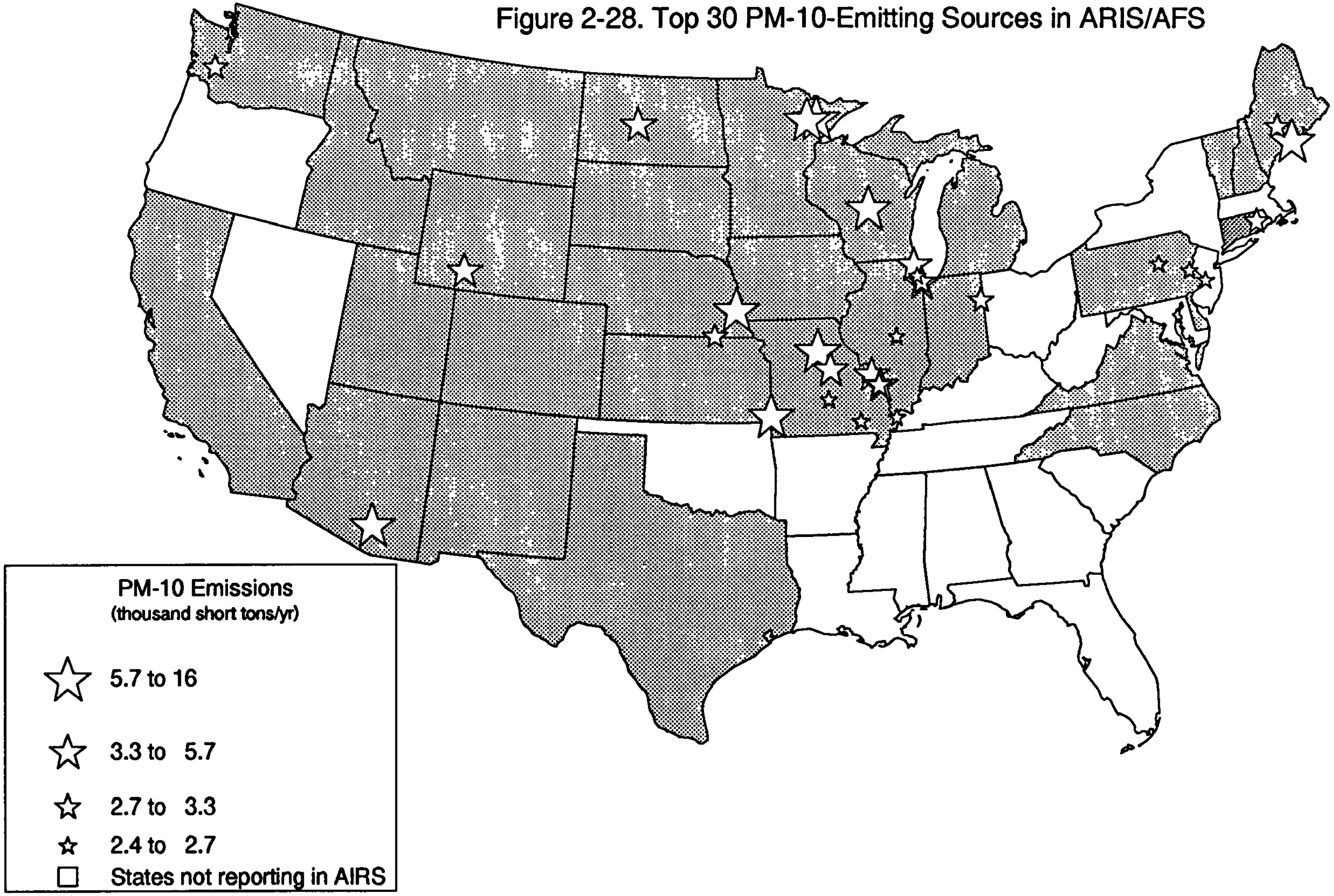
Figure 2-27. PM-10 1992 National Emissions by Source Categories





* ALL OTHER categories are listed with emissions in Tables A-18, A-19, and A-20 in Appendix A.

Figure 2-28. Top 30 PM-10-Emitting Sources in ARIS/AFS



Note: These sources were extracted from AIRS/AFS on November 19, 1993

SECTION 3.0

SUMMARY OF NATIONAL EMISSION TRENDS

This section presents the estimated national emission trends. Estimates for CO, NO_x, SO_2, and VOC for 1990, 1991, and 1992 are preliminary, as explained in section 5, and will change as ozone SIP inventory information becomes available. Emission estimates for Pb and PM-10 are preliminary for 1992, and the 1991 reported as preliminary estimates in the previous report[7] have been revised.

3.1 INTRODUCTION

The historic NAPAP emission estimates presented in Table ES-1 for the period from 1900 to 1935 and for the years 1945, 1955, and 1965 were extracted from two reports: a report on historic U.S. emissions of SO_2 and NO_x[2] and a report on historic U.S. emissions of VOC.[3] These estimates are based on national fuel consumption, industrial production rates, and various other indicators of source category activity and emission factors. The historic SO_2 and NO_x emission estimates have been compared to other available estimates of historic emissions, including estimates from the 1985 *Trends* report[8], and differences among estimates have been reconciled.[9] Historic national emissions of NO_x, SO_2, and VOC are presented in this report, while state-level emissions can be obtained from the earlier reports.[2,3]

Emission estimates for 1940, 1950, 1960, and 1970 to 1984 were calculated by the EPA using the same methodology as in previous reports[7] and have been refined and improved each year on an on-going basis. This methodology includes the latest emission factors and control efficiencies, in addition to various other improvements, as described in section 5.

Emissions for 1985 are a modified version of the 1985 NAPAP Inventory. The 1986 through 1992 emissions were estimated by using the *Interim* methodology. The 1990, 1991, and 1992 emission estimates are preliminary numbers and will be revised in the next report when final data from the SIP inventories are available.

Tables 3-1 through 3-6 present the national emissions by source category for each pollutant from 1940 to 1992 in units of thousand tons per year (except Pb). Estimates are available for every 10 years from 1940 to 1990 and every year from 1990 to 1992. The trend in total national Pb emissions is expressed in units of tons per year and the estimates are presented for every 5 years from 1970 to 1990 and every year from 1990 to 1992. Figures 3-1 through 3-8 (except 3-4) present the emissions trends for all available years by major source category for each pollutant.

From 1900[k] to 1992, total national NO_x emissions have increased by approximately a factor of 9, SO_2 emission have increased approximately 130 percent, and VOC emissions increased 195 percent. From 1970 to 1992, emissions of Pb show the greatest decrease (98 percent), followed by PM-10 [excluding fugitive dust (51 percent)], SO_2 (27 percent), CO (27 percent), and VOC (24 percent). NO_x emissions have increased approximately 11 percent. Emissions of PM-10 and Pb show their greatest decrease in the 1970s, while emissions of the other pollutants show their greatest decrease in the 1980s.

Changes from 1991 to 1992 were primarily caused by (1) changes in fuels consumed by electric utilities, a major source of SO_2 emissions, (2) increased usage of highway vehicle emission controls, a major source of CO, NO_x, and VOC emissions, and (3) varied production levels in industrial activity. Based on the preliminary emission estimates for 1992, Pb emissions have increased slightly from 1991, while emissions of all other pollutants continue to decrease.

The following paragraphs of this section discuss the most important factors influencing the emission trends of each pollutant. The analysis is divided by source category into three parts: (1) 1900 to 1939 (where emission estimates are available); (2) 1940 to 1970, when significant changes occurred in technology, activity patterns, and fuel use; and (3) 1970 to 1992, when emissions controls were progressively applied.

3.2 CARBON MONOXIDE EMISSIONS

The trend in CO emissions is presented in Table 3-1 and Figure 3-1. Table 3-1 presents the Tier 1 source categories for every 10 years for 1940 to 1990 and every year from 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-1 presents the trends in CO emissions from 1940 to 1992. The break in the graph at 1980 indicates a major break in transportation methodology from 1979 to 1980. The "All Other" category includes electric utility and industrial fuel combustion, petroleum and related industries, other industrial processes, solvent utilization, and storage and transport. The miscellaneous emissions are primarily from forest fires.

3.2.1 Fuel Combustion: Electric Utility, Industrial, and Other

CO emissions from fuel combustion sources occur mainly in the residential sector. In 1940, residential wood combustion was 12 percent of the total CO national emissions. By 1970, only 2 percent of the total national emissions were from residential wood combustion. Consumption of wood in the residential sector steadily declined until the late 1970s because fossil fuels were abundant, cheap, and more convenient than fuel wood. Emissions from residential wood consumption almost doubled from 1970 to 1980 due to a disruption in crude oil supplies and the curtailment of natural gas deliveries, as well as rising crude oil and natural gas prices in the 1970s, which revived interest in wood as a fuel for residential space heating. The decline in emissions from 1980 to 1992 (19 percent) from residential wood combustion was the result of a decline in conventional fuel prices after the mid-1980s. In 1992, residential wood combustion accounted for 6 percent of total national CO emissions. More detailed emission estimates are located in Table A-1, in Appendix A.

3.2.2 Industrial Processes

In 1940, industrial processes accounted for 8 percent of the total CO national emissions. Emissions from chemical and allied product manufacturing decreased 19 percent from 1940 to 1970, but, during the same period, metals processing increased 33 percent, and petroleum and related industry increased by a factor of 10. The increase in the petroleum refining sector was a result of increased refinery throughput to meet increased demand for gasoline and other distillate products. Since 1970, emissions have decreased by 48 percent as a result of the obsolescence of certain high-polluting processes such as the manufacture of carbon black by channel process and as a result of installing more emission controls. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-2, in Appendix A.

3.2.3 Transportation: Highway Vehicle and Off-Highway

In 1940, highway vehicles contributed 30 percent of CO emissions. From 1940 through 1970, emissions from all types of highway vehicles nearly tripled. By 1970, highway vehicles accounted for 67 percent of the total national CO emissions.

Since 1970, highway vehicles have been the largest single contributing source of CO emissions. Table A-3 in Appendix A shows how the emissions from major highway vehicle subcategories have changed. From 1970 to 1980, total VMT increased 36 percent, but because of the implementation of the Federal Motor Vehicle Control Program (FMVCP) on new vehicles, total CO emissions from highway vehicles increased only 11 percent.[1] From 1980 to 1992, VMT increased 49 percent, but as a result of pollution controls and the retirement of older, uncontrolled vehicles, CO emissions from highway vehicles decreased 37 percent during this period. Without the implementation of vehicle emission controls, CO emissions from highway vehicles would have increased more than threefold from 1970 to 1992. In 1992, highway vehicles produced 63 percent of the total national emissions.

In 1940, off-highway emissions were 9 percent of the total emissions. They increased from 1940 to 1970 by 19 percent but were only 8 percent of the total emissions. In 1992, off-highway emissions were 17 percent of the total emissions.

The abrupt rise in emissions from 1979 to 1980, shown in Figure 3-1, is a result of methodological changes in estimating emissions from highway and off-highway sources. Steps will be taken to extend these changes to years prior to 1980 for the 1994 *Trends* report. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-3, in Appendix A.

3.2.4 Remaining Sources

CO emissions from other sources also decreased from 1940 to 1992. In 1940, waste disposal and forest wildfires were 4 and 28 percent, respectively, of the total emissions. By 1970, forest wildfires decreased by 78 percent but waste disposal emissions nearly doubled. From 1970 to 1992 forest wildfire emissions decreased from 5.6 million tons to 1.2 million tons. Emissions from solid waste disposal decreased 76 percent from 1970 to 1992 as a result of regulating or prohibiting burning of solid waste in many areas of the country. By 1992, forest wildfires and waste disposal are 1 and 2 percent, respectively, of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-4, in Appendix A.

3.3 NITROGEN OXIDES EMISSIONS

The trend in NO_x emissions is presented in Table 3-2 and Figure 3-2. Table 3-2 presents the Tier 1 source categories for every 10 years for 1940 to 1990 and every year from 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-2 presents the trend in NO_x emissions from 1900 to 1992. The break in the graph at 1980 indicates a major break in transportation methodology from 1979 to 1980. The "All Other" category includes petroleum and related industries, solvent utilization, metals processing, waste disposal and recycling, miscellaneous, and storage and transport.

3.3.1 Fuel Combustion: Electric Utility, Industrial, and Other

In 1900, electric utilities were 4 percent of the total emissions. By 1930, electric utility emissions had increased by a factor of 6. Emissions continued to increase from 1930 to 1970 from 0.6 to 4.9 million tons, respectively. In 1992, electric utility emissions were 7.5 million tons, or 32 percent of the total emissions. New Source Performance Standards (NSPS) have helped reduce the growth in NO_x emissions from electric utilities. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-5, in Appendix A.

3.3.2 Transportation: Highway Vehicle and Off-Highway

In 1900, highway vehicle emissions were zero percent of the total emissions. By 1920, they had increased to 5 percent of the total emissions. Highway vehicle emissions continued to increase by a factor of 3 from 1920 to 1940. Emissions from highway vehicles increased by a factor of 6 from 1940 to 1980. In 1992, highway vehicle emissions were 32 percent of the total emissions.

Highway vehicles emssions are now controlled as a result of the implementation of FMVCP and the replacement of older, less efficient automobiles with newer vehicles. Without these changes, NO_x emissions from highway vehicles may have more than doubled from 1970 to 1992. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-6, in Appendix A.

3.3.3 Remaining Sources

The historical NO_x emissions are presented in the historic SO_2 and NO_x document[2] for five source categories (electric utility, industrial, commercial-residential, highway vehicle, and other). This categorization makes comparisons prior to 1940 on a source category basis difficult. In general, however, the remaining sources increased from 1900 to 1920 and continued to increase from 1920 to 1940, but at a slower rate. The remaining sources (industrial processes, waste disposal and recycling, and miscellaneous-other combustion) were 17 percent of the total 1940 NO_x emissions. Other combustion emissions have steadily decreased from 1940 to 1970 by 67 percent and continued to decrease from 1970 to 1992 by 60 percent. Waste disposal and recycling steadily increased from 1940 to 1970 by a factor of 4, but decreased from 1970 to 1992 by 81 percent. Industrial process emissions steadily increased by a factor of 3 from 1940 to 1970. The emissions then decreased 28 percent from 1970 to 1980. The increase from 1980 to 1992 of 58 percent is due in part to a methodological change in emission estimates beginning in 1986.[m] In 1992, the remaining sources were 5 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-7, in Appendix A.

3.4 REACTIVE VOLATILE ORGANIC COMPOUND EMISSIONS

The trend in VOC emissions is presented in Table 3-3 and Figure 3-3. Table 3-3 presents the Tier 1 source categories for every 10 years for 1940 to 1990 and every year from 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-3 presents the trends in VOC emissions from 1900 to 1992. The break in the graph at 1980 indicates a major break in transportation methodology from 1979 to 1980. The "All Other" category includes electric utility, industrial, and other fuel combustion, petroleum and related industries, and other industrial processes. The miscellaneous emissions are primarily from forest fires.

VOC is a principal component in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants. The VOC species that primarily contribute to the formation of ozone are included in the total VOC emission estimates, while methane, a nonreactive compound, is not included. Emissions of organic compounds from biogenic sources, such as trees and other vegetation, are presented in section 7. VOC emissions from natural sources are almost equal to anthropogenic emissions (according to recent research), but the extent to which biogenic emissions contribute to oxidant formation has not been clearly established.

Emission estimates of VOC were developed from current emission factors. No adjustments have been made to include chlorofluorocarbons or to exclude ethane and other VOCs with negligible photochemical reactivity. If no data were available for a source category, the total nonmethane hydrocarbon or the total hydrocarbon emission factor from AP-42 was used.[13] Highway vehicle emissions were estimated as nonmethane hydrocarbons.

Historic emissions[n] of VOC from anthropogenic sources have been estimated by state and source category from 1900 to 1985 in support of federal research activities under NAPAP.[3]

3.4.1 Fuel Combustion: Electric Utility, Industrial, and Other

In 1900, fuel combustion was 68 percent of the total emissions. The combustion of wood was 90 percent of the fuel combustion emissions. By 1920, fuel combustion sources had decreased to 55 percent of the total emissions. By 1940, fuel combustion sources were 12 percent of the total. This decline in emissions continued until 1992, with fuel combustion emissions contributing only 3 percent of the total emissions in 1992. (The exception is a peak in residential wood combustion that is explained in section 3.2.1.) More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-8, in Appendix A.

3.4.2 Industrial Processes

In 1900, industrial processes were 3 percent of the emissions. By 1920, industrial process emissions had increased to 9 percent of the total. Surface coating operations were 98 and 41 percent, respectively, of the 1900 and 1920 total emissions. Emissions from the petroleum industry increased by a factor of 3 from 1900 to 1920. By 1940, industrial processes were 26 percent of the total emissions. Industrial process emissions peaked in 1970 at 12.3 million tons. Solvent utilization was responsible for 58 percent of the total industrial emissions in 1970. Through the

1970s, VOC emissions from industrial processes would have continued to increase, if uncontrolled, due to higher production levels, particularly in organic chemical production and industrial uses of organic solvents. Emission control devices and process changes have helped limit the growth in emissions from these industrial processes. Emissions from petroleum product storage and marketing operations increased during the mid-1970s as a result of increased demand for petroleum products, especially motor gasoline. Since 1978, emissions from these sources have decreased as the result of more effective control measures. Another reason for the decrease in emissions since 1970 is due to the substitution of water-based emulsified asphalt for asphalt liquified with petroleum distillates. This reduction is reflected in the decreased emissions reported for solvent utilization. In 1992, industrial processes are 48 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-9, in Appendix A.

3.4.3 Transportation: Highway Vehicle and Off-Highway

In 1900, transportation sources accounted for 2 percent of the total emissions. Railroad coal emissions were 99 percent of the transportation emissions. Railroad emissions peaked in 1920 when transportation emissions increased to 13 percent of the total emissions. Total VOC emissions from transportation sources increased 145 percent from 1940 to 1970. By 1970, railroads contributed only 1 percent to the total emissions. Highway vehicle emissions peaked in 1970 at 12 million tons, or 41 percent of the total emissions. VOC emissions from gasoline and diesel-powered highway vehicles decreased 50 percent from 1970 to 1992. The FMVCP initiatives have been responsible for this decrease in emissions, despite increases in VMT.

Figure 3-4 presents an example state's (shown as "State X") evaporative emissions as a function of Reid vapor pressure (RVP) and VMT. As shown, the decrease in RVP has offset the increase in VMT resulting in reduced emissions since 1982. In 1992 highway vehicles accounted for 27 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-10, in Appendix A.

For estimating the highway emissions for 1980 through 1992, the EPA improved the method by including state-specific and monthly maximum and minimum temperatures, gasoline volatility values, I/M programs, and vehicle speed data. Since this change was not implemented for all years, caution should be used when comparing highway vehicle emissions prior to 1980. For example, this change in methodology is the primary cause for the jump from 9.06 million tons in 1979 to 10.99 million tons in 1980, as shown in Figure 3-3.

3.4.4 Remaining Sources

In 1900, solid waste disposal and miscellaneous other sources (forest fires) were 6 and 21 percent, respectively, of the total emissions. By 1920, solid waste disposal emissions were still 6 percent and miscellaneous other sources had decreased to 17 percent. The decrease in miscellaneous other sources is due primarily to the success of fire prevention programs. Wildfire emissions peaked in 1930, representing 35 percent of the total emissions. Forest wildfire emissions have decreased since 1930. In 1992, forest wildfires were 1 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-11, in Appendix A.

3.5 SULFUR DIOXIDE EMISSIONS

The trend in SO_2 emissions is presented in Table 3-4 and Figure 3-5. Table 3-4 presents the Tier 1 source categories for every 10 years for 1940 to 1990 and every year 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-5 presents the trend in SO_2 emissions from 1900 to 1992. The "All Other" category includes petroleum and related industries, other industrial processes, solvent utilization, waste disposal and recycling, chemical and allied product manufacturing, and storage and transport sources.

SO_2 emissions have been identified as precursors of acidic precipitation and deposition. To support federal research activities on this subject, more detailed historical emission estimates of SO_2 have been developed. Interested readers may wish to review the historical SO_2 and NO_x emissions document[2], which contains estimates of SO_2 emissions from 1900 through 1980 by state and by source category, together with historic fuel consumption data.[o]

3.5.1 Fuel Combustion: Electric Utility, Industrial, and Other

In 1900, electric utilities represented 4 percent of the total emissions. Emissions from electric utilities steadily increased until 1925 (by a factor of 5). Emissions decreased during the 1930s due primarily to the Great Depression. By 1940, emissions were approximately the same as they had been in 1920. From 1940 to 1970, emissions from electric utilities doubled every decade. From 1940 to 1970, SO_2 emissions increased 57 percent as a result of increased consumption of fossil fuels. By 1970, coal combustion accounted for 82 percent of total SO_2 emissions from all fuel combustion sources. From 1970 to 1992, coal consumption by electric utilities more than doubled, but electric utility coal emissions decreased by 9 percent as a result of coal cleaning and lower sulfur coal blending. SO_2 emissions from other fuel combustion sectors have also generally decreased, primarily due to less coal burning by industrial, commercial, and residential consumers. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-12, in Appendix A.

3.5.2 Industrial Processes

The historical SO_2 emissions are presented in the historical SO_2 and NO_x document[2] for five source categories (electric utility, industrial, commercial-residential, highway vehicle, and other). This categorization makes comparisons prior to 1940 on a source category basis difficult. Industrial (both process and combustion) emissions steadily increased from 1900 to 1925 (by a factor of 2). The emissions decreased during the 1930s due to the Great Depression. In 1940, industrial processes emitted 20 percent of the total emissions. These emissions increased by 74 percent from 1940 to 1970. From 1970 to 1992, industrial process emissions decreased by 70 percent due to the increased use of emission control devices by industry. In particular, SO_2 emissions have been greatly reduced at nonferrous smelters. By-product recovery of sulfuric acid at these smelters has increased since 1970, resulting in recovered sulfuric acid not being emitted in the form of SO_2. In addition, new sulfuric acid manufacturing plants have been subject to NSPS since 1972. As new plants were built or modified, they had to achieve more stringent emission controls. In 1992, industrial processes accounted for 9 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-13, in Appendix A.

3.5.3 Remaining Sources

The historical SO_2 emissions are presented in the historical SO_2 and NO_x emissions document[2], for five source categories (electric utility, industrial, commercial-residential, highway vehicle, and other). This categorization makes comparisons prior to 1940 on a source category basis difficult. In 1940, the remaining sources (waste disposal, other combustion, and transportation) were 19 percent of the total emissions. Railroad emissions were 15 percent of the total emissions in 1940. By 1970, railroad emissions had decreased by 95 percent as a result of the obsolescence of coal-fired locomotives. Waste disposal and highway vehicle emissions had increased by factors of 3 and 93, respectively. Between 1970 and 1992, waste disposal and highway vehicle emissions increased by factors of 5 and 3, respectively. The remaining sources are 5 percent of the total emissions in 1992. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-14, in Appendix A.

3.6 LEAD EMISSIONS

The trend in Pb emissions is presented in Table 3-6 and Figure 3-5. Table 3-5 presents the Tier 1 source categories for every 5 years for 1970 to 1990 and every year from 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-6 presents the trends in Pb emissions from 1970 to 1992. The "All Other" category includes electric utility and industrial fuel combustion, other industrial processes, and chemical and allied product manufacturing.

3.6.1 Fuel Combustion: Electric Utility, Industrial, and Other

Fuel combustion emissions in 1940 were 5 percent of the total emissions. They decreased 69 percent from 1970 to 1992. By 1992, fuel combustion emissions were 10 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-15, in Appendix A.

3.6.2 Industrial Processes

Industrial process emissions in 1970 were 12 percent of the total emissions. They decreased 91 percent from 1970 to 1992. By 1992, industrial process emissions were 45 percent of the total emissions. More detailed emissions stimates for 1970, 1980, and 1983 through 1992 are presented in Table A-16, in Appendix A.

3.6.3 Remaining Sources

Highway vehicle emissions in 1970 were 78 percent of the total emissions. Total national lead emissions also decreased sharply from 1970 to 1986 as a result of FMVCP. This program has resulted in the widespread use of catalytic converters on automobiles to reduce NO_x, VOC, and CO emissions and the use of unleaded gasoline for vehicles with these converters. Gasoline consumption increased 16 percent between 1970 and 1975, but, because of the decrease in the lead content of gasoline, lead emissions from highway vehicles actually decreased 24 percent.

From a historic perspective, lead emissions have changed little in recent years. From 1975 to 1992, the percent of unleaded gasoline sales increased from 13 to 99 percent, and the lead emissions from highway vehicles decreased about 99 percent (130.21 thousand tons in 1975 to 1.38 thousand tons in 1992). The bulk of the reductions in lead emissions during this period occurred when the U.S. EPA required petroleum refiners to lower the lead content of leaded gasoline to 0.5 grams per gallon in 1985 to 0.1 grams per gallon in 1986. The lead content of leaded gasoline had been 1.1 grams per gallon or more. In 1992, highway vehicle emissions were 27 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-17, in Appendix A.

3.7 PARTICULATE MATTER EMISSIONS

The trend in PM-10 emissions is presented in Table 3-6 and Figure 3-7 (point and process fugitive sources) and Figure 3-8 (fugitive dust sources). Table 3-6 presents the Tier 1 source categories for every 10 years for 1940 to 1990 and every year 1990 to 1992. Categories displayed below Tier 1 do not sum to Tier 1 because they are intended to show major contributors. Figure 3-7 presents the trends in PM-10 emissions (excluding fugitive dust sources) from 1940 to 1992. The "All Other" category includes other and industrial fuel combustion, petroleum and related industries, other industrial processes, chemical and allied product manufacturing, and waste disposal and recycling. The miscellaneous emissions are primarily from forest fires. Figure 3-8 presents the fugitive dust source emissions from 1985 to 1992.

3.7.1 Point and Process Fugitive Sources

Point and fugitive process sources are all PM-10 sources except fugitive dust sources. These emissions are presented in Table 3-6 and Figure 3-7.

3.7.1.1 Fuel Combustion: Electric Utility, Industrial, and Other

In 1940, emissions from fuel combustion were 23 percent of the total. A large portion of the PM-10 emissions from fuel combustion sources resulted from the combustion of coal. In 1940, coal was consumed mostly by the industrial and residential sectors. Since 1940, residential coal use has declined substantially, resulting in a corresponding reduction in emissions. Industrial coal use has also declined, but not to the same extent as residential use. Emission controls used by industrial coal consumers have increased over the years and, by 1970, emissions had decreased to about 15 percent of the 1940 level.

Since 1970, PM-10 emissions from electric utilities have decreased, despite continued increases in coal consumption as a result of installing air pollution control equipment required by new facilities constructed in the 1970s to meet NSPS. Fuel combustion contributed 11 percent to the total emissions in 1970, and 18 percent in 1992. In 1992, 76 percent of the PM-10 emissions from fuel combustion sources originated from wood burning as compared to 60 percent in 1970. Today, wood stoves, wood furnaces, and fireplaces in residential homes account for 51 percent of the PM-10 emissions from wood burning. In 1992, fuel combustion sources are

18 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-18, in Appendix A.

3.7.1.2 Transportation: Highway Vehicle and Off-Highway

Transportation emissions in 1940 were 17 percent of the total emissions. Railroad and light-duty gasoline vehicles (LDGV) were 16 and 1 percent, respectively of the total emissions in 1940. By 1970, railroad emissions had decreased by 97 percent but LDGV emissions had tripled. Railroad emissions continued to decrease from 1970 to 1992 (by 45 percent). By 1992, LDGV emissions had increased further by 16 percent since 1970. In 1992 transportation emissions are 31 percent of the total emissions. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-19, Appendix A.

3.7.1.3 Remaining Sources

PM-10 emissions from industrial processes increased from 1940 through 1950, primarily as a result of increased industrial production. From 1950 to 1970, industrial output continued to grow, but installation of pollution control equipment mandated by air pollution control programs more than offset the increase in production. In 1970, industrial processes contributed 63 percent to the total and in 1992, they contributed only 33 percent, thus indicating considerable progress in reducing emissions. Table A-20, in Appendix A, shows estimated emissions for specific processes.

In 1940 wildfires contributed 14 percent to the total national emissions but by 1992 they contributed only 8 percent to the total. More detailed emission estimates for 1970, 1980, and 1983 through 1992 are presented in Table A-20, in Appendix A.

3.7.2 Fugitive Dust Sources

The inclusion of fugitive dust source emissions began with the 1991 *Trends* report. Figure 3-8 presents the emission estimates for the six fugitive dust sources estimated for *Trends* (wind erosion, mining and quarrying, agricultural tilling, paved and unpaved roads, and construction) for 1985 through 1992. Unlike the point and fugitive process emission estimate methodologies, most fugitive dust emission estimate methodologies utilize meteorological data (number of days with greater than 0.01 inches of precipitation, amount of rain, and wind speed) which can vary significantly from year-to-year. The PM-10 emissions from fugitive dust sources have increased by 2 percent from 1985 to 1992. During this time period, the emissions have ranged from 42.04 million tons in 1987 to 59.84 million tons in 1988. Unlike other fugitive dust sources, wind erosion can be highly variable. For example, the total national emissions from wind erosion in 1987 are estimated to be 1.46 million tons, compared to 17.51 million tons in 1988. The lack of precipitation in 1988 prior to spring crop planting, especially in the central and western United States, contributed to greater wind erosion for that year. In 1992, total national fugitive dust PM-10 emissions are estimated to be about eight times greater than the total emissions from point and fugitive process sources.

[k] It should be noted that the historic emission estimates may not be as reliable as the more recent estimates as a result of increased uncertainty in early statistics and assumptions.

[l] This change may be due to the use of different methodologies in estimating highway vehicle emissions. The next report will use a more consistent methodology.

[m] Starting with 1986, rule effectiveness was applied to all point sources with known control efficiencies. The result is increased emissions.

[n] The emission estimates from *Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985*[3] for the years 1940 to 1980 may differ from those in this report since they have not been updated. Further explanation of the changes in emissions for years prior to 1940 are explained in the document.

[o] The emission estimates from this document for the years 1940-1980 may differ from those in this report since they have not been updated.

Table 3-1. Total National Emissions of CO, 1940 through 1992
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	4	110	110	237	322	314	314	311
FUEL COMB. INDUSTRIAL	435	549	661	770	750	716	723	714
FUEL COMB. OTHER	14,890	10,656	6,250	3,625	6,230	5,726	5,583	5,154
Residential Wood	11,279	7,716	4,743	2,932	5,992	5,435	5,290	4,872
fireplaces	2,639	1,805	1,110	686	1,402	NA	NA	NA
woodstoves	8,640	5,910	3,633	2,246	4,590	NA	NA	NA
Residential Other	3,501	2,833	1,507	630	178	158	161	149
CHEMICAL & ALLIED PRODUCT MFG	4,190	5,844	3,982	3,397	2,151	1,893	1,906	1,873
METALS PROCESSING	2,750	2,910	2,866	3,644	2,246	2,080	1,992	1,978
PETROLEUM & RELATED INDUSTRY	221	2,651	3,086	2,179	1,723	435	439	403
OTHER INDUSTRIAL PROCESSES	114	231	342	620	830	716	711	722
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	2	2	2
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	102	103	100
WASTE DISPOSAL & RECYCLING	3,630	4,717	5,597	7,059	2,300	1,686	1,644	1,686
HIGHWAY VEHICLES	27,370	41,372	58,297	79,258	87,991†	59,801	58,825	55,288
Light-Duty Gas Vehicles & MC	19,860	28,149	42,604	59,959	59,125	41,523	40,840	38,386
light-duty gas vehicles	19,849	28,098	42,547	59,662	59,125	41,523	40,840	38,386
Light-Duty Gas Trucks	2,596	4,229	5,390	9,554	17,661	13,706	13,537	12,682
LDGT1	1,992	3,251	4,135	6,992	NA	NA	NA	NA
LDGT2	603	978	1,255	2,561	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	4,914	8,965	10,178	9,398	10,040	2,951	2,798	2,574
Diesels	NA	29	126	347	1,165	1,621	1,651	1,646
HDDV	NA	29	126	347	1,150	1,565	1,591	1,584
OFF-HIGHWAY	8,051	11,610	11,575	10,001	16,117†	14,642	14,238	14,679
Non-Road Gasoline	3,777	7,331	8,753	7,658	14,475	12,655	12,323	12,659
construction	1,198	2,409	2,262	584	413	395	364	395
industrial	780	1,558	1,379	1,909	1,090	1,228	1,195	1,228
farm	1,351	2,716	3,897	3,842	1,963	63	52	63
recreational marine vessels	60	120	518	398	1,301	1,207	1,176	1,207
Aircraft	4	934	1,764	995	1,023	966	966	997
Railroads	4,083	3,076	332	280	277	122	128	121
MISCELLANEOUS	29,210	18,135	11,010	7,909	8,344	4,267	4,202	4,271
(Other Combustion)								
forest wildfires	25,130	11,159	4,487	5,620	5,396	1,178	1,178	1,178
TOTAL	90,865	98,785	103,777	118,700	129,004	92,379	90,682	87,183

NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
†There is a change in methodology for highway vehicle and off-highway emission estimates 1970 to 1980.
NA = not available
MC = motorcycle
LDGT = light-duty gasoline truck (1: < 6000 lbs, 2:6000 to 8500 lbs)
HDDV = heavy-duty diesel vehicle

Table 3-2. Total National Emissions of NO_x, 1940 through 1992

(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	660	1,316	2,536	4,900	7,023	7,527	7,482	7,468
Coal	438	996	1,926	3,497	5,675	6,707	6,662	6,698
bituminous	255	584	1,154	2,112	3,439	4,603	4,522	4,579
subbituminous	125	288	568	1,041	1,694	1,706	1,732	1,705
anthracite & lignite	58	123	204	344	542	399	408	414
FUEL COMB. INDUSTRIAL	2,542	3,193	4,075	4,326	3,554	3,535	3,604	3,523
Coal	2,012	1,077	782	771	444	613	610	613
bituminous	1,301	688	533	532	306	444	438	444
Gas	365	1,756	2,955	3,061	2,619	1,924	1,991	1,915
natural	337	1,692	2,846	3,053	2,469	325	325	324
FUEL COMB. OTHER	530	647	763	836	741	732	745	734
CHEMICAL & ALLIED PRODUCT MFG	6	63	111	271	216	398	400	401
METALS PROCESSING	4	110	110	77	65	81	79	78
PETROLEUM & RELATED INDUSTRIES	105	110	220	240	72	100	103	94
OTHER INDUSTRIAL PROCESSES	107	93	132	187	205	306	298	301
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	2	2	3
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	3	4	3
WASTE DISPOSAL & RECYCLING	109	215	330	440	111	82	81	82
HIGHWAY VEHICLES	1,523	2,453	4,423	7,427	8,705†	7,816	7,715	7,477
Light-Duty Gas Vehicles & MC	1,105	1,611	2,967	4,734	4,651	3,535	3,551	3,517
light-duty gas vehicles	1,104	1,611	2,966	4,730	4,651	3,535	3,551	3,517
Light-Duty Gas Trucks	164	271	421	868	1,378	1,173	1,158	1,125
Heavy-Duty Gas Vehicles	255	487	597	547	370	198	199	196
Diesels	NA	83	438	1,277	2,306	2,909	2,807	2,639
HDDV	NA	83	438	1,277	2,285	2,838	2,731	2,561
OFF-HIGHWAY	990	1,539	1,443	1,825	2,724†	2,843	2,769	2,852
Non-Road Diesel	103	187	247	663	1,430	1,478	1,350	1,482
construction	70	158	157	185	732	944	866	944
Railroads	657	992	772	705	827	929	980	925
MISCELLANEOUS	990	665	441	330	248	133	132	133
TOTAL	7,566	10,404	14,584	20,859	23,664	23,559	23,413	23,149

NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
†There is a change in methodology for highway vehicle and off-highway emission estimates, 1970 to 1980.
NA = not available
MC = motorcycle
HDDV = heavy-duty diesel vehicle

Table 3-3. Total National Emissions of VOC, 1940 through 1992
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	2	9	9	30	45	36	33	32
FUEL COMB. INDUSTRIAL	108	98	106	150	157	284	289	279
FUEL COMB. OTHER	1,867	1,336	768	541	848	437	426	394
Residential Wood	1,410	970	563	460	809	405	394	363
fireplaces	340	231	131	107	189	NA	NA	NA
woodstoves	1,070	739	431	353	620	NA	NA	NA
CHEMICAL & ALLIED PRODUCT MFG	884	1,324	991	1,341	1,595	1,771	1,778	1,758
Organic Chemical Mfg	58	110	245	629	884	684	686	676
METALS PROCESSING	325	442	342	394	273	72	69	70
PETROLEUM & RELATED INDUSTRIES	571	548	1,034	1,194	1,440	737	745	715
OTHER INDUSTRIAL PROCESSES	130	184	202	270	237	478	475	475
SOLVENT UTILIZATION	1,971	3,679	4,403	7,174	6,584	6,063	6,064	6,062
Surface Coating	1,058	2,187	2,128	3,570	3,685	2,619	2,598	2,616
Nonindustrial	490	NA	1,189	1,674	1,002	1,900	1,934	1,911
consumer solvents	NA	NA	NA	NA	NA	1,083	1,111	1,090
STORAGE & TRANSPORT	639	1,218	1,762	1,954	1,975	1,861	1,868	1,823
Bulk Terminals & Plants	185	361	528	599	517	658	646	624
area source: gasoline	158	307	449	509	440	560	550	524
HIGHWAY VEHICLES	4,774	7,172	10,370	12,219	10,990†	6,977	6,812	6,099
Light-Duty Gas Vehicles & MC	3,720	5,331	8,224	9,545	7,133	4,628	4,529	4,051
light-duty gas vehicles	3,716	5,314	8,204	9,442	7,133	4,628	4,529	4,051
Light-Duty Gas Trucks	507	831	1,082	1,652	2,486	1,677	1,630	1,447
Heavy-Duty Gas Vehicles	547	998	1,018	897	955	239	227	193
Diesels	NA	11	46	125	416	433	426	409
HDDV	NA	11	46	125	409	408	398	380
OFF-HIGHWAY	778	1,213	1,215	1,392	2,315†	2,120	2,060	2,127
Non-Road Gasoline	208	423	526	586	1,740	1,646	1,602	1,646
lawn & garden	NA	NA	NA	NA	828	728	711	728
WASTE DISPOSAL & RECYCLING	990	1,104	1,546	1,984	758	2,262	2,217	2,314
MISCELLANEOUS	4,079	2,530	1,573	1,101	1,134	577	568	577
Other Combustion	4,079	2,530	1,573	1,101	1,134	576	567	577
forest wildfires	3,420	1,510	768	770	739	162	162	162
TOTAL	17,118	20,856	24,322	29,743	28,350	23,674	23,404	22,726

NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
†There is a change in methodology for highway vehicle and off-highway emission estimates, 1970 to 1980.
Change in the 1990 through 1992 methodology does not allow for estimating fireplace and woodstove emissions.
NA = not available
MC = motorcycle
HDDV = heavy-duty diesel vehicle

Table 3-4. Total National Emissions of SO_2, 1940 through 1992

(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	2,427	4,515	9,264	17,398	17,483	15,871	15,784	15,841
Coal	2,276	4,056	8,883	15,799	NA	15,201	15,101	15,270
bituminous	1,359	2,427	5,367	9,574	NA	13,342	13,203	13,382
subbituminous	668	1,196	2,642	4,716	NA	1,421	1,381	1,371
anthracite and lignite	249	433	873	1,509	NA	438	517	517
Oil	151	459	380	1,598	NA	639	652	541
residual	146	453	375	1,578	NA	629	642	533
FUEL COMB. INDUSTRIAL	6,060	5,725	3,864	4,568	2,951	3,106	3,139	3,090
Coal	5,188	4,423	2,703	3,129	1,527	1,843	1,821	1,843
bituminous	3,473	2,945	1,858	2,171	1,058	1,380	1,356	1,381
subbituminous	1,070	907	574	669	326	29	28	29
Oil	554	972	922	1,229	1,065	827	878	820
residual	397	721	663	956	851	633	684	633
Gas	145	180	189	140	299	345	350	337
Other	173	150	51	70	60	85	84	84
Internal Combustion	NA	NA	NA	NA	NA	6	6	6
FUEL COMB. OTHER	3,642	3,964	2,319	1,490	971	597	608	589
Residential Other	2,517	2,079	1,250	492	211	175	179	174
bituminous/subbituminous coal	2,267	1,758	868	260	43	30	30	26
CHEMICAL & ALLIED PRODUCT MFG	215	427	447	591	280	424	426	419
METALS PROCESSING	3,309	3,747	3,986	4,775	1,842	908	874	868
Nonferrous Metals Processing	2,760	3,092	3,322	4,060	1,279	735	709	701
copper	2,292	2,369	2,772	3,507	1,080	546	529	519
PETROLEUM & RELATED IND.	224	340	676	881	734	440	444	411
OTHER INDUSTRIAL PROCESSES	334	596	671	846	918	401	391	397
SOLVENT UTILIZATION	0	0	0	0	0	1	1	1
STORAGE & TRANSPORT	0	0	0	0	0	21	21	21
WASTE DISPOSAL & RECYCLING	3	3	10	8	33	36	36	36
HIGHWAY VEHICLES	3	103	114	279	458	743	770	785
OFF-HIGHWAY	3,192	2,418	339	379	531	265	274	271
Railroads	2,975	2,174	215	138	133	68	71	67
MISCELLANEOUS	545	545	554	110	11	4	4	4
TOTAL	19,954	22,384	22,245	31,325	26,212	22,818	22,773	22,731

NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
NA = not available

Table 3-5. Total National Emissions of Pb, 1970 through 1992
(short tons)

Source Category	1970	1975	1980	1985	1990	1991	1992
FUEL COMB. ELEC. UTIL.	327	230	129	64	64	61	62
FUEL COMB. INDUSTRIAL	237	75	60	30	18	18	17
FUEL COMB. OTHER	10,052	10,042	4,111	421	418	416	416
Misc. Fuel Comb. (Ex. Residential)	10,000	10,000	4,080	400	400	400	400
CHEMICAL & ALLIED PRODUCT MFG	103	120	104	118	136	132	140
(Inorganic Chemical Mfg)							
(lead oxide and pigments)							
METALS PROCESSING	24,224	9,923	3,026	2,097	2,138	1,939	2,069
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,409	1,258	1,323
primary lead product	12,134	5,640	1,075	874	728	623	628
primary copper product	242	171	20	19	19	19	20
primary zinc product	1,019	224	24	16	9	11	11
secondary lead product	1,894	821	481	288	449	414	470
second copper product	374	200	116	70	75	65	63
lead cable coating	127	55	37	43	50	48	50
Ferrous Metals Processing	7,395	2,196	911	577	576	517	561
ferroalloy production	219	104	13	7	18	14	17
iron production	266	93	38	21	18	16	18
steel production	3,125	1,082	481	209	138	145	145
gray iron production	3,773	910	373	336	397	339	378
OTHER INDUSTRIAL PROCESSES	2,028	1,337	808	316	169	167	139
Mineral Products	540	217	93	43	26	24	24
(cement manufacturing)							
Misc Industrial Processes	1,488	1,120	715	273	143	143	115
WASTE DISPOSAL & RECYCLING	2,200	1,595	1,210	871	804	582	742
(Incineration)							
municipal waste	581	396	161	79	67	55	59
other	1,619	1,199	1,049	792	738	528	683
HIGHWAY VEHICLES	171,961	130,206	62,189	15,978	1,690	1,519	1,383
Light-Duty Gas Vehicles & MC	142,918	106,868	48,501	12,070	1,263	1,135	1,033
OFF-HIGHWAY	8,340	5,012	3,320	229	197	180	207
(Non-Road Gasoline)							
TOTAL	219,472	158,541	74,956	20,124	5,634	5,014	5,176

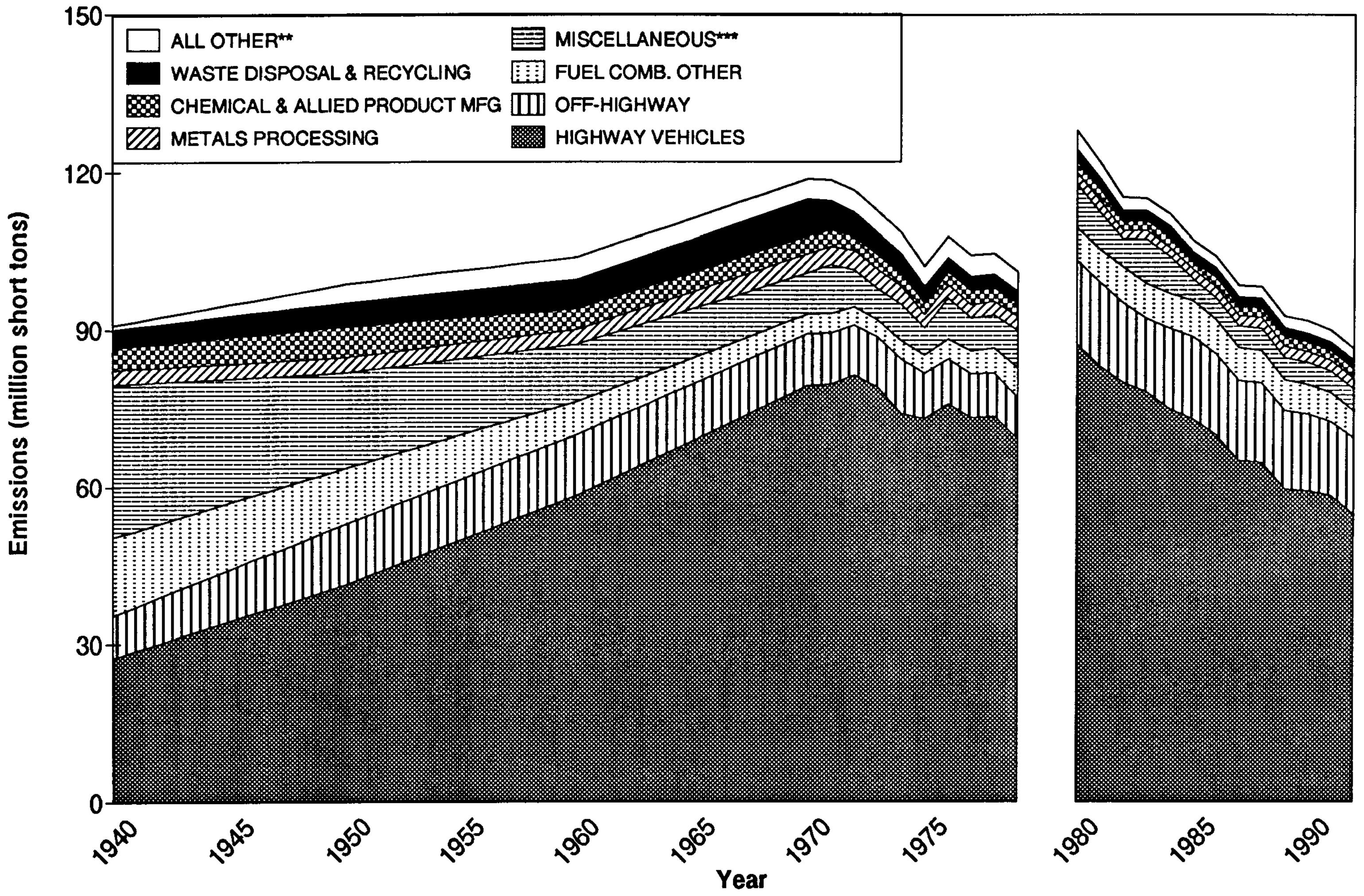
NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
MC = motorcycle

Table 3-6. Total National Emissions of PM-10, 1940 through 1992
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	432	497	456	246	190	167	163	165
FUEL COMB. INDUSTRIAL	708	604	331	641	679	487	477	463
FUEL COMB. OTHER	2,338	1,674	1,113	455	887	509	496	466
Residential Wood	1,716	1,128	850	384	818	469	457	429
fireplaces	402	264	199	90	191	110	107	100
woodstoves	1,315	864	651	294	626	359	350	328
CHEMICAL & ALLIED PRODUCT MFG	330	455	309	235	148	115	113	121
METALS PROCESSING	1,208	1,027	1,026	1,316	622	409	392	416
Nonferrous Metals Processing	588	346	375	593	130	83	84	88
copper	217	105	122	343	32	28	27	28
PETROLEUM & RELATED INDUSTRIES	366	412	689	286	138	123	118	119
OTHER INDUSTRIAL PROCESSES	3,996	6,954	7,211	5,832	1,846	1,328	1,251	1,284
Mineral Products	2,701	5,460	5,563	4,620	1,261	783	745	779
cement mfg	1,363	1,998	2,014	1,731	417	226	212	217
other	794	2,690	2,369	1,798	296	133	134	137
WASTE DISPOSAL & RECYCLING	392	505	764	999	273	221	216	252
HIGHWAY VEHICLES	210	314	554	960	1,112	1,477	1,528	1,558
Light-Duty Gas Vehicles & MC	159	220	417	644	602	697	724	739
LDGV	159	220	416	639	594	697	724	739
Light-Duty Gas Trucks	21	34	53	104	158	180	187	190
Heavy-Duty Gas Vehicles	29	51	68	71	61	46	41	42
Diesels	NA	9	15	141	291	554	575	586
HDDV	NA	9	15	141	279	514	533	544
OFF-HIGHWAY	2,480	1,788	201	273	273	279	269	272
Railroads	2,464	1,742	110	65	58	41	38	36
MISCELLANEOUS	2,968	1,934	1,244	839	852	45,728	50,320	46,309
Other Combustion	2,968	1,934	1,244	839	852	961	784	808
wildfires	2,179	1,063	428	385	514	634	456	482
Fugitive Dust	NA	NA	NA	NA	NA	44,767	49,536	45,501
wind erosion	NA	NA	NA	NA	NA	4,192	10,125	4,658
unpaved roads	NA	NA	NA	NA	NA	15,649	14,254	15,167
paved roads	NA	NA	NA	NA	NA	7,533	8,150	7,901
other	NA	NA	NA	NA	NA	17,393	17,006	17,775
TOTAL	15,426	16,163	13,897	12,081	7,020	50,844	55,341	51,427

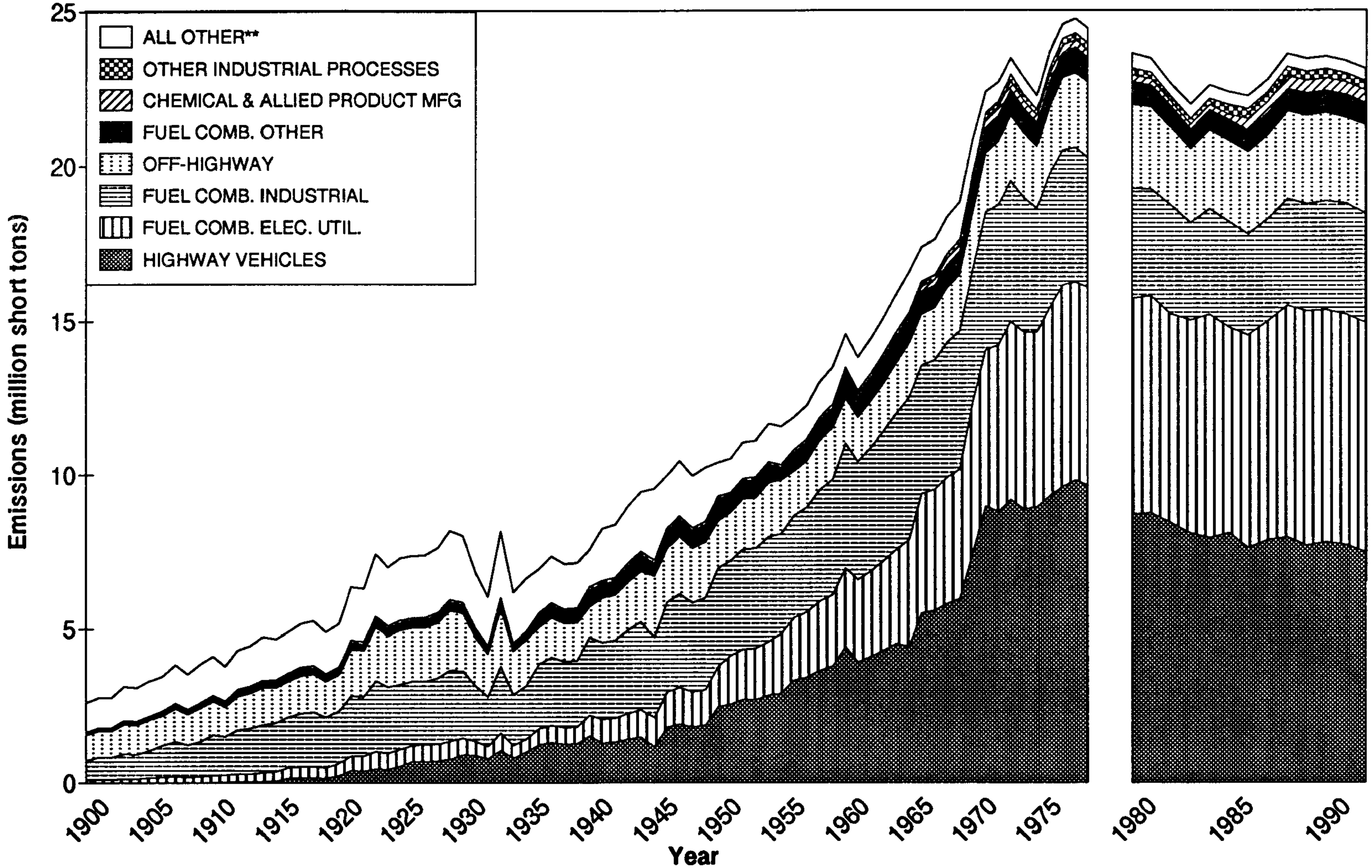
NOTE(S): 1990 through 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
NA = not available
MC = motorcycle
LDGV = light-duty gasoline vehicle
HDDV = heavy-duty diesel vehicle

Figure 3-1. Trend in CO Emission Estimates by Tier 1 Source Category, 1940 through 1992 *



* The abrupt rise in emissions from 1979 to 1980 is due to changes in methods for calculating highway vehicle and off-highway emissions.
** All other is defined as fuel combustion (electric utility & industrial), petroleum & related industries, other industrial processes, solvent utilization, and storage & transport.
*** Miscellaneous is primarily forest fire emissions.

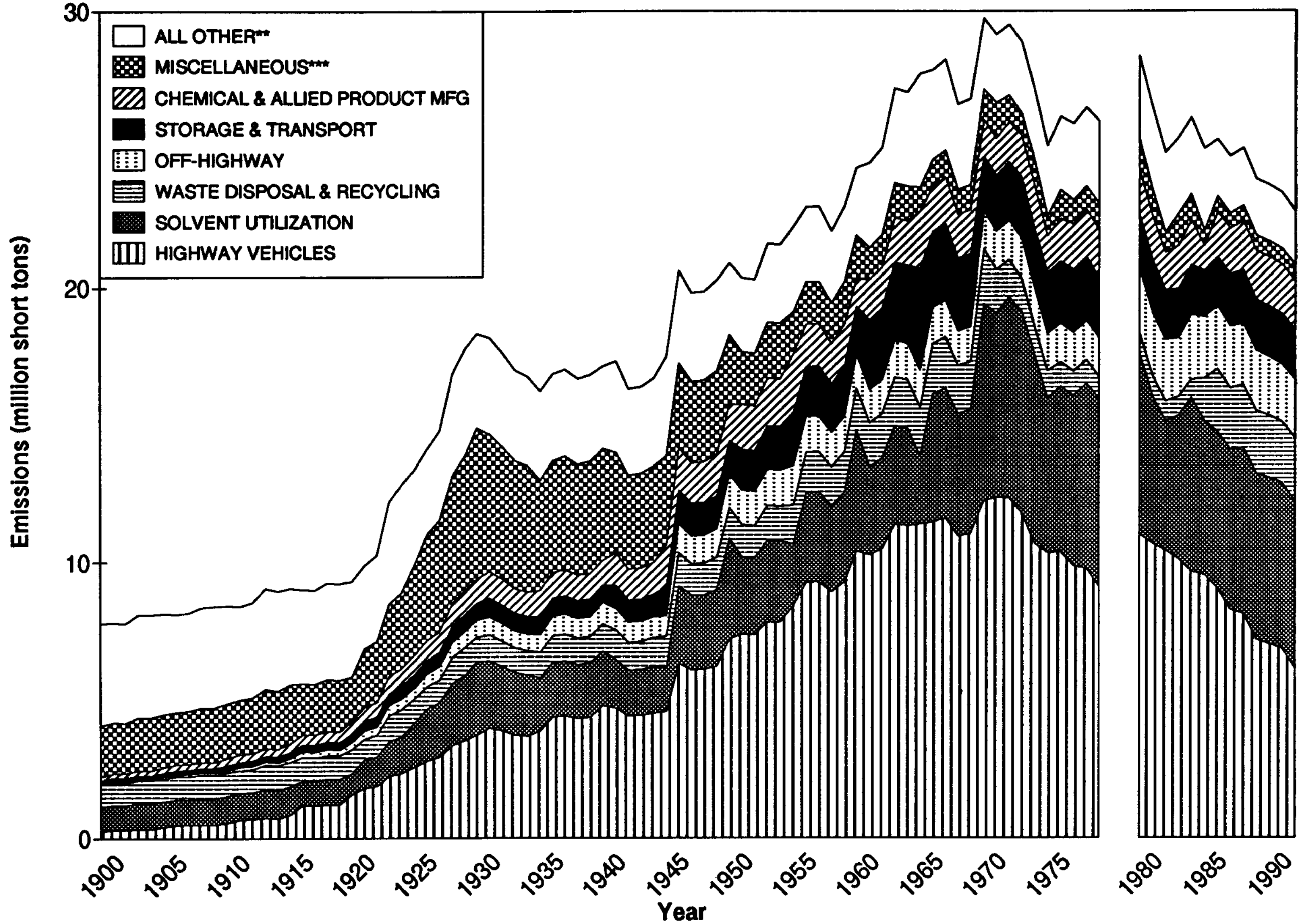
Figure 3-2. Trend in NO_X Emission Estimates by Tier 1 Source Category, 1900 through 1992 *



* The change in emissions from 1979 to 1980 is due to changes in methods for calculating highway vehicle and off-highway emissions.

** All other is defined as miscellaneous, petroleum & related industry, waste disposal & recycling, metals processing, solvent utilization, and storage & transport.

Figure 3-3. Trend in VOC Emission Estimates by Tier 1 Source Category, 1900 through 1992*

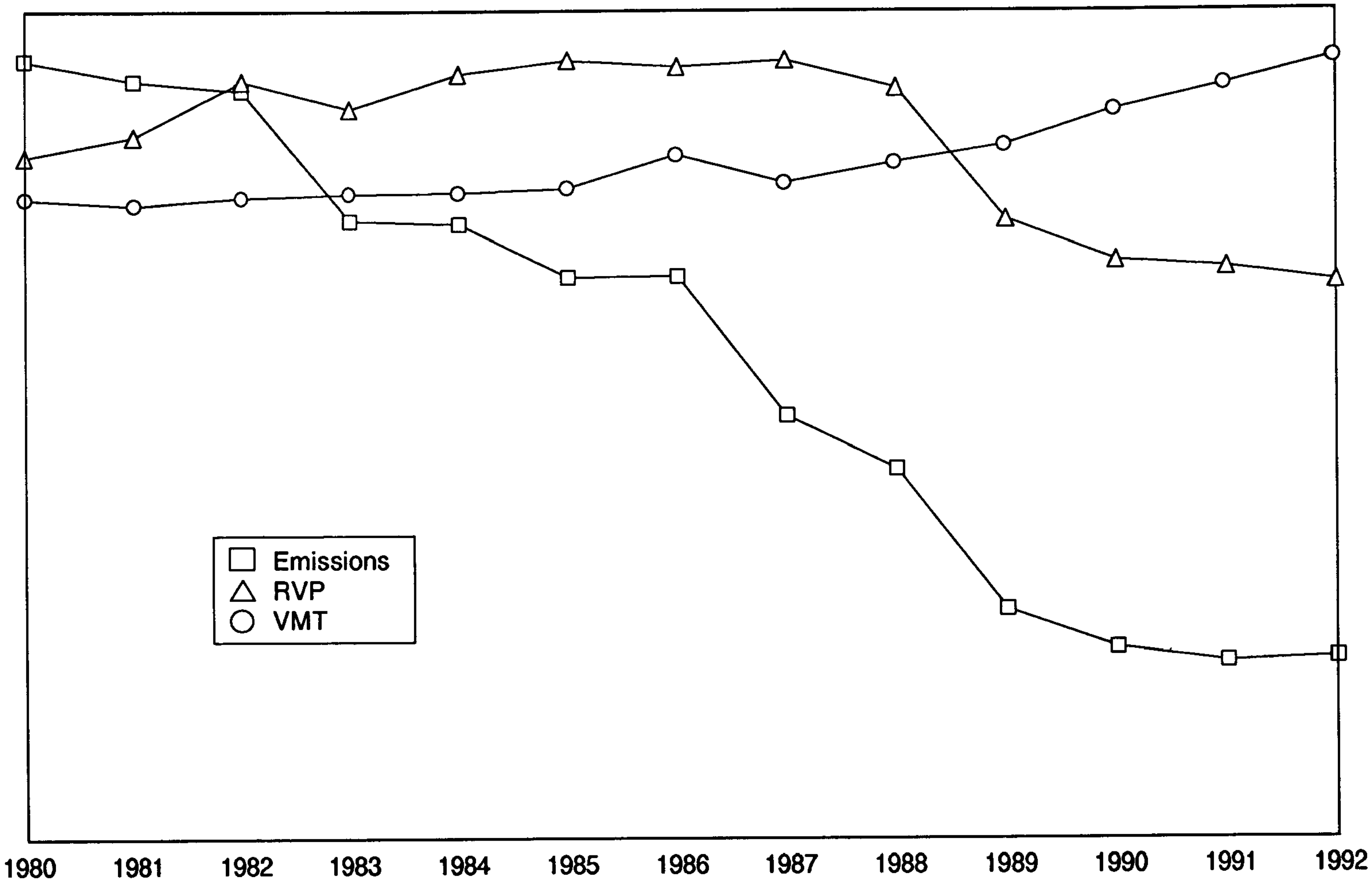


*The abrupt rise in emissions from 1979 to 1980 is due to changes in methods for calculating highway vehicle and off-highway emissions.

** All other is defined as petroleum & related industries, other industrial processes, fuel combustion, and metals processing.

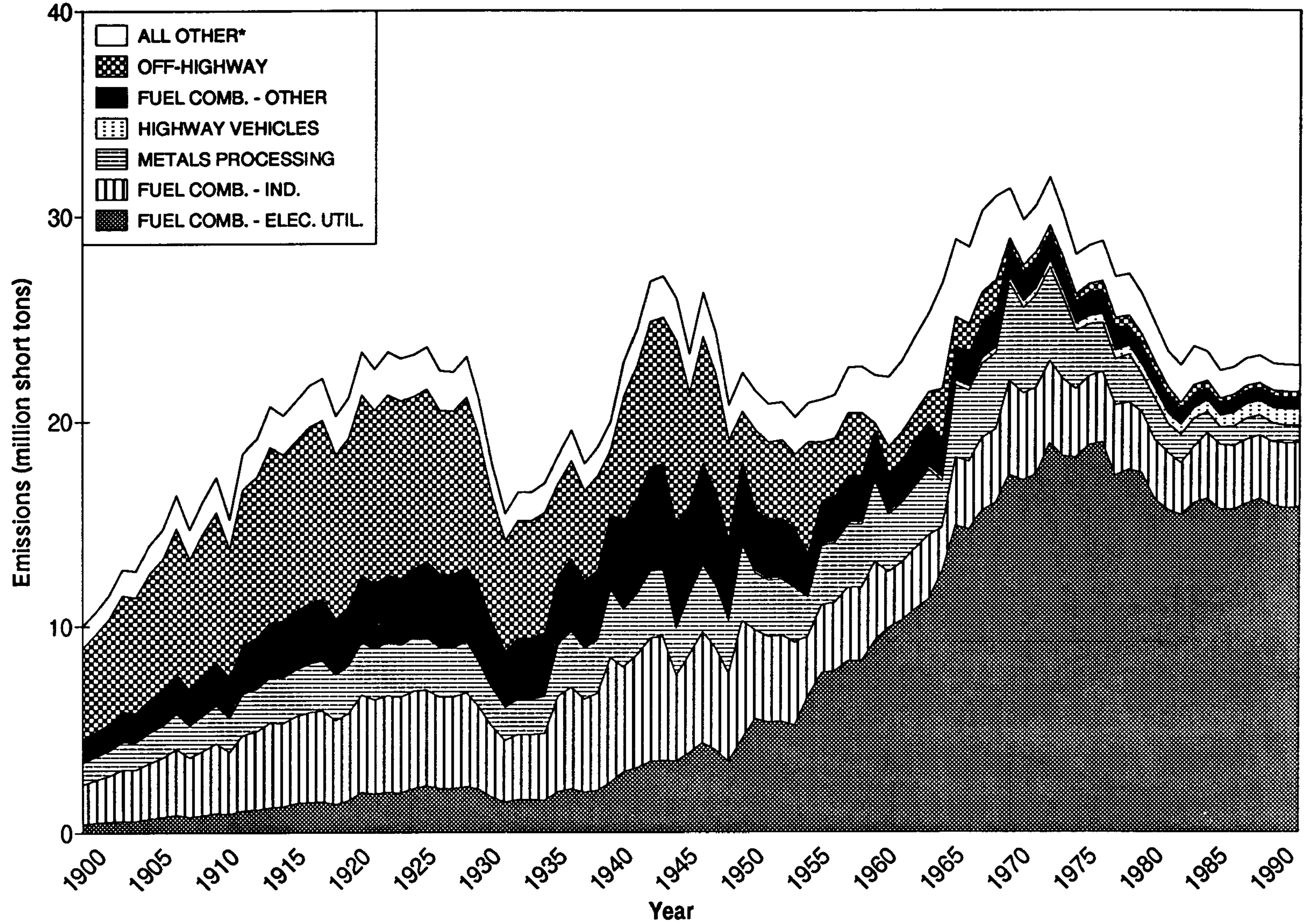
*** Miscellaneous is primarily emissions from forest fires.

Figure 3-4. Trend in State X Evaporative Emissions as a Function of RVP and VMT



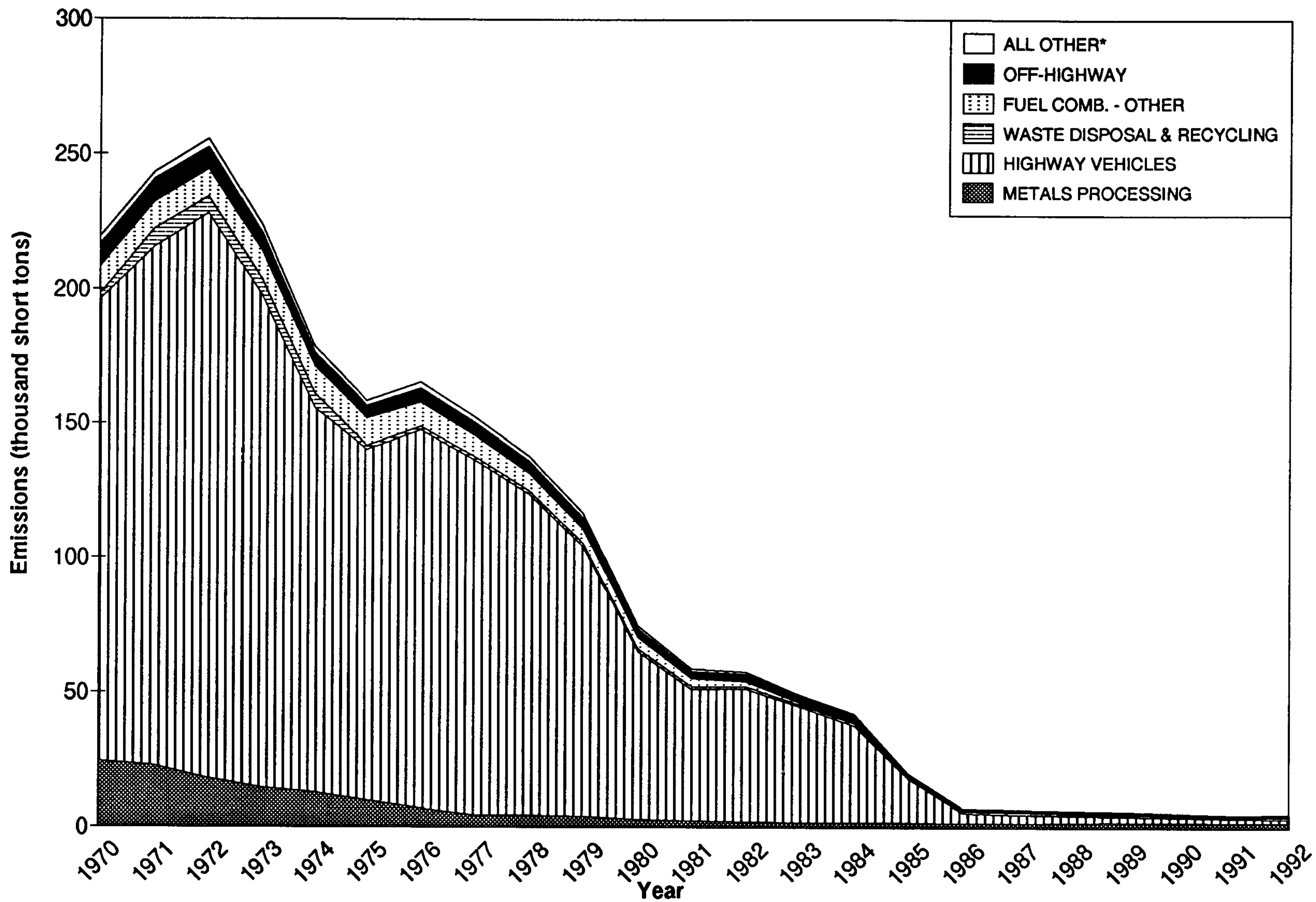
Note: Data provided by EPA's Office of Mobile Sources (RVP) and the Federal Highway Administration (VMT)

Figure 3-5. Trend in SO_2 Emission Estimates by Tier 1 Source Category, 1900 through 1992



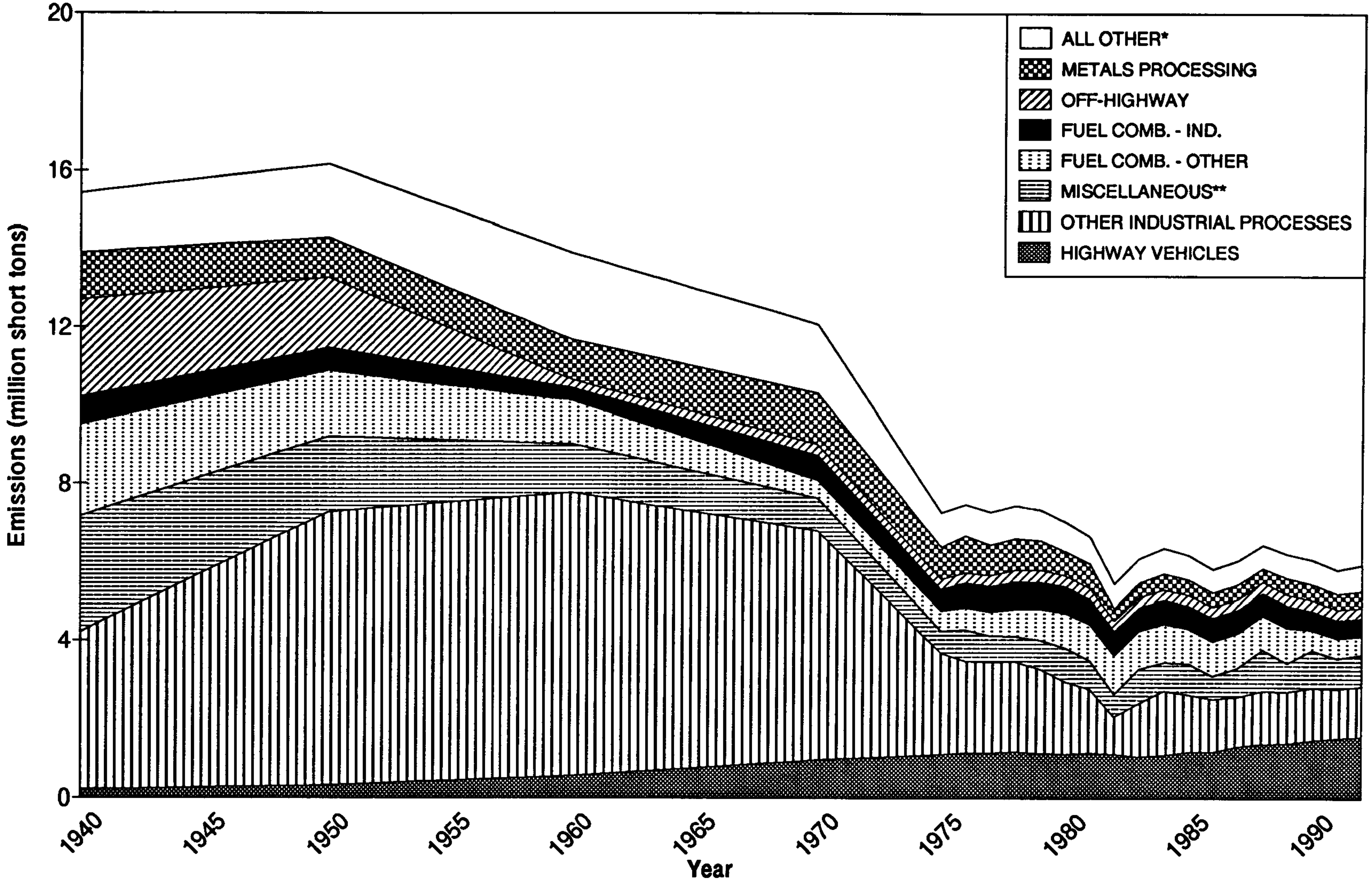
* All other is defined as chemical & allied product, petroleum & related industries, other industrial processes, waste disposal & recycling, storage & transport, and miscellaneous.

Figure 3-6. Trend in Pb Emission Estimates by Tier 1 Source Category, 1970 through 1992



* All other is defined in section 2.5.1

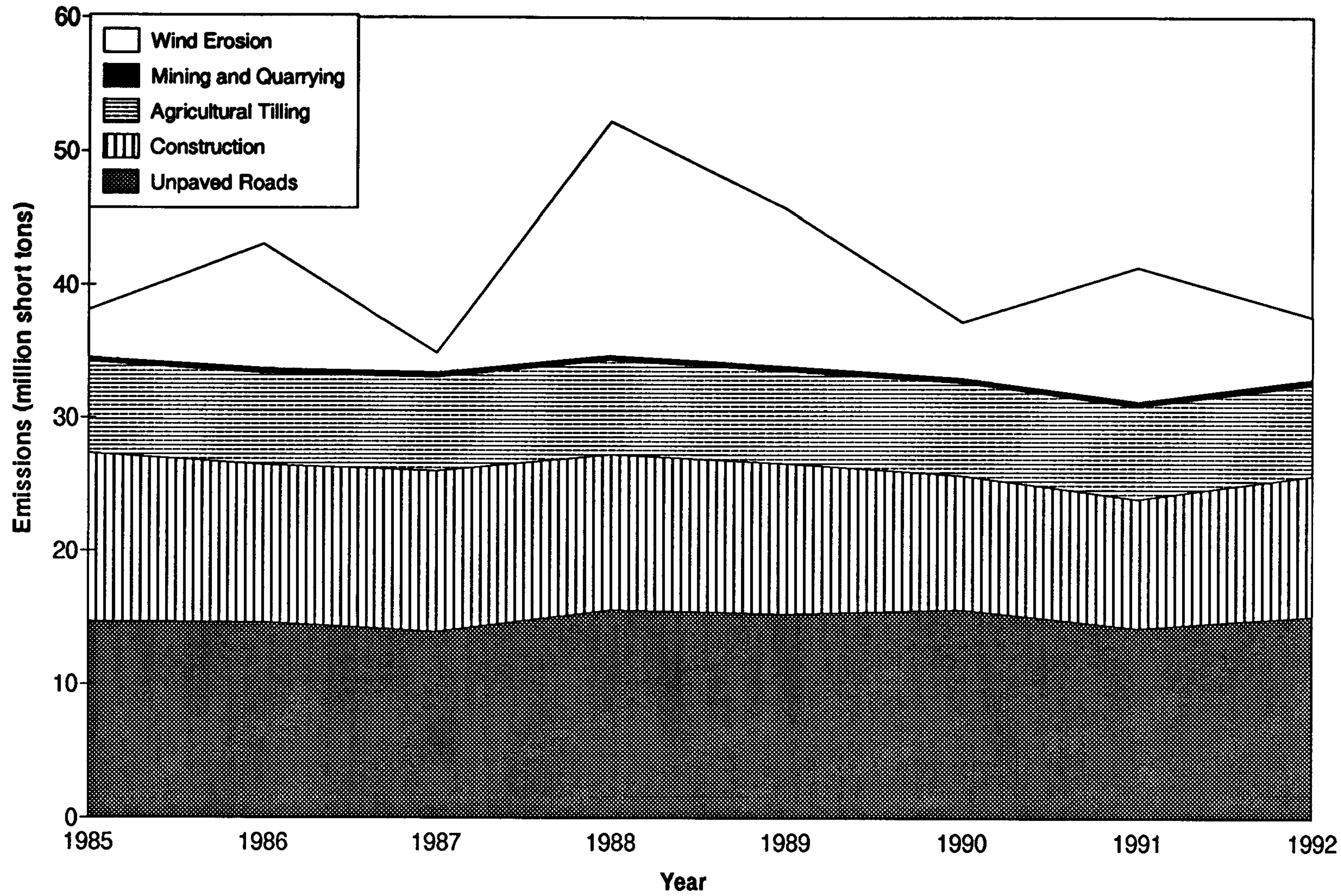
Figure 3-7. Trend in PM-10 Emission Estimates by Tier 1 Source Category (excluding fugitive dust emissions), 1940 through 1992



* All other categories are listed with emissions in Table A-18, A-19, and A-20 in Appendix A.

**Miscellaneous is primarily wildfires.

Figure 3-8. Trend in PM-10 Emission Estimates from Fugitive Dust Sources, 1985 through 1992



SECTION 4.0

REGIONAL EMISSION TRENDS, 1985 THROUGH 1992

This section presents the results of estimating the total emissions in each of the 10 EPA regions. A map of the 10 EPA Administrative regions is presented in Figure 1-1. When comparing emissions from different regions, it is important to consider the size of the region, population, economic activity, predominant types of industry, soil type, and other factors that affect air pollution. Total regional emissions for 1985 through 1992 are presented by pollutant and year in Appendix B, Tables B-1 through B-8. Figures 4-1 through 4-6 show the total emissions of each pollutant by EPA region for 1985 through 1992.

It should be noted that the regional emission estimates shown in the previous report[7] have been replaced by new estimates. As described in sections 5.2.4 and 5.6, regional emissions for PM-10 and lead are calculated as a fraction of the total national emissions of each source category. Regional emissions of VOC, CO, NO_x, and SO_2 are the sum of county emissions in each region.

The trends in regional emissions closely follow the trends in national emissions. This effect is largely due to the fact that each region has a diversity of source categories which reflect the national diversity. Some source categories, however, such as forest fires, prescribed burning, wind erosion, and certain industrial processes, produce significant regional effects and, therefore, do not necessarily follow national trends within the source category. These source categories will generally account for large changes at the regional level from one year to the next.

Figure 4-1. Trend in CO Emission Estimates by Region
(million short tons)

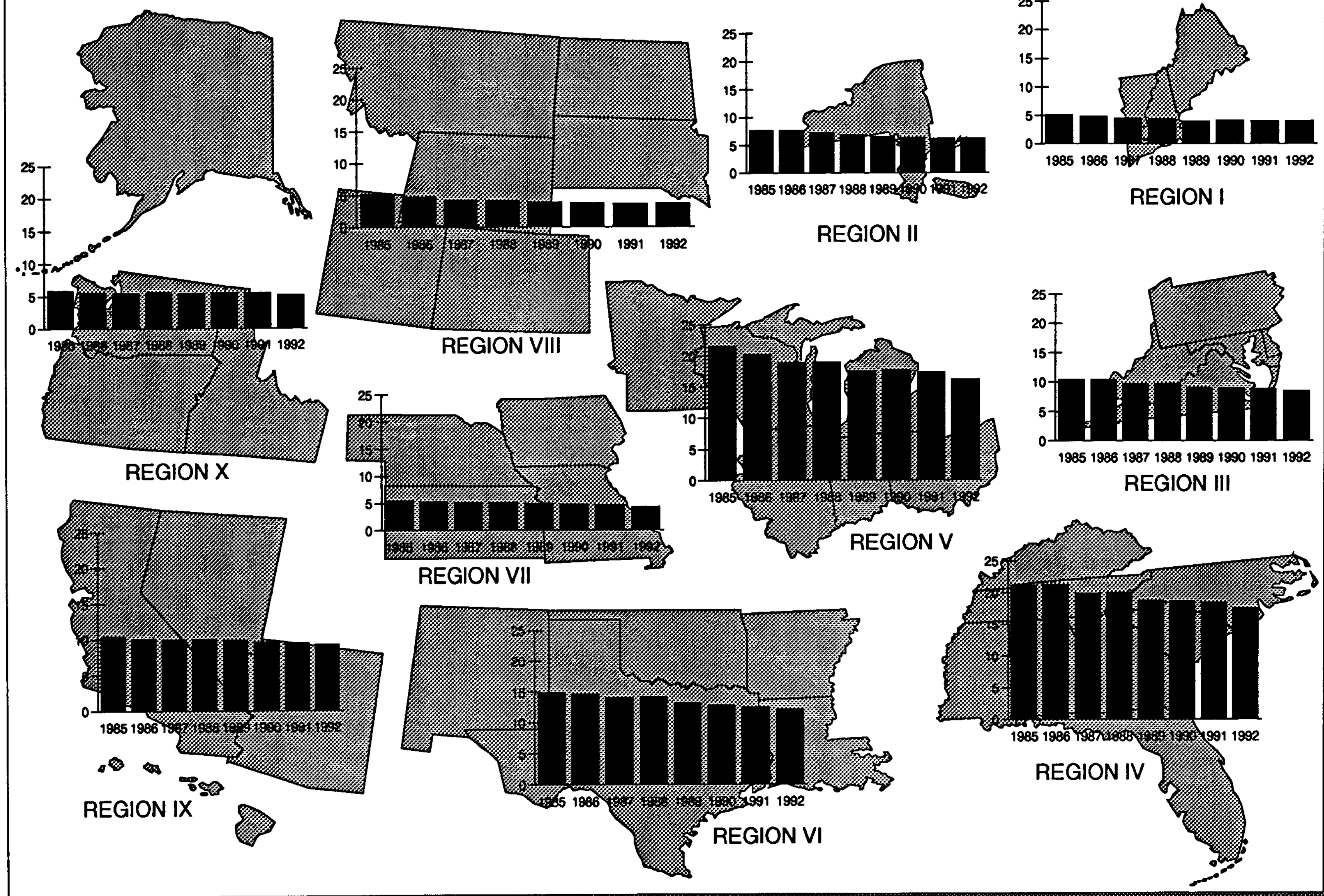


Figure 4-2. Trend in NO_x Emission Estimates by Region
(million short tons)

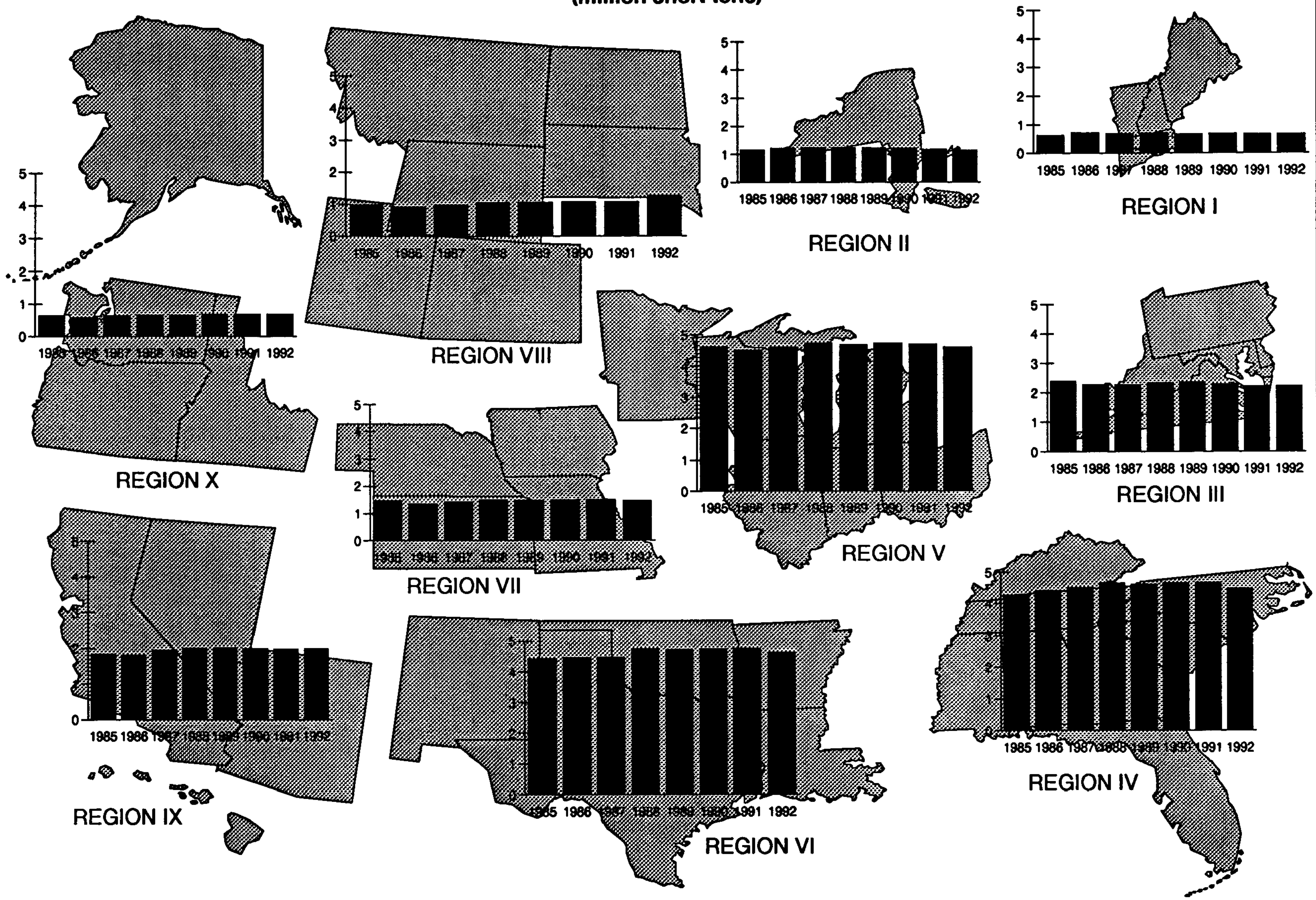


Figure 4-3. Trend in VOC Emission Estimates by Region
(million short tons)

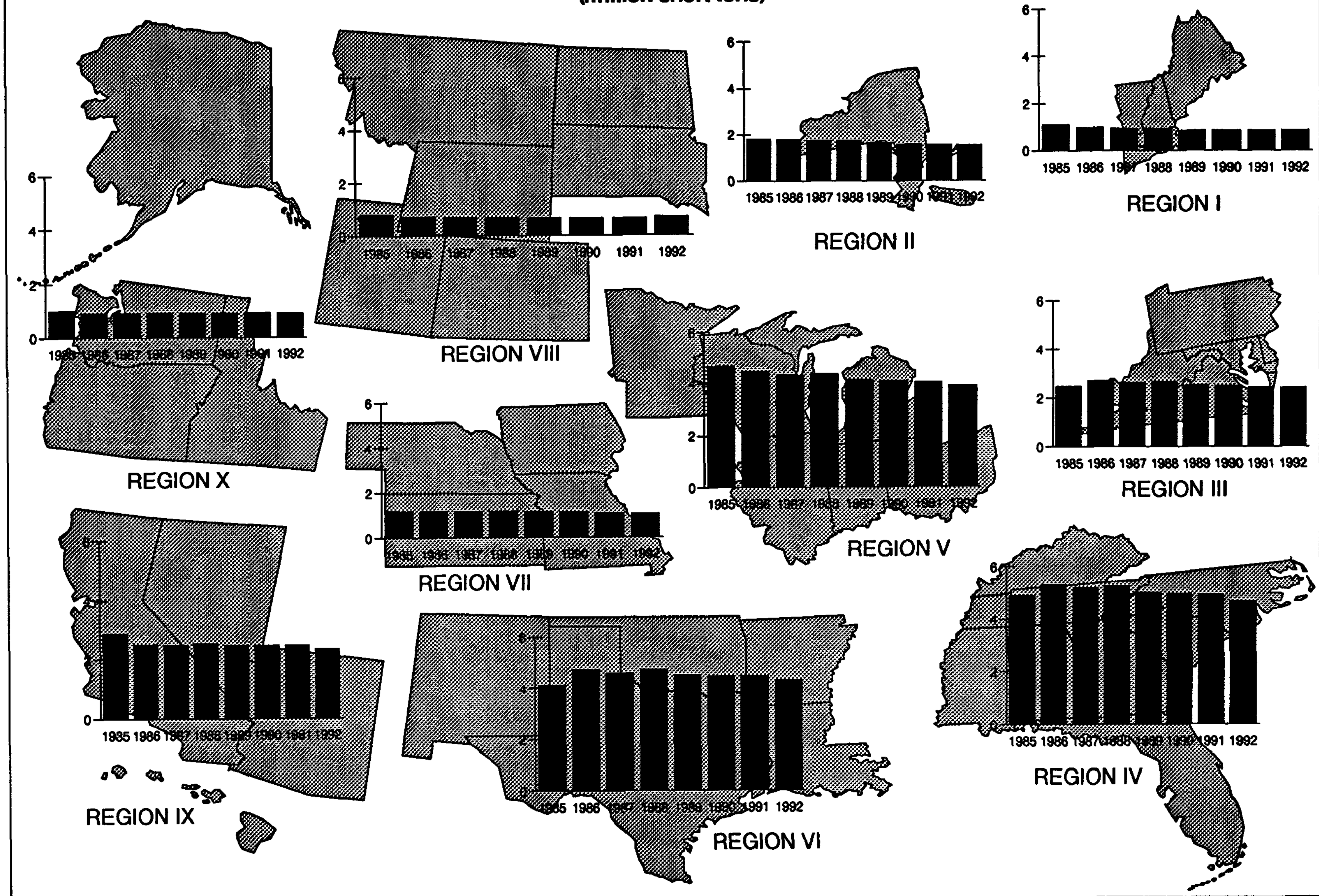


Figure 4-4. Trend in SO_2 Emission Estimates by Region
(million short tons)

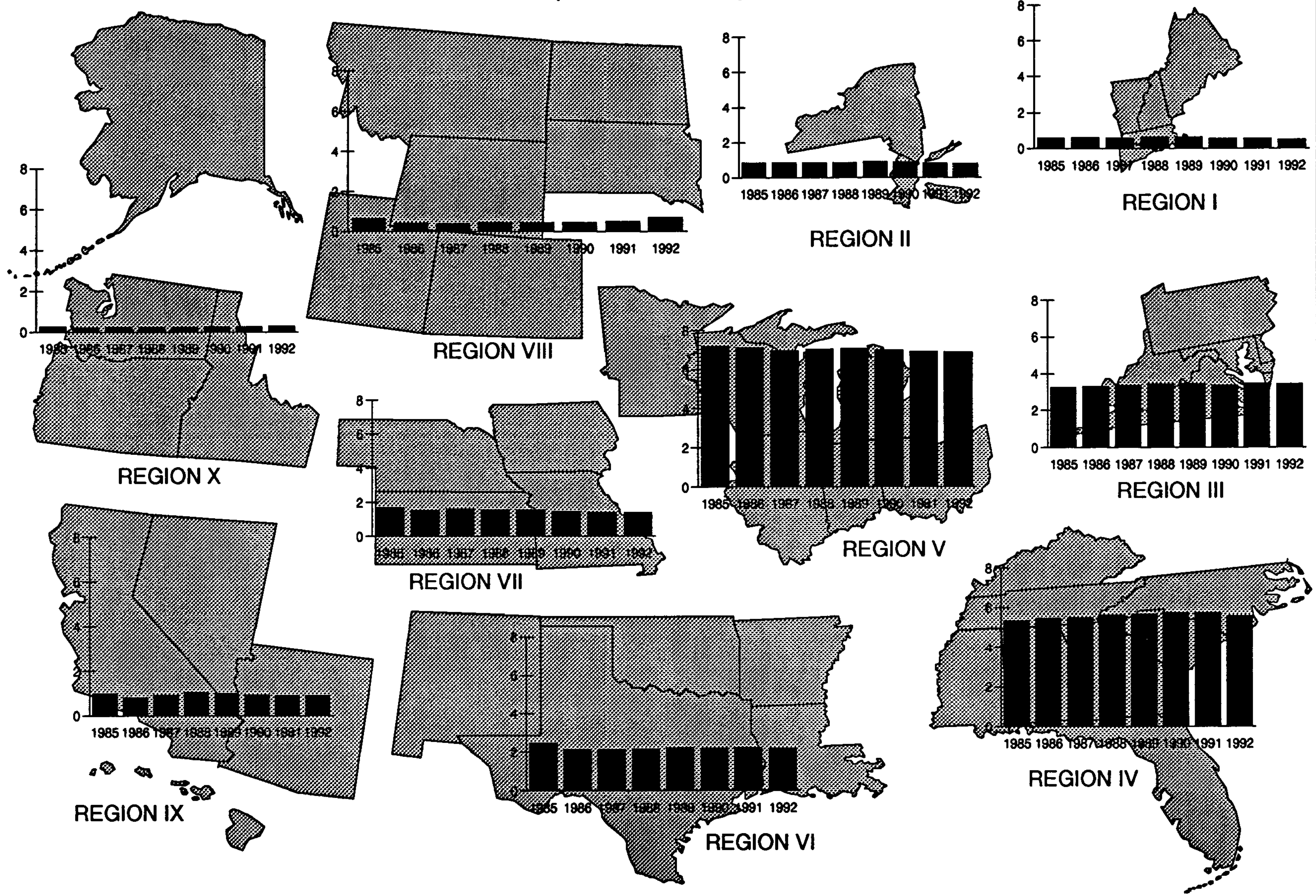


Figure 4-5. Trend in Pb Emission Estimates by Region
(thousand short tons)

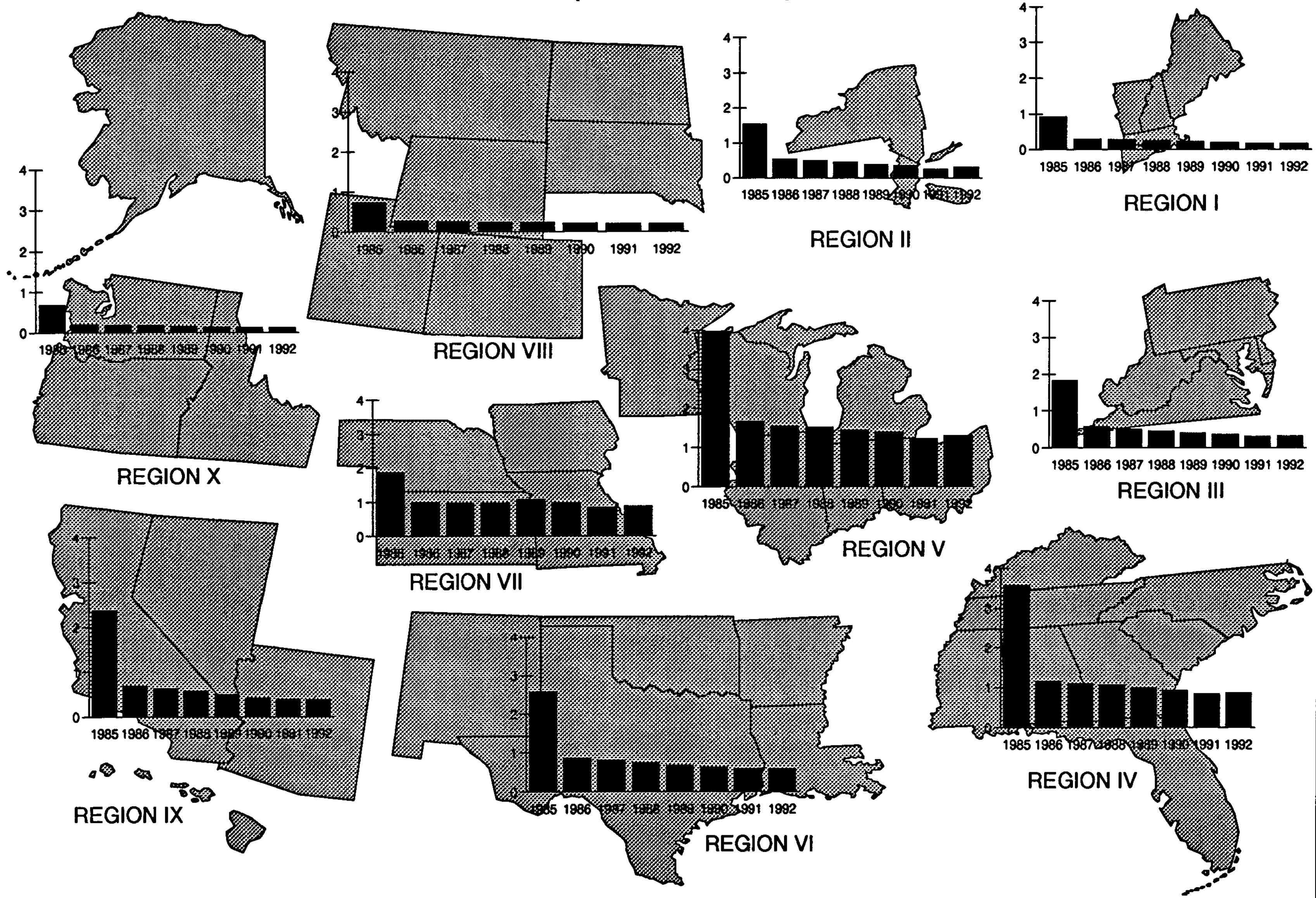
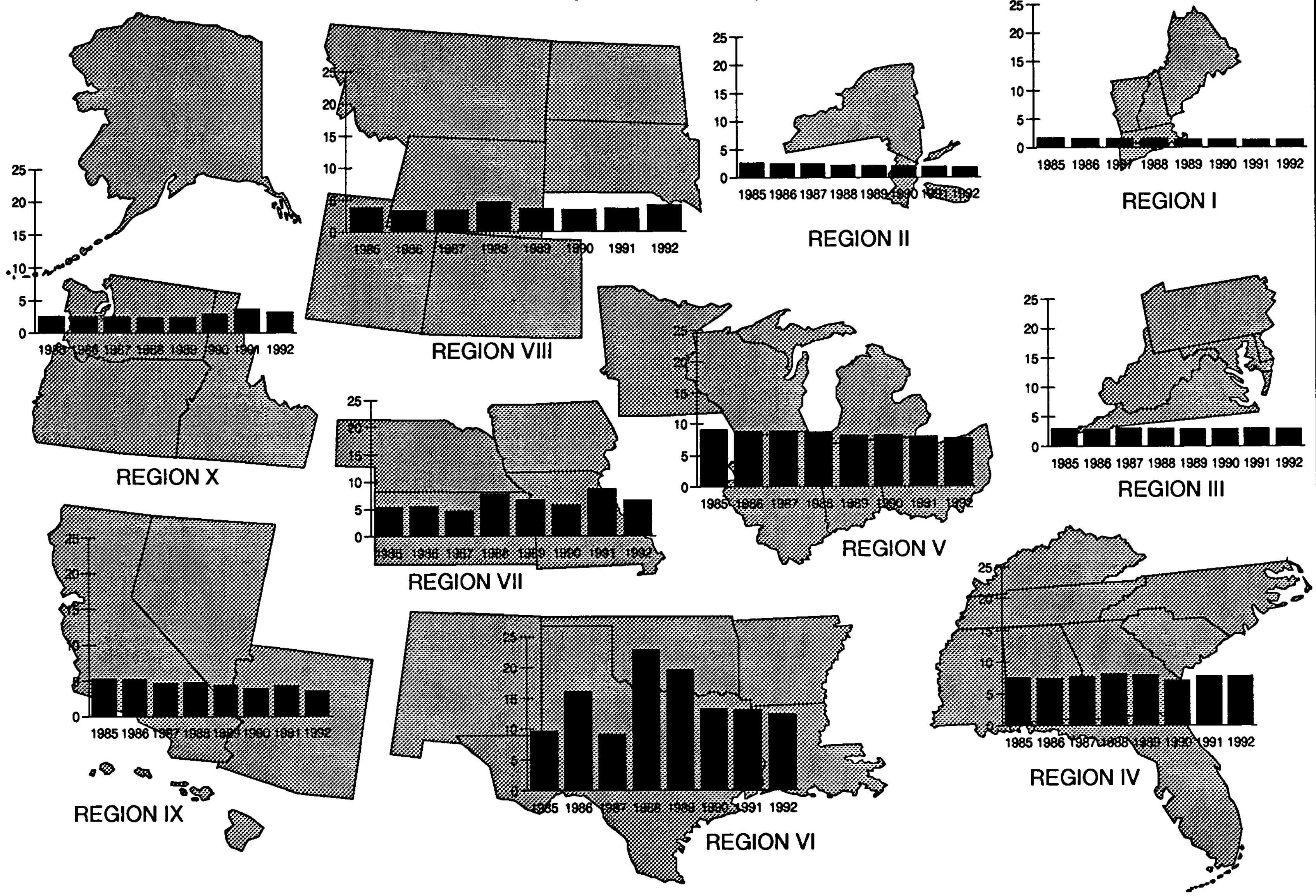


Figure 4-6. Trend in PM-10 Emission Estimates by Region
(million short tons)



SECTION 5.0

EMISSION ESTIMATION METHODOLOGY

Each year the EPA has prepared national emission estimates for assessing historic trends in criteria pollutant emissions. While these estimates have been prepared using consistent methodologies and have been useful for evaluating emission changes from year to year, they have not provided an absolute indication of emissions for any given year. States are currently finalizing a large emissions data base from calendar year 1990 to support CAAA requirements for ozone and CO nonattainment areas. This section discusses activities that have been undertaken to integrate these two data bases. Action to revise the *Trends* methodology to achieve consistency with state emission inventories will be described.

In order to provide an absolute indication of emissions as discussed above, please note that methodologies have changed from 1970 to the present, THUS COMPARISON OF VALUES WITH PREVIOUS *TRENDS* REPORTS IS NOT A VALID EXERCISE. The reader should use caution when comparing historical numbers from this report with any reports previously published.

5.1 INTRODUCTION

Emission inventory data that will be submitted by states in response to the CAAA will be used in numerous activities, one of which is modeling. The modeling community will require emissions data for ROM and UAM runs. The EPA will be running the ROM to provide base and future year boundary conditions for the UAM. For the base year, this will require multiple ROM runs to cover approximately 180 episode days over a 5-year period (1987 to 1991). For the future base year modeling, attainment years 1996, 1999, 2005, and 2007 will be modeled. To support the ROM runs, an emission inventory is needed for the regional airshed. Because states are not required to develop or submit statewide emission inventories for all source categories, and because nonattainment area emission inventories are not required to be submitted and approved in time to support ROM runs, EPA developed an *Interim* Inventory for the 1987 to 1991 base years. Within the current AIRS, the majority of the emissions data reported is for nonattainment areas, because that is currently the only information the states are required to report. For modeling analysis and for trend evaluations, however, information on emissions from all sources (both inside and outside of nonattainment areas) is required.

Several projects are in progress, or have recently been completed, that address parts of the problem described above. For instance, the EIB has developed a standard set of source reporting categories[10], commonly referred to as "tier" categories. The availability of a standard format which all agencies can use to report their data will facilitate comparisons across political boundaries and will enable EPA to readily compile national emission estimates. The EIB is developing procedures/ criteria[5] for replacing *Interim* emissions data with ozone SIP-submitted data. This will eventually result in a 1990 Base Year Inventory consisting of state data for nonattainment areas and EPA-generated data for all other areas.

When all these tasks are completed, the EIB will be able to extract the most current state inventories from AIRS and supplement the gaps with EPA-generated attainment inventories. The EIB has already made several changes to the *Trends* methodology to make the substitutions smoother.

Efforts to revise the *Trends* methodology to achieve consistency with state emission inventories have begun by integrating the *Interim* methodology. The next step will be to integrate the ozone SIPs into *Trends*. In general, the *Trends* emissions will reflect the *Trends* methodology for 1900 through 1984, the NAPAP methodology for 1985, and the *Interim* methodology for 1986 through 1992. The following sections describe any modification made to the three methodologies.

5.2 TRENDS METHODOLOGY

Although many changes have been made to the *Trends* emission estimates, the methodology has remained constant for the 1900 through 1939 VOC, NO_x, and SO_2 emissions; all particulate (1940 to 1992) and lead (1970 to 1992) emissions; and all SO_2 (except 1980 electric utility) emissions. NO_x, CO, and VOC emissions from 1940 to 1984 (except 1980 through 1984 transportation emissions) reported in *Trends* are based on a national "top-down" methodology. The 1900 through 1939 VOC, NO_x, SO_2 emissions were extracted from the NAPAP historical emissions report.

The estimation of national emissions by pollutant and by year involves many steps. Ideally, national emission estimates should be the result of adding the emissions of each individual source in the country. However, this is not possible for years prior to 1985, and therefore, reliable emission estimates must be based on a "top-down" calculation approach.

The methods used to prepare the estimates presented in this report are as similar as possible to those used for AIRS/AFS data preparation.[11] To develop the AIRS point source file, a complex calculation procedure must be followed which includes source-by-source and plant-by-plant emissions calculations. Individual point source estimates are summed to get state-level totals, and these are then summed to get national-level figures.

To develop area source emissions[12], statistical information must be collected on each type of area source. Area sources[p] are small sources (generally those which produce emissions of less than 100 tons per year) that are too numerous to account for individually. Residential fuel combustion and solid waste disposal are examples of area sources.

Fugitive dust emissions (emissions from unconfined sources such as storage piles, material loading, and wind erosion of land) must also be estimated. These estimates are based on large-scale data and various calculation procedures developed in recent years.

5.2.1 Calculation Procedure

Since it is impossible to measure the emissions of every historic source individually, a top-down estimating procedure must be used. The emissions are calculated either for individual sources or for many sources combined, using indicators of emissions. Depending on the source category, these indicators may include fuel consumption or deliveries, VMT, tons of refuse burned, raw material processed, etc.

When indicators are used, emission factors which relate the quantity of emissions to the activity indicator must also be used.

Emission factors are not necessarily precise indicators of emissions. They are quantitative estimates of the average rate of emissions from many sources combined. These factors are most valid when applied to a large number of sources. If their limitations are recognized, emission factors can be extremely useful tools for estimating national emissions.

The basic calculation procedure for most source categories, excluding highway vehicles and copper smelters, may be represented by the following equation:

$$E_{p,s} = A_s * EF_{p,s} * \left(1 - \frac{C_{s,p}}{100}\right) \quad \text{(eq. 1)}$$

where,

E	=	emissions
p	=	pollutant
s	=	source category
A	=	activity level
EF	=	emission factor
C	=	percent control efficiency

National activity data for individual source categories are obtained from many different publications. Emission factors are generally obtained from the U.S. EPA's *Compilation Of Air Pollutant Emission Factors*, or AP-42[13], and from MOBILE5, EPA's most current mobile source emission factor model at the time of calculation.[14] The overall control efficiency of a source category is currently derived from AIRS/AFS data. In the past, control efficiency was derived from the National Emissions Data System (NEDS)[15], the predecessor of AIRS, and from the 1985 NAPAP Emission Inventory.

Exceptions to this approach include estimates for electric power plants, copper smelters, and highway vehicles. For years prior to 1985, SO_2 emissions from electric power plants are calculated on a plant-by-plant basis. For copper smelters from 1975 to 1984, SO_2 emissions were obtained from the plants directly through the respective state air pollution agencies. For highway vehicles, VOC, CO, and NO_x, emissions (1980 to 1984) are calculated by state and month using a method described in section 5.3.

The following sections describe the methodology used for estimating the annual emissions of all criteria pollutants (1940 to 1984) and of Pb and PM-10 (1985 to 1991) for each major source category.

5.2.1.1 Transportation

The methodology used to estimate highway vehicle and off-highway emissions is described in this section. This category includes gasoline and diesel-powered motor vehicles, aircraft, railroad, vessels, and nonhighway use of motor fuels. The off-highway emissions (all transportation sources except highway vehicles) are adjusted for the years 1980 to 1984 by the method described in section 5.3 for CO, NO_x, and VOC.

5.2.1.1.1 Highway Vehicles — Emissions from gasoline and diesel-powered motor vehicles are based upon VMT[16] and emission factors. Eight vehicle categories are considered: gasoline-powered automobiles, diesel-powered automobiles, light-duty gasoline trucks (trucks less than 6,000 pounds in weight), light-duty gasoline trucks (6,000 to 8,500 pounds in weight), light-duty diesel trucks, heavy-duty gasoline trucks and buses, heavy-duty diesel trucks and buses, and motorcycles.

Emission factors for VOC, NO_x and CO are obtained from the MOBILE5 model, which is designed to be used as a tool for estimating exhaust and evaporative emissions from highway vehicles. The model requires information such as temperatures, vehicle speeds, and gasoline volatility. For PM-10 and SO_2, emission factors were obtained from AP-42. The PM-10 factors account for tire wear, brake wear, and tailpipe exhaust emissions.

For years prior to 1980, the emissions are calculated on the national level only, using a single average annual temperature, a single gasoline volatility, and a national distribution of VMT by vehicle speed and vehicle type. For 1980 and subsequent years, VOC, CO, and NO_x emissions are calculated on the state and monthly level using a new method.[q] RVP values obtained from Motor Vehicle Manufacturers Association (MVMA) Fuel Volatility Survey[17] through EPA's Office of Mobile Sources (OMS)[18], and average monthly maximum and minimum temperatures in each state are utilized by MOBILE5.

Lead emission estimates are based on gasoline consumption, gasoline lead content, percent unleaded gasoline, and emission factors. The lead content of gasoline in 1970 was obtained from the Bureau of Mines, U.S. Department of Interior (DOI)[19], and for subsequent years, from AP-42. The percent unleaded gasoline was obtained from the EIA, U.S. Department of Energy (DOE).[20]

5.2.1.1.2 ***Aircraft*** — Emissions from aircraft are based on the number of landings and take-offs reported by the Federal Aviation Administration[21] and on AP-42 emission factors for various types of aircraft. Emissions occurring when aircraft are above 3,000 feet are not included in the estimates. Average emission factors are calculated, taking into account the national mix of different types of aircraft used for general aviation, military, and commercial purposes.

5.2.1.1.3 ***Railroads*** — Emissions from railroads are based on diesel and residual fuel oil consumption by railroads as reported by the EIA.[22] Coal consumption by steam locomotives has been negligible since 1955. The average emission factors used are applicable to each type of fuel. For the case of SO_2 emission estimates, the average sulfur content of each fuel is included in the emission factor.

5.2.1.1.4 ***Vessels*** — The consumption of diesel fuel, residual oil, and coal by vessels operating inside the U.S. boundaries is obtained from the U.S. DOE.[20,22,23] Gasoline consumption is based on national boat and motor registrations together with usage factors (gallons/motor/year)[20], and marine gasoline sales as reported by the U.S. Department of Transportation (DOT).[16] The estimates of fuel consumption are multiplied by AP-42 emission factors. In the case of coal-fired vessels, an average emission factor for coal combustion in boilers is used.

5.2.1.1.5 ***Off-highway Vehicles*** — This source category includes farm tractors, other farm machinery, construction equipment, industrial machinery, small general utility engines such as lawn mowers and snowmobiles, and motorcycles. Fuel use is estimated for each subcategory from equipment population data and an annual fuel use factor[24] together with fuel deliveries of diesel fuel reported by the U.S. DOE[22] and for gasoline sales reported by the U.S. DOT[16] for off-highway use.

5.2.1.2 Stationary Source Fuel Combustion

This major category includes the combustion of bituminous, lignite, and anthracite coal, fuel oil, natural gas, wood, and other fuels from electric utilities, industries, and other sources.[r] This section describes the methodology for estimating emissions from all stationary source fuel combustion for all pollutants before 1985. In addition, this section discusses emissions of PM-10 and Pb after 1985.

5.2.1.2.1 ***Coal*** — The consumption of bituminous, lignite, and anthracite coal by various end users is reported by the U.S. DOE.[23,26] Most coal is consumed by electric utilities. The reported consumption by source category is multiplied by an average emission factor representative of each category. For SO_2emissions, the emission factor includes an average sulfur content value for each type of coal consumed.[27] In addition, the sulfur dioxide emission factor for electric utilities is adjusted to account for the amount of sulfur controlled by flue gas desulfurization systems, according to information reported by the U.S. DOE.[27] In the case of PM-10, an overall control efficiency is obtained from AIRS/AFS for all power plants combined.

5.2.1.2.2 ***Fuel Oil*** — Residual, distillate, and kerosene oil are burned by electric utilities, industrial boilers, commercial and institutional boilers and furnaces, and residential heaters. The consumption of each fuel type by end user is reported by the U.S. DOE.[22] Average emission factors and sulfur content values are calculated and applied to the consumption data.

5.2.1.2.3 ***Natural Gas*** — Natural gas consumption is reported by the U.S. DOE for various end-user groups.[28] AP-42 emission factors were used to calculate the emissions.

5.2.1.2.4 ***Wood and Other Fuels*** — Consumption of wood is estimated by the U.S. DOE[29,30,31] for wood stoves and residential fireplaces. Consumption of bagasse is based on data reported in AIRS/AFS. Sales of liquified petroleum gas are reported by the U.S. DOE.[20] Coke and coke-oven gas consumption is obtained from the U.S. DOE.[32] These consumption values are multiplied by appropriate emission factors obtained either from AP-42 or AIRS/AFS.

Lead emissions from the combustion of waste oil were based on information obtained from the U.S. EPA's Office of Solid Waste. The amount of waste oil burned is assumed to remain constant, while the lead content of waste oil is assumed to decrease as a result of the general reduction in leaded oil and petroleum products.

5.2.1.3 Industrial Processes

This category includes chemical and allied product manufacturing, metals processing, petroleum and related industries, other industrial processes, solvent utilization (both industrial and nonindustrial), and storage and transport. Production data for industries that produce the majority of emissions were obtained from available publications. Generally, the *Minerals Yearbook*[19] and *Current Industrial Reports*[33], published by the Bureau of the Census, provided most of the necessary data. Average emission factors were applied to the various production data. Average nationwide control efficiency values for various processes were obtained either from published reports[34], the 1985 NAPAP Emission Inventory, or AIRS/AFS.

Petroleum product storage and petroleum marketing operations, including gasoline, crude oil and distillate fuel oil storage and transfer, gasoline bulk terminals and bulk plants, and retail gasoline service stations, are included as industrial processes. Also included are industrial surface coating and degreasing operations, graphic arts (printing and publishing), and dry cleaners. All of these processes involve the use of organic solvents. Emissions from the consumption of organic solvents are estimated from information reported by the U.S. EPA.[35] It is assumed that all solvents consumed eventually evaporate, except in surface coating operations where some of the organic solvent vapors are controlled. The control efficiency of surface coating operations is derived from AIRS/AFS.

Nonindustrial organic solvent use includes nonindustrial sales of surface coatings for architectural coating and solvent evaporation from consumer products such as aerosols, deodorants, polishes, and toiletries. This category also includes the use of organic compounds in products such as general cleaning solvents, paint removers, liquefaction of asphalt paving compounds, and miscellaneous others. Total national organic solvent use is estimated from chemical production reports, along with estimates of the percentage of total production that each chemical used as a solvent represents.[35,36] It is assumed that the total quantity of each solvent produced includes an offset for solvent loss by evaporation.

Lead emissions from miscellaneous industrial processes include lead alkyl production (a major source of lead) and other minor sources such as type metal production, can soldering, and cable covering. The lead alkyl production is based on information reported by the U.S. International Trade Commission.[37] Production information for other minor sources is obtained from the U.S. DOI.[19]

5.2.1.4 Solid Waste Disposal

This category is represented in the waste disposal and recycling Tier 1 source category. The emissions from this category are based on an assumed per capita solid waste generation rate of 5.5 pounds per day. This value is based on a study of solid waste collection and disposal practices.[38] This value is adjusted each year based on information contained in AIRS/AFS. Average AP-42 emission factors are applied to the estimated quantities of solid waste disposal.

5.2.1.5 Miscellaneous

This source category includes forest fires, agricultural burning, coal refuse burning, structural fires, and fugitive dust sources.

5.2.1.5.1 Forest Fires — The U.S. Forest Service of the Department of Agriculture[39,40] and the U.S. DOI[41] publish information on the number of forest fires, their location, and the acreage burned each year. The amount of biomass and controlled areas burned of forest areas are estimated by the EPA.[42] Average emission factors are applied to the estimated quantities of materials burned.

5.2.1.5.2 Agricultural Burning — A study was conducted by the U.S. EPA to obtain local agricultural and air pollution control agency estimates of the number of acres and quantity of material burned per acre in agricultural burning operations.[42] These data are updated and used to estimate emissions based on average emission factors.

5.2.1.5.3 ***Coal Refuse Burning*** — Estimates of the number of burning coal-refuse piles in the United States are reported by the Bureau of Mines.[43] This publication presents a detailed discussion of the nature, origin, and extent of this source of pollution. Rough estimates of the quantity of emissions are made by applying average emission factors for coal combustion. It should be noted that the number of coal-refuse piles decreased to a negligible level by 1975.

5.2.1.5.4 ***Structural Fires*** — The U.S. Department of Commerce publishes information on the number and type of structures damaged by fires each year.[44] Emissions are estimated by applying average emission factors for wood combustion to these statistics.

5.2.1.5.5 ***Fugitive Dust PM-10 Sources*** — Estimates of fugitive dust PM-10 emissions are made for the following categories: unpaved roads, paved roads, wind erosion, agricultural tilling, construction activities, and mining and quarrying. An EPA study[45] shows that emission estimates at both the national and regional level for these source categories require either modification of existing PM-10 or TP emissions estimation methods or development of new methodologies.[46] As a result, new estimation methods were developed for each category to predict the latest annual emissions. Predictive methods for some sources were required because the necessary data were not available in time to estimate the 1992 emissions. A brief description of the method used for each source category follows.

5.2.1.5.5.1 ***Unpaved Roads.*** Regional emissions from unpaved roads are determined using the method developed as part of an EPA study to determine the feasibility of developing regional emission estimates.[45] The method is similar to that developed by NAPAP.[46] Three minor modifications, relative to the NAPAP method, were made in determining the emission estimates for unpaved roads. First, the AP-42 emission factor for unpaved roads is utilized for all unpaved road surface types. Secondly, a plume depletion factor is not applied to the emission estimates. These first two modifications are made to be consistent with the approach used for other source categories. AP-42 emission factors are applied throughout to produce the emission estimates. Plume depletion factors are not (and have not ever been) applied to particulate emissions from other particulate sources. Thirdly, variable (not fixed) values of vehicle speeds, weights, and number of wheels are used to develop the emission factor for unpaved roads.

5.2.1.5.5.2 ***Paved Road Resuspension.*** Regional PM-10 emissions from paved road resuspension are estimated by summing regional emission estimates. A "dry days" term similar to that used in the unpaved road emission factor is included in the AP-42 emission factor equation for paved roads in an attempt to account for the effect of precipitation.

An empirical model is used to express the relationship between traffic volume and surface silt loading. Surface silt loading values are determined for various paved road function classes by EPA region. Average daily traffic volume is calculated by dividing the total VMT for a particular functional class, year, and state by the number of days in the year.

For the years 1985 to 1991, the total VMT (by EPA region and functional class) is obtained from the FHWA.[16] VMT from paved roads is calculated by subtracting the unpaved VMT from the total VMT. For 1992, the total preliminary VMT is obtained by rural and urban EPA region. The rural and urban VMT are further subdivided into functional classes using the 1991 VMT distribution.

5.2.1.5.5.3 Wind Erosion. Regional PM-10 wind erosion emission estimates for agricultural lands are made by modifying the NAPAP method for estimating wind erosion emissions. The original NAPAP method and the method used here both develop an expectation of the dust flux based on the probability distribution of wind energy. The method developed for this report uses the mean wind speed, information on threshold friction velocity, and information on precipitation to predict the wind erosion flux potential for soils.

It should be noted that the emission estimates developed as part of the NAPAP effort utilized a 30-year wind record and thus represent a 30-year average emission estimate. The wind erosion emission estimates developed for this report use state-level, year-specific wind and activity data.

5.2.1.5.5.4 Agricultural Tilling. Regional PM-10 emissions from agricultural tilling are made using the AP-42 emission factor equation for agricultural tilling with year-specific and state-level emission factor correction parameters and activity data.

5.2.1.5.5.5 Construction Activities. Regional PM-10 emissions are estimated using the AP-42 TP emission factor for construction activity, a PM-10 correction factor, and the estimated acres of land under construction in the nation. The average duration of construction was also estimated.

5.2.1.5.5.6 Mining and Quarrying. Regional PM-10 emission estimates for mining and quarrying operations include the following sources: (1) overburden removal, (2) drilling and blasting, (3) loading and unloading, and (4) overburden replacement. Transfer and conveyance operations, crushing and screening operations, and storage and travel on haul roads are not included in the estimates.

For the four operations listed above, metallic ore emissions are calculated by assuming that the PM-10 emission factors for copper ore processing operations apply to all metallic ores. Nonmetallic ore and coal emissions are calculated by assuming that the PM-10 emission factors for western surface coal mining apply to both nonmetallic ores and coal.

5.2.2 National Pb and PM-10 Emission Estimates for 1992

The emission estimates made in 1993 for 1992 are based on estimating the activity level for most source categories. The weighted emission factors and control efficiencies are assumed to be constant from 1990 to 1992.

During 1991, the 1990 preliminary estimates were made using one of two methods. The first method uses weighted 20-year specific source category activity data. This method was applied to the year 1989 to check the methodology. The difference between the preliminary 1989 values and the actual 1989 values provided an indication of the estimation error. For many source categories, the percent error was quite small, but for others it was significant. Therefore, a second method using linear regression with weighted 7-year activity data was developed. The percent error was calculated and the results of both methods were compared. The second method was found to yield better estimates for those source categories where the activity trend was significantly different 10 to 20 years ago compared to today.

These two methods are applied to the appropriate source category to yield the 1992 emission estimates. The method described above is not applied to the following:

- forest fires,
- highway vehicles (except lead emissions),
- electric utilities, and
- several industrial processes: petroleum refining (TCC, FCC) and agricultural industries (cotton ginning; cattle feedlots; and grain milling, except soybeans).

The 1992 emission estimates for these source categories, except forest fires, are based on preliminary or actual activity data obtained from other federal agencies. The number of acres burned from forest fires is not available. Therefore, the default methodology of averaging burned acreage data for the last 5 years is used.

5.2.3 Regional Pb and PM-10 Emission Estimates, 1985 to 1992

For each source category, except industrial processes, state-level activity data are obtained for 1985 through 1988. In most cases, state-level data are obtained directly from the same references from which the national data are obtained. The state-level activity data are aggregated to the EPA regional level and the regional totals are used to develop regional fractions of the national activity. These fractions are multiplied by the national emissions to obtain regional emissionestimates by source category. The regional emissions of all source categories are added to produce regional total emissions.

In the case of industrial process categories, except copper smelters, the regional fractions are obtained from the 1985 NAPAP Emission Inventory. The same fraction is used for each year from 1985 through 1992 because the changes in regional fractions for nonindustrial source categories are negligible from year to year.

5.3 UPDATED 1985 NAPAP EMISSIONS

The following changes apply only to VOC, CO, NO_x, and SO_2 emissions. The 1985 *Trends* emission estimates are based on the 1985 NAPAP estimates with updated estimates for VOC, CO, NO_x, and SO_2 highway vehicle emissions; SO_2 electric utility emissions; and VOC, CO, NO_x, and SO_2 off-highway emissions. Table 5-1 presents the changes from past *Trends* methodology in VOC, CO, and NO_x highway vehicle emission estimates. In general, the VOC, CO, NO_x highway vehicle emissions are derived using the MOBILE5 emission factor model for all states except California (which uses EMFAC7F). Emissions of VOC are now expressed as nonmethane organic gases (NMOG). The state-level *Trends* VMT was used, but the *Interim* apportionment of VMT by speed (nine speeds rather than three), vehicle type, and county has been applied. The *Trends* methodology used monthly site-specific maximum and minimum temperatures and MVMA's RVPs obtained from the OMS. The default MOBILE5 registration distribution replaces the *Trends* calculated annual national registration distribution. The *Interim* assumptions for altitude and Federal Test Procedure (FTP) operating mode for all speeds is used. The SO_2 highway vehicle emissions are replaced with estimates generated by a combination of the *Trends* methodology (AP-42 emission factor) and *Interim* Inventory (VMT). The 1985 SO_2 electric utility emissions are the National Allowance Data Base[47] emissions. The off-highway VOC, NO_x, CO emissions are replaced by grown 1985 NAPAP emissions. The growth is based on the change between the 1986 *Interim* Inventory emissions and the 1986 *Trends*[7] emissions, as shown below.

$$Off\text{-}highway_{1985} = Off\text{-}highway_{1985NAPAP} * \frac{Off\text{-}highway_{1986Interim}}{Off\text{-}highway_{1986Trends}} \quad \text{(eq. 2)}$$

5.4 INTERIM INVENTORY (1987 TO 1991 EMISSIONS)

The VOC, CO, NO_x, and SO_2 emissions for 1987 to 1991 found in this report are the *Interim* emissions with some modifications. The 1987 to 1991 *Interim* Inventory is composed of annual county-level estimates by source category of point, area, and mobile source emissions. The methodologies used in developing these components are discussed in detail in *Regional Interim Emissions Inventories (1987-1991), Volume I: Development Methodologies.*[4]

5.4.1 Background

Because urban model performance will be evaluated for episodes in the years 1987 through 1991, a regionwide inventory must be available for use in the ROM for each of these years. This regional inventory is considered as an "interim inventory" because 1990 state ozone SIP submittals will be incorporated into the 1990 *Interim* Inventory. Areas for which state submittals are neither available nor required will be covered by the *Interim* inventory. This is being done to ensure that the data used in the ROM and UAM are as similar as possible.

Initially, the base year ROM runs (1987 to 1991) will be based entirely in the *Interim* Inventory in order to provide timely information to states. The future year (1996, 1999, 2005, 2007) ROM runs will be based on a revised version of the 1990 *Interim* Inventory, which will include as much state data as can be included by the time the modeling begins.

As previously noted, the *Interim* Inventory is not intended to replace the state inventory submittals. In fact, the 1987 to 1991 *Interim* regional inventory contains only annual county-level emission estimates (i.e., no activity or emission factor data).

5.4.2 Major differences with 1985 NAPAP

Table 5-2 summarizes how the 1987 to 1991 *Interim* estimates are derived. This methodology produces an emission inventory which presents a reasonable representation of aggregate emissions from a large geographic area. The results for a given source or locality (e.g., nonattainment area) cannot be as accurate as estimates from site-specific information.

5.4.3 Modifications to the Interim Inventory

The estimates derived by the *Interim* methodology are adjusted for the purpose of providing up-to-date emissions for the *Trends* report. Since *Trends* is a national inventory, steps are taken to add Hawaiian and Alaskan emissions by estimating highway vehicle, electric utility[s], and solvent emissions for these states. The highway emission estimates from the *Interim* Inventory for California are adjusted by using emission factors derived from EMFAC, the California Air Resource Board's emission factor model. Lastly, the 1991 electric utility emissions are re-estimated using actual boiler-level data.[48]

5.5 CO, NO_x, SO_2, AND VOC EMISSIONS, 1986 and 1992

The 1986 emissions in this report are also developed using the *Interim* methodology, with some modifications. These modifications are made to the methodologies used to derive the highway vehicle and electric utility emissions. The highway vehicle emissions are determined using the same method applied to calculate the 1985 emissions. The electric utility emissions include estimates for Alaska and Hawaii.

The 1992 nonutility point and area source emissions are estimated using the E-GAS[49] growth factors instead of the *Interim* growth factors used to derive the 1991 emissions (see Table 5-2). The 1992 electric utility emissions are estimated based on the *Interim* methodology of growing the 1991 emissions with 1992 plant-level information.[50] The highway vehicle emissions for 1992 are calculated in the same manner as the 1985 emissions. The only exception is the use of 1991 data currently unavailable for 1992.

5.6 REGIONAL CO, NO_x, SO_2, AND VOC EMISSION ESTIMATES, 1985 to 1992

The regional estimates are developed by summing the county-level emissions for each state in each EPA Region.

5.7 FUTURE MODIFICATIONS

In order to achieve consistency with state data, the *Trends* report has become less consistent in methodology. Future modifications will help eliminate this problem. The following sections outline some of the modifications to be incorporated in future *Trends* estimates.

5.7.1 Merging of Trends and Interim Methodologies

The *Trends*, NAPAP, and *Interim* inventories were originally developed for different purposes. Future *Trends* reports will try to incorporate the best feasible methodology (based on resource and data constraints) from the above methodologies. This was not done for the current report because of resource constraints and timing conflicts associated with project completion. An additional modification to the *Trends* estimates will be the use of ozone SIP data. Some categories that were not updated for the *Interim* inventory but which are important in evaluating emissions trends (copper smelters and forest fires) will be modified. In addition, changes will include updating the pre-1986 *Trends* emission estimates to reflect improvements in methodologies incorporated in the *Interim* Inventory (such as updated control efficiencies, rule effectiveness, and emission factors).

5.7.2 *AIRS Extractions*

Starting with last year's *Trends* report, a listing of the top 50 facilities (currently top 30) from AIRS/AFS for NO_x, CO, VOC, and SO_2 was published. The intention of this list is to alert the states that some of the information available from AIRS/AFS is lacking quality control. Once this data base contains quality - assured and EPA-approved emissions, the *Trends* report will extract, at a minimum, the nonattainment area emissions for the country. The methodology for incorporating the AIRS data into the *Interim* data base is currently under development by the Source Receptor Analysis Branch (SRAB). The data base system to manipulate the *Interim* data is also under development by the EIB.

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[p] The Area/Mobile Source Subsystem (AMS) of AIRS cannot presently calculate national area source emissions.

[q] Section 5.3 describes the methodology in more details.

[r] The 1980 SO_2 electric utility emissions presented are from the 1980 NAPAP[25] Emission Inventory.

[s] The electric utility emissions referred to in this section are the fossil-fuel steam-generated emissions.

Table 5-1. Methodology Changes in Highway Vehicles

Past Methodology	Current Methodology	
1980-1991	**1992**	**1980-1991**
MOBILE4.1 and California emissions for 1980-1991. Alaska and Hawaii not included.	**MOBILE5** for all states except California, for which EMFAC was used	Same as 1992
	Alaska and Hawaii included	Alaska and Hawaii included
NMHC, CO, NO_x	**Pollutants**: HC (expressed as NMOG), CO, NO_x	HC (expressed as NMOG), CO, NO_x
State-level VMT for 1980-1991, 3 speeds: 55, 45, 19.6	**VMT**: Interim Inventory methodology. This includes speed (15, 20, 25, 30, 35, 40, 45, 55, 60 mph), distribution of VMT by vehicle type, and distribution of VMT by state and road type. VMT from the 1991 Interim Inventory was grown using SEDS gasoline consumption data at the state level.	1987-1991 use of Interim Inventory VMT. 1980-1986 use of Trends state-level VMT and Trends VMT mix by vehicle type used the Interim Inventory breakdown of VMT by speed, and county. Nine speeds.
Same as 1980-1986 current	**Temperature**: Actual monthly temperature at the state level.	1980-1986: actual monthly temperature at the state level 1987-1991: 30-year average seasonal temperature for each state
1980-1991 ran state-level emission factors by month	**Model Runs:** At monthly level with seasonal VMT allocation factors broken into monthly VMT allocation factors based on the number of days per month in each season.	1987-1991: seasonal runs 1980-1986: same as 1992
Not used	**Oxygenated fuels** modeled for appropriate counties	Not used
National derived registration	**Registration Distribution**: MOBILE5 default and January/July distribution flag	MOBILE5 default and January/July flag
Same as 1992	**RVP**: Obtained nonattainment RVP from OMS broken out to states and months by OMS guidance	Same as 1992 Note: RVP average by season for 1987-1991
No I/M modeled	**I/M**: Based on I/M Program Design Summary obtained from OMS (state level)	Same as 1992
All state: CO, NM, UT, WY; partial state AZ, ID, MT, NV	**Altitude**: Interim inventory assumption: entire state of CO, NM, and UT and certain counties in NV. All other states and counties low altitude.	Same as 1992
Assumed 100% of the VMT at 55 miles per hour occurred in the hot stabilized mode.	**Operating Mode**: The FTP operating mode (20.6%, of the VMT in the cold start mode, 27.3% of the VMT in the hot start mode, and 52.1% of the VMT in the hot stabilized mode). This assumption used in Interim Inventory.	Same as 1992

Table 5-2. Summary of 1987 to 1991 Interim Regional Inventory Methodology

Source	Type	Methodology	Comment
Point Source Data			
	Fossil-Fuel Steam Utilities	Derived from Forms EIA-767[48] and EIA-759[50] for each year (1987-1991)	Complete overhaul of NAPAP emissions
	Nonutility Point	Projected from 1985 NAPAP Inventory values for each year (1987-1991) using Bureau of Economic Analysis (BEA)[51,52,53,54] historical earnings for 2-digit Standard Industrial Classification (SIC) codes. Except: (1) applied 80% rule effectiveness (RE), and (2) revised control efficiencies (CE).	(1) Exceptions to 80% RE are listed in Ref #4. (2) CE for VOC, CO, NO_x, SO_2 for Texas and VOC and CO for other states deemed too high
Area Source Data			
	Solvents	Solvent usage estimates obtained from 1989 and backcasted/projected for each year (1987-1988, 1990-1991) based on U.S. Paint Industry Data Base[55] and Industrial Solvent Marketing[56,57] reports.	Complete overhaul of NAPAP emissions
	Other Area Sources	Projected from the 1985 NAPAP Inventory for each year (1987-1991) using (BEA) earnings and population data and State Energy Data System (SEDS)[58] fuel consumption data. Except: (1) alternative projections, (2) emission factor updates, (3) refined emissions, and (4) CE and 80% RE inclusion.	(1) State Energy Data System was used for fuel combustion and gasoline marketing; AAR[59] was used for railroads; FAA[60] was used for aircrafts; Corp of Engineers[61] was used for vessels; Petroleum Supply Annual[62] was used for petroleum refinery fugitives; no growth was projected for residential residual fuel oil, forest fires, managed burning, and structural fires; and BEA was used for all other categories. (2) residential wood (VOC, CO, NO_x); railroads (VOC, CO, NO_x, SO_2); aircrafts (SO_2); and vehicle refueling (updated RVP). (3) Use of Emission Standards Division's 1989 TSDF[63] emissions; and petroleum refinery emissions updated (see Ref. 4), and (4) CE and RE were added to VOC emissions from gasoline marketing (Stage I & vehicle refueling), petroleum refinery fugitives and bulk gasoline plants and terminals.
	Off-Highway Sources	Based on EPA's 1990 off-highway emission[64] estimates and projected/backcasted using BEA data for other years (1987-1989, 1991).	Except aircraft, commercial marine vessels, railroads and SO_2 emissions that are derived similarly to the other area sources.
Mobile Source Data			
	Vehicle Miles Traveled (VMT)	Federal Highway Administrations' Highway Performance Monitoring System (HPMS) for all years (1987-1991)	Complete overhaul of NAPAP emissions
	Mobile Emission Factors	EPA's MOBILE5 Mobile Source Emission Factor Model for all years (1987-1991)	

SECTION 6.0

NATIONAL EMISSION PROJECTIONS

Emission projections are important for examining the potential combined effect of the 1990 CAAA and the expected changes in the national economy and resulting pollution generating activity. Projections have been made for the years 2000 and 2010 using currently available information. The current emission projections for CO, NO_x, VOC, and SO_2 are described below, along with basic assumptions.

The projections for each pollutant show an expected decrease in total national emissions from 1990 to 2000. The decreases are the result of mandatory emission reductions imposed by the CAAA on a broad range of source categories. These mandatory reductions are expected to offset increases due to assumed economic growth. *For VOC, the projections assume the timely implementation by states of discretionary and mandatory emission controls principally needed to meet the ambient air quality standard or reasonable further progress requirements.* For motor vehicles, the only discretionary control program modeled was reformulated gasoline for those areas that have taken significant action to opt into the program. The low emission vehicle (LEV) program (for areas outside of California) and the Tier II tailpipe standard were not included, because of the uncertainty concerning whether and where these programs might be implemented. Total national emissions of CO and NO_x increase from 2000 to 2010, while emissions of VOC and SO_2 decrease slightly for the same period.

In order to project emission trends, it is necessary to predict economic growth, industrial activity, fuel consumption, and other factors. Therefore, future trends are speculative and contain a significant level of uncertainty. Projected emission estimates will be updated periodically using the most recent information on actual activity factors by each source category.

6.1 HIGHWAY VEHICLE EMISSION PROJECTIONS — METHODOLOGY

The following is a brief description of the methodology used to project the 2000 and 2010 highway vehicle emissions for CO, NO_x, and VOC. The motor vehicle emission projections for these years were based on predicted emissions changes from 1990 for eight geographic areas. In order to select these areas, an estimate was made of the fraction of the population affected by each possible combination of motor vehicle control measures present in the projection years. The eight control measure combinations affecting the largest portion of the population were selected. For each of these control combinations, a nonattainment area or rest-of-state attainment area that would be subject to the chosen control combination was selected. When choosing these eight areas, an attempt was made to represent diverse geographical and meteorological conditions. The eight selected areas are shown in Table 6.1.

Seasonal 1990, 2000, and 2010 VMT for each area was developed using national annual

VMT projections from the Fuel Consumption Model, April 1991.[65] The national projected VMT estimates from this model were allocated to states using state population estimates from the Bureau of Economic Analysis (BEA) for these 3 years. State VMT growth rates were then derived by dividing the 2000 and 2010 state VMT by the 1990 state VMT. The appropriate state growth rates were applied to the 1990 annual *Trends* VMT estimates from each of the eight selected areas. The resulting annual VMT estimates for each area were seasonally allocated using the Federal Highway Administration 1990 monthly traffic volume trends. Table 6-2 shows the seasonal adjustment factors.[66]

The MOBILE5a model was used to estimate the 2000 and 2010 motor vehicle emission factors for the six selected areas outside of California. An EPA in-house version of MOBILE5a adapted to simulate the California fleet was used to estimate the 2000 and 2010 motor vehicle emission factors for the two selected California areas. The model inputs reflected the combination of motor vehicle control measures, seasonal temperatures, and RVP values expected to be appropriate for each area. The enhanced and basic I/M program inputs simulated the EPA's basic and enhanced I/M performance standards and were provided by OMS.[67] Maximum low emission vehicle (LEV) credits were applied throughout California. Seasonal temperature conditions were taken from the 1990 Statistical Abstract (30-year average minimum and maximum daily temperatures). RVP values used for modeling the summer season were the Phase II July RVP limits specified. Winter season RVP model input values were the 1990 January RVP values applied to each nonattainment area or state following previous guidance from OMS (see section 5). Spring and autumn RVP values were averages of the January RVP values and the July Phase II RVP limits. The nine speeds used for calculating the 1992 motor vehicle emission factors were also used for these emission factor calculations.

The 1990 emission factors were modeled for the selected areas in the same manner as the 2000 and 2010 factors with the following exceptions: (1) actual July 1990 RVP values were used (as discussed in section 5) instead of the Phase II July RVP limits, and (2) actual 1990 I/M program inputs were used. Reformulated gasoline, oxygenated fuels, and LEV were not modeled for the 1990 emission factors.

The 1990, 2000, and 2010 seasonal emissions for each of the eight selected areas were calculated using the seasonal VMT data and emission factors. Annual 1990, 2000, and 2010 emissions for each area were calculated by summing the four sets of seasonal emissions. For each area, emission ratios were calculated as the ratio of the 2000 emissions to the 1990 emissions and the ratio of the 2010 emissions to the 1990 emissions. Both annual and peak ozone (summer) season emission ratios were calculated in this manner. The 1990 *Trends* county-level emission estimates previously calculated using the method described in section 5 (which used more refined monthly and county specific emission factors) were aggregated into eight groups. These eight groups contained the emissions from counties with control program combinations most closely corresponding to the control program combinations in the eight selected geographic areas. The 2000 and 2010 annual and peak ozone season emission ratios from a given area were applied to the corresponding group of aggregated 1990 *Trends* emission estimates to obtain national motor vehicle emission estimates for 2000 and 2010.

Please note that highway vehicle emission projections for different areas in the nation have been estimated by several departments within the Agency. Differences in totals will occur due to the use of varying model parameters. The reader should use caution when comparing these national totals to other regional values generated elsewhere.

6.2 FUTURE TRENDS IN CARBON MONOXIDE EMISSIONS

Table 6-3 presents the current estimates of future total national CO emissions and highway vehicle CO emissions. The expected emission trends are shown in Figure 6-1. The "All Other" source estimates are based on the Emission Reduction and Cost Analysis Model (ERCAM) for CO. The "All Other" category includes off-highway estimates. The projections show an expected 27 percent decrease from 1990 to 2000 in total CO emissions from highway vehicles as the result of several factors: (1) continued fleet turnover and (2) implementation of new measures such as enhanced vehicle I/M programs, oxygenated fuels, the cold temperature CO standard, and the 1990 CAAA Tier I CO tailpipe standards for light-duty trucks. The changes in future year motor vehicle emission rates were estimated using MOBILE5a. It is important to note, however, that after the year 2000 total CO emissions are estimated to begin growing due to increasing highway vehicle emissions as the number of vehicles driven and the number of VMT increases.

6.3 FUTURE TRENDS IN NITROGEN OXIDE EMISSIONS

Table 6-4 presents estimates of future NO_x emissions by major source category. These projected emission trends are also shown in Figure 6-2. The projections account for the expected net effect of all CAAA provisions, including the following: (1) the NO_x emission limits prescribed for utility boilers under the acid rain provisions, (2) the Tier I automobile tailpipe standards, and (3) application of technology based requirements to nonutility boilers (generally greater than 100 tpy) in ozone nonattainment areas and the Northeast Ozone Transport Region. The estimates do not fully incorporate NSR requirements (such as offsets and lowest achievable emission rates in nonattainment areas), or additional controls that might be required based on attainment demonstration modeling because these requirements and controls can not be adequately predicted. In addition the estimates do not contain any attempt to estimate the exemption of any areas from the NO_x stationary source controls under section 182(f).

Projections of NO_x emissions from highway vehicles were calculated as described in section 6.1. As a result of the 1990 CAAA Tier I tailpipe standards, enhanced I/M, and fleet turnover, NO_x emissions from highway vehicles are expected to decrease by 19 percent from 1990 to 2000. Off-highway emissions are included in the "All Other" category.

By 2000, all electric utility units with capacities greater than 25 megawatts are expected to meet new emission limits imposed by the 1990 CAAA. In addition, new or modified electric power units will be subject to revised performance standards. As a result, NO_x emissions from electric utilities are expected to decrease by 11 percent from 1990 to 2000. The estimates of utility emissions were made under the assumption that all utility boilers would emit at the level specified under the Title IV emission limits. As a result, the 6.7 million ton estimate for electric utilities in 2000 is 2 million tons less than what would have been emitted by utilities if the CAAA controls had not been implemented.

Estimates of future NO_x emissions from industrial sources are based on the use of state-level growth factors and, where required, the application of reasonably available control technology (RACT). As a result, an 11 percent reduction is expected in NO_x emissions from industrial sources from 1990 to 2000. This reduction may be more than offset by increases in emissions between 2000 and 2010 with the expected increased growth in economic activity. The future trend of stationary source NO_x emissions is presently uncertain, because it is not yet known if any ozone nonattainment areas will be exempt [CAAA 182(f) exemptions] from the NSR policy requiring lowest achievable emission reductions and new major source offsets.

Again, it is important to note that after the year 2000 total NO_x emissions are expected to grow. This will have potentially adverse consequences for efforts to attain the ozone NAAQS.

6.4 FUTURE TRENDS IN REACTIVE VOLATILE ORGANIC COMPOUND EMISSIONS

Table 6-5 presents the estimates of future total national VOC emissions and highway vehicle VOC emissions. The expected emission trends are shown in Figure 6-3. The "All Other" source estimates (including off-highway sources) are based on the ERCAM,[68] used to analyze costs and benefits of the nonattainment provisions in the CAAA. The estimates are based on presumed growth in population and industrial activity. It is assumed that mandatory emission control measures specified in the CAAA, such as prescribed emission controls for point sources, will be implemented. It is also assumed that states will meet the minimum emission control requirements and reasonable further progress reductions specified in the CAAA in order to meet the NAAQS for ozone. The methodology used to estimate the highway vehicle emissions for 2000 and 2010 is described in section 6.1.

Table 6-5 shows an expected 25 percent decline in total national VOC emissions from 1990 to 2000. This decrease is largely due to an expected 30 percent reduction in emissions from highway vehicles as a result of continued fleet turnover, the Tier I tailpipe standards, Phase II RVP control, reformulated gasoline, and basic and enhanced I/M programs.

From 2000 to 2010, the estimates are substantially more uncertain, but indicate that total emissions will remain stable. Growth and development in attainment areas (areas meeting the NAAQS for ozone) are expected to result in increased emissions. This increase is expected to offset continued declines in nonattainment area emissions, especially those where additional reductions will be needed after 2000.

6.5 FUTURE TRENDS IN SULFUR DIOXIDE EMISSIONS

Table 6-6 presents the estimates of future total national SO_2 emissions, and SO_2 emissions from electric utilities and other sources. The expected emission trends are shown in Figure 6-4.

6.5.1 Electric Utilities

Research has shown that SO_2 emissions from the combustion of fossil fuels are the principal contributor to acid precipitation. Title IV (Acid Deposition Control) of the 1990 CAAA established a new market-based approach for the control of total utility SO_2 emissions in the United States in order to reduce the effects of acid rain on the public health and welfare and the environment. This new control approach, called the "Acid Rain Control Program," will begin in 1995, and will utilize the concept of market-based emission "allowances." An allowance is an authorization to emit 1 ton of SO_2. After the program begins in 1995, affected utility operators must hold one "allowance" for each ton of SO_2 emitted from their facility. Operators of existing utility units are given an initial allocation of allowances by the EPA for each year their facilities are affected by this program. In most cases, new units are not allocated allowances and must obtain them on the open market in order to operate.

The total tons of allowances allocated under the program for future years will be significantly less than historical utility SO_2 emissions. After the allowances are allocated, they are fully marketable commodities and can be traded and held by utility and nonutility entities. This approach to overall SO_2 emission control is designed to allow market forces to efficiently allocate SO_2 emission reductions at the least cost to society. Because utilities must still meet traditional SO_2 emission limitations designed to protect public health and welfare around their facilities, the purchase of allowances cannot be used as a method for circumventing acceptable air quality levels.

The forecasted emissions/allowances for 2000 to 2003 and for 2010 are calculated on an annual average basis over each period. These estimated emission/allowance forecasts reflect the required SO_2 emission levels under the CAAA prior to any interstate emissions trading or emissions banking. Actual emissions by state will likely differ significantly. Also, the emission estimates include forecasted emissions at "unaffected" units in Phase I and Phase II. These projected emissions were developed based on EPA's energy and economic assumptions used in its SO_2 Regulatory Impact Analysis (RIA) (see next section).

As noted above, the estimated emissions do not reflect emissions banking. However, estimates have been finalized by the Acid Rain Division, U.S. EPA and the Department of Energy[69] and will be discussed and reported in the 1994 Emission *Trends* report. These estimates for 2000 and 2010 that include emissions banking projections will show a slight overall increase as compared to this year's *Trends* estimates. Because of this, the reader should use caution when comparing values from various EPA documents.

The SO_2 emission totals listed in Table 6-6 were estimated separately for each time period, as described below. The principal sources of data or information were as follows: (1) Table A of the 1990 CAAA (for Phase I allowances), (2) Coal and Electric Utility Model (CEUM) projected SO_2 emissions for unaffected units from the SO_2 RIA low trading case,[t] (3) EPA data regarding Phase I extension reserve allowances, and (4) allowance allocations as calculated for Technical Documentation for Phase II Allowance Allocations (the Phase II TSD).

The calculations used for each time period are as follows:

- **2000-2003**: These estimates are based on the following values:
  1) Phase II Allowances from the Phase II TSD [ratcheted basic allowances for the 2000-2009 period, *less the set-aside for clean coal technology (CCT) repowering*, plus total bonus allowances plus Section 405(a)(3) allowances],
  2) Allowances granted for CCT Repowering, as estimated for the Phase II TSD, and
  3) SO_2 emissions forecast by CEUM for non-Phase II affected units ("Unaffected Emissions").

- **2010**: These estimates are the sum of the following values:
  1) Phase II allowances, including adjusted basic and section 405(a)(3) allowances, and
  2) SO_2 Emissions forecast by CEUM for non-Phase II affected units in 2010 ("Unaffected Emissions").

6.5.2 All Other Sources

SO_2 emissions from nonutility point sources have declined from 1980 levels due to reduced activity in the historically major sources: steel production, nonferrous smelting, and other heavy industrial processes. Emission reductions mandated in the CAAA were based on the assumption that net emission reductions which occurred between 1980 and 1985 would not be offset by growth in future years. Nonutility SO_2 emissions presented in Table 6-5 for 2000 and 2010[u] were determined by projecting from the 1985 NAPAP emission inventory levels using the projected growth earnings by SIC category as reported by the BEA.[70]

Further reductions in SO_2 emissions are expected after 1990 as a result of motor vehicle diesel fuel being limited to 0.05 percent sulfur (by weight). This limit is expected to produce about an 80 percent reduction in emissions per diesel-powered vehicle. Some of this reduction may be offset by the expected increase in diesel fuel consumption over the next 10 to 20 years.

6.6 SEASONAL EMISSION PROJECTIONS

Table 6-7 provides a comparison of peak ozone season average NO_x emissions and annual average NO_x emissions. Peak ozone season average NO_x emissions are lower than annual average emissions because motor vehicle NO_x emissions decrease with increasing temperature within the temperature range used for the emissions projections. This analysis does not attempt to capture seasonal variations in point source emissions. Nonmotor vehicle emissions shown in Table 6-7 for 2000 and 2010 are therefore identical for peak ozone season and annual average days. While demand for electricity may be higher in the summer than in other seasons and can produce corresponding peaks in emissions from electric utilities, these peak demand periods can vary significantly by day and by location. Thus, the values shown in Table 6-7 should not be considered representative of emissions in any specific area. There is no reason to expect that industrial NO_x emissions will vary significantly by season on the national level.

A comparison of peak ozone season average VOC emissions and annual average VOC emissions is shown in Table 6-8. The peak ozone season is typically the summer months (June, July, and August) when ambient temperatures are generally high and contribute to increased formation of ozone in the lower atmosphere. The 1990 CAAA measure progress toward attaining the ozone NAAQS in terms of decreases in peak ozone season VOC emissions. Table 6-8 shows the 1987 base year emissions and projected emissions for the years 2000 and 2010. The 1987 base year was chosen since it is the mid-point of the ambient ozone concentration data used to determine the nonattainment status of different areas of the country.

Table 6-8 shows that on a daily basis, peak ozone season VOC emissions are less than annual average emissions. Although evaporative VOC emissions from motor vehicles increase with temperature, a new emphasis on reducing these emissions through fuel changes and more effective evaporative control systems makes ozone season emission rates much closer to these in other times of the year than they were during the 1980s. This, coupled with the fact that exhaust hydrocarbon emissions are inversely proportional to temperature, has resulted in motor vehicle VOC emission rates being lower in summer than in other seasons. For nonmotor vehicle VOC emissions, the ozone season emissions are lower than average annual emissions because residential wood burning decreases in the summer. Projection year differences in total VOC emissions by season narrow with time as the contribution of motor vehicle emissions decreases due to more stringent emission controls.

The ozone season motor vehicle emissions were calculated using the summer season emissions and the same procedures outlined in section 6.1. The average ozone season emissions were calculated by dividing the seasonal emission by the number of days in the summer season.

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[t] See *Regulatory Impact Analysis of the Proposed Acid Rain Implementation Regulations*, prepared for EPA/OAIAP, September 16, 1991.

[u] The U.S. EPA is required to act to ensure that industrial SO_2 emissions do not exceed 5.6 million tons as of the year 2010, as outlined in section 406 of the 1990 CAAA.

Table 6-1. Selected Areas Used to Model the Highway Vehicle 2000 and 2010 Emissions

Area	I/M Programs	Reformulated Gasoline	Phase II RVP Limit (psi)	Oxygenated Fuels
New York-Northern New Jersey-Long Island, NY-NJ-CT	enhanced	yes, class C (Federal)	9.0	yes
Houston-Galveston-Brazoria, TX	enhanced	yes, class B (Federal)	7.8	no
Miami-Fort Lauderdale-West Palm Beach, FL	basic	no	7.8	no
Dayton-Springfield, OH	basic	no	9.0	no
Attainment Areas in Kansas	none	no	7.8*	no
Attainment Areas in Washington	none	no	9.0	no
Los Angeles-South Coast Air Basin, CA	enhanced	yes, class B (California)	7.8	yes
Attainment Areas in California	none	no	7.8	no

NOTE(S): For modeling purposes, attainment areas in California (last area listed above) were used as surrogates for attainment areas nationwide. Because of this, the use of reformulated gasoline was omitted from the model run, even though reformulated gasoline is used in California statewide.

* The enforceable limit on fuel RVP in Class B attainment areas under the Phase II volatility rules is 9.0 psi. The use of 7.0 - 8.0 psi in this scenario may result in a slight overestimation of the emission reductions attributable to volatility control for these areas.

Table 6-2. Seasonal VMT Adjustment Factors

Month	Monthly VMT (millions)	VMT Percentage	Season	Seasonal VMT (millions)	VMT Percentage
December	168,621	7.85			
January	163,600	7.62			
February	153,559	7.15			
			Winter	485,780	22.62
March	178,771	8.32			
April	179,033	8.34			
May	189,247	8.81			
			Spring	547,051	25.47
June	189,529	8.83			
July	195,470	9.10			
August	197,057	9.18			
			Summer	582,056	27.10
September	178,415	8.31			
October	182,634	8.50			
November	171,565	7.99			
			Fall	532,614	24.80
Total	2,147,501	100.00	Total	2,147,501	100.00

Source: Federal Highway Administration.[66]

Table 6-3. Annual National CO Emissions, 1980 to 2010
(million short tons)

	1980	1990	2000	2010
Highway Vehicles	88.0	59.8	43.8	46.0
All Other Sources	41.0	32.6	28.4	28.2
Total	129.0	92.4	72.2	74.2

NOTE(S): Historical emissions were updated from previous report. See section 5.0 for more details.
The projected "All Other" source emissions are based on a September 1991 analysis.

Figure 6-1. Projected Trend in CO Emissions

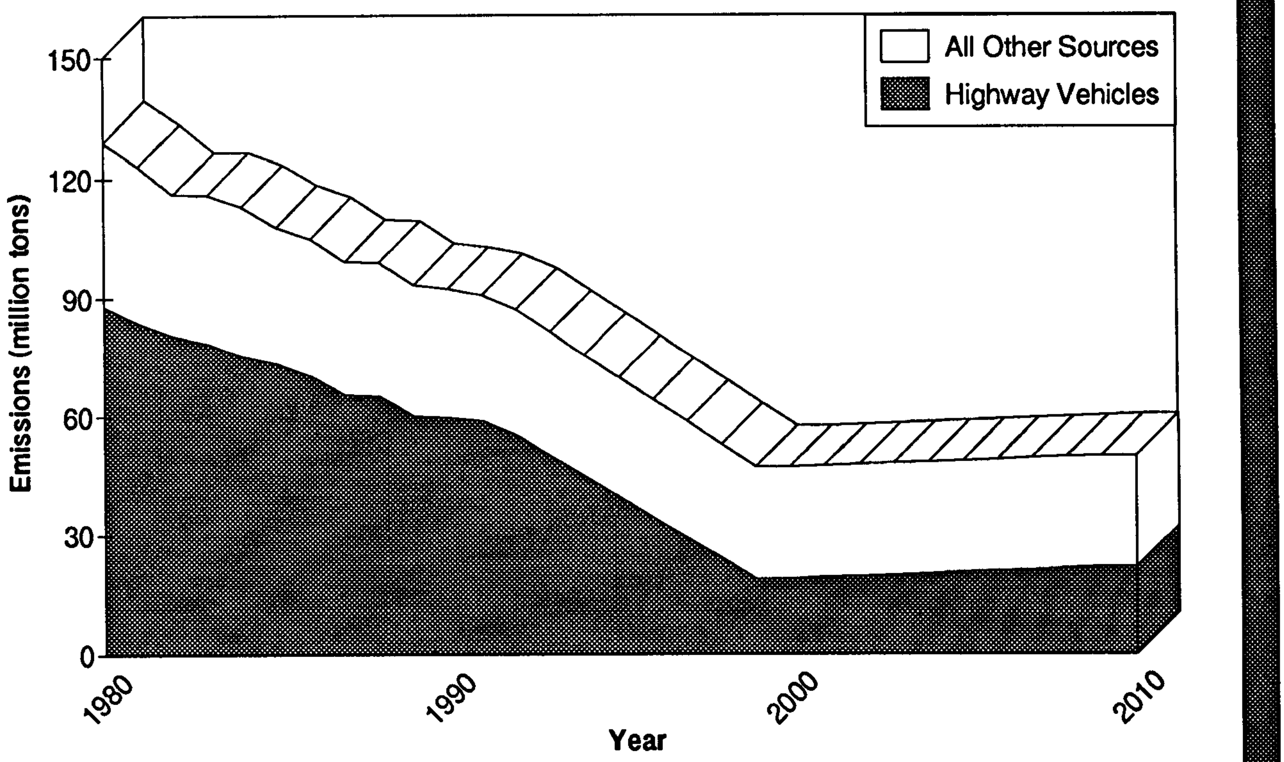


Table 6-4. Annual National NO_x Emissions, 1980 to 2010

(million short tons)

	1980	1990	2000	2010
Electric Utilities	7.0	7.5	6.7	8.2
Industrial Sources	4.1	4.4	3.9	4.5
Highway Vehicles	8.7	7.8	6.3	6.1
All Other Sources	3.9	3.9	3.3	3.5
Total	23.7	23.6	20.2	22.3

NOTE(S): Industrial sources include industrial fuel combustion and processes.
Historical emissions were updated from previous report. See section 5.0 for more details.

Figure 6-2. Projected Trend in NO_x Emissions

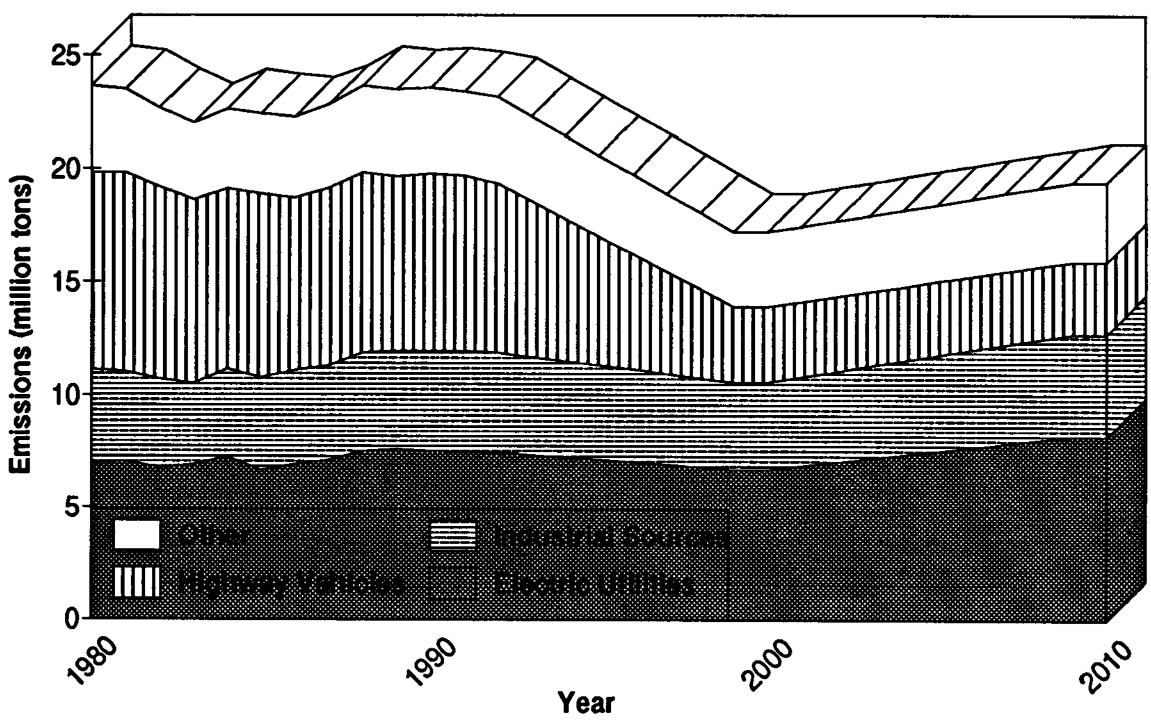


Table 6-5. Annual National VOC Emissions, 1980 to 2010

(million short tons)

	1980	1990	2000	2010
Highway Vehicles	11.0	7.0	4.9	4.7
All Other Sources	17.4	16.7	12.8	12.8
Total	28.4	23.7	17.7	17.5

NOTE(S): Historical emissions were updated from previous report. See section 5.0 for more details.
The projected "All Other" source emissions are based on a September 1991 analysis.

Figure 6-3. Projected Trend in VOC Emissions

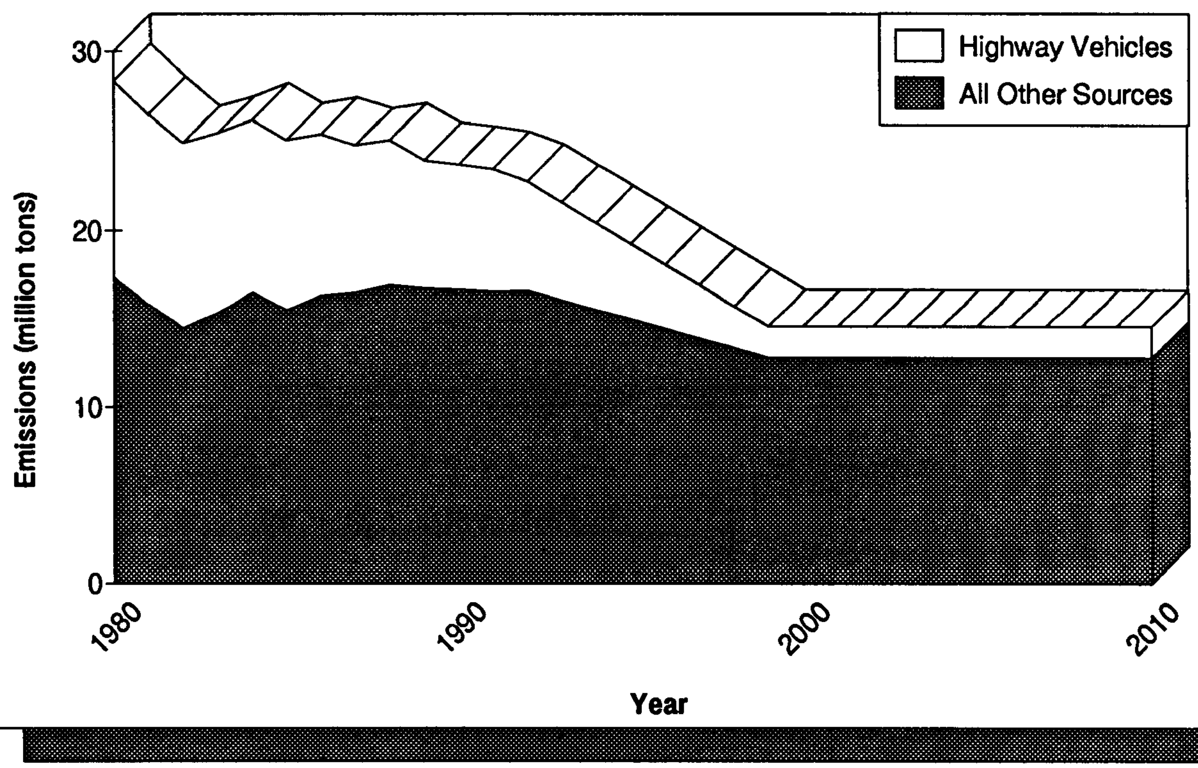


Table 6-6. Annual National SO_2 Emissions, 1980 to 2010
(million short tons)

	1980	1990	2000	2010
Electric Utilities[71]	17.5	15.9	9.7	9.0
Nonutility, Point Sources	6.7	5.3	5.4	5.6
All Other Sources	2.0	1.6	1.5	1.2
Total	26.2	22.8	16.6	15.8

NOTE(S): Historical emissions were updated from previous report. See section 5.0 for more details. The projected "All Other" source emissions are based on a September 1991 analysis.

Figure 6-4. Projected Trend in SO_2 Emissions

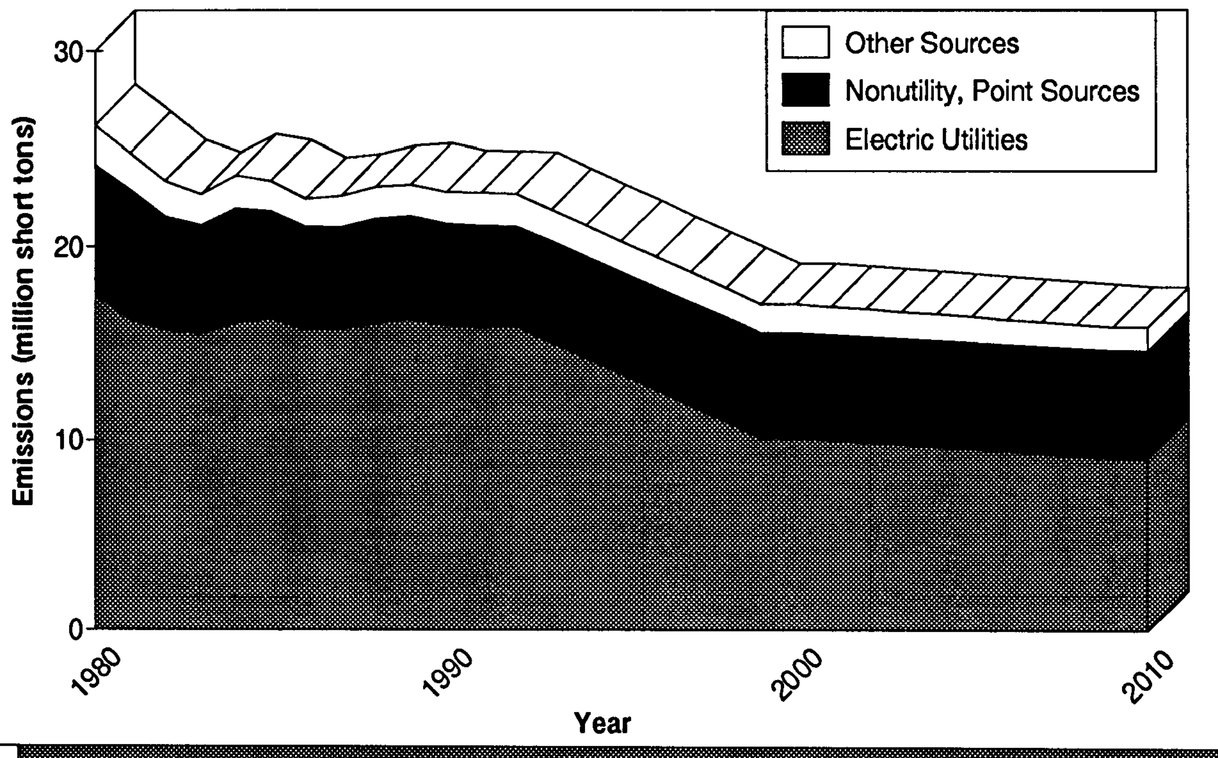


Table 6-7. Comparison of Peak Ozone Season and Annual Average NO_x Emissions

(thousand short tons/day)

	Peak Ozone Season			Annual Average		
	1987	**2000**	**2010**	**1987**	**2000**	**2010**
Highway Vehicles	16.4	17.0	16.6	21.6	17.4	16.8
All Other Sources	40.3	38.0	44.4	38.6	38.0	44.4
Total	56.7	55.0	61.0	60.2	55.4	61.2

Table 6-8. Comparison of Peak Ozone Season and Annual Average VOC Emissions

(thousand short tons/day)

	Peak Ozone Season			Annual Average		
	1987	**2000**	**2010**	**1987**	**2000**	**2010**
Highway Vehicles	27.0	12.0	11.5	22.6	13.3	13.0
All Other Sources	39.0	32.4	32.7	40.2	35.1	35.1
Total	66.0	44.4	44.2	62.8	48.4	48.1

NOTE(S):

1. The projection year NO_x emissions are from a September 1992 analysis of the 1990 CAAA.
2. Emission estimates for the years 2000 and 2010 reflect additional reductions needed for areas to meet estimated 3 percent reductions or attainment targets. More reductions may be needed. Some may come from NO_x after 1996.
3. The projection year VOC emissions are from the ERCAM-VOC model results, based on a September 1992 analysis of the 1990 CAAA.

SECTION 7.0

BIOGENIC EMISSIONS

Plants emit a variety of VOCs as a function of incident light intensity and temperature. Vegetative emissions have been determined to consist of numerous hydrocarbons, aldehydes, and alcohols. Lamb, Westberg, and Pierce have constructed a national biogenic emissions inventory for eight landcover types for each month of the year based on statewide climatic data.[72] Emissions in this inventory are comprised of isoprene, a-pinene, other identified monoterpenes, and other hydrocarbons. Emissions are calculated for oak forests, other deciduous forests, coniferous forests, grasslands, scrublands, urban vegetation, agricultural crops, and inland waters, as shown in Figures 7-1 through 7-8. A forest canopy model is used to account for canopy effects on solar radiation, temperature, humidity, and wind speed. Agricultural emissions are shown assuming an emission factor of zero for corn. The results of recent field studies suggest that previous emission factors for corn have been overestimated by roughly a factor of a thousand. Total annual biogenic emissions from each state are shown in Figure 7-9, and the seasonal breakdown of total emissions are shown in Figure 7-10.

The 1990 total biogenic hydrocarbon emissions were 26.28 million tons, while the 1990 *Trends* total anthropogenic reactive VOC emissions were 23.67 million tons.

Figure 7-1. Oak Forest 1990 Emission Estimates by State

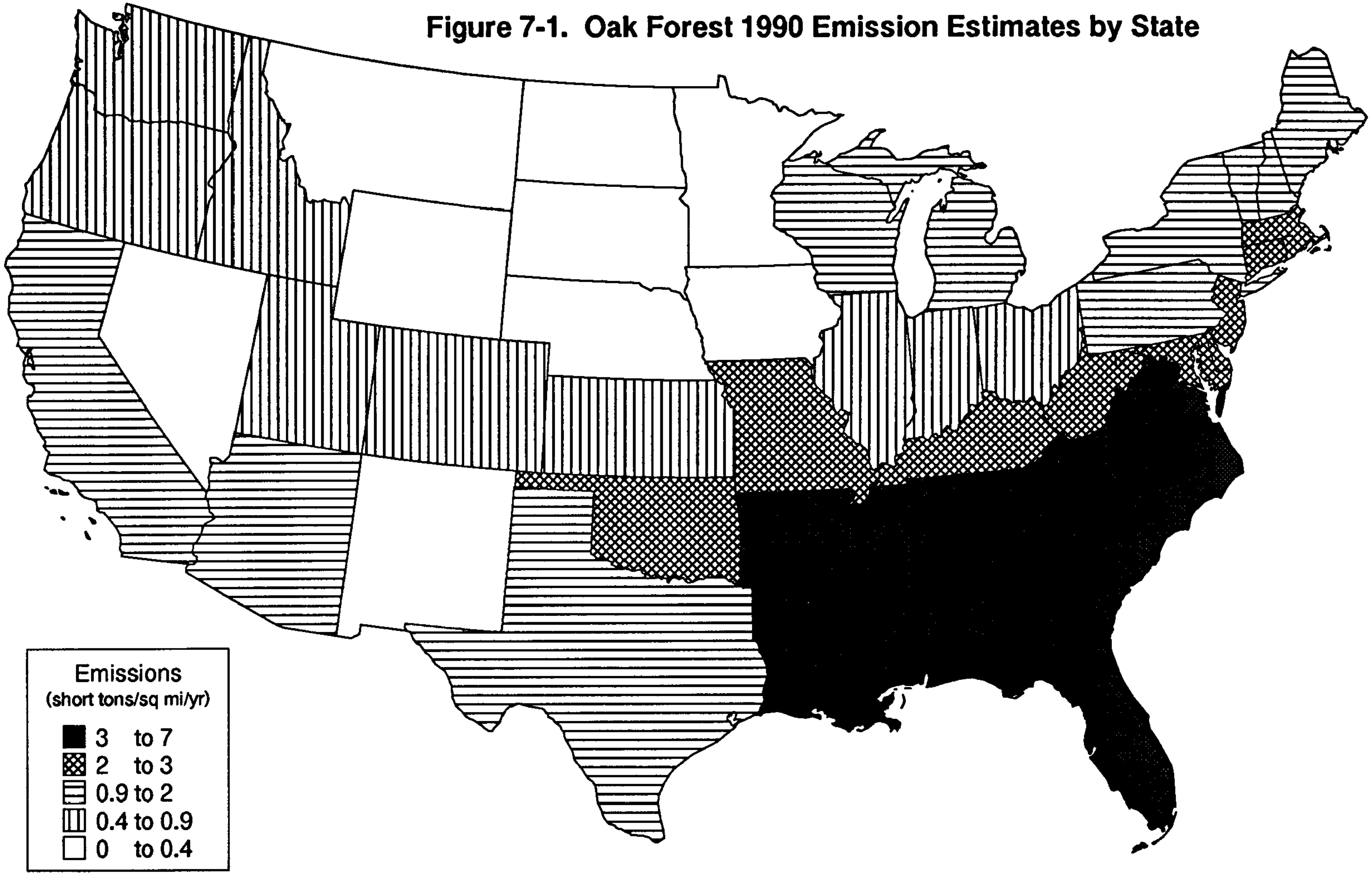


Figure 7-2. Other Deciduous Forest 1990 Emission Estimates by State

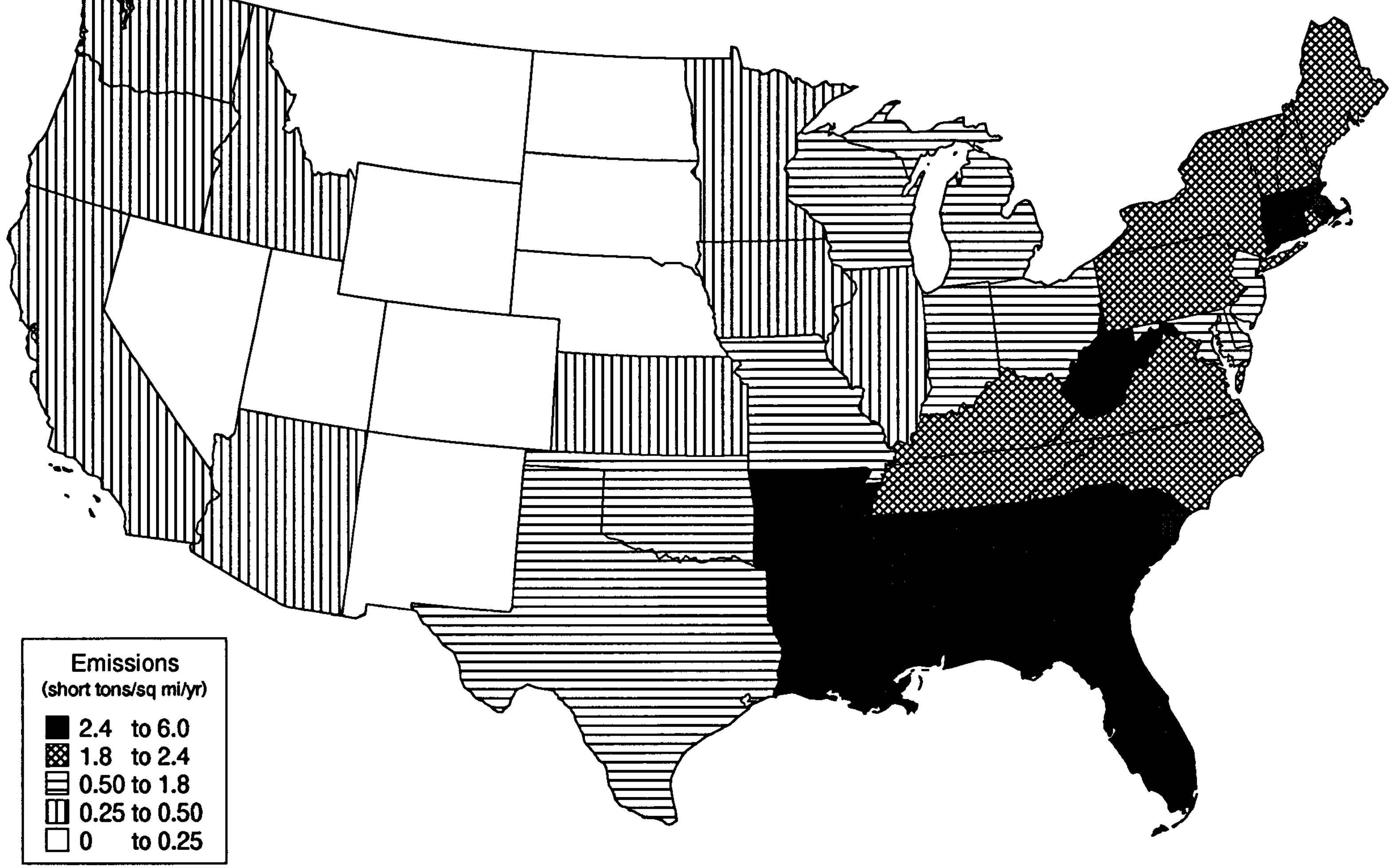


Figure 7-3. Coniferous Forest 1990 Emission Estimates by State

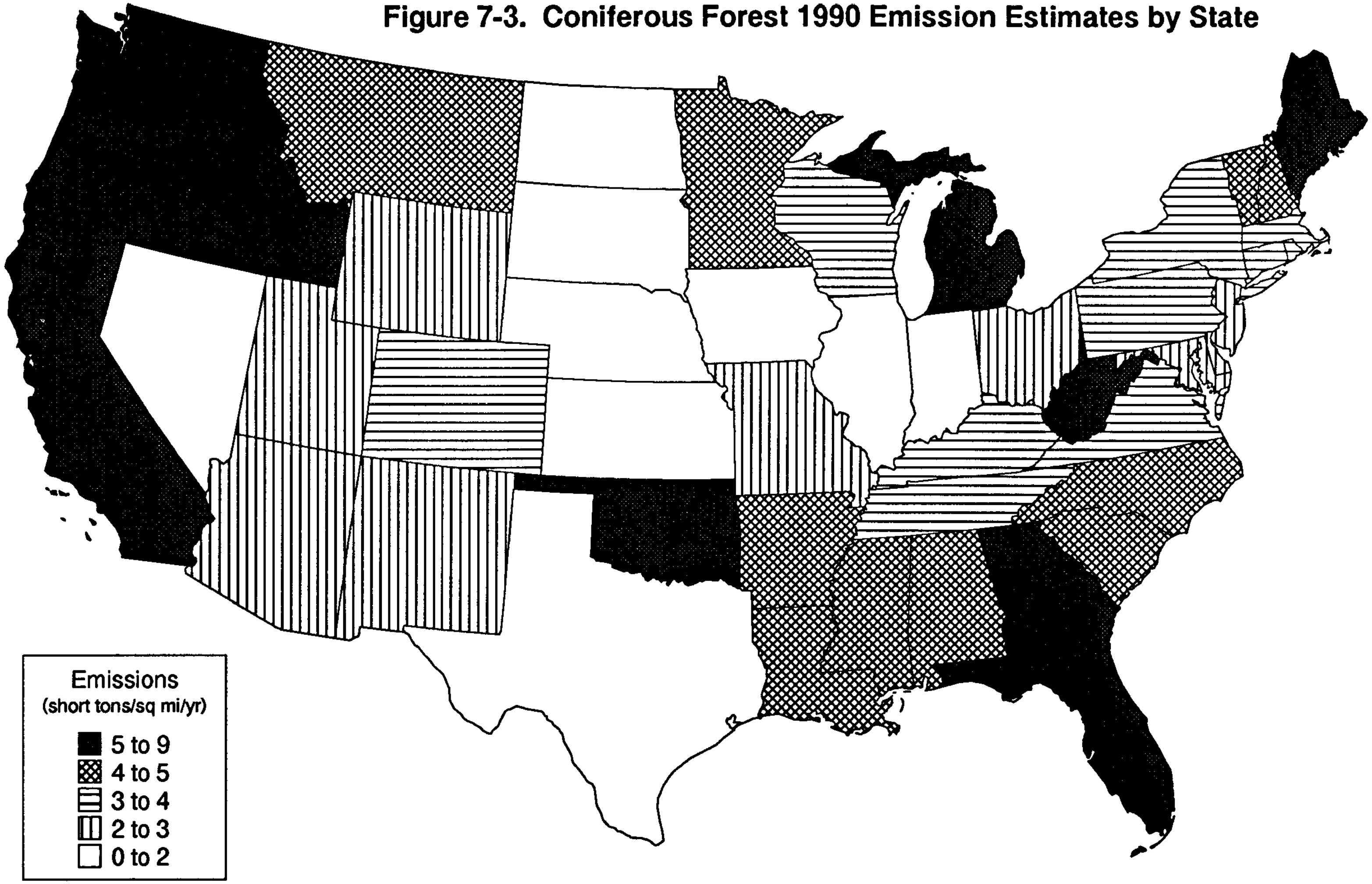
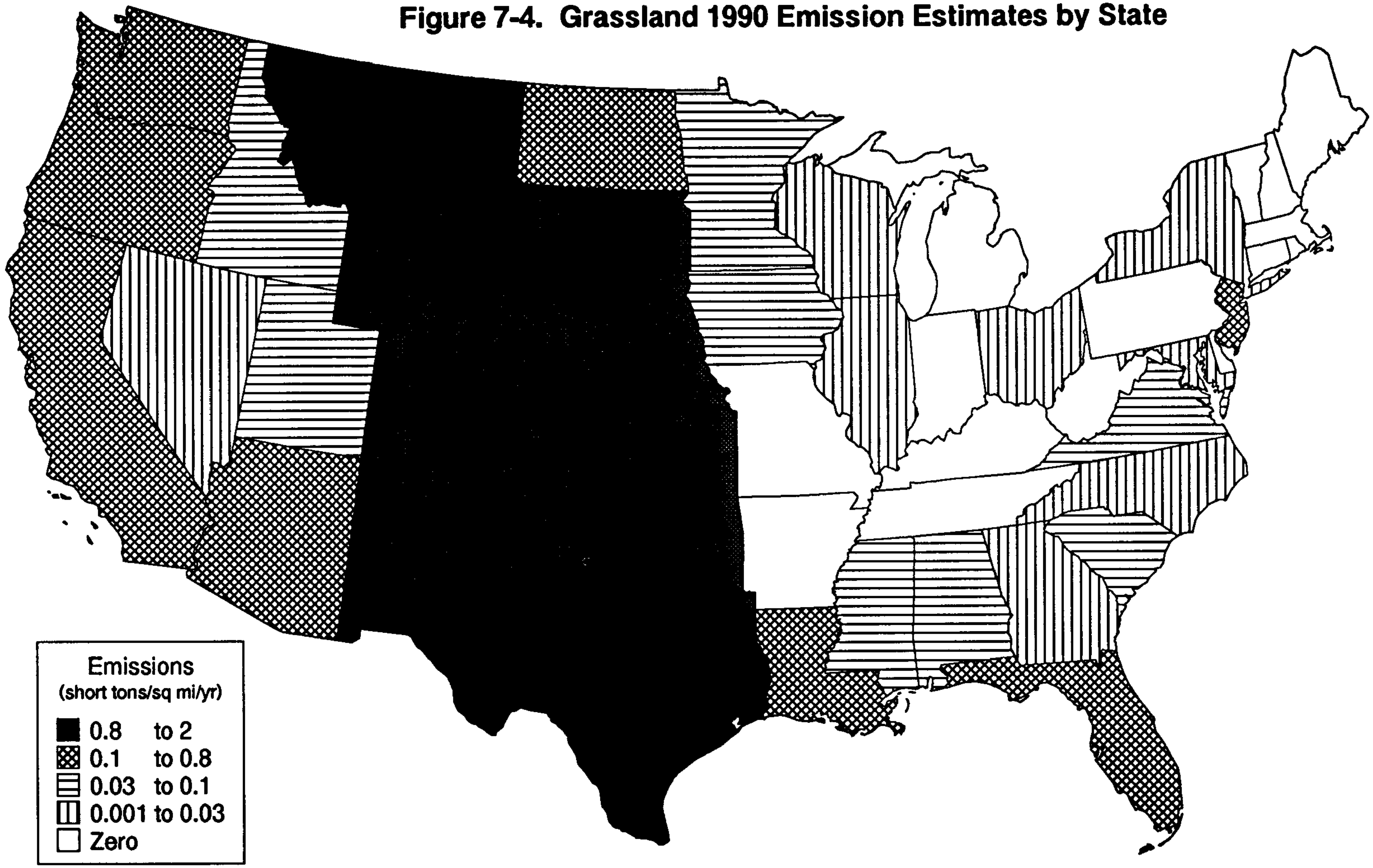


Figure 7-4. Grassland 1990 Emission Estimates by State



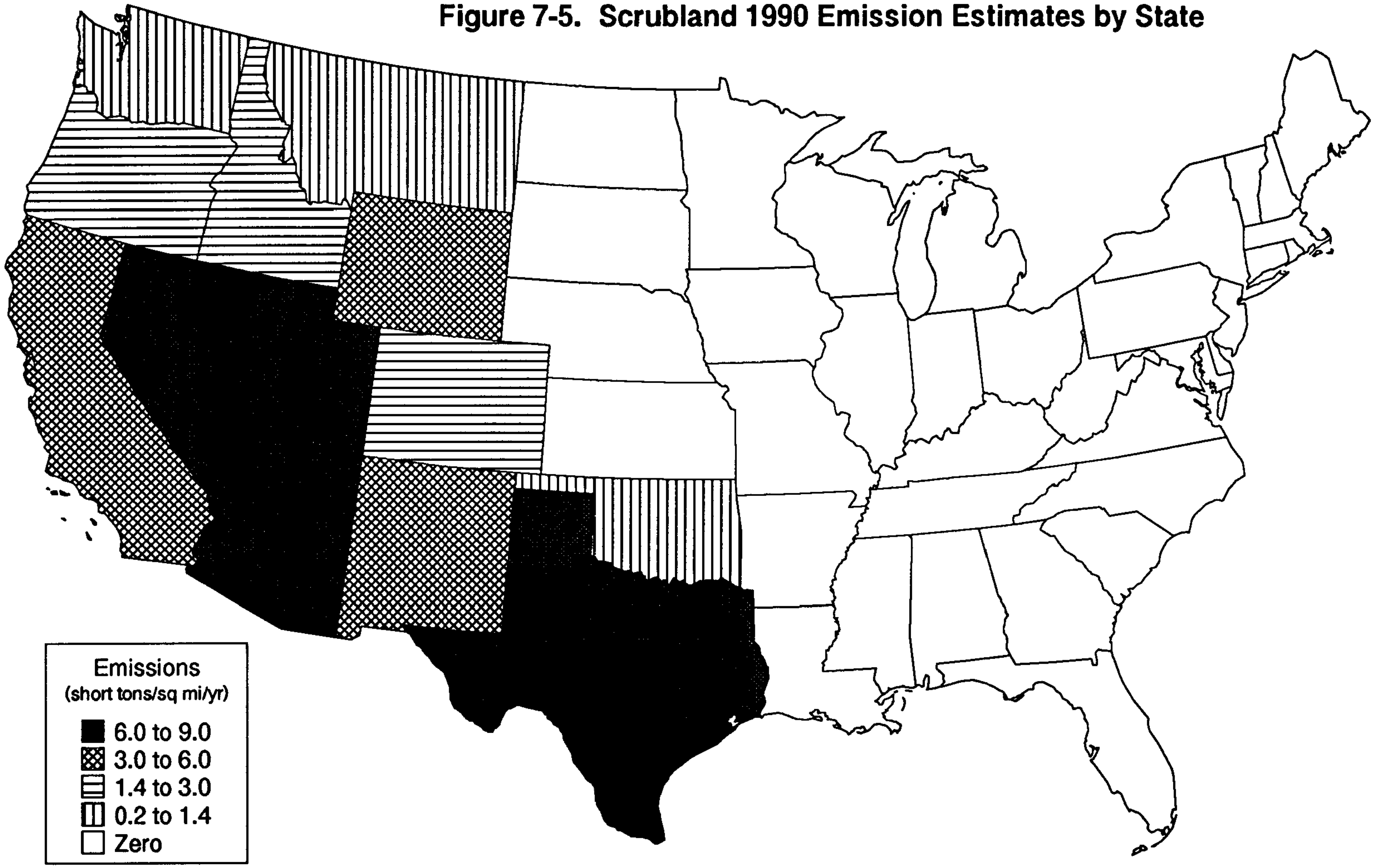


Figure 7-5. Scrubland 1990 Emission Estimates by State

Figure 7-6. Urban Vegetation 1990 Emission Estimates by State

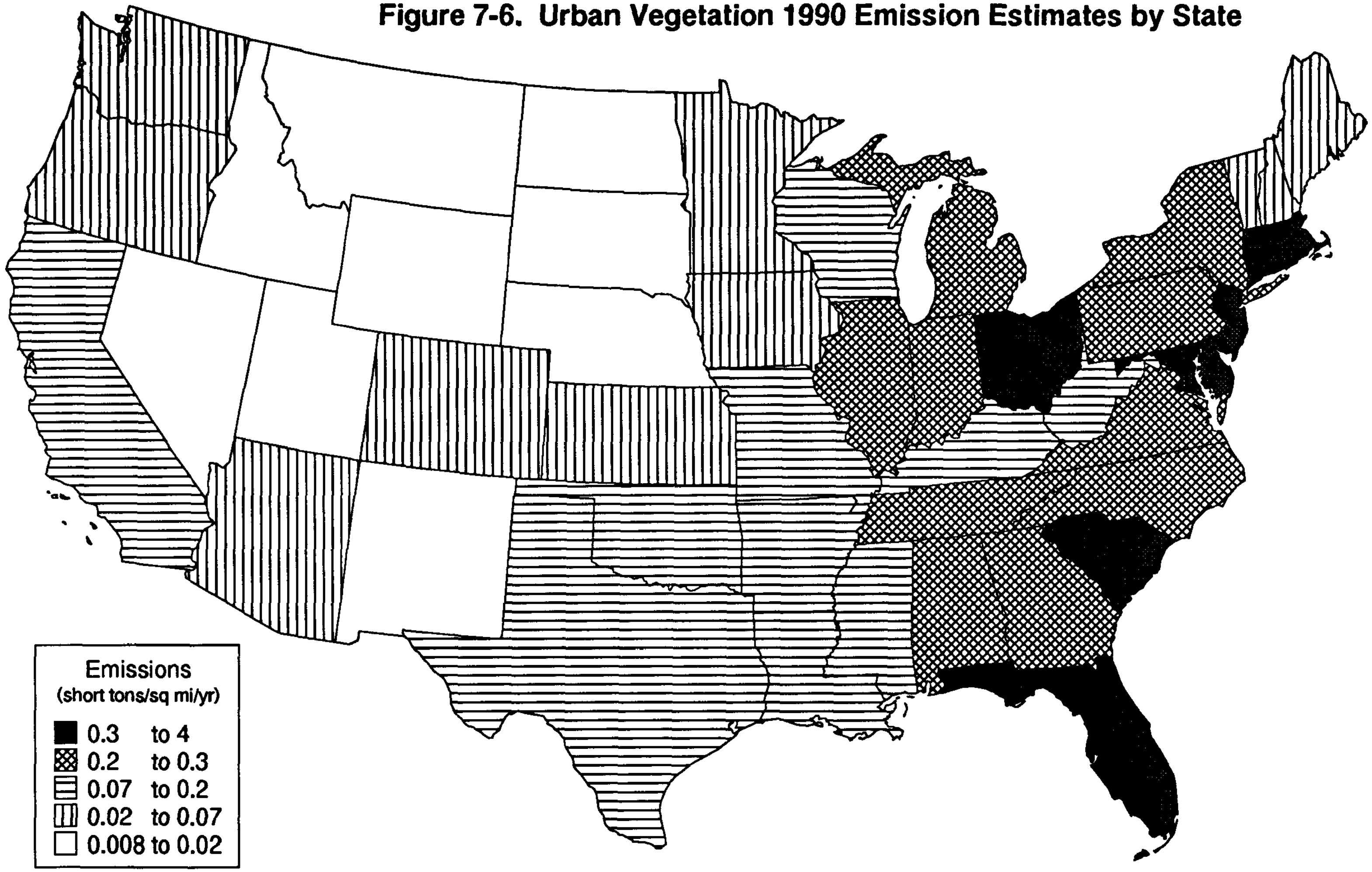
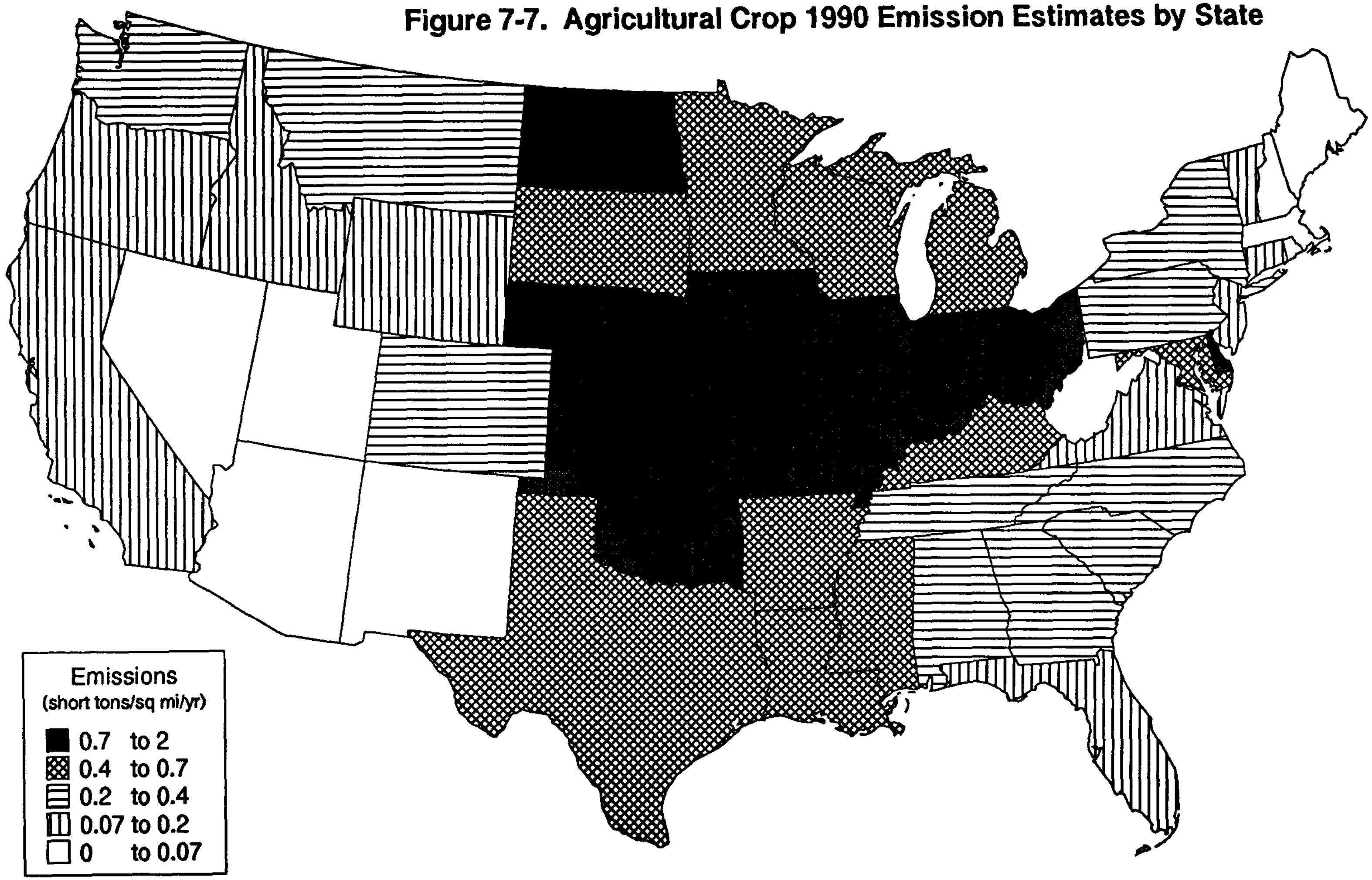


Figure 7-7. Agricultural Crop 1990 Emission Estimates by State



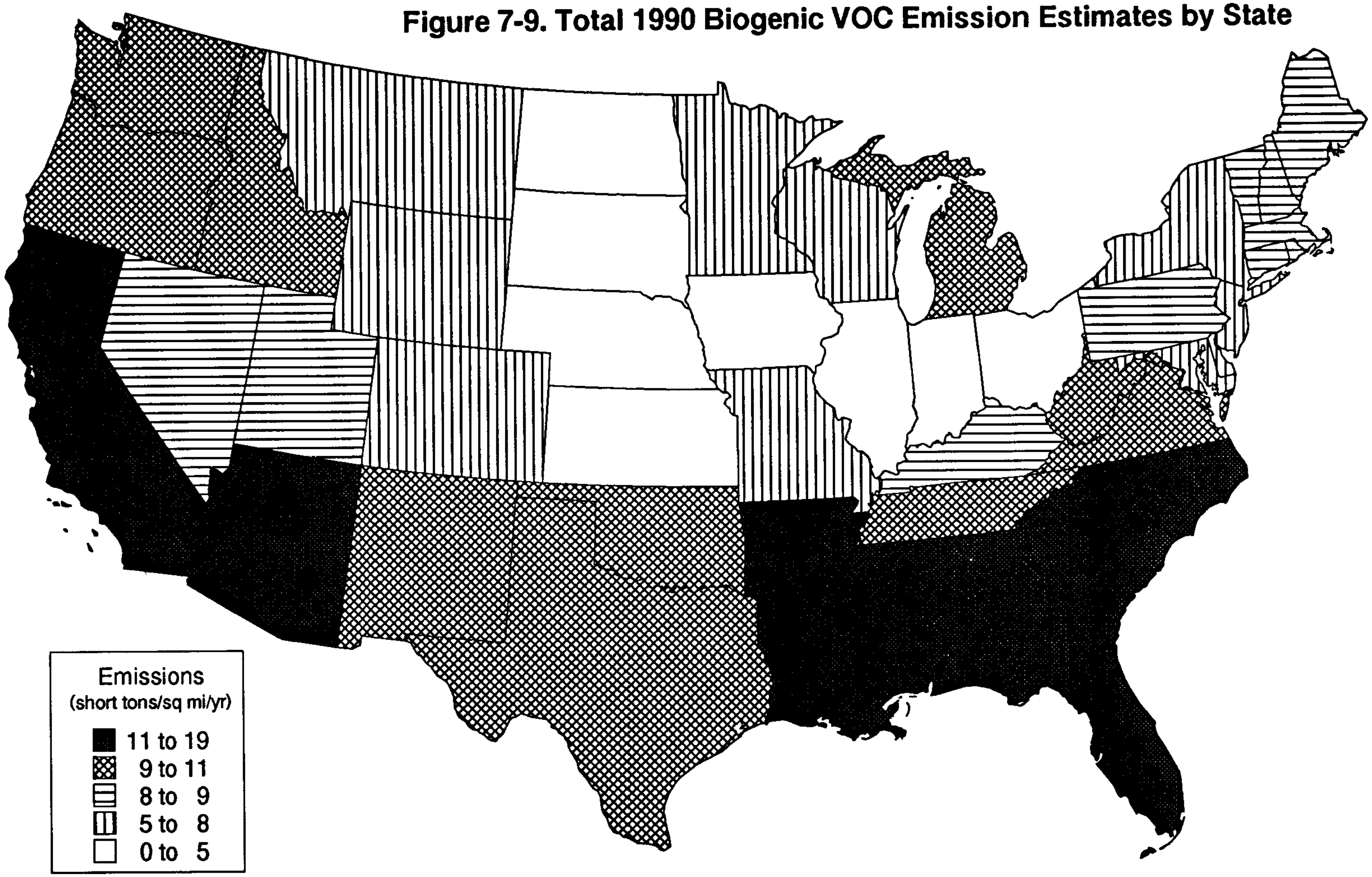


Figure 7-9. Total 1990 Biogenic VOC Emission Estimates by State

Figure 7-8. Inland Water 1990 Emission Estimates by State

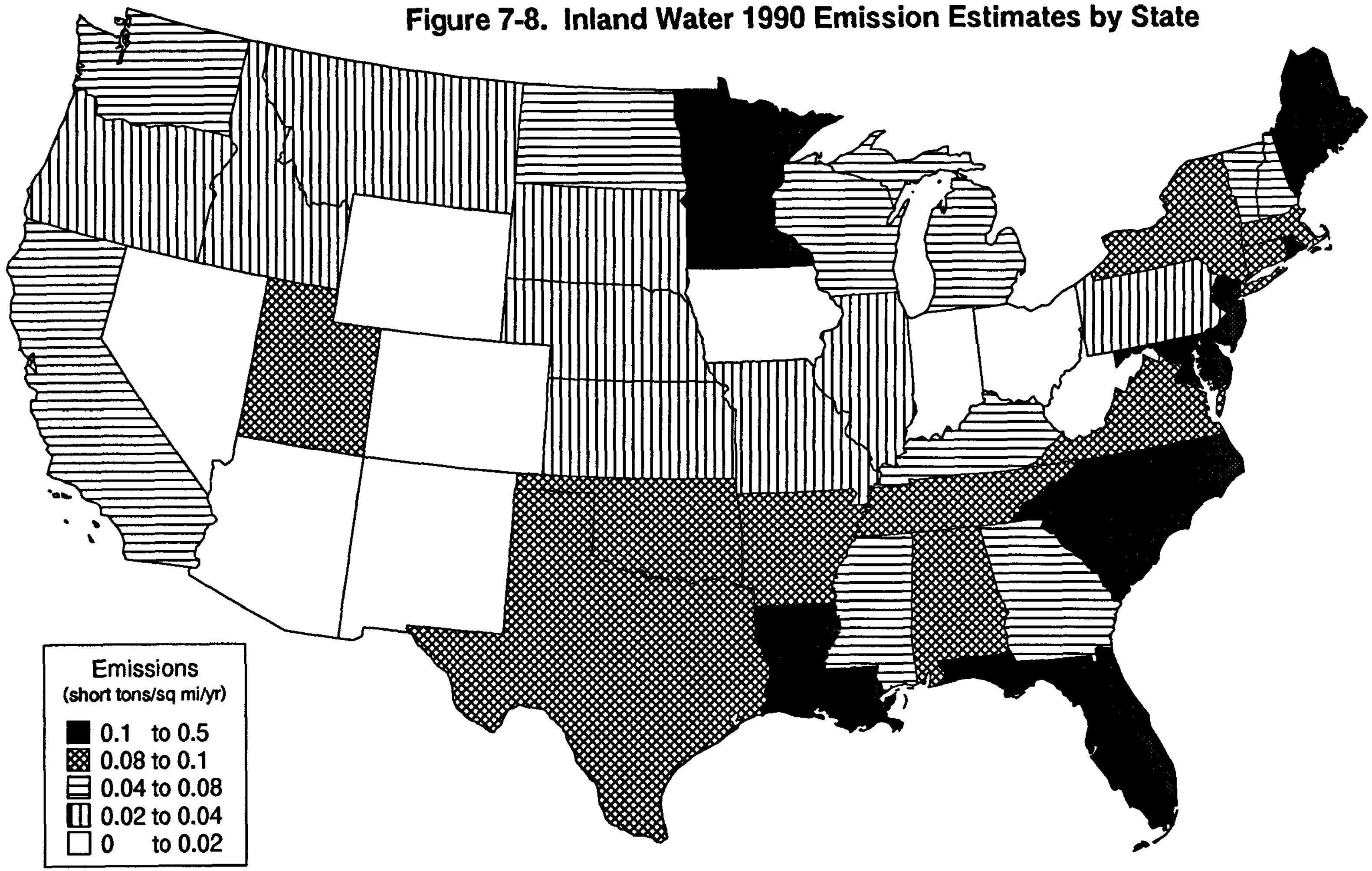
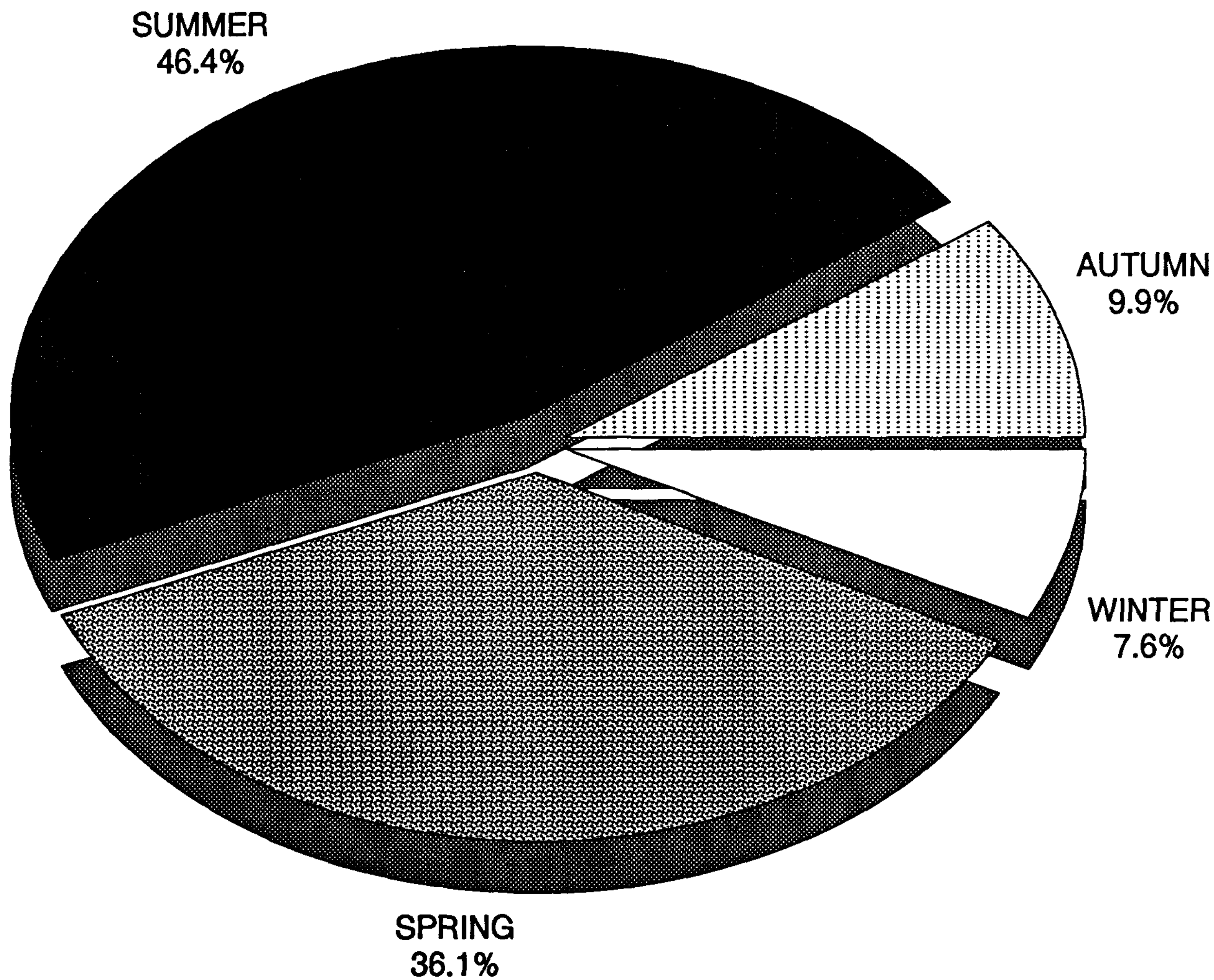


Figure 7-10. Seasonal Breakdown of Total 1990 Biogenic VOC Emission Estimates



SECTION 8.0

NATIONAL AND INTERNATIONAL INVENTORIES: GREENHOUSE GASES, TOXICS, AND CRITERIA POLLUTANTS

8.1 GREENHOUSE GASES

8.1.1 Introduction

The United States signed the Framework Convention on Climate Change (FCCC) at the United Nations Conference on Environment and Development in June 1992 and, in October 1992, became the first industrialized nation to ratify the treaty. Since the mid-1980s, the United States has actively supported international cooperation to help implement the provisions of this agreement. In particular, the United States has worked with technical experts from over 50 countries, along with the Organization for Economic Cooperation and Development (OECD), as part of the inventory program of the Intergovernmental Panel on Climate Change (IPCC). This cooperative effort has helped facilitate agreement on methods for estimating emissions of greenhouse gases to ensure that inventories eventually submitted to the Conference of the Parties of the FCCC will be comparable and accurate.[v]

As a signatory country to the FCCC, the United States understands the importance of aiding in the development of greenhouse gas emission estimates on the national level. The goal behind this is twofold: (1) to provide a basis for on-going development of a comprehensive and detailed methodology for estimating sources and sinks[w] of greenhouse gases and (2) to develop an international system of consistent national inventories of greenhouse gas emissions and sinks for all signatory countries to the FCCC. As part of these efforts, the majority of the U.S. greenhouse gas emission estimates presented in this report are taken directly from the U.S. EPA review draft report, *Estimation of Greenhouse Gas Emissions and Sinks for the United States, 1990.*[73] The estimates for greenhouse gas emissions are presented in Table 8-1. These estimates are currently being revised to reflect public comment and recent analyses by EPA and other agencies.

8.1.2 Methodology and Data

Emission estimates of greenhouse gases for various source categories were made using methods adapted from those recommended by the IPCC and reported in the OECD report, *Estimation of Greenhouse Gas Emissions and Sinks: Final Report from the OECD Experts Meeting, 18-21 February 1991.*[74] The OECD report describes methodologies for estimating greenhouse gas emissions for a variety of source categories. These methodologies were refined based on recommendations provided at an IPCC-sponsored experts workshop held in Geneva, Switzerland in December 1991 and at an OECD/Netherlands-sponsored workshop in Amersfoort, Netherlands in February 1993.

To the extent possible, the present U.S. inventory relies directly on published activity, source, and consumption data. Instances where the data used did not come directly from published sources, or where the methods used to estimate emissions deviated from IPCC-recommended methods, are noted and the sources and/or methodology documented to ensure that the estimates presented can be reproduced. The majority of the U.S. methane (CH_4) emission estimates presented in this inventory are taken directly from the U.S. EPA report, *Anthropogenic Methane Emissions in the United States: Estimates for 1990, Report to Congress*.[75] This report provided 1990 U.S. CH_4 emissions for a variety of sources, including natural gas systems, coal mining, landfills, domesticated livestock, livestock manure, rice cultivation, fuel combustion, and production and refining of petroleum liquids.

A sector-by-sector summary of the 1990 U.S. greenhouse gas emission and sink estimates is provided in Table 8-1 and follows the reporting format recommended by the IPCC. (Note: These values are reported in english units.)

8.2 AIR TOXIC EMISSIONS

The 1990 CAAA mandated fundamental changes in air toxics regulation.[x] Prior versions of the Act provided for a cumbersome process for listing and regulating hazardous air pollutants (HAPs) with the potential for causing increases in mortality or serious illnesses. During the 1970 to 1990 period, the National Emission Standards for Hazardous Air Pollutants (NESHAPS) regulated eight pollutants: arsenic, asbestos, benzene, beryllium, mercury, radionuclides, radon-222, and vinyl chloride. The CAAA revises the Clean Air Act section 112 with new provisions that:

(1) explicitly list 189 substances requiring regulation;

(2) require technology-based standards for reducing the emissions of these substances;

(3) require risk-based controls after evaluation of the residual risk remaining after implementing technology-based standards; and

(4) establish an accidental release program.

This report is the first in this series to include information on air toxics. The inclusion of air toxics will help assess progress in reducing emissions and concentrations of all air pollutants known to potentially cause health problems. These emission estimates from TRI are for general trend indication only because, in addition to the fact that TRI does not include all point source categories or area and mobile sources, there is evidence that it severely underestimates air toxic emissions from point sources. While criteria pollutants will remain the focus of this report, information on air toxics will provide perspectives on questions such as "How much improvement has there been in the Nation's air since passage of the CAAA?" and "What are the overlapping benefits of the ozone control program and the air toxics program?" This second question is important because, although ozone control frequently focuses on reducing VOCs because of their importance to ozone formation, many VOCs are also air toxics. In addition, the challenge of meeting the air toxics provision in the CAAA is inspiring the development of numerous innovative control programs by some affected industries and states. Lessons from such programs could have important applications to criteria pollutant control programs.

8.2.1 *Hazardous Air Pollutants*

Table 8-2 shows emissions of individual HAPs reported in the greatest amounts in the TRI data base.[76,77] The TRI data base contains yearly updated emission estimates for over 300 compounds, including all but 16 of the 189 HAPs. The data are self-reported by manufacturing facilities [Standard Industrial Classification (SIC) codes 20 through 39] who manufacture or use the chemicals in amounts greater than specified thresholds. The facilities are not required to perform any monitoring or testing to estimate their emissions. Despite these limitations, the TRI data are presented here as an indicator of toxics from manufacturing operations. The emission quantities represent national totals. Generally, the chemicals listed are used as common industrial feedstocks and solvents. Most of the reported emissions decreased between 1987 and 1991.

8.2.2 *Carcinogens*

Fifty-three of the HAPs in the TRI data base are known or suspected human carcinogens. Table 8-2 summarizes the carcinogens emitted in the greatest quantities. As the table shows, there is a clear downward trend of carcinogen emissions over the 5-year period. Since many of these chemicals are or will be covered by specific EPA programs designed to reduce chemical emissions, further reductions are expected in the future.

8.2.3 *High Risk/Early Reduction*

Table 8-2 shows emissions of the HAPs that EPA has preliminarily identified as high risk substances for the purpose of the Early Reduction Program. These high risk substances receive a higher weighting in determining whether a source has met its 90 percent reduction target.

8.2.4 *State and Industrial Emissions*

Toxic air emissions of all TRI chemicals reported in each state are shown in Table 8-3[76,77] for 1987 to 1991. Generally, the states reporting the greatest emissions are the industrial states in the Northeast, Great Lakes, Middle Atlantic, Gulf Coast, and California. The one exception is Utah, which is dominated by one facility with very large emissions. Texas ranked first with reported emissions of 83 thousand tons, equivalent to 8 percent of the 1991 national total. The number of regions in which individual HAPs occurred in the top 10 chemicals emitted in the region is presented in Table 8-4. Table 8-5[76, 77] presents the national air emissions of all TRI chemicals by 2-digit SIC code for 1987 to 1991. During this time period, emissions from all industries decreased, except in the food industry. These changes may be real or "paper" changes. Real changes include source reduction (process changes, elimination of spills and leaks, inventory control, improved maintenance, and alternative methods of cleaning and degreasing); chemical substitution; production increases/decreases; abnormal events (accidental releases or cleanup); and installation of pollution control equipment. Examples of paper changes are changes in estimation methodology, clarification of reporting guidance, and reporting errors (mathematical miscalculations and typographical errors).

8.3 GLOBAL EMISSIONS

This is the first report in this series to present global emissions. The report presents 1985 NO_x, SO_2, and VOC emission estimates for the United States, Canada, and 12 European countries [Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, United Kingdom (Europe-12)]. The methods and goals for determining air pollution emissions differ among countries; comparisons among countries should therefore be made with caution.

The total 1985 NO_x emissions were 36.14 million tons with the following global distribution: 62 percent from the United States, 32 percent from Europe-12, and 6 percent from Canada. The United States emitted 54 percent of the 1985 international SO_2 emissions. The Europe-12 countries and Canada emitted 35 and 11 percent, respectively, of the 1985 SO_2 total international emissions of 43.01 million tons. In 1985, the United States emitted 25.01 million tons of the 48.67 million tons of VOC emitted globally. The Europe-12 countries emitted 21.66 million tons of VOC and Canada emitted 2 million tons of VOC in 1985.

8.3.1 Canada

As noted earlier, this is the first time this report has included emissions from Canada. The emissions were provided by Marc Deslauriers of Environment Canada. Details on the methodology to develop these estimates can be found in *Management Plan for Nitrogen Oxides and Volatile Organic Compounds*[78] and *Eastern Canada Acid Rain Control Program.*[79] The 1990 estimates are preliminary and do not correspond with those reported in the *Interim* report. National Canadian estimates are presented in this report, as well as estimates for three provinces (Ontario, Quebec, New Brunswick). The estimates by major source categories for 1985 and 1990 are given for NO_x, VOC, and SO_2 emissions in Tables 8-6, 8-7, and 8-8, respectively.

8.3.2 CORINAIR: The Atmospheric Emission Inventory for Europe[y]

On June 27, 1985, the European Council of Ministers adopted Decision 85/338/EEC on a Commission world program for gathering, coordinating, and ensuring the consistency of information on the state of the environment and natural resources in the European Community. This program was called CORINE (COoRdination d'INformation Environnementale) and one of its component projects was the CORINe AIR emission inventory (CORINAIR).[80]

When the Council Decision on CORINE was adopted, there were several air emissions data collection campaigns in progress at the international level (OECD, UNECE, and PHOXA). The methodology for the prototype 1985 CORINAIR (CORINAIR85) inventory was based on the methodology of OECD and was developed in collaboration with experts from each of the member states, as well as from the European Commissions (CEC), OECD, UNICE, CEFIC, EUROTRAC, and IIASA.

On May 7, 1990, the Council adopted Regulation 1210/90 which established the European Environment Agency (EEA) and the European environment information and observation network. The regulation gives the Agency responsibility for the collection, processing, and analysis of environmental data and for the continuation of work started under the CORINE decision. It also lists several areas of work to be given priority. Air quality and atmospheric emissions are included in this list.

Pending a decision on the location of the EEA, the CORINE program is being continued by the EEA Task Force (EEA-TF) formed within the Directorate General Environment, Nuclear Safety and Civil Protection (DGXI) of the CEC. The CORINAIR project is being continued through an update for 1990 (CORINAIR90). Following agreements reached with the UNECE on a common source sector split for reporting atmospheric emissions, the CORINAIR90 system has been made available to 30 European countries on a voluntary basis or with financial support from the CEC.

The CORINAIR90 system is therefore currently available to the following:

(1) The Europe-12 community;

(2) 5 EFTA countries: Austria, Finland, Norway, Sweden, and Switzerland;

(3) 3 Baltic States: Estonia, Latvia, and Lithuania;

(4) 9 Central and Eastern European countries: Albania, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia; and

(5) Russia.

8.3.2.1 CORINAIR85

The prototype emission inventory for 1985 — CORINAIR85 — was based on the following:

(1) a new nomenclature (which was technology-based, since the NACE was considered inappropriate for environmental needs);

(2) a *Default Emission Factor Handbook* (based broadly on OECD and PHOXA results but also introducing new developments);

(3) addressing major localized emission sources as point sources (large point sources) and other minor or diffuse sources as area sources, with areas based on the Community's Nomenclature of Statistical Territorial Units (NSTU); and

(4) software for data input and the calculation of emissions.

These features of the CORINAIR system were developed by the contractor (CITEPA, in Paris) in conjunction with the following:

(1) the CORINAIR Technical Unit (which included other contractors and representatives of DGXI, the customer);

(2) working groups covering specific sources/pollutants (stationary NO_x, mobile sources, stationary VOC, natural VOC, and ammonia); and

(3) the CORINAIR Expert Group, with experts from each of the member states and from related international activities.

The CORINAIR85 inventory was based on 120 activities divided into eight categories: combustion (other than industry), oil refining, industrial combustion, industrial processes, solvent evaporation, road transport, nature, and miscellaneous activities. It also quantified three pollutants: NO_x, VOC (including CH_4), and SO_2. Tables 8-9, 8-10, and 8-11 present the summary of the results obtained.[81]

With certain restrictions on the use of the limited subset of data held in confidence within the CORINAIR data base, CORINAIR85 data are available on request from the CITEPA in Paris or the EEA-TF in Brussels. The complete CORINAIR85 inventory (activity statistics, emission factors, emission estimates, etc.) is held in personal computer files in Paris and Brussels. Emission estimates by territorial unit are held for mapping and analysis in ARCINFO files on the CORINE data base in Brussels.

8.3.2.2 CORINAIR90

Atmospheric emission inventory requirements and methodologies were developed rapidly at the national and international level during the course of the CORINAIR85 project. Estimates were extended to newly quantified sources of emissions and to additional pollutants. Each international project became informed of the work being carried out elsewhere, overlaps in work being performed, and, hence, the need to harmonize these activities.

In preparing for the CORINAIR90 project, the CORINAIR Technical Unit and Expert Group were able to collaborate closely with UNECE and OECD. The UNECE requires emission inventory data as part of the obligations under the various Protocols for the Long Range Transboundary Air Pollution (LRTAP) convention. The OECD is developing the methodology for greenhouse gas emissions on behalf of the IPCC. This collaboration has achieved these results:

(1) produced a more developed nomenclature [source sector split (SNAP90)] involving over 260 activities grouped into a three-level hierarchy of subsectors and 11 main sectors;

(2) extended the list of pollutants to be covered to eight (SO_2, NO_x, NMVOC, ammonia, CO, CH_4, NO, and CO_2);

(3) extended the number of sources to be considered as point sources (there were over 1400 large point sources in the CORINAIR85 inventory);

(4) extended the availability of the CORINAIR system to 30 countries; and

(5) increased the awareness of CORINAIR and the need to produce an inventory within a reasonable time frame to serve the requirements of the user community.

Initial data from CORINAIR90 was scheduled to become available in mid-1993. The project and report completion are scheduled for early 1994.

[v] Article 4-1 of the FCCC requires that all parties "develop, periodically update, publish, and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties."

[w] A "sink" is a mechanism that leads to the removal and/or destruction of greenhouse gases.

[x] The air toxic section of the CAAA addresses over 1.4 billion of the 2.0 billion pounds of toxic chemicals reported to the TRI for 1991. The remaining 600 million pounds of toxic chemicals are subject to control as VOCs under the ambient air standard for ozone, or are subject to the particulate matter ambient air standard.

[y] The acronyms found in section 8.3.2 are defined in the list of Acronyms and Abbreviations found on page xiii.

Table 8-1. DRAFT Summary of U.S. Greenhouse Gas Emissions and Sinks By Source Category[a]

(thousand short tons)

Source Category	CO_2	CH_4	N_2O
I. EMISSIONS FROM ENERGY PRODUCTION AND CONSUMPTION			
A. STATIONARY SOURCES			
Electric Utilities			
Solid (fossil)	1,617,835	1 - 22	NA
Liquid (fossil)	106,481	<0.5	NA
Gas (fossil)	166,336	NA	NA
Biomass	1,213[b]	NA	NA
Other[c]			
Total	1,890,542	1 - 22	NA
Industry			
Solid (fossil)	342,482	<0.5	NA
Liquid (fossil)	287,478	<0.5	NA
Gas (fossil)	530,534	NA	NA
Biomass	163,139[b]	<0.5 - 13	NA
Other[c]	NA	NA	NA
Total	1,160,384	<0.5 - 13	NA
Commercial/Institutional			
Solid (fossil)	9,921	<0.5	NA
Liquid (fossil)	77,601	<0.5	NA
Gas (fossil)	156,085	NA	NA
Biomass	2,976[b]	NA	NA
Other[c]	NA	NA	NA
Total	243,607	<0.5	NA
Residential			
Solid (fossil)	6,063	1 - 11	NA
Liquid (fossil)	93,915	<0.5	NA
Gas (fossil)	261,354	NA	NA
Biomass	56,658[b]	<0.5 - 926	NA
Other[c]	NA	NA	NA
Total	361,442	<0.5 - 937	NA
TOTAL STATIONARY SOURCES			
Solid (fossil)	1,976,190	22 - 33	NA
Liquid (fossil)	565,586	<0.5	NA
Gas (fossil)	1,114,198	18 - 69	NA
Biomass	223,876[b]	<0.5 - 939	NA
Other[c]	NA	NA	NA
Total	3,655,974	19 - 1,042	NA
B. MOBILE SOURCES			
Highway Vehicles			
Passenger Cars			
Gasoline	NA	64 - 192	37 - 112
Diesel	NA	<0.5	<0.5
Other	NA	NA	NA
Subtotal	NA	64 - 192	37 - 112
Light Trucks			
Gasoline	NA	55 - 165	15 - 45
Diesel	NA	<0.5	<0.5
Other	NA	NA	NA
Subtotal	NA	55 - 165	15 - 45

(continued)

Table 8-1. (continued)

Source Category	CO_2	CH_4	N_2O
Heavy-Duty Vehicles			
Gasoline	NA	10 - 30	<0.5
Diesel	NA	7 - 20	2 - 7
Other	NA	NA	NA
Subtotal	NA	17 - 50	2 - 7
Motorcycles	NA	2 - 7	<0.5
Total Highway Vehicles			
Gasoline	NA	131 - 392	53 - 158
Diesel	NA	7 - 20	3 - 9
Other	NA	NA	NA
Total	NA	138 - 412	6 - 55
Off-Highway Vehicles			
Aircraft	NA	3 - 10	<0.5
Locomotives	NA	2 - 6	<0.5 - 2
Vessels	NA	4 - 13	2 - 6
Farm Equipment	NA	3 - 10	<0.5 - 2
Construction Equipment	NA	1 - 3	<0.5 - 2
Other Off-Highway	NA	NA	NA
Total Off-Highway	NA	14 - 31	3 - 10
TOTAL MOBILE SOURCES	1,869,599	151 - 454	58 - 174
TOTAL ENERGY COMBUSTION			
Solid (fossil)	1,976,190	NA	NA
Liquid (fossil)	2,435,185	NA	NA
Gas (fossil)	1,114,198	NA	NA
Biomass	223,876[b]	NA	NA
Other	NA	NA	NA
Total	5,525,573	170 - 1,496	58 - 174
C. ENERGY PRODUCTION, STORAGE, & DISTRIBUTION			
Natural Gas Systems			
Field Production	NA	761 - 2,006	NA
Processing	NA	44 - 298	NA
Storage and Injection/Withdrawal	NA	11 - 66	NA
Transmission	NA	650 - 2,271	NA
Distribution	NA	187 - 827	NA
Engine Ehaust	NA	298 - 705	NA
Total	NA	2,403 - 4,696[d]	NA
Other Oil & Gas Production Activities	7,231	110 - 683	NA
Coal Mining	NA	3,968 - 6,283	NA
TOTAL ENERGY PRODUCTION, STORAGE, & DISTRIBUTION	7,231	6,481 - 11,662	NA
II. PROCESS AND AREA SOURCE EMISSIONS			
Cement Production	36,045	NA	NA
Adipic Acid (Nylon) Production	NA	NA	68.6728
Non-Energy Industrial Processes			
Landfills			
Large Municipal Landfills (152)[e]	NA	2,866 - 4,630	NA
Medium Municipal Landfills (1,137)[e]	NA	3,638 - 6,614	NA
Small Municipal Landfills (4,744)[e]	NA	992 - 1,653	NA
Industrial Landfills[e]	NA	661 - 992	NA
Total Landfills	NA	8,929 - 13,007	NA
TOTAL	36,045	8,929 - 13,007	68.6728

(continued)

Table 8-1. (continued)

Source Category	CO_2	CH_4	N_2O
III. AGRICULTURAL, FORESTS, AND LAND USE			
A. EMISSIONS FROM AGRICULTURE			
Domesticated Animals			
Dairy Cattle			
Dairy Cows[e]	NA	992 - 1,543	NA
Replacements[e]	NA	331 - 441	NA
Beef Cattle			
Beef Cows[e]	NA	1,984 - 2,976	NA
Replacements[e]	NA	441 - 661	NA
Bulls[e]	NA	220 - 331	NA
Feedlot Fed Cattle[e]	NA	992 - 1,433	NA
Other Animals[e]	NA	220 - 331	NA
Total Domesticated Animals	NA	5,071 - 7,606	NA
Animal Wastes			
Dairy Cattle[e]	NA	661 - 1,102	NA
Swine[e]	NA	882 - 1,543	NA
Other[e]	NA	331 - 1,323	NA
Total Animal Wastes	NA	1,874 - 3,968	NA
Rice Cultivation	NA	127 - 794	NA
Nitrogen Fertilizer Use	NA	NA	55 - 915
TOTAL	NA	7,071 - 12,368	55 - 915
B. EMISSIONS FROM FORESTS, LAND USE, AND BIOMASS BURNING			
Timber Removal and Growth	(670,966)	NA	NA
Forest Soil Carbon Loss	NA	NA	NA
Croplands Soil Carbon Loss	6,063 - 10,582	NA	NA
Agricultural Crop Waste Burning	NA	72	NA
TOTAL	(660,384 - 664,903)	72	NA
TOTAL EMISSIONS — ALL SOURCE CATEGORIES[f]	**4,904,101 - 4,908,730**	**22,707 - 38,580**	**187 - 1,157**

NOTE(S): The CO_2 estimates in this table pertaining to energy consumption include all of the carbon emitted from energy consumption activities. In some cases, the carbon is not initially emitted as CO_2. The IPCC has recommended this reporting format to ensure that all countries report emissions from energy activities. This reporting convention means that other carbon-containing emissions from energy consumption should be viewed as a subset of the carbon reported as CO_2 to avoid double counting.

a. *Estimation of Greenhouse Gas Emissions and Sinks for the United States, 1990*, DRAFT, U.S. Environmental Protection Agency. June 21, 1993.
b. CO_2 emission estimates from biomass fuel combustion are not included in any of the totals.
c. This category includes LPG, waste oil, coke, and coke oven gas.
d. The uncertainty in the total is estimated assuming that some of the uncertainty for each source is independent. Consequently, the range of the total is narrower than the sum of the ranges.
e. *Anthropogenic Methane Emissions in the United States: Estimates for 1990*, Report to Congress, U.S. Environmental Protection Agency Air and Radiation, EPA 430-R-93-003, April 1993.
f. These totals are draft values. The reader should exercise caution when comparing with other Federal Agency reports. Final values will be reported in the 1994 *Trends* report.

Values in parentheses indicate amount sequestered, not emitted.
NA = Underlying data not available at time of publication.

Table 8-2. HAPs with Greatest Air Emissions in TRI (1987 Basis)

(short tons per year)

Compound	Rank			Amount Emitted					4-year change	
	HAPs	Carcinogens	High Risk	1987	1988	1989	1990	1991	Emissions	Percent
1,1,1-Trichloroethane	3	NA	NA	82,388	88,384	87,932	82,251	68,753	-13,635	-16.55
1,1,2,2-Tetrachloroethane	NA	15	NA	52	22	18	22	32	-20	-38.22
1,1,2-Trichloroethane	NA	NA	14	988	871	394	303	264	-724	-73.29
1,2-Dibromoethane	NA	17	NA	33	33	30	29	19	-14	-42.12
1,2-Dichloroethane	NA	NA	10	3,098	2,268	2,146	2,802	1,998	-1,100	-35.52
1,3-Butadiene	NA	2	9	4,692	3,442	2,915	2,581	1,975	-2,717	-57.90
2-Nitropropane	NA	NA	20	138	195	88	42	53	-85	-61.69
Acrolein	NA	18	NA	24	17	10	11	14	-10	-40.63
Acrylic acid	NA	6	NA	411	400	179	216	205	-206	-50.05
Acrylonitrile	NA	3	11	2,690	2,098	2,194	1,575	1,094	-1,596	-59.31
Arsenic compounds	NA	12	NA	135	134	88	83	95	-40	-29.51
Asbestos (friable)	NA	19	NA	21	25	20	10	6	-15	-70.09
Benzene	14	1	5	15,945	15,631	13,370	11,010	8,737	-7,208	-45.20
Cadmium compounds	NA	13	NA	76	50	43	46	35	-41	-54.28
Carbon disulfide	6	NA	NA	67,938	62,057	50,095	49,213	44,670	-23,268	-34.25
Carbonyl sulfide	17	NA	NA	11,244	10,092	9,213	9,317	8,363	-2,881	-25.62
Carbon tetrachloride	NA	NA	12	2,167	1,888	1,725	870	773	-1,394	-64.31
Chlorine	8	NA	NA	53,607	67,054	66,390	52,426	38,805	-14,802	-27.61
Chloroform	16	NA	6	12,627	12,518	12,857	11,263	9,541	-3,085	-24.43
Chloromethane	19	NA	7	7,065	6,168	4,915	3,920	2,849	-4,216	-59.67
Chloroprene	NA	11	NA	141	974	894	781	735	594	421.46
Chromium compounds	NA	8	17	365	385	710	379	281	-84	-23.00
Dibenzofuran	NA	20	NA	18	36	32	15	20	2	11.24
Dichloromethane	7	NA	1	67,922	63,997	62,080	50,138	39,669	-28,253	-41.60
Epichlorohydrin	NA	NA	19	210	233	236	213	230	20	9.32
Ethylene glycol	18	NA	NA	7,734	6,636	6,445	5,528	5,330	-2,404	-31.08
Ethylene oxide	NA	4	13	2,092	2,347	1,576	1,224	897	-1,195	-57.15
Formaldehyde	20	NA	8	6,780	5,946	6,506	6,197	5,109	-1,671	-24.64
Glycol ethers	11	NA	NA	21,434	24,206	24,239	24,429	21,957	523	2.44
Hydrochloric acid	9	NA	NA	36,584	36,966	40,689	43,065	41,461	4,877	13.33
Methanol	2	NA	NA	108,569	114,133	105,892	100,701	99,841	-8,728	-8.04
Methyl ethyl ketone	4	NA	NA	78,960	68,018	68,030	64,246	51,711	-27,249	-34.51
Methyl isobutyl ketone	15	NA	NA	15,315	15,813	15,762	13,855	13,599	-1,716	-11.20
Methyl isocyanate	NA	14	NA	72	5	7	7	4	-68	-94.59
Methylenebis	NA	7	NA	396	123	162	305	313	-83	-20.92
Phosgene	NA	16	NA	42	11	4	2	2	-40	-94.78
Styrene	13	NA	4	16,190	16,311	17,385	15,540	14,238	-1,952	-12.06
Tetrachloroethylene	12	NA	3	16,604	17,897	13,739	11,198	8,344	-8,260	-49.75
Toluene	1	NA	NA	145,610	146,099	134,776	120,839	99,282	-46,328	-31.82
Toluene-2,4-diisocyanate	NA	9	NA	306	83	47	29	662	356	116.33
Trichloroethylene	10	NA	2	26,990	26,890	24,675	19,462	17,529	-9,461	-35.05
Urethane	NA	NA	16	398	73	2	2	1	-397	-99.74
Vinyl chloride	NA	5	15	784	719	635	568	524	-260	-33.20
Vinylidene chloride	NA	10	18	233	148	110	152	143	-90	-38.80
Xylene (mixed isomers)	5	NA	NA	75,502	77,196	77,856	68,098	57,776	-17,726	-23.48

SOURCE: 1990 Toxics Release Inventory (1987),[76] Table 23.
1991 Toxics Release Inventory (1988-1991),[77] Table 3.8.

NOTE(S): NA = Not applicable.

Table 8-3. State Total Air Emissions in TRI Data Base, 1987-1991

State	Total TRI Emissions (tpy)					4-Year Change	
	1987	1988	1989	1990	1991	Emissions	Percent
Alabama	50,968	52,598	52,933	51,619	49,236	-1,732	-3.40
Alaska	15,769	11,523	10,475	7,984	6,613	-9,156	-58.06
Arizona	8,798	8,149	6,385	6,352	4,727	-4,071	-46.27
Arkansas	24,853	24,345	21,893	16,887	15,447	-9,406	-37.85
California	44,038	45,613	41,721	40,774	32,493	-11,545	-26.22
Colorado	5,197	6,010	5,412	3,616	2,922	-2,275	-43.78
Connecticut	13,948	12,852	10,784	8,729	7,876	-6,072	-43.53
Delaware	4,586	3,782	4,320	3,010	2,917	-1,670	-36.40
Florida	25,711	25,757	30,637	23,546	18,966	-6,745	-26.24
Georgia	46,723	42,115	38,227	37,410	28,767	-17,957	-38.43
Hawaii	457	437	343	345	290	-167	-36.55
Idaho	2,498	2,683	2,678	2,843	3,058	560	22.42
Illinois	53,007	54,696	51,486	44,726	40,050	-12,957	-24.44
Indiana	56,814	55,477	57,204	53,325	47,537	-9,278	-16.33
Iowa	20,138	22,356	22,608	19,602	17,462	-2,676	-13.29
Kansas	13,508	16,286	16,458	15,104	13,479	-29	-0.22
Kentucky	23,617	24,258	22,626	20,851	18,492	-5,125	-21.70
Louisiana	73,201	69,159	67,422	54,864	48,262	-24,939	-34.07
Maine	8,086	8,538	7,778	6,831	6,875	-1,211	-14.98
Maryland	9,391	9,007	9,236	6,569	5,756	-3,635	-38.71
Massachusetts	16,014	13,916	12,468	10,596	8,122	-7,892	-49.28
Michigan	59,192	49,844	53,412	43,071	34,933	-24,259	-40.98
Minnesota	24,761	27,458	31,243	25,424	19,485	-5,276	-21.31
Mississippi	32,823	30,086	30,271	29,039	27,295	-5,528	-16.84
Missouri	24,521	25,230	24,320	22,823	17,346	-7,176	-29.26
Montana	1,375	1,200	1,253	1,226	1,180	-195	-14.17
Nebraska	7,250	9,350	8,336	8,451	7,376	127	1.75
Nevada	389	352	343	373	471	82	21.10
New Hampshire	6,483	6,165	5,495	4,066	2,634	-3,849	-59.37
New Jersey	22,097	19,532	15,596	7,937	10,348	-11,748	-53.17
New Mexico	1,948	1,067	1,411	1,280	1,076	-872	-44.77
New York	50,855	50,614	43,399	37,649	31,924	-18,931	-37.23
North Carolina	50,834	49,593	47,605	44,866	41,025	-9,809	-19.30
North Dakota	898	736	671	636	388	-510	-56.81
Ohio	70,545	71,317	70,281	57,905	48,825	-21,720	-30.79
Oklahoma	18,131	18,159	14,829	14,220	11,870	-6,261	-34.53
Oregon	10,358	10,839	9,983	9,332	8,710	-1,648	-15.91
Pennsylvania	46,819	45,834	40,904	38,218	32,814	-14,005	-29.91
Rhode Island	3,960	3,890	3,150	2,610	2,175	-1,785	-45.07
South Carolina	34,174	33,922	51,207	34,010	30,760	-3,414	-9.99
South Dakota	1,248	1,265	1,615	1,455	1,316	67	5.38
Tennessee	68,826	73,425	80,035	73,790	69,254	428	0.62
Texas	113,175	103,661	98,252	87,849	83,226	-29,948	-26.46
Utah	42,334	60,796	65,201	53,083	37,174	-5,160	-12.19
Vermont	618	784	595	469	450	-169	-27.29
Virginia	75,735	62,598	40,977	38,909	33,144	-42,591	-56.24
Washington	14,347	14,851	14,306	14,226	12,961	-1,386	-9.66
West Virginia	20,563	18,470	17,224	15,396	13,257	-7,306	-35.53
Wisconsin	24,851	23,231	21,763	21,505	18,415	-6,437	-25.90
Wyoming	1,254	1,446	1,830	2,344	1,439	185	14.78

SOURCE: 1990 Toxics Release Inventory (1987)[76], Table 20; 1991 Toxics Release Inventory (1988-1991)[77], Table 3-7.
NOTE(S): The emissions include all chemicals reported in TRI data base, not just HAPs. Totals do not add to those in Table 8-5 since emissions from Washington, DC, America Samoa, Puerto Rico, and the Virgin Islands are excluded.

Table 8-4. Occurrences of HAPs in the Top 10 Chemicals Reported in the TRI Data Base for 1990 by EPA Region

HAP	Occurrences
1,1,1-Trichloroethane	10
Methanol	10
Toluene	10
Methyl ethyl ketone	9
Dichloromethane	8
Xylene	8
Hydrochloric acid	5
Glycol ethers	4
Trichloroethylene	3
Carbon disulfide	2
Sulfuric acid	2
Benzene	1
Chlorine	1
Chloroform	1
Hydrogen fluoride	1
Tetrachloroethylene	1

SOURCE: Evaluation of Air Emission Trends Using TRI Data, Appendix B, Table B-1.[81]

Table 8-5. TRI Total Air Emissions by Industry, 1987 to 1991

(short tons/year)

		Total TRI Emissions					4-Year Change	
SIC Code	**Industry**	**1987**	**1988**	**1989**	**1990**	**1991**	**Emissions**	**Percent**
20	Food	10,052	8,955	12,322	13,113	13,856	3,804	37.84
21	Tobacco	3,376	909	853	1,229	1,137	-2,238	-66.31
22	Textiles	27,656	18,467	15,429	13,167	12,210	-15,446	-55.85
23	Apparel	1,375	512	678	639	687	-689	-50.06
24	Lumber	15,254	16,118	17,382	16,728	15,144	-110	-0.72
25	Furniture	29,396	33,055	32,346	30,566	27,396	-2,000	-6.80
26	Paper	134,549	110,465	102,680	102,399	104,124	-30,425	-22.61
27	Printing	31,816	30,199	28,502	25,047	22,404	-9,412	-29.58
28	Chemicals	492,062	425,305	389,037	345,241	302,080	-189,982	-38.61
29	Petroleum	44,164	32,390	32,177	29,488	28,151	-16,013	-36.26
30	Plastics	91,158	84,455	91,292	88,545	72,913	-18,245	-20.01
31	Leather	7,612	7,386	6,454	6,095	4,788	-2,824	-37.10
32	Stone/Clay	15,033	13,666	13,229	10,452	10,445	-4,588	-30.52
33	Primary Metals	112,150	120,092	121,129	104,930	78,013	-34,136	-30.44
34	Fabr. Metals	68,966	65,135	67,088	62,654	53,795	-15,172	-22.00
35	Machinery	30,318	29,843	28,323	24,321	19,022	-11,296	-37.26
36	Electrical	64,448	61,473	48,942	39,192	31,575	-32,873	-51.01
37	Transportation	120,911	105,733	101,665	86,327	72,775	-48,136	-39.81
38	Measure/Photo	32,341	28,024	25,879	21,874	19,211	-13,131	-40.60
39	Miscellaneous	14,467	15,264	14,268	12,351	9,151	-5,316	-36.75
Multiple codes 20-39		0	119,000	126,238	100,948	83,861	83,861	
Non-codes 20-39		7,616	6,608	5,186	6,048	6,934	-682	-8.95
Total		1,354,720	1,333,055	1,281,097	1,141,352	989,673	-365,047	-26.95

SOURCE: 1990 Toxics Release Inventory (1987),[76] Table 24.
1991 Toxics Release Inventory (1988-1991),[77] Table 3-9.

NOTE(S): The emissions include all chemicals reported in TRI data base, not just HAPs.

Table 8-6. Canadian NO_x Emission Forecast by Province

(thousand short tons)

	Ontario		Quebec		New Brunswick		CANADA	
SECTOR	**1985**	**1990**	**1985**	**1990**	**1985**	**1990**	**1985**	**1990**
Transportation								
Cars	139	97	80	66	10	6	383	276
Light-Duty Trucks								
Gas	26	28	8	11	3	2	91	88
Diesel	0	0	0	0	0	0	0	0
Heavy-Duty Trucks								
Gas	9	3	3	1	1	0	32	11
Diesel	90	115	29	71	8	9	273	323
Off-Road Diesel								
Construction	10	12	4	5	0	0	34	36
Agriculture	8	10	4	5	0	0	58	80
Railroads	31	33	17	11	2	2	135	138
Other	30	54	23	43	3	9	160	203
Other	21	27	17	20	0	0	86	99
Fuel Combustion								
Residential	16	17	8	9	1	1	45	47
Commercial	14	14	4	5	1	1	33	35
Industrial								
Natural Gas	0	0	0	0	0	0	153	179
Other	108	102	45	48	4	4	267	295
Power Generation	172	87	2	7	8	16	330	292
Industrial Processes	32	33	12	13	3	3	112	123
Incineration/Miscellaneous	5	5	5	6	1	1	27	31
TOTAL	716	643	267	327	51	59	2,226	2,263

NOTE(S): These are preliminary numbers provided by Marc Deslauriers of Environment Canada, Conservation and Protection, Pollution Data Analysis Division, Hull, Quebec.

Table 8-7. Canadian VOC Emission Forecast by Province

[thousand short tons (as total nonmethane hydrocarbons)]

SECTOR	Ontario 1985	Ontario 1990	Quebec 1985	Quebec 1990	New Brunswick 1985	New Brunswick 1990	CANADA 1985	CANADA 1990
Transportation								
Cars	175	130	98	88	12	7	507	380
Light-Duty Trucks								
Gas	44	47	14	19	5	4	152	148
Diesel	0	0	0	0	0	0	1	0
Heavy-Duty Trucks								
Gas	14	3	5	1	1	0	47	10
Diesel	11	12	3	7	1	1	34	34
Off-Road Gasoline	6	25	2	8	0	0	72	79
Other	32	25	14	12	1	2	74	87
Fuel Combustion								
Fuelwood	37	34	44	39	5	0	118	94
Residential/Commercial	1	1	0	0	0	0	4	4
Industrial	6	7	0	1	0	0	52	60
Industrial Processes								
Petrochemicals	13	15	6	7	0	0	33	36
Petroleum Refining	66	38	40	25	7	5	179	113
Plastics	8	6	3	2	0	0	15	10
Other	30	24	11	12	1	1	67	82
Incineration/Miscellaneous								
Surface Coatings	59	139	34	47	2	0	134	216
Fuel Marketing	10	38	3	19	0	3	31	99
Dry Cleaning	5	6	4	2	0	0	15	14
Solvent Use	142	181	76	80	8	7	325	505
Slash Burning	17	17	22	21	5	5	106	108
Other	4	16	9	35	0	1	21	139
Power Generation	0	0	0	0	0	0	3	3
TOTAL	689	771	397	435	55	41	1,998	2,232

NOTE(S): These are preliminary numbers provided by Marc Deslauriers of Environment Canada, Conservation and Protection, Pollution Data Analysis Division, Hull, Quebec.

Table 8-8. Canadian SO_2 Emission Forecast by Province
(thousand short tons)

PROVINCE	SECTOR Primary Metals	Power Generation	Other *	TOTAL
Ontario				
1985	860	370	409	1,808
1990	757	214	443	1,560
Quebec				
1985	554	0	250	887
1990	733	14	320	1,177
New Brunswick				
1985	18	103	28	166
1990	20	155	34	232
CANADA				
1985	1,972	812	1,392	4,603
1990	2,061	750	1,555	4,814

NOTE(S): These are preliminary numbers provided by Marc Deslauriers of Environment Canada, Conservation and Protection, Pollution Data Analysis Division, Hull, Quebec.

* "Other" includes remaining Industrial Process sectors, Fuel Combustion, Transportation, and Incineration/Miscellaneous

Table 8-9. CORINAIR 1985: NO_x Emissions

(thousand short tons/year)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc	Total	Percent
Belgium	72	7	41	30	0	201	0	0	349	3
Denmark	164	2	14	6	0	114	0	0	300	3
Germany	919	31	250	157	0	1,637	0	0	2,994	26
Greece	163	4	9	31	0	132	0	0	340	3
Spain	293	14	44	75	0	500	0	0	927	8
France	284	20	137	121	0	1,207	0	0	1,769	15
Ireland	40	0	9	6	0	39	0	0	93	1
Italy	487	30	128	139	0	951	0	0	1,735	15
Luxembourg	2	0	3	10	0	10	0	0	25	0
Netherlands	149	22	31	19	0	299	0	0	519	5
Portugal	15	2	12	13	0	63	0	0	106	1
United Kingdom	942	45	331	14	0	1,010	0	0	2,342	20
EUR-12	3,532	177	1,009	619	0	6,162	0	0	11,499	
Percent	31	0	9	5	0	54	0	0		

Table 8-10. CORINAIR 1985: VOC Emissions

(thousand short tons/year)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc.	Total	Percent
Belgium	20	12	3	32	90	213	31	78	479	2
Denmark	15	3	2	2	64	106	8	28	228	1
Germany	110	32	23	100	1,235	1,286	280	3,383	6,450	30
Greece	2	7	1	4	31	127	216	290	678	3
Spain	40	24	2	23	360	539	966	406	2,360	11
France	208	34	8	73	483	1,311	467	476	3,060	14
Ireland	19	1	1	1	23	26	23	26	121	1
Italy	52	42	6	50	438	1,090	244	1,326	3,246	15
Luxembourg	0	0	0	0	3	7	3	2	15	0
Netherlands	8	13	11	12	181	239	15	0	479	2
Portugal	1	4	1	19	57	58	72	8	220	1
United Kingdom	99	34	62	267	736	872	88	2,165	4,323	20
EUR-12	574	207	120	583	3,701	5,874	2,413	8,188	21,661	
Percent	3	1	1	3	17	27	11	38		

Table 8-11. CORINAIR 1985: SO_2 Emissions

(thousand short tons/year)

	Combustion excluding industry	Oil refineries	Industrial combustion	Processes	Solvent evaporation	Road transport	Nature	Misc.	Total	Percent
Belgium	208	39	109	60	0	18	0	0	433	3
Denmark	266	4	67	18	0	12	0	0	367	2
Germany	1,705	160	459	164	0	65	0	0	2,553	17
Greece	411	31	89	20	0	0	0	0	551	4
Spain	1,873	107	290	69	0	74	0	0	2,413	16
France	672	247	489	116	0	109	0	0	1,634	11
Ireland	87	1	61	2	0	4	0	0	155	1
Italy	1,307	163	606	143	0	84	0	0	2,304	15
Luxembourg	3	0	6	9	0	0	0	0	18	0
Netherlands	78	90	17	23	0	12	0	0	220	1
Portugal	95	14	76	25	0	8	0	0	218	1
United Kingdom	3,250	133	615	106	0	47	0	0	4,151	28
EUR-12	9,956	990	2,884	755	0	433	0	0	15,018	
Percent	66	7	19	5	0	3	0	0		

SECTION 9.0

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APPENDIX A

NATIONAL EMISSION ESTIMATES (1970 TO 1992) BY SUBCATEGORY

Table A-1. CO Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	237	322	301	316	324	291	300	313	319	314	314	311
Coal	106	188	207	220	232	208	217	229	231	233	233	235
Oil	41	48	27	25	20	24	20	25	26	20	19	15
Gas	90	85	68	72	58	48	53	48	51	51	51	51
Other	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA	NA
Internal Combustion	NA	NA	NA	NA	10	11	10	11	11	11	11	11
FUEL COMB. INDUSTRIAL	770	750	696	732	692	679	681	705	709	716	723	714
Coal	100	58	67	74	86	87	85	87	87	86	86	86
Oil	44	35	23	23	47	47	47	47	46	46	46	46
Gas	462	418	360	385	280	269	282	298	306	313	323	311
Other	164	239	246	249	166	173	172	175	174	172	170	172
Internal Combustion	NA	NA	NA	NA	113	103	96	98	96	98	98	98
FUEL COMB. OTHER	3,625	6,230	6,720	6,760	7,014	6,571	6,338	6,172	5,942	5,726	5,583	5,154
Commercial/Institutional Coal	12	13	20	22	14	14	14	15	15	15	15	14
Commercial/Institutional Oil	27	21	16	17	18	18	19	18	17	16	16	16
Commercial/Institutional Gas	24	26	24	25	42	42	43	47	49	50	51	50
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	NA	57	60	59	55	55	52	50	52
Residential Wood	2,932	5,992	6,461	6,485	6,721	6,280	6,046	5,868	5,654	5,435	5,290	4,872
fireplaces	686	1,402	1,512	1,517	NA	NA	NA	NA	NA	NA	NA	NA
woodstoves	2,246	4,590	4,949	4,967	NA	NA	NA	NA	NA	NA	NA	NA
Residential Other	630	178	199	212	162	157	157	168	153	158	161	149
TOTAL FUEL COMBUSTION	4,632	7,302	7,717	7,808	8,030	7,541	7,319	7,189	6,971	6,756	6,620	6,179

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-2. CO Emissions from Industrial Processes

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	3,397	2,151	1,844	2,082	1,475	1,810	1,756	1,873	1,880	1,893	1,906	1,873
Organic Chemical Mfg	340	543	560	599	143	261	260	278	285	286	282	281
ethylene dichloride	11	17	17	20	0	0	0	0	0	0	0	0
maleic anhydride	73	103	103	122	11	16	15	16	16	16	16	15
cyclohexanol	36	37	37	39	5	5	5	6	6	6	6	6
other	220	386	403	418	127	240	240	256	264	265	260	260
Inorganic Chemical Mfg	190	191	148	167	88	94	89	95	95	95	96	94
pigments; TiO2 chloride process: reactor	18	34	35	37	77	82	77	83	84	83	84	82
other	172	157	112	129	11	12	11	12	12	12	12	12
Polymer & Resin Mfg	NA	NA	NA	NA	18	19	18	18	18	19	19	19
Agricultural Chemical Mfg	NA	NA	NA	NA	15	16	16	17	17	17	17	17
Pharmaceutical Mfg	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other Chemical Mfg	2,866	1,417	1,136	1,316	1,210	1,420	1,373	1,465	1,464	1,476	1,491	1,462
carbon black mfg	2,866	1,417	1,136	1,316	811	792	763	802	819	833	842	827
carbon black furnace: fugitives	NA	NA	NA	NA	149	165	161	185	180	179	184	178
other	NA	NA	NA	NA	250	463	449	478	465	464	465	457
METALS PROCESSING	3,644	2,246	1,560	1,734	1,866	2,079	1,984	2,101	2,132	2,080	1,992	1,978
Nonferrous Metals Processing	652	842	606	741	535	656	619	661	682	686	661	642
aluminum anode baking	326	421	303	371	41	40	38	40	41	41	40	39
prebake aluminum cell	326	421	303	371	422	494	456	493	512	521	503	483
other	NA	NA	NA	NA	73	122	125	128	130	124	119	120
Ferrous Metals Processing	2,991	1,404	954	993	1,330	1,423	1,365	1,439	1,449	1,394	1,331	1,336
basic oxygen furnace	440	80	36	64	694	640	617	650	662	642	615	617
carbon steel electric arc furnace	181	280	239	235	126	129	125	132	132	128	122	123
coke oven charging	62	43	24	29	8	9	8	9	9	8	8	8
gray iron cupola	1,203	340	220	201	141	294	281	288	280	262	249	248
iron ore sinter plant windbox	1,025	600	391	418	304	280	266	287	293	283	269	272
other	81	61	43	46	57	72	68	73	73	71	68	68
Metals Processing NEC	NA	NA	NA	NA	0	0	0	0	0	0	0	0
PETROLEUM & RELATED INDUSTRIES	2,179	1,723	484	383	426	451	455	441	436	435	439	403
Oil & Gas Production	NA	NA	NA	NA	11	9	8	8	8	8	9	8
Petroleum Refineries & Related Industries	2,168	1,723	484	383	414	440	445	431	427	425	429	394
fcc units	1,820	1,680	460	362	403	398	408	393	390	389	392	358
other	348	44	24	21	11	41	37	38	37	36	37	35

(continued)

Table A-2. CO Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Asphalt Manufacturing	11	NA	NA	NA	1	2	2	2	2	2	2	2
OTHER INDUSTRIAL PROCESSES	620	830	864	908	693	715	713	710	716	716	711	722
Agriculture, Food, & Kindred Products	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	0
Textiles, Leather, & Apparel Products	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	0
Wood, Pulp & Paper, & Publishing Products	610	798	836	877	627	647	646	649	655	657	653	664
sulfate pulping: rec. furnace/evaporator	NA	NA	NA	NA	475	491	489	491	497	498	496	504
sulafte (kraft) pulping: lime kiln	610	798	836	877	140	145	144	145	146	146	145	147
other	NA	NA	NA	NA	12	12	13	13	13	13	13	13
Rubber & Miscellaneous Plastic Products	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Mineral Products	10	32	28	31	42	44	44	44	43	43	41	42
Machinery Products	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Electronic Equipment	NA	NA	NA	NA	18	18	18	13	12	12	11	11
Transportation Equipment	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	NA	6	5	5	5	5	5	5	5
SOLVENT UTILIZATION	NA	NA	NA	NA	1	2	2	2	2	2	2	2
Degreasing	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Graphic Arts	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	NA	0	0	0	1	1	1	1	0
Other Industrial	NA	NA	NA	NA	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	NA	NA	NA	NA	46	94	91	100	101	102	103	100
Bulk Terminals & Plants	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	NA	45	88	86	95	95	96	98	95
Inorganic Chemical Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	NA	0	5	5	5	5	5	5	5
TOTAL INDUSTRIAL PROCESSES	9,840	6,950	4,751	5,107	4,506	5,151	5,001	5,227	5,266	5,228	5,153	5,079

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-3. CO Emissions from Transportation

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
HIGHWAY VEHICLES	79,258	87,991	78,670	75,400	73,515	70,470	65,600	65,222	60,127	59,801	58,825	55,288
Light-Duty Gas Vehicles & Motorcycles	59,959	59,125	52,414	49,736	47,103	45,084	45,538	45,465	41,706	41,523	40,840	38,386
light-duty gas vehicles	59,662	59,125	52,414	49,736	47,103	45,084	45,538	45,465	41,706	41,523	40,840	38,386
motorcycles	298	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Light-Duty Gas Trucks	9,554	17,661	17,384	17,436	18,520	18,674	15,178	14,849	13,810	13,706	13,537	12,682
ldgt1	6,992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ldgt2	2,561	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	9,398	10,040	7,717	7,013	6,393	5,365	3,377	3,334	3,057	2,951	2,798	2,574
Diesels	347	1,165	1,155	1,215	1,499	1,348	1,506	1,574	1,554	1,621	1,651	1,646
hddv	347	1,150	1,126	1,186	1,469	1,318	1,461	1,526	1,503	1,565	1,591	1,584
lddt	NA	5	8	6	6	6	18	19	20	23	25	25
lddv	NA	11	21	23	24	23	27	29	30	33	35	37
OFF-HIGHWAY	10,001	16,117	14,246	15,619	15,798	15,659	15,333	15,296	14,997	14,642	14,238	14,679
Non-Road Gasoline	7,658	14,475	12,774	13,982	14,248	13,720	13,377	13,309	13,001	12,655	12,323	12,659
recreational	86	161	149	132	393	375	361	350	337	324	315	324
construction	584	413	203	198	433	414	401	413	405	395	364	395
industrial	1,909	1,090	956	881	1,267	1,231	1,219	1,258	1,246	1,228	1,195	1,228
lawn & garden	NA	6,411	6,009	6,461	7,162	6,859	6,623	6,442	6,225	6,001	5,862	6,001
farm	3,842	1,963	1,279	1,813	62	57	59	60	67	63	52	63
light commercial	NA	3,033	2,843	3,057	3,329	3,245	3,213	3,318	3,291	3,254	3,179	3,254
logging	NA	20	22	24	27	26	31	32	32	33	32	32
airport service	NA	81	91	104	118	120	127	135	143	149	146	153
recreational marine vessels	398	1,301	1,219	1,311	1,455	1,391	1,340	1,301	1,254	1,207	1,176	1,207
other	839	2	2	2	2	2	2	2	2	2	2	2
Non-Road Diesel	199	305	292	328	337	833	831	852	864	841	761	842
recreational	NA	0	0	0	0	0	0	0	0	0	0	0
construction	51	62	52	58	222	549	538	556	544	528	484	528
industrial	50	52	44	49	22	54	54	55	55	54	53	54
lawn & garden	NA	4	4	4	2	4	4	4	4	3	3	3
farm	98	138	140	158	64	159	166	164	185	176	143	176
light commercial	NA	13	12	13	6	14	14	14	14	14	14	14
logging	NA	2	2	2	1	2	3	3	3	3	3	3
airport service	NA	34	38	43	20	50	53	56	59	62	61	64

(continued)

Table A-3. CO Emissions from Transportation (cont'd)

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Aircraft	995	1,023	949	1,044	954	955	962	962	955	966	966	997
Marine Vessels	870	38	48	53	48	50	52	55	57	58	60	60
coal	575	4	4	5	5	6	6	6	6	6	7	7
diesel	287	32	42	47	42	43	46	48	50	51	52	52
residual oil	8	1	1	1	1	1	1	1	1	1	1	1
Railroads	280	277	183	212	211	102	111	117	119	122	128	121
TOTAL TRANSPORTATION	89,260	104,108	92,916	91,019	89,313	86,129	80,933	80,518	75,124	74,442	73,063	69,967

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-4. CO Emissions from Other Sources

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
WASTE DISPOSAL & RECYCLING	7,059	2,300	2,026	2,028	1,938	1,916	1,850	1,806	1,747	1,686	1,644	1,686
Incineration	2,979	1,246	1,070	1,089	955	949	920	903	876	849	830	849
conical wood burner	1,431	228	130	150	17	18	18	19	19	18	18	18
municipal incinerator	333	13	7	7	32	35	34	35	35	35	34	35
industrial	NA	NA	NA	NA	9	9	9	10	9	9	9	9
commmercial/institutional	108	60	41	41	30	33	35	38	39	40	40	40
residential	1,107	945	891	891	865	852	822	800	773	745	726	745
other	NA	NA	NA	NA	2	2	2	2	2	2	2	2
Open Burning	4,080	1,054	956	939	982	966	930	903	870	836	814	836
industrial	1,932	1,007	926	909	20	21	21	21	21	21	20	21
commmercial/institutional	2,148	47	30	30	4	4	4	4	5	5	5	5
residential	NA	NA	NA	NA	958	941	905	877	845	811	789	811
Landfills	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other	NA	NA	NA	NA	0	0	0	0	0	0	0	0
MISCELLANEOUS	7,909	8,344	8,551	7,011	4,111	4,156	4,198	4,327	4,286	4,267	4,202	4,271
Other Combustion	7,909	8,344	8,551	7,011	4,111	4,156	4,198	4,327	4,286	4,267	4,202	4,271
structural fires	101	217	195	198	242	242	242	242	242	242	242	242
agricultural fires	873	501	492	492	396	441	483	612	571	552	487	557
slash/prescribed burning	1,146	2,226	2,226	2,226	2,295	2,295	2,295	2,295	2,295	2,295	2,295	2,295
forest wildfires	5,620	5,396	5,636	4,093	1,178	1,178	1,178	1,178	1,178	1,178	1,178	1,178
other	169	4	3	2	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL OTHER	14,968	10,644	10,577	9,039	6,049	6,072	6,049	6,133	6,033	5,953	5,846	5,958

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-5. NOx Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	4,900	7,023	6,920	7,268	6,676	6,909	7,128	7,530	7,607	7,527	7,482	7,468
Coal	3,497	5,675	5,960	6,299	5,997	6,061	6,278	6,668	6,708	6,707	6,662	6,698
bituminous	2,112	3,439	3,614	3,820	4,631	4,427	4,529	4,623	4,665	4,603	4,522	4,579
subbituminous	1,041	1,694	1,780	1,882	972	1,290	1,411	1,659	1,650	1,706	1,732	1,705
anthracite & lignite	344	542	566	597	394	344	337	387	392	399	408	414
Oil	431	486	278	240	192	246	204	260	272	210	201	161
residual	391	447	261	217	169	242	200	257	269	207	198	158
distillate	40	39	17	23	20	4	4	4	4	3	3	3
other	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	NA
Gas	972	862	682	729	433	552	599	551	578	559	569	561
natural	972	862	682	729	419	552	599	551	578	559	569	561
process	NA	NA	NA	NA	4	NA	NA	NA	NA	NA	NA	NA
other	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA
Other	NA	NA	NA	NA	6	NA	NA	NA	NA	NA	NA	NA
Internal Combustion	NA	NA	NA	NA	48	50	48	50	49	50	50	49
FUEL COMB. INDUSTRIAL	4,326	3,554	3,159	3,414	3,424	3,277	3,294	3,443	3,475	3,535	3,604	3,523
Coal	771	444	512	573	607	613	596	617	615	613	610	613
bituminous	532	306	355	397	429	438	435	446	446	444	438	444
subbituminous	164	94	109	122	14	14	14	15	14	14	14	14
anthracite & lignite	75	44	48	54	33	31	27	29	30	30	30	30
other	NA	NA	NA	NA	131	130	120	126	125	124	127	124
Oil	332	286	175	176	309	302	293	298	295	299	307	296
residual	228	179	100	100	189	181	172	175	176	177	185	177
distillate	104	63	50	52	89	89	89	91	88	90	91	90
other	NA	44	25	24	31	32	32	32	31	32	31	29
Gas	3,061	2,619	2,277	2,457	1,728	1,633	1,725	1,828	1,880	1,924	1,991	1,915
natural	3,053	2,469	2,151	2,329	327	322	311	327	324	325	325	324
process	8	5	3	3	220	211	205	208	204	206	207	197
other	NA	145	123	125	1,181	1,100	1,209	1,293	1,351	1,394	1,459	1,394

(continued)

Table A-5. NOx Emissions from Fuel Combustion (cont'd)

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Other	162	205	195	208	128	130	129	131	130	129	127	128
wood/bark waste	102	138	144	144	88	92	92	93	92	91	90	91
liquid waste	NA	NA	NA	NA	12	12	12	12	12	12	12	12
other	60	67	51	64	28	26	25	26	26	26	26	25
Internal Combustion	NA	NA	NA	NA	652	599	552	569	556	570	568	570
FUEL COMB. OTHER	836	741	649	672	704	694	710	737	730	732	745	734
Commercial/Institutional Coal	23	25	34	37	37	36	37	39	38	39	40	36
Commercial/Institutional Oil	210	155	96	96	106	110	121	117	106	99	100	101
Commercial/Institutional Gas	120	131	122	126	144	139	144	157	159	164	169	167
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	NA	11	12	11	11	11	11	11	11
Residential Wood	44	74	80	81	81	76	73	71	68	66	64	59
Residential Other	439	356	317	332	326	320	323	343	347	352	361	360
distillate oil	118	85	62	64	75	76	79	80	78	81	82	84
natural gas	242	238	219	228	248	241	241	259	267	269	275	274
other	79	33	36	40	3	3	3	3	3	3	3	2
TOTAL FUEL COMBUSTION	10,062	11,318	10,728	11,354	10,805	10,879	11,132	11,710	11,812	11,793	11,831	11,725

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-6. NOx Emissions from Transportation

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
HIGHWAY VEHICLES	7,427	8,705	8,096	7,947	8,113	7,634	7,868	7,977	7,703	7,816	7,715	7,477
Light-Duty Gas Vehicles & MC	4,734	4,651	4,216	4,012	3,696	3,532	3,539	3,562	3,461	3,535	3,551	3,517
light-duty gas vehicles	4,730	4,651	4,216	4,012	3,696	3,532	3,539	3,562	3,461	3,535	3,551	3,517
motorcycles	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Light-Duty Gas Trucks	868	1,378	1,427	1,446	1,497	1,520	1,234	1,224	1,174	1,173	1,158	1,125
ldgt1	610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ldgt2	258	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	547	370	317	296	273	233	187	195	190	198	199	196
Diesels	1,277	2,306	2,136	2,193	2,647	2,349	2,909	2,997	2,877	2,909	2,807	2,639
hddv	1,277	2,285	2,095	2,153	2,605	2,308	2,849	2,933	2,812	2,838	2,731	2,561
lddt	NA	6	10	7	8	8	24	25	27	29	31	31
lddv	NA	15	31	33	33	32	36	38	39	43	45	46
OFF-HIGHWAY	1,825	2,724	2,387	2,537	2,599	2,649	2,723	2,826	2,855	2,843	2,769	2,852
Non-Road Gasoline	236	195	155	173	221	128	126	128	126	124	120	124
recreational	1	1	1	1	2	1	1	1	1	1	1	1
construction	19	14	8	7	6	3	3	3	3	3	3	3
industrial	38	30	28	24	135	78	77	80	79	78	76	78
lawn & garden	NA	14	12	11	13	8	7	7	7	7	7	7
farm	169	93	64	84	1	1	1	1	1	1	1	1
light commercial	NA	8	7	6	8	4	4	5	5	4	4	4
logging	NA	0	0	0	0	0	0	0	0	0	0	0
airport service	NA	4	3	3	4	2	3	3	3	3	3	3
recreational marine vessels	NA	19	19	24	39	22	22	21	20	20	19	20
other	9	11	12	12	14	8	8	7	7	7	7	7

(continued)

Table A-6. NOx Emissions from Transportation (cont'd)

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Non-Road Diesel	663	1,430	1,350	1,418	1,277	1,462	1,457	1,500	1,514	1,478	1,350	1,482
recreational	NA	0	0	0	0	0	0	0	0	0	0	0
construction	185	732	643	680	856	980	959	992	972	944	866	944
industrial	204	257	231	241	110	126	125	128	127	125	122	125
lawn & garden	NA	6	6	6	5	6	6	6	6	5	5	5
farm	274	340	352	367	181	207	216	214	242	230	187	230
light commercial	NA	20	21	21	19	22	22	23	23	22	22	22
logging	NA	4	5	5	5	5	6	6	6	7	7	6
airport service	NA	71	92	99	100	115	123	131	138	144	142	149
other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aircraft	122	126	121	134	161	132	136	139	136	139	142	144
Marine Vessels	99	146	168	172	181	148	155	164	168	173	177	177
coal	20	0	0	0	0	0	0	0	0	0	0	0
diesel	6	99	138	142	152	124	130	138	142	145	148	149
residual oil	73	47	30	30	29	23	25	26	27	27	28	28
Railroads	705	827	593	640	758	780	848	895	911	929	980	925
TOTAL TRANSPORTATION	9,252	11,429	10,483	10,484	10,712	10,283	10,591	10,803	10,558	10,659	10,484	10,329

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-7. NOx Emissions from Other Sources

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	271	216	145	161	159	380	370	397	394	398	400	401
Organic Chemical Mfg	70	54	56	57	29	38	38	42	42	42	42	41
Inorganic Chemical Mfg	201	159	89	104	22	19	17	18	18	19	19	18
Polymer & Resin Mfg	NA	NA	NA	NA	20	22	22	23	23	23	23	24
Agricultural Chemical Mfg	NA	NA	NA	NA	58	262	256	276	274	277	278	281
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	3	NA	NA	30	38	37	39	38	37	37	37
METALS PROCESSING	77	65	49	54	70	80	76	82	83	81	79	78
Nonferrous Metals Processing	NA	NA	NA	NA	15	26	26	28	28	27	26	26
Ferrous Metals Processing	77	65	49	54	54	53	48	53	54	53	51	51
Metals Processing NEC	NA	NA	NA	NA	1	1	1	1	1	1	1	1
PETROLEUM & RELATED INDUSTRIES	240	72	68	70	124	109	101	100	97	100	103	94
Oil & Gas Production	NA	NA	NA	NA	69	55	48	48	47	50	52	47
Petroleum Refineries & Related Ind	240	72	68	70	55	53	52	51	49	50	50	46
Asphalt Manufacturing	NA	NA	NA	NA	1	1	1	1	1	1	1	1
OTHER INDUSTRIAL PROCESSES	187	205	192	203	326	328	320	315	311	306	298	301
Agriculture, Food, & Kindred Products	NA	NA	NA	NA	5	5	5	5	5	5	5	5
Textiles, Leather, & Apparel Products	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Pub Products	18	24	25	26	73	76	76	76	77	77	76	77
Rubber & Misc. Plastic Products	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Mineral Products	169	181	167	177	239	238	230	225	220	216	209	210
cement mfg	97	98	92	101	137	136	130	126	124	121	117	118
glass mfg	48	60	57	57	47	48	47	46	45	44	42	43
other	24	23	18	19	54	54	53	53	51	51	49	50
Machinery Products	NA	NA	NA	NA	2	2	2	2	2	2	2	2
Transportation Equipment	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	NA	7	8	7	7	7	7	7	7

(continued)

Table A-8. VOC Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	30	45	43	45	41	30	34	37	37	36	33	32
Coal	18	31	34	37	33	24	25	27	27	27	27	27
Oil	7	9	5	4	4	4	5	7	7	5	3	2
Gas	5	5	4	4	2	2	2	2	2	2	2	2
Other	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Internal Combustion	NA	NA	NA	NA	1	1	1	1	1	1	1	1
FUEL COMB. INDUSTRIAL	150	157	150	156	115	270	265	290	284	284	289	279
Coal	4	3	3	3	7	7	7	7	7	7	7	7
Oil	4	3	2	2	16	16	16	16	16	16	16	16
Gas	77	62	54	59	39	194	191	215	210	210	216	206
Other	65	89	91	91	35	36	36	36	36	36	35	35
Internal Combustion	NA	NA	NA	NA	18	16	15	15	15	15	15	15
FUEL COMB. OTHER	541	848	912	917	1,491	499	482	470	452	437	426	394
Commercial/Institutional Coal	1	1	2	2	1	1	1	1	1	1	1	1
Commercial/Institutional Oil	4	3	2	2	4	4	4	4	4	4	4	4
Commercial/Institutional Gas	6	7	6	7	6	6	6	6	7	7	7	7
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	NA	4	4	4	4	4	4	4	4
Residential Wood	460	809	872	875	1,459	468	451	438	422	405	394	363
fireplaces	107	189	204	205	NA	NA	NA	NA	NA	NA	NA	NA
woodstoves	353	620	668	671	NA	NA	NA	NA	NA	NA	NA	NA
Residential Other	70	28	30	32	16	16	16	17	15	15	16	14
TOTAL FUEL COMBUSTION	722	1,050	1,105	1,118	1,647	800	782	797	774	756	748	706

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-7. NOx Emissions from Other Sources (cont'd)

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
SOLVENT UTILIZATION	NA	NA	NA	NA	2	3	3	3	3	2	2	3
Degreasing	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	NA	2	2	2	2	2	2	2	2
Other Industrial	NA	NA	NA	NA	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	NA	NA	NA	NA	3	3	3	3	3	3	4	3
Petroleum & Petroleum Prod Store	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Petroleum & Petroleum Prod Trans	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	NA	2	2	1	2	2	2	2	2
Inorganic Chemical Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	NA	0	0	0	1	1	1	1	1
WASTE DISPOSAL & RECYCLING	440	111	91	90	87	87	85	85	84	82	81	82
Incineration	110	37	24	24	27	29	29	31	31	32	32	32
Open Burning	330	74	67	66	59	58	56	54	52	50	49	50
Landfills	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other	NA	NA	NA	NA	0	0	0	0	0	0	0	0
MISCELLANEOUS	330	248	254	210	130	131	132	134	133	133	132	133
Other Combustion	330	248	254	210	130	131	132	134	133	133	132	133
TOTAL OTHER	1,545	917	799	788	901	1,120	1,088	1,120	1,108	1,107	1,098	1,095

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-9. VOC Emissions from Industrial Processes

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	1,341	1,595	1,548	1,620	881	1,640	1,633	1,752	1,748	1,771	1,778	1,758
Organic Chemical Mfg	629	884	843	909	349	635	624	674	678	684	686	676
ethylene oxide mfg	8	10	11	12	2	2	2	2	2	2	2	2
phenol mfg	NA	NA	NA	NA	0	0	0	0	0	0	0	0
terephthalic acid mfg	29	60	56	60	15	31	30	32	32	32	32	32
ethylene mfg	70	111	111	121	28	43	42	48	47	46	48	46
charcoal mfg	48	40	34	36	37	41	41	45	46	46	44	45
socmi reactor	81	118	121	138	43	169	167	181	186	187	187	183
socmi distillation	NA	NA	NA	NA	7	11	10	11	11	12	12	11
socmi air oxidation processes	NA	NA	NA	NA	0	2	2	2	2	2	2	2
socmi fugitives	194	254	233	251	173	180	177	191	190	192	192	192
other	199	291	278	293	43	156	152	162	161	165	166	162
Inorganic Chemical Mfg	65	93	67	77	3	36	35	39	38	38	39	38
Polymer & Resin Mfg	271	384	395	369	343	291	287	312	309	313	317	315
polypropylene mfg	0	1	1	1	12	14	13	15	15	15	15	15
polyethylene mfg	17	22	26	27	51	83	81	90	88	89	90	89
polystyrene resins	10	15	15	17	6	8	8	8	8	8	8	8
synthetic fiber	112	199	194	152	217	62	61	64	64	66	65	66
styrene/butadiene rubber	77	70	67	73	45	61	60	66	65	65	66	65
other	55	77	92	99	12	64	64	69	69	71	72	71
Agricultural Chemical Mfg	NA	NA	NA	NA	11	23	23	25	25	25	26	25
Paint, Varnish, Lacquer, Enamel Mfg	61	65	69	74	8	10	10	11	11	11	11	11
paint & varnish mfg	61	65	69	74	8	10	10	11	11	11	11	11
other	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	40	77	88	93	43	226	244	247	247	254	252	254
Other Chemical Mfg	275	92	85	98	125	420	411	443	440	446	448	440
carbon black mfg	275	92	85	98	26	25	24	26	26	27	27	26
printing ink mfg	NA	NA	NA	NA	2	13	13	13	13	13	13	14
fugitives unclassified	NA	NA	NA	NA	12	17	16	18	18	18	18	17
carbon black furnace: fugitives	NA	NA	NA	NA	4	4	4	5	5	5	5	5
other	NA	NA	NA	NA	81	360	353	381	378	383	384	377

(continued)

Table A-9. VOC Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
METALS PROCESSING	394	273	155	182	50	73	70	74	74	72	69	70
Nonferrous Metals Processing	NA	NA	NA	NA	10	19	18	19	20	20	19	19
Ferrous Metals Processing	394	273	155	182	40	54	51	54	54	52	50	50
coke oven door & topside leaks	216	152	85	101	9	12	11	12	12	11	10	10
coke oven by-product plants	NA	NA	NA	NA	3	3	3	3	3	3	3	3
other	177	121	70	81	28	39	37	39	39	38	37	37
Metals Processing NEC	NA	NA	NA	NA	0	0	0	0	0	0	0	0
PETROLEUM & RELATED INDUSTRIES	1,194	1,440	1,270	1,253	1,025	764	752	733	731	737	745	715
Oil & Gas Production	411	379	379	392	104	79	70	71	68	72	73	68
Petroleum Refineries & Related Ind	773	1,045	877	847	921	682	679	659	659	662	669	643
vaccuum distillation	24	32	30	30	11	14	14	13	13	13	13	12
cracking units	27	21	9	8	34	33	33	32	31	31	32	29
process unit turnarounds	NA	NA	NA	NA	9	14	14	13	13	14	14	13
petroleum refinery fugitives	NA	NA	NA	NA	67	131	129	120	124	126	127	119
other	721	992	838	809	800	490	489	480	479	478	484	471
Asphalt Manufacturing	11	16	15	14	1	3	3	3	3	3	3	3
OTHER INDUSTRIAL PROCESSES	270	237	245	227	264	445	460	479	476	478	475	475
Agriculture, Food, & Kindred Products	208	191	191	168	100	221	241	248	249	254	255	252
vegetable oil mfg	59	81	85	85	7	96	115	120	123	127	129	127
whiskey fermentation: aging	105	64	56	34	24	24	24	24	23	23	24	23
bakeries	45	46	50	49	51	52	51	52	51	51	50	50
other	NA	NA	NA	NA	19	50	51	52	52	52	53	52
Textiles, Leather, & Apparel Products	NA	NA	NA	NA	10	10	10	10	10	10	10	10
Wood, Pulp & Paper, & Pub Products	NA	NA	NA	NA	41	44	44	44	44	44	43	44
Rubber & Misc. Plastic Products	60	44	52	58	35	43	43	46	46	46	46	45
rubber tire mfg	60	44	52	58	8	10	10	11	11	11	11	10
green tire spray	NA	NA	NA	NA	4	5	5	6	6	6	6	6
other	NA	NA	NA	NA	23	28	28	29	29	29	29	29
Mineral Products	2	2	2	2	13	15	15	14	14	14	14	14
Machinery Products	NA	NA	NA	NA	3	4	4	4	4	3	3	3
Electronic Equipment	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	NA	NA	0	1	1	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	NA	61	108	103	112	109	106	103	106

(continued)

Table A-9. VOC Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
SOLVENT UTILIZATION	7,174	6,584	5,232	6,309	5,620	5,710	5,828	6,034	6,053	6,063	6,063	6,062
Degreasing	707	513	411	500	391	628	676	749	751	752	750	732
open top	NA	NA	NA	NA	21	28	28	29	29	28	27	28
conveyorized	NA	NA	NA	NA	3	5	5	5	4	4	4	4
cold cleaning	NA	NA	NA	NA	31	33	31	34	35	34	32	34
other	707	513	411	500	337	562	612	682	683	685	686	666
Graphic Arts	319	373	274	360	298	373	390	415	417	419	416	429
letterpress	NA	NA	NA	NA	1	2	2	2	2	2	2	2
flexographic	NA	NA	NA	NA	18	19	19	20	20	20	20	21
lithographic	NA	NA	NA	NA	4	4	4	4	4	4	4	4
gravure	NA	NA	NA	NA	60	138	140	148	150	151	150	154
other	319	373	274	360	215	211	225	241	241	241	240	248
Dry Cleaning	263	320	215	248	254	217	216	215	212	209	205	213
perchloroethylene	NA	NA	NA	NA	NA	110	110	109	107	105	103	107
petroleum solvent	NA	NA	NA	NA	NA	106	106	106	105	104	103	106
Surface Coating	3,570	3,685	3,006	3,655	2,319	2,602	2,606	2,646	2,635	2,619	2,598	2,616
industrial adhesives	52	55	45	58	12	353	353	366	375	383	391	384
fabrics	161	186	181	186	15	34	35	35	35	35	34	36
paper	652	626	503	631	295	109	110	114	114	114	113	115
large appliances	49	36	28	30	1	19	19	19	18	18	18	17
magnet wire	7	5	4	4	0	0	0	0	0	0	0	0
autos & light trucks	165	165	119	138	62	86	88	87	87	86	85	80
metal cans	49	73	68	65	18	96	95	96	95	95	94	90
metal coil	18	21	23	19	14	50	49	50	50	49	49	47
wood furniture	211	231	191	202	27	140	142	143	140	138	137	138
metal furniture	35	52	47	50	1	44	44	44	44	43	43	43
flatwood products	64	82	56	56	19	4	4	4	4	4	4	4
plastic parts	17	25	27	32	9	11	11	11	11	11	10	11
large ships	21	20	17	18	9	16	15	16	15	15	15	14
aircraft	1	2	2	3	23	29	26	31	34	33	31	33

(continued)

Table A-9. VOC Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
misc. metal parts	NA	NA	NA	NA	14	14	14	14	14	14	13	13
architectural	442	477	457	489	456	502	503	504	500	495	493	498
traffic markings	NA	NA	NA	NA	NA	106	106	107	106	105	104	106
maintenance coatings	108	106	76	91	NA	80	80	80	80	79	79	79
railroad	5	9	8	9	NA	3	3	3	3	3	3	3
auto refinishing	83	186	215	240	227	132	132	133	132	130	130	137
machinery	39	62	53	51	37	28	28	29	28	28	28	26
eletronic & other electrical	NA	NA	NA	NA	11	79	79	80	79	78	78	76
general	79	52	32	36	118	147	148	158	154	153	148	154
miscellaneous	942	799	518	861	85	109	108	105	103	98	93	98
thinning solvents	NA	NA	NA	NA	80	92	94	97	96	95	93	96
other	372	415	335	385	786	317	318	320	317	315	312	316
Other Industrial	640	690	555	690	456	172	173	175	170	164	160	161
miscellaneous	39	44	36	37	72	136	137	139	135	130	127	127
rubber & plastics mfg	309	327	264	350	378	29	29	29	29	28	28	28
other	292	319	255	303	6	7	6	6	6	6	6	6
Nonindustrial	1,674	1,002	771	856	1,901	1,717	1,768	1,834	1,867	1,900	1,934	1,911
cutback asphalt	1,045	323	216	198	192	175	186	199	199	199	199	200
pesticide application	241	241	205	258	NA	263	262	262	260	258	255	258
adhesives	NA	NA	NA	NA	NA	332	332	345	353	361	369	363
consumer solvents	NA	NA	NA	NA	NA	947	988	1,030	1,056	1,083	1,111	1,090
other	387	437	349	400	NA	NA	NA	NA	NA	NA	NA	NA
STORAGE & TRANSPORT	1,954	1,975	1,801	1,810	1,678	1,767	1,893	1,948	1,856	1,861	1,868	1,823
Bulk Terminals & Plants	599	517	418	416	424	620	632	652	651	658	646	624
fixed roof	14	12	10	9	11	14	14	15	15	15	15	15
floating roof	45	39	31	31	16	47	48	50	50	49	47	50
variable vapor space	1	1	0	0	1	1	1	1	1	1	1	1
efr with seals	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA
underground tanks	NA	0	0	0	NA	0	0	0	0	0	0	0
area source: gasoline	509	440	356	354	386	526	537	554	553	560	550	524
other	30	26	21	21	10	32	32	33	33	33	33	34

(continued)

Table A-9. VOC Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Petroleum & Petroleum Prod Storage	300	306	268	275	162	217	214	215	210	212	214	207
fixed roof gasoline	47	43	35	35	17	25	25	24	23	24	24	23
fixed roof crude	135	148	135	139	25	24	22	21	21	21	21	21
floating roof gasoline	49	45	36	36	22	26	26	25	24	25	25	24
floating roof crude	32	36	32	33	5	5	5	5	5	5	5	5
efr / seal gasoline	3	3	3	3	1	2	2	2	2	2	2	2
efr / seal crude	1	2	1	1	0	0	0	0	0	0	0	0
ifr / seal gasoline	1	1	1	1	1	1	1	1	1	1	1	1
ifr / seal crude	2	2	2	2	0	0	0	0	0	0	0	0
variable vapor space gasoline	3	3	2	2	1	1	1	1	2	2	2	1
other	25	23	22	23	89	132	131	135	132	133	134	131
Petroleum & Petroleum Prod Transport	92	61	42	46	73	123	123	125	125	125	125	125
gas loading: normal / splash	3	0	0	0	1	3	3	3	3	3	3	3
gas loading: balanced / submerged	20	2	1	1	5	20	21	21	22	21	20	21
gas loading: normal / submerged	39	3	2	2	18	41	40	41	42	42	42	42
gas loading: clean / submerged	2	0	0	0	1	2	2	2	2	2	2	2
marine vessel loading: gas & crude	26	50	35	38	24	23	23	23	22	22	23	23
other	2	6	4	5	24	34	34	35	35	35	35	35
Service Stations: Stage I	416	461	456	457	384	213	219	223	223	230	234	231
Service Stations: Stage II	521	583	564	560	616	400	511	522	441	428	436	429
Service Stations: Breathing & Emptying	NA	NA	NA	NA	NA	48	51	52	52	53	54	54
Organic Chemical Storage	26	46	53	57	16	129	127	142	139	139	142	137
Organic Chemical Transport	NA	NA	NA	NA	3	17	16	16	15	16	16	15
Inorganic Chemical Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
TOTAL INDUSTRIAL PROCESSES	12,326	12,103	10,250	11,402	9,518	10,399	10,637	11,019	10,938	10,982	10,999	10,903

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-10. VOC Emissions from Transportation

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
HIGHWAY VEHICLES	12,219	10,990	10,076	9,631	9,492	8,998	8,234	8,082	7,151	6,977	6,812	6,099
Light-Duty Gas Vehicles & Motorcycles	9,545	7,133	6,502	6,150	5,858	5,545	5,471	5,386	4,737	4,628	4,529	4,051
light-duty gas vehicles	9,442	7,133	6,502	6,150	5,858	5,545	5,471	5,386	4,737	4,628	4,529	NA
motorcycles	103	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Light-Duty Gas Trucks	1,652	2,486	2,451	2,425	2,558	2,548	2,004	1,943	1,729	1,677	1,630	1,447
ldgt1	1,140	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ldgt2	512	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	897	955	748	675	622	505	308	299	252	239	227	193
Diesels	125	416	375	381	455	399	451	455	433	433	426	409
hddv	125	409	364	370	443	388	432	434	410	408	398	380
lddt	NA	2	3	2	3	3	9	9	10	12	13	14
lddv	NA	5	8	8	9	9	10	12	12	14	15	15
OFF-HIGHWAY	1,392	2,315	2,129	2,349	2,247	2,298	2,249	2,227	2,178	2,120	2,060	2,127
Non-Road Gasoline	586	1,740	1,632	1,808	1,433	1,842	1,785	1,753	1,701	1,646	1,602	1,646
recreational	41	77	67	62	146	188	180	175	168	161	157	161
construction	27	22	11	11	28	37	35	37	36	35	32	35
industrial	114	69	59	56	60	77	76	79	78	77	75	77
lawn & garden	NA	828	785	839	648	834	805	782	756	728	711	728
farm	220	120	98	110	4	5	6	6	6	6	5	6
light commercial	NA	195	189	193	149	191	189	195	194	191	187	191
logging	NA	6	7	8	6	7	9	9	9	10	9	9
airport service	NA	4	5	5	5	6	6	7	7	7	7	8
recreational marine vessels	104	415	411	523	386	496	478	463	446	429	417	429
other	80	1	1	1	1	1	1	1	1	1	1	1
Non-Road Diesel	92	147	145	158	251	196	196	201	205	200	180	200
construction	15	25	22	23	150	122	119	124	121	118	108	118
industrial	20	23	20	22	20	15	15	15	15	15	14	15
lawn & garden	NA	1	1	1	1	1	1	1	1	1	1	1
farm	57	85	88	97	52	41	43	43	48	46	37	46
light commercial	NA	4	3	4	5	3	3	4	4	3	3	3
logging	NA	0	0	0	1	0	0	0	0	1	1	0
airport service	NA	10	11	12	23	13	14	15	16	17	17	17

(continued)

Table A-10. VOC Emissions from Transportation (cont'd)

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
Aircraft	275	199	177	190	288	191	194	195	192	192	193	199
Marine Vessels	260	28	35	38	50	34	35	38	39	39	40	41
coal	59	0	1	1	1	1	1	1	1	1	1	1
diesel	188	25	32	36	46	31	33	35	35	36	37	37
residual oil	13	3	2	2	3	2	2	2	2	3	3	3
Railroads	180	201	141	155	224	35	38	40	41	42	44	42
TOTAL TRANSPORTATION	13,611	13,305	12,205	11,980	11,739	11,296	10,483	10,310	9,328	9,097	8,872	8,226

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-11. VOC Emissions from Other Sources

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
WASTE DISPOSAL & RECYCLING	1,984	758	689	687	1,554	2,293	2,256	2,310	2,290	2,262	2,217	2,314
Incineration	548	366	329	331	62	63	61	60	59	57	56	57
Open Burning	1,424	372	337	331	309	304	292	284	274	263	256	263
industrial	NA	NA	NA	NA	6	6	6	6	6	6	6	6
commmercial/institutional	NA	NA	NA	NA	1	1	1	2	2	2	2	2
residential	NA	NA	NA	NA	302	297	285	277	266	256	249	256
other	1,424	372	337	331	NA	NA	NA	NA	NA	NA	NA	NA
POTW	NA	NA	NA	NA	10	11	11	11	11	11	11	11
Industrial Waste Water	NA	NA	NA	NA	1	2	1	2	2	2	2	2
TSDF	NA	NA	NA	NA	1,171	1,913	1,890	1,953	1,945	1,929	1,893	1,981
Landfills	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other	11	20	23	25	0	0	0	0	0	0	0	0
MISCELLANEOUS	1,101	1,134	1,162	951	554	561	567	585	579	577	568	577
Other Combustion	1,101	1,134	1,162	951	554	561	566	584	579	576	567	577
structural fires	19	40	36	36	44	44	44	44	44	44	44	44
agricultural fires	131	70	68	68	55	61	67	85	79	77	68	77
slash/prescribed burning	147	285	285	285	293	293	293	293	293	293	293	293
forest wildfires	770	739	772	561	162	162	162	162	162	162	162	162
other	34	1	1	0	NA	0	0	0	0	0	0	0
Health Services	NA	NA	NA	NA	0	1	0	1	1	1	1	1
TOTAL OTHER	3,085	1,892	1,851	1,637	2,108	2,855	2,823	2,895	2,869	2,839	2,785	2,892

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-12. SO2 Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	17,398	17,483	15,451	16,023	16,243	15,701	15,715	15,990	16,218	15,871	15,784	15,841
Coal	15,799	NA	14,608	15,315	NA	14,860	15,034	15,224	15,408	15,201	15,101	15,270
bituminous	9,574	NA	8,863	9,291	NA	13,454	13,513	13,546	13,576	13,342	13,203	13,382
subbituminous	4,716	NA	4,366	4,577	NA	1,048	1,182	1,311	1,423	1,421	1,381	1,371
anthracite and lignite	1,509	NA	1,380	1,446	NA	357	338	368	409	438	517	517
Oil	1,598	NA	842	707	NA	811	651	734	779	639	652	541
residual	1,578	NA	833	692	NA	799	640	722	765	629	642	533
distillate	20	NA	10	15	NA	12	11	12	14	10	10	8
Gas	1	NA	1	1	NA	1	1	1	1	1	1	1
Internal Combustion	NA	NA	NA	NA	NA	30	29	31	30	31	30	30
FUEL COMB. INDUSTRIAL	4,568	2,951	2,523	2,723	3,169	3,116	3,068	3,111	3,086	3,106	3,139	3,090
Coal	3,129	1,527	1,695	1,805	1,818	1,828	1,817	1,856	1,840	1,843	1,821	1,843
bituminous	2,171	1,058	1,177	1,254	1,345	1,374	1,373	1,393	1,383	1,380	1,356	1,381
subbituminous	669	326	363	386	28	29	29	29	29	29	28	29
anthracite and lignite	289	144	155	165	90	82	72	79	79	80	80	80
other	NA	NA	NA	NA	355	343	343	355	350	353	357	353
Oil	1,229	1,065	528	597	866	831	811	809	815	827	878	820
residual	956	851	397	464	670	637	617	614	625	633	684	633
distillate	98	85	63	69	111	109	106	108	107	108	109	108
other	175	129	67	64	84	86	87	87	83	86	85	79
Gas	140	299	251	264	389	363	349	354	339	345	350	337
Other	70	60	49	57	89	87	85	86	85	85	84	84
Internal Combustion	NA	NA	NA	NA	7	6	6	6	6	6	6	6

(continued)

Table A-12. SO2 Emissions from Fuel Combustion (cont'd)

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. OTHER	1,490	971	699	728	578	611	663	660	623	597	608	589
Commercial/Institutional Coal	109	110	183	195	158	161	164	172	169	176	180	166
Commercial/Institutional Oil	883	637	314	312	239	267	310	295	274	233	237	237
Commercial/Institutional Gas	1	1	1	1	2	2	2	2	2	2	2	2
Misc. Fuel Comb. (Except Res.)	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Residential Wood	6	13	14	14	11	11	10	10	10	9	9	8
Residential Other	492	211	188	206	168	169	175	180	167	175	179	174
distillate oil	212	157	115	131	128	129	134	137	132	137	139	140
bituminous/subbituminous coal	260	43	59	63	30	30	32	33	27	30	30	26
other	20	11	13	13	10	10	10	10	8	9	9	8
TOTAL FUEL COMBUSTION	23,456	21,405	18,673	19,473	19,990	19,428	19,445	19,761	19,926	19,574	19,532	19,520

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-13. SO2 Emissions from Industrial Processes
(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	591	280	216	229	441	417	410	433	423	424	426	419
Organic Chemical Mfg	NA	NA	NA	NA	16	16	17	19	17	17	17	17
Inorganic Chemical Mfg	591	271	202	212	354	329	322	341	334	333	335	329
sulfur compounds	591	271	202	212	351	326	320	339	332	331	333	327
other	NA	NA	NA	NA	2	2	2	2	2	2	2	2
Polymer & Resin Mfg	NA	NA	NA	NA	7	7	6	7	7	7	7	7
Agricultural Chemical Mfg	NA	NA	NA	NA	4	4	4	4	4	4	4	4
Pharmaceutical Mfg	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	10	14	16	60	61	61	62	61	62	63	61
METALS PROCESSING	4,775	1,842	1,352	1,387	1,042	888	946	1,032	987	908	874	868
Nonferrous Metals Processing	4,060	1,279	1,033	1,004	857	714	781	857	809	735	709	701
copper	3,507	1,080	819	779	655	525	596	667	619	546	529	519
lead	77	34	53	40	119	111	110	112	112	111	105	108
aluminum	80	95	68	83	16	15	15	14	14	15	15	14
other	396	71	93	102	66	62	60	63	64	63	61	60
Ferrous Metals Processing	715	562	318	383	172	161	153	162	165	160	152	154
Metals Processing NEC	NA	NA	NA	NA	14	13	11	12	13	13	13	12
PETROLEUM & RELATED IND.	881	734	719	707	505	469	445	443	429	440	444	411
Oil & Gas Production	111	157	185	166	204	176	155	159	156	164	167	154
natural gas	111	157	185	166	202	175	154	157	155	163	165	153
other	NA	NA	NA	NA	2	1	1	1	1	1	1	1
Petroleum Refineries & Related Ind.	770	577	534	541	300	291	289	283	272	274	276	256
fluid catalytic cracking units	480	330	296	310	212	207	207	202	195	196	197	181
other	290	247	239	231	88	84	82	81	77	78	79	75
Asphalt Manufacturing	NA	NA	NA	NA	1	1	1	1	1	1	1	1

(continued)

Table A-13. SO2 Emissions from Industrial Processes (cont'd)

(thousand short tons)

Industrial Processes	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
OTHER INDUSTRIAL PROCESSES	846	918	860	923	425	427	418	411	405	401	391	397
Agriculture, Food, & Kindred Prod.	NA	NA	NA	NA	3	3	3	3	3	3	3	3
Textiles, Leather, & Apparel Prod.	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing	169	223	234	245	131	135	135	135	136	137	137	139
Rubber & Misc. Plastic Prod	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Mineral Products	677	694	626	678	286	285	276	268	261	257	247	251
cement mfg	618	630	571	621	192	190	183	177	172	169	163	166
other	59	64	55	57	95	95	93	91	89	87	84	85
Machinery Products	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Electronic Equipment	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Misc. Industrial Processes	NA	NA	NA	NA	3	3	3	3	3	3	2	3
SOLVENT UTILIZATION	0	0	0	0	1	1	1	1	1	1	1	1
Degreasing	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Other Industrial	NA	NA	NA	NA	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	NA	NA	NA	NA	19	19	19	21	21	21	21	21
Petroleum Product Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Petroleum Product Transport	NA	NA	NA	NA	1	1	1	1	1	1	1	1
Organic Chemical Storage	NA	NA	NA	NA	16	16	16	17	17	17	17	17
Inorganic Chemical Storage	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	NA	1	2	2	2	2	2	2	2
TOTAL INDUSTRIAL PROCESSES	7,093	3,773	3,146	3,246	2,433	2,221	2,239	2,340	2,266	2,194	2,157	2,116

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are *provided in section 5.0.*

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-14. SO2 Emissions from Other Sources

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985*	1986	1987	1988	1989	1990	1991	1992
WASTE DISPOSAL & RECYCLING	8	33	25	25	34	35	35	36	36	36	36	36
Incineration	4	21	14	14	25	26	26	28	28	29	29	29
Open Burning	4	12	11	11	9	8	8	8	8	7	7	7
Landfills	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Other	NA	NA	NA	NA	0	0	0	0	0	0	0	0
HIGHWAY VEHICLES	279	458	483	507	575	562	656	697	704	743	770	785
Light-Duty Gas Vehicles	128	159	173	179	179	185	197	208	212	223	232	237
Light-Duty Gas Trucks	28	55	62	67	74	81	69	72	74	78	80	82
Heavy-Duty Gas Vehicles	10	16	14	13	13	11	9	10	10	12	10	11
Diesels	113	229	234	248	309	285	381	408	408	431	447	456
OFF-HIGHWAY	379	531	391	403	353	227	240	254	259	265	274	271
Non-Road Gasoline	11	7	6	6	10	NA	NA	NA	NA	NA	NA	NA
Non-Road Diesel	50	75	74	78	83	NA	NA	NA	NA	NA	NA	NA
Aircraft	10	14	14	16	14	7	7	7	7	7	7	8
Marine Vessels	170	301	204	204	155	163	171	181	186	190	195	196
Railroads	138	133	92	99	91	57	62	65	66	68	71	67
MISCELLANEOUS	110	11	10	9	4	4	4	4	4	4	4	4
Other Combustion	110	11	10	9	4	4	4	4	4	4	4	4
TOTAL OTHER	776	1,033	909	944	966	828	935	991	1,004	1,049	1,084	1,096

NOTE(S): *Methodologies to estimate 1984, 1985, and 1986 emission estimates differ. Because of these differences, the allocation of emissions among source categories could result in significant changes in the emission estimates between the years, particularly at the more detailed source category level. Details on the different methodologies are provided in section 5.0.

NA = not available. For several source categories, emission estimates either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emission estimates that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

Table A-15. Pb Emissions from Fuel Combustion
(short tons)

Fuel Combustion Sources	1970	1975	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	327	230	129	87	88	64	69	64	66	67	64	61	62
Coal	300	189	95	67	71	51	50	48	46	46	46	46	48
bituminous	181	114	57	40	43	31	30	29	28	28	28	28	29
subbituminous	89	56	28	20	21	15	15	14	14	14	14	14	14
anthracite, lignite	30	19	9	6	7	5	5	5	4	4	4	4	5
Oil	28	41	34	20	17	13	19	16	20	21	18	15	14
residual	27	40	34	20	17	13	19	16	20	21	18	15	14
distillate	0	1	0	0	0	0	0	0	0	0	0	0	0
FUEL COMB. INDUSTRIAL	237	75	60	29	29	30	25	22	19	18	18	18	17
Coal	218	60	45	21	21	22	17	14	14	14	14	15	15
bituminous	146	40	31	14	14	15	12	10	10	10	10	10	10
subbituminous	45	12	10	4	4	5	4	3	3	3	3	3	3
anthracite, lignite	27	7	4	2	2	2	2	1	1	1	1	1	1
Oil	19	16	14	8	8	8	8	8	5	4	3	3	2
residual	17	14	14	8	8	7	7	7	5	3	3	2	1
distillate	1	1	1	1	1	1	1	1	1	1	1	1	1
FUEL COMB. OTHER	10,052	10,042	4,111	549	424	421	422	425	426	420	418	416	416
Commercial/Institutional Coal	1	16	12	6	7	6	6	5	5	4	4	3	3
bituminous	1	6	6	4	5	4	4	3	3	3	3	2	2
subbituminous	NA	2	2	1	1	1	1	1	1	1	1	1	1
anthracite, lignite	NA	7	4	1	1	1	1	1	1	1	0	0	0
Commercial/Institutional Oil	4	11	10	5	4	4	5	5	5	4	4	4	4
residual	3	10	9	4	3	3	4	4	4	3	3	3	3
distillate	NA	1	1	1	1	1	1	1	1	1	1	1	1
other	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Misc. Fuel Comb. (Ex. Res)	10,000	10,000	4,080	528	400	400	400	400	400	400	400	400	400
Residential Other	47	16	9	10	13	11	11	14	16	12	10	9	9
TOTAL FUEL COMBUSTION	10,616	10,347	4,299	664	541	515	516	510	511	505	500	495	494

NOTE(S): NA = not available

Table A-16. Pb Emissions from Industrial Processes

(short tons)

Industrial Processes	1970	1975	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	103	120	104	139	133	118	108	123	136	136	136	132	140
Inorganic Chemical Mfg	103	120	104	139	133	118	108	123	136	136	136	132	140
lead oxide and pigments	103	120	104	139	133	118	108	123	136	136	136	132	140
METALS PROCESSING	24,224	9,923	3,026	2,025	1,919	2,097	1,820	1,818	1,917	2,153	2,138	1,939	2,069
Nonferrous Metals Processing	15,869	7,192	1,826	1,366	1,244	1,376	1,161	1,204	1,248	1,337	1,409	1,258	1,323
primary lead product	12,134	5,640	1,075	924	709	874	660	673	684	715	728	623	628
primary copper product	242	171	20	18	20	19	16	16	17	19	19	19	20
primary zinc product	1,019	224	24	15	17	16	11	7	8	9	9	11	11
secondary lead product	1,894	821	481	232	304	288	296	347	353	433	449	414	470
second copper product	374	200	116	73	79	70	63	31	61	37	75	65	63
lead battery mfg	41	49	50	62	67	65	66	73	73	74	78	77	81
lead cable coating	127	55	37	29	34	43	47	56	50	50	50	48	50
other	38	32	24	12	15	3	2	1	1	1	1	1	1
Ferrous Metals Processing	7,395	2,196	911	504	530	577	553	499	554	582	576	517	561
coke manufacturing	11	8	6	3	4	3	3	3	4	4	4	3	3
ferroalloy production	219	104	13	3	3	7	13	14	14	20	18	14	17
iron production	266	93	38	22	23	21	16	17	18	19	18	16	18
steel production	3,125	1,082	481	216	219	209	200	128	157	138	138	145	145
gray iron production	3,773	910	373	260	282	336	320	337	361	401	397	339	378
Metals Processing NEC	960	535	289	156	144	144	107	115	115	234	153	163	186
metal mining	353	268	207	147	129	141	106	114	114	234	153	163	185
other	606	268	82	9	15	3	1	1	1	1	1	1	1
OTHER INDUSTRIAL PROCESSES	2,028	1,337	808	529	483	316	199	202	172	173	169	167	139
Mineral Products	540	217	93	44	48	43	25	28	23	23	26	24	24
cement manufacturing	540	217	93	44	48	43	25	28	23	23	26	24	24
Misc Industrial Processes	1,488	1,120	715	485	435	273	174	174	149	150	143	143	115
TOTAL INDUSTRIAL PROCESSES	26,354	11,381	3,938	2,693	2,535	2,531	2,128	2,143	2,224	2,461	2,443	2,238	2,348

NOTE(S): NA = not available

Table A-17. Pb Emissions from Other Sources

(short tons)

Other Source Categories	1970	1975	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
WASTE DISPOSAL & RECYCLING	2,200	1,595	1,210	906	901	871	844	844	817	765	804	582	742
Incineration	2,200	1,595	1,210	906	901	871	844	844	817	765	804	582	742
municipal waste	581	396	161	79	74	79	52	52	49	45	67	55	59
other	1,619	1,199	1,049	828	828	792	792	792	768	720	738	528	683
HIGHWAY VEHICLES	171,961	130,206	62,189	42,696	35,930	15,978	3,589	3,121	2,700	2,161	1,690	1,519	1,383
Light-Duty Gas Vehicles & MC	142,918	106,868	48,501	33,096	27,737	12,070	2,689	2,325	2,018	1,614	1,263	1,135	1,033
Light-Duty Gas Trucks	22,683	19,440	11,996	8,623	7,448	3,595	841	748	637	512	400	364	331
Heavy-Duty Gas Vehicles	6,361	3,898	1,692	976	745	313	59	48	44	36	28	20	19
OFF-HIGHWAY	8,340	5,012	3,320	2,273	2,310	229	219	222	211	207	197	180	207
Non-Road Gasoline	8,340	5,012	3,320	2,273	2,310	229	219	222	211	207	197	180	207
TOTAL OTHER	182,501	136,813	66,719	45,875	39,141	17,078	4,652	4,187	3,728	3,133	2,692	2,281	2,333

NOTE(S): NA = not available

Table A-18. PM-10 Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1970	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
FUEL COMB. ELEC. UTIL.	246	190	145	147	146	153	155	165	171	167	163	165
Coal	150	107	109	116	121	119	125	132	133	135	135	139
bituminous	89	65	66	70	73	72	76	80	81	82	82	84
subbituminous	44	32	33	35	36	36	37	39	40	40	40	42
anthracite and lignite	17	10	10	11	11	11	12	12	13	13	13	13
Oil	89	76	31	26	20	30	25	32	33	28	24	22
residual	85	74	31	26	20	29	25	32	32	27	23	21
distillate	3	2	0	1	1	1	1	0	1	1	1	1
Gas	7	7	5	5	5	4	5	1	4	4	4	4
FUEL COMB. INDUSTRIAL	641	679	610	615	605	603	601	568	581	487	477	463
Coal	83	18	16	18	19	20	19	20	20	20	20	20
bituminous	52	12	11	13	13	13	13	14	14	14	14	14
subbituminous	16	4	3	4	4	4	4	4	4	4	4	4
anthracite and lignite	15	2	2	2	2	2	2	2	2	2	2	2
Oil	89	67	33	34	34	33	32	12	16	14	12	9
residual	83	63	30	32	31	30	28	10	14	11	10	6
distillate	6	4	3	3	3	3	3	3	3	3	3	3
other	0	0	0	0	0	0	0	0	0	0	0	0
Gas	27	23	19	21	20	20	19	22	24	25	25	26
natural	24	20	17	18	17	17	16	19	20	22	21	22
process	4	3	3	3	3	3	3	3	4	4	4	4
Other	441	571	541	542	532	531	531	513	521	427	420	408
wood/bark waste	415	566	538	538	529	528	528	510	517	424	417	405
other	26	5	3	4	2	3	3	3	4	3	3	3
FUEL COMB. OTHER	455	887	962	975	865	874	884	864	893	509	496	466
Commercial/Institutional Coal	13	8	7	7	6	6	7	7	6	6	5	5
Commercial/Institutional Oil	52	30	13	13	12	14	14	11	12	12	11	10
Commercial/Institutional Gas	4	4	2	2	2	2	2	2	2	2	2	2
Residential Wood	384	818	916	927	821	828	835	824	848	469	457	429
fireplaces	90	191	214	217	192	194	195	193	199	110	107	100
woodstoves	294	626	701	710	629	634	640	631	650	359	350	328
Residential Other	3	27	25	26	24	25	26	20	24	21	21	20
TOTAL FUEL COMBUSTION	1,342	1,756	1,717	1,737	1,617	1,631	1,640	1,597	1,644	1,163	1,135	1,095

NOTE(S): NA = not available
Zero values represent less than 500 short tons/year.

Table A-19. PM-10 Emissions from Transportation

(thousand short tons)

Transportation Sources	1970	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
HIGHWAY VEHICLES	960	1,112	1,042	1,087	1,177	1,176	1,301	1,378	1,396	1,477	1,528	1,558
Light-Duty Gas Vehicles & MC	644	602	540	559	558	578	616	648	662	697	724	739
ldgv	639	594	540	559	558	578	616	648	662	697	724	739
motorcycles	4	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Light-Duty Gas Trucks	104	158	145	156	172	187	160	167	171	180	187	190
ldgt1	86	91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ldgt2	18	67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	71	61	56	53	50	44	35	38	38	46	41	42
Diesels	141	291	302	319	397	366	490	524	526	554	575	586
hddv	141	279	276	295	371	341	454	487	487	514	533	544
lddt	NA	3	6	4	5	5	13	14	14	15	15	16
lddv	NA	9	20	21	21	20	22	24	24	25	26	27
OFF-HIGHWAY	273	273	252	260	268	277	270	285	281	279	269	272
Non-Road Gasoline	12	10	9	9	9	9	9	9	8	8	7	8
recreational	2	3	3	2	2	2	2	2	2	2	2	2
construction	1	1	0	0	1	1	1	1	1	1	1	1
industrial	3	2	2	1	1	1	1	1	2	2	2	2
farm	6	3	2	3	3	3	3	2	2	2	2	2
other	1	2	2	2	2	2	2	2	2	2	2	2
Non-Road Diesel	70	93	94	98	106	111	105	117	112	111	110	111
construction	14	19	17	17	20	23	20	22	21	23	22	23
industrial	18	17	16	16	14	13	13	13	17	15	15	13
farm	38	57	61	64	73	76	71	82	74	73	72	75
Aircraft	109	82	81	82	82	88	85	85	87	86	79	81
Marine Vessels	16	31	28	28	29	30	32	32	33	34	35	36
diesel	7	11	15	15	17	18	20	21	21	20	20	21
residual oil	8	20	13	13	12	12	12	12	12	14	15	15
Railroads	65	58	40	43	40	39	40	41	41	41	38	36
TOTAL TRANSPORTATION	1,232	1,385	1,294	1,347	1,445	1,453	1,571	1,662	1,677	1,757	1,797	1,830

NOTE(S): NA = not available

Zero values represent less than 500 short tons/year.

Table A-20. PM-10 Emissions from Other Sources
(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	235	148	121	143	125	95	99	82	107	115	113	121
Organic Chemical Mfg	43	19	19	19	19	15	17	17	16	17	16	17
Inorganic Chemical Mfg	61	25	10	13	13	11	12	13	12	12	12	12
Agricultural Chemical Mfg	46	61	55	67	48	34	32	10	34	41	42	43
Other Chemical Mfg	86	42	37	44	45	35	38	43	45	45	43	48
METALS PROCESSING	1,316	622	375	419	401	354	378	356	414	409	392	416
Nonferrous Metals Processing	593	130	92	99	92	79	81	73	87	83	84	88
copper	343	32	27	28	29	30	32	25	31	28	27	28
lead	53	18	14	13	12	11	12	12	14	14	13	14
zinc	20	3	2	2	3	3	3	1	3	3	3	3
other	177	77	49	56	47	35	34	35	39	38	41	43
Ferrous Metals Processing	198	322	178	195	190	168	174	163	198	196	172	187
primary	31	271	147	161	149	129	133	120	148	147	129	139
secondary	167	51	32	34	41	39	42	44	50	50	43	48
Metals Processing NEC	525	170	104	125	120	107	122	119	129	130	136	141
PETROLEUM & RELATED INDUSTRIES	286	138	119	124	120	123	126	121	117	123	118	119
Petroleum Refineries & Related Ind	69	41	26	21	16	14	12	12	13	13	13	13
fluid catalytic cracking units	69	41	26	21	16	14	12	12	13	13	13	13
Asphalt Manufacturing	217	97	93	102	104	110	114	108	104	110	105	106
OTHER INDUSTRIAL PROCESSES	5,832	1,846	1,365	1,633	1,445	1,340	1,269	1,347	1,314	1,328	1,251	1,284
Agriculture, Food, & Kindred Prod	485	402	303	442	475	448	400	406	390	405	365	360
country elevators	257	258	181	275	299	275	244	249	249	260	221	220
terminal elevators	147	86	68	104	113	104	92	94	94	98	83	83
feed mills	5	3	2	3	3	6	3	3	3	2	2	2
soybean mills	25	22	23	28	27	33	32	32	16	16	29	25
wheat mills	5	1	1	1	1	1	1	1	1	1	2	2
other grain mills	9	6	2	4	5	3	3	2	3	3	4	6
other	38	26	25	27	26	26	26	25	24	24	24	24
Wood, Pulp & Paper, & Pub Product	727	183	147	168	167	148	153	160	139	140	141	145
sulfate (kraft) pulping	668	142	109	125	124	100	103	114	89	90	92	95
other	59	41	38	43	43	48	51	46	50	50	49	50

(continued)

Table A-20. PM-10 Emissions from Other Sources (cont'd)

(thousand short tons)

Other Source Categories	1970	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Mineral Products	4,620	1,261	915	1,023	803	744	716	782	784	783	745	779
cement mfg	1,731	417	269	303	287	230	216	229	232	226	212	217
surface mining	134	127	124	142	131	131	131	134	142	150	144	149
stone quarrying/processing	957	421	357	396	206	235	233	282	280	274	255	275
other	1,798	296	166	182	179	148	137	137	131	133	134	137
WASTE DISPOSAL & RECYCLING	999	273	228	226	226	219	219	219	219	221	216	252
Incineration	229	75	48	49	49	44	44	44	44	43	40	43
residential	51	42	40	40	40	39	39	39	39	38	38	38
other	178	32	8	9	9	5	5	4	4	5	2	5
Open Burning	770	198	180	177	177	175	175	175	175	178	177	209
other	770	198	180	177	177	175	175	175	175	178	177	209
MISCELLANEOUS	839	852	871	724	45,478	50,497	42,775	60,890	53,885	45,728	50,320	46,309
Other Combustion	839	852	871	724	801	597	732	1,055	721	961	784	808
wildfires	385	514	537	390	469	265	400	725	393	634	456	482
managed burning	390	315	314	314	314	314	314	314	314	314	314	314
other	64	23	20	20	18	18	18	16	15	13	14	12
Fugitive Dust	NA	NA	NA	NA	44,677	49,901	42,043	59,835	53,163	44,767	49,536	45,501
wind erosion	NA	NA	NA	NA	3,565	9,390	1,457	17,509	11,826	4,192	10,125	4,658
unpaved roads	NA	NA	NA	NA	14,709	14,661	13,948	15,615	15,335	15,649	14,254	15,167
paved roads	NA	NA	NA	NA	6,563	6,814	7,132	7,616	7,403	7,533	8,150	7,901
other	NA	NA	NA	NA	19,840	19,036	19,505	19,096	18,600	17,393	17,006	17,775
TOTAL OTHER	9,507	3,878	3,080	3,269	47,795	52,629	44,867	63,015	56,055	47,924	52,410	48,502

NOTE(S): NA = not available

Zero values represent less than 500 short tons/year.

APPENDIX B

REGIONAL EMISSION ESTIMATES (1985 TO 1992)

Table B-1. Regional Emission Estimates of CO

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	5.09	4.81	4.43	4.34	3.97	4.13	4.07	4.05
II	7.64	7.67	7.25	6.90	6.49	6.33	6.16	6.17
III	10.43	10.46	9.73	9.75	9.12	8.96	8.78	8.48
IV	21.21	21.29	19.99	20.06	18.81	18.74	18.47	17.59
V	21.61	20.22	18.91	18.98	17.60	17.68	17.38	16.17
VI	14.87	14.69	14.14	14.21	13.21	12.81	12.43	12.08
VII	5.51	5.34	5.11	5.09	4.91	4.81	4.72	4.37
VII	5.23	4.72	4.23	4.14	3.89	3.78	3.67	3.74
IX	10.46	10.16	10.00	10.03	9.89	9.62	9.49	9.29
X	5.87	5.55	5.52	5.56	5.51	5.53	5.51	5.24
Total	107.90	104.89	99.30	99.07	93.39	92.38	90.68	87.18

Table B-2. Regional Emission Estimates of NOx

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	0.63	0.72	0.68	0.69	0.67	0.68	0.67	0.66
II	1.16	1.22	1.23	1.23	1.23	1.21	1.17	1.14
III	2.39	2.26	2.28	2.34	2.35	2.28	2.23	2.22
IV	4.28	4.42	4.52	4.67	4.60	4.66	4.67	4.48
V	4.62	4.51	4.61	4.74	4.68	4.74	4.71	4.60
VI	4.42	4.46	4.47	4.74	4.71	4.73	4.74	4.63
VII	1.48	1.36	1.43	1.50	1.49	1.51	1.49	1.46
VII	0.98	0.93	0.99	1.07	1.05	1.07	1.07	1.27
IX	1.85	1.82	1.96	2.01	2.02	1.99	1.98	2.00
X	0.63	0.58	0.64	0.66	0.67	0.68	0.69	0.68
Total	22.42	22.28	22.81	23.63	23.48	23.56	23.41	23.15

Table B-3. Regional Emission Estimates of VOC

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	1.11	0.99	0.95	0.95	0.87	0.87	0.86	0.86
II	1.81	1.80	1.76	1.74	1.64	1.59	1.55	1.55
III	2.48	2.71	2.63	2.66	2.53	2.50	2.44	2.43
IV	4.91	5.32	5.20	5.25	5.00	4.97	4.92	4.67
V	4.69	4.47	4.34	4.37	4.16	4.12	4.06	3.92
VI	4.12	4.72	4.60	4.74	4.51	4.46	4.45	4.29
VII	1.19	1.19	1.16	1.18	1.14	1.12	1.10	1.06
VII	0.82	0.73	0.69	0.69	0.66	0.65	0.65	0.70
IX	2.87	2.51	2.49	2.53	2.49	2.46	2.45	2.34
X	1.00	0.90	0.91	0.92	0.91	0.92	0.92	0.90
Total	25.01	25.35	24.72	25.02	23.91	23.67	23.40	22.73

Table B-4. Regional Emission Estimates of SO2

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	0.60	0.61	0.58	0.63	0.63	0.57	0.55	0.51
II	0.86	0.84	0.86	0.87	0.89	0.87	0.83	0.79
III	3.26	3.32	3.38	3.46	3.46	3.35	3.48	3.47
IV	5.35	5.50	5.51	5.63	5.67	5.75	5.73	5.60
V	7.20	7.10	6.96	7.05	7.08	6.98	6.91	6.89
VI	2.49	2.12	2.13	2.16	2.22	2.20	2.21	2.19
VII	1.71	1.52	1.60	1.56	1.55	1.47	1.41	1.41
VII	0.66	0.42	0.41	0.45	0.45	0.45	0.49	0.69
IX	1.00	0.82	0.94	1.03	1.00	0.92	0.91	0.91
X	0.25	0.21	0.24	0.24	0.25	0.25	0.26	0.27
Total	23.39	22.48	22.62	23.09	23.19	22.82	22.77	22.73

Table B-5. Regional Emission Estimates of Pb

(thousand short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	0.93	0.30	0.28	0.24	0.22	0.19	0.17	0.17
II	1.54	0.54	0.50	0.44	0.38	0.35	0.26	0.30
III	1.83	0.59	0.52	0.47	0.41	0.37	0.32	0.32
IV	3.57	1.16	1.11	1.07	1.00	0.93	0.86	0.87
V	3.98	1.68	1.55	1.53	1.45	1.40	1.24	1.32
VI	2.58	0.87	0.81	0.74	0.68	0.64	0.60	0.60
VII	1.88	1.00	0.99	0.98	1.08	0.99	0.86	0.89
VII	0.74	0.27	0.26	0.24	0.23	0.21	0.19	0.20
IX	2.39	0.68	0.64	0.57	0.50	0.42	0.39	0.38
X	0.68	0.21	0.19	0.17	0.15	0.13	0.13	0.12
Total	20.12	7.30	6.84	6.46	6.10	5.63	5.01	5.18

Table B-6. Regional Emission Estimates of PM-10 from Point and Fugitive Process Sources

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	0.18	0.19	0.19	0.18	0.19	0.16	0.16	0.16
II	0.23	0.24	0.25	0.24	0.25	0.22	0.22	0.22
III	0.51	0.54	0.57	0.56	0.57	0.52	0.51	0.51
IV	1.30	1.21	1.23	1.27	1.31	1.12	1.10	1.12
V	1.28	1.31	1.32	1.35	1.36	1.31	1.26	1.29
VI	0.67	0.57	0.58	0.60	0.64	0.58	0.58	0.59
VII	0.46	0.42	0.42	0.51	0.48	0.41	0.40	0.41
VII	0.34	0.25	0.26	0.50	0.28	0.27	0.26	0.27
IX	0.81	0.72	0.83	0.80	0.78	0.71	0.70	0.71
X	0.39	0.37	0.40	0.42	0.35	0.76	0.62	0.65
Total	6.18	5.81	6.04	6.44	6.21	6.08	5.81	5.93

Table B-7. Regional Emission Estimates of PM-10 from Fugitive Dust Sources

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	1.50	1.41	1.42	1.43	1.26	1.20	1.18	1.16
II	2.45	2.22	2.22	1.93	1.89	1.77	1.75	1.55
III	2.45	2.33	2.47	2.41	2.30	2.34	2.44	2.42
IV	6.24	6.17	6.50	6.86	6.69	5.97	6.67	6.70
V	7.85	7.46	7.47	7.38	6.82	6.92	6.73	6.39
VI	8.98	15.52	8.54	22.26	18.97	12.68	12.49	11.82
VII	4.99	5.12	4.25	7.33	6.26	5.38	8.28	6.21
VII	3.53	3.07	3.17	4.20	3.33	3.12	3.36	3.88
IX	4.48	4.50	3.84	4.02	3.60	3.20	3.61	2.84
X	2.20	2.11	2.16	2.03	2.04	2.18	3.02	2.52
Total	44.68	49.90	42.04	59.84	53.16	44.77	49.54	45.50

Table B-8. Regional Emission Estimates of PM-10

(million short tons)

Region	1985	1986	1987	1988	1989	1990	1991	1992
I	1.68	1.60	1.61	1.61	1.45	1.37	1.34	1.32
II	2.68	2.45	2.47	2.17	2.14	1.99	1.97	1.77
III	2.95	2.87	3.04	2.97	2.87	2.86	2.94	2.94
IV	7.55	7.37	7.73	8.13	8.00	7.10	7.78	7.82
V	9.13	8.77	8.80	8.73	8.18	8.23	7.99	7.68
VI	9.66	16.09	9.12	22.86	19.61	13.26	13.07	12.41
VII	5.45	5.54	4.67	7.83	6.75	5.79	8.67	6.62
VIII	3.87	3.32	3.43	4.70	3.61	3.40	3.62	4.15
IX	5.29	5.22	4.67	4.82	4.39	3.91	4.31	3.55
X	2.59	2.48	2.56	2.46	2.38	2.94	3.65	3.17
Total	50.86	55.71	48.08	66.27	59.38	50.84	55.34	51.43

APPENDIX C

NATIONAL TOTAL PARTICULATE EMISSION ESTIMATES (1940 TO 1992) BY SUBCATEGORY

Table C-1. Total Particulate Emissions from Fuel Combustion

(thousand short tons)

Fuel Combustion Sources	1940	1950	1960	1970	1980	1985	1990	1991	1992
FUEL COMB. ELEC. UTIL.	1,431	2,179	3,122	2,603	919	479	456	445	454
Coal	1,419	2,142	3,089	2,475	797	432	394	394	407
bituminous	822	1,240	1,847	1,492	483	262	239	239	247
subbituminous	405	611	910	735	238	129	118	118	122
anthracite and lignite	192	291	333	247	75	41	37	37	39
Oil	11	36	30	121	116	42	56	47	42
residual	11	34	29	117	113	40	54	45	41
distillate	0	2	1	4	3	1	2	2	2
Gas	0	1	3	7	7	6	5	5	5
FUEL COMB. INDUSTRIAL	3,870	3,334	1,960	2,436	1,503	1,355	1,071	1,058	1,030
Coal	3,598	2,934	1,659	1,444	272	132	92	98	99
bituminous	2,227	1,756	1,103	982	188	92	64	68	69
subbituminous	686	541	340	303	58	28	20	21	21
anthracite and lignite	685	638	217	159	26	12	8	9	9
Oil	44	82	76	106	80	43	22	20	15
residual	33	62	56	83	63	35	14	13	8
distillate	0	2	2	9	6	5	5	5	5
other	11	17	18	14	11	4	3	3	3
Gas	6	15	25	27	23	20	26	26	27
natural	5	13	22	24	20	17	22	21	22
process	1	2	3	4	4	3	5	5	5
Other	222	302	200	859	1,129	1,159	930	914	889
wood/bark waste	171	252	187	818	1,121	1,156	926	911	885
other	51	50	13	40	7	3	4	3	4
FUEL COMB. OTHER	2,678	2,062	1,247	509	937	900	538	523	493
Commercial/Institutional Coal	415	480	58	47	36	21	14	13	13
Commercial/Institutional Oil	25	45	63	71	44	19	20	20	19
Commercial/Institutional Gas	0	1	2	4	4	4	4	4	4
Residential Wood	1,716	1,128	850	384	818	821	469	457	429
fireplaces	402	264	199	90	191	192	110	107	100
woodstoves	1,315	864	651	294	626	629	359	350	328
Residential Other	522	408	275	4	36	35	30	29	29
TOTAL FUEL COMBUSTION	7,979	7,575	6,328	5,549	3,360	2,734	2,065	2,026	1,977

NOTE(S): NA = not available

Zero values represent less than 500 short tons/year.

Table C-2. Total Particulate Emissions from Transportation

(thousand short tons)

Transportation Sources	1940	1950	1960	1970	1980	1985	1990	1991	1992
HIGHWAY VEHICLES	220	329	582	1,004	1,161	1,233	1,412	1,451	1,451
Light-Duty Gas Vehicles & Motorcycles	169	232	442	681	637	594	698	726	726
ldgv	169	232	441	677	629	591	694	722	722
motorcycles	0	0	1	4	7	4	4	4	4
Light-Duty Gas Trucks	23	36	56	111	171	189	234	238	238
ldgt1	18	28	45	91	96	112	148	163	163
ldgt2	5	8	11	20	75	76	86	75	75
Heavy-Duty Gas Vehicles	29	51	68	71	61	51	52	43	43
Diesels	0	9	15	141	291	400	427	444	444
hddv	0	9	15	141	279	375	410	427	427
lddt	0	0	0	0	3	4	4	3	3
lddv	0	0	0	0	9	21	13	14	14
OFF-HIGHWAY	2,762	2,014	245	317	281	286	285	274	278
Non-Road Gasoline	2	16	19	17	14	13	11	10	11
recreational	0	0	0	2	3	3	2	2	2
construction	0	5	5	1	1	1	1	1	1
industrial	0	3	2	3	2	1	2	2	2
farm	0	7	10	9	5	5	3	3	4
other	0	1	2	2	2	3	3	2	3
Non-Road Diesel	1	16	22	71	94	107	112	110	112
construction	0	12	12	14	19	20	23	22	23
industrial	0	0	3	19	18	14	16	16	14
farm	0	4	7	38	57	73	73	72	75
Aircraft	0	0	40	110	82	96	86	80	81
Marine Vessels	107	1,982	45	49	32	30	35	36	37
coal	94	87	28	32	0	0	0	0	0
diesel	6	7	7	7	11	17	20	20	21
residual oil	7	13	10	9	22	13	15	16	16
Railroads	2,651	0	119	70	60	40	41	38	37
TOTAL TRANSPORTATION	2,982	2,342	827	1,321	1,442	1,520	1,696	1,725	1,729

NOTE(S): NA = not available

Zero values represent less than 500 short tons/year.

Table C-3. Total Particulate Emissions from Other Sources

(thousand short tons)

Other Source Categories	1940	1950	1960	1970	1980	1985	1990	1991	1992
CHEMICAL & ALLIED PRODUCT MFG	330	456	310	238	150	129	121	118	127
Organic Chemical Mfg	6	9	18	45	21	23	22	22	23
Inorganic Chemical Mfg	68	31	45	62	25	13	12	12	12
Agricultural Chemical Mfg	19	15	16	46	61	48	41	42	43
Other Chemical Mfg	237	401	230	86	42	45	45	43	48
METALS PROCESSING	4,478	4,853	3,170	2,781	782	496	486	461	487
Non-Ferrous Metals Processing	620	385	443	731	151	112	99	100	105
copper	238	120	146	428	38	34	33	32	33
lead	168	82	46	57	19	13	16	14	15
zinc	188	89	52	24	3	4	4	4	4
other	26	94	199	222	91	61	47	50	52
Ferrous Metals Processing	3,446	4,189	2,247	1,473	430	242	248	217	237
primary	3,287	3,858	2,083	1,304	379	201	198	173	188
secondary	159	331	164	169	51	41	50	43	49
Metals Processing NEC	411	279	481	577	201	142	138	144	146
PETROLEUM & RELATED INDUSTRIES	389	547	1,219	687	166	144	152	147	148
Petroleum Refineries & Related Industries	2	23	50	70	41	16	13	13	13
fluid catalytic cracking units	2	23	50	70	41	16	13	13	13
Asphalt Manufacturing	387	524	1,169	617	125	128	139	133	134
OTHER INDUSTRIAL PROCESSES	4,366	8,152	9,042	7,949	2,542	2,196	1,994	1,878	1,919
Agriculture, Food, & Kindred Products	882	898	1,036	872	629	834	639	574	563
country elevators	371	417	512	426	388	465	404	344	342
terminal elevators	351	313	346	310	152	252	142	121	120
feed mills	24	26	27	20	10	27	18	16	12
soybean mills	48	60	53	30	22	27	16	29	25
wheat mills	12	11	9	10	2	3	1	2	2
other grain mills	17	19	20	20	11	10	6	7	9
other	58	53	69	56	43	52	52	56	53
Wood, Pulp & Paper, & Publishing Products	550	866	1,031	788	229	220	202	202	208
sulfate (kraft) pulping	470	729	886	668	142	124	90	92	95
other	80	137	145	120	87	96	112	110	114

(continued)

Table C-3. Total Particulate Emissions from Other Sources (cont'd)

(thousand short tons)

Other Source Categories	1940	1950	1960	1970	1980	1985	1990	1991	1992
Mineral Products	2,934	6,388	6,975	6,289	1,684	1,142	1,153	1,103	1,148
cement mfg	1,363	1,998	2,014	1,731	417	287	226	212	217
surface mining	175	307	403	388	385	392	444	428	442
stone quarrying/processing	482	764	1,411	1,582	500	206	275	255	276
other	914	3,319	3,147	2,587	382	256	207	209	213
WASTE DISPOSAL & RECYCLING	550	659	962	1,210	365	318	304	288	334
Incineration	330	327	417	440	167	141	127	111	125
residential	98	86	115	134	112	105	101	101	101
other	232	241	302	306	55	35	26	10	24
Open Burning	220	333	544	770	198	177	178	177	209
other	220	333	544	770	198	177	178	177	209
MISCELLANEOUS	4,081	2,791	1,903	1,210	1,186	1,114	1,312	1,087	1,116
Other Combustion	4,081	2,791	1,903	1,210	1,186	1,114	1,312	1,087	1,116
wildfires	2,774	1,353	544	490	654	597	807	581	613
managed burning	881	987	903	581	472	471	471	471	471
other	426	451	456	139	59	47	34	35	32
TOTAL OTHER	14,195	17,458	16,606	14,074	5,190	4,397	4,370	3,979	4,130

NOTE(S): NA = not available
Zero values represent less than 500 short tons/year.

APPENDIX D

NATIONAL EMISSION ESTIMATES (1940 TO 1992) FROM THE REPORT IN METRIC UNITS

Table D-1. Total National Emissions of CO, 1940 through 1992 in Metric Units

(gigagrams)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	3	100	100	215	292	285	285	283
FUEL COMB. INDUSTRIAL	395	498	600	699	680	649	656	647
FUEL COMB. OTHER	13,508	9,667	5,670	3,288	5,652	5,195	5,065	4,676
Residential Wood	10,232	7,000	4,303	2,660	5,436	4,930	4,799	4,420
fireplaces	2,394	1,638	1,007	622	1,272	NA	NA	NA
woodstoves	7,838	5,362	3,296	2,038	4,164	NA	NA	NA
Residential Other	3,176	2,570	1,367	572	162	143	146	135
CHEMICAL & ALLIED PRODUCT MFG	3,801	5,301	3,612	3,082	1,951	1,717	1,729	1,700
METALS PROCESSING	2,495	2,640	2,600	3,306	2,037	1,887	1,807	1,795
PETROLEUM & RELATED INDUSTRY	201	2,405	2,800	1,977	1,563	395	398	366
OTHER INDUSTRIAL PROCESSES	104	210	310	562	753	650	645	655
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	2	2	2
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	92	94	91
WASTE DISPOSAL & RECYCLING	3,293	4,279	5,078	6,404	2,086	1,530	1,492	1,530
HIGHWAY VEHICLES	24,831	37,533	52,887	71,903	79,826	54,251	53,366	50,157
Light-Duty Gas Vehicles & MC	18,017	25,537	38,650	54,395	53,638	37,670	37,050	34,824
light-duty gas vehicles	18,007	25,491	38,598	54,125	53,638	37,670	37,050	34,824
Light-Duty Gas Trucks	2,355	3,836	4,889	8,667	16,022	12,434	12,281	11,505
ldgt1	1,807	2,949	3,751	6,343	NA	NA	NA	NA
ldgt2	547	887	1,139	2,324	NA	NA	NA	NA
Heavy-Duty Gas Vehicles	4,458	8,133	9,233	8,526	9,109	2,677	2,538	2,335
Diesels	NA	26	114	315	1,057	1,471	1,498	1,493
hddv	NA	26	114	315	1,043	1,420	1,443	1,437
OFF-HIGHWAY	7,304	10,533	10,501	9,073	14,621	13,283	12,916	13,317
Non-Road Gasoline	3,426	6,650	7,941	6,947	13,131	11,481	11,179	11,484
construction	1,087	2,185	2,053	529	375	358	331	358
industrial	708	1,414	1,251	1,732	989	1,114	1,084	1,114
farm	1,226	2,464	3,536	3,485	1,781	57	47	57
recreational marine vessels	54	109	470	361	1,180	1,095	1,067	1,095
Aircraft	4	847	1,600	903	928	876	876	904
Railroads	3,704	2,790	301	254	251	111	117	110
MISCELLANEOUS	26,499	16,452	9,988	7,175	7,570	3,871	3,812	3,875
(Other Combustion)								
forest wildfires	22,798	10,123	4,071	5,098	4,895	1,069	1,069	1,069
TOTAL	82,433	89,618	94,146	107,684	117,032	83,806	82,267	79,092

NOTE(S): NA = not available

1990 - 1992 emissions are preliminary and will be updated in the next report.

Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

Table D-2. Total National Emissions of NOx, 1940 through 1992 in Metric Units

(gigagrams)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	599	1,194	2,301	4,445	6,371	6,828	6,787	6,775
Coal	397	903	1,747	3,172	5,148	6,085	6,044	6,076
bituminous	231	530	1,047	1,916	3,120	4,175	4,103	4,154
subbituminous	113	261	515	944	1,537	1,548	1,571	1,546
anthracite & lignite	53	112	185	312	492	362	370	375
FUEL COMB. INDUSTRIAL	2,306	2,897	3,697	3,925	3,224	3,207	3,269	3,196
Coal	1,825	977	709	699	403	556	553	556
bituminous	1,180	624	484	483	278	403	397	403
Gas	331	1,593	2,681	2,777	2,376	1,746	1,807	1,737
natural	306	1,535	2,582	2,770	2,240	295	295	294
FUEL COMB. OTHER	481	587	692	758	672	664	676	665
CHEMICAL & ALLIED PRODUCT MFG	5	57	101	246	196	361	363	363
METALS PROCESSING	4	100	100	70	59	74	71	71
PETROLEUM & RELATED INDUSTRIES	95	100	200	218	65	91	93	85
OTHER INDUSTRIAL PROCESSES	97	84	120	170	186	278	270	273
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	2	2	2
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	3	3	3
WASTE DISPOSAL & RECYCLING	99	195	299	399	101	75	73	75
HIGHWAY VEHICLES	1,382	2,225	4,012	6,738	7,897	7,091	6,999	6,783
Light-Duty Gas Vehicles & MC (light-duty gas vehicles)	1,002	1,462	2,692	4,295	4,219	3,207	3,221	3,191
Light-Duty Gas Trucks	149	246	382	788	1,250	1,064	1,051	1,020
Heavy-Duty Gas Vehicles	231	442	542	497	336	180	181	178
Diesels	NA	76	397	1,159	2,092	2,639	2,546	2,394
hddv	NA	76	397	1,159	2,073	2,574	2,478	2,323
OFF-HIGHWAY	898	1,396	1,309	1,656	2,471	2,579	2,512	2,587
Non-Road Diesel	93	170	224	601	1,297	1,341	1,225	1,345
construction	64	143	142	168	664	857	785	857
Railroads	596	900	700	640	751	843	889	839
MISCELLANEOUS	898	603	400	299	225	121	119	121
TOTAL	6,864	9,439	13,230	18,923	21,468	21,373	21,240	21,001

NOTE(S): NA = not available.

1990 - 1992 emissions are preliminary and will be updated in the next report.

Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

Table D-3. Total National Emissions of VOC, 1940 through 1992 in Metric Units

(gigagrams)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	2	8	8	27	40	32	30	29
FUEL COMB. INDUSTRIAL	98	88	96	136	142	258	262	254
FUEL COMB. OTHER	1,694	1,212	697	491	769	396	386	357
Residential Wood	1,279	880	511	417	734	368	358	330
fireplaces	308	210	119	97	172	NA	NA	NA
woodstoves	971	670	391	320	562	NA	NA	NA
CHEMICAL & ALLIED PRODUCT MFG	802	1,201	899	1,217	1,447	1,607	1,613	1,595
Organic Chemical Mfg	53	100	223	571	802	620	622	613
METALS PROCESSING	295	401	310	357	247	66	63	63
PETROLEUM & RELATED INDUSTRIES	518	498	938	1,084	1,306	669	676	649
OTHER INDUSTRIAL PROCESSES	118	167	184	245	215	433	431	431
SOLVENT UTILIZATION	1,788	3,338	3,995	6,508	5,973	5,500	5,501	5,500
Surface Coating	960	1,984	1,931	3,239	3,343	2,376	2,357	2,373
Nonindustrial	444	NA	1,079	1,519	909	1,724	1,754	1,734
consumer solvents	NA	NA	NA	NA	NA	983	1,008	989
STORAGE & TRANSPORT	579	1,105	1,598	1,772	1,792	1,688	1,694	1,654
Bulk Terminals & Plants	168	328	479	543	469	597	586	566
area source: gasoline	143	279	408	462	399	508	499	476
HIGHWAY VEHICLES	4,331	6,506	9,407	11,085	9,970	6,330	6,179	5,533
Light-Duty Gas Vehicles & MC	3,374	4,836	7,461	8,660	6,471	4,199	4,109	3,675
light-duty gas vehicles	3,371	4,820	7,443	8,566	6,471	4,199	4,109	3,675
Light-Duty Gas Trucks	460	754	982	1,498	2,255	1,521	1,479	1,313
Heavy-Duty Gas Vehicles	497	906	923	814	866	217	206	175
Diesels	NA	10	42	113	378	393	386	371
hddv	NA	10	42	113	371	370	361	345
OFF-HIGHWAY	706	1,100	1,102	1,263	2,100	1,923	1,869	1,930
Non-Road Gasoline	188	384	477	531	1,578	1,493	1,453	1,493
lawn & garden	NA	NA	NA	NA	751	661	645	661
recreational marine vessels	15	29	113	95	377	389	379	389
WASTE DISPOSAL & RECYCLING	898	1,001	1,402	1,799	688	2,052	2,012	2,099
MISCELLANEOUS	3,700	2,296	1,427	999	1,029	523	515	524
Other Combustion	3,700	2,296	1,427	999	1,029	523	514	523
forest wildfires	3,103	1,370	697	699	671	147	147	147
TOTAL	15,530	18,921	22,065	26,983	25,719	21,477	21,233	20,617

NOTE(S): NA = not available.

1990 - 1992 emissions are preliminary and will be updated in the next report.

Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

Table D-4 Total National Emissions of SO2, 1940 through 1992 in Metric Units

(gigagrams)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	2,202	4,096	8,404	15,783	15,861	14,398	14,319	14,371
Coal	2,065	3,679	8,058	14,333	NA	13,790	13,700	13,853
bituminous	1,233	2,202	4,869	8,686	NA	12,104	11,978	12,140
subbituminous	606	1,085	2,397	4,278	NA	1,289	1,253	1,244
anthracite and lignite	226	392	792	1,369	NA	397	469	469
Oil	137	417	345	1,450	NA	580	591	491
residual	132	411	341	1,432	NA	571	583	483
FUEL COMB. INDUSTRIAL	5,498	5,194	3,505	4,144	2,677	2,818	2,848	2,803
Coal	4,706	4,012	2,452	2,839	1,385	1,672	1,652	1,672
bituminous	3,151	2,672	1,685	1,970	960	1,252	1,230	1,253
subbituminous	971	823	520	607	296	26	26	26
Oil	503	882	836	1,115	966	750	796	744
residual	360	654	601	868	772	574	621	574
Gas	132	164	171	127	271	313	318	305
Other	157	136	46	64	54	77	77	76
Internal Combustion	NA	NA	NA	NA	NA	5	6	5
FUEL COMB. OTHER	3,304	3,596	2,104	1,352	881	542	552	534
Residential Other	2,283	1,886	1,134	446	191	159	162	158
bituminous/subbituminous coal	2,057	1,595	788	236	39	27	28	23
CHEMICAL & ALLIED PRODUCT MFG	195	388	406	536	254	384	386	380
METALS PROCESSING	3,002	3,399	3,616	4,332	1,671	824	793	787
Nonferrous Metals Processing	2,504	2,805	3,013	3,683	1,161	666	643	636
copper	2,079	2,149	2,515	3,182	980	495	479	470
PETROLEUM & RELATED IND.	203	309	614	799	666	399	403	373
OTHER INDUSTRIAL PROCESSES	303	541	609	768	832	364	355	360
SOLVENT UTILIZATION	0	0	0	0	0	1	1	1
STORAGE & TRANSPORT	0	0	0	0	0	19	19	19
WASTE DISPOSAL & RECYCLING	3	3	9	7	30	33	33	33
HIGHWAY VEHICLES	3	94	103	253	415	674	698	712
OFF-HIGHWAY	2,896	2,193	308	344	482	241	248	245
Railroads	2,699	1,972	195	125	121	61	65	61
MISCELLANEOUS	494	494	503	100	10	4	4	4
TOTAL	18,103	20,307	20,180	28,418	23,779	20,700	20,659	20,622

NOTE(S): NA = not available.

1990 - 1992 emissions are preliminary and will be updated in the next report.

Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

Table D-5. Total Emissions of Pb, 1970 through 1992 in Metric Units

(megagrams)

Source Category	1970	1975	1980	1985	1990	1991	1992
FUEL COMB. ELEC. UTIL.	297	208	117	58	58	56	56
FUEL COMB. INDUSTRIAL	215	68	54	27	16	16	15
FUEL COMB. OTHER	9,119	9,110	3,729	382	379	377	377
Misc. Fuel Comb. (Ex. Residential)	9,072	9,072	3,701	363	363	363	363
CHEMICAL & ALLIED PRODUCT MFG	93	109	95	107	123	120	127
Inorganic Chemical Mfg	85	99	86	97	112	109	115
lead oxide and pigments	93	109	95	107	123	120	127
METALS PROCESSING	21,976	9,002	2,745	1,902	1,940	1,759	1,877
Nonferrous Metals Processing	14,397	6,525	1,656	1,248	1,279	1,142	1,200
primary lead product	11,008	5,117	975	792	661	566	569
primary copper product	219	155	18	17	18	17	18
primary zinc product	925	203	22	14	8	10	10
secondary lead product	1,719	745	436	261	407	376	426
second copper product	339	182	105	64	68	59	57
lead cable coating	115	50	34	39	46	44	46
Ferrous Metals Processing	6,708	1,992	826	523	522	469	509
ferroalloy production	199	94	12	6	17	13	15
iron production	241	84	34	19	17	15	16
steel production	2,835	982	436	190	125	132	131
gray iron production	3,423	825	338	305	361	307	343
OTHER INDUSTRIAL PROCESSES	1,840	1,213	733	287	153	151	126
Mineral Products (cement manufacturing)	490	197	84	39	23	22	22
Misc Industrial Processes	1,350	1,016	649	248	130	130	105
WASTE DISPOSAL & RECYCLING	1,996	1,447	1,098	790	730	528	673
(Incineration)							
municipal waste	527	359	146	72	61	49	53
other	1,469	1,088	952	718	669	479	620
HIGHWAY VEHICLES	156,003	118,123	56,418	14,495	1,534	1,378	1,255
Light-Duty Gas Vehicles & MC	129,655	96,951	44,000	10,950	1,145	1,029	937
OFF-HIGHWAY (Non-Road Gasoline)	7,566	4,547	3,012	208	179	163	188
TOTAL	199,105	143,829	68,000	18,257	5,112	4,549	4,695

NOTE(S): NA = not available.

1990 - 1992 emissions are preliminary and will be updated in the next report.

Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

Table D-6. Total National Emissions of PM-10, 1940 through 1992 in Metric Units

(gigagrams)

Source Category	1940	1950	1960	1970	1980	1990	1991	1992
FUEL COMB. ELEC. UTIL.	392	451	414	223	172	152	148	150
FUEL COMB. INDUSTRIAL	642	548	300	581	616	442	432	420
FUEL COMB. OTHER	2,121	1,518	1,010	413	805	462	450	423
Residential Wood	1,557	1,023	771	348	742	426	414	389
fireplaces	364	239	180	82	174	100	97	91
woodstoves	1,193	784	590	267	568	326	317	298
CHEMICAL & ALLIED PRODUCT MFG	299	413	280	213	134	105	102	109
METALS PROCESSING	1,096	932	931	1,194	564	371	356	378
Nonferrous Metals Processing	533	314	340	538	118	75	77	80
copper	196	95	111	312	29	25	25	25
PETROLEUM & RELATED INDUSTRIES	332	374	625	259	125	111	107	108
OTHER INDUSTRIAL PROCESSES	3,625	6,308	6,542	5,290	1,674	1,205	1,135	1,165
Mineral Products	2,451	4,953	5,046	4,191	1,144	710	676	707
cement mfg	1,236	1,812	1,827	1,571	378	205	192	197
other	720	2,441	2,149	1,631	268	120	122	124
WASTE DISPOSAL & RECYCLING	356	458	693	906	248	200	196	229
MISCELLANEOUS	2,692	1,754	1,129	761	773	41,485	45,650	42,012
Other Combustion	2,692	1,754	1,129	761	773	872	711	733
wildfires	1,977	965	388	349	466	575	414	437
Fugitive Dust	NA	NA	NA	NA	NA	40,613	44,939	41,279
wind erosion	NA	NA	NA	NA	NA	3,803	9,185	4,226
unpaved roads	NA	NA	NA	NA	NA	14,197	12,932	13,760
paved roads	NA	NA	NA	NA	NA	6,834	7,394	7,167
other	NA	NA	NA	NA	NA	15,779	15,428	16,126
HIGHWAY VEHICLES	190	284	502	871	1,009	1,340	1,386	1,413
Light-Duty Gas Vehicles & MC	145	199	378	584	546	633	657	670
ldgv	145	199	378	580	539	633	657	670
Light-Duty Gas Trucks	19	30	48	94	144	163	169	173
Heavy-Duty Gas Vehicles	26	46	62	64	56	42	38	38
Diesels	NA	9	14	128	264	503	522	532
hddv	NA	9	14	128	253	466	484	493
OFF-HIGHWAY	2,250	1,622	182	247	248	253	244	247
Railroads	2,236	1,580	100	59	52	37	35	33
TOTAL	13,994	14,663	12,607	10,960	6,368	46,126	50,206	46,654

NOTE(S): NA = not available.
1990 - 1992 emissions are preliminary and will be updated in the next report.
Categories displayed below Tier 1 do not sum to Tier 1 totals since they are intended to show major contributors.

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