United States
Environmental Protection
Agency

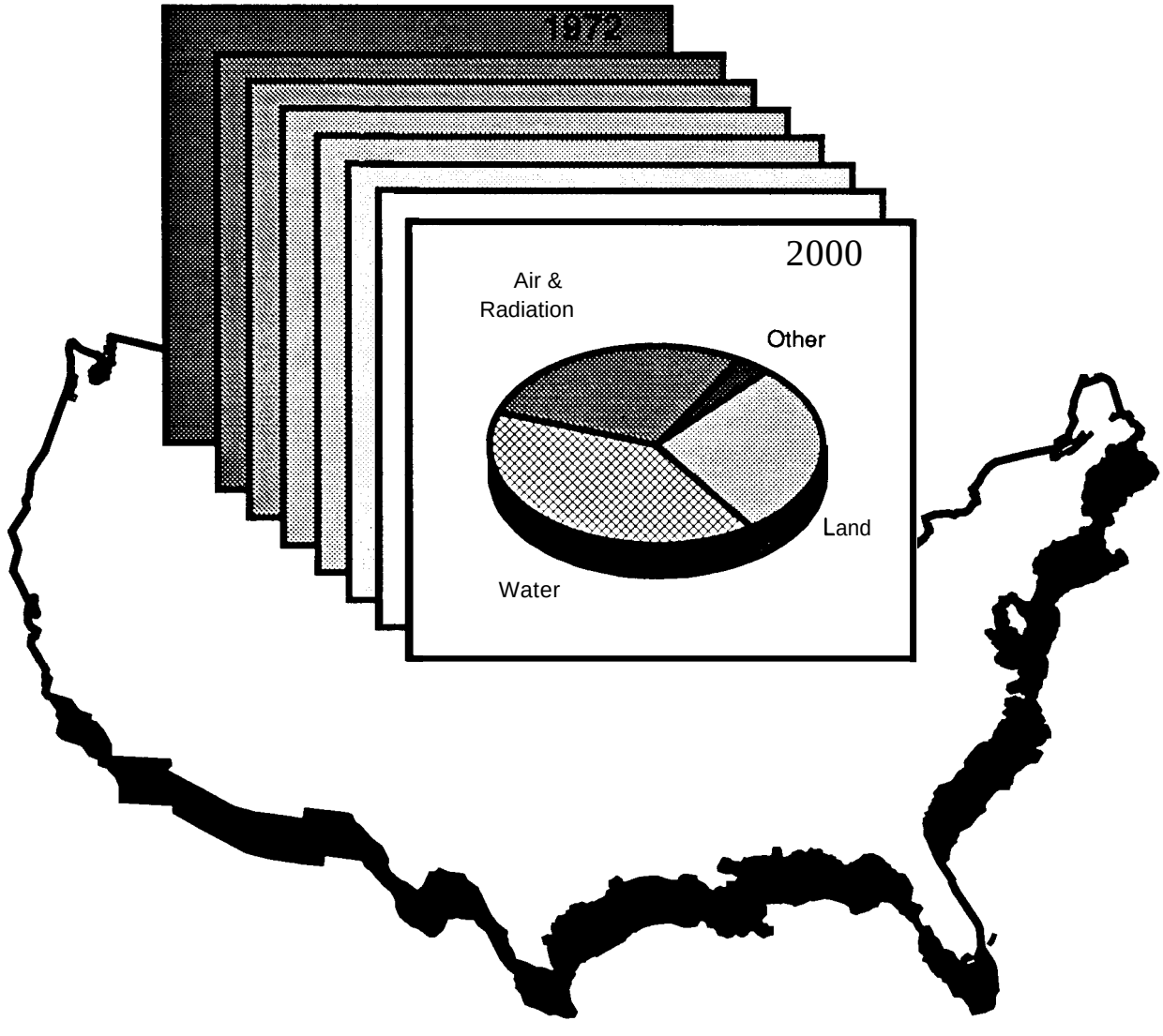
Policy, Planning,
And Evaluation
(PM-221)

EPA-230-12-90-084
December 1990

EPA

Environmental Investments: The Cost Of A Clean Environment

A Summary



Environmental Investments: The Cost of a Clean Environment, a Summary is based on a 500 page full report entitled *Environmental Investments: The Cost of a Clean Environment, Report of the Administrator of the Environmental Protection Agency to the Congress of the United States*. This full report can currently be obtained from:

(1) National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. The NTIS order number is PB91-153783 and orders can be placed by calling (703) 487-4600.

(2) Island Press, Box 7, Covelo, CA 95428. Orders can be placed by calling 1-800-828-1302 or, for those in the Washington, D.C. area, 202-232-7933. Their Washington address is Suite 300, 1718 Connecticut Ave., N.W., Washington, D.C. 20009.

EPA-230-12-90-084
December 1990

ENVIRONMENTAL INVESTMENTS:

THE COST OF A CLEAN ENVIRONMENT

A SUMMARY

Alan Carlin

with the assistance of the

Environmental Law Institute

Science, Economics and Statistics Division
Office of Regulatory Management and Evaluation
Office of Policy, Planning and Evaluation
U.S. Environmental Protection Agency
Washington, DC 20460

ADMINISTRATOR'S PREFACE

Over the past 20 years, the citizens of the United States have made a significant, enduring commitment to protecting the environment. This new report, *Environmental Investments: The Cost of a Clean Environment*, for the first time shows the full extent of this commitment—amounting to an investment of $115 billion a year in current dollars to protect and restore our nation's air, water, and land. This is just over two percent of our Gross National Product. EPA's report looks in some detail at what our country has spent, what we are spending, and what we are projected to spend on all types of pollution controls.

Of course, the country has received considerable value for these investments, and EPA has underway additional work to compile these benefits.

In the current report, a handful of points stand out:

- First, *spending on environmental problems is rising* significantly with obvious consequences for the expenditures of governments at all levels and of industry. Moreover, if the upward trend continues into the next century, this increased spending could affect U.S. competitiveness in world markets.

- Second, besides the level of spending, *the allocation of resources is changing*. The share of costs devoted to land protection is projected to rise relative to that for air and water protection over the next decade.

- Third, *the costs of pollution control are rising at a time when unmet environmental needs are still quite large*. The American people are asking for more in the way of environmental improvements and making clear politically they will not tolerate backsliding. Nor do I want to see rollbacks of hard won environmental progress. But particularly in today's economy, I am concerned about the price tag of meeting growing environmental demands.

Thus, one of my priorities at EPA is ensuring that resources devoted to achieving the nation's environmental goals are used as efficiently and effectively as possible. All EPA programs are considering the most cost-effective ways to meet the Agency's mandate consistent with our statutory responsibilities. Yet I have concluded we must redouble our efforts to find and apply more cost-effective approaches, to engage in negotiations and voluntary agreements to cut pollution, to foster breakthroughs in cleanup technologies, and to explore new ways to finance environmental improvements.

One promising approach to making environmental protection more efficient is to craft incentives that harness the marketplace on behalf of the environment. Using a combination of incentives and vigorous enforcement of existing laws, we can engage the marketplace to deal effectively with the subtle and complex environmental problems of the 1990s. These are often caused by small, widely scattered sources not always amenable to federal regulation—problems

like municipal and hazardous wastes, toxic substances in the air and water, contamination of ground and surface waters from agricultural and urban runoff, and global atmospheric changes—to name some current problems with which the Agency is grappling.

A good example of this approach is the system of economic incentives proposed by President Bush to curb acid rain, which were passed by the 101st Congress in the new Clean Air Act Amendments of 1990. Under this system, electric utilities will be given a limited number of marketable permits designed to reduce their sulfur dioxide emissions by about half. EPA will monitor emissions to ensure that they do not exceed the allotted levels. If a company finds that cleanup costs are high at one plant and that purchasing additional allowances would be less expensive, it will be able to buy allowances from other utilities. On the other hand, a company may cut emissions so far that it will be able to sell its extra allowances or bank them to provide for future growth. And the plant will be able to pursue the least expensive methods of pollution control—energy conservation, different fuels, new technology—provided only that it achieves the pollution reductions the law requires. Setting the goals nationally while providing to plant and business managers, who know their operations best, the flexibility to choose the methods that work for them will achieve air quality goals at the lowest possible cost, by our estimates at perhaps one-fifth less than the cost of more traditional command and control approaches. Like other economic incentives, this emission trading system also has the advantage of promoting innovation in pollution prevention.

As part of my emphasis at EPA on economically smart approaches to environmental protection, I am increasing the use of economic analysis, strategic planning, and research. They will be used to ensure that the resources devoted to pollution control are directed towards environmental goals where the greatest reductions in environmental risks can be achieved. In this regard, EPA is in the process of using the data base developed in this report to see where our spending can be better aligned with the most serious environmental risks. We believe, for instance, that some of the environmental problems that will see the greatest expected increase in costs during the decade, as reported here, are also areas where as yet uncontrolled environmental risks may be less than originally thought. In many cases, there is no discretion under the law as to what EPA must do, and we will carry out these responsibilities as fully and vigorously as we can. In other cases, EPA proposes through its strategic planning process and review of future regulations to direct resources, where discretion is allowed, to the highest priority environmental risks.

In sum, our challenge over the next decade is to reconcile the expectations of the American people for greater environmental protection with our country's aspirations for growth. We need to deliver in the most cost-effective manner the continued public health benefits of pollution control and assure that the natural systems that sustain all human activities, including economic activities, continue to provide for generations to come.

William K. Reilly
Administrator

EXECUTIVE SUMMARY

This report summarizes data presented in a much more detailed report entitled *Environmental Investments: The Cost of a Clean Environment, Report of the Administrator of the Environmental Protection Agency to the Congress of the United States*. This more detailed report is being transmitted to Congress as a report of the Administrator in response to Section 312(a) of the Clean Air Act and Section 516(b) of the Clean Water Act.

Unlike earlier EPA reports to Congress on the costs of environmental protection, this report goes beyond air and water costs to present a broader picture of environmental pollution control costs reflecting the Environmental Protection Agency's broad mandate. More specifically, this summary report, as well as the Report to Congress, presents data on environmental pollution control costs during the period 1972-1987, projects these costs for each subsequent year to the year 2000 under a number of assumptions, and breaks them down in a variety of ways. These ways include differentiating among capital, operating, and annualized costs, as well as the medium where the pollution is controlled, the economic sector (e.g., public, private) from which the control is funded, and whether the costs result from new or existing regulations.

The historical data are based largely on surveys of actual spending as conducted primarily by the Department of Commerce. Projections are based on simple extrapolations of spending trends as well as EPA estimates of the cost of newly implemented and proposed regulations. The Administration's January 1990 Clean Air Act reauthorization proposal was the basis for projections of future air pollution control costs.

SUMMARY OF COSTS

This report concludes that total annualized costs for all pollution control activities in the United States at seven percent interest have increased and are projected to increase as follows (figures for year 2000 are provided for both present and full implementation scenarios):

				2000	
Total Annualized Costs	**1972**	**1987**	**1990**	**Present**	**Full**
In billions of 1986 dollars	26	85	100	148	160
In billions of estimated 1990 dollars	30	98	115	171	185
As Percent of GNP	0.9	1.9	2.1	2.6	2.8

The present implementation option assumes that present levels of implementation of existing programs remain the same as in 1987. The full implementation option assumes that the investments needed to bring about nationwide attainment of the national ambient air quality standard for ozone and the fishable/swimmable goals of the Clean Water Act for municipal systems are made by the year 2000. The comparison with Gross National Product is intended to provide a frame of

reference to judge the relative importance of environmental costs to a well-known aggregate measure of economic activity.

Although total annualized costs are increasing, they are increasing at a decreasing rate. The yearly rate of increase in total annualized costs decreased from 14 percent between 1972 and 1973 to six to eight percent in the mid-1980s and is projected to fall further to about three percent in the late 1990s (assuming full implementation).

Pollution control capital investment is estimated to be as follows (figures for year 2000 are provided for both present and full implementation scenarios):

				2000	
Pollution Control Capital Investment	**1972**	**1987**	**1990**	**Present**	**Full**
In billions of 1986 dollars	20	30	41	30	39
In billions of estimated 1990 dollars	23	35	47	35	45
As Percent of Total US Capital Investment	2.5	2.3	2.8	1.7	1.9

In general, pollution control capital investment as a percentage of total capital investment, which is an important measure of the impact of pollution control costs on U.S. capital markets, reached a high in the mid-1970s at about 3.4 percent and has been trending irregularly downward since then. It is important to mention, however, that the year 2000 capital costs may be underestimated because when the data were unclear, future costs for new regulations were assigned to operating rather than capital costs.

COST COMPARISONS

Comparisons of cost data presented in the report indicate the following:

- There is expected to be a major reallocation of the percentage of pollution control expenditures devoted to each media over the next decade from air and particularly water pollution control to land pollution control. This is a result of the major land pollution control legislation passed by Congress beginning in the mid-1970s and greatly expanded in the 1980s. Specifically, the media shares were or are projected to be:

Media Shares of Pollution Control Expenditures (percent of total)	**1987**	**1997**
Air and Radiation Costs	28.9	27.1
Water Costs	42.9	35.7
Land Costs	26.0	33.9
Chemical Control Costs	1.2	1.9
Multi-media Costs	1.1	1.5

- Although increasing, national environmental pollution control expenditures remain less than half those for clothing and shoes, one-third those for national defense, one-third those for medical care, one-fifth those for housing, and one-sixth those for food.

- The non-EPA federal share of total annualized pollution costs is projected to increase by more than 140 percent between 1987 and 2000, primarily as a result of the cost of military and nuclear waste clean-up. All other shares, particularly the private sector, are expected to fall somewhat. Even though the EPA share is projected to fall somewhat, the net effect is that the federal share as a whole is projected to increase over this period while the state and local government share decreases slightly.

- Although the percentage share of the burden on local government is expected to fall slightly relative to that of other sectors, there is expected to be a significant increase in the real costs of pollution control on this sector; the result will be an increased burden on the taxpayers and rate payers, which may be burdensome for some smaller communities unless mitigating measures are undertaken.

- National expenditures on environmental pollution control have been somewhat higher than in many Western European nations as a percentage of gross domestic product.

ENVIRONMENTAL RESULTS

The report also summarizes the available evidence concerning changes in ambient pollution levels and emissions, the "result" of the pollution control expenditures detailed in other sections of the report. An ideal comparison of the costs and benefits of pollution control would require that these benefits be identified, quantified, and monetized. This is an extremely difficult and data intensive task and is not attempted in this report.

Instead, the report relies on historical data on estimated air and water pollutant emissions and ambient pollution levels, and information on the production and regulation of hazardous waste and toxic substances to provide an indication of environmental quality levels over time. While this provides some indication of changing environmental quality levels, it does not adequately show the degree of environmental protection afforded by cumulative pollution control efforts. In the absence of controls, increasing population and levels of economic activity would have resulted in steadily decreasing environmental quality over time. In order to show environmental quality improvements resulting from pollution controls adequately, one would need to compare current levels of environmental quality indicators with estimated levels that would have prevailed in the absence of cumulative pollution control efforts. Except in the case of the criteria air pollutants emissions, such comparisons are precluded by the absence of data.

There are data, however, showing that there has been a substantial decrease in emissions of major air pollutants since 1970 compared to what they would have been without controls:

ACTUAL EMISSIONS AS A PERCENTAGE OF ESTIMATED EMISSIONS USING 1970 LEVELS OF CONTROL

Year	Particulate Matter	Sulfur Dioxide	Nitrogen Oxides	Volatile Organic Compounds	Carbon Monox-ide	Lead
1984	33	71	82	60	56	19
1988	30	58	72	58	43	3

There has also been a substantial actual decrease in industrial and municipal discharges of total suspended solids into water and some improvement in biochemical oxygen demand over the same period.

TABLE OF CONTENTS

ADMINISTRATOR'S PREFACE iii

EXECUTIVE SUMMARY v

LIST OF FIGURES xi

LIST OF TABLES xi

FOREWORD xii

1. INTRODUCTION 1-1
- 1.1. DEFINITION OF COSTS 1-1
  - *1.1.1. Scope of Costs* 1-1
  - *1.1.2. Nature of Costs* 1-2
- 1.2. COST BREAKDOWNS 1-2
  - *1.2.1. Costs by Economic Type* 1-2
  - *1.2.2. Costs by Environmental Medium* 1-3
  - *1.2.3. Costs by Economic Sector* 1-5
  - *1.2.4. New and Existing Regulatory Costs* 1-5
  - *1.2.5. Costs by Year* 1-6
- 1.3. DATA SOURCES 1-6
  - *1.3.1. U.S. Department of Commerce Survey Data* 1-6
  - *1.3.2. EPA Budget Justification Data* 1-7
  - *1.3.3. Regulatory Impact Analyses Data* 1-7
  - *1.3.4. Special EPA Analyses Data* 1-8
- 1.4. CONVENTIONS USED 1-8
  - *1.4.1. Projection Techniques* 1-8
    - 1.4.1.1. Existing Programs 1-8
    - 1.4.1.2. New Regulations 1-8
  - *1.4.2. Price Deflators Used* 1-9

2. AGGREGATE POLLUTION CONTROL COSTS 2-1
- 2.1. TOTAL COSTS 2-1
- 2.2. TOTAL COSTS BY FUNDING SOURCE 2-5
- 2.3. TOTAL CAPITAL EXPENDITURES 2-5

3. COSTS BY ENVIRONMENTAL MEDIUM AND PROGRAM 3-1
- 3.1. COSTS BY ENVIRONMENTAL MEDIUM 3-1
- 3.2. AIR AND RADIATION POLLUTION CONTROL COSTS 3-2
- 3.3. WATER POLLUTION CONTROL COSTS 3-3
- 3.4. LAND POLLUTION CONTROL COSTS 3-4

3.5. CHEMICAL POLLUTION CONTROL COSTS 3-5
3.6. MULTI-MEDIA COSTS 3-5

4. COST COMPARISONS AND CONCLUSIONS 4-1
4.1. COST COMPARISONS 4-1
4.1.1. Environmental Media Expenditure Shares 4-1
4.1.2. GNP Expenditure Shares 4-4
4.1.3. Cost Burdens on Local Governments 4-4
4.1.4. Long Term Trends in Total Costs 4-6
4.1.5. International Pollution Control Expenditures 4-7
4.2. CONCLUSIONS 4-9

5. ENVIRONMENTAL TRENDS 5-1
5.1. AIR QUALITY

5.1.1. Criteria Pollutant Emissions 5-2
5.1.2. Effects of Pollution Controls on Air Emissions 5-2
5.1.3. Ambient Air Quality 5-3
5.2. WATER QUALITY 5-4
5.2.1. Discharges 5-4
5.2.1.1. Municipal 5-4
5.2.1.2. Industrial 5-5
5.2.2. Non-point Source 5-5
5.3. LAND QUALITY 5-5
5.3.1. Hazardous Waste Management 5-5
5.3.2. Hazardous Waste Remediation 5-6
5.3.3. Underground Storage Tanks 5-6
5.4. EXPOSURE TO CHEMICALS 5-6
5.4.1. Toxic Substances 5-6
5.4.2. Pesticides 5-7

LIST OF FIGURES

Fig. 2-1: Total Annualized Costs by Type of Regulation 2-1
Fig. 2-2: Total Annualized Costs as a Percentage of GNP 2-4
Fig. 2-3: Percent Change in Annualized Costs 2-4
Fig. 2-4: Total Annualized Costs by Funding Source 2-5
Fig. 2-5: Environmental Capital Investment as a Percentage of Total Investment 2-6

Fig. 3-1: Total Media Costs Annualized at 7%, Assuming Full Implementation 3-1

Fig. 4-1: Percentage of Capital Plus Operating Expenditures by Medium 4-1
Fig. 4-2: Total Land Capital Plus Operating Expenditures by Type of Regulation 4-2
Fig. 4-3: Total Land Capital Plus Operating Expenditures by Program 4-2
Fig. 4-4: Solid Waste Capital Plus Operating Expenditures by Type of Reg. 4-3
Fig. 4-5: UST Capital Plus Operating Expenditures by Type of Regulation 4-3
Fig. 4-6: Hazardous Waste Capital Plus Operating Expenditures by Type of Regulation . 4-3
Fig. 4-7: Superfund Capital Plus Operating Expenditures by Type of Regulation 4-4
Fig. 4-8: 1985 International Pollution Control Expenditures as % of GDP 4-8

Fig. 5-1: Actual 1988 Emissions as a Percentage of Hypothesized Emissions at the 1970 Level of Control 5-3

LIST OF TABLES

Table 2-1: Total Annualized Costs 2-2
Table 2-1: Total Annualized Costs (continued) 2-3

Table 3-2: Annualized Air & Radiation Pollution Control Costs 3-2
Table 3-3: Annualized Water Pollution Control Costs 3-3
Table 3-4: Annualized Land Pollution Control Costs 3-4
Table 3-5: Annualized Chemical Pollution Control Costs 3-5
Table 3-6: Annualized Multi-Media Pollution Control Costs 3-6

Table 4-1: Potential Increases in Annual Charges by City Size by 2000 4-5
Table 4-2: Capital Plus Operating Expenditures for Some Countries 4-8

FOREWORD

This summary report is based entirely on *Environmental Investments: The Cost of a Clean Environment, Report of the Administrator of the Environmental Protection Agency to the United Congress*, which is being released at the same time as this summary report. This report summarizes the contents of the Report to Congress for those who may not be concerned with the full derivation of the cost estimates and the more detailed results. Readers who would like the Report to Congress can obtain it from Ms. Ernestine Thomas, U.S. EPA (PM-223X), Washington, D.C. 20460, telephone (202) 382-5606.

This summary was edited and partly written by Alan Carlin of the Science, Economics and Statistics Division in the Office of Policy, Planning and Evaluation with the assistance of the Environmental Law Institute. The Environmental Law Institute provided economic and data analysis, most of the data compilation and graphics, and assistance in desk-top publishing. Apogee Research, Inc. provided some of the early data compilation, graphics, and desk-top publishing assistance as a subcontractor to ELI. Anne Grambsch of SESD contributed the cover design and some of the graphics, suggested a number of other ideas used in the layout of the report, and handled report reproduction. The summary also benefited from the work of the many contributors to the Report to Congress and to a number of other individuals for their comments and assistance.

1. INTRODUCTION

This report summarizes the results of a study by the U.S. Environmental Protection Agency (EPA) to estimate comprehensively the direct costs of public and private pollution control activities in the United States. This summary highlights the study findings and conclusions, which are presented more fully in a companion report entitled *Environmental Investments: The Cost of a Clean Environment, Report of the Administrator of the Environmental Protection Agency to the Congress of the United States* (hereafter referred to as the Report to Congress).

Estimates of annual pollution control costs over the years 1972-2000 for each public sector and the private sector are summarized here. Cost estimates are given for each of five categories of environmental media and for all combined. The estimates are also used to provide some comparisons of U.S. pollution control costs with those of several Western European nations and to make a number of other costs comparisons that may prove important over the next several years.

The nature and scope of the cost estimates, the categories of costs considered, and the data sources are reviewed briefly in the remainder of this Chapter. Estimates of aggregate pollution control costs are presented and discussed in Chapter 2. Chapter 3 presents cost estimates for individual environmental media categories. Cost comparisons and conclusions are discussed in Chapter 4. Trends in environmental quality—the "output" of environmental pollution control expenditures—are presented in Chapter 5. A more detailed discussion of all these topics as well as data sources and derivation are to be found in the Report to Congress.

1.1. DEFINITION OF COSTS

1.1.1. Scope of Costs

Cost estimates are provided for the total costs of EPA programs to all economic sectors pursuant to each of the major federal environmental pollution control statutes. This provides a picture of the total direct costs of all federal pollution control efforts and permits cost comparisons across environmental media and major EPA program areas. Costs of state, local, and private pollution control programs that are closely related to areas for which EPA currently has responsibility—pollution control and improved environmental quality—are also included and broken out separately. The costs of federal environmental programs that are not pollution control programs, such as wildlife conservation and land management, are not included.

By far the most significant of the included costs that are not directly mandated by federal law are those for local government and private sector trash collection and disposal. Federal solid waste legislation is concerned primarily with the regulation of solid waste disposal facilities. Yet, local governments and private entities are involved with the full range of solid waste activities, including collection, handling, storage, treatment, and final disposal. All solid waste costs are included in this report, though only a relatively small portion of the total costs for these activities

are incurred as a result of federal legislation. This is done on the grounds that all such expenditures contribute to pollution control and improved environmental quality.

1.1.2. Nature of Costs

The costs presented here represent estimates of direct regulatory implementation and compliance costs. They are the first-order costs to those entities that implement control measures and undertake compliance activities. For example, the private costs associated with existing programs represent the before-tax expenditures associated with all compliance activities, such as the purchase, installation and operation and maintenance of existing pollution control equipment. The private costs of new and future programs represent, for the most part, projections of before-tax capital investment and operation and maintenance costs calculated using engineering analyses.

1.2. COST BREAKDOWNS

The cost estimates included in this report are presented in several different ways (and discussed in the sections of the report indicated):

1.2.1. By economic type;
1.2.2. By environmental medium;
1.2.3. By the economic sector directly incurring the cost;
1.2.4. By new and existing regulations;
1.2.5. By year.

1.2.1. Costs by Economic Type

Two basic types of costs are included to represent implementation and compliance costs:

- capital costs, and
- operating costs.

From these, two aggregate cost measures are derived—annualized costs and total expenditures. Annualized costs are the aggregate cost measure used throughout most of this report. Total expenditures represent the sum of capital and operating costs. They are used only in Sections 4.1.1, 4.1.2, and 4.1.5 of Chapter 4. The Report attempts to minimize confusion by referring to capital plus operating costs as expenditures rather than costs. Further discussion of total expenditures can be found in these Sections.

The definitions of capital and operating costs used in the derivation of annual costs follow those of the primary data sources used—The U.S. Department of Commerce *Government*

Finances reports[1] and "Pollution Abatement and Control Expenditures" articles.[2] Capital costs include expenditures for plant and equipment (both replacement and expansion) and construction in progress, as well as the costs of changes in production processes that reduce or eliminate pollution generation. Such costs are chargeable to an establishment's accounts for plant and equipment and subject to amortization. Operating costs include all costs and expenses for the operation and maintenance of pollution abatement processes, including spending for materials, equipment leasing, parts and supplies, direct labor, fuel and power, services provided by private contractors, and research and development.

Annualized costs, the principal aggregate cost presented in most of this report, are the sum of the operating costs for the year in question plus amortized capital costs, which include interest and depreciation associated with accumulated capital investment. Amortized (or annualized) capital costs represent the real resource costs of tying-up funds in the purchase and installation of capital equipment or other fixed assets required by environmental regulation. They are computed using a seven percent rate of amortization and the following assumptions with regard to life of capital investment for different program areas:

Mobile source air pollution control capital	10 years;
Radiation control capital	25 years;
Water pollution control capital (except drinking water)	30 years;
Superfund remediation capital	30 years;
Underground storage tank capital	30 years;
All other capital	20 years.

The basis for selecting these capital lives and a detailed presentation of the capital and operating cost estimates used to derive the costs presented in this report can be found in the Report to Congress. That Report also provides estimates of annual costs computed using capital amortization rates of three and ten percent as well as seven percent.

1.2.2. Costs by Environmental Medium

The cost estimates are categorized into three environmental media—air, water, and land—as well as useful chemicals and multi-media. Useful chemicals (such as pesticides) differ from the pollutants associated with air, water, and land because they have economic value and are not simply waste products. The fifth category, labelled "multi-media," contains costs that do not fit well in any of the other four categories. Except in the case of chemicals, costs are allocated to the environmental medium that is most directly affected by the pollution controls associated with expenditures. There are cases, of course, where costs are incurred to reduce the threats posed

[1] U.S. Department of Commerce, Bureau of the Census, *Government Finances*, various years.
[2] U.S. Department of Commerce, Bureau of Economic Analysis, various articles often entitled "Pollution Abatement and Control Expenditures," published periodically in the *Survey of Current Business*.

by pollution that initially is released into one medium but later impacts another. For the purposes of this report, however, costs to reduce pollutant emissions directly into a particular medium are allocated to that medium.

As mentioned above, the allocation of pollution control costs among different environmental media categories is bound to cause some overlap and confusion due to the cross-media nature of many environmental problems and the control programs used to address them. This is particularly true for many of the program areas included under the "land" medium, which have as one of their most important objectives the prevention and reduction of groundwater contamination. Yet, because programs such as those relating to hazardous waste disposal are concerned with pollution that is initially released primarily onto land, their costs are allocated to the land medium. Despite problems of overlap, it was felt that the advantages of this categorization scheme favored its use.

The four major environmental media categories also correspond roughly to the four major program offices within EPA, and follow from the major pollution control laws that EPA administers. They include:

- Air pollution and radiation control costs pursuant to:

  Clean Air Act; and
  Radon Gas and Indoor Air Quality Research Act of 1986, Radon Pollution Control Act of 1988, and earlier acts.

- Water pollution control costs pursuant to:

  Clean Water Act; Marine Protection, Sanctuaries and Research Act; and
  the Safe Drinking Water Act.

- Land pollution control costs pursuant to:

  Resource Conservation and Recovery Act; and
  Comprehensive Environmental Response, Compensation, and Liability Act.

- Chemical control costs pursuant to:

  Toxic Substances Control Act; and
  Federal Insecticide, Fungicide, and Rodenticide Act.

The fifth category, multi-media, includes those costs pursuant to:

Energy Security Act; and
Title III of the Superfund Amendments and Reauthorization Act.

Other non-media-specific EPA costs that are administered independently of the above programs are included in the following sections:

Management and support; and
Interdisciplinary.

1.2.3. Costs by Economic Sector

The cost estimates are also broken down by the economic sector that directly incurs them. Separate categories are included for:

- EPA costs;
- Non-EPA federal costs by other federal agencies;
- State government costs;
- Local government costs; and
- Private sector costs.

This classification is useful because it permits cross-sector evaluation. EPA and state government costs are primarily for program implementation, while non-EPA federal, local government, and private costs are largely associated with compliance activities.

1.2.4. New and Existing Regulatory Costs

Finally, distinctions are made among the following pollution control costs:

- **Costs of existing regulations**—those associated with regulations and programs that were substantially in place by 1987 and have achieved substantially full compliance with standards or attainment of goals;

- **Costs of new regulations**—those estimated to result from new or recently implemented regulations and programs (*i.e.*, those not substantially in place by 1987) and regulations currently under development or proposed by EPA; and

- **Costs of full implementation**—those that would arise from full attainment or full compliance with those existing laws, regulations, and programs for which the attainment deadline has passed but for which there was substantially less than full attainment by 1987. They include the costs of bringing all cities into attainment with the national ambient air quality standard for ozone and the costs to satisfy the nation's municipal wastewater treatment needs to bring about fishable/swimmable water quality.

The costs for existing regulations are based on survey data on historical expenditures and extrapolations from these. New regulation costs are based on *ex ante* estimates of the costs associated with new and forthcoming regulations derived in EPA regulatory impact studies. The

year 1987 is selected as the cut-off date because that is the last year for which survey data were available when the Report to Congress was prepared.

The estimates used to represent full implementation costs were derived from recent EPA analyses of wastewater treatment needs and measures required to reach substantially complete attainment of the air quality standards for ozone. Wastewater treatment costs were derived from a report to Congress on current and future municipal needs to bring about fishable/swimmable water quality and the estimated expenditures required to meet them. The ozone attainment costs were derived from EPA analyses of the ozone attainment costs associated with the Administration's original proposed amendments to the Clean Air Act.

In November 1990, President Bush signed the Clean Air Act Amendments of 1990. These contained provisions that are expected to result in higher costs than those contained in the Administration's original proposed amendments. As a result, the costs for the Amendments are expected to be significantly higher by the year 2000 than the estimates presented in this Report. This is discussed further in Section 3.2.

1.2.5. Costs by Year

Finally, cost estimates are presented over the period 1972-2000. The year 1972 was selected as the starting date because it represents the first year for which the Commerce Department collected reasonably complete cost data. The year 2000 was selected as the ending date because it is near enough so that reasonable cost projections can be made but far away enough to provide a useful perspective on future cost trends.

1.3. DATA SOURCES

The cost estimates were derived from five principal data sources. These are listed below along with the sections in which they are discussed.

1.3.1. U.S. Department of Commerce survey data on historical private and government expenditures;
1.3.2. EPA budget justification data on historical EPA expenditures;
1.3.3. EPA regulatory impact analyses data for new and proposed regulations; and
1.3.4. Special EPA analyses data for programs not covered by other data sources.

1.3.1. U.S. Department of Commerce Survey Data

The basic source of pre-1988 data for private, non-EPA federal, state, and local costs is the U.S. Department of Commerce. Data on private expenditures over the years 1972-1987 were obtained from a series of articles entitled “Pollution Abatement and Control Expenditures” (PACE reports), which are published periodically in the *Survey of Current Business* by the Bureau of Economic Analysis (BEA). These articles compile and organize data derived from a number

of sources, including two key agency surveys—the "Pollution Abatement Costs and Expenditures Survey" (PACE Survey) and the "Pollution Abatement Plant and Equipment Survey" (PAPE Survey)—which are conducted annually by the Census Bureau for BEA.

Annual cost estimates for non-EPA federal agencies are also gathered by BEA in their surveys; however, these data are not reported in the PACE reports. For this report, pre-1988 cost estimates for non-EPA federal agencies were thus derived directly from the PACE and PAPE survey results.

Data on state and local expenditures for the years 1972-87 are primarily from the results of an annual survey on governmental expenditures conducted by the Census Bureau and published in a series of annual reports entitled, *Government Finances*. The data, which are reported for fiscal years, were converted into calendar years.[3] Federal grants in each program area were subtracted from total expenditures, and interest on debt, where reported, was netted from annual expenditure data to isolate O&M costs.

Data on state and local expenditures for air pollution control were obtained from the PACE reports published in the *Survey of Current Business*.

1.3.2. EPA Budget Justification Data

The main source of data for EPA expenditures is the *Justification of Appropriation Estimates for Committee on Appropriations*. Outlays are shown for Fiscal Years 1972 through 1989 with budget projections of outlays shown for Fiscal Years 1990 and 1991, as reported in an annual attachment entitled "Summary of Budget Authority, Obligations, Outlays, and Workyears by Media."

1.3.3. Regulatory Impact Analyses Data

The basic sources of data for new and forthcoming regulations are Regulatory Impact Analyses (RIAs) and similar EPA analyses of major EPA regulations. RIAs have been prepared prior to the issuance of each major regulation since 1981 and include data on estimated compliance costs and benefits. Similar analyses for costs only were issued under different names before 1981. Table 2-3 of the Report to Congress lists those regulations for which RIA cost estimates have been used in this report; Appendix A of the Report contains summary information for each of these rules.

[3] To derive estimates for calendar year 1986, for example, one-half of the reported Fiscal Year 1986 estimate was added to one-half of the reported fiscal year 1987 estimate.

1.3.4. Special EPA Analyses Data

Where the above data sources did not provide adequate or reliable data, special analyses conducted by EPA program offices or contractors were used. In general, this is the case for those programs not involving air, water, or solid waste, since these are the media covered by the Commerce Department data. Cost estimates for the Superfund program, for example, relied on a special analysis. In addition, a special EPA analysis was undertaken to estimate the costs of air mobile source control because of particular EPA expertise in this area and because the Commerce Department data on mobile sources are not based on Commerce Department survey data.

1.4. CONVENTIONS USED

Several conventions were followed to project future costs and to convert cost estimates into constant dollars. These are discussed briefly below.

1.4.1. Projection Techniques

1.4.1.1. Existing Programs

Projecting future costs for existing programs is an attempt to predict what government and private sectors will spend to maintain compliance with existing pollution control requirements in the face of a changing economy and an expanding population.

Historical pollution control expenditures were linearly regressed against time and the resulting parameter estimates used to predict costs for future years. Use of this method assumes that trends in population growth, economic growth, compliance levels, and other factors that may affect pollution control costs will continue as in the recent past and will have similar influences on expenditures. All projections were calculated at the most disaggregated level of detail—municipal operating expenses for wastewater treatment plants, for example. Aggregations to national totals are arithmetic sums of component projections.

The estimated equations chosen for projecting costs for any regulation or program were those that best fit the individual time series data, considering recent trends in the data, the types of spending involved, and the maturity of the individual program. In a number of cases there were one or more significant changes in trend during the years for which data were available. In such cases, equations fit on the most recent clearly discernible trend were used.

1.4.1.2. New Regulations

For new and not fully implemented regulations and programs, this report used cost estimates contained in EPA's Regulatory Impact Analyses (RIAs). Capital costs were gathered from the RIAs associated with new regulations identified in each EPA program area. Future capital costs are presented on both annual demand for capital and annualized (amortized) bases.

To show the timing of capital costs for new regulations, capital costs were typically spread out in equal lumps over a relatively few years. This method of showing demands for capital results in graphs with erratic changes in aggregate capital costs from year to year. In practice, control capital is typically phased in more gradually over time, imposing smoother demands for capital over a five to ten year compliance period.

Operation and maintenance (O&M) costs for new regulations were also derived from the RIAs. For the most part, O&M costs were assumed to begin one year after a capital investment is made and to continue through the expected useful life of the capital facility. Under these assumptions, annual O&M costs peak in the year after the last increment of capital is put in place and continue at this level throughout the useful life of the capital. In certain cases, only annualized cost estimates were available for new or forthcoming regulations. In such cases, these estimates were reported under the O&M cost category.

1.4.2. Price Deflators Used

The price deflators shown in Table 1-1 of the Report to Congress were used to convert current dollars in to 1986 dollars, which is the year in which most dollars are denominated in this report. These include indices developed by the Bureau of Economic Analysis of the U.S. Department of Commerce for air, water, and solid waste costs, and the GNP implicit price index. For other media and programs, the GNP price index was used for operating costs, and the Construction Cost index compiled by the *Engineering News Record* was used for capital costs.

2. AGGREGATE POLLUTION CONTROL COSTS

General trends in total pollution control costs over time are discussed below. Total annualized costs and total capital costs for all pollution control programs are presented in Section 2.1 and 2.2, respectively. Cost breakdowns by economic sector are discussed in Section 2.3.

2.1. TOTAL COSTS

As shown in Table 2-1, total annualized costs at a seven percent discount rate for all pollution control efforts increased or are projected to increase as follows (figures for year 2000 are provided for both present and full implementation scenarios):

Total Annualized Costs	1972	1987	1990	2000	
				Present	Full
In billions of 1986 dollars	26	85	100	148	160
In billions of estimated 1990 dollars	30	98	115	171	185
As Percent of GNP	0.9	1.9	2.1	2.6	2.8

The difference between the full and present implementation estimates (as explained in Section 1.2.4 above) is that the latter includes the costs associated with nationwide attainment of the air quality standards for ozone and the costs to fulfill the nation's wastewater treatment needs. Congress passed new Clean Air Act legislation in October, 1990 that included provisions for attainment of the ozone standard. There is no current legislation or proposed regulatory action likely to bring about fulfillment of the wastewater treatment needs.

Yearly estimates of annualized costs for the period 1972-2000 under both alternative scenarios are shown in Figure 2-1. The full implementation scenario is represented by the sum of the costs for existing and new regulations plus full implementation costs. Existing regulations are estimated to account for about $127 billion of total annualized costs in the year 2000, new regulations for $21 billion, and full implementation for $13 billion.

Fig. 2-1: Total Annualized Costs by Type of Regulation

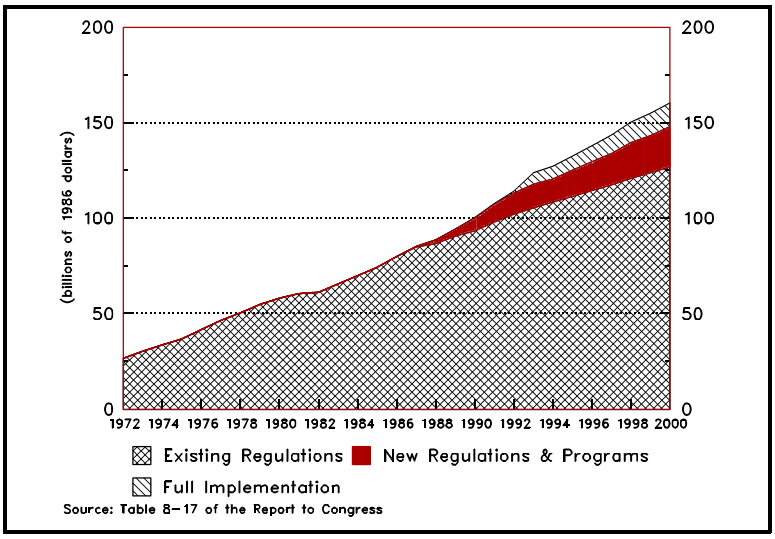


Table 2-1: Total Annualized Costs

(Assumes full implementation at seven percent. In millions of 1986 dollars)

Media	1972	1973	1974	1975	1976	1977	1978
Total Costs	26,481	30,261	33,614	36,842	41,572	46,509	50,482
Percent of GNP	0.88%	0.96%	1.07%	1.19%	1.28%	1.37%	1.41%
Air and Radiation, Total	7,934	9,598	10,182	11,156	12,686	14,460	15,998
Air	7,916	9,581	9,927	10,925	12,528	14,287	15,761
Radiation	18	17	255	232	158	173	237
Water, Total	9,912	11,484	13,439	15,126	17,419	19,391	21,078
Water Quality	9,110	10,600	12,441	13,991	16,125	17,940	19,445
Drinking Water	802	883	998	1,135	1,294	1,451	1,623
Land, Total	8,436	8,898	9,348	9,790	10,389	11,330	11,920
RCRA*	8,436	8,898	9,348	9,790	10,389	11,330	11,920
Superfund	**	**	**	**	**	**	**
Chemicals, Total	92	143	183	181	349	408	583
Toxic Substances	**	**	9	5	9	47	158
Pesticides	92	143	175	176	340	361	424
Multi-Media, Total	108	139	461	587	729	919	903

Media	1986	1987	1988	1989	1990	1991	1992
Total Costs	80,046	85,290	88,490	94,280	100,167	107,867	114,181
Percent of GNP	1.87%	1.92%	1.91%	1.98%	2.14%	2.26%	2.34%
Air and Radiation, Total	25,431	27,006	27,591	28,267	28,029	29,488	30,217
Air	25,077	26,679	27,238	27,872	27,588	29,005	29,692
Radiation	355	327	353	396	441	483	525
Water, Total	35,365	37,531	38,491	40,262	42,410	44,746	46,890
Water Quality	32,386	34,421	35,241	36,847	38,823	40,820	42,571
Drinking Water	2,979	3,111	3,250	3,415	3,587	3,926	4,319
Land, Total	17,511	19,092	20,318	23,013	26,547	29,753	32,956
RCRA*	17,107	18,409	19,388	21,664	24,842	27,629	30,139
Superfund	404	683	930	1,348	1,704	2,124	2,816
Chemicals, Total	822	819	910	1,255	1,579	1,885	2,130
Toxic Substances	402	365	456	558	600	799	960
Pesticides	420	453	454	697	979	1,085	1,170
Multi-Media, Total	918	842	1,180	1,483	1,603	1,995	1,989

* Includes solid waste, hazardous waste, and underground storage tank costs in all economic sectors whether mandated by RCRA or not.

** Program was not in existence.

Table 2-1: Total Annualized Costs (continued)

(Assumes full implementation at seven percent. In millions of 1986 dollars)

1979	1980	1981	1982	1983	1984	1985	1986	Media
54,824	57,969	60,539	61,237	65,477	69,925	74,021	80,046	Total Costs
1.49%	1.58%	1.62%	1.68%	1.74%	1.74%	1.78%	1.87%	Percent of GNP
17,134	17,854	18,397	18,844	20,780	22,324	23,513	25,431	Air and Radiation, Total
16,902	17,635	18,196	18,624	20,573	22,109	23,279	25,077	Air
232	219	201	220	207	215	233	355	Radiation
22,970	24,745	26,525	27,871	29,765	31,286	33,141	35,365	Water, Total
21,147	22,763	24,328	25,514	27,294	28,700	30,376	32,386	Water Quality
1,823	1,982	2,198	2,357	2,471	2,586	2,765	2,979	Drinking Water
12,981	13,612	14,131	13,204	13,630	14,972	15,908	17,511	Land, Total
12,981	13,612	14,116	13,145	13,518	14,737	15,596	17,107	RCRA*
**	**	15	59	112	235	312	404	Superfund
853	889	791	712	610	685	773	822	Chemicals, Total
345	429	367	315	237	245	303	402	Toxic Substances
508	461	424	397	374	440	470	420	Pesticides
886	868	695	606	692	657	687	918	Multi-Media, Total

1993	1994	1995	1996	1997	1998	1999	2000	Media
123,735	127,039	132,426	137,806	143,447	150,062	155,004	160,416	Total Costs
2.49%	2.50%	2.56%	2.61%	2.67%	2.74%	2.78%	2.83%	Percent of GNP
35,096	35,518	37,151	38,917	40,451	42,078	43,361	44,944	Air and Radiation, Total
34,528	34,905	36,493	38,212	39,699	41,278	42,513	44,049	Air
568	613	659	705	752	800	847	896	Radiation
49,017	51,212	53,543	55,769	57,916	60,104	62,197	64,134	Water, Total
44,430	46,295	48,194	50,085	51,967	53,840	55,706	57,563	Water Quality
4,586	4,917	5,350	5,684	5,949	6,264	6,491	6,571	Drinking Water
35,247	35,836	37,158	38,402	40,247	42,938	44,388	46,148	Land, Total
31,808	31,787	32,468	33,106	34,289	36,293	37,033	38,055	RCRA*
3,439	4,050	4,690	5,296	5,958	6,645	7,355	8,093	Superfund
2,348	2,408	2,472	2,580	2,657	2,721	2,799	2,892	Chemicals, Total
1,091	1,104	1,119	1,174	1,192	1,206	1,217	1,234	Toxic Substances
1,257	1,305	1,353	1,407	1,465	1,516	1,582	1,658	Pesticides
2,027	2,065	2,102	2,138	2,177	2,220	2,260	2,298	Multi-Media, Total

Sources: Tables 8-3 and 8-6 of the Report to Congress

In order to provide a frame of reference to make it easier to judge the relative importance of environmental costs compared to a well-known aggregate measure of economic activity, a comparison can be made with Gross National Product (GNP). Annualized costs as a percentage of GNP are shown graphically in Figure 2-2 for both scenarios. In order to compute total pollution control costs as a percentage of GNP for future years, data on GNP over the period 1972-1989 (in constant 1986 dollars) were linearly extrapolated to years 1990-2000.

Although total annualized costs are increasing, they are increasing at a decreasing rate. As shown in Figure 2-3, the yearly rate of increase in total annualized costs decreased from 14 percent between 1972 and 1973 to six to eight percent in the mid-1980s and is projected to fall further to about three percent in the late 1990s (assuming full implementation).

Fig. 2-2: Total Annualized Costs as a Percentage of GNP

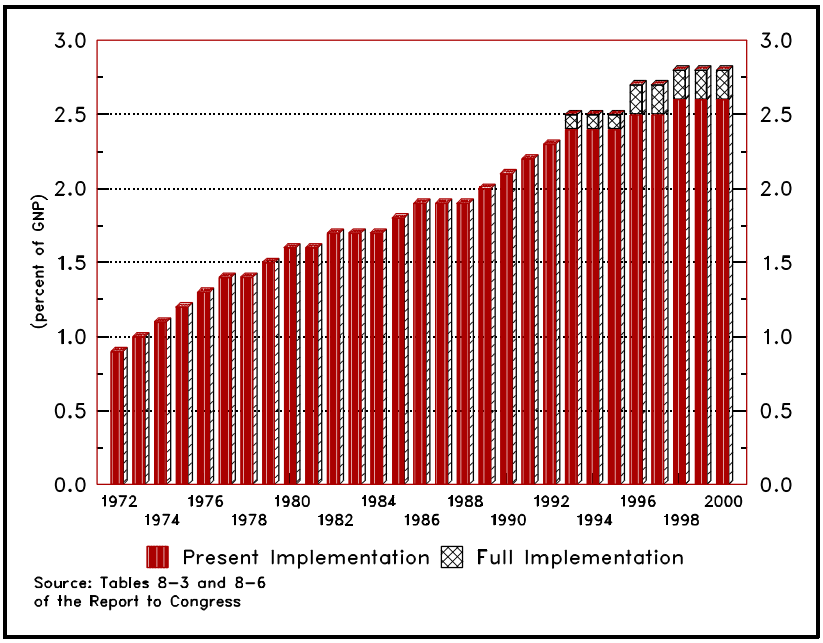
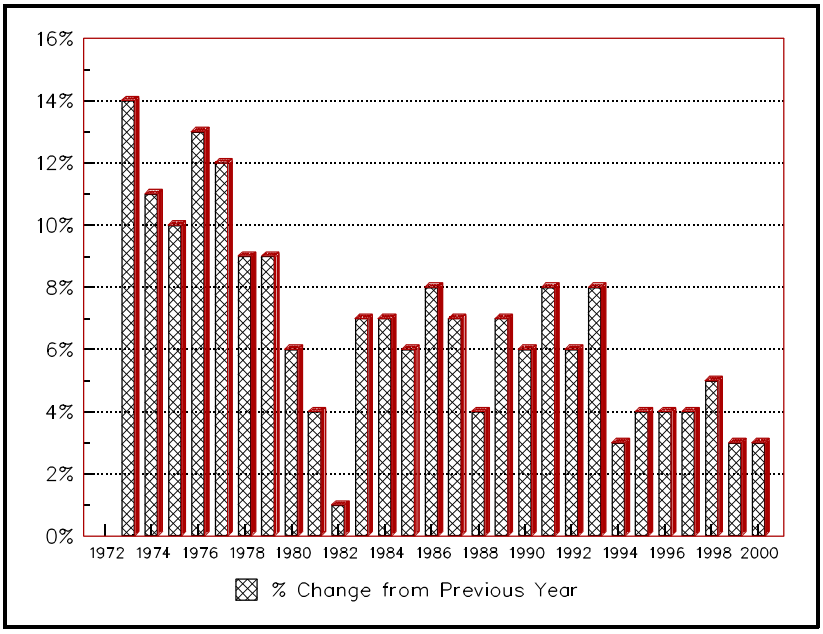


Fig. 2-3: Percent Change in Annualized Costs



2.2. TOTAL COSTS BY FUNDING SOURCE

Fig. 2-4: Total Annualized Costs by Funding Source

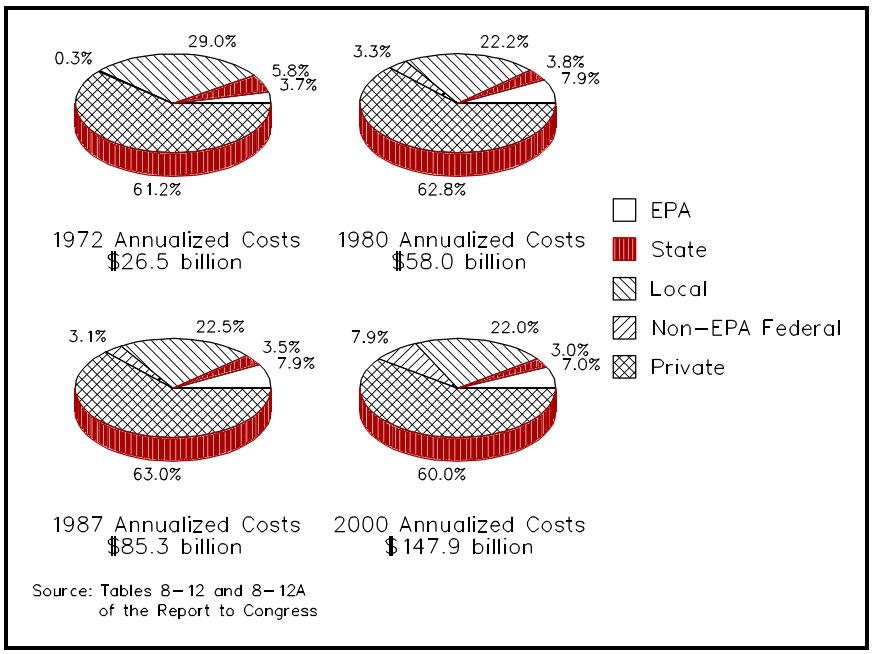


Figure 2-4 shows total annual costs by funding source under the present implementation scenario. It should be noted that the totals are different than those shown in Table 2-1 because the costs are for the present rather than the full implementation scenario. The data indicate that the share of total annualized costs incurred by state and local governments fell during the 1970s at the expense of the federal government, which was expanding its environmental involvement, while private sector costs remained relatively stable. During the period 1980-87, there was remarkable stability in the cost shares. The future projections, however, are for a rapid growth in the federal share with a corresponding reduction in all other shares, particularly the private sector, over the period 1987-2000. The primary reason for this is the projected 140 percent increase in non-EPA federal costs, primarily due to proposed Department of Defense and Department of Energy expenditures on military and nuclear waste clean-up.

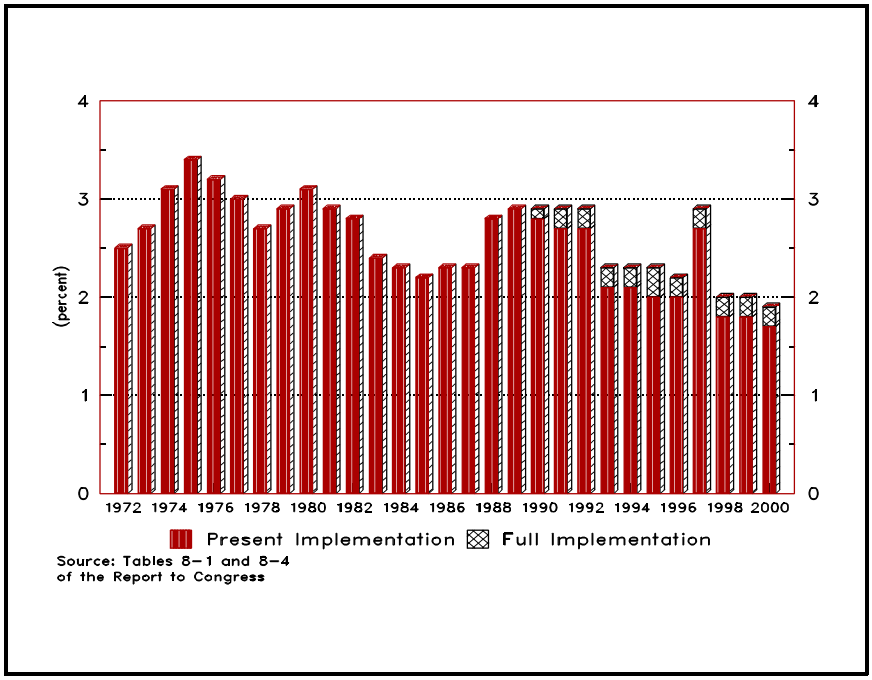
2.3. TOTAL CAPITAL EXPENDITURES

Total capital costs can be summarized as follows:

Pollution Control Capital Investment	1972	1987	1990	2000	
				Present	Full
In billions of 1986 dollars	20	30	41	30	39
In billions of 1990 dollars	23	35	47	35	45
As Percent of Total Capital Investment	2.5	2.3	2.8	1.7	1.9

In more detail, total capital expenditures were relatively stable at about $25-30 billion annually over the period 1975-1987. There is expected to be a significantly higher level of capital expenditures during the period 1988-1992, however. Capital expenditures are estimated to reach $43 to 46 billion in 1992 (depending on whether the present or full implementation scenarios are used), followed by falling levels over the years 1993-2000 except for a large jump in 1998. Capital expenditures are expected to reach $47 to 51 billion in 1998 due to over $10 billion in capital investment for the upgrade/replacement of underground storage tanks in that year. Capital expenditures are then expected to fall back to roughly $36 to 39 billion over years 1999-2000.

Fig. 2-5: Environmental Capital Investment as a Percentage of Total Investment



To put these estimates in perspective, it is useful to compare capital investment in pollution control as a percentage of total national investment in plant and equipment over time. Figure 2-5 shows the highest percentages were in the mid-1970s at a little over three percent. These rates were somewhat lower over the period 1978-1982, and even lower over the next five years. Pollution control capital costs were an estimated 2.3 percent of national capital expenditures in 1987. This percentage is estimated to have jumped to 2.9 percent in 1989, but is projected to fall steadily over the period 1990-1996—to a low of two to 2.2 percent in 1997. After a jump to 2.7 to 2.9 percent in 1998 due to large capital outlays for the upgrade/replacement of underground storage tanks, rates are expected to resume this fall, dropping to 1.7 to 1.9 percent by the year 2000.[1] It should be noted, however, that future capital costs may be understated relative to operating costs.[2]

[1] In order to compute capital investment in pollution control as a percentage of total capital investment for future years, data on total national plant and equipment expenditures over the period 1972-1988 (in constant 1986 dollars) were linearly extrapolated to years 1989-2000.

[2] See Section 8.1.1 of the Report to Congress.

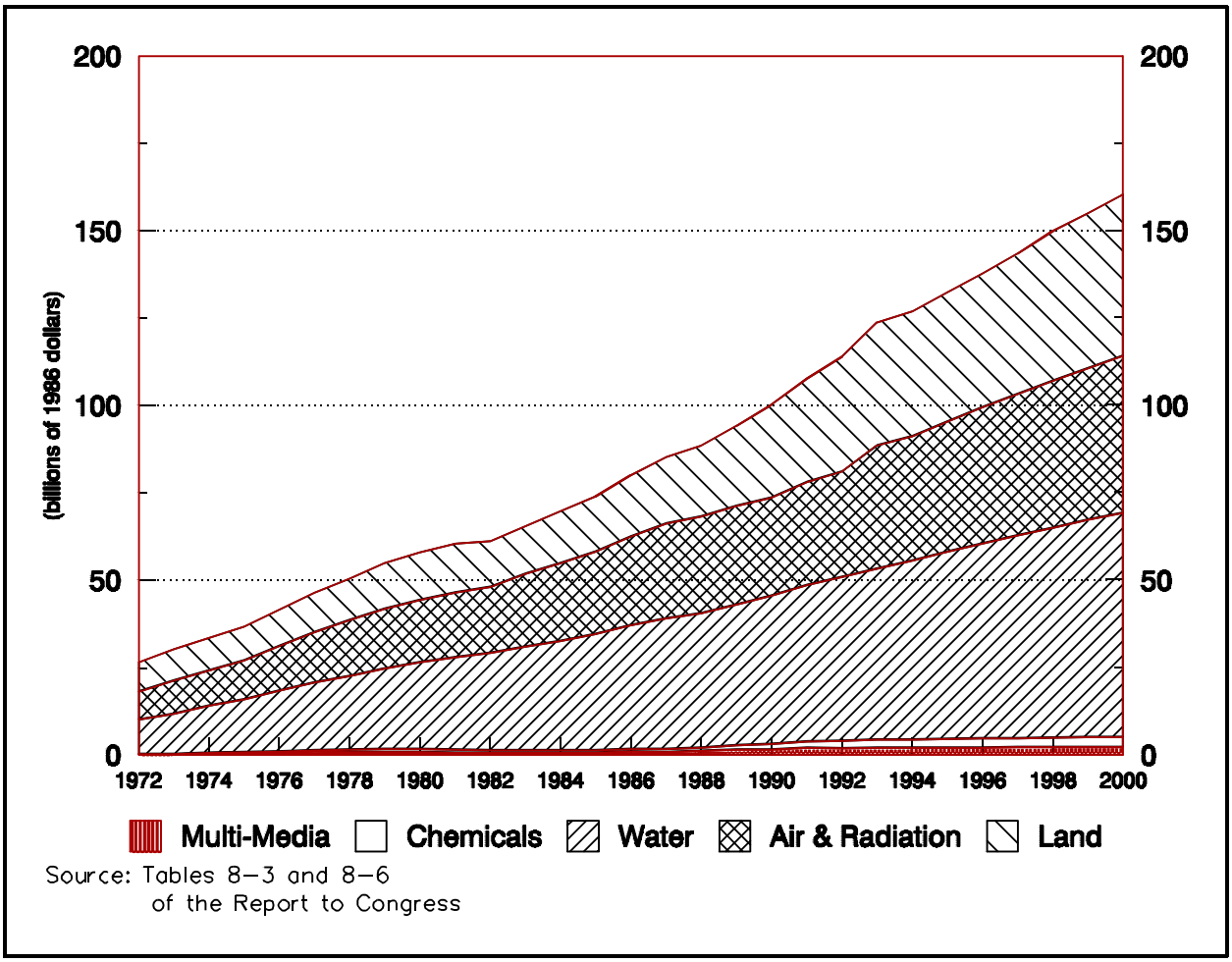
3. COSTS BY ENVIRONMENTAL MEDIUM AND PROGRAM

This Chapter summarizes annualized costs assuming full implementation by medium and within each medium by major EPA program and sub-program where data are available. The same data are presented for each year between 1972 and 2000 in Table 2-1 for all media at the primary program level. The data presented in this Chapter provides a sub-program level of detail not found in Table 2-1, but not on a yearly basis.

3.1. COSTS BY ENVIRONMENTAL MEDIUM

Figure 3-1 shows a breakdown of total pollution control expenditures by environmental medium in order to provide an overall perspective. This shows each of the five media which will be discussed in the rest of this Chapter.

Fig. 3-1: Total Media Costs Annualized at 7%, Assuming Full Implementation



Source: Tables 8–3 and 8–6 of the Report to Congress

3.2. AIR AND RADIATION POLLUTION CONTROL COSTS

As shown in Table 3-1, the air and radiation pollution control program has been disaggregated first into air and radiation. Air pollution control, in turn, has been broken down into mobile and stationary source control and a residual, undesignated category of EPA costs that cannot be broken down between the other two. Mobile source control includes emissions control on all motor vehicles and other transportation sources such as airplanes.

Table 3-1: Annualized Air & Radiation Pollution Control Costs

(millions of 1986 dollars)

Program	Year				
	1972	1980	1987	1995	2000
Air Pollution Total	7,916	17,635	26,679	36,493	44,049
Stationary Source	6,230	13,298	18,960	25,118	29,725
Mobile Source	1,345	4,010	7,469	11,097	14,140
Undesignated Source	341	327	250	207	184
Radiation	18	219	327	659	896
Total Air & Radiation	7,934	17,854	27,006	37,151	44,945

Source: Table 3-3 of the Report to Congress

Annualized air and radiation pollution control costs have increased steadily since the passage of the Clean Air Act in 1970. As shown in Table 3-1, total costs increased from almost $8 billion in 1972 to an estimated $27 billion in 1987. Stationary source air pollution control costs accounted for approximately 67-74 percent of total costs during this period, while radiation control programs accounted for less than two percent. In the future, costs associated with existing programs are expected to rise only slightly. The Clean Air Act Amendments of 1990, however, will significantly increase the costs of new regulations in the future. This report was prepared using the January 1990 cost estimates of the original Administration proposal. At that time, it was estimated that the Administration's strategies for addressing ozone, acid rain, and air toxics would add about $5.8 billion in control costs by 1995 and roughly $14.6 billion by the year 2000. In sum, a revision of the Clean Air Act along the lines of the Administration's proposal would have pushed total annual air and radiation pollution costs to over $34.5 billion by 1993, to $39.6 billion by 1997, and to $45 billion by the year 2000. Stationary source costs would account for approximately 67 percent of total future air pollution control costs.

Since the time that these cost estimates were prepared, the estimated costs for the Administration proposal have been adjusted upward due to revisions in air toxics cost estimates. Estimates of the costs of the Senate and House bills were higher than the original Administration

proposal, mainly due to requirements for tighter tailpipe standards, reformulated gasoline, and oxygenated fuels. Due to these modifications, the costs of the Clean Air Act Amendments may be significantly higher than the estimates presented in this report.

3.3. WATER POLLUTION CONTROL COSTS

As shown in Table 3-2, water pollution control costs have been disaggregated first between water quality and drinking water. Drinking water costs are those associated with the treatment of drinking water supplies to improve their quality for human consumption. Water quality costs are defined as those pursuant to the Marine Protection, Sanctuaries and Research Act of 1972 and the Clean Water Act as amended in 1987. Water quality is then broken down by "point" and "non-point" sources. Non-point source expenditures are those incurred to control pollution from sources other than single, specific locations. Non-point sources include land runoff, precipitation, drainage, and seepage, including agricultural storm drainage, and irrigation return flows.

Table 3-2: Annualized Water Pollution Control Costs

(millions of 1986 dollars)

Program	Year				
	1972	1980	1987	1995	2000
Water Quality Total	9,110	22,763	34,421	48,194	57,563
Point Source	8,543	22,116	33,642	47,300	56,604
Non-point Source	567	647	779	893	959
Drinking Water	802	1,982	3,111	5,350	6,571
Total Water	9,912	24,745	37,532	53,543	64,134

Source: Table 4-3 of the Report to Congress

Total annual water pollution control costs increased steadily over time, from about $9.9 billion in 1972 to $37.5 billion in 1987. Costs associated with point source control accounted for over 90 percent of these expenditures. Most of the historical point source control costs are due to local expenditures for sewerage services and wastewater treatment and to private expenditures for the control of industrial effluents and the pretreatment of wastewater discharges to treatment facilities. Future costs are expected to increase significantly, reaching a projected $58 billion by the year 2000. These future costs are also driven primarily by point source control expenditures by local governments and the private sector. Moreover, if the costs associated with fulfilling the nation's current and projected future municipal wastewater treatment needs are included, total costs would reach $64 billion by the year 2000.

3.4. LAND POLLUTION CONTROL COSTS

Land pollution control costs are presented in Table 3-3. They are broken down into two major components: those pursuant to or related to the Resource Conservation and Recovery Act (RCRA) and subsequent amendments (such as the Hazardous and Solid Waste Amendments of 1984 or HSWA), and those pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) and subsequent amendments. RCRA programs are directed towards current solid and hazardous waste management practices, while the Superfund program involves the remediation of damages resulting from past waste disposal at sites not currently actively managed. RCRA costs are further broken down into solid waste, hazardous waste, and underground storage tank (UST) costs. Solid waste costs are those pursuant to Subtitle D of RCRA, including public and private expenditures for solid waste collection, transportation, and disposal. Hazardous waste costs are those pursuant to RCRA Subtitle C. UST costs are those pursuant to Subtitle I, such as those resulting from the technical standards and financial responsibility requirements for petroleum-containing underground storage tanks.

Table 3-3: Annualized Land Pollution Control Costs

(millions of 1986 dollars)

Program	Year				
	1972	1980	1987	1995	2000
RCRA Total	8,436	13,612	18,409	32,468	38,055
Solid Waste	8,436	13,612	16,683	20,338	22,302
Hazardous Waste	**	**	1,725	9,210	12,062
Underground Storage Tanks	**	**	1	2,920	3,691
Superfund	**	**	683	4,690	8,093
Total Land	8,436	13,162	19,092	37,158	46,148

** Program was not in existence.

Source: Table 5-3 of the Report to Congress

Total annual costs associated with land pollution control, including costs for solid waste collection and disposal services, increased steadily from approximately $8.4 billion in 1972 to $19 billion in 1987. Future costs are expected to rise dramatically, due primarily to new and forthcoming hazardous waste and UST regulations and increased levels of activity under Superfund. Land pollution control costs are expected to be $25.6 billion in 1990, increasing to $37 billion by 1995, and to $46 billion by the year 2000. Hazardous waste, UST and Superfund are expected to account for 35 percent of these costs by 1990, 43 percent by 1995, and by more than 50 percent by the year 2000.

3.5. CHEMICAL POLLUTION CONTROL COSTS

Chemical pollution control costs are presented in Table 3-4. They are broken down into toxic substance and pesticide control costs. Toxic substance costs involve costs to determine and control the hazards posed by the manufacture, use, and transport of useful chemicals other than pesticides. Pesticide costs relate to the costs of control of the use of insecticides, rodenticides, herbicides, and fungicides.

Table 3-4: Annualized Chemical Pollution Control Costs

(millions of 1986 dollars)

Program	Year				
	1972	**1980**	**1987**	**1995**	**2000**
Toxic Substances	**	429	365	1,119	1,234
Pesticides	92	461	453	1,353	1,658
Total Chemicals	92	889	818	2,472	2,892

** Program was not in existence.
Source: Table 5-3 of the Report to Congress

Total annual costs of chemical control increased from $92 million in 1972 to $889 million in 1979. Costs were lower in subsequent years, averaging $680 million over the period 1980-1988. Private sector pesticide control costs accounted for over 40 percent of these expenditures. Total costs are expected to increase significantly over the next several years, reaching $2.4 billion in 1995 and $2.9 billion by the year 2000. Private expenditures for pesticide control are projected to increase to an estimated $1.6 billion by the year 2000. The increase in private pesticide costs is due to an expected steady rise in costs for pesticide research and development, cancellations and suspensions, and increased farmworker safety and applicator training and certification costs. These cost increases reflect accelerated levels of pesticide re-registration activity and more stringent pesticide applicator and farmworker safety requirements mandated by the 1988 FIFRA Amendments.

3.6. MULTI-MEDIA COSTS

The multi-media control costs include all those costs that cannot easily be allocated to any specific medium. Five categories are included in Table 3-5: EPA management and support, the EPA energy research program, the EPA interdisciplinary research program, the Emergency Planning and Community Right to Know Act (EPCRA), and undesignated non-EPA federal costs. EPA Management and Support expenditures provide executive direction and policy oversight for

all EPA programs as well as administrative and support services not assigned to specific programs. The EPA Energy Program is a multi-media research and development effort aimed at providing scientific information for the evaluation of environmental impacts from, and the potential controls on, the nation's energy sector. The EPA interdisciplinary Program addresses environmental issues that affect several media and require an interdisciplinary approach. The EPCRA Program, also known as SARA Title III, sets requirements for federal, state, and local governments and industry regarding emergency planning and community-right-to-know reporting on hazardous and toxic chemicals. The undesignated non-EPA federal category are those non-EPA federal costs for environmentally-related activities that have not been broken down by media.

Table 3-5: Annualized Multi-Media Pollution Control Costs

(millions of 1986 dollars)

Program	Year				
	1972	**1980**	**1987**	**1995**	**2000**
Management & Support	96	214	276	399	460
Energy	**	183	54	6	0
Interdisciplinary	11	37	59	138	184
EPCRA	**	**	**	916	916
Undesignated	**	434	453	642	738
Total Multi-Media	108	868	842	2,102	2,298

** Program was not in existence.
Source: Table 7-3 of the Report to Congress

Total annual costs for multi-media environmental programs increased from $108 million in 1972 to $869 million in 1980. Over 50 percent of these expenditures are non-EPA federal costs, and approximately 25 percent are EPA costs for its management and support programs. During the period 1981-1987, annual costs for multi-media programs averaged $728 million. Future annual costs are expected to rise significantly, largely due to the costs associated with the recently implemented EPCRA provisions. Annual costs are expected to increase from an estimated $842 million in 1987 to $2.3 billion by the year 2000. The EPCRA provisions are expected to account for approximately 45 percent of these costs; undesignated non-EPA federal programs, 32 percent; and EPA management and support programs, 15 percent.

4. COST COMPARISONS AND CONCLUSIONS

The cost estimates presented in this report, together with data from other recent EPA studies, permit some interesting comparisons of pollution control costs. This Chapter discusses five such cost comparisons, and some general conclusions that follow from these and others made in Chapter 2.

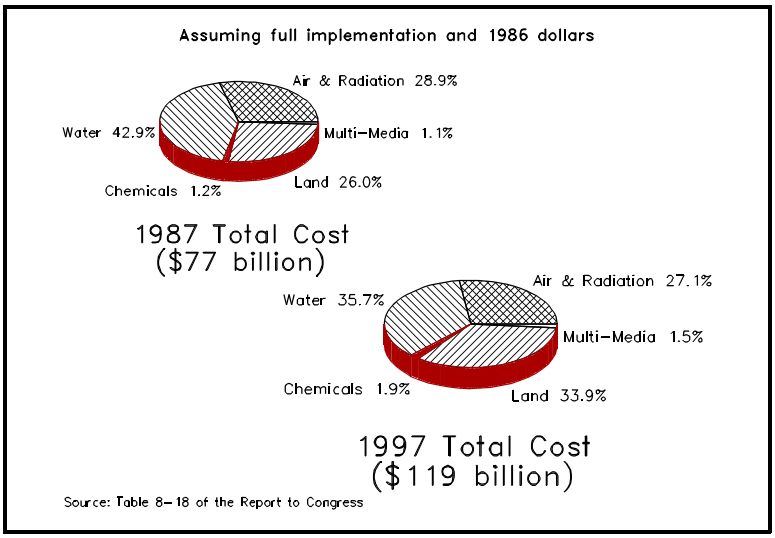
4.1. COST COMPARISONS

Below, comparisons of costs over time are discussed for the following categories of pollution control costs and expenditures:

4.1.1. Environmental media expenditure shares;
4.1.2. Comparisons with other U.S. expenditures from Gross National Product;
4.1.3. Cost burdens on local governments;
4.1.4. Long term trends in total costs; and
4.1.5. International pollution control expenditures.

4.1.1. Environmental Media Expenditure Shares

Fig. 4-1: Percentage of Capital Plus Operating Expenditures by Medium



The first comparison involves the shares of total U.S. expenditures accounted for by different environmental media over time. The sum of capital and operating expenditures is used for these comparisons since this measure of costs does not include interest and depreciation costs on past capital investments and thus illustrates near-term future trends more clearly than annualized costs. The total expenditures measure differs from the total annualized costs measure discussed in previous chapters. Annualized costs reflect the sum of operating and amortized capital costs. Amortized capital costs represent depreciation and interest charges on the stock of capital in use as of that year. The total expenditures measure, on the other hand, represents total operating costs plus the total value of capital equipment purchased in that year alone. It thus includes total monetary outlays in a particular year and excludes depreciation and interest charges on past capital investments. As discussed in Section 1.2.1, this measure is referred to as "total expenditures" to distinguish it from "annualized costs."

The most significant increase in total expenditures is expected in the land medium. As shown in Figure 4-1 in percentage terms, land expenditures are estimated to increase from 26 percent of total expenditures in 1987 to 34 percent by the year 1997. On the other hand, the share of water expenditures over these years is projected to fall from 43 percent of total expenditures in 1987 to 36 percent in 1997, while the share of air expenditures is expected to fall only slightly from 29 to 27 percent. Since there estimates assume full implementation, the fall in the share of water expenditures would be even greater if the full implementation assumptions with regard to water are not fulfilled.

Figure 4-2 shows that total expenditures for existing land programs are projected to increase steadily over the period 1987-2000. The increase in land expenditures associated with new regulations follows a less regular trend. Expenditures for new regulations are expected to increase rapidly over the period 1987-1992. By 1992, new regulations will account for an estimated 33 percent of total land expenditures. Expenditures for new regulations are expected to fall off considerably over the next few years to roughly one-half the 1992 level. However, expenditures for new land regulations are expected to jump again in 1998 and then fall back to the mid-1990 trend over years 1999-2000.

Fig. 4-2: Total Land Capital Plus Operating Expenditures by Type of Regulation

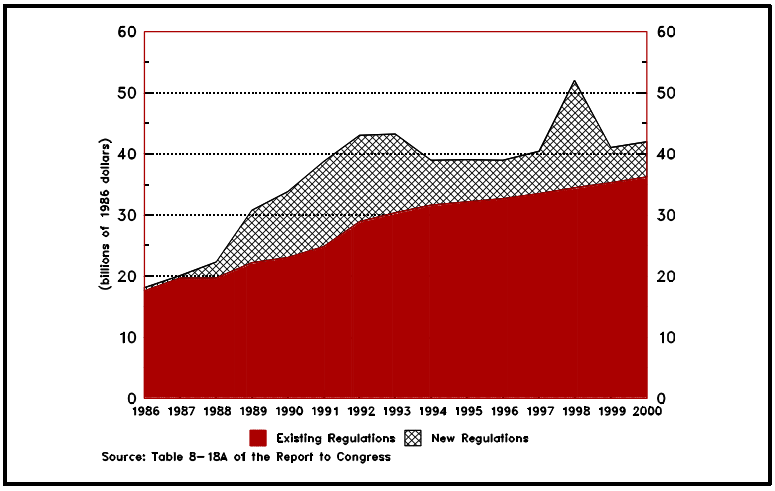


Figure 4-3 shows that the two jumps in new regulation expenditures are due largely to expenditures associated with new rules for underground storage tanks (UST). The first jump is due in part to large UST corrective action expenditures; the second jump is due primarily to large capital expenditures for the upgrade/replacement of tanks in 1998, the regulatory deadline for such action. The UST expenditures are broken out in Figure 4-4.

Fig. 4-3: Total Land Capital Plus Operating Expenditures by Program

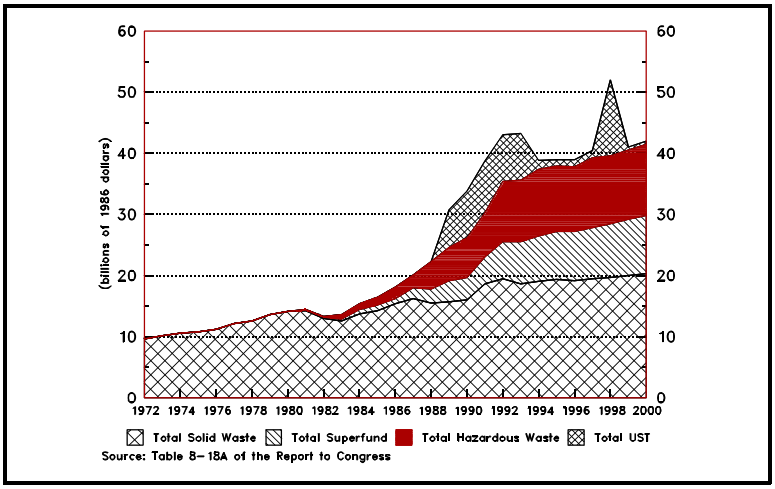


Figure 4-3 shows that solid waste is expected to account for the largest share of land expenditures over the period 1987-2000, followed by hazardous waste, Superfund, and UST. The large majority of solid waste expenditures are for local government and private sector trash collection and disposal activities, however, most of which do not result from federal laws and regulations. As shown in Figure 4-5, new federal solid waste regulations are expected to account for only 15 percent of total solid waste expenditures in 1992, decreasing to about ten percent in subsequent years.

Fig. 4-4: Solid Waste Capital Plus Operating Expenditures by Type of Reg.

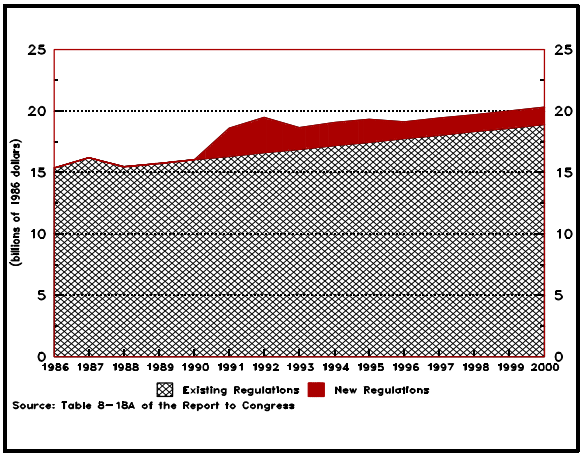


Fig. 4-5: UST Capital Plus Operating Expenditures by Type of Regulation

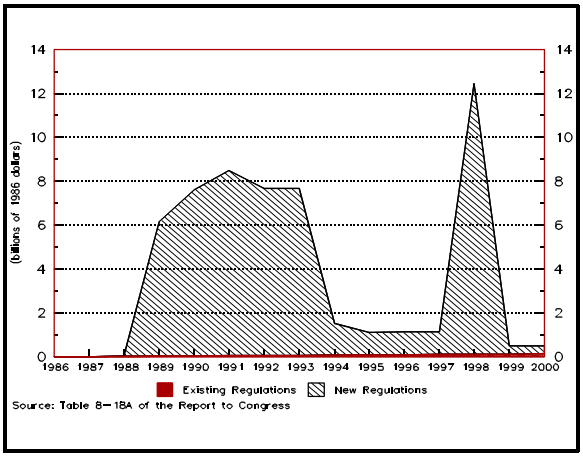
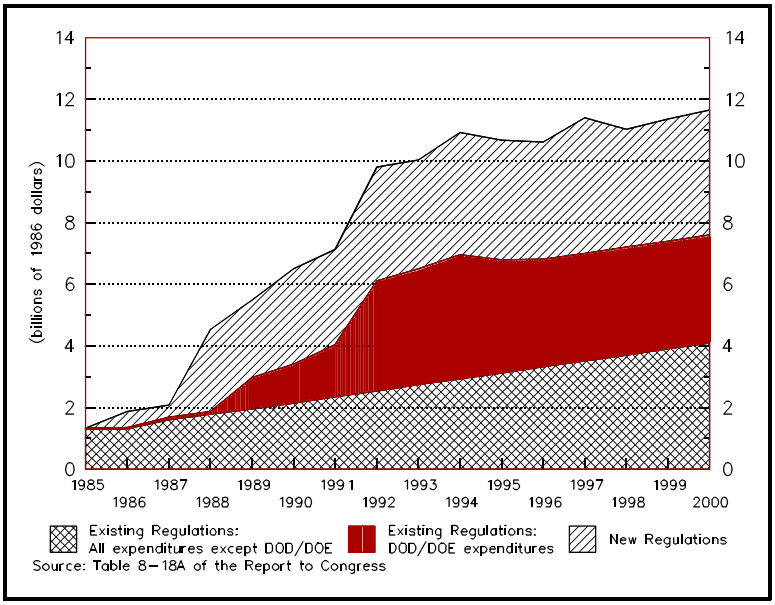


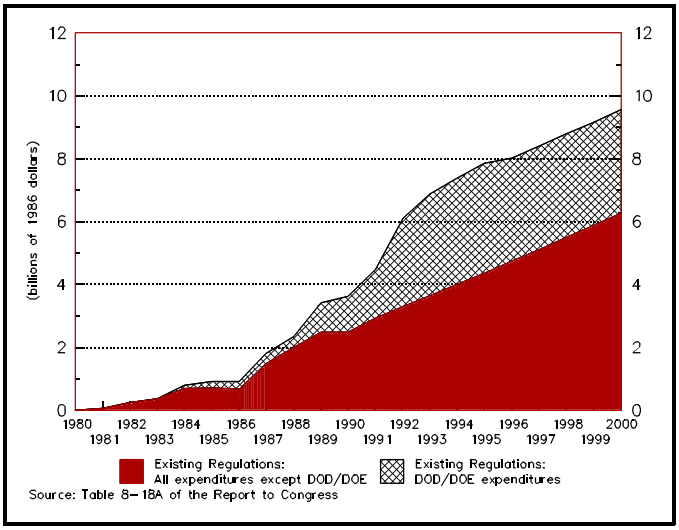
Figure 4-6 breaks out hazardous waste expenditures by existing and new regulations and also shows that portion of existing regulation expenditures expected to be incurred by the U.S. Department of Energy (DOE) and the U.S. Department of Defense (DOD). This figure shows that existing regulations will account for roughly 64 percent of total hazardous waste expenditures over the period 1992-2000. An average of about 52 percent of these expenditures for existing regulations over the period will be incurred by DOE and DOD.

Fig. 4-6: Hazardous Waste Capital Plus Operating Expenditures by Type of Regulation



Finally, Figure 4-7 shows total Superfund expenditures and that portion of the total expected to be incurred by DOE and DOD. Superfund expenditures are estimated to increase rapidly over the period 1987-2000, and DOE and DOD together are expected to account for an average of approximately 35 percent of the total over the period.

Fig. 4-7: Superfund Capital Plus Operating Expenditures by Type of Regulation



4.1.2. GNP Expenditure Shares

Another comparison which can be made using the total expenditures data is how environmental pollution control expenditures compare with other national expenditures familiar to the individual citizen. These comparisons can be made in terms of percentages of Gross National Product (GNP) as follows:

COMPARATIVE U.S. EXPENDITURES AS PERCENT OF GNP	1980	1987
Environmental Pollution Control[1]	1.8	1.7
Clothing and Shoes[2]	3.6	4.2
National Defense[2]	5.4	6.9
Medical Care[2]	6.3	7.0
Housing[2]	9.8	9.3
Food[2]	12.4	11.7

[1] From Table 8-19 of the Report to Congress. Assumes full implementation.
[2] From *Economic Report of the President*, January 1989, Tables B-2 and B-11.

As can be seen, environmental pollution control represents a small fraction of the expenditures on many of the major components of GNP.

4.1.3. Cost Burdens on Local Governments

A third interesting comparison involves local government pollution control costs over time. The estimates presented in Chapter 2 suggest that although the percentage share of costs funded by local government is not projected to change much, total annualized dollar costs to local governments will increase substantially over the period 1987-2000. Annual local government

costs under the full implementation scenario are expected to increase from $19 billion in 1987 to over $32 billion by the year 2000, a 69 percent increase. Increases in local costs are driven primarily by costs for wastewater treatment and by revisions to several environmental laws in recent years that establish broader and more stringent standards for drinking water treatment, sewage sludge disposal, and solid waste disposal.

A more detailed examination of the economic impacts of environmental pollution control regulations at the local level can be found in the *Municipal Sector Study*[1] released by EPA in 1988. This report was part of a larger study that summarized the economic impacts of expanding pollution control requirements on municipalities, small business, and agriculture.[2]

Table 4-1: Potential Increases in Annual Charges by City Size by 2000

		Types of Regulations (1986$s per household)				
Municipal Population	Number of Cities	Waste Water	Drinking Water	Solid Waste	Other	Total
0 - 2,500	26,315	45	40	26	59	170
2,500 - 10,000	6,279	20	15	23	32	90
10,000 - 50,000	2,694	20	5	32	23	80
50,000 - 250,000	463	20	10	28	12	70
Over 250,000	659	60	15	51	34	160

Note: User charge increases have been calculated using weighted average costs of new regulations. The costs that a municipality may incur will depend on the regulations it has to comply with.

Source: U.S. Environmental Protection Agency, *The Municipal Sector Study: Impacts of Environmental Regulations on Municipalities*, Office of Policy, Planning and Evaluation, Report EPA-230-09/88-038, September, 1988, p. v.

The *Municipal Sector Study* found that new and forthcoming pollution controls on local governments will require significant additional capital investments and increases in rates charged to customers for expanded environmental services. It is estimated that in the coming years the average household will be charged an additional $100 annually for locally-provided environmental services. Those municipalities with populations under 2,500 and over 250,000 will experience the greatest increases in total user costs on a per household basis, with average additions to annual user charges and fees of $170 and $160, respectively (see Table 4-1). When these costs are added

[1] U.S. EPA, *The Municipal Sector Study: Impacts of Environmental Regulation on Municipalities*, Report No. 230-09-88-038, September 1988.

[2] U.S. EPA, *Municipalities, Small Business, and Agriculture: The Challenge of Meeting Environmental Responsibilities*, Report No. 230-88-037, September 1988.

to projected increases in costs necessary to maintain current services, average household costs in the year 2000 are estimated to be 60 to 120 percent higher than 1986 costs. Municipalities with populations under 2500 are expected to experience costs in the upper end of this range. Because smaller municipalities tend to have lower average household incomes and higher unit costs for improved environmental services, households in smaller communities will be required to pay a greater proportion of their incomes on average than households in larger cities for comparable environmental services. Households in communities with populations under 2,500 will pay an average 0.7 percent of their incomes for environmental services while those in larger cities will pay, on average, 0.5 percent.

Most municipalities are expected to be able to meet the estimated increases in environmental expenses and still remain financially sound. The municipalities most likely to experience difficulties will be those with populations of 2,500 or less. Between 21 percent and 30 percent of these communities may experience difficulties because of the high costs of certain individual regulations, the cumulative costs of recent legislative requirements, and the limited margin for expanding financial obligations in small communities. Such difficulties are not limited to small cities, but it is estimated that a much smaller proportion (between three and seven percent) of cities with populations over 2,500 persons will face financial problems as a result of EPA requirements.

The individual environmental regulations that account for the largest potential cost increases to small municipalities are sewage treatment and new drinking water treatment requirements. Several of the more costly drinking water regulations will apply to a greater proportion of smaller municipalities than larger municipalities since they deal with environmental risks that are more often found in smaller community water systems. Many larger water supply systems already have introduced treatment systems to control such risks. The costs of solid waste disposal, asbestos removal in schools, and underground storage tank regulations also account for a significant portion of the additional costs expected to be borne by smaller communities.

4.1.4. Long Term Trends in Total Costs

As discussed in Section 2.1, a comparison of total annualized costs over the period 1972-2000 shows that pollution control costs in constant dollars and as a percentage of GNP have increased over time, but at a decreasing rate of increase, and are expected to do so through the year 2000. In the year 2000, costs are expected to be more than 70 percent higher than year 1987 levels under the present implementation scenario, which includes costs for all current and planned pollution control programs. Year 2000 costs are estimated to be over 85 percent higher than 1987 levels under the full implementation scenario, which includes the costs of achieving the ozone National Ambient Air Quality Standard nationwide and the expenditures needed to fulfill the nation's wastewater treatments needs, in addition to costs for all current and planned programs. Since the ozone standard is more likely to be implemented, given the enactment of the Clean Air Amendments of 1990, than the wastewater treatment needs are to be met, the most likely projected costs would seem to be between the present and full implementation projections. On the other hand, as discussed in Section 3.2, the cost estimates for the Clean Air Act Amendments

appear likely to be higher than those used in this report. A case can therefore be made that the costs may lie nearer the full than the present cost projections.

Beyond the year 2000, the difficulty of projecting costs becomes even greater. The Clean Air Act Amendments envision increasing costs beyond the year 2000. The annual costs for the Administration's Clean Air Bill included in this report are estimated to be $4 to $7 billion higher by the year 2005 than in 2000. The trend also points upward, but at a decelerating rate of increase. All of this suggests continued cost increases beyond the year 2000, at least until 2005.

4.1.5. International Pollution Control Expenditures

Comprehensive estimates of pollution control costs in other developed countries are available for certain Western European nations only. However, these estimates are expressed in terms of total pollution control expenditures—capital outlays plus operating costs—instead of in annualized terms.[3] As discussed in Section 4.1.1, the total expenditures measure differs from the total annualized costs measure discussed throughout the previous chapters. In addition, the pollution control expenditure estimates reported by most of the European nations include non-household expenditures only. To permit comparisons of U.S. costs with those in the other countries, the U.S. estimates are adjusted to reflect non-household expenditures for pollution control as well as total expenditures.

[3] These cost estimates are reported in: Organization for Economic Cooperation and Development, *Pollution Control and Abatement Expenditure in OECD Countries: A Statistical Compendium*, OECD Environment Monographs No. 38, November 1990, p. 40.

Table 4-2: Capital Plus Operating Expenditures for Some OECD Countries

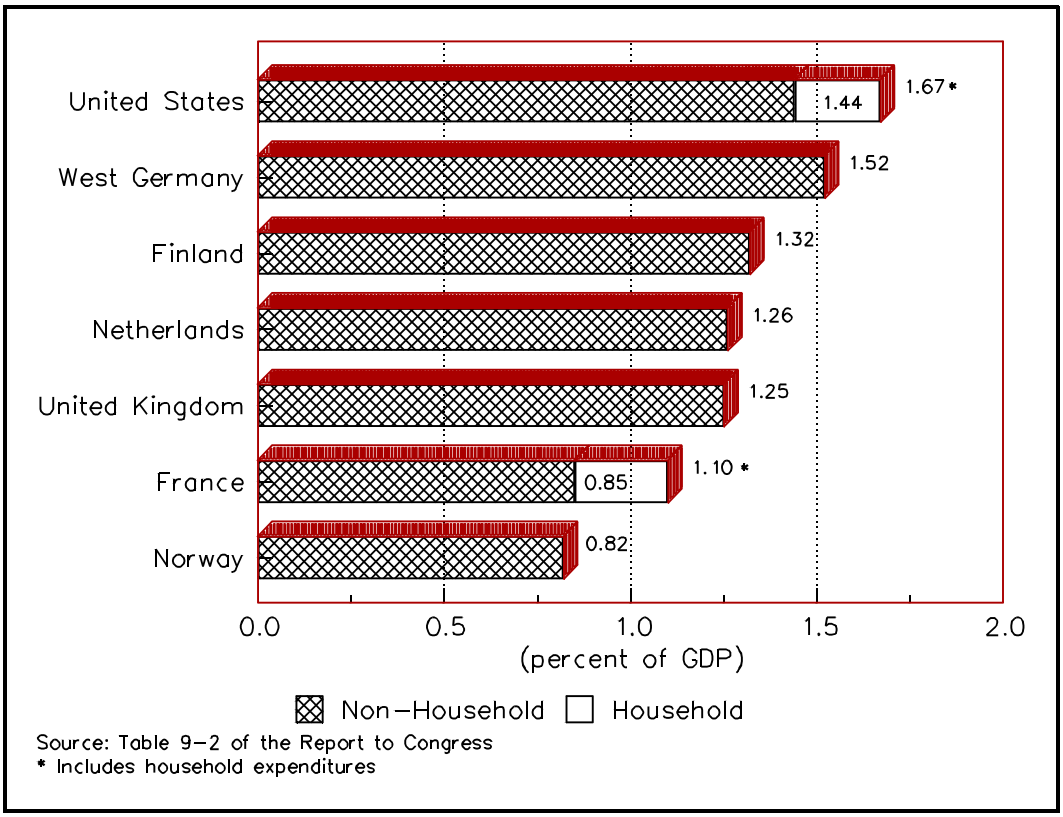
Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
United States	(Figures represent percentage of Gross Domestic Product)											
Non-household	1.60	1.59	1.59	1.51	1.57	1.60	1.53	1.50	1.45	1.42	1.44	1.50
Incl households	1.87	1.85	1.86	1.77	1.81	1.83	1.74	1.70	1.67	1.66	1.67	1.74
Austria		1.09	1.16	1.10	1.13							
Finland						1.31	1.19	1.24	1.12	1.10	1.32	1.16
France												
Non-household							0.87	0.86	0.85	0.84	0.85	0.89
Incl households											1.10	1.15
West Germany	1.37	1.36	1.29	1.33	1.37	1.45	1.45	1.45	1.41	1.37	1.52	
Netherlands						1.11		1.18			1.26	
Norway											0.82	
United Kingdom		1.66					1.57				1.25	

Source: Table 9-2 of the Report to Congress

Table 4-2 compares the sum of capital and operating expenditures as a percentage of Gross Domestic Product (GDP) for the United States and Western European countries over the years 1975-1985. The data for 1985, the most recent year for which there are data for all the countries listed in Table 4-2, are shown graphically in Figure 4-8.

The estimates indicate that in most years for which there are comparable data, non-household U.S. pollution control expenditures as a percentage of GDP were higher in the U.S. than in most of the Western European countries represented by the data. In 1985, the most recent year for which data are available for most of the countries listed in Table 4-2, the percentage of non-household pollution control expenditures in the U.S. were nine to 76 percent higher than in Finland, the Netherlands, the United Kingdom, France, and Norway, and five percent less than in West Germany. It should be noted that the differences in the estimates for the United States and West Germany are small enough that they could be the result of inaccuracies in the data or the methods used to put them in comparable terms.

Fig. 4-8: 1985 International Pollution Control Expenditures as % of GDP



4.2. CONCLUSIONS

The comparisons of pollution control costs discussed in this Chapter and Chapter 2 lead to six conclusions. First, over the next decade there is expected to be a shift in the relative shares of total environmental control costs accounted for by different environmental media. Most significantly, there is expected to be a substantial increase in the share of total costs directed towards land pollution control (which includes a significant groundwater protection component) and a corresponding decrease in the share of total costs directed towards the control of surface water quality. This is due largely to legislation enacted in the 1980s relating to past and current practices involving the generation, handling, storage, treatment, and disposal of hazardous wastes. Costs associated with the Superfund clean-up of abandoned hazardous waste sites and various RCRA programs involving current hazardous waste operations, including the corrective action and underground storage tank programs, are expected to impose significantly increasing costs over the next decade.

Second, although increasing, national environmental pollution control expenditures remain less than half those for clothing and shoes, one-third those for national defense, one-third those for medical care, one-fifth those for housing, and one-sixth those for food.

Third, the non-EPA federal share of total annualized pollution costs is projected to increase by more than 140 percent between 1987 and 2000, primarily as a result of the cost of military and nuclear waste clean-up. All other shares, particularly the private sector, are expected to fall somewhat. Even though the EPA share is expected to fall, the net effect is that the federal share is projected to increase over this period.

Fourth, although the percentage share is expected to fall slightly, it is projected that over the next several years real pollution control burdens on municipalities will increase dramatically and result in large increases in the fees charged to consumers for locally-provided environmental services. Moreover, many smaller municipalities may face severe difficulties in securing the capital resources necessary to comply with pollution control requirements. The EPA is currently extending technical and financial assistance to alleviate these constraints. The EPA, municipalities, and private entities are also exploring more innovative ways to mitigate pollution control burdens on localities. These include public partnerships and regionalization projects, whereby two or more communities may share expertise, jointly purchase environmental services in volume at discount prices, and enter into joint ventures for financing pollution control infrastructure.

Fifth, the estimates presented in this report show that total annualized costs for pollution control programs have been increasing fairly rapidly in recent years, and the trend is projected to continue through the year 2000. Currently, the nation spends about two percent of GNP on pollution control; this is expected to increase to between 2.6 and 2.8 percent of GNP by the year 2000 assuming a seven percent discount rate.

There is reason to believe that pollution control costs will be rising significantly at least through the year 2005. Even if no new environmental legislation is passed beyond the Clean Air Act Amendments of 1990, pollution control costs appear likely to continue to increase beyond the costs projected in this report for the year 2000. Moreover, if new environmental legislation should be enacted in the future, costs would be higher than those projected in this report.

Finally, national expenditures on pollution control as a percentage of GDP have been somewhat higher in the U.S. than in many Western European nations for which comparable data are available. While these results are not conclusive evidence, they do suggest that the United States' commitment to national pollution control is at least as great as that of many of its Western European economic counterparts.

5. ENVIRONMENTAL TRENDS

This chapter summarizes data and information on historical trends in various measures that are suggestive of the level of environmental quality over time. The objective is to provide some indication of the "output" of the pollution control costs presented in this summary report. As indicators of environmental quality only, these data are not readily comparable to the monetary cost estimates. Pollution controls have resulted in substantial and valuable national benefits in the form of improved human health, recreational opportunities, visibility, and general environmental integrity. An ideal comparison of the costs and benefits of pollution control would require that these benefits be identified, quantified, and monetized. This is an extremely difficult and data intensive task and far beyond the scope of this report.

Instead, this chapter relies on historical data on estimated air and water pollutant emissions and ambient pollution levels, and information on the production and regulation of hazardous waste and toxic substances to provide an indication of environmental quality levels over time. While this provides some indication of changing environmental quality levels, it does not adequately show the degree of environmental protection afforded by cumulative pollution control efforts. In the absence of controls, increasing population and levels of economic activity would have resulted in steadily decreasing environmental quality over time. In order to show environmental quality improvements resulting from pollution controls adequately, we would need to compare current levels of environmental quality indicators with estimated levels that would have prevailed in the absence of cumulative pollution control efforts. Except in the case of the criteria air pollutants emissions, such comparisons are precluded by the absence of data. As a result, none of the other environmental indicators discussed in this chapter will provide such comparisons.

The data presented for different environmental media and regulatory program areas are of widely varying quantity and quality. As might be expected, nationwide data on the more mature pollution control programs, such as those directed to air and water quality, are more extensive and better than those for the newer regulatory programs. Data and information on various environmental quality indicators are summarized in the following sections corresponding to the media used in Chapter 3 of this report:

5.1. Air Quality;
5.2. Water Quality;
5.3. Land Quality; and
5.4. Exposure to Chemicals.

The actual data that provide the basis for the following discussion can be found in the Report to Congress.

5.1. AIR QUALITY

5.1.1. Criteria Pollutant Emissions

EPA estimates of historical air emissions of the six criteria air pollutants or their precursors—particulate matter (PM), sulfur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO), and lead (Pb)—indicate that, since 1970, there has been a substantial decrease in emissions of each of these pollutants except nitrogen oxides. Because one of the criteria air pollutants, ozone, is a secondary pollutant formed by the reaction of reactive volatile organic compounds and nitrogen oxides, emissions of reactive volatile organic compounds and nitrogen oxides (a criteria pollutant in its own right) are measured rather than ozone.

5.1.2. Effects of Pollution Controls on Air Emissions

In addition to data on actual emissions for the criteria air pollutants, EPA has developed estimates of emissions that would have occurred over the period 1970-1988 if pollution controls pursuant to the Clean Air Act had not been introduced. The data indicate that by 1984 air pollution controls had resulted in substantial reductions in air emissions for all of the criteria air pollutants from levels that would have been observed in the absence of controls:

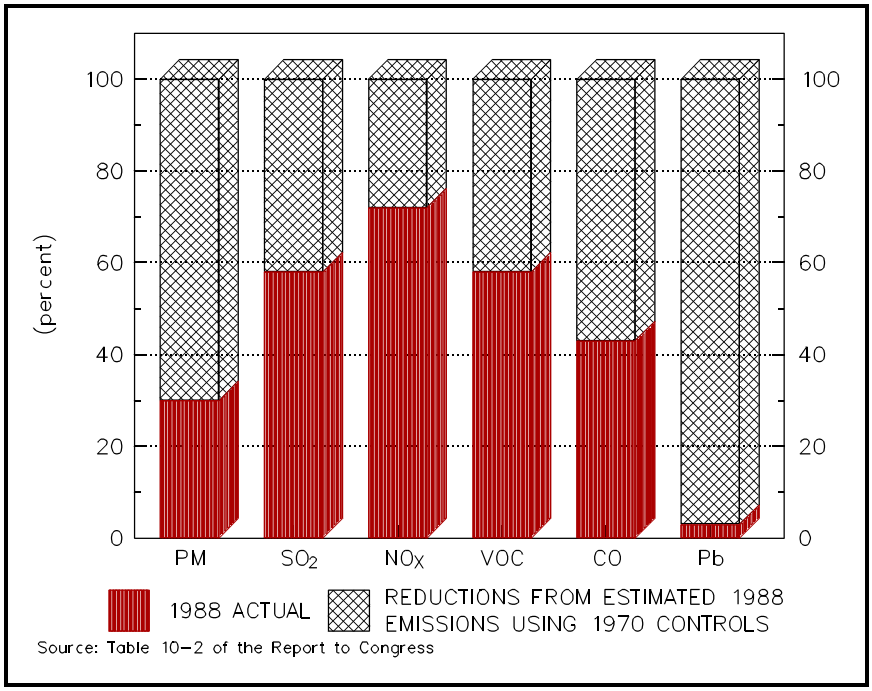
ACTUAL EMISSIONS AS A PERCENTAGE OF ESTIMATED EMISSIONS USING 1970 LEVELS OF CONTROL

Year	Particulate Matter	Sulfur Dioxide	Nitrogen Oxides	Volatile Organic Compounds	Carbon Monox-ide	Lead
1984	33	71	82	60	56	19
1988	30	58	72	58	43	3

Source: Table 10-2 of the Report to Congress.

For example, particulate matter emissions were about 33 percent of what they would otherwise have been without the introduction of additional controls since 1970. In other words, pollution controls adopted since 1970 eliminated an estimated 67 percent of the particulates that would otherwise have been emitted into the atmosphere in 1984. By this measure, there has been continued improvement in air emissions since 1984, as shown in Figure 5-1, which illustrates actual emissions in 1988 as a percentage of estimated 1988 emissions at the 1970 level of control.

Fig. 5-1: Actual 1988 Emissions as a Percentage of Hypothesized Emissions at the 1970 Level of Control



5.1.3. Ambient Air Quality

Data are also available on ambient air concentrations of each of the six criteria air pollutants—particulates, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide and lead between the years 1979 and 1988. In terms of ambient air quality since 1978, clear improvements have been observed with respect to each of these pollutants except ozone. The experience with ozone has been mixed. Despite these improvements, many regions of the country are still not in compliance with the National Ambient Air Quality Standards (NAAQS) associated with one or more of the criteria pollutants. Air quality data before the mid-1970s are of questionable quality and thus are not included in the estimated trends. Below, the data are used to examine trends in average ambient pollutant concentrations over time and to compare estimated concentrations with the NAAQS for each pollutant.

Taken as a whole, the data show a downward national trend in average ambient concentrations for the criteria air pollutants over the ten year period. Annual average concentration of particulates fell by over 20 percent over the period; sulfur oxide concentrations, by over 35 percent; carbon monoxide concentrations, by about 32 percent; and lead concentrations, by 88 percent. Moreover, except in the case of ozone, between 75 and 90 percent of all sites sampled showed average pollutant concentrations less than or equal to the NAAQS for each pollutant.

There are many regions of the country that are not in compliance with one or more NAAQS, however. In 1987, an estimated 21.5 million people lived in counties where average particulate levels were above the NAAQS for particulate matter; 1.6 million people lived in areas that

exceeded the sulfur dioxide standards; 29.4 million people lived in areas that exceeded the carbon monoxide standards; 7.5 million people lived in areas that exceeded the standard for nitrogen dioxide level; 2.8 million people lived in areas that exceeded the lead standard; and 88.6 million people lived in areas where ozone levels were above the NAAQS level.

5.2. WATER QUALITY

Since the early 1970s, pollutant loadings for both industrial and municipal point source water pollution have decreased. Municipal point source improvements are primarily the result of better control technology. Industrial point source improvements are also the result of increased and improved control technology, as well as process changes and increased discharges to public treatment facilities. However, the available evidence suggests that non-point source pollution loadings have increased significantly over time. Taken as a whole, the data indicate that discharges of conventional water pollutants have been increasing over time. Moreover, while point-source discharges appear to be decreasing, non-point source loadings are increasing and more than offsetting point source gains. Finally, the data suggest that non-point sources account for the vast majority of all discharges of conventional water pollutants. Water pollution discharges are discussed in more detail below.

5.2.1. Discharges

5.2.1.1. Municipal

Data are available on municipal treatment plant discharges of total suspended solids (TSS) and biological oxygen demand (BOD), two traditional water pollution indicators, in years over the period 1960-1988. The data show that discharges of both TSS and BOD increased significantly over the period 1960-1973. By 1980, the level of both had fallen considerably, but this was followed by a gradual rise in pollutant loadings over the 1980s. By 1988, municipal discharges of both TSS and BOD were comparable to those experienced in the 1960s, but were still well below the year 1973 levels. The increase in pollution loadings from municipal treatment plants in recent years is probably due to a large increase in the volume handled by such facilities. This, in turn, is the result of an increase in the number of people served by municipal systems, as well as a significant increase in the amount of industrial and commercial wastes, both pretreated and untreated, being processed by municipal treatment plants. The increase in the volume of wastes handled by municipal systems would probably have resulted in much greater discharges of pollutants had it not been for expanded pollution controls. Improved water pollution controls have resulted in "cleaner" discharges from these facilities in terms of lower concentrations of pollutants per volume of wastewater released into waterways.

5.2.1.2. Industrial

Data are also available on the direct discharges of TSS and BOD in 1973 and the period 1982-1987 for major industrial categories. The data show that for these industries total industrial discharges of BOD declined by 93 percent over the two time periods, and discharges of suspended

solids declined by 96 percent. One important reason for these declines is that more industrial wastes are being discharged to municipal treatment plants instead of being discharged directly to water bodies. Currently, only about 27 percent of total BOD discharges and 39 percent of suspended solids discharges from these industries are made directly to water bodies. Better and more widely applied control technology and treatment techniques as well as industrial process changes are also responsible for the dramatic reduction in direct discharges from industrial sources.

5.2.2. Non-point Source

Data on non-point source discharges of four conventional water pollutants—biological oxygen demand, suspended solids, nitrogen, and phosphorus—are available for years 1973 and 1980. These non-point sources include agriculture, silviculture, and urban runoff. The data indicate that non-point source discharges of each pollutant increased significantly between 1973 and 1980. The increase in non-point source discharges was driven primarily by agricultural discharges, which historically have accounted for the bulk of all non-point loadings.

5.3. LAND QUALITY

5.3.1. Hazardous Waste Management

Data are available on hazardous waste generation and management in years 1981 and 1985. These data were developed by two national surveys conducted in the early and mid-1980s, respectively. Direct comparison of the two data sets is limited somewhat by changes in the definition of hazardous waste and waste generators for the 1981 and 1985 data. Some general comparisons can be made, however, and these are useful because they span years before and after much of the first phase of RCRA regulations were put in place. Most of the current RCRA regulatory program was implemented after 1985, however, and thus is not reflected in the data.

The data show that only slightly more waste was generated in 1985 than in 1981. The slightly higher waste generation reported in 1985 was most likely due to the wider definition of hazardous waste used in the later survey and its inclusion of more than three times the number of small-quantity generators than were included in the 1981 survey. The relative shares of total wastes accounted for by different classes of generators changed somewhat between the two years, however. While the share of total waste generation accounted for by chemical and petroleum industries was slightly more than 70 percent in each of the two years, the share accounted for by metals-related industries dropped significantly from 1981 to 1985. The data also show that there were more commercial treatment, storage, and disposal facilities in 1981 than in 1985. Some facilities probably closed after 1981 due to lack of certification or profitability, or concern about more stringent prospective regulation.

Data are also available on the use of the various waste treatment and disposal options for the period 1983-1987, which were collected in a national survey of selected commercial hazardous waste management firms. The data show an increase in the use of incineration and landfill

disposal options over the period and a decrease in the use of deep-well injection. Recently promulgated rules restricting the land disposal of hazardous waste will most likely increase the use of waste recovery, treatment, and incineration in future years. Much waste will continue to be landfilled, however, until alternative disposal options become more widely available.

5.3.2. Hazardous Waste Remediation

Data on EPA activities under the Superfund Program, which is directed to cleaning-up abandoned hazardous waste sites, show that first-starts for hazardous waste removals, site investigation studies, remedial design studies, and remedial actions (*i.e.*, site clean-ups) increased steadily throughout the 1980s except for a drop in 1986, the year that the controlling legislation was reauthorized. Moreover, EPA activity under the program has increased more rapidly in recent years. Private actions have also increased significantly in recent years but currently represent only about one-third of all Superfund activity.

5.3.3. Underground Storage Tanks

Data on underground storage tanks and estimated rates of future growth in the use of different types of tanks indicate that bare steel tanks, currently the most widely used type, are expected to be phased out rapidly over the next several years and replaced with more leak resistant tank varieties required by the recently promulgated technical standards rule. The production of protected tanks increased from roughly 15 percent of total tank production in 1980 to over 60 percent in 1987.

5.4. EXPOSURE TO CHEMICALS

5.4.1. Toxic Substances

More than 65,000 chemical substances are licensed for manufacture or processing for commercial use in the United States. Notifications of intent to bring new chemicals into domestic production and/or use have been received by EPA for over 1000 new chemicals each year since 1982. This level of new chemical introduction is up sharply from levels experienced in the 1970s and early 1980s and is expected to continue into the future. By the end of fiscal year 1985, EPA had received a total of 6,200 pre-manufacturing notices for new chemical introductions; this had jumped to 9,132 by the end of fiscal year 1987, however. As of 1987, EPA had prohibited or restricted the manufacture, use, or distribution of a total of 553 new chemicals.

5.4.2. Pesticides

Data on the agricultural use of herbicides, insecticides, and all other pesticides for years 1964-1986 show that the use of pesticides peaked in 1981 and has since stabilized at somewhat lower levels. The decrease in pesticide use is probably due to a combination of factors, including greater use of integrated pest management practices, an increased awareness of the potential

danger in handling and using insecticides, and greater use of targeted insecticides that, while more potent, require smaller quantities.