A Review of the U.S. Environmental Protection Agency: Environmental Research Outlook FY 1976 Through 1980

August 1976

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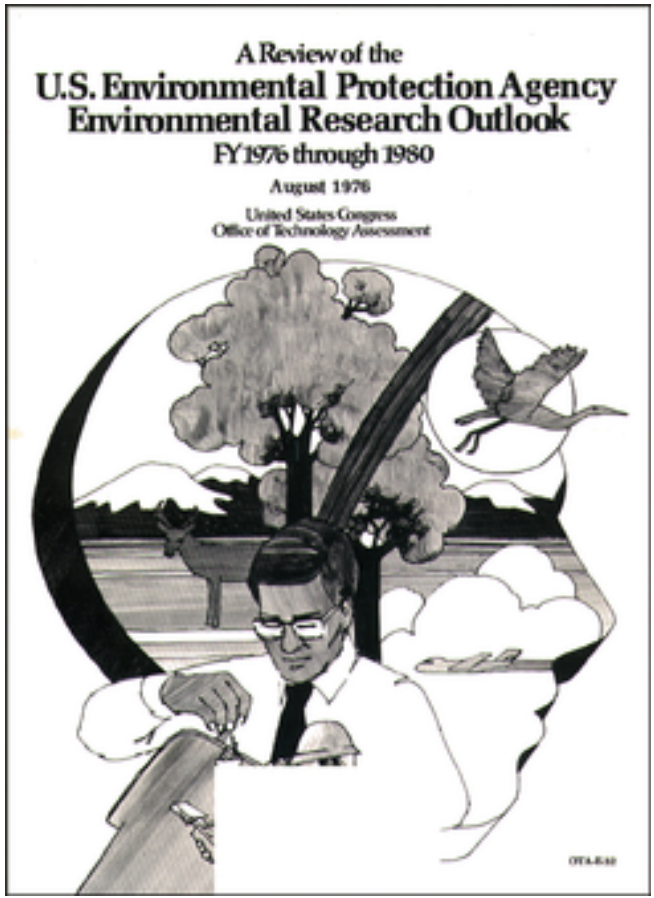

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Electric Power Research Institute

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Quarry Hill

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Mark D. Levine
Stanford Research Institute

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Wright Water Engineers, Inc.

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Southern California Edison

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Colorado Open Space Council

Calvin K. Sudweeks
Utah State Division of Health

Walt Westman
University of California at Los Angeles

Stuart G. Younkin
Campbell Soup Company

H. Michael Utidjian
Stanford Research Institute

Consultants

Francis Berlandi
Environmental Research and Technology Corporation

Buford R. Holt
Stanford Research Institute

Wil Lepkowski
Independent Consultant

Stephen Miller
Energy and Environmental Analysis, Inc.

Panel Ill-overview

Members

Robert L. Sansom, Chairman
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A. Karim Ahmed
Natural Resources Defense Council

Hayden Boyd
Motor Vehicle Manufacturing Assoc.

Richard Briceland
Illinois Environmental Protection Agency

W. David Corm
University of California, Los Angeles

John Gibbons
University of Tennessee

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Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

EMILIO Q. DADDARIO
DIRECTOR

DANIEL V. DE SIMONE
DEPUTY DIRECTOR

AUG 4 1976

Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

Gentlemen:

On behalf of the Office of Technology Assessment, we are pleased to forward a report: A Review of the U.S. Environmental Protection Agency Environmental Research Outlook, FY 1976 through 1980.

The report concludes OTA's review of the first EPA five-year research Plan presented to Congress in February 1976. It presents and discusses issues identified by three panels convened to assist in the review and analysis of the Plan. The report is being made available to the Committee in accordance with Public Law 92-484.

Sincerely,

Olin E. Teague
Chairman

Sincerely,

Clifford P. Case
Vice Chairman

Enclosure

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DEPUTY DIRECTOR

Honorable Olin E. Teague
Chairman of the Board
Off ice of Technology Assessment
Congress of the United States
Washington, D. C. 20515

Dear Mr. Chairman:

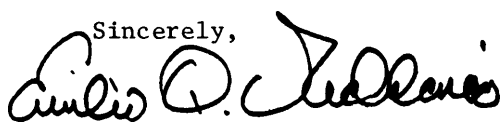
The enclosed report, "A Review of the U.S. Environmental Protection Agency Environmental Research Outlook, FY 1976 through 1980", presents OTA's analysis of EPA's five-year research Plan.

This study was conducted at the request of the House Committee on Science and Technology on behalf of the Chairman of its Subcommittee on the Environment and the Atmosphere. As you know, early study results were presented in a preliminary briefing for the requesting committee during its consideration of the EPA R&D Authorization Bill for FY 1977. This report presents our final results to Congress.

I am especially grateful to EPA Administrator, Russell E. Train and Assistant Administrator, Wilson K. Talley, for EPA's cooperation in the conduct of this study. Thanks also are due to the Deputy Assistant Administrators of the Office of Research and Development for their help.

Inevitably, a review of the kind reported here gives the appearance of emphasizing deficiencies. However, the context in which I hope this report will be read should be one of appreciation and understanding for the difficulty of planning a comprehensive five-year research program for the first time and, in the larger sense, EPA's commendable accomplishments to date. Our review is intended to serve as a supportive and constructive base to enhance the dialogue between EPA and Congress.

Sincerely,



EMILIO Q. DADDARIO
Director

Enclosure

Introduction

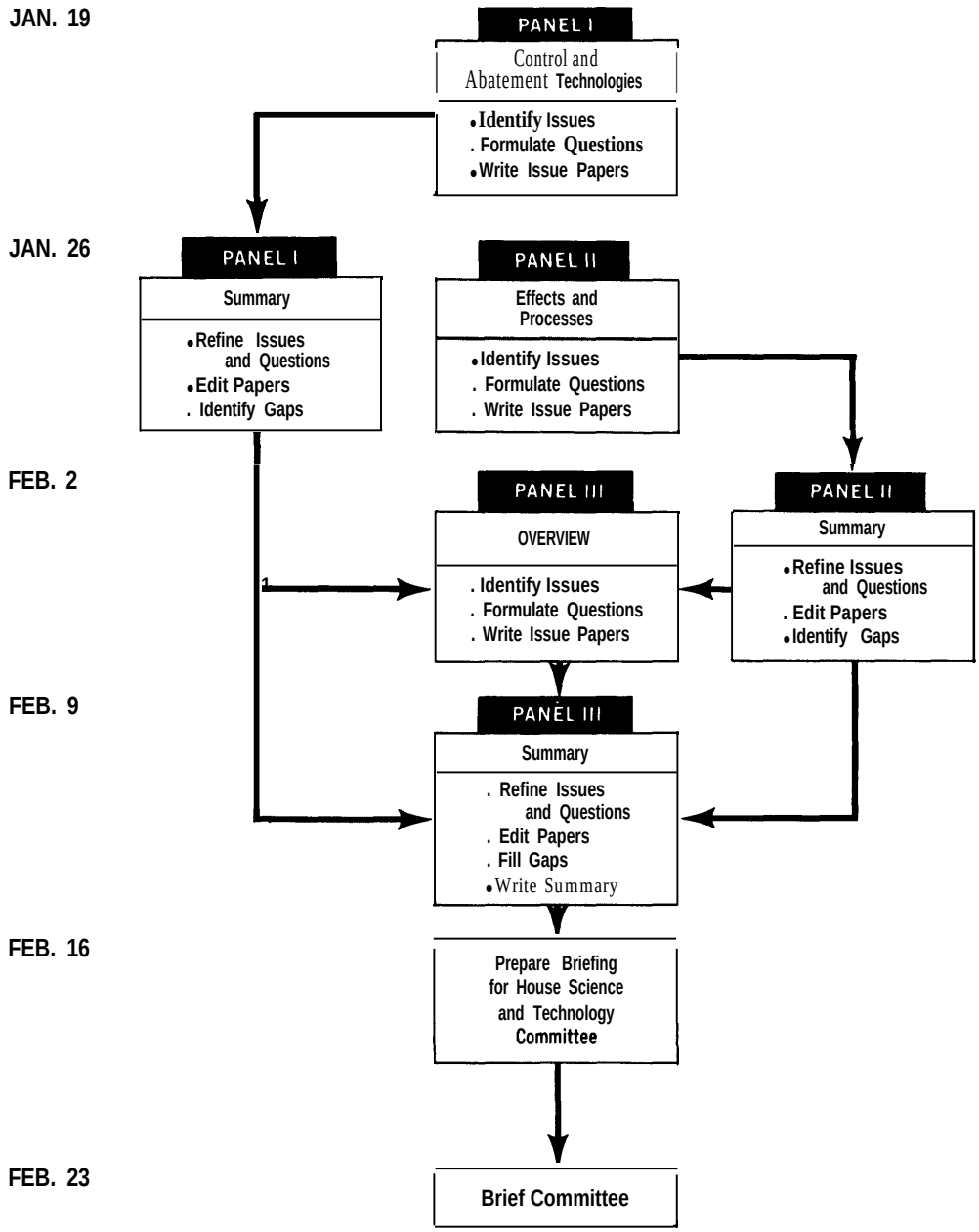
The Office of Technology Assessment (OTA) is pleased to present its review of the U.S. Environmental Protection Agency (EPA) report, entitled "Environmental Research Outlook, FY 1976–1980," which was presented to Congress in February 1976.

The EPA Research and Development Authorization bill for fiscal year 1976 requires that the Administrator of EPA annually submit to Congress a comprehensive 5-year plan for environmental research, development, and demonstration. On December 9, 1975, Chairman Olin E. Teague and Congressman George E. Brown of the House Committee on Science and Technology requested OTA to review the first EPA 5-Year Research Plan; the request was subsequently approved by OTA's Congressional Board. Congressman Brown, who chairs the Subcommittee on the Environment and the Atmosphere of the Committee on Science and Technology, further requested that OTA complete its review in time to brief the subcommittee in February 1976, during its consideration of the EPA Research and Development Authorization bill for fiscal year 1977.

To assist in this review, OTA convened three panels in late January and early February 1976. The members were drawn from a wide range of disciplines and points of view. Scientists, engineers, physicians, biologists, lawyers, ecologists, administrators, economists, and other concerned citizens were called upon from industry, academia, Federal and State governments, research institutes, consulting firms, and public interest groups.

Panel I addressed EPA's research plans for Control and Abatement Technologies, while Panel II considered the plans for research on Effects and Processes. Panel III, the Overview Panel, reviewed the Plan as a whole; it identified crosscut issues and

Figure 1. OTA Review of the EPA 5-Year Research Plan



organized the material for further analysis and presentation. Figure 1 depicts the process by which the 5-Year Plan was reviewed and evaluated.

The panelists had diverse views on environmental issues. This report does not necessarily reflect the opinions held by individual panel members; rather, it is a synthesis of their statement of the issues.

Time constraints required that OTA's organization and conduct of the review be compressed and intense. It was necessary in this limited study to deal with the salient features of the Plan rather than undertake a detailed analysis.

To augment this inquiry, the OTA panels interviewed key staff members from the Environmental Protection Agen-

cy, the Energy Research and Development Administration, the U.S. Department of Agriculture, the Department of the Interior, the Department of Health, Education, and Welfare, and the Commission on Natural Resources.

Invariably, a review of the kind reported here begins by identifying perceived shortcomings of the document under review. Thus, the review alone may appear somewhat negative. To provide a balanced perspective and greater appreciation for what motivates EPA's research, an article is appended (see appendix A), entitled "The Research Mission" by Dr. Wilson K. Talley, EPA's Assistant Administrator for Research and Development, which appeared in the October 1975 edition of the EPA]ounal.

This report consists of six chapters covering significant issues identified by the panels. The first chapter addresses the question of the role of long-range research. The remaining chapters deal with specific aspects of the EPA Plan; in each of these chapters a short introductory statement highlighting identified issues is followed by papers addressing each issue. Each issue paper includes a summary, further questions on the issue, and background statements.

EPA was established in December 1970 by Executive order under Reorganization Plan No. 3. The purpose of forming EPA was to unify the disparate environmental agencies engaged in pollution control scattered throughout the Federal Government. EPA inherited 15 separate programs from several Federal agencies addressing air, water, and noise pollution, solid waste management, pesticides, water supply, radiation, and toxic substances.

EPA's regulatory mission is supported by the Office of Research and Development (ORD). ORD's research programs derive from nine major environmental statutes and EPA directives appearing in various appropriation reports. While EPA has the line responsibility for setting and enforcing standards, many other Federal agencies also conduct environmental R&D programs. For example, EPA coordinates an interagency environmental-energy program with 18 other Federal agencies. Appendix B of this report details the statutory and administrative background of EPA.

This project was conducted by Dr. Robert Daly, project director; Dr. Audrey Buyrn, executive secretary for the Panel on Effects and Processes; Mr. Patrick Gaganidze, executive secretary of the Panel on Control and Abatement Technologies; Dr. Hend Gorchev, American Political Science Association Fellow; Dr. Richard Rowberg, planning adviser; Dr. Charles Wolf, American Association for the Advancement of Science Fellow; Ms. Lisa Jacobson; Ms. Ogechee Koffler; Ms. Linda Parker; Ms. Patricia Poulton; and Ms. Joanne Seder. General support for this project was provided by Mr. Edward Edelson, Mr. David Sheridan, and Mr. Peter Miller.

The project was organized and performed within OTA's Energy Assessment Program, directed by Mr. Lionel Johns. Special thanks are due to OTA's Energy Advisory Committee and the Technology Assessment Advisory Council for their helpful comments in reviewing this study. The project staff is grateful to Mr. Frank R. Hammill, Jr., counsel, House Science and Technology Committee, for his assistance.

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Executive Summary

The Environmental Protection Agency (EPA), in presenting to Congress for the first time a 5-Year Plan for Environmental Research and Development activities, has taken an important step toward expanding the public dialog necessary to identify and establish national environmental goals. Shortcomings in the initial EPA R&D Plan serve notice of potential issues which must be resolved if EPA is to continue to effectively and authoritatively perform its mission of protecting environmental quality for both present and future generations. Foremost among the shortcomings in the R&D Plan is EPA's failure to indicate a commitment to long-range research and, as a corollary, an excessive focus on short-term R&D issues related directly to the enforcement and/or achievement of EPA's current regulations. Accordingly, the Plan emphasizes the development and demonstration of control technologies. In many cases, however, the larger problems involve social, economic, and institutional patterns which not only impede technical solutions but which require nontechnical approaches. To develop effective overall environmental management strategies will require more systematic and sustained socioeconomic research efforts than those specified in the Plan. An added R&D emphasis on long-range environmental concerns and a more responsive role to its line responsibility as coordinator of Federal environmental R&D would do much to enhance EPA's effectiveness and credibility.

In February 1976, the Environmental Protection Agency (EPA) presented a 158-page document to Congress setting forth its plans for research and development over the next 5 years. The Plan, proposing a comprehensive 5-year environmental research agenda for congressional review, provides a unique opportunity to develop a dialog between Congress and EPA that goes beyond the usual considerations of plans and programs for the upcoming fiscal year. Congressional interest in forward research planning by EPA, including the request for this OTA analysis, is an indication of the increasing importance to the legislative process of Federal endeavors in environmental research and development.

The desire on the part of the Congress to ask questions and seek better answers, on which judgments can be based, has led to these inquiries:

- Is the Plan realistic and well-conceived and can EPA carry it out?
- Does it present a well-balanced program that will permit the Agency to meet legislative goals of environmental quality?
- Will it lead to the scientific data necessary to support sound national policy?
- Does it provide mechanisms to integrate Federal environmental research and development programs?

When EPA was created in December 1970, there were 40 organizationally separate and diverse laboratories that had to be integrated into a unified research and development program. Considerable progress has been made in this difficult task of integrating disparate organizations and diverse skills to meet EPA's complex and demanding research and regulatory responsibilities. These responsibilities are mandated by nine major environmental statutes as well as directives in reports accompanying congressional appropriations for EPA.

The Principal Finding

The EPA 5-Year Plan does not indicate a clearly defined commitment to long-range environmental research. Where the Plan does address long-range activities, it discusses the development of techniques rather than considering which long-range issues are important. Yet, such broad long-range concerns must be at the heart of an effective environmental research planning process. Examples of the questions that should be addressed are:

. Can control technologies reduce pollution fast enough to keep pace with economic growth?

. Can major shifts in economic activities, such as new industries, be made compatible with environmental quality?

. What balance should be struck between research on pollutants affecting people today and those that could affect future generations-through genetic mutations or gradual changes in the environment?

This absence of specific long range issues to guide the research planned by the Office of Research and Development (ORD) will be frequently referred to in the chapters that follow.

ORD's focus on the short-term prevents it from exercising national scientific leadership in environmental research. The short-term emphasis also makes it difficult for ORD to conduct useful policy analyses addressing long-range environmental concerns.

In addition to supporting EPA's short-term regulatory needs, the absence of long-range environmental research commitments may well be caused by factors not under ORD or EPA control. How ORD is constrained by factors such as the following requires exploration:

- Research serves a support function in EPA;
- Environmental concerns appear to be increasingly tempered and modified by concerns over energy and the economy;
- EPA's research resources are diminishing; and
- Civil Service Commission constraints make it difficult to alter the mix of skills of the professional staff to match emerging issues.

General Appraisal of the Plan

With the exception of plans for energy-environmental research, the ORD Plan fails to recognize the function of EPA in coordinating Federal environmental programs. At present, there appears to be no coherent integration of Federal environmental research programs. Because of EPA's line responsibility in setting and enforcing standards, ORD is the logical leader in determining the goals and priorities of environmental research conducted by Federal agencies. ORD's scientific resources must provide a strong basis for EPA's regulatory function. ORD's research program is properly responsive to EPA's regulatory needs; however, it ought not be unduly limited by short-term regulatory considerations.

The document prepared by EPA lacks the essential characteristics of a plan. It does not clearly delineate program priorities nor does it relate priorities to overall program goals. The planning process is vague and no guidelines are offered for future updates of the Plan. It is difficult to discern a rationale for the strategic thrusts suggested in the budget. For example, the Plan offers no basis for the dominant expenditure on developing control technology over the 5-year period.

Control and Abatement Technology Research

EPA's efforts in the development of control and abatement technologies appear to favor demonstration over exploratory research projects. EPA's efforts in this area need to be planned with due regard for the Energy Research and Development Administration's (ERDA) specific mandate to develop environmentally sound energy technologies and for the efforts of private companies with the capability and economic incentive to continue control technology development. To the extent that EPA is both regulator and developer, it could be put in the position of promoting its own technology.

The EPA Research Plan fails to address the tasks of identifying and controlling pollution from new industrial technologies or from changes in raw material usages, new requirements in industrial energy or large-scale use of waste, biomass, solar and geothermal energy sources. Research into the economic and institutional problems of operating complex secondary and tertiary wastewater treatment plants requires more attention than is given in the EPA Plan.

Transport, Fate, and Monitoring Research

Much of the work planned in researching the transport, fate, and monitoring of pollutants seems fragmented. Research into the complex of processes that link emissions from a source and their effect on the biosphere has not been assigned a high enough priority to support the scientific basis of the regulatory process. The ORD Plan does not offer a program to develop a centrally coordinated and technically strong monitoring capability to unify the fragmented responsibilities that now exist in ORD. Nor does it reveal an adequate screening program to detect toxic materials; it is the absence of such a capability that has contributed to the current "pollutant of the month" syndrome.

Although analyses of global processes of chemical transport and transformation of pollutants may seem to have little apparent relevance to the Agency's immediate regulatory needs, EPA should insure that no gaps exist in data about atmospheric and oceanic processes of transport of pollutants through the biosphere. Moreover, it would be useful to undertake studies and to develop a taxonomy of ecosystems not covered by generalized ORD studies. Such long-range studies may lead to regulations which reflect regional variations in environmental sensitivity.

Health and Ecological Effects Research

Long-term studies into the health effects of chronic, low-level exposure to pollutants are needed to strengthen the basis for standards. Because of the present commitment of EPA to respond to near-term exigencies, it has not been able to develop a strong long-term health research capability. Nonetheless, it is within the scope of ORD's research program to develop a system for discovering previously undetected pollutants in the environment and assessing their relative potential for harm.

The ORD 5-Year Plan does not describe how health research will be coordinated or how results will be shared with other Federal agencies.

Because some contractor and university research groups depend on EPA for continued financial support, there is a danger that EPA's declared regulatory policies may affect the objectivity of contractor scientists.

Although EPA is mandated to perform and coordinate research on noise, such research is not discussed in the Plan. The ORD Plan makes only a brief reference to indoor air quality and neglects consideration of environmental management techniques for its improvement.

Socioeconomic Research

Despite repeated references to socioeconomic research in the Plan, neither the document itself nor interviews with ORD officials indicate that there will be a systematic and sustained research effort in this area. ORD places the highest priority on technological solutions to environmental problems, although in many cases the most important and difficult problems are institutional—namely, the implementation and enforcement of environmental standards. Effective strategies of environmental management, combining both technological and nontechnical approaches, require greater contributions from socioeconomic research than appear in the Plan. Attention is lacking in the Research Plan to the development and application of socioeconomic research methods responsive to these needs. The organizational structure and commitment of resources suggested in the Plan to develop and use socioeconomic research methods appear inadequate.

I. The Principal Finding



I. The Principal Finding

Long-Range Research

As individuals, EPA's scientists are qualified and dedicated to producing high-quality research. As an organization, however, EPA's Office of Research and Development (ORD) lacks a clearly defined commitment to research addressing long-range environmental concerns; it appears to be preoccupied with the day-to-day demands of the regulatory process. Short-term research in support of the regulatory process is necessary, to be sure; but this should not preclude a strong commitment by ORD to long-range research.

Where long-range research is mentioned in the Plan, in most cases the development of techniques is addressed rather than a clear definition of what long-range issues are considered important. The following illustrative questions exemplify the considerations that should govern the planning of an effective long-range strategy:

- Can control techniques reduce pollution at a rate adequate to keep pace with environmental goals when, simultaneously, economic growth continues?
- How are global and regional ecosystems reducing, or amplifying, the adverse effects of human pollutants?
- What role could lifestyle changes, as opposed to strict "hardware" control solutions, play in the achievement of environmental quality?
- Can major shifts in the economy, such as might be brought about by energy shortages, be made compatible with environmental quality?

It may take years to illuminate these questions and some of them may not be answerable categorically or conclusively, But they must be addressed in a systematic, mission-oriented manner. The knowledge gained from pursuing research on long-range environmental issues is essential to the regulatory and legislative processes.

This is not to say knowledge gained on the long-range scientific, technical, social, and economic issues guarantees that a regulatory strategy or a legislative approach will necessarily be effective. If comprehensive information is available to all interested parties, however, the decisionmaking process has a chance, at the very least, of surviving the major pitfalls of misinformation and erroneous assumptions.

To serve the decisionmaking process, research must become policy oriented. That is, research should explore the alternative strategies open to decisionmakers and attempt to determine their relative social, economic, and environmental costs and benefits. Consistent with its neglect of long-range research, the ORD Plan offers little that can be identified as policy analysis organized and planned to support the environmental policymaking process.

ORD's preoccupation with the short term prevents it from exercising national scientific leadership and becoming a forum for scientific knowledge reflecting the broadest input from the scientific community and the public. For example, when environmental debates stem from scientific questions, such as the effects of sulfates or pesticides, ORD should assess the state of knowledge on the subject and provide a rational and objective basis for discussions.

Specific instances suggesting ORD's emphasis on the short term can be found throughout the Plan. While the Plan appropriately emphasizes research to achieve environmentally acceptable use of coal in the short term, it does not include long-range projects to assess the environmental implica-

tions of large-scale use of waste, biomass, solar and geothermal energy sources. Nor does the Plan discuss long-range research of problems associated with new industrial technologies or changes in industrial energy and raw material sources. Similarly, long-range studies of the health effects of chronic, low-level exposure to pollutants are absent. The Plan fails to discuss socioeconomic research on long-range environmental management strategies combining both technological and nontechnological approaches to environmental problems.

The Other Side of the Coin

Dr. Wilson Talley, EPA's Assistant Administrator for Research and Development, states this view of the role that research plays within EPA:

> First and foremost is the full recognition that research serves a support function within the agency. Our strategy, specific objectives and priorities should not and cannot stand as entities in and of themselves. Rather, they must derive from those of the Agency in the accomplishment of its total legislative mandate.[1]

Dr. Talley also points out that, although ORD performs mission-oriented research, as opposed to basic research, providing the best scientific data and anticipating future problems is an integral part of ORD's research program.

Thus, the lack of a well-defined commitment to research addressing long-range environmental concerns may reflect the dedication of this Office to its primary job of supporting the regulatory role of EPA. Indeed, ORD was strongly urged to do this by the Berliner Committee of the National Academy of Sciences, whose principal conclusion was that: "The present Office of Research and Development planning and management system fails to meet the needs of the Agency."[2] This exhortation by the National Academy of Sciences was a key factor in determining the mid-1975 reorganization of ORD.

It could be argued, in addition, that with environmental concerns apparently ebbing in the face of energy and economic problems, it is not surprising to find EPA spending its shrinking R&D dollars on supporting its most immediate and direct means of effecting environmental regulation. Moreover, some legislative mandates do require EPA to demonstrate the availability of control technology to meet EPA's environmental standards. The role of the regulatory agency and pressing legislative needs may create an atmosphere unsympathetic to the uncertainties of long-range comprehensive research planning. Therefore, because resources available to ORD are constrained, its natural tendency is to concentrate on well-defined Agency requirements and to support regulatory needs as they occur.

For the short term, the EPA 5-Year Research Plan represents an impressive compendium of environmental research problems. It is apparent that ORD has thoroughly identified research needs to support EPA's immediate regulatory role. The difficulty for the short term, therefore, appears to be not so much what environmental research must be done, but how to do it. This may partly explain the deficiencies in EPA's Plan.

[1] "The Research Mission," Dr. Wilson Talley, *EPA Journal*, Oct. 1975. See app. A.

[2] Letter report to Russell E. Train, Administrator, EPA, from the Review Committee on the Management of EPA's R&D Activities, National Research Council/National Academy of Sciences, Aug. 27, 1974.

II. General Appraisal of the Plan



II. General Appraisal of the Plan

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8. PLANNING FOR THE UNEXPECTED. **24**
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II General Appraisal of the Plan

INTRODUCTION

The development of a comprehensive 5-year planning process in environmental research is a difficult and complex undertaking, and may require substantial dedication of ORD planning skills over the next few years. A number of issues addressing ORD's planning, budgeting, and organization as well as issues addressing the role of ORD and its research are presented in this chapter.

Planning, Budgeting, and Organization

The ORD 5-Year Research Plan fails to inform Congress of the thrust, relevance, adequacy, and utility of the proposed research program. Clear statements relating program goals and priorities cannot easily be found nor are they evident from numerous research activities projected over the 5-year period. (Issue 1)

The deficiencies of the Plan stem from an incomplete planning process. The Plan, for example, does not fully examine alternative research approaches or resource allocations. The planning process is not discussed nor is the process to modify the Plan over a period of time suggested. (Issue 2)

A strategic thrust to identify, develop, and demonstrate industrial control technology appears to dominate ORD's 5-year budget. With the exception of a temporary rise in funding in the Industrial Processes Program needed to meet 1985 water-quality goals, the ORD 5-year budget projection indicates little change in long-term relative priorities of established research programs. (Issue 3)

The ORD 5-Year Plan was designed to support an organizational structure which was first established in 1970. In mid-1975, however, ORD was reorganized to improve staff morale and to achieve greater efficiency. The Plan, which was developed shortly after the reorganization, does not reflect the benefits of the new organizational structure. Additionally, it is difficult to relate budgeted responsibilities and the processes of planning, managing, and implementing the research activities with the new organization. Furthermore, the role and function of the 15 laboratories in the implementation of the planned research are inadequately described. (Issue 4)

The Plan does not indicate how, or whether, the public was involved in the development of the Plan. Such input could aid ORD as it attempts to develop priorities and define problems of public concern. (Issue 5)

The Role of ORD and Its Research

With the exception of plans for energy-environmental research, the ORD Plan fails to recognize the function of EPA in coordinating Federal environmental programs. At present, there appears to be no coherent integration of Federal environmental research programs. Since EPA has the line responsiblity for setting and enforcing standards, ORD should provide the required leadership in determining the environmental research goals and priorities among governmental agencies conducting environmental research. (Issue 6)

For the work performed by ORD to have high quality and proper content, ORD's program plans should not be unduly biased by short-term regulatory needs. To avoid misuse or misinterpretation of scientific data in regulatory actions, ORD should be responsible for the scientific credibility of new regulations. (Issue 7)

Environmental crises requiring immediate action by EPA appear to be occurring with increasing frequency. While one cannot predict the nature and time of environmental crises, an exploratory research program that attempts to anticipate problems would add a worthwhile dimension to ORD's program. (issue 8)

II. General Appraisal of the Plan

ISSUES

THE PLAN

Issue 1

The first ORD 5-Year Plan is inadequate as a planning document.

Summary

Although the Plan identifies issues and attempts to assign priorities to research elements, it generally fails to inform Congress of the thrust, relevance, adequacy, and utility of the proposed research program, and of the interrelationships between the proposed ORD research program and non-EPA environmental research activities.

While ORD's research Plan lists numerous research projects for the 5-year period, it does not clearly delineate program priorities; nor does it relate these priorities to overall program goals. It is impossible to determine what would be lost if some program components were dropped, or what would be gained if new program components and funding were added.

Questions

1. What are the major research priorities for 1977? For 1980? How have they changed since 1975?

2. How is the Plan to be used as a working document in EPA? Outside EPA?

Background

The EPA's first 5-Year Research Plan does not provide the data necessary to conduct a review in a reasonably expeditious fashion. As a plan, the document is not sufficiertt,

A plan develops strategies to achieve stated objectives with known priorities. Alternative strategies which achieve objectives within internal and external constraints are evaluated. A plan analyzes the allocation of human, capital, and financial resources in the pursuit of objectives. It also relates resources with the size and content of the endeavor. A research plan sets forth an organization and schedule for interrelated sequences of parallel and serial tasks. Statements such as, "Plans in the future call for . . . ," followed by a list of projects without priority or apparent interrelationship, are not amenable to analysis. Such statements do not inform; they lead to supposition about the intents of the program. Thus, there is no apparent rationale for determining whether the Plan presents a balanced research program with respect to:

- hardware versus management control options,
- exploratory research into innovative concepts versus demonstration of available technologies,
- regulatory-supporting research versus problem-solving research,
- development of control and abatement technology versus establishing dose/response characteristics.

While the Plan describes research programs as ''mission-oriented, with emphasis on timely outputs, neither of these attributes appears to be developed in the Plan,

In a sound plan there is internal consistency, within each major program and, further, goals and plans in major program areas are interrelated within the framework of clearly articulated national environmental goals.

A plan must provide information which allows Congress to monitor and assess the progress and accomplishments of ORD and to compare planned versus achieved results over time.

Because of the complexity of environmental research, the fragmentation of this work among various governmental agencies, and the competition for limited resources, a comprehensive ORD research plan is essential.

THE PLANNING PROCESS

Issue 2

The deficiencies of the ORD 5-Year Plan stem from an undeveloped planning process.

Summary

The Plan does not reflect a sufficient attempt to assess priorities, to examine the merit and costs of alternate research approaches, to quantify trade-offs or to allocate limited resources according to systematically devised research strategies. The planning process is not discussed nor is the process to modify the Plan over a period of time suggested.

Questions

1. How was the development of a 5-Year ORD Research Plan affected by:

(a) the public perception of immediate environmental hazards?

(b) legislative mandates?

(c) challenges to Agency regulations by industry or environmental groups?

(d) existing ORD facilities and staff skills?

2. How were priorities and funding levels determined?

3, What trade-off studies were conducted?

4. To what extent were others involved in the planning process, e.g.:

(a) EPA divisions?

(b) Federal agencies?

(c) State and local governments?

(d) Peer scientists?

(e) Industry?

(f) Private institutions? and

(g) The public?

5. Describe the process to update the 1977 5-Year Plan?

6. How were previous research results incorporated into the Plan?

Background

The following discussion summarizes the panels' understanding of the steps taken in developing the first Plan; it is offered to raise questions that may assist in improving the ORD planning process.

The planning procedure followed by ORD has been characterized by one observer as a "middle up-middle down" approach. This process involved soliciting candidate research topics from various headquarters and field offices within EPA; aggregating these tasks into programs within the four ORD project offices; developing a draft 5-year plan around these programs; soliciting comments on this draft throughout the Agency; assigning dollar and staff resources to the various programs; and publishing the final plan.

There are certain factors which influenced how this planning process proceeded and how decisions were made:

- Each of the individual pollution control program offices (air, water, etc.) is so completely absorbed with the day-to-day urgency of their tasks as to preclude significant guidance on long-term research programs which need to be carried out to improve pollution control.

- There were apparently no attempts to fit overall Agency strategy into the ORD Plan. Top management review was given to the budget implications of the 5-Year Plan, but substantive review to assure the consistency of the research plan (the programs, priorities, and distribution of funding) from an Agencywide perspective does not appear to have been considered.

- There were no explicit guidelines or criteria used for assigning research priorities evident in the planning process.
- There appears to be general acceptance within the ORD senior management staff that (a) the primary ORD mission is to provide the scientific and technical base needed to support the regulatory, standard-setting function of the Agency, and, (b) R&D activities should consist almost exclusively of directed research, i.e., research designed to accomplish some specific regulatory goal with no apparent role for basic science activities.
- No attempt was made to develop alternative, broad research programs around different R&D strategies. There were no systematic analyses that explored different approaches for accomplishing the ORD mission or that defined alternate program options in terms of research accomplishments.
- The planning process did not lead to development of a set of discrete alternate program research packages, i.e., alternate research programs containing identified levels of effort, priorities, and budgets for different mixes of basic research work, control technology, technical support work, socioeconomic work, health effects, etc.
- There was no external peer review of the 5-Year Plan.
- Ultimate decisions about the structure of the 5-year research program, the research projects included in the Plan, and the priorities and resources assigned to these activities were essentially made on the basis of subjective judgments by ORD personnel. Clearly, both external and internal pressures played important roles in these subjective judgments. External pressures included legislative mandates, perceived areas of public concern, outside challenges to Agency regulations and standard-setting procedures. Internal pressures included lack of flexibility caused by the organization of existing facilities, a staff trained in selected disciplines, established patterns of laboratory interests, and ongoing projects.

BUDGET IMPLICATIONS

Issue 3

A strategy to identify, develop, and demonstrate industrial control technology appears to dominate ORD's 5-year budget.

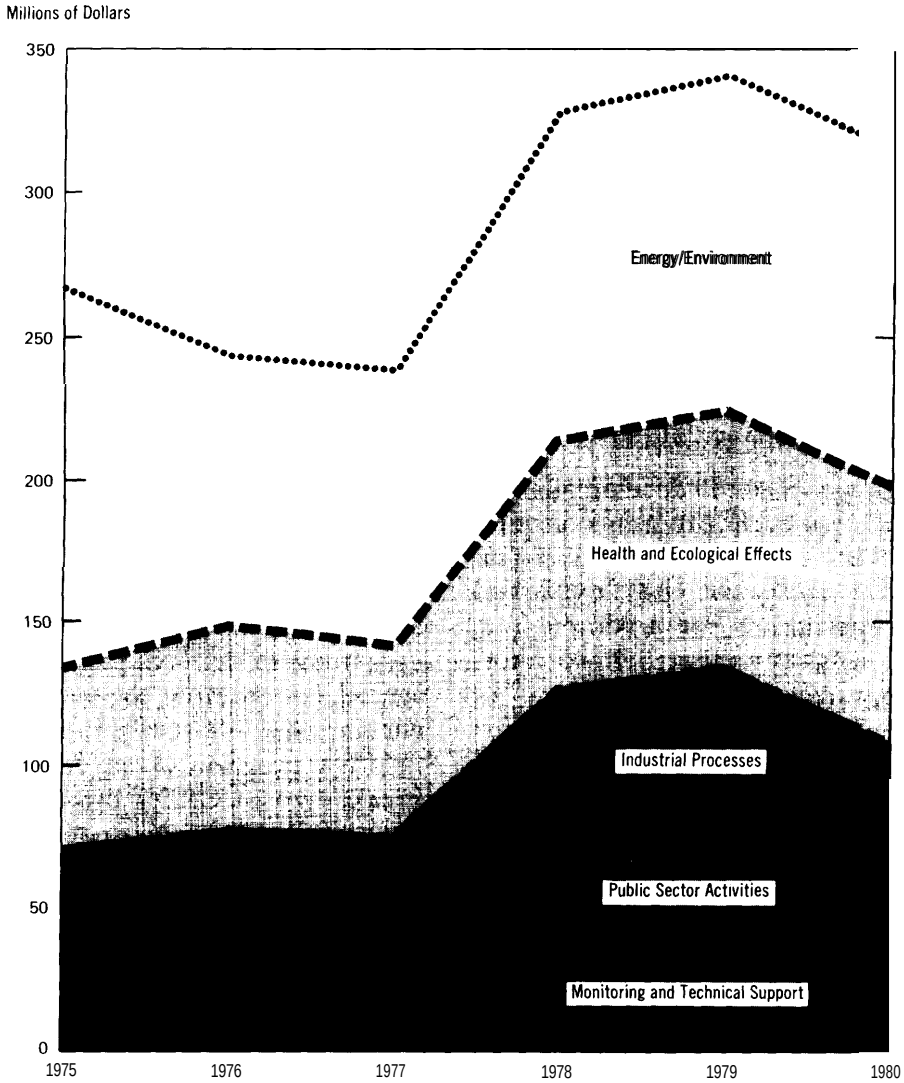
Summary

Figure 2 depicts ORD's projected allocation of resources for each program area. Although the Plan discusses each program area, it is difficult to discern research directions or budget emphases from those program aggregations of research projects which are presented. For example, the large energy program encompasses efforts similar to those pursued in other program areas. A possible alternate breakdown of ORD's projected allocation of resources is presented in figure 3. Subprograms were rearranged to form three new research categories replacing three of the ORD programs. Two ORD programs were unchanged. The new research categories are a first attempt at combining similar research from different programs. Table 2 compares the aggregation of the subprograms for the two ways of breaking down ORD's projected resource needs.

Figure 3[1] suggests the dominance of ORD's activity in industrial control technology. While it is true that this alternate breakdown may be disputed with added data on the distribution of funds within subprograms and added information on subprogram content, it is not an unreasonable interpretation of the 5-Year Plan.

[1] A table entitled "Planned ORD Funding by Subprogram Area" which appeared in a draft copy of the 5-Year Plan, dated Nov. 14, 1975, was used to construct the plots of figure 3 (the 1977 figures had to be adjusted).

Figure 2. Projected ORD Resource Needs ORD Breakdown Total ORD Budget



With the exception of the temporary rise in funding in the Industrial Processes Program needed to meet 1985 water-quality goals, the ORD 5-year budget projection indicates little change in the long-term priorities of established research programs.

Questions

1. Approximately what percentage of ORD's budget will be spent on identifying, developing, and demonstrating control technology over the 5-year period?

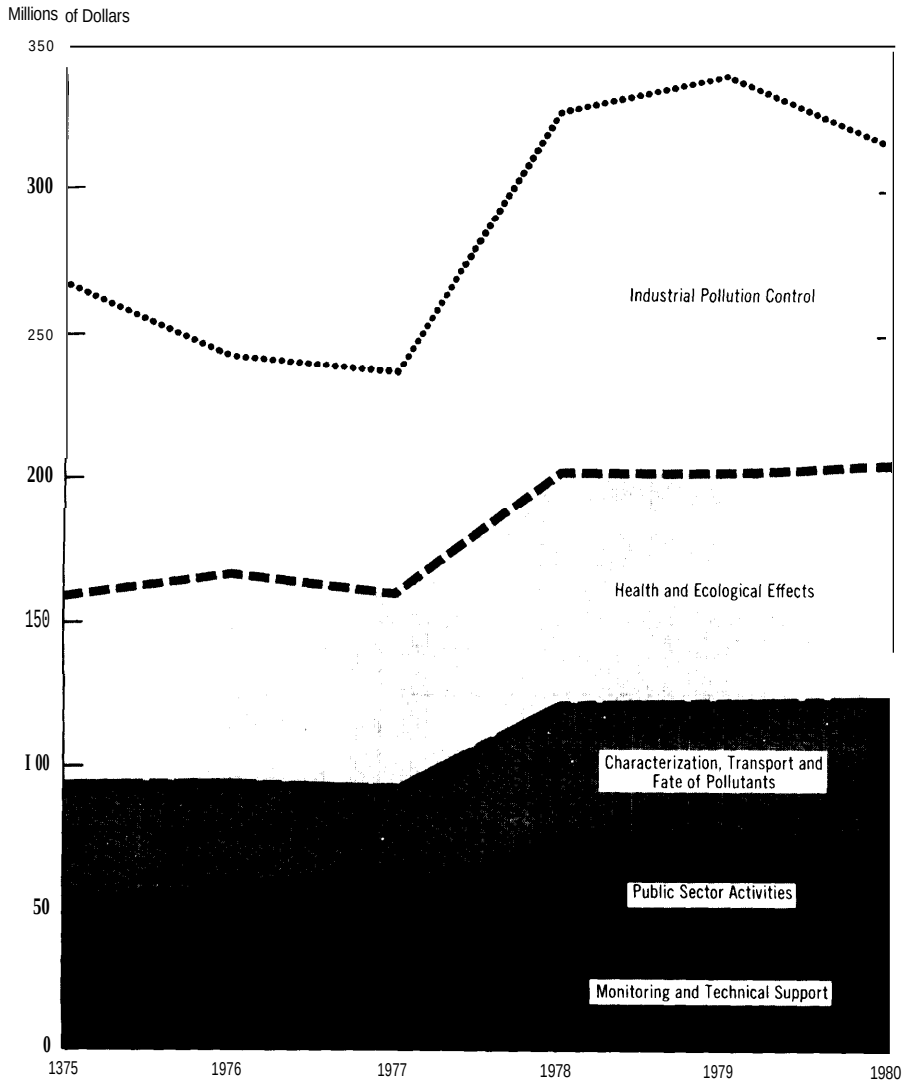
2. It appears that EPA must aggressively pursue the control technology area. What considerations led to this strategy?

Background

Figure 2 shows that the funds for all programs decrease slightly from 1976 to 1977. Ignoring the passthrough of energy funds, this is the first time that EPA's research budget is decreasing. When inflation is included, the decrease in 1976 dollars in the nonenergy base R&D is approximately $16 million.

ORD is projecting a temporary increase in the Industrial Processes Program to encourage development of appropriate control technology to meet 1985 water-quality goals. The Plan also offers two options for allocations of

Figure 3. Projected ORD Resource Needs Alternate Breakdown
Total ORD Budget



funds to the program areas under the constraint that the annual budget for the years 1977 to 1980 will remain at the 1977 level. One option is an attempt to achieve the 1985 water-quality goals at the expense of other programs, while the other essentially maintains the 1977 distribution of funds.

THE REORGANIZATION OF ORD

Issue 4

The first ORD 5-Year Plan does not adequately reflect how the mid-1975 reorganization improves management and planning.

Summary

Although the 5-Year Plan assigns planning and implementation responsibilities for the subprograms among the four offices of ORD, it is difficult to relate the new organizational structure to the processes of planning, managing, and implementing the research activities and budgeted responsibilities. In addition, the role and function of the 15 laboratories in the implementation of the planned research are inadequately described.

Table 1. ORD and Alternate Subprogram Aggregation

ORD Subprogram Aggregation	Alternate Subprogram Aggregation
Health and Ecological Effects Program • Health Effects • Ecological Processes and Effects • Transport and Fate of Pollutants	**Health and Ecological Effects Category** • Health Effects • Ecological Processes and Effects • Health and Ecological Effects/Energy (1/3 of total)
Industrial Processes Program • Mineral, Processing and Manufacturing • Renewable Resources	**Characterization, Transport and Fate of Pollutants Category** • Transport and Fate of Pollutants • Health and Ecological Effects/Energy (2/3 of total)
Energy/Environment Program • Extraction and Processing Technology/Energy • Health and Ecological Effects/Energy • Conservation-Utilization Technology Assessments/Energy	**Industrial Pollution Control Category** • Minerals, Processing and Manufacturing • Extraction and Processing Technology/Energy • Renewable Resources Ž Conservation-Utilization Technology Assessments/Energy
Public Sector Activities program • Waste Management • Water Supply • Environmental Management	**Public Sector Activities Program** • Waste Management • Water Supply • Environmental Management
Monitoring and Technical Support Program • Monitoring Techniques and Equipment Development • Quality Assurance • Technical Support	**Monitoring and Technical Support Program** • Monitoring Techniques and Equipment Development • Quality Assurance • Technical Support

Questions

1. Assuming that the mid-1975 reorganization had little effect on ongoing research, at the time, what impact has the current four-office structure of ORD had on changing the direction of research programs?

2. Since very few of the scientific personnel in the Environmental Research Laboratories have been assigned to different laboratories, to what extent can it be shown that the research programs of the laboratories have been consolidated ?

3. How did the laboratories contribute to the planning process? How will they contribute in the future?

Background

When EPA was established in 1970, the Office of Research and Monitoring (now ORD) inherited 40 separate field installations. These field installations were reduced in number and three large units (National Environmental Research Centers) were established: In Cincinnati, Ohio; Research Triangle Park, N. C.; and Corvallis, Oreg. Later, a fourth was established in Las Vegas, Nev.

Several independent studies of the ORD management structure in 1974 concluded that no clear lines of responsibilities existed between the laboratories and headquarters, that the excessively complicated management

structure at headquarters, greatly increased unnecessary and duplicative paperwork. Morale among the researchers was low, in part because of the absence of a long-term program to achieve specific goals to guide the research effort.

In response to these critiques, the management structure of ORD was reorganized in mid- 1975. The reorganization established four offices with in ORD reporting directly to the Assistant Administrator. The National Environmental Research Laboratories were reorganized so that each laboratory had four or fewer programs with a director of the program reporting to the corresponding office in ORD. A small number of employees at headquarters were reassigned to the laboratories and others who had management or administrative duties vis-a-vis the laboratories have now apparently been given responsibilities for performing reviews, analyses, and studies to fulfill headquarters' needs. The Washington Environmental Research Center, primarily engaged in socioeconomic analysis, was disbanded and its researchers were scattered among the programs within ORD.

PUBLIC PARTICIPATION

Issue 5

The Plan does not indicate how or whether the public and industry were consulted in formulating the 5-Year Research Plan.

Summary

Numerous local and regional environmental public interest groups and private industrial research programs offer a largely untapped potential for new insights into research approaches. Their contributions could help achieve a balance among research priorities, focus appropriate attention on regional problems, and bring to light developing industrial expertise.

Questions

1. What provisions exist for the public and industry to review and comment on EPA/ORD research plans?

Background

Consultations with the interested public and industry could enrich the research planning process and make research goals and priorities more enduring and responsive. Local public interest organizations and industrial plant personnel may have highly developed expertise or insights into environmental problems of national concern. Unless these organizations have forceful national forums, their valuable contributions may go unrecognized and unheeded.

EPA'S LEADERSHIP AND INTERAGENCY COOPERATION

Issue 6

At present, there appears to be no coherent integration of Federal environmental research and development programs except in the energy area. In their 5-Year Plan, EPA/ORD has not provided any proposed method of achieving such coordination.

Summary

The ORD Plan fails to recognize and delineate the actual function of EPA in coordinating Federal environmental programs, including programs related to research and development. Though mention is made that such a role exists, the Plan proposes no method to achieve it. The Executive initiative which created EPA and the numerous subsequent legislative acts mandating environmental programs seem clearly to place this responsibility with EPA.

Because there are numerous Government agencies conducting environmental research, leadership in determining the environmental research goals and priorities among these agencies is essential; ORD is the logical center for such leadership.

Questions

1. What should the EPA/ORD role be in the planning, implementation, and evaluation of Federal environmental R&D programs?

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2. How will ORD coordinate their environmental R&D programs and demonstration projects with other Federal agencies?

3. How does ORD obtain knowledge about the progress of the various environmental R&D programs and projects carried out by other Federal agencies?

4. To what extent does the ORD evaluate the effectiveness of environmental programs under the direction of other Federal agencies.

5. What potential conflicts and misunderstandings with other agencies would be anticipated if EPA expanded its lead-agency role in environmental research?

6. Is there a need for more explicit congressional authority to EPA/ORD to coordinate, monitor, and evaluate all Federal environmental R&D programs? Why?

7. Currently, ORD monitors and evaluates those environmental R&D programs in which EPA has the lead responsibility of transferring funds to other Federal agencies. How can this procedure be improved to provide more effective coordination?

8. To what extent should a portion of ORD's role within EPA be insulated from the Agency's short-term program needs in order to free ORD to better integrate Federal environmental R&D programs?

9. Is there a national clearinghouse that disseminates information about ongoing Federal environmental R&D projects? To what extent should ORD be involved in providing such a service?

Background

The creation of EPA as a major Federal line agency (based on Reorganization Plan No. 3, Dec. 4, 1970) was an attempt by the executive branch to consolidate environmentally related programs of the Federal Government into a single administrative unit. EPA inherited 15 separate programs from several Federal agencies: Federal Water Quality Administration (Interior), National Air Pollution Control Administration (HEW), Bureau of Water Hygiene (HEW), Bureau of Solid Waste Management (HEW), Bureau of Radiological Health (HEW), Pesticide Standards and Research (Interior, HEW), Pesticides Registration (Agriculture), Federal Radiation Council (AEC), and Studies of Ecological Systems (CEQ), Executive Office of the President.

At the same time, a number of Federal environmental R&D programs were retained or expanded in existing Federal agencies. According to the 5-Year ORD Plan, EPA research interacts with the following Federal agencies:

Department of Commerce-(National Oceanic and Atmospheric Administration, National Bureau of Standards)

National Aeronautics and *Space* Administration

Department of the Interior-- (Fish and Wildlife Service, Geological Survey, Bureau of Land Management)

U.S. Department of Agriculture

Energy Research and Development Administration

Nuclear Regulatory Commission

Department of Defense-- (Army Corps of Engineers)

National Science Foundation-(Research Applied to National Needs, National Center for Atmospheric Research)

Department of Health, Education, and Welfare —(National Cancer Institute, National Institute of Environmental Health Services, National Institute of Occupational Safety and Health, Food and Drug Administration)

Department of Transportation

Department of Housing and Urban Development

Council on Environmental Quality

Tennessee Valley Authority

As mentioned in the 5-Year Plan, EPA is directly responsible for administering a 5-year energy R&D program with 18 other Federal agencies.

It is apparent that there are areas of cooperation and formal interaction between

EPA and other Federal agencies. However, it is not clear from the 5-Year Plan how EPA/ORD plans to implement their administrative charge, nor how they plan to coordinate and evaluate the many R&D programs and individual projects. The Plan mentions the program areas without indicating how the specific projects under each program will be planned, carried out and monitored for performance. There is no discussion of whether duplication or undesired overlap of R&D functions exists and whether or not redundancy in R&D projects is planned so as to reinforce and complement a research objective.

Thus, the Plan seems to assume that Federal environmental R&D programs will proceed as funds become available, without real need for overall comprehensive planning.

MAINTAINING QUALITY RESEARCH IN EPA

Issue 7

ORD's involvement in short-term urgencies arising out of EPA's regulatory responsibilities or in the handling of emergencies diverts resources needed for establishing a strong scientific basis for EPA's regulatory function.

Summary

ORD serves as a primary source of scientific information used by EPA in developing and assessing environmental regulations. For the work performed by ORD to have high scientific quality, ORD's program plans should not be unduly biased by short-term regulatory needs. To avoid misuse or misinterpretation of scientific data in regulatory actions, ORD should review the scientific credibility of new regulations prior to their issuance. The Plan does not address the issue of how ORD insures the research program's integrity. It does, however, provide some evidence of potential overemphasis in support of EPA's regulatory function, particularly in the development of control systems.

Questions

1. How are the needs of regulatory programs considered in the ORD Plan? What program elements are not stimulated by regulatory needs?

2. How are the goals of research programs in control technology determined?

3. How does EPA identify and conduct research programs intended to look beyond existing or pending regulatory requirements?

4. At what point in control system development do research program personnel transfer responsibility to the regulatory branches?

5. How are ORD research staff assigned to "firefighting" activities?

6. How are inputs from the ORD to the EPA regulation review process made?

Background

When a regulatory agency conducts its own research to evaluate and support regulations that it must enforce, there is a danger that a strong regulatory orientation will permeate the research program. If this occurs, the efficiency, content, and quality of the research being performed may be seriously degraded. It is a matter of special concern when the research program is not only supposed to establish regulatory support data but also promote the development of basic science in the affected areas.

Scientific research staff are an important base of expertise for any operating regulatory program. The accessibility of research personnel, however, must be carefully managed to prevent their overinvolvement in the legal, procedural, and political activities of regulatory operations.

Such problems appear to be occurring in two kinds of situations faced by EPA:

- The handling of unanticipated environmental emergencies,
- The broader problem of regulatory program responsibility spillover, when operational responsibilities of the agency regulatory arms are carried out by ORD.

The first problem often characterized as the "pollutant-of-the-month syndrome" has been and will continue to be an unavoidable and important role for ORD experts as long as the problem persists. They must be accessible to quickly and accurately evaluate a situation and give regulatory responses to emergency environmental problems. The Agency, however, should provide assurances that these kinds of activities do not degrade R&D efforts.

The second problem typically involves the case of new legislative mandates requiring standard -setting activities under stringent time constraints. Under these conditions, regulatory program offices are likely to become overloaded and tend to shift some of the regulatory activities into the R&D program offices. Specifying control requirements and developing Control Regulations Support Documents cannot be added tasks of research personnel without jeopardizing research programs.

Although ORD personnel should be protected from excessive work in regulation development or formulation, their participation in scientific regulation review should be maintained and formalized. When a regulation is promulgated, the Administrator and the public must have an understanding of the scientific basis for the regulations, of the data base's adequacy, and of the extent to which scientific knowledge has been simplified in developing a manageable regulatory procedure.

At present, EPA uses a steering committee and a working-group mechanism to develop interagency review of al 1 regulations. Under this procedure, the Assistant Administrator of ORD has the opportunity to concur or not to concur. This procedure, in cases of significant scientific impact, may be inadequate. The multitude of regulations can easily turn this procedure into a rubberstamp exercise. At best, an official scientific reading of the issue from ORD cannot always be assured. ORD should be accountable to the Administrator and the public for the scientific quality of regulations.

PLANNING FOR THE UNEXPECTED

Issue 8.

It appears that ORD frequently cannot respond effectively to crises because the need for R&D was not forseen or funds to support anticipatory R&D were not available.

Summary

Environmental crises demanding immediate action by EPA appear to be occurring with increasing frequency. These events require some planning for a prompt and adequate response that anticipates problems. Development of such a capability requires appropriate exploratory research

Questions

1. How does EPA/ORD anticipate future environmental issues to provide timely data for the regulatory or legislative processes?

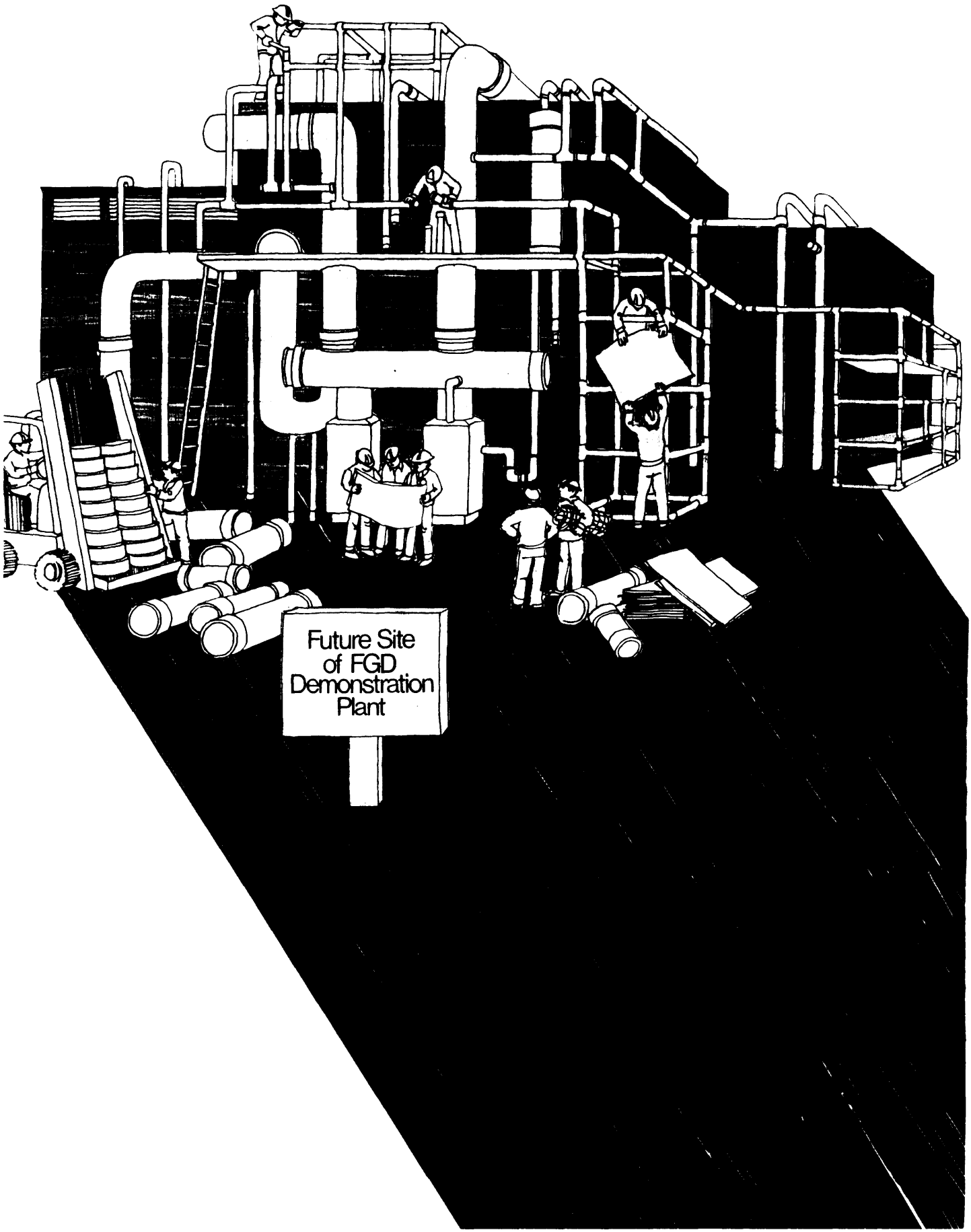
2. What methodology does EPA/ORD use to establish R&D priorities and programs in the exploratory area?

3. What constrains ORD from pursuing exploratory research to anticipate environmental problems?

Background

Inevitably, significant social, technological, and resource changes will affect the environment. While one cannot predict the nature and time of environmental crises, an exploratory research program that attempts to anticipate problems would add a worthwhile dimension to ORD's program.

III. Control and Abatement Technology Research


Future Site
of FGD
Demonstration
Plant

III. Control and Abatement Technology Research

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III. Control and Abatement Technology Research

INTRODUCTION

During the past 10 years, Federal environmental control efforts have been complemented by new initiatives in the private sector. These initiatives have included the development of major new industries in such areas as environmental monitoring, pollution control, and industrial process modification. With the growth of these new capabilities, alternatives and supplements to publicly funded control efforts have been created. Evaluation of the control technology elements of the ORD 5-Year Plan raises issues regarding the balance, substance, suitability, and utility of the planned research program.

Research Balance

EPA efforts planned in the development of control technologies appear to favor large demonstration projects as opposed to striking a balance with exploratory research projects. At this time, greater benefit may possibly result if ORD conducted more exploratory research projects and less large demonstration projects. (Issue 1)

Research Suitability

In general, the Extraction and Processing Technology subprogram relates poorly to program objectives and funding estimates. There may be unproductive overlap between ORD's planned efforts and those of other Federal agencies. (Issue 2)

In the area of flue-gas desulfurization (FGD), the ORD Plan projects significant expenditures to develop technology based on "throwaway" processes. Because such technology is now commercially available, further efforts on first-generation FGD systems appear unnecessary. If it is the intention of EPA to work on second-generation technology which recovers sulfur products, then the Agency should present the information required to justify that course of action. It is necessary to demonstrate: first, that sludge disposal poses serious environmental problems; and second, that there are insufficient incentives for private industry in this area. (Issue 3)

ORD seeks to develop environmental-control technology for offshore oil and gas production. The extensive efforts of both private industry and Government agencies such as the U.S. Geological Survey and the U.S. Coast Guard appear to have not been adequately recognized. The ORD program in this area may duplicate current work outside EPA. (Issue 4)

The EPA, through ORD, conducts extensive research which can be used as the basis for promulgation of EPA standards and regulations. So long as EPA performs the dual role of developer and regulator, some may claim that EPA promotes its own control technology versus other approaches to compliance with its standards. (Issue 5)

Research Substance

Mobile source emissions are a significant source of environmental pollution. Several agencies, including EPA, ERDA, as well as the Department of Transportation, work in this area. While EPA's automotive engine technology program has been transferred to ERDA, gaps still exist in the basic data and management methodologies and they need to be filled in order for EPA to reduce transportation emissions as mandated. (Issue 6).

A problem which is receiving increased attention concerns small particle control technology. Such particles, those less than 3 microns in diameter, are now recognized as a substantial health problem. The ORD Plan underemphasizes the need to develop control and monitoring technology in this area. (Issue 7)

The ORD Plan for Minerals, Processing, and Manufacturing focuses on creating a data base for air and water standards established by law. However, the Plan fails to discuss research associated with the identification and control of pollution from new industrial technologies, changes in raw material usage, or new requirements in industrial energy. *(Issue* 8)

The ORD Plan does not indicate the direction of its solid waste management research program. Also not discussed are coordination and balancing of various alternatives and the meshing with ERDA's energy recovery program. (Issue 9)

Technology Transfer

Useful technology has been developed by ORD for secondary and tertiary wastewater treatment and for community-systems wastewater and sludge management. Because the required technology has high operating costs relative to original capitalization and Federal funding concentrates on capital costs, not operating costs, it is important that available R&D information be translated into practice in communities across the Nation. ORD needs to commit additional resources to researching the economic and institutional problems of secondary and tertiary wastewater management as well as the nonstructural approaches to wastewater treatment practices. (Issue *10*)

III. Control and Abatement Technology Research

ISSUES

BALANCE BETWEEN EXPLORATORY RESEARCH AND DEMONSTRATION OF CONTROL TECHNOLOGY

Issue 1

The Plan neglects exploratory research while emphasizing the demonstration of control systems that are readily applicable to cope with mandated emissions standards.

Summary

The EPA has an extensive mandate to identify, develop and, where necessary, to demonstrate control technology which is applicable to air and water pollutant emission standards. While a number of demonstration projects have been funded, insufficient resources are devoted to exploratory or fundamental research into control principles or novel control approaches. These areas should receive greater attention if effective and economic control options are to be developed to meet the long-term needs of the Nation. Such efforts should be detailed in the Plan.

Questions

1. How does EPA identify exploratory research opportunities?

2. What has been EPA's experience in funding exploratory research? What have past efforts yielded?

3. What portion of EPA's budget is earmarked for exploratory control methods research? What expenditure level would be sufficient to meet long-term national needs in this respect?

4. What exploratory research is EPA conducting to identify pollution control technologies which consume less energy than present systems?

5. What exploratory pollution control research is being carried out by other agencies? How is it coordinated with EPA's research ?

Background

Regulatory requirements have affected the allocation of research resources among exploratory, developmental, applied, and demonstration projects in ORD's control systems research. Emphasis has been placed on identifying, demonstrating, and refining existing technological options. This is an appropriate emphasis in the control program. However, it has been developed in the Plan to the virtual exclusion of exploratory work essential to long-term development of environmental controls in new technology areas.

The Plan indicates that several demonstration plants are being funded, but it reveals scant information on planned exploratory or fundamental research. The funds allocated for just one of these plants could support a variety of exploratory projects. For example, the chemical form in which nitrogen exists in coal, oil, or shale oil is not well enough understood. If it were, a method for removal of the nitrogen might be conceived, thereby reducing or eliminating NO_x emissions from combustion of those fuels.

EPA-funded research into new methods of physical coal cleaning has led to the identification of promising techniques for removing inorganic sulfur from coal. The research in the physical coal-cleaning area appears to have undergone a logical transition from an analysis phase, in which fruitful areas of control technology were identified, to an exploratory phase, in which a significant number of exploratory projects were carried out, and finally to a technology-developed phase. Such an approach may constitute an appropriate model for other areas of control technology research.

In sum, increased support for exploratory research is warranted.

ENERGY EXTRACTION AND PROCESSING TECHNOLOGY

Issue 2

The projects listed in the Energy Extraction and Processing Technology subprogram appear to relate poorly to the program objectives and funding estimates. The projects do not seem to be planned with a sufficient awareness of existing control technology and research activities outside EPA.

Summary

Since coal is expected to play a major role in satisfying the Nation's energy needs, it is appropriate that the ORD Plan emphasize research to achieve environmentally acceptable use of this resource. The Plan also acknowledges a significant potential for energy recovery from waste, biomass, solar and geothermal sources but does not include projects to enable ORD to assess the environmental implications of large-scale use of these energy sources. ORD does not explain how projects to produce new technology to desulfurize oil will represent an improvement over existing technology.

In general, there may be duplication of effort in this area of research between ORD and other Federal agencies as well as an inability to accomplish significant progress at the proposed funding level because of the large number of tasks identified.

Questions

1. What projects have been formulated to assess the environmental implications of large-scale use of new energy sources such as biomass, solar and geothermal?

2. What is the relationship between EPA, ERDA, and the U.S. Bureau of Mines programs in developing environmentally acceptable new technologies for mining and use of coal and the work proposed by ORD?

3. The Federal Government has devoted substantial effort for many years to support R&D in the area of acid drainage control from coal mines, and control techniques are now available. Why does the Plan suggest more research in this area?

4. In view of existing commercial processes for desulfurizing oil, what is ORD's justification for developing control technology in this area ?

Background

To meet national energy needs, techniques must be developed to permit increased coal use in an environmentally acceptable manner and encourage the commercialization of alternative energy sources. In recognition of this, the ORD Plan defines a large number of broad programs aimed at reducing the environmental impacts of coal use. Since increased use of coal can impact quickly and significantly on our energy needs, this emphasis is proper. However, the Plan ignores environmental research into other potential energy sources. Although a project is proposed to develop a data base for oil shale mining, definitive projects aimed at assessing the environmental implications of large-scale use of other energy resources—such as geothermal, waste, biomass, solar, and wind-are absent. These energy resources, although further from commercialization, should be studied now because environmental constraints may influence the course of their utilization. For example, the problems of hydrogen sulfide evolution during the processing of geothermal brines and the difficulties of disposing of these mineral-laden liquors could seriously delay use of this resource unless solutions are found.

The Bureau of Mines proposes to spend in excess of $250 million over the next 5 years to develop new coal-mining systems with enhanced productivity and improved environmental performance. The ORD Plan does not indicate how or if ORD and the Bureau of Mines will cooperate on this large program.

A variety of Federal and State agencies for many years have supported research in the area of acid mine drainage control. As a result



Acid drainage from mine near Rico, Colorado.

of this work, the causes of the problem are now well understood and a variety of control systems have been tested and commercially demonstrated. In light of these accomplishments, the need for further work by ORD in mine drainage control is questionable.

The petroleum industry currently uses catalytic hydrogenation processes to reduce the sulfur content of refined products. These processes can also be used in the treatment of liquids from oil shale, tar sands, and coal. In view of the present availability of technology for desulfurizing oil, ORD has not presented adequate justification for the further development in the control technology area.

Finally, it is difficult to understand how significant progress can be accomplished in the large number of projects which have been defined and targeted for completion by 1980. The proposed annual budget of $15 to $30 million appears to be seriously inadequate. The program would have more credibility if it contained an explanation of priorities among the research tasks along with expected timetables and milestones for their achievement.

DEMONSTRATION OF FLUE-GAS DESULFURIZATION TECHNOLOGY

Issue 3

The commercial availability of flue-gas desulfurization (FGD) technology indicates a need to reevaluate the ORD development program in this area.

Summary

There appears to be little justification for ORD to continue spending large sums of money on FGD systems based on so-called "throwaway" processes, because these systems are commercially available. Although continued research is needed on second-generation FGD systems designed to recover sulfur products, ORD has not established a justification that the Federal Government should do it.

Questions

1. What is the justification for ORD funding "throwaway" FGD systems when they are already commercially available?

2. What conflicts of interest exist when EPA is both the regulator as well as the developer of FGD technology?

3. Do adequate incentives currently exist for private industry to develop second-generation, regenerable FGD systems? If not, how will ORD funding in this area significantly hasten the introduction of advanced systems that recover sulfur products?

Background

Over the past 5 years, ORD has funded a number of flue-gas desulfurization demonstrations, The primary emphasis has been placed on the so-called "throwaway" processes using lime or limestone as the absorbing alkali. Although some have criticized EPA's role in the development of FGD technology, it is generally acknowledged that the demonstration projects and symposia supported by EPA have advanced the state of the art and hastened commercialization of the technology. Today there are about a dozen FGD manufacturers who have expertise in designing workable lime/limestone systems. Since the "throwaway" flue-gas desulfurization system is now commercial, there seems little reason for continued ORD involvement. The ORD Plan states that "R&D efforts will focus on remaining problems such as upgrading operating performance and reliability, minimizing costs, waste product disposal problems and treatment, and byproduct recovery." These activities are properly carried out by manufacturers, to improve the competitive advantages of their product. As such, the justification for the three test systems at Shawnee—the Louisville Gas & Electric test program, the pilot and prototype double alkali FGD program, and Bakco FGD systems—is weak at best.

The development of second-generation FGD systems designed to recover sulfur products raises somewhat different questions. There are many areas of the country, especially urban areas, where it is impractical to dispose of the calcium-sulfur sludges resulting from the operation of "throwaway" FGD systems. If EPA can make a case that industries manufacturing FGD systems lack incentives and/or resources to develop the sulfur recovery technology, then a basis would be established for ORD work in this area.

ENVIRONMENTAL CONTROL IN OFFSHORE PETROLEUM OPERATIONS

Issue 4

The proposed Office of Energy, Minerals, and Industry program to develop environmental control technology for offshore oil and gas production apparently does not recognize existing industry programs and technologies.

Summary

The EPA/ORD Office of Energy, Minerals, and Industry (OEMI) proposes to develop and demonstrate control technologies to minimize adverse environmental effects from the installation and operation of offshore oil and gas production facilities, including platforms, pipelines, and other transportation systems, and onshore terminal facilities. The Plan does not specify definitive goals for R&D in offshore pollution-control technology. Further, the program statements convey the impression that ORD may be pressed into an area where their expertise is undeveloped compared to that already developed by the private sector in response to regulations. If this is true, then EPA's entry into a hardware development program related to the offshore oil and gas extraction industry may be questionable. Federal involvement already exists through agencies such as the U.S. Geological Survey and the U.S. Coast Guard. The EPA program may be more usefully directed toward biological and geological research in the coastal and marine environment. EPA can also provide the needed coordination of Federal activities in the offshore area.

Questions

1. Has OEMI thoroughly investigated the available technology in the offshore pollution-control industry?

2. What environmental control technology research for offshore operations is being carried out in other Federal and State agencies?

3. How does EPA intend to identify research opportunities in the offshore area, or have they already done so? Are these efforts coordinated with efforts in the U.S. Coast Guard, Department of the Interior, etc. ?

4. What effect will EPA's entry into the offshore control systems development area have on private-sector work in the same area?

Background

The offshore petroleum industry is into its third decade of development. Recently, private industry has emphasized the safe and efficient extraction of oil and gas. The efforts of industry in developing control technology, not only in preventing oilspills, but also in the areas of leak-detection systems, underwater completion devices, automated drilling procedures, general-support equipment development, waste management priorities, and pipeline construction need to be reflected in an ORD evaluation of the state of the art when initiating hardware development in the offshore area. Since hostile environments may present different problems, a Federal exploratory control technology program for offshore development of oil and gas in hostile environments may be necessary,

The social-environmental impact of offshore development upon onshore communities is being studied in Louisiana, Delaware, New Jersey, Texas, California, and other coastal regions. Yet, more research remains to be done. There are also many areas of biological and geological research in the

coastal and marine environment which need further attention. These are activities in which EPA should be involved. The proper EPA role in the control of offshore petroleum operations should include coordination of Federal activities.

POTENTIAL CONFLICT OF INTEREST WITH REGARD TO EPA RESEARCH ON ENVIRONMENTAL CONTROL TECHNOLOGY

Issue 5

The Plan does not adequately define ORD's role in developing and demonstrating environmental-control technology which may subsequently form the basis for promulgation of EPA emissions standards.

Summary

As was the case with the now defunct Atomic Energy Commission, any agency of the Government which both develops a technology and regulates its use may come under suspicion of favoring, promoting, and enforcing the use of the technology which was developed internally. Suspicion in this respect may never be completely eliminated, and it is necessary, therefore, to examine the benefits and liabilities which arise from EPA's current dual role.

Questions

1. Should a regulatory agency develop control technologies that it will eventually regulate or use as a regulatory tool?

2. What mechanisms are provided by EPA to insure that the Agency does not bias its decisions in favor of internally developed control options?

3. What objective mechanisms are used in the control system research program to reassess and, if necessary, modify or abandon research projects which do not measure up to the quality of work being done outside of EPA?

4. What criteria does EPA use to identify, justify, or terminate major development and demonstration projects? How does research done outside of the Agency influence these decisions?

Background

The concerns raised here center on the circumstances under which control technology development is appropriate, the criteria for project review (initiation, continuation, or termination) and the general ability of EPA to assess and use in regulatory actions its own technological developments in an u n - biased manner, The potential for conflict of interest is great. It is unfortunate that the Plan never addressed these issues. The following is a summary of the arguments for and against control technology development by EPA.

Pros

EPA's research on control technologies is a critical element of the entire emission control program and provides the Agency with a means of accelerating pollution-control efforts, eliminating undue costs to control technology users, and developing a strong information base for regulatory action.

In particular, EPA's control technology research program is essential to development and demonstration of control options which industry has no incentive to develop or is unwilling to develop. EPA's control development program may also in certain instances be able to do research more economically than industrial sectors that are too small, diverse, and dispersed to fund research individually or have not organized to develop a unified research effort.

In many cases, EPA's regulatory action depends upon demonstrable technological feasibility y. Without a control research program to insure this requirement, EPA would have no means of assessing technology improvements.

Generally, EPA's control research program gives the Agency access to key scientific fields, This provides the Agency with the necessary scientific knowledge to develop sound regulatory requirements and to observe the value and quality of control development work going on outside of Government.

Con

As long as EPA is both developing and regulating environmental control technologies, there will always be potential for the misuse of data and biasing of decisions toward the control methods and information developed within the Agency.

Historically, the Atomic Energy Commission came under severe criticism for being simultaneous y the advocate and the regulator of atomic energy technologies. Although EPA's situation is somewhat different (EPA is an advocate of protective measures), EPA's regulation and control requirements can still cause significant socioeconomic effects and even environmental harm.

So long as EPA serves as developer and regulator, it may be suspected of promoting its own technologies, ignoring reasonable alternatives and discounting any secondary or environmental effects of "i n-house' technologies.

EPA's entry into the control system development area can also distort private markets for the same types of controls. When contract research is funded by EPA, one or more developers will be funded, putting other developers at a disadvantage. In addition, once EPA has entered into a control development effort of its own, many private developers assume a wait-and-see position and reduce their own efforts.

A third problem is that Government programs of this kind develop their own momentum, making worthwhile modification, redirection, or termination of control development projects difficult to carry out. For example, in areas such as flue-gas desulfurization development, the prime goal has been achieved, but the Agency appears to be unnecessarily continuing refinement research which may be more properly left to the private sector.

MOBILE SOURCE EMISSION ABATEMENT RESEARCH

Issue 6

The EPA and ERDA mobile source emission abatement research plans and the DOT and EPA transportation research plans appear to ignore several significant research areas.

Summary

EPA's automotive engine technology program has been transferred to ERDA. Nevertheless, automobile and heavy-duty - vehicle emissions control requires added support not provided for in either ERDA or EPA plans. In particular, the fundamental body of analysis needed to design effective and economical transportation plans is not being provided, thereby leaving little chance—to either default on the existing emissions control strategy or to implement costly, disruptive, and largely ineffective plans. In addition, there is a paucity of basic information needed to compare the cost and effectiveness of pollution controls for trucks, cars, and buses, or other mobile sources with those for stationary sources.

Questions

1. What coordination exists between EPA and other Federal- and State-level agencies on control of mobile source emissions?

2. What has EPA done to develop methodologies and information needed to design and implement less costly and more effective transportation control plans? What coordination is provided with DOT?

3. What methods are used to compare control options for new vehicles with transportation controls, control of other mobile sources, and control of stationary sources?

4. What research and analysis is planned to provide design incentives for manufacturers

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to develop fundamentally less polluting engines as opposed to costly modifications to existing designs?

Background

In the ORD Plan the research effort in mobile source control is limited to some test procedure and emissions characterization work and some study of transportation management. ERDA's current research plan calls for demonstration of high-efficiency, low-emission alternatives to the internal combustion engine, such as the diesel, the Sterling, and the gas turbine. DOT is also involved in some transportation research related to env iron mental protection. Yet, gaps remain in the basic data and methodologies needed to fulfill EPA's mandate to reduce transportation emiss ions.

Transportation plans were promulgated for a number of metropolitan areas in the early 1970's. Hastily assembled under tight time and budget constraints and without adequate data and analysis, the plans included proposals to limit automobile travel as well as to retrofit pollution controls to older vehicles and to reduce evaporation of hydrocarbons from stationary sources. Because of the apparent disruption of economic activity and lifestyle implied by these plans, they met with widespread opposition which tended to undermine public and political support for clean-air goals. While the original plans may be moribund, the desirability of plans for air-quality improvement remains. EPA could develop the facts and analytical techniques for a more systematic estimate of the probable economic, social, and environmental conse-



Air, noise, **and eye pollution emanate from situations depicted** in this photograph of rush-hour traffic on the Southwest Freeway, Houston, Texas.

quences of alternative strategies. Then, perhaps more effective and less costly plans with better chances of acceptance could be designed. However, a research mission of this kind is not evident in the Plan.

Among the considerations in establishing an air pollution control program is that pollutants emitted by automobiles are also emitted by stationary sources to varying degrees. While controls must be applied uniformly to vehicles because of their mobility and widespread distribution, controls for stationary sources can be tailored for a particular location--depending on overall pollution load and atmospheric conditions.

In the case of NO_x abatement, comparative analysis of mobile and stationary controls is needed. The 90-percent reduction of NO_x from automobiles which was mandated by the 1970 Clean Air Act Amendments has proven much more difficult than Congress anticipated. Mass-producible catalyst systems with the durability to pass EPA's 50,000-mile test have not been demonstrated and may be well beyond the present state of the art. Moreover, even total elimination of automobile NO_x would not suffice in some urban areas because emissions from powerplants and other stationary sources contribute a significant and growing part of the total. EPA's analysis suggests that, while some control of automobile NO_x. is cost effective, so too is substantial stationary source control. More work is needed, however, to update the cost information, to apply the analysis to different geographical regions, and to account more accurately for the temporal and geographic differences in NO_x. emissions from various sources within each region.

SMALL PARTICLE CONTROL TECHNOLOGY

Issue 7

The development of monitoring and control technology to reduce small particle emissions is given insufficient attention in the ORD Plan.

Summary

The Plan gives little attention to research on the monitoring, characterization, and control of small particles (those less than 3 microns in diameter). Small particles have been recognized as a health problem of consequence. More thorough definition is needed of ORD plans, timetables, and methods of approach for developing technology to deal with small particles.

Questions

1. What is EPA's timetable for the establishment of new source performance standards or ambient air-quality standards for small particles? How is ORD control technology research designed to support this timetable?

2. What is the rationale by which ORD has assigned a high priority to flue-gas desulfurization projects and a lesser one to an expanded research effort on small particle monitoring and control?

3. What progress has ORD made in its recent research on monitoring, characterization, and abatement of small particle emissions?

Background

The effective control of small particle emissions represents a classic dilemma for EPA. The criteria document set ambient air-quality standards for the total mass of airborne particles. At the time that the standard was set, most authorities recognized that health problems of particle emissions were caused primarily by respirable particles, those that enter and remain in the deep alveolar recesses of the lung. Most of the respirable particles are 3 microns or less in diameter. The failure to distinguish between coarse and fine particles in the standard has been attributed to the lack of suitable technology, both to monitor the size distribution of particle emissions and to effectively control emissions of fine particles. Apparently, because the air-quality standards were not set on the basis of size, incentives for

ORD to emphasize small particles were less than incentives to develop improved controls for the criteria pollutants, for which legislative mandates existed. As a result, the pace of research and development related to small particles has lagged behind the expectations of many observers outside and within EPA.

Recent evidence suggests that the problem may be more complicated than originally thought. The composition of the small particle emissions may be an important determinant of their health effects. The major point, however, is that considerable research needs to be done on technologies to monitor, characterize, and control the emissions of fine particles in order to set an air-quality or new source performance standard that industry can comply with and EPA can enforce. To the extent that large and costly demonstration projects on criteria pollutants receive excessive attention by ORD, research on the small particle problem will be inadequate. ORD should define more precisely its goals, timetables, and methods of approach to deal with the small particle emission problem.

FUTURE INDUSTRIAL POLLUTION CONTROL REQUIREMENTS

Issue 8

The ORD Plan for Minerals, Processing, and Manufacturing fails to discuss research directly aimed at the identification and control of prospective pollution problems associated with new industrial technologies or changes in industrial energy and raw material sources.

Summary

The ORD Plan for Minerals, Processing, and Manufacturing focuses on establishing the data base to support water and air emission standards mandated by the associated laws. There are no apparent efforts in the Plan for identifying upcoming pollution control needs resulting from changes in processing technologies, raw materials, and energy sources. Changes in the price and availability of fuels and raw materials are leading to increasing use of lower grade ores as well as recyclable materials and to development of new processes by industry. Research into the environmental impact of these changes would better enable ORD to anticipate upcoming pollution problems and to establish control research priorities.

Questions

1. What is the level of EPA research into the future market penetration of new industrial processes and changing patterns of industrial fuel and raw material use?

2. What is the nature and extent of EPA's effort to discuss with industry the potential conflicts between existing regulations, or controls under development, and new processing technologies being developed?

3. What level of effort is put into projecting trends in industrial pollution—based on shifts in fuel, feedstock and mineral resource use, and new processes? What level of effort is devoted to evaluating new management or hardware options for industrial pollution control ?

Background

Industry is continually developing new p recesses. Associated environmental problems may accompany the eventual commercialization of some new processes, with a resulting requirement for new control measures. If EPA does not anticipate these problems, unnecessary ecological or health risks may result.

An investigative research program is needed to assess the environment control needs associated with future trends in industrial raw material and energy use. Changes in industrial pollutants will result from shifts in chemical feedstocks to heavier hydrocarbons and in mineral sources to low-grade ores and recycled materials as well as the general shift from gas to oil and oil to coal. EPA has a responsibility to investigate trends and encourage development of control methods (either by industry or, if appropriate, by EPA) to reduce potential health and environmental

damage caused by new industrial processes and practices.

SOLID WASTE MANAGEMENT

Issue 9

The direction of EPA's research on solid waste management alternatives cannot be determined from its Plan.

Summary

The Nation faces massive problems in the area of solid waste management. A variety of efforts underway in EPA, ERDA, and the private sector is aimed at reducing solid waste production, recovering usable materials and energy from solid waste, and minimizing environmental effects of solid waste disposal. The ORD Plan's description of the proposed solid waste management research effort lacks substance. In particular, it fails to address significant issues regarding the research program direction, coordination, and balance which are indispensable to an understanding of EPA's intentions in this area.

Questions

1. What research is planned or in process by ORD on the reduction of waste at its source as a control alternative?

2. What economic assessment is being done of material recycle and recovery projects? How are salable products identified and markets evaluated ?

3. How does the ORD Solid Waste Management Program coordinate with the EPA liquid waste and air-quality regulatory programs and with the ERDA and FEA energy-recovery programs?

4. How does EPA cooperate with private-sector groups such as the food industry currently involved in research into waste generation reduction and solid waste recycle, reuse, and energy recovery?

5. How will EPA's effort be allocated between high versus low technology solid waste management systems?

6. How will EPA consider costs and benefits in identifying and ranking solid waste management research opportunities?

Background

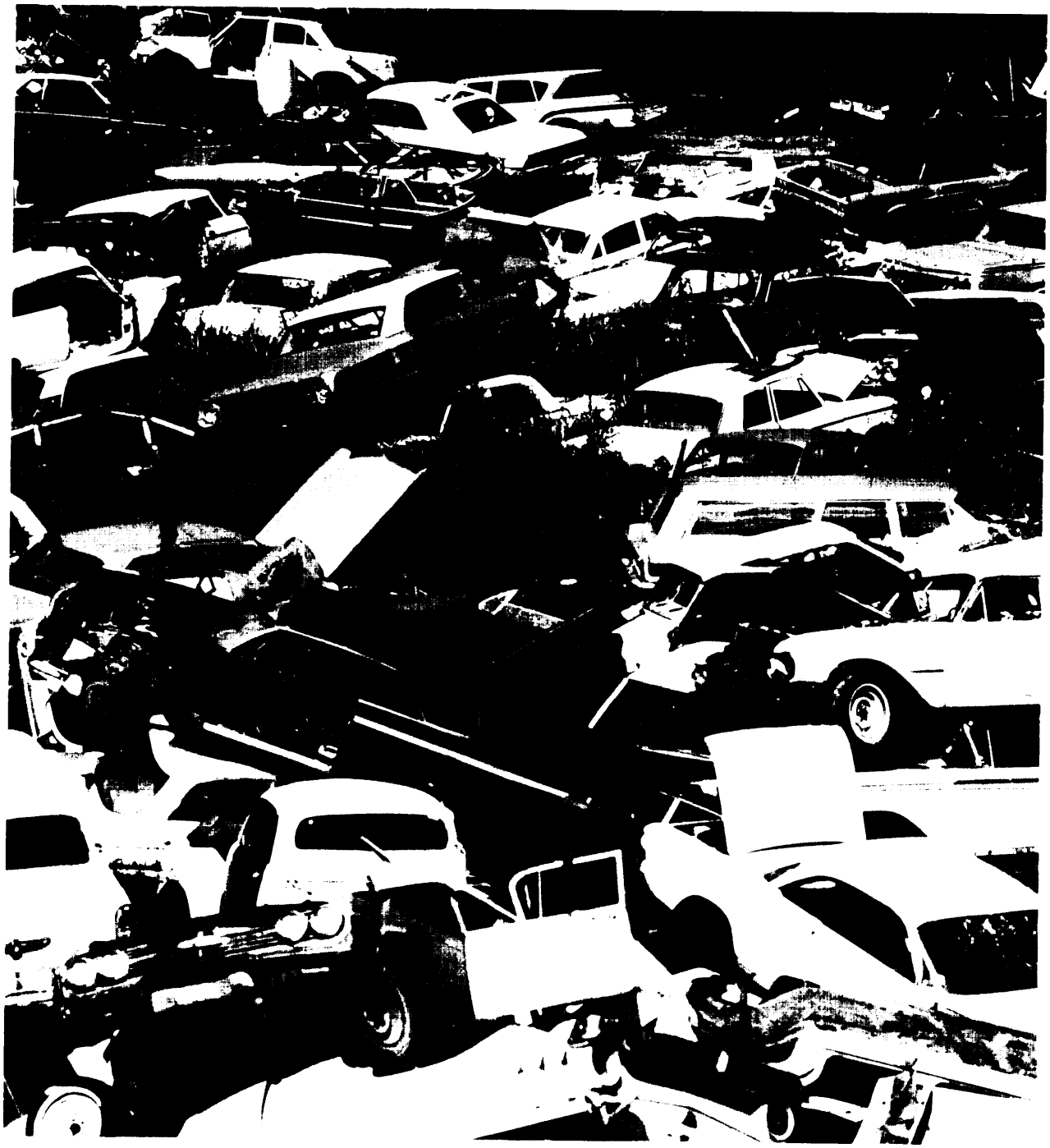
Solid wastes—including consumer product wastes and hazardous wastes—represent a tremendous material depletion, environmental degradation, and public health problem. Waste treatment and reduction require substantive program attention. The Office of Solid Waste Management Programs (OSWMP) was established by EPA to deal with the national solid waste problem.

Working on an annual budget of approximately $20 million, OSWMP is engaged in a variety of research and development as well as demonstration efforts in areas which appear to overlap those planned by its sister division ORD. Moreover, within ERDA, there is still another program of solid waste management aimed at energy resource recovery. An appropriate division of labor among these entities should be specified.

The ORD Waste Management subprogram is budgeted at a slightly lower level than the OSWMP program. It is not clear how much of the Waste Management budget is allocated to consumer and hazardous wastes, and the Plan gives no indication of how the OSWMP program and ERDA programs compare to ORD's effort, how responsibilities have been delegated, and how the three efforts will be coordinated.

The Plan makes no reference to the vital area of research directed at reduction of wastes at the source through education/participation as well as technical means. No mention is made of resolving the conflict between high-technology "blackbox" approaches to waste management and 1ow-tech - nology approaches which incorporate source separation and waste reduction. Recycling of materials for nonenergy uses is not discussed.

Solid waste represents an important energy source and an opportunity for energy conser -



EAST COAST

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therefore, could substantially save energy and resources required to produce certain materials (i.e., aluminum, glass, copper, etc.) and could minimize their environmental impact.

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viable resources. 'Although the EPA Plan addresses resource recovery in a general way, it does not cope with the difficulties of establishing and maintaining markets for waste byproducts, EPA's Solid Waste program needs



WEST COAST

Solid waste litter—Anza-Barego State Park, California.

to focus on research and development of changes in the recycled materials at the recov - ery plant that will improve their acceptance by industry.

Portions of the ORD Plan suggest a lack of knowledge about current industrial solid waste management practices. For example, the Plan indicates that EPA will fund, over the next 5 years, a major project in byproduct recovery from potato processing. In fact, the food-processing industry has for several years been recovering animal feed materials from potato-processing wastes and has several

ongoing programs which are investigating reduced generation of solid waste.

TECHNOLOGY TRANSFER FOR EFFECTIVE WASTEWATER MANAGEMENT SYSTEMS

Issue 10

The research ORD is conducting on wastewater treatment and community systems for wastewater and sludge management is not being fully used in achieving the legislative mandates imposed on EPA.

Summary

Technology which has been developed for secondary and tertiary wastewater treatment and community wastewater and sludge management is not being fully used because it is costly to operate relative to original capitalization. Federal cost sharing concentrates primarily on capital costs rather than operating costs. To provide a better framework for congressional consideration of various alternative strategies, ORD needs to commit more resources to researching economic and institutional problems in secondary and tertiary wastewater management as well as nonstructural solutions to wastewater treatment problems. Many of the performance problems with existing systems arise from improper operating procedures, insufficient instrumentation, and excess hydraulic loading caused by infiltration inflow or combined sewer conditions. These facilities can benefit from knowledge of treatment methods and control needs, and improved operation and repair of wastewater collection systems to minimize peak hydraulic loadings.

Questions

1. What priority has ORD placed on R&D aimed at improving existing waste treatment plants, such as waste treatment lagoons or older mechanical-type plants?

2. What priority has ORD given to financial and marketing research in wastewater and sludge management techniques?

3. What part of ORD's overall control development program is aimed at improving operating procedures? What control benefits are to be derived through better training of operating personnel?

4. Has ORD investigated the potential value of maximizing control of infiltration inflow or flow with combined sewers utilizing existing collection systems?

5. To what extent will EPA explore strategies for wastewater source reduction such as use of porous concrete, improved street-sweeping techniques, and other management strategies ?

Background

There are approximately 25,000 municipal or joint municipal-industrial wastewater treatment plants in the United States. Twenty thousand of these plants are small and serve population equivalents under 10,000 people. About 70 percent of these wastewater treatment plants incorporate secondary treatment facilties; i.e., wastewater lagoons, trickling filters, or activated sludge plants. Recent EPA studies show that more than two-thirds of these secondary treatment plants are not meeting either their design capabilities or the minimum secondary standards as defined by EPA in meeting the goals of Public Law 92-500. This means that approximately 50 percent of the wastewater treatment plants in the United States could benefit from the improvement of existing capital facilities. The remaining 30 percent of wastewater treatment plants have less than secondary treatment plants. This 30 percent could benefit from the construction of new wastewater process technologies without abandonment of existing capital facilities.

Almost all the municipal or municipal-industrial wastewater treatment plants are based on microbiological conversion of waste and the subsequent settling of suspended solids. This is true for wastewater lagoons, trickling filters, and activated sludge plants. Most existing plants were

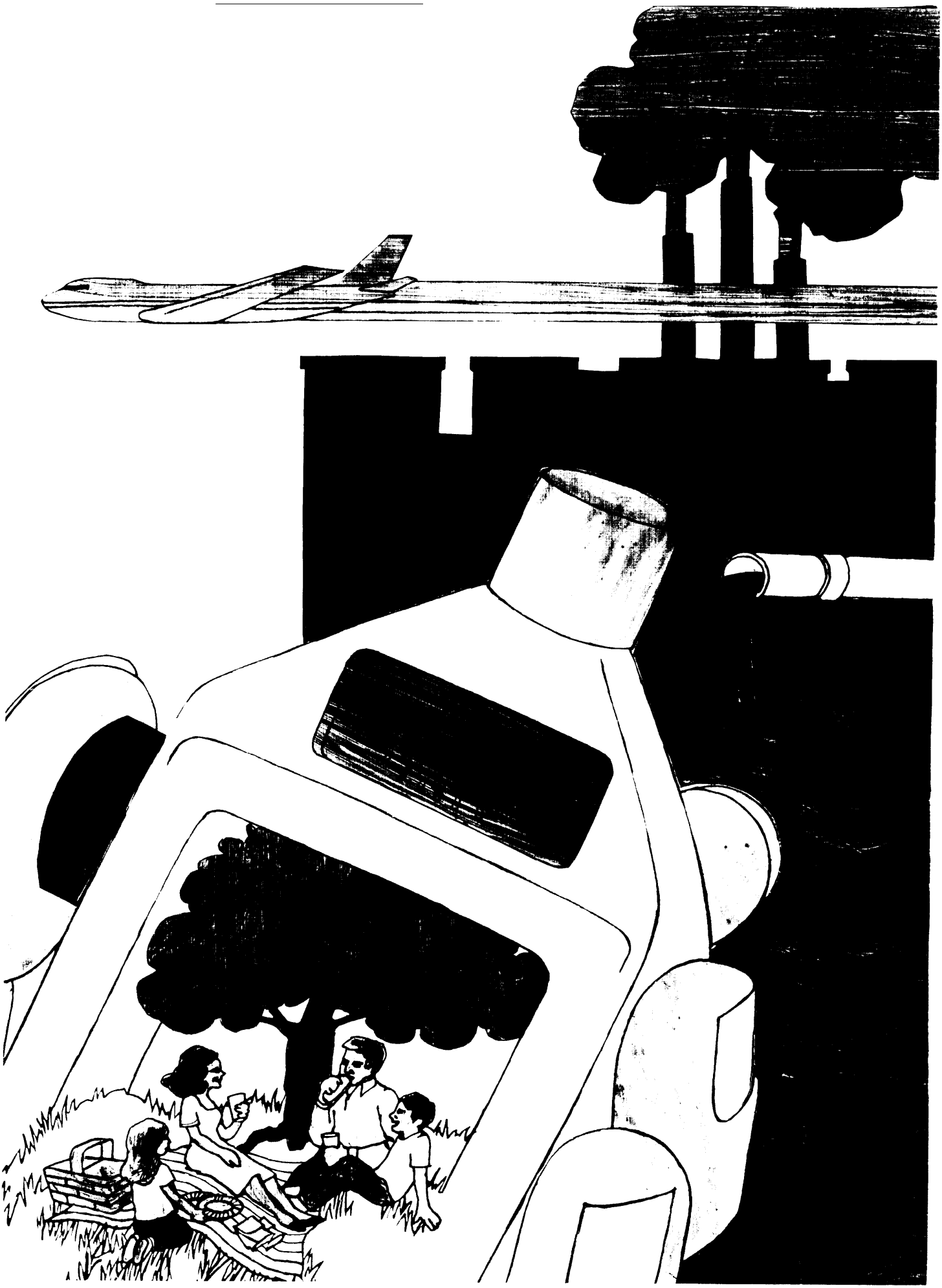
designed by rule of thumb or to comply with an applicable building code, rather than for opt i mum operation. Not surprisingly, a significant number of these older plants cannot meet secondary treatment standards, Most of these plants have inadequate or poorly developed microbial cultures which produce insufficient treatment or difficult-to-settle solids. A better understanding of the causes of poor microbial behavior and solids settling can lead to improved control measures such as the addition of chemicals or procedural changes. However, the majority of existing plants may be too small and their personnel may not be sufficiently trained in microbiology, chemistry, mechanics, or electronics to insure attainment of the maximum benefits. Management schemes to provide this knowledge should be investigated as a procedural control option.

The wastewater collection system is equal i n importance to the treatment facilities. Wastewater collection procedures can be adjusted to achieve integrated system effectiveness. Infiltration inflow control or flow routing can be used to minimize peak hydraulic loading at wastewater treatment plants. This type of control procedure reduces the need for additional capital investments i n treatment capacity and maximizes the use of the capital investment in the collection system itself.

Another opportunity for improving the effectiveness of existing facilities lies in the improvement of storm sewer and combined sewer operations. Research should be directed at sewer operating procedures. Streets and sewers, unless periodically cleaned, become clogged with solid wastes during periods of low flow, then drop this load on the treatment system when the flow is increased suddenly, as i n a storm. Nonstructural approaches, such as intermittent sewer cleaning or flushing, street sweeping, and in-system flow regulation, can maximize the capacity of sewers and treatment facilities to handle and treat the storm and combined sewer wastes.

For the 30 percent of treatment plants that do not include secondary treatment facilities, a broad base of technology already exists and additional technology is advancing rapidly for both advanced treatment per se and community systems management of wastewater and sludge. Generally, the technology requires a low capital investment relative to operating costs. At the community level, sanitary engineers have been slow in accepting these new technologies. More economic research is needed that analyzes the costs of various alternative strategies for wastewater management, especially as they relate to health and environmental costs.

IV. Transport, Fate, and Monitoring Research



IV. Transport, Fate, and Monitoring Research

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IV. Transport, Fate, and Monitoring Research

INTRODUCTION

Rational regulatory action for control of a pollutant depends on an understanding of the ways in which pollutants are transported throughout an ecosystem and how they change or combine with other substances to become more or less troublesome.

Monitoring research is necessary to detect and document the movement and transformation of pollutants. This broad field of study combines two other large areas of EPA/ORD research: the control of sources, on the one hand, and the health of humans and ecosystems, on the other hand.

Before discussing specific issues, a general concern should be noted. A substantial portion of the research on the transport and fate of pollutants and on ecological effects is contained with in the energy -related subprograms. The importance of energy and energy-environmental research is clearly recognized and not at issue here. However, the Office of Research and Development (ORD) Plan does not adequately reflect the close ties that should exist between administratively separate, but scientifically similar research. The fragmentation of these efforts in the Plan hindered assessment of the overall content and thrust of research on the transport and fate of pollutants.

The review of the transport, fate, and monitoring elements of the ORD 5-Year Plan raises issues regarding monitoring and measurement technologies, research initiatives, specific ecosystems, and water research.

Monitoring and Measurement Technologies

The results of diverse studies within EPA must eventually be combined to set standards and to forge the control strategies to implement the standards. This requires a centrally coordinated and technically strong monitoring effort beyond the apparently fragmented responsibility existing within ORD. (Issue 1)

The ORD Research Plan suggests the absence of an adequate screening program to detect toxic materials singly or in combination in air and water. A broad monitoring-screening program will help avoid the "pollutant of the month" syndrome. (Issue 2)

In the ORD research monitoring program, physical and chemical techniques are emphasized to the neglect of biological needs. Neither biological monitoring research nor guidelines to discharges on effective biological monitoring are projected in the ORD Plan. *(Issue* 3)

EPA's methods to analyze air quality attempt to define air pollution levels and not pollutant concentrations. Further research is needed to develop analytical tools for the measurement of specific hazards not currently being researched. *(Issue* 4)

The variety and number of identified pollutant substances are steadily increasing. Accountability for analyzing these new substances is fragmented; new methodologies require extensive time for acceptance; and standards for technique acceptance are ill defined. *(Issue* 5)

Research Initiatives

Rational control strategies require knowledge extending beyond ambient levels of pollutants and emissions and their precursors. It also is necessary to understand the processes of dilution, transport, transformation, and removal that determine human and ecosystem exposure. Complex interrelationships are involved; thus, the research cannot be effectively performed in "bits and pieces." Since results strongly influence the develop-

ment and enforcement of regulations, such research deserves high priority within EPA/ORD. (Issue 6)

While pollution is often thought of in local or regional terms, it is also a global problem. To determine how global concentrations may affect us, it is necessary to have a fuller understanding of the global movement of pollutants. For example, EPA does not allow the sale of DDT in this country, yet significant quantities could enter this country through atmospheric circulation. (Issue 7)

Specific Ecosystems

Regional environmental concerns in studies of the transport, fate, and effects of pollutants deserve stronger support. It may be helpful to develop a taxonomy of ecosystems and, at least, undertake studies of the most critical ones that may not be covered by more generalized ORD studies. (Issue 8) "

The ORD research Plan, while enumerating the environmental studies being carried out by several agencies in Alaska, does not indicate that EPA is coordinating efforts so the State's environmental research needs are being thoroughly met. (Issue 9)

Water Research

Many basic questions relating to wastewater treatment and protection of water supplies remain unanswered. The EPA Plan presents research approaches and programs, but they are not assigned priorities in terms of the scale of effort or the perceived magnitude of potential health risks. (Issue 10)

The ORD Plan to examine tolerable pathogenic concentration in primary-contact recreational waters is too limited. The program does not currently include research on viruses and other parasites. Since Public Law 92–500 stresses such research, the program warrants expansion. (Issue 11)

IV Transport, Fate, and Monitoring Research

ISSUES

ABSENCE OF INTEGRATED MONITORING RESPONSIBILITY

Issue 1

Monitoring activities appear widely dispersed throughout ORD with no provision for centralized responsibility for accuracy of data, comparability of methods, or quality assurance.

Summary

ORD's Office of Monitoring and Technical Support has responsibility for establishing Federal reference methods used in pollutant sampling and analysis, and for the engineering development of new systems. Other offices are engaged in a wide variety of programs in which monitoring of pollutant levels play a central role, such as epidemiological studies of human health effects, emissions inventories, air- and water-quality model development, and trend analysis of ambient pollutant levels.

The results of such diverse studies must eventually be combined to set standards and to forge the control strategies to implement the standards.

The ORD Plan contains no provision to insure that the procedures and methods used in making these measurements will yield data that are accurate and comparable. To the extent these results are not comparable, control strategies cannot be designed with confidence that allowable emission levels are neither overly stringent nor too lax.

Questions

1. Under current priorities and organization, what level of effort and what mechanisms are directed toward coordination and quality assurance in ORD's monitoring activities?

2. Is this level of effort commensurate with the critical nature of the problem?

3. How does the present organizational structure provide a means, formal or informal, to insure that monitoring of activities and quality assurance are well coordinated ORD-wide? Agency wide?

4. How would the Agency respond to a recommendation that the currently fragmented monitoring and quality assurance activities throughout the EPA be brought under the direct control of a single, strong, properly funded central office within ORD?

5. How would the Agency respond to an alternate recommendation that a central authority within ORD oversee and coordinate these activities?

Background

The original organization of the Agency (1970) established the monitoring function as a major effort of the Agency's Science Office. Subsequent policy review of the monitoring function in 1972 resulted in a new concept of monitoring and assigned responsibility for various aspects of monitoring to the individual program offices. The Office of Enforcement and General Counsel was given responsibility for case preparation or compliance monitoring; i.e., monitoring which is undertaken to gather technical evidence for a specific case, hearing, or other form of litigation. The Offices of Air, Water, and Categorical Programs were given responsibility for ambient monitoring; i.e., monitoring which seeks to establish long-range environmental baselines against which changes can be measured.

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Air pollution: industrial gases belching from a steel plant in Houston, Texas

The Offices of Air, Water, and Categorical Programs were also given responsibility for monitoring specific sources in all media to measure point discharges. The Office of Research and Monitoring (ORM) was given responsibility for research monitoring; i.e., monitoring required in basic research experiments. Research monitoring, as defined, would be the smallest portion of the monitoring activity and of the least direct environmental importance.

An immediate result of this decision was the reemphasis of monitoring within ORM and renaming that office, ‘‘The Office of Research and Development (ORD). ” Portions of the monitoring function left within ORD, i.e., research monitoring, are further dispersed throughout ORD, and are not controlled or coordinated by the Office of Monitoring and Technical Support. There is no center of cross-media monitoring expertise within the Agency.

MONITORING SCREENING PROGRAM

Issue 2

The current monitoring program may not be capable of detecting certain toxic materials.



Water pollution: industrial wastes pollute a salt marsh in Middleton, Rhode Island Regulations require industry to obtain permits to discharge Into water supply outlets.

Summary

A monitoring screening program to detect undiscovered toxic materials in air and water is needed. There are few Federal agencies systematically testing a modest number of samples of polluted air and water to detect the myriad of toxic compounds which may be found in them, and assigning priorities to those needing most urgent attention. (An example is the National Cancer Institute program to screen 500 compounds for carcinogenicity.)

A broad screening program would greatly help EPA in identifying new pollutants of major concern. The program could be conducted by EPA and coordinated with other Federal agencies. At present, one of the major barriers to this program is the difficulty in obtaining information from industry on the nature and quantity of toxic materials which they release.

Questions

1. What monitoring research program attempts to detect all toxic pollutants of major concern present in the environment?

2. If such a program exists, how are its findings and predictions communicated to the ORD planners for appropriate action?

3. Is new legislation required to allow EPA to conduct a major monitoring screening program for toxic materials in the environment, and to obtain the necessary information on the materials in discharges?

4. How does ORD plan to collect adequate data in relatively clean areas to compare with data from more polluted areas? Will such data include information on whole ecosystems?

Background

A recent panel of the National Science Foundation, headed by Dr. Norton Nelson, attempted to develop an early-warning system for industrial organic toxic substances. The panel's program was based on the recognition that there were not sufficient mechanisms for anticipating the presence of potentially toxic materials in the environment. The panel compiled a list of materials, in order of importance, needing further study. Its work, however, fell short of the objective in part because of difficulties in obtaining appropriate information on the nature and amounts of major toxic materials used in industrial processes. EPA should take responsibility for an ongoing monitoring/screening program of toxic materials in the environment. The various transformations which chemicals experience in ecosystems after release make it important to anticipate what might form in the air or water from these emissions. For example, monitoring for the byproducts of emitted sulfur dioxide and nitrogen oxides could have been instituted long before they were if appropriate chemical analysis of potential transformations had been made. Such an anticipatory monitoring program needs to be carried out by the Federal Government, not just by industry and municipalities.

The emphasis on performance standards for technology leads inevitably to monitoring for the effectiveness of pollutant removal at the source. While some monitoring of ambient levels of pollutants in air and water is conducted by EPA, the effort is small in relation to need. There is little indication how EPA will determine which potential pollutants in the environment, other than those for which control levels have been set, should be monitored. The proposed study of viruses in aerosols from wastewater irrigation is useful, but many other more critical problems appear neglected. Particular emphasis needs to be put on detecting and measuring in the environment:

- synthetic organic compounds of potential toxic properties, for example, chlorinated hydrocarbons, pesticides, PCBs, chloroform, and carbon tetrachloride,
- other organics such as acrylamide,
- heavy metals, especially mercury, cadmium, arsenic, and lead in air, soil, and water, and
- viruses and other pathogens in water.

EPA will devote considerable attention in the future to remote sensing technology and development of sophisticated automated

devices for measuring individual chemicals. While these efforts are valuable, they may be insufficient unless coupled with a strong screening program to determine which pollutants are being formed or found in the environment other than already well-known pollutants.

IN-STREAM BIOLOGICAL MONITORING

Issue 3

Current research monitoring efforts emphasize physical and chemical monitoring technology and neglect in situ (in-stream) biological monitoring methods whose use was mandated by Congress wherever appropriate.

Summary

Little research to improve detection of potentially toxic pollutants on living organisms in receiving waters is indicated in the planning document. Section 308 of the Federal Water Pollution Control Act (FWPCA) (1972) requires that the effects of each point discharge on aquatic organisms be monitored in the receiving waters wherever appropriate (''in-stream'' or biological monitoring). However, neither EPA research nor the development of guidelines for dischargers on how to conduct biological monitoring are projected in the research Plan.

Questions

1. What emphasis has EPA given thus far to in-stream biological monitoring of the effects of pollutants on stream organisms?

2. Are guidelines available to dischargers on how to conduct the in-stream biological monitoring mandated by Congress? If not, when will they be available?

Background

Past emphasis on the effect of single pollutants on single species in the environment has encouraged sampling for ambient levels of single pollutants. In the case of toxic materials w hich accum ulatc i n food chains (e.g., mercury, cadmium, copper, DDT), measuring the levels of these materials in water or air gives no accurate indication of the extent they exist in tissues of organisms in the affected ecosystem. The FWPCA mandates EPA to require of dischargers, wherever appropriate, the monitoring of effects of their discharges on aquatic life in receiving waters, "including accumulation of pollutants in tissue * * * [in] organisms representative of appropriate levels of the food chain * * *" (Sees. 308 and 504).

EPA proposes to continue measurement of effects of single pollutants in water using single species in tanks. This technique does not adequately reflect the likely response of an organism in a multispecies setting to a mixture of compounds. Hence, this technique is of limited value. The EPA proposes to increase research on pollutants in multispecies settings in the laboratory (microcosms), which, though useful for testing of new chemicals prior to full-scale production, does not address the need for in-stream biological monitoring of effluents from existing factories.

Development of biological indicator organisms, in both air and water, and signs of ecosystem disturbance due to pollutant effects also need considerable emphasis; it is not clear from the Research Plan how much attention this area will receive. There is, for example, no indication that EPA is planning to characterize the structure and function of ecosystems in sufficient detail to develop indices or to develop general guidelines for implementation of the initial steps taken by segments of the Agency.

MEASUREMENT OF AMBIENT AIR QUALITY

Issue 4

EPA's assessment of the hazards associated with the criteria pollutants other than CO are

subject to question because the analytical methods currently prescribed by EPA for measuring ambient air quality yield, in many cases, only indices of air pollution levels rather thn concentrations of the actual pollutants whose control is being sought.

Summary

The methods prescribed by EPA for measuring criteria air pollutants are not, in all cases, specific to the air pollutants whose concentrations are to be controlled. Additional research is needed to develop analytical methods that measure specific pollutants whose health effects are thought to be detrimental and whose concentrations in ambient air may need control. ORD has the capability of doing this research and contributing to the development of improved techniques.

Questions

1. Do the currently prescribed analytical methods used to monitor concentrations of hydrocarbons, SO_2, NO_x, and suspended particles in ambient air really measure these materials? If not, what do they measure? Are better methods under development? If so, what hope for progress is there?

2. Is it possible to measure sulfates separately in current particle determinations? Are methods for measuring sulfates and nitrates in the respirable size range being developed?

3. All hydrocarbons are not equally reactive in photochemical smog formation. Can the "reactive" species be measured as a unique group?

Background

From the time that the first ambient air-quality criteria documents were issued in 1969, there has been a serious question as to the validity of the analytical techniques recommended by EPA for measuring the concentrations of the criteria pollutants in ambient air. The first such case recognized by EPA was the use of the Jacobs-Hochheiser procedure as a measure of $N0_2$, It was found to be inaccurate and imprecise. Since that time, all measurements of concentrations of criteria pollutants in ambient air have been challenged.

It is well recognized that the dose-response relationships for health effects caused by $N0_2$, hydrocarbons, oxidants, $S0_2$, and suspended particles have not been unequivocally established by the epidemiological data in the public domain, This is attributable, in part, to the fact that the determinations of the pollutant concentrations were not accurately made during the studies. As a consequence, the conclusions reached concerning the health effects of the pollutants are vulnerable to question. It is most important that additional research be conducted to develop better methods for measuring individual pollutants in ambient air for future health-effect studies.

STANDARDIZATION OF ANALYTICAL TECHNIQUES FOR MONITORING

Issue 5

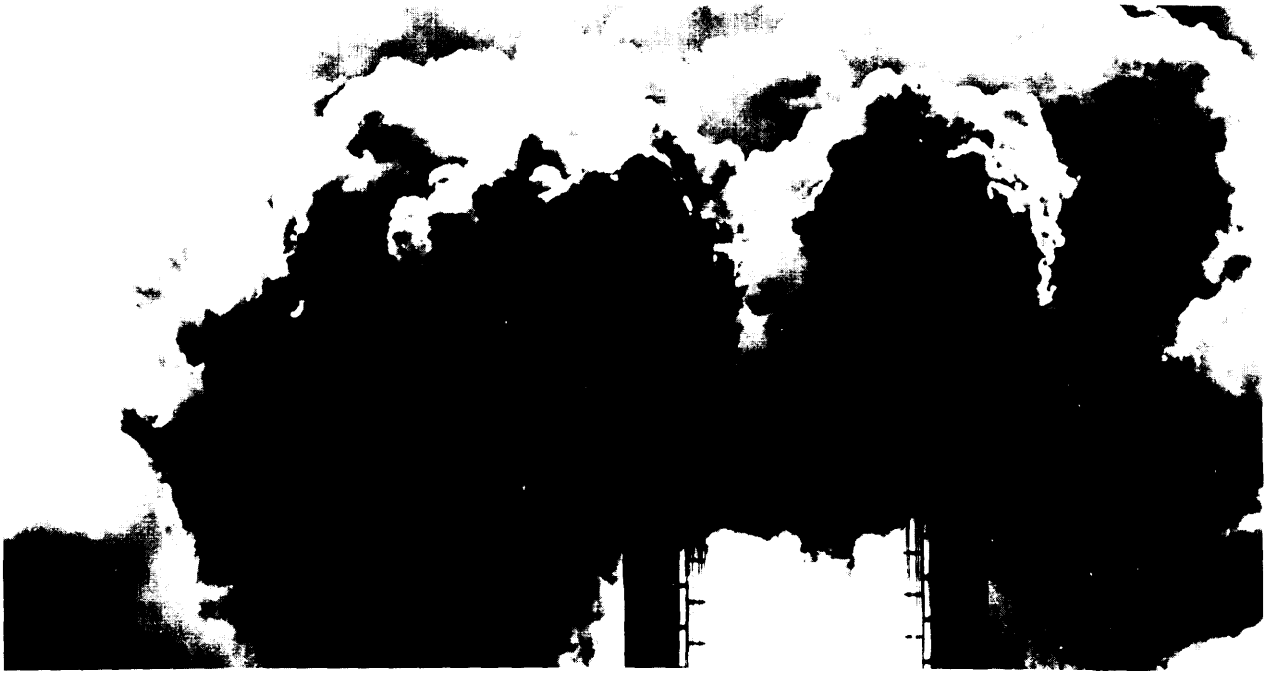
Improved measurement techniques and uniform analytical procedures are needed.

Summary

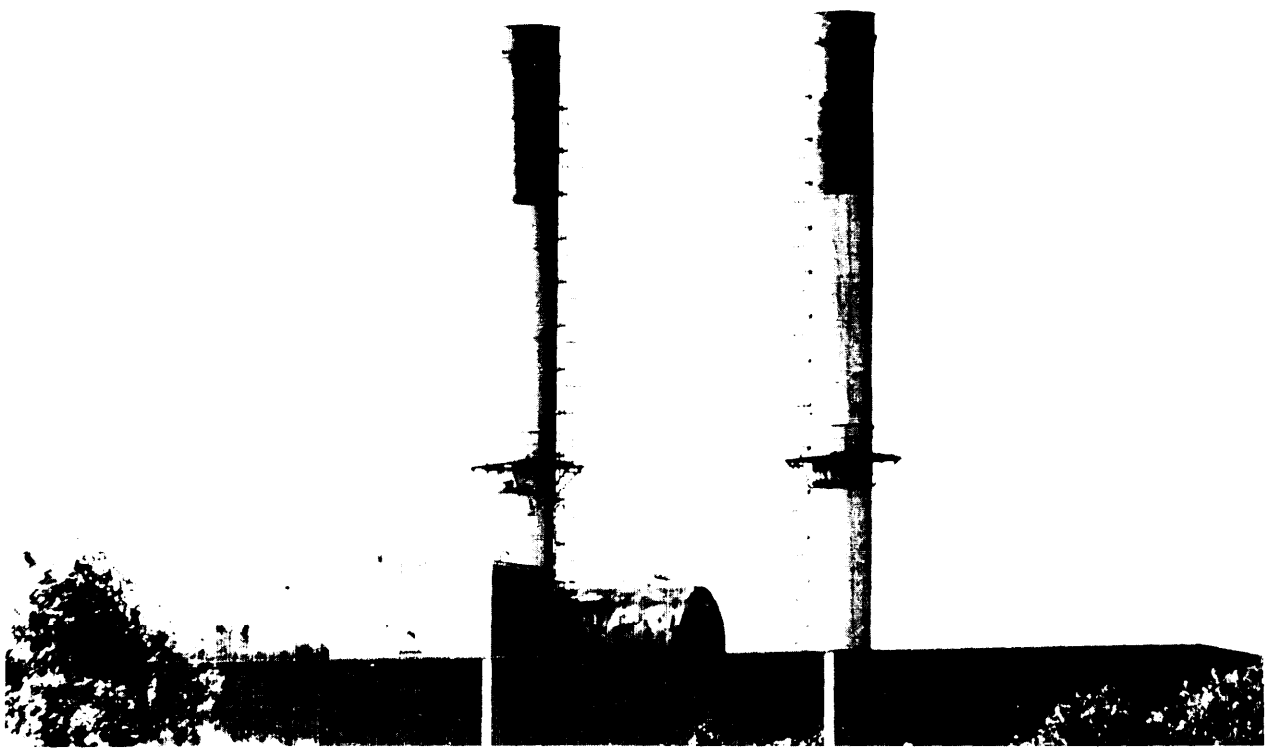
The variety and number of identified pollutant substances are steadily increasing. The authorities responsible for maintaining and developing analytical methods are spread throughout EPA and other Federal agencies. In some instances, analytical methods recommended by one agency are unacceptable to another agency. The introduction of improved methods is slow and cumbersome. The standards for techniques are ill defined. A review process is needed to establish mutually acceptable present and future techniques for air, water, and terrestrial measurements.

Questions

1. What is the role of the Office of Monitoring and Technical Support in promulgating uniform analytical procedures?



The pollution generated by this incinerator in south Houston Texas became so severe that citizen complaints and the cllosing of nearby schools forced the local government to discontinue its operation in January 1974



The same incinerator after closlng July 1975

2. What is EPA's method for staying abreast of the rapid proliferation of procedures?

3. What priority is assigned to the coordination of physical -chemical-biological measurements within the EPA and among Federal, State, and local agencies?

4. Does the variety of recommended analytical procedures between EPA, National Institute for Occupational Safety and Health (NIOSH), U.S. Geological Survey, and others represent an unnecessary redundancy in the measurement technology area ?

Background

A recent instance in which lack of reliable analytical techniques frustrated efforts for policy implementation is that of photochemical oxidant monitoring in southern California. The Los Angeles Air Pollution Control District was using a different technique for measuring oxidants than was the State Air Resources Board (ARB) or EPA, and was recording levels of oxidant 20 to 30 percent lower than ARB and EPA. Further testing established that the Los Angeles Air Pollution Control District technique, while less than perfect, was the most trustworthy. In the meantime, however, considerable confusion was generated among the public agencies, industrial emitters, and the public. A means of thoroughly checking the validity of monitoring methods before they are recommended in EPA regulations, either as principal or alternative means of monitoring, is needed.

Needed improved instrumentation is currently being introduced into the environmental market. However, the administrative procedures leading to acceptance of an improved instrument or procedure are inordinately time consuming, even after the technology has been proven. Improved analytical methods could be encouraged by establishing an effective, rapid review for a suggested improved technique. This review should not emphasize rapidity at the expense of quality.

SOURCE-EFFECT COUPLING MECHANISMS

Issue 6

ORD may assign too low a priority to research into the complex of processes that link source emissions and their effect on the biosphere.

Summary

The development of rational control strategies to reduce pollutants to medically safe and ecologically acceptable levels requires understanding a complex web of processes. Pollutants, or their precursors, are emitted by sources and eventually affect the biosphere. In between they undergo processes of dilution, transport, chemical transformation, and removal. Thus, any strategy aimed at maintaining safe levels must properly reflect these processes of change as well as ambient pollutant levels. Further complications follow because variable and uncontrollable natural conditions in the environment modify the entire chain of events. Regulations also frequently require protection for "worst case" conditions. Defining and achieving safe levels requires a research program which includes—

- complete, integrated, and well-funded research into the transport and fate of pollutants,
- assembly of results of such research for use in control strategy development.

Questions

1. Is knowledge of the transport and fate of pollutants adequate to define with reasonable certainty how a change in emission levels (for example, automotive reactive hydrocarbons) will influence subsequent achievement of pollutant standards (for example, photochemical oxidant) ?

2. Is the proposed research program into the transport and fate of pollutants strong enough and focused so that deficiencies in present knowledge will be systematically eliminated ?

3. Will research into the transport and fate of pollutants be related organizationally to regulatory needs so that the flow of new information permits periodic reevaluation and adjustment of control programs?

Background

Control strategies are now being developed and applied throughout the Nation in order to reduce or eliminate adverse effects of air and water pollutants. However, pollutants are exposed to an open lengthy, complex sequence of processes which may modify them before they reach sensitive elements of the biosphere.

Examples illustrating the importance of modifying processes are readily available. In air, formation of oxidant or photochemical smog is a classic case. The conversion of sulfur-containing combustion byproducts to sulfuric acid and sulfates is another important example. In both instances, control to avoid adverse effects is an important need, yet is difficult to achieve.

One approach to relating control requirements to emissions is based on the collection of comprehensive empirical data. Then, as emissions are reduced, the response of sensitive organisms can be observed. Controls can be eased when it is seen that impacts are reduced to acceptably low levels. Such a factual, direct basis for control may be an essential element of any strategy. But, unfortunate y, this approach demands vast amounts of data unique to each air basin or drainage. Also, some of the data obtained would be inexact. Therefore, an alternative, parallel approach is essential.

There is a common bond in the basic physics and chemistry of dilution, transport, transformation, and removal that intervene between the emission of a pollutant to the biosphere and its eventual deleterious effects on human health and ecological systems. A vigorous research program into this area could produce results with general applicability, and thus make best use of limited resources. Such a program is essential because current control decisions are evolving in an atmosphere of uncertainty. Better evidence is needed for making the difficult choices ahead.

GLOBAL BACKGROUND POLLUTANT CONCENTRATIONS

Issue 7

International sources of many pollutants will become increasingly important as controls within the United States become more effective and as industrialization increases in the rest of the world. Significant pollutants carried by wind or water must be evaluated and background levels must be monitored in anticipation of ultimate international efforts to coordinate controls.

Summary

Experiences with nuclear fallout and DDT have demonstrated that significant quantities of pollutants can be readily disseminated by global atmospheric circulation. Comparably broad distribution by means of ocean currents is possible. As the economies of the INorthern Hemisphere continue to expand, the significance of such international transport of pollutants will increase. International cooperation in pollution control becomes increasingly desirable, necessitating a careful appraisal by the U.S. Government. Moreover, it is plausible to expect that chemicals such as DDT, which the EPA allows to be sold only for use outside the United States, may reenter the country in significant quantities through the atmosphere.

Questions

1. What steps is the EPA taking to insure that it has an adequate understanding of global movement of pollutants, either through its own research or through that of other Federal or international agencies? What information exchange programs exist with other countries in this field?

2. What steps is the EPA taking to understand and monitor t natural sources of pollutants prior to setting standards?

3. What steps have been taken or are planned to determine the magnitude of the international movement of toxic materials other than radioactive fallout?

Background

The recent controversy over the role of fluorocarbons in the destruction of ozone in the upper atmosphere is an excellent example of a difficult-to-anticipate problem which could best be addressed by reliance on basic research. It is also a problem which requires analysis of global processes of chemical transport and transformation. To date, these areas have received little attention from EPA. There are several understandable reasons for this. Analyses of global processes have little apparent immediate relevance to the Agency's regulatory responsibilities, are expensive, and seemingly overlap with the jurisdiction of other agencies, NOAA in particular. Nonetheless, it appears necessary that EPA take action to insure that its specific data requirements for atmospheric, oceanic, and biospheric phenomena are met.

It appears probable that serious gaps will occur in the data base compiled by NOAA, NSF, and DOD in these areas of research unless the EPA undertakes its own reviews of the state of the art in global studies, and sees to it that the gaps are filled wherever feasible. This potential is illustrated by the record of DDT research, in which few measures were made of DDT in the atmosphere prior to 1970, despite the discovery through global modeling that the atmosphere must be a major reservoir of DDT. The lack of data was apparently not because of an inability to measure DDT in air prior to that time, but merely a failure to attempt to assess the potential magnitude of DDT transfers between environmental media.

In general, a similar failure to examine environmental problems in a sufficiently broad conceptual framework is present in the EPA Plan, raising the possibility of simple oversights in current appraisals of pollutant hazards. The remedy appears to be vigorous appraisal of the fate of pollutants at several levels, beginning with global overviews, and proceeding to appraisals within individual ecosystems which span the range of environments to be found within the United States and its territories, including its territorial waters.

SPECIFICITY OF RESEARCH AND REGULATION

Issue 8

Ecosystems should be characterized in sufficient detail to accommodate regional variation in the potential impacts of pollution.

Summary

Effective regulation of pollutants requires appraisals of the toxicity, transport, transfer - mation, and ultimate degradation of pollutants. All of these, particularly transport, transformation, and degradation, respond to variations in the properties of both the pollutants and the recipient ecosystems. Both of these sources of variation have received attention, but EPA has disproportionately emphasized pollutant-specific phenomena. The resulting regulations have not accommodated regional variations and have lowered the credibility of controls even where they are fully appropriate. Variation in the sensitivity of environments can be accommodated into regulations by increasing the specificity of the circumstances under which controls are required. A significant step in this direction could be achieved by increasing the specificity of the environmental distinctions already made in the EPA's regulations, such as discriminating between major lake types as opposed to merely discriminating between streams and lakes. Such distinctions are present in the EPA's research reports, but they do not carry into regulations nor does there appear to be a systematic attempt to explore the range of environmental sensitivities before regulations are formulated.

The selection of environments which are studied appears to be based wholly on con-

veniences of study, economic importance, and maximum sensitivity. These are necessary but not sufficient criteria.

Questions

1. What steps has the EPA taken toward the development of a comprehensive and detailed taxonomy of ecosystems?

2. How does ORD select ecosystems for study? How does ORD plan to extrapolate results from the limited number of ecosystems which it can study to the varied ecosystems which it cannot study?

3. What procedures are used to inventory regional problems and establish priorities for research? What are examples of regional research funded under these procedures?

4. To what extent does criteria setting depend on characterization of the environmental context in which the regulations will be applied? Would this activity benefit from an expanded effort in integration/characterization studies?

5. What efforts are made to use regional problems (for example, high ultraviolet radiation and high CO levels along the front range of the Rockies or air pollution in the Los Angeles basin) to anticipate effects of potential national problems or to determine long-term sensitivity of human populations to some pollutants?

6. Given that the need for rapid action and the paucity of appropriate data bases may often limit EPA's ability to set very specific standards initially, what procedures might ORD and the regulatory arm of EPA jointly institute to allow periodic refinement of regulations as research progresses?

Background

Primary standards are designed to protect human health from direct effects of pollutants. As such, they are designed for a single target orgna n ism (i .e., humans) and national standards for exposure to pollutants are appropriate. H owever, the persistence of pollutants in the natural environment and the rate of their dispersal vary regionally. Consequently, the hazards to humans associated with a given release of a pollutant vary with time and place. Regulations regarding the release of criteria pollutants should also reflect these variations if they are to adequately protect the public without excessive use of controls. In practice, this means that EPA's research and regulatory arms must use a taxonomy of ecosystems more detailed than is exemplified, for example, in the regulatory division of fresh waters into lakes and streams, so that both research and regulation can be tailored to the great diversity of landscapes present in the United States and its Trust Territories.

The same arguments apply to secondary standards, which are designed to protect human welfare from indirect effects of pollut - ants upon ecosystems which suppor or affect humans in the broadest sense. Adequate appraisals of the potential for such impacts require a discrimination among ecosystem types at least as detailed as that implied by the distinctions between coniferous and deciduous forests in the health and environmental effects section of the research Plan, preferably more so,

Recommendation of use of a detailed taxonomy of ecosystems is not meant to imply each ecosystem type be examined. Rather, usage of a richly detailed conceptual framework is recommended as a means for tuning the regulatory system and extrapolating research results. Nor is it meant to imply that adjustment of standards should be only in the direction of relaxation. Indeed, care must be taken to avoid errors arising from overrelaxa - tion of standards when there is a possibility of direct or indirect impact on more sensitive ecosystems. To avoid this, effects should be appraised. at levels o f biological organization above and below the one of regulatory interest. For example, regulation designed for secondary standards requires ecosystem-level research, and should consider effects at the biosphere and population levels of biological organization to obtain an adequate perspective on the context in which regulations are to operate. A sufficiently broad approach is required to avoid value judgments based on a

limited view of the significance of natural ecosystems, such as their utility as sources of timber and food, while other values such as recreation are overlooked.

ALASKA ENVIRONMENTAL IMPACTS

Issue 9

Is the involvement of EPA/ORD in Alaska sufficient to safeguard the environmental quality of this large and diverse State?

Summary

Alaska is unique among the 50 States because much of its vast area lies within arctic and subarctic ecosystems which have experienced virtually no human impact in the past. The scene is now changing rapidly. Federal lands are being apportioned to natives, to the State, and to the multiple Federal designations as a result of the Alaska Native Claims Settlement Act, the Statehood Act, and subsequent legislation. Pressures for accelerated development of Alaska's energy and other resources are strong. EPA's responsibility in Alaska is exceptionally large because of the immense national interest in Alaska as a source of energy and other resources to meet national needs, because of the large share that all Americans hold in the extensive Federal lands in Alaska, and because of the high value many Americans place on Alaska's relatively undisturbed natural environment. The ORD research Plan, while enumerating the environmental studies being carried out by several agencies in Alaska, does not indicate that EPA is coordinating these efforts so the State's environmental research needs are met. (The same holds for similar environments in the northern part of the Great Lakes States and the northern Rockies.) In addition, there is need for followup studies on the environmental impacts of large development projects such as the Trans-Alaska Oil Pipeline. Such studies could serve as a basis for assessing the effectiveness of environmental impact evaluations made prior to the projects. Such studies coulld also assess the effect iveness of environmental stipulations governingi construction which resulted from the environmental impact evaluations.

Questions

1. Is research which has been initiated to assess the effects of spilled oil in the arctic marine environment sufficiently comprehensive to provide information on how a major oilspill would influence sea ice albedo, marine fish, mammals, birds, and invertebrates? The reference to such work in the Plan is quite vague.

2. Is EPA or the Department of Transportation monitoring the environmental effects of commercial polar flights which are now known to enter the stratosphere in the polar region ?

3. Does EPA's monitoring program include icefield sampling in Alaska to record long-term changes in fallout levels of industrial source pollutants as is being done in Greenland and Antarctica?

4. Are lichen plant communities, which are essential as winter range for caribou and reindeer, included in EPA's program to study pollution-sensitive vegetation types? (Early interests by NSF and the oil industry for support of this research have waned and no comprehensive studies have been initiated.)

5. What program exists to assess thoroughly the capacity of Alaska's rivers and streams to sustain the increased demands being placed on them as domestic water sources and effluent recipients due to the accelerated program to develop public water and sewage systems in rural Alaskan villages? What coordination exists with the Fish and Wildlife Service, the Corps of Engineers, and other agencies in this regard?

6. Is EPA accumulating data to anticipate the water and air pollution problems which will be associated with an expanded petrochemical industry in Alaska, assuming a trans-Alaska gas pipeline and liquefaction facility and additional oil and gas discoveries in Alaska?

7. What support could the EPA provide the State Department in the event of negotiations regarding trans-Canadian pipelines?

Background

Alaska's Outer Continental Shelf is considered to have an oil potential greater than that of any other State, yet the waters involved also support the largest commercial fishery harvest of all of our Continental Shelf areas. Oil and gas exploration and development on Alaska's Outer Continental Shelf should be conducted in concert with the collection and assessment of comprehensive marine, coastal, and estuarine ecological data. Such data are essential for setting guidelines to minimize the impacts on fisheries, marine mammal, sea bird, and other natural resource values.

The major anticipated environmental impacts associated with large-scale petroleum development in arctic Alaska apparently has been overlooked by EPA and other Federal agencies responsible for environmental protection. The Prudhoe Bay oil discovery, on State land, has attracted little Federal attention.

Since the initial environmental assessments necessary for the development of an environmental impact statement for the Trans-Alaska Oil Pipeline, the Federal Government has restricted its attention to pipeline surveillance during the construction period. The oil industry is preoccupied with the task of pipeline construction. The unique opportunity to carry out research on pipeline, road construction, and associated developments in northern environments has been largely overlooked. Several unexpected environmental problems have arisen as a result of pipeline construction and there is a need for research to assess their consequences, These include blowing road dust along the haul road which causes premature snowmelt—thereby exposing underlying vegetation and leading to concentrations of water fowl, caribou, and other wildlife—and $S0_2$ fallout from pumping stations on adjacent caribou lichen winter ranges.

Unanticipated widespread oil exploration and development on U.S. Naval Petroleum Reserve No. 4, and adjacent Federal lands and native selected lands, apparently falls outside the responsibilities of Federal research into environmental consequences of large-scale energy development, which is aimed at western oil-shale lands and the Outer Continental Shelf. Comprehensive environmental research in these arctic ecosystems is essential as a basis for prescribing guidelines for development activities. EPA should assume overview responsibility to insure that the needed information is being collected. These arctic and subarctic ecosystems are the basis for the subsistence economies of Eskimos, Indians, Aleuts, and many other Alaskans as well as supporting commercial harvests of renewable resources of great importance to Alaska and the Nation.

EPA's responsibility for coordinating environmental research also provides the incentive for development of a comprehensive system of information exchange with countries with similar northern ecosystems, associated problems, and experience in dealing with them. Full opportunity should be taken to use existing bilateral exchange agreements with the U.S.S.R. and to establish similar agreements where they do not exist with Canada, Denmark (Greenland), and Norway (Spitsbergen) to foster the exchange of information on problems of northern development. The international Man and the Biosphere Program (MAB) Project No. 6—Mountain and Tundra Systems—provides one such mechanism.

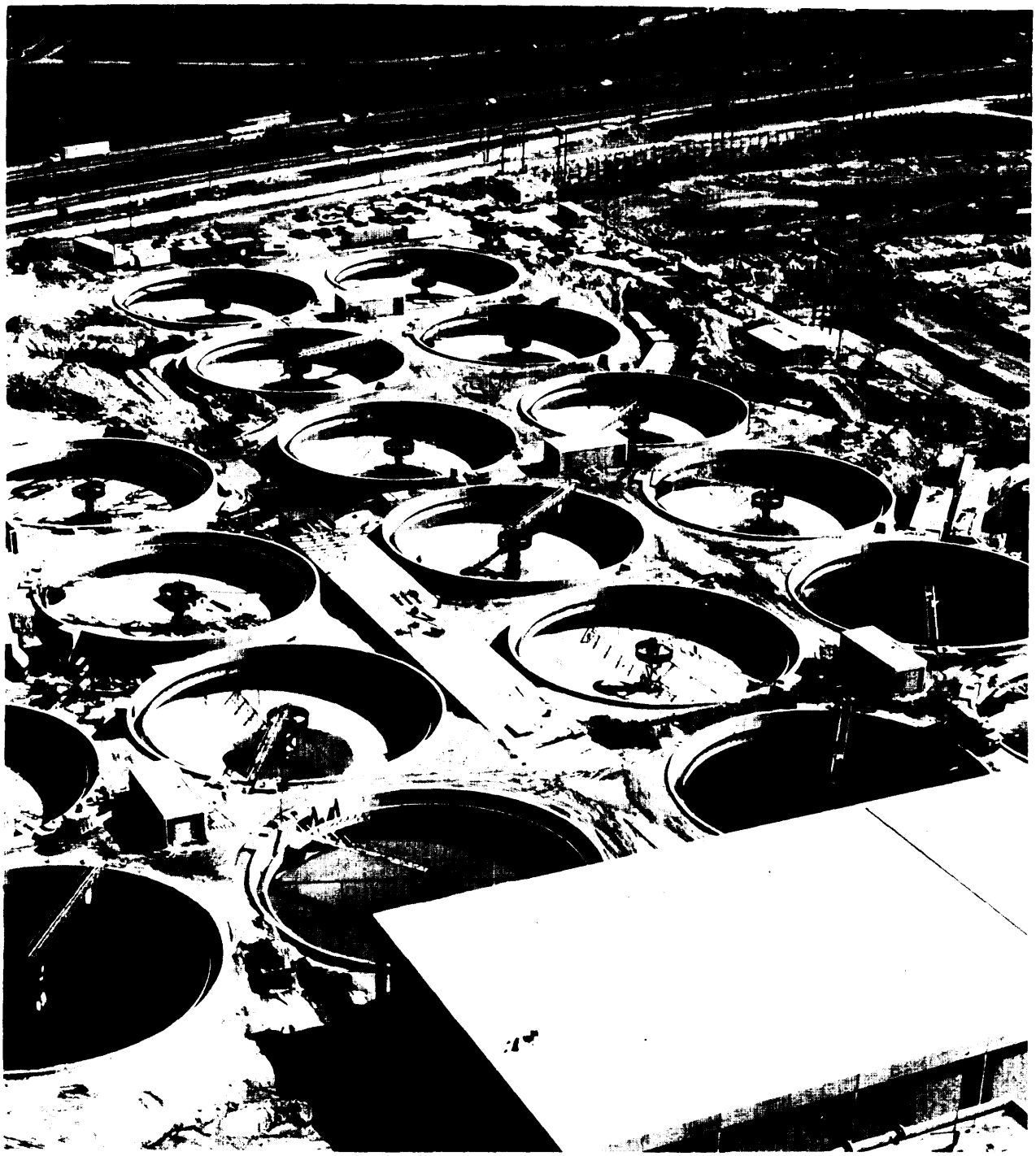
WATER TREATMENT AND FATE OF EFFLUENTS

Issue **10**

Expanded and redirected research into control of wastewater effluents and treatment of drinking water supplies is needed.

Summary

The EPA Plan expresses concern for the potential hazards to human health presented by



Sewage treatment plant, **Blue** Plains, Maryland

the growing amounts of wastewater and of water treatment byproducts entering the water system. There is reason for concern because today's wastewater effluent becomes tomorrow's water supply. And with growing demand, there is a movement toward shortcutting portions of the hydrologic cycle and so bypassing natural purification process. The ORD Plan lists research approaches and programs in this subject area primarily in general and nonspecific terms, without indicating priorities in terms of scale of effort or perceived magnitude of potential health risks. In constrast, emphasis is given to the potential

hazard of dispersion of viruses in aerosol form from irrigation with wastewater sludges. But this specific proposal is not matched, for example, by corresponding concern for the health effects of chemical toxicants from the same sources.

Many basic questions related to wastewater treatment and protection of water supplies remain unanswered, for example: the effectiveness of chlorine and ozone for virus inactivation, the effectiveness of removal of organic compounds, and the mechnisms for the transport and removal of viruses or carcinogens within aquifers. Proliferation of treatment plants and increased use of wastewater in irrigation, use of sludges in land treatment, and potential contamination of water for recreational use and drinking water supplies demand a direct and yet broad-based research effort. Balanced concern is needed across the full range of classes of agents: pathogenic micro-organisms (bacteria and viruses), and chemical toxicants (metals, pesticides, carcinogens, and other toxic substances) .

Questions

1. How effective are conventional wastewater treatment methods in removing toxic chemicals? Do removal processes add undesirable constituents?

2. How may constituents of particular concern, such as viruses and toxic chemicals, be carried from a wastewater source to a relatively nearby water source location?

3. How effective is inactivation of viruses using chlorine and conventional wastewater treatment methods? How do results compare with use of ozone and ultraviolet radiation? What is the extent of the research effort proposed in these areas?

4. What research is being done into the technology of removing organic compounds from drinking water?

5. How much is known about the types and extent of pollution of air, ground water and surface water supplies arising from sites used for sludge disposal ?

6. What research is being done to assess the effects of land disposal of sewage in place of secondary, not just tertiary, treatment of wastewater ?

Background

Under Public Law 93-523 (Safe Drinking Water Act) an increased effort is to be made to insure the safety of the Nation's drinking water supplies. To accomplish this, many new areas of research need development and a substantial commitment of resources must be made. One important reason for this growth in research need is that the quality of water supply is closely linked to wastewater treatment effectiveness. And since the time when standard methods of wastewater treatment were established, a great variety of new chemical contaminants (largely of industrial origin) have been introduced. The list includes toxic heavy metals such as mercury, carcinogenic materials such as asbestos fibers, highly persistent organic chemicals of high toxicity (including carcinogenic potential) such as polychlorinated biphenyls (PCB's), and the ever-increasing variety of pesticides.

In the past, it has generally been assumed that pollutants in wastewater will be diluted and dispersed when they reach large bodies of water. At this point all hazards to human health would be removed. This is not necessarily the case, however, particularly when growing demands for water dictate circumstances such as development of water recreation sites close upon wastewater disposal or sludge disposal locations. Both the transport and fate of potentially hazardous constituents, microbiological and chemical, must be thoroughly understood so that risk to the health of users in such instances can be controlled. This requires development of an augmented, balanced research program.

In addition, there still are basic research needs with respect to conventional water supply and treatment processes that have not yet been met. For example, the question of how standard disinfectants inactivate viruses, and whether or not the mechanism is similar to that of bacterial inactivation, needs to be

answered. Halogenated organics, found to be formed through use of chlorine during normal - disinfection practice, are suspected of being carcinogens. The present EPA research program to find alternate routes to disinfection appears inadequate.

A multiplicity of organic compounds has been found in the drinking water of several cities. The EPA is considering a standard for organics in drinking water. However, unless technology to achieve a standard is rapidly developed, States and local agencies may find themselves in the uncomfortable position of not being able to comply with the standard.

Pathogenic micro-organisms, bacteria and viruses, are present in raw sewage and constitute a threat to human health. These organisms can escape deactivation if the treatment processes are bypassed in times of flooding overloads. Both are likely to persist to some degree in sludges which are a result of treatment processes and may be used as a fertilizer or soil conditioner. Thus, a wide range of ways are open through which such microorganisms may persist (as in soil), may be taken up and even concentrated by living organisms, and may contaminate streams and rivers by runoff or percolation. Much more research remains to be done in this area.

RECREATIONAL WATER STANDARDS

Issue 11

Expanded research on the question of tolerable pathogenic concentrations in primary-contact recreational waters is desirable.

Summary

EPA's program to determine tolerable pathogenic concentrations that may occur without jeopardizing health of humans in primary recreational contact with marine waters is too limited, The program should be expanded and include consideration of viruses and other parasites. This need relates directly to the congressional mandate in Public Law 92–500 relative to recreation in and on the waters.

Questions

1. Is there a correlation between recreational water standards and hazards to human health? Is there a significant public health hazard associated with present standards for natural surface waters?

2. Has the question of deterioration of water quality resulting from bather loads in natural water bodies and impoundments been evaluated ?

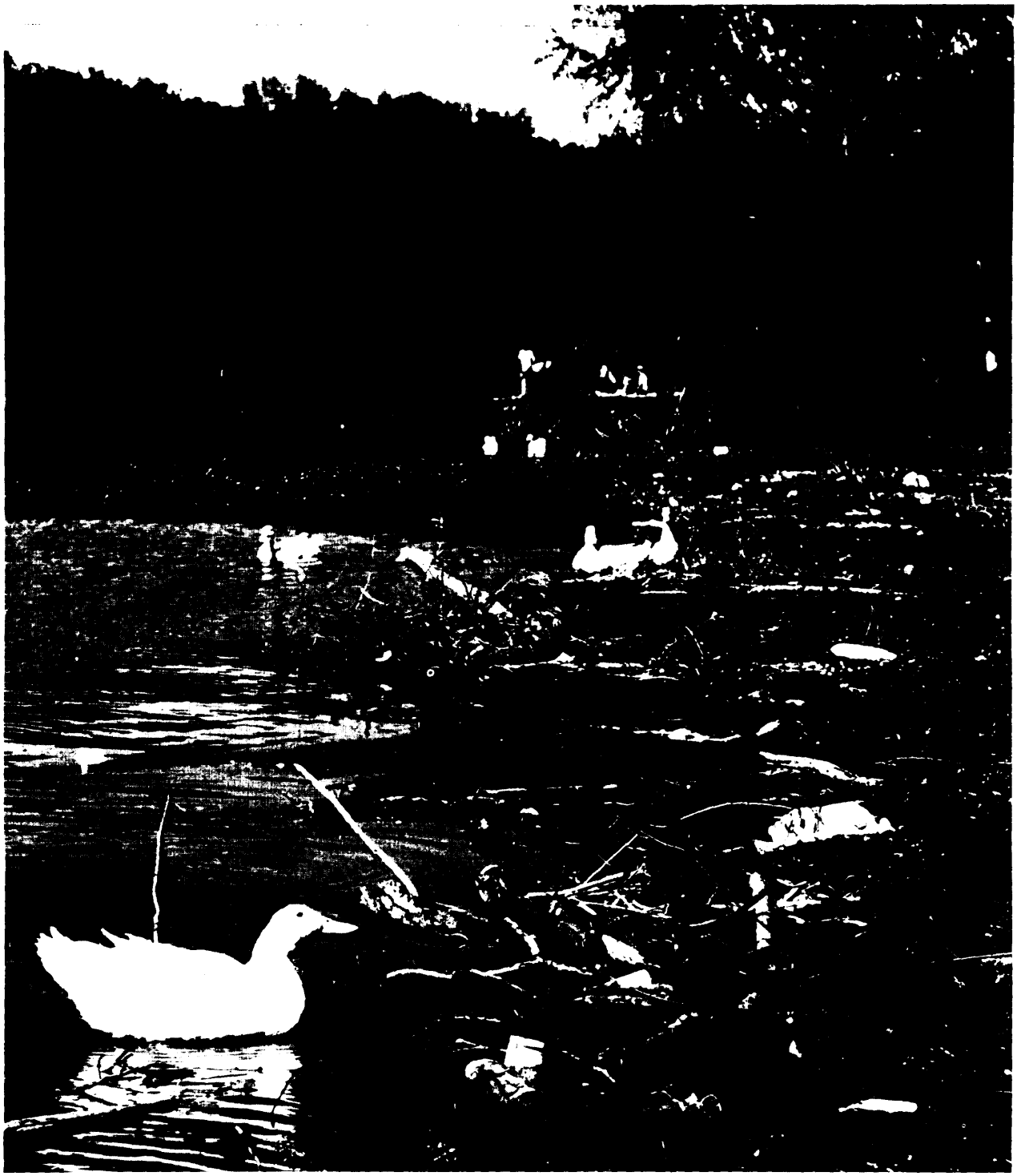
3. Are there pathogens of concern for which no standards have been set?

Background

Public Law 92-500 has had the effect of requiring the upgrading of many areas of surface waters to swimmable quality by 1983. The need to carefully study the human health hazards relating to this mandate is of utmost importance. The present standards for swimming in natural waters should be carefully examined and evaluated. The question of contamination of the waters by the bathers themselves should be examined, since there is evidence that a considerable pollution load comes from this source.

In many natural water, bodies, the water quality may appear satisfactory for swimming as long as there are no bathers, but may become unsatisfactory when there are bathers.

The common indices of water quality include counts of total and fecal coliform organisms. These have long been useful indicators of treated-water quality because chlorination adequate to protect health reduces coliform levels to very low values. However, many untreated waters may contain coliform organisms which have a soil or animal origin and may be in no way indicative of any important health risk. At the same time, tests for other bacteria and for viruses are not commonly included as a part of untreated-water quality determination. To show that this is not an academic distinction, recent research on the quality of natural waters used for recreation



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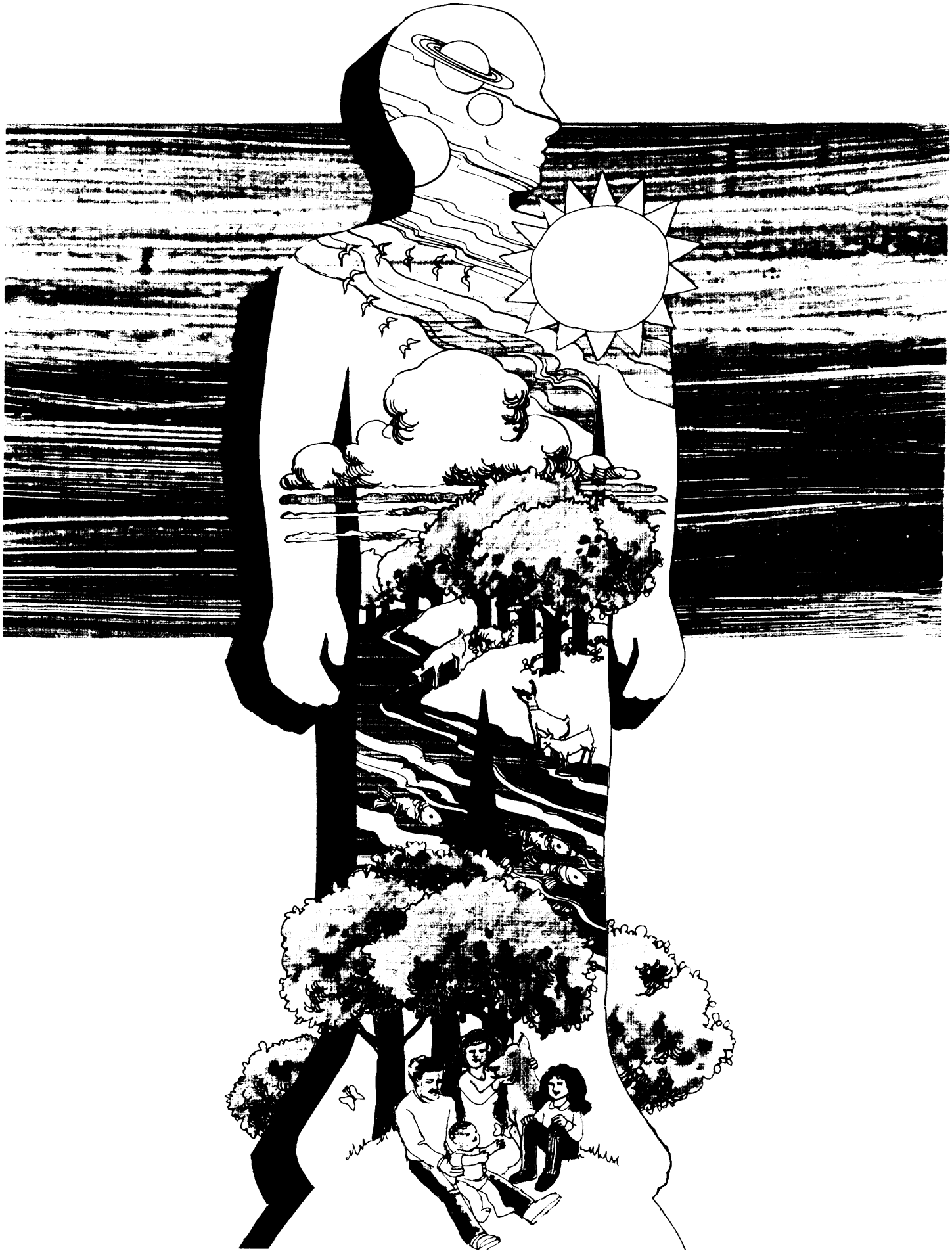
V. Health and Ecological Effects Research



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V. Health and Ecological Effects Research

INTRODUCTION

The ORD Health and Ecological Effects program is basic to EPA's mission to protect human health and maintain and enhance environmental quality. To provide a scientific basis for EPA's criteria, standards, and guidelines, the program must aim for an understanding of the total effect of a vast number of chemical and physical agents on man and the ecosystem, including possible interactive and synergistic effects. This chapter addresses six issues relating to Office of Research and Development (ORD) research on health and ecological effects.

Long-Term Studies

Because present primary standards are based on incomplete health-effect data, long-term studies of the health effects of chronic, low-level exposure to pollutants need to be made. Parallel to this effort, sequential studies are required during and following incidents when there is a temporary, sharp increase in pollutant levels. Such studies would help put standard setting on a firmer scientific base, The effects of agents in the environment upon health problems such as cardiovascular and chronic respiratory disease should receive as high a priority as carcinogenesis, A method of following the population under study for 20–40 years needs to be developed. It is not clear whether these long-term studies are best undertaken by EPA or by another governmental agency such as the National Institute of Environmental Health Sciences, In any case, EPA should have a strong planning and oversight role. (Issue 1)

Selecting Chemicals and Agents for Study

It is within the scope of the research performed by ORD to formalize a system for predicting the presence of a pollutant in the environment and to rank its relative potential for harm. (Issue 2)

Coordinated Health Research

Although the ORD 5-Year Plan does attempt to summarize the efforts of other Federal agencies in environmental and health research, the document fails to describe the mechanisms through which such research will be coordinated and results shared. (Issue 3)

Extramural Research

When a research group depends on EPA for continued financial support, there is a danger that contractor-scientists may be compromised by perceptions of EPA's regulatory policy. (Issue 4)

Lack of Noise Research

EPA/ORD apparently was not funded to do noise research, although this is part of their mandate. The research being conducted elsewhere in the Federal Government on noise effects on human is not sufficiently detailed in the Plan to assess its adequacy. Because of indications that noise may aggravate the impact of other pollutants, there is reason for ORD to undertake its own noise research program. *(Issue* 5)

Indoor Air Quality

The EPA 5-Year Plan makes only a brief reference to indoor air quality, and then only in relation to health effects. It apparently neglects research on effective environmental management strategies for indoor air quality improvement. This is an area for EPA/ORD both to research and to coordinate the programs of other agencies (Occupational Safety and Health Administration/National Institute for Occupational Health and Safety (OSHA/NIOSH), HUD, Consumer Product Safety Commission). (Issue 6)

V. Health and Ecological Effects Research

ISSUES

LONG-TERM STUDIES

Issue 1

Both long-term studies of chronic exposure and followup studies of acute exposures are needed to determine effects of pollutants which do not cause immediately apparent injury.

Summary

At present, EPA asks: "What are the long-term effects on health of chronic exposures to pollutants?" and "are the present primary standards safe?" If EPA postpones starting long-term studies designed to answer such questions, we shall still be asking these same questions in another 20 to 30 years. Such studies imply a long-term commitment of funds, equipment, and personnel.

Parallel to this effort, specific investigations are needed during and following an incident when there is a temporary increase in pollutant levels. These investigations could help to answer the question whether acute episodes have temporary or permanent effects. These, in turn, may serve as a basis for long-term studies if the effects appear to be chronic.

It seems appropriate that such studies be included in a Federal environmental research program. Long-term studies are particularly important as a means to determine the critically needed dose-effect curves for low levels of pollutants in air or water.

Questions

1. What role do long-term studies play in EPA's research plans?

2. What are the major scientific and nonscientific problems in such studies?

3. Does EPA have plans to develop long-term chronic exposure studies? If so, what are the plans?

4. Does EPA have a plan to take advantage of opportunity-laden episodes?

If EPA plans such studies, the following specific questions might be asked:

- What parameters would ORD select to follow in the population?
- How would ORD propose to maintain contact with a population sample for 30–40 years?
- What criteria would ORD use to determine the pollutants to be studied and the timespan of the study?
- How would ORD insure that the levels measured truly represented the exposure or dose to the population? and
- What criteria would ORD use to terminate a given long-term study?

5. What is the present status of EPA's support of the Community Health Effects Surveillance Studies (CHESS) program? Is a thorough analysis of accumulated CHESS data contemplated ?

Background

Chronic degenerative diseases, including cardiovascular disorders, chronic bronchitis and emphysema, renal disease, and arthritis, are the major causes of death and disability in the United States. Evidence is accumulating that suggests there are significant environmental factors involved in the causation or aggravation of these disorders. Hence, there is a great need for better information on the effect of long-term exposures to pollutants on health over and beyond that of a possible carcinogenic effect. For example, present air



Cropdusting of sulfur on grapevines south of Fresno, California to retard mildew.
Long-term effects that pesticides may have on the environment need to be determined.

pollution standards are almost totally based on acute pollutant effects, plus the inclusion of a safety factor. There is controversy concerning the stringency or inadquacy of each standard In some cases, slight alterations in primary air quality standards translate into billion; of dollars of control costs, potentially significance health effects, and possibly a substantial impact on individual lifestyles. The inclusion in the standards of a safety factor below observed acute effects appears to be reasonable and prudent considering the relative absence of information concerning possible long-term toxicity. Accordingly, it is of utmost importance to determine whether exposure to pollutants at levelsapproximating

the current standards do or do not have an effect after many' years of exposure.

Rough approximations of exposure can be estimated from historical data, but are always suspect and imprecise. Thus, retrospective-prospective studies have limited value, though they can be used to develop hypotheses to be tested. Of greater potential value are prospective studies of defined populations for whom exposure levels are carefully monitored. Such studies will require a long-term commitment with respect to money, personnel, equipment, and planning. Because of the present commitment of EPA to respond to acute situations and external pressures to investigate a specific situation, EPA has not been able to develop a strong long-term research capability.

Long-term research to establish historical profiles is not only important in studying human health problems but also in determining impact on ecological processes. Long-term monitoring of various animal or plant species can detect changes in ambient conditions and can serve as an early-warning system, This can give EPA and other agencies the capability to identify the problem before it becomes acute and to take appropriate action.

Considerable information can also be obtained by studying effects during acute episodes. For example, an inversion and accumulation of pollutants occurred over western Pennsylvania. Another such acute episode recently occurred in the Los Angeles area as the result of an extensive fire. Such episodes can be exploited in more detail than they have been in order to obtain information on their immediate effects. A followup study after the pollution has subsided is also necessary to see whether there have been any long - term effects or whether the changes, if any, were reversible, After the followup study, a decision would then be made whether to stop at that point or to continue with a more prolonged study.

Contingency plans are required that can be activated to respond to such episodes. Each one may require different techniques with respect to details, but the basic principles and modus operandi could be developed beforehand. Studies of such events have been spotty. In the instance of the Donora, Pa., exposure, the study in 1948 and followup 10 years later have been good. In others, they have been inadequate or nonexistent.

Studies of the effects of long-term and acute episodes could be run as (1) in-house research with careful scrutiny by a qualified advisory committee, or as (2) an extramural project under grant or contract with similar advisory committee oversight, or (3) this responsibility could reside in another governmental agency such as the National Institute of Environmental Health Sciences (NIEHS).

EPA must develop a philosophy concerning long-term health research commitments which consider the balance of long-term and short-term studies, the support structure for these commitments, and the various mechanisms that can be used to guarantee continuity of the committed program.

POLLUTANT SCREENING

Issue 2

It is within the capabilities of ORD to provide EPA with information to more effectively predict and forestall future chemical environmental problems.

Summary

Observers not connected with EPA were the first to bring several pollution problems to the attention of EPA and the public. Notable examples are vinyl chloride and nitrosamines in air and chloroform in water. This suggests the need to enhance the ability of EPA to detect and predict environmental problems, It is within the scope of the research carried out by ORD to develop a system for predicting pollutant existence i n the environment and assessing its relative potential for harm.

To avoid undue duplication of effort, a program to select chemicals and agents for study should include, as a first step, the determination of the extent to which such hazards

are under study by other agencies. Second, the understanding that a substance could on the basis of chemical and physical properties and environmental access represent a potential hazard should be used to screen suspects. At that point, research priorities could be assigned to the remaining candidates. The information derived from the screening and research program would be fed into the appropriate EPA program offices for determination of regulatory action or consideration for further effects or control technology research.

Questions

1. Presently, how does EPA/ORD make a determination as to when and under what circumstances a particular problem area will be investigated?

2. What priority does EPA/ORD assign to developing a pollutant-prediction capability? What is the state of development of EPA/ORD's capability to foresee environmental hazards?

3. What are EPA/ORD's present thoughts on the problems inherent in developing a continuously updated list of pollutants worthy of detailed examination and assigning research priorities to the potential hazards on the list?

4. How will ORD use and develop screening procedures in order to predict the effects of individual pollutants and combinations of pollutants?

5. What is EPA/ORD's estimate of the resources required to develop an effective early-warning system for environmental hazards?

6. How will ORD approach synergistic problems in specific ecosystems?

Background

The basic elements of one possible pollutant screening system are as follows:

The first step is to determine qualitatively that a particular substance or its precursor will be emitted into the air or water or placed onto the land. Such information may be gathered from previously performed analyses of industrial effluent streams, domestic sewage sludges, or air emission streams. Once a listing of substances has been compiled, a qualitative assessment of their chemical reactions and transport is required in order to assess the distribution of the pollutant in the environment. The pollutant dispersion from emission points should be ranked according to whether it is widespread or localized in nature.

A toxicity ranking based on acute effects, dose-response toxicological studies, occupational studies, and biological monitoring data (if available) should be made. The pollutant then should also be ranked in terms of its emissions, its biosphere persistence, and its tendency to accumulate in the food chain, ground water, soil, sediments, or the atmosphere. The results of these rankings would assist in determining the pollutants which pose a more serious threat to society.

It is assumed that an interdisciplinary group drawn from various ORD research programs and familiar with appropriate sources of scientific literature would be responsible for screening. Once the rankings have been completed, the substances of greatest importance will become objects of new experimental research. One research sequence would include analysis of future emissions and their potential distribution. This would be based on economic and engineering analysis of the industrial use or generation of the substance or its precursor (s) . Simultaneous research on control technology would also be done. Once emission patterns have been determined, research on the movement from the sources to the ecosystems can be carried out. Simultaneously, dose-response research with and without synergisms can be carried out. If the substance is already known to be in the environment, epidemiological studies should be done to attempt to understand the substance's effects on human populations. The research results would then be communicated to EPA program offices, where cost/benefit analyses would be performed at various levels of control for ultimate use in standard-setting procedures.

New pertinent information is continuously generated by EPA as well as non-EPA organizations. The determination of both the relative priorities of environmental problems, and the priority for studies and control efforts within each problem area should be subject to extensive ongoing review so that EPA does not become locked into unneeded research and can respond to newly perceived problems.

We recognize that in establishing priorities for R&D, EPA is generally dealing with imprecise areas. In assigning such priorities, EPA will have to exercise sound judgment in interpreting existing data as well as including many other factors besides obvious ones such as acute effects and environmental dispersal. Decisions concerning R&D expenditures will require not only estimates of potential harm but also insights into the likelihood that the proposed research will pay off. Moreover, the difficulties in establishing priorities for research among known harmful agents are different than those inherent in detecting unrecognized environmental toxicants.

COORDINATED HEALTH RESEARCH

Issue 3

The ORD 5-Year Plan does not describe the mechanisms through which interagency environmental and health research planning will be coordinated and results shared.

Summary

EPA is charged with coordination of the environmental-related activities of Federal agencies. Although the ORD 5-Year Research Plan does attempt to summarize the efforts of other Federal agencies in environmental and health research, the document fails to describe the mechanisms through which such research will be coordinated and results shared. Effective coordination is vital in order to avoid unnecessary duplication of research and to identify relatively neglected, but important, areas of research.

Questions

1. How are interagency activities in environmental health research coordinated to insure that significant hazards are addressed by the proper agency in a timely fashion?

2. What procedures are in force to avoid unnecessary duplication of research?

3. What role should ORD play in the field of carcinogenesis research, and how does this role fit into the entire Federal carcinogenesis research effort?

Background

Several Federal agencies in addition to EPA have extensive environmental research programs. The total budget to support these programs has been estimated at $1.3 billion. EPA has a research budget of $257 million, with approximately $100 million assigned to health and ecological research.

Although EPA has been charged with coordinating the environmental research of other Federal agencies, it is not clear from the 5-Year Plan what coordinating procedures are in place or how well they work.

The identification of projects already underway or in the planning stage would avoid unnecessary duplication of effort. On the other hand, there are some cases where the nature of the scientific work or the importance of the information are such that some deliberate, informed, selective duplication is advantageous. It is as important to identify programs where duplication and verification are necessary as those where it is wasteful. These considerations are particularly applicable to ORD's planned entry into carcinogenesis research.

A close coordination with another agency could often allow EPA to obtain information pertinent to its mission. For example, there are a number of potential public health problems described in the EPA/ORD document where useful information could be obtained by studying the work force in facilities producing

the polluting agent. Such studies may be given a relatively low priority by NIOSH in terms of their total mission, perhaps because of the relatively small size of the work force. There should be some mechanism to insure that occupational health or other studies pertinent to the general population are not overlooked because of formal agency boundaries.

It is also vital for EPA to maintain a capability to react quickly to newly identified significant hazards in concert with other agencies. One can be reasonably certain that during the next 5 years some urgent environmental problem will develop that is not foreseen in the EPA/ORD document and that, although within the responsibilities of EPA, will require input for its solution from non-EPA scientists.

MAINTAINING QUALITY EXTRAMURAL RESEARCH

Issue 4

Because contractors for extramural research are limited, continuing relationships with particular contractors tend to develop from repeated use and may lead to the loss of independence among such contractors.

Summary

If EPA is to obtain an objective scientific base to support its regulatory responsibility, these data must be carefully constructed and managed. The presentation of these data must openly acknowledge the weaknesses as well as the strengths of their design, collection, and analysis. Because such information, by its very nature, never provides unequivocal and absolute conclusions, it must be subject to continuous review. This review process should aid in defining the relative magnitude of the environmental problem, the scale of future allocations of resources for its study, and the appropriateness of existing or proposed regulations. The mishandling of any of these issues can have serious ecological and economic consequences.

To meet these concerns, objective scientific review is imperative. However, the reality remains that the scientists involved might be compromised since the economic survival of their research organization may become largely dependent upon the Agency's continued support. Given the limited availability of professionals, recommending expansion of such a resource pool neither resolves present needs, nor is it necessarily feasible or even desirable. With the range of individual and organizational expertise and skills that inevitably emerge, choosing those most competent may once more lead to a narrowing of the potential advisers. Exploring alternatives probably will require careful examination of the EPA as both the provider and consumer of environmental scientific data in its primary role as a regulator. Totally divorcing such a research capability from the enforcement agency may, however, produce other impediments to the ultimate goal of protecting environmental quality. To pursue long-term research in some areas of basic environmental science requires that EPA assist in developing contractor capabilities where none exist. This implies a long-term commitment to some contractors.

Questions

1. Given the limited number of nongovernmental research resources of quality, what mechanisms are employed to assure that an objective, independent response to EPA needs are obtained ?

2. If nongovernmental researchers were funded by transfer from another agency, how can one be assured that such an agency would continue to provide support if it perceives these activities to be peripheral to its own mission ?

3. Given the temptation to extend analyses beyond the limits of the data bases and to exclude or emphasize data consistent with perceived or explicit policies, how can the researchers producing such data provide an objective presentation of their work? How can

they provide independent opinion without risk of jeopardizing their continued fiscal support?

Background

Perceived policy goals, whether responsive to explicit agency mandates or to supposed positions, will tend to subtly mold the viewpoint of a researcher. This is especially true where positions become specific as in rulemaking and the standard-setting processes. At one extreme, the viewpoint of contractor-researchers may be influenced by their own internal biases rather than by a customer agency. At the other extreme, the establishment of a standard (and, *inter alia,* the procedural impediments to its subsequent adjustment) may impair objectivity if, for example, data contrary to a stated EPA position are subsequently generated by con tractor - researchers. In other words, the scientists may tend to develop a "vested interest" or an emotional commitment to the standard that they have helped establish. Present realities of fiscal support of university-based researchers do not preclude such conflicts if these scientists are used as contractors.

Alternative approaches should be considered, although their inherent shortcomings must be recognized. If research activities are "passed through" to other agencies, without regulatory responsibility, the newly responsible agency may regard such an acquisition as dissipating its total resources. Even if required by statute to provide continuing support, future fiscal exigencies may imperil research activities. The flow of data output may be impeded by organizational channels not geared to regulatory needs.

In sum, unless objective scientific data are forthcoming, environmental regulations being established, *or* already in place, will not be readily open to reassessment or change in the light of new information. The quality of objectivity need not be distorted by bad intent or even conscious desires, but its subtle impairment can influence the substance of regula - tions.

NOISE RESEARCH

Issue 5

Despite the passage of the Noise Control Act of 1972 which authorizes EPA to conduct and coordinate research programs i n environmental noise, EPA/ORD is not presently studying noise, nor does its Research Plan propose such research.

Summary

Noise causes behavioral, psychological, and physiological changes in humans and animals, and may through such changes alter the susceptibility of organisms to other pollutants. As a potential modifier of the impact of other pollutants, noise deserves study by ORD despite the presence of analyses of the effects of noise itself by other agencies. Moreover, although the hearing ranges of animal species differ and their susceptibility to direct noise impacts probably diverge, there appears to be no Federal research involving the effects of noise on species other than man and selected laboratory' animals.

Questions

1. Does EPA feel it has sufficient information on the human health and psychological effects of noise to promulgate and enforce reasonable regulations on noise?

2. Does EPA think it has sufficient coordinating authority, and that sufficient funds exist within the Federal establishment, to secure further information needed to establish and enforce noise regulations ?

3. To what extent are possible interactive effects between noise and other pollutants being investigated?

4. Why is there no mention of noise research in the EPA Research Plan?

5. What has EPA done to evaluate the responses of wildlife to noise, particularly at frequencies which are inaudible to man?

6. What has EPA done to evaluate the effects of sudden irregular bursts of noise such as sonic booms on wildlife?

Background

Americans inhabit an environment in which noise levels have been rising as inexorably in recent decades as have other forms of pollution. The potential magnitude of noise impacts in routine life is exemplified by recent data which found teenagers to have hearing loss comparable to that of a 55-year-old group. While this hearing loss was surely in large part self-inflicted by voluntary exposure to excessively amplified sound, it means that such groups have little margin of safety with respect to hearing, because the effects of noise on hearing are cumulative and irreversible. Preliminary NIEHS data have indicated that noise can aggravate the adverse effects of chemical pollutants in laboratory animals. The adverse effects of certain kinds of noise on reproduction of chickens and lactation in cows have also been observed, Wildlife populations can be disturbed significantly in mating, reproduction, and other behavior by the noise from construction (e.g., Alaska pipeline), off-the-road vehicles (e.g., southwest desert), transportation (SST's, cars), and other sources. Aquatic organisms, like whales and dolphins, can also be substantially disturbed by noise. Noise and inaudible vibrations may be an important contributor to psychological and physiological ill health, work efficiency loss, and other effects.

Research may be needed on effects of noise on wildlife because none now exists within the Federal establishment, despite its importance to the survival of wildlife populations. Animals do not sense noise in the same way as humans do. Rather, they respond to a different set of frequencies, and often in different and more dramatic ways. Regulation controlling the noise generated by machines adequate for human protection may not be adequate for wildlife (e.g., off-the-track vehicles).

At present, EPA has no research program on noise. It is entirely dependent on what other information may be available on this topic, and seems ill prepared to respond quickly to problems of environmental noise which may arise. Unless some further attention is paid to problems of general noise, annoyance of sonic booms, and other noise-related questions, the importance of these factors in human and ecosystem health will remain unclear. The research being conducted elsewhere in the Federal Government on noise effects on human health is not sufficiently defined in the Plan to enable an assessment of its adequacy. In particular, it appears that EPA has the clearest responsibility to appraise the psychological and esthetic impacts of incongruous noises upon the environment.

INDOOR AIR QUALITY

Issue 6

Although ORD has stated that it will study indoor air quality, the Plan does not disclose the size, distribution of research effort, or techniques to be used.

Summary

According to the 5-year Plan, ORD will study indoor air quality. However, neither the magnitude nor the distribution of research efforts are clear. Moreover, there are no apparent plans to investigate techniques for indoor air-quality improvement. Some effort should be committed to investigating impact and possible control of toxic air pollutants either released in, or accumulating indoors. Studies could be made of ways to reduce indoor air pollution levels through improved building and ventilation system design, the restriction of toxic-vaper-generating products, and attention to interior furnish i rigs. Interactions between indoor pollutants and nonpollutant factors such as air temperature, humidity, and air movement in relation to health effects should also be studied. In addition, there is evidence that tobacco smoking may be an important source of exposure to carbon monoxide, respirable particles, nitrogen oxides, and airborne carcinogens to smokers and nonsmokers alike.



Noise Pollution: Noisy construction equipment such as the type being utilized here by a Washington, DC. construction worker is common throughout the United States.

Questions

1. What overall priority will EPA assign to monitoring indoor air quality and to finding effective management strategies for its improvement?

2. What will be the distribution of effort within the indoor air-quality research program between research on health effects, and the development of effective management programs to improve air quality?

3. What steps does the EPA plan to determine the seriousness of the release of toxic agents and how to control it? Similarly, what investigations are underway to examine the

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accumulation of outdoor pollutants indoors, as, for example, the buildup of jet fuel fumes in airport terminals?

4. What emphasis should be given to the contribution of tobacco smoking to indoor air quality relative to other sources?

5. What steps will be taken to broadly disseminate the results of such studies?

Background

Despite progress in cleaning the ambient air outdoors, Americans continue to be exposed to adverse air conditions indoors.

At present, the focus is upon industrial plant atmospheres, but other indoor working environments—such as offices, garages, other service shops, laboratories, warehouses, and stores—also come under the jurisdiction of OSHA and may ultimately be regulated. Indoor air quality in the home is the sole research responsibility of EPA, but there are other physically confined space areas which must not be forgotten. For many public buildings such as schools and theaters which are technically workplaces for a few but are occupied by a much larger number of persons, research responsibility is presumably shared between EPA/ORD and OSHA/NIOSH. Even for industrial plants the responsibility is shared between the two agencies. Exhaust fumes from such plants can be hazardous to the ambient air. This was probably first recognized in the case of beryllium-using plants during World War II. Since then, asbestos, vinyl chloride, and arsenic emissions have also ceased being solely matters of occupational concern.

Nonpollutant factors in indoor air quality, notably temperature, humidity, and air movement, possibly have a greater influence on health, especially the upper respiratory tract, than is generally realized. Research is needed into this area.

There is also considerable potential for toxic pollutant exposures in the American home. Millions of Americans are sporadically exposed indoors to high concentrations of toxic vapors and particles from domestic cleaning fluids, floor polishes, and fresh paint as well as from pressurized aerosol sprays which can be retained in the deep lung to produce pneumoconioses. Asbestos fibers, of proven carcinogenic properties, can become suspended in the domestic air from exposed insulation of boilers and pipes, from the incorporation of asbestos in domestic building and surfacing materials, and from the use of some brands of talcum power in the bathroom. Potentially dangerous aerosol sprays are used in confined spaces (kitchens and bathrooms) by three-fourths of the adult population. Cigarette smoke contains particulate and carbon monoxide which are of potentially toxic significance to exposed persons in confined areas. Domestic cooking and heating devices are potential sources of nitrogen oxides and carbon monoxide.

Very little is known about how to encourage safe use of toxic products in homes and schools. The EPA could exercise leadership in this area through public education, air management in Federal public buildings, and recommendations for building design and ventilation. EPA's Office of Toxic Substances should provide data to FDA and the Consumer Product Safety Commission on regulation of the contents of products to be used in the home, including the proscription of certain constituents, the limitation of others, and precautionary labeling. Development of cheap, portable pollutant-monitoring devices would be of great value in ascertaining the extent of indoor air pollution.

The current EPA research Plan conveys no sense of the priority regarding these problems. If they are not vigorously addressed, costly ambient air cleanup efforts may yield fewer health benefits than anticipated in improving human health.

VI. Socioeconomic Research

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buses only

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VI. Socioeconomic Research

INTRODUCTION

The Office of Research and Development (ORD) Plan is replete with references to needed socioeconomic research. It would seem beyond question that the value—indeed the necessity--of such research is clearly recognized and fully appreciated. In particular, the National Environmental Policy Act calls for interdisciplinary approaches combining the methods of the natural and social sciences and the design arts. Yet so little follows in the way of reasoned proposals and structured programs as to cast serious doubt on ORD's commitment to research in this area.

Interviews with ORD managers disclosed that socioeconomic research occupies a low priority because they perceive no explicit congressional mandate. This perception may account for some of the uncertainty ORD managers voice as to the proper focus and thrust of socioeconomic research as well as their lack of direction in formulating meaningful research questions or realizing fruitful applications in this area.

Environmental Management

Effective strategies of environmental management, combining both "nonstructural/nontreatment" and technological approaches, demand far greater inputs from socioeconomic research than the ORD Plan provides. Problems of environmental management occur on all levels of governmental responsibility—multi-State and national as well as State and local. ORD's circumscribed outlook on this research area needs broadening to comprehend the full range of problems and possibilities, present and future. (Issue 1)

Methodological Requirements

Methodological developments across a broad front of socioecomic research are needed to support ORD's progress in environmental management and other areas of concern. Nothing resembling such a programed effort appears in the Plan, however. A systematic and sustained program of methodological development is required if substantive problems of socioeconomic research are to be successfully analyzed and solved. (Issue 2)

Organizational Requirements

Socioeconomic research is scattered and fragmented throughout the Plan. Research in this area does not now exist on a sound organizational basis within ORD. A coherent and consistent organizational structure is needed to correct deficiencies in research policy, planning, management, coordination and utilization of socioeconomic research. Failure to commit organizational resources to socioeconomic research precludes significant progress in this area. A program of socioeconomic research that is organizationally distinct but functionally integrated with other ORD research activities seems essential. (Issue 3)

VI. Socioeconomic Research

ISSUES

ENVIRONMENTAL MANAGEMENT AND SOCIOECONOMIC RESEARCH

Issue 1

The Plan does not provide evidence of an adequate, substantive effort to integrate socioeconomic research into environmental management.

Summary

"Environmental management" has not been properly or fully conceptualized by ORD; consequently, the research proposed in this area is incomplete and insubstantial. This is especially true in respect to socioeconomic research which must form a major portion of the knowledge base required. The Plan is conspicuously weak in its disregard for research on relevant social behavior and social institutions. Nonstructural/nontreatment approaches to environmental management have not been analyzed and developed to any significant depth. Similarly, the effective combination of technological and nontechnological approaches to environmental management are not explored and treated to any considerable length. There is no appreciation indicated of the policy research dimensions and implications for the area; no guiding principles of environmental management research and practice are adduced and applied. Difficult institutional problems of implementation and enforcement persist amid preoccupations with marginal control technology and industrial process improvement. A realinement of research priorities from single-purpose abatement techniques to comprehensive environmental management seems justified. In ORD's provision of planning assistance to State and local managers, urban environmental management is a critical area that deserves greater research emphasis. Local concerns, including citizen involvement, should not preclude attention to environmental management issues at multi-State and national levels of concern, however. Environmental management as "crisis management" should be replaced by an anticipatory research function within ORD. Overall, an enlarged conception and heightened awareness of environmental management are needed, together with an expanded and intensified research effort. While immediate research payoffs can be expected, the longer term benefits of sound environmental management are of paramount importance.

Questions

1. Does ORD construe "environmental management" as a comprehensive process for the analysis of complex environmental systems and the coordination of activities impinging on them? If so, how is it proceeding to specify and conduct needed research on this level?

2. What level of effort and commitment of resources would be needed in support of a broad program of research on environmental management ?

3. Is a research program needed to extend planning assistance to larger (multi-State and national) geographical areas and governmental entities? If so, what plans are being formulated to achieve this research purpose, since no funds are identified with it in the Plan?

4. Does ORD view its Environmental Management Subprogram as primarily one of providing planning assistance for local management of pollution abatement programs? Is this restriction in scope a decision internal to EPA?

5. In view of the evident widespread need for planning assistance to local jurisdictions on environmental management problems, how is the low funding level—$3 million per year over the next 5 years—justified?

6. To what extent has EPA established a working relationship of environmental management programs with local jurisdictions so that research conducted by ORD is applicable and useful? Were any formal means used to elicit suggestions from these local authorities to aid in formulation of the Plan?

7. What are the limitations of "hardware" solutions (i. e., control technologies) for achieving and maintaining environmental quality, and what are the roles in this regard of lifestyle changes and institutional restructurings (in energy conservation, transportation, urban design, and the like) ?

8. What attention is being paid to new urban design concepts and land-use plans and to the development and demonstration of decentralized technology, such as sewage and solid waste reuse and energy capture at the individual home or small community level, as approaches to environmental management?

9. What ORD efforts, planned or underway, would be likely to anticipate and adjust inconsistencies between national economic and environmental goals? What is the likelihood that future resource shortages in energy, food, and materials may result in pressure to relax environmental standards and regulations?

10. Considering the potential long-term effects of large-scale technology on the world's ecosystems, what alternative management strategies can help insure future generations against severe penalties without economic disruption in the short term?

Background

The Concept of "Environmental Management"

In the language of the Plan, environmental management involves the use of "management techniques that improve environmental quality through nonstructural and nontreatment methods, thereby reducing required capital costs (for example, change farming methods, institute profitable industrial process changes, and modify land-use patterns) (p. 9). Socioeconomic research would appear crucial to the successful application of such methods.

Besides nontechnological methods, environmental management is further said to employ "institutional approaches to implement technological options (e.g., improve regulatory approaches, provide economic incentives or sanctions). " The effective use of such implementation strategies strongly implies a vigorous socioeconomic research effort in technology assessment and institutional analysis. A final description is that of "comprehensive approaches to integrating all environmental programs in an efficient manner * * *." The principles for guiding program selection and integration reside in the national environmental policy enunciated by NEPA and similar legislation. To derive and apply these principles requires a further level of research effort, that of environmental policy research.

Given this broad construction of environmental management, the task for ORD research managers is to plan, organize, and conduct a program of ' 'multimedia, multidisciplinary" research to engage the broad spectrum of environmental problems. In fact, however, ORD's concept of environmental management is constricted and its effort deficient, especially in regard to socioeconomic research. It is this conceptual failure which perhaps accounts for EPA's difficulty in formulating significant research questions and seeing relevant program applications.

Socioeconomic Research in Environmental Management

A conspicuous weakness in the Plan is its disregard for research on the social institutions and social behavior relevant to environmental management. For example, the ques-

tion of incentives needs to be approached in a more fundamental way. Presently, short-term profit incentives militate against energy and materials conservation and the substitution of low-impact materials and technologies. Traditional economic approaches discount the future more heavily than makes sense from the standpoint of the welfare of future generations. If the overall incentive structure is to promote environmental protection and enhancement, a better understanding of social behavior and social institutions will be required.

Technological Fix

In the absence of a larger conception of what environmental management research should be about, ORD's recourse is to focus narrowly on innovations in control technology and alterations in industrial process as the principal means to achieve environmental quality objectives. Despite occasional disclaimers, this "technological fix" attitude pervades the Plan. It is unfortunate that it should persist at a time when institutional constraints appear far the most persistent and problematic, and the environmental strategy which places chief reliance on technological solutions appears more and more doubtful of success. Transportation plans in particular have proved difficult to institute and implement. Institutional problems must be confronted and understood; the difficulties in nontechnological approaches are the reason for doing research on them, not for avoiding them. In terms of research payoff in the near term, it could even be argued that these are the most promising avenues. Even so, the longer term benefits of sound environmental management are likely to be the more important ones.

While the Plan acknowledges that socioeconomic and institutional methodologies are needed **"to** judge environmental management options and balance these options against competing national needs" (p. 2), a more accurate gage of ORD's commitment is the less than 1 percent of its projected budget allotted to the Environmental Management Subprogram. A substantial diversion of research funds from single-purpose abatement techniques to comprehensive environmental management seems appropriate. This is not to imply, however, that simply elevating priorities and augmenting budgets will achieve the objectives of environmental management in the absence of a well-conceived and structured research program,

Planning Assistance

According to ORD's interpretation, the Environmental Management Subprogram is intended to provide "regional" environmental planners and managers with methods to determine feasible alternative solutions to specific environmental problems and to provide techniques for arriving at least-cost solutions to such problems. This is reasonable since the implementation of many environmental laws and regulations is left to State and local governments. Strategies to achieve specified environmental objectives are recognized by ORD as varied and complex, and their development as generally beyond the financial and technical capabilities of State and local authorities. Hence, the Environmental Management Subprogram is designed to provide the planning assistance to these authorities needed for implementing Federal environmental quality programs. The funding level of $2–$3 million per year allotted to the Environmental Management Subprogram appears inadequate, however.

Public Participation

The Plan makes scant provision for public involvement in environmental planning, design, decisionmaking, and management. Potential users of socioeconomic research are confined to "environmental planners and managers" without recognizing the public's role mandated by Public Law 92–500 and other legislation. While mention is made of the need to research ways of presenting various environmental management alternatives to the public (p. 98), research is also required into techniques of public involvement and the analysis and evaluation of environ-

mental perceptions and preferences held by different sectors of the public.

The Urban Environment

Of special concern are problems of environmental management in the urban environment. Continuing geographical concentration of human activity will tend to further exacerbate the interrelated environmental problems confronting urban planners and managers, Local officials are devoting increasing attention to land use, transportation, housing, and municipal services as key features of the urban environment. The need appears pressing for ORD to initiate a thoroughgoing investigation of how these options can be better managed to improve the quality of urban life.

Attention to problems of urban environmental management seems lacking in the ORD Plan. This is regrettable in light of the concentration of environmental problems that accompanies the concentration of urban populations.

Multi-State and National Levels of Environmental Management Concern

The emergence of major multi-State- and national-level environmental problems would seem to warrant a deliberate ORD research effort into alternative means by which their effective management can be undertaken. I1-lustrative of such emergent problems is the large-scale development of energy resources in the Western States, now under study by Office of Energy, Minerals, and Industry (OEMI). Such development could precipitate a series of interrelated, multi-State problems in water resource management, air and water pollution, and in the socioeconomic conditions associated with a population influx. This is one prime example of the need to begin looking toward ways in which complex and widespread environmental problems can be dealt with. Similarly, at the national level, competing needs of economic development and environmental quality must be analyzed and reconciled. In both cases, a central feature of environmental management research should be to develop methodologies for incorporating socioeconomic factors into a comprehensive planning and management process.

Environmental Management as Crisis Management

Inadequate provision is made for developing the anticipatory research function necessary for effective environmental management systems. Events of a "crisis" nature are accumulating at an increasing rate, and it becomes increasingly difficult for managers to respond to these in a timely fashion. The "pollutant-of-the-month" syndrome is symptomatic of the failure to anticipate research needs. Frequently, ORD cannot respond effectively to short-term information requirements because the need for R&D was not anticipated or, if foreseen, not translated into an ongoing research program. Many important policy decisions need R&D results within days to months; such research therefore *must* be anticipated well in advance.

It is impossible, of course, to predict accurately the time and nature of all future environmental "crises. " There are some emergent issues that clearly warrant ORD's attention, however. Significant technological and social changes are forecast as natural resources are depleted and concerns over environmental degradation increase. While it is said that "EPA's research must be both anticipatory as well as responsive" and that a reasonable balance must be struck between short- and long-term research "to meet future and emerging environmental policy, " it remains that "this Plan does not * * * reflect a level of resources sufficient to fully perform all anticipatory research and development which would allow ORD to get a headstart on newly emerging problems * * *" (p. 14). But this is not only a matter of resource constraint within ORD. It is also a question of research leadership.

METHODOLOGICAL REQUIREMENTS FOR SOCIOECONOMIC RESEARCH

Issue 2

The Plan's frequent references to environmentally related socioeconomic research are not embodied in concrete proposals to develop and apply the requisite methodologies.

Summary

Methodological requirements for socioeconomic research are not matched by proposed methodological developments, Deficiencies in this area prevent the use of integrated approaches to environmental-impact assessment required by NEPA. Broad recognition of needed methodological research extends to environmental problem identification, formulation of environmental management alternatives, socioeconomic impact assessment and evaluation. But these are not connected by ORD in a general framework of environmental planning methodology. Attention should be focused on:

(1) anticipatory research on technological and social trend forecasting;

(2) policy research on competing national needs and their implications for environmental quality goals and strategies;

(3) integrated assessment for combining technological and nontechnological approaches to environmental management and resource development;

(4) research into a broad spectrum of socioeconomic impacts and their distribution;

(5) institutional analysis for implementing and enforcing environmental management options for pollution control; and

(6) evaluation research on the effectiveness of environmental policies and programs and the utilization of socioeconomic research results.

Among many possible approaches to developing socioeconomic methodology, environmental modeling receives major attention. The experience with Strategic Environmental Assessment System (SEAS) raises questions about the utility of large-scale modeling approaches, however. Overall, the Plan does not confirm a strong ORD commitment to pursuing a systematic and sustained effort of methodological development. A comprehensive program is required if substantive problems in socioeconomic research are to be successfully analyzed and solved.

Questions

1. What difficulties are responsible for ORD's failure to provide a concrete program of research for methodological development in the socioeconomic area? How might such difficulties be resolved?

2. Why have research efforts toward more adequate whole-systems characterization and assessment been reemphasized when the need for better ways of dealing with whole systems (environment, resources, economy, social institutions, cultural patterns, etc.) is becoming more apparent?

3. In the absence of a comprehensive program of methodological research, how can substantive results be obtained on socioeconomic questions?

4. What is being done in a concrete way to implement anticipatory research ?

5. Is there a legitimate role for ORD in environmental policy research or is the need for policy analysis fully satisfied elsewhere in EPA (e.g., the Office of Planning and Management) ?

6. What steps are being taken to institute and implement an operational methodology of integrated assessment?

7. What actions are being taken or contemplated to expand the limited scope of previous effects research, particularly in regard to "welfare effects" and distributional studies?

8. What methodological developments are needed in the area of institutional analysis? What measures are proposed for realizing them ?

9. In view of the massive public investment in environmental quality programs, why has no systematic program of evaluation research to test their effectiveness been developed? What are present plans for filling this research need and what is projected over the coming 5 years?

10. Reflecting on the experience with SEAS, what is now considered to be the utility of large-scale modeling as a methodological approach to socioeconomic research? What portions of the SEAS effort can be retained and further refined?

Background

Substantive analyses in environmental management and other areas of socioeconomic research require a wide variety of methodological developments. Since environmental management involves analyzing the systemic interrelations of diverse technological and nontechnological components in intermedia and interregional contexts, the Plan accordingly calls for development of "comprehensive systems analysis and evaluation methods" (p. 98). What work is actually being done or planned along these lines is not divulged, however, and no serious attempt is made to place such development within a general framework of environmental planning methodology. Similarly, while the interdisciplinary and integrative nature of ORD's research is duly stated (p.3), the Plan omits any discussion of means to effect the methodological integration of socioeconomic with other approaches. Hence, the unified approach prescribed in NEPA remains inoperative. The need for methodological development is recognized at numerous points in the Plan, but there is nothing that resembles a programed effort to meet it. The Plan fails especially to support the methodological requirements of socioeconomic research. Major discrepancies persist between the severe methodological demands of socioeconomic research problems and the adequacy of analytic tools presently available to solve them.

Although not stated as a coherent research program, the Plan does imply methodological developments over a wide range of socioeconomic research needs. Typical are the following:

Problern identification.--"Methodological tools should be developed for assessing environmental problems * * *" (p. 9), including the anticipation of future problems.

Formulation of alternatives. --The development of alternative control technologies and management methods to effect environmental enhancement and restoration (p. 22).

Impact assessrnent. —Methodologies for assessing the socioeconomic impact of pollutants, including assessment of resource utilization (p. 43), and for predicting consequences of alternative pollution control strategies (p. 9).

Impact evaluation.—Methodologies for measuring the effectiveness of environmental controls (p. 9) and evaluating the total community costs and benefits of environmental programs (p. 100), including the relevant costs, risks, and benefits of feasible control options (p. 22).

Taking the Plan as a whole, a methodologically complete program of socioeconomic research would seem to require attention to at least the following six interrelated areas:

1. Anticipatory research. The Plan calls for research on the assessment of long-term probable trends in the production of renewable resources (p. 78), including trends in agricultural production such as "large-scale farming, conversion of marginal lands to cropland, chemical and energy-intensive practices and the likely increase in irrigation" (p. 68) and, in the area of alternative pest management, the need for "identifying emerging agronomic trends that can be made environmentally sound before coming into

general use" (p. 84). In the field of environmental management, the need is stated to make available "types of economic and environmental forecasting procedures" (p. 98). In addition, technological forecasting of both industrial and control technology seems necessary for achieving and preserving environmental quality standards over the coming decades. The identification and assessment of these social and technological trends demands a corresponding methodological development in the area of anticipatory research.

2. *Policy research.* Policy research should be directed toward the identification of environmental policy issues: What degree of environmental disruption constitutes a problem requiring public policy response and whether a particular environmental problem is better approached at national, State, or local levels; the formulation of environmental goals and policies as influenced by legislative, administrative, and legal actions; and the evaluation of socioeconomic costs and benefits of environmental policy implications across a broad spectrum of affected parties at interest. A key policy research question involves recognizing and resolving the "significant conflicts [that] may arise between energy development, production and use, community development and renewable resource activities" (p. 78), Maintaining goal consistency in the midst of "competing national needs" (p. 2) is a central issue that policy research must address.

3. *Integrated assessmmt.* As stated in the Plan, "Environmental, economic and social consequences of energy alternatives together must be used as a basis for EPA policies" (p. 138). But it is not apparent how this is to be approached methodologically. For instance, while it is stated that ''Current scientific opinion and recent judicial proceeding indicate a need to evaluate the impact of pollutants on entire systems as well as individual species, " the Plan cautions that "Unfortunate y, satisfactory methods of such systems evaluation are still inadequate" (p. 43). The whole-system analyses required for environmental management have yet to be developed. Such assessments are vital to any *integrated* procedure that involves tradeoffs among economic, social, and environmental impact and between technological and non-technological factors. The methodology of technology assessment—which actually spans all six areas considered here—would be a prime candidate for assisting this development. In any event, further effort is required to derive benefit from the i m proved multimedia techniques called for in the Plan (p. 98).

4. *Effects research.* Continued support of ''comprehensive environmental/socio-economic assessments" is cited as a basic research guideline for the Plan (p. 9). Indeed, needed research on social and economic impacts is widely noted in the contexts of alternative pollution control strategies (p. 9), renewable resources (p. 78), water quality (p. 79), pest management (p. 84), soil treatment systems (p. 88), advanced land monitoring systems (p. 108), and metropolitan development (p. 155), on levels of both community and regional impact. In light of its general applicability, social and economic impact assessment should correspondingly receive major research attention. Yet the Plan offers no real basis for predicting major advances in this vital area. Past research performance suggests a chief preoccupation with costs and not benefits, and with individual health effects to the exclusion of other "welfare" effects. Little added emphasis has been placed on distributional studies, almost totally neglected previously.

5. *Institutional analysis.* Institutional analysis is crucial to any strategy of environmental management. Environmental management effectiveness is determined by the capacity of institutions to implement environmental quality standards and by society's acceptance of their enforcement. Equallv, the institutional impacts of environmental policy options must be included in any comprehensive program of "integrated assessment. " While recognizing the importance of such considerations, the Plan gives no concrete suggestions on how research can accelerate methodological development in the area of institutional analysis.

6. Evaluation research. Evaluation research is needed to test both the effectiveness of socioeconomic research approaches and the usefulness of their results. Whether work completed and in progress is achieving established objectives is especially critical in the relatively ill-defined area of socioeconomic research. A second, and more central, question for evaluation research is not only whether socioeconomic research results are meeting user needs but also whether research applied in regulatory practice is achieving desired standards of environmental quality. In both these respects, a quality-control measure of research performance is required. A program of methodological development in this area should review and refine evaluation research methods now widely in practice and adapt them to the specific program needs of ORD.

One methodological approach in particular recurs throughout the Plan-environmental modeling. The socioeconomic research components of modeling approaches are noted in regard to predictive terrestrial ecosystem models (p. 55), comprehensive basin water quality models (p. 61), and energy development on a regional scale (p. 158). But it is in regard to SEAS that the major socioeconomic modeling effort has already taken place, and it is here that major questions of the suitability of large-scale models arise. While the Plan holds out the prospect of further development of SEAS "to support impact assessment of energy, environmental and recovery trade-offs and alternatives" (p. 115), the future of this modeling effort seems questionable.

ORGANIZATIONAL REQUIREMENTS FOR SOCIOECONOMIC RESEARCH

Issue 3

The existing organizational structure of ORD does not support the full development and proper use of socioeconomic research,

Summary

Nowhere in ORD is there a distinct organizational element concerned with socioeconomic research. The scattering of socioeconomic research throughout the Plan does not represent a clearly defined and well-managed research program. It is evident that a sound organizational base is lacking. A properly conducted program of socioeconomic research is needed both to avoid unnecessary duplication and to encourage positive developments. The need appears pressing for an organizationally distinct socioeconomic research function that is functionally integrated with all phases of ORD research activity. This need emerges at every stage in the research cycle: policy, planning, management, coordination, and use. Socioeconomic research has not been effectively brought to bear on EPA policy research needs; a closer relation of socioeconomic research to ORD policymaking seems needed, In research planning, no basis is found for determining socioeconomic research needs and for setting research priorities. The nature of the research task in the socioeconomic area has not been sufficiently well analyzed to delineate the necessary methodological developments and their substantive applications. Failure to commit organizational resources to socioeconomic research precludes making significant progress in this area. Research management is confounded by lack of established research objectives, and consequently of criteria and measures for gaging progress toward their attainment.

While some duplication of research effort is inevitable and even desirable, severe resource constraints necessitate full research coordination. There appears to be no systematic means for scanning relevant socioeconomic research and assimilating their results, however. Whether ORD is meeting the need for effective research use is not discernible from the Plan. Overall, it appears that many of ORD's failures in socioeconomic research are traceable to defective organization.

Questions

1. Are there sufficiently broad legislative

mandates for ORD to conduct needed socioeconomic research? Is there clear policy guidance for carrying out this research? If not, what steps are being taken to secure the necessary authorizations ?

2. What kinds of socioeconomic research should ORD sponsor to make regulatory procedures more effective?

3. How are socioeconomic research priorities determined within ORD? What is the basis for projecting future research needs in this area?

4. How has ORD's socioeconomic research program been affected by the recent reorganization, particularly the disbanding of the Washington Environmental Research Center (WERC) ? Have problems in the recruitment and retention of qualified researchers impeded the development of a more forceful program of socioeconomic research ?

5. How should socioeconomic research be organized to facilitate meeting the goals established by ORD?

6. How does socioeconomic research interact with other technical and scientific activities of ORD? Is there continuous interplay? Do they have reasonable physical access to each other to provide easy communication?

7. Do the EPA program offices have direct input into socioeconomic research? How are the results of such research brought into the regulatory process?

8. What steps should be taken to improve the use of socioeconomic research findings in regulatory practice?

9. What criteria should be applied in judging research performance in the socioeconomic area? What measures of research effectiveness should be used to determine how well these criteria are being met?

10. What is the most effective mechanism for achieving coordination with socioeconomic environmental research done by other Federal agencies and by private researchers and institutions? What is ORD doing to improve coordination with other organizations involved in environmental R&D and to define jurisdictional responsibilities in areas of cooperative effort critical to socioeconomic research?

Background

Underlying the lack of a comprehensive program for methodological development is a more fundamental issue: the need to conceive and structure a broad organizational process for supporting and conducting socioeconomic research. Aspects of such a process will be considered under the topics of research organization, policy, planning, management, coordination, and use.

Research Organization: While mentioned in almost all sections of the Plan, socioeconomic research is accorded only piecemeal treatment. Nowhere is it brought to a sharp focus as regards research policy, planning, management, coordination, and utilization of results. Identifiable socioeconomic research in the Plan is loosely divided between Office of Health and Ecological Effects, in respect to health and other welfare effects; Office of Air, Land, and Water Use (OALWU), in respect to nontechnological elements in its Environmental Management Subprogram; Office of Energy, Minerals, and Industry, in respect to the socioeconomic aspects of "integrated assessment"; and Office of Monitoring and Technical Support (OMTS), in respect to the SEAS modeling effort. In all these the organizational context for socioeconomic research appears precarious at best,

The prevailing organizational climate for socioeconomic research in ORD is scarcely conducive to its full development and proper use. The scattering of socioeconomic research interests and efforts throughout the Plan does not represent a clearly defined and well-managed research agenda. A properly **organized** and conducted program of socioeconomic research is needed both to avoid unnecessary duplication and to encourage positive developments. Organizational effectiveness does not of itself guarantee research effectiveness, of course. It may,

however, be a necessary condition. An organizationally separate socioeconomic research function within ORD appears necessary. At the same time, there is a counterpart need for the functional integration of such research in all phases of ORD research activity.

Research Policy: While the existing mechanisms for research policy formation are not clearly delineated in this Plan, they seem to operate to inhibit the conception and execution of a coherent and consistent program of socioeconomic research. More positive contact between research in this area and ORD policymaking appears highly desirable. There is need for high-level representation of socioeconomic research interests in ORD. The presence on the Science Advisory Board of senior members with direct experience in conducting as well as managing socioeconomic research would be a constructive first step.

Research Planning: The Plan offers no basis for determining socioeconomic research and for setting research priorities. This condition implies a lack of integration in ORD research planning rather than the "interconnected system of research pursuits" called for in the Plan (p. 20). Hence, there is no way of predicting at what stage of development socioeconomic research should be in 5 years, and no basis for planning its development in as orderly a fashion as the research function permits. The nature of the research task in the socioeconomic area has not been sufficiently well analyzed to delineate the necessary methodological developments and their substa nt ive applications. Fai1ure to commit organizational resources to such a plan of development virtually precludes its accomplishment.

Research Management: Because socioeconomic research appears in so fragmented a condition throughout the Plan, no clear-cut accountability for its performance can be assigned. The lack of organizational focus for this research area would appear to undermine the ability of research management to function smoothly. Because of indefinite research objectives, moreover, it is difficult to apply criteria and measures of research performance to gage how well those objectives are being met and to schedule work and allocate resources for their accomplishment.

Research Coordination: "While EPA is clearly mandated to be the lead Agency in environmental R&D, the missions of other federal agencies necessitate environmental R&D. Therefore, EPA has the responsibility to make sure that environmental R&D capabilities in other agencies are not unnecessarily duplicated but are recognized and utilized as efficiently as possible" (p. 144). There appears to be no systematic means for scanning this research and assimilating its results, however. Besides coordination of research outside EPA, a similar problem arises within ORD because of the scattered condition of socioeconomic research.

Research Use: In socioeconomic research as in other areas, the payoff from research comes in its actual use. Prospective users are found in EPA program offices, in municipal and State environmental agencies, and in the offices of ORD itself. Users within ORD are directly affected insofar as integrated assessment and other comprehensive methodologies are involved. How well ORD is meeting the requirement of effective research use cannot be determined from the Plan. How ORD intends to improve its performance in this final research task is likewise uncertain.

Appendices

Appendix A

The Research Mission

By Dr. Wilson K. Talley*

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The fundamental mission of the Environmental Protection Agency isn't hard to state: the achievement and enhancement of a quality environment. Our research contributes to the development of effective pollution control strategies and i n the promulgation of reasonable and scientifically sound environmental standards and regulations.

Some of the basic questions confronting EPA's research program include:

When does a substance in the environment become a "pollutant"?

To what extent should a pollutant be controlled?

What is the best way to eliminate or control the pollutant?

EPA's Office of Research and Development needs the answers to provide timely and valid scientific information and necessary technical tools and control systems.

Phosphates provide a simple illustration of some of the basic questions we are concerned with. As we all know, phosphates are a widely used fertilizer and can play a useful role for man.

However, excess phosphate in our waterways can cause degradation of water quality and lead to fish kills. These results occur because too much phosphate stimulates massive growths of algae and other aquatic vegetation which later die and absorb the oxygen in the water.

So we have the responsibility of determining how much phosphate a lake can tolerate before it suffers from excess algae. Then we have to decide what techniques can be used to deal with this problem most effectively.

These are the types of problems we have been dealing with in the case of Lake Shagawa in northern Minnesota, for example. We have been successful in restoring this badly polluted body of water by drastically reducing the amount of phosphates discharged in wastewater from an advanced waste treatment plant.

SEVEN ACTS

Our research program is authorized by seven separate congressional acts: The Clean Air Act; the Federal Water Pollution Control Act; the recently passed Safe Drinking Water Act; the Solid Waste Disposal Act; the Federal, Insecticide, Fungicide, and Rodenticide Act; the Public Health Service Act; and the Noise Control Act.

Through this legislation, we have available $250 million for research this fiscal year. Of this total, $66 million will support the in-house activities of our staff of 1800 professional and support workers in 15 field units and headquarters. The remainder of the money will support an outside research program—fully integrated with the in-house research—that is carried out through grants and contracts with the academic, research, and industrial communities, as well as through cooperative agreements with other Federal, State, and local agencies.

The ties between the in-house researchers and the EPA-financed external programs are and must be close. The research program exists to support the regulatory role of the Agency, and hence either the researcher or, if the research is extramural, the research manager, has to be available to assist the Agency in developing appropriate regulations and standards, to provide expert advice to policy makers, to provide continuity and direction to the research, and to testify, if necessary, at enforcement actions.

Because of the manner in which the Agency receives its authorizing legislation, the research program for budgetary purposes has been classified along specific media or

*Dr, Wilson K, Talley is Assistant Administrator for Research and Development.

categorical lines such as air, water, pesticides ... But pollution problems seldom restrict themselves to such arbitrary boundaries—pollutants often create spillover effects in other media. And other factors-costs, for instance, and feasibility of alternative strategies—preclude focusing solutions in only one medium. Consequently, environmental research must be integrated.

5-YEAR PLAN

This integration must fit a time frame suited to the schedule of problems and responsibilities we face. So in working out a new structure for the research program, we have shifted our planning from a year-to-year schedule to a 5-year time frame. Each year, we will spell out what we can foresee for the next five—and thus revise this 5-year plan each year. ORD's new organizational structure follows accordingly, and is organized by type of product.

ORD's short-term activities, primarily quality assurance, monitoring, and analytic responses to the immediate needs of other Agency programs, were grouped together under the Office of Monitoring and Technical Support.

The relatively more stable long-term activities, relating to the determination of the human health and ecological effects of pollutants, were organized into the Office of Health and Ecological Effects.

The third component of ORD's mission—meeting legislative and Agency mandates for control or abatement technology—was, because of its size, organized into two groups: The Office of Energy, Minerals, and Industry; and the Office of Air, Land, and Water Use. Our main programs are organized within this framework.

These four offices plan and implement research that can be broken into our 14 major program areas.

Health effects is a base research program, where our scientists work to determine and evaluate health hazards that may arise from pollution from a number of media and categories including air, water, pesticides and radiation. In taking environmental action to protect human health, we regulate exposure to specific contaminants, not their effects. In this way, adverse health effects associated with pollution may be reduced or eliminated rather than treated after the fact.

In developing the data needed to establish exposure/response relationships, we examine how pollutants reach man: i.e., via air, water, food or a variety of routes. In addition to laboratory studies, one of the ways we investigate exposure/response relationships is through observing the health of different population groups.

For example, we are assessing the incidence of illness in swimmers at relatively clean and relatively polluted beaches to determine better how the illness can be correlated to chemical or microbial indicators of water quality. The information obtained will be used to help us develop health criteria for recreational water quality.

Similarly, we are carrying out studies to assist in evaluating existing standards and developing new ones for air quality. Conducted in several locations across the country, these studies are designed to investigate the relationship between air quality and health effects such as respiratory disorders in children, asthmatics, and other population subgroups.

Ecological effects and processes is a research program which determines the effects of air and water pollutants on the structure and function of ecosystems and on subcomponents of such systems. Work is planned and organized along problem area lines; it is directed toward target media—freshwater, marine, and terrestrial--and conducted according to the character of the problem.

Among the studies in progress are those to define and characterize ecosystems; that is, to unravel the myriads of individual ecosystem components and then to understand their dynamic, functional relationships,

To do this, we carry out field studies on natural ecosystems as well as attempt to

simulate ecosystems in the laboratory. With the knowledge gained, we can enhance our capability for accurately determining the impact of existing pollution on the ecological balance and for predicting the damage of increasing pollution.

For example, we are studying the effects of pollutants from a new coal-fired power plant on the wildlife and on the surrounding grasslands in Colstrip, Montana.

We must answer questions such as: what effect will pollutant X have on the plant or animal organisms in an ecosystem ? Will the pollutant impair the organism's ability to reproduce or escape predation? How will the ecosystem be functionally altered if pollution renders a species of plant or animal incapable of surviving ?

Transport and fate of pollutants research produces empirical and analytical techniques to allow relating air and water pollution emissions to ambient exposures. In the atmosphere, we must identify sources, sinks, and transport and transformation processes for gases and particulate. In aquatic environments similar considerations apply. This area also includes effects on visibility, turbidity, rainfall, water quality, and intermedia transfer of pollutants.

To discover feasible control and abatement technology, several programs address various aspects of this complex work.

Waste management program research focuses on the prevention, control, treatment, and management of pollution resulting from community, residential or other nonindustrial activities. This area includes municipal and domestic wastewater, collection/transport systems, land surface runoff, municipal solid wastes and air pollutants. Current research includes the development of improved methods for the processing and disposal of sewage sludge. We are also looking at the possibilities of incinerating the sludge in combination with solid waste and attempting to make use of heat generated in this process.

Water supply activities include research, development, and demonstration necessary to provide a dependable and safe supply of drinking water, and to prevent health damage resulting directly or indirectly from contaminants in drinking water.

For example, new and improved technology is being developed for the removal of infectious agents in drinking water. The problem with using chlorine as a disinfectant is that it produces substances which may be toxic, so we are exploring alternatives to chlorination. These alternatives include the use of ozone and the use of ultraviolet light.

We are also looking at technology for the removal of potentially toxic organic contaminants from drinking waters. One such technique for removal of these organics involves the use of activated carbon. Added to the water in powder or granular form, the carbon acts as a sort of sponge—the organic compounds attach themselves to the carbon which is then removed,

Mineral extraction processing and manufacturing program research is concerned with point sources of air, water, and residues pollution that may arise from the industrial sector of the economy. It is focused on those mining, manufacturing, service, and trade industries which are involved in the extraction, production, and processing of non-energy materials into consumer products. In addition, the environmental problems that can arise from accidental material spills are studied. This research activity supports the technical requirements of the Clean Air Act and Water Pollution Control Act by developing and demonstrating new or improved, cost-effective abatement technology.

Renewable resources program activities encompass the development of total management systems, including predictive methodology, that are to control air, water, and land pollution resulting from the production and harvesting of food and fiber. This area includes the assessment of probable trends in the production of renewable resources and their resulting environmental impact. Major areas of concern include crop production in both irrigated and nonirrigated

lands, forestry practices, and animal production.

Environmental management research looks at environmental management strategies—various comprehensive approaches to integrating all environmental programs in an efficient manner, utilizing land use management as the basic integrating mechanism. For example, methods are being developed to assess the environmental impacts of sewer and transportation systems on community growth. Also, methods for integrating regional air and water quality planning efforts are under way.

Energy extraction and processing technology covers the assessment of problems and development of control techniques to mitigate the environmental impact of the mining and processing of coal and other energy resources. Solid, liquid, and gaseous fuel as well as such non-fossil energy sources as uranium and geothermal sites are considered. The range of problems considered spans the spectrum from assessment of the socio-economic aspects of resources extration and good practice in offshore drilling to abatement of acid mine drainage and coal cleaning.

Energy conversion-utilization technology assessments is the category aimed at assuring adequate energy production from fossil fuels with minimum damage to environmental quality. After assessing environmental impacts, this program identifies, develops, and demonstrates the required pollution control technology for present and emerging energy systems.

For example, our Industrial Environmental Research Laboratory at Research Triangle Park has been developing and demonstrating flue gas desulfurization technology, commonly known as stack gas scrubbers. These units can be used to control sulfur dioxide emissions from stationary sources, with particular emphasis on coal-fired electric power plants.

Integrated technology assessment is required to identify significant technology gaps and provide information for important policy decisions. The assessment must include environmental, energy, economic, and social factors.

Energy health and ecological effects include those research efforts necessary to determine the environmental effects associated with energy extraction, transmission, conversion, and use. With this knowledge, measures can be taken to protect human health and welfare, the ecosystem, and social goals while increasing energy production.

Measurement, techniques and equipment development research provides methods which serve as the Agency's "eyes, ears, and nose." Some of the more immediate needs of the Agency concern environmental monitoring. After all, if we can't be sure a pollutant is there, how are we to control it?

In this program, physical, chemical, and biological principles provide the basis for development of procedures and instruments to measure pollutants. These procedures and instruments are then used by the Agency in its monitoring networks.

As an example of how this program works, we may find that we need to routinely measure a newly identified environmental pollutant such as vinyl chloride. Vinyl chloride is a colorless gas which recently was identified as the industrial chemical responsible for causing a kind of cancer in industrial workers. A procedure to measure vinyl chloride was developed by our monitoring program in cooperation with the regional surveillance and analysis laboratories. This system was used by the regions in a national monitoring survey to evaluate the vinyl chloride problem. The analytical procedure is currently being refined in our laboratories under the measurement, techniques, and equipment development program.

Monitoring quality assurance serves all environmental monitoring activities of the Agency. Its purpose is to assure that monitoring data used to support the Agency's regulatory programs are scientifically sound and legally defensible.

To illustrate this problem area, consider a butcher weighing a piece of meat. If he were to

take the same piece of meat and repeatedly weigh it, each successive weighing would be different from the others. If he used a good balance, these differences would be small and there would be no cause for alarm. However, if the differences were large, the customer could become very distressed.

It is the purpose of the quality assurance program to standardize the measurement procedures to reduce the variations in such successive measurements to acceptable differences. The quality assurance program also provides standard reference materials of certified purity and reference samples of known concentration so that analysts can check the accuracy of their analyses. Quality control guidelines and manuals are developed to assure uniform analytical practices. Finally, the quality assurance program provides for evaluation of laboratories for the adequacy of their facilities and the competencies of their technical personnel.

Technical support is also provided by our research program to other elements of the Agency. This is usually not research per se; it is mainly the application of our findings in all fields, and the lending of our research scientists and our research facilities to other parts of the Agency for their immediate or unusual needs.

These needs may be for technical information, for the evaluation of a particular pollution control problem, for a surveillance or monitoring job in one of the Regions, or perhaps for monitoring and control of an emergency pollution episode. Identification of this function as a distinct activity reflects a determination that we will continue to be responsive to the immediate needs of the Agency.

Taken together, these 14 program areas are the totality of our research program. The specific content of any area is based on a number of fundamental factors.

First and foremost is the full recognition that research serves a support function within the regulatory Agency. Our strategy, specific objectives and priorities should not and cannot stand as entities in and of themselves. Rather, they must derive from those of the Agency in the accomplishment of its total legislative mandate.

The program, then, is one of mission-oriented research and not one of so-called basic research. This is not to say that some very fundamental research is not, in fact, an integral part of our program. It is and must continue to be so because of our responsibility to provide the best scientific data and to develop control systems for pollution problems that are beyond the present state-of-the-art. Further, a most important research function is to anticipate the problems that will emerge in the future and—if we cannot prevent them—tag them so that they will not arrive unheralded.

Appendix B

Statutory and Administrative Background

The establishment of the Environmental Protection Agency and its Office of Research and Development is an outgrowth of the recognized need to enhance the level of environmental quality and to unify, where possible, the disparate environment-related agencies and offices scattered throughout the Federal Government.

Statutes

The Agency was created through powers granted to the President under sections 901 (a), 901 (a) (3), and 907 of Title Five of the U.S. Code.

Section 901 (a) provides that the President may reorganize elements of the Executive Branch "to promote the better execution of the laws, the more effective management of the Executive Branch and its agencies and functions." Section 901 (a) (3) notes that reorganization is permitted "to increase the efficiency of the operations of the Government to the fullest extent practicable." Section 907 acts as a bridge for the orderly transfer of such Federal business as public hearings and other, ongoing actions. Using this legislation, the President established the Environmental Protection Agency in December 1970, under Reorganization Plan No. 3.

Federal environmental objectives are set forth in the National Environmental Policy Act of 1969. The purposes of this legislation are to establish "a national policy which will encourage (a) productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation, and to establish a Council on Environmental Quality."

Title I states that all policies, regulations, and laws shall conform to the policy established in the act. Federal agencies are required to use a systematic, interdisciplinary approach to formulate such plans and policies that may affect the environment and to consult with the Council on Environmental Quality. In addition, they are to provide a report with all legislative and proposed Federal actions which describes a proposed program's environmental impact, alternative proposals, and short- and long-range environmental effects as well as noting any irreversible or irretrievable environmental damage that a given program may cause.

Title II establishes the Council on Environmental Quality. This three-member Council is required to aid the President in formulating environmental decisions, to review Federal programs, to conduct investigations and studies, to document and define changes in the national environment, to provide an annual report on environmental quality, and to advise the President on pending legislation.

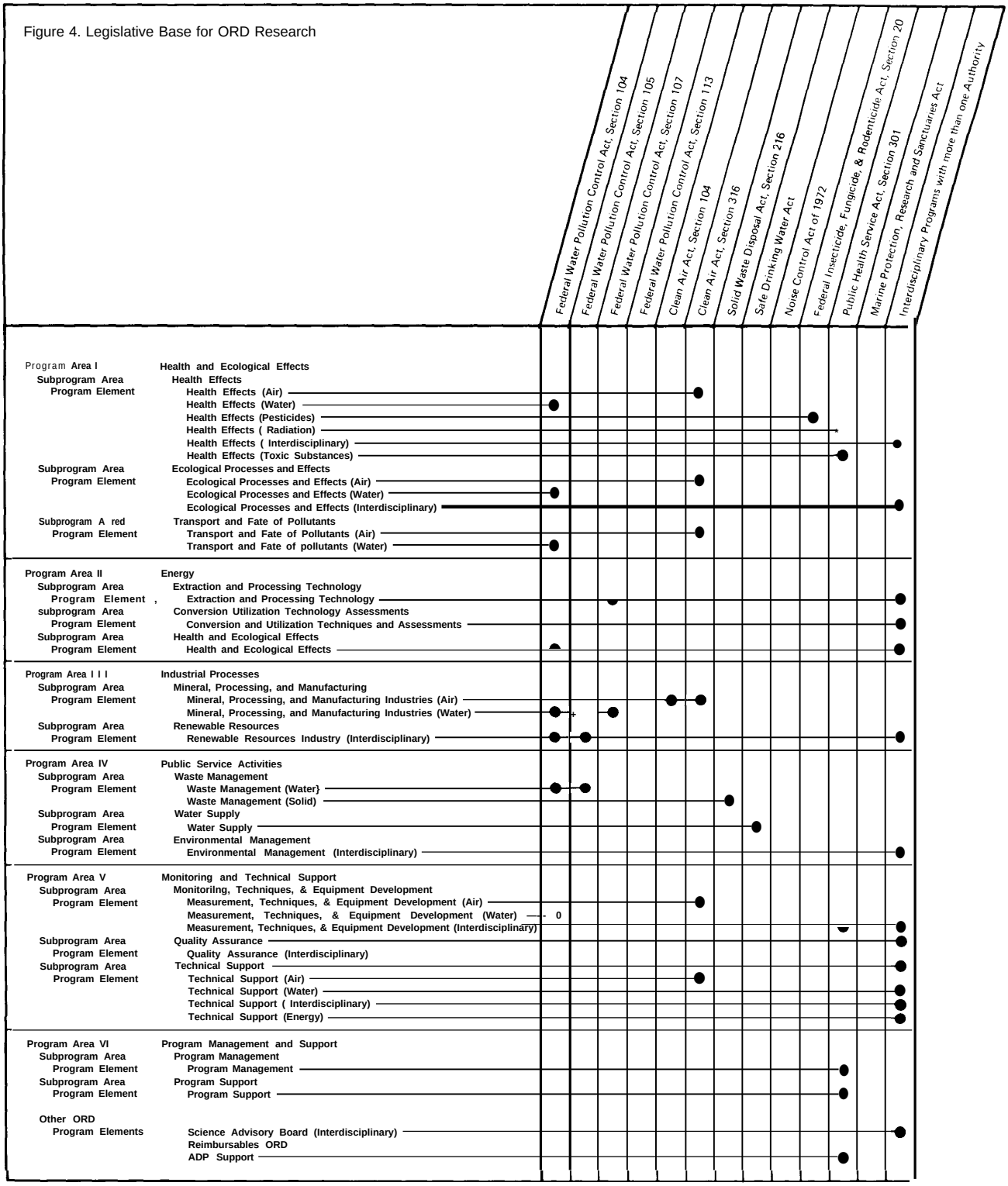
While the National Policy Act establishes a central Federal direction in the area of environmental planning, EPA/ORD is governed by eight separate laws as amended, plus guidance from various appropriations reports. The eight Federal laws, in alphabetical order, are:

Clean Air Act.—Requires EPA to establish a research and development program that coordinates and accelerates investigations to determine the causes, effects, extent, prevention, and control of air pollution.

Federal Insecticide, Fungicide, and Rodenticide Act.—This legislation requires EPA to develop biologically integrated pest control alternatives and to formulate a national monitoring program.

Federal Water Pollution Control Act. --Creates a research and development program

Figure 4. Legislative Base for ORD Research



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under EPA to prevent, reduce, and eliminate pollution in navigable waters. Requires research and development in such specific areas as Great Lakes pollution, oilspills, and thermal discharges. Provides for the establishment of a control technology and management program to eliminate the discharge of waterborne pollutants.

Marine Protection, Research, and Sanctuaries Act.—Working with the Commerce Department and the Coast Guard, EPA must monitor and study the pollutants dumped into the ocean or which reach the Great Lakes. EPA is required to consult with the Commerce Department on such topics as overfishing, man-induced changes in the ecosystem, and the long-range effects of pollution.

Noise Control Act.—Provides that EPA will establish a research and development program to examine noise control, abatement technology, and the health effects of noise under various conditions.

Public Health Service Act.—This legislation instructs EPA to determine environmental radiation levels, associated health risks, to review present radiation standards, and to assess the nuclear fuel cycle and its relationship to the environment.

Safe Water Drinking Act.—Provides for EPA to conduct research and development studies on waterborne contamination and the diagnosis, treatment, control, and prevention of such contaminates. It also requires that EPA establish a research and development program to assure a safe supply of drinking water.

Solid Waste Disposal Act.—Directs EPA to work in numerous waste disposal areas including research and development on the operation and financing of solid waste disposal systems; monitoring to determine negative health effects; development of methods to reduce negative health effects; the reduction of unsalvageable materials; and new methods of collecting, processing, and recovering materials and energy generated from solid waste.

In addition to requirements set forth in Federal legislation, appropriations reports are a source of EPA directives. Specific requests for research and development through appropriations reports have included an assessment of adverse environmental impacts affecting the Chesapeake Bay and a study of the potential impact created by powerplant siting on the lower Ohio River in terms of environmental, social, and economic factors.

ADMINISTRATION

When the EPA was first established, it consolidated 15 separate organizational programs in the Federal Government. The environmental research units among these programs were formed into the Office of Research Monitoring, which was subsequently renamed the "Office of Research and Development." ORD was an amalgam, at that point, of 40 separate field installations—installations with different functions, interests, and interrelationships.

In June 1973, the 40 installations were consolidated into three major field units called National Environmental Research Centers (NERC's). Later a fourth NERC was established, These major centers, in turn, administered 24 field laboratories.

By 1975, the consolidation under the four NERC's was becoming administratively cumbersome. A second reorganization occurred. This time the order of organization was based on the type of output desired.

Under the second reorganization, four offices were established. Each is responsible for planning one or more of the major ORD subprograms. In one case—monitoring techniques and equipment development—planning authority is shared by two offices. Each office also has implementation responsibilities for individual subprograms. Implementation responsibility is frequently shared by two or more offices.

The Office of Health and Ecological Effects has planning responsibility for two subprograms: health effects and ecological processes and effects.

The Office of Energy, Minerals, and Industry plans the research and development effort for four subprograms: mineral, processing, and manufacturing; health and ecological effects/energy; extraction and processing technology/energy; and conservation, utilization, and technology assessments/energy. Two subprograms are planned by the Office of Monitoring and Technical Support: quality assurance and technical support. The monitoring techniques and equipment development subprogram is planned by the Office of Monitoring and Technical Support and the Office of Air, Land, and Water Use. The latter Office has five additional subprograms for which it has planning responsibility: transport and fate of pollutants, renewable resources, waste management, water supply, and environmental management.

Each subprogram established by ORD has been created as a result of Federal legislation. Some programs are formulated on the basis of a single law, while others have many legal references. The matrix displayed in figure 4, which lists ORD program areas, subprogram areas, and program elements, charts the relationship between environmental legislation and each activity.

Glossary of Terms

Glossary of Terms

Abate—(abatement) (1) to put an end to, (2) to reduce in degree in intensity or to reduce in value or amount.

Acid Rainfall—Rainfall that is increasingly more acid, and thus more toxic to the environment, under conditions of increasing air pollution. Rainfall in the eastern United States has become 32 times more acid than it was in the 1950's,

Activated Sludge Plants—Wastewater treatment facilities in which the wastewater passes through an aerated tank containing a suspension of aerobic bacteria which feeds on the nutrients in the wastewater.

Agronomy—A branch of agriculture dealing with field crop production and soil management.

Ambient-General condition all around a given point.

Amine—(1) any of various basic compounds derived from ammonia by replacement of hydrogen by one or more univalent hydrocarbon radicals, (2) a compound containing one or more halogen atoms attached to nitrogen.

Best Management Practice (BMP)—Alternatives designed to reduce or prevent runoff of pollution discharges or emissions that adversely affect air, land, or water, including cost-effective determinations and evaluation of social and economic impacts.

Bioassay—A particular technique for testing a substance against a living tissue for toxic, mutagenic, carcinogenic, and teratogenic agents.

Biodegradable —Capable of being broken down into innocuous products by the action of living beings (micro-organisms).

Biomass—The amount of living matter (as in a unit area or volume of habitat),

BOD—Biochemical oxygen demand; biological oxygen demand.

Brines—(d) water saturated or strongly impregnated with common salt, (b) strong saline solution (as of calcium chloride),

"BROX" System—System which treats organically contaminated brines generated in glycol production.

Carcinogen— A substance or agent which produces or incites cancer.

Catalyst—A substance (as an enzyme) that initiates a chemical reaction and enables it to proceed under milder conditions (for example, at a lower temperature) than otherwise possible.

Chemosterilant—A substance that produces sterility (as of an insect) without marked alteration of mating habits of life expectancy.

CHESS (Community Health Effects Surveillance Studies) — EPA's CHESS study found that sulfate concentrations in California and in States east of the Mississippi are in the 7– 13$^{\mu m}/_{m}$3 range (μ m—micromoles) and that Northeastern States have concentrations over 13$^{\mu m}/_{m}$3. This means that within the eastern half of the continental United States, levels of sulfates were higher at urban sampling sites than at nonurban sites. This study gives significant evidence of the adverse effects of atmospheric sulfates. From such studies there may be enough evidence to show a cause/effect relationship between ambient sulfur oxides and pulmonary diseases, such as emphysema.

Climatology—The science that deals with climates and their phenomena.

Closed-Cycle Technology—Processes designed to prevent all pollutants from escaping into the environment.

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Combined Sources Research—The development of technology to treat industrial wastes from several plants in a region with a single facility or in combination with municipal waste management.

Compliance Monitoring—Monitoring which is undertaken to gather specific evidence from a point source or discharge for use in possible litigation.

Control Technology—A combination of hardware, operating procedures, or process changes used to reduce the harmfulness of gaseous, liquid, or solid effluents from a pollution source; normally based on contaminant (1) removal and isolation, (2) transformation chemically and/or physically to a less harmful form, or (3) dispersion to prevent localized high levels.

Critera Pollutants—Pollutants for which an ambient air quality standard has been set, Currently standards have been set for six pollutants, sulfur dioxide ($S0_2$), carbon monoxide (CO), total suspended particles (TSP), hydrocarbons (HC), oxidants (OX) and nitrogen oxide (NO_x). The expectation is that approximately 25 more criteria pollutants will be promulgated between 1976 and 1978.

Cytogenetics —A branch of biology that deals with the study of heredity and variation by the methods of both cytology (history of cells) and genetics.

Ecological Criteria Development—Includes laboratory studies (such as bioassays) to establish tolerable pollutant levels. Work performed under ecological criteria is performed in direct response to legislative mandates to define numerical standards for pollutants.

Ecological Processes and Effects Subprogram —This research subprogram provides EPA with the knowledge and theoretical structure on which to base environmental criteria, standards, and regulations.

Ecosystem— A living community and the physical environment associated with it, functioning as a unit in nature.

Effluent—The outflow from a pollution source.

Energy Conservation, Utilization, and Technology Assessment Subprogram—This subprogram focuses on identification, characterization, assessment, and development of control technology for pollutants associated with utility and industrial combustion sources.

Energy Extraction and Processing Technology Subprogram—The objective of this subprogram is to permit a rapid increase in extraction and processing of domestic energy resources and to enable these energy sources to be used effectively in an environmentally compatible manner.

Environmental Management Subprogram— The objective of this subprogram is to provide regional environmental planners and managers with methods to determine feasible alternative solutions to specific environmental problems and to provide techniques for selecting lowest cost solutions.

Epidemiology—(1) a branch of medical science that deals with the incidence, distribution, and control of disease in a population; (2) the sum of factors controlling the presence or absence of a disease or pathogen.

Estuary—A water passage where the tide meets a river current, especially an arm of the sea at the lower end of a river.

Eutrophic—Well nourished—rich in dissolved nutrients (as phosphates) but often shallow and seasonally deficient in oxygen.

Fate—The final destination for a substance which has traveled through the biosystem.

F1oc—A loose, fluffy mass formed by the aggregation of a number of fine particles suspended in a liquid medium, usually water.

Flocculate—To cause to aggregate into a fluoculent (loose, fluffy organization) mass.

Flue-Gas Desulfurization (FGD)—Process by which flue gas from coal-fired utility and industrial boilers is cleaned by passage over or through a bed of chemically active

minerals, such as lime or limestone. This process is one of the few coal pollution control techniques available in the 1970's which meets Clean Air Act requirements.

Fluidized-Bed Combustion (FBC)—Technique for burning coal on a suspended bed of mineral matter.

Freon—Generic term, originally a trade name, used for any of various nonflammable fluorinated hydrocarbons used as refrigerants and/or propellants for aerosols.

Geothermal-Of or relating to the heat of the earth's interior.

Glycol—Ethylene glycol—an alcohol contain- ing two hydroxyl groups.

Groundwater—Water within the earth that supplies wells and springs.

Halogen—Any of five elements—fluorine, chlorine, bromine, iodine, and astatine—That form part of group VII A of the periodic table and exist in the free state normally as diatomic molecules.

Hazardous Air Pollutant—An air pollutant to which no ambient air quality standard is applicable and which in the judgment of the EPA Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating illness.

Health and Ecological Effects Program—This program is fundamental to EPA's responsibility to set criteria standards and guidelines to enhance environmental quality. It provides information for the establishment of water quality criteria, air quality criteria, ocean disposal criteria, pesticide registration guidelines, effluent standards for toxic and hazardous materials, and radiation standards.

Health and Ecological Effects/Energy Subprogram—This subprogram identifies all adverse environmental aspects (essential for criteria development and control technology requirements) associated with energy extraction, conversion and use.

Integrated Assessment Subprogram (part of the Energy/Environmental Program)—This subprogram's objectives are to integrate the complex, environmental, social, and economic issues of various technologies under alternative environmental management systems.

Intermittent Controls-Controls which are used at intervals, that is, put into use when pollution is heavy, then later turned off or discontinued.

Lichen—Any of numerous complex thallophytic plants made up of an algae and 'a fungus growing in symbiotic association on a solid surface (as a rock).

Malathion—A thiophosphate insecticide $C_{10}H_{19}O_6PS_2$ with a lower mammalian toxicity than parathion.

Marginal Land—Land that is barely productive agriculturally due to its nonproductive capacity or its limited water supply. Attempts made to use such "marginal land" often result in accelerated land erosion, resource degradation, and the impairment of wildlife habitat and aquatic environments.

Materials Processing Research—This research covers many industrial activities that mechanically or chemically change a material from one form to another (e.g., metalworking or electroplating).

Materials Production Research—This research includes problems of industries concerned with exploration for and production of raw materials such as iron, aluminum, and limestone.

Measurement Techniques and Equipment Development Subprogram—This subprogram involves development, evaluation, and demonstration of field and laboratory measurement and monitoring methods and instrumentation.

Microcosm—A community or other unity that is a typical or ideal example of a larger unit y.

Minerals Processing and Manufacturing Industries Subprogram—This subprogram considers point sources of water, air, and residue pollution produced by industry.

Minority Institutions Research Support (MIRS)—An EPA program conducted to direct research grants to minority institutions in the area of environmental research.

Mobile Source Pollutants—Pollutants resulting from a source that moves (i.e., automobile emissions).

Monitoring and Technical Support Program—This program includes research, development, and demonstration activities and direct assistance and support to all of EPA. Program includes three subprograms: Measurement Techniques and Equipment Development, Quality Assurance, and Technical Support.

Mutagenesis—The occurrence or induction of a relatively permanent change in hereditary material involving either a physical change in chromosome relations or a biochemical change in the codons (a triplet of nucleotides that is part of the genetic code and that specifies a particular amino acid in a protein or starts or stops protein synthesis) that make up genes.

Noncriteria Pollutant—Hazardous pollutant (such as mercury, fluorides, vinyl chloride, etc.) for which no ambient air quality standard has been established. Insufficient health effects data have been developed to establish a "safe" exposure level for these pollutants.

Nonpoint Source Pollutants—Pollutants arising from certain management practices in the area of renewable resources, such as application of fertilizers or pesticides to productive land.

NO_x. Control Technology—This research and development seeks to identify, assess, and promote development of cost-effective commercial methods for control of oxides of nitrogen (NO_x) from both existing and new stationary combustion sources.

OSWMP (Office of Solid Waste Management Programs)—This Office was established by EPA to deal with the national solid waste problem.

Outfall—The outlet of a body of water; the mouth of a drain or sewer.

Ozone—A triatomic form of oxygen formed naturally in the upper atmosphere by a photo chemical reaction with solar ultraviolet radiation. It is also generated commercially by an electric discharge in ordinary oxygen or air. It is a major agent in the formation of smogs and is used especially in disinfection and deodorizatiort and in oxidation and bleaching. Its natural role in the upper atmosphere is to shield the earth from excess ultraviolet radiation.

Pathogen—A specific disease-causing agent such as a bacterium or virus.

Pesticide Registration—The EPA process by which a pesticide is approved for use.

Petrochemical—A chemical isolated or derived from petroleum or natural gas.

Pheromone—A chemical substance that is produced by an animal and serves as a stimulus to other individuals of the same species for one or more behavioral responses.

Physical and Chemical Coal Cleaning—This process involves methods to physically or chemically remove sulfur from coal having a moderate sulfur content (1–2%). This allows coal to be burned in conformity with Clean Air Act standards.

Pollutant-of-the-Month Syndrome-Crisis atmosphere produced by a continuing series of revelations which show new substances to be harmful.

Primary Air Quality Standards—Primary standards are defined as "allowing an adequate margin of safety" in protecting the public health.

Public-Sector Program—This program includes three research subprograms: Waste Management, Water Supply, and Environmental Management.

Pyrolysis—Breaking up of large organic molecules brought about by the action of heat.

Quality Assurance Subprogram--This subprogram focuses on standardizing measurement methods, providing standard reference materials and samples, developing quality-control guidelines and manuals, on-site evaluation of analytical laboratories, etc.

Regenerable—Substances which can be reconstituted and used again.

Renewable Resources Subprogram—This subprogram includes food, fiber, and wood production and related activities ranging from agricultural production through har - vesting.

Retrofit—To furnish with new parts or equipment not available or installed at the time of manufacture.

Safe Drinking Water Act (SDWA)—The EPA Administrator may conduct research, studies, and demonstrations relating to the causes, diagnosis, treatment, control, and pretension of physical and mental diseases and other impairments of man resulting directly or indirectly from contaminants in water, or to the provision of a dependably safe supply of drinking water.

Saline—Consisting of or containing salt.

Salmonid—Genus name (Salmonidae) of any of a family of elongate soft-finned fishes (as a salmon or trout) that have the last vertebrae upturned.

Science Advisory Board (SAB)—Board established to provide a strong, direct link between EPA's Administrator and the scientific community.

Scrubber—A large-scale and relatively expensive device for accomplishing flue-gas desulfurization (see FGD definition). In addition, some scrubbers accomplish partial removal of NO_x particles.

Second-Generation Flue-Gas Desulfurization Process—Any of several processes which yield usable sulfur compounds as a byproduct and/or permit reuse of the chemicals required in the desulfurization process.

Secondary—A backup system or program.

Secondary Air Quality Standards—These standards protect the public "from any known or anticipated adverse effects" (i.e., not necessarily health effects).

Secondary Treatment Plants—Examples of these plants are: wastewater lagoons, trickling filters, or activated sludge plants. These plants alleviate the need for installation of entirely new treatment systems.

Silviculture—A branch of forestry dealing with the development and care of forests,

Sludge—(l) a muddy deposit (as on a river bed); (2) a muddy or slushy mass, deposit, or sediment: as a precipitated solid matter produced by water and sewage treatment process or muddy sediment in a steam boiler.

Small Particle Control Technology-Control technology to reduce fine particle emissions (less than 3 microns in diameter).

Solid Waste Disposal Act (SWDA)—This act directs the EPA Administrator to conduct and cooperate research efforts relating to any adverse health and welfare effects of the release into the environment of materials present in solid waste, and methods to eliminate such effects; the operation and financing of solid waste disposal programs; the reduction of the amount of such waste and unsalvageable materials; the development and application of new **and improved methods** of collecting and disposing of solid waste, and processing and recovering materials and energy from solid wastes.

St. Louis Regional Air Pollution Study—ORD study to develop and validate regional-scale models for criteria air pollutants.

Standard of Performance—A standard for emission of air pollutants which reflects the degree of emission limitation achievable through the application of the best system

of emission reduction which (taking into account the cost of achieving such reduction) the EPA Administrator determines has been adequately demonstrated.

Stationary Source Pollutants—Pollutants caused by sources which do not move (i.e., factories and powerplants).

SEAS (Strategic Environmental Assessment System)—An operational tool for environmental forecasting and policy analysis. EPA planned to have SEAS support an impact assessment of energy, environment, and recovery tradeoffs and alternatives, but it is now undergoing reevaluation.

Synergism—A cooperative action of discrete agencies (such as chemicals or muscles) so that the total effect is greater than the sum of two or more effects taken independently.

Tertiary—A system which follows both a main and secondary effort.

Teratology—The study of malformations, monstrosities, or serious derivations from the normal type in organisms.

Toxicology—A science that deals with poisons and their effect and the problems involved (as clinical, industrial, or legal).

Toxic Substance—Chemicals considered dangerous to health and the environment (e.g., phenols).

Trace Metals—Possibly toxic metals that move through the environment and humans in very small quantities.

Transport—Movement of a substance through the ecosystem.

Transport and Fate of Pollutants Subprogram—This subprogram is responsible for the development of empirical and analytical techniques that relate air and water pollution source emissions and discharges to ambient exposures.

Triazine —Any of three compounds $C_3H_3N_3$--containing a ring composed of three nitrogen atoms; also: any of various derivatives of these including several used as herbicides.

Trickling Filters—Wastewater treatment equipment in which wastewater is sprayed on and trickles down through an aerated bed of rocks, the surfaces of which are coated with bacterial populations which feed on the nutrients in the wastewater.

Tritium—A radioactive isotope of hydrogen of mass three times the mass of ordinary light hydrogen.

Trophic-Of, relating to, or characterized by nutrition.

Trophic Level-One of the hierarchal strata of a food web characterized by organisms which are the same number of steps removed from the primary producers.

Ureas—A soluble basic nitrogenous compound $(CO(NH_2)_2)$ that is the chief solid component of mammalian urine and an end product of protein decomposition, is synthesized from carbon dioxide and ammonia, and is used especially in synthesis (as of resins and plastics) and in fertilizers and animal rations.

Waste Management Subprogram—This subprogram focuses on prevention, control, treatment, and management of pollution produced by community, residential, or other nonindustrial activities. Research concerns municipal and domestic waste water and collection/transport systems, urban land surface runoff, municipal solid wastes, and associated air pollutants.

Wastewater Lagoons—Shallow earthen ponds, usually lined, in which liquid wastes are stored for an extended period to promote natural setting of suspended solids and decomposition of organic compounds in the stored fluid.

Watershed—(1) water parting, (2) a region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water, (3) a crucial dividing point or line.

Water Supply Subprogram—This subprogram focuses on three areas of concentration: health effects, water treatment, and systems management and groundwater management.