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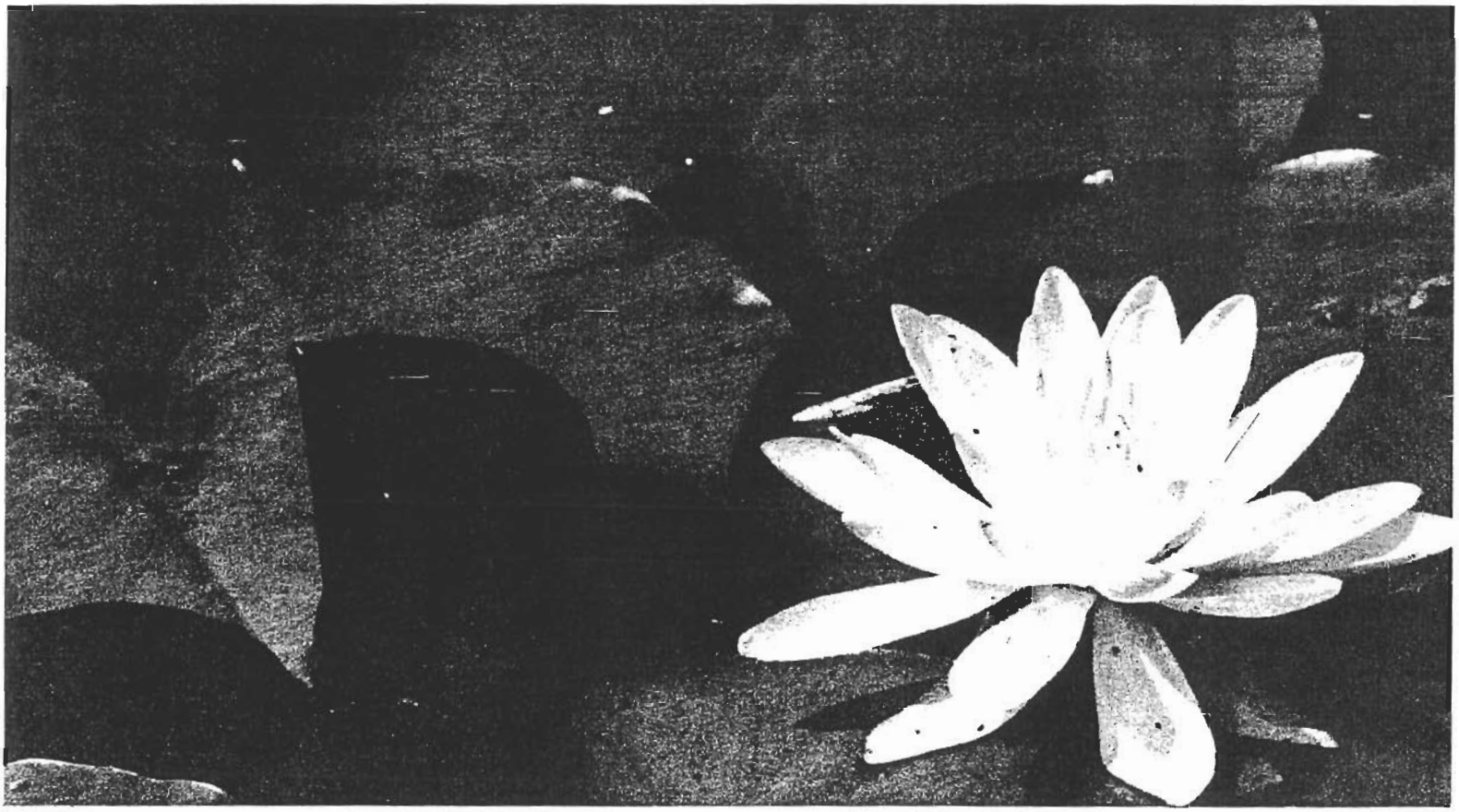
The Report Of The Strategic Options Subcommittee

Relative Risk Reduction Project



Reducing Risk

Appendix C

NOTICE

This report has been written as part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency; hence the contents of this report do not necessarily represent the view and policies of the Environmental Protection Agency or of other Federal agencies. Mention of trade names or commercial products does not constitute a recommendation for use.

This particular project was conducted at the request of the EPA Administrator and addresses a broader range of issues and concerns than most SAB reports. Consequently, many of the findings and recommendations in this report have a greater policy-orientation than is usually the case.

ABSTRACT

The Strategic Options Subcommittee of the Relative Risk Reduction Strategies Committee identified strategy options for reducing risks from a sample of 13 environmental problems. In addition, the Subcommittee developed eight broad recommendations for environmental risk reduction:

1) EPA should establish priorities based on the potential for risk reduction.
2) Pollution prevention should be the most important approach for reducing environmental risks over the long term.
3) In order to reduce risk and prevent pollution in a significant way, EPA must substantially broaden its kit of environmental protection tools, especially to emphasize economic incentives and information transfer.
4) Environmental protection must be integrated into other policy areas, in as fundamental a manner as are economic concerns.
5) In order to integrate environmental policy into other policies, a special governmental mechanism should be created in the Executive Branch.
6) EPA should continue to perform analyses similar to the present Relative Risk Reduction Strategies Project and integrate the results into the Agency's strategic planning process.
7) EPA's annual budget should more directly reflect risk-based priorities.
8) The Agency should develop an enhanced environmental education and training program for both professionals and the general public.

Key words: Risk reduction; pollution prevention; risk assessment

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Beginning with the enactment of the National Environmental Policy Act of 1970 and continuing with the founding of the Environmental Protection Agency in the same year, the United States launched an unprecedented effort to address environmental and health problems caused by human activities. Many laws and programs have been enacted and implemented since then, resulting in important improvements in environmental quality.

Unfortunately, we still face daunting environmental problems. Stubborn portions of older problems have resisted our control efforts and newly identified problems appear increasingly difficult to solve. Economic growth, increasing population, the global nature of some problems, the diversity of sources of contamination, the time and resources required to reverse many problems, and difficulties with the approach, structure and priorities of existing programs all make the job of environmental protection harder.

1.2 The Subcommittee

Recognizing that the nature of the environmental problems facing the U.S. and the world is changing, the Administrator of EPA asked the EPA Science Advisory Board (SAB) to undertake a project to advise him broadly on new directions for reduction of environmental risks. To undertake this project, the SAB set up a special committee, the Relative Risk Reduction Strategies Committee, which in turn set up three subcommittees. This report summarizes the work and conclusions of the Strategic Options Subcommittee, which was assigned to identify and analyze a range of the most promising types of risk reduction options that EPA should consider, and to provide a procedure for continuing work by EPA along these lines.

The twelve members of the Subcommittee had a range of technical expertise and viewpoints. In developing promising risk reduction options and thematic recommendations for EPA, the Subcommittee primarily considered factors such as cost, risk

reduction, technological feasibility, and implementation requirements associated with each option.

1.3 Framework and Methodology

The Subcommittee developed and analyzed risk reduction options in four steps:

1. Selecting environmental problems for study. The Subcommittee selected 13 environmental problems for analysis -- generally those posing the greatest risks. The Subcommittee thus considered only a portion of EPA's programmatic domain. However, the 13 problems are sufficiently rich and diverse to suggest patterns likely to emerge in a broader analysis.

2. Developing an extensive list of potential risk reduction strategies for each problem. The Subcommittee developed potential strategies for each problem. To aid in the identification of these options, the Subcommittee outlined a series of six general approaches: scientific research and technical innovation, provision of information, market incentives, conventional regulations, enforcement measures, and cooperation with other agencies and nations. Three assumptions were made in generating strategies: (1) existing risk reduction measures already in place would remain so; (2) strategies outside of existing legislative mandates could be considered; (3) strategies would not be limited to those within EPA's scope of responsibility, although EPA's role should be emphasized.

3. Selecting the most promising options for each problem. The Subcommittee developed evaluation criteria which it used to help select preferred strategies for each problem. Strategies for the different problem areas were not ranked against each other. Subcommittee members wrote short papers on each environmental problem, addressing the risks posed by the problem, the policy background, and the strategy options. These papers constitute Appendix A to this report.

4. Developing cross-cutting strategy options and recommendations. Many of the strategy options selected for one problem were similar or even identical to strategies for another problem. In its final choice of options, the Subcommittee preferred options that would realize benefits across several problem areas.

The Subcommittee believes that a methodology like the one used in this effort has potential to assist EPA in identifying preferred risk reduction options. Any such process must be systematic and comprehensive, and force Agency personnel to take a broad and innovative perspective.

The Subcommittee also examined the generic approaches that frequently appeared to have promise among the individual strategy options for the problem areas. This investigation prompted several of the Subcommittee's broad recommendations regarding EPA's approach to risk reduction -- supporting greater use of market incentives and information strategies, for example.

The strategy options for individual environmental problems should not be construed as recommendations, and they do not represent the primary product of the Subcommittee's work. The strategy options represent reasonable approaches to each environmental problem, but they have not been analyzed in any formal way sufficient to warrant asserting that they are the best approaches to each problem. Nor is the list of strategy options necessarily comprehensive; most likely there are other strategy options that would also offer effective responses to the environmental problems we have examined.

1.4 Conclusions and Recommendations

The Subcommittee's analysis of strategies to address its sample of 13 key environmental problems suggests that fundamental changes are necessary achieve significant further progress in environmental protection. To this end, the Subcommittee made eight recommendations:

1. **EPA should establish priorities based on the potential for risk reduction.**

Over the past 20 years U.S. environmental policy has developed in a piecemeal, ad hoc fashion. Laws have been passed at different times and little attempt was made to coordinate them. Nor was any attempt made to compare the relative seriousness of different environmental problems in order to make judgments about the relative urgency of different environmental protection efforts. But experience has taught us that not all environmental problems are equally serious and not all protection efforts are equally urgent. We must set environmental priorities.

These priorities should be based on an explicit comparison of the relative risk posed by different environmental problems, and, more specifically, on the opportunities for cost-effective risk reduction. The recommendations that follow in this report spell out more specific measures that EPA, Congress and others should take to make this principle a reality.

2. Pollution prevention should be the most important approach for reducing environmental risks over the long term.

The recommendation that EPA should place a much greater emphasis on pollution prevention as the preferred way to address environmental risks is not new. Pollution prevention represents a way of thinking about alleviating environmental risks that is fundamentally different from the pollution control approach long practiced in this country. Pollution prevention emphasizes avoiding the creation of risks from pollution or from natural resource depletion by changing raw materials, technologies of production and products, as opposed to attempting to control or mitigate what has already been created. Pollution prevention can also include changing activities and the location of those activities so as not to harm sensitive ecosystems. In a number of instances pollution prevention can be the most cost-effective way or even the only way to reduce environmental risks. Pollution prevention is also the key to sustainable development and protection of natural resources for future generations (examples are banning lead in gasoline or substituting for CFCs). This approach is applicable to a broad array of problems and can be implemented through a variety of policy tools.

No list of recommendations can cover the myriad of ways that pollution prevention can be stimulated by public policy. In order

to be successful, the responsibility for pollution prevention must be accepted by all parts of EPA, the rest of the Federal government, the States, the private sector and individual citizens.

3. **In order to reduce risk and prevent pollution in a significant way, EPA must substantially broaden its kit of environmental protection tools, especially to emphasize economic incentives and information transfer.**

It is very clear to the Subcommittee that the most promising strategies for risk reduction encompass a wide variety of policy approaches. The Subcommittee identified six policy approaches which EPA and other Federal agencies could employ to change the behavior of individuals, corporations and other institutions to reduce risk: 1) scientific research and technical innovation; 2) provision of information; 3) market incentives; 4) conventional regulatory standards; 5) enhanced enforcement; and 6) cooperation with other agencies and nations. Oftentimes these approaches can or need to be combined. For instance, marketable permit systems can be combined with regulatory ceilings on emissions or discharges to assure that certain minimum reductions are realized.

EPA needs to overcome its bias against new approaches. Today, when new approaches are examined, they tend to be held to a higher level of performance than existing approaches. There are long lists of known implementation problems with existing approaches but the status quo continues partly because thorough evaluations of the effectiveness and cost of existing programs are not routinely performed. EPA needs to allocate resources to non-conventional approaches and to give these types of measures serious consideration in agency decision making. In this connection, EPA might look closely at the strategy options discussed in this report.

4. **Environmental protection must be integrated into other policy areas, in as fundamental a manner as are economic concerns.**

Many types of government policies significantly affect the environmental problems that EPA needs to address. These policy

areas include, but are not limited to: 1) energy, 2) agriculture, 3) tax, 4) transportation and housing, 5) natural resources, and 6) foreign policy. For example, many air pollutants and other environmental problems (e.g. oil spills) arise from energy production and use. Likewise, agricultural practices create much of our remaining water pollution problems, as well as other problems from pesticide and fertilizer use. Energy and agriculture, as well as other areas of activity, are subject to many government incentive and control programs.

It is critical that a framework be established to assure that environmental objectives are part of other major Federal program objectives. For example, agricultural policy should be aimed not only at producing food and fiber, but also at reducing land run-off and pesticide use. Energy policy should be aimed not only at producing energy reliably and cheaply, but also at minimizing environmental damage from extraction, transportation, production and combustion. Environmental quality objectives need to be built into major government legislation, policies and programs.

5. **In order to integrate environmental policy into other policies, a special governmental mechanism should be created in the Executive Branch.**

The broad environmental strategies discussed above for energy, agriculture, tax, transportation, natural resource and foreign policy areas require an institutional mechanism within the Executive Branch. There are several means by which this might be done: the Council on Environmental Quality could be expanded and given clearer policy development responsibilities, a Cabinet Council on the Environment could be reconstituted and given a staff, or a new entity could be established. Another option would be to create a new Environmental Policy Council (EPC), which might be chaired and staffed by the Chairman of CEQ or it could be jointly chaired by the Administrator of EPA (or Secretary of Environment) and the Chairman of CEQ.

6. **EPA should continue to perform analyses similar to the present Relative Risk Reduction Strategies Project and integrate the results into the Agency's strategic planning process.**

The Agency needs to conduct the type of exercise undertaken in this project and make it a part of its regular planning process. It can do this internally, or jointly with outside groups. The use of outside experts to suggest directions for priorities and strategies has great merit, if these experts work closely with the Agency.

In developing strategies, it is critically important that certain elements exist: a) risk-based priorities must be updated periodically; b) the strategies should be organized around solving critical environmental problems, not around planning for the future of existing programs; as such, it may be most helpful to look not only at problems (such as the 13 we reviewed), but also sources (e.g. automobiles, waterfront development), effects (e.g. respiratory diseases, habitat reduction) and sectors that contribute to the problem (e.g., energy, agriculture, etc.); c) the Agency should then subject individual strategies to disciplined analysis. The selected strategies should incorporate innovative approaches and should be coordinated across program offices.

7. **EPA's annual budget should more directly reflect risk-based priorities.**

Historically, EPA's budgets have reflected the costing-out of regulatory mandates, with little focus on cost-effective risk reduction. Accordingly, some of the highest risk environmental problems, such as radon and other indoor air pollution, have received only a small fraction of the EPA budget. Under the present leadership, EPA now has greater concern for integrating risks and priorities. However, EPA's leaders are not the only people who play a role in determining EPA's budget.

The change in budget priorities need not and should not take the form of radical, overnight change. Small but consistent changes over time will accomplish the same objectives without undue disruption. The changes in budget also do not need to make allocations exactly proportional to risk and risk reduction. Some risk reduction can be accomplished at low cost.

The Subcommittee specifically recommends that at the beginning of the budgetary process, that the Administrator provide clear advice to the program offices regarding certain high-risk areas

that appear relatively unfunded. A second review should take place just prior to the time the budget is sent to the Office of Management and Budget.

8. **The Agency should develop an enhanced environmental education and training program for both professionals and the general public.**

Reducing current environmental risks and protecting against future hazards requires a sophisticated knowledge of the biosphere and the stresses which affect it, of the human activities which cause the stresses, and of technologies and strategies which are necessary to address these problems. Environmental professionals and officials must also understand the economic, social, political, and legal implications of developing and implementing solutions to environmental problems. Education and training are essential not only for environmental professionals but also for business people, farmers, engineers, scientists, physicians and others who carry out activities which affect or are affected by the environment, as well as members of the general public.

The rapidity with which we are developing our understanding of environmental problems requires continuing education and training of the current workforce. EPA needs to expand its role in supporting environmental education and training, especially at the university level. This role is as important as any of the Agency's other roles in encouraging risk reduction and will become more important in the future as environmental problems become more complex, interconnected and international in scope. EPA is currently starting a new environmental education program. The Subcommittee supports efforts in this direction.

1.5 Additional Perspectives on Reducing Environmental Risks

In the course of its deliberations the Subcommittee evaluated several concepts that seem particularly helpful in thinking systematically about risk reduction. Because of the limited time available, some of these items were not completely considered or analyzed. Some of these issues and topics are discussed in Appendix B and include: a) the necessity of considering alternate points for intervention in the chain of events leading to an environmental risk or hazard; b) additional thoughts on the rationale and approach to pollution prevention; c) the desirability

of strategies that address multiple environmental problems; d) EPA and social spending and public opinion on environmental problems; e) the importance of local flexibility; f) the role of uncertainty in implementing risk reduction strategies; g) the importance of strategies that are integrated across media, industries and sources; and h) the counterproductiveness of regulatory complexity.

2.0 INTRODUCTION

2.1 Progress and Problems

The beginning of the 1970s saw the dawn of a new environmental awakening. In rapid fire, the Council for Environmental Quality (CEQ) and EPA were created, laws were enacted and bureaucracies were put in place. Seven major federal environmental statutes and innumerable state and local laws and ordinances have been enacted since that dramatic beginning. These laws address a broad array of environmental problems: pollution of air, water and land; waste disposal; exposure to toxic substances; harmful pesticides; contaminated drinking water; and many more.

Each of these statutes generally deals with a single environmental medium (air, water, drinking water), a single class of pollutants (pesticides, toxic substances), or a single activity (management of hazardous wastes). With few exceptions, the approach adopted to implement them has involved regulating specific sources of pollution (e.g., industrial plants, sewage treatment facilities, automobiles, hazardous waste landfills) or specific substances (e.g., lead). These conventional "command and control" regulations have been established specifying the level of emissions or discharges allowed from each source type, and/or the control technologies each is required to use. The regulatory approach for specific pollutants generally has been to ban them or to set limits on their use on a chemical-by-chemical basis.

These regulatory efforts have been direct and forceful. They have resulted in important improvements in environmental quality.

a) Air quality has been significantly improved through efforts to reduce the emissions of criteria air pollutants, such as SOx, NOx, particulate matter, lead, and CO. SOx emissions are estimated to have been reduced by over 40 percent from the early 1970's. VOC emissions, a precursor to ozone, have been reduced by an estimated 30 percent and lead emissions by more than 90 percent.

b) The discharge of effluents by industrial and municipal

sources has been sharply reduced. The great majority of major industrial direct dischargers have installed "best available" treatment technology to control their effluents and well over 80 percent of municipalities provide secondary treatment or better for their waste water. Almost 90 percent of our country's public water supply systems meet the health standards developed by EPA for pollutants in drinking water.

c) Certain toxic substances that once were used widely, such as lead, asbestos and several carcinogenic pesticides, have been nearly eliminated from commerce and human exposure has been reduced dramatically.

d) Management techniques for hazardous wastes have improved in response to regulatory programs that have imposed stringent treatment and disposal standards. And abandoned hazardous waste sites, a legacy of poor hazardous substance management practices in the past, are being identified and remediated through both federal and state programs.

To understand the progress we have made one can also look to Eastern Europe and the USSR and see what would have happened if we had not begun to enact stringent environmental protection programs years ago. These countries face environmental problems of enormous proportions, despite the fact that they do not have some of the sources of pollution that we do, such as a large number of automobiles.

Unfortunately, in spite of our environmental protection programs and the progress we have made, we still face a number of serious environmental problems. Many of these problems persist despite well-established regulatory programs to deal with them. We also face newly discovered problems that we are just beginning to address. For example:

a) By-products of our industrial society are being shown to affect the earth's climate and the stratospheric ozone layer, which protects humans and other living species from ultraviolet radiation.

b) The health standard for ozone still is exceeded in many

urban areas; over 100 million people live in counties that at least periodically violate the national ambient air quality standard for ozone. More people live in areas with elevated levels of ozone today than in 1970.

c) Non-point sources of water pollution result in silt that carries toxic materials into water bodies and harms ecologically sensitive areas.

d) Some pesticides and fertilizers used by the agricultural sector to improve crop yields still present health risks to applicators and farm workers, and contaminate both surface and ground water.

e) Over 50 percent of our original wetlands, our most biologically productive ecosystems, have been destroyed or altered permanently by development activities and agricultural practices.

f) Radon and other indoor air pollutants present a significant health threat in many residences across the country.

g) Tropical forests are being destroyed at an alarming rate and threaten biological diversity.

2.2 Challenges

Despite progress over the last twenty years, we face a number of stubborn old problems and daunting new challenges. Our conventional regulatory approaches do not appear to be sufficient to deal with many of these issues. The reasons include:

2.2.1 Increasing Importance of Diverse Sources of Pollution

The environment is affected by large scale human activities, such as energy extraction and use, transportation, food production, manufacturing, housing, and recreation. Actions by individuals regarding where to live and work, what products to buy, and what activities to pursue have collective impacts on local, regional, and global environmental systems. Most large point sources of pollution have now been addressed through conventional regulatory means, often through end-of-pipe regulations. The remaining

sources of pollution resulting from general economic activity and lifestyle decisions are numerous and now are major contributors to many environmental problems. In total they are causing unprecedented changes to the biosphere. These sources strain the limits of traditional regulatory programs. These limitations involve the large numbers of individual processes and substances that must be regulated; the burden of proof to justify proposed regulations; the information requirements, and the time and costs necessary to meet such a burden of proof, especially on a case by case basis; the time and cost involved in issuing and enforcing permits for a multiplicity of sources; the economic costs inherent in controlling small (versus large) sources; and often excessive rigidity inherent in such regulation.

2.2.2 Ineffectiveness of Traditional Approaches in Addressing Residual and Emerging Environmental Problems

Many of the emerging environmental problems also are often not very amenable to conventional regulations. Problems such as indoor air pollution, indoor radon and agricultural chemical use are very difficult to regulate. Problems such as ozone depletion and climatic change are global in scope, requiring extensive international cooperation and research. Unfortunately, the less conventional approaches that may be appropriate for these problems -- market incentives, information strategies, intergovernmental cooperation or others -- are not yet well developed. The United States has concentrated on conventional regulatory approaches to environmental protection. This has left us with little practical experience on the best methods to implement non-conventional approaches, at a time when it appears that we need to use them much more extensively.

2.2.3 Environmental Risks and EPA's Priorities

EPA's budgetary and programmatic priorities are established largely by Congress, which in turn responds to the interests expressed by the electorate. The public's attitude about an environmental problem is often heavily influenced by qualitative aspects of the risks it presents -- whether the risks are voluntary or involuntary; whether there is an identifiable "villain" responsible for the problem; whether the risks are familiar and predictable or unusual and dreaded. By contrast, scientists and

other technical experts are trained to judge the seriousness of an environmental problem in much more quantitative terms, asking, for example, about the number and severity of adverse effects likely to be caused by the problem. As a result, the environmental problems that they consider most important often do not match the priorities set by Congress. (See Appendix B.4)

2.2.4 Piecemeal Approaches to Environmental Problems

Current regulatory programs generally are organized around single media or single classes of pollutants. This disjointed approach can result in cross-media shifts of pollutants, where the means of abating emissions to one medium may simply transfer the pollutants to another medium. Perhaps more importantly, the current approach also makes it difficult to implement integrated strategies to provide comprehensive protection for certain vulnerable resources. For example, estuaries and the Great Lakes are affected by multiple sources and in ways that can not be anticipated by an approach that focuses on specific sources of pollution or on problems that arise from a single environmental medium. The current approach can also ignore some problems and activities that cause environmental problems, for example biological diversity and (until recently) indoor air pollution.

2.2.5 Increasing Costs of Environmental Regulation

While the benefits of protecting the environment are substantial and viewed by many as well worth the costs, there is no escaping the fact that the costs are also large. The direct expenditures of administration and compliance with programs to protect the environment currently exceed $100 billion per year and are growing. Most of these costs are legitimate and necessary and should be paid by those who benefit from the damage, since otherwise they are imposed on others.

But many costs are now imposed simply by imperfect approaches and regulatory strategies themselves: costs of paperwork and lawsuits, cost of treatment technologies when changes in materials or processes might achieve the same results more cheaply, costs of technologies that control pollutants for one medium by moving them to another, costs of uniform compliance rather than concentrating on the most serious sources, and costs of correcting problems defined rigidly by statutes rather than those known to be most

serious.

Because societal resources are limited and future efforts to protect human health and environmental quality should be maximized, we need to prioritize risk reduction strategies so that the most effective and cost-efficient strategies are used first. Systematically applying this principle will ensure that the most effective improvements in environmental protection are achieved, at the least cost.

2.2.6 Pressures of Population Growth and Economic Development

Population growth, industrial and agricultural development, and the wide dispersion of human settlements and activities have tended to offset the gains realized by existing regulatory programs. For example, since 1970 there has been about a 20 percent increase in the U.S. population and over a 160 percent increase in economic output. Electricity generation has increased by about 40 percent and the number of miles that people travel in vehicles has increased by about 73 percent. The reductions in emissions and improvements in environmental conditions resulting from prior regulatory programs are impressive given these increases in pollution-generating activities. Assuming, though, that our population and economy continue to grow in the future, we will need to further reduce the amount of pollution per capita or per unit of GNP just to maintain current environmental conditions.

2.2.7 Increasing Time Required for Reversing Environmental Problems

Time and reversibility have become very important factors in developing policies for environmental protection. Various pollutants cause diseases such as cancer that have latency periods lasting years or decades. Several environmental problems such as global warming and ozone depletion will require many decades or even centuries to reverse. Others, such as species depletion, are irreversible. The long time lags may result either from: a) the nature of the effect or disease, b) the lengthy period of time necessary to abate emissions or production of a nearly ubiquitous pollutant (e.g., CO_2), and/or c) the lengthy period subsequently required for the environment to recover from the stress and return to more natural conditions (which may be the result of the persistence of the pollutant and a very slow rate by which the

environment can cleanse itself of the pollutant).

Environmental problems having such characteristics require us to look ahead and anticipate what the effects of present activities will be. They also present difficult moral and strategic issues. We must ask whether it is right to leave serious environmental problems for future generations that will compromise their health and welfare. For global problems, we must decide how much of the responsibility for control will fall on the developed nations, and how much on the lesser developed world. As a strategic matter, when faced by problems that entail potentially huge but highly uncertain future risks and massive control costs, we must decide the best allocation of resources between doing research to understand the problem better and taking immediate actions, even if they later turn out to be overreactions, since delay could lead to irreversible results.

2.3 Contents of This Report

This report is organized as follows:

a) Chapter 3 describes the approach the Subcommittee followed.

c) Chapter 4 describes the Subcommittee's recommendations.

d) Appendix A includes strategy papers for each of the 13 environmental problems the Subcommittee studied. Each paper provides background on an environmental problem, and discusses the selected strategy options.

e) Appendix AA contains lists of the possible strategy options developed in Appendix A and sorted three ways; by environmental problems, by tools, and by policies.

f) Appendix B contains several thoughts and ideas that were discussed by the Subcommittee but never completely developed. They are useful for further discussion.

g) Appendix C contains descriptions of the categories of strategy options, the rating criteria and an evaluation matrix.

3.0 METHODOLOGY

3.1 Subcommittee Charge and General Approach

The goal of the Relative Risk Reduction Strategies Project of the U.S. EPA Science Advisory Board (SAB) was to advise the EPA Administrator about the best technical and scientific knowledge available on the relative risks posed by different environmental problems and the options to reduce those risks. To this end, the SAB formed the Relative Risk Reduction Strategies Committee. The charge to the Committee was to:

a) Provide a critical review of the report, Unfinished Business: A Comparative Assessment of Environmental Problems (EPA, 1987), that reflects any significant new information that bears on the evaluation of the risks associated with specific environmental problems.

b) Provide, to the extent possible, merged evaluations of cancer and non-cancer risks (i.e., Health Risks) and of ecological and welfare risks (i.e., Environmental Risks).

c) Provide optional strategies for reducing the major risks; and

d) Develop a long-term strategy for improving the methodology for assessing and ranking risks to human health and the environment and for assessing the alternative strategies that can reduce risks.

To carry out this assignment, the Committee established three subcommittees: the Human Health Subcommittee, the Environmental and Welfare Subcommittee, and the Strategic Options Subcommittee. The first two Subcommittees reviewed the EPA's Unfinished Business report. This report describes the work and conclusions of the Strategic Options Subcommittee.

The charge to the Strategic Options Subcommittee was further defined as follows:

1. Identify and analyze cost-effective and promising strategy options for reducing remaining major risks.

2. Develop and demonstrate a method of analysis useful to EPA for more in-depth studies of risk-reduction strategy options.

The objective was not to recommend a narrow set of specific measures that EPA should pursue, but rather to provide a range of the most promising types of risk reduction options that EPA should consider, and to provide a procedure for continuing work by EPA along these lines.

The twelve members of the Subcommittee had a range of technical expertise and viewpoints. The Subcommittee included engineers, natural scientists, social scientists, and former environmental program managers. Affiliations included academia, industry, environmental organizations, consulting firms and government. A list of the Subcommittee members and the SAB and EPA staff supporting them is provided at the end of this report. Representatives of the other Subcommittees and EPA program staff provided additional expertise as needed.

The Subcommittee held six public meetings in the course of performing its tasks and developing this report. The Subcommittee proceeded through four steps:

1. Selecting environmental problems for study.

2. Developing a list of potential risk reduction options for each problem.

3. Selecting the most promising options for each problem.

4. Developing cross-cutting strategies and recommendations.

The Subcommittee based its findings on the expertise and professional judgment of its members. In developing promising risk reduction options and thematic recommendations for EPA, the Subcommittee primarily considered technical factors such as cost, risk reduction, technological feasibility, and implementation requirements associated with each option.

3.2 Selecting Environmental Problems for Study

EPA's Unfinished Business report identified and assessed 31 environmental problem. In view of time and resource constraints, the Subcommittee decided that it could not address all 31 problems. Initially, 10 problems -- those posing the greatest health and ecological risks according to the original Unfinished Business rankings -- were selected for analysis. The Subcommittee then added 2 problems (hazardous wastes and municipal solid waste) to include problems from another environmental medium and because of the large amounts of resources and the public interest devoted to them. Two more problems (habitat alteration and wetlands) were added after it became apparent that the Ecological and Welfare Subcommittee was likely to rank them as particularly important. Finally, one of the problems, worker exposure to toxic chemicals, was dropped because the Subcommittee lacked proper expertise to evaluate risks and options. The resulting list of 13 problems included:

- Criteria air pollutants
- Radon
- Ozone depleting substances
- Nonpoint source discharges
- Estuaries and coastal waters
- Hazardous waste
- Pesticides
- Toxic air pollutants
- Indoor air pollution
- CO_2 and global warming
- Wetlands
- Habitat alteration
- Municipal solid waste

The 13 problems the Subcommittee analyzed are sufficiently rich and diverse to suggest some general patterns likely to emerge in an expanded analysis. The 13 problems cover all of the Agency's major media programs. Some of the 13 problems are the subject of substantial current federal programs while some represent newer problems for which major governmental programs do not yet exist. Some of the 13 problems represent sources of pollution, some represent classes of pollutants, and some represent resources that EPA wants to protect. This inconsistent scheme for defining problems is due to a decision by the authors of the Unfinished Business study to follow legislative and program definitions of environmental problems; the Subcommittee recognized this inconsistency but did not attempt to redefine the environmental problems.

3.3 Developing a List of Potential Risk Reduction Options for Each Problem

The Subcommittee sought to develop a broad list of potential risk reduction options for each of the 13 problems. An explicit attempt was made to avoid limiting the strategy options to the conventional approaches now being implemented for each problem. The Subcommittee made several assumptions:

a) Existing risk reduction measures already in place would remain so unless the Subcommittee explicitly called for their removal. The Subcommittee would focus on options to reduce residual risks in each problem area, beyond those that will be abated by current programs.

b) Strategies outside of explicit existing legislative mandates could be considered.

c) Recommended strategies should not be limited to those within EPA's scope of responsibility, although EPA's role should be emphasized.

To identify candidate risk reduction options for particular problems, the Subcommittee divided into two subgroups of 5-6 members, with about half of the problems assigned to each group. The composition of the groups was designed to take account of expertise and diversity of opinion. Each group identified a broad sweep of potential risk reduction options for their problem areas primarily by brainstorming. Experts from relevant EPA program offices, members of the Human Health and the Ecological and Welfare Subcommittees, and the staff to the Subcommittee attended the meetings and also contributed suggestions. EPA staff were encouraged to represent their personal expertise, not official Agency positions.

To aid in the process of identifying risk reduction options, the Subcommittee developed a list of six classes of measures: scientific and technical, provision of information, market incentives, conventional regulations, increased enforcement, and cooperation with other agencies and nations. The major classes and related types of strategies are shown in Appendix C.1. As specific strategies were identified, they were grouped according to these generic classes. The resulting list of grouped strategy

options is shown for each problem area following the discussions of the problem areas in the appendices to this report.

3.4 Selecting the Most Promising Options for Each Problem

In order to evaluate risk reduction options for the selected problem areas, the Subcommittee undertook a process of establishing evaluation criteria, evaluating each strategy with respect to the criteria, and selecting the strategies with the highest ratings. Nine criteria for judging the suitability of a risk reduction strategy were formulated. The criteria focus on such attributes as the risk reduction, cost, cost-effectiveness, and dependability of the strategy options. The criteria used in rating the options are described in Appendix C.2.

Initially a simple scoring system for each criterion was also developed, and the Subcommittee began to apply it to the candidate options. To help this process, the Subcommittee developed matrices for the 13 problem areas, listing the candidate strategies for each and providing space for scoring each strategy with respect to each criterion. A blank matrix is provided as Appendix C.3. Several Subcommittee members completed the scoring matrices based upon their own judgments. However, it became apparent that the Subcommittee as a whole would not have sufficient time to reach consensus on each of 9 criteria scores for several hundred strategy options. The Subcommittee abandoned the explicit scoring approach, and decided to select strategies based on group discussion and consensus, considering the factors outlined in the criteria. The Subcommittee encourages the Agency to consider the scoring approach more fully, recognizing that while scoring systems are a good way to structure and encourage discussions, experience shows that they can rarely be used for decisionmaking in a simple, mechanistic way.

The process of selecting options was time consuming and typically involved lengthy discussion and debate. Technical expertise was sought from EPA, the other SAB subcommittees, and outside sources. Experts on each of the 13 problem areas attended the Subcommittee meetings, offering opinions on the risks posed by the problems and options that might help to reduce the risks, and providing reactions to tentative options generated by the Subcommittee. The Subcommittee's processes of identifying candidate risk reduction strategies and selecting the most promising ones became iterative -- new strategy suggestions were

added throughout the process, and many of the more promising options were developed by combining elements of several individual candidate strategies.

After two meetings conducted largely in the two subgroups, each dealing with half of the environmental problems, the Subcommittee reconvened in plenary session. The subgroups' strategy options were presented to the overall Subcommittee for discussion and debate. Following decision by the Subcommittee on a set of preferred strategies for the problem areas, each problem area was assigned to a Subcommittee member who was responsible for drafting a strategy paper. These papers addressed the risks posed by the problem, the policy background, and the strategy options for the problem. The draft papers were debated and revised in subsequent Subcommittee meetings. The final strategy papers comprise Appendix A in this report.

3.5 Developing Cross-Cutting Strategies and Recommendations

Many of the options selected for one problem area were similar or even identical to those selected for other problem areas. The Subcommittee performed a cross-problem analysis to identify those options that achieved risk reduction objectives in a number of different problem areas. In its final choice of options, the Subcommittee gave a clear preference to those that would realize benefits across several problem areas. Some broad strategies, such as energy conservation and pollution prevention, hold substantial promise in this regard.

The Subcommittee also examined the generic approaches that frequently appeared to have promise among the individual strategies recommended for the problem areas. This investigation prompted several of the Subcommittee's recommendations regarding EPA's approach to risk reduction -- supporting greater use of information strategies and market incentives, for example.

Finally, the Subcommittee looked briefly at the relationship between risk-based priorities and public and private expenditures to assess environmental risks. This short study provided additional support for some of the Subcommittee's broader recommendations to EPA. For further discussion see Appendix B to this report, "Perspectives on Reducing Environmental Risks."

One last word of caution is necessary in interpreting the strategy options. These strategy options should not be construed as recommendations, and they do not represent the primary product of the Subcommittee's work. The strategy options represent reasonable approaches to each environmental problem, but they have not been analyzed in any formal way sufficient to warrant asserting that they are the best approaches to each problem. Nor is the list of strategy options necessarily comprehensive; most likely there are other strategy options that would also offer effective responses to the environmental problems that we have examined.

3.6 Commentary

Beyond the results of this exercise for the 13 selected problems, the Subcommittee believes that a methodology like the one used in this effort has strong potential, if further developed and refined, for assisting EPA in identifying preferred risk reduction strategies. In particular, it is important to consider the approach of looking at environmental problems, at sectors and also at the full range of possible tools.

The Subcommittee recognizes that this methodology is a first effort and that many improvements are possible and should be considered. But even more important than the specific methodology is that EPA use an approach that is systematic, aims at comprehensiveness, and ensures that Agency personnel take a broad and innovative perspective. Because Agency staff may be constrained by programmatic responsibilities, the Subcommittee recommends the participation of outside groups also. Outside groups are more likely to generate innovative approaches. Agency staff are better able to analyze their administrative feasibility. One option is to replicate the exercise conducted here. Another might use some mix of Agency officials and outside experts. The assessment of risk reduction options should also be repeated periodically. The advantages of such a systematic, broad-based approach are:

a) It allows a large number of environmental problems and potential risk reduction strategies to be examined in a relatively short time.

b) It forces an overview of a large menu of problems and potential solutions.

c) It releases the analyst from the limits of specific legislative or regulatory mandates so that strategic thinking is more possible.

d) It requires cross-program analyses that highlight multiple benefits to several problems that accrue from a particular risk reduction intervention.

e) It gives explicit attention to multiple desirable characteristics of a risk reduction approach.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

The Subcommittee's analysis of strategies to address the sample of 13 key environmental problems suggests that fundamental changes are necessary to achieve further progress in environmental protection. End-of-pipe regulatory requirements have served us well in the past in dealing with gross air and water pollution control and in coping with other environmental problems. After using such techniques over the past 20 years, it is not surprising that the residual problems we face are less amenable to traditional techniques. Some problems, such as widespread ground level ozone, are the product of continuing economic growth offsetting much of the gain from regulatory measures. Non-point sources of water pollution have never been amenable to direct regulatory measures for both technical and political reasons. Some newer problems, such as indoor air pollution and radon, are similarly not amenable to command-and-control approaches. The great majority of the Subcommittee's promising strategy options do not rely on conventional regulatory requirements such as end-of-pipe effluent standards. Instead, the most promising direction for the future is, whenever possible, to prevent pollution before it is ever created.

Although criticisms of conventional regulatory control systems are often heard, this does not mean that our past regulatory programs were or always are inappropriate, nor that additional command-and-control regulation cannot be beneficial. Because of past regulatory programs, our air and water are cleaner, hazardous wastes are better managed, exposures to many of the most toxic substances are reduced, and industry and other sectors of society have become more sensitive to environmental concerns. There will be, however, significant limitations in achieving risk reduction through a system based on end-of-pipe controls in the future.

The broad recommendations below are designed to attack these problems strategically, and overcome many of the current obstacles to success. While most of the recommendations are oriented to the Federal government, many of them are also applicable to State and local governments.

The Subcommittee's eight major recommendations are as follows:

1. **EPA should establish priorities based on the potential for risk reduction.**

2. **Pollution prevention should be the most important approach for reducing environmental risks over the long term.**

3. **In order to reduce risk and prevent pollution in a significant way, EPA must substantially broaden its kit of environmental protection tools, especially to emphasize economic incentives and information transfer.**

4. **Environmental protection must be integrated into other policy areas, in as fundamental a manner as are economic concerns.**

5. **In order to integrate environmental protection into other governmental policies, a special mechanism should be created in the Executive Branch.**

6. **EPA should continue to perform analyses similar to the present Relative Risk Reduction Strategies Project and integrate the results into the Agency's strategic planning processes.**

7. **EPA's annual budgets should more directly reflect risk-based priorities.**

8. **The Agency should develop an enhanced environmental education and training program for both professionals and the general public.**

These major recommendations are described further in the pages that follow. The recommendations derive primarily from the Subcommittee's review and assessment of the numerous strategy options developed for the 13 environmental problems. The Subcommittee has not performed sufficient analysis to recommend adoption of any one of the specific strategy options for any of the 13 problems. As mentioned previously, the strategy options were generated through an interactive process relying on the

collective judgement and experience of Subcommittee members. In our view, the strategy options we chose represent reasonable approaches for reducing risks in each problem area, but nothing more. The Subcommittee does believe they merit attention by the Agency.

These recommendations reflect broad crosscutting themes that draw from the more specific strategy options. In the discussion of each recommendation, examples of strategy options that give rise to the recommendation are cited and referenced to a section of the appendix.

4.2 Risk Reduction

RECOMMENDATION #1:

EPA should establish priorities based on the potential for risk reduction.

DISCUSSION:

Over the past 20 years U.S. environmental policy has developed in a piecemeal, ad hoc fashion. As the nation recognized different environmental problems, such as deteriorating urban air quality and the "death" of lakes and stream segments, Congress acted to solve them by passing different pieces of environmental legislation -- the Clean Air Act, the Federal Water Pollution Control Act, etc. Because these laws were passed at different times and for different purposes, little attempt was make to coordinate them. Nor was any effort make to compare the relative seriousness of different environmental problems in order to make judgments about the relative urgency of different protection efforts.

Seen in its historical context, the ad hoc development of our national environmental policy is understandable. Yet twenty years of experience developing and implementing environmental policy has taught us that not all environmental problems are equally serious, and not all protection efforts are equally urgent. We can not do everything at once. We must set environmental priorities.

Over the past several years EPA has improved its ability to characterize environmental risks, and in Unfinished Business it

has begun to compare the relative seriousness of the risks posed by different environmental problems. But EPA and the country at large must go further. We should set priorities for environmental protection based on an explicit comparison of the relative risk posed by different environmental problems and, more specifically, the opportunities for cost-effective risk reduction. And we should act on those priorities.

In practice, of course, EPA's activities are defined by the laws that the agency is required to administer. As an agency in a democratic government, EPA also has a responsibility to respond when the public raises concerns about an environmental problem, no matter how limited the risk may seem to be. However, to the extent that EPA has discretion to emphasize one environmental protection program over another, it should emphasize the program that reduces the most environmental risk at the lowest overall cost to society. The Congress should also be encouraged to observe this principle in writing and revising legislation.

The recommendations that follow in this report spell out some more specific measures that EPA, Congress and others should take to make this principle a reality.

4.3 Pollution Prevention

RECOMMENDATION #2:

Pollution prevention should consistently be the most important approach for reducing environmental risks over the long term.

DISCUSSION:

We are not the first group to suggest that EPA place a much greater emphasis on pollution prevention as the preferred way to address environmental risks. A fundamental restructuring of the way the Agency approaches risk reduction is in order; the Agency's primary focus should be to prevent the creation of risks, as opposed to trying to control such risks once created. This is so for a series of reasons:

1. For some environmental problems, such as stratospheric ozone depletion and global climate change, pollution prevention is the only solution. We must use substances which will not destroy the ozone layer and also use energy sources that minimize CO_2 emissions.

2. Pollution prevention is oftentimes the most effective solution. For instance, in the case of lead, asbestos, PCBs and certain pesticides, the most effective solution has been to ban their use.

3. There can be a tremendous cost benefit for pollution prevention in terms of avoiding costs of control, cleanup and liability. Industrial efficiency and productivity can also increase.

4. Pollution prevention is the key to sustainable development. In many areas we are approaching or even exceeding the capacity of the environment to absorb pollutants. It is clear that economic and industrial strategies for the future that minimize the production of pollution and the consumption of resources are more likely to be sustainable economic and industrial strategies.

5. Pollution prevention often prevents the solution to one environmental problem from re-emerging as another kind of environmental problem in another environmental medium, sometime in the future or in another place.

6. Pollution prevention can help improve international relations in two ways. First, it can help developing countries leapfrog the environmental problems that we had in the U.S. by moving directly to low polluting, low waste technology. Second, because of the worldwide impact of the U.S. production of pollution and consumption of resources, our moving towards pollution prevention will be practicing what we preach: exerting leadership and avoiding anti-U.S. sentiment because of the constraints that the rest of the world will have to absorb in order to deal with global environmental problems.

7. Pollution prevention protects the natural resources on the planet for future generations by not leaving excessive levels of wastes and residues and pollution and by not depleting resources.

Our review indicates, however, that a fundamental problem hindering progress on pollution prevention has been confusion over precisely what pollution prevention is and how it is different from

pollution control. We define pollution prevention to be changes in raw materials, products or technologies of production which reduce the use of hazardous materials, energy, water, or other resources and/or the creation of pollutants or destructive results, without creating new risks of concern. Energy conservation, for example, represents a prime form of pollution prevention, obviating environmental damage from extraction, transport, processing and combustion of fuels.

Technologies of production are the fundamental means used by people to accomplish the core productive activities of life, from mining to manufacturing to farming to transportation. Changes in the configuration of such technologies to cut hazardous materials use or the creation of pollution would constitute pollution prevention; the addition of supplementary technologies to control hazardous materials already used or pollution already created constitutes pollution control. Considering just one example, substituting water for chloroflurocarbon-113 as the solvent used at a circuit board manufacturing facility is pollution prevention; adding recycling equipment to the facility to capture and recycle CFC-113 and stop its release to the atmosphere is pollution control. Pollution prevention can also include changing activities and the location of these activities so as not to harm sensitive ecosystems; avoiding development near wetlands is an example.

From our study of a limited number of problems we have identified a large number of strategy options which are pollution prevention approaches. Upon reviewing these options, several cross-cutting themes emerged:

1. EPA's pollution prevention programs should be directed broadly to address products and many productive sectors, not just industrial production processes. EPA should promote prevention in all sectors, from manufacturing to agriculture to construction. Energy conservation is a key part of any pollution prevention strategy.

2. EPA and other Federal agencies should go beyond problem-by-problem pollution prevention to focus on comprehensive multiproblem solutions, such as toxics use reduction and energy efficiency and conservation, and on altering specific technologies of production or products which contribute to multiple problems.

3. Federal agencies should identify and eliminate standards, subsidies, activities or approvals that promote polluting or damaging activities or technologies, and instead promote non-polluting activities, technologies, and products, through incentives, research, technical assistance, procurement and other means.

4. Since pollution prevention concepts are relatively new to many people, EPA should actively work with representatives of many interests to promote better understanding of pollution prevention. EPA should pursue this among many types of people, from EPA personnel to academics to corporate officials responsible for the design, selection and purchase of raw materials, production processes, and products. Collaborative research, education, and technology development and transfer efforts with industry, state agencies, organized labor and public interest groups should be considered. EPA should seek to make prevention the responsibility of every agency and federal employee, not just that of a single office in EPA. If pollution prevention goals were integrated into all policies, pollution prevention could play a large role in restoring and preserving the quality of the environment.

5. Community right-to-know and other related programs should be given special attention and possibly expanded. These possibilities include having more producers and users of certain toxic chemicals and pesticides report publicly on such production and use. These producers and users should be further encouraged to conduct audits, prepare plans and set goals for reducing their production and use. The aim is to ensure that producers and users identify the pollution implications of their decisions and consider alternatives that would generate less pollution.

6. In the long run, economic incentives and disincentives need to promote pollution prevention. Energy policy should encourage conservation. Tax policy should encourage pollution prevention-oriented recycling and reuse.

The section on pollution prevention in Appendix B, "Perspectives on Reducing Environmental Risks," provides further thoughts on this subject.

EXAMPLE STRATEGIES:

POLLUTION PREVENTION - PP

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.2.4 Reduce use of solvents in consumer products. PP, INFO, REGS

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs, halons and other ozone depleters. PP, FOR

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, MI, INFO, REGS

(See Appendix AA for complete listing)

(The codes preceding each example strategy refer to the part of Appendix A where the example strategy is discussed in more detail. The codes following each example strategy indicate the categories into which it falls. See the first page of Appendix A for a more complete explanation of the coding of these example strategies).

4.4 A Broader Kit of Tools

RECOMMENDATION #3:

In order to reduce risk and prevent pollution in a significant way, EPA must substantially broaden its kit of environmental protection tools, especially to emphasize economic incentives and information transfer.

DISCUSSION:

EPA has made a considerable investment in a limited set of conventional regulatory tools: end-of-pipe effluent limitations,

design standards, product specifications, and use restrictions. Most EPA program staff are dedicated to this set of regulatory approaches and their implementation through permits, compliance monitoring and enforcement. A large part of the research budget is devoted to supporting this effort. Even the Office of Policy, Planning and Evaluation, the least constrained of EPA's offices, makes only a modest investment in nontraditional environmental policy measures.

The reason for this emphasis does not lie with EPA alone. EPA looks to conventional regulatory methods for environmental protection because enabling legislation and public expectations push the Agency strongly in that direction.

The Subcommittee feels strongly that the most promising strategies for risk reduction encompass a wide range of policy approaches. As described in the previous chapter, we identified six broad policy approaches which EPA and other Federal agencies could employ to change the behavior of individuals, firms, and other institutions to reduce risk (not in order of priority):

Scientific and technical measures;
Provision of information;
Market incentives;
Conventional regulatory standards;
Enhanced enforcement of regulations; and
Cooperation with other agencies and nations.

These approaches are not meant to be mutually exclusive, as many policy measures combine elements of several approaches. It is also sometimes difficult to categorize specific strategies as falling within a single approach. Nevertheless, we believe the six approaches delineate the basic strategy elements available to EPA for environmental protection.

In order to give fair consideration to the non-traditional approaches, EPA needs to increase dramatically the resources and commitment devoted to them. This was also the principal recommendation of a recent report of the National Research Council concerning waste reduction research needs (NRC, 1990). First, the existing applications of innovative alternatives to traditional controls need to be evaluated. Experiments in providing information, such as Section 313 of SARA and Proposition 65 in

California, need to be evaluated to determine what types of behavior were affected. Economic incentive-based alternatives or supplements to regulations should be developed, analyzed, and wherever possible, pilot-tested. (For years, California has led in regulatory initiatives and recently in an information initiative. There is no reason States could not lead in non-conventional techniques, possibly induced by availability of Federal assistance.) To conduct these functions, EPA needs to allocate resources to non-conventional approaches, evaluate their effectiveness, and give these types of measures serious consideration in agency decisionmaking.

EPA will also need to overcome its bias against new approaches. Today, when new approaches are examined, they tend to be held to a higher standard than existing approaches. It is easy to identify a long list of potential problems with implementation of new approaches, and thus the approaches are often rejected at an early stage. There may be an equally long list of potential problems with an existing approach. Some of these problems are accepted unquestioningly -- expected difficulties in implementing a command-and-control regulatory scheme are assumed to necessitate massive resources for program implementation (permitting, compliance monitoring, enforcement, state oversight, etc.) rather than casting doubt on whether the scheme is the best approach in the first place. Other potential problems with existing approaches never come to light because thorough evaluations of the effectiveness and cost of existing programs are not routinely performed once the regulations are promulgated. In this connection, EPA might look closely at the strategy options discussed below and in Appendix A.

4.4.1 Scientific and Technical Measures

Two major sets of these measures are: (1) research and development activities to improve understanding of problems and point to promising solutions; and (2) innovations in pollution-prevention approaches and pollution control technology. In some cases, other approaches -- such as market incentives -- will lead to such research and development and/or product innovation (and diffusion). In other cases, we focus on these scientific and technical measures as constituting a "general approach" themselves.

Beyond such particular scientific and technical strategies, EPA needs both:

a) A substantial increase in its budget and policy commitment for research. The nation invests heavily in research on military defense, industrial competitiveness, quality health care and management of the economy, and should also do so to protect the environment. The SAB's Future Risk report suggested a doubling of EPA's research budget in five years.

b) An aggressive broadening of its risk reduction research program. This should include health and ecological effects, environmental transport and fate studies, engineering technologies and regulatory support as at present, as well as information on the relative risks of various hazards; on the design options for strategies to reduce them, including economic, social and communication issues; and on the effectiveness and side effects of such strategies once they are tried. Because an important goal is to change the behavior of individuals and institutions, it is essential that EPA increase its research in the social sciences.

Many of these general points were also made in the SAB's Future Risk report.

EXAMPLE STRATEGIES:

SCIENTIFIC AND TECHNICAL MEASURES - S&T

S.1.6 Further investigate the relative roles of VOCs and NOx in ozone formation, S&T

S.4.4 Develop better instruments to diagnose sick buildings. S&T

S.6.1 Understand better the potential for global warming and its impacts. S&T

S.6.2 Increase research on ways of preventing and adapting to global warming. S&T

S.9.3 Develop ecologically protective and cost-effective technologies to manage contaminated sediments in estuaries. S&T

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.4.2 Provision of Information

In a number of cases, risk reduction can be promoted by providing information to producers, consumers, or both. In some situations, even if individuals and firms have the "right incentives" they may fail to reduce risk appropriately. This general category of information-provision strategies encompasses three quite distinct approaches. First, there is the provision of more information about risks to consumers of various goods and services. Laws and regulations which compel firms to produce information for the public can provide powerful incentives for firms to reduce pollution. "Green labeling" and consumer guides to environmentally friendly products are examples of initiatives that are currently being undertaken in various areas. The pressure of information in the marketplace was clearly demonstrated when the U.S. banned CFC's in aerosols in 1976 with an effective date of 1978; in short order virtually all aerosols contained no CFC's.

Second, technical assistance on cost-effective means of preventing or controlling pollution may be provided to firms or other polluters that lack adequate information. Small and medium sized firms can particularly benefit from this assistance. Third, EPA might continue to assist or encourage environmental self-auditing, whereby firms periodically evaluate their performance in order to facilitate management control of environmental practices and assess compliance with company policies and regulatory requirements.

EXAMPLE STRATEGIES:

PROVISION OF INFORMATION - INFO

S.3.2 Improve techniques of communicating radon risks so public can make informed decisions. S&T, INFO

S.4.1 Provide state and local governments with technical information to help them address indoor air pollution. S&T, INFO

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourage industrial audits of these facilities. PP, INFO, AP

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.4.3 Market Incentives

A key to reducing environmental risks is to ensure that consumers and producers face the full costs of their decisions -- not just their direct costs, but the full social costs and consequences of their actions. Economic incentive systems provide various ways to do this. They may also reduce the aggregate social cost of achieving target levels of pollution abatement. Most economic incentives can be viewed as falling within one of five major categories: (1) pollution charges, (2) marketable permits, (3) deposit-refund systems, (4) market barrier reductions, including provision or elimination of government subsidies, and (5) revision of legal standards defining liability for damages from pollution. These categories are closely related and the boundaries between them are often not distinct. Many market incentives would not be fully under the control of EPA, and are also discussed in the next section of this chapter on cooperation with other agencies.

1. Charge systems impose a fee or tax on pollution (or, usually less desirably, on pollution-generating activities). When there is a charge for polluting, it pays firms to reduce pollution, with those that can abate pollution at low cost reducing or controlling proportionately more and those facing higher costs reducing or controlling proportionately less. Thus, the total costs of pollution control are minimized, as compared with other allocations of the pollution control burden across firms. Under this and other economic incentive approaches, additional pollution control efforts are in the financial interest of firms, as long as

the costs of controlling pollution are lower than the charge imposed on the pollution. Hence, these mechanisms provide ongoing incentives for firms to develop and adopt newer, better and less expensive pollution control technologies. One example of a pollution charge would be a carbon tax on fossil fuels to help control global climate change. Other types of taxes and fees also can be used to promote environmental protection in a flexible manner without direct government regulations.

2. Under a marketable or tradeable permit system, the allowable overall level of pollution is established by regulation and then allotted in the form of permits among firms. Firms that keep emission levels below their allotted level may sell or lease their surplus permits to other firms or use them to offset excess emissions in other parts of their own facilities. As with a charge system, the societal cost of control is pushed toward a minimum level for any given level of total pollution control. The use of marketable permit systems for VOCs in nonattainment areas and for SO_2 emissions by electric utilities could lead to savings relative to traditional regulatory methods, both because their inherent flexibility takes advantage of wide differences in control costs across sources and because they allow individual firms to decide where and how to make desired reductions. These systems also provide strong incentives for innovation, compared to technology-prescribing regulations. Marketable permit systems with regulatory ceilings on emissions or discharges can also be used to avoid a problem posed by charge systems, namely that one can not know in advance what level of cleanup will result from any given charge.

3. Deposit-refund systems represent a third type of incentive-based instrument. Under this approach, surcharges are paid when potentially polluting products are purchased. When the product's consumers/users return the product, their deposit is refunded. One advantage of the deposit-refund system is that it reduces the incentive for illegal dumping which exists under a waste-end tax or fee. In the case of hazardous waste it should be noted that criminal penalties and the manifest system already discourage illegal dumping. Also, to the extent the refund causes the item to be collected and brought to a location where it is recycled or reused, the system reduces the need for waste disposal capacity. This approach has already been used successfully in a number of states in so-called "bottle bills" to reduce littering with beverage containers, and it has been used in West Germany for

hazardous waste disposal. Deposit-refund systems may also be effective for other items such as lead-acid batteries, crank-case oil and motor vehicle tires.

4. In some cases, substantial gains can be made in environmental protection simply by removing existing, government-mandated barriers to market activity. For example, if electric utilities with insufficient generating capacity were provided an incentive to choose the least costly alternative among a full range of options for increasing supplies and/or reducing demands, more efficient energy generation and consumption would result.

Another type of market incentive involves situations in which existing government subsidies promote inefficient and environmentally unsound development. For example, a subsidy which is both economically inefficient and environmentally disruptive is that associated with certain water resource projects, which provide an (unintentional) incentive for the drainage and clearing of wetland areas. Such subsidies could be reduced or eliminated.

Alternatively, positive subsidies or incentives can be created to encourage environmentally beneficial activities, such as preferential Federal government acquisition of clean-fueled cars or recycled paper products. The municipal sewage treatment program is an example of a subsidy that has been used for environmental protection.

5. Finally, revision of the legal standards prescribing liability for damages from polluting activities can provide a very powerful incentive to modify behavior. The strict, joint liability standard under CERCLA has had a major effect in inducing solid and hazardous waste generators, transporters and disposers to pay much closer attention to their operations. In theory, numerous attributes of liability standards could be adjusted in order to support environmental aims: the burden of proof, limitations on damage awards, standing to sue, allocations of responsibility among contributing parties, etc.. Liability standards could be established or modified in several areas, including application of pesticides, worker exposure to toxic chemicals, and production and sale of products with toxic components. In practice, the Subcommittee recommends substantial caution in using this very powerful tool. The eventual effects of revised standards of liability are very difficult to predict accurately. Using

litigation as a tool to achieve environmental goals often involves very large, unproductive transaction costs, and the winning and losing parties often get very different treatment than they would have if the case had not been settled in court.

Although economic incentive-based approaches promise reduced costs and greater efficiency in addressing numerous environmental problems, the Subcommittee does not endorse them for all situations as the preferable alternatives. The record for market incentives is mixed, and they need careful examination when being considered for any application, just as conventional regulatory approaches do. One needs to be certain that an incentive will actually lead to a reduction in pollution, and will not simply make it possible for a source to pay for the opportunity to pollute. One also needs to pick the right type of incentive. Surveying the various types of incentives, charges often provide little certainty, and marketable permits are only useful when the subject pollutants cause similar damages over a large area. Reducing perverse subsidies, on the other hand, should usually be appropriate.

EXAMPLE STRATEGIES:

MARKET INCENTIVES - MI

S.1.1 Use marketable permits to lower costs and spur innovation in reducing acid rain. MI, EP

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.12.4 Create deposit/refund systems for tires, batteries, car hulks, used oil and packaging containers. MI

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.4.4 Conventional Regulations

Although the subcommittee generally argues for greater consideration of non-traditional environmental protection tools, conventional regulatory approaches hold out substantial promise of achieving further reductions in environmental risk for many problems. Conventional regulatory approaches cover a broad range: end-of-pipe standards (performance standards), design standards, use restrictions and product specifications. Some of these types of regulation contribute directly to pollution prevention, rather than simply controlling emissions. Most existing environmental laws and regulations utilize one form or another of such conventional policy instruments. This includes technology-based standards, risk-based standards, uniform emission standards, uniform ambient standards, location-based standards, product bans, and numerous other requirements.

EXAMPLE STRATEGIES:

CONVENTIONAL REGULATIONS - REGS

S.3.3 Require radon inspections for schools and certain other buildings. REGS, TH

S.3.4 Establish airflow and radon protection standards for new buildings. REGS, TH

S.11.4 Simplify RCRA regulations and provide a more flexible array of hazardous waste management standards. REGS

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.4.5 Enforcement

Virtually no set of strategies for environmental risk reduction will be effective without a commitment on the part of the Federal and state governments to enforcement. In a number of cases, substantial gains can be made in environmental risk reduction by more vigorously enforcing existing statutes and regulations.

If firms perceive that the expected value of penalties for exceeding permitted emissions under either a uniform emission standard or a tradeable permit program is less than the marginal cost of pollution control, they may decide that it is in their interest to exceed permitted levels (all other factors held constant). The expected value of penalties is affected not only by the level of the penalties but also by the likelihood that they will be levied. To the extent that penalties or other sanctions are not enforced, such laws and regulations will be ineffective. In many cases other factors like ethics and the importance of public opinion mitigate against strict economic compensation.

While the subcommittee believes that enforcement-based approaches can provide risk reduction opportunities for many of the EPA problem areas, it did not have enough time to develop specific concepts. Two generic concepts were raised. First, to be effective, an enforcement program must provide a deterrent effect for the entire regulated community. In many program areas today, agency/state enforcement efforts target a narrow range of the community. Non-targeted groups have no real likelihood of enforcement scrutiny. For those groups that are not targeted, statistical sampling should be a part of the enforcement strategy so that the threat of an inspection is always present.

Furthermore, it should be recognized that effective enforcement toward one firm has the added advantage of providing a credible threat to other firms, thus encouraging compliance more generally. This deterrent effect is credible and effective only if it hits close to home -- if a firm or individual perceives that other firms or individuals very like themselves are being enforced against.

Second, the current approaches to enforcement are very resource intensive for the Agency. It seems that other approaches could be used which would more fully utilize the private sector

(either the regulated universe itself, independent inspectors, the insurance industry, the financial rating authorities, or informed citizens). If well crafted, these types of approaches could provide proper incentives for companies to perform rigorous self-audits.

EXAMPLE STRATEGIES:

ENFORCEMENT - ENF

S.11.5 Identify contaminated waste sites posing immediate threats and quickly bring them under control. REGS, ENF

S.11.7 Encourage site cleanup by third parties through enforcement and use of reasonable settlement procedures. REGS, ENF

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.4.6 Cooperation with Other Agencies and Nations

Due to EPA's limited jurisdiction, cooperation with other agencies and nations often presents the best opportunities to reduce environmental risks. Domestically, there are many programs and policies administered by other Federal, state and local departments and agencies that can contribute to environmental risk reduction. There is also a group of environmental problems that are fundamentally transboundary or global in nature, and require a good deal of interaction with other countries. Global warming and ozone depletion are prime examples. The Subcommittee found the issue of cooperation so important that they have made them the subject of the next two sections and recommendations.

4.5 Integrating Environmental Protection With Other Policy Areas

RECOMMENDATION #4:

Environmental protection must be integrated into other policy areas, in as fundamental a manner as are economic concerns.

DISCUSSION:

Many types of government policies significantly affect the environmental problems that EPA needs to address. Thus it is critical for EPA to work with the departments and agencies that are responsible for these policies to develop clear and measurable objectives for environmental performance and to create the proper incentives for sustainable development. Environmental quality must be integral to decisionmaking in these agencies, not just a constraint at the end of the policymaking process. It is not sufficient, for example, for energy or agricultural policies to be developed and then examined for potential negative environmental impacts. Instead, energy and agricultural policies should be designed from the start to contribute positively toward environmental goals.

In virtually every case, changing U.S. policies in sectors not traditionally linked with environmental protection can provide major cost-effective environmental benefits. These benefits can equal or exceed those achieved to date through other means. Not taking environment into account will inevitably lead to confrontation as well as missed opportunities.

These policy areas include, but are not limited to energy, agriculture, housing and commercial development, tax, transportation, natural resources, and foreign policy. In many cases, the generic tools that these agencies have, such as economic incentives, have been discussed in the previous section.

To make this integration real, EPA must devote people and money to the effort. EPA presently spends a great deal of its budget to develop and review regulations, but it spends comparatively little to work with other agencies.

4.5.1 Energy Policy

In addition to the obvious benefits to society, the production and use of energy is responsible for a great deal of damage to the environment. This damage can result from a limited consideration of environmental impacts in making energy decisions. Some examples of environmental effects of energy production are:

a. Combustion of energy in the industrial, transportation, commercial and residential sectors results in the bulk of the pollutants involved in urban smog and acid precipitation.

b. Energy activities are responsible for half of all the greenhouse gases produced by human activity.

c. Coal mining operations result in widespread destruction of surface areas and acid runoff into local streams, while coal burning results in massive amounts of ash, SOx, NOx, particulates and toxic air pollutants.

d. Oil exploration and production often cause environmental damage.

e. Cooling systems, scrubbers and other environmental control devices produce significant amounts of solid waste and consume large amounts of water and power.

f. Accidental spills while transporting oil have damaged inland and coastal waters. Leaking petroleum storage tanks are one of the primary causes of ground-water contamination.

g. Nuclear wastes present unique problems.

h. Tightening older buildings to conserve energy can increase health risks from indoor air pollution.

Energy policy can work in harmony with environmental goals. Energy policy has been driven largely by security concerns and fuel availability. In the future, the choice of which mix of energy options to pursue will need to be driven just as heavily by environmental concerns. Energy conservation measures, if given high priority, will improve the balance of payments, lower world

oil prices and reduce security threats, in addition to protecting the environment. Conservation must be driven by U.S. policy choices based on full cost accounting of environmental concerns, as well as security and other objectives.

While scrubbers and tailpipe controls can reduce some types of emissions substantially, the best way to control emissions is often to invest in conservation approaches that produce less pollutants in the first place. New buildings and factories are using new technologies that require a small fraction of the energy and resources of their predecessors. A major focus of energy policy must be to accelerate adoption of efficient designs and production practices. This will require changes in a number of current regulatory programs.

Promoting energy efficiency requires research investment in a broad range of technologies for buildings, industry, and transportation. For instance, without care in design, improvements in the energy efficiency of buildings can lead to deteriorating indoor air quality. We also need to promote energy conservation through institutional changes, such as incentives for utilities to encourage conservation. More general market incentives and regulatory changes that promote greater energy efficiency are also important.

A second major focus must be to develop new energy supplies that do not damage the environment. This will require a deliberate and effective national strategy, to shift both national and world reliance from high-polluting and depletable fossil fuels, such as coal and petroleum, to more benign alternatives. It will also require serious comparative research, as quickly as possible, on the environmental impacts and energy efficiencies of alternative sources of energy -- for instance renewable fuels (not all of which are environmentally benign themselves), hydrogen, "passively safe" nuclear technologies, solar energy and perhaps others -- and on the relative effectiveness of alternative instruments for implementing such a strategy.

EXAMPLE STRATEGIES:

ENERGY POLICY - EP

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.5.2 Agriculture Policy

Over the years, agriculture policies have been extremely successful in boosting U.S. output of food and fiber. Many agricultural programs have also improved the quality of the environment.

Unfortunately, however, agriculture is still a major contributor to environmental problems across the U.S. Use of pesticides in agricultural production and food processing amounts to 75 - 80% of total pesticide use, causing substantial damage to human health and natural ecosystems. Agriculture accounts for roughly 50 - 70% of the known instances of impaired surface waters, primarily as a result of nonpoint source runoff. Agricultural chemicals are one of the leading sources of ground-water contamination. Agricultural drainage is responsible for about 90% of the wetlands lost in the past several decades. Methane from rice production and farm animals is a significant source of greenhouse gases.

Federal farm programs have a considerable influence on what farmers grow and how they grow it. In recent years, annual Federal farm payments of $10-26 billion have constituted up to 50% of net

farm income. More than 2/3 of U.S. cropland is enrolled in Federal commodity programs. Agricultural extension agents in nearly 3000 counties provide much of the education and advice that farmers receive on technical issues.

These Federal farm programs are not generally designed to abate environmental problems. To the contrary, some unintentionally exacerbate them. The agricultural subsidy programs often provide incentives for farmers to farm intensively, using great quantities of pesticides and fertilizers to maximize per acre yields. Farmers seeking to use alternative, more environmentally benign practices -- crop rotation, covering idled acreage with forage crops, reduction of chemical use to economic minimums -- may sometimes receive reduced federal program benefits.

Federal agriculture policies and programs should be revised not only to reduce or eliminate disincentives to environmentally benign farming, but to directly support good environmental practices. The Conservation Title of the 1985 farm bill provided a start in this direction, as does the 1990 farm bill and several recent proposals among the President's water quality initiatives. Considering, however, the quality of the Agriculture Department's research, development, and technology transfer programs and the impact that its subsidy programs have on farming practices, the Department could do much more to promote environmental improvements.

Agricultural policy can most effectively promote environmental improvement in two areas. First, a major goal of agricultural policy could become a serious commitment to reduce soil erosion and runoff of agricultural chemicals into surface waters. Agricultural policies could induce much greater use of "best management practices" such as planting of buffer strips to reduce nonpoint sources of pollution. Second, agricultural policy could be directed at low-input sustainable agriculture through promoting integrated pest management and reducing use of agricultural chemicals.

Many of the steps toward an environmentally positive farm policy rely on the traditional approach of financial and technical assistance offered to farmers on a voluntary basis. Farmers have been free to determine whether to accept these program benefits or not. Integrating environmental concerns with Federal price

support, crop loan, technical assistance and other programs will undoubtedly encourage improved environmental practices by many farmers. But one may question whether better environmental practices by farmers should continue to be optional.

Pollution from agriculture is substantially less regulated than are the environmental problems caused by other major sectors such as manufacturing, transportation, mining and silviculture. Many areas of government, the service sector and even households (automobiles, wood stoves) are regulated to some degree. There are no strong philosophical or practical reasons why at least large farms should not be held to similar standards as other major polluters. Large farms could monitor and report on their use of chemicals and emissions and effluent. Permits could be written and enforced for large farms prescribing use of best management practices to minimize off-farm pollution impacts. Pesticides could be made available for large volume farm use on a prescription basis only. It appears worthwhile both to modify Federal farm incentive programs so as to elicit satisfactory environmental performance by farmers on a voluntary basis, and to investigate the role that mandatory regulatory programs might play.

EXAMPLE STRATEGIES:

AGRICULTURAL POLICY - AP

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, MI, INFO, REGS

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.5.3 Tax Policy

Tax policies affect the environment in a variety of profound ways. Policies that promote investment in new plants and equipment have positive impacts, as new technologies tend to be less polluting and more energy efficient. Tax policies that stimulate home ownership -- certainly an admirable goal -- appear to have contributed to urban sprawl, increasing pressure on natural areas and increasing energy use. Favorable tax treatment of second homes has been particularly important in encouraging development of coastal wetlands and barrier islands. Tax policies that provide subsidies for virgin extractive industries reduce incentives for waste reduction and recycling. Taxes on energy can promote efficiency and encourage development of different energy sources.

Tax policy is perhaps the most effective incentive tool that the government has. Through a system of taxes and credits, tax policy can be designed to encourage or deter economic behavior. It can also create a funding base for specific environmental programs as it did with Superfund. To date, tax policy has been selectively used to create incentives for environmental investments and to encourage the replacement of environmentally undesirable processes or products. It has also been used in a limited fashion to raise money for environmental programs. However, its use as a positive incentive to broadly affect the future behavior of corporations and individual citizens has not been fully utilized, nor has careful analysis been performed that could serve as the basis for modifying environmentally counter-productive taxing programs.

While there are always serious political problems associated with new taxes, three points are important to mention. First, the public continues to show its willingness to pay for environmental protection, and earmarked environmental taxes hold some attraction. Second, environmental goals could be fostered by revenue neutral approaches that shift existing tax incidence. Third, "taxes" that are designed not to raise general revenues but to charge the costs of real environmental damage to those who benefit from them, and when possible to pay for the services necessary to prevent or correct the damage, are in fact not taxes in the general sense at all, but merely user fees that should be paid by the beneficiary in any case.

EXAMPLE STRATEGIES:

TAX POLICY - TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

S.12.3 Tax wastes and virgin materials to promote waste reduction and recycling. MI, TAX

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.5.4 Transportation, Housing and Commercial Development Policies

Transportation and commercial development policies affect the environment in profound, but not always obvious ways. The extraordinary U.S. financial investment in highways has helped stimulate a sprawling pattern of development around urban centers, particularly in the west. A range of Federal tax, subsidy, and other activities encourage single family development. These policies have led to air and noise pollution and destruction of critical ecological habitats.

Transportation and urban development policy needs to take the environment into account. Transportation and infrastructure development should attempt to lessen, rather than increase dependence on the automobile. Urban traffic problems need to be fixed to prevent unnecessary emissions from idling and stop and go driving. Mass transit, carpools and other mechanisms should be aimed at reducing urban driving.

Housing and commercial development policy provides an opportunity to prevent environmental damage before it happens by controlling development in ecologically fragile areas, and also to influence the clean-up of any past problems. Appropriate building design and siting provide the most direct way to assure that residential, commercial, and public buildings are healthful. Product performance standards, voluntary information programs, and mandatory problem identification/problem correction programs all have a role here. Requirements imposed at the time when a property is sold or requirements associated with Federal mortgage financing are particularly promising.

Transportation is responsible for about a third of U.S. fossil fuel consumption. Specifically, passenger cars consume 12%, trucks 10% and other transportation modes 9%. Highway vehicles alone produce 34% of the nitrogen oxide emissions, 24% of volatile organics, and 54% of carbon monoxide. Policies designed to increase the efficiency of transportation or to substitute clean fuels can have multiple environmental benefits.

Under existing regulatory policies for fuel efficiency and emissions control, motor vehicles have become more efficient and less polluting. For example, new model passenger cars have their exhaust emissions of volatile organics and carbon monoxide reduced over 90% from uncontrolled vehicles, and the average fuel economy of new passenger cars has risen by nearly 100% since 1974. Unfortunately, vehicle miles travelled have increased, due to lower gasoline prices, lack of transportation alternatives, etc. Although forecasts vary, vehicle use and travel are expected to increase by as much as 75% in the next 20 years.

With the limited further gains in emission control available from traditional end-of-pipe controls, policies to encourage retirement of older automobiles, to improve traffic flow, and even to provide alternative modes of urban development and transportation need to be investigated. The 20-year plan of the South Coast Air Quality Management District to improve pollution levels in Los Angeles is a pioneering effort in this regard.

EXAMPLE STRATEGIES:

TRANSPORTATION, URBAN, HOUSING AND COMMERCIAL DEVELOPMENT POLICY - TH

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land use planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.5.5 Natural Resource Policy

Federal policy on land and resource conservation and use of the nation's natural resources has a substantial influence on many environmental problems.

The Federal government owns about 21% of the land in the lower 48 states and 32% of the land in the entire United States. Much of this land is in natural or near-natural condition, providing the nation's largest reserves for protection of natural diversity. The balance that is struck in managing this land between preservation and use for forestry, grazing, mining, recreation, development or other activities is a major determinant of the extent to which natural communities will survive. The share of federal land acquisition funds allocated among competing purposes (e.g. acquisition of natural areas vs. recreational areas vs. historic areas) is also important.

Policies regarding the availability of resources from Federal lands are a major determinant of prices for basic commodities and

the ability of recycled materials to compete with virgin supplies. To the extent U.S. Forest Service timber sales, for example, are subsidized, they depress the overall price for timber and act as a disincentive to recycling of paper and other wood products. Federal lands provide the following shares of basic commodities in the U.S.: timber, 33%; oil, 11%; gas, 26%; grazing acreage, 27%.

Federal lands are also direct sources of pollution. Ten states report silviculture as a significant nonpoint source problem for surface waters, often involving federal lands. Federal requirements specifying allowable harvests, streamside buffers and road building practices can have a major influence on this problem. Federal range lands are in notoriously poor condition, with 63% of them classified as being in fair or poor condition. Their condition is partially a function of low federal grazing fees, which encourage overuse of the land and provide insufficient funds for their maintenance.

Federal water projects (dams, channelizing, dredging, etc.) are responsible for a large proportion of the physical alteration of aquatic ecosystems that has left only about 1/3 of the nation's riparian ecosystems in a natural condition. Although federal subsidies for water projects have been reduced in recent years, the projects' beneficiaries still pay an average of only a few percent of the project costs. Irrigation water from federal projects is particularly highly subsidized, with prices often set under 30-40 year contracts to recover only a portion of the original building costs. Irrigation accounts for about 80% of consumptive water use in the arid west. In this area, reduced stream flows because of consumptive water withdrawals constitute a major ecological stress, and pollutants from irrigation return flows (salinity, nitrates, selenium) cause further ecological damages.

EXAMPLE STRATEGIES:

NATURAL RESOURCE POLICY - NR

S.6.5 Reduce CO2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.10.1 Develop a nationwide inventory and preservation plan for important habitats. NR

S.10.3 Dramatically increase Federal acquisition of important ecological areas and open space. NR

S.12.3 Tax wastes and virgin materials to promote waste reduction and recycling. MI, TAX, NR

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these example strategies)

4.5.6 Foreign Policy

In recent years it has been become apparent that many environmental problems are international in nature and require cooperative, multi-national solutions. It is heartening that foreign policy is adapting faster to the environmental imperative than some other governmental functions. Initially, international efforts focused heavily on either transboundary problems (such as Great Lakes pollution, acid rain or movement of wastes) or pollution occurring in international waters (oil pollution, ocean dumping). Today, issues such as global warming and ozone depletion engage the economic trading partners of the West, the currently or previously centrally planned economies, and many of the developing nations. Concern over the cold war is being replaced by concern over trade and environment.

Problems such as global warming and stratospheric ozone depletion can not be solved by any country working alone. Even the strictest regulations of global pollutants will be ineffective when conducted unilaterally. Such unilateral action, while well intended, would substantially affect the economic balance in competitive production.

The U.S. might improve the growing linkage between foreign policies and environmental concerns by conducting a thorough and impartial assessment of the impacts of U.S. international trade, debt and finance policies on global human and environmental conditions. This analysis should address direct actions by the U.S.

government, the positions the U.S. advocates in international agencies and lending institutions, and the practices of U.S.-based multinational corporations.

Efforts to push for pollution prevention and low waste/low resource consumptive technology both at home and abroad will pay off by making the U.S. an example for others to follow and helping other countries to avoid problems they might otherwise face. The U.S. should also boost education and training programs for developing countries to promote sustainable development in technology and agriculture.

EXAMPLE STRATEGIES:

FOREIGN POLICY - FOR

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs, halons and other ozone depleters. PP, FOR

S.6.5 Reduce CO2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.6.6 Pursue an international agreement on greenhouse gases. FOR

(See Appendix AA for complete listing)

(See first page of Appendices for explanation of the coding of these examples strategies)

4.6 Federal Environmental Policymaking

RECOMMENDATION #5:

> **In order to integrate environmental policy into other governmental policies, a special mechanism should be created in the Executive Branch.**

DISCUSSION:

The broad environmental strategies discussed above for energy, agriculture, tax, transportation, natural resource and foreign policy areas require an institutional mechanism within the Executive Branch. There are several means by which this might be

done: the Council on Environmental Quality could be expanded and given clearer policy development responsibilities, a Cabinet Council on the Environment could be reconstituted and given a staff, or a new entity could be established. Another option would be to create a new Environmental Policy Council (EPC), which might be chaired and staffed by the Chairman of CEQ or it could be jointly chaired by the Administrator of EPA (or Secretary of Environment) and the Chairman of CEQ.

The primary responsibility of such a group would be strategy development. This group would devise means of harnessing and coordinating existing government programs to serve environmental goals, as well as developing new approaches for integrating environmental goals into major legislation such as farm or energy bills. Individual government agencies would remain responsible for implementation of the strategies developed under such a mechanism.

Such a group could also look to the future, examining future trends and options for production sectors which affect the environment. Long range strategies could then be developed that are consistent with and do not threaten other objectives. Areas for study could include each of the general areas discussed in the previous section of this chapter as well as more specific topics, such as new materials, biotechnology, etc.

4.7 Risk-Based Strategic Planning

RECOMMENDATION #6:

EPA should continue to perform analyses similar to the present Relative Risk Reduction Strategies Project and integrate the results into the Agency's strategic planning processes.

DISCUSSION:

The Agency needs to conduct the type of exercise undertaken in this project and make it a part of its regular planning process. It can do this internally, or with input from outside groups. The use of outside experts to suggest directions for priorities and strategies has great merit, if these experts work closely with the

agency. In developing strategies, it is important that certain elements exist:

1. Risk-based priorities must be updated periodically. A major review of the environmental risks facing the nation should be conducted every several years, to reflect changes in scientific knowledge and progress in mitigating problems over time. Specific strategies for reducing these risks should be updated more often (probably annually).

2. The strategies should be organized around solving critical environmental problems, not around planning for the future of existing programs. It is extremely useful to analyze problems defined in alternative ways -- for example, as pollutants (e.g., criteria air pollutants, toxic air pollutants), as sources (e.g., automobiles, power plants), in terms of their effects (e.g., increased respiratory diseases, reduced visibility), in terms of the sectors affecting them (e.g., energy, transportation and urban development, tax). Looking at environmental problems in different ways suggests different types of strategic solutions. Only after taking a multi-faceted, comprehensive look at problems and potential solutions is it appropriate to develop plans for specific EPA programs.

3. The Agency should subject individual strategies to disciplined analysis to determine how much risk reduction each will achieve. This analysis should not become so complicated or drawn out as to become itself an obstacle to progress. Also needed is information on cost, timing, certainty, and ancillary benefits or risks. The matrix developed by the Subcommittee represents one approach of evaluating alternative strategies against a set of criteria.

The resulting strategies should incorporate innovative approaches and should be built into the program plans for implementing offices in a coordinated manner. To date, EPA strategies have often been limited to clearly defined statutory requirements and to the use of clear-cut statutory tools. The Subcommittee suggests that EPA aggressively use the full scope of its statutory authorities to achieve the desired environmental results. The Toxic Substances Control Act (TSCA) provides broad authority for information-oriented strategies. Several laws may give the Agency authority to charge user fees, which could form the basis for economic incentive programs. All major statutes

provide authority for research, information dissemination, technical assistance, training, and cooperation with other agencies.

4.8 Risk-Based Budgeting

RECOMMENDATION #7:

EPA's annual budget should more directly reflect risk-based priorities.

DISCUSSION:

Historically, EPA's budgets have reflected simply the resources necessary to establish and implement the regulatory programs mandated by Congress, with little focus on risk and on where the cost-effective opportunities lie for reducing risk. Accordingly, some high risk environmental problems, such as radon and other indoor air pollution, have received only a small fraction of the EPA budget. EPA has some independent ability to shift its budget incrementally toward greater concern over risks in establishing priorities. EPA's present leaders have demonstrated greater concern in this respect; they are making changes, and should continue to do so. However, EPA's leaders are not the only people who play a role in determining EPA's budget.

The change in budget priorities need not and should not take the form of radical, overnight change. Small but consistent changes over time will accomplish the same objectives without undue disruption. The changes in the budget also do not need to make allocations exactly proportional to risk and risk reduction. Some risk reduction can be accomplished at low cost.

The Subcommittee specifically recommends that at the beginning of the budgetary process, the Administrator or the Deputy Administrator provide clear advice to the program offices regarding certain high-risk activities that appear relatively underfunded. A second review should take place just prior to the time the budget is sent to the Office of Management and Budget to assure that these activities continue to be reflected as high priorities.

This strategic process should assist in the review of

budgetary priorities. But, whatever the process chosen by the agency, it is critically important that a specific process be developed to compare budgetary allocations with risk.

Fundamentally, though, it is the Congress, constituency groups and the public that set EPA's broadest priority directions. To the extent these directions from outside the Agency differ from EPA and expert's risk-based view of what the Agency priorities should be, public discussion about environmental priorities becomes critical. EPA must listen to Congress, interest groups and the public about why they see environmental problems as they do, and EPA must also communicate its own views on these issues and solutions. Significant disagreement about priorities between the public concerned with environmental protection and the agency charged with assuring it needs to be aired publicly so that a common understanding can be reached. The agency needs to stress the risk-based approach in this discussion.

Appendix B, "Perspectives on Reducing Environmental Risks," contains several sections that are directly relevant to this recommendation, concerning risks, priorities, and EPA and social spending.

4.9 Education and Training

RECOMMENDATION #8:

The Agency should develop an enhanced environmental education and training program for both the general public and professionals.

DISCUSSION:

The preceding recommendations by the Subcommittee suggest a broad approach to environmental protection in the Nation. Individuals making decisions about production or consumption of goods and services should understand the environmental implications of their actions and their opportunities to prevent pollution rather than generate it. Environmental concerns should be fully considered in developing government policies regarding economics, energy, agriculture, housing, natural resources and other sectors. The tools used for environmental protection should be extended well

beyond traditional command-and-control end-of-pipe regulation to include less direct but broader-based approaches such as economic incentives, provision of information, and research and development.

This expanded approach places responsibility for environmental protection on all sectors of society, not just on environmental professionals (e.g., environmental engineers, agency staffs, corporate environmental personnel, activist groups) alone. Producers, consumers, businessmen, farmers, architects, bankers, scientists, government officials and others all must understand the impact of their activities on the environment. This will require an improved program of environmental education and training throughout society, supported by EPA. EPA should support programs in three specific areas:

1. Broad environmental education for the general public.

2. Incorporation of environmental concerns into higher education and in-service training for non-environmental professions (e.g., engineers, architects, etc.).

3. Improved education for environmental professionals on pollution prevention, cross media concerns, and risk communication.

Regarding the general public it is clear that real improvements in many environmental conditions depend upon actions by individual citizens. It is the individual who decides whether or not to obey a particular regulation, whether or not to change his/her behavior, and whether or not to support a particular risk reduction strategy. Individuals can segregate their trash, conserve energy and water, and buy non-polluting products. Such actions depend on a public that is educated to understand and choose practices that will reduce risk in a cost-effective manner. This education should begin at a young age. The fundamental concepts of environmental protection and stewardship can and should be taught early. By effectively communicating a few fundamental environmental messages, the nation can help mobilize a huge social force to address the needs of environmental protection. EPA is currently starting a new environmental education program. The Subcommittee supports efforts in this direction.

The second group for which environmental education programs should be improved includes a wide range of professionals not

directly concerned with environmental quality but whose decisions nevertheless have a profound impact on environmental condition -- businessmen, architects, engineers, farmers, bankers, developers, and others. In some areas, such as real estate transaction, mergers and acquisitions, and siting new industrial plants, these professionals have recently recognized that they must pay attention themselves to environmental concerns and cannot leave them solely to environmental specialists. However, the set of issues on which decision-makers should pay serious attention to environmental concerns is much broader, including decisions about what products to produce and how, building design, farming practices, etc.. We hope that professionals making such decisions can be trained to recognize the choices they have among alternative ways of conducting their productive activities that can minimize the generation of pollutants and wastes.

EPA should provide financial assistance to universities for the incorporation of environmental concerns and understanding into professional curricula. EPA should also work with the professional societies and other organizations interested in continuing education for professionals. EPA might lend its experts as lecturers and consultants to these organizations, and might support development of appropriate teaching materials.

Finally, EPA must concern itself with the education of environmental professionals. This concern should extend to both the number of individuals being educated and the quality of the education being provided. Within our educational institutions, student interest (and arguably also student capability) in sciences, mathematics and engineering is flagging. The result is, for example, a serious shortfall in the number of engineers and scientists relative to our needs for dealing with such problems as hazardous waste. Traditional scientific education programs are only beginning to appreciate the need for multidisciplinary, multimedia approaches to our current and emerging environmental problems. For example, only a handful of colleges and universities have strong waste reduction curricula; none has a comprehensive multimedia pollution prevention program.

To address the widening gap between needed and available personnel, the Agency should develop an aggressive training program for graduate scientists and engineers. The program might include fellowships for promising environmental professionals, increased

environmental research grants to university faculty that can also support student assistants, and teaching materials for environmental courses.

The case for education and training aimed at present environmental professionals is, in some ways, even more compelling than that for future professionals. The pace at which we are discovering new problems and nuances of old problems has outstripped the ability of many specialists to remain current with all the latest developments. Sophisticated computer modeling, impacts on an unprecedented global scale, and the perplexing difficulty of some of the simplest questions (e.g., "How can we tell if this ecosystem is 'sick'?") have leapfrogged over the training of many scientists and engineers schooled to address more traditional localized concerns (e.g., "How do we construct the best water treatment facility?"). Important areas where knowledge has recently burgeoned warrant special attention in training courses: pollution prevention, multimedia and integrated environmental management, risk assessment (both human and ecological), non-regulatory strategies for risk reduction, and risk communication.

As environmental problems in the future become more complex, interdependent and global in scope, improved environmental education and training will become critical in empowering our society to make sensible, informed environmental choices. EPA support for improved education and training may be as important in ultimately reducing environmental risks as any of the other more tangible steps the Agency may take.

4.10 Conclusion

The environmental challenges of the 1990's are daunting. The contaminants of concern extend from natural soil conditions to chemical manufacturing plants. The exposure occurs everywhere, from individual basements to the entire globe.

The problems of the 1990's no longer fit neat patterns where villainous industries or municipalities belched air pollutants or discharged raw sewage. Rather, we are dealing with problems without clear culprits or simple end-of-the-pipe solutions. We are recognizing that virtually all public policy affects the quality of the environment, one way or another.

Hence, we conclude where we started. The traditional regulatory mechanisms for addressing environmental problems -- certainly with many victories to their credit -- will not suffice to meet many of problems of the 1990's. The new challenges require development and use of a much broader variety of tools and much earlier consideration of environmental factors in national decisionmaking. If these steps are not taken, environmental problems of many sorts will continue to increase. In other instances we may improve environmental conditions, but at excessive costs. In both cases, we will have failed to meet our risk reduction potential.

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Appendix A

Optional Strategies for 13 Specific Environmental Problems

Each of the strategy options listed for the different problem areas in Appendix A has been listed again at the end of this Appendix (AA.1) and has been sorted according to risk reduction tool (AA.2) and according to policy area (AA.3). The sorting makes use of the codes shown below. Representative examples of these strategy options also appear in the main text of the report where appropriate.

Risk Reduction Tools

- PP - Pollution Prevention
- S&T - Scientific and Technical Measures
- INFO - Provision of Information
- MI - Market Incentives
- REGS - Conventional Regulations
- ENF - Enforcement

Policy Areas

- EP - Energy Policy
- AP - Agricultural Policy
- TH - Transportation, Urban, Housing and Commercial Development Policy
- TAX - Tax Policy
- NR - Natural Resource Policy
- FOR - Foreign Policy

A.1 Criteria Air Pollutants

A.1.1. Risk Background

The problems associated with the criteria air pollutants (carbon monoxide, suspended particulate matter, lead, ozone, nitrogen dioxide, sulfur dioxide and -- for the purposes of this report, -- sulfates and nitrates) are perhaps the best understood of any this Subcommittee is considering. To be sure, uncertainties attend estimates of emissions, chemical transformation, transport, deposition, and ultimate effects on human health, ecological processes, materials, aesthetics, and also the costs of control. But because the federal government has had basic research, monitoring, and control programs in place for twenty years, and because many state and local governments were controlling particulates and sulfur dioxide for at least ten years prior to 1970, we have accumulated an impressive store of knowledge about these pollutants.

Health risks:

Primary National Ambient Air Quality Standards (NAAQS) have been established for each criteria air pollutant. The NAAQS are intended to prevent the variety of health effects that criteria air pollutants may cause, often particularly affecting sensitive groups such as children or people with asthma. Despite substantial progress in reducing emissions of criteria air pollutants and attaining NAAQS, in 1988 over 121 million people in the U.S. resided in counties which exceeded at least one air quality standard (USEPA, 1990).

a) Ozone standards are those most frequently violated. Approximately 112 million people live in \counties not attaining ozone standards. Both clinical and epidemiological studies have found links between acute (short-term) exposures to ozone and a variety of adverse health effects, including nose and throat irritation and respiratory problems including changes in pulmonary function tests and asthma attacks. Some animal toxicological studies have suggested that prolonged exposures to ozone may increase the risk of chronic pulmonary problems, but there is as yet no confirmatory human epidemiological evidence, even in populations exposed to relatively high levels for long periods of time.

b) Particulate matter is a more localized pollutant. Although some 26 million people live in non-attaining counties, only some of them are actually subject to levels above the standard. Acute exposure to such levels has been linked to respiratory problems, particularly for sensitive populations like people with asthma, small children, or the elderly. Extended chronic exposure is thought by some to cause premature death.

c) Carbon monoxide in ambient air affects relatively few individuals among the 29 million people in non-attainment areas. In high concentrations, CO aggravates angina and may cause developmental or neurological effects.

d) Nitrogen oxides can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections. Over 8 million people live in counties which exceed the nitrogen dioxide standard.

e) Sulfur dioxide standards are exceeded in areas affecting 1.7 million people. It can aggravate asthma.

f) Lead can cause learning disabilities and is particularly dangerous to children. Though 1.6 million people live in lead non-attainment areas, a very small proportion of them are children exposed to levels above standards. Lead may cause adverse health impacts by several means in addition to inhalation.

g) Acid aerosols do not have air quality standards, but are associated with various criteria pollutants. These particles have been linked to lung damage, aggravated respiratory disease, and increased mortality (perhaps several thousand cases per year).

The health effects of criteria air pollutants are well known, based on extensive animal studies, human experiments, and epidemiological investigations. Human exposure can be modelled using ambient air monitoring data of good quality.

Ecological risks:

Plant damage from ozone and acid deposition has been documented. The underlying dose response relationships have been established in experimental settings. However, in the field, plant damage is difficult to link to specific criteria pollutants. Damage is often due to a combination of pollution and natural phenomena, such as droughts, pests, or harsh winter weather.

Ozone damage to vegetation includes leaf damage, reduced growth, altered reproductive capacity, and altered sensitivity to pests. Damages vary by species and location, but the potential for damage is nationwide. Despite the predominance of urban sources of ozone, long range transport results in elevated ozone levels in many forested, rural areas.

Deposition of acidic sulfur and nitrogen compounds causes damage to lakes, streams, and forests in some parts of the U.S. Increased acidity from deposition to lakes and streams can affect the reproduction and growth of many aquatic species. In several areas of the country (the Adirondacks, Michigan's Upper Peninsula, and Florida) up to 12% of the lakes have been acidified. Acid deposition can also leach nutrients from soil, inhibit photosynthesis, and kill microorganisms. It may

also mobilize toxic metals so that they enter soils or harm aquatic life, crops, or trees. Acid deposition is suspected, though not proven, to be a factor in forest dieback and declines in coniferous growth.

Welfare risks:

Criteria air pollutants cause large welfare damages; these damages have been more closely studied than those for any other environmental problem. Materials damage and soiling, reduced commercial agricultural and forest yields, and reduced visibility result in economic losses estimated in the tens of billions of dollars annually.

A.1.2. Policy Background

Federal, state, and local governments have been implementing programs to control criteria air pollutants many decades. In general, state and local governments have primary responsibility for preventing and controlling criteria air pollutants, which they do by conducting permitting, monitoring, inspection, enforcement, and planning programs. The federal government supports these activities through research and development, technical and financial assistance, and establishment of national standards. These programs have had impressive effects and have carried impressive costs.

Despite growth in population of 10% and real GNP of 26% over the 10 years from 1979 to 1988, improvements in both ambient concentrations and emissions have been seen for five of the six criteria pollutants (USEPA, 1990).

Trends for 1979 - 1988

	Avg. Monitored Pollutant Conc.	Total National Annual Emissions
Particulates	-20%	-22%
Sulfur dioxide	-36%	-17%
Carbon monoxide	-28%	-25%
Nitrogen oxides	- 7%	- 8%
Ozone	+ 2%	-17% (VOCs)
Lead	-89%	-97%

Ozone concentrations appear to have increased because of an unusually warm summer in 1988 and alternatively a cooler 1989 resulted in substantially lower ozone levels. These improvements (except for ozone) in air quality have reduced health, ecological, and welfare damages from criteria air pollutants. Although some attempts have been made to quantify these beneficial effects in physical terms and to place dollar values on at least some of them, we currently have no really clear idea of the overall economic value of the benefits; however, they are clearly substantial.

The costs associated with twenty years of air pollution control are somewhat more amenable to quantification. In order to comply with federal air pollution control regulations we currently spend about $35 billion per year, almost all of which is directed at criteria air pollutants. Of this total, about half goes for emissions control at stationary sources and half goes to controlling emissions from cars, trucks, and buses. Over the past two decades, total expenditures necessitated by the Clean Air Act have exceeded $200 billion (U.S. DOC, 1988).

In spite of the air pollution control efforts to date, emissions are still significant and pollution-related risks remain. For example, ambient ozone concentrations remain high in many areas, most notably Los Angeles. Concern about acid deposition from sulfates and nitrates has prompted pending legislation that would almost halve annual emissions of sulfur dioxide in the U.S. Concern also exists in some areas about ambient concentrations of carbon monoxide, fine particulates (particularly acidic sulfates) and nitrogen oxides. The sources responsible for the emissions of each criteria air pollutant in 1988 were (USEPA, 1990):

Sources of Total National Emissions
(in percent)

Pollutant	A	B	C	D
Particulates	20	25	38	17
Sulfur oxides	4	79	17	0
Carbon monoxide	67	12	8	13
Nitrogen oxides	41	55	3	1
VOCs	33	5	46	16
Lead	34	7	26	33

Transportation = A
Fuel Combustion = B
Industrial Processes = C
Solid Waste & Miscellaneous = D

A.1.3. Possible Strategy Options

Four major challenges must be faced in developing a strategy for criteria air pollutants:

a. Reduce sources of SOx and NOx that lead to acid deposition.

b. Reduce emissions of volatile organic compounds that are considered the major contributors to ozone formation.

c. Pursue pollution prevention steps to assist in achievement of standards, and even more important, to assure their maintenance.

d. Research, development, and monitoring to support compliance efforts.

a. Reducing sources of SOx and NOx that lead to acid deposition. President Bush recommended that annual emissions of sulfur oxides be reduced by 10 million tons per year. Whatever number is finally chosen, an acid deposition control program is crucial to coping with criteria air pollutants.

Although acidic rain and acid aerosols do not represent criteria pollutants per se, their control is inextricably intertwined with control of criteria pollutants.

While a regulatory program would be established to achieve the reduction mandated, it is important to use a market mechanism to drive actual remedial actions. The marketable permit proposal could reduce the costs of a control dramatically. For example, a 10 million ton per year reduction in SO_2 emissions will cost about $4 billion annually if marketable permits are used. Under this proposal, utilities with opportunities to reduce SO2 emissions at low cost would reduce their emissions more than is required, and would sell their credits for having overcontrolled to utilities facing higher costs. If, however, an equivalent reduction is pursued through the required installation of scrubbers at coal-fired power plants, the annual costs of the program jumps to approximately $8 billion. Moreover, the marketable permit approach provides incentives to utilities to find least cost innovative control technology or other measures that would not exist if legislation were instead to mandate that all utilities install a particular control technology.

The marketable permit approach, however, must be applied carefully, so as not to allow trading between sources which affect different impacted regions.

S.1.1 Use marketable permits to lower costs and spur innovation in reducing acid rain. MI, EP

b. Reducing volatile organic compounds. The Subcommittee considered many options for reducing emissions of volatile organic compounds (VOCs). The Subcommittee endorses steps EPA is examining, such as volatility restrictions, on-board controls, vapor recovery nozzles at filling stations, and vapor recovery technology at re-filling operations. The Subcommittee also looked at other possible ways to reduce VOCs, particularly since VOC use is likely to increase with population and per capita GNP growth.

One option available is a deposit/refund system or tax on the VOC components in solvents. Imposing a front-end charge would create strong incentives for users of solvents to find substitutes, to reduce use and to find recycling possibilities. To encourage recycling, no tax or deposit would be levied when recycled solvents are purchased.

Instead of or in addition to the front-end charge, there might be a refund for solvents returned for recycling. This option would be less onerous to industry. However, it might be difficult to determine the quality of the solvents returned. These technical issues must be dealt with to determine if this option is viable.

Regulation of volatile solvents in paints and other products represents either an independent option or a supplement to the tax or deposit/refund system.

Finally, the Congress could mandate an across-the-board reduction in the VOC content of solvents, using a marketable permit system to achieve the reduction cost-effectively. This proposal would have the same effect as a solvent tax, raising the price and thus creating a market for reducing solvent use, and establishing the option to sell rights to other companies.

S.1.2 Reduce VOC emissions through deposit-refund programs, taxes or marketable permits. MI

c. Pursue pollution prevention efforts to assist in the achievement of standards, and more importantly, to assure their maintenance. The approaches listed above for reducing VOC emissions can help apply pollution prevention principles to one class of criteria air pollutants. There are numerous other pollution prevention approaches that can be worthwhile. Probably the most significant pollution prevention activity in the U.S. has been the substantial improvements in energy efficiency over the past 17 years. While GNP has grown over 40 percent, energy use has been roughly constant. The majority of criteria air pollution emissions result from combustion of fossil fuels. If energy use had followed GNP growth, our pollution problems would be much more severe.

Substantial future energy conservation potential still exists. The Subcommittee focused on conservation in only two sectors: the electric utility and transportation sectors. Numerous promising pollution prevention and energy conservation strategies exist beyond several listed below.

Electric utilities are responsible for most of the SOx and NOx emissions, and a substantial fraction of particulate emissions. Rate systems for utilities encourage expansion and penalize conservation. Even during a period when incremental costs exceed average costs, utilities stand to return more to investors by adding capacity. If utilities could make money on conservation investments, or at least not lose money, then they would have incentives to develop conservation programs, such as installing high efficiency equipment at their customers' facilities.

Some states have developed incentive systems designed to overcome current barriers to conservation in utility procedures. The Federal government, at modest cost, could assure that a number of these systems are demonstrated. Conservation incentive rate structures could potentially promote conservation goals within the industry, just as the Public Utilities Regulatory Policy Act (PURPA) has revolutionized production by independent power producers.

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP

A wide variety of measures to improve energy efficiency in the transportation sector could have a substantial effect in reducing emissions of criteria air pollutants from vehicles and production and marketing of motor fuels.

Improvements in fuel efficiency might be obtained by strengthening the Corporate Average Fuel Economy (CAFE) standards, or by imposing a tax on purchase of fuel-inefficient autos (a "gas guzzler tax"). Although these measures would reduce gasoline use, they would have to be designed carefully to reduce criteria air pollutant emissions from vehicles. Since these emissions are

now regulated on a grams per mile basis, manufactures may use less effective pollution control equipment on a more fuel efficient car and achieve no improvement in emission per mile relative to a "gas guzzler". To the extent that tighter CAFE standards or taxes raise the purchase cost of new cars, a countervailing effect may also come into play -- older, more polluting cars may be kept in use longer. Policies to accelerate fleet turnover, such as the recent offers by companies in California to purchase older cars and retire them, may be beneficial. Other means of improving vehicle fuel efficiency would include measures to smooth traffic flow and reduce congestion.

Measures to reduce the number of vehicle miles traveled could also be adopted: car pooling, mass transit alternatives, better land - use planning, etc.

Increasing the gasoline tax might be the most desirable of all measures. It would provide an incentive for purchasing more fuel efficient cars; for retiring older, fuel-inefficient cars, and for reducing vehicle miles travelled.

Although unpopular, a gasoline tax would solve many national problems at once; it would: create a strong revenue source, reduce the negative balance of payments, reduce future oil prices and energy insecurity, and promote environmental improvement. U.S. gasoline taxes are among the lowest of any developed country. A gasoline tax of 50 cents a gallon would still result in U.S. gasoline prices being among the lowest in the world. To reduce regressivity a system could be created to rebate funds to the driving poor.

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

Finally, pollution from the transportation sector might be prevented by modifying the engines, vehicles, or fuels used. Alternative fuels, reformulated gasoline, or electric vehicles represent some possibilities. A substitute for conventional gasoline is attractive, assuming that is does not add to global warming or jeopardize energy security. While the Subcommittee does not express an opinion on the best option, some steps must clearly be taken to reduce VOC pollution from automobile fueling and use in many areas of the country. Electric vehicles offer an interesting option, but they would require substantial capital investment in vehicles and fuel distribution infrastructure.

As a final theme in discussing pollution prevention approaches for criteria pollutants, we note that efforts to speed up capital turnover broadly throughout manufacturing, transportation, housing and many other sectors would result in less polluting, less energy-using facilities. Federal tax and fiscal policies have a substantial effect on the rate of capital replacement through provisions for capital gains, depreciation, investment tax credits, tax treatment of research and development, etc. Policies that encourage greater investments in new plant and equipment would have positive environmental impacts.

d. Research, development and monitoring efforts. Because criteria air pollutants are relatively well understood, research and development and monitoring strategies are not as attractive as for other environmental problems before the Subcommittee. However, accelerated scientific work may be particularly warranted in two areas:

1. Establishing more remotely sited air pollution monitors for ozone and its precursors. Currently, almost all air pollution monitors are located in more highly populated metropolitan areas. As population centers grow in heretofore rural areas, however, it is important to understand the pollution levels to which residents there are exposed. This means more diffusely situated monitoring devices. Such monitors will also help provide data on the actual pollution levels to which forests, agricultural crops, and visitors to national parks are exposed.

S.1.5 Establish more remote monitors for ozone. S&T

2. Further investigating the relative roles of VOCs and NOx in ozone formation. Recent evidence suggests a more important role for NOx than previously thought in some areas. With major VOC sources now reasonably well controlled in most ozone nonattainment areas, very expensive or intrusive measures addressing smaller sources are now under consideration (e.g. restrictions on use of lighter fluids for backyard barbecues). Substantial cost and inconvenience may be avoided if control of NOx emissions can substitute for this next generation of VOC controls in some areas.

   The research should attempt to identify areas where VOC control alone is most effective, where NOx control is effective, and where control of both is necessary.

   If research does suggest substantial ozone reduction benefits from NOx controls, developing and disseminating information on NOx control techniques will be essential.

S.1.6 Further investigate the relative roles of VOCs and NOx in ozone formation. S&T

e. Note that many of these approaches for mitigating problems from criteria air pollutants would provide substantial benefits for other environmental problems considered by the Subcommittee. Energy conservation, for example, will reduce the problems associated with toxic air pollutants and global warming. As another example, reduction on volatile solvents in paints and other products will cut air toxics emissions and improve indoor air quality.

References

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A.2 Toxic Air Pollutants

There are hundreds or even thousands of chemicals that may occur in concentrations in air sufficient to cause adverse human health effects. Human exposure is generally to a mixture of these chemicals. Many different health effects (carcinogenic and noncarcinogenic) may occur and various susceptible or highly exposed subpopulations (e.g., children, elderly) may be at greater than average risk.

A.2.1 Risk Background

The control program for criteria air pollutants, particularly volatile organic compounds (VOCs), has reduced emissions of many air toxics substantially. However, urban air is characterized by the presence of numerous chemical substances that may pose significant risk for city dwellers. The present air toxics data base is inadequate to characterize accurately current exposures, risks, and the sources of risks. The most recent scientific assessments conclude that:

a) air toxics are probably not responsible for a significant proportion of the national cancer incidence;

b) insufficient toxicity data and lack of more accurate information on real human exposure prevent reliable estimates of the exposure levels, potential health effects and risk from air toxics; and

c) the current cancer risk assessment methods used by EPA have shortcomings with regard to evaluating complex mixtures that are particularly important for air toxics.

Significant sources of air toxics include:

a) mobile sources through fuel combustion (gasoline and diesel - PAHs, benzene, 1-,3-butadiene, fine particles),

b) use of solvents by industry, commercial, businesses, and consumers (electronics industry, dry cleaning, paints, cleaning products and personal products),

c) combustion of fuels and use of a wide variety of toxic chemicals in industrial processes.

Although present data are highly uncertain, estimates suggest that mobile sources, including the secondary formation of formaldehyde, contribute approximately 58 percent, and stationary sources approximately 42 percent, of the total annual cancer incidence due to air toxics. The same preliminary estimates indicate that area sources are responsible for approximately 80 percent and point sources 20 percent, of the total annual incidence associated with high outdoor exposure to air toxics.

It is sometimes difficult to distinguish between point and area sources of air toxics. The following source categories can be considered area sources: motor vehicles, treatment, storage and disposal facilities (TSDFs), woodsmoke, asbestos, demolition and renovation, gasoline marketing, coal and oil combustion (residential only), solvent use/degreasing, publicly owned treatment works, dry cleaning, pesticide usage, chlorinated drinking water, paint stripping, and benzene fugitives.

A major review by EPA (1989) of studies examining the sources and risks from air toxics has concluded that of the approximately 90 pollutants evaluated, 12 accounted for over 90% of total estimated annual cancer incidence for the chemical group. Of these, a poorly defined category-products of incomplete combustion (PICs)-were responsible for about 35% of the calculated total. Other major contributors included 1, 3-butadiene, hexavalent chromium, benzene, formaldehyde, and chloroform.

Unfortunately, these risk estimates suffer from a high level of uncertainty in assessing the carcinogenic potency (unit risk) and the real human exposure to air toxics. Two recent EPA studies have investigated personal exposures during common activities in various microenvironments and identified certain consumer products or personal activities (such as wood-staining and painting, visits to beauty shops and autobody shops, etc.) as sources of VOC exposures that far exceed simultaneously measured outdoor concentrations, even in chemical manufacturing and petroleum refining areas. Thus the present emphasis on outdoor concentrations of air toxics -- both in assessing risks and in controlling sources -- may be inappropriate.

A.2.2 Policy Background

To date EPA and state agency strategies have focused on regulating one toxic air pollutant at a time. This method has proved slow, ineffective, and costly, and it may be ignoring synergistic effects of pollutants. This approach may also result in substitution of unregulated pollutants in the course of controlling the few pollutants that are regulated.

Title 3 of the Superfund Amendments Reauthorization Act (SARA) provided the public with its first look at the air toxics emissions from industrial sources in their geographical area. Public disclosure of this information galvanized a number of groups into challenging industries in their areas to reduce their use of toxic compounds. It also appears to have induced some corporate managers to reduce their emissions voluntarily.

States began to establish programs to control sources of air toxics in the early 1980s without guidance from EPA. As a result, a multitude of programs have been developed each of which look at compounds and structure regulations differently. States and the USEPA are just now beginning to look at multi-exposure pathways from air toxics from stationary sources.

EPA and the states have been active in exchanging information on air toxics. The USEPA has been improving technology transfer to states and sources through the National Air Toxics Clearinghouse and the computer data base Air Risk Information Support Center (AIRISK). The Control Technology Center has also been instrumental in providing State and local agencies with critical technical assistance.

Congressional revisions to the Clean Air Act (CAA)

regarding air toxics have looked at technology-based controls followed by a determination of residual risk through risk assessments and decisions regarding additional controls on all sources. This approach involves identification of a list of hazardous air pollutants and determination of controls for all major stationary sources emitting these pollutants without regard to their potential risks. Air toxics emissions from mobile sources are addressed by several measures. These are provisions for specific additional reductions in mobile source VOCs and toxics, as well as for the use of clean fuels. Additional research will be needed to implement these provisions. Studies of specific problems (e.g. air deposition of toxics to the Great Lakes, solvents in consumer products, urban soup) are also included in the proposed amendments.

Since gasoline and diesel combustion are major sources of airborne toxics, interest in alternative fuels and reformulated gasoline has led to changes in fuel combustion in mobile sources. The oil and auto industries have formed a research organization that will spend more than $10 million by the end of 1990 researching reformulated gasoline and other alternative fuels. Vehicle manufactures and energy suppliers are gearing up to provide fuels such as methanol and compressed natural gas and demonstration fleets of vehicles that can use these fuels to evaluate their potential over the next 3-5 years. Also, California has a major program to promote the use of clean fuels throughout the state in the next 10 to 20 years.

Considering air toxics as a discrete problem may not be the most effective way to address these compounds. Most of the reduction in air toxics emissions to date has probably occurred as a result of control technologies installed primarily to abate emissions of criteria air pollutants from industrial and mobile sources. In the future, many air toxics problems could effectively be addressed by strategy options in other areas being suggested by this Subcommittee. For example, strategies being developed to control volatile organic compounds and ozone will also control air toxic compounds of concern. Second, energy conservation measures that will reduce the amount of fuel combusted for mobile and stationary sources will also reduce the amounts of PAHs, benzene and other products of incomplete combustion which are air toxics of concern.

A.2.3 Possible Strategy Options

The Risk Reduction Subcommittee has considered four broad classes of strategy options that could reduce risks of exposure to air toxics. They overlap substantially with the strategy options already cited for criteria air pollutants. Numerous strategies in addition to those cited below are undoubtedly also attractive.

a. Reducing the amount of fuel consumed in transportation. Market incentives could be developed to encourage consumers to use convenient and inexpensive public transportation as an alternative to driving their cars to work each day and using them to run errands. A number of strategies can be designed to reduce the fuel consumed per mile travelled or to reduce the pollution produced per mile by changing the fuel. These strategies often require cooperation among agencies involved in land use planning. For example one goal could be to increase the density of suburban areas. This serves to reduce the distance travelled to work or play. In addition, transportation planning should support modes of travel that are more energy efficient. For example, moving goods by rail travel is more energy efficient than by truck travel. These strategies are expensive, but dependable, and have multiple benefits besides decreasing exposure to air toxics.

Mobile source strategies could include incentives aimed at reducing the number of vehicle miles traveled (VMT) and increasing fleet turnover. Reducing each automobile's VMT could be accomplished through improved transportation and land use planning, employee and employer incentives for carpooling, and high - occupancy vehicle strategies like vanpools. In addition, restrictions on parking in high density areas and increased parking fees, combined with changes in the tax structure, could decrease the amount of time people travel in single occupant vehicles. An increase in vehicle engine efficiency would reduce the amount of energy used to power a vehicle per mile and, therefore, reduce the emissions produced per mile. Other mechanisms that need to be investigated include high speed railways in urban corridors like that between Boston and Washington. Such trains could reduce air pollution by keeping many low-occupancy vehicles off the road.

There is mounting evidence that half or more of mobile source emissions of VOCs and air toxics come from a small fraction of highly emitting, mostly older vehicles that are improperly tuned or have been tampered with. Mechanisms or incentives to identify and remove these vehicles should be applied.

S.2.1 Reduce auto emissions by reducing vehicle miles travelled through better land use planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

b. Demonstrating the uses and feasibility of clean fuels and alternative fuels (other than hydrocarbon based) in vehicles. This would include improved formulations for gasoline that are less toxic and reactive, as well as non-gasoline based fuels. Any discussion of conventional and/or alternative fuels should review the entire production process for the new fuels. That is, the risks associated with the entire life of the fuel, from production through use, must be investigated. Modeling of the air quality improvements expected from these new fuels as well as an estimate of the reduction in risk from exposure to toxic compounds would have to be investigated in isolated air basins, as well as in transport corridors. For example, the potential exists for increases in ambient formaldehyde as a result of increased use of alcohol based fuels. Efforts are underway in California and at federal laboratories (both environmental and energy labs) to investigate these issues. The estimated costs to produce and distribute these fuels range from a few cents per gallon above the current price of gasoline to as much as 25-30 cents above the current price. The dependability is uncertain, given the above concerns about the production and distribution of the fuels. In addition, consumer acceptance of new fuels is untested and will depend heavily on availability and ease of use.

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

c. Requiring process audits at manufacturing plants. This would include a comprehensive look at a manufacturer's process and periodic reviews to target the sources of air toxics in a manufacturing setting. Audits offer a mechanism different from technology-based control standards, which take a long time to put in place and actually implement. Audits require manufacturers to inspect their processes in an integrated fashion to identify places where substitutes could be made for a toxic chemical, points where chemicals could be recycled and reused, and places where the use of a specific chemical could be reduced. These audits can also be viewed as compliance as well as a process audits. An audit can be a mechanism for finding sources of fugitive emissions, such as leaks in piping, that are often contributors to air toxics. Doing energy and material balances for a specific chemical allows manufacturers to discover where and when a chemical is released to the atmosphere or other media. A process audit is an excellent way to find locations in a production facility from which toxics are escaping. The audit enables manufacturers to reduce their releases of toxic chemicals, provides opportunities for them to save money through reduced use of toxic chemicals, can improve their company's community relations by demonstrating improved process control and reduced consumption and release of toxic compounds, and can save their firm the cost of disposing of toxic compounds.

S.2.3 Require process audits of manufacturers to find fugitive sources of pollution, leaks in piping, and other preventable releases. PP, ENF

d. Reducing the use of solvents in consumer products (paints, cleaners, personal products) through regulations and demonstration projects. Several states are already promulgating regulations to reduce the solvent content of paints. Other states are looking at regulations to reduce the solvent content in other home use products, such as deodorants and hairsprays. These measures may reduce an individual's exposure to air toxics at home and work. This strategy can cost - effectively reduce exposures, when compared to technology-based controls on manufacturing facilities. The strategy is very dependable since a product is redesigned and the toxic in dispute is no longer used in the formulation of the product. These goals might be achieved through direct federal regulations of products under TSCA, or by supporting and publicizing successful state efforts.

S.2.4 Reduce use of solvents in consumer products. PP, INFO, REGS

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A.3 Radon

A.3.1 Risk Background

Radon is a radioactive gas produced by the natural decay of radium. It occurs naturally in most soils and rocks and can migrate from them into the ambient air. Radon can enter buildings through cracks or other openings in foundations or through release from water in showers, washers, tubs, etc., and accumulate to levels which cause a significant risk to human health. Studies of thousands of underground uranium and other miners have found that long-term exposure to elevated levels of the natural decay products of radon causes lung cancer.

Federal and state surveys of homes since 1985 indicate that a substantial number of homes have significantly elevated radon levels (See Table 1). Approximately 4.4 million of the 59 million single family homes (7.5%) are estimated to have average radon levels which exceed 4 pCi/L (Puskin and Nelson, 1989). Based on risk models of the National Academy of Sciences (BEIR IV Committee) (NAS, 1988) and the International Commission on Radiological Protection (ICRP 50 Committee) (ICRP, 1987), exposure to radon at 4 pCi/L over a lifetime can cause one of every 200 people to die from lung cancer. Based on the distribution of radon levels in homes indicated in Table 1, EPA projects that exposure to radon is causing from 5,000 to 20,000 lung cancer deaths per year and may be the second leading cause of lung cancer after cigarette smoking. EPA has established a level of 4 pCi/L as the level above which building owners should take action to reduce exposure to radon.

Table 1. Distribution of Houses and Radon-Induced Lung Cancer Risk With Respect to Radon Concentration. The estimated values are based on the lognormal distribution of radon levels estimated by Nero et. al.

Radon Level X (pCi/L)	Portion of Houses Above X	Radon Level in Houses Above X (pCi/L)	Percent of Risk Associated with Houses Above X
0	1×10^{0}	1.5	100
1	4.6×10^{-1}	2.7	82
2	2.2×10^{-1}	4.2	60
4	7.4×10^{-2}	7.0	33
10	9.7×10^{-3}	15	9
20	1.3×10^{-3}	28	2
50	4.8×10^{-5}	65	0.2
100	2.4×10^{-6}	130	0.01

A.3.2 Policy Background

The current EPA and state programs for reduction of risk from indoor radon are oriented toward reducing exposure to radon in existing buildings and preventing exposure in new buildings. The approach is to inform the public of the potential hazards

and provide cooperative technical assistance through state and Federal governmental agencies with the hope that building owners will act voluntarily to reduce exposure to radon. Quality control programs for air testing and analysis, research and demonstration of techniques for radon mitigation and risk communication, and epidemiological studies of homeowners are being actively implemented. EPA is working on the development of building codes to prevent elevated radon levels in new buildings. These efforts are being publicized as part of an active EPA public awareness program.

Elevated radon levels have been found primarily in single family homes. Elevated, multiple family structures usually have low radon levels. Monitoring to date indicates that there is no simple way to characterize which homes may have elevated radon levels based on location. Radon levels vary dramatically from house to house in a given neighborhood and elevated radon levels occur in areas which are not considered high risk areas based on soil/geology criteria. Basements of homes have the highest levels; higher floors usually have levels 2-4 times lower. The only certain way to determine the radon risk in each home is to test the air quality in the home. A nationwide program of radon testing in all 59 million single family homes would cost approximately $1 billion.

There is a great deal of attention being given to reducing the EPA guideline for mitigation action from 4 pCi/L to 2 pCi/L. EPA estimates that most of the population cancer risk is from the large number of people who live in homes with a radon level which is between 0 and 4 pCi/L. If all homes greater than 4 pCi/L were brought to 2 pCi/L, an estimated 7,000 excess cancer deaths per year could be eliminated. This could be done at a cost of $2.7 to $5.4 billion ($300,000 - $600,000 per life saved; a very low cost relative to many other environmental programs). The 2 pCi/L level is achievable in 75% of the homes through subslab ventilation which costs about $1,500 per home (Oge, 1990). If all homes greater than 2 pCi/L were brought to 2 pCi/L another 2,000 excess cancer deaths could be eliminated.

Despite EPA and state public awareness programs, only 5% of the nation's homes have been tested for radon and less than 3% of those with levels above 4 pCi/L have taken action to reduce radon exposure (Oge, 1990). A major issue for EPA is public motivation for testing and mitigating action. In several states, commercial financial lenders and potential homebuyers are requiring testing and mitigation before the sale of existing homes. Public assurance that radon mitigation work performed by contractors will be effective and done properly is also a major issue for EPA.

A recent national survey by EPA of 130 schools found that 50% of the schools had at least one room with a radon concentration exceeding 4 pCi/L. Of the 3000 rooms tested in the program, 20% exceeded the action level. The survey is too limited in scope to make any national projections on the magnitude of the exposure in school buildings. However, EPA is concerned about the potential for significant radon exposure in schools. The exposure is involuntary; the size of the school population is large; children spend 4-7 hours per day, five days per week in school; and children are being exposed to a carcinogenic substance at very early ages.

The current EPA program for radon risk reduction is largely conducted separately from programs for other indoor air pollution problems. Indoor air pollution from tobacco smoke, household chemicals and building materials (e.g., asbestos and formaldehyde) has been estimated by EPA to cause 5000 - 8000 cancer deaths per year (USEPA, 1989). Should the EPA program of public awareness, action, and exposure prevention in new buildings address other indoor air pollutant problems concurrently with radon? Many of the strategy options we discuss below will abate problems associated with other indoor air pollutants in addition to radon.

A.3.3 Possible Strategy Options

The Subcommittee views indoor radon as an environmental problem causing serious health risks that may be mitigated quite cost-effectively through expenditures by individual homeowners. The primary role for EPA should be to ensure that homeowners know and understand these risks, and to facilitate remedial actions by individuals choosing to undertake them.

To date, the public appears surprisingly apathetic about the health risks of radon (Cothern, 1990). Some examples of public reaction to radon are: reluctance to mitigate the problem, forgetting to put out the testing device, hesitance to purchase a testing device, suspicion about the testing firms viability or competence, failing to relate housing prices and high radon levels, and minimal and decreasing interest in services like testing and mitigation. As the result of an intensive information campaign in Washington, D.C., over 100,000 test kits were purchased. However, only about 1.2% of those with levels over 4 pCi/L have taken convincing remedial action (Doyle et.al., 1990). Despite an aggressive EPA nationwide program and state public awareness programs only 5% of the nation's homes have been tested for radon and less than 3% of those with levels above 4 pCi/L have taken action to reduce radon exposure (Oge, 1990). There have even been articles in newspapers suggesting that the problem is not nearly as serious as many scientists feel it is (Washington Times, 1989 a&b). A recent survey by the Roper organization shows that concern regarding radon has decreased 4% in the last year while the concern for most environmental problems has increased (Roper, 1990).

a. Information for home owners at time of transfer. A first strategy option might focus on making homeowners more aware of the radon levels that exist in their homes. Testing for radon levels might be required at the time at which properties are transferred, just as homes are typically inspected now for termites prior to sale. If high radon levels were found, the buyer and seller could negotiate various possibilities, including remediation paid for by the seller, a lower sale price, etc.

EPA could work with other federal agencies (HUD, Treasury, VA) to make radon testing and disclosure mandatory for government financed mortgages (FHA, VA, Fannie Mae, Ginnie Mae, Freddie Mac). EPA could work with states and local governments and

private lending institutions to extend this requirement to all mortgages or to all home sales. Several states have already adopted such requirements.

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

b. Improved radon communications program. Knowing the radon levels that prevail in the home is only the first step toward a homeowner making an informed decision about a course of action. Homeowners must also know what these radon levels mean in terms of risk. Better decisions would also result with more confidence in the accuracy of the radon testing, and assurance that any radon mitigation work undertaken will be done properly and effective. EPA has efforts under way already in some of these areas. Perhaps the most immediate need is to improve risk communication. We have little solid understanding of which risk communication techniques are effective and which are not. More research in this area would be profitable.

S.3.2 Improve techniques of communicating radon risks so public can make informed decisions. S&T, INFO

c. Regulate testing and remedial actions for schools and other public buildings. While homeowners can be left to decide for themselves whether to mitigate a radon problem they find, owners of schools or other public buildings should be required to mitigate any problems they find. Exposure to radon in schools and other public buildings is involuntary and potentially significant. EPA should establish a regulatory program for mandatory testing for and remediation of radon levels in primary and secondary schools. If national surveys demonstrate problems in other public buildings the requirement should be established for them also.

S.3.3 Require radon inspections for schools and certain other buildings. REGS, TH

d. Standards for airflow and radon protection for new buildings. Mitigation of high radon levels in existing buildings can be costly. It is far less costly to build a new home correctly in the first place. EPA might seek to have federal, state and local building codes require new homes and other buildings to be built in a manner which reduces exposure to all indoor pollutants including radon. Requirement of vapor barriers for radon (average cost of $300 per home), proper building ventilation and careful choice in building materials will result in a large reduction in future health risks from indoor air pollution. This focus on new construction could eventually yield impressive benefits. It is estimated that 40% of the housing by the year 2020 will have been built after 1990.

S.3.4 Establish airflow and radon protection standards for new buildings. REGS, TH

e. Increase scientific understanding of exposure patterns, epidemiology, and mitigation techniques for radon. Finally, our scientific understanding of radon problems might be improved in several ways. We need to understand better which subpopulations are at greatest risk and how radon exposure affects them, in order to develop a cost-effective national strategy. Further surveys to characterize the magnitude, extent and duration of population exposure in homes and schools should be performed. Additional epidemiological studies to provide more information on the magnitude of the health risk among building dwellers should be conducted. Research and demonstration on prevention and mitigation techniques, with particular emphasis on passive/low maintenance technology, should be expanded.

S.3.5 Increase knowledge base for radon, including exposure patterns, epidemiology, and mitigation techniques. S&T

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A.4 Indoor Air Pollution

A.4.1 Risk Background

In the past few years, a growing body of scientific evidence has begun to show that air within homes and other buildings can be more seriously polluted than outdoor air in even the largest and most industrialized cities. Studies of where people spend their time have indicated that they spend roughly 90% of their time indoors (USEPA, 1988). Thus, for most of the people most of the time, the health risk due to exposure to air pollution may be greater due to indoor exposure than that due to outdoor exposure. Besides homes, other buildings that exhibit indoor air problems include public

buildings, schools and office buildings. Indoor air problems in factories are normally addressed differently, as occupational exposures.

In addition, people who may be exposed to indoor air pollutants, especially those exposed for long times, are often those most susceptible to the adverse effects involved. Such groups include the very young, the elderly and the chronically ill, especially those suffering from respiratory or cardiovascular disease.

Of all the potential indoor air contaminants, radon appears to lead to the largest number of fatalities. It is for this reason that indoor air radon is discussed in a separate category in the current study. Environmental tobacco smoke may be the second most important contaminant in indoor air, leading to as many as 5000 lung cancer deaths annually (Repace, 1985).

Potential biological contaminants can pervade indoor air including bacteria, mold and mildew, viruses, animal dander and cat saliva, mites, cockroaches, and pollen. These can trigger allergic reactions, including hypersensitivity, pneumonitis, allergic rhinitis, and some types of asthma. Some transmit infectious illnesses such as influenza, measles, chicken pox, and Legionella.

In addition to environmental tobacco smoke, other sources of combustion products include unvented kerosene and gas heaters, fireplaces, and gas stoves. The major pollutants released from these sources are carbon monoxide, nitrogen dioxide, and particulates. These can cause fatigue in healthy people; chest pain in people with heart disease; eye, nose, and throat irritation; and respiratory infections and bronchitis (USEPA, 1988).

Other indoor contaminants include organic gases, formaldehyde, pesticides, asbestos, and lead. These may derive from building products (e.g. plywood, insulation, paint), consumer products (e.g. cleaners, hairspray); and elsewhere. Some surveys provide a more extensive list of indoor air contaminants and problems (NRC, 1981, USEPA, 1988 and Nero, 1988).

Because indoor air is a relatively new research area, gaps in our knowledge exist and plans have been developed to provide this missing information (USEPA, 1987).

A.4.2 Policy Background

It is often commented that the Environmental Protection Agency does not have the necessary authority to regulate indoor air contaminants. However, through such Acts as the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Superfund Amendments Reauthorization act (SARA) the Agency is already regulating indoor air contaminants. For example, SARA Title IV requires the USEPA to establish a committee to coordinate Federal indoor air quality activities. The committee attempts to allocate the total Federal budget for indoor air to specific problems according to the relative risk associated with each problem. The Agency is also involved in monitoring activities such as the Total Exposure Assessment Methodology (TEAM) study. Although further authority may be needed and may be provided, some already exists in this area.

Areas in which indoor pollutants have been regulated include asbestos in schools and smoking in public places. A major study from Johns Hopkins, Yale, and other institutions recently concluded that the available data do not indicate that asbestos associated lung cancer or functional impairments can occur as a result of exposure to concentrations of airborne asbestos in many buildings. (Mossman et al, 1990) On the contrary, health risks may be generated when asbestos is released during the removal process. Within a year, the USEPA will likely propose a regulation for radon in the drinking water source. Some new proposed regulations that affect the indoor environment include the recent proposal concerning lead at the tap; such regulations are important, since some of the major sources are in the home itself.

Another area that could be regulated is the home use of various pesticides like termiticides and wood preservatives.

The effort to make homes and other buildings more energy efficient by tightening them up has heightened concern over indoor air pollutants in recent years. This sealing-up of buildings has lowered the rate of exchange between indoor and outdoor air, which has led to higher concentrations of contaminants indoors. The air exchange rate is one of the most important variables in determining the concentration of indoor air contaminants (NRC, 1981). Recent policy analysis from the National Research Council suggests that energy management strategies that could lead to reduction in indoor air quality should be weighed against the potential reduction in productivity that could result (NRC, 1987).

A.4.3 Possible Strategy Options

a. Educate state and local governments about existing technical information on indoor air pollution. One of the strategy options in the indoor air area is the general concept of providing information to state and local governments to stimulate their involvement in addressing the problem. There are several ways to do this, including dissemination of information that can be used to educate the public, training of environmental personnel, providing technical assistance, and providing a clearinghouse for information.

Because of the many different contaminants that contribute to indoor air contamination, the task of developing information resources is large and complex. This effort would involve developing information in areas where research is needed, collecting existing information, and packaging the information in pamphlets, books, papers, and reports suitable for a wide variety of audiences.

Although providing information to such a diverse audience is a complex task, it is of low cost to both EPA and society. Currently the Indoor Air Division budget is $1.3 M, of which approximately 1/2 is for direct dissemination of information. Past efforts to provide information have been shown to be dependable and quick in transferring the

needed information to those who can use it. This is an immediately implementable strategy.

S.4.1 Provide state and local governments with technical information to help them address indoor air pollution. S&T, INFO

b. Cooperate with other Federal Agencies to regulate indoor air. Another strategy option is for EPA to cooperate with other Federal Agencies to identify high risk sources and pollutants, in order to pool authorities to control them and provide more complete information.

A number of other Federal Agencies are involved in the area of indoor air, including the Department of Energy, the Consumer Product Safety Commission, the Department of Housing and Urban Development, and the Department of Health and Human Services (including the Center for Disease Control and the National Institute of Occupational Safety and Health). Cooperation with these and other Federal Agencies can lead to cost efficiencies, increased speed in dealing with the problem, and can also lead to a more dependable solution.

S.4.2 Work with other agencies to regulate products that cause indoor air problems. PP, INFO, REGS

c. Establishment of ventilation standards and practices for new and exising homes. A final strategy option is a more active Federal involvement in the development of ventilation standards and practices for both new and existing structures. The ventilation rate is one of the most important parameters in controlling the concentration of indoor air pollutants; better information and more effective control are needed in this area. Since it is one of the most important variables, it is most cost effective to look at this area first. This control strategy or policy could be easily implementable and is a most dependable way to reduce indoor air pollution. Because of the time needed for new buildings to adopt a code change and because new buildings are only a few percent of all buildings, this strategy could take many years to be effective. However, if implemented now, approximately 40% of buildings could be controlled by the year 2020.

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

S.4.4 Develop better instruments to diagnose sick buildings. S&T

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A.5 Stratospheric Ozone Depletion

A.5.1 Risk Background

Stratospheric ozone shields the earth's surface from ultraviolet-B radiation (UV-B). As the ozone is depleted, increased UV-B causes more skin cancers, cataracts, and suppression of immune systems, as well as possibly damaging crops and aquatic organisms. Chemicals containing chlorine that reach and persist in the stratosphere cause such ozone depletion; these include chlorofluorocarbons (CFCs) like $CFCl_3$ and CF_2Cl_2, halons like $CBrF_3$ and $CBrClF_2$, and to a lesser extent, methyl chloroform (CH_3CCl_3) and carbon tetrachloride (CCl_4). The ozone depleting action of these chemicals may be lessened by the presence of carbon dioxide (CO2), nitrogen oxides (NO, NO2), and methane (CH4). Nitrogen dioxide, for example, normally acts as a catalyst in photochemical reactions which destroy and create ozone (roughly at the same rate). However, in the presence of chlorine atoms, nitrogen dioxide (NO2) can mitigate against ozone depletion by combining with chlorine to form chlorine nitrate (ClNO3), thus removing chlorine which acts as a catalyst in ozone-destroying reactions.

As well as being ozone-depleters, CFCs are also potent greenhouse gases. They account for about 20% of total greenhouse gas emissions from human activities on a carbon dioxide equivalent basis (Federal Register, 1988).

Currently, CFCs are primarily used in refrigeration, foam blowing, and as solvents in electronics production. Halons (brominated substances) are used in fire fighting. Methyl chloroform is used as a solvent in electronics manufacture. Carbon tetrachloride is a specialty chemical and a precursor to CFCs in the United States; it is used elsewhere as a grain fungicide and a solvent.

A.5.2 Policy Background

The problem of ozone-depleting substances serves as a model in which EPA has departed from its traditional approach to pollution control, i.e., engineering controls and product-use bans. The rich experience here can aid in addressing other high-priority environmental problems. Strategies adopted to date include:

a) Allocated Quota Option: The producers and importers of CFCs and halons receive production and

consumption (production minus exports plus imports) rights or allowances. These implement the Montreal Protocol and are marketable. CFC quantities are to be reduced to 1986 levels, followed by a 20% reduction by 1993, and an eventual reduction to 50% by 1998. Halons are frozen at their 1986 levels starting in 1992. In London, in late June 1990, an agreement signed by 93 countries at a meeting of the parties to the Montreal Protocol set a new phase-out plan, although it must be ratified before it is official. The new agreement calls for a 20% reduction in CFC production by 1993; a 50% reduction by 1995; and 100% reduction by the year 2000 (all from 1986 levels). A halon phase-out is also described, with a cessation of halon production by 2000. In addition, a "declaration of intent" is formulated for a phase-out of hydrochlorofluorocarbons (HCFCs); the proposed deadline is 2040, with 2020 preferred. Alternative options evaluated but not selected were "regulatory fees," "auctioned rights," and "engineering controls and product bans" (Federal Register, 1988).

b) Excise Tax: A tax is assessed on each pound of regulated chemical based on its ozone-depleting potential. The tax is progressive, thereby increasing the cost of the material through future years. It provides an economic incentive for recycling, as recycled material is not taxed, and also generates a market for substitutes (Omnibus Budget Act, 1989).

c) Evaluation of Alternative Chemicals: EPA is reviewing environmental and toxicological effects of alternatives to CFCs and halons. Environmental concerns include not only ozone-depleting potential, but also effects on energy consumption and consequent increased carbon dioxide production.

d) Technology Transfer to Developing Countries: The agreement signed at the London meeting of the parties to the Montreal Protocol established a fund to aid developing nations in pinpointing the ozone-depleters they use and in installing ozone-safe technology. A fund expected to total $240 million will be managed by the World Bank.

e) Recovery/Recycle/Replacement: EPA is working closely with user sectors to eliminate barriers to recycling by setting industry standards for product purity, by establishing a program for certification of refrigerant recovery devices, and by co-sponsoring projects on alternative refrigeration mixtures and foam structures. Several other consortia with producers and users have been formed concerning appliances, fire fighting foams, and solvents.

f) Other Ozone Depleters: Under the London agreement, methyl chloroform will be reduced 70% (from 1989 levels) by the year 2000 and its production will be halted by 2005. Carbon tetrachloride will see a 50% reduction (from 1989 levels) by 1995 and will be phased out entirely by 2000.

Preliminary estimates place the U.S. cost of the phaseout of chlorofluorocarbons and halons by the year 2000 at $2.7 billion over the next decade for the schedule of intermediate reductions currently incorporated in the Montreal Protocol. (U.S. Government Printing Office, 1990). The cost for the accelerated program under the London agreement will presumably be higher.

The Subcommittee views the current EPA effort (EPA, Nov. 1989) on ozone depleters at least in a qualitative sense to be of the broad-based nature required to address global issues in an effective manner. Some in this area question whether sufficient resources are being placed on fully implementing all the programs that are being undertaken.

A.5.3 Possible Strategy Options

a. Use global cooperation to virtually eliminate use of CFCs, halons and other stratospheric ozone depleters. Ozone depletion is a global problem and efforts to slow it require global cooperation. Strengthening of the Montreal Protocol is the key to achieving this. The effects of a complete phase out of CFCs, halons, carbon tetrachloride, and methyl chloroform are being evaluated by EPA. The President has called for a complete elimination of CFCs and halons by the year 2000, providing safe substitutes are available. An international meeting of all parties to the Montreal Protocol took place in June 1990 to address similar issues. While the agreement in which the meeting resulted steps up the phase-out of CFCs and halons and sets timetables for the elimination of methyl chloroform, carbon tetrachloride, and possibly HCFCs, the timetables will not be official until the agreement is ratified. Furthermore, some environmentalists think that the deadlines at or beyond the year 2000 are too lenient and that phase-outs of ozone-depleting substances should occur much more quickly. In any case, we should work towards a timely ratification and realization of the goals set in the London agreement. Renegotiation to speed up phase-outs even further and to establish some concrete language concerning HCFCs provide additional possibilities for ozone protection.

Besides strengthening the Montreal Protocol, EPA should consider tracking by regulatory means the application and usage of various CFC and halon substitutes that significantly deplete ozone.

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs, halons, and other ozone depleters. PP, FOR

b. Work with other countries to develop ozone-safe technologies. In addition to strengthening the Montreal Protocol, its original supporters could take steps to encourage participation by other nations, particularly that of lesser developed countries. At this point only 12 developing countries have signed the Montreal Protocol. The London agreement, through its provisions for technological transfer, added both India and China to the list. EPA-sponsored teams plan to visit developing countries to aid their evaluation of alternative, ozone-safe technologies. Financial assistance to lesser developed countries that wish to support the Montreal Protocol is also provided by the London agreement. A fund of $240 million will be available to those countries, in order that they may identify their use of ozone-depleters and implement ozone-safe technologies. An active technical transfer program, as well as one which supplies financial aid, is crucial to worldwide involvement in the Montreal Protocol.

S.5.2 Help other countries develop ozone-safe technologies. PP, FOR

c. Develop recycling techniques and safe alternatives for CFCs. Recycling of CFCs will be necessary if the U.S. hopes to cut CFC use and still maintain its standard of living. EPA plans to develop a program to encourage or require recycling of CFCs in selected areas.

Also, the need to recycle CFC substitutes (HCFCs and HFCs) will be investigated.

Development of recycling techniques that are complete and widely accepted needs to be fostered by EPA. This can be done through testing and evaluation, financial aid, or other means similar to those in the CERCLA SITE program. Recycling also is needed to support CFC-using products past the year 2000 to avoid costly retrofit or premature retirement. The EPA National Advisory Council for Environmental Technology Transfer has published a series of very useful reports on how to foster technological innovation (e.g., Palmisano 1989).

The Agency should provide technical information to small user firms on safe substitutes and recycling opportunities. The efforts of the Pollution Prevention Office could be focused on extensively promoting application of safe alternatives (including chemical and process alternatives) known to be available for any current ozone- depleter uses. The ozone-depleter phaseout is the most prominent pollution prevention effort currently undertaken in the world, and this office's network capabilities could be focused on taking advantage of the opportunities presented and on ensuring that it accomplishes the most broad pollution prevention possible.

EPA should consider a more aggressive effort to promote known safe alternatives to ozone-depleting substances. In its efforts to expedite testing of chemical alternatives, the agency should not miss opportunities to ensure that known safe alternatives are implemented by users wherever possible. This is particularly true with respect to substitutes for the solvents CFC-113 and methyl chloroform. The agency has stated its desire to ensure that users do not replace these solvents with solvents which are considered to be ozone depleters or probable human carcinogens (Federal Register, 1989). However, the agency, to our knowledge, has not yet taken positive regulatory steps to ensure that this does not happen, e.g., by invoking its significant new use rule powers under TSCA (GAO, 1989) or by undertaking focused technology transfer efforts to promote superior alternative processes, such as aqueous cleaning. EPA might also consider coordinating a program to allow "ozone-friendly" labels on substitute products to increase public awareness.

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

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A.6 CO_2 and Global Warming

A.6.1 Risk Background

The earth's atmosphere traps heat from the sun, thus making the planet habitable. This phenomenon, called the "greenhouse effect", can be exaggerated if human activity changes the composition of the atmosphere. Carbon dioxide, methane (natural gas), N_2O, and chlorofluorocarbons (CFCs -- used in refrigeration, foam products, etc.) result in about 86% of human impact on the atmosphere's greenhouse effect even though they are a small fraction of the total atmosphere (USEPA, 1989). About half of the human impact results from the consumption and production of energy (USDOE, 1990). Deforestation, agriculture, mining, and other activities contribute the rest.

Human activities have increased atmospheric carbon dioxide concentrations 25% above preindustrial levels (Ramanthan, 1986). It is likely that human activity will double carbon dioxide concentrations during the next 30-40 years (USEPA, 1989, USDOE, 1990 and OECD, 1989). Methane concentrations have more that doubled. Human activities are now responsible for about half of the N_2O, and methane released into the environment.

There is controversy over the consequences of doubling carbon dioxide and other greenhouse gases, because of the extreme difficulty in using computer models to simulate unprecedented global climatic conditions. However, a significant body of opinion suggests that emissions equivalent to doubling carbon dioxide in the atmosphere would increase global temperatures 1.5-4.5 degrees centigrade. While not all the effects of climate warming would be negative, it is clear that a temperature change of this magnitude would, at a minimum, result in major disruptions. Temperature increases of this magnitude could disrupt agricultural practices,

alter ecosystems, and create severe drought conditions in some areas and violent storms in others (USDOE, 1990). The destructive power of hurricanes and other storms could increase 40-50% due to global warming (Emmanuel, 1987). It is even possible that world ocean levels could rise a meter or more, threatening the coastal areas where most people of the world now live. Most of the world's productive wetlands and fisheries are also in these coastal areas. There is no certainty that biological systems could adapt rapidly enough to avoid major ecological calamities. Areas with marginal agriculture and poor coastal nations (such as Egypt and Bangladesh) would be most greatly affected.

A.6.2 Policy Background

Policy designed to affect global climate change should be made recognizing that:

a) Enormous uncertainties about the magnitude and timing of the risks involved will remain for some time.

b) If we wait to take action on climate change until these uncertainties are resolved or until climatic change has clearly occurred, the atmosphere will have changed sufficiently to prevent reversing the changes for a century or more.

c) The U.S. is responsible for about 20% of the emissions affecting global climate change; the problem and the solutions are international in scope.

d) Programs designed to slow climate change significantly could reduce releases of greenhouse gases from human activity by 50-80%.

e) No simple change can result in significant reductions of greenhouse gases. A comprehensive, balanced program will be required to increase global energy efficiency and to replace existing energy supplies with low-carbon substitutes (such as renewables and passively safe nuclear power).

f) Programs designed to encourage major changes in energy production may require research on new technologies, a regulatory environment that encourages environmentally acceptable technologies, and programs providing subsidies to low-carbon energy sources or taxes on less desirable fuels.

g) Since the greenhouse gases already released are likely to have significant effect on the global climate, it will probably be necessary to develop programs for adapting to climate change as well as programs to slow the change.

Many policies designed to deal with global climate change can be justified on other grounds; the threat of climate change gives them greater urgency. Programs to encourage energy efficiency and alternatives to carbon-based fuels, for example, can reduce criteria and toxic air pollutants, provide cost-effective energy services, and reduce U.S. dependence on foreign suppliers.

A.6.3 Possible Strategy Options

A comprehensive international approach is needed to make the changes needed for a significant effect on global warming. The following specific strategies provide several of the necessary elements of such an approach. An international climate change protocol should be developed to tie these elements together. (USEPA, 1989, USDOE, 1990 and Project 88, 1988).

a. Increased research to better understand global warming mechanisms. Increased research will help us understand the way human activities can change the global environment, and the impact of climate change. Research could focus on improving our ability to predict changes in air and water temperatures, sea-levels, rainfall, and storm conditions and evaluate the implications of these changes on managed and unmanaged ecosystems. This will require improvements in models treating interactions between different components of the earth (the atmosphere, hydrosphere, lithosphere, and biosphere), including such phenomena as cloud formation, ocean currents, assimilative capacity of forests and oceans, and the circulation of carbon dioxide and other gases in the oceans (NRC, 1975).

The President's 1991 budget proposal includes $1.03 billion in funding for global climate change research (U. S. Government Printing Office, 1990).

S.6.1 Understand better the potential for global warming and its impacts. S&T

b. Investigate ways to prevent and adapt to global warming. Increased research on agricultural practices that reduce methane produced from cattle, rice production, fertilizer uses, and other activities could result in significant reductions in greenhouse emissions. Technologies to minimize emissions have not received priority.

Excess greenhouse gases already released will affect the global climate, thus increased research in adaptive techniques is important. Priority should be given to development of drought-and heat-resistant species, increased efficiency in irrigation, and methods for protecting shorelines against sea level rises and severe storms. Planning should be undertaken to explore ways low lying areas can adapt. This would require accurate predictions of new water-levels and other impacts on coastal areas. Land-use and water management plans should also be modified to reflect climate change concerns.

S.6.2 Increase research on ways of preventing and adapting to global warming. S&T

c. Use energy conservation as a method for slowing global warming. Technologies that increase energy efficiency are often the most cost-effective way to reduce production of greenhouse gases. Fossil fuel in the United States is used in roughly equal quantities by buildings, industry, and transportation (taking into account the fossil fuels used to generate electricity). About 70% of all electricity in the U.S. and 97% of all transportation energy comes from fossil fuels (USDOE, various issues). Promoting energy efficiency requires research investment in a broad range of technologies for buildings, industry, and transportation. It also requires creating a market

for energy-efficient techniques. Some of the most effective strategy options include:

1. Consider imposing a fuel tax based on the carbon content of the fuel and/or imposing a tax on gasoline. A gasoline tax might be set at a level high enough to expand markets for efficient vehicles and products -- at least 50 cents per gallon. The carbon tax would be the most effective way to reduce CO_2 emissions, but the economic dislocations it would cause are unknown. Revenues from a 50 cent per gallon tax on gasoline alone would yield $56 billion annually; this money could be used to subsidize investments in efficiency elsewhere in the economy.

2. Tax inefficient vehicles and provide rebates for purchases of efficient vehicles. Encourage use of more efficient modes of transportation, such as public transportation in preference to private autos.

c) Public Utility Commissions could provide utlities incentives to make cost-effective investments in efficiency. Utilities could also be required to include environmental costs explicitly in capacity-expansion planning decisions. Better analytical tools for utilities, changes in federal utility regulation, and creative management of federally regulated power marketing authorities would help.

3. Develop model energy-efficient building codes and encourage their adoption nationwide. Federally owned and leased buildings should set a national standard.

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

d. Technologies involving non-fossil and non-carbon energies to be encouraged. An obvious long term solution would be to develop energy sources that do not produce greenhouse gases. Energy supply problems are dominated by: 1) the need to provide a liquid fuel substitute for transportation, and 2) the need to supply rapidly growing demands for electricity. Unless changes are made, fossil fuel consumption for transportation could grow rapidly worldwide. Increased demand for electricity in the U.S. and elsewhere is likely to be met primarily by coal. While it is technically possible to capture the carbon dioxide released by burning fossil fuels, the process is cumbersome and expensive. Important initiatives include:

1. Promoting development of alternative approaches and substitutes for fossil-based transportation fuels and supporting greater use of alternative fuels in the near-term. Promote research on conversion of wood and other biological materials to liquid fuels and production and storage of hydrogen for the long-term. Combustion of wood and other biological materials releases carbon dioxide into the atmosphere, but the carbon can be captured if new plants are grown to replace them (and provide a future source for more fuel). Such a cycle adds no net carbon dioxide. Hydrogen can be produced from electricity.

2. Promoting development of non-carbon sources of electricity. The 14% of U.S. energy needs not met by fossil fuels comes from nuclear power and renewable energy sources -- primarily hydroelectric power, direct combustion of wood and wood products, and geothermal power. A vigorous research program is needed to increase this share. In the near-term, high-efficiency uses of natural gas should be encouraged as alternatives to coal combustion. Research for long-term power sources should focus on development and deployment of a variety of renewable resources (wind, photovoltaic, geothermal, gassified biomass) and the possible use of passively safe nuclear power.

3. Creating incentives for the adoption of non-carbon energy sources through utility regulation. The Public Utilities Regulatory Policy Act requires utilities to purchase power from independent power producers at its avoided cost. Considering the externalities associated with coal use, a further increase might be appropriate.

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

e. Promote international cooperation to preserve and enhance the world's forests. The world population continues to grow at a rapid rate. As energy demands will increase with population, it will become even more important to have worldwide cooperation in controlling global production of greenhouse gases. International cooperation is also needed to preserve and enhance forests worldwide through debt-for-forest trades, reforestation programs, and regulations requiring planting that offsets carbon production from new generating facilities. A global convention for international trading in greenhouse gases would provide a world market for such trades.

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

f. Develop international agreement on greenhouse gases. The problem of global warming is clearly international in scope and its solution requires an international effort. The efforts of the Intergovernmental Policy Coordinating Committee (IPCC) should be encouraged.

S.6.6 Pursue an international agreement on greenhouse gases. FOR

g. Develop strategies to reduce use of CFCs and halons. Finally, strategies to reduce CFC's, which are greenhouse gases as well as stratospheric ozone depleters, would be helpful in slowing global warming.

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INRO, MI, TAX, FOR

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A.7 Non-Point Source Discharges to Surface Water

A.7.1 Risk Background

Non-point source discharges are the largest contributing source type to pollution of surface waters. Nonpoint sources are responsible for most of the loadings of conventional pollutants -- 96% of the sediment, 79% of the nitrogen, 74% of the phosphorus and 41% of the BOD -- and similarly high fractions of many toxic pollutants (Gianessi, 1986). In recent water quality assessments, states found that nonpoint sources contributed to impairment of beneficial uses in many more miles of streams than did point sources (USEPA, 1990).

Percentage of Impaired River Miles Affected by Each Source of Pollution

Nonpoint Sources	
Agriculture	55
Resource Extraction	13
Hydrologic Modification	13
Silviculture	9
Construction	6
Land Disposal	4
Nontraditional Point Sources	
Storm Sewer/Urban Runoff	9
Combined Sewers	4
Traditional Point Sources	
Sewage Treatment Plants	16
Industrial Plants	9

Distinctions between point and nonpoint sources of pollution are not always clear; states have generally addressed them based more upon how they are controlled than how they originate. Point sources are generally controlled via permits that limit allowable amounts of pollutants and are subject to enforcement action if their permit limits are violated. Nonpoint sources, on the other hand, are addressed primarily via voluntary controls such as best management practices and incentive programs. Few regulatory programs exist for nonpoint sources, and these are managed only at the state or local level.

Some sources have both point and nonpoint elements. Storm sewers/urban runoff is a leading example; historically regarded as more of a nonpoint source, it is now becoming subject to point source controls. Even sources widely acknowledged as nonpoint may contain some point source elements (e.g., permits may be required for some agricultural activities such as animal feedlots; many mining discharges are regulated under the point source permit program).

As the table above shows, agricultural activities contribute substantially more to non-point source pollution across the country than any other activity. Agriculture is responsible for between 68 and 83% of the non-point source loadings of four conventional pollutants (Gianessi, 1986). A survey of states found agriculture responsible for 64% of the river miles affected by non-point source pollution (ASIWPCA, 1985). In some specific regions, though, urban runoff, silviculture, grazing, mining, construction, septic tanks, contaminated in-place sediments, air deposition, or discharge of contaminated ground water may be the major contributor to a nonpoint source problem.

Some of the various ecological damages from nonpoint source discharges include: eutrophication from excessive nutrient loadings, siltation and loss of spawning habitat from sediment in runoff, reduction in water transparency leading to loss of submerged aquatic vegetation, bioconcentration of toxics in fish (pesticides from farms, metals in urban runoff), and acidification from mine drainage. The intensity of damage can range from long stretches of streams rendered lifeless from acid mine drainage in the Appalachians, to radical changes in the nature of aquatic communities in eutrophic lakes, to more subtle impacts on fish health and reproduction from low levels of persistent toxic chemicals. Adverse human health impacts can result from consumption of contaminated fish, shellfish, and drinking water.

A.7.2 Policy Background

Several decades ago, point sources were the largest contributors to water quality problems, but annual expenditures of roughly $20-30 billion on control of point sources (USDC, 1987) have resulted in their now being far better controlled than nonpoint sources. At present, the great majority of industrial point sources comply with permits requiring use of "Best Available" control technology, and 84% of the nation's municipal wastewater is treated to secondary or better standards (EPA, 1990). Certainly more remains to be done in controlling point sources -- municipal sewage treatment plants, for example, are usually regulated to control only a subset of the toxic constituents in their effluent. But nonpoint sources, in contrast, have received little control effort. For example, over 40% of the nation's cropland is eroding at excessive rates (USDA, 1989). Nitrogen application to agricultural soils often exceeds that recovered by crops by 50 - 70% (Johnson, 1989). Much overapplication is due to widely varying carryover from the previous crop year; farmers gear application to the unusual year when large amounts may be needed. This results from a lack of information about nitrogen actually remaining in the soil (Magdoff, 1984; Fox and Pechielek, 1983).

It is difficult to evaluate the results of this concentration of control effort on traditional

point sources. Water quality trend analysis has been hampered by the lack of good baseline data, changing definitions of what constitutes good water quality, and a focus on chemical rather than more meaningful biological indicators. It appears that improved point source controls have led to improved water quality immediately downstream of the treatment plants (Leo, 1984). But modeling studies suggest that relatively few river reaches nationwide are sufficiently affected by point sources to profit substantially from improved point source controls. One analysis found that only about 7% of river reaches would show detectable water quality improvements with typical improvements in point source treatment (Gianessi, 1981). By contrast, nonpoint sources affect many more river reaches. The broadest statistical analysis of water quality trends found no clear nationwide improvement over the period 1974-1981. The U.S. Geological Survey conducted statistical analyses of water quality trends over this period for 34 constituents at several hundred monitoring stations across the country. For all constituents, far more stations showed no statistically significant change than showed an improving or worsening trend. Constituents for which many more stations showed improving rather than worsening trends included microbial contaminants (presumably due to improved sewage treatment) and lead (from general reductions in the use of lead). Constituents for which concentrations grew substantially worse over this period included nitrate, dissolved solids, turbidity, and several metals (Smith, et.al., 1987). Presumably, these trends developed as a result of lack of attention to nonpoint sources, despite intensive investment in point source controls.

Most types of nonpoint sources have proven far more difficult to control than point sources primarily because a command and control regulatory approach is difficult to implement for them. Nonpoint source dischargers are numerous and widespread, and are difficult to identify, monitor, establish control requirements for, and enforce against. They discharge sporadically (primarily when it rains) and in highly variable amounts and concentrations. Also, with regard to agricultural nonpoint sources in particular, virtually no jurisdictions have shown the political will for a regulatory approach.

A.7.3 Strategy Options

A first option is for EPA to increase its efforts with the Department of Agriculture to reform farming practices. Farming can be conducted profitably in a manner that minimizes off-site damages to water resources (National Research Council, 1989). The following are some of the practices that should be encouraged:

a) Reduce use of fertilizers and pesticides through increased use of techniques such as integrated pest management, crop rotation, alternative tillage practices (such as ridge till) and soil testing.

b) Use best management practices (BMPs) that reduce off-site losses of soil and those chemicals that are applied (e.g., no-till and low-till planting, filter strips, grassed waterways)

c) Reduce farming activity on erodible acreage in priority watersheds.

d) Maintain or create vegetative stream buffers.

Modifying farming practices on 2 million farms across the nearly 400 million U.S. acres of cropland is an ambitious goal. The best chance for success lies in working with USDA to build greater concern for off-farm environmental impacts into the huge existing federal agriculture programs. If the $10 - 26 billion recently spent annually on Federal farm programs, the $2.4 billion spent on agricultural conservation programs, and the agricultural extension agents in nearly 3,000 U.S. counties can be oriented even marginally more toward environmental protection, the impact will dwarf that achievable by direct EPA and state nonpoint source control programs. (By contrast with the resources directed at agricultural issues, EPA's resources devoted directly to nonpoint source controls total less than $100 million per year.) Desirable revisions in agricultural policies could include:

a) Seek certain changes proposed by the Administration, community groups, and many others in the upcoming farm bill and in future farm legislation. The calculation of a farmer's base acreage on which price support payments will be made should be revised to eliminate the current strong disincentive against crop rotation. The Conservation Reserve Program (CRP) should be reoriented to target areas within priority watersheds that contribute significantly to water pollution, instead of targeting areas that are highly erosive (in effect, the targeting should reflect off-farm impacts rather than on-farm impacts). A higher ceiling price should be adopted for CRP acres taken out of production. With a better targeted CRP, fewer acres ultimately need be enrolled. Even with a higher ceiling price, the total costs of the CRP will not increase, while water quality benefits will increase substantially.

b) Support development of an integrated farm management program incorporating low-input sustainable agriculture (or as some prefer to call it, input-efficient agriculture), integrated pest management, improved tillage practices, and other nonpoint source BMPs. USDA's research budget in these areas is small and fragmented and should be increased. Agricultural extension agents should be directed and funded to emphasize these approaches to farmers as means to maximize long-term farm profitability (as opposed to short-term farm yield) and as elements of farmers' environmental responsibilities. Demonstration projects should be conducted that show convincingly that this approach to farming is effective, economical and environmentally protective relative to traditional practices. EPA should become more active in this area, participating in and reviewing USDA research and demonstration projects.

There are several major attractions to this agricultural policy strategy:

1. Although potentially involving large sums of money, it relies primarily on redirection of USDA resources, and hence will have a minimal additional cost to the government.

2. Most of the changes in farming practices it seeks will increase farm profitability. To the

extent slightly reduced agricultural production results, it will affect heavily price-supported commodities. Social costs should be at most small; an actual reduction in the total cost of farming is more likely.

3. The likely risk reduction from widespread adoption of more benign farming practices is extremely large, constituting much of the total risk from nonpoint sources. Reduced use of agricultural chemicals will have substantial risk reduction benefits in other areas also, for example, reducing pesticide residues on foods and reducing ground water contamination by nitrates and pesticides.

This strategy will, however, clearly be difficult and slow to implement. EPA has little direct influence over USDA or farmers. It might require a decade or so before a substantial payoff is realized.

c. To accelerate progress, EPA might begin to investigate whether and where regulatory controls over environmental problems caused by agriculture should be adopted. Virtually all of the current or potential USDA programs seeking environmentally sound farming practices rely on voluntary participation by farmers. Farmers are offered technical assistance, subsidies, cost sharing and other inducements to act in an environmentally responsible manner, and they are free to accept or reject them. By contrast, standards have been established prescribing the levels of water pollution allowed from industrial and municipal point sources, and compliance with these standards is vigorously enforced. Regulatory controls imposed by federal, state or local authorities are the norm for several other sources of nonpoint source pollution, including silviculture, mining, and construction. Why should farmers be treated differently than other polluters? Several of the traditional arguments against regulating farmers appear to be valid no longer:

1. "Point sources of water pollution are a bigger problem, and can be controlled more cost-effectively." After several decades of progress in controlling point sources, nonpoint sources now seem to be an equal or larger water quality problem. Studies conducted by EPA's Regulatory Innovations staff on point-nonpoint trading in the Great Lakes, Wicomico (MD), Boone (TN), and Dillon (CO) watersheds have found that nonpoint source controls could abate nutrient loads at a lower cost per pound than further point source controls.

2. "Farming is a worthy, independent way of life. The government should not tell farmers how to farm." Farming is a business -- with high technology, heavy capital investment and large enterprises -- like others whose environmental impacts are regulated. Total assets of the farm sector nearly equal that of manufacturing. The largest 4% of farms account for 50% of agricultural sales (Cook, 1985).

3. "Direct regulation of agricultural nonpoint sources is not administratively feasible." While it may be impractical to establish effluent limitations for farms and monitor their compliance, it is administratively feasible to establish design and operating standards prescribing farm BMPs that are tailored to local environmental conditions. Other nonpoint source types are successfully regulated in this manner. Requiring installation of BMPs via permits for individual farms might also be feasible, if limited to large farms in critical areas.

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

d. Another strategy option regarding nonpoint sources is for EPA to work with states to enhance water quality management programs. The bulk of EPA and state attention in water programs is devoted to regulating, permitting and enforcing against point sources. To the extent the focus begins to shift to a concern for water quality, the attention given to nonpoint sources will increase. For several years EPA has leaned hardest on states to reduce point source permit backlogs, implement pretreatment programs for POTWs, and take appropriate enforcement actions against point sources. EPA has not similarly emphasized the states' water quality responsibilities -- establishing meaningful water quality standards, upgrading water quality monitoring, identifying water bodies not meeting standards, calculating total maximum daily loads for those water bodies, and assigning control responsibilities beyond technology-based requirements to the appropriate point and nonpoint sources in order to meet the standards. EPA appears recently to have begun shifting some of its efforts from developing and implementing technology-based standards to a water quality-based approach. The agency should continue to do so. We further suggest targeting this water quality concern. Attention should not be directed broadly at all water bodies in violation of standards, but should be focused on the specific water bodies where inadequate water quality is preventing realization of particularly high potential ecological, recreational, water supply or commercial values. Several specific actions might include:

1. Seek increased funding for the Clean Water Act Section 319 program of grants to states for nonpoint source planning and targeting. Of the $400 million authorized for 1987-1991, only $40 million has been appropriated. Only $15 million is sought for FY 1991. States can use these funds very effectively in levering programs of other federal agencies that affect water quality (e.g., USDA agricultural programs, USFS silvicultural programs, DOI range management programs). EPA Headquarters can develop informational materials for states that suggest how they can interact with these other programs, and EPA and USDA need to find ways to coordinate these programs.

2. Encourage state water quality agencies to take a broader view of their responsibilities. Water quality agencies should try to influence the activities of resource management agencies (e.g., agriculture, forestry, fish and game, mining, oil and gas). Water quality agencies should try to broaden the range of financial resources that are applied to nonpoint source control activities (e.g., coastal zone management planning grants).

3. Develop guidance materials on the concept of trading control obligations between point and nonpoint sources when both source types contribute the same pollutant to a specific area. This

approach may provide a particularly cost-effective way to attain water quality standards where point sources have met their technology-based requirements, yet further controls are still necessary. Although the number of areas to which this approach might be applied is now very limited, the utility of such an approach may increase in the future. With this option we are not advocating relaxation of controls or requirements for point sources; we are advocating that further progress toward water quality goals be achieved in a cost-effective fashion.

Like the agricultural strategy, this approach of working with states to emphasize water quality management will probably be relatively slow to bring results. Lacking any direct ability to regulate nonpoint sources, EPA must resort to such an indirect, cooperative approach.

S.7.2 Focus EPA and state water programs more on enhancing water quality and less on permitting point sources. REGS, NR, AP

e. Finally, EPA should consider increasing its research and technical assistance efforts on a variety of non-agricultural nonpoint source problems that are of substantial importance to particular regions of the country. While agriculture is responsible for the bulk of nonpoint source loadings nationwide, it also is beginning to receive virtually all the federal attention to nonpoint sources. Other nonpoint source problems can cause locally severe impacts. Septic tanks provide one example. In some regions (Long Island, Cape Cod, some rural communities) septic tanks are a major contributor to pollution of ground and surface waters with nutrients and pathogens. EPA's research on low-technology improvements to or alternatives to septic tanks has been reduced, as have the agency's technology transfer efforts in this area through the "Small Flows Clearinghouse" and the National Rural Water Association. These efforts should be reinvigorated. In several other areas of nonpoint source concern (urban runoff, silviculture, mining, construction), EPA might increase its efforts to study and disseminate information on successful state and local control programs. Numerous successful programs exist, yet are not widely known of and copied. EPA might consider, for example, drafting model language that local governments could use to manage nonpoint sources based upon their land use control authorities. EPA could work with Federal land-managing agencies (USFS and BLM primarily) to mitigate the substantial impacts from grazing, forestry, mining and construction on Federal lands.

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

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A.8 Wetlands

A.8.1 Risk Background

For over 200 years, wetlands have been drained, cleared, filled, and exploited for whatever resources could be extracted from them. In their natural state, wetlands also produce significant benefits for society by: filtering and purifying water; providing essential habitat for flora and fauna; regulating flows; storing water; and buffering the effects of storms.

Wetlands help maintain water quality by trapping sediments and filtering out pollutants. Indeed, artificial ones are now being created as a cost-effective means of treating sewage. For example, the town of Arcadia, California, restored approximately 154 acres of wetlands as an integral part of its wastewater sewage treatment system. But the capacity of wetlands to improve water quality is limited and improper solid waste disposal in "sanitary landfills" causes significant nationwide detrimental impacts on wetlands. Discharges of irrigation return flows, stormwater,

other non-point source run-off, and municipal and industrial wastewater pose substantial risks to wetlands. Hazardous waste threats to wetlands are sizable: more than 40% of Superfund sites are directly associated with wetlands (see our discussions of municipal and hazardous waste problems). One recent study indicates that 72%, 90%, and 97% of sanitary landfills are within 1/4, 1/2, and 1 mile of wetlands, respectively (Lambou et al, 1989).

Forested and other wetland areas are also valuable as habitat for fish and wildlife. Nearly one-third of the 21,588 plant species found in the US occur in wetlands, although only 5% of the land area of the lower 48 states is comprised of wetlands. One-third of the nation's endangered or threatened species live in or depend on wetlands, and between 60% and 90% of U.S. commercial fisheries use coastal wetlands as spawning grounds and nurseries. Wetlands also support a major portion of the nation's multimillion-dollar fur and hide harvest. Sport fishing, hunting, bird watching, and other wetland-related recreational activities generate billions of dollars of economic activity annually (USOTA, 1984).

Despite the fact that wetlands are vital elements in ecosystems, they are disappearing rapidly. Approximately 215 million acres of wetlands existed in the 48 contiguous states at the time of European settlement, but by the mid-1970's, less than half of the original wetland acreage remained. During a recent 20-year interval, wetland losses averaged 458,000 acres annually; an area about half the size of Rhode Island was lost each year. Losses in specific regions have been even more dramatic. Originally, there were 26 million acres of wetlands in the Mississippi Delta; only 5 million remain. The prairie potholes in the Upper Midwest have shrunk from 20 million to 7 million acres. Florida's Everglades covered 2.3 million acres at the turn of the century; less than half survive. The wetlands of California's Central Valley have been reduced from 4 million to 300,000 acres (Tiner, 1984).

If wetlands are so valuable in their natural state, why are they nevertheless being so rapidly depleted? The answer is that although wetlands serve society in multiple ways, the nature of wetland benefits are such that their owners typically cannot capture those benefits for use or sale. Flood protection benefits accrue to others downstream; fish and wildlife that breed and inhabit wetlands migrate; and benefits associated with improved water quality and sediment trapping cannot be commercially exploited. Hence, for the owner of a wetland to benefit from this resource, it is often necessary to develop it. Since most wetlands are privately owned, these areas are extremely vulnerable.

The most important economic sector absorbing wetlands has been agriculture (See our discussions of non-point source pollution and pesticides), accounting for 87% of recent wetland conversions through the mid-1970's. Although urban development and other commercial conversions accounted for only 13% of wetland losses in the twenty-year period, 1955-1975, such uses are likely to pose increasing threats in the years to come (USOTA, 1984).

A.8.2 Policy Background

A number of Federal programs are intended to protect wetlands, but Federal policies tend to push and pull wetlands in opposing directions. Some Federal programs, such as flood-control and drainage projects of the U.S. Army Corps of Engineers and the Soil Conservation Service, encourage wetland conversion by reducing the cost and risk while increasing the revenue of wetland development. Simultaneously, other Federal programs, such as Section 404 of the Clean Water Act (PL 92-500), control or manage wetland use through regulation and mitigation to offset the effects of development projects (Tripp, 1988). Additionally, the Federal government acquires wetland areas for protection through the U.S. Fish and Wildlife Service. The U.S. Department of Agriculture's (USDA) "Water Bank" program has been offering some protection to wetlands since 1970, and the Conservation Reserve Program (CRP) has enrolled 400,000 acres of wetlands for 10-year contractual periods (See our discussion of non-point source water pollution for further comments on USDA's Conservation Reserve Program).

President Bush has enunciated a policy goal of no net loss of wetlands, but a national wetland protection policy has yet to be established to set priorities and reconcile conflicting programs. By offering funds for activities that protect wetlands with one hand and for harmful developments with the other, agencies work at cross-purposes, and Federal activities wind up being inconsistent and financially wasteful.

A.8.3 Possible Strategy Options

A successful plan for conserving the nation's wetlands will make use of a variety of approaches (Conservation Foundation, 1988). We suggest four possible strategy options: (1) remove government subsidies for wetland development; (2) develop new and appropriate funding sources for Federal acquisition and management of wetlands; (3) reform conventional wetland regulation; and (4) consider direct and indirect impacts in environmental impact statements for federal flood control and drainage projects.

a. Remove Government Subsidies for Wetland Development Wetlands are widely dispersed, government budgets for acquisition are extremely small relative to the amount of vulnerable acreage, and conventional regulation is frequently not palatable. Hence, a comprehensive approach to wetland conservation should include self-enforcing inducements for people to take into account the full social value of wetlands. Although this may sound difficult to implement, an important step would simply be to remove government subsidies

which promote economically inefficient and environmentally unsound development in wetland areas (Stavins, 1990). This would provide two additional benefits: 1) promote a stronger, more competitive economy by restricting government programs which distort market signals and thus foster unsound development; and 2) reduce government expenditures at a time of chronic budgetary deficits.

There are a number of strategy options which could be considered. First, total subsidies on construction of Federal flood-control and drainage projects could be reduced or eliminated. Some progress has been made in this area with passage of the Water Resources Development Act of 1986 (PL 99-662). The Act provides for increased local cost-sharing (25%) of project costs and emphasizes proper identification and compensation for all project environmental costs. It is too early to say, however, whether full benefit financing and the laudable efficiency and environmental goals of the Act will be implemented through subsequent legislation and regulation.

Second, favorable tax treatments of wetland conversion (to agricultural and other uses) could be eliminated. Moves in this direction have already occurred with the Tax Reform Act of 1986, whereby several tax code provisions which previously provided an incentive for wetland conversion were eliminated. Third, consideration could be given to strong cross-compliance legislation linked to receipt of Federal commodity program payments. A broad range of agricultural programs and subsidies provide incentives for economically inefficient and environmentally unsound development of wetland areas, including price- and income-support programs, and subsidized loans (Goldstein, 1988). While these programs obviously benefit individual farmers and others, they are in conflict with increasing recognition of the importance of reforming economically inefficient agricultural policies. In this regard, the so-called "swampbusting provisions" of the 1985 "farm bill" constitute a move in the right direction. Title XII-C of Public Law 99-198, the Food Security Act of 1985, provides that a farm operator is ineligible for price-support payments, farm storage facility loans, crop insurance, disaster payments, and insured or guaranteed loans for any year in which annual crops were produced on converted wetlands.

These strategy options for reducing or removing government sub sidies for wetland development are attractive for a number of reasons. First of all, they are likely to be effective in achieving wetland protection. Second, they will do so at minimal cost to government; indeed, net government revenues ought to be increased. Third, because subsidies for inefficient activities are removed, costs to society are minimized; in other words, these approaches are cost-effective. Fourth, those strategies which work by removing existing subsidies (in all cases) will require little, if any, monitoring and enforcement by government.

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

b. Develop new funding sources for Federal acquisition and management of wetlands. Since lack of funding is the primary limit on current wetland acquisition programs, the development of new, appropriate funding sources is crucial. Properly managed, the Land and Water Conservation Fund (LWCF) ought to be adequate for this task. The LWCF was established in 1964 to ensure that a portion of receipts from Federal offshore oil and gas leasing would be invested in acquiring inholdings and additions to the public lands. Thus, through the Fund, the depletion of nonrenewable resources finances the protection of renewable resources.

Dedication of some part of these monies to wetland acquisition could be helpful and appropriate. But, annual outlays from the LWCF have dwindled to historic lows, despite increases in revenues from offshore leasing. We find attractive a previous recommendation by the President's Commission on Americans Outdoors that a new fund be created that would accumulate sufficient capital to generate a steady stream of $1 billion per year in interest income for land acquisition, and that the Fund be used to leverage state, local, and private action (President's Commission, 1987).

A number of other appropriate potential funding sources for wetland acquisition merit consideration. First, it would be valuable to modify the Federal-Aid in Fish Restoration Fund (Dingell-Johnson Act) program, which authorizes matching grants to the states for up to 75% of the cost of projects undertaken to enhance sport fish resources, so that matching grants would include wetland acquisition and restoration projects. This proposed change would place part of the responsibility for wetland protection on the beneficiaries of these resources, as most species of sport fish depend upon wetland habitats for some portion of their life cycle.

Wetlands are just as important for maintaining commercial fisheries, for both domestic and foreign harvesters. Thus another possible source of funding would be a tax on all commercial sales of fish and shellfish in the U.S.

Complementary funding could also be made available from a portion of the Federal-Aid in Wildlife Fund (Pittman-Robertson Act), since a number of wildlife species are also dependent upon wetland habitats. A recent move in the right direction is the North American Wetlands Conservation Act (Public Law 101-224, 103 Stat. 1905 (1989)), which established a Wetland Trust Fund which is financed by interest on the Pittman-Robertson account, fines and penalties, and direct appropriations. Appropriations of $15 million annually are authorized for the period 1991-1994, and a North American Wetlands Conservation Council is established to approve wetland restoration projects.

For the long run, consideration could be given to creating a "Sport Fishing Conservation Stamp," modelled after the highly successful "Duck Stamp" program, carried out by the Fish and Wildlife Service (in the U.S. Department of the Interior) under authority of the Migratory Bird Conservation Act of 1934. Through the Duck Stamp program, wetland habitats are acquired with revenues from the sale of mandatory Federal Duck Stamps to holders of state hunting licenses. Likewise, the proposed fishing stamp could be required of all state-licensed fishermen, with the revenues used exclusively for wetland acquisition.

The logic behind this proposal is analogous to the reasoning behind the Duck Stamp program and our suggestion for restructuring the Federal-Aid in Fish Restoration Fund. The proposed stamp would essentially be a user fee, in which beneficiaries of wetlands are paying for their provision and protection. How much wetland protection would this proposal provide? A $1 stamp would raise up to $20 million annually (Wolf, 1988).

Strategy options of augmenting current funding for wetland acquisition can be cost-effective if appropriate sources of funds are utilized, as in our suggestions regarding the LWCF and the Sport Fishing Conservation Stamp. The former requires essentially no monitoring or enforcement; and the stamp program presents a minimal burden in this regard because of its association with existing state-level licensing programs.

Also, research and guidelines are needed on wetland restoration, wetland mitigation (i.e. trades for wetland losses), and constructed wetlands for wastewater treatment.

S.8.2 Develop new funding sources for federal acquisition and management of wetlands. NR

c. Reform Conventional Wetland Regulation Current wetland regulatory programs are flawed and could be reformed in a number of ways. First, jurisdiction under current laws and regulations could be expanded to cover a broader set of wetland alterations. Currently, the Section 404 program covers only wetlands altered by dredging and filling, but there are numerous other ways -- including drainage -- in which wetlands are altered and degraded. Indeed, a Congressional Research Service study found in 1982 that approximately 80% of U.S. wetland losses are not subject to Section 404 provisions (Environmental and Energy Study Conference, 1989). Federal and state regulatory programs need to address explicitly: removal or excavation of soils; drainage and flooding; destruction of plant life; and placement of obstructions.

Second, the 404 program could be amended to allow for state delegation in the case of navigable waterways. Currently, states are discouraged from developing programs due to an important legislative constraint: the ability of states to accept jurisdiction is limited to waters defined as "navigable" (Clean Water Act (PL 92-5000), Section 404 (g) (1)). Hence, there is split jurisdiction between state programs and the Federal (Corps of Engineers) permit program. This creates problems for potential permittees and discourages many states from devoting their greatest attention to the wetland areas of most concern. By changing this statutory provision and allowing states to accept 404 delegation for all waters (while preserving the Corps' ability to comment on permits to insure navigation servitude), the delegation process can be made more effective.

Third, penalties sufficient to discourage violations could be utilized. It is frequently the case that when a wetland violation is discovered, instead of a penalty, either a retroactive permit authorizing the activity is issued or the violator is given a cease-and-desist order. Rarely does the damage get repaired and the wetland restored.

Fourth and finally, a strong executive order may be needed to restrict Federal actions which encourage development of sensitive ecological areas, including wetlands. Since most actions which alter these habitats are undertaken by individuals and firms, direct regulation of all such actions is infeasible. But a substantial portion of those development projects are instigated, subsidized, or licensed by the Federal government. Hence, it would be effective and feasible to require Federal departments and agencies to consider alternatives to any wetland-altering actions.

A new executive order for a broad class of sensitive habitats could be based upon existing wetlands Executive Order 11990, which states that Federal agencies "shall avoid undertaking or providing assistance for new construction located in wetlands unless ... there is no practicable alternative ... and the proposed action includes all practicable measures to minimize harm to wetlands which may result ..." A broader executive order for the protection of sensitive habitats might include: (1) extended coverage for non-construction activities such as agriculture and silviculture; (2) extended coverage for the issuance of Federal permits and licenses; and (3) enumeration of sensitive ecological areas to be protected.

S.8.3 Reform conventional wetlands regulation. REGS, ENF, TH

d. Use Accurate Impact Areas in Environmental Impact Statements A question, in the context of Environmental Impact Statements (EIS's) and elsewhere, is whether the estimated areas of impact of Federal flood-control and drainage projects on wetlands should be limited to (minimal) construction impacts, or whether they should include impacts which occur when such projects cause private landowners to drain and clear their wetland holdings. In more general terms, should "secondary" (economically induced) impacts of projects be considered as part of the EIS process? From a legal standpoint, the answer is clearly yes, but during the past fifteen years, in preparing their EIS's, Federal agencies typically have not

included areas of secondary impacts, such as wetland areas cleared and drained by private landowners. It has now become clear, however, that Federal flood-control and drainage projects directly induce private landowners to convert their wetland holdings to dry croplands (Stavins and Jaffe, 1990).

These impacts should be candidly assessed through the NEPA (the National Environmental Policy Act of 1969 (PL 91-190)) process. Whether environmental impacts together with other costs of Federal projects will be found to outweigh project benefits is a question which must be addressed on a case-by-case basis, but it is essential that "environmental impact areas" be correctly defined to include areas where drainage and clearing are induced, not simply the relatively small areas where project construction occurs. More generally, so-called secondary (economically induced) impacts of Federal projects of all kinds should be assessed through the existing NEPA process. Significantly, this should include housing projects and highway development projects which receive Federal support.

This strategy option could be cost-effective, but it will involve increased costs for Federal agencies. Its impact will be limited by the limitations of the EIS process in general, i.e. agencies are not precluded form taking actions found by EISs to have adverse consequences; they are required only to take these consequences in to account in making their decisions.

S.8.5 Include consideration of direct and indirect impacts in Environmental Impact Statements for all federal programs including flood control and drainage projects. NR, INFO, TH

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A.9 Estuaries, Coastal Waters and Oceans

A.9.1 Risk Background

Estuaries support some of the world's most diverse and productive ecosystems. Many species of fish and birds depend on estuaries for one or more of their critical life stages. Estuaries serve different species as breeding areas, nursery areas, wintering areas, feeding areas, and migration pathways. More than 70% of the American fish species of commercial importance depend on estuarine and coastal waters in one or more of their life stages. The Gulf of Mexico provides critical habitat for 75% of North American migratory waterfowl.

Environmental conditions in estuaries are fragile and highly subject to perturbation by human activities (NRDC, 1989). Municipal and industrial effluents, agricultural and urban runoff, and air deposition can contribute pollutants changing the chemical composition of estuarine waters. Eutrophication (from nutrients), low dissolved oxygen concentrations (from BOD and nutrients), reduced light penetration (from suspended sediment), and bioconcentration of toxic chemicals (from pesticides, heavy metals, and toxic organics) have resulted in many areas. Development of shorelines and filling of coastal wetlands have altered habitat conditions needed for survival by many estuarine species. Consumptive water

withdrawals upstream of estuaries have changed fresh-water flows and salinity gradients in estuaries. Excessive commercial or sport harvesting have sharply reduced the populations of many species.

A coherent national summary of the condition of estuarine and coastal aquatic ecosystems is not available. Several statistics suggest concern, however (USEPA, 1989):

a) About 1/3 of the Nation's productive shellfish beds are closed by NOAA and FDA to commercial harvesting, mostly because of bacteriological contamination from inadequately treated human waste.

b) About 1/2 of the coastal wetlands existing in the mid-1700's have been lost. (However, this trend is not inevitable. Since strong shoreline protection programs were adopted by Maryland and Virginia in the 1970's, coastal wetland losses in the Chesapeake Bay have been stopped.)

c) About 1/4 of monitored estuarine waters have elevated levels of toxic substances. State and local governments have advised limited or no consumption of fish and shellfish in many areas.

d) In the Chesapeake Bay, submerged aquatic vegetation covered about 30% of the bottom acreage in 1970, but only about 6% in 1986. Eutrophication and reduced light transmission in more turbid water are responsible. Partially as a result, populations of key fish and shellfish (e.g., striped bass, white perch, shad, oysters) have declined. The harvest of Bay oysters, for example, has declined from 3.4 million bushels in 1981 to .9 million bushels in 1988 (USEPA, 1990)

Estuaries are not, however, universally degraded. A compilation of 1988 data from 23 states reporting on the quality of their estuarine waters shows 72% of estuarine square miles fully supporting designated uses, 23% partially supporting them, and 6% not supporting them. These figures on support/non-support are nearly identical to those characterizing the quality of rivers and streams. The causes of non-support in estuaries were cited as (USEPA, 1990):

Nutrients	50%
Metals	10%
Pathogens	48%
Siltation	7%
Organic enrichment/low DO	29%
Unknown toxicity	5%
Oil and grease	23%
Organics	4%

Relative to rivers and streams, the causes of non-support in estuaries are more often nutrients and pathogens, and less often siltation. Human waste is cited as the most common source of these pollutants, with agriculture second.

A.9.2 Policy Background

Until recently, the Federal government had no comprehensive policy regarding estuaries or coastal waters. Federal programs included a variety of uncoordinated measures that served to protect these areas (e.g., prevention and cleanup of oil spills by the Coast Guard, restrictions on ocean dumping, coastal zone management planning grants, designation of marine sanctuaries, pollution control requirements for point sources of air and water pollution). There were also many Federal activities that encouraged development of estuarine watersheds, unintentionally contributing to deterioration of estuarine water quality (e.g., Federal flood insurance, financial support for construction of infrastructure).

Although the Great Lakes Program began in 1970 and the Chesapeake Bay Program in 1977, it was not until 1985 that the Federal government recognized estuaries as a class of resource needing focused protection. In 1985 Congress directed EPA to conduct targeted programs in four estuaries, two more were added in 1986, and the 1987 Clean Water Act Amendments named 11 estuaries for priority consideration. Now, EPA is conducting programs in nearly 20 estuaries, with several more projects awaiting approval.

EPA's estuaries program is intended to improve water quality and enhance living resources in nationally significant estuaries. For an estuary accepted into the program, EPA will convene and provide financial support for a planning process (a "management conference") that will (USEPA, 1989):

a) Conduct a phased program to identify and define priority problems, establish their probable causes, and devise alternative strategies to address them; and

b) Coordinate all concerned Federal, State and local agencies, and secure commitments from them to carry out the recommended actions.

EPA's role is limited by statute to supporting a 5-year planning and management effort for each estuary; it is not expected that EPA will provide financial support to implement remedial measures called for by the plan.

The longstanding programs of this sort for the Great Lakes and Chesapeake Bay are showing success. Water quality and living resources in these areas appear to be improving recently. However, EPA's financial and administrative support for these two programs has far exceeded the five years and limited resources that are contemplated for other estuaries.

EPA has also recently established a program to solve problems in coastal waters other than estuaries. The "Near-Coastal Waters Program" is identifying threatened and impaired coastal waters, and supporting several innovative management actions in these waters that are intended to demonstrate useful techniques for application elsewhere.

A.9.3 Possible Strategy Options

The key to preserving and enhancing the quality of an estuary is focusing on it as a resource. Nearly all of EPA's programs focus on sources, pollutants, or products. To focus on a resource is different -- the needs of the resource become paramount, and the approaches necessary to meet them typically extend well beyond controls on sources, pollutants, and products. To protect a resource, far greater capabilities and authorities are needed than those of EPA alone. EPA's major role must become supporting research and planning to identify needs and solutions, and then marshalling the resources of other federal, state, local, and private agencies to achieve mutually agreed-upon goals.

a. View and deal with estuaries as integrated systems and avoid focusing only on water quality. The history of the Chesapeake Bay Program provides an example (CEC, 1988, 1989). EPA's initial focus was on water quality. EPA supported revision of Bay water quality standards, conducted sophisticated water quality modeling efforts, and contributed to huge investments in advanced wastewater treatment by communities in the watershed. However, the alarming decline in some of the Bay's resources (fish, shellfish and waterfowl populations, SAV, and natural shoreline) continued. It became clear over time that the public was fundamentally concerned not with chemical quality of the Bay's water, but with preserving the living resources and even the culture of the Bay. Scientific studies established that several factors other than water pollution from point sources were primarily responsible for deteriorating conditions:

1. Rapid shoreline development was shrinking the amount of wetlands and other natural habitat necessary for species breeding, nursing, and feeding.

2. Overfishing was placing severe stress on the population of several species.

3. Critical pollutants were contributed mostly by nonpoint sources. Nutrients causing eutrophication and a decline in SAV derived primarily from agriculture in the Susquehanna basin and the Eastern Shore, and also substantially from long-range air deposition. At least half of the sediment that reduced light penetration and SAV growth came from shoreline erosion, exacerbated by construction and development activities. Toxics accumulating in some species came from long-ago contaminated sediments, often stirred up by dredging.

The policy measures adopted to respond to these problems relied largely on non-EPA authorities:

1. Maryland adopted a Critical Areas Program, implemented by localities through their land-use control authorities, that has carefully limited development. This program and others appear to have reduced the rate of loss of coastal wetlands in the Bay to zero.

2. A joint ban on rockfish harvesting by Maryland and Virginia has resulted in a significant recovery of population.

3. USDA and State incentive-based programs for farmers have reduced agricultural nonpoint source nutrient loadings.

In its design of other estuary programs throughout the country, EPA seems clearly to appreciate these lessons. The Subcommittee applauds the basic thrust of EPA's focus on an estuary as a resource. Scientific studies followed by policy development are both defined broadly enough to cover the full scope of threats to the resource: pollution, habitat alteration, harvesting, and development and growth in general. All relevant Federal, State, local, and private agencies contribute in a coordinated manner to the study and implementation phases of the project.

The Subcommittee believes that this broad resource protection model being used for estuaries has promise for application in other fields. EPA's protection efforts toward key wetland areas, important aquifers, and valuable airsheds are perhaps not as aggressive as they might be. In such areas EPA typically limits its involvement to using the tools under more direct Agency control (e.g., 404 permits, sole source aquifer designations, PSD permitting), which are able to address only some of the threats facing the resource. EPA might consider a more comprehensive approach relying extensively on cooperation with other agencies.

Although the Subcommittee thinks highly of EPA's resource-oriented approach toward estuaries, several potential institutional problems associated with the program will need attention:

1. What is to limit the number of estuaries to which EPA can give such individual attention? The number of estuaries in the program seems to be growing inexorably. It is not clear that any of the current estuary projects are finishing, and new areas are petitioning to be added to the program. It does not seem that, as was hoped, the existing projects are providing demonstrations or models that other areas are adopting without needing assistance from EPA.

2. Can and should EPA limit its assistance to planning and management within a five year period? Or should EPA assist with the much higher costs inherent in long-term, continuing remediation and protection? How can EPA extricate itself after some reasonable period of time from a program for managing a specific estuary, and leave a viable institutional structure to continue the program?

3. If EPA personnel are to understand habitat alteration, fisheries and growth management issues in addition to pollution control, their education and training will have to be significantly broader than it typically is now.

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

b. Protect estuaries in general, though, a broad emphasis on pollution prevention.

Estuaries constitute a major zone for accumulation of pollutants. In contrast to upstream flowing waters, estuaries typically have long residence times. Pollutants flowing into estuaries will tend to remain there, accumulating in sediments, the water column, and biota. Also, given the relatively large surface area encompassed by estuaries, they receive substantial additional pollution loadings through air deposition. Because of this potential for long-range transport of pollutants to estuaries, it is often difficult to identify and control the specific sources of pollution affecting an estuary. The following are some recent findings regarding unexpected sources of estuarine pollution (Hiller, 1990).

1. Air deposition of nitrates is thought to provide about 30% of the nutrient load to the Chesapeake Bay and 20% of that to Long Island Sound.

2. Air deposition is the largest source of toxic chemical loadings to the Great Lakes.

3. A small and declining population of Beluga whales lives in the estuary of the Saint Lawrence River. A key toxic chemical found in the whales is mirex, a pesticide that has apparently never been produced or used in the St. Lawrence basin. Where did the mirex come from? Atlantic eels are a primary food source for the whales. The eels migrate from the Great Lakes to the mid-Atlantic Ocean. As they pass through Lake Ontario, they pass two plants near Niagara, New York that produced and used mirex, and must have discharged it. The eels appear to pick up mirex in Lake Ontario, and the major impacts of the pollutant are eventually felt among a population of whales at least 600 miles away (CF, 1990).

Specific measures to prevent pollution (e.g., by reducing nonpoint source discharges and pesticide use through the strategy options in A.7 and A.13) in the catchment area for a particular estuary can be important. But when the sources of pollution to estuaries can be as distant and unexpected as the examples cited above, a broad nationwide pollution prevention effort seems appropriate.

S.9.2 Protect estuaries from accumulation of pollutants transported long distances through general waste reduction and pollution prevention efforts. PP

c. Manage contaminated sediments in estuaries by developing an ecologically protective and cost-effective technology. In a final observation regarding estuaries, the Subcommittee wishes to comment on the increasingly serious consideration being given to large projects to dredge and clean contaminated estuarine sediments. More research on this subject is needed. Highly contaminated sediments can pose serious risks, as evidenced by designation of several areas of contaminated sediments as Superfund sites. But dredging, cleaning, and disposing of these sediments can also be dangerous -- resuspending contaminants in the water -- and costly. Sediment/water/biota interactions are not well understood, and satisfactory sediment quality standards have not yet been developed. The relative merits of covering, removing, or ignoring contaminated sediments should be investigated more thoroughly before action is taken in most cases.

S.9.3 Develop ecologically protective and cost-effective technologies to manage contaminated sediments in estuaries. S&T

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A.10 Habitat Alteration

A.10.1 Risk Background

Physical alteration of aquatic and terrestrial habitats caused by human activity has been ranked as one of the most serious ecological risks by both the original Unfinished Business participants and by the Science Advisory Board's Ecology and Welfare Subcommittee (a sister committee to ours). Modification of natural habitats can also cause substantial loss of economic and aesthetic values. Development, resource extraction, agriculture, and

timber harvesting represent the major categories of activity affecting aquatic and terrestrial habitats. Practices that can have particularly important effects on aquatic habitats include dredging and filling, creation of impoundments, drainage, channelization, shoreline stabilization, and upland activities that significantly change the magnitude, timing and temperature of water flows (e.g., water withdrawals, forestry, urbanization of a watershed). Terrestrial habitats can be affected by a wide variety of construction activities -- roads, housing and other structural development -- and land uses including agriculture, grazing, forestry, mining, and even recreation.

Physical alteration of habitats results in substantial ecological damage because of the intensity, scale, and permanence of the effects caused. Physical alteration can cause critical alteration of conditions in an ecosystem (e.g., change in moisture, temperature, disease agents or other stress) or complete destruction of a given habitat. The range of impacts could include: stress on individual species in an ecosystem, elimination of one or more species, conversion to another type of ecosystem, or complete loss of an area as a natural habitat. The threat to biological diversity is especially serious. A particular species can become extinct if features of its habitat crucial to its development are destroyed or significantly altered. Similarly, if a habitat is sufficiently fragmented, migration and general movement paths of the species will be disturbed; this isolation makes the species more vulnerable to other stresses such as disease outbreak.

Over time, the scale of physical alteration in the U.S. has become immense. About 1/2 of the wetlands existing during colonial times no longer exist (Tiner, 1984). Only about 1/3 of the original acreage of riparian plant communities now remains in a near natural condition (Swift, 1984). The amount of the U.S. land area (excluding Alaska) in developed uses (cropland, urban land, homesites, etc.) has increased by about 1/3 between 1910 and 1982 (USDA, 1988). Some habitat alteration can have effects on a larger than regional scale, such as deforestation and its effect on the global carbon cycle.

Most worrisome is that adverse effects of this habitat alteration often approach being irreversible. Whereas ecosystems can recover from most pollution impacts within years or decades following cessation of the pollution, the SAB Ecological and Welfare Subcommittee of this project projected a century or more as the typical time frame for recovery of an ecosystem from physical alteration.

A.10.2 Policy Background

The federal government conducts a wide variety of programs to protect specific varieties of important habitats. Such programs include acquisition and management of park, refuge, and wilderness lands; protection of wetlands, endangered species habitat, coastal zones, barrier islands and floodplains; and the environmental impact statement (EIS) requirements for major federal actions. Most federally owned land (USFS and BLM) is managed for multiple purposes, based on a planning process that weighs preservation against use values for the land. State, local, and private agencies are also very active in protecting important habitats, operating such programs as park systems, property tax abatements for open space preservation, critical area zoning, and prohibitions of construction in wetland areas.

These programs are, however, highly fragmented and tend to be poorly coordinated. They apply to some types of important habitats and not to others. There exists no consistent nationwide inventory of all critical ecological areas, and no nationwide plan to protect them.

Arrayed against these programs that protect habitat from alteration are a great variety of governmental programs that encourage development. Federal programs include subsidies for agriculture, housing, water resource projects, sewage treatment, water supplies, highways, airports, mass transportation, energy production, businesses, rebuilding after disasters, etc.. It is not clear, on balance, if the Federal government does more to encourage physical alteration of important habitats or to discourage it.

EPA has limited authority to preserve habitats from physical (as opposed to chemical) alteration. Important EPA programs include review and comment on federal EISs, responsibilities under Section 404 of the Clean Water Act, and support for integrated management of estuaries (particularly Chesapeake Bay) threatened by both pollution and physical alteration. EPA's major participation in the alteration of habitats is through community growth induced by the sewage treatment construction grant and revolving loan programs. Through these programs, EPA provided about 40% of the money spent on constructing municipal sewage treatment plants in the U.S. between 1974 and 1984 (Apogee Research, 1987).

A.10.3 Possible Strategy Options

As a general matter, EPA could begin by asserting an interest in protecting ecosystems from physical damage as well as from chemical (pollution) damage. EPA has traditionally been concerned with pollution control and not with comprehensive protection of the environment from the full range of threats. This expanded role for EPA will have to be coordinated carefully with other federal agencies. Although each of EPA's major statutes gives the agency a broad mandate to protect the environment as a whole, impacts from physical alteration of the environment have traditionally been the province of others: e.g. the Fish and Wildlife Coordination Act provides a central role for the Fish and Wildlife Service in protecting habitats for wild animals, and the National Environmental Policy Act establishes the responsibility of each federal agency to consider alternatives to environmentally

harmful actions that it proposes. Our strategy options for reducing the risks of habitat alteration are not primarily for direct EPA action. Instead, they involve EPA working to convince the entire executive branch to take concerted action.

a. EPA could support the development of a national inventory of important ecological areas. No integrated national inventory of important ecological areas currently exists. If one did, it would serve an important function in organizing a broad range of federal, state, local, and private preservation efforts, as well as demarking areas that should be avoided by development interests. Several of our further strategy options listed below are practical only if they can be targeted at designated, limited land areas.

Partial inventories do currently exist: for wetlands and endangered species habitat, for natural areas in many states, and by the Nature Conservancy in many areas. They can serve as a starting point in developing the national inventory. The most difficult aspect of developing a national inventory may be reaching a consensus on the criteria defining lands that are to be included. Habitat preservation is motivated by various concerns -- protecting genetic diversity, open space, land for recreation, endangered species, game species, wilderness -- each of which suggests different areas on which to focus. Some areas to be included in such an inventory would be key wetlands, old growth forests, critical habitats for endangered species, and unique ecosystems.

A planning process might follow completion of the inventory: assessing the condition of the inventoried areas, evaluating threats to them, and establishing priorities and strategies for preserving the most vulnerable and important ones.

S.10.1 Develop a nationwide inventory and preservation plan for important habitats. NR

b. A second strategy option is to consider an executive order that will restrict federal actions encouraging development of important ecological areas. Most actions altering important habitats are undertaken by private individuals or corporations. Direct regulation of the vast number of such actions is clearly infeasible. However, a substantial portion of such actions are probably instigated by (e.g., accelerated economic development subsequent to completion of a federal water project), subsidized by (e.g., clearing forest land to plant federally subsidized crops), or licensed by (e.g., federal environmental permits for a new factory) the federal government. If each federal agency can be required to consider alternatives to supporting any habitat-altering action, many such actions will not go forward.

The proposed executive order could be modeled after the existing wetlands executive order (EO 11990). Under this order, each federal agency "shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use." Several modifications to the wetlands approach might be considered for a habitat order:

1. Extend the coverage to any of a series of inventoried important ecological areas,

2. Extend the coverage to include non-construction activities such as farming and timber harvesting,

3. Seek legal authorization for citizen suits to enforce compliance with the order.

It is clear that such an executive order could be implemented only if the land areas to which it applied were: a) Clearly designated in advance, and b) Limited in geographic extent (probably well less than 1% of the U.S. land area). The inventory would be critical.

Several other elements of current or proposed strategies for protecting wetlands might also be extended to designated ecologically important habitat areas, for example, adoption of a "no net loss" goal, enactment of a requirement to obtain a permit before destroying them, or adoption of a requirement for federal agencies to mitigate or offset any damage they do to them.

S.10.2 Restrict federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

c. The most direct, though expensive, option for preserving important habitat areas is to acquire them. EPA could support substantially increased federal acquisition of these areas. Several federal programs provide funding for acquisition of natural areas, the largest among them being the Land and Water Conservation Fund (LWCF). In recent years these programs have been funded at less than $200 million annually, far less than their levels in many years during the 1970's and early 1980's. The LWCF now contains an unappropriated balance of about $8 billion, with receipts mostly from offshore oil and gas leasing of about $900 million being added annually. Legislation establishing the LWCF argued that the federal government should invest the funds it obtains from depleting the nation's oil reserves in a countervailing preservation effort. Increasing the annual appropriations from the LWCF for federal land acquisition to $1 billion or more would be consistent with this argument. Two other actions should accompany this increase in appropriations:

1. A plan could be developed that determines which land is most worthy of federal acquisition to preserve its ecological value. The LWCF finances acquisition of properties serving somewhat differing purposes: urban recreation and historic preservation, as well as ecological preservation. It is important to obtain the maximum ecological value from the portion of the LWCF spent for this purpose. A careful, long-range acquisition plan focusing on lands of national ecological importance

could help in obtaining the greatest ecological bang for the buck (see (Mantell, 1989) for a general discussion of LWCF).

2. Careful consideration could be given to acquisition of less than full interests in land (e.g., conservation easements) when doing so would fulfill preservation goals at reduced cost.

S.10.3 Drastically increase federal acquisition of important ecological areas and open space. NR

d. The federal government currently owns ecologically important habitats; these should be identified and managed to assure preservation of their ecological communities. The multiple use agencies (US Forestry Service and the Bureau of Land Management) seem to identify their ecologically important landholdings satisfactorily, and conduct open and arguably successful planning programs to determine how to manage them. It is unclear, though, that other land-owning agencies (DOD, DOE, those holding assets of failed financial institutions) have similar procedures. Ecologically important federally owned land should not be developed or sold; it should be preserved in federal ownership and managed appropriately.

S.10.4 Identify important habitats now in federal ownership and manage them to preserve ecological communities. NR

e. While federal habitat preservation is important, support of state, local, and private preservation programs would be beneficial also. There are numerous diverse ecological preservation efforts under way relying on tax abatements, zoning, local ordinances, charitable trusts, user fees, hunting stamps, volunteer groups, educational campaigns, and many other mechanisms. Innovation is rampant. EPA could provide an important organizing service by evaluating many of these programs, publicizing the successful ones, and providing technical assistance to organizations in replicating them. There exist many initiatives to preserve wetlands areas that appear successful. EPA should explore these initiatives for use as possible sources of innovation in other areas.

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical asssistance. S&T, MI, TH, TAX, NR

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A.11 Hazardous Waste

A.11.1 Risk Background

In 1985 the amount of hazardous liquid and solid wastes managed in accordance with requirements of Subtitle C of the federal Resource Conservation and Recovery Act (RCRA) totaled about 275 million metric tons (USEPA, 11/88). Other wastes subject to the less-stringent requirements of Subtitle D of RCRA totaled a much larger amount, greater than 11 billion tons (USEPA, 10/88). These wastes included industrial nonhazardous wastes (7 billion tons), wastes associated with oil and gas production (up to 3.5 billion tons), and mining wastes (greater than 1.4 billion tons).

There are risks associated with all of these wastes from the point at which they are created, through handling, transport, treatment, and disposal. Although these risks have not been precisely quantified, EPA indicates that the greatest current risks are most likely from those wastes which are not currently regulated, and from facilities: 1) for which adequate management standards have not yet been set, 2) that have not been permitted, or 3) that are not in compliance with existing standards (USEPA, 1989).

Assuming that these problems are addressed, the greatest future risks may come from wastes for which there is not adequate recycling, treatment, or disposal capacity, if such a capacity shortfall arises. However, it is very difficult to predict whether there will be any future capacity shortages until final waste treatment standards are established; companies select alternatives to current land disposal practices; and states, the Federal government, and generators determine to what extent reduced creation of waste will be successful (GAO, 1988).

Past mismanagement of hazardous materials has left the United States with a legacy of contaminated sites. EPA has identified approximately 30,000 possible sites, 1,226 of which EPA has included or proposed for inclusion on the National Priorities List (NPL). EPA has determined that 17,500 of the sites do not qualify for this list and is investigating the rest (EPA, 1989). EPA has projected that the NPL could grow to some 2100 sites in the next ten years, while the U.S. Congress' Office of Technology Assessment projects that the list could grow to greater than 10,000 sites (OTA, 1989). OTA based this figure on its estimate that the total number of potential sites could range from 130,000 to 439,000, taking into account current hazardous waste treatment, storage, and disposal facilities; municipal landfills; mining waste sites; non-petroleum underground storage tanks; federal facilities; and other sites.

Few people disagree that the extent of contamination of air, water, and land from these contaminated sites has been very significant, yet the health problems caused by and risks attributable to these sites are very difficult to quantify. The potential pathway of exposure most often found is groundwater contamination; other significant pathways at some sites are windblown particles, direct exposure at unrestricted areas, and surface water contamination. Recent studies of NPL sites indicate that less than thirty percent of such sites - perhaps less than ten percent - at the time of discovery pose significant current health risks which are of concern in the short term (Travis and Doty, 1989). Risks which may occur in the future are considered to be more significant at more sites, but are usually estimated based on hypothetical exposure scenarios. Possible economic risks include loss of home values, loss of a community's economic activity and development, and loss of current and future water supplies. Current and potential environmental degradation is not well-assessed but is thought to be significant; in 1984 EPA estimated that about half of NPL sites pose threats to sensitive areas such as freshwater wetlands, coastal wetlands, and critical habitats (OTA, 1989).

A.11.2 Policy Background

Hazardous waste management and site remediation have been two of the most debated and controversial environmental issues of the last decade. Congress has established a detailed set of guidelines for tackling these problems, most recently through the Hazardous and Solid Waste Amendments Act of 1984 and the Superfund Amendment and Reauthorization Act of 1986. The issues remain controversial, but in recent years there has emerged greater consensus on a number of points, ranging from an increased emphasis on pollution prevention techniques, to more targeting of Superfund resources to those sites posing the greatest current risks. To a great extent, the following strategy options reflect emerging points of agreement.

A.11.3 Possible Strategy Options

Hazardous Waste Management

a. Reduce the generation of hazardous wastes by using EPA's authorities broadly. Our primary strategy option is that EPA could increase its efforts to promote the reduced generation of wastes. Many analyses indicate that the amounts of wastes currently generated could be substantially reduced through changes in raw materials, production processes, and products. For example, Congress' Office of Technology Assessment concluded that a reasonable goal would be for
United States generators as a whole to reduce their generation of all types of wastes of a hazardous nature entering all media by 10 percent each year for five years (OTA, 1986). EPA could take action to, and where necessary seek Congressional authority to: 1) require companies to conduct audits of their production processes in order to identify and evaluate the feasibility of generation reduction opportunities; 2) require companies to track their progress at achieving reductions and on their goals/plans for future achievements; 3) assist states in implementing such programs and in providing technical assistance to generators who need such help; and 4) continue to enforce against, and establish needed standards for, generators and waste management facilities.

This effort to press for reduction should not be seen as solely a RCRA - based program. Other statutory authorities could be used where possible and appropriate, e.g. SARA Title III, TSCA, or the Clean Air or Water Acts. Multimedia permitting concepts could be explored and tested. Provisions in single-media statutes that cross reference other media should be exploited to press for the reduced generation of all forms of hazardous wastes and to prevent shifting of wastes from one medium to another.

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

b. By ensuring that waste reduction goals are met and by adding new facilities is necessary, help states acheive adequate treatment and disposal capacity. Our second strategy option is that EPA could continue under its SARA authority to work with states to facilitate planning to determine whether additional waste handling capacity will be needed in the future and if so, to help ensure that necessary facilities are constructed. To help with the former task, EPA could establish necessary waste treatment standards which are protective of public health and the environment, and which, consistent with our first strategy option, require states to set concrete goals for how much waste generation will be reduced in their states. Generation reduction should be the preferred method for ensuring capacity. States could be required to explain how they will ensure that such reduction goals are met. EPA could also monitor industry efforts to reduce waste generation, the extent to which economic incentives and market forces are spurring new capacity, and industry's choices of new treatment technologies as they move away from land disposal, and communicate what EPA finds to the states. EPA also could issue any further needed location criteria for facilities, and facilitate the exchange of information among states regarding successful or potentially successful approaches to facility siting.

S.11.2 Help states achieve adequate treatment and disposal capacity -- by ensuring that waste reduction goals are met, and by adding new facilities if necessary. PP, INFO, REGS

c. Support the product stewardship concept. Our third strategy option is that, in order to better address problems associated with small generators of hazardous waste, EPA could promote the concept of "product stewardship". Under this concept, large producers of chemicals work with their customers to help engender responsible use and

handling of chemicals and associated wastes. Certain chemical companies have already begun such programs, in part because of concerns over potential liability for chemicals that they manufacture. EPA should study and implement, and where necessary seek Congressional authority to implement, measures to promote such product stewardship. One attractive option may be a front-end tax for certain chemicals or products (e.g. lubricating oils, solvents) which works as a deposit, with a refund payable when quantities of the chemical or product are turned in to designated facilities operated by the seller, whether for recycling, proper treatment, or disposal (Russell, 1988; Bohm, 1981). Such a deposit-refund system would provide important incentives: first, there is an incentive to follow rules for proper disposal and to recapture would-be losses from the production process; second, there is an incentive for producers and users to look for non-hazardous substitutes; and third, agencies' monitoring problems will no longer include the nearly impossible task of preventing illegal dumping of small quantities at dispersed sites in the environment.

S.11.3 Support the "product stewardship" idea -- a manufacturer has a responsibility to contribute to appropriate use, reuse, recycle, and disposal of his products. PP, INFO, MI, NR

d. Simplify RCRA regulations and provide a more flexible array of hazardous waste management standards. Our fourth strategy option is that EPA could simplify and where necessary recommend to Congress simplifications of, the RCRA regulatory framework in order to provide the agency with greater flexibility in how it regulates wastes. The current RCRA scheme with its many categories of wastes and associated requirements is too complex and inflexible. The result is that important wastes which do not fit into categories regulated to date are virtually unregulated. The system leads to loopholes and confusion and poor compliance on the part of the regulated community. The system should be made more flexible so that EPA is able to apply to any particular waste the management standards which the agency finds to be adequately protective of public health.

S.11.4 Simplify RCRA regulations and provide a more flexible array of hazardous waste management standards. REGS

Cleanup of Contaminated Sites

The first two of our strategy options are related. They apply to the Superfund program, the RCRA corrective action program, and other federal cleanup programs: 1) EPA could focus its cleanup efforts on discovering all sites posing significant current risks, i.e. those of concern in the short-term, and then quickly taking steps necessary to bring them under control, using permanent cleanup techniques to the extent practicable; and 2) as its next priority, EPA could develop and apply at sites which pose future risks technologies which achieve permanent cleanup at reasonable costs. Together, these two strategy options establish an approach to cleanup which emphasizes finding and acting at sites which pose the greatest and more immediate risks first; this approach also emphasizes a commitment to the accelerated development and use of truly permanent cleanup technologies, which we define to mean treatment technologies which destroy, detoxify, or recover contaminants.

a. Identify contaminated waste sites posing immediate threates and quickly bring them under control. With respect to the first strategy option, recent reviews of EPA's Superfund program have concluded that there has been little correlation between the risks posed by sites and the sites given priority for attention by EPA (Travis and Doty, 1989 and OTA, 1989). Those reviews and EPA's own recent management review (USEPA, 1989) have recommended that EPA should give priority to those sites posing immediate or short-term risks. Measures should be taken quickly to eliminate such current risks and, where necessary, stabilize sites to control contamination sources until final remedies can be applied.

An important corollary to acting first at the highest current risk sites is that the highest current risk sites must be found. Therefore we also urge, as did the OTA review, that EPA much more aggressively attempt to discover sites which pose significant health, environmental or economic risks. One way to do this which EPA and Congress should pursue is to require hazardous waste generators, transporters, and disposers to disclose where they disposed of wastes in the past. Authorities for such information gathering authority may be found in TSCA Section 8, CERCLA, and perhaps other statutes also.

S.11.5 Identify contaminated waste sites posing immediate threats and quickly bring them under control. REGS, ENF

b. Identify long-term cleanup and permanent cleanup techniques. Our second strategy option is that EPA could give much greater emphasis to accomplishing long-term cleanup using truly permanent remediation technologies, i.e. those which destroy, detoxify or recover contaminants. The reviews noted above have concluded that EPA is not giving sufficient consideration to the permanence of the remedies being implemented. One review which examined fifty of the 74 final decisions made by EPA during fiscal year 1987 found that only nineteen percent of the source remedies afforded permanence to the maximum extent practicable. Forty-five percent of the remedies were found to provide minimal permanence (Travis and Doty, 1989). We suggest that EPA devote far greater attention to fostering the development and use of technologies that destroy or recover hazardous materials. This suggestion goes further than EPA has proposed in the Agency's recent review and strategy (EPA, 11/89). EPA commits to technologies which provide long-term effectiveness and reliability, but does not commit more specifically to technologies that destroy or

recover contaminants. We also emphasize that remediation at any particular site should, after application of any initial measures necessary to address current risks, in general be held until permanent measures are available at reasonable costs.

S.11.6 Address future risks from contaminated waste sites by developing and applying permanent cleanup techniques. S&T, REGS, ENF

c. Encourage third-party cleanups and though enforcement. Our third strategy option for contaminated sites is that EPA could encourage third-party cleanups through greater and tougher enforcement and the use of reasonable settlement procedures. This suggestion also is consistent with those of recent reviews and with recent EPA management initiatives. Possible approaches to accomplishing this goal through existing authorities would be aggressive searches for more potentially responsible parties at sites and obtaining cleanup orders through the courts, as well as using other strong enforcement powers which EPA has but has not used, e.g. penalizing parties who do not cooperate. Another approach worthy of exploration is the establishment of arbitration procedures or special courts to help speed agreements. In addition, we recommend that EPA review the current liability, enforcement, and settlement scheme to determine whether it might be modified to involve smaller responsible parties more effectively in paying for cleanups, while retaining all of the incentives that it currently provides for third-party cleanups and better waste management.

S.11.7 Encourage site cleanup by third parties through enforcement and use of reasonable settlement procedures. REGS, ENF

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A.12 Municipal Solid Waste

A.12.1 Risk Background

Americans generated approximately 160 million tons of municipal solid waste in 1986. With current purchasing and disposal practices this amount was expected to increase by approximately 1% per year to a total of 193 million tons by the year 2000 (USEPA, 1988c). By far, the dominant method for disposal of these wastes at present is landfilling, but an estimated one-third of the nation's landfills are expected to close by 1991 (EPA, 1988c). Rathje (1989) notes that, on average, most landfills have always had only a five year remaining lifetime, since they were routinely designed for a ten-year time horizon; what is new now, however, is the vastly increased cost and difficulty in siting replacement facilities. New landfills are proving far more costly and difficult to site than in the past.

With the exception of waste reduction (generating less waste material in the first place), each of the principal methods for solid waste management -- landfilling, composting, incineration, and even recycling -- has potential risks for public health and the environment if implemented poorly. Landfilling and composting pose health and environmental risks associated with leaching of chemicals into both surface and groundwater, and gaseous emissions to the air; they also pose welfare risks associated with both the prohibitive costs (to many communities) of designing and operating new landfills and of safe closure of old ones, with the side effects of operations (odor, dust, truck traffic, etc.), and with the related social and political stigma of siting new landfill facilities.

Incinerators involve many similar hazards, but, if poorly designed and operated, also more

concentrated risks associated with the release of toxic metal contaminants, acid gases, and organic toxins to the air. Even recycling may involve high direct exposures of waste management workers and neighbors to heavy metals, toxic chemicals, and other hazardous materials in the waste stream.

As yet, there has been no definitive risk comparison among these management methods, though a more limited comparison of landfills and incinerators was conducted in 1987 (ESRG, 1987). Such a comparison is needed to provide guidance for choices among management methods, but the best choice is likely to vary from location to location. Similar comparisons are also needed to identify the overall risks of alternative product materials (for example, paper versus plastic or styrofoam) throughout their life cycles from extraction through disposal (National Research Council, 1990).

In short, therefore, managing current and future solid wastes involves a potential for at least medium-degree risks to human health and the environment, and medium to high risk to human welfare due to the rapid escalation of waste management costs and diminishing availability of disposal capacity.

A.12.2 Policy Background

The National Environmental Policy Act of 1970 charged all federal agencies explicitly to "use all practicable means... to enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources" (42 USC 4331.b.6). EPA has had additional authority since 1976 for policy initiatives to promote municipal solid waste reduction and recycling, including a specific mandate to publish federal procurement guidelines for including the highest practicable percentages of recovered materials in products purchased. By 1987, however, it had produced only one such guideline, and a second was promulgated (and four others promised) only after a 1987 lawsuit; several were produced in 1988 and 1989. In practice, EPA has limited its role to modest amounts of technical assistance to state and local agencies. Federal policy initiatives and resource commitments for MSW management, and even for MSW research, have been almost nonexistent.

Primary policy responsibility for solid waste management has traditionally rested with municipal and county governments, with some involvement of state governments (Melosi, 1981, 1988). Their exercise of this responsibility, however, is pervasively influenced by EPA regulatory policies. EPA requirements in the 1970s led to the cessation of open burning and closing of dumps, the abandonment of most ocean dumping, the accumulation of greatly increased quantities of ash and sludge from air and water pollution control equipment, and the diversion of waste streams from all these destinations into a far smaller number of sanitary landfills. Therefore, along with population growth and increases in per capita consumption, these policies contributed to the accelerated fill rate of existing landfills, which has precipitated the current crisis of waste disposal capacity.

Similarly, more recent EPA policies -- both existing and anticipated -- are among the major forces shaping current local decisions in solid waste management. These policies include present or proposed EPA regulations ending the disposal of hazardous wastes into municipal landfills (RCRA Subtitle C); setting stringent standards for landfill construction and operation and financial assurance for safe closure (RCRA Subtitle D); and regulating emissions and ash disposal from municipal solid waste combustion facilities. The costs and restrictions imposed by these sets of regulations are probably the most important influences, along with political opposition to new waste facility siting, driving the current trend toward aggressive waste reduction and recycling.

The EPA Administrator in 1989 promulgated an explicit policy statement endorsing pollution prevention through waste reduction as EPA's primary approach to environmental protection (EPA, 1989a). The Strategic Plan prepared by EPA's Office of Solid Waste and Emergency Response (OSWER) for FY 1992-1995 identifies as its first goal the minimization of the quantity and toxicity of waste created by commercial, domestic, and governmental activities. Its second objective, next in priority after encouraging hazardous waste reduction and recycling, is to reduce the quantity of municipal solid waste disposed of or sent to combustion devices from an estimated 160 million tons in 1986 to 133 million tons by 1992 (USEPA, 1988c, 1989d).

In addition to these federal policies directly influencing local solid waste management decisions, several other potential strategies for solid waste reduction are exclusive prerogatives of the federal rather than local governments. These include quality, labelling, and packaging standards for many products sold in interstate commerce; federal procurement standards, as the federal government is probably the single largest customer for many products; federal tax policies and subsidies (for instance, third-class postal rates); and policies for forest products and minerals extraction, many of which underprice or subsidize the extraction of virgin materials that compete against waste reduction and recycling of materials already in use (Kovacs, 1988).

Some policies simply are more effectively administered by the federal government than by state and local agencies. Examples include environmentally harmful trade standards for products, such as excessive brightness standards for paper products (which increase water pollution due to chlorine bleaching and limit the use of recycled paper fibers); deposit/refund systems for many nationally marketed products; and restrictions on the heavy-metal content of consumer products.

Finally, proposals have been made that EPA use federal mandates to force states to assure more aggressive siting of incinerators and landfill

capacity. Such capacity assurance requirements have already been enacted for hazardous waste disposal facilities, but not yet for nonhazardous solid waste disposal capacity.

A.12.3 Possible Strategy Options

Any risk reduction strategy for municipal solid wastes ought to include two basic elements. The first is a set of strategy options for waste reduction and recycling, to reduce, insofar as possible, the volume and toxicity of the materials that are discarded as wastes in the first place and the costs of disposing of them (USEPA, 1987, 1988a,b). The second is a strategy to assure there are adequate and safe facilities for handling of the remaining wastes, using a risk-minimizing combination of the known technologies -- landfills, composting, combustion, and any others that may be identified -- that are available for waste treatment and disposal. A third element, the cleanup of contaminated sites of past solid waste disposal, is discussed elsewhere as an issue of hazardous substance site cleanup (Superfund).

a. Use existing authorities to reduce toxic materials in consumer products. EPA has authorities under existing legislation, chiefly RCRA, but also TSCA, that it could possibly use to undertake a leadership role in waste reduction and recycling. These authorities are significantly underutilized. If EPA were to use them to their full potential, it would signal a serious federal commitment; it would expand the markets for recovered materials, providing both encouragement and necessary support for local waste reduction and recycling initiatives; and it would stimulate needed economic investments in industrial modernization to make more efficient use of materials and energy.

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF,NR

b. Eliminate federal standards, subsidies and procurement specifications that discourage waste reduction and recycling. Some of the most important strategies for reducing risks from MSW do not require promulgating new regulations or subsidies, but simply eliminating old ones whose effects are costly and perverse (Bower, 1977, 1989). An example is standards for paper brightness that make paper far whiter than necessary, which requires extra bleaching that increases water pollution and limits the use of recycled fibers. Another example is the federal subsidies and tax benefits for the extraction of virgin materials, such as minerals and forest products, that compete directly against recycled materials. A third example is the subsidized postal rates for commercial third class mail ("junk mail"). Finally, procurement specifications that require virgin materials content could often be replaced by performance requirements that could also be met (sometimes more cheaply) by recovered materials.

Strategically, what needs to be done is: (1) to create markets (i.e., federal purchasing, uniform labelling of recycled rmaterials, etc.); (2) create supply (mandate recycling); (3) overcome barriers (tax subsidies for virgin materials, unnecessary specifications): (4) reduce waste products (reduce subsidies for junk mail, etc.).

S.12.2 Eliminate federal standards, subsidies and procurement specifications that discourage waste reduction and recycling. PP, MI

c. Change tax structure to promote waste reduction and recycling. A basic flaw in current waste management is that in most localities, disposal costs are paid out of property tax revenues rather than in proportion to the amounts of waste discarded. This system provides no incentive for those who dispose of wastes to reduce or recycle: waste disposal seems "free." Correcting this disincentive, by charging for both the human and the environmental costs of waste management in proportion to wastes generated, is a fundamentally important principle for solid waste management. One form of such a charge is already being imposed locally in some communities, such as Seattle (and in many cities in Europe), where residents are charged by the container for the amounts of waste generated.

A useful supplement or alternative at the national level would be a raw materials tax, based on weight and density and levied at the point of first manufacture of the materials into primary products. Proceeds from the tax could be redistributed to local governments by formula and restricted to use for recycling and waste management services. Relatively simple refinements could be added to cover exports and imports, and to offset the equity impacts of an extra tax on material goods.

S.12.3 Tax wastes and virgin materials to promote waste reduction and recycling. MI, TAX, NR

d. Deposit-refund systems. A national deposit-refund system for lead-acid batteries would be an effective and efficient strategy for reducing this major type of toxic waste materials. It would also provide a model for other problem wastes. This approach would involve a front-end tax which works as a deposit, with a refund payable when the battery is turned in to a designated facility for recycling or safe disposal (Russell, 1988; Bohm, 1981). Such a system would provide an effective incentive for safe management rather than haphazard discard. The approach could be applied also to other "problem" products such as tires, car hulks, used oil, and packaging containers.

A deposit-refund system is only a mechanism for segregating and collecting problem wastes and it is of little use unless there is a market for the collected waste, or a safer method for disposing of these wastes in concentrated rather than dispersed facilities.

S.12.4 Create deposit/refund systems for tires, batteries, car hulks, used oil and packaging containers. MI

e. Local planning for old facilities. Many state and local governments do not now have effective programs to assure adequate future capacity for solid waste management. EPA could play a useful information transfer role by identifying successful strategies and disseminating information about them -- even supporting temporary transfers of staff members to help other states emulate them -- to other states and local governments. Examples might include negotiated siting procedures (e.g. Wisconsin's), risk communication strategies, regional cooperative facility development, and local capacity mandates such as Florida's and California's. EPA could also provide training assistance for state and local solid waste planners, a category of professionals who have not existed in most communities and many states, but who now are widely needed.

The major unsolved problem, however, is the declining capacity of permitted waste management and disposal facilities as old facilities reach their capacities and few new ones are sited. One option for EPA would be to seek a federal statute mandating that each state assure adequate capacity for its solid waste streams, backed by threats of federal fund withdrawals, similar to the mandate that now exists for hazardous waste disposal capacity. It is not yet clear that such mandates are effective, however, nor that there is any fundamental reason why all such wastes should be disposed of in the state of origin. Lacking such justification, such policies would represent a major new federal intrusion into a policy arena in which state and local governments have historical primacy.

S.12.5 Encourage better state and local planning for solid waste management capacity. INFO, REGS, TH

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A.13 Pesticides

A.13.1 Risk Background

Pesticides are designed to control living organisms. It should come as little surprise that unintended effects, often involving non-target organisms, are common once pesticides are released deliberately into the environment. This is particularly true when compared with other environmental issues under EPA's mandate, as confirmed in EPA's original Unfinished Business report, where pesticide risks ranked in the highest category.

Pesticides can cause unintended health risks to pesticide applicators and farmworkers, and to the general population through the food supply, through contamination of groundwater and surface water, and through air contamination (spray drift and volatilization), and through long range transport. Pesticides may also cause ecological risks by direct exposure to non-target organisms and by contaminating soil, water, air, plant matter, and pests consumed by wildlife (NRC, 1987 and EPA, 1988).

There are about 850 active pesticide ingredients in production that potentially can cause ecological or health risks (EPA, 1983). In addition, there are hundreds of pesticidally inert, but not toxicologically inert, compounds which are mixed with the active ingredients to make formulated pesticide products. Products registered at the Federal level have numbered as many as 50,000 (EPA, 1989). Examples of pesticide inerts include methylene chloride, formaldehyde, and other solvents or carriers, some of which have been shown to have potential or actual health and environmental risks. Risks from pesticides result from both active and inert pesticidal ingredients.

About 1.1 billion pounds of conventional active pesticide ingredients are used in the United States each year. The agricultural sector accounts for about 75 percent of pesticide usage; the industrial, commercial, and government sectors account for about 18 percent; and the remaining 7 percent is used in homes and gardens. Pesticide usage consists of about 58 percent herbicides, 24 percent insecticides, and 12 percent fungicides. There are about 1 million certified private pesticide applications (mostly farmers) and about 250 thousand certified commercial pesticide applicators (EPA, 1989).

EPA's Pesticide Program categorizes pesticides according to the following uses:

a) Agriculture (including farms and greenhouses)

b) Post harvest use

c) Urban (including household and garden use)

d) Other non-food uses (including anti-fouling paints, structural pest control, disinfectants, wood preservatives, forests, right of ways, nurseries, and aquatic applications for weed and/or insect control).

These uses of pesticides result in differing exposure scenarios. A wide range of strategies can be pursued to reduce exposure to and risks from pesticides.

A.13.2 Policy Background

Of all EPA's regulatory programs, the pesticide program is the oldest. Long before EPA was formed in 1970, pesticides were registered under a USDA licensing regime. Over the years, the pesticide regulatory program has changed from a program designed to ensure efficacy to a program which has a strong risk reduction component. However, the pesticide program still differs significantly from most of EPA's other programs.

First, the Congressional/legislative tie is to the Agriculture Committees, not the Environmental Committees. Second, the program applies to a single class of substances across all the media in which they may occur. For example, pesticide use has major implications for EPA's wetland program, non-point source program, groundwater program, and indoor air program. Yet until recently, integration mechanisms were not strong. Third, regulations under the program are to be based on comparison of risks and benefits, unlike technology-based or risk-based programs like EPA's major air, water, and waste programs. Fourth, while the pesticide program has the legal framework

to control use through manufacturing sale and transport, it has no current authority to control pesticide manufacture, like its chemical counterpart, the Toxic Substances Control Act (TSCA). In fact, the agency having the most influence on the pesticide-using community is USDA, not EPA. Information received by users in the past through USDA extension agents, research and data collection efforts--has typically focused on increasing crop production and quality, which may have conflicted with environmental protection. Finally, the enforcement mechanisms crafted in FIFRA are noticeably weaker than in all other EPA statutes. This combines with a state implementation framework that provides for very little Federal guidance or oversight or state reporting.

A.13.3 Possible Strategy Options

The first possible strategy option is for EPA actively to encourage the reduced use of pesticides (NRC, 1989). The volume of pesticide usage in our country continues to grow (EPA, 1989). While safer pesticides are clearly a highly desirable goal, less pesticide use will most directly help achieve reduced exposure and environmental burden as well as pollution prevention (EPA, 1983). To encourage farmers in this area, higher prices could be developed for organically grown products and more acreage allotment could be given them. This can be achieved by:

1. Providing incentives for increased farmer use of integrated pest management (IPM) or low input sustainable agriculture (LISA) as means for reducing the general use of pesticides. This includes encouraging the use of biologically-based pesticides (such as microbials and biochemicals) that are compatible with both approaches and may be preferred alternatives to conventional chemical pesticides (NRC, 1989).

2. Better educating farmers about how little pesticide they really need to use.

A strategy to encourage farmers to use IPM and LISA should also include a plan to encourage the development and Federal registration of preferred safer alternatives.

a. Encourage use of integrated pest management. There are a broad spectrum of market incentives which can be used to encourage IPM. Various types of fees or grants with payment structures to reward specific behavior are one approach. EPA could consider using such approaches only within particular sensitive geographical areas. An alternative to fees or grants is targeted demonstration or pilot programs. Once data begins to emerge, EPA could take an active role in helping USDA disseminate the data. EPA should re-examine the positive role it can play in providing oversight and inputs into Land Grant College activities. One benefit to EPA of participating more extensively in IPM research is that EPA could then more actively use that data in its re-registration process. IPM can be considered in the alternatives analysis that EPA does as part of its risk/benefit balancing. EPA can also consider aggressively encouraging the use of pesticides such as microorganisms and biochemicals that are compatible with IPM.

b. Change use patterns of pesticides. Another strategy option is to work more actively to prohibit unnecessary use of pesticides. The cosmetic use of pesticides is one example. In some cases, this will require changes in statutes or regulations of other agencies, such as with USDA standards for food grading. Inter-agency coordination and public education would be important if cosmetic uses of pesticides were to be discouraged. Another area of potential attention is efficacy data. EPA could require pesticide manufacturers or very large volume users to produce efficacy data to justify continued use. Efficacy data requirements could be targeted to sensitive environmental areas or particular pesticide ingredients where data is insufficient or safer substitutes exist. EPA might require comparison of product performance data to show yield and quality changes with a variety of crop production techniques (alternative chemicals, IPM, and organic). Registrations could sunset unless efficacy data were produced.

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, MI, INFO, REGS

c. Create right-to-know programs. The second strategy option addresses the need for more public knowledge and involvement in pesticide usage. A knowledgeable community can have a significant affect on practices that affect the local environment in undesirable ways. Experience has also shown that peer pressure can result in people or companies behaving in a more publicly acceptable manner than they might if their actions were kept private. The SARA Title III chemical reporting program and the responses of companies and communities is a good example of this process.

We suggest that EPA develop a right-to-know program regarding pesticide use modeled after the SARA 313 program. If such reporting cannot be required under SARA or FIFRA, new legislation might be required. The program could have several components. Major users could be required to report annually on the pesticide quantities used and purposes served. The reports should be publicly available. EPA could develop a phased reporting program, beginning with high volume users for specific pesticides of concern or specific uses. EPA could also require these major users to develop and make publically available their plans to reduce future use of pesticides.

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourage industrial audits of these facilities. PP, INFO, AP

d. Develop safer home use of pesticides. A third strategy option is for EPA to regulate directly the practices of large pesticide users. The pesticide program has been and will continue to be implemented by the states. However, there are very few Federal attempts to set minimum requirements to protect health and the environment that all states must adopt. Since state boundaries are not effective in stopping environmental pollution in fish, groundwater, or food products, some Federal requirements for users may be appropriate. These more conventional command and control requirements could aim to create incentives for reduced pesticide use and early identification of any environmental problems. Some specific ideas to implement this strategy include:

1. Require large volume users of pesticides to carry environmental impairment liability insurance to cover third party claims and clean-up costs.

2. Require extra licensing/certification procedures for use of pesticides in sensitive environments, through a prescription approach, for example.

3. Require large volume users of pesticides in certain sensitive environments to do groundwater or surface water monitoring or to get stormwater discharge permits.

4. Require large volume users of pesticides to contract for independent pesticide use audits with a goal of minimizing pesticide use.

These approaches would require extensive discussions with states and other agencies. It would be useful to pilot them in an interested state. Despite the difficulty of imposing additional use controls, these controls are likely to be most effective in directly reducing pesticide usage in sensitive areas. As such, they directly tie in with the types of strategies which will address problems in wetlands, non-point sources, habitat alteration, and estuaries/coastal waters.

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

A final strategy for EPA involves home users of pesticides. It appears that home use both indoors and outdoors often grossly exceeds necessary levels. Knowledge of home use patterns and resulting risks is quite limited; an appropriate first step for EPA might be to conduct surveys to understand consumer practices. Once the most dangerous practices are identified, effort might shift to designing outreach strategies that would effectively communicate to purchasers the risks to the homeowners themselves and to broader environment--of household pesticide use. A strategy involving product labeling, advertising and other informational displays at the point of purchase, and perhaps product reformulation should be developed to elicit safer behavior by home users.

S.13.4 Learn more about home use of pesticides, and develop ways to encourage safer practices. S&T, INFO

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AA.1 STRATEGY OPTIONS SORTED BY ENVIRONMENTAL PROBLEMS

Criteria Air Pollutants

S.1.1 Use marketable permits to lower costs and spur innovation in reducing acid rain. MI, EP

S.1.2 Reduce VOC emissions through deposit-refund programs, taxes or marketable permits. PP, MI

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.1.5 Establish more remote monitors for ozone. S&T

S.1.6 Further investigate the relative roles of VOCs and NOx in ozone formation, S&T

Toxic Air Pollutants

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land use planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.2.3 Require process audits of manufacturers to find fugitive sources of pollution, leaks in piping, and other preventable releases. PP, ENF

S.2.4 Reduce use of solvents in consumer products. PP, INFO, REGS

Radon

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

S.3.2 Improve techniques of communicating radon risks so public can make informed decisions. S&T, INFO

S.3.3 Require radon inspections for schools and certain other buildings. REGS, TH

S.3.4 Establish airflow and radon protection standards for new buildings. REGS, TH

S.3.5 Increase knowledge base for radon, including exposure patterns, epidemiology, and mitigation techniques. S&T

Indoor Air Pollution

S.4.1 Provide state and local governments with technical information to help them address indoor air pollution. S&T, INFO

S.4.2 Work with other agencies to regulate products that cause indoor air problems. PP, INFO, REGS

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

S.4.4 Develop better instruments to diagnose sick buildings. S&T

Ozone Depleting Substances

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs and halons. PP, FOR

S.5.2 Help other countries develop ozone-safe technologies, PP, FOR

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

COs 2 and Global Warming

S.6.1 Understand better the potential for global warming and its impacts. S&T

S.6.2 Increase research on ways of preventing and adapting to global warming. S&T

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.6.6 Pursue an international agreement on greenhouse gases. FOR

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

Nonpoint Source Pollution

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.7.2 Focus EPA and State water programs more on enhancing water quality and less on permitting point sources. REGS, NR, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

Wetlands

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.8.2 Develop new funding sources for federal acquisition and management of wetlands. NR

S.8.3 Reform conventional wetlands regulation. REGS, ENF, TH

S.8.4 Consider direct and indirect impacts in Environmental Impact Statements for Federal flood control and drainage projects. INFO, NR

Estuaries and Coastal Waters

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

S.9.2 Protect estuaries from accumulation of pollutants transported long distances through general waste reduction and pollution prevention efforts. PP

S.9.3 Develop ecologically protective and cost-effective technologies to manage contaminated sediments in estuaries. S&T

Habitat Alteration

S.10.1 Develop a nationwide inventory and preservation plan for important habitats. NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.10.3 Dramatically increase Federal acquisition of important ecological areas and open space. NR

S.10.4 Identify important habitats now in Federal ownership and manage them to preserve ecological communities. NR

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

Hazardous Waste

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

S.11.2 Help states achieve adequate treatment and disposal capacity -- by ensuring that waste reduction goals are met, and by adding new facilities if necessary. PP, INFO, REGS

S.11.3 Support the "product stewardship" idea -- a manufacturer has a responsibility to contribute to appropriate use, reuse, recycle, and disposal of his products. PP, INFO, MI, NR

S.11.4 Simplify RCRA regulations and provide a more flexible array of hazardous waste management standards. REGS

S.11.5 Identify contaminated waste sites posing immediate threats and quickly bring them under control. REGS, ENF

S.11.6 Address future risks from contaminated waste sites by developing and applying permanent cleanup techniques. S&T, REGS, ENF

S.11.7 Encourage site cleanup by third parties through enforcement and use of reasonable settlement procedures. REGS, ENF

Municipal Solid Waste

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF, NR

S.12.2 Eliminate federal standards, subsidies and procurement specifications that discourage waste reduction and recycling. PP, MI

S.12.3 Tax wastes and virgin materials to promote waste reduction and recycling. MI, TAX, NR

S.12.4 Create deposit/refund systems for tires, batteries, car hulks, used oil and packaging containers. MI

S.12.5 Encourage better state and local planning for solid waste management capacity. INFO, REGS, TH

Pesticides

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, INFO, REGS, AP

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourge industrial audits of these facilities. PP, INFO, AP

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

S.13.4 Learn more about home use of pesticides, and develop ways to encourage safer practices. S&T, INFO

AA.2 STRATEGY OPTIONS SORTED ACCORDING TO TOOLS

POLLUTION PREVENTION - PP

S.1.2 Reduce VOC emissions through deposit-refund programs, taxes or marketable permits. PP, MI

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land use planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.2.3 Require process audits of manufacturers to find fugitive sources of pollution, leaks in piping, and other preventable releases. PP, ENF

S.2.4 Reduce us of solvents in consumer products. PP, INFO, REGS

S.4.2 Work with other agencies to regulate products that cause indoor air problems. PP, INFO, REGS

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs and halons. PP, FOR

S.5.2 Help other countries develop ozone-safe technologies, PP, FOR

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

S.9.2 Protect estuaries from accumulation of pollutants transported long distances through general waste reduction and pollution prevention efforts. PP

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

S.11.2 Help state achieve adequate treatment and disposal capacity -- by ensuring that waste reduction goals are met, and by adding new facilities if necessary. PP, INFO, REGS

S.11.3 Support the "product stewardship" idea -- a manufacturer has a responsibility to contribute to appropriate use, reuse, recycle, and disposal of his products. PP, INFO, MI

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF

S.12.2 Eliminate federal standards, subsidies and procurement specifications that discourage waste reduction and recycling. PP, MI

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, INFO, REGS

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourage industrial audits of these facilities. PP, INFO, AP

<u>SCIENTIFIC AND TECHNICAL MEASURES - S&T</u>

S.1.5 Establish more remote monitors for ozone. S&T

S.1.6 Further investigate the relative roles of VOCs and NOx in ozone formation. S&T

S.3.2 Improve techniques of communicating radon risks so public can make informed decisions. S&T, INFO

S.3.5 Increase knowledge base for radon, including exposure patterns, epidemiology, and mitigation techniques. S&T

S.4.1 Provide state and local governments with technical information to help them address indoor air pollution. S&T, INFO

S.4.4 Develop better instruments to diagnose sick buildings. S&T

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

S.6.1 Understand better the potential for global warming and its impacts. S&T

S.6.2 Increase research on ways of preventing and adapting to global warming. S&T

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

S.9.3 Develop ecologically protective and cost-effective technologies to manage contaminated sediments in estuaries. S&T

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

S.11.6 Address future risks from contaminated waste sites by developing and applying permanent cleanup techniques. S&T, REGS, ENF

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, INFO, REGS

S.13.4 Learn more about home use of pesticides, and develop ways to encourage safer practices. S&T, INFO

<u>PROVISION OF INFORMATION - INFO</u>

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.2.4 Reduce us of solvents in consumer products. PP, INFO, REGS

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

S.3.2 Improve techniques of communicating radon risks so public can make informed decisions. S&T, INFO

S.4.1 Provide state and local governments with technical information to help them address indoor air pollution. S&T, INFO

S.4.2 Work with other agencies to regulate products that cause indoor air problems. PP, INFO, REGS

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

S.8.4 Consider direct and indirect impacts in Environmental Impact Statements for Federal flood control and drainage projects. INFO, NR

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

S.11.2 Help state achieve adequate treatment and disposal capacity -- by ensuring that waste reduction goals are met, and by adding new facilities if necessary. PP, INFO, REGS

S.11.3 Support the "product stewardship" idea -- a manufacturer has a responsibility to contribute to appropriate use, reuse, recycle, and disposal of his products. PP, INFO, MI

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF

S.12.5 Encourage better state and local planning for solid waste management capacity. INFO, REGS, TH

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, INFO, REGS

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourage industrial audits of these facilities. PP, INFO, AP

S.13.4 Learn more about home use of pesticides, and develop ways to encourage safer practices. S&T, INFO

MARKET INCENTIVES - MI

S.1.1 Use marketable permits to lower costs and spur innovation in reducing acid rain. MI, EP

S.1.2 Reduce VOC emissions through deposit-refund programs, taxes or marketable permits. PP, MI

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

S.11.3 Support the "product stewardship" idea -- a manufacturer has a responsibility to contribute to appropriate use, reuse, recycle, and disposal of his products. PP, INFO, MI

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF

S.12.2 Eliminate federal standards, subsidies and procurement specifications that discourage waste reduction and recycling. PP, MI

S.12.3 Tax wastes and virgin materials to promote waste reduction and recycling. MI, TAX

S.12.4 Create deposit/refund systems for tires, batteries, car hulks, used oil and packaging containers. MI

CONVENTIONAL REGULATION - REGS

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.2.4 Reduce us of solvents in consumer products. PP, INFO, REGS

S.3.3 Require radon inspections for schools and certain other buildings. REGS, TH

S.3.4 Establish airflow and radon protection standards for new buildings. REGS, TH

S.4.2 Work with other agencies to regulate products that cause indoor air problems. PP, INFO, REGS

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

S.7.2 Focus EPA and State water programs more on enhancing water quality and less on permitting point sources. REGS, NR, AP

S.8.3 Reform conventional wetlands regulation. REGS, ENF, TH

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

S.11.2 Help state achieve adequate treatment and disposal capacity -- by ensuring that waste reduction goals are met, and by adding new facilities if necessary. PP, INFO, REGS

S.11.4 Simplify RCRA regulations and provide a more flexible array of hazardous waste management standards. REGS

S.11.5 Identify contaminated waste sites posing immediate threats and quickly bring them under control. REGS, ENF

S.11.6 Address future risks from contaminated waste sites by developing and applying permanent cleanup techniques. S&T, REGS, ENF

S.11.7 Encourage site cleanup by third parties through enforcement and use of reasonable settlement procedures. REGS, ENF

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF

S.12.5 Encourage better state and local planning for solid waste management capacity. INFO, REGS, TH

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, INFO, REGS

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

ENFORCEMENT - ENF

S.2.3 Require process audits of manufacturers to find fugitive sources of pollution, leaks in piping, and other preventable releases. PP, ENF

S.8.3 Reform conventional wetlands regulation. REGS, ENF, TH

S.11.1 Use EPA's authorities broadly and creatively to reduce the generation of hazardous wastes. PP, INFO, REGS, ENF

S.11.5 Identify contaminated waste sites posing immediate threats and quickly bring them under control. REGS, ENF

S.11.6 Address future risks from contaminated waste sites by developing and applying permanent cleanup techniques. S&T, REGS, ENF

S.11.7 Encourage site cleanup by third parties through enforcement and use of reasonable settlement procedures. REGS, ENF

S.12.1 Reduce toxic materials in consumer products and expand markets for recovered materials. PP, INFO, MI, REGS, ENF

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

AA.3 STRATEGY OPTIONS SORTED ACCORDING TO POLICIES

ENERGY POLICY - EP

S.1.1 Use marketable permits to lower costs and spur innovation in reducing acid rain. MI, EP

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.6.4 Promote non-fossil and non-carbon energy technologies. PP, S&T, EP

AGRICULTURAL POLICY -AP

S.7.1 Modify national agricultural policy to reduce nonpoint source pollution. PP, S&T, INFO, MI, AP

S.7.2 Focus EPA and State water programs more on enhancing water quality and less on permitting point sources. REGS, NR, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.13.1 Encourage reduced use of pesticides by providing incentives for farm use of integrated pest management (IPM), and by prohibiting unnecessary uses. PP, S&T, AP, INFO, REGS

S.13.2 Create a right-to-know program regarding pesticide use by large agricultural firms. Encourage industrial audits of these facilities. PP, INFO, AP

S.13.3 Regulate the practices of large pesticide users, particularly in sensitive environments. REGS, ENF, AP

TRANSPORTATION, URBAN, HOUSING AND COMMERCIAL DEVELOPMENT POLICY - TH

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CAFE standards. PP, MI, REGS, EP, TH, TAX

S.2.1 Reduce auto emissions by reducing vehicle miles travelled -- through better land planning, car pooling, and mass transit alternatives. PP, INFO, EP, TH

S.2.2 Promote the use of clean and alternative fuels in cars and trucks. PP, REGS, EP, TH

S.3.1 Ensure that homeowners understand radon risks by requiring testing before properties can change hands. INFO, MI, TH

S.3.3 Require radon inspections for schools and certain other buildings. REGS, TH

S.3.4 Establish airflow and radon protection standards for new buildings. REGS, TH

S.4.3 Establish ventilation requirements for new and existing homes. REGS, EP, TH

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.8.3 Reform conventional wetlands regulation. REGS, ENF, TH

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

S.12.5 Encourage better state and local planning for solid waste management capacity. INFO, REGS, TH

TAX POLICY - TAX

S.1.3 Alter state utility rate structures to persuade utilities to sell conservation rather than BTUs. PP, MI, EP, TAX

S.1.4 Reduce energy use in transportation through a gasoline tax and tighter CARE standards. PP, MI, REGS, EP, TH, TAX

S.5.3 Support recycling and reuse of CFCs and development of safe alternatives. PP, S&T, INFO, MI, TAX

S.6.3 Slow global warming through energy conservation. PP, MI, EP, TAX

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

NATURAL RESOURCE POLICY - NR

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.7.2 Focus EPA and State water programs more on enhancing water quality and less on permitting point sources. REGS, NR, AP

S.7.3 Support state and local efforts to control land uses that generate nonpoint source pollution. PP, S&T, INFO, AP, NR

S.8.1 Remove economic incentives for development in wetlands. MI, AP, TH, TAX, NR

S.8.2 Develop new funding sources for federal acquisition and management of wetlands. NR

S.8.4 Consider direct and indirect impacts in Environmental Impact Statements for Federal flood control and drainage projects. INFO, NR

S.9.1 Manage estuaries as integrated systems; avoid focusing only on water quality. S&T, AP, TH, NR

S.10.1 Develop a nationwide inventory and preservation plan for important habitats. NR

S.10.2 Restrict Federal activities that contribute to development of ecologically important areas. MI, REGS, AP, TH, TAX, NR

S.10.3 Dramatically increase Federal acquisition of important ecological areas and open space. NR

S.10.4 Identify important habitats now in Federal ownership and manage them to preserve ecological communities. NR

S.10.5 Support state, local, and private efforts to preserve important habitat areas through tax breaks and technical assistance. S&T, MI, TH, TAX, NR

FOREIGN POLICY - FOR

S.5.1 Strengthen the Montreal Protocol to virtually eliminate use of CFCs and halons. PP, FOR

S.5.2 Help other countries develop ozone-safe technologies, PP, FOR

S.6.5 Reduce CO_2 accumulation in the atmosphere by creating incentives to preserve and enhance the world's forests. MI, TAX, NR, FOR

S.6.6 Pursue an international agreement on greenhouse gases. FOR

S.6.7 Reduce use of CFCs and halons (S.5 strategies). PP, S&T, INFO, MI, TAX, FOR

B. PERSPECTIVES ON REDUCING ENVIRONMENTAL RISKS

In the course of generating and evaluating risk reduction options, the Subcommittee developed several concepts that seem particularly helpful in thinking systematically about risk reduction. Within the limited time available, the Subcommittee was not able to pursue these concepts to the extent it would have liked. With more time and resources to devote to the issue of evaluating risk reduction options, EPA can develop and apply them fully. In this appendix, these ideas are loosely organized as a series of observations.

B.1 Alternative Points of Intervention to Reduce Risks

Most environmental risks or hazards result through a common chain of events (See Figure B-1). The chain is illustrated in this case for a hypothetical nuclear power plant accident releasing radioactive iodine and resulting in thyroid cancer. Similar examples could be developed for other environmental problems, such as those involving emissions from industrial processes, purchase of polluting consumer products, use of pesticides, etc. The events giving rise to the risks and the possible points for control interventions are the same for other cases.

For most environmental problems, EPA thinks about reducing risks first by intervening between initiating events and the release of pollutants. Control technologies are researched and regulations mandating their installation are implemented and enforced. Very little effort is devoted to determining whether interventions at other points might be more effective and/or cost-effective. For instance, in many cases, the initial choice of a more environmentally benign technology may prevent risk most cost-effectively. Pollution prevention activities such as toxics use reduction measures or process audits to reduce the likelihood of initiating events may also be particularly worthwhile. Alternatively, reducing exposure to pollutants already in the ambient environment is another approach that should be considered. In the Superfund program, for example, exposure reduction measures (provision of alternative water supplies, site access restrictions, etc.) typically provide quicker and more cost effective risk reduction results than permanent, engineered site remedies. The extent of site cleanup can then be addressed separately.

Although pollution prevention approaches are often superior, one should not always favor one approach or intervention point over another. The point is simply that one should investigate the full range of ways by which risks posed by a given problem might be reduced.

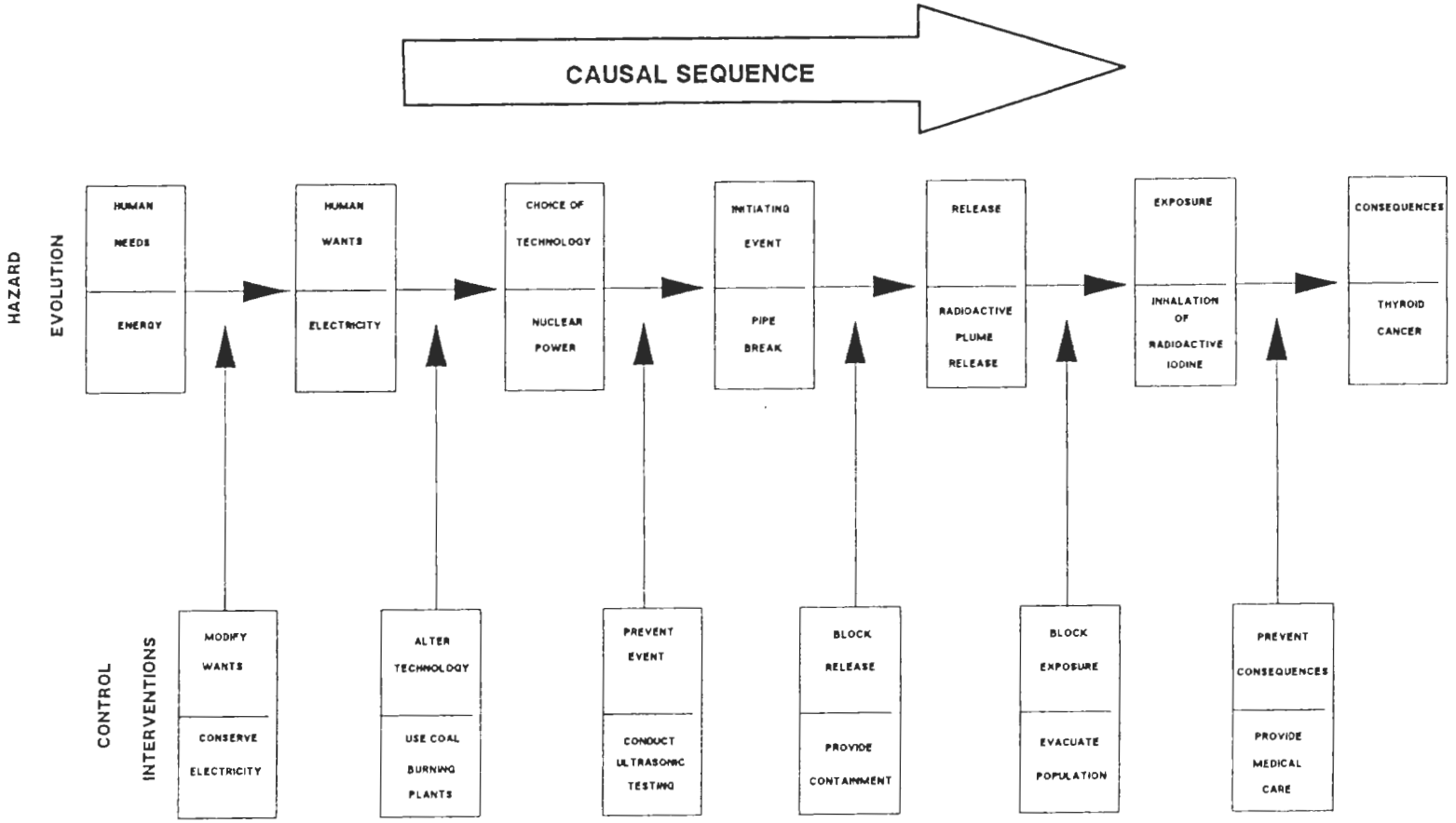


Figure B.1 The hazard chain model, as applied to a hypothetical nuclear plant accident.

B.2 Pollution Prevention As a Key Theme in Risk Reduction

During the last few years inside and outside EPA there has been greatly increased discussion of pollution prevention as a preferred approach to environmental risk reduction. Pollution prevention has emerged as a new theme largely in counterpoint to the perceived limitations of the pollution control efforts of the last two decades. Where pollution control focuses on attempting to control or mitigate pollution once produced, pollution prevention emphasizes avoiding its creation in the first place.

The pollution control approach has come under attack for many reasons, including:

a) **limited effectiveness** - despite the investment of billions of dollars in pollution control technologies, our country continues to be faced with severe pollution problems. There is no better example of this than urban air pollution, where despite twenty years of effort many of our major cities remain out of compliance with federal clean air standards. A major contributor to such noncompliance is the automobile. Application of pollution control technology has made automobiles less polluting than twenty years ago. During that same time period, however, the number of vehicle miles travelled in urban areas has increased, thus offsetting pollution control gains achieved by this technology.

b) **expense** - the pollution control system is costly; dollars spent on pollution control are not available for expenditure on producing valuable goods.

c) **cross-media transfers** - application of pollution control technologies can have the effect of shifting pollutants inadvertently from one medium to another. Alternatively, pollution control requirements may induce generators to move pollutants intentionally from a heavily regulated medium to one which is less regulated. For example, a major problem that sewage treatment plants have faced is the handling of sewage sludge; it is often so contaminated with pollutants removed from water that it has to be burned, buried, or otherwise disposed of.

d) **operation and maintenance shortfalls** - because pollution control equipment is costly to operate and does not normally contribute to primary production processes, there is little incentive other than regulatory enforcement and the operator's conscience to keep equipment functioning properly. This situation has contributed to widespread noncompliance with environmental laws such as the Clean Water Act.

e) **limits in knowledge about necessary levels of control** - scientific understanding of the fate and effects of various pollutants is limited, severely in many cases. Preventing pollution altogether is far safer than settling on an acceptable level of pollution and running the risk of underestimating the

subsequent adverse effects of the pollution that has been allowed. Also, there often are long and protracted debates over appropriate levels of control for various pollutants, leading to long delays in action. A prime example has been the debate over the appropriate level of control for benzene, a single chemical, which has dragged on in the regulatory agencies and the courts for years.

As observers in government, industry, and the public interest community have become increasingly aware of these problems, interest in alternatives to control approaches has increased. More attention has been placed on finding ways not to create pollutants in the first place, therefore reducing the need to control pollutants. Initially, such prevention concepts were most heavily debated and refined in the area of hazardous waste, beginning with concepts of hazardous waste/source reduction, and later were extended to concepts of multimedia waste reduction. In the last few years, many have suggested a turn to pollution prevention approaches to help solve a full spectrum of environmental problems, as we do here.

Despite much discussion of pollution prevention, however, the concept remains somewhat vague and undefined, and our review reveals that no consistent definition of the concept has been offered to date. This has contributed to a lack of progress in implementing pollution prevention approaches. For the purposes of this report, we have adopted the following general definition of the concept:

"Pollution Prevention" means changes in the configuration of, use of, or demand for raw materials, products or technologies of production so as to reduce the use of hazardous materials and/or the creation of hazardous products, byproducts, or pollutants or destructive results. Such changes are not considered to be "pollution prevention" if they result in one hazardous material, product, byproduct or pollutant or destructive result being substituted for another so as to create substantial new risks of concern. Pollution prevention can also include changing activities and the location of those activities so as not to harm human health or sensitive ecosystems; avoiding development near wetlands is an example.

A key phrase which may not be clear in this definition is "technologies of production." The term refers to the fundamental technologies used by humans to accomplish productive activities such as mining, manufacturing, farming, and transportation. Changes in such technologies refer to alterations in the configuration of the technologies themselves, as contrasted with the addition of supplementary technologies. The purpose of such changes is to reduce the use of hazardous inputs or the creation or formation of hazardous products, byproducts or pollutants or destructive results by those production technologies.

For example, one production technology used to accomplish the productive activity of human transportation is the automobile.

Replacing automobiles in an urban area suffering from air pollution with mass transportation, bicycles, or non-polluting vehicles would be a form of pollution prevention, as long as the alternatives did not create substantial new risks. An alteration in the engine of the automobile to make it burn gasoline more cleanly and produce less carbon monoxide also would be a pollution prevention change. In contrast, adding a catalytic converter to the engine is simply the addition of a supplementary technology to control engine emissions.

Similarly, changes in raw materials or in products can constitute pollution prevention. For example, substitution of a water-based paint product for an oil-based paint product can eliminate hazardous solvents in the paint and associated emissions and wastes.

Finally, reductions in the demand for some product can prevent pollution. For example, reduced demand for electricity can lead to reduced production of greenhouse gases by electrical generating facilities burning fossil fuels. In contrast, a pollution control approach targeted at greenhouse gases might be to plant more trees to attempt to offset the carbon dioxide production of the generating facilities.

There is a fundamental difference, then, between pollution prevention approaches as we have defined them and pollution control approaches. The latter involves the use of supplementary technologies to control pollutants or destructive results once they already have been created.

Experience with the pollution prevention approach as applied in several settings shows that pollution prevention strategies applied in place of or combined with pollution control can help to overcome many of the problems associated with pollution control noted above. With regard to effectiveness, pollution prevention approaches, such as eliminating the use of DDT or of lead in gasoline, have brought us some of our greatest success stories in reduction of environmental pollution. With respect to costliness, some firms have reported notable cost savings from the use of pollution prevention approaches, mostly in the form of avoided pollution control costs, but also through the increased productive efficiency of their operations. As for the problem of crossmedia shifting, reduced use of solvents can reduce the need for air pollution control equipment which produces hazardous wastes which must be disposed of. Pollution prevention can avoid problems of operation and maintenance shortfalls because changes in production processes for purposes of pollution prevention bring the incentives to maximize production of product into alignment with the incentive to produce the least amount of pollution. And finally, with respect to the problem of limits of knowledge, a technique which eliminates the use of a toxic chemical also eliminates the need to debate necessary levels of control.

It is important to note that some pollution prevention approaches are more fundamental and comprehensive than others. This is true because some technologies of production and associated raw materials and products contribute to multiple environmental problems. For example, the manufacturing and use of paints containing toxic solvents can contribute to any or all of the following problems: criteria air pollutants; toxic air pollutants; indoor air pollution; nonpoint source pollution; pollution of estuaries and coastal waters; hazardous waste; and municipal solid waste. From a pollution prevention perspective, one can approach these problems one at a time or, preferably, simultaneously. For example, a paint manufacturer could practice waste reduction by rescheduling production so as to reduce the number of tank cleanings needed each day. This is desirable, but a far more desirable pollution prevention approach, which would reduce all of the problems noted above, would be to reformulate the paint so it contained less or no toxic solvent.

It makes sense, then, to establish pollution prevention programs not around specific problems, but around specific types of technologies of production, raw materials, and products. This type of program can then be focused simultaneously on all of the problems associated with a particular set of production technologies or products, and preference can be given to pollution prevention approaches which can impact multiple problems, not just one or two.

The need for such multifaceted prevention programs already has been recognized in several states moving forward aggressively on pollution prevention. For example, the States of Massachusetts, Oregon, and Illinois last year established toxics use reduction laws which encourage manufacturers to recognize explicitly how hazardous substances used in their production technologies and products affect workers, consumers, and different parts of the environment.

Pollution prevention can be implemented through careful use of any of a number of policy tools, if applied appropriately. Market incentives can be used, such as the imposition of a gasoline tax to promote the purchase of more fuel efficient cars, thereby reducing the production of CO2 and air toxics. Information-provision tools can be very helpful, such as requirements for large farmers to report publicly their use of, and their plans to reduce use of, pesticides. Conventional regulations are applicable, such as the use of the authorities under the Toxic Substances Control Act to restrict toxic substance content of consumer products which must be disposed of as municipal solid waste.

Many of the strategies we have identified for promoting prevention focus primarily on "soft" approaches, such as requirements for auditing and planning or further research and development. One reason that the implementation of strong regulatory requirements is not a more frequent recommendation is

that pollution prevention is still a relatively new way of thinking for many. Thus, approaches which emphasize education, training, and information gathering and dissemination are logical at this time. As our knowledge base on and experience with prevention approaches builds, more far-reaching measures may become more appropriate.

B.3 The Desirability of Strategies That Address Multiple Problems

Many of the risk reduction options we find most promising address multiple problems. An agricultural policy that reduces the incentives for overuse of agricultural chemicals will contribute to solving nonpoint source, pesticide, and estuary problems. Increased energy efficiency and conservation will reduce risks associated with criteria air pollutants, global warming, acid rain, air toxics, and other problems such as those associated with coal and oil extraction, oil spills, leaking underground storage tanks and sludge and flyash disposal; the balance of payments and national security would also benefit. Strategies that address multiple problems are much more desirable than they appear when viewed from a perspective concerned with only a single problem.

Evaluating the risk reduction benefits of broad strategies that address multiple problems may be particularly difficult. When a strategy reduces risks by numerous, disparate and often indirect means, it becomes difficult to measure and aggregate the benefits from the strategy. Giving a cross-cutting strategy with benefits for multiple problems sufficient credit becomes particularly difficult in EPA's programmatic organizational structure, in which each individual program office typically focuses on a narrow range of problems.

Two of the Subcommittee's major recommendations (see Chapter 4) involve EPA encouraging pollution prevention generally and supporting improved environmental education and training. The risk reduction benefits of such approaches are virtually impossible to document or measure, but they are nevertheless very significant across all of the environmental problem areas we studied.

B.4 Additional Comparisons of Environmental Problems: EPA and Social Spending On Them, and Public Opinion About Them

In this project, EPA charged the SAB with evaluating the risk rankings produced under the Unfinished Business project, and going beyond these rankings to develop promising options for addressing the risks. Another issue briefly considered in the earlier project was how the risk rankings for the problems correlate with public perception of them and social attention to them. We have several thoughts about how EPA might review and update the earlier work on this topic.

Unfinished Business observed that the relative amount of attention EPA devoted to problems did not correlate well with the

relative risks posed by the problems. Several problems were cited that appeared to pose relatively high risks, yet received minimal attention from EPA. Conversely, very high levels of funding were directed at several of the lower risk problem areas. The disparity was explained by the fact that EPA's funding priorities are determined largely by Congress, reflecting public opinion about the severity of different environmental problems.

While we would probably agree that these observations from Unfinished Business were and are still true, we suggest that EPA undertake the following investigations:

1. Estimate the relative amounts of EPA spending (dollars and personnel) on the different environmental problem areas. This could be done as follows. Each element of EPA's budget could be assessed and then apportioned to the problem or problems it addresses. By summing across budget elements, one could then determine how EPA's total budget is allocated among the problems. Some of EPA's budget is for management overhead (e.g., the Office of Administration and Resource Management) or for multi-media purposes (e.g., non-programmatic health effects research) and could not be allocated to specific problem areas. The list of problem areas for which the analysis should be performed would probably be somewhere between 13 and 31. The 31 problems considered by Unfinished Business include several for which identifying appropriate budget amounts would be extremely difficult (e.g. consumer exposure to toxic chemicals). The 13 problems considered by the Subcommittee exclude several areas of significant EPA spending (e.g. drinking water, point source discharges to surface water).

2. Estimate the relative amounts of spending by the entire nation (government, industry, consumers, etc.) on the different environmental problem areas. The EPA's new Cost of a Clean Environment report could provide a basis for this analysis. In discussing the funds devoted to different environmental problems, the Unfinished Business study considered only EPA spending and did not also investigate total national spending. Both priorities for social spending and priorities for EPA spending are important, and should be analyzed. The sets of priorities need not be identical. For some problem areas, EPA has taken on the costly role of financing the capital costs of control or cleanup technologies (e.g., Superfund, construction grants). These areas may receive a large fraction of EPA's budgetary attention, but they also receive a much smaller fraction of total national environmental spending. For other problem areas, a relatively modest EPA budget devoted to issuing regulations may drive much greater levels of national spending (e.g. industrial point sources). Such problem areas show an opposite pattern, receiving a larger share of the national pie than the EPA pie.

3. Evaluate public perception of the relative seriousness of major environmental problems. The authors of Unfinished Business did this, but more recent public opinion data from the Roper

organization is now available (see Figure B-2). The recent polling is also based on definitions of environmental problems much closer to those used for Unfinished Business and this project. It must be recognized that this polling data, while it covers a wide range of environmental problems, is still somewhat superficial. A more complete measurement and characterization of public perception would include not only poll results, but also more in-depth psychological and sociological surveys.

4. Compare how environmental problems rank in terms of risk, EPA spending, national spending, and public opinion. We expect that a very simple graphical analysis in which problem areas are assigned to quadrants based upon their risk and another factor would be very revealing, even though the data on public perception are not as robust as would be ideal. Figure B-3 shows two samples.

Problems located in the low/low or high/high quadrants present few policy dilemmas, but the high/low combinations can pose significant issues of leadership, values, and ethics for policy makers in a democratic society. Should a problem posing high residual risks, yet receiving a low EPA budget, get more attention? Should a low risk/high budget problem get less attention? What should be done about a problem posing high residual risks (as evaluated by EPA staff or SAB committees) that the public perceives as not very serious? Or vice versa? Such problems present challenges in risk communication. It is not clear if the "experts" know things about these problems that the public does not and public opinion about them would change if the public were better educated. Alternatively, the public may be reacting rationally to a qualitative aspect of the risk posed by the problem that the "experts" have failed to take into account in their analysis.

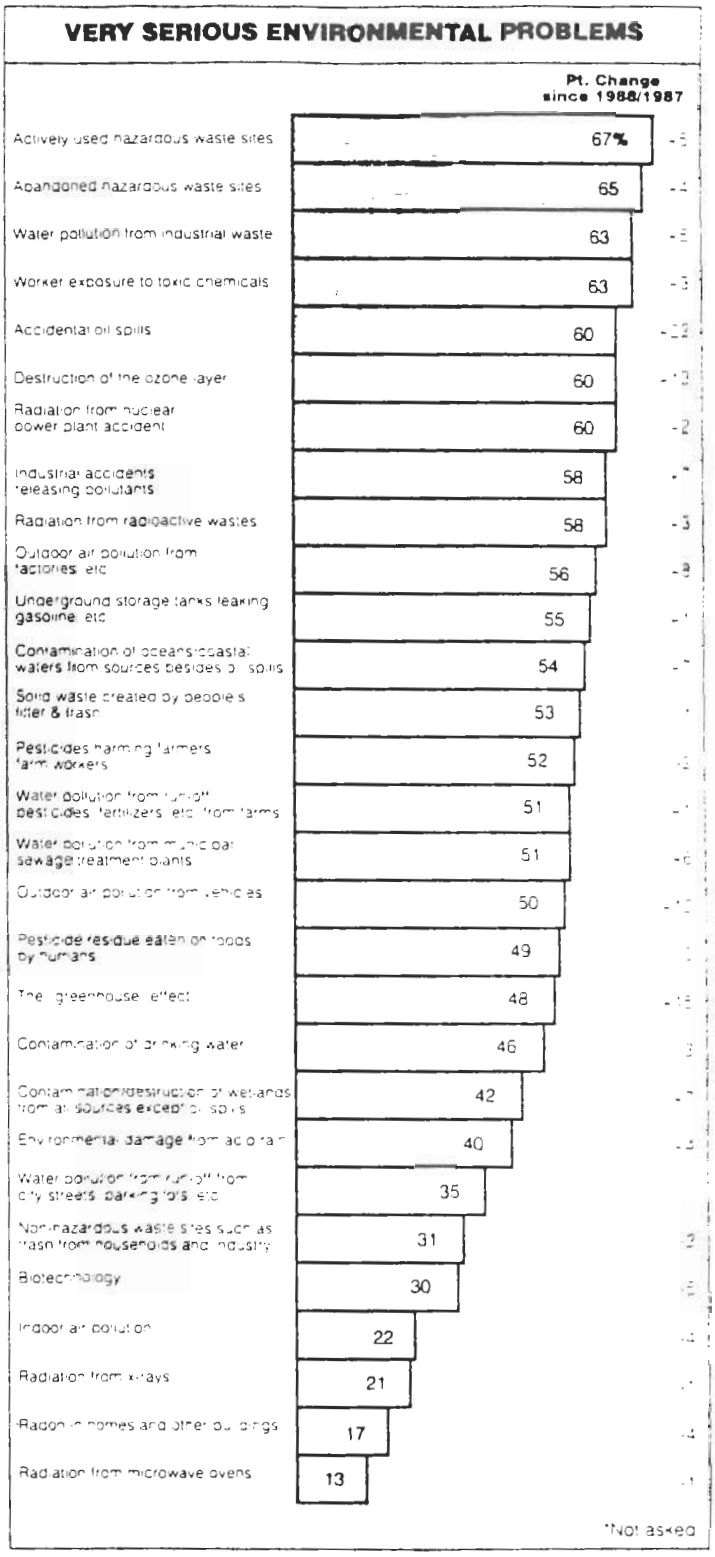
B.5 Geographic Diversity and the Need for Local Flexibility in Risk Reduction Strategies

The Subcommittee generally concerned itself with federal government measures for dealing with national environmental problems. This is partially a function of our charter to advise the Administrator of EPA rather than officials at other levels of government, and partially due to time limitations that led us to concentrate on developing a few broad recommendations rather than many specific ones. This broad, nationwide focus of our recommendations seems to us to obscure an increasingly important point about environmental protection in the U.S. -- that environmental problems vary widely on a geographic basis and federal environmental policies should respect the resulting geographic diversity of needs and possibilities for different, cost-effective solutions. It is important that Federal policies to reduce risk recognize this regional diversity.

For several decades federal pollution control programs have concentrated on setting and enforcing uniform national standards. This approach has been motivated by two premises: that each citizen

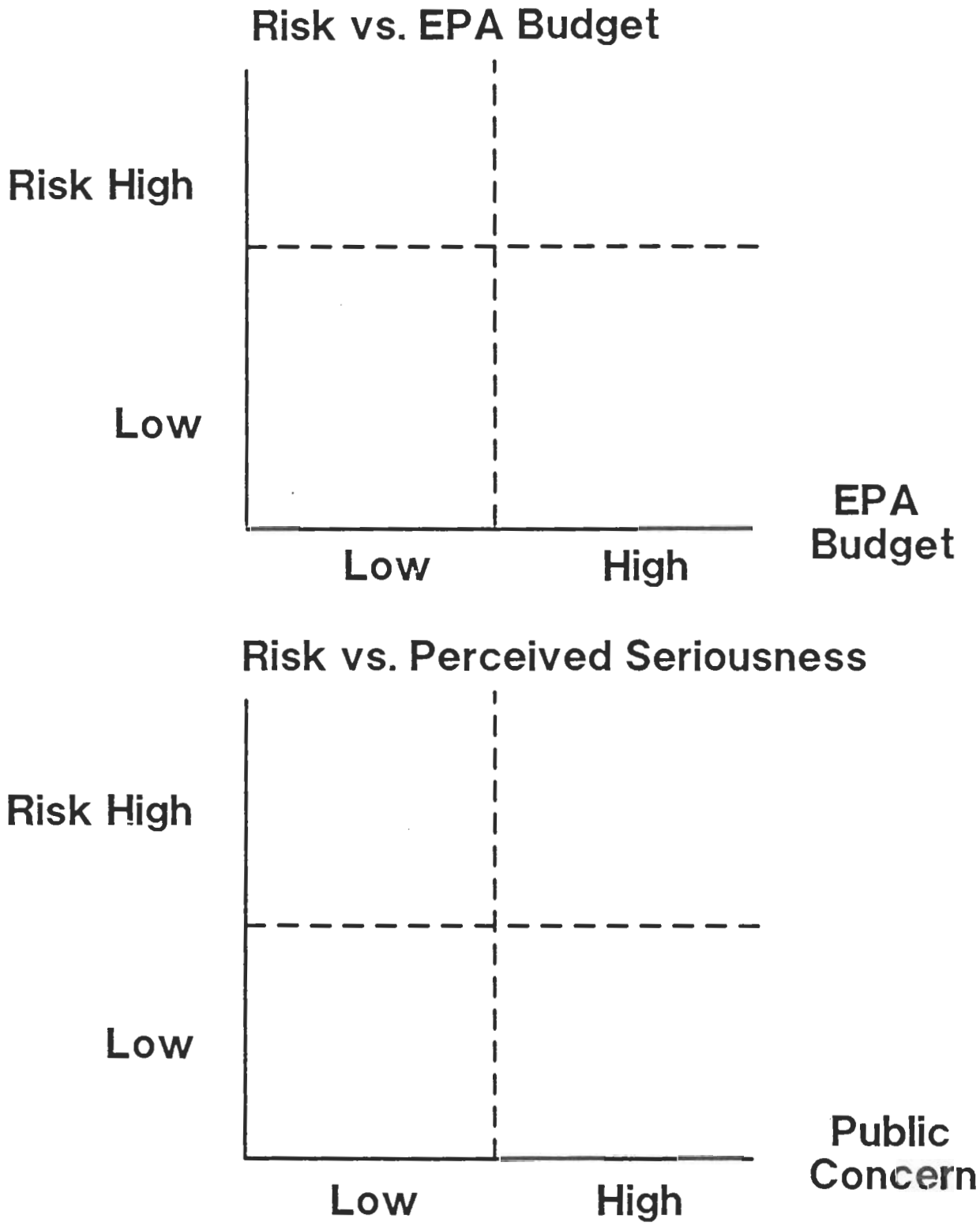
Figure B.2

Public Ranking of Environmental Problems



Source: Roper Reports,
The Roper Organization
New York, 1990, Volume 90-2

Figure B.3
Comparing Risks to Other Factors



is entitled to the same minimum level of environmental protection, and that industry in one locale should not gain a competitive advantage over industry elsewhere by being subject to less stringent pollution control requirements. The resulting nationwide programs have achieved great progress; the obvious, pervasive problems of the past have been greatly reduced.

Many of the problems remaining now are neither conspicuous nor ubiquitous. Instead, they are site-specific, varying from area to area and requiring tailored controls at the regional, state, or local level for cost-effective mitigation. Uniform nationwide requirements on sources of pollution can be an inefficient response to such problems -- they will provide under-control in some areas and over-control in others. Unique local conditions in terms of source mixes, exposure patterns, meteorology, hydrogeology, personal preferences, and numerous other factors often demand unique local solutions. We are not suggesting abandoning existing nationwide ambient standards; it is important to maintain the minimum level of protection they provide. We are suggesting local flexibility in how these standards are attained.

Today, pollution problems often also require control measures that are outside the federal realm of authority. Effective response to nonpoint source water pollution problems may depend on land use controls. Carbon monoxide and ozone air pollution problems often require vehicle inspection and maintenance programs. Indoor air pollution may be addressed most effectively through building codes and testing and mitigation required at the time of property transfers. To the extent that pollution problems shift more toward being caused by individuals and their lifestyles rather than by polluting industries, controls over land use, transportation, zoning, building codes, and water rights become important. Authority over such areas typically lies with state and local governments. One might argue further that newer pollution control requirements will intrude more into formerly private decisions, such as how we use our property, what we eat and drink, and what we do in our homes; therefore, decisions about these requirements should be made at less distant levels of government--in states and localities.

These points argue for a growing importance for states, localities, and individuals in environmental protection. Their role should include implementing programs that are designed and established at the federal level and, more fundamentally, determining what the structure of those programs should be; they can also play an important role as experimenters in policymaking. Some environmental decisions, where cross-regional or even cross-national impacts are at issue (e.g. long-range transport of air pollutants or global climate change) and where products are sold in nationwide markets, should be made at the national or international level. Research is another area in which Federal involvement is most efficient. But state and local governments and individuals will, in the future, frequently be making basic decisions about which environmental problems deserve governmental

attention and what the nature of that attention should be. Federal environmental policies should provide flexibility for state and local governments and individuals to seek cost- effective solutions, while still ensuring a basic level of protection.

B.6 The Role of Uncertainty in Implementing Risk Reduction Strategies

Uncertainty analysis plays an important role in assessing health and ecological effects and in attempting to rank environmental problems. One may rank a problem as high priority for further consideration and possible risk reduction work either because it is thought with a great deal of certainty to cause high risks or because it might cause high risks but there is a great deal of uncertainty about this.

In this latter case, when the uncertainty about potential effects is large, it may be appropriate to conduct further research to narrow the uncertainty, or it may be appropriate to implement risk reduction strategies immediately. If the most likely health and ecological damages during the time needed to do research are not high and the cost of research is low compared to the cost of risk reduction measures, research is the most appropriate step. However, if the cost of the risk reduction strategies is low compared to the costs of research and the expected damages that would occur during this period of research, it may be very appropriate to implement them immediately, rather than spend time and money obtaining better data.

In addition, it may be appropriate to consider certain low cost risk reduction strategies concurrently with additional research. Information-based strategies and certain market incentive strategies are likely to be good candidates to achieve low cost risk reduction. Two examples of where risk reduction is appropriate even with high uncertainty are information dissemination to individuals about how to mitigate indoor air pollution and information collection/dissemination on industrial solid waste disposal amounts/locations.

B.7 Programmatic Disconnects, Particularly in the Industrial Sector

The work of the Subcommittee has shown that many times a single strategy can be an excellent option for addressing multiple problem areas. One example of this is mandatory waste minimization audits as a strategy for reducing chemical releases to all media from the industrial sector.

In contrast, the current Agency approach to selecting strategies on a program-by-program basis may optimize risk reduction for each EPA program, but not for an industrial sector as a whole. In fact, the current approach may lead to shifts in pollution between media, overlapping regulations which address the same problem in different ways, overlapping reporting and

recordkeeping requirements, and inefficient pollution control expenditures for the affected sector and for EPA's enforcement program.

For example, a growing problem for the industrial sector is the overlap/disconnect between the water office regulations and the waste office regulations. Through recent and upcoming changes in the NPDES regulations, sludge regulations, and the land disposal regulations, the Agency is giving conflicting direction to hazardous waste treatment (and all industrial sector companies who perform it) without formal consideration of the impacts that these uncoordinated actions have on the affected industrial sector or the waste management infrastructure. On the one hand, the land disposal restrictions rule is driving wastes into the NPDES/POTW system. On the other hand, the proposed sewage sludge and NPDES regulations are driving wastes toward the RCRA regulatory system. Failure to integrate these rules will result in additional unproductive media-shifting of pollutants and severe strain on the orderly development of safe treatment capacity. Moreover, to the degree pollution prevention is the highest priority goal, this type of regulatory approach is a very inefficient way to get there.

B.8 Regulatory Complexity May Be Counter-Productive

EPA's regulations are getting more and more complex. The best examples are probably the hazardous waste regulations under RCRA. Such complexity results from Agency attempts to carefully specify every aspect of the rule's coverage and implementation. While the goal is laudable, the results tend to be problematic. Neither the regulated universe nor the state and regional EPA staff can fully understand the regulations in the period directly after rule promulgation. Significant non-compliance occurs by companies who are trying to comply but can't understand or misunderstand the rules due to their complexity. Also, regulatory agency training and enforcement resources must increase significantly as a result of the complexity.

The goal of any regulatory program should be environmental compliance. Given that, EPA should consider a trade-off between a perfect rule (one that solves 100% of the environmental problem) which results in lots of inadvertent non-compliance due to complexity, and a rule which only solves perhaps 80% of the underlying problem, but which is crafted so as to result in very high compliance rates.

C. Categories and Evaluation of Strategy Options

C.1 Description of the Strategy Categories

I. Scientific and Technical:

R & D and monitoring to understand the problem -- Includes systemic studies undertaken to establish facts, insights, and principles and to make technological advances; applications range from improved assessment of a problem to innovative solutions. It includes work in the natural sciences, engineering and social sciences. The applicability of research and development to reduce a particular risk depends upon the extent of knowledge about the risk, e.g., research and development is of lesser utility for risks for which the cause and effects are well known and the solution lacks only funds to implement. More details can be found in the 1988 Future Risk report of the Science Advisory Board.

Innovation -- Includes the process of transforming scientific discoveries to uses beneficial to society. Technological innovation for environmental purposes encompasses both less polluting production processes and better end-of-the-pipe treatment technologies. Social/institutional innovation can include incentives for risk reduction behavior. Strategies potentially useful in enhancing innovation are: 1) EPA's innovation program authorized by each media law, 2) flexible permitting systems, 3) handling liability concerns, 4) federal assistance, and 5) regulatory changes that eliminate disincentives. The extent to which innovation applies to a given environmental risk depends upon 1) whether the source of the risk is a direct emission versus a reservoir of material or a product application, and 2) whether science is available upon which to base the required solution. Detail can be found in issue papers prepared by the Technological Innovation and Economics Committee of the National Advisory Council for Environmental Technology Transfer.

II. Information:

Consumer information -- Includes information provided directly to individuals who are most likely to be affected by pollution. Includes information that helps consumers reduce their risk (e.g., information about radon), helps them reduce damage to society (information on disposal of toxic agents) or informs them about potential community threats (Title III of SARA). Information can affect business decisions, as well as decisions by individual consumers.

Technical assistance and technology transfer -- Includes measures to inform more people about effective mitigation techniques for the problem and help them implement the techniques. The technical assistance may be directed at groups causing the problem (e.g., to industry on pollution prevention; to farmers on best management practices for controlling agricultural runoff) or at groups working to ameliorate the problem (e.g., training for publicly owned treatment works operators or technical assistance to state environmental programs).

Auditing -- Includes visits by expert personnel to a site where pollution is generated (e.g. an industrial plant, government or commercial facility, institution or farm or resource extraction operation) to observe operations at the site and suggest ways of preventing or controlling the pollution. EPA may encourage more auditing in various ways. For some problems we suggest that EPA might require audits at certain plants by regulation -- in these cases we list auditing in the "Regulations, other" section.

III. Market Incentives:

Marketable permits -- Includes systems where the total amount of a polluting activity is established by regulation and then the right to conduct the activity is allotted among firms in the form of permits. Firms that reduce pollution below their allotted amount of permits may sell or trade surplus permits to other firms. Those sources that have the lowest cost of abating pollution have an incentive to control more and to sell excess permits, whereas those firms with high pollution control costs have an incentive to buy permits, rather than to control pollution. In theory, the result is that the desired level of pollution reduction is achieved at lowest total cost. Congress currently is considering using marketable permits to control acid rain.

Deposit/refund systems -- Includes schemes in which a surcharge is levied on an item (e.g., beverage containers) when it is purchased and before it is used, with the surcharge being refunded if the item is returned after use. The deposit provides an economic incentive to return the item (often for reuse or recycling) rather than to dispose of it. The approach has been used to encourage recycling of beverage containers and could also be used for products such as tires and batteries.

Fees and taxes -- Includes systems in which fees or taxes are assessed on emissions or on materials or products that cause pollution. This increases the cost of pollution and creates an incentive for polluters to reduce the amount of pollution. Polluters generally would be free to decide how much they want to continue to pollute. In theory, they will reduce pollution up to the point where the marginal cost of control equals the fee or tax. The amount of pollution control that is likely to result from a given fee usually can only be roughly estimated in advance

of imposing the fee. An example might be a tax on emissions of sulfur compounds by power plants. Fees or taxes may also be used in conjunction with other regulatory controls. Fee receipts often can be allocated directly to cleaning up remaining pollution, whereas tax receipts usually get added to general revenues and bear no further relationship to the environmental problem they are intended to solve. Environmental fees and taxes are rarely used in the U.S.

Subsidies & tax credits -- Includes measures that reduce the cost of controlling pollution, rather than raising costs as do fees and taxes. Subsidies and tax credits could be keyed to levels of emissions or pollution, but they have typically been used to defray part of the expense of pollution control systems. Examples are federal matching grants for construction of municipal sewage treatment plants and pollution control bonds. This category also includes strategies to eliminate government subsidies that inadvertently create incentives that have adverse environmental consequences. For example, "below cost" timber sales could lead to increased timber cutting and to substantial losses in habitat and damage to watersheds.

Other -- Includes other measures that rely on market incentives or that remove barriers to market activity that could have environmentally beneficial effects. Examples include: using federal procurement to commercialize an emerging, environmentally beneficial technology; changing the standards under which polluters are legally liable for damages they cause; and removing constraints on trading scarce western water rights.

IV. Conventional Regulations:

End-of-pipe controls -- Includes regulatory measures that prescribe allowable levels of pollution or emissions, or that require the use of specific or equivalent control technology.

Use restrictions -- Includes restrictions on the ways in which potentially harmful materials may be used. Examples include: bans on the use of chlorofluorocarbons as aerosol propellants and restrictions on crops to which specific pesticides may be applied.

Product specifications -- Includes standards specifying content or performance of products. Examples include: limits on sulfur content of diesel fuel; and tolerance levels for pesticide residues on foods.

Monitoring and public disclosure -- Includes measures that require polluters to monitor their emissions so as to enable federal or state agencies to enforce regulatory requirements. Public disclosure of such information may enhance governmental enforcement through activities of public interest groups and citizen suits.

Other -- Includes other regulatory measures not included in the previous categories. Examples include: requirements that states implement specified environmental control programs; requirements that environmental testing laboratories be certified; and audits of environmental control activities.

V. Enforcement

Includes measures to enhance existing enforcement and to obtain greater compliance with existing regulatory requirements. In addition to traditional enforcement by the government it includes innovative measures such as citizen suits.

VI. Cooperation

With other agencies -- Includes efforts by EPA to cooperate with other federal, state, or local agencies in using the Agencies' different statutory authorities, expertise, delivery mechanisms, etc. in a concerted approach to environmental problems. There are many such opportunities in the areas of energy policy, agricultural policy, etc.

With other countries -- Includes efforts to cooperate with other countries to mitigate an environmental problem. In several cases, such as stratospheric ozone depletion and global warming, such cooperation is essential.

VII. Indirect Measures

There is another category of measure on which the Subcommittee did not focus very intensively because they are not direct government actions, but which are generally acknowledged to play a very important part in the reduction of environmental risk. These are broad social trends which EPA has some ability to affect. It may be possible to compare the amount of risk reduction resulting from an indirect measure with that resulting from one of the more direct strategies.

Public relations -- The increasing concern of corporations with their public image and the damage done to this image by being branded as a polluter.

Liability and insurance -- The increasing degree to which polluters are legally liable for the damages they cause; the decreasing degree to which the risks entailed by this liability can be transferred to insurers; and the increasing cost of premiums for such insurance.

Disposal costs -- The increasing cost of disposal of solid and hazardous wastes and the strong resulting pressure to reduce their generation.

Capital turnover -- The extent to which an environmental problem will be mitigated as a result of the natural turnover of the nation's capital stock. New capital equipment tends to use less energy and is often less polluting.

VIII. Pollution Prevention

Pollution prevention could be stimulated by any of the foregoing options. For example, market incentives could be adopted to discourage use of harmful products or to conserve energy. Regulations could ban use of certain products. Information could assist consumers to buy environmentally benign products. While not a measure per se, we have listed it here to show its relationship to the broad range of measures.

C.2 Description of Rating Criteria for Strategy Options

Cost to EPA -- The annual cost to EPA of implementing the strategy.

Cost to society -- The annual cost to the public and private sectors of the U.S. (excluding EPA) of implementing and complying with the strategy. Transfer payments should not be counted as costs.

Dependability -- The degree of assurance that the strategy will obtain the desired risk reduction.

Speed -- The rapidity with which risk reduction is likely to occur following initiation of the strategy.

Implementability/enforceability -- The ease with which the strategy can be implemented, and the ease with which compliance with requirements under the strategy can be enforced against those who are objects of the requirements.

Intermedia transfers and other environmental benefits -- Indicates whether the strategy reduces (or increases) pollution in other media or ameliorates (or exacerbates) other environmental problems.

Risk reduction -- The fraction of the risk posed by the environmental problem that will be reduced by the strategy.

Cost-effectiveness -- Provides an assessment of the cost of the strategy relative to the absolute amount of expected environmental improvements. Cost-effective strategies have a low cost per unit of risk reduced or pollutant or activity affected. Cost-effective strategies may be difficult to develop for environmental problem areas with low absolute risks -- areas that either inherently involve only low risks, or areas where residual risks are low because of substantial progress already in risk reduction.

Short-term and long-term scores -- Provides overall assessments of the desirability of the strategy as a risk reduction measure in the short term (up to 10 years) and the long term (beyond 10 years).

C.3 Evaluation Matrix

ENVIRONMENTAL PROBLEM:

GENERAL APPROACH	TYPE OF TECHNIQUE	SPECIFIC STRATEGY	COST		DEPEND-ABILITY	SPEED	IMPLENT / ENFORCE	INTERMEDIA TRAN + OTHER	RISK RED	C/E	SCORE	
			EPA	SOCIETY							SHORT	LONG
I. ***SCIENTIFIC & TECHNICAL***	R & D & MONITORING (to understand problem)											
	INNOVATION IN TECHNOLOGY											
II. ***INFORMATION***	CONSUMER INFORMATION											
	TECHNICAL ASSISTANCE/ TRANSFER											
	AUDITING											
III. ***MARKET INCENTIVES***	MARKETABLE PERMITS											
	DEPOSIT/REFUNDS											
	FEES & TAXES											
	SUBSIDIES & TAX CREDITS											
	OTHER											
IV. ***CONVENTIONAL REGULATIONS (Command and control)***	END-OF-PIPE CONTROLS											
	USE RESTRICTIONS											
	PRODUCT SPECIFICATIONS											
	MONITORING AND PUBLIC DISCLOSURE											
	OTHER											
V. ***ENFORCEMENT***												
VI. ***COOPERATION***	WITH OTHER AGENCIES											
	WITH OTHER COUNTRIES											
VII. ***INDIRECT MEASURES***	PUBLIC RELATIONS											
	LIABILITY & INSURANCE											
	DISPOSAL COSTS											
	CAPITAL TURNOVER											