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Risk Ranking Project
Region 2

Economic/Welfare Ranking and Problem Analysis

U.S. Environmental Protection Agency
Risk Ranking Work Group
Region 2

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Foreword

What are our nation's worst environmental problems? Pesticides in our foods, dwindling wetlands, toxic wastes, the hole in the ozone layer, radon lurking in the basement, acid rain, closed beaches, and urban smog are among the many problems that pose threats to our health, to the environment, and to our well being.

Over the last 20 years, the Environmental Protection Agency (EPA) has been given responsibility to deal with many of these problems under a patchwork of legislative mandates. Given the scarcity of resources available to confront the expanding list of threats to public health and to the environment, we need to know what the worst environmental problems are in terms of risks to people, natural systems, and our welfare. Then, we must assess whether our priorities make sense in light of the relative risks posed by these problems.

On a national level, *Unfinished Business: A Comparative Assessment of Environmental Problems*, a landmark study published by EPA in 1987, was designed to start answering these questions. In January 1990, EPA's Office of Policy, Planning and Evaluation requested that the seven EPA regions which had not yet completed comparative analyses of the risks posed by environmental problems at the regional level undertake such studies.

In Region II, a work group composed of staff members with varied backgrounds, representing each of the divisions was created, and asked by the Regional Administrator to undertake the Risk Ranking Project. The work group proceeded to: 1) define the regional list of environment problems; 2) develop the criteria and methodologies for evaluating the problem areas; 3) collect data and analyze the risks; and, 4) complete a relative ranking of the problem areas on the basis of their health, ecological and welfare risks.

On October 1, 1990, the work group presented its rankings and the rationale for its findings to the Regional Administrator and the region's senior managers. The work group's recommendations were unanimously adopted by the senior managers.

The Regional Risk Ranking project is composed of four documents. A summary report contains an overview of the Region II's relative risk rankings for health, ecological and welfare effects, and the rationale for those rankings. There are three additional reports which contain the detailed health, ecological and welfare problem areas analyses on which the rankings are based.

This is the Economic/Welfare Report; it includes both the background analyses and a discussion of the work group deliberations that led to the relative ranking.

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I. Introduction

The primary objective of the Region II Risk Ranking Project is to compare the risks posed by the different environmental problems facing the New York/New Jersey/Caribbean Region. The intent of the project is not only to inform EPA staff and managers, but to inform and to influence the public debate over environmental issues as well. Another objective is to use the results as a critical component of a strategic planning process for the region. The level of risk is only one factor that determines priorities. Strategic planning also takes into account a variety of other factors: cost/effectiveness; public concern; the effects of disinvestment; statutory and regulatory mandates; and, how well government effort leverages private investment in environmental improvement. The strategic planning process for the Fiscal Year 1993 budget began in the fall of 1990.

The Risk Ranking Project has two components: analysis and professional judgement. An interdivisional work group, composed of Region II staff with diverse academic backgrounds and encompassing all program areas, was named. On January 31, 1990 the Regional Administrator convened the work group and charged it with responsibility for completing a comparative risk analysis and ranking. In the ensuing months, the work group developed the list of environmental problem areas that were ranked, and the methodologies and criteria for ranking the problems on the basis of their health, ecological and welfare effects. Individual staff members conducted research and analyzed the environmental problem areas.

After staff analyses were completed, initial meetings were held to determine the relative risks posed by environmental problems for health, ecological and welfare effects. The work group evaluated the data and analyses submitted as well as the professional judgement of the work group, especially the persons who completed the analyses. The group also considered the direction of the uncertainty, data gaps, consistency and the technical merit of the analysis.

After the initial rankings were developed, work group members had several weeks to review the analyses more thoroughly and to consider the relative rankings. Proposals to adjust the rankings were prepared during this period. At a subsequent meeting, the work group reached a consensus on the rankings. They were presented to the region's senior staff during September 1990. At a joint meeting on October 1, 1990, the Regional Administrator and his senior staff concurred with and adopted the work group's rankings.

This document provides detailed background on the economic/welfare rankings, and the supporting analyses for each problem area.

II. Measuring Economic/Welfare Effects

Along with EPA's mandate to protect human health and ecosystems is a concern about reducing the negative effects of pollution on the welfare and economic well being of society.[1] The effects of environmental problems on human welfare include a variety of damages to property and resources that affect human use or enjoyment.

Economic damages were one of the components of the national comparative risk study. The Region II work group decided that economic damages were an important aspect of decision making. One driving factor in this judgment was that some environmental problems in the region (e.g. beach closings, fisheries closings, and ground water losses) have large economic effects but small health or ecological effects. The work group thought that including an economic analysis in the project would better account for the full range of concerns about environmental degradation because some important areas are captured only in the welfare ranking.

If priorities were set on the basis of health and ecological criteria alone, EPA would not be troubled by beach closings or closing of drinking water wells because health concerns have been eliminated and the ecological impacts are negligible. But protecting society from the economic damages of caused by pollution and environmental destruction is one of the EPA's roles. This role can be especially important because environmental problems are often characterized by an unequal distribution of benefits and costs. Often the individuals whose well being is affected by a soiled beach or a closed shellfish bed are different from those who benefit from the reduced costs that contributed to the pollution in the first place.

The economic/welfare damages analyzed include: damages to commercial and recreational fishing; the need for treatment of surface water supplies; loss of commercially valuable forests; loss of recreational opportunities in wetlands, forests or coastal areas; declines in property value around toxic waste sites or other polluted areas; buildings and cultural monuments damaged by air pollution; reduced visibility; destruction of watersheds; increased health care costs; and, destruction of ground water resources. This list is not all inclusive but serves to illustrate the major categories of economic damages from pollution considered. Health care costs were included because the increased cost of health care adds to the concern created by personal pain and suffering resulting from environmental health problems.

It is important to distinguish between the losses and damages caused by pollution that are encompassed in the analysis and ranking, and the economic costs of controlling pollution. The costs of control are not included. It is tempting but incorrect to try to compare the estimates of damages to control costs.

First, the analysis could not be conducted with sufficient detail to lead to any conclusions about cost versus benefits. Second, neither time frame nor equity concerns have been

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[1]*Although the term "welfare" connotes a broader range of impacts than economics effects alone, both terms can be used for this analysis. The type of economic effects considered include monetization of damages to an individual's welfare such as loss of recreational opportunities and other public goods. Although individuals are not currently paying for enjoyment, there is definite evidence that individuals value these goods and would be willing to pay for continued use.*

addressed, and these are very important components of cost/benefit analysis. For many environmental issues, the control costs are large but they are incurred in the present, while benefits characteristically continue infinitely into the future. Comparing the level of costs and benefits hinges upon the time frame and discount rate considered appropriate. An example may help to illustrate the nuances involved.

In the analysis, acid rain was found to result in approximately $400 million in losses to society yearly. While the present day control costs are probably higher than this, the benefits resulting from healthy forests and fisheries will continue for generations. In addition, the people who benefit from the lower cost of electricity that results in acid rain are different from those who are hurt by the effects of the pollution. Equity concerns, even intergenerational equity, need to be considered in a cost benefit analysis, along with the level of dollars estimated.

Structure of the Report

This report is a summary of both the analyses prepared for the Region II Risk Ranking Project, and the work group discussions and decisions on the relative magnitude of the economic problem posed by each environmental problem. The analyses prepared for the regional ranking project were completed both by regional staff and by contractors. The review of the literature and the staff analyses were constrained by the time and resources available. While there is confidence in the order of magnitude of the damages and their legitimacy for ranking purposes, the actual dollar figures are not exact. Dollar estimates were not included for two very important damages, the loss of a life and the existence of ecosystems. The methods for putting dollar values on these types of damages are controversial and unreliable. It is noted here because damages that are not quantified are often minimized in value, and this is not intended.

The work group reviewed the results of the analyses, and determined the relative ranking of each problem area. This was a difficult task because some evaluations contained only part of the total economic impact since certain factors could not be quantified; some environmental problems had no dollar estimates at all. The group did not want to restrict the ranking to quantitative problem areas, so they used best professional judgement to rank the more qualitative problem areas. The differences between problems ranked within the same categories are often minimal. The categories are more reliable and are in general order of magnitude. They are:

- o Very high = over a half billion dollars annually
- o High = $ 500 - 50 million
- o Medium = $ 50 - 1 million
- o Low = minimal damages

The limits and uncertainties of the data and methods used are discussed fully in the report. The uncertainties are in the following areas:

1) Does the economic damage exist, or is it theoretical?

2) Does data exist on the size or extent of the damage?

3) Is the method for estimating the dollar value of the damage sound?

4) Does the data accurately reflect what is being estimated?

The welfare ranking of the problem areas is contained in Table 1. The background analyses on which the work group deliberations were based, along with a summary of the actual work group deliberations (which relied heavily on expert judgment in some cases) follows. Each environmental problem area is discussed separately for the most part. However, because the Region II ranking was by sources of pollution and the economic analysis was often structured by the impact or receptor of the pollution, several environmental problem areas were analyzed together.

For example, both point and nonpoint sources of water pollution can affect fisheries, and both Superfund sites and underground storage tanks can damage the ground water resource. The analysis of damages to the ground water resource covered five environmental problem areas, and the analysis is fully described in Part III and referenced throughout the report. A separate analysis of Health Care Costs based on the estimated annual cancer incidence included in the Health Risk Analysis was completed. It is described in Part IV, and referenced throughout the report.

TABLE 1

WELFARE/ECONOMIC RANKING

VERY HIGH

Nonpoint Sources of Water Pollution
Industrial Point Discharges and Municipal/Public Wastewater Treatment Discharges to Water
Combined Sewer Overflow Discharges to Water
Land Use Changes/Physical Modifications of Terrestrial Habitats
Land Use Changes/Physical Modifications of Aquatic Habitats
Indoor Air Pollutants Other than Radon
Mobile Sources of Air Pollution - Motor Vehicles
Area/Non-point Sources of Air Pollution other than Chlorofluorocarbons
Extra-Regional Sources Leading to Acid Deposition

HIGH

Stationary Sources of Air Pollution
Accidental Releases during Production or Transport
Radon
Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons
Abandoned Hazardous Waste Sites/Superfund Sites
Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C
Active Hazardous Waste Sites Currently Regulated under RCRA Subtitle C
Municipal Solid Waste - Storage and Landfills

MEDIUM

Pesticide Residues on Food
Other Underground Injection Wells (Class IV-V)
Pesticides Contamination during Application
Municipal Solid Waste - Incinerators
Operation and Maintenance of Drinking Water Systems - Trihalomethanes, Lead and Microbiological Contamination
Radiation other than Radon

LOW

Underground Injection Wells (Classes I - III)
Municipal Sludge Disposal and Treatment
Dredging and Dredge Disposal
Wastewood Disposal or Treatment

III. Damages to Ground Water Resources

Many environmental problem areas - superfund sites, underground storage tanks, municipal solid waste landfills, nonpoint sources and pesticides - contribute to the contamination of ground water. This section discusses the monetary estimates of damages to the ground water resource for any problem area that affects ground water.

Ground water has economic value in Region II primarily as a source of drinking water. Contamination by toxics damages the ground water resource by reducing the available volume of good quality water. The following review discusses the types of economic damage society suffers when ground water is contaminated, and the information needed to estimate these damages for Region II. Currently available information has been used in an effort to quantify these economic damages. However, information linking the source of contamination to various ground water contamination incidents should be considered speculative.

In earlier comparative risk projects, many programs that contaminate ground water supplies have not ranked highly based on either health or ecological criteria. For example, the health risk from drinking contaminated ground water is often minimal because wells can be closed, and the risk eliminated. In addition, ground water is not an ecosystem, and therefore ground water is not a high priority ecological problem. However, when ground water is contaminated, a loss of society's resources has taken place, and that loss should be reflected in the evaluation of economic damages. Many states demonstrate concern for this resource by enacting ground water protection policies. Rather than using health risk as a primary criterion for cleanup of contaminated ground water, these policies generally call for the restoration of damaged natural resources whenever possible, regardless of current health exposure.

Economic Damages from the Contamination of Ground Water

Economic damages to society from the contamination of current drinking water wells can be divided into three components. First, and most obvious, is the need for replacement water supplies when wells are closed. These supplies must be replaced by digging new wells, hooking up to other water supplies, or treating the water. Data is available on the actual number of wells that have been replaced and possible costs.

The second category of economic damages involves costs incurred when potable ground water not currently used for drinking water is contaminated. Although the contamination does not cause current harm, it results in a decrease in the stock of ground water available for future use. For example, restrictions against new wells in areas surrounding toxic waste sites are often instituted, thus increasing the cost of finding a new supply of water. The following analysis could only provide speculative estimates because data on the extent of ground water contamination are lacking, and no practical economic method has been devised for the valuation of losses to future supplies of water.

The third and least obvious economic damage to society occurs when contamination of drinking water wells occurs, but the wells continue to be used because the health effects are considered negligible. It is unclear what value to place on this decreased quality. Yet many citizens consider their water quality to be reduced and often drink bottled water, at very high costs, partly because of the perception that water from the tap is contaminated. Despite evidence that such damage exists, the data for quantifying any losses are not available.

Another issue that will not be addressed is the value of non-potable ground water that is contaminated. Whether people value the existence of clean ground water in the abstract - removed from any consideration of potential current or future use - is debatable. Calculation of such intrinsic value is more readily applicable to wetlands and endangered species than to ground water.

Damages to Current Drinking Water Supplies

The following method can be used to determine the monetary losses due to ground water contamination of drinking-water supplies that must be replaced:

Volume of water to be replaced x the cost of replacement = Monetary Damages

To estimate the water supplies needing replacement, data are needed on the number of wells in Region II that have been closed or treated because of contamination. For regulatory purposes and for this report, data on drinking water wells are categorized by private wells or public wells.

Public wells, sometimes called municipal wells or community wells, are regulated units. Both federal and state regulations impose testing requirements. Under those regulations, 163 municipal wells in New York have been closed as a result of contamination (draft 1990 305b report.) In the State of New Jersey, 88 public wells were found to have unacceptable levels of volatile organic compounds (VOCs), and an additional 32 wells were treated. Overall, 283 public wells need treatment or replacement.

No central source provides data on the number of private wells that need replacement. Private wells are regulated by counties, and no mandatory testing and monitoring is conducted nor is there a central database indicating the numbers or percentages of contaminated private wells. However, several statewide sampling studies of public wells provide a rough idea of the extent of private well contamination. For example, the New Jersey monitoring program found 18 percent of public water sources with detectable levels of organic contaminants. Of these systems in New Jersey, 9.4 to 12 percent were contaminated at levels where actions were recommended but not mandatory; mandatory action was necessary for 6 percent of systems. A federal survey showed a similar percentage (21 percent) as did a New York program (14 percent).

Private well contamination is calculated at comparable percentages to the contamination reported for public wells. In some cases, where private wells are shallower than public systems, the private well may be more vulnerable to contamination. However, private wells also are usually found in areas with less industrial development, and the possibility of pollutants in those areas is lower. An example of the lower potential for pollution comes from Suffolk County where the Bureau of Drinking Water found that approximately 3 percent of private wells exceeded limits on Maximum Contaminant Levels (MCLs), and required closure. (This contrasts with the 10 to 21 percent contamination rate in public wells.) An estimate of 10% of private wells contaminated was obtained from the New Jersey Department of Health professionals. Because of the range of estimates, the Region II analysis uses two separate sensitivity cases: 3 percent of private wells contaminated, and 10 percent of private wells contaminated.

Cost of Replacement

To determine the cost of replacing water supplies, several measures can be used:

- o Cost of drilling a new well
- o Cost of hook-up to an uncontaminated water supply
- o Cost of wellhead treatment

Capital costs for well replacement vary widely, depending primarily on well size and design. For the purposes of this analysis, the well costs are estimated for both public wells and private wells.

Estimates of well replacement costs were obtained from the State of New Jersey's wellfield tracking system. These data are compiled only for wells that apply for state funds. The main method of replacing municipal wells, as reported by water purveyors and the wellfield tracking systems, is some type of treatment (aeration or granular activated carbon). The average cost of such systems was $315,000. This figure is comparable to costs from the Region I comparative risk project, where a cost of $300,000 was reported. Other estimates, from a California water district, indicate that capital costs for a municipal well can range from $450,000 to $250,000, excluding land acquisition costs. Thus, a capital cost of $300,000 was used for public well replacement cost.

Operation and maintenance costs for wells are primarily the energy costs for pumping, and the cost varies with the flow rate. However, operation and maintenance costs were excluded from the analysis because these costs are not additional costs, but would be incurred with the untreated or uncontaminated wells.

Private wells are replaced mainly by connecting households into a municipal water system (personal communication, water purveyors, NYDOH, NJDOH). Two different capital cost figures are used in the analysis - $3,500 and $17,500. Region I used a $3,500 value in its comparative risk analysis. When a large number of private wells are connected, capital costs per household are often in this range. However, New Jersey's well tracking data system shows an average well connection cost of $17,500, a figure that may be more representative of conditions throughout Region II where economies of scale are not always experienced, especially in upstate New York.

For private wells, the analysis also considers an additional annual water bill of $250. Although the average water bill in New Jersey is $132 yearly, most small municipal water companies have higher yearly bills because they do not benefit from the economies of scale enjoyed by larger cities and towns (NJDEP Municipal sector study).

In converting capital costs to annual yearly costs, four different calculations were used:

- o A 0.04 rate over 10 or 20 years
- o A 0.08 rate over 10 or 20 years

The first method reflects a depreciation of capital approach which could be correct if private water companies were the water purveyors. The latter method may be more representative of conditions in Region II. This method uses an 8 percent interest rate to reflect the annual cost of payments by municipalities who borrow money to finance infrastructure improvement.

Results - Current Use of Ground water

The yearly household costs for well replacement are lowest - approximately $500 - when using a low capital cost estimate and the 0.04 rate over 20 years. The highest yearly cost - $2,858 - occurs when the average capital cost ($17,500) is combined with an 8 percent interest rate over 10 years. The higher estimate is probably closer to the actual costs because it assumes average capital costs rather than lowest cost values, and it accounts for the need of municipalities to borrow capital to finance most of these water connections. The municipal sector study indicates that many municipalities are in fact financing environmental improvements thorough a combination of increased user fees and increased debt.

TABLE 2

ECONOMIC LOSSES FROM CONTAMINATED GROUND WATER (Annual Impact)

CAPITAL COSTS	TOTAL PRIVATE WELLS	PRIVATE + PUBLIC WELLS
TEN PERCENT OF PRIVATE WELLS CONTAMINATED		
$ 3,500	$ 54 -	$ 60.4 - 67 million
$ 3,500	82 million	$ 88.4 - 95 million
$17,500	$ 216 -	$ 222 - 229 million
$17,500	304 million	$ 310 - 317 million
THREE PERCENT OF PRIVATE WELLS CONTAMINATED		
$ 3,500	$ 1.6 -	$ 8.0 - 14.6 million
$ 3,500	2.4 million	$ 8.4 - 15.4 million
$17,500	$ 4.9 -	$11.3 - 17.9 million
$17,500	9.1 million	$15.5 - 22.1 million

These damages do not account for increased costs of obtaining water in the future due to current contamination incidents that have not closed wells but have reduced the available stock for future use.

Sources of Well Contamination

Little information is available on the sources of contamination at public or private wells. The databases and monitoring surveys indicate that well owners and operators often cannot trace the source of contamination. Therefore, allocating the economic losses among environmental problem areas is difficult.

In New Jersey, the percentage distribution of ground water contamination is reported as follows (NJ 305b report, draft 1990):

- Unknown sources - 40 percent
- Underground storage tanks - 20 percent
- Landfills - 13 percent
- Surface spills - 11 percent
- Septic tanks - 6 percent
- Lagoon disposal - 6 percent

In addition, the New Jersey 305b report ranks contamination sources in the following order, with the most serious problem first in the list:

1. Underground storage tanks
2. Industrial/commercial septic/Class V injection wells
3. Surface spills
4. Landfills (municipal/industrial)
5. Unidentified

The 305b report for New York also ranks underground storage tanks as the primary source of ground water contamination, with 65 percent of private well contamination related to the underground storage tanks. However, New York's ranking of other sources differs somewhat from the list for New Jersey:

1. Underground storage tanks
2. Hazardous materials, leaks, and spills
3. Abandoned hazardous waste sites
4. Wastewater treatment and small leaks and spills
5. Municipal landfills

Because this data does not define sources in a consistent manner with the ranking, and because it does not provide numerical estimates, rough approximations of the percentage contributed by the sources in the various ranking categories were made by Region II staff. From these percentages, which should be considered speculative, an annual distribution of economic costs was constructed.

TABLE 3

SOURCES AND COSTS OF GROUND WATER CONTAMINATION

	Percent of Ground Water Contamination Incidents	Share of Estimated Damages
UIC WELLS - CLASS V annually	7 percent	$22 million
MUNICIPAL LANDFILLS	7 percent	$22 million
RCRA SITES	7 percent	$22 million
UNDERGROUND STORAGE TANKS	65 percent	$207 million
SUPERFUND SITES	7 percent	$22 million
PESTICIDES	7 percent	$22 million

Future Use Damages

An additional loss not included in the estimates in the previous section, is the value of ground water that has been contaminated but is not currently used as a drinking water source. This ground water has lost economic value because the stock of clean ground water available for future use is limited, and this contamination reduces the available supply. In both New York and New Jersey, localized supply problems already exist. Ground water contamination is making the supply situation worse and is thus increasing the cost of the water.

Part of the potential economic damage attributable to future use stems from the heavy reliance on ground water in New York and New Jersey. In some areas, ground water is the only source of drinking water. For example, 3 million people on Long Island depend upon ground water as the sole source of drinking water, and 80 percent of the State of New Jersey has been designated as a sole-source aquifer. That reliance shows no signs of abating. To demonstrate the potential magnitude of these difficult to quantify costs, the Region II analysis includes an assessment of the monetary value of lost future use of ground water.

The need for additional water supplies in those states is evident from the effort expended to develop new wells. In New Jersey, more than 20,000 well-drilling permits are approved each year, and one-half of the water systems are expecting to expand their systems in the next five years. Anecdotal evidence shows that drilling deeper wells underneath the contaminated zones of aquifers has been used as the source of a new supply. New Jersey also has local areas of concern, called critical areas, where water level declines and increased development have resulted in limits on water withdrawal. In these areas, one can assume that the contamination of aquifers increases the costs of supplying water of good quality to residents. In New York State, Long Island's reliance on ground water and the contamination of this ground water has led to increasing use of deeper aquifers with resultant increases in costs.

Some measure of the value of good quality ground water can be obtained by comparing the cost of using good quality ground water to the cost of treating the ground water or obtaining surface water supplies. Currently, ground water is inexpensive in comparison to surface water supplies. For example, it costs about $100 per million gallons to obtain untreated ground water. In ground water overdraft areas in New Jersey, some communities switching to surface water supplies will be paying ten times more. This equals a $340 increase per household per year. On a statewide level, the public and private water systems are expected to spend $1.4 billion dollars in the next five years to comply with drinking water and supply requirements. Some portion of this cost is incurred because of ground water contamination. For example, the water supply master plan update for New Jersey indicates that $25 million has been earmarked to treat polluted wellfields.

To obtain a rough value estimate for the potentially lost future supplies of ground water, it was assumed that every household using ground water increased its yearly cost by the $340 experienced by some communities in New Jersey (see above). On the basis of that estimate, $1.2 billion in annual costs could be incurred in New York and New Jersey as a result of ground water contamination. These estimates are highly speculative and are not meant to serve as projected costs. However, they do serve to indicate the potential magnitude of pollution effects.

In summary, for areas that rely heavily on ground water for drinking water, there are significant future economic costs as a result of increased water supply costs as water demand increases and toxic contamination reduces the supply of ground water of good quality.

Ground Water Problems in the Caribbean

Virgin Islands

Ground water in the U.S. Virgin Islands has been relatively free of contaminants. An exception is the Tutu area of St. Thomas, which has had a nitrate problem since the 1970's because of malfunctioning sewage treatment plants in the area. Recently, other areas have been identified as suffering damage from sewage pollution as well. One study indicated the existence of contamination by chlorinated solvents and petroleum products, but the extent and severity of the contamination is unknown.

Puerto Rico

Ground water provides approximately 24 percent of the total water used on the island, but dependence upon ground water varies by locality. Ground water contamination has been assessed in the northeast region of Puerto Rico where wells have been contaminated. The three suspected sources of contamination are hazardous waste sites, municipal landfills, and underground storage tanks. Numbers of wells or percentage of wells contaminated were not provided in the 305b report.

In addition, nitrate contamination in Puerto Rico has affected approximately 25 percent (5 wells) of the wells studied, and at least three other wells have been permanently closed. The source of the contamination is under investigation. Industrial wastewater, illegal landfills, septic tanks, and agricultural runoffs are suspected.

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IV. Health Care Costs

The range of health care costs for cancer used throughout this analysis are the same as those used in the Region I analysis, originally developed by Hartunian (1981). The increased health care costs are:

Annual direct medical costs (in 1988 dollars)	\$28,000 - \$57,000
Annual indirect costs (days lost from work)	\$52,000 - \$80,000
Total annual costs per case	\$80,000 - \$137,000

These costs were used as annual costs and then multiplied by the estimated increased cancer cases per year (generated in the health analysis) to obtain annual increased health care costs from cancer. This method is a simplification from true health care cost for cancer.

The first simplification is the use of an average cost for cancer, cancer differs in cost from locality to locality and by types of cancer. The second simplification is that cancer incidence, which is a yearly estimate, was used with these yearly health care cost estimates even though there was no accounting for years of survival for cancer (i.e. these estimates implicitly assume that the cancer was treatable indefinitely).

It was explicitly decided by the work group that no monetary estimates would be calculated for the non-monetary costs of cancer such as pain and suffering and, of course, death. Even though the legal and insurance systems and some economists often make such calculations, the work group decided that the methods for calculating a monetary value for loss of life were too unreliable and controversial to be included in the analysis.

Table 4 shows the various cancer incidence values from the health analysis and the corresponding health care costs. The average of the cancer incidence values was used throughout the analysis. The health care costs are shown only for environmental problem areas where cancer incidence was estimated, all other problem areas were assessed qualitatively. For a full discussion of the uncertainties and assumptions involved, please see the health analysis report.

TABLE 4

Problem Area	Estimated Annual Cancer Incidence	Annual Health Care Costs from Cancer (000,000)
26. Chlorofluorocarbons	6400	$500 - 877
25. Indoor Air Pollutants	3700	300 - 507
24. Radon	200	16 - 27
13. Superfund Sites	390	31 - 53
19. Pesticides in Food	154	12 - 21
21. Mobile Sources of Air Pollution	95	8 - 13
22. Area Sources of Air Pollution	46	4 - 6
12. RCRA Sites	40	3 - 6
20. Stat Sources of Air Pollution	28	2 - 4
6. Underground Injection Wells	27	2 - 4
16. Underground Storage Tanks	8	0.6 - 1
3. Trihalomethanes, Lead, Micro-biological Contamination	7	0.6 - 1

Sources

Cannon, James S. The Health Costs of Air Pollution, A survey of studies published 1984 - 1989. American Lung Association. 1990.

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V. Problem Area Analyses

Analyses of the 27 environmental problem areas for economic/welfare effects in Region II are presented in the following section. The analyses are arranged in the order in which they appeared in the master list for the project. The order of the list is not related to the priority ranking.

In many cases no information was available on the extent of economic damages. The work group ranked all problem areas, regardless of data availability, because they concluded that environmental problems that were not ranked would not be given priority. Therefore, in some cases, the explanation of the work group deliberation is the only assessment of the magnitude of the problem available.

The background analysis on which the work group deliberations were based, along with a summary of the actual work group deliberations (which relied heavily on expert judgement in some cases) follows. Each environmental problem area is discussed separately for the most part. However, because the Region II ranking was by sources of pollution and the economic analysis was often structured by the impact or receptor of the pollution, several environmental problem areas were analyzed together.

For example, both point and nonpoint sources of water pollution can affect fisheries, and both Superfund sites and underground storage tanks can damage the ground water resource. The analysis of damages to the ground water resource covered five environmental problem areas, and the analysis is fully described in Part III and referenced throughout the report.

A separate analysis of Health Care Costs based on the estimated annual cancer incidence included in the Health Risk Analysis report was completed. It is described in Part IV, and referenced throughout the report.

1. Industrial Point Discharges and Municipal/Public Waste Water Discharges to Surface Water
2. Combined Sewer Overflows (CSOs) Discharges to Water
4. Nonpoint Sources of Water Pollution

Introduction

Because the same types of economic damages to surface water are caused by three problem areas (industrial point source discharges and POTW (publicly owned treatment works) discharges, combined sewer overflows, and nonpoint source discharges, the economic damages were researched and analyzed together. The major categories of economic damages from surface water pollution are:

- o Damages to recreational fisheries
- o Damages to commercial fisheries
- o Reduction in recreational opportunities, tourism and other businesses that depend upon recreational activities
- o Increased treatment costs of drinking water supplies from surface water

Estimates were obtained from studies on recreational fishing, commercial fishing and recreation and tourism. Estimates of the increased treatment costs of drinking water supplies are omitted, however, because data was not readily available. It was more difficult to obtain information on the proportional contributions of different sources to overall damages to water quality and related uses. As a result, the allocation of damage estimates contained in the report must be regarded as suitable for ranking purposes only. A summary of the studies used to estimate damages and the allocation of the damages between pollutant sources follows.

Numerous methodological and empirical studies, including studies for Region II, have been conducted to ascertain fisheries damages and recreation losses resulting from surface water pollution. Because of time constraints, the analysis focused on significant pieces of existing research on the largest fisheries and recreation areas in Region II.

Most of the studies used for this report cover specific geographic areas (i.e., the Hudson River, the New York Bight, and Long Island Sound), and relatively in-depth research was conducted on these three areas. Unpublished reports and analyses were obtained through contacts in government agencies and universities. Many of the articles and papers were originally prepared by local universities.

Data gaps remain even for damages to fisheries and recreation. Some waterways in Region II were not covered in the studies analyzed. These include the Great Lakes, the Finger Lakes, the Delaware River, and smaller rivers and streams throughout the region. However, only damages to the Great Lakes fishery are assumed to be large. Given the lack of data on these areas, however, it is assumed that the estimates are a lower bound. Nonetheless, because the population centers in Region II are located near the coastal areas, the studies focusing on the coastal regions probably capture the largest categories of damages.

Coastal Regions: New York/New Jersey Bight

Several studies have calculated the economic damages caused by pollution in coastal areas. The most complete evaluation is one by Swanson and Kahn for the State University of New York, Marine Science Research Center. Their report covers the economic impacts of beach closures, fisheries damages, and navigation impairments. According to the study, the largest annual economic losses, both direct and indirect, are:

- Beach closures - $1.4 billion to $5.8 billion
- Unsafe seafood - $1.4 billion
- Commercial navigation - $525 million
- A negative impact on fisheries abundance - not measured but assumed to be large (i.e. a change in species from those that are more desirable commercially to those that are less desirable or a decline in numbers of fish)

The most significant impact reported by Swanson/Kahn was for beach closures. Their report tabulates beach closings in the summer of 1988 for the entire coastal area of New Jersey and the south shore of Long Island. Calculation of the economic impact from the closings is based on an assessment of beach attendance. The study found no comprehensive time series data on total beach attendance, with the exception of data on New York State Park beaches. Thus, it was extremely difficult to determine the impacts of the scattered beach closings on attendance in general. To overcome this data gap, Swanson/Kahn assumed that attendance at the New York State Park beaches is a constant percentage of total attendance. The reduction in attendance was based on the percentage declines reported for particular beaches. The dollar estimates for economic impacts then were generated by calculating the amount of days lost at the beach and assuming an average expenditure per person. In addition, an economic multiplier effect was added.

Two additional estimates corroborate the level of damages found in the Swanson/Kahn study. The two billion dollar economic loss due to beach closings often used by Region II and the media in Region II was derived from a report by Thomas Conoscenti (1989) and an estimate by the New Jersey Department of Tourism. The figures are comparable to the Kahn study although different methods were used. Conoscenti used a 1983 Long Island Tourism and Convention Commission study as a basis for his estimates. He assumed that tourism would grow at the historical annual average of 5.6 percent per year; then he compared the potential expenditures from tourism with actual revenue figures for hotels, food, and transportation in 1988. The result is an estimated $1.3 billion difference that was attributed to the lowered tourism demand resulting from the widely reported beach pollution.

The New Jersey Tourism Department estimated that $0.7 billion per year has been lost due to beach closings and the resulting drop in tourism. Combining both the Conoscenti and tourism bureau estimates, Region II staff concluded that $2 billion per year is a reasonable estimate for losses from beach closures. The estimate is within the range calculated in the Swanson/Kahn study, but it assumes that 100 percent of the tourism industry and 100 percent of the downturn that year were beach-related. This is not likely. As Conoscenti notes, "Since the public has many optional activities with which to replace a visit to the beach, it is reasonable to assume that some portion of the people who would normally patronize the beaches participated in other activities on the Island. Thus, the absolute net effect was considerably less than $1.3 billion."

The economic losses reported by both the Swanson/Kahn and Conoscenti studies are quite large. Some examples from the raw data illustrate how such large economic losses are possible. For example, the Long Island State Park Commission reports that Jones Beach/Captree and Robert Moses experienced an attendance decline of more than 3.7 million persons in 1988 (Conoscenti, 1989). The New York State Office of Parks, Recreation, and Historic Preservation reported that annual attendance on Long Island beaches fell from 17.5 million in 1987 to 12.1 million in 1988. This was the lowest turnout in 20 years.

Another direct indication of the magnitude of economic damages is the response to a survey by DiLernia and Malchoff (1989) of charter and open boat owners, who were asked in a mail questionnaire to document alleged business declines since mid-summer 1988. The returned surveys indicated a 23 percent decline in passengers and a 30 percent decline in trips. Sixty percent of the boat owners identified floatables as the most important reason for the declines; fish abundance and seafood safety were also noted as important.

The contribution of different pollution sources to the economic impacts was reported in the Swanson/Kahn report. The study claims that New Jersey beaches tended to be closed because of pathogens, and Long Island beaches because of floatables. "Eighty to 90 percent of New Jersey's coastal beach closings are attributable to localized sources of storm-water runoff containing elevated bacterial pollution," they report. (The higher level of beach closures in New Jersey due to pathogens may be due to New Jersey's monitoring practices and not because of a greater contribution of this type of pollutant.) In addition, the authors note that the floatable incidents leading to the 1988 beach closings on Long Island were not predominantly sewage-related. That is, they was not primarily caused by a CSO (combined sewer overflow) or sewage treatment plant bypasses. Instead, the floatables source apparently was associated with improper solid waste disposal.

Coastal Regions: Striped Bass Fishery

The economic value of the Atlantic Coast commercial and recreational striped bass fishery was the focus of an in-depth study by Norton, Smith, and Strand (1984). The study looked at the value of the fishery in the early 1970's and compared it to the 1980 landings. After considering the multiplier effect, the authors conclude that the net economic loss to the mid-Atlantic region was $105 million dollars and 3000 jobs lost annually. While the study defined the mid-Atlantic region as the States of New York, New Jersey and Delaware, Delaware accounts for an extremely small portion (less than 1 percent) of the recreational fishing value, and less than 2 percent of the commercial value. Thus, for practical purposes, the totals for the mid-Atlantic are representative for the States of New York and New Jersey.

Long Island Sound: Fisheries

Estimates of the value of Long Island Sound fisheries are available from a variety of sources, but no overall analysis of the Sound's economic value has been published. (The University of Connecticut Sea Grant Office is currently conducting an analysis of the Sound's economic value.) Preliminary estimates of the value of Long Island Sound's commercial fisheries have been compiled by Hasbrouck (1990). He reported an estimated value of $30 million for the 1989 commercial fishery landings. Using a multiplier of 3.5 to account for both direct and indirect expenditures, the total economic value is approximately $100 million. No estimation of the damage to the fishery from pollution was attempted in this analysis.

Coastal Fisheries (General)

The Cornell Cooperative Extension Service analyzed the economic effect of floatables and marine pollution on the dockside prices of key species harvested and landed by New York fishermen. Although the press reported prices 35 percent lower than the previous year because of consumer reaction to the floatables incidents, Cornell's subsequent research did not indicate such a decline. The study did indicate a leveling off of prices paid to local fisherman, however, in an era of generally increasing prices due to an increased demand for seafood.

Finally, Kahn has reported that the value of the saltwater recreational fisheries on Long Island is "on the order of a billion dollars a year (before multiplier effects)." He did not estimate the sensitivity of this value to changes in the quality of the fishery. However, for both the Hudson and Long Island fisheries, recreational fishery benefits outweigh commercial fishery benefits. The survey Kahn used for recreational fishing on Long Island provides some information on the damages pollution has caused to recreational fishing. For example, 40 percent of respondents indicated that they did not fish because there was too much pollution. This study also reports that an estimated 0.5 million households engage in recreational fishing on Long Island.

Hudson River: Striped Bass Fishery

PCB contamination forced the closing of the commercial striped bass fishery in the Hudson River in 1975. A 1988 study (McLaren, Klauda *et al*) included an assessment of that fishery's value. Unfortunately, both the landings and the market prices varied considerably over the years. For example, the reported commercial landings of striped bass in the Hudson River varied irregularly by a factor of 35 between 1931 and 1980, with no discernable increasing or decreasing trends. The dockside value of striped bass catch also varied considerably, making it difficult to project economic losses.

Great Lakes: Recreational Swimming

Recreational swimming is affected by beach closings as well as by perceptions that water quality is poor. To assess the impacts of pollution on swimming in the Great Lakes region, Region II staff considered reports both of beach closings and of poor water quality. Data on beach closings included a 1988 survey of the Great Lakes bathing beaches. Responses were collected from 100 percent of the relevant agencies, thus covering almost 100 percent of the beaches regularly monitored for pollution. The State of New York reported four beaches closed or restricted, and one beach permanently closed. These numbers have been steady since 1980 in New York State, but beach closings in other Great Lakes states have shown no discernable trends. Unfortunately, because beach attendance figures were not reported in the survey, economic value of the beach closings cannot be estimated.

Beach closings are not the only indication of reduced recreation swimming; consumer perception of poor water quality will have an effect even if beaches are not officially closed.

Data indicate that water quality violations exist at Great Lakes beaches, reaffirming possible consumer reaction. For example, water quality criteria were violated in Chautauqua County 116 times in 1988, and the water quality in Lake Erie can be very poor at times although beaches were not closed in 1988.

Caribbean

No separate analysis of damages to waterways was conducted for the Caribbean. However, surface water quality is strongly related to the tourist economy in this region. Therefore, surface water pollution could have a large deleterious impact on the islands.

Trend

It is difficult to determine the trend of losses in recreational swimming and fishing, and commercial fisheries. Although water quality in general has been improving, the recent floatable incidents and oil spills can effectively wipe out increased demand for recreational swimming. While some may argue that the level of recent damages might never happen again, other large floatable incidents happened as recently as 1976, a year that saw a pronounced decline in attendance at beaches.

Economic losses in fisheries are expected to increase as information on the levels of toxics in fish increase and the public health standards tighten.

Direction of Uncertainty

Because the pollution of surface waters in Region II is longstanding (floatables were noted problems as early as 1895), current evaluations of the damages to recreation and fisheries underestimate the overall problem. By necessity, the studies measure only recent incremental changes. Historical pollution levels make it impossible to account for the full value of coastal surface waters if they were returned to a pristine level in the New York/New Jersey region. For example, the true losses to the residents of these states should theoretically include the difference between the present condition, both perceived and real, and the freedom to swim without hesitation in the Hudson or to eat shellfish straight from the Raritan.

Given the information readily available and the types of economic damage measured in existing studies, two major areas of uncertainty are apparent: the omission of the recreational values of entire water bodies that have not been studied closely, and the omission of estimates of the increased costs of treating of drinking supplies obtained from surface water bodies.

Results

The total value of economic damages calculated from surface water pollution is $3.4 billion to $7.8 billion per year. Again, this estimate should be considered lower than actual damages because it does not include estimates of all known damages.

Apportioning Damage from Various Sources

It is widely assumed that beach closures from floatables and bacteria are primarily due to CSOs. Thus, 100 percent of the economic damages of beach closures are allocated to CSOs.

No consensus exists on the proportion of impairment from point versus nonpoint sources. Therefore, a 50/50 split was chosen after consultation with staff from Region II's Water Management Division.

- o CSOs are assumed to cause 100 percent of the beach closures, at an annual cost of $1.4 billion to $5.8 billion.
- o Industrial point sources and POTW discharges cause 50 percent of the damages to surface waters, a cost estimated at $1 billion per year.
- o Nonpoint sources of pollution lead to the other 50 percent of damages to surface waters, again at an estimated cost of $1 billion per year.

Work Group Deliberations

The Region II work group decided that point and nonpoint sources of surface water pollution cause the largest economic damages. The overriding reason was that the value of the resources they affect - primarily fisheries, recreation and surface water supplies - is high, and the impacts are well-established. Apportioning the damages between nonpoint sources and point sources is inexact, however, the work group agreed with Water Management Division staff that nonpoint sources generally cause more damage.

These estimates have a very low uncertainty and are not all-inclusive, further confirming their place at the top of the economic damages ranking.

In addition, CSO's were ranked as having very high economic damages. The main economic impact of CSO's is their potential to reduce beach recreation. The economic damages due to beach closings have been studied by several authors who estimate losses between $1.4 - 5.8 billion dollars for the worst years. Since the monetary estimates were based on the worst years, the group felt that these estimates should not be considered yearly estimates, and should be ranked lower than the yearly fishery losses. Despite this concern, the economic damages of beach closings are substantial and well documented.

Sources

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3. Operation and Maintenance of Drinking Water Systems - Trihalomethanes (THMs), Lead, Microbiological Contamination

The primary economic damage from THM's, lead and microbiological contaminants cause is increased health care costs and lost productivity. The costs are estimated for cancer at approximately $1 million per year. (See Health Care Costs analysis, Section IV.) Health care costs from microbiological contamination must be added to these figures. In addition, the benefits from reducing lead in air and in water are large and well-documented. For example, reducing lead levels in the drinking water in Boston would result in approximately $8 million dollars annually in decreased health care costs for hypertension and cardiovascular disease in adults, reduced materials damage due to corrosion, and avoided neurological damage in children. Therefore, it is likely that the economic damages from lead in New York and New Jersey are at least as great and most likely much greater.

Work Group Deliberations

This problem area ranked medium in the overall ranking.

Sources

Cannon, James S. The Health Costs of Air Pollution, A survey of studies published 1984 - 1989. American Lung Association. 1990.

N. Hartunian et al, The Incidence and Economic Costs of Major Health Impairments, (Lexington Books), 1981.

U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation. "Reducing Lead in Drinking Water: A Benefits Analysis", December 1986

5. Traditional Underground Injection Wells (Classes I - III)

Due to lack of data, no quantitative estimates of economic damages were attempted.

Work Group Deliberations

Because the health impacts of Class I - III Underground Injection Wells are minimal and the contamination of usable ground water is unknown, this problem area was ranked as "low".

6. Other Underground Injection Wells (Classes IV and V)

See the Damages to Ground Water Resources analysis, Section III, and Health Care Costs analysis, Section IV.

Work Group Deliberations

Class IV-V wells were ranked in the "medium" category of economic damages. Class IV-V wells have both health care costs and are a ground water contamination problem. Class IV-V wells contribution to ground water contamination problems in Region II is estimated at $22 million plus future use.

7. Land Use Changes/Physical Modifications of Aquatic Habitats (Wetland Destruction)

Wetlands have important ecological value that translates into economic value. Wetlands provide fishery habitat, flood protection, water purification and recreational resources that translate into direct economic benefits to industries and individuals. For example, 60 to 90 percent of commercially valuable marine fish in the Atlantic depend on coastal wetlands for part of their life cycle. However, economic methods to trace these values back to particular wetlands are not reliable theoretically or empirically.

Work Group Deliberations

Using the replacement cost of a wetland as a starting point despite the fact that no dollar estimates were considered reliable, the work group felt that wetlands deserved to be ranked in the "very high" priority category. Another area of uncertainty is that the amount of wetlands lost historically is not known, and estimates of the current loss rates are unreliable.

8. Land Use Changes/Physical Modifications of Terrestrial Habitats (except dredging)

Increased pollution can result from land development with commensurate damages from pollution. Many types of economic damages result such as damages and loss of recreation areas; increased dredging costs and surface water quality degradation due to soil erosion; and increased air pollution. None of these damages, however, could be realistically measured for this project. However, large and very real economic costs will be incurred in the region due to overdevelopment of important watersheds. The principal cause of the pollution of the watershed surrounding the reservoirs that supply water to New York City is the destructive development of surrounding lands. Estimated capital costs of filtering the city's water range from $1.5 billion - $5 billion; these estimates do not include operation and maintenance costs. The sole source aquifer in Long Island is another example of a valuable natural resource where costs of supplying water are increasing due to overdevelopment in the watershed.

Work Group Deliberations

Land Use Changes/Physical Modifications of Terrestrial Habitat were given a "very high" priority ranking by the Region II work group. The work group determined that this problem area deserved a "very high" priority because of the estimated costs of watershed destruction along with the costs not estimated.

Sources

New York State Senate, "The Impending Pollution of New York City's Water Supply", June 4, 1990.

9. Dredging and Dredge Disposal
10. Municipal Sludge Disposal and Treatment
11. Wastewood Disposal and Treatment

No economic damages have been estimated for dredging and the disposal of dredging). wastes, municipal sludge disposal and treatment, or waste wood disposal and treatment. The economic damages from these problem areas are assumed to be small, because the ecological impacts are assumed to be small.

The economic damages associated with sludge disposal are estimated to be minimal or non-existent. After ocean dumping ceases, alternative methods of disposal may have increased economic damages associated with them. It is possible that some of the reduced beach use is associated with consumer perception that ocean dumping of sludge reduces the quality of the water, however, it was not possible to prove or quantify the effect.

12. Active Hazardous Waste Sites; Sites currently regulated under RCRA's Subtitle C

Three types of economic or welfare damages were considered for RCRA sites: property value declines, ground water resource damages and increased health care costs. (See Section III for Damages to Ground Water Resources analysis, and Section IV for Health Care Costs analysis.) Although professional judgment and anecdotal information indicate that the public is concerned about buying homes surrounding RCRA sites, no studies document this impact. Generally, public knowledge of and concern about Superfund sites far exceeds concern about RCRA sites. Thus, no empirical studies support estimating the existence or level of declining property values at the RCRA sites.

Work Group Deliberations

RCRA sites were judged by the Region II Work Group as ranking "high" in the economic damages ranking. Ground water contamination due to RCRA sources is estimated at 7 percent of total ground water damages, or $22 million annually not including future use (see Damages to Ground Water Resources analysis, Section III). Although there are no statistical studies on property value decline near RCRA sites, the work group assumed that losses in property value would be about half that of Superfund sites. Therefore, the total economic damages due to RCRA sites was estimated at $120 million.

13. Abandoned Hazardous Sites/Superfund Sites

Three types of economic concerns - increased health care costs, damages to the ground water resource, and property value declines - are caused by Superfund sites. The largest economic damage is the decline in property values for homes located near Superfund sites. This section contains Region II's analysis of potential property value declines. The analyses of Damages to Ground Water Resources is contained in Section III; and Health Care Costs, in Section IV.

Property Value Declines and Toxic Waste Sites

The impact of toxic waste dumps on the property value of surrounding homes has generated considerable community concern as well as academic study. Although no studies of property value declines in Region II have been published, an estimate of possible property value declines in Region II, based on studies completed in Massachusetts and California, was completed for purposes of the ranking project. Although the estimates must be considered speculative, much anecdotal information exists in Region II. For example, concern expressed by community members at public meetings, phone calls from individual home buyers on the location of toxic sites, and requests by lending/home financing institutions lead to the conclusion that there is some decreased demand for housing surrounding toxic waste sites.

Because the study of declines in property value near toxic sites is relatively new, there is no general consensus on the conditions that must exist (for example, risk beliefs, media attention, public knowledge) for the property values to decline. In addition, the size of the property value declines has not been established. As a result, any dollar estimates of the losses should be considered speculative; the uncertainty in those figures is relatively high. Because of this uncertainty, a range of assumptions were used in the analysis. The uncertainty differs considerably from uncertainties in most of the economic analysis. More often, the estimates of economic damages from pollution are uncertain because damages are known but cannot be calculated. A good example is the loss of wetlands, where economic damages to fisheries, recreation, scientific study, and surface water quality exist but cannot be fully calculated. However, when dollar estimates do exist (i.e., dollar losses due to beach closures), they are generally concrete. In contrast, the property value estimates presented here are far from precise because the existence of the property value loss is uncertain.

The analysis of Region II property value declines estimates losses in residential property value only. Declines in commercial property value will occur as well. However, because there are no studies estimating the extent and existence of these economic losses, they were excluded from the analysis.

Methodology

Estimation of property value declines consisted of multiplying the value of the decline per home by the number of homes per site, and then by the number of sites. The resulting dollar total is the measure of property value declines resulting from pollution. Each factor is described in the following pages.

Damage Per Home

Estimates of the dollar decline per home were obtained from various studies, primarily econometric analyses, that estimated the difference between the value of homes near a site and the value of comparable homes elsewhere. Other studies surveyed the public for "willingness to pay": that is, how much more would the buyer pay for a home if it were farther from the waste site. Michaels (1990) notes that many methodological issues remain, and identifying price effects has been an elusive goal with results of different studies varying considerably.

In a 1986 publication, Smith and Descvousges reported on a survey of property values conducted in suburban Boston. Residents were asked about their attitudes and the prices of housing units that lay at varying distances from toxic waste sites. (The neighborhood involved currently has several Superfund sites.) For the homeowners in the sample, "willingness to pay" estimates ranged from $330 to $495 per mile from a toxic waste site. That is, the farther a property lay from the waste site, the more a resident was willing to pay for that property.

In another study, Schultz, McClelland, and Hurd (1989) used a statistical estimation of property value declines. Their work for the Office of Policy, Planning, and Evaluation (OPPE) analyzed sales data from 173 homes surrounding the Operating Industries, Inc., landfill in the Los Angeles area. The site had received both municipal and hazardous waste, and odor from the landfill was a significant problem.

The study showed a statistically significant decline in property values despite the fact that 62 percent of recent purchasers were not aware of the landfill when they bought their homes. The difference in sales price between homes in that neighborhood and similar homes elsewhere was an average of $2,084, with a reasonable upper bound limit of $4,793. Unlike other studies, the values were not reported on a yearly basis.

A similar approach also has been used in a study by Michaels, Smith, and Harrison of Resources for the Future (the study is currently undergoing peer review). The research is based on a sample of sales prices for 2,182 single-family homes in suburban Boston. The study shows a "uniform, statistically significant effect" for price/distance relationships but notes that this relationship varied in different housing markets and localities. For example, the willingness to pay for distance from a waste site was $1,799 per year in a premier housing market but $38 in an "average" housing market. In 1977 dollars, the average value per household per year was $124. Using 1988 dollars, the average each household was willing to pay was $241, with a range of $3,500 to $74.

The variability in public willingness to pay for distance from waste sites also was discussed by Pettit and Johnson in a 1987 Waste Age article. "The impact of a solid waste facility on nearby development and property values can vary according to the circumstances of each particular case," they concluded. They cited a number of cases and studies in which different results had been reported: Some found a positive increase in property values; others reported no impacts; and others found negative impacts on property values. However, the reported increase in property value was a case where government purchases of property to buy land for a landfill had increased the land values. This case is therefore not applicable to Superfund sites, although it may apply to new RCRA facilities or incinerators. Two studies showed no property value decline; one analyzed the property values around Three Miles Island after the shutdown, and other has been criticized on methodological grounds. Thus , these studies are not convincing for purposes of the Region II assessment. In addition, although Pettit and Johnson report that "property value characteristics other than distance to the landfill appear much more important in explaining prices," their study does not disprove the hypothesis that when everything else is equal, a landfill or toxic waste site will decrease property values.

EPA Risk Analysis Results

Two other regional comparative risk projects supported by EPA have examined property value declines. Region X did not directly estimate the property value losses, but cited local examples. Region I estimated the extent of property value losses. Region II's analysis follows the same general approach as the Region I assessment. However, Region I used different population density information and a similar range of estimates for the size of property value declines, specifically, a lower bound limit of $69, and upper bound limit of $500 per site within one mile, and an absolute worst case of $4,800 per home. In contrast, because of the range of losses reported in the literature, the Region II analysis uses the values $70, $500, and $1,000. The values were rounded from the study values (i.e., $69 was rounded to $70 and so on) so that no false sense of precision will be conveyed. In addition, the analysis avoided using $4,800 as an absolute worst case because it appears to be a one-time loss rather than a yearly loss (the value was lost at the time the house was sold).

Number of Homes Per Site

Initially, Region II staff planned to extract information on population and homes from actual site data, and then to extrapolate those data to the region. Initially population data was extracted from the same 20 ATSDR reports that were used to generate estimates of health risk. These sites selected were considered to be representative of sites with high human health risk. After the information was collected, however, it was determined to be less reliable than an alternative method described below.

As an alternative, Region II staff developed an "assumed distribution" of sites based on a CERCLIS characterization study. The 1989 CERCLIS study indicates that 37.6 percent of the sites in Region II are in urban areas, 27.4 percent are in suburban areas, 27.9 percent in rural areas, and 7.1 percent "unknown." The percentage listed as unknown was allocated evenly to the other three categories, and the proportions were then rounded slightly. Thus, the study treats 40 percent of the sites as urban, 30 percent as suburban, and 30 percent as rural.

Housing density figures were developed to determine the number of homes - rural, suburban, and urban - found within one mile of a toxic waste site. For the rural areas, the computation yielded an estimate of 60 homes in the region lying within one mile of waste sites. To calculate suburban density figures, measures of 1,000 persons per square mile were used, from New Jersey data and 2 and 2.7 persons per household from census data. Thus, an estimated 370 housing units per square mile is the density factor for the suburban areas. For urban areas, the 1983 Census County and City Data Book provided population densities for 28 urban areas in the states of New York and New Jersey. The average population density for these areas (10,603) was divided by 2.7 persons per housing unit, for a density factor of 3,927, approximately 4,000 homes per square mile.

Total Number of Homes

The final step in estimating the number of homes vulnerable to potential property-value declines involved multiplying the number of waste sites in each area by the housing density for the area:

- o Rural: 60 sites x 60 homes = 3,600
- o Suburban: 60 sites x 370 homes = 22,000 homes
- o Urban: 80 sites x 4,000 homes = 320,000 homes

Number of Sites

Several choices are available for factoring in the number of waste sites that might affect property values in the region. For example, sites on the National Priority List (NPL) are generally well known and receive frequent media attention. Since public knowledge is an essential ingredient in declines in property values, one might simply use the NPL sites as those affecting property value. But Region II has, in addition, many potential NPL sites that although not currently listed, have generated a great deal of local concern or have been placed on the larger state cleanup lists. Region II staff concluded that approximately 3,200 sites are under investigation, and two-thirds of these will require some further action. Approximately 1,000 sites are considered NPL candidates. Given these options, the current analysis uses the same values applied in the health analysis: 200 sites, 600 sites, and 1,000 sites. As a result, housing deemed at risk for property value declines are as follows:

- o Assuming 200 sites: 345,600 homes within one mile
- o Assuming 600 sites: 1,036,800 homes within one mile
- o Assuming 1,000 sites: 1,728,000 homes within one mile

Results

The lowest estimate obtained for property value declines resulting from pollution damage was $24.2 million dollars per year. It was obtained by multiplying the lowest reported damage per home ($70) by the number of homes around the 201 NPL sites experiencing property value declines.

TABLE 5

POSSIBLE PROPERTY VALUE DECLINES AT SUPERFUND SITES

Yearly Loss per home	Number of Homes Within 1 mile	Total Yearly Losses
200 NPL SITES		
$ 70	345,000	$ 24.2 million
$ 500	345,000	$172.8 million
1000 POSSIBLE NPL SITES		
$ 70	1,728,000	$121.0 million
$ 500	1,728,000	$864.0 million

The largest estimate obtained for property damage is $1.728 billion per year. This estimate used a value of $1,000 for loss per home and included all 1,000 potential NPL sites. However, even this estimate is not considered to be an upper-bound one. Some reported property value declines are as high as $5,000. These may be just one-time losses rather than annual losses. But, if the $5,000 value proves to be a reasonable factor for yearly losses, the upper-bound estimate could be as high as $8.6 billion annually.

Work Group Deliberations

The analysis encompassed a wide range of assumptions regarding amount of loss per home and number of sites. The estimates range from $173 million to $1 billion. The work group agreed that the most reasonable estimates were on the low end of the range. In its assessment, the work group chose to consider only current NPL sites for the economic assessment, while the Superfund analysis for health and ecological considered all the potential NPL sites. In addition, Superfund also contributed approximately 5 percent or $22 million to ground water contamination not including future use losses, plus approximately $31 million - $52 million in health care costs.

Sources

Michaels, Gregory R, "Hazardous Waste Sites and Hedonic Housing Analysis: Improvements yet questions Linger", AERE Newsletter.

14. Municipal Solid Waste Sites - Storage and Landfills

Work Group Deliberations

Economic damages resulting from pollution at municipal solid waste sites include property value losses and ground water resource damages. The work group used the same assumptions for municipal solid waste sites as for RCRA sites (contribution to ground water contamination and loss of property value) to come up with an estimated $120 million in economic damages. Therefore, the work group ranked this problem area in the "high" category. Some of the property value studies are based on Superfund sites that are also municipal solid waste sites.

15. Municipal Solid Waste - Incinerators

Work Group Deliberations

The work group ranked municipal solid waste incinerators in the "medium" economic damage category. Health care cost increases were estimated at $10 million. In the future, as more incinerators are sited, this problem area is expected to have greater economic damages associated with it. One issue of concern is whether or not property value declines should be considered for incinerators.

16. Underground Storage Tanks Materials Storage Tanks, Sites and Pipelines Not Regulated under RCRA Subtitle C

Work Group Deliberations

Leaking underground storage tanks were judged as "high" in the economics ranking by the work group, largely because of their impact on the ground water resource. The New York State 305(b) report indicates that 65 percent of private well contamination is related to UST's. Therefore, 65 percent of ground water contamination was attributed to UST's for the purpose of this analysis (See Damages to Ground Water Resources analysis, Section III.) UST's were estimated to be causing $200 million dollars worth of damage. This estimate does not include future use (i.e., contamination which has not closed wells, but is reducing the available stock of ground water).

17. Accidental Releases During Transport or Production

Economic damages from accidental releases include damages from oil spills, evacuation costs, materials damages, and health-care costs. Although various databases exist (especially the ERNS database), the data was not considered reliable as to the size or number of spills. Data on the damages caused by spills was largely absent. In addition, because the economic damages from oil spills are considered to be large and important, EPA has developed an economic damages model to be used for litigation purposes. Further investigation on the use of the model revealed that previous analysis done with the model on actual spills cannot be used because it is litigation sensitive. Therefore data were not available to conduct any type of economic damage assessment.

Work Group Deliberations

Even without data, because of evacuation costs, property damage and oil spills the work group determined that this was a "high" priority with the potential to be even greater, e.g. in the case of a Valdez-like spill.

18. Pesticides Contamination Associated with Application

Work Group Deliberations

The work group ranked this problem in the "medium" economic damage category. Pesticides contribution to ground water contamination is estimated at $22 million plus future use. See Damages to Ground Water Resources analysis, Section III.

19. Pesticide Residues in Food

Work Group Deliberations

The work group ranked pesticides residues on food as a "medium" priority for the economic damage category. Increased health care costs from cancer were the only area of concern. See Health Care Costs analysis, Section IV.

20. Stationary Sources of Air Pollution
21. Mobile Sources of Air Pollution
22. Area Sources of Air Pollution

In order to determine the economic/welfare damages from criteria air pollution in Region II, estimates were first calculated for the damages from air pollution, and then the proportion of the damage from each of the three sources was determined. Estimates were made of the following types of damages:

- Health care costs
- Materials damages
- Aesthetic/Visibility losses
- Agriculture and Forestry losses
- Global warming damages

Estimates of the first four damages (health care costs, damages to man-made materials, agriculture, forestry and visibility) were provided by a consultants to Region II (RCG, 1990). The global warming estimates were extracted from a national study. Summaries of both these analyses follow.

Health Care Costs

Increased health costs from criteria air pollution are based on the human health problems discussed in the human health volume. The types of human health problems analyzed include: asthma attacks from ozone, respiratory restricted activity days from ozone, restricted activity days from particulates, and increased cancer incidence from air toxics. A range of estimates was provided by the consultant, however, Region II staff determined that the county population should be used for ranking purposes. Annual average estimates in 1988 dollars based on county population are:

Ozone	- Asthma attacks	$ 63,000
Ozone	- Restricted activity	$ 1,200,000
PM	- Restricted activity	$ 143,000,000
Air Toxics	- Costs from cancer	$ 20,000,000

Materials Damages

Estimates were made for materials damages from three criteria air pollutants - particulate matter, ozone and nitrogen dioxide. The uncertainty associated with these estimates is high because the estimates were based on national studies, and then gross assumptions were made to proportion the estimates to Region II. However, because the existence of materials damages from criteria air pollution has been well established, the estimates were included.

Particulate matter causes soiling and discoloration effects on an wide variety of materials including paint, structural metals and other building materials. Based on county population data, increased household costs from soiling was estimated to be $286 million annually. In addition to these increased household costs, the increased costs on two metal industries was estimated in a national study. Scaling down the national estimates using Region II's proportion of the U.S. population, the increased costs for Region II were estimated to be $401 million annually.

Using estimates from two national studies and scaling the damages based on population, estimates of the materials damage from nitrogen dioxide and ozone were made. For nitrogen dioxide the primary deleterious effect on materials is dye fading. Damages were estimated at $34 million annually. The primary effect from ozone is on elastomers, specifically for auto and truck tires. Damages for Region II were estimated to be $24 million annually.

Decreased Crop Yields

Based on the national crop loss assessment network's analyses, the consultant estimated potential decreased crop yields from ozone. The results range between $34 - $62 million lost annually in reduced yields for the crops of alfalfa, corn, forage and wheat.

Damages to Forests from Air Pollution

The potential for damages to forests from air pollution, especially ozone, is well known (RCG, 1990). Rural ozone concentrations have been widely associated with changes in forest growth, yield and composition. However, given the magnitude of the uncertainties regarding the magnitude of the decline and its economic impact on widely harvested species in Region II, it was not possible to estimate the damages credibly.

Decreased Visibility

There is little uncertainty that people put a value on improved visibility. In numerous surveys over many years, the public reports consistently that they would be willing to pay for increased visibility in either urban areas or scenic areas. Given that there is no real market for visibility, or even good proxies, all dollar values have been obtained by surveys, mostly in national parks. Despite this uncertainty, estimates were made of the dollar value of visibility impairments for Region II that ranged from $300 - 2620 million annually. Given the high uncertainty the lower-bound estimate was used for ranking purposes.

Global Warming

Global warming may cause sea levels to rise and lead to losses of crops, forests, and fisheries. Thus, the property value damages caused by global warming should be considered when ranking the economic damages from criteria air pollution. In developing such estimates for this analysis, Region II staff extracted data from a recent EPA report to Congress. The report described the potential effects of global warming on the entire United States. The estimates developed on this basis are tentative at best and are included only as an attempt to place parameters on the potential magnitude of any problems. This caveat applies especially to any dollar values reported. For example, the upper-bound estimate for a sea-level rise resulting from global warming is two meters. A rise that large would drown most of New York City unless a massive and costly engineering feat were accomplished. Any predictions of the *actual* responses, economic or otherwise, to a global change this drastic is pure guesswork. Nonetheless, given the magnitude of the impacts if global warming occurs, it is important to include some estimate of the impact, even given the uncertainty. The various effects estimated for Region II in the Report to Congress are:

- o Cost of replacing sand on recreational beaches
- o Infrastructure and property protection
- o Infrastructure costs for New York City
- o Increased electricity demand
- o Costs to elevate beaches and prevent coastal barrier island loss; rebuilding roads and elevating structures; constructing levees and bulkheads to protect developed lowlands

On the basis of the EPA estimates and speculation about global warming effects, the following estimates have been made for Region II. Although it was impossible, given time constraints, to gather and analyze the original studies to determine the various discount rates and time frames used. If one assumed that the total damages would take place equally in the next 100 years, damages could amount to $340 - 880 million per year.

Apportioning Damages to Sources of Air Pollution

In order to rank the problem areas, apportionment of damages to sources was necessary. Staff with expertise in criteria air pollution in Region II used their professional judgment and apportioned the damages into sources. The result of the apportionment is as follows:

TABLE 6

ANNUAL DAMAGES IN MILLIONS

Source	Visibility	Ozone	NOX	TSP	TOTAL	Global Warming
STATIONARY	15	9	10	138	172	100?
MOBILE	90	44	17	275	426	100?
AREA	60	35	7	310	412	100?
ACID RAIN	135	-	-	-	-	-

Based upon the order of magnitude, and including increased health care costs from air toxics of approximately $20 million, mobile and area sources could result in economic damages of a half billion dollars annually. Stationary sources result in lower damages of between 50 and 500 million dollars annually. The uncertainty associated with these percentages is high, and should be used for ranking purposes only.

Work Group Deliberations

The work group ranked the economic/welfare damages from mobile sources of air pollution in the very high category. Both mobile and area sources of air pollution contribute to health care costs, materials damages, agricultural and forestry damages from ozone, increased soiling of buildings and materials, reduced visibility and to possible damages from global warming such as sea level rise, crop losses and increased electricity demand. While each of these damages was estimated with varying degrees of confidence, estimates of economic damages from mobile and area sources, excluding possible global warming damages, were approximately $400 million yearly. The work group determined that mobile and area sources should be ranked in the very high category.

The work group ranked stationary sources as "high" on the economic ranking. Stationary sources of air pollution create the same damages to society as mobile and area sources. (See discussion above.) Stationary sources are ranked lower because in Region II, stationary sources are responsible for a much smaller contribution.

Sources

RCG/Hagler, Bailly Inc. EPA Region II Comparative Risk Project, Criteria Air Pollutants. August 17, 1990.

U.S. Environmental Protection Agency. December 1989. The Potential Effects of Global Climate Change on the United States. EPA-230-05-89-050.

Personal Communication

Kevin Doering, U.S. Environmental Protection Agency Region II
Robert Kelly, U.S. Environmental Protection Agency Region II

23. Acid Rain (Sources of Air Pollution that lead to Acid Deposition, Primarily from Large Stacks)

Introduction

Ecological damages from acid rain generate economic impacts on society. The damages of concern are those to materials, fisheries, the forest ecosystem, agricultural productivity, and, possibly, water-supply systems. It is difficult to determine exact dollar figures for these impacts, primarily because the extent and existence of the impacts are not well established scientifically. In addition, economic analysis is not well suited to the ambiguities posed by the acid rain issue. For example, issues such as long term, possibly significant, depletion of ecosystem nutrients are potential ecological and economic concerns, however, the extent and actual occurrence of those damages is very uncertain. In addition, despite the significance of these potential ecological and economic damages, the negative effects from acid rain are currently small but may be increasing rapidly in the future. Economic analysis is best equipped to estimate *current and incremental* damages. Studies estimating the economic damages from acid deposition have thus concentrated on damages to current use. These estimates, not surprisingly, have been fairly small.

Researchers have emphasized the problems in using economics in analyzing the acid rain problem. The authors of both studies used to generate monetary estimates caution, "benefit/cost measurements of acid deposition may well involve major errors of commission and omission" (Crocker, 1985) and that the models developed are only intended to estimate use values. "Reviews of the possible magnitude of non-use values indicates that non-use values may be larger than the use values" (Violette, 1985).

A complete literature review was not conducted because so many studies are unpublished, and thus not easily accessible in the time frame for this project. However, two studies were located that are useful in characterizing the acid rain problem for Region II. Both studies were conducted by well-known researchers and have undergone peer review.

Impacts on Fisheries in the Adirondacks

The most detailed of the studies used in assessing economic damages from acid rain is a 1985 study by Violette for EPA's Office of Policy, Planning, and Evaluation. The analysis calculates current-use impairments to recreational fisheries in the Adirondacks. Violette concludes that $1 million to $12 million (1984 dollars) in annual losses occur. To develop that estimate, Violette combined a 1976-1977 New York Anglers Survey (3 percent of licensees, with 12,000 replies) with Adirondack Lake and Pond data as primary sources. He then compared results from a modified travel-cost model and a participation model. In this way, estimates for the value of each fishing site were obtained (i.e., the willingness to pay) based on out-of-pocket travel costs (gas and expenses) and opportunity of time (hourly wage). These estimates of the "value" of the fishing sites were combined with estimates of the number of fishing opportunities lost as a result of acidification. (The fishing opportunities lost were obtained using catch rate and acreage information from the NAPAP study. The analysis has been reviewed by OPPE economists.)

The Violette study does have some limitations, because of its underlying assumptions. For example, the small dollar amount calculated for "lost" fishing results primarily from the assumption that a large number of substitute lakes are available for fishing to replace the fishing in lakes currently acidified. This assumption is open to question, because currently acidified ponds are often high-elevation lakes that combine a "wilderness" experience with fishery recreation. Thus, the acidified ponds may constitute a unique recreation experience. Other fishing sites are not a perfect substitute.

Aggregate Estimates

The second study (Crocker, 1985) provides a much broader, albeit rougher, estimate of damages. Of greatest interest is the estimation of an entire set of economic losses (materials damages, forest ecosystems, agricultural losses, aquatic ecosystems, and water-supply systems) *except* for non-user values. In this larger scheme, damages to aquatic ecosystems are approximately 5 percent of total damages.

Unfortunately, Crocker's estimates are for the eastern one-third of the United States, and the results must be scaled back to apply for Region II. Still, the overall proportion of the damages is informative.

TABLE 7

Maximum Losses from Acid Deposition
Eastern One-Third of the United States

Effects Category	Maximum Losses (billions)
Materials	2.00
Forest ecosystems	1.75
Direct agricultural	1.00
Aquatic ecosystems	0.25
Others (health, water supply)	0.10

Source: Crocker, 1985

Visibility

Sulfate particles contribute to reduced visibility. In the Region I comparative risk analysis, this loss of visibility was included as an economic damage resulting from acid deposition. Depending upon definitions, the visibility estimates developed under the criteria air analysis can be categorized in either the acid deposition or the criteria air pollution problem area.

Conclusions

The range of estimates ($1 million to $36 million annually, in 1988 dollars) provided in the Violette study provides a lower-bound estimated cost for fisheries losses in the Adirondacks. These damages only account for a small proportion of total damages; however, using Crocker's estimate that fisheries losses are only 5 percent of total losses to scale up to total losses, Region II staff approximated that $20 million to $272 million annually for a rough estimate of total user damages. Again, this estimate is highly speculative and was generated only to determine the <u>relative</u> magnitude of the acid rain problem in economic terms. Non-user values are not included, but may be larger than use values. In addition, acid deposition also causes visibility impairments. (See discussion for Problem Areas 20 to 22). Region II staff estimated that acid rain caused a large proportion of visibility damages. Adding visibility damages of approximately $135 million annually to the rough estimate for materials, fisheries and forestry totals $400 million annual losses. This figure is a very rough approximation with a high uncertainty.

Work Group Deliberations

The work group ranked acid deposition as a "very high" priority for economic/welfare damages. Acid rain damages to materials, fisheries and forests, losses in agricultural productivity and visibility problems create economic impacts upon society. It is difficult to determine any exact dollar figures primarily because the extent of damages from acid rain are not well established scientifically. Using available studies of <u>current damages</u> only, estimates of approximately $270 million annually are possible. (Note that the Adirondack fishery is but a small proportion of the total, 5 percent.) Adding the value of visibility decreases could increase acid rain damages to nearly $500 million annually. The uncertainty associated with these figures is extremely high. Researchers indicate that "... benefit/cost measurements of acid deposition may well involve major errors of commission and omission."

Sources

Crocker, T.D. and J.L. Regens, "Acid Deposition Control: A Benefit-Cost Analysis, Its Prospects and Limits." *Environmental Science Technology* (Vol. 19, No. 2) 1985.

Violette, D.M. *A Model Estimating the Economic Impact of Current Levels of Aquification on Recreational Fishing in the Adirondack Mountains.* (Washington, D.C., U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation EPA 230-12-86-021) 1985.

24. Radon

Work Group Deliberations

The work group ranked radon in as a "high" priority for economic damages. For radon the only relevant area of concern is increased health care costs from increased cancer. Health care estimates range from $60 to 274 million annually. See Health Care Costs analysis, Section IV.

25. Indoor Air Pollutants

Work Group Deliberations

The work group ranked the economic/welfare damages from Indoor Air Pollutants other than Radon as a "very high" priority. The only economic damages estimated for indoor air are the health care costs from cancer. The very large cancer incidence numbers estimated result in this problem area rating a very high ranking. Health care costs include direct medical expenditures as well as lost productivity. Using the wide range of estimates from the cancer ranking and a smaller range of estimates on health care costs resulted in annual losses of $56 to 904 million annually. Given this wide range and the fact that this estimate is all inclusive, indoor air was ranked very high but below damage estimates of fisheries, beach closing and wetlands where dollar estimated may not be as high as the high end of the range of values. By comparison, fisheries, beach closings and wetlands estimates do not include all damages. See Health Care Costs analysis, Section IV.

26. Chemical Use that Depletes the Ozone Layer - Chlorofluorocarbons

Work Group Deliberations

The work group ranked Chlorofluorocarbons in the category of "high" economic damages. Ozone depletion can cause both health and non-health economic damages. The estimates used in the ranking were for the cost of health problems from skin cancer and cataracts. Research is underway to determine how the cost of skin cancer compares to the health care costs of other cancers; however, preliminary figures indicate that it could be one quarter lower, leading to estimates of health care costs of approximately $100 - 200 million. The non-health problems associated with CFC's include crop loss and habitat change, in addition, CFC's are predicted to add to global warming problems. The uncertainty associated with both the cancer estimates and the health care estimates are high. See Health Care Costs analysis, Section IV.

27. Radiation other than Radon

Work Group Deliberations

The Work Group ranked non-radon radiation in the "medium" category of economic damages. The only damages estimated were increased health care costs from cancer, approximately $10 million. See Health Care Costs analysis, Section IV.