HUDSON BASIN PROJECT

TASK GROUP REPORTS

7 AIR RESOURCES

The Rockefeller Foundation

The Hudson Basin Project was initiated by The Rockefeller Foundation in 1973 to identify and explore significant environmental issues in an area sufficiently large, coherent, and complex to offer a full range of interconnected problems.

Professional Staff

C. David Loeks
Director

Chadbourne Gilpatric
Deputy Director

Christopher Wright
Senior Associate

Caroline F. Raymond
Program Associate

Gilbert Tauber
Associate, Environmental Policy

Michael Marmor
Associate, Physical Sciences

Ellen B. Jeronimo
Associate, Demography and Economics

L. Gordon Hamersley
Administrative Assistant

Support Staff

Antonia Salvato
Secretary

Pamela J. Dushensky
Secretary/Research Assistant

Jane Davis
Secretary

Marilyn Tromer
Administrative Secretary

Marion Barclay
Bookkeeper

Program Consultant

Leonard B. Dworsky
Professor
Department of Environmental Engineering
Cornell University
Ithaca, New York

Special Consultants

Robert E. Ford
Professor
Department of Sociology
SUNY-Buffalo
Amherst, New York

James M. Kenney
Associate Professor
Department of Economics
Union College
Schenectady, New York

Thomas R. Kershner
Chairman, Department of Economics
Union College
Schenectady, New York

Ruth P. Mack
Director, Economic Studies
Institute of Public Administration
New York, New York

John P. Milsop
Wildcat Service Corp.
New York, New York

William R. Ginsberg, Esq.
Professor of Law
Hofstra University
Hempstead, New York

Vincent J. Moore
Saratoga Associates
Saratoga, New York

Donald B. Straus
President, Research Institute
American Arbitration Association
New York, New York

Anthony Wolff
Editorial
New York, New York

Philip Wilde
Communications-Videotape
Cornell University
Ithaca, New York

HUDSON BASIN PROJECT

REPORT OF THE

AIR RESOURCES TASK GROUP

Library of Congress Catalog Card Number 76-6700 38

ABOUT THIS REPORT

The Hudson Basin Project was a three-year effort to examine the principal environmental problems and issues of the New York metropolitan area and that part of its hinterland consisting of the Hudson River watershed. Funded by the Rockefeller Foundations's Quality of the Environment Program, and carried out by Mid-Hudson Pattern, Inc., the Project represents an experimental effort to test how such problems can be considered on a regional scale, and whether new perceptions would emerge which, in time, would result in policies and programs beneficial to society.

At the outset, the Project defined the following ten subject areas for the analysis of environmental problems and related public policies: Land Use/Human Settlement; Land Use/Natural Resource Management; Transportation; Environmental Service Systems; Energy Systems; Water Resources; Air Resources; Biological Communities; Human Health; and Leisure Time and Recreation. Each subject area was assigned to a five-man Task Group which worked over a period of approximately five months to provide an initial overview of the region's environment.

Although approaches varied among the Task Groups, they were encouraged to focus on the definition of major issues and their significant relationships, and the examination of institutional capabilities for resolving these issues. The Task Groups were also asked to assess the adequacy of existing information and identify new information needed for environmental management.

The Hudson Basin Project Task Group Reports--ten volumes in all--are a significant part of the Project's research effort. These together with other Project efforts provide the basis for the policy analysis, conclusions and recommendations presented in the Project's final report,

"Anatomy of an Environment." Now that the Project is concluded, these Task Group reports are being published to assist those who want further information on specific aspects of the Project's work.

C. David Loeks, A.I.P.
Project Director

President
Mid-Hudson Pattern, Inc.

June 1976

MEMBERS OF THE AIR RESOURCES TASK GROUP

Philip L. Bereano, J.D.
Assistant Professor
School of Civil and
Environmental Engineering
Cornell University
Ithaca, New York 14850

Edward Davis
Director
Bureau of Abatement Planning
Division of Air Resources
Department of Environmental Conservation
Albany, New York 12201

Michael R. Greenberg, Ph.D.
Associate Professor
Department of Community Development
Lucy Stone Hall
Rutgers University
New Brunswick, New Jersey

Robert E. Laessig, Ph.D.
Assistant Professor of Management
and Operations Research
Drexel University
Philadelphia, Pa. 19104

Alexander Rihm, Jr.
Director
Division of Air Resources
Department of Environmental Conservation
Albany, New York 12201

P. Walton Purdom, Ph.D., Chairman
Director
Environmental Studies Institute
Drexel University
Philadelphia, Pa. 19104

BACKGROUND

The Hudson Basin Project (HBP) is an attempt to take a total view of man-environment interrelationships in a regional geographic area. Even so, the effort tends to consider the physical environment as it affects man, and the effect of man on the environment, including its ecosystems.

Several views were taken of the various environmental systems as they interact with one another and other factors. Ten policy areas were designated for this purpose: land use/human settlement; transportation; environmental service systems; energy systems; land use/natural resource management; water resources; air resources; biological communities; human health; and leisure time and recreation. Multidisciplinary teams of five persons were established to review and report on each of the policy areas.

This report represents the work of the Air Resources Task Group. A view was taken of the actual conditions existing in the region studied. Contemporary cases were examined to determine the realities of coping with air quality questions. The results indicate a vast interacting network of decisions, the complexities and ramifications of which are little understood by those making the individual choices.

SUMMARY

The atmosphere in the Hudson Basin at times contains pollutants in excess of national standards. This pollution is a result of many complex activities. The Air Resources Task Group developed several case studies which illustrate these complexities.

While there are extensive air monitoring programs, they are not integrated in a standardized unified system that is completely representative of air quality. A computer-based management information system for all types of environmental concerns seems indicated.

Such factors as land use, industrial location, transportation, growth policy, and regional economic development all have an impact on air quality. Each of these, in turn, can be affected by standards for air quality.

Some factors, such as land use, are controlled by the smallest civil division of government, whereas the larger units, because of their resources, information, and area of jurisdiction, are better able to handle developments with great impact potential. The courts have an increasing role in resolving conflicts where various value systems clash, raising questions about the adequacy of the courts system and the participation of citizens in government decision making.

The Task Group concluded that air quality issues can be handled by the existing institutions of government available in the U. S. system, but more effective utilization of these institutions is necessary with adaptation to the requirements of the problem requiring solution. Studies and measures that would lead to greater effectiveness are indicated.

ACKNOWLEDGEMENTS

The Air Resources Task Group expresses appreciation to the New York State Department of Environmental Conservation and the New Jersey Department of Environmental Protection for data helpful in developing the background information for this undertaking. Individual members of the Task Group prepared the case studies.

Mr. Alex Carter and Mr. Miguel Ruelan, graduate students at Drexel University, assisted in developing two of the case studies.

The Task Group is also indebted to Mr. Michael Marmor of the Hudson Basin Project Staff for his thoughtful guidance and assistance.

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INTRODUCTION

The term air pollution refers to the presence in the atmosphere of any number of contaminants that tend to degrade its quality in some way, irrespective of whether the contamination is the result of man's activities or some other phenomenon. Air contaminants are considered to be substances that: are or tend to be injurious to human or animal health; interfere with physiological function or tend to stimulate such functions in irritating or undesirable ways; damage property, goods, buildings, vegetation, and the like; interfere with commercial, industrial, and social activities; impair the use of environments or vistas; reduce visibility and the transmission of sunlight; are obnoxious to smell; or otherwise degrade the quality of the environment and its enjoyment. While "natural" phenomena may account for some air contaminants, they are usually dispersed and are not significant sources of the concentrations experienced in urban areas. Consequently, the focus of this Task Group was on human activities that contribute to air pollution.

Environmental management activities are aimed at eliminating the hazards to human health, protecting environments from man's deletrious activities, and promoting the enhancement of human health and the quality of life. The Task Group considered a variety of problems that might be amenable to control by measures which could be adopted in the Hudson Basin. While it is speculated that world wide air pollution by particulates may ultimately intercept sunlight to the point of cooling the earth, or may result in sufficient carbon dioxide to absorb enough heat to warm the earth, the Task Group did not consider such global problems.

To focus attention on tangible issues, the Task Group examined current air quality in the region. Then it studied several actual cases illustrating the interactions between human activities and air quality, including associated economic, social, and political factors. These explorations emphasized a variety of issues relating to health, economic, and social values, and concern for other environmental parameters. The case studies also showed that air quality is dependent on a number of

factors whose total effect may be revealed indirectly and in subtle ways. For example, land use, transportation systems, and other aspects of development have significant consequences in determining air quality.

Working from this background, the Task Group then considered the interactions and interrelationships that impinge on air quality and those upon which air quality standards act as constraints. Such an examination would not be complete without looking at the capability of existing institutions for dealing with these complex issues.

I. AIR QUALITY

A. AIR QUALITY STANDARDS

Public awareness of the effects of air pollution increased dramatically in the 25-year period following World War II. This awareness was caused by numerous factors, including increases in source emissions from automobiles and electric-generating facilities, episodes of air pollution in which mortality and morbidity showed significant rise, and increasing social concern for the quality of life.

Government has responded to the needs of its citizens by passing legislation to control sources of air pollution. The Clean Air Act Amendments of 1970 set the achievment of clean air as a national goal. This legislation gave the Environmental Protection Agency (EPA) certain powers, including the authority to promulgate national air quality standards, standards of performance for new stationary sources, and requirements for new automobiles. Other actions under the Amendments were left to the states. But if they failed to carry out their responsibilities, the EPA administrator was empowered to assume them.

In April 1972, the EPA promulgated national air quality standards for six air contaminants whose control was deemed essential to protect the health and welfare of the nation's populace--standards for suspended particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, hydrocarbons (nonmethane), and photochemical oxidants. The national primary standards were established to protect health; the national secondary standards were established to safeguard property, vegetation, and animal life, as well as to promote the general public well-being. The primary standards were to be achieved by 1975 with extensions possible to 1978. The secondary standards are to be met within a reasonable time. Except for sulfur dioxide and suspended particulate matter, primary and secondary standards are set at the same values. For these two, the secondary standards are more stringent. Table 1 lists these national standards at the present time.

Table 1. National Primary and Secondary Ambient Air Quality Standards

Pollutant	Type of Standard	Averaging Time	Frequency Parameter	Concentration $\mu g/m^3$	Concentration ppm
Carbon Monoxide	Primary and secondary	1 hr	Annual maximum[a]	40,000	35
		8 hr	Annual maximum[a]	10,000	9
Hydrocarbons (nonmethane)	Primary and secondary	3 hr (6 to 9 a.m.)	Annual maximum	160[b]	0.24[b]
Nitrogen dioxide	Primary and secondary	1 yr	Annual arithmetic mean	100	0.05
Photochemical oxidants	Primary and secondary	1 hr	Annual maximum[a]	160	0.08
Particulate matter	Primary	24 hr	Annual maximum[a]	260	--
		1 yr	Annual geometric mean	75	--
	Secondary	24 hr	Annual maximum[a]	150	--
		1 yr	Annual geometric mean	60[c]	--
Sulfur dioxide	Primary	24 hr	Annual maximum[a]	365	0.14
		1 yr	Annual arithmetic mean	80	0.03
	Secondary	3 hr	Annual maximum[a]	1,300	0.5

(a) Not to be exceeded more than once per year.
(b) As a guide in devising implementation plans for achieving oxidant standard.
(c) As a guide to be used in assessing implementation plans for achieving the annual maximum 24-hour standard.

The Clean Air Act does not prevent lower orders of government from having more stringent standards of their own. New York State, for example, adopted its first-in-the-nation standards in 1964. Where these were not as stringent as the federal standards, they have been either amended or dropped; those that were more stringent have been retained. Thus, much of the New York portion of the Hudson Basin has air quality standards for suspended particulates that are higher than those set by the EPA. The classification for New York is shown in Figure 1. The New York standards, including those for some additional parameters such as dustfall, are listed in Table 2.

The Clean Air Act requires each state to prepare an implementation plan showing how national standards will be achieved. To assist the states in meeting the requirement, the Act authorized the establishment of Air Quality Control Regions. Regions within the Hudson Basin Project study area are shown in Figure 2. The required implementation plans have been or are being prepared by the states of Connecticut, New Jersey, and New York. Revisions are encouraged under the Act, making change an almost constant process.

B. AIR QUALITY MONITORING SYSTEMS

Air quality monitoring has been an essential component of virtually every air pollution control program in the nation. In fact, an effective control program is virtually impossible without base information on current air quality and past trends. The Clean Air Act did not precipitate new monitoring activity in the HBP study area; rather it served to reinforce an already developed program. The existing monitoring networks and the principal contaminants measured are shown in Figures 3 and 4.

1. Systems Within New York State

a. State System

New York State's monitoring network is divided into two systems: the intermittent system, which collects samples over a finite sampling time,

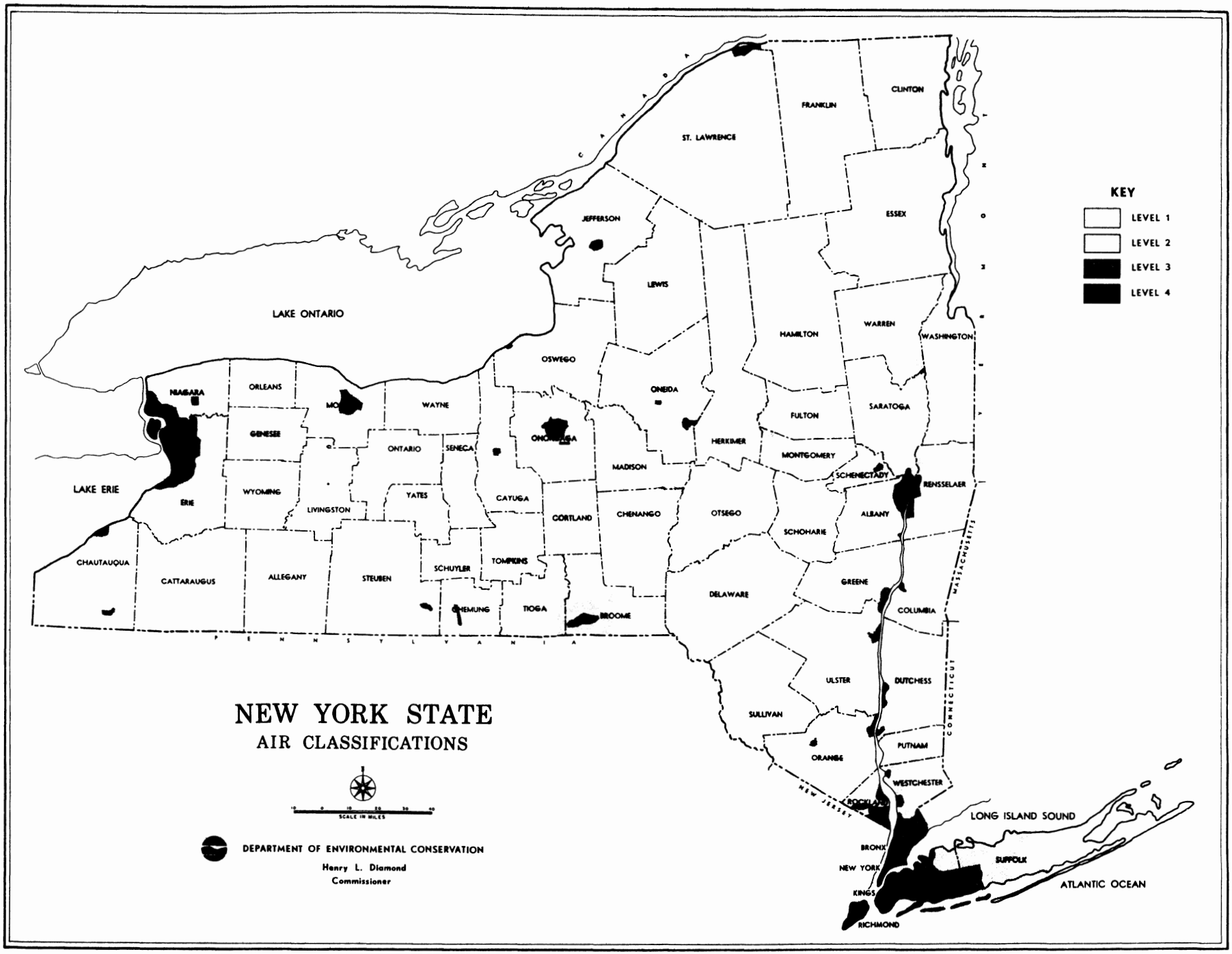


Figure 1. New York State Air Classifications

Table 2. Summary of New York State Ambient Air Standards

Contaminant	Interval	ppm	g/m^3 (25 C)	Level(s)
Sulfur Dioxide	Arithmetic Mean (Annual)	0.03	80	All
	24-hr Concentration	0.4(a)	365	All
	3-hr Concentration	--	--	---
	1-hr Concentration	0.50(b)	1,300	All
Particulates (Suspended)	Geometric Mean (Annual)	--	75	IV
			65	III
			55	II
			45 (c)	I
	24-hr Concentration	--	250	All
Carbon Monoxide	8-hr Concentration	9	10 mg/m^3	All
	1-hr Concentration			--
Photochemical Oxidants	1-hr Concentration	0.03	160	All
Hydrocarbons	3-hr Concentration	0.24	160	All
Nitrogen Dioxide	Arithmetic Mean (Annual)	0.05	100	All
Fluorides				
a) Total Fluorides as F (Dry Weight Basis)	Growing Season (6 months)	40	--	All
	Any 60 Days	60	--	All
	Any 30 Days	80	--	All
b) Gaseous Fluorides as F (Volume Basis)	12-hr Concentration	4.5 ppb	3.7	All
	24-hr Concentration	3.5 ppb	2.85	All
	1-wk Concentration	2.0 ppb	1.65	All
	1-mo Concentration	1.0 ppb	0.8	All
Beryllium	1-mo Concentration	--	0.01	All
Hydrogen Sulfide	1-hr Concentration	0.01	14	All
Settleable Particulates (Dust Fall)	(d)			

(a) Also 99% of 24-hr values shall not exceed 0.10 ppm (260 g/m^3) on an annual basis.
(b) Also 99% of 1-hr values shall not exceed 0.25 ppm (650 g/m^3) on an annual basis.
(c) NYS also has an annual 84% value of the 24-hr average concentrations in the 4 levels.
(d) During any 12 consecutive months, 50% of the 30-day average concentrations shall not exceed 0.30 mg/cm^2 at Levels I and II; 0.40 mg/cm^2 at Level III; and 0.60 mg/cm^2 at Level IV. During any 12 consecutive months, 84% of the concentrations shall not exceed 0.45 mg/cm^2 at Levels I and II; 0.60 mg/cm^2 at Level III; and 0.90 mg/cm^2 at Level IV.

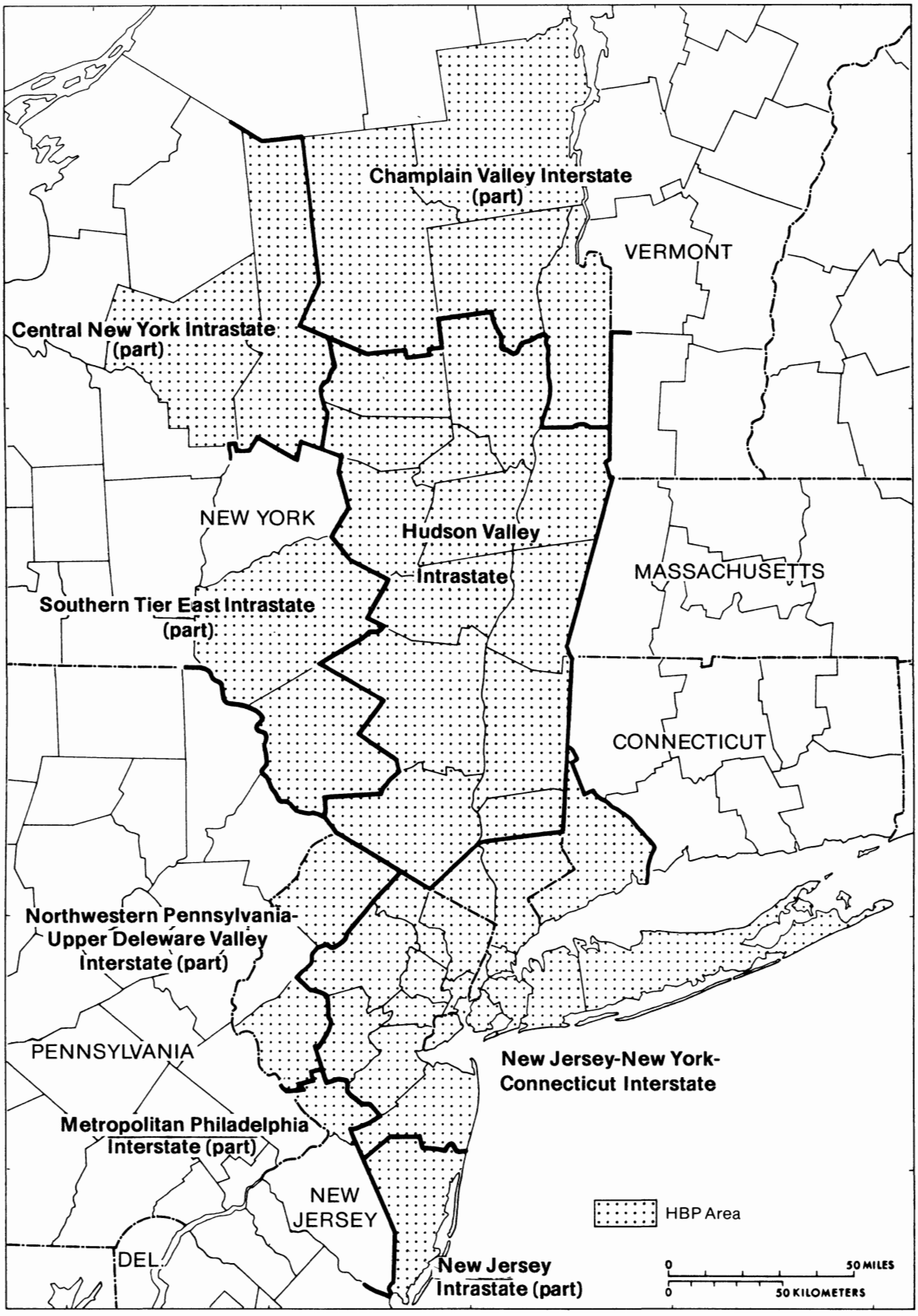


Figure 2. Federal Air Quality Control Regions in the HBP Region

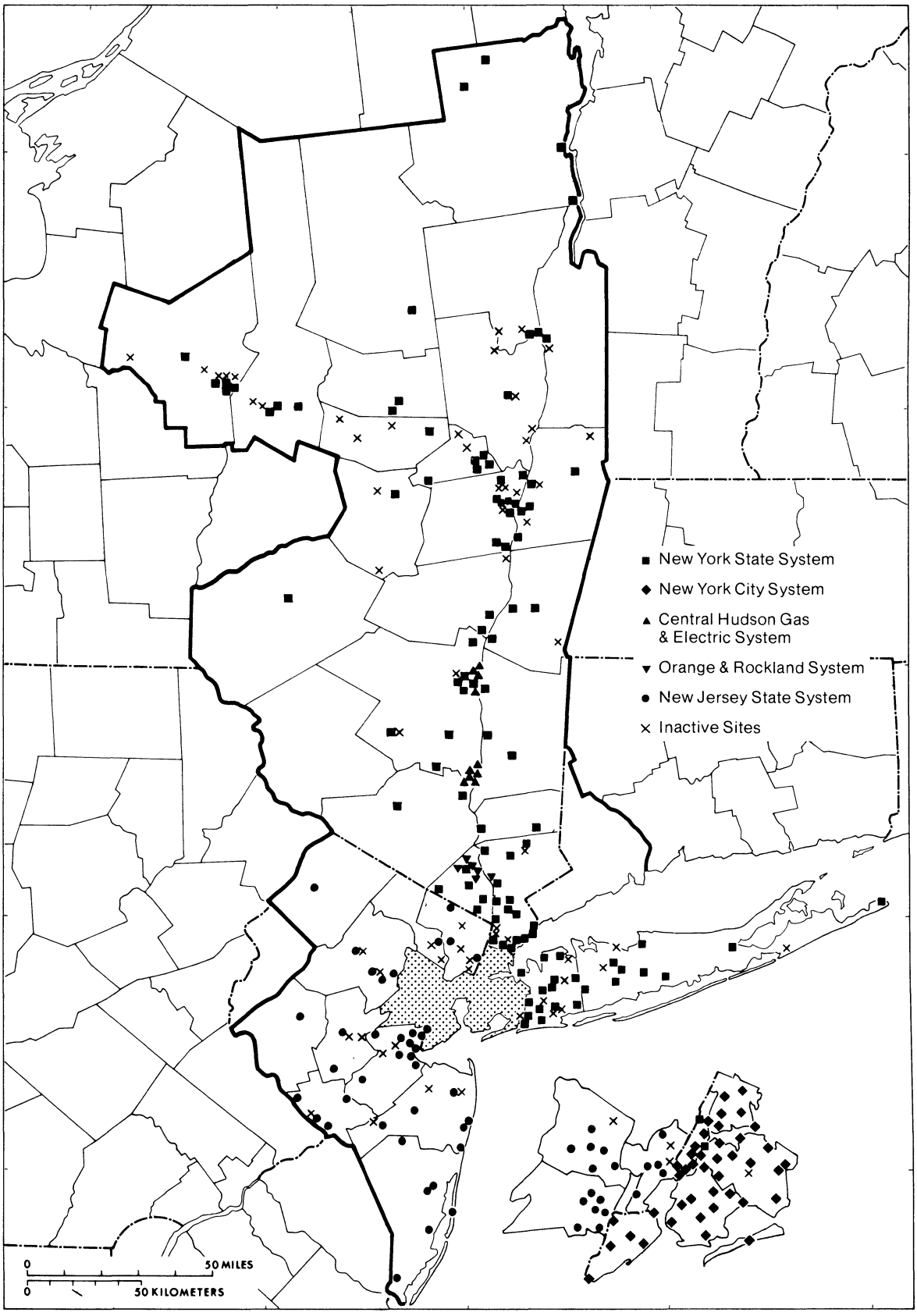


Figure 3. Air Monitoring Networks in the HBP Study Area

Figure 4. Contaminants Measured by Air Monitoring Networks

with analysis performed at a laboratory; and the continuous system, which analyzes at the sampling location and yields results by use of telemetry and computer at the Albany reception center.

The continuous system is the more sophisticated part of the network. Its monitors analyze a variety of pollutants and meteorological conditions at primary, secondary, and satellite locations. Primary sites monitor SO_2, NO, NO_2, CO, hydrocarbons, soiling, ozone, and up to 11 meteorological parameters, including wind speed, wind direction, ultraviolet radiation, rainfall, temperature, pressure, and gustiness. Secondary sites are scaled-down versions of the primary, usually analyzing several contaminant and meteorological parameters. Satellite sites are designed to sample for only one or two contaminants. None have been established in the Hudson Basin. One is planned for Nassau County. The Long Island Lighting Company network will be incorporated into the satellite system.

New York's intermittent monitoring system was initiated in 1957 with sampling for suspended particulate matter at some 15 locations. This network is still in existence and filters collected still receive the same special analyses at this time--analysis for sulfates, nitrates, benzene solubles, and pH. The intermittent system has expanded with the need for air quality data. It now numbers about 107 locations including some that are associated with the continuous system.* All but a handful collect high volume air samples for suspended particulate matter. Most stations have sampled for sulfur dioxide in the past using sulfation techniques. Those shown in Figures 3 and 4 now sample for sulfur dioxide using accepted bubbler techniques. Nitrogen dioxide is sampled at a few sites.

b. New York City System

The city air sampling system is similar to the state's in many ways. Much of it is intermittent; however, the heart of the system employs

* Over the years a number of stations have been discontinued because a particular study had terminated or because a sampling site could no longer be used.

telemetry to a central reception station. The current system comprises 38 rooftop sites and three street-level locations. The street-level sites are intended to monitor traffic-related contaminants, particularly carbon monoxide.

The rooftop system provides adequate coverage throughout the city for sulfur dioxide and suspended particulate matter. However, greater coverage is needed for nitrogen dioxide and photochemical oxidants, with emphasis on the use of federally approved methods. Expanded coverage must also be provided for carbon monoxide at street level.

c. Private Systems

For the past several years, the state has required electric utilities to monitor existing air quality prior to receiving an operating certificate for a new facility. Three such systems have been established in the Hudson Basin--two by Central Hudson Gas and Electric and one by Orange and Rockland Utilities. These networks have been established just north of Kingston, north of Newburgh, and around Haverstraw. Meteorological and concentration data from these systems are reported to the state, becoming part of the public record.

Since the private networks are specifically oriented to generating facilities, sampling equipment is confined to the plant vicinity, and contaminants associated with fossil fuel combustion are the only ones measured. All stations sample for sulfur dioxide. One network does no sampling for particulate matter.

Despite their expansion in recent years, the state, New York City, and private systems still do not provide sufficient sampling to give an accurate picture of air quality in the Hudson Basin's New York portion. This is true for even the most common sampling parameter--suspended particulates. Noticeable areas where more data are needed include most of Orange County, lower Saratoga County, and additional sites around some of the urban areas. Peculiarly, although not nearly as much sulfur dioxide data are available as particulate matter, it appears that ample sampling

is being performed to supply adequate definition of areas with potential problems. Sampling for other gaseous contaminants is extremely deficient and must be supplemented at least fivefold to provide an adequate data base.

2. New Jersey System

New Jersey's monitoring system has evolved along much the same lines as New York State's. However, less emphasis has been placed on intermittent systems, particularly for suspended particulates. Thus, the ability to establish trends is limited by insufficient data prior to 1970.

Within the New Jersey portion of the Hudson Basin, 62 sites for suspended particulates have been established, 44 of which are in current operation. Unfortunately, the 18 that have been discontinued are among those with the longest periods of data collection. In some instances, the equipment was relocated at a new site in the same community.

Continuous monitors have operated at 14 locations, with monitoring for sulfur dioxide, carbon monoxide, photochemical oxidants, and nitrogen dioxide at most sites.

As with New York, there are probably too few samplers in the basin to accurately project air quality patterns, especially for suspended particulates. For gaseous pollutants, adequate information is probably available for contaminants associated with motor vehicles. Additional sulfur dioxide measurements would be useful in more accurately defining the potential problem area(s).

3. Connecticut System

Connecticut has established a sampling network in Fairfield County. Although this presentation will not speak to measurements in Connecticut, it appears that there are sufficient stations to determine where problems exist.

C. AIR QUALITY LEVELS AND TRENDS

1. Suspended Particulates

Although portions of the sampling networks date back to the 1950s, this treatment of the air quality data extends back only to 1964. Suspended particulate data for this 10-year period are listed in Table 3.

At the end of 1973, most of the area of the Hudson Basin Region was meeting the federal primary standard (Figure 5). Areas in excess of this standard were a good portion of the New York metropolitan area, including most of the city and adjacent New Jersey, and areas around Trenton, Newburgh, Kingston, Catskill, and Albany. Considerably more area was in excess of the 60 $\mu g/m^3$ to be used as a guide for achieving the national secondary standard. Extensive areas around those places exceeding the primary standard were in excess of the secondary standard.

This is a totally different picture from that which existed in 1970 (Figure 6), the data on which the implementation plan was based. At that time, virtually all of the City of New York exceeded the primary standard, as did most of Nassau County. The lower portion of Westchester County, comprising the cities of Yonkers, Mt. Vernon, and New Rochelle, also exceeded the standard. Most of adjacent New Jersey, comprising large portions of Hudson (all), Bergen, Essex, Union, and Middlesex counties; much larger areas around Newburgh, Kingston, Catskill, and Albany; as well as a portion of Utica, also were higher than 75 $\mu g/m^3$. The 60-$\mu g/m^3$ figure was also exceeded throughout a significantly larger area than in 1973. In 1970, 68 of the 134 stations in the region were above the 75-$\mu g/m^3$ annual average. Another 33 were over the 60-$\mu g/m^3$ value. In 1973, only 29 of 196 exceeded the national primary standard, while 47 were between 60 and 75 $\mu g/m^3$. Clearly, significant progress has been made in abating air pollution in the Hudson Valley, particularly in those areas where the federal standards were grossly exceeded in 1970. From the data presented, it appears that greater reductions have occurred in New York than in New Jersey.

Table 3. Suspended Particulate Geometric Means

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
NEW YORK STATE SYSTEM											
Albany County											
Albany	0101-02	-	-	-	-	-	-	-	-	-	110
	0101-03	74	86	82	87	73	64	70	67	59	58
	0101-07	88	84	-	-	-	-	-	-	-	-
	0101-08	124	124	130	142	117	107	122	124	118	101
	0101-10	-	-	-	-	-	-	-	-	108	102
	0101-13	-	-	-	-	-	-	-	-	-	93
Cohoes	0102-01	82	82	-	69	68	53	61	-	-	61
Watervliet	0103-01	80	88	-	-	-	-	-	-	-	-
Coeymans	0152-01	82	90	-	-	-	-	-	-	58	63
	0152-02	-	-	-	-	-	-	-	-	53	54
Colonie	0153-01	92	98	-	-	-	-	-	-	-	-
	0153-02	-	-	-	62	62	61	-	-	-	-
	0153-03	-	-	-	-	-	-	-	-	-	55
Columbia County											
Hudson	1001-02	103	90	98	88	64	49	62	60	52	56
Philmont	1021-02	55	52	50	41	34	34	33	-	32	31
Copake	1056-03	-	-	-	-	-	27	28	-	-	-
Germantown	1058-01	-	-	-	-	-	-	-	-	-	51
Dutchess County											
Poughkeepsie	1302-01	66	67	71	66	51	50	48	-	-	-
	1302-04	-	-	-	-	-	-	-	-	63	48
Rhinebeck	1327-02	-	-	-	-	-	-	-	-	-	46
LaGrange	1357-01	45	51	50	56	39	35	41	36	39	41
Essex County											
Lake Placid	1523-01	-	-	-	-	-	-	-	-	29	31
Ticonderoga	1527-01	-	-	-	-	-	-	-	-	27	31
Fulton County											
Gloversville	1701-03	-	-	-	49	46	-	-	-	-	-
Johnstown	1702-01	-	-	-	46	40	36	39	38	37	40
Greene County											
Catskill	1953-02	-	-	-	-	-	-	-	-	-	107
New Baltimore	1961-01	67	72	-	-	-	-	-	-	-	-
Hamilton County											
Wells	2058-01	-	-	-	19	17	-	-	-	-	19

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Herkimer County											
Ilion	2101-01	-	-	-	53	56	-	-	-	-	-
Frankfort	2121-01	-	-	-	58	55	-	-	-	-	-
Mohawk	2123-01	-	-	-	44	45	-	-	-	-	33
Herkimer	2124-01	-	-	-	68	63	-	-	-	-	-
	2124-02	-	-	-	-	-	-	-	-	-	51
Little Falls	2129-01	-	-	-	51	52	-	-	-	-	42
Montgomery County											
Amsterdam	2801-01	-	-	-	64	60	57	62	73	62	61
Canajoharie	2822-01	-	-	-	61	60	-	-	-	-	-
Fonda	2825-01	-	-	-	46	48	-	-	-	-	-
St. Johnsville	2828-01	-	-	-	39	39	-	-	-	-	-
Nassau County											
Glen Cove	2901-01	108	-	108	116	107	110	111	86	68	65
Freeport	2904-01	116	102	-	-	-	-	-	-	-	-
	2904-03	-	-	-	93	79	82	-	-	-	-
	2904-04	-	-	-	-	-	-	-	73	54	56
Garden City	2905-01	86	83	76	66	60	58	60	68	53	54
Rockville Ctr.	2909-01	146	139	93	105	109	111	121	92	73	74
Kings Point	2944-01	107	66	103	86	83	78	75	66	43	45
Hempstead	2950-01	104	91	90	-	95	86	95	83	56	59
	2950-02	-	-	74	77	84	-	-	-	-	-
	2950-03	-	-	-	96	130	105	121	100	73	68
	2950-09	-	-	-	-	106	-	-	-	-	-
	2950-10	-	-	-	-	-	-	-	-	56	65
	2950-11	-	-	-	-	-	86	95	83	57	59
	2950-12	-	-	-	-	-	-	-	-	80	73
No. Hempstead	2951-01	104	91	90	74	72	75	79	61	49	55
Oyster Bay	2952-01	108	122	82	78	77	77	78	90	58	58
	2952-02	89	86	84	-	-	-	-	-	-	-
	2952-03	89	91	76	65	69	-	-	-	-	-
	2952-05	-	-	-	-	-	66	64	53	43	42
	2952-08	-	-	-	-	-	-	81	69	45	49
Oneida County											
Rome	3201-01	-	-	-	61	70	55	55	61	71	66
Utica	3202-01	101	100	98	99	90	78	79	79	63	64
	3202-02	-	-	-	49	63	-	-	-	-	-
	3202-03	-	-	-	69	79	-	-	-	54	52
	3202-06	-	-	-	-	-	-	-	-	-	40
	3202-07	-	-	-	-	-	-	-	-	63	52
	3202-08	-	-	-	-	-	-	-	-	-	30
Whitesboro	3237-01	-	-	-	54	70	-	-	-	-	43
Oriskany	3239-01	-	-	-	35	45	-	-	-	-	-
Verona	3271-01	-	-	-	37	51	-	-	-	-	-

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Orange County											
Newburgh	3502-02	-	-	-	-	-	72	84	76	71	84
Putnam County											
Cold Springs	3920-01	-	-	-	-	-	-	-	-	-	40
Brewster	3922-01	-	-	-	-	-	-	-	-	-	51
Rensselaer County											
Rensselaer	4101-02	-	-	-	-	-	66	72	75	77	74
Troy	4102-02	69	83	62	57	52	46	45	51	52	55
	4102-03	79	82	-	-	-	-	-	-	-	-
Hoosick Falls	4120-01	56	64	-	-	-	-	-	-	-	-
Cast. on Hud.	4124-01	-	-	-	-	-	-	51	-	43	34
E. Greenbush	4152-01	57	61	-	-	-	-	-	-	-	61
	4152-02	103	100	103	92	82	66	87	80	57	61
Grafton	4153-01	31	36	31	29	25	23	24	25	30	31
Rockland County											
W. Haverstraw	4322-01	-	-	-	-	-	-	-	-	-	47
Suffern	4329-06	-	-	-	46	51	49	52	54	61	56
Clarkstown	4350-01	64	77	68	62	62	49	50	52	56	52
Orangetown	4352-01	-	-	-	-	-	-	-	-	-	54
Saratoga County											
Saratoga Spr.	4501-02	-	-	-	55	48	-	-	-	-	-
	4501-03	-	-	-	-	-	-	-	-	-	47
Corinth	4521-01	-	-	-	45	43	-	-	-	-	-
Mechanicville	4523-01	97	88	-	72	62	-	-	-	-	-
Stillwater	4567-01	59	51	-	-	-	-	-	-	-	-
Schenectady County											
Schenectady	4601-02	76	84	87	-	62	59	60	64	63	73
	4601-04	-	-	-	74	65	62	64	63	61	70
Duanesburg	4650-01	38	38	40	30	39	28	31	31	32	32
Glenville	4651-01	41	44	-	-	-	-	-	-	-	-
Niskayuna	4652-01	53	49	49	49	45	42	48	45	43	47
Rotterdam	4654-01	57	59	-	-	-	-	-	-	-	-
Schoharie County											
Cobleskille	4720-03	-	-	-	67	81	-	-	-	-	-
Gilboa	4757-01	-	-	-	35	36	-	-	-	-	-
Schoharie	4761-01	-	-	-	61	70	43	52	54	50	52
Suffolk County											
Babylon	5150-01	87	-	89	77	59	58	62	63	52	55

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Suffolk County (Cont.)											
Brookhaven	5151-01	51	51	55	63	51	51	62	74	57	53
	5151-03	53	-	42	-	44	68	105	72	47	41
Islip	5154-01	64	-	61	46	-	-	-	-	-	-
	5154-02	62	67	66	54	52	47	50	54	47	52
Smithtown	5157-01	71	65	62	60	59	-	-	-	-	-
	5157-02	64	59	58	56	-	-	-	-	-	-
	5157-04	-	-	-	-	-	-	52	43	47	48
Southampton	5158-01	48	48	45	32	46	38	36	35	34	45
	5158-02	49	47	42	46	-	-	-	-	-	-
Ulster County											
Kingston	5501-01	100	88	-	-	-	-	-	-	-	-
	5501-02	-	-	112	67	76	68	71	69	64	70
	5501-04	-	-	-	-	-	-	-	-	-	69
New Paltz	5522-01	56	75	66	77	80	80	62	-	63	57
Ellenville	5526-01	98	108	116	106	-	-	-	-	-	-
	5526-02	-	-	-	-	67	67	58	55	42	42
Saugerties	5564-01	78	98	103	112	82	78	66	66	72	69
Shawangunk	5566-02	-	-	-	-	-	-	-	40	39	51
Ulster	5567-01	156	-	-	-	113	88	121	125	124	101
Warren County											
Glens Falls	5601-01	-	-	-	57	54	46	57	-	53	56
	5601-02	-	-	-	50	52	-	-	-	-	-
Luzerne	5656-01	-	-	-	36	29	-	-	-	-	-
Washington County											
Hudson Falls	5726-01	-	-	-	-	-	-	-	-	-	43
Fort Edward	5755-01	-	-	-	59	52	-	-	-	-	-
Westchester County											
Peekskill	5901-01	-	-	-	89	77	68	67	73	74	65
White Plains	5902-01	80	82	83	82	74	77	89	81	64	57
Mt. Veron	5903-01	96	86	80	82	74	77	72	71	-	-
	5903-04	-	-	-	-	-	-	-	-	-	71
New Rochelle	5904-02	112	126	95	93	86	84	81	78	65	-
Ossining	5905-01	72	68	67	71	64	58	59	50	49	44
Port Chester	5906-02	-	-	-	-	55	58	72	67	53	55
Yonkers	5907-03	129	145	137	-	-	-	-	-	-	-
	5907-04	90	93	85	85	81	-	-	-	-	-
	5907-08	-	-	-	130	179	110	88	99	72	-
Rye	5908-01	-	-	-	91	61	67	74	72	64	58
Mamaroneck (V)	5909-01	-	-	-	-	-	68	70	63	57	51
No. Tarrytown	5932-01	-	-	-	-	46	54	56	56	47	46
Greenburg	5953-01	-	-	-	-	-	-	83	-	67	59
Mamaroneck (T)	5956-01	-	-	-	-	-	-	-	-	-	60
Mt. Pleasant	5957-02	-	-	-	-	46	48	50	43	41	41

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Westchester County (Cont.)											
Somers	5966-01	48	53	47	60	59	-	-	-	-	-
	5966-02	-	-	-	-	-	-	45	45	43	36
Yorktown	5968-02	-	-	-	-	27	36	39	36	30	33
New York County											
Manhattan	7093-02	-	-	-	115	118	105	93	90	84	76
	7093-03	-	-	-	-	-	-	94	83	76	74
NEW YORK SYSTEM											
Manhattan	00						-	130	124	94	101
	2						136	115	107	78	86
	5						110	112	110	83	76
	10						110	108	109	84	83
	37						-	96	90	73	60
Queens	7						102	122	130	78	74
	8						65	81	85	68	81
	12						-	109	115	90	75
	13						90	102	112	72	63
	14						69	86	83	59	57
	15						67	64	76	55	54
	16						65	78	80	67	55
	20						89	92	99	75	72
	22						95	92	-	-	-
	23						58	80	77	63	62
	28						65	88	93	79	-
	29						71	82	78	64	51
	30						74	74	76	58	52
Bronx	1						84	86	98	75	63
	3						112	101	120	93	84
	4						90	80	85	69	63
	6						129	116	120	91	85
	9						72	72	70	68	64
	38						83	96	95	94	62
Brooklyn	11						102	105	112	99	82
	17						100	102	125	86	87
	18						78	110	140	64	54
	19						68	102	100	82	70
	21						70	98	95	65	74
	24						-	86	90	72	70
	25						98	88	100	73	-
	26						70	84	78	61	58
	27						79	82	83	65	67

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
NEW YORK CITY SYSTEM (Cont.)											
Staten Island	31						96	92	98	78	78
	32						90	101	96	84	81
	33						92	110	105	84	94
	34						78	-	80	60	66
	35						90	86	90	71	74
	36						64	72	71	59	63
CENTRAL HUDSON GAS & ELECTRIC NETWORK											
Kingston	CK-1									61	52
	CK-2									92	109
	CK-3									57	55
	CK-4									46	42
Roseton	CR-1									61	57
	CR-2									49	50
	CR-3									41	37
	CR-4									62	64
	CR-5									45	43
NEW JERSEY STATE SYSTEM											
Asbury Park	001			-	-	76	64	75	75	68	52
Bayonne	002			92	76	91	84	85	90	66	71
Bloomfield	003			-	-	51	57	60	-	-	-
Bound Brook	004			-	-	-	-	69	75	54	58
Carteret	005			-	92	101	84	87	78	63	68
Dover	006			-	-	61	68	65	56	50	-
East Orange	007			-	-	61	68	71	101	114	103
Edison	008			74	67	80	62	66	-	-	-
Fairview	009			103	93	104	94	97	114	81	81
Fort Lee	010			-	-	74	98	108	91	72	-
Hackensack	011			-	-	-	84	134	238	146	142
Hoboken	012			-	-	-	120	144	-	113	115
Irvington	013			-	-	60	63	64	65	48	48
Jersey City	014			-	108	131	109	106	118	83	89
Jersey City	015			-	-	-	105	103	98	75	85
Linden	016			-	-	89	80	90	87	70	75
Livingston	017			-	-	41	46	43	45	34	37
Morristown	018			-	-	67	48	69	56	47	48
Newark	019			131	146	141	123	125	147	134	125
Orange	020			-	-	74	71	68	71	57	57
Passaic	021			-	-	-	58	66	55	56	61
Paterson	022			-	-	-	63	74	68	56	57
Perth Amboy	023			-	85	80	74	78	70	56	57
Red Bank	024			-	-	-	62	60	-	45	-
Roosevelt	025			-	-	45	45	42	42	35	32
Roselle	026			87	84	94	78	84	86	66	70
Rutgers	027			-	-	68	58	-	41	37	49

Table 3. (Cont.)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
NEW JERSEY STATE SYSTEM (Cont.)											
Sayreville	028			-	-	-	79	88	73	68	63
Somerville	029			-	-	71	58	54	53	47	41
Union City	030			-	106	117	89	93	101	80	84
Westwood	031			-	-	65	54	57	62	42	47
Trenton	033			-	-	-	-	65	72	68	73
Rahway	035								67	66	55
South Amboy	036								73	58	58
Woodbridge	037								74	66	74
Toms River	040								48	45	47
Sewaren	041									-	56
South Brunswick	S01									41	42
Hamilton	S03									57	58
Grovers Mill	S05									44	42
Millstone	S07									40	35
Fair Lawn	S08									45	43
Cheesequake	S09									52	42
Secaucus	S10									56	60
Metuchen	S11									54	49
Red Bank	S13									45	40
Brielle	S15									35	35
Island Beach St. Park	S16									39	44
Jackson	S17									27	27
Upper Saddle River	S18									-	36
Washington Crossing Park	S19									-	38
Waretown	S23									25	32
Tuckerton	S24									22	27
Fort Lee	S25									-	43
Clinton Twp.	S26									-	33
Dover	S29									-	40
Florham Park	S30									-	32
West Orange	S32									-	48
Kean College (Newark St. College)	S33									-	51
Frankford Twp.	S34									-	29
Middlesex	S35									-	51
Skillman	S36									-	30

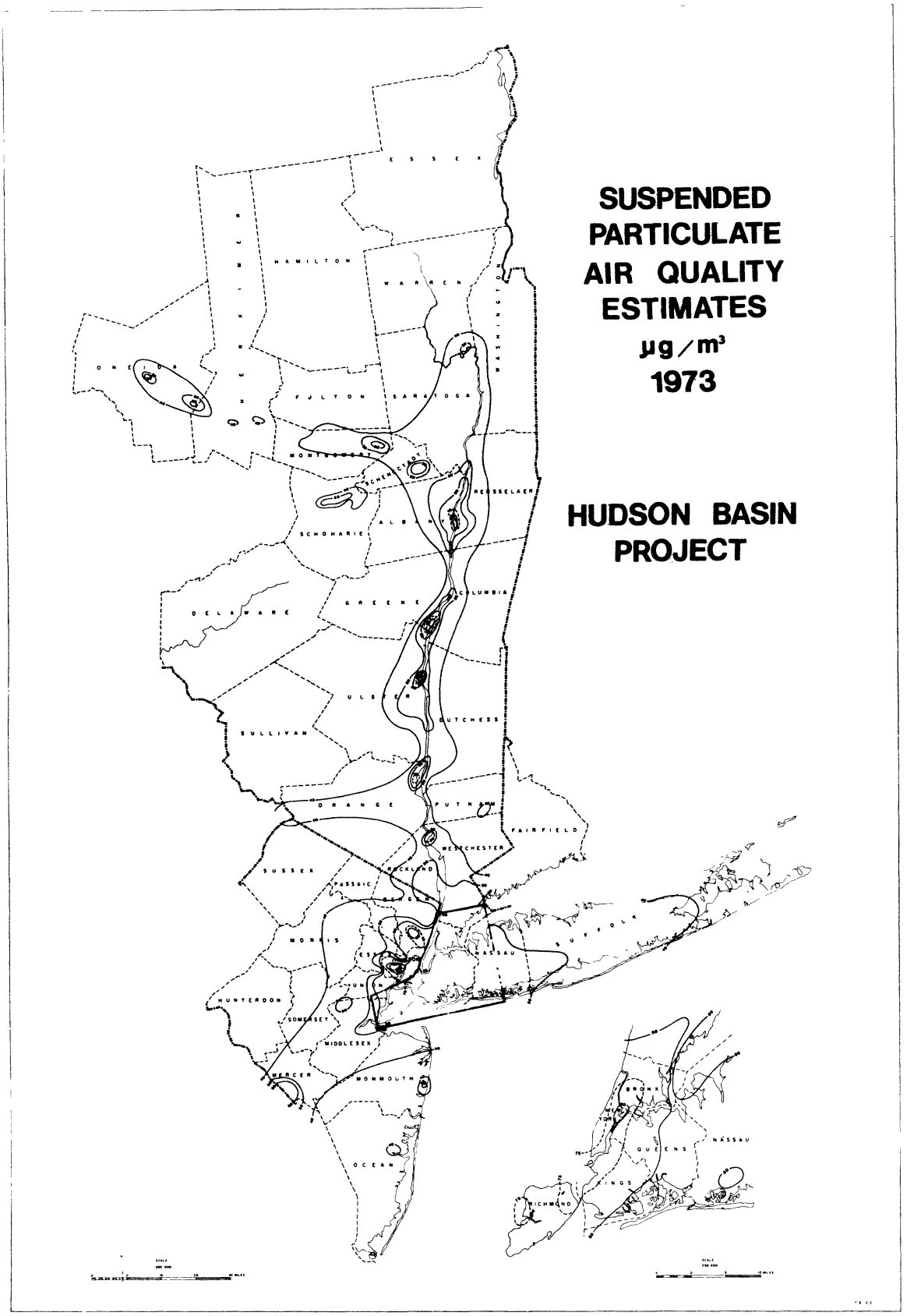


Figure 5. Suspended Particulate Air Quality Estimates, 1973

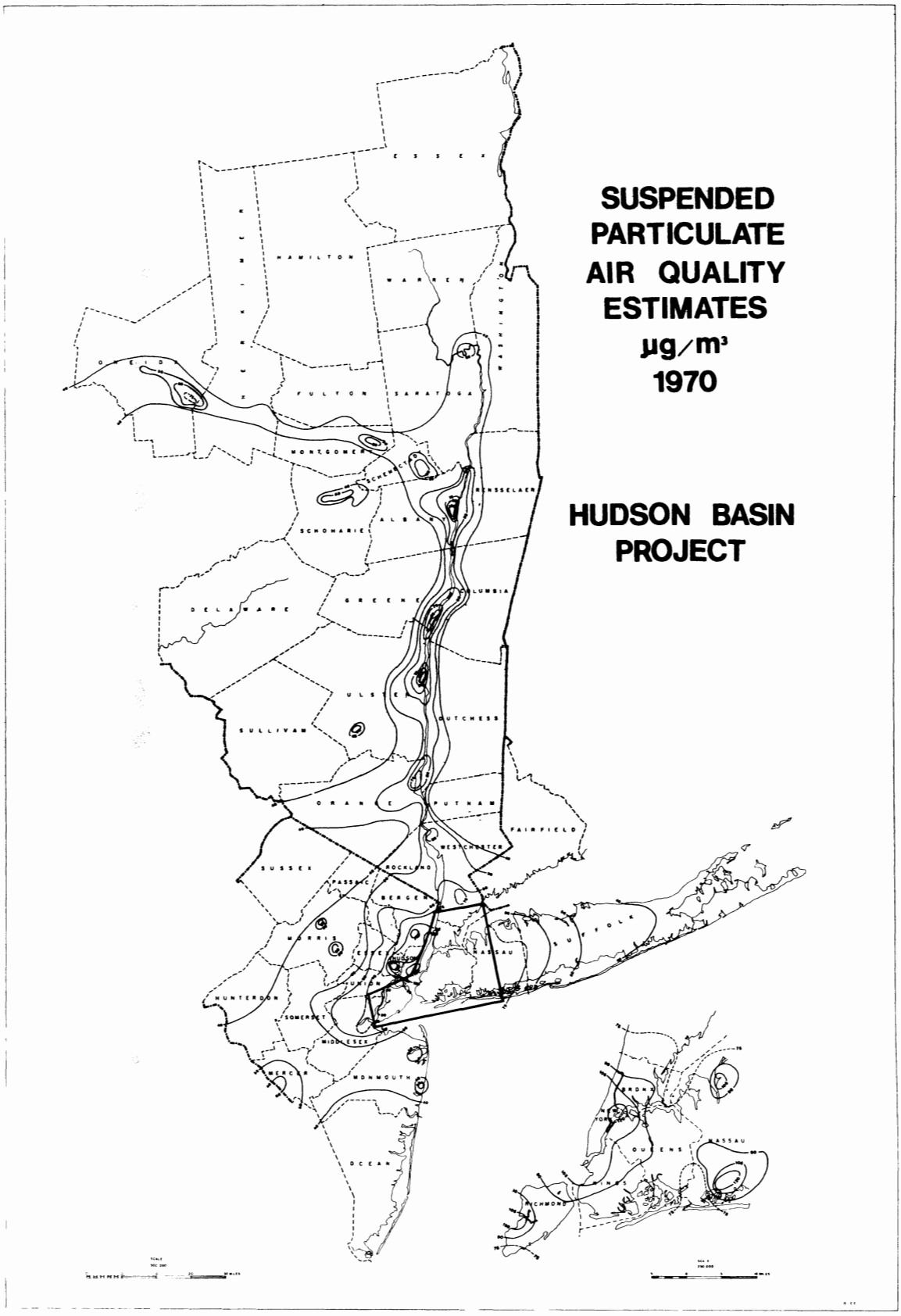


Figure 6. Suspended Particulate Air Quality Estimates, 1970

The national standards for maximum 24-hour suspended particulate values are listed in Table 1. Shown in Table 4 are concentrations for the 24-hour period of July 9, 1973, a day which showed high values at virtually all stations. For this day, three stations exceeded the national short-term primary standard Of 260 $\mu g/m^3$ (East Orange, N.J., at 282 $\mu g/m^3$; and a location in the Central Hudson system at 437 $\mu g/m^3$; and a location in Brooklyn at 273 $\mu g/m^3$). However, many did exceed the national secondary standard of 150 $\mu g/m^3$. For many of these stations, this date would be the one day which would be allowed to exceed the 150 $\mu g/m^3$ value. At most stations, other values over 150 also occurred during 1973. Yet, at some of them, the 60-$\mu g/m^3$ figure was met. From a statistical perspective, even if the 60-$\mu g/m^3$ value is achieved, the probability of exceeding 150 $\mu g/m^3$ is high, particularly under conditions of high wind speed and a dry day. In this instance, much of the suspended particulate matter is not due to the activities of man at all, but rather the erosion phenomena of the wind acting upon the earth. Control activities within the region have been aimed at reducing annual emissions so that the national secondary standard for particulate matter will be achieved. Evidence on hand indicates two related issues: (1) maintaining an annual value of 60 $\mu g/m^3$ most likely does not provide for meeting a second highest 24-hour concentration of 150 $\mu g/m^3$ to be exceeded only one time, and (2) emission abatement activities have not been directed to source contributions on peak days and, therefore, may not suffice to attain standards.

2. Sulfur Dioxide

Through 1970, New York City was the only area in the region where sufficient sulfur dioxide data were available to provide a picture of area-wide air quality (Table 5, Figures 7 and 8). Isopleths of annual sulfur dioxide concentrations for 1970 (Figure 8) for New York City show all areas well above the national primary standard of 0.03 ppm annual average. Values as high as 0.10 ppm were found, yet these were significantly improved from those reported in 1965-66. As can be seen in Figure 9, most of the region now meets the standard. Exceptions are portions of New York City, Newark, and Albany.

Table 4. Suspended Particulates ($\mu g/m^3$) in the Hudson River Basin, July 9, 1973

NEW YORK STATE SYSTEM

Albany	0101-02	194*	Rensselaer	4101-02	153*
	0101-03	94	Troy	4102-02	110
	0101-08	151*	Cast. on Hud.	4124-01	43
	0101-10	211*	E. Greenbush	4152-02	97
Cohoes	0102-01	69	Grafton	4153-01	75
Coeymans	0152-01	-	W. Haverstraw	4322-01	152*
	0152-02	84	Suffern	4329-06	-
Colonie	0153-03	72	Clarkstown	4350-01	126
Hudson	1001-02	159*	Orangetown	4352-01	138
Philmont	1021-02	81	Saratoga Spr.	4501-03	93
Germantown	1058-01	-	Schoharie	4761-01	114
Delhi	1221-02	141	Babylon	5150-01	135
Poughkeepsie	1302-04	133	Brookhaven	5151-01	70
Rhinebeck	1327-02	90		5151-03	115
LaGrange	1357-01	132	Islip	5154-02	139
Lake Placid	1523-01	43	Smithtown	5157-04	139
Ticonderoga	1527-01	77	Southampton	5158-01	107
Moriah	1558-01	66	Kingston	5501-02	116
Johnstown	1702-01	50		5501-04	87
Catskill	1953-02	156*	New Paltz	5522-01	103
Wells	2058-01	38	Ellenville	5526-02	38
Mohawk	2123-01	68	Saugerties	5564-01	38
Herkimer	2124-02	110	Shawangunk	5566-02	208*
Little Falls	2129-01	79	Ulster	5567-01	-
Amsterdam	2801-01	115	Glens Falls	5601-01	85
Glen Cove	2901-01	-		5601-04	-
Freeport	2904-04	152*	Hudson Falls	5726-01	82
Garden City	2905-01	172*	Peekskill	5901-01	143
Rockville Ctr.	2909-01	109	White Plains	5902-01	130
Kings Point	2944-01	126	Mt. Vernon	5903-04	-
Hempstead	2950-01	149	New Rochelle	5904-02	112
	2950-03	147	Ossining	5905-01	104
	2950-10	7	Port Chester	5906-02	123
	2950-11	156*	Yonkers	5907-08	127
	2950-12	192*	Rye	5908-01	138
No. Hempstead	2951-01	147	Mamaroneck (V)	5909-01	82
Oyster Bay	2952-01	137	Dobbs Ferry	5925-02	98
	2952-05	137	No. Tarrytown	5932-01	139
	2952-08	114	Greenburg	5953-01	85
Rome	3201-01	85	Mamaroneck (T)	5956-01	140
Utica	3202-01	90	Mt. Pleasant	5957-02	123
	3202-06	90	Somers	5966-02	90
Whitesboro	3237-01	79	Yorktown	5968-02	100
Newburgh	3502-02	145	Manhattan	7093-02	-
Wallkill	3566-02	-		7093-02	147
Cold Springs	3920-01	84			
Brewster	3922-01	104			

Table 4 (Cont.)

NEW YORK CITY SYSTEM		
Manhattan	00	-
	2	144
	5	164*
	10	185*
	37	157*
Queens	7	210*
	8	-
	12	195*
	13	165*
	14	112
	15	148
	16	155*
	20	166*
	22	-
	23	164*
	28	225*
	29	-
	30	51
Bronx	1	125
	3	162*
	4	154*
	6	164*
	9	-
	38	206*
Brooklyn	11	141
	17	-
	18	119
	19	193*
	21	-
	24	164*
	25	-
	26	181
	27	273*
Staten Island	31	177*
	32	175*
	33	170*
	34	169*
	35	179*
	36	154*

CENTRAL HUDSON SYSTEM		
Kingston	CK-1	106
	CK-2	437**
	CK-3	168*
	CK-4	99

CENTRAL HUDSON SYSTEM (Cont.)		
Roseton	CR-1	123
	CR-2	154*
	CR-3	116
	CR-4	187*
	CR-5	111

NEW JERSEY SYSTEM		
Asbury Park	001	131
Bayonne	002	194*
Bloomfield	003	-
Bound Brook	004	134
Carteret	005	154*
Dover	006	-
East Orange	007	282**
Edison	008	-
Fairview	009	155*
Fort Lee	010	-
Hackensack	011	232*
Hoboken	012	190*
Irvington	013	138
Jersey City	014	174*
Jersey City	015	174*
Linden	016	174*
Livingston	017	123
Morristown	018	-
Newark	019	185*
Orange	020	-
Passaic	021	132
Paterson	022	127
Perth Amboy	023	136
Red Bank	024	-
Roosevelt	025	96
Roselle	026	157*
Rutgers	027	-
Sayreville	028	163*
Somerville	029	138
Union City	030	163*
Westwood	031	126
Trenton	033	165*
Trenton	034	114
Rahway	035	124
South Amboy	036	133
Woodbridge	037	172*
Toms River	040	136
Sewaren	041	129

Table 4 (Cont.)

NEW JERSEY SYSTEM (Cont.)

South Brunswick	S01	149
Hamilton	S03	150
Grovers Mill	S05	132
Millstone	S07	150
Fair Lawn	S08	-
Cheesequake	S09	145
Secaucus	S10	166*
Metuchen	S11	46
Red Bank	S13	112
Brielle	S15	122
Island Beach St. Park	S16	108
Jackson	S17	85
Upper Saddle River	S18	113
Washington Crossing Park	S19	148
Waretown	S23	116
Tuckerton	S24	104
Fort Lee	S25	111
Clinton Twp.	S26	151*
Dover	S29	129
Florham Park	S30	108
West Orange	S32	136
Kean College (Newark St. College)	S33	143
Frankford Twp.	S34	116
Middlesex	S35	-
Skillman	S36	-

*Exceeds national secondary standard
**Exceeds national primary standard

Table 5. Annual Averages of Sulfur Dioxide in the Hudson River Basin (ppm)

		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
NEW YORK STATE SYSTEM											
Albany County											
Albany	0101-03				0.026	0.039	0.035	0.034	0.030	0.022	0.020
	0101-08		0.054	0.060	0.040	0.035	0.042	0.033	0.028	0.028	0.034
Columbia County											
Copake	1056-03							0.010	0.010		
Fulton County											
Gloversville	1701-03					0.009					
Herkimer County											
Mohawk	2123-01					0.014					
Nassau County											
Hempstead	2950-10							0.020	0.022	0.016	0.016
Oneida County											
Utica	3202-06					0.010					0.011
Rensselaer County											
Rensselaer	4101-02							0.020	0.020	0.019	0.017
Rockland County											
W. Haverstraw	4322-01								0.006	0.004	0.005
Nyack	4324-04								0.008	0.007	0.006
Clarkstown	4350-03								0.006	0.003	0.002
Schenectady County											
Schenectady	4601-05									0.018	0.016
Suffolk County											
Babylon	5150-01										0.020
Ulster County											
Kingston	5501-04							0.040	0.029	0.024	0.024
Warren County											
Glens Falls	5601-04										0.013

Table 5 (Cont.)

Westchester County						
White Plains	5902-01			0.017	0.010	0.011
Port Chester	5906-02			0.016	0.010	0.010
Mamaroneck (V)	5909-01			0.016	0.010	0.012
Greenburgh	5953-01			0.010	0.007	0.010
Mamaroneck (T)	5956-01		0.030	0.032	0.017	0.012
Mt. Pleasant	5957-02			0.007	0.007	0.008
Somers	5966-02			0.009	0.006	0.007
New York County						
Manhattan	7093-02		0.080	0.057	0.026	0.019
NEW YORK CITY SYSTEM						
Manhattan	00	0.112	0.091	0.058	0.031	0.033
	2	0.097	0.096	0.049	0.036	0.048
	5	0.089	0.100	0.053	0.026	0.034
	10	0.147	0.098	0.061	0.038	0.044
	37	0.069	0.078	0.038	0.027	0.021
Brooklyn	11	0.104	0.090	0.050	0.022	0.033
	17	0.072	0.066	0.032	0.023	0.016
	18	0.108	0.091	0.048	0.030	0.030
	19	0.077	0.076	0.031	0.015	0.018
	21	0.063	0.058	0.024	0.014	0.011
	24	0.073	0.078	0.033	0.025	0.019
	25	0.080	0.073	0.038	0.021	0.024
	26	0.085	0.077	0.036	0.017	0.025
	27	0.066	0.059	0.028	0.020	0.022
Bronx	1	0.074	0.077	0.041	0.026	0.023
	3	0.107	0.092	0.062	0.036	0.042
	4	0.060	0.058	0.031	0.019	0.014
	6	0.079	0.101	0.063	0.032	0.034
	9	0.059	0.060	0.029	0.020	0.020
	38	0.087	0.072	0.022	0.022	0.023
Richmond	31	0.068	0.077	0.031	0.018	0.016
	32	0.083	0.080	0.040	0.016	0.024
	33	0.066	0.074	0.030	0.019	0.017
	34	0.069	0.070	0.033	0.018	0.030
	35	0.062	0.070	0.032	0.015	0.020
	36	0.052	0.071	0.036	0.029	0.023
Queens	7	0.078	0.097	0.049	0.035	0.053
	8	0.079	0.078	0.040	0.025	0.034
	12	0.068	0.082	0.036	0.017	0.011
	13	0.090	0.094	0.060	0.025	0.036
	14	0.083	0.079	0.040	0.025	0.028
	15	0.062	0.073	0.038	0.023	0.019
	16	0.045	0.056	0.026	0.011	0.021
	20	0.068	0.084	0.042	0.028	0.031
	23	0.056	0.068	0.026	0.020	0.016
	28	0.045	0.057	0.022	0.014	0.014
	29	0.047	0.056	0.024	0.013	0.017
	30	0.062	0.066	0.032	0.018	0.023

Table 5 (Cont.)

CENTRAL HUDSON GAS & ELECTRIC SYSTEM									
Kingston	CK-1							0.005	0.008
	CK-2							0.009	0.008
	CK-3							0.008	0.008
	CK-4							0.010	0.008
Roseton	CR-1							0.012	0.011
	CR-2							0.014	0.011
	CR-3							0.013	0.013
	CR-4							0.013	0.013
	CR-5							0.016	0.012
	CR-6							0.012	0.011
ORANGE & ROCKLAND UTILITIES SYSTEM									
	OR-1							0.009	0.008
	OR-2							0.008	0.008
	OR-3							0.006	0.009
	OR-4							0.006	0.006
	OR-5							0.010	0.009
	OR-6							0.004	0.006
NEW JERSEY STATE SYSTEM									
Asbury Park						0.008	0.005	0.005	0.007
Bayonne	002	0.115	0.083	0.063	0.053	0.044	0.030	0.020	0.021
Elizabeth	3					0.036	0.029	0.018	0.013
Elizabeth	4							0.026	0.032
Freehold						0.008	0.008	0.007	0.012
Hackensack	011					0.019	0.017	0.015	0.011
Jersey City						0.040	0.030	0.019	0.020
Morristown						0.017	0.014	-	0.007
Newark	019	0.128	0.099	0.086	0.055	0.053	0.030	0.021	0.020
Paterson						0.014	0.014	0.008	0.006
Perth Amboy						0.026	0.025	0.018	0.024
Somerville						0.013	0.012	0.008	0.006
Toms River						0.005	0.006	0.005	0.006
Trenton						0.013	0.015	0.012	0.011

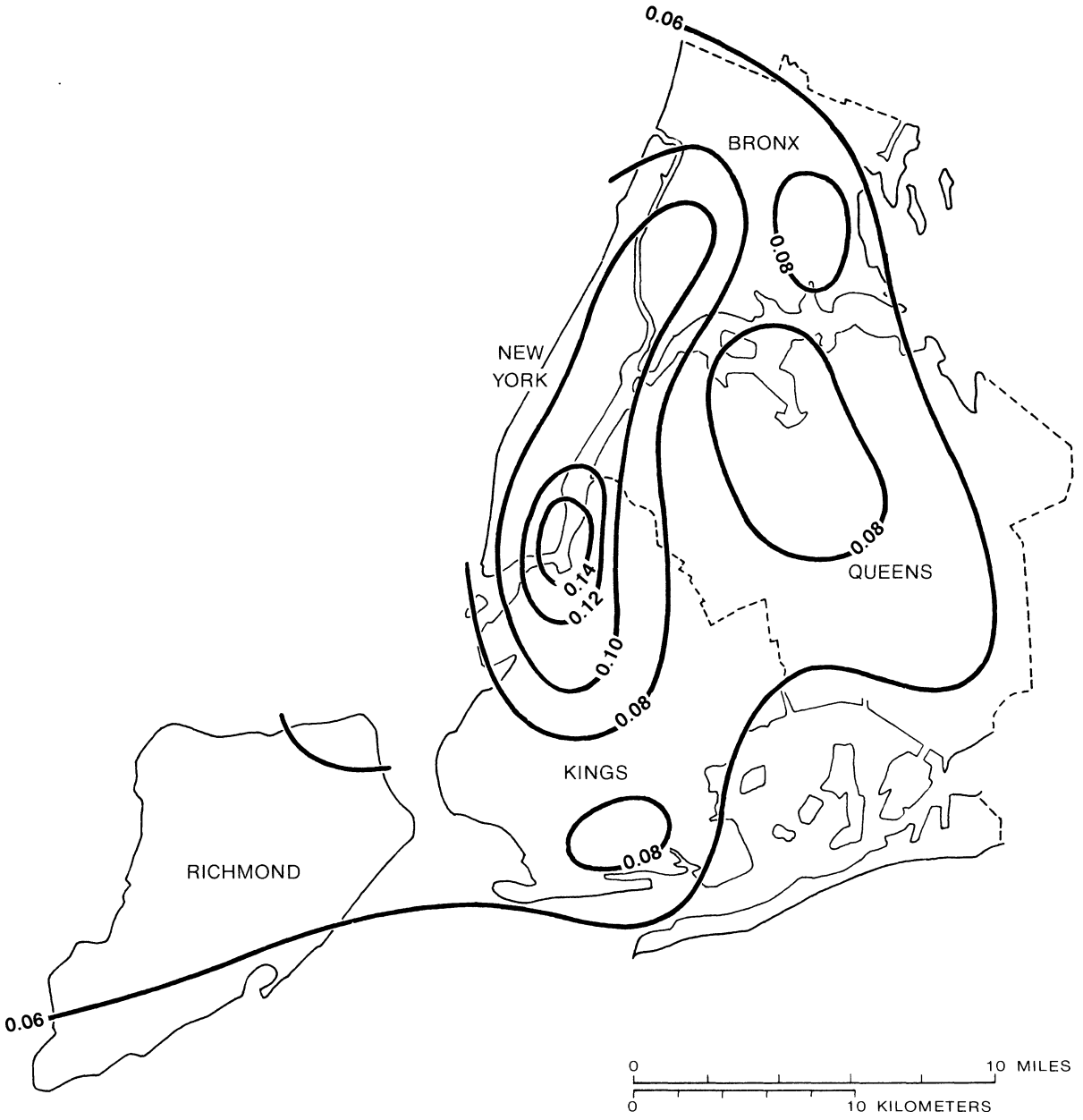


Figure 7. Sulfur Dioxide Estimates for New York City (ppm), 1969

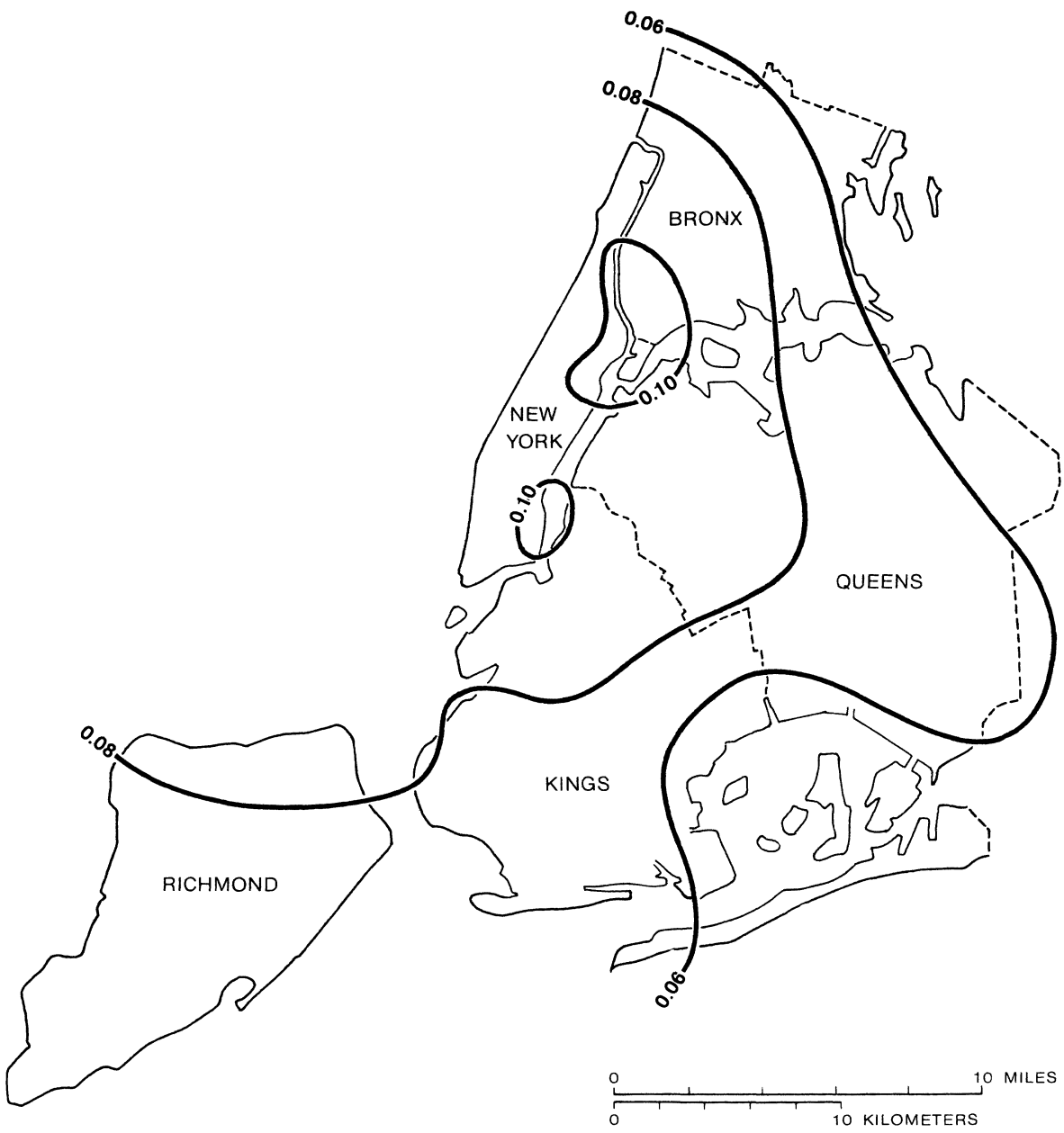


Figure 8. Sulfur Dioxide Estimates for New York City (ppm), 1970

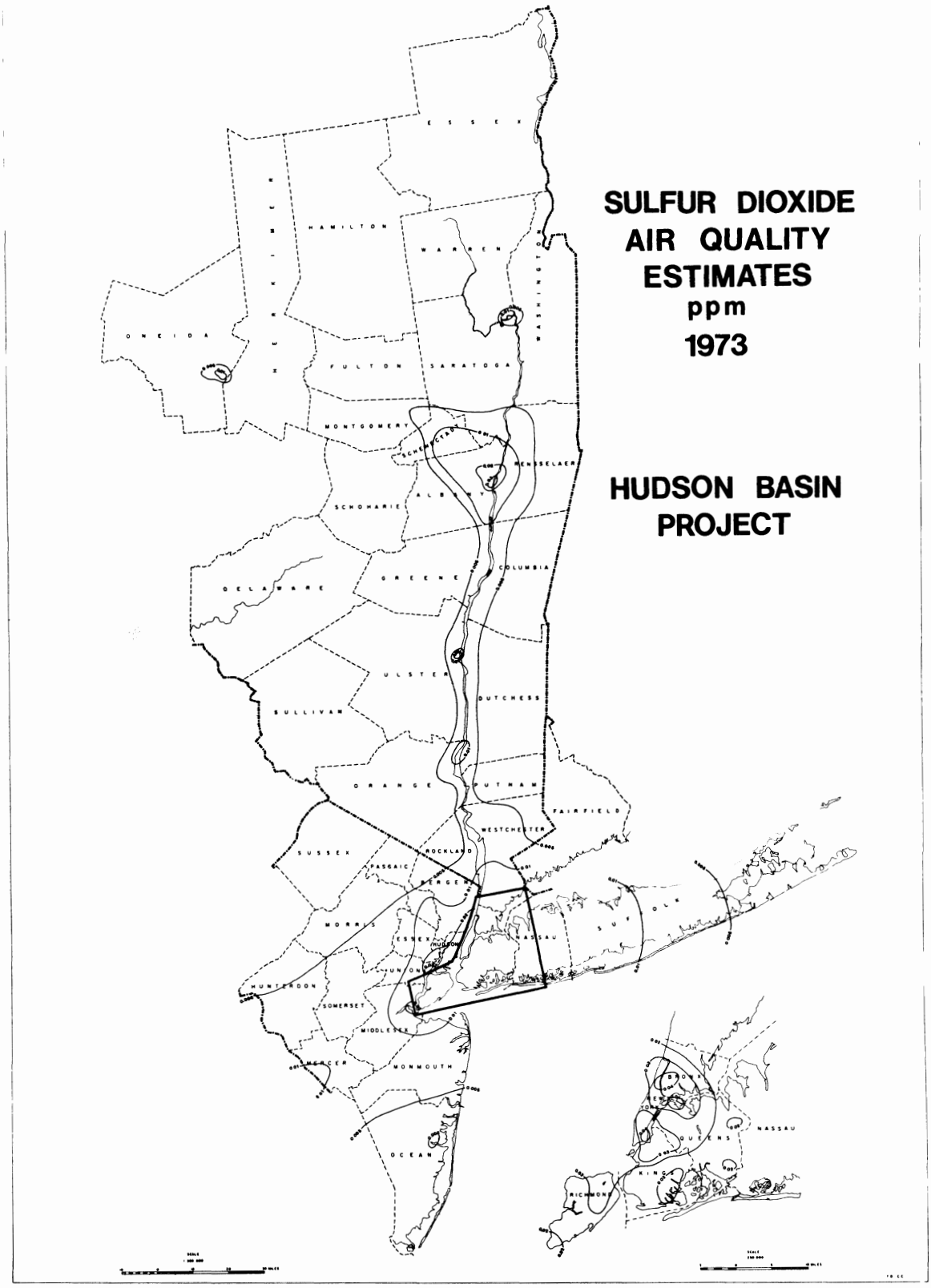


Figure 9. Sulfur Dioxide Air Quality Estimates, 1973

During the period from 1969 to 1973, sulfur dioxide has shown the greatest air quality improvement of all the major pollutants. Reductions of over 50 percent from 1970 levels have occurred in New York City. Most of this reduction can be directly attributed to fuel sulfur restrictions in the New Jersey-New York-Connecticut Air Quality Control Region (See Figure 2). As a result of this action, the use of coal has been almost terminated and heavy oil sulfur content has been reduced by over 80 percent. Further compliance with existing state regulations is felt to be sufficient to achieve the 0.03-ppm standard.

3. Nitrogen Dioxide

Nitrogen dioxide data have been collected at relatively few sites throughout the Hudson Basin (See Table 6). However, a picture of current air quality can be determined for the area in spite of the paucity of data. It appears that the entire region, except for the New York metropolitan area, is well below the national primary standard of 0.05 ppm. Because nitrogen dioxide is not source-specific (concentrations are rather uniformly dispersed in all of the region), the limited data for the urban areas appear to approximate the worst locations. Outlying areas would exhibit appreciably lower annual averages.

In the New York metropolitan area, it appears from the results at Newark and Elizabeth that achievement of the standard may occur sometime in the 1975-through-1977 period, primarily as a result of lower emission from newer automobiles. The sampling method used in the continuous monitoring system is not the method prescribed by the EPA, as its method does not lend itself to continuous monitoring. Thus, the results at Newark, Elizabeth, and the New York State systems may be somewhat different in relation to the federal reference method. Correlation studies appear to be needed.

The establishment of additional NO^2 sampling sites within the region is probably unnecessary.

Table 6. Annual Averages of Nitrogen Dioxide in the Hudson River Basin (ppm)

Station		1966	1967	1968	1969	1970	1971	1972	1973
Albany	0101-03		0.024	0.030	0.026	0.031	0.027	0.022	0.019
	0101-08		0.031	0.030	0.030	0.027	0.025	0.023	0.016
Hempstead	2950-10					0.030	0.030	0.039	0.043
Utica	3202-06						--	0.027	0.031
Rensselaer	4101-02						0.020	0.019	0.017
Schenectady	4601-05							0.023	0.021
Kingston	5501-04					0.040	0.040	0.026	0.019
Glens Falls	5601-04						--	--	0.013
White Plains	5902-01						0.029	0.030	0.031
Port Chester	5906-02						0.029	0.027	0.029
Mamaroneck (V)	5909-01						0.027	0.030	0.036
Greenburgh	5953-01						0.028	0.038	0.037
Mamaroneck (T)	5956-01					0.030	0.050	0.042	0.035
Mt. Pleasant	5957-02						0.018	0.023	0.027
Somers	5966-02						0.016	0.024	0.019
New York City	7093-03						0.060	0.052	0.048
Brooklyn	18						--	0.020	--
Queens	14						--	--	0.047
Bronx	1						--	--	0.049
	3						--	0.030	--
51 Astor Pl.	--						--	0.030	0.051
Bayonne	002	0.050	0.050	0.052	0.054	0.043	0.043	0.045	0.047
Newark	019	0.068	0.060	0.061	0.063	0.050	0.057	0.057	0.064
Elizabeth	4							0.063	0.061

3. Carbon Monoxide

Of all the contaminants considered in this discussion, the problem of carbon monoxide is the one most difficult to delineate. Concentrations are extremely source-oriented. They disperse to significantly lower levels within very short distances (about 100 yards). Thus, carbon monoxide measurements in the region are essentially illustrative, rather than definitive, of a particular problem.

Carbon monoxide measurements have been taken in most urban areas in the Hudson Basin. However, many of these, particularly in the New York State and New York City systems, have been taken in conjunction with other contaminant measurements at rooftop sites or away from areas of suspected high concentrations, and have therefore yielded results that are considered low. Most of the New Jersey system, as well as the New York City traffic-monitoring network, exhibits results significantly higher. From these data (See Table 7), it appears that in virtually all the region's downtown area, the national primary standard for 8-hour carbon monoxide concentrations will be difficult to obtain without the imposition of additional controls beyond the federal new-vehicle standards.

The federal program was based on assumptions that the new source standards would significantly reduce carbon monoxide concentrations in most areas, and that additional control measures by the respective states would be necessary only in a few instances, like New York City. The data in Table 7 indicate that such is not the case and that the federal emission standards may be too late to permit attainment of the Clean Air Act's carbon monoxide standards by the end of 1977. Extensions granted to the auto industry complicate this problem even further. To meet the carbon monoxide standards within a reasonable time, additional controls affecting most vehicles operating within the region will be necessary. Restraints on vehicle movement (reducing the number of vehicle miles traveled) seem to be insufficient. The only reasonable available alternatives are the reductions in per-vehicle emissions. But this suggestion would require a

Table 7. 8-Hour Maximums of Carbon Monoxide in the Hudson River Basin (ppm)

Station		1966	1967	1968	1969	1970	1971	1972	1973
Hempstead	2950-10						21.6	13.6	21.4
Utica	3202-06						--	--	7.1
Rensselaer	4101-02						7.1	7.3	13.0
Schenectady	4601-05						--	14.6	30.9
Kingston	5501-04						11.3	6.2	7.9
Mamaroneck (T)	5956-01						10.5	10.8	17.1
New York City	7093-03						12.6	8.9	8.5
Manhattan	00					10.0	13.0	18.0	13.0
	5					9.0	17.0	9.0	14.0
	10					12.0	18.0	12.0	10.0
	94					42.0	33.0	42.0	49.6
	96					45.0	36.0	19.0	21.5
	98					32.0	28.0	26.0	25.3
Queens	14					11.0	7.0	6.0	11.0
	30					12.0	16.0	14.0	11.0
Bronx	1					8.0	18.0	7.0	9.0
	3					9.0	13.0	11.0	12.0
Brooklyn	11					10.0	17.0	11.0	15.0
	18					8.0	11.0	9.0	14.0
	26					11.0	17.0	8.0	14.0
Staten Island	34					11.0	9.0	7.0	9.0
Bayonne	002	12.3	9.0	8.6	5.3	6.9	10.8	7.2	7.9
Hackensack	011						21.6	14.0	23.5
Newark	019	39.7	25.3	17.2	16.1	19.3	20.8	17.6	20.7
Asbury Park							11.2	9.9	12.3
Elizabeth	3						26.5	23.0	28.7
	4							13.7	13.4
Freehold							20.5	26.6	23.6
Jersey City							25.1	24.8	24.4
Morristown							9.7	8.0	31.4
Paterson							23.5	23.0	25.7
Perth Amboy							17.7	21.7	20.1
Somerville							26.1	19.2	39.4
Toms River							18.6	29.8	24.3
Trenton							28.8	34.5	32.3

massive vehicle retrofit program--a program that cannot be implemented in time because the service industry could not install such devices, nor could the manufacturers supply them in sufficient numbers.

Escape from this dilemma will require either modification in the Clean Air Act or a determination by the EPA that 8-hour carbon monoxide values in downtown street level locations do not constitute a health problem, in that no susceptible receptors are subjected to these concentrations for an 8-hour period.

4. Photochemical Oxidants

Photochemical oxidant data within the region are rather limited. As seen from Table 8, indications are that the federal standard is not being achieved throughout much of the region. During 1972, the federal reference method was changed from a potassium iodide method to one employing chemiluminescence. This change has had a pronounced effect on reported values (compare the 1972 and 1973 data in Table 8). The values have generally risen, markedly in some cases; yet it cannot be stated that air quality has worsened. In fact, air quality should be improving as hydrocarbon emissions--the alleged precursors of photochemical oxidants --are reduced within the region.

The change in method will have a pronounced effect on programs within the Hudson Basin Region. It must be emphasized that the standard of 0.08 ppm 1-hour value, not to be exceeded more than once a year, was based on effects noted using the potassium iodide method. No supportive health studies have been performed using the chemiluminescence method, which measures only ozone, not photochemical oxidants. Many agencies, including the New York State Department of Environmental Conservation, have postulated that photochemical oxidant concentrations (ozone) are not entirely a function of urban hydrocarbon emissions. This is evidenced by the fact that rural maximums are about as high as those found in urban areas. This theory is being evaluated during the summer of 1974. If studies

Table 8. 1-Hour Maximums of Photochemical Oxidants in the Hudson River Basin (ppm)

Station		1966	1967	1968	1969	1970	1971	1972	1973
Hempstead	2950-10						0.127	0.106	0.178
Utica	3202-06						--	--	0.095
Rensselaer	4101-02						0.054	0.087	0.170
Schenectady	4601-05						--	0.095	0.191
Babylon	5150-01						--	--	0.149
Kingston	5501-04					0.060	0.080	0.084	0.161
Glens Falls	5601-04						--	--	0.115
Mamaroneck (T)	5956-01						0.095	0.136	0.183
New York City	7093-03						0.174	0.207	0.179
51 Astor Pl.						0.120	0.090	0.080	0.250
Bayonne	002		0.215	0.183	0.173	0.140	0.113	0.108	0.283
Newark	019		0.197	0.158	0.135	0.130	0.109	0.101	0.264
Elizabeth	4							0.096	0.171

indicate that reduction of urban hydrocarbon emissions will not significantly reduce ozone measurements, then the EPA will be asked to reevaluate its air quality standard and control techniques for this contaminant.

II. ISSUES AND ILLUSTRATIVE SITUATIONS

Five case studies were undertaken by the Task Group on Air Resources. They illustrate some of the complex issues and interrelationships encountered in the planning and implementation of public and private actions affecting the environment. The cases studied were: the Storm King pumped-storage project; a deepwater oil terminal for northern New Jersey; Boomer v. Atlantic Cement; air quality and natural resources in the Catskills; and air pollution and transportation in the New York City area.

A. STORM KING

The proposed Storm King pumped-storage project is designed to meet intra-day peaking requirements. During off-peak hours, water would be pumped to a storage reservoir at higher elevation. This water would be released as necessary to drive turbines to generate electricity for the peak period. The storage reservoir would be located in the Hudson Highlands, filling a depression between hills and covering about 240 acres.

The environmental questions raised by this proposal are numerous:

1. What will be the damage to scenic vistas by the flooding of the land between the hills?
2. What will be the effect on ecology by removal of this land from its current use and flooding it?
3. Will the pumping of water to the reservoir kill fish and other life in the river?
4. Will there be any compensating recreational value in the new reservoir or will fluctuating water levels negate such use?
5. Fifty percent more energy will be required to pump the water than will be generated. Is this acceptable?
6. If the additional energy use is supplied by fossil fuel rather than nuclear, what additional air pollution will result from the system?

7. The electricity will benefit people in New York City and vicinity. Should the area remote from New York City bear the brunt of environmental degradation for the benefit of other areas?
8. What will be the impact of the transmission lines?

Ancillary issues raised include:

1. Should the consumer demand for electric energy be uncontrolled or checked in some way?
2. Should environmental impacts be concentrated in urban and other areas where benefits accrue, or should impacts be dispersed so that their effect at any one place will not be so great?
3. Should New York City's planning exclude those in remote areas who receive impacts from sustaining the city?

This case also raised issues concerning institutional arrangements. The government agencies concerned included: the Federal Power Commission, the State Department of Environmental Conservation, the City Department of Air Resources, fish and wildlife agencies, water resource agencies, local agencies concerned with land use, agencies concerned with the construction of the reservoir dam, and the AEC. There may be others.

In addition to the official agencies, there would be the interest of investors in the utility and its management, the financial institutions loaning the money for the project, fuel suppliers, and the citizens groups concerned with air quality or fish and wildlife. Not to be overlooked are the publics in New York City and in the area of the reservoir.

This project illustrates the great role of sunk costs in perpetuating a plan, even if it is a bad plan. Conditions have changed since this project was first proposed and approved. Nuclear plants have not been built as originally envisioned to provide clean energy for pumping. The fossil-fuel situation is critical and, in the short range, changing from day to day. How can projects of this type be reviewed after the lapse of time to update the evaluation of the plan? How can the sunk costs in a

bad plan be discounted so as not to overwhelm efforts to reevaluate the situation with freedom to select more desirable alternatives?

B. DEEPWATER OIL TERMINAL

To facilitate the unloading of large supertankers for oil, it has been proposed that a floating facility be located off the Atlantic Coast. Supertankers reduce the shipping costs about 50 percent. At the national level, a critical goal is to import sufficient oil to maintain the economic health and security of the nation.

Much of the productive capacity, population, and need for petroleum is in the Northeast. One proposed location for such an offshore oil terminal is near northern New Jersey, an area already plagued with industrial development (especially petrochemical), population, and waste disposal.

An oil terminal of the magnitude proposed will stimulate regional development through the use of oil as an energy source and as a raw material for the petrochemical industry. Indirectly, it will stimulate the development of a new, or the enhancement of an existing, infrastructure and regional market.

The following environmental issues are raised by this case:

1. Will the offshore facility contribute to air pollution from escaping vapors of hydrocarbons, or to water pollution from accidental spills and intentional cleaning of tankers, etc.?
2. What will the onshore impacts be, including the effects from the induced growth of industry, population, and transportation, and the resulting wastes?
3. Air quality data is collected by inconsistent sampling procedures and under different site conditions. How can data be related to health and environmental concerns?
4. It is assumed that a low level of growth comparable to normal past growth can be obtained. Is this so, or will economic pressures force a high level of growth? Is a "normally" low

level of growth acceptable in an area already burdened with population and pollution?

5. Is a small increment of pollution linearly additive in its impact on health or environmental quality? Is there a threshold beyond which even small increments of pollution are unacceptable?
6. Is there a limit on the capacity of an area to absorb pollution, population, industrial development, etc.?
7. Is there need for a centralized, computerized, standardized data bank?
8. What are the implications of development at the microspatial scale? Are improved models required for single-source plumes, network (transportation) sources, and multiple sources (e.g., residential and commercial areas)?
9. Should plans be based on normal conditions or should abnormal conditions also be considered, as done by the AEC (probabilistic simulation of malfunctions)?
10. Is the developmental philosophy of concentrating pollution in areas already burdened an acceptable one?

This case illustrates the inadequacy of the uncoordinated decision-making process concerning land use. At present, land use is generally determined at the smallest civil division. In this case, the construction of the superport would unleash economic and political forces beyond the capability of these small units of government to handle.

However, in some ways the small civil division protects local interests. If national and multi-state regional interests are served, environmental burdens may be thrust upon a local area without its consent or any concomitant compensation. This raises questions about the most appropriate level for decision making where the issues involve international, national, regional, state, local, and private interests.

A very serious question raised by this case is the capability, or even desirability, of attempting to accomplish complex decision making in an

overall planned fashion. Should independent decisions be made in the interests of economic development, environmental quality, social goals, etc., and provision made for competition of interests on the battlefield of political action?

With respect to institutional arrangements, this case involved the following federal agencies: the Coast Guard, the U.S. Army Corps of Engineers, the U.S. Maritime Administration, the National Oceanic and Atmospheric Administration, the Department of Transportation, the Department of Interior, the Council of Economic Advisers, the Office of Emergency Preparedness, and the Council on Environmental Quality.

Other agencies that should have interests, but have apparently not had a significant role in the decision making include: the Tri-State Regional Planning Commission (TSRPC), the Regional Plan Association (RPA), the Port Authority of New York and New Jersey (PANYNJ), and Region II of the Environmental Protection Agency (EPA II). TSRPC and EPA II have attended meetings. A report of TSRPC has not been released and EPA II has not made detailed studies. RPA and PANYNJ have not actively studied the issue.

This case also reveals the inability of local planning commissions to deal effectively with such an extensive and complex question, as well as some of the political ramifications of major issues.

C. BOOMER v. ATLANTIC CEMENT

This case not only illustrates the relationship between land use and air pollution, but it also brings to the fore the role of the courts in decision making. In this case the court, in effect, directed that there be some degree of air pollution in the public interest.

A combination of natural resources--deposits useful in the manufacture of cement and access to transportation along the Atlantic seaboard via the Hudson River--made this an ideal location for the cement plant. Air pollution control equipment was installed, but it did not remove all of

the pollution. Sometimes there were operating problems, and miscellaneous sources of fugitive dust were not adequately controlled. Affected neighbors brought suit against the company. The courts considered the school tax and other benefits to the community in allowing the company to continue operating after paying permanent damages.

In this case the air pollution was considered to be a nuisance and not a direct health hazard. The right of the state to control air pollution emissions was not questioned.

Environmental issues raised by this case are:

1. How are the interests in natural resource development, environmental quality, and regional economic development balanced in site selection for industry?
2. Does the award of nuisance damages to private individuals protect environmental quality? Is it an acceptable approach to land use that degrades the environment for all subsequent populations in the area?
3. Is it ever in the public interest to degrade environmental quality?
4. Should health values or property values be superior?
5. Does air pollution control rest on proven health hazards of a specific, short-term, acute nature, or is an effect detrimental to the quality of life also considered to be a health hazard?
6. Should ambient air quality or emissions be the basis for air pollution control?
7. Should the courts be the final arbiter of the public interest in determining how much air pollution is acceptable?
8. Should taxes paid by an industry be a determinant of how much air pollution is to be controlled?
9. Is it all right to pollute the air if compensation is paid to property owners for the financial damage?
10. Do all citizens have a constitutional right to a clean environment? If not, should there be a constitutional amendment to that end?

11. Are natural resources a public trust?
12. Should local environments be degraded in order for a larger population to receive the benefits of a natural resource?
13. What standing should the interests of individual citizens have in matters concerning their environmental quality?
14. Should environmental impact statements be required for all major developments, whether public or private ventures?

Interests in this case, aside from the litigants, included the State Department of Commerce (which helped select the site), the State Department of Environmental Conservation, the State Attorney General's Office, the Coeymans Town Board, the Ravena-Coeymans-Selkirk School Board, and the Albany County Department of Health.

D. AIR QUALITY AND NATURAL RESOURCES IN THE CATSKILLS

Some 10 million people in New York State alone live within 2 to 3 hours driving time of the Catskills. Millions more live in nearby areas of New Jersey, Conecticut, and Massachusetts. Travel to the Catskills, and tourist activity within the area, induce pollution from autos and ancillary development. But the Catskills may also be affected by pollution generated in remote areas. Previous studies have not considered the interactions between a natural area, tourist influxes, and air quality. Because it contains no major sources of pollution, there is a dearth of baseline information about air quality in the Catskills. Furthermore, little is known about the interactions of the forests and other wildlife with air pollution.

More research is required to ascertain the effects of air pollution on vegetation, especially secondary effects in combination with other factors such as disease and insects. Little or nothing is known about the effects of air pollution on: disease and insect susceptibility; genotypic and phenotypic evolution; responses of plants to stress; agricultural productivity and timber yields; quantitative dose response from acute and chronic exposure; and quality of plant-derived food and fiber.

Environmental issues raised by this case include:

1. Should recreational areas in a state be available to persons from outside the state? How can the overwhelming of a natural area be avoided?
2. Forested land in New York State is increasing. Why? Is this desirable? Is marginally productive agricultural land being returned to a use for which it is better suited? If so, are geology, topography, etc., determinants of basic land use potential?
3. Is commerical forestry compatible with recreational pursuits?
4. Is mining compatible with preservation of forest lands?
5. Air pollution from northern New Jersey and New York City may be transported at times to this area. What is the potential for damage? What can be done to control air pollution generated in areas remote from the receptor?
6. Should major highways be constructed in the vicinity of such an area?
7. Is industry compatible with natural recreational areas?
8. Are there benefits from forests other than recreation, such as the release of oxygen in the fixing of carbon?
9. How can air pollution effects on vegetation be minimized?
10. What is the long-term effect of air pollution on the natural succession of flora and fauna?
11. What are the interactions among land use, regional economy, recreation, and air quality? How will further development affect trees, etc.?
12. Air quality data are lacking in the Catskill area. Are they necessary for proper planning?
13. What is the effect on forests and vegetation of low-level exposures to air pollution over a long period of time? What is the effect of economic and population growth (power plants, cement plants, transportation, etc.) on the extent of forests?
14. Of the institutions concerned with development of the recreational potential of the Catskills, are any concerned with air pollution?

In the Catskills case, there appears to be little interaction between the interests concerned with wildlife and recreation, on the one hand, and the New York and New Jersey air pollution control agencies on the other. Furthermore, interaction is also lacking with those concerned with transportation planning, land use, and regional economic development from the standpoint of air pollution generation as it may affect this area.

E. AIR POLLUTION AND TRANSPORTATION IN THE NEW YORK CITY AREA

From the standpoint of the Air Resources Task Group, transportation systems in urban areas and transit corridors are of interest because of their impact on air quality. Of course, dust and other air pollutants may be generated in the construction of facilities, but it is the pollution resulting from day-to-day operations that is of major concern.

In urban areas, motor vehicles are a major source of certain pollutants--carbon monoxide, oxides of nitrogen, and hydrocarbons. Motor vehicles may also be a significant source of particulates, but little attention has been given to this possibility.

If electric power is substituted for internal combustion engines, pollutants from generating stations must be considered. If nuclear fuel is used, air pollution is virtually eliminated but the potential hazards of ionizing radiation must be considered. If fossil fuel is used at electric power stations, the pollutants of concern are different from those generated by internal combustion engines. They are primarily oxides of sulfur and particulates, along with some oxides of nitrogen, carbon monoxide, and hydrocarbons. Both nuclear and fossil-fueled generating stations produce waste heat, which must be considered both in its potential impact on atmospheric conditions (e.g., vapors from cooling towers), and in its impact on water resource (e.g., consumption, alteration of flows, and temperature changes).

Community air sampling data show excessively high levels of carbon monoxide, which could be a problem in other communities over 25,000 population. Carbon monoxide was therefore selected to illustrate this case.

A number of strategies have been advanced for controlling vehicle emissions and traffic. On a short-range basis, emissions from mobile sources may be reduced by three general approaches: by reducing the rate of emission of pollutants, by reducing total vehicle-miles of travel, and by shifting travel to modes of lower pollution potential. On a longer-range basis, the need for travel and transport can be reduced through design of land use and through changes in spatial arrangements and living habits.

This case raises a variety of issues of great complexity, both from the standpoint of environmental impacts and institutional interactions. Among the environmental issues are:

1. How well defined are the health effects from levels of pollution permitted from motor vehicles?
2. Are the pollutants from motor vehicles more or less hazardous to health than the pollutants produced by electric generating stations?
3. Is the thermal pollution from electric generating stations more acceptable than air pollution from motor vehicles?
4. Is it possible and feasible to control emissions from motor vehicles without restricting travel?
5. If exhaust emissions are controlled, will particulates from tire wear, pavement wear, wear of brake shoes, etc., be a sufficient problem that travel will have to be restricted?
6. If alternate mass transit is made attractive, will people forego use of a personal car? How can they be encouraged to do so?
7. Will people accept industry in residential areas if the industrial plant is designed to have no pollution, noise, or other objectionable features? If so, will people elect to live close to work (within walking distance)?
8. Should land use patterns in cities be restructured to encourage walking and cycling?
9. Can mass transit systems be developed which do not require the use, in part of the trip, of a personal car?

10. What kinds of deterrents to travel in a personal car would be effective in reducing pollution levels? Will people accept such restrictions?

Auxiliary issues raised include:

1. Who or what agency should plan for transportation? Should air pollution control agencies determine acceptability of transportation strategies in a control function or in the actual transportation planning role.
2. Should it be left to government agents and professional planners to decide what is "good" for the population at large?
3. How can ways of life and habits be changed? Should they be?
4. How much personal choice should there be in selecting a mode of transportation; a location to live with respect to work?
5. Can a majority choice for air quality be imposed to restrict actions by a minority of polluters?
6. Should air quality, land use, transportation, and energy be the responsibility of one super and ineffective agency?
7. Should density of work places be restricted?

Among the public agencies involved in these issues are: EPA and its Region II office, the U.S. Department of Transportation, the Interstate Commerce Commission, the New York State Department of Environmental Conservation, the New York City Division of Air Pollution Control, the Interstate Sanitation Commission, the Port Authority of New York and New Jersey, and the New Jersey Department of Environmental Conservation. Indirectly concerned are the planning agencies controlling land use, utility commissions concerned with transportation and energy, real estate developers, highway departments, investment bankers, industrial planners, and a host of others.

F. ANALYSIS OF ISSUES

1. Criteria

The cases studied reveal uncertainty with respect to the phenomena to be observed and evaluated in determining environmental quality.

With respect to air quality, federal legislation has mandated the Environmental Protection Agency to establish primary air quality standards to protect health. Secondary standards are also to be set. There is some uncertainty about these, e.g., are levels of NO_x too severe and levels of CO and hydrocarbons too lenient? Furthermore, only acute physiological responses are considered in the primary standards, not the effects of air pollution on the mental health and well-being of man. In the analyses in this report, the Task Group did not examine the basis for the federal standards, referring such questions to the Task Group on Human Health.

The effect of air pollution on ecology is presumed to be potentially detrimental because damage to vegetation in specific locations or test situations has been cited. However, the case of the Catskills reveals a lack of generally applicable knowledge for evaluating effects of air pollution on a large region with diverse species. While acute effects may be forecast under certain conditions, their interaction under natural conditions of climate, disease, insects, etc., is not fully understood. It is also not known how air quality might favor the dominance of certain species over others and the resulting impacts on ecosystems. With the transport of air pollution over great distances, from urban-industrial locations to more primitive areas, and the location of transportation corridors through agricultural and forested areas, these matters demand more attention.

One of the parameters evolving in the evaluation of air quality is the energy investment in "clean" or "dirty" air. This is not just the influence that air quality standards have on the selection of energy conversion and energy transportation systems, but includes the energy requirements to meet air quality standards (or to restore damage caused

by air pollution if standards are not met). Such analyses may be compared with benefit-cost analysis of the economic type, but with energy, a criterion other than the dollar is needed.

Strategies to preserve or enhance air quality affect aesthetic considerations directly and indirectly. In the Boomer case, the dusty operations that depressed land values were objectionable but not necessarily detrimental to health. In the Storm King case, a scenic vista was to be altered and a reservoir substituted for a valley. The social and economic value of aesthetic considerations in such cases is somewhat elusive, but nevertheless real. Aesthetics, as such, may have value in mental health and in stimulating mental development. This, too, is an area for further research.

All of these factors--health, ecology, energy and economic investment, and aesthetics--are parameters in the evaluation of environmental quality. Proposed actions should be evaluated to determine their impact on each factor. Further refinement of these parameters is sorely needed for use in decision making.

2. Measurements

Where there is agreement or legislation on criteria and standards (e.g., the EPA primary standards for air pollutants) planning and decision making rest on measurements. In several of the cases reference is made to the need for uniformity, or at least consistency, among jurisdictions on parameters to be sampled, test procedure, sampling locations, frequency of sampling, number of samples, time period, and other aspects of sampling methodology. Standardization is essential to permit comparability of data between areas. In most cases data were lacking or were inadequate for evaluation and planning purposes.[1]

1. This is especially true when considering the effects of a given project, or potentially detrimental activity, at the distances somewhat removed from the immediate site of the project. This point is exemplified in the Catskills case study.

In addition to measurements of air quality, other indicators of environmental change should be observed to determine indirect effects of air pollution and to see what other environmental and social conditions lead to air pollution.

Community air monitoring systems are costly, but when compared with investments in air pollution control by the private sector, these outlays for data-gathering are warranted. Unfortunately, monitoring activities have little dramatic appeal. Appropriating bodies are more prone to support expenditures for direct action programs.

It is also possible that data currently collected are not utilized to the extent that they might be. Samples may not be in the location most representative or useful for evaluation or planning. The relationship between pollutant emission from multiple sources and community air quality is not precisely understood to the point of predictability. Accordingly, much control is on a "trial and error" basis, following the rules of thumb of "best practice" or "available technology."

3. Indirect and Subtle Effects

Where air pollution from an isolated exhaust stack causes acute responses in the immediate vicinity, the relationships are readily recognized and appropriate action can be considered almost immediately. In the cases cited herein, the causal relationships are more subtle or indirect and require more thoughtful examination.

Examples are:

1. The transport of pollutants from point of generation to remote areas, such as from northern New Jersey and New York City to the Catskills.
2. The effects on air quality of increasing population density and industrial and commercial activity, as in the onshore activity stimulated by the development of a deepwater oil terminal.

3. In a similar vein, the ultimate effects on air quality of "normal" growth of population and economic activity.
4. The effects on air quality of decisions pertaining to such matters as energy or transportation systems. Similarly, the impact of air quality regulations and standards on choices in these other areas.

The examples reveal even more remote relationships that involve land use, regional and national economic development, resource utilization, and the like. Decisions in all of these areas influence air quality, and achievement of air quality goals may ultimately require changes in these other areas.

There appears to be considerable knowledge which could be brought to bear on the examination of these issues, but there are also significant constraints on the utilization of that knowledge:

1. the lack of a centralized, coordinated, computerized environmental data bank based on a uniform sampling and measurement system;
2. the fact that land use planning and control is done at the level of the smallest political unit with little or none at the regional, state, and federal levels;
3. the lack of attention to environmental determinants for decision making with respect to growth patterns, land use, energy systems, transportation systems, and the like; and
4. the lack of environmental impact analysis where NEPA does not apply, or inadequte breadth of focus where NEPA or similar requirements do apply.

These constraints might be eased by reorganization of governmental activities at various levels and by legislation. But those steps would not be easy because of existing strong relationships between agencies and the non-governmental interests that they deal with.

4. Policy Issues

These cases raise policy questions which are typical of other situations in other locations.

Among them are:

1. Should air quality be a major determinant in policy formulation for, and control of, land use, transportation, and energy sources and systems?
2. Should developments that tend to degrade the environment be situated in areas already degraded to a degree (concentrated) or in areas relatively free of pollution (dispersed)?
3. What growth policies should be pursued--maintenance of "normal" growth, economic expansion, zero growth, deconcentration?
4. What relative weight should be given to environmental quality, resource development, economic expansion, and energy investment in decision making?
5. How should economic and human values be balanced? Where do private property values fit?
6. To what extent should personal freedom of choice be restricted in the interest of the whole population?
7. To what extent should public and private discretionary decisions be subject to public scrutiny, review, and control?

These questions are interwoven with people's concepts of their personal relationships to their government and society. Habits, culture, and behavior must also be considered.

There is the very sensitive question of whether judgments of government technical experts are based on limited professional criteria or consider the values of the people affected? Questions like these can only be resolved in the political arena. The problem then becomes one of whether information and knowledge are available to, and conveniently assembled for, analysis by those making decisions, be they the electorate or their representatives.

Accordingly, the major concern here is the satisfactory resolution of questions related to criteria and measurements, and the understanding of indirect and subtle relationships so that more informed decisions are possible.

The social, economic, and health implications of these decisions are important in the evaluation of alternative proposed actions, including the "no-action" alternate. One may raise the question of the extent to which a public agency should assume an advocacy role with respect to these matters. If so, is the agency assuming multiple, and possibly incompatible roles, e.g., responsibility for the promotion of energy production facilities and simultaneoulsy the protection of public safety and health from hazards associated with these facilities?

Where decision-making responsibilities are vested in a government agency, communication between the agency, the principals, and the public must be considered. The agency may be able to communicate its findings and determinations, but may lack the means and opportunity to ascertain public feelings and communicate them to government officials in the process of formulating decisions. Since the implementation of decisions is frequently delayed, it is important to provide a mechanism for reviewing and updating past decisions to make sure they are still economic, in the public interest, and represent the best available alternatives.

5. Coordination

These cases all involved a multiplicity of agencies at various levels of government. It appeared as though these agencies operate at times as adversaries or competitors. It is apparent also that agencies designated as "planning agencies" are not the only ones doing planning, and the planning they do may be very restricted in scope.

One of the problems in planning is moving from the analysis and planning phase to the implementation phase. Where planners conduct their activities without the direct involvement of the change agents, implementation may flounder from lack of support.

The forecast of private planning and decisions in public planning exercises becomes difficult. However, government is not without persuaders to influence private decisions. Taxes, subsidies and other incentives, eminent domain, laws and regulations, are devices that may be invoked to promote or deter certain decisions. More subtle withholding of utilities, transportation, and other services can stimulate or deter development.

Even so, problems of level of jurisdiction, branch of government, and unit therein, all become issues. Should courts be the final arbiter in issues of environmental quality? Should the smallest political unit determine land use? What is the role of private citizens and citizen activist groups in government decision making?

It has been suggested that the level of jurisdiction should encompass sufficient territory that implementation of the plan of action will have a significant effect on the air quality. One may postulate that this territory should also contain sufficient taxable resources to provide financial support for an adequate program. It is also necessary to coordinate with other decision-making processes in the same territorial jurisdiction.

Satisfaction of these criteria may mean a shift to larger jurisdictional areas. The hazard in this process is one of aggregating majorities that will impose or add to the environmental stress of some segment of the area.

6. Interdependencies

There are numerous illustrations of the interaction between areas of the environment, as well as with other areas of social concern. These matters will be explored in the next chapter.

III. PRIORITY POLICY INTERDEPENDENCIES

Interrelationships and interdependencies between air resources and other areas of environmental concern fall into two categories. One relates to activities that generate air pollution and that have to be restricted in some way to achieve air quality goals. Another category of interdependencies deals with actions or activities adversely affected by air pollution.

Air quality goals might restrict activity in various categories of land use (commercial, industrial, high-density residential), as well as in transportation, solid waste disposal, resource extraction, and energy conversion. Uses adversely affected by air pollution, but not considered major sources of air pollution in themselves, include natural forests and similar areas, agriculture, low-density residential neighborhoods, resort development, and certain types of industrial development such as electronics and food processing.

A. GENERATORS OF POLLUTION

1. Land Use

A feature that threads through practically all the case studies is the interdependency between land use and air pollution. When one considers the normal meteorology and topography of an area, it is suggested that there is a carrying capacity of that area to receive air pollution within prescribed limits based upon the ventilation rate. Accordingly, the quantity or tonnage of air pollutants which the atmosphere could handle without exceeding standards has a limit. In other words, the land area has a carrying capacity for sources of air pollution. The density of these sources has to be restricted, as well as the quantity of emission permitted at individual source locations. Inasmuch as technology is not perfect in removing pollutants from exhaust stack gases, there is a limit as to how many such stacks can be discharging to the atmosphere in a given area. Accordingly, the future development or dispersal of various

activities should consider the assimilative capacity of the air and the area's existing burden.

Such an approach raises the additional question of whether or not air pollution control activities should be based on normal conditions or extreme adverse conditions. In urban areas with a diversity of pollution sources, individual adjustments based on meteorological conditions and forecasts become extremely difficult, if not impossible, to manage. Consequently, it appears that the control effort in such areas would have to be based upon extreme conditions.

If land use were used as an instrument in air pollution control, then an area with excessive air pollution might be discouraged or prohibited from further development that would introduce more pollutants into the atmosphere. For example, the Hudson Valley should not be used as the location of any more fossil-fueled electric generating plants. Similarly, the Arthur Kill should not be the site of additional petroleum refining facilities. On the other hand, natural resources, such as those used in manufacturing cement, are site-specific and their use may result in some unavoidable local degradation.

The question has been previously raised whether industrial sources should be dispersed so that some sources go into relatively clean areas with some degradation of the atmosphere. The alternative is to place industries that produce air pollution in an area with similar industry, thereby aggravating an already degraded environment. The resolution hinges on value considerations related to air quality goals, economic development aspirations, etc.

2. Transportation

In the preceding section the influence of transportation on air pollution was emphasized. Most transportation-related air pollution is from mobile sources. Even so, the many small sources of pollution do tend to be concentrated in certain areas or corridors. These areas of concentration are transportation corridors, parking facilities, and such major traffic

generators as sports stadiums and shopping centers. Topography obviously can influence the concentration of pollutants from these mobile sources. In addition, certain man-made features, such as tall buildings and tunnels, tend to aggravate this situation. The location of a transportation corridor in a natural area will introduce air pollution and may disturb existing ecosystems. The routing of traffic and the arrangement of buildings will influence the concentrations of pollutants within the urban area.

There has been previous discussion of the possibility of controlling emissions from these sources, as well as restricting or facilitating vehicular movements to reduce the amount of air pollution. On a longer-term basis, rearrangement of spatial relationships between place of work, recreation, and residence could do much to reduce emissions from mobile sources.

If electric power is substituted for the internal combustion engine, air pollution from electric generation must be considered. Substitution of mass transit for autos will also reduce overall pollution, but may also tend to concentrate it.

The question of transportation is obviously related also to land use, which was discussed in the preceding section.

3. Solid Waste Disposal

No cases were developed to illustrate problems associated with solid waste disposal. However, some communities use incineration to reduce the volume of solid waste that must be disposed of in landfills. Incinerator feed may consist of garbage and combustible refuse. It may also include the solids resulting from a treatment of liquid waste. The burning of sewage sludges presents special problems not necessarily associated with the burning of garbage and combustible refuse. Problems most frequently associated with the combustion of solid waste are those of odor and fly-ash. There is some concern about the possibility of producing carcinogens in the burning of plastics, and there is not much known about other

chemical by-products resulting from combustion of the many things that go into a municipal incinerator. Federal research in this area has been curtailed in recent years.

Aside from generating air pollution, the burning of solid wastes simply to reduce volume neglects the potential for recovery and recycling. Even where resource recovery is practiced, the heat value of the combustible solid waste may be recovered to produce low quality steam to heat buildings and for other purposes.

4. Resource Extraction

The Boomer case illustrates a type of problem associated with the extraction of site-specific natural resources. If these resources are to be exploited, there may be air pollution problems. Since the location of these resources is not under human control, it may be necessary to restrict or prohibit some types of development near the point of resource extraction to avoid air pollution problems. If this is impossible, it may be necessary to alter the existing use in the vicinity of the resource so that resource extraction can proceed.

5. Electric Energy Generation and Air Pollution

Most contemporary electric power plants use either fossil or nuclear fuel. Air pollution standards tended to restrict the use of fossil fuel because of the sulfur content of fuel oil and coal. There are practical means of stripping sulfur from fuel oil, but this has thus far not proved to be practical in the advance preparation of coal. Crushing can remove pyrites, but there would still be about 2 percent sulfur left in the coal unless the supply of coal is unusually low in sulfur to begin with. Removing sulfur from stack gases is still in the experimental and pilot-plant stage. Trial commercial installations have reported considerable difficulty in maintaining consistent operations. If nuclear fuel is substituted for fossil fuel to avoid air pollution problems, we are faced with an evaluation of the effects of the ionizing radiation that results from operation of the nuclear plants. While the levels of ionizing

radiation resulting from the operations of nuclear facilities are generally below those of background radiation, there are individuals who are concerned about this minimum amount, as well as the possibility of catastrophic emissions due to system failure.

Whether the plant is nuclear or fossil fueled, there is waste heat to be absorbed by the environment. Nuclear plants are less efficient than fossil-fueled plants, so there is more heat to be disposed of per kilowatt hour generated. This hot water, if discharged to streams, can produce changes in aquatic ecosystems which may be considered detrimental. An alternative is to dissipate the heat to the atmosphere through cooling towers or cooling ponds. This may alter the immediate climate, perhaps resulting in some greater frequency of fogging. The large cooling towers necessary for natural draft may have a visual impact which some people might wish to avoid.

Because of concern for the safety of population, the tendency is to locate nuclear plants remote from populations. This requires construction of transmission lines. The broad rights-of-way that must be cleared for such lines may cause ecological changes where they pass through forested areas.

B. RECEPTORS OF POLLUTION

1. Natural Resources

We do not know the extent to which air pollution will change the ecology of forests or other natural areas. However, the transport of pollution from urban areas could introduce a significant quantity of sulfates to such an environment. These sulfates result from the combustion of fossil fuels containing sulfur. The likelihood would be that the rainfall in such circumstances would be acid in nature. This too, could alter the ecology in such areas.

It has been demonstrated that many truck crops are adversely affected by various pollutants--oxides of nitrogen, oxides of sulfur, hydrocarbons,

and so forth. Thus, the transport of pollutants from urban areas is also of concern in agricultural areas.

2. Neighborhoods

Apart from its adverse health effects, air pollution can adversely affect the quality of life in residential neighborhoods. Odors are disturbing; particulate matter will dirty the linens and automobiles and other things in the neighborhood; sulfates will have an adverse effect on paints and statues and promote rust. Particularly severe problems can be caused by lead, fluorides, other metallic compounds, and acid fumes from smelters.

In addition to the direct health effects and the direct economic damage from pollution, one must consider the effect on the mental health and mental development of persons living in neighborhoods subjected to air pollution. Little is known about this and suitable research attention might be applied to this area.

3. Special Developments

One frequently hears about the retarding effect of air pollution control requirements on some types of economic development. Little consideration is given to the fact that air pollution also retards economic and industrial development. An example was the stagnation of Pittsburgh before the cleanup. This is particularly true if the industries require clean air to maintain the quality of the product, as in electronics and food processing. Furthermore, employees of a relatively clean industry are sometimes unwilling to work or live in a dirty community.

4. Recreation

Recreational values are particularly sensitive to air pollution, whether generated by visitors or transported from other areas. Scenic vistas have already been desecrated in the Los Angeles area where the beautiful foothills are no longer visible from the boulevard and valley on days of photochemical smog accumulation. Yosemite National Park has suffered

from the great number of visitors in automobiles. If these problems are anticipated, they can be controlled to a degree to protect the natural beauty of such areas as Lake Tahoe and the Catskills. Once such areas are disturbed, it is difficult, if not impossible, to regenerate them.

C. OTHER INTERDEPENDENCIES

In evaluating alternatives between the use of the personal automobile and mass transportation, the suggestion is offered that this is a comparison between pollution created by the internal combustion engine and pollution created by an electric generating station which may burn fossil fuel. In actuality, the environmental and social impacts of the decision are much more extensive.

In evaluating alternatives to sources of power, one should consider the environmental pollution which will result from the extraction of the uranium, oil, or coal, whether from strip mining of coal, oil spills in the vicinity of oil wells, blowouts, or the hazards to the environment from uranium mining. Not to be overlooked would be questions of black lung and silicosis among coal miners and the effects of ionizing radiation on uranium miners. The transportation of oil by sea entails the risk of oil spills. Unusual safety requirements are required with respect to transportation of nuclear materials. Coal has the problem of dust being blown from stockpiles in the vicinity of power plants.

The air pollution in the actual processing of the fuel to generate electricity has been discussed, but one should also consider the disposal of the wastes resulting from the combustion. In the case of coal, there are the ashes and collected fly ash. In the case of nuclear plants, there is the problem of radioactive waste. Thus far, we do not have a final disposal method for radioactive waste. The present method of handling has to be considered a temporary holding until a more satisfactory method of recycling or other disposal is developed. True, the amount of radioactive waste from nuclear power plants is insignificant compared to the wastes from weapons manufacturing.

Not to be overlooked, and equally as important as physical and biological impacts, are the social impacts of the decisions. If the choice is made to burn petroleum products rather than coal, then coal miners are left unemployed and the petroleum refineries employ very few people. The question might also be raised, is it better for uranium miners to be unemployed than for coal miners to be unemployed.

The fallacy of this reasoning is that people should be employed in some task that is not socially dysfunctional. If make-work projects are to be undertaken, they might better be considered with respect to projects of great social value. To do otherwise would be to protect those who have investments in a particular way of life or mode of operation rather than to protect the great number of individuals who might be employed in that kind of operation. It would be like suggesting that one should smoke cigarets in order to keep farmers employed in raising tobacco and other individuals employed in manufacturing cigarets. It would be of much greater value to society to have the farmers engaged in raising food and the cigaret manufacturers engaged in processing the food.

D. RECOMMENDATIONS

The following are offered as suggestions for strengthening the effectiveness of institutions in dealing with questions of environmental quality in the interest of society. In general, it does not appear that new, innovative institutions are necessary. What may be necessary is a reorientation of the institutions' objectives and modes of operation, a greater utilization of available knowledge, seeking of additional knowledge for purposes of decision making, and a possible rearrangement or reallocation of functions among existing institutions.

1. Environmental Ethics

The adoption of what might be termed a code of environmental ethics by both public and private institutions could lead to a more sensitive evaluation of the environmental impacts of decisions and to the formulation of attitudes that would lead to a better quality environment. As an

example, it is understood that the Maine Bankers Association adopted a code of ethics to use in developing their lending and investment policies. It is also understood that some of the large New York investment banks have hired consultants to advise on the environmental and ecological impact of large-scale projects seeking investment capital. It is understood that in the Scandinavian countries the banks have recognized that they have a significant role to play in influencing decisions to preserve and enhance environmental quality. Such postures, adopted on a wide scale by decision makers in industry, in government agencies, and even by individuals in their personal decisions, would go a long way toward avoiding those projects and activities which create air pollution and otherwise degrade the environment.

To fully develop this "voluntary" approach to better environmental quality, it is necessary to have knowledge upon which decisions can be based. This suggests the incorporation of appropriate course work in the curricula of institutions that train engineers, scientists, business administrators, public administrators, and other potential decision makers. If the electorate is to exercise its opportunities in an informed way, then it would be necessary to incorporate environmental concerns in the high school curricula. This might best be done, not in special courses, but by training high school teachers in science and civics so they could use environmental examples in their classroom work.

Obviously there will be continued need for specialists who can advise on unusual problems, foresee future events, and correct the mistakes of the past. Unfortunately, in recent years the federal government has withdrawn its support for such educational activities. Since the financial rewards in this field are not as great as in some others, there is a continuing need to subsidize scientific education to provide government and industry with the expertise necessary to conduct sound environmental programs.

2. Coordination of Planning

In the government sector, the critical area of concern seems to be that of planning, particularly the planning of land use and associated

transportation. What we have seen in the cases outlined previously is land use planning by the smallest civil divisions, which cannot begin to cope with the large-scale developments associated with such things as a deepwater oil port. Nor can it cope with the population concentration that occurs in the vicinity of New York City and northern New Jersey.

Unfortunately, land use planning seems to consider primarily physical and economic development concerns. Little attention is given to the ultimate impact on air quality or other environmental concerns in land use planning as practiced by the small civil divisions. To be effective, land use planning would need to be conducted at several levels of government with varying purposes receiving primary attention at respective levels. The level should be such that it can materially influence the end results. For purposes of air pollution control, planning would have to be on some regional basis encompassing more than townships and small cities. It would have to include at least the areas designated as "Standard Metropolitan Statistical Areas" by the Bureau of the Census. A step in this direction was taken recently by the Delaware Valley Regional Planning Commission when they decided to hire a staff air pollution control expert.

Because of the intimate relationship between transportation and air quality, the planning process must include transportation along with land use and concerns for air pollution control. it is apparent from the case studies that there is a great deal of fragmentary planning going on in the transportation field. Elements at various levels of government are not fully coordinated, nor is there adequate coordination among those planning for various modes of transportation. This lack of coordination is detrimental to the end goal of improved air quality.

3. Monitoring

Government interventions to improve air quality have been focused on establishing air pollution control agencies to monitor environmental conditions and propose remedial action, employing legislative sanctions where necessary. Unfortunately, the monitoring systems are neither

sufficiently uniform nor sufficiently extensive to allow the optimum use of monitoring data in planning air pollution control programs.

What is needed is a centralized, computerized data bank with uniform methods of sampling, location of samplers, test methods, data processing and the like. To permit meaningful decisions to be made, other environmental parameters must be measured along with those relating to air quality.

4. Air Quality

A factor generally overlooked is the role of the courts in the question of air quality. The Atlantic Cement case brings out the very important role of the courts in air quality and other environmental issues. One might raise the question whether the courts are adequately prepared to act in such a role and whether or not the value systems used in adversary proceedings employed in most courts should be applied in determining social policy with respect to environmental quality. If courts are to be used in this manner, there should probably be more extensive research into the matter of providing information such that informed decisions are made. Legislation should be structured so that appropriate social values are taken into account, and the training of lawyers should be modified so that they will be informed as to their best role in this kind of proceeding. Courts may require expert opinion and are encouraged to obtain it.

Consideration might be given to some other approach to the resolution of contests involving air quality. The difficulty is that such questions do not rest on matters of air quality alone, nor do they rest on the protection of the health of individuals and populations. Also to be considered are the rights of individuals and the compensation of interested parties when their use of property is denied or taken for higher purposes of society in the interest of environmental quality.

Not to be overlooked are the rights of groups of people to the amenities of life, the need to preserve and protect ecosystems, and the rights of populations to a healthful and stimulating quality of life. To pursue these interests of the people, a role could be created for a public

defender, as individuals may not have the knowledge or resources to adequately assess environmental quality issues and the impacts of proposed actions.

IV. INSTITUTIONAL CAPACITIES

This section focuses on principal decision-making institutions and the interactions between these institutions and others concerned with environmental quality in the Hudson Basin. The powers and requirements of these institutions are also explored, with a view toward improving the effectiveness of the institutional arrangements to cope with environmental interactions.

The initial focus of this section is on the deepwater oil terminal case. An attempt is then made to synthesize some general conclusions based on this and the remaining cases, and to formulate a general model of the inter-institutional decision-making process. Current strengths and weaknesses are identified, and recommendations for improvement are made. It should be noted that no attempt is made to assess institutional capacities in terms of budgeting and manpower considerations. Rather, the focus is on participation in the planning and decision-making process, and the strength and adequacy of the institutions' role in that process.

Many of the issues raised in this section are explored elsewhere in this report. Of particular interest are Chapter II and Chapter III. Chapter V also serves to summarize these various sections and tie them together.

The deepwater oil terminal case illustrates the interactions among various categories of environmental concern, such as air and water quality, as well as land use and economic considerations. It also presents rather clearly some of the important institutional capacities, or lack thereof, for dealing with complex environmental issues.

Those issues seldom involve environmental questions alone. Usually, they also encompass considerations of economic stability and growth, of private economic interests, and of land use, as well as other issues that reach beyond the immediate decision being considered.

The issues involved are further clouded by a lack of clear, concise information on the probable impact of decisions. This is due partly to a dearth of basic data and analytical information, but there are other factors: (1) no clear overall objectives have been stated for environmental programs, (2) no criteria or measures of performance have been established, let alone measured, and (3) no requirements for involvement of all concerned parties have been promulgated.

These and other points can be illustrated in the Deepwater Oil Terminal case. As shown in Figure 10, the principal agency involved in the planning and decision making for the terminal is the Army Corps of Engineers. Of course, the power of the Corps emanates from Congress, but much of the decision making is delegated directly to the Corps. The two primary opportunities for impact by outside institutions come in the site-planning stage of activity and, to a lesser extent, in the financing stage. The nature of the impact in the planning stage will be discussed below. In the financing stage, the Corps is forced to rely on Congress, which may be influenced by feedback during the planning and decision stages, or on private sources of funds. In the latter case, the emergence of a voluntary code of environmental ethics by financial and other private institutions may serve as a check on the Corps' decisions. However, once the decision making has progessed to this stage, there is little else available to check the process other than direct litigation in the courts.

In the planning stage, on the other hand, there is a tremendous potential for intervention by other concerned institutions (see Figure 11). Such potential has hardly been realized in practice. But with proper development, such involvement by other institutions may foster adequate consideration of the complex issues surrounding the planning of projects with potentially broad environmental impact. The purpose of such involvement may be not so much to resolve the issues, but to focus adequate attention on all aspects of them, so that the best-informed decisions can ultimately be made.

Figure 11 illustrates possible interrelationships, shown as responses or inputs to Corps' decisions, during the planning and early decision

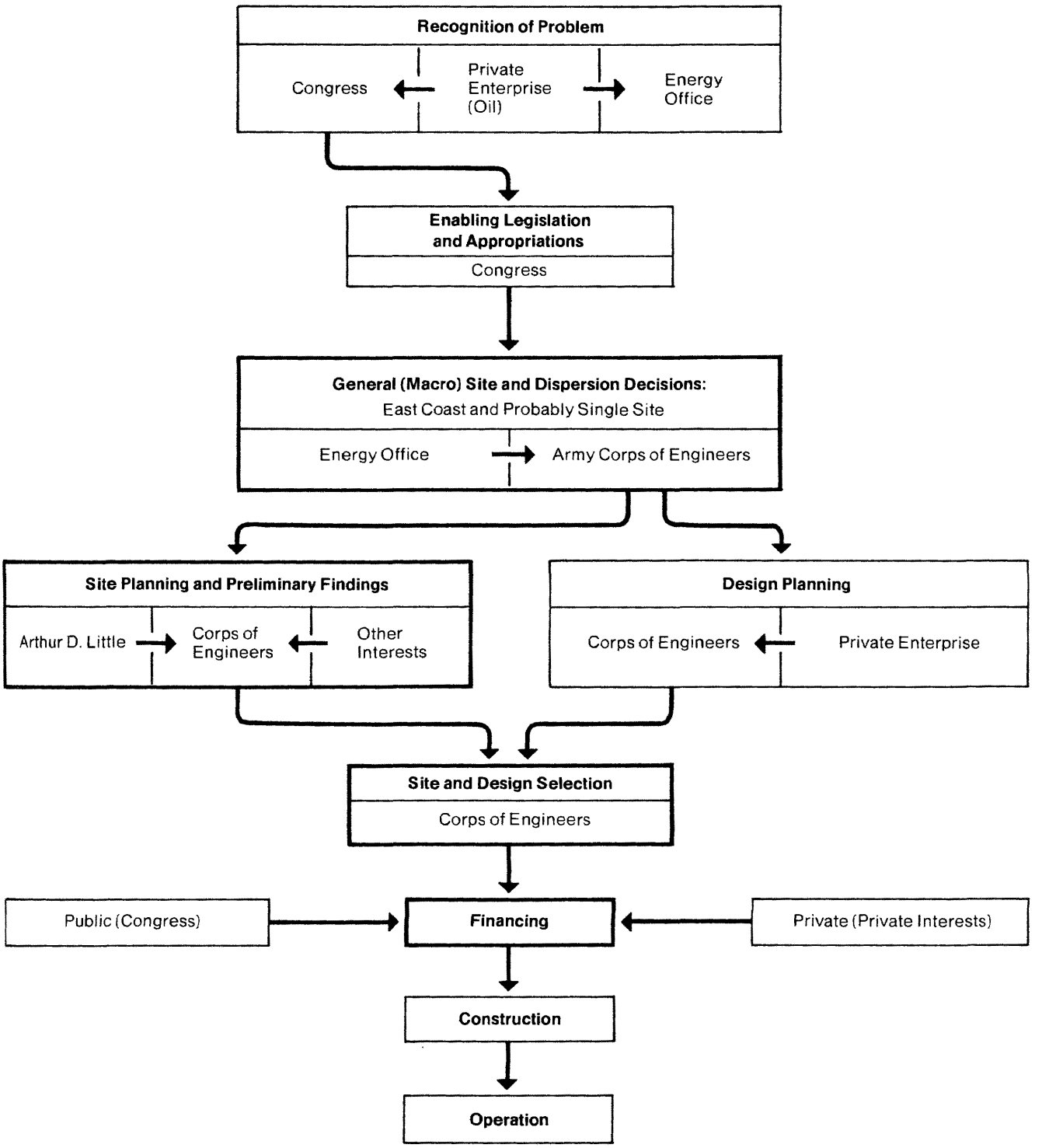
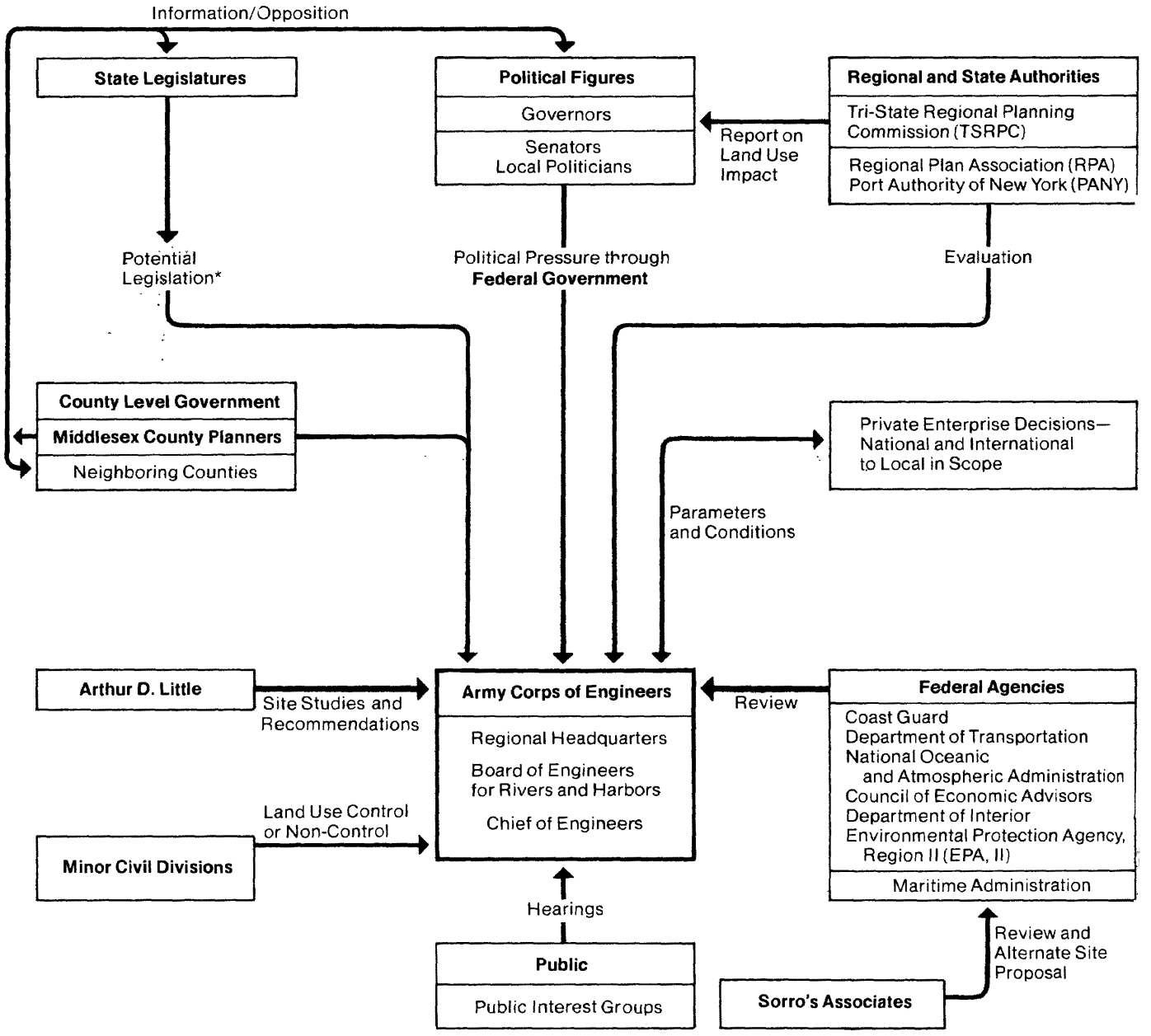


Figure 10. Decision Diagram for Deepwater Oil Terminal



NOTES

1. **Information** is critical to all interactions, and must emanate from the Corps as well as among the various institutions.
2. Common potential interaction among all institutions is through the **Courts.**
3. **Federal Government** may have a balance of direct power, although **Financial Backing** is also a powerful force.

*Two types possible:

1) ban — e.g. Delaware's 1971 Legislation and New Jersey's Coastal Area Review Act of 1973
2) Control — direct, plus control of secondary (induced) impacts

Figure 11. Opportunities for Intervention in Planning the Deepwater Oil Terminal

that action by political bodies is predicated upon public and economic pressure, or lack of it, without full information and analysis of the complete issue involved.

The heavy lines in Figure 11 represent the primary inputs to the planning and decision-making process. It is apparent that there are no requirements for involvement by other institutions except for the federal agencies noted. Although there are numerous other peripheral inputs which together represent a fair degree of potential power, there is no effective coordination of this latent power.

This lack of effective power is due to (1) a perceived weakness of any opposition stance because of a lack of data and information upon which to base that stance; (2) the threat of embarrassment if the opposition is overridden or otherwise ineffective; (3) inability to form a sufficiently vocal, powerful, and lasting bloc due to diversity of interests and lack of individual commitments; and (4) inability to force the Corps to consider the opposition or issues raised.

This last point is especially true for offshore activities that can lend momentum to subsequent onshore activities. For example, it is possible that little can be done by concerned institutions until onshore activities are actually begun, at which time action such as litigation can be initiated. However, at this point it is likely that the burden of proof of negative impacts will rest on the intervening parties, rather than on the Corps to show that no such negative impacts exist. In addition, sunk costs for such activities as engineering design often make it seem difficult to abandon a project. This is true even though such sunk costs should not be considered in such a decision. The Storm King case illustrates this point well.

One interrelationship which is not isolated on Figure 11, but which represents a potentially powerful point of impact on the Corps' decisions, is the information link with the Environmental Protection Agency. The interested parties could easily bring pressure upon the EPA to become actively involved in the project planning and review. Such involvement

could force consideration of important environmental interactions that may otherwise be ignored. One of the main roadblocks to this form of intervention, however, is the lack of data and information upon which to base both challenges and answers. The development of a comprehensive data bank, as described earlier, thus becomes essential to this as well as other forms of intervention.

This interaction through the Environmental Protection Agency represents an opportunity to force complex issues such as the deepwater oil terminal out into the open. This presumes, of course, that the information generated will be made readily available. (In this respect, it should be noted that any decision to stop publishing and circulating environmental impact statements would be a very serious setback to environmental quality.)

One pervasive problem illustrated by this case, as well as the others, is that clearly defined criteria are sorely needed for assessing projects that may affect the environment. Governmental and public criteria are often vague and often reflect objectives that are competing or conflicting. This is due in large part to the broad nature of environmentally related projects and to the involvement of many separate institutions. It is especially true when tradeoffs between environmental quality and economics or regional development are required.

Clear objectives and criteria for assessing their degree of attainment are essential for guiding subsequent policy analysis and decisions. However, environmental objectives and criteria are especially difficult to enunciate because of the necessity to recognize, accept, and provide for the impact of environmental quality on other aspects of life. Nevertheless, without such objectives and criteria, environmental planning will continue to lack direction, will be continually thwarted by "contingencies" and "mitigating circumstances," and will not be susceptible to evaluation.

Criteria for governmental or public action are not the only problem. The criteria used by private enterprise are usually inadequate and misdirected for environmental quality, too. However, there are some indications that

"environmental morality" may become a factor in business decisions. The voluntary adoption of an environmental code of ethics should by all means be encouraged.

An associated problem is that of relating components of environmental quality, such as ambient air quality, to pollution discharges, such as stack emissions. The link between these two ends of the same problem is at best elusive and requires additional research. Controls have been largely directed toward emission reduction, coupled with ambient monitoring to assess the performance of the control. This approach may be far from optimal. It fails to address issues related to locational factors, both on the micro scale and on the regional scale. Further technical research is required to relate emissions and ambient air quality. Such research should ultimately take into cognizance: (1) the regional focus of air pollution impact and control; (2) provision for future impacts in an area, for example as a result of induced growth near the oil pipeline terminus; and (3) the efficient use of our air resource, including the utilization of its carrying capacity and the provision for catastrophic occurrences and episodes. An example of this latter point relates to the availability of cement raw materials in the Hudson Basin. In the utilization of available air resources, priority should be given to the development of this mineral resource as opposed to other uses such as fossil-fueled power generation.

This problem of pollution emissions and ambient concentrations also illustrates an inherent data problem. Ambient air quality data are useful because they relate to air pollution effects and because they are relatively easy to collect, but they do not relate to regulation. Emission data are less useful because their link to effects is elusive and because there are really too many data for any regulatory agency to collect. However, it is easy to relate emissions to regulatory efforts.

A central conclusion can be drawn from the preceding discussion. It is that the most pressing need with respect to institutional capacity is to develop a system that will first <u>recognize</u> and then <u>balance</u> environmental

interactions. The institutions themselves exist, and additional institutions probably are not required. Certain agencies have direct regulatory power (the EPA), others have the authority to commit financial resources to project planning and design (the Army Corps of Engineers). Legislatures can enact law, politicians can exert their influence, local jurisdictions can regulate land use, and even private citizens can take court action individually or in class action litigation. Of course, none of these powers is absolute and all are tempered by the financial resources of private enterprise, by federal governmental powers, and by inherently conflicting objectives, especially those requiring tradeoffs between economic growth and environmental quality. However, they do exist, and perhaps only require a mechanism for assuring their appropriate utilization. Even the rather limited power of some governmental agencies to evaluate and advise can be strengthened--with coincidental improvement in environmental planning and decision making--by requiring that their evaluations and advice be sought and answered in any major decisions affecting the environment.

Theoretically at least, these complex and interrelated forces can be brought together to provide for planned environmental impact. However, the actual situation is more often of an adversary nature. Thus, a balance is struck among issues impinging upon the environment by means of a contest of power (be it financial or legal or rational) rather than by means of comprehensive, cooperative analysis and planning. The "Boomer v. Atlantic Cement" case illustrates the power and potential breadth of this type of arrangement in utilizing the courts as a means of resolving environmental issues.[1] This form of conflict resolution is not necessarily bad, provided that the power struggle is based on sound information and provides for just determination of the "winner" or for a suitable compromise.

Whether the balancing of environmental interactions is based on planned deliberations or adversary contests, it is essential that there be a firm

1. In this respect, the recent Supreme Court ruling regarding class-action suits, namely that plaintiffs in such cases must individually notify every identifiable member of the class about the suit before it can be litigated, may be considered a setback to environmental efforts.

commitment by all parties to the environment and to possible change. Private enterprise might do well to establish a code of environmental ethics, or at least be forced to recognize the possible environmental consequences (both direct and indirect or induced) of their actions, for example, through NEPA. Governmental and public institutions need to vitalize their awareness of, and responsibility to, the environment as well. It is often all too easy to avoid conflict situations. There needs to be a commitment to change, in terms of internal change and willingness to encourage change in other institutions, when that change fosters environmental balance. In this regard, the use of environmental impact statements needs to be built into the planning and decision-making process. This might be accomplished by executive action, by legislation, or by private decisions. There must be provision for, and motivation for, full participation of all institutions even remotely associated with a given issue. Such participation should reflect an environmental consciousness as well as a recognition of the full ramifications of a given project, both good and bad.

Such institutional interaction should assist in determining the proper course of action to pursue, whether it be to seek to stop a project, or to anticipate its impact and plan for change accordingly, or to just accept it as it is.

A possible suggestion for fostering inter-institutional participation is to require all parties even remotely involved in the impacts of a given project to submit an analysis or at least a statement of the possible environmental impacts of the project and a position statement with respect to the plan. The position statement can be in the form of questions that need to be answered before final decisions should be made. The institution proposing the project (for example, the Army Corps of Engineers) must then consider and balance these analyses and statements in its final proposal, which should contain reasonable alternatives with a statement of the pros and cons of each. This final proposal is then to be presented for adoption, unless it is challenged on the basis of not having adequately

answered (as determined by technical and financial considerations) the previously posed questions. The judgement as to adequacy must be left to an impartial arbiter, most probably the courts.

Although this suggestion would entail delay in the adoption of projects, it does provide a mechanism for generating broad inputs to the planning and decision process, and also places the burden of justifying the project or the proposer of it. The suggestion may also be attacked on the basis of the costs imposed for answering frivolous challenges. However, the proposer always has the right to ignore such challenges and need only show adequate reasons in court to justify the action.

The suggestion is perhaps little more than a formalization of what already takes place to some extent in environmental conflict resolution, except that it does make the initial institutional response to a proposal mandatory. It also calls for the designation of those institutions that must respond to any given proposal. The mechanism to accomplish this is not clear, but the development of institutional interrelations such as that shown in Figure 11 may help facilitate such designation.

Whether or not this suggestion is seriously considered, the need to actively involve institutions in the planning and decision-making process is obvious. The fundamental basis for such involvement is information. Thus, it should be required that full disclosure of major projects be made, from the time of preliminary investigation through to the development of final plans, on a stage-by-stage basis. Such disclosures should be a matter of public record and should be filed with appropriate environmental and planning institutions. A first step in this direction is the continued publication of NEPA statements. Beyond that, additional research might be appropriate to identify possible mechanisms for dissemination of information and for designation and involvement of appropriate institutions in the environmental planning and decision-making process.

V. STRATEGIES FOR UTILIZING KNOWLEDGE AND ESTABLISHING RESEARCH PRIORITIES

In this chapter attention will be given to the knowledge likely to be relevant to policy analysis, with some assessments as to its adequacy and an attempt to identify areas for research or the advancement of strategies.

A. TECHNICAL ISSUES

Two items of technical concern, already apparent from previous discussions, are significant in the examination of policy analyses and determination. One has to do with the data base used for decision-making purposes. It has been previously indicated that, at present, the methodologies, parameters, and location practices of sampling networks vary between jurisdictions. An effort should be made to develop a centralized, computerized, integrated, environmental data collection system and data management information system which would serve the several states and jurisdictions in the region.

If there were concurrence and uniform implementation of agreed upon procedures, each state could manage its own system, providing the data obtained are readily available to the other states, to all decision-making authorities, and to the public. Experience would indicate, however, that it would be better if this were centralized rather than handled by the several states independently.

If there were an adequate data base, it would be possible to proceed with the development of a computerized simulation model. The purpose of this would be to examine the physical impact of alternatives before investments were made which would preclude feasible alternatives. For example, one could propose a location of a particular electric generating station, a manufacturing process, a resource extraction operation, a transportation system, or other similar action and, using the model, evaluate the impact of these actions without actually having to experience them and make expensive corrections. Such a model could help avoid the problem of what

to do about Storm King. It would also help to examine locations for an offshore oil terminal. Other similar problems could be handled by this means.

These two proposals would require considerable research and investment. But in considering priority, one might compare the cost of these efforts with the cost of all the installations which might be constructed in future years. It would certainly be worthwhile to invest in these kinds of efforts and avoid some very costly mistakes, both in terms of human value and economic investment.

Another area of investigation which might be included under technical issues is the determination of the carrying capacity of a geographic region for various kinds of human activity. How much water pollution, air pollution, population density, traffic, and other pollution can an area assimilate before the resulting impairment of health, destruction of social values, degradation of the quality of life, or other costs exceed tolerable limits. While there is developing a general concensus that there are limits to the amount of pollution or other environmental stress that can be absorbed by an area, these limits are yet to be defined.

B. SOCIAL ISSUES

One of the critical items in connection with social issues is the definition of public interest. This involves the articulation of important social values that people in groups desire to have effectuated. Every public decision may have costs and benefits, but a crucial--and frequently overlooked--aspect of the decision is the distributional effect. In other words, which groups bear the costs and which groups reap the benefits. This thesis is generally accepted, but problems arise in developing the parameters or indicators to be measured and the method of measurement for considering these social values. Are the social values

to have one system of concern paramount over others? In other words, are environmental quality and the health of people superior to economic values? What about the aesthetics and the enjoyment of a clean environment? Should this be subservient to employment or to the generation of capital wealth? Should one area accept an environmental stress so that another area can receive the benefit of a resource extracted from the first area? Better articulation of social values is needed, as well as greater precision in the indices used to measure the achievement of these values.

In attempting to formulate strategies in the public interest, one has to consider the preceding discussion about the inadequacy of technical knowledge. One also had to consider the capacity of governmental institutions to formulate rational actions, and the capacity of the system of institutions to implement a rational plan. While these two problems do not fully define the contours of the difficulties faced in analyzing and formulating environmental policies for the Hudson Valley region, they are significant. In addition, it is impossible to engage in meaningful policy analyses without directly considering the normative aspects. What social values are public laws, regulations, and institutions effectuating in terms of the evaluation of options? What are the criteria for deciding which set of effects of a given outcome is "good" and which is "bad"?

Justice Brandeis once expounded the idea that a chief virtue of federalism as a mode of national organization is that it allows the existence of numerous social laboratories to test out policies. The social laboratories theory is working in many ways in the environmental area; Vermont, Florida, and Hawaii are experimenting with new land use schemes; Michigan and other states are investigating new legal relationships; the federal government led the way with the idea of environmental impact statements; Oregon has pioneered in solid waste legislation regarding returnable bottles and containers. One might propose innovative methods be attempted in the Hudson Valley Region to handle the social issues associated with decision making involving matters which impact on environmental quality.

In formulating the public interest in environmental quality decisions, the question arises as to the appropriate role for special interest

groups. In particular, the question may be raised as to what is the appropriate role for public environmental organizations in decision making at state and local levels. At what stage or stages can the public be most effective? Are PL 92-500 and other formal citizen involvement mechanisms means of involving the public, or are they a means of keeping the public dissenters busy shuffling papers? Are public forums a more effective means of developing public opinion? One might also explore whether or not these environmental organizations really reflect the public interests or the interests of a very narrowly oriented group of individuals.

C. ENVIRONMENTAL ASSESSMENT

The National Environmental Policy Act has been instrumental in requiring thoughtful analysis of the potential impacts of proposed activities where there is a substantial federal involvement. This or a similar mechanism has not been universally adopted by states and was not specifically adopted in New York State. However, there has recently been an opinion developed in New York State that the Department of Environmental Conservation, through part 615 of its rules and regulations, may require some environmental impact analysis of matters affecting water quality. There have been other movements that would lead to a state law requiring state impact statements. Reliance on NEPA alone is not adequate. Each state should have its own laws and regulations to achieve the kind of review required by NEPA for major undertakings. The environmental assessment might even be required of various departments, because of their fractionated interests, before the review would be complete. It is now the responsibility of the agency involved in regulatory action or the commitment of funds to develop the environmental assessment statement. In practice, it is understood that they circulate such statements to the Council on Environmental Quality, which in turn may ask other agencies for their opinions, with the Environmental Protection Agency performing much of the staff work of reviewing assessments. Where multiple interests are involved--asthetics, protection of wildlife, forest areas, protection of air and water, and other amenities of environmental quality--it would be appropriate

to devise some system to assure that each of the official interests involved in the assessment would be given the opportunity for appraisal and recommendation.

It seems that there is also a private role to be performed in the assessment of environmental impact. Some private organizations have adopted what might be considered ethical standards of practice with respect to decision making in the environmental area. It would be interesting to research this area to determine how extensive such standards of ethical practice are. It would also be interesting to see to what extent the private sector has the resources and the will to live up to the ethical standards already adopted. It is entirely possible that the adoption of a standard of ethical practice may simply be another public relations gimmick. On the other hand, it should be recognized that many of these efforts are quite sincere and are to be encouraged. Appropriate research in this area might ascertain the effectiveness and the extent to which these private assessments are influential in formulating decisions that result in improved environmental quality. A crucial new generation of environmental issues is surfacing. These issues are essentially distributional. No longer satisfied with merely efficient approaches to solving environmental problems, groups are pressing equity considerations on public policy-making organs.

Despite its long history of social progressivism and despite its forward-looking establishment of the Department of Environmental Conservation and of land use planning in the Adirondacks, in most environmental areas New York is sadly lagging behind other states of the union. Only in strategies dependent upon a strong executive branch arrangement--a personal proclivity of former Governor Rockefeller--has New York been active. Four strategies for action adopted in other political jurisdictions are relevant to the Boomer case and other environmental problems, and ought to be seriously investigated: (1) an operative substantive declaration of environmental policy coupled with a requirement for the preparation of environmental impact statements by state agencies and possibly large private-sector organizations; (2) the institution of an operative constitutional declaration of the right to a clean and healthful and sustaining environment; (3) a

recognition that natural resources are held by the government in a "public trust" for the benefit of the citizenry; and (4) recognition of citizen standing to raise environmental issues, patterned on Michigan legislation.

New York State has a constitutional provision for environmental protection (effective January 1, 1970); but this provision has been interpreted as being merely hortatory and addressed solely to the legislature. This is in contrast to the policy declaration in the National Environmental Policy Act, which is gradually winning judicial recognition as a legislative expression of changed social values, establishing substantive policy changes that agencies must follow and that citizens may raise in court. Legislation requiring environmental impact statements from state agencies passed the New York Legislature in 1972, but was vetoed by Governor Rockefeller in May of that year in a statement calling it "wastefully duplicative, administratively uncertain and costly," a view contested by the Republican chairman of the Assembly's conservation committee. One of the issues in environmental proceedings is that of "standing". It is possible to distinguish between the practical results of the Whalen and Boomer cases by speculating about the nature of the plaintiffs in such litigation. Whalen was brought by a rural farmer, presumably having a long family attachment to his homestead. Boomer occurred in a fast developing suburb of the state capital. In the intervening period, our society has become vastly more mobile. Current estimates are that one-fifth of all American families move annually; a deep-rooted long-standing attachment to a particular parcel of land is becoming more and more rare. A policy which enables a polluting corporation to buy out neighboring homeowners may be more acceptable in an era in which the homeowners would just as soon take a fat check and move to another bedroom community. At the same time, however, environmental litigation has frequently raised the issue of standing because many environmental plaintiffs are not suffering from specific individual (and usually pecuniary) damage, but are more publicly motivated. Thus, class actions and public interest litigation are familiar features in environmental law. The courts have a long tradition of refusing to hear parties who are not complaining of personal and direct injury. The doctrine of "standing" is an expression

of the courts' belief that parties presenting an issue must have a major stake in the outcome. The post-industrial era, however, has seen an increase in the ideologically motivated plaintiff, among which we would include many environmental organizations and public interest law firms. These would-be plaintiffs cannot show damage to their lungs or their houses. Should they be allowed to raise important issues in court? Many commentators (most notably Professor Louis Jaffee in "The Citizen as Litigant in Public Actions: The Non-Hohfeldian or Ideological Plaintiff," 116 University of Pennsylvania Law Review 1033 (1968)) have argued that such plaintiffs may well bring at least as much commitment, energy, and adversity to the litigation as the more traditional type. Michigan and a number of other states have recognized this, and have opened up the courthouse doors to such environmental plaintiffs, relying on the discretionary powers of the court to screen out frivolous litigation.

Without serious consideration of some of these public policy techniques developed in recent years, environmental management in the Hudson Basin is likely to proceed in a hierarchical, bureaucratic form, increasingly alienating the general citizenry by stemming its desire for public participation, and perhaps failing to adequately protect environmental quality.

Along with commitment and responsiveness, information and knowledge are the keystones of successful environmental quality control. The elements of technological knowledge that appear to be most critical are: (1) assessment of the environmental impacts of proposed projects; (2) identification or development of appropriate control technology, and (3) identification or establishment of mechanisms for implementing control technology. Impact and control technology apply here not only in the sense of engineering design, but also in the sense of general technology assessment.[1]

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1. See, for example, Martin V. Jones, "A Technology Assessment Methodology," Project Summary Report, The Mitre Corporation, Contract No. 26 for OST, Project No. 1310, June 1971.
Philip L. Bereano et al. "A Proposed Methodology for Assessing Alternative Technologies," Report of the Program on Science, Technology and Society, Cornell University, December 1972, pp. 179-190.

It is recognized that the mere existence of engineering technology does not assure achievement of control. The implementation of control technology is obviously required as well. However, the cases also point out the essential, and often overlooked, need to integrate consideration of social and economic impact control, including land use control, as well as political and judicial aspects of control into the total environmental quality effort.

For the most part, institutional capacities seem to exist to handle these requirements, at least to the extent possible under present knowledge limitations and within the existing integrative framework. The basic problem seems to be that these institutional capacities are fragmented and not fully responsive to broad environmental problems and issues; in fact, the general integrative framework referred to above does not really exist.

There are two general areas that require attention in order to develop such a framework: (1) development of mechanisms to identify significant environmental projects and those institutions that are appropriate for review of each such project, and (2) clarification and organization of the multiple, competing, and conflicting objectives related to environmental quality control, and the identification of criteria related to these objectives.

The identification of projects with significant environmental impact is not always simple, often because such a project may not be announced until it has progressed to a stage where it is difficult to stop. NEPA has made progress towards eliminating this difficulty though. Another reason for difficulty in identifying such projects lies in the hidden nature of induced (secondary and even tertiary) impacts on the environment. For example, the induced growth near the terminus of the deepwater oil terminal pipeline probably has a much more severe impact on the environment than the pipeline itself. As another example, the use of the Catskills for recreation generates air pollution from automobiles, but the synergistic effects of air pollution and diseases or insects on the vegetation of the area are not fully known. Also, the role of such forest land in the

overall oxygen cycle is not known and could be of critical importance to life on this planet. On a simpler level, the identification of a project with significant air pollution emissions does not necessarily imply that it will cause significant environmental degradation (of course, the reverse is true as well). So again we see that problems arise because of a lack of knowledge about the relationships between emissions and ambient air quality.

Coinciding with the problem of identifying all significant environmental impacts of a project is the problem of identifying the appropriate institutions to review the project. In fact, the problems are really the same because once all impacts are identified, the appropriate institutions should be obvious. Similarly, if all the appropriate institutions are found, then they should have the expertise to identify all the potential impacts.

The solution to the dilemma posed above is not readily identifiable. It seems clear, though, that any solution will require full disclosure of major projects in their early stages, either to the public at large or to appropriate environmentally concerned institutions. Such disclosure requirements seem to be a logical first step toward solving this aspect of environmental problems. Again, NEPA may be cited as serving this need, but NEPA requirements should be strengthened, and certainly the publication of statements should not be discontinued, as has recently been proposed.

Another aspect of any ultimate solution to this dilemma should recognize the dynamic nature of environmental problems and issues. Thus, any plan should almost surely provide flexibility in the review process. In particular, a multi-institutional, progressive (staged) review process should be incorporated into the ultimate design.

Some additional suggestions for addressing current needs in environmental policy analysis may be made. These suggestions, or some adaptation of them, merit consideration in their own right. In addition, they serve to point out existing needs in current systems.

Review powers might be granted to any party concerned about a project with potential environmental impact. The review power may be limited to the power to impose delay on the project for further review by appropriate institutions without providing for outright veto power. A less drastic version of this basic idea might grant such review power to regional, state, and local institutions for all plans affecting their jurisdictions. Such a proposal would of course require that these institutions be informed of all projects with potential environmental impact. To help avoid prejudices in deciding what projects are significant, a criterion might be developed based on the potential environmental impact and/or size of the project. For example, review might be required at the local level for all projects situated in their jurisdiction; in addition, county review would be required if a project exceeded a given size, say $\$X_1$; state review would be required if a project exceeded $\$X_2$, where $\$X_2 > \$X_1$; and regional or federal review if a project exceeded $\$X_3$, where $\$X_3 > \$X_2$. Outright approval would need to be granted at all appropriate levels for a project to proceed without interruption. Alternatively, a delay may be imposed at any level while the project proposal is referred to other appropriate institutions for evaluation; or the project might simply be delayed, in which case automatic sequencing would move the review to the next higher level of the review process.

In conjunction with this or any similar scheme, it might be advisable to require the establishment of state and local land use planning to coordinate such review efforts. The plan might be similar to Vermont's, which involves an inventory (monitoring) system, guidelines for development, and even a system of permits and regulations. Establishment of a planning committee or a planning staff with legislatures would also serve as a mechanism for achieving awareness and control in political institutions.

Another possibility for assuring adequate attention to, and routing for review of, project proposals would be to establish a joint committee or authority that cuts across all levels and branches of authority (especially governmental) and location and field of interest. This committee or authority would review all proposals and route them for further required review by other institutions.

Such a committee/authority would facilitate review and routing of projects. However, it would also create some problems as well. The first problem would be its design, particularly its composition. Adequate representation of all major parties would probably result in unwieldy size and tremendous conflict potential. In addition, it would create yet another institution, which some may argue are already too abundant. However, if it is kept reasonably small and if limits of its jurisdiction were clearly established (for example, based on project size, similar to those described above regarding the sequencing of a multi-stage review process), then it might be very worthwhile.

The design of the remainder of the system elements is a topic for further research. However, the identification of potential participants in the institutional review process might be facilitated at least in part by the development of schematics such as those shown in Figures 10 and 11 in Chapter IV. On a more basic level, the fostering of simple communication among institutions, especially on an inter-jurisdictional basis, would be a step in the right direction. If concerned institutions are simply informed of what is happening, they can respond appropriately.

Other mechanisms for disseminating information, providing for public awareness, and assuring public input are suggested by the cases. Some of them are listed here for the sake of completeness.

1. Professional and public seminars on environmental issues.
2. Public forums and public educational funding.
3. Hearings by appropriate institutions, both with and without cross-examination. These might be modeled on Atomic Energy Commission Hearing Boards made up of a multidisciplinary, independent panel of experts who hear both statements and sworn (provable) testimony, and who then render an independent and enforceable decision.
4. Formal recognition of public interest litigation with requirements that the defendants and plaintiffs share the cost of notifying the class plaintiffs (which would help eliminate frivolous suits but also require that project proposers bear

part of the just cost of information dissemination regarding their proposals). This should also provide for judicial power to require input from such additional institutions as deemed appropriate in any given case.

To develop these suggestions further, there is a need for further investigation of mechanisms for fostering exploration and dissemination of alternative viewpoints concerning any project or environmental issue. Financial support is, of course, important to any such mechanism and should be provided, as should proper dissemination of the existence of such a mechanism once it is developed. The provision of funds to special interest groups to conduct public educational programs regarding environmental issues and means for participation in them is one example of such a mechanism.

The above discussion has been directed toward the need to identify projects with potentially significant environmental impact; to identify the appropriate institutions to be involved in the review of such a project; and to assure that institutional capabilities are utilized effectively in environmental planning and decision making. As important as these items are, however, there is one other need that ultimately will be even more important. That is the need to clarify and organize the multiple, competing, and conflicting objectives of environmental quality control, and to specify criteria related to environmental quality. The criteria must then be adopted for active implementation.

Of special importance, in addition, is the need to incorporate into such objectives and implementation plans a recognition of the inexorable interrelations among environmental, economic, social, political, and judicial objectives and actions. It appears that too often in the past, the perspective has been too narrow. The result has often been that "solutions" to problems have led to other, unexpected problems, simply because such interrelations were not explicitly considered in the first place. Furthermore, to act as if environmental objectives exist without impact on or from those other areas is to ignore very fundamental tradeoffs between, for example, environmental quality and economic growth of a

region. These tradeoffs will be made in any case, often by political institutions, but they should be made in a manner that is as explicit and as possible. It is probably less important whether such tradeoffs are presented by adversary institutions or by a single institution. The best arrangement would probably involve cooperating institutions. Balances must continually be struck among environmental and other objectives such as economic growth. Therefore, it is imperative that serious thought be given to the development of guidelines or objectives to assist in the balancing of these competing or conflicting concerns. If it is impossible to provide adequate guidelines or objectives that are so encompassing, then attention should be devoted to developing and refining mechanisms whereby the interacting tradeoffs will be identified and whereby the alternative tradeoffs will be made as explicit as possible. This information, coupled with the identification of the final decision-making body, will at least assure that well-informed decisions will be made (although there must always be provision for appeals and litigations). This was the topic of the first part of this chapter.

D. PROCEDURES FOR CONFLICT RESOLUTION

If the appropriate technical knowledge is available upon which decisions can be rationally made, and if mechanisms are established for making rational decisions with the appropriate involvement of public and private interest, there may nevertheless be conflicts. Different groups vary in their priorities among such values as economics, health, aesthetics, and fish and wildlife. Thus, one of the more fruitful areas of investigation would pertain to procedures for conflict resolution. In this regard, one has to look at the institutional capabilities. Earlier in this report, we raised questions about jurisdiction and whether or not an agency could implement measures within its jurisdiction that would have a significant influence on environmental quality--specifically, the quality of the air. Questions have also been raised as to whether or not the jurisdiction would have the necessary information upon which to base rational decisions. For example, land use controls are usually exercised by the lowest level of political jurisdiction such as a township in the case of a zoning law. The township may not have information available as to all of the implications

of its action, and it certainly would not have the technical capability to ascertain the impact of the decisions. Even if these two criteria are satisfied, i.e., sufficient geographic area to have an impact on the air quality and sufficient resources to develop adequate information for rational decision making, other questions are raised concerning the procedures for conflict resolution.

One might ask whether the federal government should restrict the siting prerogatives of multi-national corporations whose facilities can upset regional planning efforts. One may also inquire if the deadlines promulgated in federal environmental legislation result in hasty compliance with undesirable results at state and local levels; for example, the policy of regionalization of sewage treatment, the establishment of water quality standards and the like. While discussing the federal level (and it is certainly a matter for concern at other levels) the question is sometimes raised as to whether federal agencies, through their discretionary powers, modify the intent of federal environmental legislation. Do the agencies interpret the laws in the way the committees that held hearings intended when they developed the legislation, or does the agency have its own value system that it seems to implement by straining the interpretation of the legislation, or through adopting its own regulations in areas of discretion?

One might ask questions about other levels of governments, such as the state government and regional agencies. The question which frequently comes to mind is, do state governments have sufficient budgets and staffs to implement legislation promulgated either at the state level or the federal level? Where federal responsibilities are placed upon states, it seems there should be accompanying appropriations to assist the state in implementing the legislation. If the federal government imposes a responsibility upon a state without providing funds for implementing the actions called for, it raises serious questions about the federal government dictating local priorities without necessarily providing the financial support for them. One might inquire whether the funds needed to develop the data base and management information system called for above, and the monitoring systems to supply the data, would be reasonable expenditures

in view of the total amount of funds expended or the damage to the environment that results from decisions based upon inadequate data. The magnitude of populations and the influence of activities of man in urban areas seem to be so great that one cannot afford to make serious mistakes in forecasting future impacts.

As mentioned above, NEPA applies only to cases involving federal action. One could examine how many important cases are missed because of this failure of the legislation to cover all significant actions. Are there a substantial number of actions that would be covered if there were state regulations requiring environmental assessments.

While the deficiencies of lowest levels of government have been enumerated above, it does not necessarily follow that the introduction of regional agencies and authorities will contribute to the solution of the problem. They may make important contributions or they may simply add another bureaucratic level. It would be interesting to investigate what roles regional agencies perform that would tend to maximize their contribution and minimize additional bureaucratic control. Roles to consider would be information collection and distribution, decision making with respect to land use, and other matters. It would be interesting to formulate examples of issues on which regional agencies should take stances and issues in which they should avoid becoming involved.

The appropriate role of local government and the relationship between various levels of government and local government with respect to environmental issues is a matter requiring consideration. An important popular belief about government in the United States is the vitality of local decision making in areas involving social values. One suspects sometimes that efforts at regionalization are really intended to place unacceptable social stress on populations who are aware of what is being proposed. On the other hand, it sometimes appears that the objections raised are without scientific foundation or merit. It would be an appropriate area of investigation to analyze whether local government should play a role, and what kind of role, in environmental impact assessment and decision making on environmental issues.

The courts have become more and more deeply involved in issues concerning the environment. One might raise the question whether the courts have selected the most appropriate cases for the development of important decisions. One might also inquire whether the court decisions have had an important impact in producing a better environment, better environmental impact statements under NEPA, and other matters relating to environmental concern. Is it better to have a court system concerned primarily or only with environmental issues? One might raise the question that this would give environmental quality preeminence over all other value systems in such courts. This may or may not be desirable from the standpoint of the entire society. Obviously, those interested in environmental quality would tend to think so. On the other hand, such courts may develop a facility for establishing the important issues and providing a framework in which conflict resolution could take place if not achieved elsewhere.

In some circumstances, conflict resolution is provided outside of the court system and the court is relegated to the role of determining whether or not legal procedures have been followed. It would be interesting to make a comparative analysis between these systems to see what impact each has had on the decision-making process and whether or not the decisions arrived at were based upon any better information. Other issues could also be investigated.

E. SUMMARY

This report has outlined a variety of issues associated with decision making on matters affecting environmental quality. These issues have ranged from technical questions, such as the indices to be measured and methods for measuring such indices, to the balancing of social values among interest groups. The Task Group has also outlined deficiencies of governmental institutions for dealing with the current problems. In some instances, strategies which may overcome some of these deficiencies are suggested either for investigation or implementation.

One of the most significant areas of discussion pinpointed by this Task Group has been the procedure under the National Environmental Policy Act

for environmental assessment. This Task Group believes that this type of investigation prior to undertaking important actions is essential to rational planning.

Ultimately, one has to consider the capability of the society's institutions for implementing rational planning, whether by private or public interests. For environmental issues, it appears that a multi-disciplinary and multifaceted approach, including interrelationships between various environmental areas of concern and other areas of human activity, must be incorporated in the system selected for implementation.

In this connection, one has to ask questions about whether or not the present educational system prepares people for this kind of approach to decision making. Are the engineers from engineering colleges, the managers produced by colleges of business administration and government administration, and others trained in various kinds of educational institutions, being made aware of the complexity and interrelationships of environmental issues.

The Task Group did not come away from this exercise with any feeling of doom. There do seem to be institutional capabilities within the present organization of society and government to handle environmental issues in a rational manner. There are areas of technical knowledge that need to be extended. There are methods of information management that would improve decision making, and there are arrangements of governmental institutions that might be more effective. It does seem possible, however, within these considerations, to provide a model of decision making which would come nearer to achieving the intended results.

CASE STUDIES

1. THE STORM KING PUMPED STORAGE PROJECT
2. BOOMER v. ATLANTIC CEMENT
3. A DEEPWATER OIL TERMINAL FOR NORTHERN NEW JERSEY
4. AIR QUALITY AND NATURAL RESOURCES IN THE CATSKILLS
5. AIR POLLUTION AND TRANSPORTATION IN THE NEW YORK CITY AREA

1. THE STORM KING PUMPED STORAGE PROJECT

Edward Davis

BACKGROUND

Electrical consumption in the United States has been increasing at a dramatic rate. This increasing demand for electricity (7 percent per year), as well as other forms of energy (3.6 percent per year), reflects the rising gross national product and standard of living. Larger and larger amounts of energy are required to satisfy the increased use of goods and services based on incremental energy consumption. For example, dishwashers, clothes dryers, and air conditioners, which were considered luxury items in the fifties, are now considered necessities. Growth of new housing developments using many of these appliances has resulted in their becoming the largest residential consumers of electricity. This trend, the growth in residential comsumption of electricity, is expected to continue, since most new homes built today incorporate more and more of the energy-intensive appliances. Presently, approximately 26 percent of all U. S. energy use is for the production of electricity; by 2000 it is estimated at 40 per cent.

The key factor in the phenomenal growth of electric consumption has been its low cost. This low cost, in turn, is a result of an abundance of cheap fuels employed to generate electricity. Fossil fuels, i.e., coal, natural gas, and petroleum products, have been the source of this cheap energy and account for about 93 percent of all energy used for electricity generation.

Coal has been the backbone of the nation's utility industry and currently supplies about 57 percent of the total energy requirements. Natural gas also has a major share (26 percent), whereas petroleum products and water power supply 10 percent and 6 percent, respectively. Nuclear energy, a newcomer to the industry, supplies 1 per cent; however, its share will rise significantly as nuclear technology improves and safe power systems are developed. As can be expected from the above figures, 65 percent of national coal production is utilized in electricity generation, with 18

percent of natural gas and 7 percent of petroleum production supplying most of the remainder of power-plant fuel requirements.

Petroleum products have replaced coal as the primary power plant fuel on the East Coast in recent years. Some of the reasons for this change in the fuel mix are:

1. the increase in the cost of coal relative to oil;
2. difficulties in transporting large amounts of coal and easy access to oil supplies;
3. unavailability of proper quality coal suited for a given boiler;
4. increase in public awareness of problems resulting in decline of coal use for aesthetic reasons;
5. increased use of gas turbine generators that cannot utilize coal;
6. passage of the Clean Air Act requiring attainment and maintenance of ambient air quality standards.

Most of this petroleum increase has been supplied by foreign sources, particularly Venezuela and the Middle East. Increases in petroleum prices and the cessation of much of the flow to the United States by the Arab nations has severely limited the availability of fuel oils on the East Coast, creating a "crisis" in the supplies of electricity, home-heating oils, and gasoline--a situation projected to last 5 to 10 years. Energy conservation is imperative, including the discouragement of operations that waste petroleum products.

ENERGY REQUIREMENTS OF THE CON ED SYSTEM[1]

The Consolidated Edison Company of New York serves over 8,500,000 people in New York City (excluding the Rockaways) and Westchester County. Population in its service area has remained reasonably stable during the

1. From 1973 Report of Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation.

last decade, yet growth in electric energy requirements has increased markedly in this same time period. This growth can be attributed to both increased commercial activity and increased use of electricity.

The growth in summer and winter peak requirements, both for the last 10 years and estimated for the next 10, is shown in Table 1-1. In the 1963-1972 period, the summer peak increased 54 percent, while the winter increased only 35 percent. This faster summer growth rate has occurred primarily from the installation of air conditioning systems, not only in commercial buildings, but also in many households. This increased demand for temperature controlled accommodations resulted in the shift in load peak in 1957 from winter to summer, a trend which started after World War II. In the period 1946 to 1963, the summer peak increased by 182 percent, while the winter gained 108 percent, from air conditioning, a boom in construction, and television. Current estimates of the air conditioning requirements in the system place its peak load at 3,200 MW. Roughly 40 percent of summertime peaking is demand for air conditioning, a fact substantiated by its late weekday afternoon (usually 3:00, 4:00, or 5:00 p.m.) occurrence. Winter peaking is a product of two phenomena, Christmas lighting and electric space heating. Usually peaks have occurred in the seven-day period preceding Christmas.

For a time, Con Ed actively sought new electric customers, including space heating. This came to an end in late 1970 when sales promotion was terminated. Shortly thereafter, a "Save-A-Watt" program was initiated because of adverse environmental impact, potential critical fuel supplies, and a general inability to locate and build generating capacity. This program has continued to the present and represents a significant step forward for a producer to discourage wasteful use of his product.

Annual requirements of the system are also increasing and growth is about the same rate as the summer peaks (Table 1-1). For 1972, the 36.8 billion kwh required, averaged out to slightly less than the summer and winter peak demand and probably significantly lower than the average load for the entire summer and winter seasons, being offset by lower demands on the system during the spring and autumn.

Table 1-1. Growth in Con Ed Demand (1963 to 1972), with Projections to 1982.

	Summer Peak (MW)	Winter Peak (MW)	Annual Requirement (10^6 kwh)
1963	5,105 (100)[a]	4,527 (100)	23,788 (100)
1964	5,505 (108)	4,733 (105)	25,387 (107)
1965	5,710 (112)	4,859 (107)	26,519 (111)
1966	6,154 (121)	5,120 (113)	27,798 (117)
1967	6,147 (120)	5,313 (117)	29,029 (122)
1968	6,960 (136)	5,441 (120)	31,037 (130)
1969	7,266 (142)	5,789 (128)	32,938 (138)
1970	7,041 (138)	5,869 (130)	34,747 (146)
1971	7,719 (151)	5,988 (132)	35,718 (150)
1972	7,872 (154)	6,104 (135)	36,810 (155)
1973	8,700 (171)	6,700 (148)	38,650 (162)
1974	9,150 (179)	7,000 (155)	40,500 (170)
1975	9,550 (187)	7,350 (162)	42,400 (178)
1976	9,950 (195)	7,650 (169)	44,400 (186)
1977	10,400 (204)	8,000 (177)	46,500 (195)
1978	10,850 (213)	8,350 (185)	48,700 (205)
1979	11,300 (221)	8,700 (192)	50,950 (214)
1980	11,750 (230)	9,050 (200)	53,300 (224)
1981	12,200 (239)	9,400 (208)	55,700 (234)
1982[b]	11,950 (234)	8,820 (195)	55,091 (231)

a. Numbers in parentheses are percentages indexed to 1963 base of 100.
b. PASNY to supply MTA demand starting May 1982.

Even during the summer peak day, demand varies by the hour. On July 19, 1972, average hourly load varied from 4,103 MW (4:00 a.m. to 5:00 a.m.) to its peak of 7,872 MW on the heaviest demand day, a difference of 3,769 MW.

For the summer of 1973, Con Ed had over 9,000 MW available within its system, apparently more than enough to supply its needs without "brown-outs". However, this apparent sufficiency is not real for several reasons, including downtime and peaking capacity. Con Ed has attempted to minimize its downtime during the summer months and for the most part has succeeded. However, peaking phenomena cannot be minimized with the present system. Summer demands are met by conventional steam electric or nuclear plants supplemented by gas turbines. About 1,800 MW are available from turbines, 257 from nuclear, and the rest from steam electric (about 7,000 MW) (see Table 1-2). To supplement its peak requirements, Con Ed purchases power through the New York State Power Pool (for other utilities in New York State) or through purchase of power in Canada and the eastern United States.

Con Ed also provides steam service to many customers in the densely developed parts of New York City. This is done mainly through the production of heat and generally is not a by-product of the steam-electric generation process. It has been said that numerous additional areas could also support a central steam system for space heating and other uses.

In the first portion of this discussion, the various generating modes were discussed, including start-up time. It was pointed out that conventional units require relatively lengthy start-up and therefore are not efficient for peaking needs. Although the boilers in these conventional units could be run and not generate electricity, their use would waste fuel and maximize air pollution potential. Similarly, gas turbines, although having rapid start-up, are less efficient than the conventional steam electric units and also are wasteful of fuel. Their pollution tendency is not so severe since most turbine systems use the lighter oils or natural gas.

Table 1-2. Four-hour Summer Capability of Con Ed Generating Facilities, 1973

Plant	Capability (MW)
Arthur Kill	806
Bowline	400
Astoria	1,458
East River	500
Ravenswood	1,778
Indian Point 1	257
Hell Gate	192
Hudson Avenue	543
Waterside	454
59th Street	123
74th Street	147
Astoria - Gas Turbine	568
Gowanus - Gas Turbine	608
Indian Point - Gas Turbine	25
Narrows - Gas Turbine	342
Ravenswood - Gas Turbine	250
Miscellaneous	391
Total	9,042

Con Ed has attempted to plan its future system to provide for peaking ability as listed in Table 1-3 and to meet this within their own system. This is primarily to be provided by several gas turbine locations (990 MW) and Storm King (2,000 MW). To this, the 2,066-MW increase from Indian Point units 2 and 3 should be added, although this is not the sole purpose of the nuclear facility expansion. Other changes in Table 1 are for growth within the system and replacement of obsolete plants. The increase in generating capacity of almost 5,000 MW by 1982 increases the present system's capacity to 14,000 MW--a growth rate for the next 10 years about equal to the increase in demand for the past 10--placing an increased emphasis on peaking.

Storm King (pumped storage) and gas turbines supply peaking loads applying a different approach. The former uses existing conventional capacity to store energy--the potential energy of a large head of water. The latter supplements existing capacity by providing separate facilities with short start-up. Both require about 50 percent greater fuel per unit of generation than conventional steam-electric plants.

DESCRIPTION OF THE PROJECT

The Cornwall (Storm King) pumped-storage project is to be located near the United States Military Academy in the Towns of Cornwall and Highland, about 40 miles north of New York City in Orange County, New York. It will pump water during times of low energy demand from the Hudson River to a storage reservoir locate in the higher country just west of the river. During periods of high demand, the system will be reversed. The downward flow of the water will drive generators producing electricity. The system can be divided into three portions--the storage reservoir, the pressure tunnel, and a generating station--which, along with transmission lines, integrate this project into the Con Ed system.

The storage reservoir will be located in the Hudson Highlands at an elevation of 1,120 to 1,160 feet. It will lie in a natural depression between several hills and ridges. Its surface area will be about 240 acres, and its maximum storage capacity will be 25,000 acre-feet. A

Table 1-3. Expected System Changes in Net Four-hour Summer Capability, 1973 to 1982

Plant	Capability (MW)
Indian Point 2	+1,003
Indian Point 3	+1,033
Astoria 6	+ 800
Gas Turbines - sites undetermined	+ 900
Cornwall (Storm King)	+2,000
Roseton 1	+ 240*
Roseton 2	+ 240*
Bowline 2	+ 400
East River	- 68
Hell Gate	- 192
Hudson Avenue	- 543
Waterside	- 454
59th Street	- 39
Net Change 1973-1982	+4,960

*Roseton 1 and 2 will no longer supply power to system by 1982.

circular tunnel 40 feet in diameter and about 10,000 feet long will connect the reservoir to the powerhouse.

The powerhouse will be below ground level. It is to consist of a turbo-generator gallery, a transformer gallery, and a gate gallery. A reconstruction of a Penn Central railroad bridge will be required. At river level, the new bridge will be the only phase of the project to be visible.

The transmission lines will not be above ground near the Hudson but will lie under the river bed. They will surface about a mile east of the river and be above ground until connecting with the existing network.

The project will begin construction during the spring of 1974 and become operational by 1979. The reservoir will be maintained at full capacity through pumping at night and on weekends. Maximum storage will be provided by a pumping time of up to 8 hours. Pumping rates will reach 9 million gallons a minute or about 16 feet per second velocity. Screens will be located in the system to prevent large objects, such as fish, from being sucked into the system. However, fish eggs and larvae would be drawn into the system.

AIR POLLUTION CONSIDERATIONS IN LICENSING

The Federal Power Commission, in making its opinion and setting forth the licensing requirements under the Federal Power Act, made some 66 findings on air pollution, fuels, and alternatives to pumped storage in the August 19, 1970 issuance of the license to Con Ed for the Storm King Project.[2] In summary, these said:

75. New York City has many air pollutants emitted into it, including those from power generating plants.
76. Serious air pollution episodes have occurred in New York City.

2. Opinion No. 584, Federal Power Commission, United States of America, August 19, 1970.

77. Estimates place 1969 emissions in New York City at 400,000 tons of sulfur dioxide and 70,000 tons of particulate matter with about 40 percent of the former and 9 percent of the latter from Con Ed.

79. The only known proven method of sulfur dioxide control is through reduction in the fuel sulfur content.

80. Nuclear power is least polluting but unsuitable for peaking while pumped storage is excellent for peaking.

81. Pumped storage is also a source of antipolluting generation of electricity in that peaking energy is supplied pollution-free and pumping energy requirements provide a demand which permits nuclear and fossil fuel generation units to operate during night hours more effectively. This in turn provides the economic and ecological incentive for construction of such units, thereby eliminating the need to continue operating the less efficient and more polluting fossil-fuel installations.

82. If the energy necessary to pump Cornwall comes from polluting power plants in New York City that would otherwise be idle, little or nothing would be gained in reducing the air pollution problem. Based on the assumption that Cornwall would go into operation in 1972, a staff study introduced in evidence showed that by 1980, approximately 89 percent of its pumping requirement could be met by virtually non-polluting sources of generation. Cornwall, to the extent that its water is not pumped by power from Con Ed low-cost nuclear plants, will be powered primarily from sources in areas adjacent to the Con Ed service area, and perhaps by imported Canadian hydroelectric power.

83. The pumping would not be done by those sources which are most polluting for economic reasons. In addition, the existence of a pumped-storage facility would permit more rapid replacement of antiquated steam-electric plants by nuclear facilities. In this way, overall air pollution can be reduced.

84. The fuel used to provide electricity for pumping would come from the most efficient conventional units--probably those burning natural gas. This condition would prevail throughout most of the year, but only last a few years.

85-86. Kerosene or natural-gas-operated gas turbines emit low amounts of sulfur dioxide but do emit carbon monoxide and methane.

87. By 1980, less sulfur dioxide would be produced with Storm King than without it.

88-89. By 1980, less fossil fuels with Storm King would be used for electric power production than without it.

90. Additions of nuclear power to Con Ed's system will occur at the rate set by staff--3,000 megawatts by 1978.

91. Storm King would offer great flexibility in providing non-polluting energy during temperature inversions.

92. Based on many of the above findings, Storm King (pumped storage) would be less polluting than any feasible alternative.

93. The Court of Appeals criticized the Commission in that it failed to make a thorough study of alternatives calling for additional hearings on the feasibility of other alternatives.

94-109. Gas turbines are less reliable for emergency purposes and have higher capital and operating costs than pumped storage.

110-113. The reliability quotient of a nuclear-gas turbine combination is far less than Storm King's and the very small per customer increase in monthly bill does not show that it is in the public interest to so charge.

114-121. An all nuclear system is not feasible because of poor reliability, outage, and adverse economics.

122-124. No feasible hydroelectric alternatives are available.

125-137. About half of Storm King's potential would be available through purchased power; however, this approach, in conjunction with other alternatives, was deemed unreliable as such purchases would not be available at the time they are needed most.

138-140. All other methods, such as minemouth generation and fuel cells, were rejected.

It is not the purpose in the discussion of this case history to criticize the Federal Power Commission's findings or decisions in the granting of the license to Con Ed for the Storm King pumped-storage project. Many of findings made by the Commission have ceased to hold true in the 3-1/2 year period since August 1970. The appraisal of the air pollution

problem was accurate; however, projections of the availability of fuels and in the Con Ed system itself have proved faulty. In some instances, in the opinion of many people, findings of the Commission were inaccurate at the time of the decision. One example of this is found in Finding 84, where natural gas would be used in conventional units to provide for pumping. Natural gas was already in short supply and the prognosis for the future did not support the Commission's findings.

OTHER CONSIDERATIONS IN LICENSING

Beside those opinions relating to air pollution and fuels, numerous other subjects were addressed. Pertinent ones are:

141-171. Scenic Beauty and Recreation

Although the Storm King project will be in an area of unique beauty and major historical significance, no real impairment of the scenic aspects of the Highland will occur. In addition, Con Ed would operate a scenic overview and provide for recreation areas, trails, and parks.

219-251. Fish Resources

Fish spawn in the Hudson River. Particularly, striped bass spawn in about equal numbers over an 80-mile range; therefore, this area cannot be considered a major spawning area. Some egg and larvae kill will occur; however, most fingerlings and a good proportion of eggs will survive. Testimony was presented making opposite claims. Con Ed would also replenish fish losses through hatchery operations.

252-290. The Catskill Aqueduct

New York City was concerned that its water-supply aqueduct from the Catskills passing near Storm King would be endangered. The Commission found that the geology of the area was well suited for construction, that the probability of damage was remote, and that a bypass to the aqueduct was not required.

PARTIES EXPRESSING CONCERN AT THE FPC HEARING

During the course of the Federal Power Commission hearings, a massive volume of testimony was presented, both by the applicant and its expert witnesses, and by numerous interested parties. The latter group included elected officials in the surrounding area; private, concerned citizens; and representatives of numerous wildlife, sporting, recreation, and conservation groups.

Much of the testimony from the recreation and conservation groups centered around two areas of concern: (1) scenic beauty and its relation to recreation, and (2) the fish resources of the Hudson. These groups included: the Appalachian Mountain Club; the Appalachian Mountain Club, Inc. (New York Chapter, Inc.); the Citizens Committee on Natural Resources; the Cortlandt Citizens Committee for the Hudson River; the Cortlandt Conservation Association; the Federation of New York State Bird Clubs, Inc.; the Garrison Fish and Game Club, Inc.; the Hudson River Conservation Society, Inc.; the Hudson River Fisherman's Association; the Izaak Walton League of America, Inc.; the National Trust for Historic Preservation; the Long Island League of Saltwater Sportsmen, Inc.; the National Parks Association; the National Party Boat Owner's Alliance, Inc.; the Nature Conservancy; the Putnam County Historical Society; the Scenic Hudson Preservation Conference; the Sierra Club; the Sportsmen's Council Marine District of New York State, Inc.; the Westport Striped Bass Club; and the Wilderness Society.

ISSUES RAISED BY STORM KING

Storm King not only poses a potential conflict between the preservation of our air resources and the maintenance of an adequate supply of electrical power, but also interfaces with other policy areas of the Hudson Basin Project.

Several changes in the supply and cost of fuel, as well as in the Con Ed system, since the Federal Power Commission issued its findings in August 1970, require that the project be reanalyzed:[3]

1. The estimated capital cost of the Storm King generating and transmission facilities has significantly increased, from an initial estimate of about $200 million to slightly less than $550 million (a rise of about $225 per kilowatt of installed capacity). In addition, it is reasonable to assume that the distribution costs have also increased, probably doubling since 1967.
2. The estimated capital cost of nuclear power plants has substantially increased. For example, the per-kilowatt capital cost of Indian Point 2 is approximately $208, whereas the estimated per-kw capital cost of Indian Point 3 is approximately $433. The investment by Con Edison in nuclear facilities (particularly facilities scheduled to be operational in the 1990s) may be necessitated by Con Edison's planned construction of Storm King.
3. Licensing difficulties, as well as other operational problems, have caused substantial delays in the addition of nuclear generating capacity. These problems have not been limited to Con Edison but are industry-wide, including other utilities in this region. Accordingly, Con Edison has been reviewing its commitment to nuclear power, and representatives of the company have stated that a relatively small change in estimated capital or operating costs of nuclear or fossil plants could cause Con Edison to substitute fossil-fuel plants for nuclear baseload plants to be constructed in the 1980s. A decision to construct fossil-fuel plants in lieu of nuclear plants could eliminate any reasonable possibility that nuclear power would provide the pumping energy for Storm King, and thus remove a principal justification for Storm King.
4. Con Edison has installed a substantial amount of peaking capacity in the form of simple-cycle gas turbines. These turbines require more

3. Summarized from An Alternative to Storm King, New York City Environmental Protection Administration, November 30, 1973.

fuel input than conventional units per unit output of electricity. However, this is offset by the relatively low capital cost of the gas turbines. Moreover, gas turbines have been reliably operated for 2,000 and more hours per year.

5. Con Edison has recently announed that it is planning to install, prior to 1980, "truncated combined-cycle facilities" consisting of gas turbines with an aggregate electric generating capacity of 220 MW and waste heat boilers with the aggregate capability of converting the waste heat from electric generation into 1.24 million pounds of steam per hour for distribution to the Con Edison steam system. The heat rate (a measure of the inefficiency of converting fuel to electricity) of the "truncated combined-cycle facilities" is less than the combined heat rate of a 220-MW baseload fossil-fuel plant and separate package boilers capable of producing 1.24 million pounds of steam per hour for distribution. Moreover, the capital and operating costs of a truncated combined-cycle facilty should be less than the capital and operating costs of an equal sized facility employing simple-cycle gas turbines.

   Con Edison is also planning to install, prior to 1982, package boilers capable of generating 3.24 million pounds of steam per hour. As an alternative to the package boilers, Con Edison could install approximately 600 MW of gas turbines in combination with waste-heat boilers capable of converting the waste heat into 3.41 million pounds of steam per hour. Con Edison's decision to install the package boilers in lieu of a truncated combined-cycle facility may be, in part, based on Con Edison's plans to construct Storm King.

6. Many utilities have recently ordered "combined-cycle facilities" consisting of (i) gas turbines for generating electricity, (ii) waste-heat boilers to convert waste heat from electricity into steam, and (iii) low pressure turbines to convert the steam into additional electricity. The heat rate of a combined-cycle facility is comparable to the heat rate of a modern fossil-fueled base-load plant. The capital cost of a combined-cycle facility is substantially less than the capital cost of a fossil-fuel plant. Moreover, a combined-cycle facility, like other peaking units, may be rapidly brought from cold standby to its maximum generating capacity.

7. Con Edison's customer rates have been increasing rapidly and will continue to do so for the forseeable future. Part of such future increases would be attributable to the necessity of large capital by Con Edison for Storm King and nuclear plants. To many people, there is substantial doubt that Con Edison will be able to raise the financing necessary for such large capital programs. Alternatives to Storm King could not only involve less capital costs than Storm King but could also reduce the necessity for investing in some of the nuclear facilities that would otherwise be necessary in the 1990s to operate Storm King economically.
8. The costs to Con Edison of raising capital to finance new construction have apparently been increasing. Furthermore, the consensus of the financial community appears to be that over the long term, interest rates paid by utilities to borrow capital will either stabilize at present levels or will increase further. Thus, there is a good possibility that Con Edison's interest charges will be higher during the period of borrowing to finance construction of Storm King than the interest charges at the time Con Edison made the cost estimates used in May 1973. To the extent that this occurs, the cost of the alternatives to Storm King would increase, since the estimated capital costs of the alternatives are between $128 million and $226 million less than the estimated capital cost of Storm King.
9. The New York metropolitan area experienced shortages of low-sulfur No. 6 oil during the 1972-1973 and 1973-1974 winters. Substantial amounts of No. 6 oil are used in apartment buildings and commercial buildings for space heating. Excessive use of No. 6 oil by Con Edison may exacerbate the shortages of No. 6 oil for heating and other uses. (Similarly, excessive use of No. 2 oil by Con Edison may exacerbate shortages of No. 2 oil for heating and other uses.) However, it appears that anticipated shortages of No. 6 and No. 2 oil will be a result of shortages of crude oil and possibly of refining capacity, rather than of No. 6 or No. 2 oil per se. Accordingly, the prospect that Storm King will require the use of considerably more No. 6 oil (through the use of base-load plants to satisfy the pumping requirement) than the No. 2 oil which would be

required by the alternatives, is a significant argument against the construction and operation of Storm King.

In addition, the long-range impact on the world's petrochemical resources must be considered for not only this project but also as a general trend. Recent trends have been toward use of these resources as a fuel rather than as a vital chemical reserve.

The growth in electric power demand is increasing at an alarming rate-doubling over the next 10-year period. At its maximum projection, one that assumes geometric growth, the next 100 years will increase energy demands 1,000-fold. More conservative approaches, using arithmetic growth, increase energy demand ten times. Obviously, either method projects significant increases and suggests that utility forecasting methods undergo revision.

Current methods of electrical generation contribute to environmental degradation through thermal, water, or air pollution. These assaults on the natural environment will only increase with growth projected for the next decade and century. Surely such unrestrained growth must be curtailed. Checks on this growth may only be effective through governmental controls. Should government exercise its authority to provide for its citizens and, therefore, act on their behalf?

Mankind, particularly that portion in the Western World, has used as a measure of its success such indicators as GNP, electrical energy demand, and amount of sulfuric acid usage--all measures of man's exploitation of his natural resources, a quantitative approach. But this world's resources are finite, not unlimited. What must be important is the quality of life, including the environment.

Storm King illustrates exploitation, not conservation, of natural resources. It is wasteful of fuel as well as costly. Government must direct itself to this situation and commit its resources to both the development of new energy sources and curbing the apparently insatiable American appetite for power.

In its planning stages, Storm King was proposed over other alternatives largely for economic reasons. Potential air pollution impact was relegated to a lesser role. Since then, this project has become negative on both counts; nevertheless, this tradeoff of environment for economics should be discouraged. Power systems should be considered to first minimize impact on the environment, and then the evaluation of cost alternatives should be factored in.

A side issue stemming from this project that merits some discussion, particularly in relation to total use of the Hudson Region, is whether the population center(s) of the region should be serviced by natural resources outside the center itself. It is the opinion of this writer that such service is no different than the supply of food. Many residents of the upper valley have in the past objected to the intrusion of New York City into the water resources of the Catskills and other areas for drinking water supply. Similar objections to the supply of electricity from these same areas have developed and will probably intensify. Yet, these same areas rely on the metropolitan area to provide them with the social and economic base that makes the Hudson Valley so vital to America.

It is imperative that everyone throughout the Hudson Valley realize that the area must function in unity. Therefore, uses of the valley must first be deemed to benefit the entire region, not only on the level of serving the needs of the population, but also to protect its natural resources and scenic beauty.

When power facilities are constructed away from their service area, many miles of transmission facilities are required. These lines disturb the natural landscape through the clearing of the path for the transmission lines and, in most cases, through their overhead construction. Consideration should be given to the placement of these transmission facilities, which at best are unsightly, at places which least disturb natural beauty, such as existing transportation routes.

Construction of power-generating facilities generally has an adverse impact on biological communities. Nowhere is this potential borne out more fully than in the plight of the striped bass in the Hudson River.

Margaret G. Nichols, Assistant Managing Editor for "Field and Stream", writing in its November 1973 issue, speaks to this point. She contends that the most serious problem posed by Storm King is what it would do to the striped bass, shad, white perch, and other aquatic inhabitants of the river. In this case, pollution is not the cause; rather it is the pumping itself. During the intake cycle, as water is pumped to the storage reservoir, everything in the river itself not caught in the large screens, including fish eggs and larvae, is pulled along. The larvae and egg stages of striped bass are helpless and fragile, and mortality among them would be almost total once caught up in the suction cycle.

This fact was recognized by Con Ed in the statement of environmental impact. At that time, they estimated that 3 percent of the striper eggs and larvae in the passing stream would be affected. More recent estimates place this figure near 30 percent because of the Con Ed failure to account for tidal flow. As most of the stripers spawn upstream from the proposed intake (70 percent), a significant number of potential adult stripers will be killed. Unfortunately, peak spawning occurs in the summer, the same time as peak electrical demand and maximum use of Storm King. It appears that roughly one-fourth of the striped bass eggs and larvae in the Hudson are doomed to destruction if Storm King is constructed and operated.

Ms. Nichols emphasizes the possible consequence on fish life in the Northeast from this pumped-storage project by relying on findings of a Dr. Goodyear. This researcher's finding is that, contrary to popular belief, the Chesapeake Bay is not the major spawning ground of the striped bass; rather, it is the Hudson. If this be the case, then Storm King and, to a lesser extent, other utility projects on the Hudson, pose serious impact to aquatic communities of the Northeast, and possibly up the cycle to birds and even man.

Finally, this case study has pointed out numerous instances where errors have been made, such as the availability of natural gas and nuclear power and the relative cost of fossil fuels. Other changes have also occurred since approvals were given. In the meantime, no significant progress has been made, although it is reported that Con Ed has spent over $20 million in development and promotion. A substantial proportion of the land for the project is still in private hands, much of it reputed to be held by Harvard.

No irreversible commitment has been made to the project. Errors in findings, as well as change that time brings, require additional review of this project. The Federal Power Commission and other licensing agencies must reevaluate the necessity, environmental degradation, economics, and other factors relating to the project. Agencies must be accountable for errors in judgment or inaccurate projections of future conditions and should take all possible actions to correct these deficiencies. As such, the FPC license for Storm King should be revoked pending further hearings. However, it is quite probable that further action could spell the demise of the project and, as such, not meet the power needs of the region's people.

2. BOOMER v. ATLANTIC CEMENT CO.[1]

Philip Bereano

BACKGROUND

One of the world's largest cement manufacturing plants was built in the Albany metropolitan area in the early 1960s. It was welcomed as a great economic boon to the Town of Coeymans and the Village of Ravena, located about 12 miles south of Albany near the Hudson River. When limestone quarrying and cement production began, however, property owners in the immediate neighborhood of the plant began to protest against the noise and dust. Lawsuits by eight of these neighbors involved the Atlantic Cement Company in a decade of litigation, costly penalties, and the award by the courts of "servitude" or easement rights to pollute neighboring lands. The New York State Department of Health, and later the Department of Environmental Conservation, also became involved in the problems of measuring air pollution, assessing the environmental damages caused by it, applying available technology to abate the cement dust emissions, and enforcing the pollution control law.

The New York State Department of Commerce assisted in the plant's birth by helping to find a suitable location for the plant, and area banks participated in financing the venture.

The Ravena location had several advantages. Extensive deposits of limestone could feed the cement kilns for 100 years at full production. Equally important was the availability of excellent rail service and the New York State Thruway for short-haul shipping of bagged and bulk cement, and tidewater docking on the Hudson River for low-cost water transportation to cement markets along the entire Atlantic coast. By the same token, fuel for the kilns and gypsum and other raw materials for cement manufacture could readily be obtained.

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1. 26 NY 2d 219 (1970)

The natural resource and locational advantages of the site were to be exploited by constructing a technologically advanced high-volume production plant whose efficiency would make possible the sale of the cement at about a penny a pound. The limestone would be quarried from hills west of the plant site and transported by a 4,000-foot conveyor to stockpiles at the plant. The landscape scars caused by quarrying would not be visible from the Hudson River, the Thruway, or Route 9W, the major road past the plant, for the quarries were located beyond the escarpment west of these north-south transportation arteries. It was, therefore, necessary to dig a 1,000-foot tunnel through this range for the limestone conveyor. From the manufacturing plant, the cement would be transported on another conveyor 7,000 feet to the ship-loading facilities on the Hudson River.

Cement plants are generally widely scattered, for they produce to meet market demand within a limited 250-mile radius. Costs for transportation by rail or truck make wider distribution uneconomical. With water transportation, however, Atlantic Cement would find it economically feasible to ship to markets in 16 seaboard states. Ten distributing plants would be built at Boston, Middletown, New York, Bayonne, Baltimore, Norfolk, Savannah, Jacksonville, Port Everglades, and Tampa to serve regional markets. Company officials aimed at capturing 10 percent of the cement market on the Atlantic seaboard, and estimated that the whole market would grow by 3 to 4 percent each year.

The plant was warmly received by state and local officials; Governor Rockefeller spoke at the groundbreaking. Investment in the facility was approximately $45 million (with another $22 million going into the ten distributing plants) resulting in a dramatic effect on the local tax base. Between 300 and 400 people were employed at Coeymans, receiving a payroll in excess of $3 million, and the area was zoned for the kind of operations Atlantic Cement was engaged in.

It is inevitable, however, that disturbances to the environment occur from beginning to end of the cement production process.

Obtaining the limestone involves blasting, crushing, and transporting by conveyor to the plant stockpiles. A series of mills pound and grind the limestone into progressively smaller pieces at the quarry. At the plant, the stone is ground to powder and mixed with water in large slurry tanks. Cement manufacture requires not only the calcareous materials from limestone, but also alumina and silica-bearing minerals found in clay or shale. The composition of the slurry is controlled to create the proper mix of these materials.

If the cement dust is not trapped and collected, up to 5 percent of the kiln output could pour out the chimney. At a daily production rate of almost 12 million pounds, 576,000 pounds of cement dust could go up the chimney every day. Fortunately, mechanical or electrostatic precipitators can reduce this dust emission considerably. As we shall see, however, Atlantic Cement's neighbors were not satisfied with the control measures installed and were disturbed by other production process aspects, especially wind-blown particles from the raw material and dust piles.

Beginning two months after the commencement of production, the Atlantic Cement plant was the subject of continuous complaints from neighboring residents, businesses, and institutions. Quarry blast explosions, odors, and noise from the conveyors and bulldozers were attacked.

The dust-control problem at the giant plant was complex and difficult to resolve. There were multiple sources of dust at the quarry, dust dump, clinker cooler and storage, and cement kilns. Spray equipment and precipitators were subject to breakdown and had to be shut down for maintenance periodically. Plant operations also had to be halted because of equipment failures. Dust collectors at the kiln stack could not be turned on again until the kilns had reached a suitable operating temperature, so there were periods during which stack emissions could not be controlled at all.

Complaints against the company began to dominate Town Board meetings. The promised local fiscal benefits did not materialize as expected. Zoning changes were proposed; numerous hearings and meetings were held

dealing with pollution problems as they impacted on neighbors; litigation was undertaken.

THE LITIGATION

In May 1967, eight property owners brought suit alleging a nuisance and seeking an injunction against particulate air pollution and quarrying activities. The plaintiffs and their properties involved were: Oscar H. Boomer (auto parts, used cars, junkyard), Avie Kinley (farm and home), Kenneth R. Livengood (home), Charles J. Meilak (home and garage), James McCall (home), Floyd W. Millious (home), Theodore J. Richard (restaurant), and Joseph L. Ventura (home). Robert Albright filed a separate suit, although he had his home and garage on the same stretch of Route 9W as the plaintiffs in the other case.

The trial was held in the Albany County Courthouse with Acting Supreme Court Justice R. Waldron Herzberg presiding. At the non-jury trial, expert witnesses for the plaintiffs contended that their homes were coated with cement dust and that their business operations could not continue. In addition to the injunction, which if granted would shut down the cement plant, the plaintiffs also sought temporary damages covering losses they claimed to have incurred from the time the plant began operating in September 1962 until the time of the trial in June 1967.

Atlantic Cement spokesmen testified that operations were carried out to minimize disturbance to the environment. A seismograph was used to measure earth movements during blasting in the quarry. Limestone stockpiles were sprayed with water in summer and with calcium chloride in winter to keep the dust down. It has already been noted that most of the cement dust produced in the kilns was collected and recycled.

In August 1967, after a 30-day trial, Justice Herzberg denied the injunction against the quarrying and cement manufacturing activities on the grounds that more than $40 million had been invested in the plant, and that the company paid large amounts of taxes to the Town and School Board, and

that it had "installed at great expense the most efficient devices available to prevent the discharge of dust and polluted air into the atmosphere." Justice Herzberg did find, however, that Atlantic Cement operations constituted a nuisance. He awarded temporary damages based on the loss of rental value or loss of usable value per month resulting from the dust and blasting as follows: Oscar H. Boomer, $50.00; Avie Kinley, $150.00; Kenneth R. Livengood, $40.00; Charles Meilak, $50.00; James McCall, $40.00; Floyd Millious $40.00; Theodore J. Richard, $125.00; and Joseph Ventura, $40.00.

Permanent damages listed in Table 2-1 were based on the drop in market value of the properties between 1962 and 1967 caused by the nuisances.

In making his decision, Justice Herzberg reasoned as follows: The dust and blasting deprived the plaintiffs of the reasonable use of their properties and the enjoyment of life and liberty on them. However, equity forbids the granting of an injunction. On balance it would produce great public hardship because of "the defendant's immense investment in the Hudson River Valley, its contribution to the Capital District's economy, and its immediate help to the education of children in the Town of Coeymans through the payment of substantial sums in school and property taxes."

The decision allowed further public or private action, not covered by the specific complaints of these specific individuals for the specific time periods alleged in their complaints.

The parties to the trial did not agree to the permanent damage awards, so the case was appealed to the Supreme Court, Appellate Division. In November 1968, fifteen months after Justice Herzberg's trial court decision, the Appellate Division affirmed his findings. Justice Aulisi, in his opinion for the five-man court, recognized the evidence that the plant had, in fact, created a nuisance to the plaintiff's properties. Nevertheless, the trial court had "carefully considered, weighed, and evaluated the relative equities, relative hardship and interests of the parties to this dispute and the public at large. Reexamining the record,

Table 2-1. Permanent Damages Based on the Drop in Market Value of Properties Between 1962 and 1967 Caused by Operation of the Atlantic Cement Co.

	Reasonable Market Value 9/1/62	Reasonable Market Value 6/1/67	Permanent Damage
Boomer	$ 25,000	$ 12,500	$ 12,500
Richard			
Property	30,000	12,000	18,000
Business	40,000	16,000	24,000
Kinley	140,000	10,000	70,000
Livengood	18,000	7,000	11,000
Millious	20,000	8,000	12,000
Ventura	25,000	12,500	12,500
McCall	22,000	11,000	11,000
Meilak	26,000	12,000	14,000
		TOTAL	$ 185,000

we note the zoning of the area, the large number of persons employed by the defendant, its extensive business operations and substantial investment in plant and equipment, its use of the most modern and efficient devices to prevent offensive emissions and discharges, and its payment of substantial sums of real property and school taxes. After giving due consideration to all of these relevant factors, the trial court struck the balance in defendant's favor and we find no reason to disturb that determination."

The parties failed to agree again after the Appellate Division affirmation of Justice Herzberg's decision. The case therefore went to the Court of Appeals, the highest in the state. The eariler decisions were reversed by a conditional injunction against Atlantic Cement. The injunction could be lifted after payment of permanent damages, the amounts to be reconsidered by the Supreme Court. The Court of Appeals accepted the trial court's finding of a nuisance, and granted the injunction on that ground alone.

THE LEGAL ISSUES

The concept of nuisance represents perhaps the law's most ancient attempt to deal with the problems of land use and pollution. It goes back at least to the year 1610 when the King's Bench Court in Britain decided William Aldred's Case, in which it was held improper to maintain a pig sty close to a property line when there was a residential dwelling nearby on the other side. In other words, nuisance deals with questions of externalties in determining compatability of land use. It is a complicated attempt to balance two extreme antithetical values--the freedom to use one's own property and the desire to avoid negative impacts from another's use of his property. It is perhaps the paradigmatic common law doctrine, insofar as it does not exist as a set of principles deductively arrived at from general rules, but on the contrary was inductively produced by the accretion of experience over the centuries from many thousands of specific land use controversies. As a result, nuisance is very difficult to define. It is a field of liability, not a term which describes particular conduct. Nuisance may be said to be "the substantial interference with the use or enjoyment of land by conduct occurring outside that land

which is unreasonable considering the circumstances.[11] Notice that this definition is replete with imprecise terms such as substantial, unreasonable, circumstances. In practice, the courts have approached nuisance litigation as an exercise in balancing the utility of one form of conduct against the harm it produces, and the associated costs of minimizing and/or compensating for that harm; as a result, it may be said to represent an unconscious form of what we now call technology assessment. In this process, courts have articulated a number of factors which should be surveyed in the balancing process. These include the social value of the defandant's use of land, the gravity (extent, intensity, duration) of the plaintiff's harm and its physical/ personal character, the ability of the plaintiff to avoid the harm or of the defendant to prevent it, the defendant's motive (malice or spite), the nature of the locality, whether the defendant's operations are "technologically up to par," whether the defendant has legislative authority (for example, under zoning, which was a legislative/administrative response begun about 50 years ago in an attempt to impose prospective coherence on the chaos which was resulting from the reliance on ad hoc and incremental decision making), whether the conduct of others is similar to that of the defendant (i.e., a test of reasonableness), and the factor of which party arrived at the scene earliest and first commenced the current use.

The remedies available for abating nuisance are similar to those for other common law harms. Monetary damages are available for harm to property, representing a dimunition of property value because of interference with use and enjoyment, or a loss of rental value, as well as for personal factors such as discomfort and inconvenience. However, an injunction may be sought in equity if damages would not be an adequate remedy, and if the harm would continue in the future and would require an endless series of lawsuits.

In this light, the most interesting issue presented by the Boomer litigation is how the court (as a public policy formulating organ of society) should handle the factor of the relative economic disparity between the parties in the course of its decision-making. This issue is not very crucial if damages are the remedy being sought, but it becomes primary if an injunction

is being considered. In other words, when can a small plaintiff, who is suffering from a continuing injury, enjoin the operation of a large industrial enterprise? Nationally, the general rule is perhaps best exemplified by the case of Madison v. Ducktown Sulphur Co., 113 Tenn. 331 (1904), where a nuisance was found to be injuring some small farmers, but the court refused an injunction on balance because of the company's larger interest. Nine years later, the highest court in New York State dealt with this issue in the case of Whalen v. Union Paper Bag Co., 208 N. Y. 1 (1913). Here, the defendant operated a $1 million paper mill and employed 400 to 500 employees, causing stream pollution which was found at the trial level to be injuring the plaintiff at the rate of $312 a year (reduced by the Appellate Court to $100 a year, but still held to be substantial). The plaintiff owned a 255-acre farm downstream, and was awarded an injunction. The real-world result is apparently that the plaintiff successfully shut down the defendant's plant.

The New York rule, that the issuance of an injunction would not depend upon the relative economic positions of the parties, was enforced in this state for almost 60 years. Although it may appear extreme, it was widely hailed as an example of "poor man's justice," and was readily justified under capitalist political economy theories as upholding the notions of individualism and competition in which every small individual should be allowed to maintain the possibility of his own growth. The Ducktown position, on the other hand, can be seen as a form of mercantilist philosophy in which the public interest is seen as tied to the continued success of the economically powerful segments of society.

What happened in Boomer? The practical effect is that the Whalen doctrine has been discarded in New York because the plaintiffs were denied receipt of a piece of paper entitled "injunction" which they could demand that the sheriff serve upon the company to close it down. From a lawyer's point of view, it is interesting, however, that the Court of Appeals specifically did not overrule Whalen, and claimed that it would follow the New York rule and grant an injunction. Agreeing with the trial court's determination that a nuisance existed, Justice Francis Bergan, writing for the majority in the Court of Appeals, posed two options: grant the

injunction, but postpone its effective date to allow for future research and development work to occur on pollution abatement devices (this is a position taken by Judge Jason in his dissent); or "grant" the injunction, but condition it on the defendant's failure to pay permanent damages (this is the outcome chosen by the majority). Either choice allows the court the luxury of claiming that it is following New York precedent, but the one selected by the majority can be seen to be a fiction.

It is true that the Boomer case presented a particularly difficult problem for the court, even aside from the economic issues discussed above. Judge Bergan curiously raises as a "threshold question . . . whether the court should resolve the litigation between the parties now before it as equitably as seems possible, or whether it should seek promotion of the general public objectives." A most profound set of problems thus appears, going to the very core of judicial decision-making in a democratic society. What is curious, however, it that the court chose the Boomer case in which to articulate this concern, since it permeates a great deal of litigation. Aside from issues of constitutional magnitude, where judicial policy-making is more explicitly recognized, any development of common law doctrine involves public welfare issues being presented in the guise of, and as inextricably part of, a specific dispute between just two parties. When the New York Court of Appeals under Judge Benjamin Cardozo took the lead in the United States in hammering out the doctrines of manufacturers' product liability early in this century, there were profound social impacts to the new policies it was creating. Similarly, Bergan's concern with the difficulties a court faces in handling a technological issue is legitimate but it is a problem which is present in a great deal of litigation--many nuisance actions, product liability, patent suits, and the like. The Boomer court's reluctance to do a more explicit technology assessment, however, directly brought into play the question of the relationship between the court and other public policy organs, such as the Attorney General's office, and the regulatory agencies of the executive branch; these issues will be discussed below.

Finally, let us note again that the cement company's use of its land was permitted under a zoning ordinance, and in New York this is usually--but not always--grounds for refusing an injunction. Also of interest, the plaintiffs had not "come to the nuisance" but has preceded it to the location. In any event, a nuisance was found, and the company has bought up the diminished property rights of the neighbors (who have moved away). Although this sounds like a form of "inverse condemnation," and might be the solution to the problem of incompatible land usage which is presented by the establishment of a new jetport (have the airport authorities buy up a buffer zone), Judge Jason's dissent reminds us that the New York constitution only allows for condemnation for "public" purposes. The practical result in Boomer, identifying the cement company so closely with "the public interest," raises the specter of neomercantilism.

ENVIRONMENTAL POLICY ISSUES

Some of the environmental issues presented by the Boomer case concern the relationship between air resource questions and questions being addressed by other task groups. The most explicit of these concern land use, both in regard to human settlements and natural resources. In regard to energy, it is of interest that some of the specific complaints about the Atlantic Cement Company operation related to energy utilization decisions. Before switching to oil as its primary energy source, the company used bituminous coal, which it stockpiled in great quantities and which, on occasion, spontaneously combusted, producing annoying odors. Air quality regulations, by favoring a switch to oil, presumably eliminated this nuisance. In regard to transportation, the location and scale of the company's operation was critically dependent upon its ready access to navigable waterways; thus there is an interrelationship with the water resources problem area as well. Waste disposal practices are relevant because the quarrying operations produce large quantities of solid waste, a portion of which at least became wind blown and contributed to the air pollution nuisance experienced in the neighborhood. In the human health area, it is interesting to realize that there is evidence to substantiate the position that cement dust is not a health hazard. The issue of technology and air quality has been previously discussed.

Implicit in the dynamics of this case are questions about the distributional aspects of air quality programs. The effect of the cement plant on the tax base of the town and school district was an important consideration, as well as issues of employment and its purchases of goods and services. On the other hand, questions must be raised as to the relationship between the spatial distribution of air pollution from a particular source and the socioeconomic distribution of the receptors. Such questions are presented by virtually every air resources management program.

REGULATORY CONTROLS

The Atlantic Cement Company designed its plant to contain the latest technologies for particulate control; about $4 million (almost 10 percent of the total capital laid out for the plant) had been invested in pollution control systems. New York State agencies were, of course, involved in the establishment of the plant. The Department of Commerce provided information and industrial location assistance. The Department of Health, as well as other agencies, reviewed the plans for the cement plant and approved them. Several other cement plants are located in the Hudson Valley, so it may be assumed that the state agencies had built up some expertise in this situation, although it may be that the unprecedented scale of the new plant and the complexities of its operation and management were responsible for the environmental problems which resulted. The dust collection systems in the plant itself were apparently not as efficient as expected. Furthermore, noise and dust were not anticipated from blasting and drilling operations at the quarry, as well as from conveying and stockpiling the crushed stone for use by the plant.

As far back as 1963, a year after Atlantic Cement started up its cement production, Dr. Norbert P. Ringleman, then Commissioner of the Albany County Department of Health, responded to complaints from area residents. He asked the State Air Pollution Control Board to order an investigation. Following out procedures in force at that time, the investigation was carried out for the Board by the Department of Labor's Division of Industrial Hygiene, Air Pollution Unit. A report indicating that there was indeed an air pollution problem at the Atlantic Cement plant was

forwarded to the County Health Department. Nevertheless, years of negotiations had to pass after this official finding before the Commissioner of Health and the Commissioner of Environmental Conservation issued orders in 1968 and 1972 requiring the company to abate the pollution to meet the standards set by The New York Rules and Regulations. A fairly detailed chronological narrative of the interaction between the company and the State Health Department, its successor agency, the Department of Environmental Conservation, and county officials appears in the Heikoff Study. A report in November 1966 found that the company was in violation of Rule #176.1, by failing to file plans for approval prior to modifying an existing facility. A conference was held in January 1967, and this was followed by a letter the following June from the State Department of Health warning the company that if the plans were not received by July 7 of that year, the matter would be referred to the Office of Counsel for legal action. This deadline was extended to September 10, 1967. By March 1968 an environmental analysis report submitted by Atlantic Cement had been reviewed by engineers in the State Health Department, finding instances of air pollution control equipment not operating up to standards.

After considering the March 1968 survey by the state and county engineers, the Department of Health attorneys decided that action to correct the polluting emissions, under a Commissioner's Order, would be more effective than legal proceedings to close the plant by injunction. In contrast to the strategy pursued by Boomer and the other plaintiffs in the nuisance and damage suit, who sought a court injunction to close the plant, the State Department of Health chose to follow administrative procedures.

The first step in this state strategy was to issue a Notice of Hearing and Complaint signed by Dr. Hollis Ingraham, Commissioner of Health. This was dated May 27, 1968, and the hearing was called for June 24, 1968. There were two charges in the complaint. One was that Atlantic Cement had violated Section 179.2 of Part 179 of the New York State Rules, on specific dates, by failing to maintain and operate its air pollution control equipment in a satisfactory manner. The other charge was violation of Section 186.1 of Part 186 of the Rules, which contained a general prohibition against causing air pollution.

The Notice of Hearing was directed mainly at the complaints by Albright and neighboring residents on Route 9W, who were then concerned about dust coming from the conveyor between the quarry and the limestone stockpiles, from the stockpiles themselves, and from the dust dump and other sources of fugitive dust around the plant. Complaints about dust from the main kiln stack by residents who lived farther away from the plant were not the focus of attention in this notice.

The hearing originally scheduled for June 24 was postponed four times and never did take place. In a Stipulation dated September 3, 1968, the company acknowledged that there were sufficient grounds for the issuance of a Commissioner's Order, waived rights to a hearing, and accepted the terms and conditions of the Order. The Order, signed by Commissioner Ingraham on October 4, 1968, ratified and confirmed the Stipulation.

The Order required the use of spray equipment to control dust, and specified that if the equipment did not operate properly, the crushing and stone handling operations must be shut down. Monitoring by the Albany County Health Department was provided, and if the equipment was found incapable of meeting air pollution standards for dust control, then the company would be expected to install additional abatement devices.

Residents of the neighborhood continued to complain, however. They were concerned about emissions from the main kiln stack, not with the operations of the spray equipment that controlled dust in the immediate environs of the plant. A governmental report on air pollution in the capital region showed that process emissions from cement and stone industries accounted for about half of the 2,400 tons of particulates that fall on Albany County each year. A newspaper comment on this report also noted that local residents found that the dust coming from Atlantic Cement Company had not noticeably abated since the Commissioner's Order, because it did not cover two of the main sources of pollution--the plant stacks and the dust dump.

In December of 1968, three months after issuance of the Commissioner's Order on the operation of the Johnson Marsh spray equipment, the Albany

Regional Office of the State Health Department noted in a memorandum to the Division of Air Resources in the central office that, in dealing with the public in response to complaints and informing them about state action, it is first necessary to arrive at a clear-cut definition of the problem. This would help to determine which rules apply and should be enforced. Three alternatives, under different sections of the rules, were explored.

During the following month, January 1969, a series of meetings and memoranda covered aspects of the state's developing strategy. One meeting, which included personnel from the central and regional offices of the State Health Department and the County Health Department, reviewed the sources of dust at the cement plant and the status of abatement action. There was considerable discussion of the options to pursue.

As the consequence of this discussion of strategy alternatives, the State Department of Health wrote to the president of Atlantic Cement about the long series of complaints that had been received since 1962. Complaints had been confirmed by investigations, but cooperation by the company had resulted in the elimination of some dust sources. There were continuing problems with the kiln stack and clinker storage, however. The Health Department therefore wrote, "In keeping with our policy of attempting to first secure voluntary compliance with our rules and regulations before initiating legal action, we would like to meet with you to discuss the solution of the control of these two sources."

Officials of the Department and the company met in March 1969. The company representatives noted that plans and specifications had already been submitted for a new dust dump and new clinker cooler bag houses. These facilities were to be completed during the following summer. In spite of these assurances, dust problems continued to plague Atlantic Cement, the residents around the plant, and the state agencies. Construction of the bag houses for the clinker coolers was delayed by late delivery of structural steel and other problems. The company made several requests for time extensions of the scheduled completion date. Finally, in July 1970, a year late, the two bag houses went on line. They were inspected,

and stack tests were conducted on the cooler stacks. Inspection and test reports indicated compliance with Part 187. Evidently one element in the complex dust control problem at Atlantic Cement had been solved.

Particulates from the kiln stack were still troublesome, especially when the electrostatic precipitators had to be shut off before and after the kilns were shut down for equipment repair and maintenance (this occurred 27 times to the two kilns during 1969, 34 times during 1970, and a total of 240 times from January 1969 through August 1971 that one or the other kiln had been shut down). The company also regretted the effects of kiln shutdown, because cement production is lost when that is necessary.

At about this time the state was also conducting tests on the kiln stack to verify compliance with Parts 187 and 195. Part 195 contained an interim standard for those older cement plants that could not meet the higher standards in Part 187 by its January 1, 1971 deadline. Cement plants in this category were to improve their emission controls according to a time schedule set by the Commissioner, but had to meet Part 187 standards no later than January 1, 1981. It was alleged in one memorandum that a stack test showed an emission rate of 1,000 pounds per hour, which greatly exceeded the limits of Parts 187 and 195. Stack tests conducted in the fall of 1970 showed particulate emission rates of 396 pounds/hour as compared to the limit of 375 pounds/hour prescribed by Part 195. These were complete tests conducted while the plant was operating under normal conditions. If the electrostatic precipitators were not operating efficiently enough to meet the standard of Part 195, the higher standards of Part 187 were certainly being exceeded.

A number of factors contributed to the decision of the Department of Environmental Conservation to call a public hearing about the Atlantic Cement situation. A June 1970 inspection by an engineer from the regional office was the first technical evidence of violations of the 1968 Order. Allegations from complaining lay people were not considered acceptable by the regional office as legal documentation for a formal charge, in spite of the fact that almost three years earlier Supreme Court Justice Herzberg had found the company was causing an air pollution nuisance on the basis

of evidence presented by eight plaintiffs including Oscar Boomer, all of whom were ordinary citizens. In November 1970, the DEC served Atlantic Cement with a Notice of Hearing and Complaint, alleging violation of the 1968 Order and of Parts 179, 186, 501 and 504. A public hearing was called for December 1, 1970. If the hearing officers found a violation, it would be punishable by a civil penalty of up to $1,000 plus $200 for each day of violation.

The hearing dragged on for a year and a half, with sometimes a month or more passing between sessions. Lay witnesses testified as well as engineers. This testimony points to odd legal and administrative contradictions. The plaintiffs in the Boomer et al. suit had no problem proving nuisance and property damage in the State Supreme Court. Yet a newspaper reporter who had followed the hearing and other events connected with Atlantic Cement wrote, "Observers of the long hearing had noted from time to time that legal evidence to prove air violations. . . was weak." Another reporter noted that some Environmental Conservation officials admitted they could not prove the air pollution case against Atlantic Cement:

> To prove its charges of violating a 1968 Commissioner's Order and state air rules, ECD officials said they would have had to show that Atlantic exceeded ambient air (average) quality standards by collecting weekly dust measurements in the plant's vicinity for a solid year and computing the annual dust fall average. Instead, they note, the state proceeded under a "nuisance rule" which applies only "where no other specific rule is applicable." And they offered test results from dust samples taken sporadically over the last two years...The year-long sampling wasn't done, ECD officials say, because of a "lack of manpower."

In spite of the tactical problems involved in proceeding against Atlantic Cement under the nuisance provisions of Part 186, Environmental Conservation chose to pursue an "ambient air" strategy rather than following up on previous successful experience with cement pollution abatement under the "stack emission control strategy" written into Parts 187 and 195. The Department witness who brought up this point testified that Marquette,

Lehigh, and a third cement plant in the Cementon-Alsen area, which had been found violating emission standards under Part 197 and Part 195, had already submitted plans for updating their emission control systems.

The hearings were occurring at the rate of one session per month, and by May of 1972 only the state had presented its case. Atlantic Cement could have taken many more months to present its side. Nevertheless, by this time both parties had had enough and worked out a consent agreement. The company had not been proved guilty of any violations, nor had any penalties been assigned to it.

The Commissioner's Order of Consent was dated May 11, 1972. Under it, Atlantic Cement agreed not to use its old dust dump, and to operate the new one according to terms and conditions set by a Certificate to Operate. Bag house collectors and precipitators were to be in operation at maximum efficiency whenever the production facilities were in operation. On kiln start-up, the precipitators must be turned on within 30 minutes after feed is introduced. If dust collectors become inoperative, the production level of the kilns and clinker coolers would be reduced so that emission levels would be no higher than those under full efficiency. If this standard could not be met, the kilns and coolers would be shut down. The company must regulate emissions from the plant so as to conform to the ambient air quality standards adopted for Albany County and prevent fugitive dust from leaving the boundaries of the Atlantic Cement property.

A noteworthy provision of the Order required the company to modify or repair its facilities to control dust emissions so as to conform with the environmental ratings assigned under Part 187 of the air pollution control rules. The original Notice of Hearing and Complaint never alleged violation of this rule. Environmental Conservation, therefore, had to finally incorporate the "stack emission control" strategy along with its original "ambient air" strategy to assure dust abatement from the kiln and clinker cooler stacks. In order to pursue both strategies, Atlantic Cement was required to perform, at its own expense for one year, stack tests on the kiln stack to demonstrate compliance with Part 187, and an ambient air quality study to demonstrate control at the materials

handling facilities and dust dump as well as other sources of fugitive dust. If by May 1, 1973 such dust control could not be demonstrated, the company would have to either install additional control equipment or modify its production process. The schedule was later extended: (1) on July 15, 1973 the results of the ambient air study would be submitted to the Department; (2) by August 1, 1973 the company would submit satisfactory abatement schedules for all sources not meeting air pollution control rules; (3) by October 1, 1974 all work required by the abatement schedule for compliance with ambient air standards would be completed.

THE ATTORNEY GENERAL'S ROLE

The Attorney General's Office may be called upon by the Department of Environmental Conservation to prosecute an alleged polluter who fails to comply with a Commissioner's Order.

On finding evidence of violation of the 1968 Order of the Commissioner of Health, the Commissioner of the Department of Environmental Conservation could have requested the Attorney General to bring Atlantic Cement into court. Instead, the Department chose to combine this violation in a complaint with other allegations against particular air pollution rules; the Department therefore summoned the company to a new public hearing rather than asking the Attorney General to litigate.

In another cement situation, the Attorney General's Office responded to complaints by residents near the Universal Atlas Cement Company facility in Cohoes. Litigation on behalf of these residents was commenced on November 11, 1971, and a judgment was handed down a short five months later. This procedure must be contrasted with the many years of effort by Boomer and the State Government to obtain cleanup.

In deciding the Boomer case, the Court of Appeals said, "The limitation of relief granted is a limitation only within the four corners of these actions, and does not foreclose public health or other public agencies from seeking proper relief in a proper court." In addition, as previously noted, the court was troubled by presentation of a social issue in terms

of the interest of two private parties; "It is a rare exercise of judicial power to use a decision in private litigation as a purposeful mechanism to achieve direct public objective greatly beyond the right and interest before the court."

Attorney General Louis Lefkowitz responded to these comments in a press release 12 days after the decision was handed down. The Attorney General was concerned both with the Court's failure to abate the air pollution and with its failure to directly consider the public issues. Saying that the decision "in effect granted a cement company a virtual lease to pollute the air," Lefkowitz continued:

> "Clearly, it is difficult, if not impossible, to separate the public interest in pollution abatement from the private interest in the particular individual whose property is damaged. A judicial disposition in the public interest should be keyed to abatement rather than continuance of the pollution. In my opinion, it becomes important that the Court consider the feasibility of a mandatory timetable for abatement. There is ample precedent for some action. In 30 actions already brought by my office, involving water and air pollution against municipalities and industries, judgements have been entered with provision for abatement in accordance with the stated timetable."

Lefkowitz also recommended to the Legislature a bill which required that when litigation is begun involving water or air pollution, the Attorney General's office must be notified so that it may participate where the public interest is involved. Such a bill was introduced on January 4, 1973 (Senate 879 and Assembly 758). Such a strategy, although it may have been proposed by the Attorney General's office solely to protect its "turf," would seem to combine the advantages of the two different decision mechanisms discussed previously. In other words, by relying on litigation, the existence of a damaging nuisance can be proved in fairly short order in a trial court (as was done in Boomer) unlike the Department of Environmental Conservation hearing which dragged on for a year and a half without reaching conclusive proof of pollution. Secondly, by having a public party as one of the litigants, the public issues would have to be

addressed by the court, and the likelihood of an injunction would be increased, leading to abatement of pollution rather than the payment of damages in return for the receipt of what amounted to a permanent easement to continue polluting neighboring properties.

The multiple-route strategy for air pollution control that is available to the people and government of New York State does not consist of mutually exclusive routes. An alleged industrial polluter may be hit by a variety of forms of abatement action--private nuisance litigation, departmental regulatory hearings, Attorney General's litigation. The Atlantic Cement Company's situation indicated, however, that there may be curious parallels and/or paradoxes in the outcome of the proceedings. In the Boomer case, the Court of Appeals reversed the Supreme Court decision, but the result was the same. The trial court had denied an injunction against the company; the appeals court granted it. Nevertheless, the outcome of both decisions was identical, for on payment of permanent damages, the company could continue to operate and emit cement dust without abatement.

This parallel is matched by the paradox that had the minority opinion prevailed in the Court of Appeals, the outcome would have been similar to the result of the Department of Environmental Conservation's formal hearing. The appeals court minority agreed with the injunction against the public nuisance of cement dust pollution, but would require abatement of the emission within 18 months as the condition for lifting the injunction. The Commissioner's Order after the long hearing required practically the same condition in exchange for averting accusation of rule violations and imposition of penalties. The Commissioner gave Atlantic Cement a year to measure its own emissions and their effect on the ambient air, and then to devise effective abatement measures.

The majority opinion in the Court of Appeals had assumed that there was no short-term prospect of technological improvements that would stop the dust emissions. Investigation by the state health and environmental conservation engineers indicated, however, that technological limitation was not the obstacle to abatement. Pollution control equipment had been

installed in the plant originally. The problem was that the equipment was not operated effectively. The Commissioner's Order, therefore, was really aimed at improving the cement company's management practices. The Johnson Marsh equipment was required to be maintained in good working order; and if it failed, crushed stone handling was to be suspended until repairs were made. The dust dump was to be operated with a sprinkler system when the material was being deposited and spread. The electrostatic precipitators were to be turned on no more than one-half hour after kiln start-up to minimize uncontrolled emissions from the main stack. Again, cement production was to be suspended in the event of equipment failure. Had the Court of Appeals had the same evidence and followed the same line of reasoning as the Department of Environmental Conservation, the "easement of pollute" precedent under the servitude on the land doctrine might never have been set.

CONCLUSIONS AND MAJOR POLICY ISSUES

An excellent analysis of the Boomer case has been provided by E. F. Roberts, Professor of Law at Cornell ("The Right to a Decent Environment; $E = MC^2$...," 55 Cornell Law Review 674 (1970)). Focusing in on siting as a key issue, along with the inquiry as to whether a factory is technologically up to par, there are two institutional modes for dealing with air pollution and land use problems--the legislative approach of zoning and the judicial approach based on nuisance and other theories. Roberts claims that the Boomer case illustrates an alteration in thinking about the allocation of losses which are attributable to industrialization of the neighborhood. Boomer reflects an application of modern consumer liability thinking to the area of nuisance law, in which a technologically par plant will be assessed for any resulting dimunition in value of the surrounding properties.

But in the long run, Boomer may be socially unresponsive. The result of the Madison case was to create a lunar landscape in the Tennessee hills, to render destitute not only the landscape but a large group of lower class yeoman farmers for the benefit of a large mercantile organization. Because of the "inverse condemnation" or "servitude on the land" aspect

of the Boomer problem, Roberts argues that this case illustrates a convergence of nuisance law and constitutional law. Once this implication is accepted, joined with the persistent effort to have a healthy and fit environment recognized as a constitutional right, we see that the legal evolution reflects the observation of a number of commentators that environmentalism presents major direct issues of political and economic philosophy.

A crucial new generation of environmental issues is surfacing, issues which are essentially distributional. No longer satisfied with merely efficient approaches to solving environmental problems, groups are pressing equity considerations on public policy-making organs. In this light, the strategy for HBP Task Groups is seen as unduly limited; the Second Status Report (February 4, 1974), Page 2, V implies that the bottleneck to a successful environmental strategy is to be found in limited knowledge; the Project must address the equally compelling possibility that the difficulties are due to incorrect and/or ineffectively articulated premises by policy makers. If the wrong questions are asked, no amount of informational or analytical sophistication can provide good answers.

Mercantilist philosophy is associated with the policy of the British government prior to the American Revolution, and in fact, is frequently cited as one of the primary causes of that event. It surfaced again as a dominant mode of thinking at the end of the 19th and beginning of the 20th century. Madison illustrates that point of view. An even more outrageous example is provided by the case of Pennsylvania Coal Company v. Sanderson, 113 Pa. 126 (1886), which permitted coal mine pollution of a stream to the detriment of downstream homesteaders on the basis of a candid discussion that the common wealth of the Commonwealth of Pennsylvania was based on the exploitation of its coal deposits irrespective of social and economic impacts. That crude doctrine held sway in Pennsylvania in the field of water pollution control for 60 years. We are not so crude today, but elsewhere Roberts raises the issue of governmental involvement in "free enterprise" in the era of a post-industrial society, an era of the collective in which the elites of the collectivities do the decision-making ("The Right to a Decent Environment: Progress Along a Constitutional

Avenue," Law and the Environment, Baldwin and Page, eds. New York: Walker and Co., 1970).

Despite its long history of social progressivism and despite its forward-looking establishment of the Department of Environmental Conservation and land use control planning in the Adirondacks, in most environmental areas, New York is sadly lagging behind other states of the union. Only in regard to strategies which depend upon a strong executive branch arrangement, a personal proclivity of former Governor Rockefeler, has New York been active. Four strategies for action, adopted in other political jurisdictions are relevant to the Boomer case and other environmental problems, and ought to be seriously investigated by the Hudson Basin Project and the State of New York: an operative substantive declaration of environmental policy coupled with a requirement for the preparation of environmental impact statements by state agencies and possibly large private sector organizations; the institution of an operative constitutional declaration of a right to a clean and healthful and sustaining environment; a recognition that natural resources are held by the government in a "public trust" for the benefit of the citizenry; and a recognition of citizen standing to raise environmental issues, patterned on Michigan legislation.

Attached hereto is a compilation (Table 2-2) of general state environmental protection measures (i.e., dealing with environmental quality overall, rather than with the abatement of specific types of pollution or with land use, etc.) as of August 1973, published in the Environmental Law Reporter. It will be seen that the only entry for New York is a constitutional provision (effective January 1, 1970); but this provision has been interpreted as being merely hortatory and addressed solely to the legislature. This is in contrast to the policy declaration in the National Environmental Policy Act, which is gradually winning judicial recognition as a legislative expression of changed social values, establishing substantive policy changes which agencies must follow and which citizens may raise in court. Legislation requiring environmental impact statements from state agencies passed the New York Legislature in 1972, but was vetoed by Governor Rockefeller in May of that year in a statement

Table 2-2 State Environmental Protection Measures as of August 1973

State	Constitutional Provisions	Legislation Patterned on the Michigan Act	EIS Requirements
Ariz.			Game and Fish Commission Policy of July 2, 1971
Calif.		Cal.Code Civ.Pro.§389.6 and §6412 (Supp.1972) Cal. Gov't. Code §§12600 et. seq.	Cal.Pub.Res.Code §§21000 et seq. (Supp. 1972)
Conn.		Conn. Gen. Stat.§§22a-1 et seq. (Supp. 1972-1973)	Pub.Act.No. 73-562 approved June 22, 1973. Conn. Executive Order No. 16 (October 4, 1972)
Del.			Ch. 15, Vol.58 Laws of Del. (June 28, 1971) adding 7 Del. Code §§7001 et. seq.
Fla.	Fla. Const. Art.11, §7, (effective Nov. 5, 1968)	Fla. Stat.§403.412 (Supp. 1971)	
Hawaii			Hawaii Executive Order (Aug. 23 1971)
Ill.	Ill. Const. Art. X1.§§1-2 (effective July 1, 1971)		
Ind.		Ind.Stat.Ann.§§3-3501 et.seq.(Supp.1971)	IC 1971, D-10-1 added by P.L. 98 1972 Ind.Stat.Ann.§35-5301 et.seq.
Md.			Ch.702, Md. Laws of 1973
Mass.	Mass.Const. Art.97 of the Amendments (effective Nov.7, 1972)	Ch.732, Acts of 1971 amended by Ch.219, Acts of 1972	Ch.781 Acts of 1972 Ch.30 §61 et.seq.

(Table 2-2 Cont.)

State	Constitutional Provisions	Legislation Patterned on the Michigan Act	EIS Requirements
Mich.	Mich.Const. Art.IV §52 (effective Jan.1, 1964)	Mich.Comp.Laws App. §§691.120 et. seq. (Supp.1971)	Mich. Executive Directive 1971-10 issued by the Governer
Minn.		Minn.Stat.§§116B.01 et.seq.(Supp.1972-73)	
Mont.	Mont.Const. Art.11, §6 (effective July 1, 1973)		R.Code Mont. §§69-501 et.seq. (Supp.1971)
Nev.			Ch.311.Laws of 1971, IRS §704
N.Mex.			N.M.S.A.§§12-20-1 et.seq.(Supp.1971)
N.Y.	N.Y.Const. Art.XIV §4 (effective Jan.1.,1970)		
NC	N.C.Coast. Art.XIV §6 (effective July 1, 1973)		N.C.Gen. State §§113A et.seq. (Supp. 1971)
Pa.	Pa.Const. Art.X §7 (effective May 18, 1971)		
RI	R.I.Const. Art. X §17 (adopted Nov. 3, 1970)		
S.Dak.		Ch.144.S.D. Laws of 1973	
Tex.			Policy for the Environment, Adopted Jan.1, 1973

(Table 2-2 Cont.)

State	Constitutional Provisions	Legislation Patterned on the Michigan Act	EIS Requirements
Va.	Va.Const. Art.XI (effective July 1, 1971)		Ch.384, Va.Laws of 1973.
Wash.			Ch.43.21C, RCW; Ch.47.04.100 et.seq. RCW
Wis.			Ch.274, Laws of 1971 adding Wis.Stat. §§1.11 et.seq.; Ch.273, Laws of 1971 adding Wis.Stat. §23.11(5)
Puerto Rico			12 Laws P.R.Ann. §§1121 et seq. (Supp. 1972)

calling it "wastefully duplicative, administratively uncertain and costly," a view contested by the Republican Chairman of the Assembly's Conservation Committee.

A final word on "standing". It is possible to distinguish between the practical results of the Whalen and Boomer cases by speculating about the nature of the plaintiffs in such litigation. Whalen was brought by a rural farmer, presumably having a long family attachment to his homestead. Boomer occurred in a fast-developing suburb of the state capital. In the intervening period, our society has become vastly more mobile. Current estimates are that one-fifth of all American families move annually; a deep-rooted long-standing attachment to a particular parcel of land is becoming more and more rare. A policy which enables a polluting corporation to buy out neighboring homeowners may be more acceptable in an era in which the homeowners would just as soon take a fat check and move to another bedroom community. At the same time, however, environmental litigation has frequently raised the issue of standing because many environmental plaintiffs are not suffering from specific individual (and usually pecuniary) damage, but are more publicly motivated. Thus, class actions and public interest litigation are familiar features in environmental law. The courts have a long tradition of refusing to hear parties who are not complaining of personal and direct injury; the doctrine of "standing" is an expression of the court's belief that they need parties who will present an issue with a high degree of adversity and a major stake in the outcome. The post-industrial era, however, has seen an increase in the ideologically motivated plaintiff, among which we would include many environmental organizations and public interest lawfirms. These would-be plaintiffs cannot show damage to their lungs or their homes. Should they be allowed to raise important issues in court?

Many commentators (most notably Professor Louis Jaffe in "The Citizen as Litigant in Public Actions: The Non-Hohfeldian or Ideological Plaintiff," 116 University of Pennsylvania Law Review 1003 (1968)) have argued that such plaintiffs may well bring at least as much commitment, energy, and adversity to the litigation as the more traditional type. Michigan and a number of other states have recognized this, and have opened up the

courthouse doors to such environmental plaintiffs, relying on the discretionary power of the court to screen out frivolous litigation. Empirical studies show that the courts have not been subjected to any major increase in litigation as a result, and that lawsuits under such legislation are not bizarre, but fairly standard in appearance.

Without serious consideration of some of these public policy techniques which have been developed in recent years, environmental management in the Hudson Basin is likely to proceed in a hierarchical bureaucratic form, increasingly alienating the general citizenry by stemming its desire for public participation, and perhaps failing as well to adequately protect environmental quality.

3. A DEEPWATER OIL TERMINAL FOR NORTHERN NEW JERSEY

Michael Greenberg

BACKGROUND

New Jersey's nickname is the Garden State. Since the turn of the century, this label has been progressively discredited by the concentration of nuisance industry in the flat, inexpensive, and conveniently located marshes in the northern quadrant of the state. These meadowlands have become the haven for industry forced out of New York City by health and zoning codes and discouraged elsewhere in the New York metropolitan region by incompatible land uses. Industry has been attracted to New Jersey by the state's favorable tax structure and by communities with an eye for ratables.

By 1970, six northern New Jersey counties (Bergen, Passaic, Hudson, Essex, Union, and Middlesex) housed 23 percent of the population of the New York-Northeastern New Jersey Standard Consolidated Area. In contrast, they accounted for more than 60 percent of the production jobs in five of the most noxious industrial groups in the region: petroleum refining, industrial chemicals, paper mills, primary metals, and leather tanning. The environmental impact of this industrial concentration is exemplified by the septic dissolved oxygen levels that afflict the Arthur Kill during the summer, by the haze that frequently blankets the New Jersey Turnpike from New Brunswick to New York City, and by the landfills that line the turnpike approaches to Manhattan.

Once passive New Jersey residents have become openly critical of the siting in northern New Jersey of the assorted unwanted industrial and refuse facilities of the New York metropolitan region. Many New Jersey citizens perceive the national policy of creating a terminal off the coast for crude oil shipments as yet another undesirable facility with degrading direct impacts--oil spills, chronic oil and chemical discharges, as well as secondary industrial, commercial, and residential effects.

THE PROPOSED DEEPWATER OIL TERMINAL

The terminal facility would include an offshore buoy at which tankers would discharge their cargo; perhaps an artificial island with storage tanks; and a pipeline capable of serving very large crude-oil carriers.[1] A site 13 miles east of Long Branch, New Jersey, has been selected by the Army Corps of Engineers. The Corps has favored the Long Branch site because it is almost midway between the refinery complexes in northern New Jersey and those in Philadelphia and environs.

The following sites have been seriously mentioned as potential onshore points for the pipeline terminus: Perth Amboy in Middlesex County; the Earle Naval Ammunition Depot in New Shrewsbury, Monmmouth County; and southern Richmond County (Staten Island), New York. The proposed facility or facilities would be designed to handle by the year 2000 anywhere from 2.5 million barrels a day (mb/d) to almost 10 mb/d of crude oil.[2] By comparison, the 1972 capacity of the Arthur Kill and Delaware Bay refineries was 1.3 mb/d.

SITING THE CRUDE OIL TERMINAL: ECONOMIC AND ENVIRONMENTAL ISSUES

The location of this controversial facility involves interests and issues at national, state, regional, county, and local levels. This section identifies the core issues and major considerations of the contending parties.

The National Scale

At the national level, the stated policy is to assure sufficient oil to maintain the economic health and security of the nation. The specific role of the oil terminal would be to offload supertankers transporting crude oil from overseas, primarily the Middle East. Imported oil presently represents about 10 percent of the American supply. This proportion has fluctuated considerably during the last 2 years. It is projected to increase to as much as half of the nation's supply by 1985, despite Project Independence. Supertankers have reduced the shipping costs of

this long-distance trade by about 50 percent. However, these vessels, ranging all the way up to 500,000 deadweight tons and still growing, have drafts to 90 feet or more and lengths of up to 1,200 feet. They cannot use the 30- to 40-foot-deep channels and narrow coastal shipping lanes that accommodate the 25,000- to 80,000-deadweight-ton tankers currently plying the waters of the eastern United States.

The projected critical need for foreign crude oil demands the prompt choice of an appropriate entry point or points capable of handling the supertankers. But the ultimate choice of a site turns out to involve two more fundamental policy choices: (1) whether to locate the facilities in already-developed or in less-developed regions, and (2) whether to develop a single site or multiple, dispersed sites.

Each of these alternatives has economic and environmental implications relevant to another area of national policy: regional economic development.[3] During the last three decades, the tendency of federal government policy has been to encourage the development of economically depressed regions. A good deal of rhetoric and initiative, though no great sums of money, have been devoted to this end. Under the auspices of the Economic Development Administration, a series of projects have sought to lure private capital to regions like Appalachia through government development of infrastructure, the investment of public funds, and the improvement of health and education.

In seeking to stimulate growth in these economically lagging regions, the government has been criticized for a single-minded focus on depressed regions at the expense of others which have great economic potential, or which are congested and overdeveloped.[4] One of the present emphases of research in development economics is to identify areas with a sufficient market size, resource base, and infrastructure to sustain economic growth.

An oil terminal facility of the magnitude proposed by the Corps of Engineers will stimulate regional development directly by making oil available both for fuel and for petrochemical manufacturing. Indirectly,

such a facility will stimulate the growth of new and existing infrastructure and a regional market. In short, a monobuoy and pipeline are really the epicenter of growth explosion that can bring economic and political power to a region, but that can also lead to congestion, suburban sprawl, and elimination of open space.

These complex considerations have prompted the federal government to involve the following agencies in the formal review of the proposed project: Coast Guard, Corps of Engineers, Maritime Administration, National Oceanic and Atmospheric Administration, Department of Transportation, Department of the Interior, Council of Economic Advisers, and Office of Emergency Preparedness. A five-part study of deepwater port needs has been prepared. It includes reviews of the probability of oil spills, marine effects from construction of the facility, onshore effects, commodity analyses, and the economic costs of several dispersed facilities versus a single terminal.

State and Regional Perspectives

Northern New Jersey is functionally a part of the New York metropolitan region, and of the megalopolitan region which stretches from Boston to Washington, D.C. While it is convenient for the federal government to consider the East Coast as a single fuel-service region for the purpose of facility siting, there is no single viewpoint on the issue that can be attributed to the entire region. The closest thing to a common opinion was stated by the consulting firm of Arthur D. Little (ADL) in response to public hearings on the proposed terminal in May 1972:

> Nowhere on the Atlantic Coast north of Cape Hatteras has a generally favorable reaction been heard. Among the individuals who spoke against such facilities were the majority of attending political officials (U.S. Congressmen, state assemblymen, state senators, and city officials).[5]

Rather than a clearly defined regional opinion, this negative response can be understood as a combination of political reflexes and public fears of the potential environmental degradation from oil spills.

A more accurate measure of the relative weight of the economic and environmental considerations is indicated by the actions of states in the region. The State of Delaware, for example, has a sizable proportion of the refining capacity of the East Coast. In 1971, Delaware passed legislation which, though under attack in 1975, effectively bans development of a deepwater port and further heavy industrial development along its coastline. At the other extreme, economically depressed regions in New Hampshire, Maine, and Nova Scotia have cautiously encouraged refinery development. The refinery proposed by Olympic Refineries for the Durham-Newmarket area of New Hampshire would have had a capacity of 400,000 b/d. More important, the $600 million refinery was expected to help transform the economically depressed region. As for the facility's environmental effects, Governor Thomson assured skeptics that "people will hardly be aware of its presence."[6] The New Hampshire State House of Representatives, however, rejected the plan after all but one of the communities near the proposed site voted against the plan in a referendum. Conversely, Nova Scotia has constructed a deepwater terminal and is seeking to turn Port Hawkesbury into an industrial complex.

Maine was one of the first states to develop a state land-use-review program.[7] A number of refinery proposals have already been rejected or tabled in response to environmental concerns expressed by local citizens and by the Canadian Government, and perhaps also in reaction to intervention by the major oil producers.[8] Nevertheless, the unhealthy economic condition of communities like Eastport leads some observers to believe that refinery facilities will ultimately be built in Maine.

The position of the State of New Jersey is the most complex among the East Coast States. The state's formal stance appears to discourage, but not to prevent, the development of a deepwater facility. The Coastal Area Facility Review Act (1973) may eliminate heavy industrial development

in much of coastal southern New Jersey by giving the state the power to ban (with appeal) any construction or facility deemed an environmental threat.

The original legislation included about one-seventh of the state's land area. Approximately one-half of the land originally designated was eliminated from the final bill, including the two areas, in the Delaware River and in Raritan Bay, that would be most seriously affected by the crude oil terminal. A second bill, which would have prevented the siting of the crude oil complex in New Jersey, was defeated by the State Senate after being passed by the Assembly. A combination of oil companies, other industrial interests, and organized labor was credited with the defeat of the bill.[9]

Both former Governor Cahill and Governor Byrne have officially opposed the facility. Their statements, however, have been relatively mild in comparison to the unequivocal opposition by opponents of the project, who complain that more than 40 percent of the refining capacity of the northeastern United States is already located in New Jersey. New Jersey will become the "Tank Farm State" unless the statehouse takes a firm stand against the additional facilities.

Unanimity among state officials should not be expected for several major reasons. First, the nomination of two sites in New Jersey pits the northeastern part of the state against the south, with state officials caught in the middle. For example, Charles Sandman, Cape May County Representative and Republican candidate for Governor in 1973, was quoted as favoring the location of the superport in Raritan Bay because "clean air and water are just a memory to people living near Raritan Bay."[10] The statement plagued Sandman throughout his unsuccessful gubernatorial campaign.

During a week of hearings in late 1972, a representative of SORO's Associates, which investigated the deepwater port for the Maritime Administration, supported a site at Cape Henlopen, Delaware, rather than the Corps' first choice of Long Branch, New Jersey. South Jersey opponents

reacted harshly to the Cape Henlopen site, contending that a single spill could destroy South Jersey's $2.5-billion-a-year resort industry. Meanwhile, residents of northern New Jersey perceive the terminal as a threat to the Gateway National Recreation Area, and especially to Sandy Hook.

In addition to the immediate political consequences of the oil terminal issue, in recent years the State of New Jersey has experienced growing heavy opposition to any energy development, and officials now tend to react with extreme caution to any energy-related proposal. For example, Shell Oil has proposed to build a $217-million refinery in Logan Township, New Jersey. Environmentalist opposition to Shell's proposal has been strong. On the one hand, New Jersey's approval of the facility might be interpreted as a rebuff to the State of Delaware, which passed its Coastal Act under pressure from Shell to accept the refinery complex in Smyrna, Delaware. On the other hand, New Jersey can block Shell's plan by not granting riparian rights along the Delaware River. As yet, however, a public position has not been released. Fortunately, the state may not have to make a decision, because Shell has decided not to go forward with the refinery in the face of an uncertain market.

A similar problem for state officials resulted from the proposal of Public Service Electric and Gas of New Jersey (PSE&G) to build a boiling-water, nuclear-power generating station on the Delaware River, 11.5 miles from Philadelphia and less than 5 miles from Trenton, the state capital. At the public hearings, the State of New Jersey intervened without voicing opposition, while the State of Pennsylvania intervened against the project. Finally, opposition has been voiced to PSE&G's proposed offshore, floating, nuclear generating station east of Atlantic City, and the state has opposed the federal government's proposed offshore oil-drilling program.

The constant pressure on state officials from the proponents of energy-related projects has culminated in recent months in the charge that the oil companies have reduced their allocations to New Jersey in retaliation for the state's relatively stringent environmental standards, and as a lever to force acceptance of the supertanker facility. New Jersey offi-

cials who sit in Trenton, within 100 miles of seven Standard Metropolitan Statistical Areas (SMSA) with over 20 million persons, and facing one of the five highest state unemployment rates, must view the supertanker issue as only one in a number of important energy-related policy decisions with far reaching implications for the state's economic, social, and environmental health--as well as for those officials' own political ambitions.

One would expect that the Tri-State Regional Planning Commission (TSRPC), the Regional Plan Association (RPA), the Port Authority of New York and New Jersey (PANY-NJ), and the Region II Office of the Environmental Protection Agency (EPA II) would be highly interested participants in the resolution of the issue. The TSRPC and the EPA II have attended meetings at which the issue has been discussed. TSRPC has prepared a report for the Governors of New York, New Jersey, and Connecticut. Although the results have not been released at this writing, TSRPC has suggested that they focus on the proposed facility's impact on their development plan for the Tri-State Region.[11] EPA II is cognizant of the issue but has not made detailed studies. Three weeks after disclosing that EPA had not made detailed studies, Gerald Hansler, Administrator of Region II, testified that the facility should be constructed off New England or the south Atlantic coast rather than New Jersey in order to prevent excessive industrial concentration in the Mid-Atlantic Region.[12] RPA and PANY-NJ have not actively studied the issue.[13] In short, the regional planning agencies seem to have minimal involvement in a decision that could have a great impact on their geographical areas of responsibility.

County and Local Perspectives

At the level of the counties and local governments, the core issue is the impact of onshore industrial development on land use controls and on the local environment. At present, townships are free to use their zoning power to invite industry in. Neighboring towns, which may receive none of the ratables may, however, have to bear a sizable share of the fiscal and environmental costs. Unchecked zoning power in the hands of minor civil divisions invites them to develop first, and then hypocritically to

denounce similar developments by their neighbors; or to use zoning and complementary legal devices for exclusionary purposes.

The planning problem created by facilities like the crude oil terminal may be illustrated in Middlesex County, New Jersey, which already has half of the refining capacity of the New York metropolitan region, and which is likely to feel the immediate onshore impact if the proposed new facility is constructed. The industrial exclusion provisions of the New Jersey Coastal Area Facility Review Bill were originally supposed to extend northward to cover much of Middlesex County. Partly at the insistence of State Senators Crabiel and Tanzman of Middlesex, much of the county was eliminated from the bill that was finally passed.[14] In contrast, the Middlesex County planning staff has taken a firm position against the proposed facility for fear that the supertanker terminal will completely destroy their development plan and overtax the area's already burdened water and air resources.[15] The planning staff has attempted to monitor the proposed project closely, to coordinate opinion in the Arthur Kill-Raritan Bay area through an environmental committee of the bordering counties, and to mobilize state and regional planning agencies against the supertanker port.

In Middlesex County, the land use and resource management issues are apparent, and the time remaining to prepare for the impact of the oil complex is short. However, legal controls are not now available and are not likely to be in the near future. Therefore, localities face the prospect of heavy onshore impacts without regional responsibility. Understandably, then, these localities are subject to quick changes of opinion motivated by fears of nearby tanker explosions, storage-tank leaks, and oil spills, and on the other hand, by promises of increased and improved gasoline supplies. In short, in Middlesex County the estimated economic benefits must be weighed against potential disruption of the environment and of public services resulting from the absence of regional development controls.

Many formal steps must be taken before the proposed oil terminal is constructed, not the least of them a decision by the Corps of Engineers on the method of financing the $250- to $750 million project. All decisions are subject to review by the regional headquarters of the Corps, by the Board of Engineers for Rivers and Harbors in Washington, D.C., and the Army's Chief of Engineers in Washington, D.C.

The proposal must then go before the appropriate committees and the two houses of Congress. Assuming that enabling legislation is approved by Congress, design and engineering funds would have to be appropriated in separate legislation.

While this tortuous process seems to suggest numerous opportunities for public opinion to be heard, the outcome may be unduly influenced by present energy problems. The selection of the site or sites can be only as good as the data and assessments provided by the agencies and consulting firms.

A case in point is the adequacy of the information used by ADL in their assessment of potential onshore impacts. ADL considered the following impacts to the year 2000: new jobs, income, population, land use, water supply, other services, and air and water emissions. The report projects the implications of two alternative oil-terminal development options. A "low level" option would bring in just enough oil (2.5 mb/d) to serve the expansion of existing refineries and limited new refinery capacity. A "high level" option would bring major new supplies (6.6 mb/d) into the Mid-Atlantic Region. ADL concludes that the high level throughput option is impractical for the Middlesex County area due to a lack of available land for industrial development.[16]

The Low Level Option

A review of volumes 2 and 4 of the ADL study indicates that the projections of economic development and of emissions resulting from a low level

facility have been made with the appropriate analytical methods. While it is possible to dispute some of the coefficients used, and to question the sensitivity of the results to certain coefficients, the results are probably reasonable indicators of what might happen in the surrounding area if the oil terminal is constructed.

The study of onshore impacts, however, falls considerably short in two important respects. First, the conclusion that the "low level" impact would be almost indiscernible from the "normal growth" expected for the Middlesex County area is not convincing. In any case it is hardly a suifficient reason in itself for permitting the facility, because even normal growth may have to be curtailed in the light of emerging environmental constraints and the limited public services in the area. Second, ADL argues against the high level option in favor of the low level alternative for northern New Jersey. The absence of land use controls in the state, however, suggests that the low level option could quickly mushroom into the high level operation, or even beyond.

The shortcomings of the ADL report can be illustrated with reference to air resources, this report's primary focus. ADL states that air quality problems exist in Perth Amboy and New Brunswick, in the industrial complexes, and along the major traffic arteries.[17] However, while projecting emissions from the petrochemical plants, the consultants ignore emissions generated by induced industrial, commercial, and residential activities. Detailed mapping of air quality in the Middlesex County area had not been completed at the time ADL gathered its data. However, a sufficient number of monitoring stations were available--including one in Perth Amboy--for the preparation of baseline tables and perhaps a map. Additional data were available from New York State stations on Staten Island. Rather than belabor this specific omission, it is appropriate to indicate what types of data shoud be gathered and how they should be used.

Monitoring Systems

A monitoring system is needed to measure factors related to health and environmental quality, at regular time intervals, and at critical sites. In contrast to this preferred system, environmental monitoring systems in the New York metropolitan region make inconsistent measurements of various factors, at different times, and at sites chosen more for convenience than for scientific relevance. The retrieval of these data is difficult because it is stored in a host of formats, on different papers and computerized forms.[18] Adequate and rational resource management requires a centralized, computerized, and standardized data bank.

It is convenient to think of a data bank as two linked modules. The first contains information about the bank's status, including location by geographical coordinates, political unit, collecting agency, air and/or watershed location, emissions, sample frequency, land use and factors sampled. This provides the user with information about the character of the sample available at a given point and the status of the information system.

The second module, whose files are linked to the first by a simple identification number, contains the actual data. This module might be housed in a central service organization. Both modules would be open-ended, so that new information could be added to the record.

Raw data generated by the sampling program should be analyzed, scaled, and processed in ways that satisfy the project's objectives. If new goals are developed, a feedback loop to the field sampling net would update raw information and prevent the accumulation and collection of useless data.

A single agency should be responsible for coordinating and managing a state or regional data bank. The data bank manager should routinely collect information gathered by many other agencies. Delay typically results in lost information.

The data should be useful for measuring the effects of development. In the case of air pollution, the data should include plume models for the petrochemical facilities, line and network source models for the increased traffic generated, and multiple source models for the residential and commercial activities.

Only when the above modeling studies have been made for both the projected normal growth and the additional impacts related to the petrochemical industries, and these results have been compared to valid standards, can it be concluded that Middlesex County and environs can tolerate even its normal projected growth, much less the low level oil facility.

The model studies represent a means of relating emissions to public health and ecosystem considerations. Such considerations are absent from the ADL study. Indeed, the consulting firm concludes that "if, as is conceivable, a high level throughput and associated development were to occur in connection with the Raritan Bay/Sandy Hook facility, a reallocation of both economic and environmental impacts within the Mid-Atlantic Region and Belt would probably result, even though total impacts would remain about the same."[19] This statement is extraordinarily naive with respect to environmental degradation. For example, BOD and SO_x are emissions, not impacts. They must be diffused over a region, and their impact on public health and the larger environment must be tested before one can generalize about the transferability of impacts between regions.

Thus, it is a mistake to equate emissions in different places. This is obvious in a water environment, where natural dilution, turbidity, and the biomass may vary considerably within short distances. In the air environment, such differences tend to be distributed over larger areas in response to meteorological conditions, industrial mix, and population distribution. In short, the public health and environmental effects of the proposed crude oil terminal will be considerably different in urbanized regions like northeastern New Jersey and Boston than in rural areas like southern New Jersey and North Carolina.

Given reliable information about the economic and environmental implications of proposed development, these must be translated into common measures for decision making. George Tolley has developed a prototype case based on a city of 1.5 million working families that has the economic potential of adding 150,000 workers.[20] Tolley compares the local revenues generated by the added population to the health, environmental, and structural damages and the costs of preventive measures. If applied to the oil terminal issue, Tolley's prototype suggests that the costs of preventing air pollution damage to communities along the Arthur Kill and Raritan Bay are likely to increase at nonlinear rather than simple linear rates. Educated guesses, however, are indadequate substitutes for analysis. The resources in the study area must be reviewed and all development alternatives must be identified and presented to the public to make clear the costs of exceeding the resource limits.

Worst-case Analysis

The ADL study fails to develop emissions data and environmental impact information for abnormal emission episodes. The consulting firm assumes a set of effluent discharge coefficients and expected removal rates in order to calculate average discharges from the petrochemical facilities. While this is an accepted procedure, it seems prudent that an industry with the potential for discharging persistent and toxic wastes, and with a history of tanker collisions and spills, should be required to develop simulations for possible malfunctions. These simulations are the rule in the nuclear power industry. Certainly, the public health and environmental implications of abnormal emissions should not be overlooked. Potential dischargers should estimate probabilities for different malfunctions, and demonstrate techniques for preventing the malfunctions, or for controlling their effects with secondary systems.

Water Supply

A final policy area in need of much more serious analysis is water supply. ADL suggests that "New Jersey's extensive groundwater reserves are being eyed by many people."[21] Indeed, the state's supplies have been

coveted by Philadelphia and New York City since the turn of the century. While ample groundwater supplies are found in southern New Jersey at this time, present surpluses are likely to be utilized or lost to development in the forseeable future.[22] Furthermore, the costs of transferring them to the water-short North may be prohibitive.[23]

Summarizing, the ADL-study conclusion that "the impact of a low level of crude-oil imports through a supertanker terminal would be virtually indistinguishable from the 'baseline' or 'normal' growth pattern" is not acceptable.[24] Nor is it necessarily true that "normal" growth will itself be tolerable; or that a small emission increment can be treated as a small linearly additive impact.

The High Level Option and Industrial Agglomeration

The ADL report projects the impact of the oil terminal on Middlesex County and the State of New Jersey to the year 2000. The low level option is estimated to generate two new petrochemical complexes and 45,000 additional residents in Middlesex County, and four new petrochemical complexes and 145,000 added residents in all of New Jersey. The high level option, which is not recommended or traced for Middlesex County except for direct land use, is projected to add 34 petrochemical facilities and 1.24 million residents to New Jersey in the same period.[25]

Nevertheless, despite ADL's assurances of a shortage of land in Middlesex County, it is far from certain that a combination of economic and environmental forces could not lead to the progressive expansion of the low level into the high level option in northeastern New Jersey. While ADL does not develop projections for the high level option in the Middlesex County region, they do equivocate on their low-level-option-only stance. First, they suggest that end-use petrochemical operations could add 25 to 50 percent to the low-level-option projections.[26] Studies by James and Hughes, and by the author suggest that the already existing transportation, skilled labor, and market advantages of the area could indeed increase the original projections substantially.[27]

ADL then suggests that if the crude oil terminal with the high level option were sited off the northern New Jersey coast, "the northern portion of the Mid-Atlantic Belt--including Middlesex County--would probably receive 25 to 30 percent of total development, as compared with 10 to 12 percent with the terminal in or off Delaware Bay."[28] By the same token, it is at least plausible to suggest that if a facility were constructed in northern New Jersey for a low level operation, the petrochemical industry would seek to make it bigger.

The forces favoring centralization of petrochemical facilities in the Arthur Kill and Raritan Bay go beyond the market forces reviewed above. If strict environmental and coastal legislation force industrial development into areas with lower water and air quality standards, Raritan Bay would be a convenient site for the transshipment of offshore oil. Raritan Bay is also close to Long Island, and might eliminate the need for a terminal in Nassau and Suffolk Counties, a terminal which has been strongly opposed by the two New York counties. Further, a deepwater port could become popular for other liquid cargoes and for large ships. The terminal's onshore transportation facilities might become another economic magnet. These agglomerative tendencies can only be countered by a firm and formal land use control mechanism that will be respected by localities as well as the major oil companies and their associated industrial allies.

If the combination of agglomerative forces outlined above were to materialize, the plans so painfully developed by Middlesex, Monmmouth, and perhaps Mercer and Ocean Counties would be torn to shreds; Raritan Bay would probably be turned into a more hydraulically efficient version of the Arthur Kill. Some observers may feel that such an outcome is highly improbable; some may fear that frightening statistics will be misused to arouse hysterical opposition to the oil project, as WASH-740 has been used against the nuclear power industry. The real implications of these forces are sufficiently threatening, however, to warrant more than the few sentences they are accorded in the four ADL volumes.

Some of the questions raised by this paper will hopefully be considered by a $523,000 study by the Federal Technology Assessment Office (OTA).

OTA has contracted with the firm of Braddock, Dunn, and McDonald to study and advise on the impact on New Jersey of plans for a deepwater port at Long Branch, offshore oil production, and nuclear power plants in the ocean. The former and present Commissioners of the New Jersey Department of Environmental Protection, Richard Sullivan and David Bardin, will be advisers to the study.

RESOLUTION OF THE ISSUES

This section explores the institutional capabilities for resolving the policy alternatives created by the oil terminal issue.

International and National Levels

There are three alternatives to a deepwater crude oil terminal off the northern coast of New Jersey: (1) reduction of demand; (2) substitution of offshore American oil and/or alternative sources of power for imported foreign oil; and (3) selection of other sites.

The first two possibilities involve decisions that can only be made at the highest levels of international corporations, and American and foreign governments. Energy conservation, oil shale, coal gasification, and nuclear power as substitutes for unpredictable Middle East petroleum sources are choices that have been debated in volumes and are beyond the scope of this paper. They can only be acknowledged as choices which, on the one hand moot the oil-terminal issue, and on the other hand create equally debatable economic and environmental impacts in other regions.

The third alternative--selection of alternative sites--suggests two broad considerations. Can the states, counties, and localities be heard? If so, can they make themselves felt? ADL concludes that "concentrated development of only one or two ports on each coast is unnecessary--indeed probably undesirable--from the standpoint of balanced economic development and environmental protection."[29] In addition to the northeastern New Jersey site, they explored the following four locations: Machias, Maine; Delaware Bay, New Jersey; Grande Isle, Louisiana; and

Freeport, Texas. Other sites that have been mentioned range from the urbanized Boston-Portland, Maine area to relatively undeveloped North Carolina.

All of these sites offer the potential for heated conflict with serious interregional political implications. If the East Coast is spared a high level operation, the Gulf Coast will be forced to bear a far greater share of the environmental burden. By the same token, the traditional U.S. oil-exporting area will acquire the fiscal and political power to lend credibility to the often-quoted southern phrase, "let the bastards freeze in the dark." If southern New Jersey or the North Carolina coast is selected, the decision makers will be charged with sacrificing open space to favor areas "already lost." If northern New Jersey or the Boston area is chosen, these already burdened regions will charge that they are being sacrificed again to preserve open space for the wealthy.

The formal arena of conflict resolution was previously described as the several offices of the Army Corps of Engineers and the Congress. The public has had access to the deepwater port hearings held by the Corps. Prior to the first hearings at Middletown, New Jersey in December 1972, the Corps indicated that it had mailed out 3,200 notices to officials and representatives of environmental groups.[30] The harsh opposition to the deepwater facility vented at the Middletown meeting led the assistant chief of the planning branch of the Corps in Philadelphia to indicate that he might recommend that the terminal not be constructed.[31] One week later, the Corps decided that the facility should be constructed with private capital and recommended three possible sites (Long Branch, Cape May, and Cape Henlopen) instead of a single site.[32] Six days later, the possibility of the federal government overriding any opposition from the Governors of New Jersey and Delaware was raised by an official from the Corps.[33] Thus in the short span of two weeks, the Corps of Engineers radically changed its public statements.

While the states, counties, and localities have been presented with a series of institutional mechanisms through which they can register their opinions with federal agencies, Congress and the executive branch ultimately

will have to assume the responsibility for the site selection. Events in Congress suggest that agreement on the role of the states and local governments will be difficult to achieve. The House approved a bill proposed by the Merchant Marine and Fisheries Committee that would make it possible for the deepwater port to be built along the East Coast, even while allowing any state within 10 miles of the proposed port to veto the project if its objections cannot be satisfied. The House rejected the stronger veto provision in a Public Works Committee bill. Environmental groups were more satisfied with the Senate bill, which virtually gave the states a veto power on the construction of a port; sought to regulate the ownership and operation of the facilities; and set up a $100 million liability fund to offset the potential impacts of oil spills.

The coastal states would like Congress and the executive branch to grant the states a veto and the power to own, operate, and control the buoy, the pipelines, and the tank farms. If the Congress rejects the opinions of the communities and states, they could argue for a legal reversal. Moreover, individuals forced to relocate by the onshore impacts of the facility may complain to the courts that the impact radius is so great as to necessitate a migration beyond the commuting range of their place of work. The mechanism of compensation to the private citizen by isolated, nuisance industries will be inadequate in the case of a facility that spreads its tentacles over a region instead of a few square miles. While this argument might be persuasive to social scientists, it is not likely to convince the courts, which are more likely to rule that the federal administrative decision is valid and unchallengeable in an issue clearly involving international and interstate commerce. The court's ruling on whether the federal or state governments control the Baltimore Canyon waters may provide some clues as to the decision on deepwater ports.

State, County and Local Levels

If Long Branch or another site in New Jersey is selected, two institutional responses might be expected. First, the New Jersey legislature could reconsider its rejection of legislation which would effectively ban the terminal. Such a step would, however, invite harsh formal and informal

responses from the federal government, including perhaps a ruling that the federal decision takes precedence over the state law banning the pipelines and that onshore land use controls aimed at controlling refineries can be set aside.

Alternatively, the state legislature could act to control the expected onshore impacts on land availability, environmental degradation, and public services. Such legislation would necessarily shift some decision-making prerogatives from the minor civil division to the state and county levels. The extent of this shift in the locus of power would necessarily be constrained by the legacy of local political power in the state. In New Jersey, it is likely that it would be more acceptable politically to shift power to the counties than to the state. The following proposal might be an acceptable compromise:

1. Power to the county to develop and to enforce county-wide land use control and, if desired, to review environmental statements;
2. Power to the state to act as an arbiter between the county and the minor civil division and to coordinate the planning of large-scale projects that reach beyond any one county's borders.

Alternatives to the above include any of the following: state review of local decisions; state guidelines; state designation and control; and state guidelines with county designation and control.[34]

While proposals for long-range, national land use policies are discussed in Washington, and close-up studies of local environmental and economic impacts are prepared by consultants, private industry and real estate interests continue to make the important land and resource commitments. Present land use policy in New Jersey is an aggregate of tens of thousands of uncoordinated decisions, a fact which is intolerable in the face of technologies that have the potential for far-reaching economic, social, and environmental impacts over a wide region.

Notes

1. The basic references for this paper are the following: Arthur D. Little, Inc. Potential Onshore Effects of Deepwater Oil Terminal-Related Industrial Development, volume 1, part 1, Executive Summary; volume 2, part 2, Mid-Atlantic Region; volume 4, Appendices. Prepared for the Council on Environmental Quality, September 1973.

2. 2.5 mb/d is low estimate of Arthur D. Little, 9.973 is the high estimate of SORO's Associates.

3. Overviews of growth center theory are presented in the following: Niles Hansen, Location Preferences, Migration, and Regional Growth, Praeger, 1973; and Brian Berry, Growth Centers in the American Urban System, Ballinger, 1973.

4. For example, Niles Hansen, Intermediate-Size Cities as Growth Centers, Praeger, 1971.

5. Arthur D. Little, Inc. (ADL), vol. 2, p. 2-2.

6. Quoted in New York Times, November 28, 1973, p. 61.

7. See Philip M. Savage, "Toward a State Land Use Policy, The Maine Experience," paper presented at the American Institute of Planners Conference, Boston, Mass., October 8, 1972, for a discussion of the use of the law.

8. See New York Times, June 21, 1970, p. 20 for a discussion of the Pittston Company's proposal for Eastport, Maine. See letter from Neil Rolde, State Representative, York, Maine for a review of the role of the major oil companies in blocking the Occidental Petroleum Company's efforts in Maine. New York Times, August 12, 1973, section 3, p. 3.

9. See New York Times, January 23, 1973, p. 84; May 4, 1973, p. 79; May 19, 1973, p. 36; May 20, 1973, p. 77; and May 22, 1973, p. 85 for commentary on these bills.

10. See New York Times, March 14, 1973, p. 91, and March 16, 1973, p. 86 for a review of Representative Sandman's comments on the superport issue.

11. Conversation with Robert Leighton, February 19, 1974.

12. Conversation with Barbara Metzger, February 19, 1974.

13. Conversation with Mr. Shore, Vice President for Public Affairs, Regional Plan Association, and with Mr. Monahan, Information Officer, Port Authority of New York, February 20, 1974.

14. See New York Times, February 13, 1972, p. 49, and May 20, 1973, p. 77 for a discussion of this change in the original bill.

15. The major document prepared by Middlesex County is a letter from the Middlesex County Planning Board Staff to the Board of Engineers for Rivers and Harbors concerning the Interim Report, Atlantic Coast Deepwater Port Facilities Studies, August 28, 1973, 12pp.

16. ADL, vol. 2, p. 2-10.

17. Ibid., p. 2-176.

18. The data management system outlined in the following paragraphs was the work of Professor Leonard Zobler, Department of Geography, Barnard College and Columbia University. An application of this system to water resource data in the New York Metropolitan Region may be found in: George Carey, Leonard Zobler, Michael Greenberg, and Robert Hordon, Urbanization, Water Pollution and Public Policy, Center for Urban Policy Research, Rutgers University, 1972.

19. ADL, vol. 2, p. 2-182.

20. George S. Tolley, National Growth Policy and the Environmental Effects of Cities, National Technical Information Service, April 1972.

21. ADL, vol. 2, p. 2-169.

22. See letter from Middlesex County Planning Board to the Corps of Engineers, August 28, 1973, pp. 4-5 for a concise discussion of this issue.

23. The problem of water transfers in metropolitan regions is developed in Leonard Zobler, George Carey, Michael Greenberg, and Robert Hordon, Benefits from Integrated Water Management in Urban Areas--The Case of the New York Metropolitan Region, National Technical Information Service, 1969.

24. ADL, vol. 2, p. 2-10.

25. ADL, vol. 1 p. 1-17.

26. ADL, vol. 2, p. 2-156.

27. Franklin James and James Hughes, Modeling State Growth, New Jersey 1980, Center for Urban Policy Research, Rutgers University, 1973; Michael Greenberg, The Pharmaceutical Industry in Middlesex County: Growth, Site Selection and Induced Economic and Environmental Effects, Class 970: 614:03, Simulating Regional Economic Development, Livingston College, Rutgers University, Spring 1973.

28. ADL, vol. 2.

29. ADL, vol. 1, p. 1-9.

30. New York Times, December 10, 1972, p. 150.

31. New York Times, January 4, 1973, p. 78.

32. New York Times, January 10, 1973, p. 86.

33. New York Times, January 15, 1973, p. 66.

34. The following are suggested for those interested in an introduction to land use control: Virginia Curtis, ed., Land Use and the Environment, EPA, 1973; Richard Slavin, "Toward a State Land Use Policy: Harmonizing Development and Conservation," State Government: the Journal of State Affairs, vol. 44, no. 1, Winter 1971, pp. 2-11. For a specific proposal in the study area see Regional Plan Association and Mid-Hudson Pattern for Progress, The Mid- Hudson: A Development Guide, RPA, 1973.

Acknowledgements

The assistance of Douglas Powell, Director of County Planning and William J. Kruse, Principal Planner, Middlesex County, New Jersey, is acknowledged. I would also like to thank Professor Jerome Rose, Department of Urban Planning and Policy Development, Livingston College, Rutgers University, for commenting on the legal aspect of the issue.

4. AIR QUALITY AND NATURAL RESOURCES IN THE CATSKILLS

Alex Carter

BACKGROUND

The Catskill region of New York is located in the southeastern portion of the state and is composed of the counties of Delaware, Sullivan, Schoharie, Ulster, Greene, Albany, Otsego, and Chenango. However, the latter two counties do not fall within the designated boundaries of the Hudson Basin Project. The region is composed of approximately 3.6 million acres of privately owned land and approximately 410,000 acres of state-owned land. Unlike the Adirondack region in northeastern New York State, large private landholdings and large timber and industrial landholdings are relatively nonexistent in the Catskill area (2).

The economy of the region centers around four major occupational specialties: agriculture or farming, forestry, recreation, and mining (3). The farming trends in the area are pointing toward increasing intensive production techniques on less land area through mechanization and greater farming efficiency. Farming practices such as dairying, livestock production, fruit production, vegetable truck farming, and poultry production are representative of the major agricultural processes underway throughout the region. However, since 1959 a reduction in the total acreage being farmed has been observed. The decline is attributable to such factors as urban expansion; low return rates on capital and labor investments; poor soil conditions; incompatible terrain for modern, mechanized farming techniques; and, finally, conversion of land to non-farm residential and recreational uses (6).

In the Catskills, the forests comprise more land area than any other natural or cultivated entity. This is typical of the entire state; approximately 51 percent of the total land area is forested. If outmoded and abandoned farmland continues to become available for conversion to other uses, and current trends continue as they have in the past, it is anticipated that forested land will increase appreciably in the future (9). Of the 410,000 acres of state-owned land within the region, 250,000

acres comprise the Catskill Forest Preserve and the remaining 160,000 acres are in state forests, multiple-use and recreational areas, and wildlife management districts (2). The principal forest vegetation is a combination of the northern and central hardwood forest types. The dominant tree species in this classification include hickory (Carya sp.), oak (Quercus sp.), ash (Fraxinus sp.), maple (Acer sp.), gum (Nyssa sp.), cherry (Prunus sp.), sycamore (Platanus sp.), hemlock (Tsuga sp.), and pine (Pinus sp.) (26). The potential for forest industry development and the resulting economic benefits lie in the marketing of such forest products as lumber, pulpwood (for paper manufacturing), poles, pilings, railroad ties, mine timber, furniture, and chemically derived forest by-products such as tannins, dyes, syrup, and plastics.

Economic opportunity also exists through the development of such recreational attractions as ski resorts, riding stables, wilderness areas, and historic sites. These attractions and others such as boating, hiking, camping, fishing, canoeing, and hunting make this area especially enticing to the 10 million people living within an easy 2- to 3-hour driving radius. This potential influx does not take into consideration the number of people living in the adjoining states of New Jersey, Pennsylvania, Connecticut, and Massachusetts who are within an equal driving radius of the Catskill area (2).

Mining in the region is a relatively minor industry compared to farming, forestry, and recreation. It is, however, the fourth largest industry, consisting of open-pit mining, and gravel and cement production (3). It appears as an incongruous entry into the aesthetically pleasing setting created by the intermingling of agriculture and forest wilderness which is characteristic of this section of the state.

METEOROLOGY

Climatic conditions of the Catskills are usually very diversified due to latitude, topographic variation, and proximity to large bodies of water. However, human activity, whether in labor or recreational pursuit, is stimulated by an invigorating winter climate and a generally comfortable

environment in the summer. It is this type of climate that contributes greatly to the agricultural, recreational, and limited industrial success enjoyed in the region. Climatic conditions are unquestionable assets to the rate of economic expansion which is enjoyed not only by the inhabitants of the Catskills but the entire state (28). However, certain meterological conditions play another important role in this area, but to the detriment of the economy. During the summer months, prevailing west-southwesterly winds pose the threat of importing polluted air masses into the scenic Catskills, especially in the eastern section of the region (27). These air masses originate in the New York and northern New Jersey urban-industrial complex. The wide array and fluctuating concentrations of pollutants and the duration of the air masses threaten to subject existing vegetative forms to pollution levels which were infrequently, if ever, previously encountered. In addition, widely varying topographical features, characteristic of the area, dictate the possiblity of further pollution isolation and concentration in certain areas such as lowlands and mountain valleys. These variables may also modify the effects of a pollutant on a given plant species within the same general geographical area, making damage assessment difficult and potentially inaccurate.

AIR POLLUTION POTENTIAL

The potential for the generation of air pollution, with resulting damage to vegetation and natural resources, appears to be on the increase. Urbanization and residential development in rural environs should increase the pollution potential from automobiles and other moving sources. The general increase in normal traffic volume, combined with the growing number of individuals commuting to work in the cities, poses a further threat of augmenting pollution generation. Also, proposed major transportation projects such as Interstate 88, Route 17, the Thruway, and the Stewart Jetport threaten to further amplify pollution levels within the region in the future (4). Air pollution emissions from home heating, incineration, and electric power generation will also increase due to the growing population inhabiting the immediate area and its periphery.

Increased tourism and recreational potential, combined with the increased use of modern mechanized techniques in agriculture, lengthen this list of potential air pollution sources. Likewise, should industrialization obtain a foothold within the region, such as with the establishment of pulp and paper mills (24) or further expansion of existing mining and related industries, additional sources of air pollution will be created with greater emission possibilities.

It can be inferred from the foregoing discussion that with an increase in air pollution generation, a decrease in air quality would be inevitable without implementation of control measures. This holds the potential of exerting a significant detrimental impact upon the forest environment, natural resources, and agricultural processess which are vital to the region's economy. At present, assessment of the extent to which certain vegetative forms and natural resources are affected; identification of the injurious mechanisms; and determination of the spatial and temporal variability of certain pollutants is impossible due to the limited extent of research and experimentation accomplished in this field (7). In the Catskills, this dilemma is further complicated by the complete absence of air monitoring. The closest air monitoring station, operated by the State Department of Environmental Conservation, is in Kingston on the Hudson River (27). Therefore, only speculation of what the air quality might be in the Catskills is possible. As a result, not only is the future of the agricultural, forest, and natural resources in question, but also the future of the wildlife forms inhabiting the area, present recreational and residential developments, land use planning programs, and possibly the very health, safety, and welfare of the people.

The impact of air pollution on the economically and aesthetically significant agricultural and forest resources in the Catskills is, at best, an incompletely defined problem with seemingly infinite ramifications. The effects of various air pollutants upon vegetation have been studied since the turn of the twentieth century (12). However, to date all research efforts on air pollution injury have been oriented toward identification of the causative agent of injury and isolation of the pollution source. Since no steps have been taken to propose a plan to coordinate these

research efforts (7), the information previously obtained is not only limited in scope and applicability, but the knowledge of the effects is significantly discontinuous and grossly incomplete. In most cases, the research procedure involves subjecting different plant species to laboratory exposures of different pollutants at varying levels of concentration until injury symptoms produced on the test plant are similar to those on vegetation near sources emitting the particular pollutant.

RESEARCH NEEDS

To obtain a complete and concise assessment of the impact of different air pollutants on agricultural, forest, and natural resources, whether in the Catskill region of New York or the tropical rain forest region of the Amazon, additional research is needed in several critical areas. These include: (1) the impact of pollution and pollutant interactions as they relate to secondary effects, such as insect and disease susceptibility; (2) genotypic and phenotypic evolution; (3) variation of pollution damage mechanisms with topography, geography, latitude, and meterological changes; (4) effects of environmental stresses on plant response to pollutants; (5) evaluation of plants as pollution sources and sinks; (6) basic information regarding the effects of pollutants on agricultural productivity and timber volume yields; (7) quantitative dose-response information to support mathematical models which have been developed to assess acute and chronic air pollution effects on plant growth, quality, and fiber; and (8) development of techniques to minimize pollution effects on vegetation.

PHYTOTOXICITY AND THE MAJOR AIR POLLUTANTS

The recognition of significant and frequently devastating impacts of air pollution upon forest and agricultural vegetation began when sulfur dioxide was identified as the phytotoxicant responsible for the complete destruction of vegetation in certain areas throughout the United States in the late 1800s. This visible injury may be the primary factor that kindled the serious concern of individuals for cleaner air. The early urban smoke problem which existed in virtually every metropolitan area

was simply termed a "nuisance". But with the exposure of the obvious deleterious effects of sulfur dioxide on vegetation near Ducktown, Tennessee, people began to place air pollution and the problems it imposed into the proper perspective. This complete destruction of vegetation is practically nonexistent today (14). However, the generation of air pollution has increased along with the affected areas. Today's phytotoxic pollutants include such chemical substances as sulfur dioxide, fluoride, nitrogen dioxide, and the products of photochemical smog (ozone and peroxyacetyl nitrate). Smog injury to vegetation is prevalent in most of the metropolitan areas of the nation and many of the outlying suburban and rural environs. In the northeastern United States, ozone and sulfur dioxide pose the most serious threat to vegetation (12).

An analytical survey in 1969-70 conducted by the Stanford Research Institute on the economic impact of air pollution upon agronomic, ornamental, and forest vegetation in California indicated an average annual loss of $35,230,000. A similar survey conducted by SRI in Pennsylvania in 1970-71 showed an annual loss of $7,391,000. In 1971, the Environmental Protection Agency sponsored a survey in New Jersey using the same criteria as the SRI surveys and assessed the loss at $1,183,754. However, this survey was directed toward agronomic crops and excluded any acute effects upon ornamental flora. As a result, due to a gradual shifting of the agricultural industry to urban-related ornamental crops, the loss figure may be substantially higher (14, 11).

The agricultural industry trend in the Catskills is very similar to that in New Jersey as are many of the commercial crops. The forest type is a combination of those found in Pennsylvania and New Jersey. Thus, it is reasonable to assume that considerable damage is being inflicted upon the economy of the Catskills in much the same manner as in New Jersey and Pennsylvania.

Since it is not the purpose of this study to analyze the symptomatology characteristic of the major phytotoxic air pollutants and their effect upon vegetation, a brief summary describing the pollutant, its origin,

and general effects will follow with tabular references of the relative sensitivities of selected vegetative forms.

Sulfur dioxide (SO_2) is emitted in the combustion of coal and petroleum products, the roasting of sulfide ores during smelting operations, petroleum refining, coke processing, and pulp and paper manufacturing. Vegetation can tolerate varying levels of SO_2 exposure below a time-concentration-related response threshold depending upon plant species and age. Table 4-1 illustrates the thresholds for various plant species as they relate to injury by sulfur dioxide (12, 19).

Fluoride, in the gaseous form of hydrogen fluoride (HF), is released into the atmosphere as the by-product of high-temperature metallurgical processes such as steel smelting and zinc foundries. Fluoride damage to vegetation is usually caused by a cumulative poisoning effect created by exposure to low concentrations of fluoride over a long period of time. Extremely sensitive plants such as gladiolus and Chinese apricot may be marked by concentrations below 0.1 parts per billion (ppb), while several times that that amount is necessary for symptomatic expression in other species. Table 4-2 illustrates the relative sensitivities of selected plants to fluoride (12).

Oxides of nitrogen (NO_x), peroxyacetyl nitrate (PAN) and ozone (O_3) are the constituents of the highly phytotoxic "photochemical smog," which became famous in the Los Angeles Basin but is becoming increasingly prevalent in the eastern United States (10). Actually, the oxides of nitrogen, precursors of the photochemical reaction which produces ozone and PAN, are frequently referred to as "oxidants" when the exact chemical species are indistinguishable. Nitrogen oxides affect vegetation only upon accidental releases or spillages resulting in short exposure durations of high concentration. Currently, there is no direct relationship between time and concentration effects on vegetation. It is known, however, that concentration influences the extent of damage more than duration of exposure. Table 4-3 illustrates the relative sensitivities of selected plants to nitrogen oxides (20).

Table 4-1 Sulfur Dioxide Concentrations Causing Injury to Agricultural and Forest Species[a]

Species	Maximum average concentrations[b] 1 hr, µg/m³ (ppm)	2 hr, µg/m³ (ppm)	4 hr, µg/m³ (ppm)	8 hr, µg/m³ (ppm)
Agricultural				
Buckwheat (*Fagopyrum* sp.)	1467 (0.56)	1022 (0.39)	681 (0.26)	393 (0.15)
Barley (*Hordeum vulgare*, L.)	1651 (0.63)	1153 (0.44)	629 (0.24)	314 (0.12)
Red clover (*Trifolium pratense*, L.)	1834 (0.70)	1205 (0.46)	707 (0.27)	367 (0.14)
Radish (*Raphanus sativus*, L.)	1991 (0.76)	1415 (0.54)	760 (0.29)	367 (0.14)
Oats (*Avena sativa*, L.)	1651 (0.63)	1546 (0.59)	891 (0.34)	445 (0.17)
Peas (*Pisum sativum*, L.)	1651 (0.63)	1546 (0.59)	891 (0.34)	445 (0.17)
Rhubarb (*Rheum rhaponticum*, L.)	1651 (0.63)	1546 (0.59)	891 (0.34)	445 (0.17)
Timothy (*Phleum pratense*, L.)	1729 (0.66)	1415 (0.54)	1048 (0.40)	550 (0.21)
Swiss chard (*Beta vulgaris* var. *cicla*, L.)	2306 (0.88)	1677 (0.64)	1074 (0.42)	707 (0.27)
Beans (*Phaseolus* sp.)	1205 (0.46)	1179 (0.45)	1127 (0.43)	550 (0.21)
Beets (*Beta vulgaris*, L.)	3432 (1.31)	2017 (0.77)	1179 (0.45)	603 (0.23)
Turnips (*Brassica rapa*, L.)	3432 (1.31)	2017 (0.77)	1179 (0.45)	603 (0.23)
Carrots (*Daucus carota*, L.)	2830 (1.08)	2070 (0.79)	1310 (0.50)	655 (0.25)
Cucumbers (*Cucumis sativa*, L.)	2830 (1.08)	2070 (0.79)	1310 (0.50)	655 (0.25)
Lettuce (*Lactuca sativa*, L.)	1677 (0.64)	1467 (0.56)	1126 (0.43)	996 (0.38)
Tomatoes (*Lycopersicon esculentum*, Mill.)	1677 (0.64)	1467 (0.56)	1126 (0.43)	996 (0.38)
Potatoes (*Solanum tuberosum*, L.)	1677 (0.64)	1467 (0.56)	1126 (0.43)	996 (0.38)
Raspberry (*Rubus idaeus*, L.)	1939 (0.74)	1651 (0.63)	1389 (0.53)	1022 (0.39)
Celery (*Apium graveolens*, L.)	2279 (0.87)	1939 (0.74)	1441 (0.55)	760 (0.29)
Spinach (*Spinacea oleracea*, L.)	3511 (1.34)	2384 (0.91)	1310 (0.50)	891 (0.34)

Table 4-1 (Cont.)

Species	Maximum average concentrations[b] 1 hr, µg/m³ (ppm)		2 hr, µg/m³ (ppm)		4 hr, µg/m³ (ppm)		8 hr, µg/m³ (ppm)	
Forest								
Cabbage (*Brassica oleracea*, L.)	2463	(0.94)	2332	(0.89)	1834	(0.70)	1179	(0.45)
Corn (*Zea mays*, L.)[c]	--	--	--	--	--	--	--	--
Bracken fern (*Pteridium aquilinum*, L.)	1179	(0.45)	891	(0.34)	625	(0.25)	550	(0.21)
Large tooth aspen (*Populus grandidentata*, Michx)	1729	(0.66)	1126	(0.43)	969	(0.37)	524	(0.20)
Willow (*Salix* sp.)	1074	(0.41)	996	(0.38)	865	(0.33)	786	(0.30)
Trembling aspen (*Populus tremuloides*, Michx)	1100	(0.42)	1022	(0.39)	681	(0.26)	341	(0.13)
Jack pine (*Pinus banksiana*, Lamb.)	1362	(0.52)	1153	(0.44)	760	(0.29)	524	(0.20)
White pine (*Pinus strobus*, L.)	1179	(0.45)	917	(0.35)	655	(0.25)	550	(0.21)
Alder (*Alnus* sp.)	1205	(0.46)	1126	(0.43)	1126	(0.43)	550	(0.21)
Red pine (*Pinus resinosa*, Ait)	2043	(0.78)	1809	(0.69)	1153	(0.44)	786	(0.30)
Balsam poplar (*Populus balsamifera*, L.)	2149	(0.82)	1703	(0.65)	1179	(0.45)	681	(0.26)
Austrian pine (*Pinus nigra*, Arnold)	1729	(0.66)	1179	(0.45)	1153	(0.44)	865	(0.33)
Witch hazel (*Hamamelis virginiana*, L.)	2987	(1.14)	1965	(0.75)	1179	(0.45)	603	(0.23)
Red oak (*Quercus* sp.)	2332	(0.89)	2149	(0.82)	1598	(0.61)	1074	(0.41)
Sugar maple (*Acer saccharum*, Marsh.)	2149	(0.82)	1703	(0.65)	1624	(0.62)	1205	(0.46)
White spruce (*Picea glauca* (Moench)(Voss)	2279	(0.87)	2070	(0.79)	1834	(0.70)	1310	(0.50)
Cedar (*Thuja, occidentalis*, L.)[c]	--	--	--	--	--	--	--	--

a. The vegetation was observed when growing under environmental conditions that made it most sensitive to SO_2.
b. Average concentrations over the reported time periods. Inaccuracies associated with instrumentation result in deviations as great as ±10 percent.
c. Never injured near recorder stations.

Table 4-2 Sensitivity of Selected Plants to Fluorides

Sensitive

Apricot, Chinese and royal
Prunus armeniaca, L.
Boxelder
Acer negundo, L.
Blueberry
Vaccinium, sp.
Corn, sweet
Zea mays, L.
Fir, Douglas
Pseudotsuga taxifolia, Brit.
Gladiolus
Gladiolus, sp.
Grape, European
Vitis vinifera, L.
Grape, Oregon
Mahonia repens, Don.
Larch, western
Larix occidentalis, Nutt.
Peach (fruit)
Prunus persica, Sieb. & Zucc.
Pine, Eastern white, lodgepole, scotch, Mugho
Pinus strobus, L.
Pinus contorta, Dougl.,
Pinus sylvestris. L.,
Pinus mugho, Turra.
Pine, ponderosa
Pinus ponderosa, Laws.
Plum, Bradshaw
Prunus domestica, L.
Prune, Italian
Prunus domestica, L.
Spruce, blue
Picca pungens, Englm.
Tulip
Tulipa gesneriana, L.

Intermediate

Apple, delicious
Malus sylvestris, Mill.
Apricot, Moorpark and Tilton
Prunus armeniaca, L.
Arborvitae
Thuja, sp.
Ash, green
Fraxinus pennsylvania var. *lanceolata*, Borkh.
Aspen, quaking
Populus tremuloides, Michx.
Aster
Aster, sp.
Barley (young plants)
Hordeum vulgare, L.
Cherry, Bing, Royal Ann
Prunus avium, L.
Cherry, choke
Prunus virginiana, L.
Chickweed
Cerastium, sp.
Clover, yellow
Melilotus officinalis, Lam.
Citrus (lemon, tangerine)
Citrus, sp.
Geranium
Geranium, sp.
Golden Rod
Solidago, sp.
Grape, Concord
Vitis labrusca. L.
Grapefruit (fruit)
Citrus paradisi, Mact.
Grass, crab
Digitaria sanguinalis, L. Scop.
Lambs-quarters
Chenopodium album, L.
Lilac
Syringa vulgaris, L.
Linden, European
Tilia cordata, Mill.
Maple, hedge
Acer campestre, L.
Maple, silver
Acer saccharinum, L.
Mulberry, red
Morus rubra, L.
Narcissus
Narcissus, sp.
Nettle-leaf goosefoot
Chenopodium, sp.
Orange
Citrus sinensis, Osbeck
Peony
Paeonia, sp.
Poplar, Lombardy and Carolina
Populus nigra, L. and *Populus cugenei*, Simon-Louis
Raspberry
Rubus idaeus, L.
Rhododendron
Rhododendron, sp.
Rose
Rosa odorata, Sweet
Serviceberry
Amelanchier alnifolia, Nutt.
Sorghum
Sorghum vulgare, Pers.
Spruce, white (young needles)
Picea glauca, Moench, Voss.
Sumac, smooth
Rhus glabra, L.
Sunflower
Helianthus, sp.
Violet
Viola, sp.
Walnut, black
Juglans nigra, L.
Walnut, English
Juglans regia, L.
Yew
Taxus cuspidata, Sieb. & Zucc.

Table 4-2 (Cont.)

Resistant

Ash, European Mt.
Sorbus aucuparia, L.
Ash, Modesto
Fraxinus velutina, Torr.
Asparagus
Asparagus, sp.
Birch, cutleaf
Betula pendula var. *gracilis*, Roth.
Bridalwreath
Spiraca prunifolia, Sieb. & Zucc.
Burdock
Arctium, sp.
Cherry, flowering
Prunus serrata, L.
Cotton
Gossypium hirsutum, L.
Currant
Ribes, sp.
Elderberry
Sambucus, sp.
Elm, American
Ulmus americana, L.
Juniper (most species)
Juniperus, sp.
Linden, American
Tilia americana, L.
Pear
Pyrus communis, L.
Pigweed
Amaranthus retroflexus, L.
Planetree
Platanus, sp.
Plum, flowering
Prunus cerasifera, Enrh.
Pyracantha
Pyracuntha, sp.
Squash, summer
Curcurbita pepo, L.
Strawberry
Fragaria, sp.
Tomato
Lycopersicon esculentum. Mill.
Tree of heaven
Ailanthus altissima, L.
Virginia creeper
Parthenocissus quinquefolia, Planch.
Willow (several species)
Salix, sp.
Wheat
Triticum, sp.

Table 4-3 Sensitivity of Selected Plants to Nitrogen Oxides

Sensitive

Azalea
Rhododendron, sp.
Bean, pinto
Phaseolus vulgaris, L.
Brittlewood
Melaleuca leucadendra
Hibiscus
Hibiscus rosasinensis
Lettuce (head)
Lactuca saliva, L.
Mustard
Brassica, sp., L.
Sunflower
Helianthus annuus, L.
Tobacco
Nicotiana glutinosa, L.

Intermediate

Cheeseweed
Malva parviflora, L.
Chickweed
Stellaria media, Cyrill
Dandelion
Taraxacum officinal, Weber
Grass, annual blue
Poa annua, L.
Orange
Citrus sinensis, Osbeck
Rye
Secale cereale, L.

Resistant

Asparagus
Asparagus officinalis, L.
Bean, bush
Phaseolus vulgaris, L.
Carissa
Carissa carandas
Croton
Codiaeum, sp.
Grass, Kentucky blue
Poa pratensis, L.
Health
Erica, sp.
Ixora
Ixora, sp.
Lambs-quarters
Chenopodium album, L.
Nettle-leaf goosefoot
Chenopodium, sp.
Pigweed
Chenopodium, sp.

PAN concentrations develop in an area where a polluted air mass is stationary due to low surface winds or an inversion layer. Since PAN usually occurs in conjunction with other pollutants, it is also referred to as an oxidant. Tables 4-4 and 4-5 illustrate plants which are sensitive to oxidants and PAN, respectively (12, 22). Ozone has been proven to be injurious to many agronomic crops and deciduous and coniferous trees throughout the United States. The major constituent of atmospheric oxidants, ozone probably causes more injury to vegetation than any other pollutant with the exception of sulfur dioxide. Many plants and their varieties are susceptible to ozone, and a compilation of the vegetative forms and their relative sensitivities can be found in Table 4-6 (22, 12).

Other phytotoxic air pollutants include ethylene, chlorine, hydrogen sulfide, hydrogen chloride and ammonia (21, 29). However, except for isolated cases of ethylene damage, the problem with these pollutants and their effects on vegetation is not considered serious at this time. Tables 4-7 through 4-10 supply the relative sensitivities of selected plants to these minor pollutants.

RESEARCH TRENDS AND PREVIOUS STUDIES

Currently, all available literature appears to be concentrated on the most phytotoxic air pollutants, which were previously discussed. Research objectives are oriented toward determination of plant symptomatology and compilation of relative sensitivity tables for given vegetative forms. There have been isolated studies on the general economic impact of air pollution on vegetation, such as that by Benedict, Miller, and Olsen in 1971 (15). Case studies of the effects of specific pollutants on specific ecosystems have been published, such as that by Dr. O. C. Taylor of the California Research Center for Air Pollution entitled "Oxidant Air Pollution Effects on a Western Coniferous Forest Ecosystem" (5). There have also been studies conducted on the effects of pollution on the environment from a point source, such as those completed by the Air Management Branch of the Canadian Ministry of the Environment on the generation of sulfur dioxide by the smelters at Sudbury, Ontario (16, 17, 18). However,

Table 4-4 Sensitivity of Selected Plants to Oxidants[a]

Alfalfa
Medicago sativa, L.
Bean, pinto
Phaseolus vulgaris, L.
Beet
Beta vulgaris, L.
Clover
Trifolium, sp., L.
Endive
Cichorium endivia, L.
Grapefruit
Citrus maxima, Merr.
Muskmelon
Cucumis Melo, L.
Oats
Avena sativa, L.
Petunia
Petunia hybrida, Vilm.
Pine, Eastern white
Pinus strobus, L.
Spinach
Spinacea oleracea, L.
Tobacco
Nicotiana tabacum, L.

a. Correlation of injury was made with a total oxidant meter. Injury could be caused by a number of pollutants; the symptoms have not been definitely associated with ozone, PAN or nitrogen dioxide.

Table 4-5 Sensitivity of Selected Plants to PAN

Sensitive

Bean, pinto
Phaseolus vulgaris, L.
Chard, Swiss
Beta chilensis, Hort.
Chickweed
Stellaria media, Cyrill.
Dahlia
Dahlia, sp.
Grass, annual blue
Poa annua, Linn.
Lettuce
Lactuca sativa, L.
Mustard
Brassica juncea, Coss.
Nettle, little-leaf
Urtica ureans, L.
Oat
Avena sativa, L.
Petunia
Petunia hybrido, Vilm.
Tomato
Lycopersicon esculentum, Mill.

Intermediate

Alfalfa
Medicago sativa, L.
Barley
Hordeum vulgare, L.
Beet, sugar
Beta vulgaris, L.
Beet, table
Beta vulgaris, L.
Carrot
Daucus carota, L.
Cheeseweed
Malva parviflora, L.
Dock, sour
Rumex crispus, L.
Lambs-quarters
Chenopodium album, L.
Soybean
Glycine max, Merr.
Spinach
Spinacea oleracea, L.
Tobacco
Nicotiana tabacum, L.
Wheat
Triticum sativum, Lam.

Resistant

Azalea
Rhododendron, sp.
Bean, Lima
Phaseolus limensis, L.
Begonia
Begonia, sp.
Broccoli
Brassica oleracea, L.
Chrysanthemum
Chrysamhemum, sp.
Corn
Zea mays, L.
Cotton
Gossypium hirsutum, L.
Cucumber
Cucumis sativus, L.
Onion
Allium cepa, L.
Periwinkle
Vinca, sp.
Radish
Raphanus sativus, L.
Sorghum
Sorghum vulgare, Pers.
Touch-me-not
Impatiens, sp.

Table 4-6 Sensitivity of Selected Plants to Ozone

Crops

Alfalfa
Medicago sativa, L.
Barley
Hordeum vulgare, L.
Bean
Phaseolus vulgaris, L.
Clover, red
Trifolium pratense, L.
Corn, sweet
Zea mays, L.
Grass, bent
Agrostis palustris, Huds.
Grass, brome
Bromus inermis, Leyss.
Grass, crab
Digitaria sanguinalis, L.
Grass, orchard
Dactylis glomerata, L.
Muskmelon
Cucumis melo, L.
Oat
Avena sativa, L.
Onion
Allium cepa, L.
Peanut
Arachis hypogaea, L.
Potato
Solanum tuberosum, L.
Radish
Raphanus sativus, L.
Rye
Secale cereale, L.
Spinach
Spinacea oleracea, L.
Tobacco
Nicotiana tabacum, L.
Tomato
Lycopersicon esculentum, Mill.
Wheat
Triticum Aestivum, L.

Trees, Shrubs, and Ornamentals

Alder
Alnus, sp.
Apple, crab
Malus baccata, Borkh.
Aspen, quaking
Populus tremuloides, Michx.
Boxelder
Acer negundo, L.
Bridalwreath
Spiraea prunifolia, Sieb. & Zucc.
Carnation
Dianthus caryophyllus, L.
Catalpa
Catalpa speciosa, Warder
Chrysanthemum
Chrysanthemum, sp.
Grape
Vitis vinifera, L.
Honeylocust
Gleditsia triacanthos, L.
Lilac
Syringa vulgaris, L.
Maple, silver
Acer saccharinum, L.
Oak, gambel
Quercus gambelii
Petunia
Petunia hybrida, Vilm.
Pine, Eastern white
Pinus strobus, L.
Pine, ponderosa
Pinus ponderosa, Laws.
Privet
Ligustrum vulgare, L.
Snowberry
Symphoricarpos albus, Blake
Sycamore
Platanus occidentalis, L.
Weeping Willow
Salix babylonica, L.

Table 4-7 Sensitivity of Selected Plants to Ethylene

Sensitive

Bean, Black Valentine
Phaseolus vulgaris, L.
Carnation
Dianthus caryophyllus, L.
Cotton
Gossypium hirsutum, L.
Cowpea
Vigna sinensis, Endl.
Cucumber
Cucumis sativus, L.
Marigold, African
Tagetes erecta, L.
Orchid
Cattleya, sp.
Pea, cream
Pisum sativum, L.
Peach
Prunus persica, Sieb. & Zucc.
Philodendron
Philodendron cordatum, Kunth.
Privet
Ligustrum, sp.
Rose
Rosa, sp.
Sweet potato
Ipomoea batatas, Lam.
Tomato
Lycopersicon esculentum, Mill.

Intermediate

Arborviate
Thuja orientalis, L.
Azalea
Rhododendron, sp.
Carrot
Daucus carota, L.
Gardenia
Gardenia radicans, Thumb.
Holly, Japanese
Ilex crenata, Thumb.
Soybean
Glycine max, Merr.
Squash
Curcurbita maxima, Duchesne

Resistant

Beet
Beta vulgaris, L.
Cabbage
Brassica oleracea, L.
Clover
Trifolium, sp.
Endive
Cichorium endivia, L.
Grass, rye
Lolium multiflorum, Lam.
Oats
Avena sativa, L.
Onion
Allium cepa, L.
Radish
Raphanus sativus, L.
Sorghum
Sorghum vulgare, Pers.

Table 4-8 Sensitivity of Selected Plants to Ammonia

Sensitive

Mustard
Brassica juncea, Coss.

Sunflower
Helianthus annuus, L.

Intermediate

Buckwheat
Fagopyrum esculentum, Moench.
Cheeseweed
Malva rotundifolia, L.
Coleus
Coleus, sp.

Grass, annual blue
Poa annua, L.
Grass, Kentucky blue
Poa pratensis, L.
Lambs-quarters
Chenopodium album, L.

Tobacco
Nicotiana tabacum, L.
Tomato
Lycopersicon esculentum, Mill.

Resistant

Apple (fruit)
Malus, sp.
Chickweed
Cerastium, sp.

Dandelion
Taraxacum officinale, Weber
Nettle-leaf goosefoot
Chenopodium murale, L.

Peach (fruit)
Prunus persica, Sieb. & Zucc.
Pigweed
Amaranthus retroflexus, L.

Table 4-9 Sensitivity of Selected Plants to Hydrogen Chloride

Sensitive

Beet, sugar
Beta vulgaris, L.
Cherry
Prunus, sp.
Larch
Larix, sp.
Maple
Acer, sp.
Tomato
Lycopersicon esculentum, Mill.
Viburnum
Viburnum, sp.

Intermediate

Begonia
Begonia rex, Putz.
Rose
Rosa, sp.
Rosebud
Rosa, sp.
Spruce
Picea, sp.

Resistant

Beech
Fagus, sp.
Birch
Betula, sp.
Fir
Abies, sp.
Maple
Acer, sp.
Oak
Quercus, sp.
Pear
Pyrus, sp.
Spruce
Picea, sp.

Table 4-10 Sensitivity of Selected Plants to Hydrogen Sulfide

Sensitive

Aster
  Aster macrophyllus, L.
Bean, kidney
  Phaseolus vulgaris, L.
Buckwheat
  Fagopyrum esculentum, Moench
Calliopsis
  Calliopsis, sp.
Clover
  Trifolium
Cosmos
  Cosmos bipinnatus, Cau.
Cucumber
  Cucumis sativus, L.
Lamb's-quarters
  Chenopodium album, L.
Nettle-leaf goosefoot
  Chenopodium murale, L.
Poppy
  Papaver somniferum, L.
Radish
  Raphanus sativus, L.
Salvia
  Salvia, sp.
Soybean
  Glycine max., Merr.
Tobacco
  Nicotiana glauca, Grah.
Tobacco, Turkish
  Nicotiana tabacum, L.
Tomato
  Lycopersicon esculentum, Mill.

Intermediate

Castor bean
  Ricinus communis, L.
Chickweed
  Stellaria media, Cyrill.
Cornflower
  Centaurea cyanus, L.
Dandelion
  Taraxacum officinale, Weber
Gladiolus
  Gladiolus, sp.
Grass, Kentucky blue
  Poa pratensis, L.
Nasturtium
  Tropaeolum majas, L.
Pepper
  Capsicum frutescens, L.
Rose
  Rosa, sp.
Sunflower
  Helianthus annuus, L.

Resistant

Apple
  Malus pumila, Mill.
Carnation
  Dianthus caryophyllus, L.
Cheeseweed
  Malva parviflora, L.
Cherry
  Prunus serotina, Ehrhe.
Coleus
  Coleus blumei, Benth.
Fern, Boston
  Nephrolepis exaltata, Schott
  var. bostoniensis, Davenport
Grass, annual blue
  Poa annua, L.
Mustard
  Brassica campestris, L.
Peach
  Prunus persica, Sieb. & Zucc.
Pigweed
  Amaranthus retroflexus, L.
Purslane
  Portulaca oleracea, L.
Strawbery
  Fragaria, sp.

studies of this nature are superficial in that they are concerned with such visible injury symptoms as chlorosis, necrosis, senescence, metabolism interference, and growth distortion. Such is the case with the investigations into injury from the less important pollutants such as heavy metals, chlorine, particulates, aldehydes, radioactive elements, and acid aerosols (acid rainfall), which are only partially documented in the literature.

At present, there are no existing case studies analyzing the long-term effects of air pollution on such aspects as the flora and fauna, economy, or aesthetic values of a region. In fact, pertinent information, when available, is so insufficient that even judicial decisions concerning tolerable pollution level exposure and its effect on agricultural production and environmental deterioration are structurally impotent (7). Since the basic groundwork has been laid as to the effects of specific pollutants on vegetation and since there is sufficient information available identifying pollutants by generation source, the obvious areas in dire need of research are those concerned with the hidden effects of pollution and with pollutant interaction on vegetation and natural resources and the projected ecological impacts. It is the aesthetic and economic value supplied by these natural resources that make the Catskills attractive as a recreational area while rendering it suitable for the intensive agricul tural and forest management practices prevalent throughout the region.

There have been several studies conducted within the Hudson Basin Region for the purpose of preserving the recreational, industrial, aesthetic, cultural, residential, and agricultural values of the area for the enjoyment of present and future generations. Each study briefly addresses the issue of air qualtiy and its impact upon vegetation and natural resources; however, none delve deeply into the question of the long-term, secondary effects of pollution on the forest ecology and agricultural industry.

The Hudson River Valley Commission was appointed by Governor Nelson A. Rockefeller in 1965 to develop a program to protect the resources previously mentioned (1). The objective of the committee studying air quality was primarily oriented toward emphasizing the development of proper air

quality standards and enforcing the existing regulations. While they advocated raising standard requirements, which would certainly serve to reduce the impact of air pollution on natural resources, there were no projections made concerning the damage that had already been inflicted upon the vegetation and natural resources by the deteriorating air quality.

In 1970, the Temporary Study Commission on the Future of the Adirondacks looked somewhat deeper into the problem of air quality as it is related to natural resources and vegetation in the Commission's Technical Report #3 entitled "Forests, Minerals, Water and Air" (30). The purpose of the report was to provide the commission with sufficient information necessary to evaluate the effects of its recommendations on the forest industry and the forest resources in the Adirondacks region.

Dr. Vincent Schaefer, of the Atmospheric Sciences Research Center at SUNY, did an excellent job of pinpointing pollution sources within the forest ecosystem and surrounding areas in the committee's report. But, apparently due to the absence of available research on the topic, he too was unable to supply projected information on the future effects of air pollution on vegetation. His resulting recommendation was the employment of abatement techniques as a form of "preventative medicine."

The most recent research effort is being exerted by the Temporary State Commission to study the Catskills (2). This commission, which was organized in 1973, is charged with the task of an in-depth investigation into the problems facing the Catskill region. The areas to be considered are essentially the same as those covered by the two previously mentioned study commissions. Although land characteristics such as ownership, use, economy, and recreation are being ignored, the air quality section in the proposed plan of study outline falls far short of that undertaken by the Hudson River Valley Commission. It appears that a description of the air quality over the region, expressed in terms used by DEC's Air Monitoring System, is the extent to which the Commission plans to pursue the issue, with the effects of a possibly deteriorating air environment within the region not even being considered for analysis.

The study of the environmental impact of long-range effects of air pollution on forest and agricultural resources is still in a primitive stage of development. It is important that we turn from the present fragmented study approach to a more encompassing and ecologically significant approach. We should view the whole plant, the entire population of plants, or even the entire ecosystem and its interactions over at least two or three generations when assessing pollution impact. The proper avenue of approach when evaluating the effects of pollution on plant growth, yield, health, or longevity, whether in the Catskill region of New York or the San Bernardino Mountains of California, is to follow the effects from seed germination through harvest age, or until the reproductive cycle is completed. This life-cycle form of study should employ the intercomparisons of plant growth in the laboratory, greenhouse, and actual field conditions identical to those of the plant's natural habitat. Also, the person responsible for research of this nature should be cognizant of the fact that other environmental stresses will produce plant symptomatology identical to that caused by many pollutants. Such stresses include nutrient deficiency, frost burn, sun scald, desiccation, and certain insect and disease-related responses.

CONCLUSIONS AND ENVIRONMENTAL ISSUES

It is apparent that air pollution does exist in the Catskill region of New York State (8). The qualitative and quantitative analysis of this pollution is not available but could be if the proper air monitoring stations were established within the region. Also, due to the lack of air monitoring data, the extent to which the current and future levels of pollution will affect the economy, and the projected study of long-term ecological impacts that can be expected, is impossible. It must be pointed out that the basic research on the impact of air pollution on the natural resources in this area is still in an infant stage. Additional investigation is greatly needed. However, this type of research should be a portion of the master plan to study the overall interactions of air pollution on the entire ecosystem. A plan of this nature should be revised as necessary every few years to reevaluate old pollution sources and take new sources into consideration.

Some environmental issues and questions brought to the surface in a study of this nature are:

1. Is the increase in forested land in New York State desirable, and if so, should applicable zoning regulations be imposed to preserve it?
2. Are the commercial forestry interests commensurate with the objectives of the inhabitants, local interest groups, and government agencies?
3. Should major transportation systems be developed in scenic and recreational areas? Is the interest of the people such that they desire the influx of visitors that will result from development of this nature? If so, they must resign themselves to the fact that there will be greater air pollution generation potential.
4. Is industry compatible with the natural scenic and agricultural areas or should a program be developed to educate the population on the beneficial and detrimental effects of industrial development?
5. Of the local and state institutions concerned with the development or preservation of the recreational potential in the Catskills, how many are knowledgeable of the air pollution situation? It is here that education and information are most critical, as these agencies are instrumental in developing and implementing necessary pollution-abatement legislation.
6. An interaction program between the states of New York and New Jersey and their respective air pollution control agencies should be developed with the intent of evaluating the interests concerned with the recreation, wildlife and forest protection and scenic area preservation within the Catskills, and the program for that region should be geared accordingly. This should also include emphasis on transportation development planning, land use, and regional economic development from the standpoint of air pollution generation and its impact on the environment.

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5. AIR POLLUTION AND TRANSPORTATION IN THE NEW YORK CITY AREA

Miguel Rueland and P. W. Purdom

INTRODUCTION

Public interest seems to have risen faster than the level of pollution in recent years. The current increase in public concern about questions of the quality of life has generated great interest in the impact of transportation facilities on the environment. Perhaps the greatest furor has been created by the question of automobile air pollution.

Past efforts to deal with air pollution issues, often characterized by fragmental and short-range attacks at the point of visible concern, have generally failed. This failure is due, in part, to a basic lack of understanding of the consequences of such efforts on related issues and problems, the lack of political mechanisms for establishing priorities acceptable to competing interest groups, the reluctance of political leadership to adequately consider the long-range consequences of current decisions, and the absence of an adequate body of knowledge upon which to base such decisions.

This case will study the characteristics and priorities of the air pollution--especially the carbon monoxide (CO)--from transportation confronting the people in Manhattan and Essex Counties. This area, including New York City, Jersey City, and Bayonne, comprises close to 7,000 square miles and contains 15 million people. In addition, the project will assess the adequacy of existing knowledge for environmental planning and conflict resolution in this region, and suggest ways in which required knowledge can be acquired and brought to bear in strengthening the processes of environmental monitoring and management.

The results of this effort will be directed to institutions and individuals with decision-making responsibilities on matters affecting the quality of the environment. These clients are as follows: (1) institutions and individuals in the public sector with public policy and program formulation responsibilities, (2) public-interest oriented private individuals and

groups concerned with evaluation and influencing public policy, (3) individuals and organizations in the private sector making decisions directly affecting the quality of the environment, and (4) the public and private research community, which makes decisions concerning the allocation of resources for the generation of new knowledge about the environment. Also to be considered is the capability of existing institutions to conduct an effective strategy for the control of air pollution from transportation.

AIR POLLUTION FROM TRANSPORTATION

Automobiles, industry, and electric power plants are the main sources of air pollution from man-controlled processes. Volcanic action, forest, and dust storms are natural sources of air pollutants, but these contribute very little in urban areas compared to the man-made sources. A summary of the principal sources of emission in the United States in 1965 is shown in Table 5-1.

It is estimated that approximately 60 percent by weight of all effluents discharged into the air are by-products of transportation. The transportation modes that produce atmospheric pollutants include automobiles, buses, and trucks with gasoline engines; diesel-powered trucks and buses; propeller and jet-powered aircraft; railroad locomotives; and marine vessels. By far the most important from an air pollution standpoint is the spark-ignited internal combustion engine using gasoline as fuel.

The major components of auto exhaust are, of course, the complete oxidation products of the fuel, carbon dioxide and water, and the nitrogen that accompanies the air fed to the combustion chamber. Because oxidation is incomplete, carbon monoxide is always present. Minor constituents, but important ones from an air pollution standpoint, are hydrogen, oxygen, unburned hydrocarbons, partially oxidized hydrocarbons, nitric oxide, and sulfur dioxide. The normal range of some of these minor constituents is shown in Table 5-2.

Table 5-1. Air Pollutant Emissions in the United States in 1965 (millions of tons per year).

Sources	Totals	% of Totals	Carbon Monoxide	Sulfur Oxides	Hydro-carbons	Nitro-gen Oxides	Par-ticles
Automobiles	86	60	66	1	12	6	1
Industry	23	17	2	9	4	2	6
Electric Power Plants	20	14	1	12	1	3	3
Space heating	8	6	2	3	1	1	1
Refuse Disposal	5	3	1	1	1	1	1
Totals	142	100	72	26	19	13	12

Table 5-2. Composition Range of Automobile Exhaust

	Idle	Acceleration	Cruising	Deceleration
Engine speed, RPM	400-500	400-3,000	1,000-3,000	3,000-400
CO, %	4-6	0-6	1-4	2-4
NO, ppm	10-50	1,000-4,000	1,000-3,000	10-50
Hydrocarbons, ppm	500-1,000	50-500	200-300	4,000-12,000
Unburned fuel, % of supplies fuel	4-6	2-4	2-4	20-60

By inspection of the table, one may see that the manner in which a vehicle is operated can greatly affect total emissions. Thus, a great deal of stop-and-go driving means longer periods in high-emission transient modes than sustained steady-speed driving. The national average for CO in 1968 was 33 grams per km.

ADVERSE HEALTH EFFECTS

Carbon monoxide, hydrocarbons, nitrogen oxide, and photochemical oxidants have all been found to adversely affect public health. The principal toxic effect of carbon monoxide is based on its reaction with hemoproteins. It combines with hemoglobin to form carboxyhemoglobin, which reduces the oxygen-carrying capacity of the blood. The basic body systems that are affected are the cardiovascular, respiratory, and central nervous systems.

Nitrogen dioxide appears to be the most hazardous to health. Its primary toxic effect is on the lungs. Effects of hyrdocarbons on humans have been noted, such as irritation of the eyes, upper respiratory tract, and skin. The reaction of hydrocarbons, nitrogen oxides, and ultra violet irradiation (sunlight) produces various toxic compounds that may have greater significance for health. The long-range effects of these primarily invisible pollutants on materials and health of plants, animals, and human beings are just beginning to be understood. The lung cancer rate in large metropolitan areas is twice as great as the rate in rural areas even after full allowance is made for differences in cigarette smoking habits. The serious pulmonary disease, emphysema, shot up eightfold during the decade of the sixties.

AIR QUALITY STANDARDS

Because of the adverse health effect of these air pollutants, the Federal government has responded to the needs of its citizens by passing legislation controlling sources of air pollution. Perhaps the climax was the Clean Air Act Amendments of 1970, which required the Environmental Protection Agency (EPA) to promulgate national air quality standards which the states would then have to meet according to a statutory timetable. These

were issued in April 1971 and are stated in the form of primary and secondary standards for air pollutants: particulate matter, sulfur oxides, carbon monoxide, hydrocarbons, oxides of nitrogen, and photochemical oxidants. The primary standards are intended to protect against adverse human health effect, while the secondary standards are intended to safeguard property and plant and animal life.

The EPA announced in July 1971 that the standards for automobile exhaust emissions for the 1975 model year will be 0.41 g/mi for hydrocarbons, 3.4 g/mi for carbon monoxide, and 0.4 g/mi for nitrogen oxides (calculated as NO_2).

CARBON MONOXIDE IN NEW YORK CITY

The concentration of CO in New York City varies widely with time and location, and CO levels follow a regular diurnal pattern of variation dependent primarily on human activity. Ambient CO concentrations generally correlate well with traffic volume. The highest correlations and levels are associated with measurements taken where vehicular traffic is heaviest. Observation in downtown New York City generally shows rapid rise in the morning, corresponding to the morning rush-hour traffic, then a constant plateau that lasts until afternoon when a slower rise begins and builds to a peak in late afternoon.

The diurnal pattern, being directly related to traffic volume, shows little variation with day of the week except for weekends and holidays. The weekday concentations are higher than those recorded on Saturdays, which are higher than those recorded on Sundays and holidays. The average CO concentrations on Saturdays and Sundays were about 20 percent less than on weekdays.

EMISSIONS OF CARBON MONOXIDE FROM TRANSPORTATION

Carbon monoxide is the most widely distributed and most commonly occurring air pollutant from transportation, and motor vehicles are the major

contributor (more then 58 percent of the national total). Gasoline engines produce much more CO per unit of power input than do diesel engines, primarily because of the lower air-fuel ratio, and the resulting less complete combustion, of gasoline-powered vehicles. Carbureted engines, such as are generally found in passenger vehicles, operate with a deficiency of combustion air under some conditions; whereas the diesel engine normally operates with combustion air in substantial excess of stoichiometric requirements.

The contribution from aircraft to the total national atmospheric CO pollution burden is at present slightly more than 2 percent. Although at this time the contribution of aircraft to total CO emission is small, atmospheric concentrations of CO at and near the airport may be creating localized problems.

There are other non-highway mobile sources. According to the Bureau of Roads and the Bureau of Mines, the total non-highway use of motor fuels, excluding aircraft, amounted to 8.2 billion gallons for 1966. This represents the consumption of gasoline and diesel fuel by trains, ships, agricultural machinery, commercial equipment, and construction machinery. Trains and ships also consumed distillate fuel oil, residual fuel oil, and coal.

THE NECESSITY OF TRANSPORTATION CONTROLS

Mobile air pollutant sources in the metropolitan area account for roughly 95 percent of carbon monoxide emissions, 65 percent of hydrocarbons, 40 percent of nitrogen oxides, and 15 percent of suspended particulates. These emissions are sufficient to cause ambient concentration in excess of primary air quality standards. Emission standards for new vehicles, established under section 202 of the Clean Air Act, will bring about less than 40 percent of the emission reductions necessary to achieve the air quality standards by 1975. Thus, additional transportation controls are necessary.

TRANSPORTATION SYSTEM PROBLEMS

Since World War II, the pattern of development of the New York area has been one of growth of suburban areas and abandonment of mass transit. There has been a large growth in automobile use, especially in the peak commuting hours. At the same time, there has been a decline in trucks bound for the center city and a significant drop in transit ridership because of increased transit fares, increased auto ownership, and changes in trip patterns.

Because of the changing nature of employment patterns in the central city from blue-collar to white-collar, and because of increasing affluence, residential land use is becoming more dispersed, locating in areas poorly served by, and not amenable to, public transportation.

In addition to an overall increase in automobile entries into the central city, there has been an inordinately high increase in the rush hours. By contrast, the overall number of person-entries for a 24-hour business day has fallen since 1963. Crowding of public transportation and highway facilities has developed as rush-hour peaking has become more chronic and prolonged.

There has been a significant growth in the ridership of a relatively new public transportation mode, the express bus, whose attractiveness has been further enhanced in some cases by the establishment of exclusive bus lanes during the morning peak. There has been noticeable difficulty, however, in attracting ridership to these buses out of private cars, especially cars carrying only a driver. Such private car commuters are relatively unresponsive to moderate economic inducements to switch to public transit.

The sensitivity of transit users to fare increases is much higher than that of highway users. Increasing tolls without equalization among the East River bridges has not resulted in any loss in automobile trips; instead, there was a significant diversion from tolled to free facilities.

In fact, the overall traffic levels increased almost 5 percent in the 6 months covering the period in which tolls were increased. These increases would be expected to create a local carbon monoxide problem and add to the area-wide oxidant problem. However, increases of five cents each in the transit fare were accompanied by large drops in ridership in 1970 and 1972.

Truck entries to the central city have declined significantly, but the space left by the departing trucks has been more than filled by newly entering automobiles. Nevertheless, truck operation is especially inefficient; the trucks travel more miles than is necessary to complete their routings, and load factors are very low; most trucks are owner-operated.

Taxicabs are responsible for about half of the travel mileage in midtown Manhattan, yet up to 50 percent of moving cabs have no passengers in them at any given time during the day. Efforts to rationalize deployment of cabs and minimize non-productive mileage are hindered by institutional constraints and the vagaries of the market.

Physical and institutional constraints, as well as the economic facts of life, preclude rapid and sweeping improvements in the system. Moreover, there is no evidence that people will abandon their cars for transit, however much it is improved. So it will not be enough simply to improve transit. Rather, it will be necessary to restrict the entry and operation of vehicles on the island of Manhattan, especially in peak hours, and simultaneously to provide an improved public transportation system to serve as an acceptable alternative to automobiles. Restriction of access must be accomplished by either physical or extreme economic restraints or both.

By minimizing vehicle emission production; restructuring parking facilities to unblock flow and discourage driving to midtown; enforcing traffic and parking regulations; improving transit to accommodate and promote increased ridership; consolidating goods movement for efficiency; and providing

facilities and inducements for using transit in preference to automobiles, the transportation system can be made to provide its essential service with greatly reduced production of air pollution.

TRANSPORTATION CONTROL STRATEGIES

The transportation control strategy developed for the New York metropolitan area sets forth the transportation and land use control measures that must be implemented to reduce emissions of mobile source pollutants to meet federally mandated air quality standards. The analysis contained in this document demonstrates that emission control systems installed on new automobiles by the manufacturers in accordance with federal standards are not adequate to attain primary standards by May 31, 1974--or, for that matter, by 1977 with the 2-year extension grantable under the Act. Additional strategies have therefore been proposed which will assure not only achievement of the primary standards but also maintenance of the standards for the foreseeable future.

The essence of the plan is the coordinated implementation of control measures selected from five major categories:

Group A - Motor Vehicle Emission Control
Group B - Traffic Control and Vehicle-Use Restraints
Group C - Mass Transit Improvements
Group D - Goods Movement Improvements
Group E - Long-Range Planning

Implementation of the selected strategies will proceed in stages. Primary stage strategies will be undertaken as soon as technically possible. The core of these strategies is replacement of older cars with 1975 and later models, which are required by federal law to have low emission rates (strategy A-1). The success of the entire plan hinges on enforcement by the Environmental Protection Agency of these congressionally mandated emission standards for 1975 and later model vehicles. The primary stage strategies are:

Vehicle Turnover (A-1)
Retrofit Heavy Duty Vehicles (A-2)
Emission Inspection of Livery Vehicles (A-3)
Heavy-Duty Vehicle Emission Inspection (A-4)
Passenger Vehicle Emission Inspection (A-5)
Mechanic Training (A-6)
Diesel Bus Maintenance and Inspection (A-7)
Light-Duty Vehicle Retrofit (A-8)
Elimination of Leaded Gasoline in New York Metropolitan Area (A-9)
Reciprocal Strategies in New Jersey and Connecticut (A-10)
Enforcement of Traffic Regulations (B-1A)
Traffic Management (B-1B)
Selective Ban on Taxi Cruising (B-1C)
Reduction in CBD Parking (B-3)
Express Bus; Exclusive Bus Lanes (B-5)
Tolls on East & Harlem River Bridge (B-7)
Stagger Work Hours (C-8)
After Hours Goods Delivery (D-3)
Citizen Participation; Public Information (E-4)

The emissions reductions projected for these strategies are listed in Table 5-3, 5-4, 5-5, and 5-6. The values are given for those locations representative of the most severe problems, since the strategies must be designed to meet air quality standards everywhere throughout the metropolitan area. All figures in the tables represent reductions from 1970 emission levels expressed as percents of the 1970 levels. Thus the goals are a 78 percent reduction in carbon monoxide levels in the downtown and midtown Manhattan central business districts (CBD's) a 67 percent reduction in hydrocarbons (oxidants) for the entire city, and a 32 percent reduction in nitrogen dioxide for the entire city. The reductions calculated for stationary source controls and vehicle turnover (Strategy A-1) are listed separately, and then it is shown how each of the other strategies contributes to achieving the required reductions.

Table 5-3. Calculation of Hydrocarbon Reduction--Metropolitan Analysis Zone

1970 Inventory = 316,153 tons/yr

Required Reduction = 67%

Emission Goal = 104,330 tons/yr

Emission reduction by 1975 with no transportation controls = 149,857 tons/yr or 47.4% including vehicle turnover and stationary source controls, including solvent reformulation.

Strategy	% HC reduction (1970 base)	Tons/yr
A-2	6	18,969
B-1C	1/5	632
B-3	2	6,323
A-11	1/5	632
B-1A	2	6,323
D-3	2	6,323
A-3	1/5	632
A-5	3	9,483
B-5 & B-7 (AM)	4	12,644
Total	19.6	61,961
Grand Total	67.0	211,818
Remaining	33.0	104,335

Table 5-4. Calculation of Carbon Monoxide Reductions--Downtown Manhattan

1970 Inventory = 121,116 tons/yr

Required Reduction = 78%

Emission Goal = 26,646 tons/yr

Emissions in 1975 through turnover and stationary controls by category are:

	Taxi	Car	Truck	Stationary
	7,277	19,100	56,925	1,145
Strategy	% Remaining after strategy application			
A-2	100	100	50	100
B-1C	80	100	100	100
B-3	100	50	100	100
A-11	86	100	100	100
B-1A	90	90	90	100
D-3 (Direct)	100	100	75	100
D-3 (Consol.)	100	100	70	100
A-3	91	100	100	100
A-5	100	90	100	100
Overall remainder	56.3	40.5	23.6	100
Tons/yr left	4,350	7,736	13,451	1,145

Grand Total = 26,682

Table 5-5. Calculation of Carbon Monoxide Reductions--Midtown Manhattan

1970 Inventory = 89,426 tons/yr

Required Reduction = 78%

Emission Goal = 19,674 tons/yr

Emissions in 1975 through turnover and stationary controls by category are:

	Taxi	Car	Truck	Stationary
	13,800	11,600	23,200	1,053
Strategy	% Remaining after strategy application			
A-2	100	100	50	100
B-1C	80	100	100	100
B-3	100	50	100	100
A-11	86	100	100	100
B-1A	90	90	90	100
D-3 (Direct)	100	100	75	100
D-3 (Consol.)	100	100	75	100
A-3	91	100	100	100
A-5	100	90	100	100
Overall remainder	56.3	40.5	25.3	100
Tons/yr left	7,769	4,698	5,872	1,053

Grand Total = 19,392

Table 5-6. Strategies for Carbon Monoxide Reductions

1. Strategy A-2. Pre-1974 cars will emit 40% of 1970 average through retrofitting. Post-1973 will meet Federal standards Some consolidation. Overall, 50% reduction from gasoline trucks occurs.

2. Strategy B-1C. Taxi cruising restrictions reduce taxi VMT's by 20%. No indirect effects credited.

3. Strategy B-3. Parking reduction of 50% reduces car VMT's during business hours by 50%. No indirect effects credited.

4. Strategy A-11. 50% of taxis are 1975s. Without California Package, they would represent 35% of 1975 emissions. Strategy reduces their emissions by 40%--overall 14% reduction.

5. Strategy B-1A. Traffic management improves vehicle speed to such an extent that the vehicular emissions are reduced by 10%.

6. Strategy D-3. After-hours delivery has a twofold effect. First, it will reduce CO emissions from trucks by a minimum of 25% during problem hours. This strategy will cause extensive consolidation in trucking at a minimum of 25% - 30% used for Downtown.

7. Strategy A-3. 50% of taxis are one year old and emit 65% of taxi CO. Deterioration factor is 1.34. Inspection will reduce deterioration factor to $1.17 - \frac{.17}{1.34} \times .65 = 9\%$

8. Strategy A-5. Inspection reduces overall car CO emissions by 10%--may be conservative.

Maintenance stage strategies designed to bring about the long-range transportation system changes necessary to maintain air quality standards beyond 1975 are:

Market Public Transit (C-1)
Integrate Transit Network (C-6)
Rehabilitate Existing Transit System (C-7)
Consolidate Trucking Activities (D-1)
Provision of Off-Street Loading Facilities (D-4)
Land Use Controls (E-3)

Implementation of these maintenance strategies requires further study and substantial capital funding. The state and city are further analyzing these strategies so that a funding package for improved mass transit can be formulated.

A contingency stage strategy--designed to be employed only if the parking restriction and stringent law enforcement strategies fail to produce the necessary emissions reduction in the central business district, or prove to be politically or institutionally impossible to implement--is the imposition of bans on private car use (B-2).

Secondary stage strategies of undetermined benefit to air quality but worthy of further study prior to a decision on implementation are:

Through Movement Streets (B-4)
Regulating Vehicle Mix (B-6)
No Interstate Commuter Discounts (B-8)
Timetable Simplification (C-2)
Free Fare (C-3)
Advanced Fare Payment (C-4)
Reciprocal Fare Agreements (C-5)
Goods Movement Technology and Management Systems (D-2)
Use of Rail for Transporting Commodities (D-5)

Development of Waterfront Facilities (D-6)
University Liaison for Research (E-1)
Special Truck Design for Urban Service (E-2)

These measures will be implemented if special studies indicate them to be effective and feasible.

With the exception of specialty vehicles for urban goods movement and low emission standards for urban buses, this plan does not recommend the use of alternative power systems in motor vehicles as one way of reducing vehicle emissions. For one thing, it will be a very long-range solution if it does happen. Secondly, the Environmental Protection Agency has over the past 3 years pursued an extensive program to foster the development of low pollution alternatives to the conventional spark ignition internal combusion engine. This, plus the effort currently underway in the State of California to develop steam power systems, has not yielded promising short-term solutions. Finally, the City of New York has investigated alternative power systems in a program that preceded the Environmental Protection Agency's alternative power systems effort. The Environmental Protection Agency preempted this effort, which has since been discontinued.

For the record, two alternative power systems that should be further developed and that are currently being ignored in federal programs are the high speed pre-chamber diesel and the stratified charge Wankel. Both engines have good potential for low emission characteristics plus excellent fuel economy--of major importance in this time of fuel shortages. We strongly recommend that federal agencies and the auto industry investigate the potential of these two systems as long-term solutions to both our vehicle pollution and energy problems.

ASSESSMENT OF SELECTED CONTROL STRATEGIES

In developing this case study, the Task Group is indebted to a group of students working under the supervision of Dr. Philip Bereano at Cornell University. The strategies included in the transportation plan for New

York City on paper and in theory may comply with the Federal Clean Air Act and offer the opportunity of meeting ambient air standards. However, it should be recognized that this plan was developed on the basis that it was necessary regardless of the cost or feasibility. It does require revolutionary changes in transportation patterns of the New York City metropolitan area. These changes, by law, must take place in a rigid time frame that is stringent, considering the actions required. For example, an improved mass transit system could not be proposed, planned, funded and built in a short period of time. It would require an extension of time, federal aid, and other actions yet to be taken. Certain proposed strategies are discussed below to point out considerations that may affect their acceptance or feasibility.

1. Vehicle Turnover

The Federal Clean Air Act requires increasingly stringent standards for the control of motor vehicle emissions with implementation by the 1976 model year. Due to the pressure of automobile manufacturers, this has been extended to 1977. Such action raises questions about the determination of the Environmental Protection Agency and the Congress to adhere to these standards. The reductions envisioned from vehicle turnover do rely upon adherence to the federal new car emission standards. If they are followed, there would be a reduction in carbon monoxide of 33 percent in downtown and 52 percent in midtown. This is based upon a turnover of 10 percent of the vehicles per year. If the standards are relaxed, the whole plan is in jeopardy.

2. Passenger Vehicle Emission Inspection

If the preceding requirement is not relaxed, periodic passenger vehicle emission inspections will be required to obtain full effectiveness. It will be necessary for the New York Legislature to pass enabling legislation. A New York Times article this year indicated that there may be resistance to passing such legislation. There is concern that the emission controls may reduce gasoling mileage. however, figures from Detroit indicate that

1975 cars with emission controls will get at least 13 percent more miles to the gallon than 1974 models. Even so, there are persons who might object to standing in line for inspection during a period when gasoline is scarce.

The Clean Air Act allows for two-thirds funding by the federal government, but this money still has to be appropriated. The capital construction costs have been estimated in past years at 21.7 million, with an annual operating cost of about 9.5 million. This would result in a vehicle inspection cost of about $3. These costs should probably be increased due to inflation. In addition, there would be the cost to the owners of vehicles that did not pass inspection, and it has been previously estimated that it might cost about $20 per vehicle to repair them to the point where they could pass inspection. Public support will be necessary to secure and implement this strategy.

3. Retrofitting of Light-Duty Vehicles

The air quality goals could be obtained more rapidly if the older model cars were retrofitted with the emission control systems rather than depending upon attrition to eliminate the old vehicles. This proposal is one which does not have a great deal of public support. It is considered to be regressive as it would apply most heavily to those persons in the low-income category. It might be that the market value of the automobile would be less than the cost of providing the retrofit system.

4. Elimination of Leaded Gasoline

The air pollution control systems depend upon catalysts which might be deactivated by the organic lead additives in gasoline. To keep this from happening, gasoline of sufficient octane rating, but with no more than a trace amound of lead, must be sold exclusively in the metropolitan area. If it proved infeasible to clean the existing storage tanks and facilities of distributors and retail dealers to prevent lead contamination, then new handling and storage facilities would have to be installed. Furthermore,

some oil refineries might have to provide additional capacity to produce the necessary lead-free gasoline. Such a system also requires a system of sampling and testing to assure that the proper kind of gasoline is sold to the public.

5. Strict Enforcement of Existing Traffic Regulations of New York City

This strategy would reduce congestion and speed traffic flow. It would require that more manpower be allocated to traffic control and enforcement. It is a question whether the current concern with street crime would permit any transfer of additional policemen to traffic control work. An alternate solution would be to use paraprofessional traffic enforcement personnel. This raises questions as to whether professional policemen would permit such a cadre of personnel to be employed and trained. In addition, there would be the necessity of having public acceptance of a strict enforcement and willingness to pay the fines that would be imposed as a result. The public would also have to tolerate what might be deemed in individual cases to be inconvenience.

6. Traffic Management

It has been stated that very little attention has been given to controlling and optimizing the use of New York City streets. If environmental factors were a primary consideration in developing a traffic management plan, the emissions could be reduced thereby. There is considerable question whether or not traffic planners could plan and effectively implement controls over traffic movement in a metropolitan area. There would be considerable conflict between the special interests of residents and business and the ideas of professional planners in this regard, particularly when it comes to establishing traffic-free areas.

7. Reduction in Number of Parking Spaces in CBD

The theory behind this strategy is that, if there are no places to park automobiles, the individuals will not use them for transportation. In order for this to be an acceptable strategy, there would have to be

improvements in public transportation service. In areas outside the CBD, there would have to be parking facilities established for those individuals who were not served by public transit and had to commute by personal automobile to a point where they could contact the public transportation system. For any near term of effectiveness, the improvements to public transportation would have to be with the existing rail system and bus service since the lead time on any construction of additional rail facilities would be very long.

8. Imposition of Tolls on all East River Bridges and Harlem River Bridges

It has been shown that traffic tends to go toward the bridge with the lower tolls, so balancing tolls would balance the traffic. At the same time, increasing tolls does not seem to necessarily reduce overall use by automobile traffic. Other measures would probably have to be imposed to reduce the vehicle miles traveled.

9. Banning of Private Automobiles from a Central Business District of Manhattan

This strategy would reduce use of automobiles and thereby curtail emissions. It could lead to congestion in areas around Manhattan Island as the traffic approached the city. This particular strategy could be expected to meet with opposition from operators of gasoline stations and parking garages in Manhattan, and may well be opposed by other business interests.

10. Designation of Certain Crosstown Streets of Manhattan for Through Movement Only

If congestion is relieved, vehicle users will probably accept this strategy. The problem would be gaining acceptance by consignees, shippers, and truckers. Parking would be prohibited on these preferred access streets. There would have to be some negotiation for goods movement access in these streets. It would also require some scheduling of deliveries by all truck operators.

11. Regulating Vehicle Mix

This plan is to separate the passenger stream from the goods stream. It would involve restricting some streets and traffic lanes to goods-movement traffic. Other streets might be closed off to goods-movement vehicles for certain parts of the day. To implement this strategy would require considerable coordination of a master traffic plan and it may require some adjustment in operating practices. Various persons whose access might be limited by this would be expected to have problems that would have to be satisfied.

12. Elimination of Commuter Discounts on Port Authority Interstate Bridges and Tunnels

While this strategy might not reduce the number of vehicles entering the city each day, it would be a disincentive. Additional revenues produced by this action could be used for implementation of other strategies. There may be some concern that this would divert workers from New York City to New Jersey.

This particular case has focused on vehicle traffic and its contribution to pollution, especially carbon monoxide. This case does not deal with the total transportation system requirements, but it does point up some issues that transportation planners should consider. An additional factor that has not been considered is that of concentrating vehicle traffic at locations in suburban areas where one transfers from private vehicles to the public transportation system.

In other case studies, the public could focus attention on specific operations that tended to generate air pollution. In this case, the air pollution is generated by the many public travelers who operate vehicles to move themselves to and from work, or to render their services, or to move goods necessary to the city. The strategies proposed thus involve all of the public in ways that are not necessarily required in the other cases. Since these strategies require major changes in patterns of

activity, it is anticipated that there will be more community resistance to the strategies proposed. Furthermore, in many cases the value of property or the desirability of a particular business location can be markedly affected by changes in the patterns of transportation. These factors make this a very complex case study involving interests at local levels as well as national levels. While the strategies proposed, if implemented, would reduce air quality, many of them raise such significant economic and political issues that one cannot be certain at this time what the outcome will be.

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Advisory Panel

*Norton Nelson
Director, Institute of Environmental Medicine
New York University
New York, New York

Joseph E. Black
Director, Social Sciences
The Rockefeller Foundation
New York, New York

John M. Cooney
Executive Assistant
Community Affairs
Office of the President
Rutgers University
New Brunswick, New Jersey

**Henry L. Diamond
Former Commissioner
New York State Department of Environmental Conservation
Albany, New York

D. Clinton Dominick, III
Former New York State Senator
Newburgh, New York

John P. Keith
President
Regional Plan Association
New York, New York

W. Keith Kennedy
Dean, New York State College of Agriculture and Life Sciences
Cornell University
Ithaca, New York

Martin Lang
Commissioner
Department of Parks
City of New York
New York, New York

**Gordon J. MacDonald
Director, Environmental Studies Program
Dartmouth College
Hanover, New Hampshire

Dick Netzer
Dean, Graduate School of Public Administration
New York University
New York, New York

Ruth Patrick
Curator of Limnology
Academy of Natural Sciences
Philadelphia, Pennsylvania

Ronald W. Pedersen
Former First Deputy Commissioner
Department of Environmental Conservation
Albany, New York

Ralph W. Richardson, Jr.
Director, Natural and Environmental Sciences
The Rockefeller Foundation
New York, New York

Donald F. Squires
Program Director
New York State Sea Grant Program
Albany, New York

Richard J. Sullivan
Former Commissioner
New Jersey State Department of Environmental Protection
Trenton, New Jersey

M. Gordon Wolman
Chairman, Department of Geography and Environmental Engineering
Johns Hopkins University
Baltimore, Maryland

*Chairman
**Resigned

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