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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY. APPENDIX V. HEAL--ETC(U)
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North Atlantic Regional Water Resources Study

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Appendix V. Health Aspects

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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY COORDINATING COMMITTEE

MAY 1972

The North Atlantic Regional Water Resources (NAR) Study examined a wide variety of water and related land resources, needs and devices in formulating a broad, coordinated program to guide future resource development and management in the North Atlantic Region. The Study was authorized by the 1965 Water Resources Planning Act (PL 89-80) and the 1965 Flood Control Act (PL 89-298), and carried out under guidelines set by the Water Resources Council.

The recommended program and alternatives developed for the North Atlantic Region were prepared under the direction of the NAR Study Coordinating Committee, a partnership of resource planners representing some 25 Federal, regional and State agencies. The NAR Study Report presents this program and the alternatives as a framework for future action based on a planning period running through 2020, with bench mark planning years of 1980 and 2000.

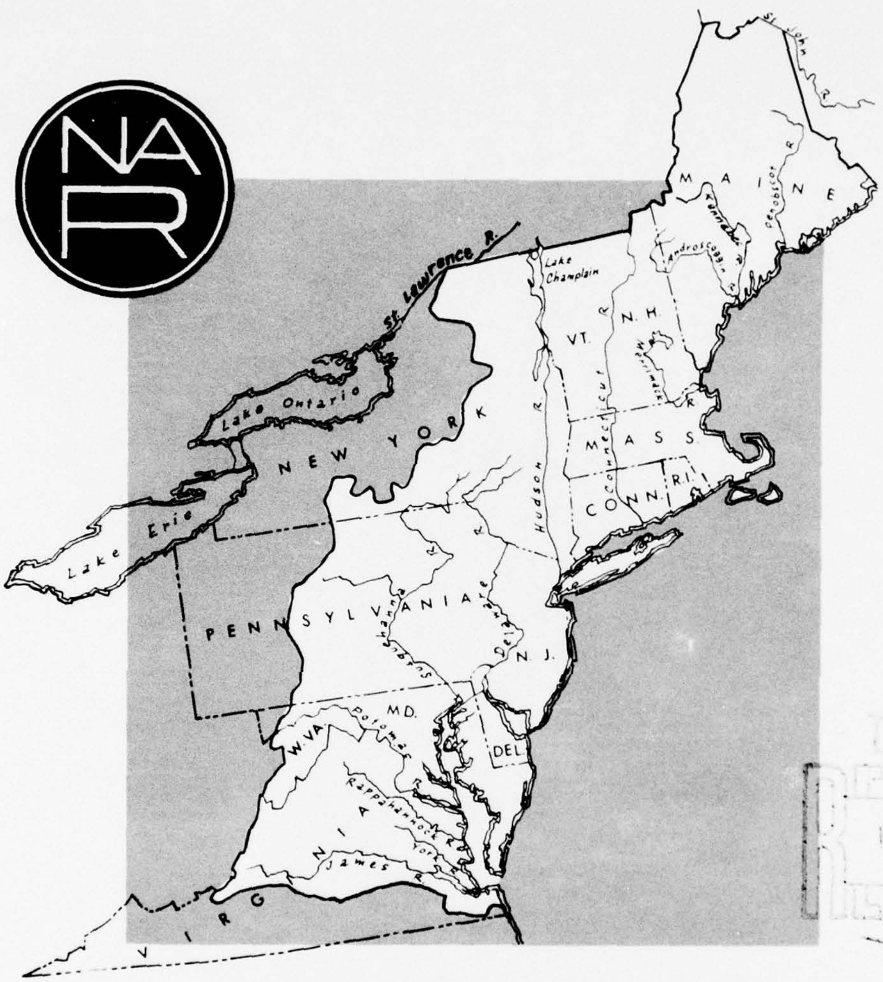
The planning partners focused on three major objectives -- National Income, Regional Development and Environmental Quality -- in developing and documenting the information which decision-makers will need for managing water and related land resources in the interest of the people of the North Atlantic Region.

In addition to the NAR Study Main Report and Annexes, there are the following 22 Appendices:

A. History of Study
B. Economic Base
C. Climate, Meteorology and Hydrology
D. Geology and Ground Water
E. Flood Damage Reduction and Water Management for Major Rivers and Coastal Areas
F. Upstream Flood Prevention and Water Management
G. Land Use and Management
H. Minerals
I. Irrigation
J. Land Drainage
K. Navigation
L. Water Quality and Pollution
M. Outdoor Recreation
N. Visual and Cultural Environment
O. Fish and Wildlife
P. Power
Q. Erosion and Sedimentation
R. Water Supply
S. Legal and Institutional Environment
T. Plan Formulation
U. Coastal and Estuarine Areas
V. Health Aspects

WATER RESOURCES NEEDS AND POTENTIALS FOR AN EXPANDING SOCIETY

Appendix V
Health Aspects



Prepared by

Division of Water Hygiene
Water Quality Office
Environmental Protection Agency

for the

NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY
COORDINATING COMMITTEE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

The Division of Water Hygiene of the Environmental Protection Agency (formerly the Bureau of Water Hygiene of the U. S. Public Health Service) is the primary Federal agency responsible for the input of public health aspects into water resources planning and related land use development studies. Within this context the Regional Offices of the Division of Water Hygiene serving the North Atlantic Region with the assistance of the Division of Water Hygiene headquarters in Rockville, Maryland, and the National Communicable Disease Center in Atlanta, Georgia, have jointly prepared the following report: Appendix V - Health Aspects. This report is intended to give a broad overview of water resource-related health problems that are occurring or could occur in the North Atlantic Regional study area.

Environmental conditions which may affect the public health must be considered very closely in developing any workable water resources plan. The North Atlantic Regional Water Resources Study is no exception. Without the proper cognizance of the health implications, these implications could act as major constraints to the development and utilization of a water resources facility. This appendix will identify some of ~~these~~ the areas of health needs for the water resources planner.

The diversity of geographical, socioeconomic, and political aspects in the North Atlantic Region leads to many varied health considerations which must be taken into account during water resources planning. This report will deal with these considerations through a discussion of the following:

I. Epidemiological Assessment;

II. Health Aspects of Water Supply;

III. Vector Control; and

IV. Environmental Health Analysis, including

A. Air Pollution Control,
B. Radiation Control,
C. Recreation Sanitation,
D. Shellfish Sanitation, and
E. Solid Waste Management.

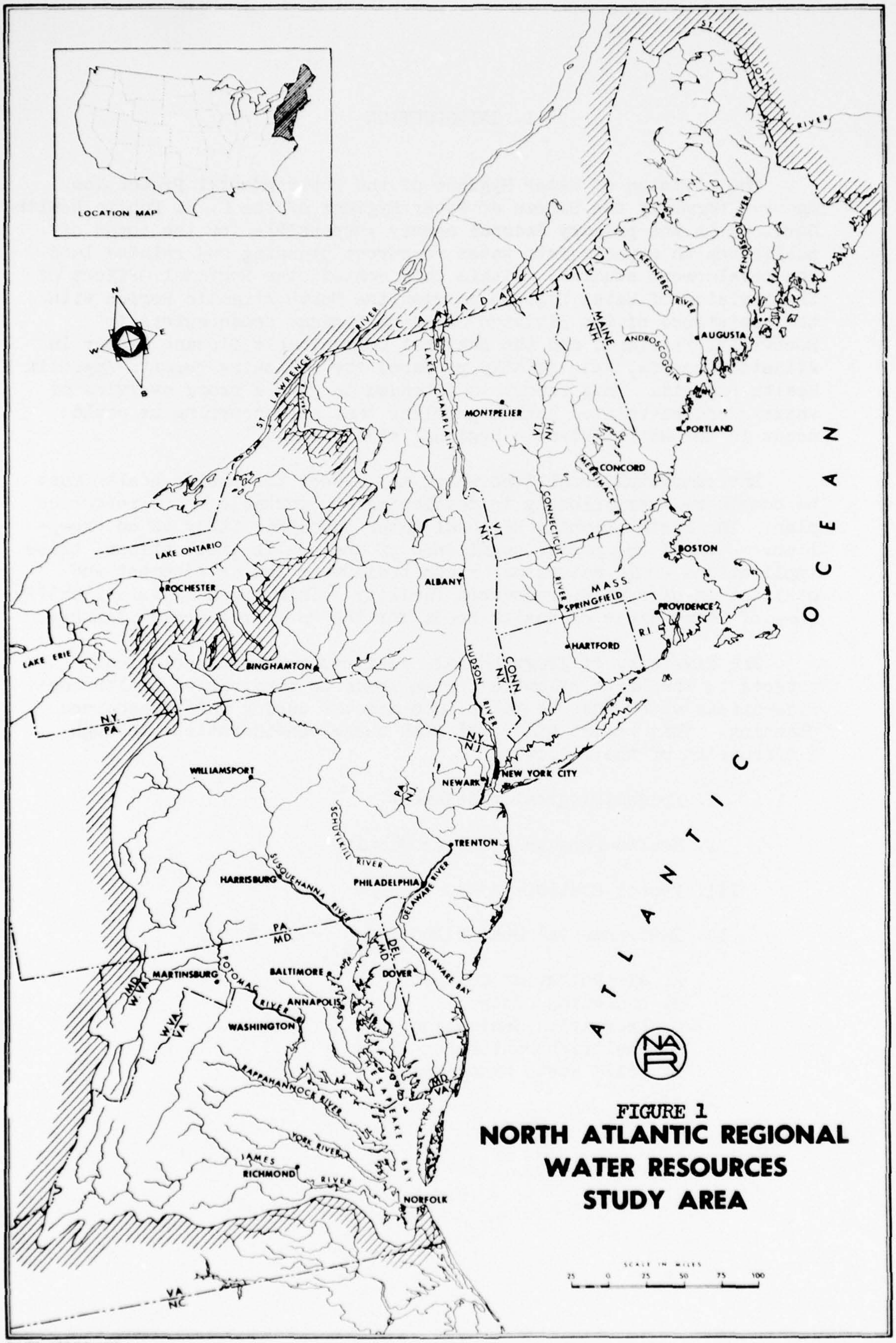


FIGURE 1
NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY AREA

Sept. 1967 — NAR Study Group, NAD
U. S. Army Corps of Engineers

II. CONCLUSIONS

The following conclusions identify major areas of need that should be acted upon in order to sustain and improve the health and well-being of the people of the North Atlantic Region concurrently with water resource and related land use development.

There has been little attempt in this Appendix to break down these health needs into the 21 planning areas used in the other sections of the North Atlantic Regional Water Resources Study. In general, it could be said that most of the identified health needs would apply to all 21 basins although these needs would certainly vary in each basin. To quantify these specific health needs would require studies which would be beyond the scope of a framework study such as the N.A.R..

The conclusions which are deemed most significant are as follows:

1. There is a lack of comprehensive water quality monitoring programs to identify future water supply sources. This is most needed in areas where metropolitan areas will have to go to local surface water sources which may have questionable water quality from a chemical standpoint.

2. Insufficient information is available on the quality of water being delivered by individual water supplies in the North Atlantic Region.

3. Research on the effect on human beings of trace metals, pesticides, or viruses is insufficient, and treatment methods now available for the removal of these constituents are inadequate.

4. Complementary use of water supply reservoirs for recreation purposes will require close study for each proposed recreational site.

5. Federal and state water supply programs require vastly expanded budgets and staff to carry out their responsibility of providing surveillance, research, and technical assistance to local water supplies in order to maintain the high level drinking water quality throughout the North Atlantic Region.

6. There is a lack of adequate data on the occurrence of waterborne diseases in the North Atlantic Region, especially on borderline epidemics.

7. A need exists for more extensive mosquito control programs to control vector borne disease and annoyance conditions. This is especially needed in recreational areas where there has been past histories of encephalitis outbreaks.

8. Continuous surveillance of recreation facilities from a health standpoint is not practiced to the extent necessary to provide adequate health protection.

9. Pollution abatement programs will do much to benefit estuarine areas, particularly from the standpoint of the shellfish industry where much revenue could be gained for the economy through the opening of the now closed shellfish growing areas. The water quality needed for water supply and recreational areas will also be benefitted by these abatement programs.

10. Adequate controls over pollution from boats are presently lacking, and there is a need for more adequate regulation of sewage discharges from boats.

III. EPIDEMIOLOGICAL ASSESSMENT

Epidemiology is a science that deals with the incidence, distribution, and control of disease in a population. Epidemiological data within the North Atlantic Region are somewhat limited with regard to the health damages resulting from waterborne diseases. The U. S. Public Health Service Communicable Disease Center does compile data for some of the diseases which could be waterborne. This information is collected weekly with yearly totals printed in their Morbidity and Mortality annual supplements.

Water has long been recognized as a potential vehicle for the transmission of organisms of various human enteric diseases. There are a number of diseases potentially transmitted by this route, but six are of greater significance in the United States. These are hepatitis, salmonellosis, shigellosis (bacillary dysentery), amebiasis (amebic dysentery), typhoid fever, and encephalitis. They are among the group of diseases which theoretically is regularly reported to the local health agencies. There are less acute gastroenteric disorders which are probably more prevalent than these six but they are among the group of optionally reported diseases so their incidence is unknown. The estimated number of reported cases of the six diseases during 1965-68 in the Region is shown in Table **V-1.**

TABLE V-1

Estimated Number of Reported Cases
of Potentially Waterborne Diseases
in the North Atlantic Region (1965-68)

Disease	1965	1966	1967	1968	4 Year Total
Amebiasis	1,329	1,403	1,837	1,786	6,355
Encephalitis	695	615	512	360	2,182
Hepatitis	7,496	7,234	9,314	11,066	35,110
Salmonellosis	4,816	5,106	4,390	4,767	19,079
Shigellosis	1,453	2,318	2,779	2,559	9,190
Typhoid Fever	73	87	57	65	282
	15,862	16,763	18,889	20,603	72,117

Approximately 25 percent of the Nation's population resides within the North Atlantic Region. The total number of reported cases of the six diseases for the Region is also about 25 percent of the total for the Nation so from an overall view there is no abnormal pattern of disease incidence. Amebiasis is the one disease that varies significantly from the normal incidence pattern. During the four year period, nearly 55 percent of the reported cases in the

Nation occurred in the North Atlantic Region. This is due to the large number of reported cases in New York City, where more than 85 percent of the cases of amebiasis reported in the North Atlantic Region occurred.

Amebiasis can be expected in economically depressed areas of a city where good sanitation practices are sometimes neglected resulting in a situation conducive to the spread of the disease. Acute cases tend to become chronic and, in the transient population common to this type of environment, immigrants to an endemic area often contract the disease. Malnutrition also is common to an area of this type and contributes to the severity and frequency of the disease. Medical clinics operating in these areas are quite familiar with the disease thereby resulting in early diagnosis and have established procedures for reporting any cases. These varied factors contributed to the large number of reported cases in New York City. The lack of these particular circumstances results in a small number of reported cases in rural areas.

It must be remembered that an unknown portion of these cases of the six diseases involved are transmitted by food or personal contact rather than by water. However, one should realize that many outbreaks go unreported and, therefore, are not listed in the Morbidity and Mortality annual publications. An example is the estimated 18,000 cases of salmonellosis that occurred in Riverside County, California, in May and June of 1965 during a waterborne outbreak. The entire United States total was listed as only slightly more than 17,000 cases — approximately 1,000 less than the Riverside epidemic produced. One has only to wonder how many more unreported waterborne epidemics occur to realize the need for constant surveillance and correction of environmental health problems.

There have been serious outbreaks in the North Atlantic Region. The following waterborne disease cases are highlighted to show how these diseases can be transmitted and that even in this modern day and age there are still problems.

One of the more serious outbreaks was the infectious hepatitis incident which put an end to the 1969 Holy Cross College football season after only two games. Epidemiologic investigations failed to incriminate any foods which could be responsible for the outbreak, so attention was directed to the field used for football practice. Examination of the area located a water line that supplied the irrigation system and the equipment house. Further investigation found that some children - four of whom had hepatitis - often used the sprinklers to cool off and many times were seen urinating on the nozzles and in the meter pits. With the very high coliform counts in water taken from the meter pits, it is theorized that a negative pressure was created in the system when water was diverted to fight a fire in another part of the city one day in late August.

This negative pressure drew contaminated water from the pits into the system and the water was delivered to the tap in the equipment house that supplied drinking water for the players during practice. These conditions resulted in the outbreak of infectious hepatitis.(1)

In November, 1963, over 300 cases of gastroenteritis were reported in Island Pond, Vermont. Epidemiological investigations strongly implicated the untreated water supply of Island Pond as the source of the disease organisms. Since then, there have been reports that a substantial number of "stomach ailments" arise in school children after strong rainstorms. Water quality of the water supply source is observed to deteriorate after these storms due to increased runoff from surrounding land, indicating a possible cause-effect relationship.(2)

In July, 1969, over 130 cases of gastroenteritis were reported at a girl's camp in Vermont. Water taps with contaminated lake water as a source were implicated as the source of transmission of this outbreak. Whil the source of the regular drinking water was a protected spring, these unsafe waters were easily available through a number of faucets throughout the camp.(2)

An outbreak of 477 cases of gastro-intestinal disturbances was experienced following major flooding during the spring of 1968 in northern New Jersey. The source of the transmitting vehicle was traced to a flooded well field owned by a large private water company in New Jersey. The threat of an infectious hepatitis outbreak required the administering of 47,870 doses of gamma globulin.

Infectious hepatitis has been shown to be transmitted through the consumption of raw or partially cooked shellfish. The following cases are highlighted to point this out. The first outbreak occurred in 1963 in Fairfield City, Connecticut, where 15 cases of infectious hepatitis were traced to the consumption of raw or inadequately cooked hard-shelled clams (Mercenaria mercenaria). These clams were found to have been illegally harvested from a closed growing area in Greenwich Cove, Connecticut. The cove had been closed for a number of years because of pollution from shoreline communities. The second disease outbreak was more extensive. Sixty-nine cases of infectious hepatitis which were atrributed to the consumption of contaminated shellfish occurred in New Haven County in early 1964. The source again was hard-shelled clams; however, this time they were believed to have been harvested from commercial channels in Narragansett Bay.

The preceding cases are well-documented in the literature; however it should be reemphasized that many disease cases occur of which the source of transmission is never detected because of

(1) Reference numbers refer to bibliography

a low incident number or dispersion of related cases. Stronger epidemiological programs and more intensive investigations will be required to obtain better information on these borderline epidemics.

IV. HEALTH ASPECTS OF WATER SUPPLY

INTRODUCTION

In any discussion of water supplies, special attention must be given to health protection for the ultimate users and intended beneficiaries — the people. As municipal water supplies are used for the domestic purpose of drinking and cooking, health and safety considerations are directly associated with those supplies.

One of the most significant achievements in the past 100 years in the United States has been the provision of safe and potable community water supplies. This initial achievement, however, was followed by a sense of complacency, and deficiencies and inadequacies now exist in many water supplies. The solution to present domestic water supply problems has two aspects. First, data gathering must be improved so that present and potential problems, their scopes, and their dangers can be better defined; and second, the necessary steps must be taken to reduce or eliminate known health hazards in our water systems.

In 1969 the Bureau of Water Hygiene, Environmental Protection Agency, conducted a Community Water Supply Study of 969 representative public water supply systems located in nine areas of the Nation. Water was delivered to over 18 million people in the study areas. The study was undertaken to answer two questions about the Nation's water supplies: (1) Are well-established standards of good practices being applied to assure the quality and dependability of water being delivered to consumer's faucets today? and (2) What needs to be done to assure adequate quantities of safe drinking water in the future on a National scale?

In the "Significance of National Findings" report(3), the section entitled National Significance of the Study Findings presents a thoughtful discussion of the study findings and the problems facing the waterworks industry; therefore, it is included in this section.

NATIONAL SIGNIFICANCE OF THE STUDY FINDINGS

Well-established standards of good practice, in terms of the full application of existing technology, are not being uniformly practiced today to assure good quality drinking water. While most professionals hold the U.S. Public Health Service Drinking Water Standards in high esteem, the study shows that an unexpectedly high number of supplies, particularly those serving fewer than 100,000 people, exceeded either the mandatory or recommended constituent levels of bacterial or chemical content, and a surprising larger number of systems evidenced deficiencies in facilities, operation, and surveillance.

The National significance can be placed in perspective by considering the size-distribution of municipal water supply systems that were the subject of comprehensive facilities census conducted during 1963. At that time, 150 million Americans were being served by 19,236 public water supply systems including 73 million people dependent upon 18,837 small systems, each serving communities of less than 100,000 people. When these statistics are compared with the fact that over 40 percent of the small systems investigated during the current study evidenced current quality deficiciences on the average and both large and small communities were judged to be giving inadequate attention to quality control factors, there can be little doubt that this situation warrants major National concern.

Most of our municipal water supply systems were constructed over 20 years ago. Since they were built, the populations that many of them serve have increased rapidly — thus placing a greater and greater strain on plant and distribution system capacity. Many systems are already plagued by an insufficient supply, inadequate transmission or pumping capacity, and other known deficiencies that become most evident during peak water demand periods. Moreover, when these systems were built, not enough was known to design a facility for the removal of toxic chemical or virus contaminants. They were designed solely to treat raw water of high quality for the removal of coliform bacteria. Such facilities are rapidly becoming obsolete as demands rise for water. The task in the future for our water treatment plants can be visualized by examining our population trend. By the year 2000 — only 30 years from now — our present population of about 205 million is expected to spurt to 300 million. By that time it is expected that 187 million people (the total U. S. Population just eight years ago) will be concentrated in four urban agglomerations — on the Atlantic Coast, the Pacific Coast, on the Coast of the Gulf of Mexico, and on the shores of the Great Lakes. Most of the remaining population will be living in cities of 100,000 or more.

In the past, communities and industries were in the favorable position of being able to select the best source of supply consistent with their quantity and quality requirements. The demand for more water to quench the thirst of a growing population and meet the needs of expanding industry have led many people to ask how future quantity requirements will be satisfied. Concurrently, expanding water use comes at a time of greatly increased pollution of ground water aquifers, as well as streams, lakes, and rivers. Historically and traditionally, ground water coming from its natural environment has been considered of good sanitary quality — safe to drink, if palatable. Nevertheless, 9 percent of the wells sampled during this survey showed coliform bacterial contamination. It seems fair to say that a similar situation prevails nationwide.

Chemical contaminants in our environment have been on the increase for about 25 years, due to the dramatic expansion in the use of chemical compounds for agricultural, industrial, institutional and domestic purposes. There are about 12,000 different toxic chemical compounds in industrial use today, and more than 500 new chemicals are developed each year. Wastes from these chemicals — synthetics, adhesives, surface coatings, solvents, and pesticides — already are entering our ground and surface waters, and this trend will increase. We know very little aboutthe environmental and health impacts of these chemicals. For example, we know very little about possible genetic effects. We have difficulty in sampling and analyzing them; we have much greater difficulties in determining their contribution to the total permissible body burden from all environmental insults.

Consideration of the findings of this study leaves no doubt that many systems are delivering drinking water of marginal quality in one or more areas of their water distribution systems today. To add to this quality problem, the deficiencies identified with most water systems justifies real concern over the ability of most systems to deliver adequate quantities of safe water in the future."

Water supply systems in the North Atlantic Region are as varied as they are throughout the Nation. Therefore, the problems enumerated above are indicative of those confronting waterworks officials in the Region.

WATER QUALITY FOR WATER SUPPLY

The quality of water can act as a constraint to a specific water use. At times quality might be a total constraint on the quantity available. For example, if a large water supply reservoir were constructed for a 20 year projected demand and it was discovered upon completion that levels of a parameter with a mandatory drinking water limit were high in the raw water and could not be removed by any available treatment, use of this reservoir for potable water would be completely negated.

There are two types of water usages which must be analyzed for constraints. These are withdrawal used and in-stream used. Withdrawal used include drinking and industrial use while in-stream use would include swimming, boating, fishing, etc.. In general, the most stringent requirements for water quality are those that must be met for water supply for both drinking and industrial used. Public health standards must be met for drinking water since a direct consumption of the product will occur.(4) Water quality requirements for industrial water use will vary based on the processes involved. Some industries might require a higher water quality than is usually produced by domestic water treatment. Other uses such as irrigation, power cooling, and industrial cooling do not have the quality constraints usually required for potable water.(5)

For in-stream use, water quality requirements are usually less than those required for withdrawal uses; however, these quality needs will vary depending on the type of in-stream use proposed. Recreation aspects are usually associated with specific water quality needs for in-stream use. Of these aspects the water-contract sports -- swimming, wading, water skiing, and surfing -- demand the highest water quality. Other in-stream uses such as boating can usually tolerate a lesser quality.

When a need for water for either withdrawal or in-stream purposes arieses, it would be desirable if this water could be supplied from a local source. The ideal situation would be for this local source to have not only a sufficient quantity of water but also have an existing water quality suitable for the use intended without requiring further treatment. As with ideal situations, this situation is the exception rather than the rule especially in the North Atlantic Region. The urban areas of the North Atlantic Region which have the highest demand for water supply usually have local water sources with low quality. Examples of these are: New York - Hudson River; Boston - Charles River; Hartford - Connecticut River: Philadelphia - Delaware River; and Washington, D. C. - Potomac River. Three of these five cities -- New York, Hartford, and Boston -- have solved their immediate problems by obtaining their water from other cleaner upland sources that require minimal treatment. Philadelphia and Washington, D. C., on the other hand, have chosen or been forced by economic or political constraints to use their local sources and provide sophisticated treatment to produce drinking water. The three former cities along with many others are now in this same position of being forced to use or consider for use these local sources of lower water quality for future demands.

Thus the big problem of the future is not the quantity of water alond but also its quality. Conventional water treatment plants which are now disigned for the removal of turbidity, color, and pathogenic bacteria will be unable to produce a product that meets human health standards in the not too distant future. Evidence for this may be seen in Table V-2 taken from the Report on Water Quality Criteria, Department of the Interior, Washington, D. C., 1968.(6) As indicated at the bottom of the bale, the removal of approximately 80% of the constituents listed is insignificant in the process of conventional treatment. Conventional treatment is defined as that which might include coagulation (less than about 50 ppm alum, ferric sulfate, or copperas with alkali addition as necessary but without coagulant aids or activated carbon), sedimentation (6 hours or less), rapid sand filtration (3 gal/sq.ft./ min or less) and disinfection with chlorine (without consideration to concentration or form of chlorine residual). Thus, as water quality decreases and the limits for the constituents listed in Table V-2 are exceeded, new methods of water treatment will have to be developed. It would be desirable if pollution abatement programs gave more consideration to the water quality requirements for drinking water supplies. This is especially important in view of the fact that conventional wastewater treatment plants are primarily designed to remove organic materials, settleable solids, and bacteria; however, this treatment has little or no effect on the many chemicals present in today's wastes.

Water quality also exerts a large degree of control over in-stream uses when health aspects are a consideration. Domestic wastewater treatment plants, in general, can improve a water's quality to the point where water contact recreation can be practiced. This is generally true when the industrial waste loads are not too great or are under strict control.

The point is: Conventional wastewater treatment as practiced today does not have the capability for removing many hazardous substances that are in the wastewater before it enters a watercourse, nor does conventional water treatment have this ability when water is withdrawn for use as drinking water.

It may be said that we do not have to worry about removing most of the consituents listed in Table V-2 from our drinking water since they are not present to any degree in our water sources. In most cases this is basically true, but the recent discovery of mercury contamination of rivers and lakes across the country should not give comfort to thos who feel that there are no problems.

TABLE V-2 Surface Water Criteria for Public Water Supplies

Constituent or characteristic	Permissible criteria	Desirable criteria	Paragraph
Physical:			
Color (color units)	75	<10	1
Odor	Narrative	Virtually absent	2
Temperature *	do	Narrative	3
Turbidity	do	Virtually absent	4
Microbiological:			
Coliform organisms	10,000/100 ml [1]	<100/100 ml [1]	5
Fecal coliforms	2,000/100 ml [1]	<20/100 ml [1]	5
Inorganic chemicals:	(mg/l)	(mg/l)	
Alkalinity	Narrative	Narrative	6
Ammonia	0.5 (as N)	<0.01	7
Arsenic *	0.05	Absent	8
Barium *	1.0	do	8
Boron *	1.0	do	9
Cadmium *	0.01	do	8
Chloride *	250	<25	8
Chromium,* hexavalent	0.05	Absent	8
Copper *	1.0	Virtually absent	8
Dissolved oxygen	≥ 4 (monthly mean) ≥ 3 (individual sample)	Near saturation	10
Fluoride *	Narrative	Narrative	11
Hardness *	do	do	12
Iron (filterable)	0.3	Virtually absent	8
Lead *	0.05	Absent	8
Manganese * (filterable)	0.05	do	8
Nitrates plus nitrites *	10 (as N)	Virtually absent	13
pH (range)	6.0–8.5	Narrative	14
Phosphorus *	Narrative	do	15
Selenium *	0.01	Absent	8
Silver *	0.05	do	8
Sulfate *	250	<50	8
Total dissolved solids * (filterable residue).	500	<200	16
Uranyl ion *	5	Absent	17
Zinc *	5	Virtually absent	8
Organic chemicals:			
Carbon chloroform extract * (CCE)	0.15	<0.04	18
Cyanide *	0.20	Absent	8
Methylene blue active substances *	0.5	Virtually absent	19
Oil and grease *	Virtually absent	Absent	20
Pesticides:			
Aldrin *	0.017	do	21
Chlordane *	0.003	do	21
DDT *	0.042	do	21
Dieldrin *	0.017	do	21
Endrin *	0.001	do	21
Heptachlor *	0.018	do	21
Heptachlor epoxide *	0.018	do	21
Lindane *	0.056	do	21
Methoxychlor *	0.035	do	21
Organic phosphates plus carbamates.*	0.1 [2]	do	21
Toxaphene *	0.005	do	8
Herbicides:			
2,4-D plus 2,4,5-T, plus 2,4,5-TP *	0.1	do	21
Phenols *	0.001	do	8
Radioactivity:	(pc/l)	(pc/l)	
Gross beta *	1,000	<100	8
Radium-226 *	3	<1	8
Strontium-90 *	10	<2	8

* The defined treatment process has little effect on this constituent.

[1] Microbiological limits are monthly arithmetic averages based upon an adequate number of samples. Total coliform limit may be relaxed if fecal coliform concentration does not exceed the specified limit.

[2] As parathion in cholinesterase inhibition. It may be necessary to resort to even lower concentrations for some compounds or mixtures. See par. 21.

Mercury **0.005***

Added to the possibility of unknown contaminants in our water supplies is the fact that future water supply will undoubtedly come from sources of lesser quality. This will increase the chances of encountering hazardous substances which are "untreatable by present day conventional treatment.

The time for action is now. Water quality monitoring for water supply must be intensified for all existing and potential water supply sources. Constituents to be measured should include all those listed in the 1962 P.H.S. Drinking Water Standards and the P.H.S. Manual for Evaluating Public Drinking Water Supplies. Intensive water quality monitoring programs are essential in order to show what trends may be occurring for the various constituents found in drinking water. Today very few water companies are analyzing for all of the constituents listed in the Drinking Water Standards. This is usually due to the complexity and high cost of the test techniques for many of the chemical constituents. If a number of strategically located water supplies throughout the North Atlantic Region were to do an adequate analysis of their raw and finished water, this would at least give an indication of the trends that may be taking place in the various parts of the Region. At the present time there is insufficient research on the toxic effects to humans from the ingestion of minute amounts of inorganic or organic chemicals through drinking water. Research is also desperately needed on effective and economically feasible methods of water treatment for the removal of these trace elements in order to produce potable water.

PROBLEM AREAS AND TREATMENT NEEDS

In this section some of the water quality problem areas in water supply around the North Atlantic Region will be discussed. Many of these water quality problems lead to a need for more extensive treatment of the water supply in order to produce a potable water. This section will not be all inclusive of the water supply problems of the North Atlantic Region; it will only highlight some of the major ones.

Vermont

A community water supply study done in the State of Vermont by the Bureau of Water Hygiene, U.S.P.H.S., in the summer of 1969 confirmed the Vermont State Health Department's contention that a number of water supplies in Vermont were contaminated with pollution-indicating bacterial organisms. Plagued by a major understaffing problem for a number of years, the water supply program of the Vermont State Health Department had been unable to provide adequate surveillance and assistance to the 216 community water supply systems of the state.

The Bureau of Water Hygiene study revealed that approximately 30 percent of the water systems in Vermont evidenced coliform organisms in excess of that allowed by the PHS Drinking Water Standards. In most cases this contamination resulted from the use of a surface supply or springs which had no treatment or marginal treatment. The sources were usually very poorly protected allowing intrusion of animals and the supposedly more civilized segment of our population. Operation of these systems in accordance with proper management practices of the water supply field was minimal. As can be expected, most of these contaminated supplies were quite small(serving less than 1000 people). These small systems do not have the capital to make necessary improvements or to hire competent water supply managers. Training of the operators of these systems was minimal.

The problems in Vermont are a classic example of what can occur when a state water supply program is unable to provide the needed surveillance and assistance to all of its water supplies. Progress is now being made in Vermont to assist those water systems which continually evidence contamination, but it will be a long uphill fight to upgrade these systems. A combination of the lack of staff in the state water supply program, the lack of capital in the water supplies' funds to provide necessary improvements in the system, and the general lack of interest or appreciation of the very real problems on the part of the people of Vermont as a whole add to the complexity of the problem.

It does not necessarily follow that Vermont is the only state which has problems with its water supplies. The situation in Vermont probable typifies many similar conditions which exist in many rural water supplies in the United States.

Burlington, Massachusetts

Burlington, Massachusetts, has experienced a rather drastic buildup in chlorides in a number of its wells over the past five years. The predominant source of these chlorides is from the salt used by state and local public works departments for ice and snow control on the complex system of streets and highways of the area. The chloride content of the wells has risen from around 30-50 mg/l in 1965 to 100-200 mg/l in 1970. The recommended drinking water stnadard is 250 mg/l. This standard is based on the Threshold taste of chlorides in water.

The nature of chlorides in water make this a fiddicult situation to rectify. There are no relatively economic treatment processes available for removing chlorides from drinking water; therefore, it usually boils down to a question of limiting salt usage in the area which could be hazardous for motorists during icy conditions or of switching to a new water source. Salt contamination might be lessened and costs reduced by using a salt/sand mixture with a minimum salt/sand ratio. Stopping the use of salt is not the entire answer since a residual of salt will remain in the soil and cause contamination until it is leached out of the soil after a period of years.

Burlington is not the only community that has evidenced chloride buildup in its well supplies from highway runoff. Other communities in the Northeast have also been affected. With the ever-increasing network of highways with the associated use of salt for ice control, salt contamination of ground and surface supplies may become a very serious problem of the future if proper controls and precautionary measures are not taken.

Fall River, Massachusetts

During the month of August, 1970, a widespread contamination of the water in the distribution system of the Fall River water supply was experienced. Coliform counts as high as 204 per 100 ml of sample, were found in finished water samples. Boil water notices were issued to the 100,000 inhabitants of Fall River as a result.

The problem was alleviated by building up the chlorine residual in the distribution system. As a result of this corrective action, boil water orders were lifted on August 27, 1970, after having been in effect for a one week period. The source of the contamination was not clearly evident. Since the treatment for Fall River consists of simple chlorination, a heavier than usual contamination in the major surface source may have overwhelmed the effectiveness of the chlorination process.

One thing is clear. Contaminated water is not just limited to small rural water supplies like those in Vermont. Large metropolitan areas can also encounter problems with the quality of their finished product.

Long Island, New York

The water for the communities on Long Island is derived exclusively from a ground water acquifer which underlies the entire island. In general, the quality of the water is good and the quantity is adequate. Presently most of the island is unsewered so that disposal of domestic wastes is accomplished by individual disposal systems such as septic tanks and cesspools. This has resulted in an increase in the nitrate concentrations of the ground water, especially in the central area of the island. Some water supplies have found their entire well fields with nitrate levels exceeding the State and Public Health Service Drinking Water Standards. Past practice has been a blending of the high nitrate water with a low nitrate water to obtain an acceptable water. When entire wellfields have this high nitrate problem, this solution is no longer feasible.

Some water companies are now considering the use of zeolite exchangers to bring the nitrate level down; however, these exchangers have a high initial cost and are expensive to operate. Until associated problems such as the disposal of the brine from regeneration are solved, their use will be delayed. Here, as in Vermont, there is more than adequate water for domestic water supply, but the quality limits the use of this water.

In Suffolk County there has been a record of problems with detergent pollution of ground water. The possibility of this pollution increasing because of the disposal of household sewage through oftentimes inefficient individual disposal systems has created questions in the minds of the Suffolk County health authorities. As a result of this concern, in the latter part of 1970, the county legislature passed an ordinance outlawing the sale of certain detergents throughout the country. This will be a difficult regulation to enforce, but again a needed one to help maintain the good quality of the groundwater of Suffolk County.

New York City, New York

New York City's water sources are made up of a number of fairly isolated upland surface reservoirs which in the past have required only chlorination in order to produce a potable water. These reservoirs resulted from very farsighted planning in the early 1900's. However, in this day and age the population explosion and encroaching suburbia have made the task of identifying new reservoir sites for New York City's water supply very difficult.

Indications now point toward the use of the Hudson River as a source of water for the metropolitan area in the not-too-distant future. This use will require at least complete conventional treatment which will add significantly to the cost of water for the consumer. The quality of the Hudson River is such that conventional treatment would probably be sufficient unless it is found that the exotic chemical levels, either organic or inorganic, exceed the New York State Drinking Water Standards. The added possibility of a spill from a tanker or the release of a slug of hazardous chemicals from an upstream industry complicate this problem. This problem of varying water quality in the raw water source is going to increase in importance as more metropolitan areas turn for their water source to nearby rivers which support a high degree of upstream industrial usage.

Northern New Jersey

Studies have shown that certain areas of northern New Jersey will have severe water shortages before the next century begins. This is due to the rapid urbanization of this area by the people who commute to work in the Newark or New York City area. Heavy industrialization and farming of the area also add to this high demand for water.

There are also problems of the present. One of these is the deterioration of the water quality in existing surface water supply reservoirs serving the large cities of northern New Jersey. Several of these cities are served by surface supplies on which the only treatment provided is chlorination. Expanding subdivisions in the upstream watersheds of these reservoirs have caused a deterioration in the water quality to the point where complete conventional treatment is required in order to produce an aesthetically acceptible finished product. However, the cost for providing filtration for this water will put a very serious strain on the already overburdened budgets of the cities involved.

Southern New Jersey

Southern New Jersey, on the other hand, is primarily served by ground water. Although there is an adequate supply of groundwater, the quality of some of the water is less than desirable. This ground water oftentimes has excessive quantities of iron and manganese which gives the water a brownish tinge and causes staining of bathroom fixtures. Clothes washed with chlorine bleach in this type of water usually come out stained.

Iron and manganese in the water is an aesthetic problem rather than a health hazard. Treatment of this water high in iron or manganese usually consists of some type of aeration or coagulation and then filtration. For the smaller water companies with a wellfield, the cost for installing and operating this type of treatment is many times prohibitive. This leaves the consumer with choice of using the rather unaesthetic public water or resorting to the use of a backyard dug well which, although appearing clearer, may have bacterial contamination.

Philadelphia, Pennsylvania

The water supply of the City of Philadelphia is derived from the Delaware River and the Schuylkill River. These rivers have low water quality because of discharges of municipal and industrial wastes in the upstream reaches; however, this water company is able to produce a safe drinking water by a rather sophisticated conventional water treatment process. This system is an example of a large metropolitan area which has already gone to nearby large rivers and provided extensive treatment to produce drinking water.

Although Philadlphia's water supply meets the 1962 U. S. Public Health Service Drinking Water Standards and is not considered to be a problem area, the water produces by this conventional treatment is not as palatable as water from higher quality sources which require lesser treatment. This can lead people to the use of bottled water for drinking purposes which, in itself, is not necessarily undesirable although the use of bottled water is a very expensive way to get drinking water. This is an area where research may be needed to find a way to produce a more palatable water when extensive treatment is involved. Since this use of water sources requiring more complex treatment will be much more prevalent in the future, it would seem like this is an area of research that is needed.

Pennsylvania

A special sort of pollution problem is encountered in the coal mining areas of Pennsylvania which can directly affect water supplies. This problem is the contamination of raw water sources by acid mine drainage. Surface water supplies whose sources are contaminated with mine acids usually exhibit high levels of iron in the water and a low pH which tends to make the water aggressive. This aggressive or corrosive water has a tendency to deteriorate metals in the distribution or domestic plumbing systems. High contents of phenols are oftentimes associated with aggressive waters caused by acid mine contamination. An example of a community in this situation is Altoona, Pennsylvania. One of Altoona's three water sources comes from a surface supply that is contaminated with mine acids. Since Altoona's treatment in the past was only chlorination, problems with high iron concentrations were encountered in certain parts of the distribution system. A

State demonstration project involving the construction of a water treatment plant for this contaminated source was begun in 1969, and it is hoped that this treatment plant will prove effective enough to be used as a model for other water supplies in the area that have this problem of mine acid contamination.

This is an area where both specialized waste treatment and water treatment are needed to gain the maximum utilization of this type of water for water supply.

Cambridge, Maryland

A different kind of chloride problem has hit a number of wells in the Cambridge, Maryland, area. This contamination is due to salt water intrusion, a process where ocean water invades a fresh water acquifer. This usually results from overpumping an acquifer so that there is an insufficient fresh water barrier to keep the salt water out.

This same problem has occurred on Long Island, New York. An experimental station has been set up in the Bayshore area to inject tertiary treated wastewater effluent back into the aquifer to stabilize the interface between the fresh and salt water so that water supplies confronted with this problem is to blend waters of lesser salt content with that from the contaminated wells. This is not, however, a very long-lasting solution; as the population in these shore areas increases and water demands rise, many overtaxed wells will become contaminated with salt water. The only answers, other than abandonment of the wells, seem to be a stabilization of the interface by ground water injection or possibly the development of an inexpensive treatment method for the removal of chlorides from water.

Discussion

The singling out of the various areas discussed in this section does not imply that these are the only areas with problems. There are undoubtedly other areas with similar problems and in some isolated instances, more serious problems. Needless to say, the problems in the Northeast are indicative of the need for stronger water supply programs on both the state and federal levels to help the local water companies solve their problems so that they may continue to provide the public with the high quality water to which they are accustomed.

USE OF WATER SUPPLY RESERVOIRS FOR RECREATION

In many basin of the North Atlantic Region, recreation studies, both for fishing and water contact sports, have indicated unsatisfied demand for open bodies of fresh water. This unsatisfied demand will probably increase with the public's sentiment being against the construction of new large dams on rivers and streams. This opposition to the construction of large dams plus the rising cost of land acquisition for dams and surrounding recreation facilities have intensified the desires of recreation planners to open up many existing water supply reservoirs to various levels of recreation. In a number of the basins this procedure would do much to satisfy the demand for open water for various forms of recreation; however, it is not as simple a solution as it appears to be.

Waterworks managers as a rule are very hesitant to endorse the use of existing water supply reservoirs for recreation especially when it is their own reservoir that is under discussion. The possibility of water quality degradation, the possible necessity for additional water treatment, and the aspect of who controls the recreation area are some of the issues which must be resolved before a water works official can consider such a proposal.

One area of conflict centers around the large number of surface water supplies in the Northeast that provide only chlorination as their main treatment i.e. Boston and New York. These large surface reservoirs would seem to offer great potential for satisfying a portion of the demand for open water by recreators. However, in most cases simple chlorination does not provide sufficient protection for the water system to allow water-contact recreation on the reservoir. The recreation interests then counter by saying that in this day of environmental pollution all surface water supplies should receive complete treatment. One of their feelings is that, even though a watershed is isolated, it is not isolated from airborne contaminants from air pollution or wild animal contamination. On the other hand, many water supply managers want to keep watershed isolation and/or protection as long as possible so that they continue to be able to meet the drinking water standards with just chlorination. They are not too anxious to incur the tremendous expense of constructing and operating filtration plants. The water supply managers want to know who will bear this increased cost for treatment if recreation is allowed on their reservoirs.

The following is a list of pros and cons which are usually put forth when any discussion of the recreational use of water supply reservoirs takes place: (7)

Pros

1. Water area for recreational use (particularly in some densely populated states) is in short supply and great demand.

2. Creation of water areas exclusively for recreational purposes is extremely costly and, except to a limited degree, is beyond the financial ability of most agencies concerned with this problem.

3. Use of reservoirs for both recreation and water supply appears feasible under appropriate regulations. Such multiple use contributes substantially to lowered costs of government services related to these uses.

4. Agencies in charge of water supplies should not reject the possibility of recreational use of water supply sources because of lack of interest,prejudice, or inadequacy of funds or authority. They should invite the shouldering of this responsibility by agencies equipped for that purpose.

5. Since water-based recreation is one of the most satisfying and healthful forms of recreation, some of the public may be deprived of the means to recreate if multiple use is not made of certain existing and future surface water supply reservoirs.

6. Modern water examination and treatment techniques, together with medical advances in the diagnosis and cure of epidemic diseases, have made the traditionally rigorous isolation of the water supplies much less valid.

7. Many public water supply systems are open to multiple recreational use in varying degrees - from fishing only under a permit system to virtual unrestricted use including swimming; a history of at least 60 years reveals no outbreaks of disease that can be attributed to those uses of the water supply.

8. The introduction of game fish such as bass, crappie, bluegills, etc. while ridding the reservoir of rough fish such as carp, suckers, or bullheads can not only provide recreational fishing but also bring about an improvement in raw water quality.

9. The fostering of more favorable public opinion toward water companies may be realized when reservoirs are opened to recreation.

Cons

1. The pollution load will be greater. It may possibly lead to eutrophication in raw water sources. Accompanying algal blooms will make the reservoir unusable if complete treatment is not practiced.

2. Water will be more difficult to treat leading to higher chemical costs for proper taste and odor control.

3. The additional cost of policing grounds and maintaing the recreational facilities (shelters, rest rooms, etc.) may be too much. If the utility assumes the cost, the consumer pays. If the recreational group assumes part or all of the cost, the utility compromises control of the reservoir.

4. The public is entitled to and should have a reservoir that is not littered or repulsive to the eye.

5. Public use creates fire hazards for the shore plantings which are important in minimizing silting of the reservoirs.

6. The utility may be subject to large claims for accidents occuring on the grounds and must either carry broard insurance or chance expensive lawsuits.

7. Demands, contrary to the best interest of the water supply, will be made by various groups who wish to increase the recreational value of the reservoir. These demands may include limitations of shore line planting, restrictions on the use of algicide, or maintainance of a constant water level.

8. Recreational privileges may bring a demand for cottage sites, trailer parking, and overnight camping creating more pollution.

9. There will be an increased potential for vandalism of water works property and equipment.

10. Public access to the water source may increase the risk or pollution or contamination by sabotage.

11. Harassment of waterworks personnel who are attempting to enforce rules and regulations will occur.

12. Drowings may occur in the reservoir creating adverse public reaction concerning the potability of the drinking water derived from this reservoir.

13. In a number of cases, it has been found that even when adequate sanitary facilities are provided at these reservoirs open to recreation, they are not utilized by the recreators to the degree necessary to protect public health.

14. The opening of a water supply reservoir to recreation can bring about a secondary reaction in that land in the surrounding area will immediately become attractive to real estate developers intent on establishing summer and vacation home developments that would rely on the reservoir for water-based recreation. The intense development of land in the watershed area of a water

supply reservoir could lead to very serious water quality degradation of the reservoir itself. This degradation could lead to the destruction of the reservoir for water-based recreation and, more importantly, could seriously impair the water supply's capability to produce potable water from that source.

PAST STUDIES ON USE OF WATER SUPPLY RESERVOIRS FOR RECREATION (7)

A number of studies have been done to determine the effect of various forms of recreation on the water quality of water supply reservoirs. Although definite conclusions were reached in each of the studies, it would be unwise to try to translate these results into condemnation or approval for the opening of water supply reservoirs to recreation. Each reservoir for which recreation is proposed must be studied individually bringing into account all the variables which could affect the water supply. However, a review of these past studies may help to give a clearer picture of some of the difficulties that one may encounter in the North Atlantic Region.

California Department of Public Health Study

Twelve reservoirs were selected for the study. The reservoirs selected represented three categories: (1) domestic water supply reservoirs closed to all recreational activity, (2) domestic water supply reservoirs open to controlled recreational activities, and (3) multi-purpose reservoirs open to controlled recreational activities.

Recreational activities at the domestic water supply reservoirs open to controlled public use included fishing from the shore and from boats, pleasure boating, picnicking, and some overnight camping. Recreational use of these reservoirs was, according to the report, not extensive.

General conclusions reached in this study, paraphrased from the 1961 report, included:

1. Under the observed condition of limited patronage, restricted uses, and supervision provided, the study revealed no serious degradation of water quality attributable to recreational activities.

2. At two of the reservoirs studied, laboratory analysis showed more bacteria in the water where there was more recreational use, though the increases in bacterial concentrations were generally not large.

3. Objectionable practices will occur and trash and fecal matter may be deposited or washed into the reservoir whenever recreational activities are permitted.

4. As an additional safeguard against unusual circumstances or the failure of recreational control measures, treatment facilities for domestic water taken from these reservoirs must be designed to protect against the worst potential hazard.

Forrest Lake, Missouri Study

Forrest Lake, an impoundment of 702 acres with a shoreline of 17 miles serves as the raw water source for the water filtration plant for the city of Kirksville, Missouri (population 13,300). The lake is surrouneded by Thousand Hills State Park (3,152 acres), and area heavily used for water-based and land-based recreation. Over 300,000 people visited the park during the study period described herein. The most popular recreational activities (in order of preference) were sightseeing, picnicking, swimming, fishing, motorboating, camping, and water skiing. Over 700 boats were licensed to operate on the lake during the study period.

From June, 1958, to May, 1960, a lake survey was conducted to assess the possible effect of the recreational use of the watershed on the bacteriological quality of the lake's waters.

The principal conclusions drawn from this study were:

"1. The high recreational use of the lake and watershed was not reflected by the bacterial counts at the intake tower.

2. The pollution study of Forrest Lake has been of importance to the City of Kirksville through better management of raw waters for the filtration plant.

3. The pollution of Forrest Lake would need to increase considerable before there would be additional costs for filtration and treatment of the waters for the municipal water supply."

Springfield, Massachusetts Study

In 1965, the effect of suspending fishing privileges on the water quality of two water supply reservoirs in Springfield, Massachusetts, was investigated. Ludlow Reservoir has a capacity of 1.8 billion gallons and a watershed of 20.5 square miles. Reservoir water is treated by slow sand filtration before delivery to the town of Ludlow and a local industrial plant. Certain areas of the reservoir had been opened to bank fishing in 1948. Approximately 15,000 people fished in the reservoir each year during the fishing season.

In October, 1959, following a complaint by officials of the town of Ludlow that the deposition of rubbish and human wastes along the reservoir's shore were creating unsanitary conditions, the Springfield Board of Water Commissioners reviewed their policy of permitting bank fishing at Ludlow Reservoir. The Massachusetts State Department of Public Health also examined this problem and recommended that more stringent enforcement of the rules and regulations governing reservoir use be accomplished. The Board concluded that, without large expenditures, adequate supervision of the fishermen was impossible and voted in October 1959, "A discontinuance of all fishing" to remedy the unsanitary conditions at the reservoir.

Many of the same problems that occurred at Ludlow also occurred at other reservoirs in the Springfield supply system where bank fishing was permitted. The largest of these reservoirs, Cobble Mountain, has a capacity of 22.8 billion gallons, a surface area of 1,134 acres, and a watershed area of 48.5 square miles. This reservoir, completed in 1932, was opened to bank fishing in 1950. Objectionable practices of fishermen forced closure of this reservoir on January 1, 1962.

From their experiences with recreational activities at Springfield reservoirs, the authors concluded, "It is our deep conviction and personal belief that water supply reservoirs should be used for only water supply purposes at all times."

Hartford, Connecticut Study

Another report published in 1965 describes the experiences of the Water Bureau of the Hartford Metropolitan District on the recreational use of its Compensating and West Branch Reservoirs. Currently, neither function is maintaining legally specified stream flows in the Farmington River.

One of these, Barkhamstead, is strictly a water supply reservoir. No recreational activities are allowed on it and trespassing on adjacent District-owned lands is prohibited. The other reservoir, Compensating, is used extensively for fishing, boating, and swimming. It serves no water supply function as previously stated. These reservoirs have similar watersheds and water from Barkhamstead is frequently discharged into the Compensating Reservoir. Comparative bacteriological data was used to show the effect of recreation on the Compensating Reservoir. Barkhamstead Reservoir, with no recreation, shows a low and fairly consistent coliform level throughout the year. Conversely, the Compensating Reservoir, with heavy recreational use, shows a large increase in coliform level each spring. The author concludes that, if depending solely on simple chlorination for protection, use of this reservoir as a water supply would be very risky.

Geist Reservoir Study

One of the more recently documented studies to date was reported in May of 1966. It concerned the Geist Reservoir, a water storage impoundment owned by the Indianapolis Water Company, and the site of a 2-year study (1963-1964) of the effects of recreation on water quality.

The reservoir stores raw water for one of the water treatment plants (coagulation, filtration, and disinfection) serving Indianapolis. Limited recreational use, principally fishing, boating, and picnicking, is permitted. Water skiing and swimming are prohibited. The most popular form of recreation practiced on this reservoir is fishing. During 1964 over 500,000 man-hours were spent on these fishing activities.

The principal conclusions derived from the analysis of the physical, chemical, and biological data collected during the study were as follows:

1. The fertile drainage area was supplying sufficient nutrients and growth stimulants to Geist Reservoir for aquatic vegetation development and that the effects of any nutrient increase resulting from currently proposed recreational use or adjacent land development would be undetectable.

2. The nutrients and growth stimulants supplied from the drainage area are contributed by agricultural run-off, municipal-industrial discharges, and non-crop run-off. A reduction of the agricultural, municipal, and industrial wastes could improve the water quality of Geist Reservoir.

3. The future development of water-contact sports such as swimming would be limited because of inadequate swimming beaches.

4. The natural die-off of bacteria that occurred in Geist Reservoir indicates that under existing conditions the development of large bacterial populations within the reservoir is remote.

5. Gross mineral analyses indicate an acceptable water quality for a public water supply.

6. .... the small amount of recreation present on Geist Reservoir has a minimum effect on the present water quality."

The Northwest Watershed Project

A study was conducted from December, 1966, through September, 1967, by the Bureau of Water Hygiene, DHEW, to measure the physical, chemical, and microbiological quality of water flowing from three watersheds in the northwestern part of the United States. These watersheds were those of the Cedar and Green Rivers in Washington and the Clackamas River in Oregon. The watersheds are similar in environmental factors such as terrain, elevation, forest cover, and meteoriological conditions but vary in their human use. The Cedar watershed is highly patrolled, hereafter called well protected; the Green watershed has some resident population and limited recreational uses; and the Clackamas watershed is open for unrestricted access and unlimited recreation.

The objectives of this study were to show the influence on water quality from the different human population levels on the three watersheds and to characterize the quality of water flowing from a well-protected watershed.

The results of this study show that increases in the human population on the Cedar (0.7 man-day/sq.mi. max.); Green (1.4 man-days/sq.mi. max.); and Clackamas watersheds (5.7 man-days/sq.mi. max.) were insufficient to produce an influence on water quality measurable by present techniques. The animal pollution of the water was probably, therefore, the dominant factor contributing to the low fecal coliform bacterial densities found in the water flowing from all parts of the watersheds.

Discussion

Although the conclusions from these various studies range from an indication of little or no deterioration in water quality, based on indicator organism densities, to a moderate rise in indicator organism counts in the high recreational use areas, the protection afforded by natural dilution, die-off, and disinfection following complete water treatment would seem to indicate that safe finished water can be produced from a source in which water-based recreation is permitted. The same confidence may not exist, however, if disinfection without pretreatment is practiced.

These studies all suffer from several shortcomings; for example: (1) no control was included in many of these studies; (2) most of the studies were done when measurement of total coliform density was the only bacteriological pollutional indicator system available; and (3) the studies were done before adequate methods for assaying bacterial and viral-pathogen content of the water were available, with the exception of the Northwest Watershed Project.

Summary

The six studies summarized in this paper indicate that little or no deterioration in bacterial water quality occurs at the water supply intake when recreation is permitted in or around public water supplies. In those cases where some rise in indicator organism did occur, it was localized within the high recreational use areas. Even in these cases, the bacterial water quality at the water supply intake was within the limits that could be removed by existing water treatment technology. Other factors, however, will continue to make the decision on whether to permit recreation on public water supplies a local matter. Problems of aesthetics, loss of control of utility property, and concern over a deteriorating trend in water quality, even though slight, will continue to cause some water supply utilities to proceed cautiously in opening their reservoirs for recreation.

Conversely, sociological and political pressures, confidence in dilution, natural die-off, and disinfection will cause other water utilities to permit recreation in their reservoirs. The purpose of future research by the Bureau of Water Hygiene will be to provide additional evidence on the influence of recreation on water quality, both for the water supply and for the recreationist, so that any water utility considering opening their reservoirs to recreational activities will have the best possible knowledge upon which to base their decision.

RECREATIONAL USE OF WATER SUPPLY RESERVOIRS IN THE NORTH ATLANTIC REGION

We have now examined some studies which were done to show the effects of recreational use on water supply reservoirs. Now the question is: How do these studies apply to the North Atlantic Region? Probably this question can most simply be answered by saying that there is no direct relationship. For each reservoir which has potential for recreation, a close look must be taken at the present conditions of that reservoir and what the possible effects might be. There is no general across-the-board statement that can be made on this subject.

One should note that of the studies previously discussed, that the only ones which occurred in the North Atlantic Region (Hartford and Springfield) were against the use of water supply reservoirs for recreation. Again this should not be construed as a pattern that should be set for the North Atlantic Region. For example, the water system for the Portland, Maine area uses Sebago Lake for its source. Treatment of the water is simple disinfection; however extensive recreation is practiced on Sebago Lake including water-contact sports. A number of factors make this multiple-use possible. The Portland Water District controls the lake within a two mile radius from its intake (no water contact in this area) and has a strong surveillance program on the lake to locate pollution from lakeside camps. The lake itself is blessed with high natural water quality and has a high dilution capacity for any pollution that enters it. So here is a case where harmony between water supply and recreational use seems to exist for the present time anyway.

There are three basic elements that must be satisfied when recreational use of any reservoir is practiced. These elements that a recreational area must have are: 1) adequate recreational development or "physical plant" including sanitary facilities; 2) proper maintenance of the facilities; and 3) sufficient personnel to supervise the public using the reservoir for recreation. All of these conditions must be met or unsatisfactory results will occur. Not only could the potability of the water supply be affected if these measures are not taken, but also the health of the recreator within the recreation area could be jeopardized.

If it can be established that these three objectives can be met, the next important step would be to attempt to ascertain the effect of this recreational use on the water quality of the reservoir. Since at best this will probably have to be a "best guess" estimation, the water company should institute a comprehensive water quality monitoring program in various parts of the reservoir to locate any areas where water quality degradation may be occurring. Since this could be somewhat of an "after-the-fact" monitoring program, the water supply must retain the authority to limit or discontinue recreation on their reservoir if it is felt the potability of the finished water is being jeopardized. Since the risk of spreading disease via the public water supply is increased, water supply management must have the final say as to how the recreation facility is operated, regardless of who bears the cost for the recreational facility or for additional water treatment if required.

INDIVIDUAL WATER SUPPLY

In any discussion of water supply, individual water supply must share a significant part of this discussion. Approximately 20 percent of the nation's population is served by individual water supplies, either in the form of a barkyard well, spring, cistern, pond, or stream. Since surveillance and quality control and monitoring is almost nonexistent with individual water supplies, most public health authorities favor the connecting of these individually-served households to municipal or rural systems. Where this is economically feasible, it certainly is most desirable that this be done, but in many cases, georgraphical location, scattered households, or poor yield of water sources make the cost o f rural water supply systems prohibitive so the trends of increasing urbanization and regionalization of water supply systems will not eliminate individualy water supplies, and the concern for the potability of these individual supplies will increase among health authorities.

This discussion of individual water supplies will deal mainly with water supply systems serving individual residential homes. In the North Atlantic Region nearly 15 percent of the people are served by individual supplies. One of the major problems with individual water supplies is that not enough is known about the adequacy of quantity or quality of the water produced by these supplies. In most monitor adequately all the public water supplies; consequently health authorities have had to rely on well drillers to construct safe and adequate wells and also on the homeowner to maintain these wells in good condition. This is not enough! In Pennsylvania it is estimated that there are 300,000 unsafe or potentially unsafe individual water supplies. A review of bacteriological records of individual water supplies in Vermont indicated that over 35% of the wells produced water that was bacteriologically unsafe.

Much information could be gained concerning the quality of water from individual supplies if the homeowner would have the water tested for bacteriological quality. Two states, Maine and Vermont, provide free laboratory services for individual water supply owners by law. The state provides the sterile bottle, and the homeowner takes the sample and sends it by mail to the laboratory for bacteriological analysis. This system, however, has had drawbacks in both sates as follows: (1) These individual system samples sometimes tend to overload the laboratory, especially when public water supplies, which have a higher priority, must be run, (2) Procedural methods dictate that the sample should be analyzed within 30 hours after taking the sample. However, many samples mailed to the laboratories do not reach their destination within this time frame, (3) This service is strictly volumtary on the homeowner's part so that many wells, possibly the worst ones, never get tested, and (4) The major drawback is that when a bad sample is found, little followup action is made other than to notify the homeowner by mail that his water is contaminated. There is insufficient staff to go out and look for problems with each well exhibiting high coliform counts. Most state and local health agencies for individual water systems. Consequently, the homeowner must have his water tested at a private laboratory. The homeowner, after finding the large expense involved, is less likely to have the test performed, so that many people drink water from backyard wells without knowing its quality. They can judge the quality of the water only on the basis of that it looks and tastes good.

Adequate and well-enforced well codes are essential to the construction of safe supplies; however, many existing wells were dug before well codes came into existence. Consequently, wells may be too close to septic tanks, manure piles, or other sources of ground water contamination. Many wells were not sealed properly so that surface runoff can go directly into the well.

The magnitude of the problem of contamination of individual water supplies in the North Atlantic Region is not known at this time. It is of sufficient concern in the State of Pennsylvania that the State Department of Environmental Resources has established a permanent section within its department to assess and deal with individual states of the North Atlantic Region. After such studies, if areas connect these households to existing central water supplies or provide new rural supplies so that the resulting surveillance and water quality testing will assure a deliverance of a safe and adequate water supply. If this is economically unfeasible, steps must be taken by health authorities to guide the homeowner in protectingand maintaining his well, reconstruction or relocating the well, or providing some type of treatment to solve the problem. If these steps are not possible, strong recommendations must be made to the homeowner to boil all water from his well intended for drinking.

One should not infer from this section that the surveillance of individual water supplies should take precedence over that of public water supplies. The fact that a larger number of people can be affected by unsafe water supplies establishes as the first priority the necessity for having adequately staffed programs to survey and assist public water supplies; however, it is also felt that the total effort should not be in public water supply surveillance alone. The individual water supply user has been neglected for too lone in too many states.

OPERATOR QUALIFICATION

One of the major problems confronting the waterworks industry is the scarcity of qualified water treatment plant operators. This lack of trained personnel is the result of various factors but two are prominent: (1) the fairly universal low pay scale of waterworks employees and (2) the deficiency in extensive training programs for water treatment plant operators.

The first problem area, the low apy scale, will be overcome only when the public realizes the tremendous need for qualified personnel in water supply operations. The provision of potable water is not an automatic process but rather one resulting from knowledgeable and careful operation of the water system. The training and experience of the water treatment plant operator must be used every day to produce the highest quality finished water possible. Since many water supplies are municipally owned, the pay scale for waterworks employees must fit into improving the waterworks operational budget has been minimal resulting in meager increases in the salaries of plant operators.

During 1969, the Bureau of Water Hygiene, Environmental Health Service of the U. S. Public Health Service, with the cooperation of State and local health departments and water utilities, conducted a nationwide Community Water Supply Study (CWSS) in eight geographically distributed Standard Metropolitan Statistical Area and the State of Vermont. The study included 969 water supply systems serving about 18.2 million people. One of the findings of this study was that 84 percent of the plant operators received a salary of $7,500 or less while 37 percent received less that $2,000 per year. The individuals in the latter category were primarily part-time operators.

The American Water Words Association committee report "Water Utility Salaries and Wages" cited low salaries paid by utilities as a significant reason for the problem of attracting qualified personnel. This is especially true in the publicly owned water utilities. The report points out that, "in many instances water utilities are being manned by unqualified personnel, simply because their low wage policy cannot attract or retain qualified and technically trained people in today's competitive labor market."

The second area of concern involves the need for training programs for treatment plant operators. Information collected in the Bureau of Water Hygiene (CWSS) study previously mentioned showed that basic education level is relatively high. Only 16 percent failed to finish high school. However, 61 percent reported they had no water treatment training at the water treatment plant operator short school level or higher. Training was markedly lakcing in microbiology and chemistry. Assuming that on-the-job training is how-to-do-it rather than the learning of fundamental why-we-do-it concepts, 77 percent were deficeint in microbiological training and 72 percent (overall) in chemistry. Chemistry training responses from facilities having more than disinfection treatment are more meaningful than overall figures. Forty-six percent of those operators were deficient in chemical training. The dangers of this situation is that untrained personnel are often unaware of the hazards to the consuming public that might result where water of substandard quality is produced.

There is a wide variation in water supply operator training programs among the states in the North Atlantic Region. Vermont did not have any training program for water supply operators at the time of the CWSS; most of the water supplies of the 216 visited during the CWSS in 1969 were operated by persons without any formal water supply training. What training there has been by equipment salesmen except for one or two communities which have sent someone to a New England Water Works training course. Recently, however, a pilot training program for water plant operators was initiated by the Vermont State Health Department under funding from the U. S. Environmental Protection Agency.

New York State, on the other hand, has a very comprehensive water supply training program sponsored by the Office of Environmental Health Manpower of the State Health Department in connection with their water treatment plant operators certification program. Courses for Grade II and III licenses are offered at Syracuse University, New York University, and State University College at Buffalo. A textbook - Manual of Instruction for Water Treatment Plant Operators - prepared by the State Health Department provides basic information for all phases of water supply and treatment. This well-written, easy to understand manual could form the foundation for basic water supply courses in any of the states of the North Atlantic Region. There are a number of county health department training programs set up to prepare operators for taking their examinations for state licenses. The New England Water Works Association in cooperation with state health departments sponsors a training course on basic water treatment. This course, which covers all aspects of water supply, is usually given in two hour night sessions, once a week for about 10 weeks. If there is sufficient interest in this course, it is hoped that it can be given semi-annually in various parts of New England. There is also some indication of expanding this program to include courses on advanced water, laboratory techniques, etc..

One way of promoting increased training activity would be for all the states within the North Atlantic Region to enact legislation establishing a water treatment plant operator certification program, either mandatory or voluntary. New Jersey was the first state in the country to adopt mandatory certification of water plant operators in 1919. An Advisory Committee on Operator Training and Certification consisting of representatives of state, educational, and professional organizations was establised to provide basic and advanced courses for the training of operators. New York State has had a mandatory certification program since 1937 which, in part, explains the degree to which their training programs have developed. Table V-3 provides information on the status of state certification programs.

TABLE V-3
Status of Certification Programs for Water Treatment Plant Operators for States in the North Atlantic Region

	Required	Voluntary	None
Connecticut			X
Delaware		X	
District of Columbia		X	
Maine	X		
Maryland	X		
Massachusetts	X		
New Hampshire			X
New Jersey	X		
New York	X		
Pennsylvania	X		
Rhode Island			
Vermont	X		X
Virginia	X		
West Virginia	X		

RESEARCH NEEDS

There are many areas in the water supply field that could greatly benefit from further research. This section will not attempt to discuss all of these needs but rather to propose areas concerned with the health aspects of municipal drinking water supply.

One of the more notable problems in the water supply field is the identification and characterization of potentially toxic organic and inorganic agents that may be found in water. To date the acute toxicity of most of the agents that may be discharged in water is known, but there is a paucity of information on the chronic effects of man's exposure to small quanities for long periods of time. Modern analytical instrumentation has provided the opportunity for the development of sensitive. precise, and specific assay methods for extremely small quantities of organic and inorganic compounds in water. However, there is the need for development of adequate methods for the recovery of organics from water and a scheme to partition these into identifiable groups so that quantification of the public health implication of these materials might be obtained. Acute toxicity, and in some cases chronic effects, can be determined by currently available assay methods which, however, are often cumbersome and involved. Rapid screening tests are needed.

Avenues of investigation for solution of these problems would include the development of instrumentation and methodology for the recovery, concentrations, partitioning, identification, and quantification of potential acute or chronic organic and inorganic agents in water supplies. Also development of chemical and bioassay methods to determine the toxicity of these agents is a necessity. These achivements would allow for the development of processes for the removal of these agents from water that is to be rendered potable.

Another area for investigation involves the examination of water reuse treatment processes to assure that they are reliable and effective in producing potable water that is safe for human consumption. Components of such a project would include the development of water quality criteria for the safe reuse of waste water as a potable water source, development of water treatment processes to remove the health-related contaminants from waste water and the development of control and monitoring systems to assure the continued safety of treated reused water.

A third area of concern involves the determination of the significance of man's contact with water as a source of viral diseases. Presently methodology for the recovery and identification of virus in water has improved. However, there is insufficient evidence necessary for an understanding of the role of water as a source of viral diseases in man. Therefore a project that would investigate the fate and survival of virus in water, the extent to which currently used bacterial indicator organisms reveal potentially hazardous occurrences of virus in water and the effectiveness of water treatment methods in removal or destruction of virus is especially needed.

STATE WATER SUPPLY PROGRAMS

One of the primary purposes of a water supply program in a state health or natural resources department is the surveillance of public water supplies. This surveillance should include inspection of water supplies and water quality monitoring to insure that the water delivered to the consumer is potable. Herein lies one of the main problems with laboratory support to provide adequate coverage of both the public and private water supplies.

Water supplies which should be visited once a year sometimes go uninspected for as long as a 10-year period. Many of the state water supply programs are able to work only with those water supplies that have emergency situations. Routine surveillance and technical assistance to help the water supplies prevent problems before they occur is oftentimes neglected because of lack of staffing in the state program and the need to deal with the emergency situations that come up.

Some state agencies do not have a separate, clearly identifiable program for water supply. Some water supply programs exist in divisions where the engineers work in other areas such as solid wastes management, air pollution control, food establishment licensing programs, etc. besides in the area of water supply. This does not lend itself to efficiency of operation in that this sort of arrangement encourages the situation where only the surveillance of water supplies with emergency conditions is practiced.

The emphasis on water pollution control has much of the manpower and budget away from water supply protection programs. This has resulted especially with health departments where water supply and pollution control were previously in one program but are now separated in order to focus attention and action on the very important pollution control aspects. The fact that the water supply programs have done an excellent job in lowering the death and sickness rate associated with water supplies over the years is not sufficient reason to diminish the importance of water supply programs. The increasing amounts of exotic chemicals and pesticides in our waters and the need for improved water treatment methods, better surveillance, and more intensive water quality monitoring are but a few reasons why our water supply programs should be strengthened, not weakened, in order to carry out their mission of assuring safe and potable water to all of the people.

FEDERAL WATER SUPPLY PROGRAM

The Bureau of Water Hygiene, Environmental Protection Agency, is the Federal agency whose program goal is to promote the safety and good quality of community water supply systems and individual home supplies as well as water used for shellfish production, recreation and other healthful purposes.

Legal authority for the activities of the Bureau of Water Hygiene are contained in Sections 301, 311, and 361 of the PHS Act, as amended. The legislation authorized the Department of Health, Education, and Welfare to conduct research and studies relating to the cause, control and prevention of diseases of man, including water purification and pollution of lakes and streams. Reorganization Plan #3 of 1970 transferred the Bureau and all its functions from the Department of Health, Education, and Welfare to the Environmental Protection Agency.

The Bureau participates in the prevention of interstate disease transmission by certifying the safety of water supplies serving interstate carriers (planes, trains, and buses). It should be noted that these 660 plus water supplies also serve an estimated 82 million residents of the communities in which these supplies are located.

The Bureau of Water Hygiene is concerned with water resources development because of its activities promoting the health interests of the public in the development of water and related land uses. It also provides technical consultation to various Federal agencies and the review of specific project plans in areas related to water resources development.

The Bureau is attempting to provide an effective basic and applied research program on health effects of chemical and biological agents found in water and developing effective means for their treatment. The finding of this research will enable the Bureau to up-date the 1962 U.S. Public Health Service's Drinking Water Standards. Also the Bureau is carryingout, cooperatively with the States, the provisions of the Interstate Quarantine Regulations with regard to interstate carrier water supplies and conducting joint surveys with the various State health departments on the quality of community water supplies. In addition the Bureau is providing specialized technical services including training assistance on a request basis to States regarding public drinking water supplies. With regard to water resources, the Bureau is advancing and implementing the public health and water supply aspects of water resources. This includes the provision of Health Aspects of Water Resources appendices for the various framework and river basin studies alongwith Municipal and Industrial Water Use appendices for many of these studies. The Bureau also reviews the Type 3 projects and environmental impact statements prepared by individual agencies for health aspects considerations. This is important as projects having health protection factors incorporated in them from the beginning, will have obvious beneficial effects over the long term and reduce the need for expensive remedial measures which might be required at a later time.

FEDERAL ASSISTANCE FOR WATER SYSTEMS

Federal assistance for municipal water treatment plants and distribution systems is available, primarily, through the Farmers Home Administration (FHA), Department of Agriculture and the Community Resources Development Administration, Department of Housing and Urban Development. The Economic Development Administration, Department of Commerce also provides grants but such funds are primarily directed toward industrial service and water supply, and only indirectly contribute to domestic water supply.

The Farmers Home Administration is engaged in providing financial assistance along with technical guidance to rural communities for the development of community water supplies. At present the FHA makes grants to States, regional authorities, and counties for the preparation of comprehensive area water functional plans. It also makes grants to organizations of rural residents such as municipalities, authorities, districts, and non-profit corporations for the installation of community water facilities. FHA grants for installation of water facilities are made only to communities which are unable to finance their facilities through conventional sources and limited to communities with a population under 5,500.

The Department of Housing and Urban Development program provides grants to construct community water facilities that are basic to orderly areawide community growth and development. Grants cover up to 50 percent of land and construction costs for new water facilities.

The projects assisted must be in conformance with the applicable State and Regional/Metropolitan health plans. Grants are limited to publicly owned systems serving 5,500 or more people.

The primary mission of the Economic Development Administration, Department of Commerce, is to alleviate economic distress in designated areas of the nation through job creation and the raising of income levels. This is done through a package of grant and loan programs, and often include involvement in the development of municipal water supplies, largely in rural areas of the nation. The program provides grants up to 50 percent of the development cost of such facilities. Severely depressed areas that cannot match Federal funds may receive supplementary grants to bring the Federal contribution up to 80 percent of the project cost.

These programs were all designed with an excellent mission - that of upgrading today's water supply systems; however, these programs have not been provided with sufficient budgets to meet the demand so that the burden for paying for improved treatment or an expanded system usually falls on the water consumer. These inadequately funded financial assistance programs may be self-defeating in that communities may have a tendency to wait on needed construction in the hopes of obtaining Federal funding rather than proceeding at their own expense. This could create problems in the future if the Federal funding does not materialize.

FLUORIDATION

Fluoridation is the deliberate adjustment of the fluoride content of public water supplies to a level of approximately one part per million of fluoride for the purpose of reducing tooth decay. Some 10 million Americans have a naturally fluoridated water supply, and in the past twenty-five years over 4,000 communities have adjusted the fluoride content of their water.

Size and Nature of Problem

Tooth decay attacks 95% of the U. S. population, and it results in over four million days of restricted activity per year. More than half of the time of the 90,000 active non-Federal dentists is devoted to treatment of dental caries at a cost of more than two billion dollars annually. Yet, the current backlog of dental traeatment needs overwhelms the present and foreseeable supply of dentists and auxiliaries.

Prevention of dental caries through fluoridation of water supplies is the most direct way of attacking this growing problem. Twenty-five years of experience shows fluoridation to be safe and capable of reducing the incidence of dental caries as much as 65 percent. It is the most effective and least expensive action available to decrease the dental caries problem, and its effectiveness as a caries preventive is not dependent on the economic means, knowledge, or motivation of the individual, or on the availability of dentists.

While eighty-eight million people drink fluoridated water, more than seventy million people, served by 12,000 water systems, do not. The cost of supplementing water supplies with fluoride is low on a per capita basis, but small communities, particularly, often find the cost beyond their means. As evidence of this problem, only one-half of the communities having populations between 10 and 25 thousand persons have controlled fluoridation, and the proportion of fluoridation communities decreases to the point that only one-fourth of the communities of 2,500 to 4,999 population and one-sixth of those with 1,000 to 2,499 population are benefiting from fluorfdation.

In a recent survey, State Dental Directors, indicated that, although the cost to fluoridate is minimal, cost is significant impediment to the adoption of fluoridation particularly in small communities. Dental health, especially the prevention of dental disease, receives low priority in competition with other needed services when public budgets are developed.

Coupled with the cost of initiating fluoridation, a small but active and vocal group of antifluoridationists have deterred the progress of fluoridation. They have argued against fluoridation on the basis of safety, effectiveness, religion and civil liberties. Every national health organization in the United States that speaks with authority on the benefits and safety of fluoridation has adopted policies favorable to the measure. Study after study in this country and abroad have demonstrated its effectiveness beyond question in the scientific community. Fluoridation is not mass treatment of disease, but is a method for adjusting the fluoride level in fluoride-deficient water up to the level that will permit the normal development of tooth enamel. And finally, the courts repeatedly have ruled that fluoridation is not a violation of individual civil liberties.

All arguments to the contrary, the incidence of dental caries can be reduced by as much as 65 percent in complete safety through the adjustment of fluoride-deficient water supplies with concomitant reductions in the costs of dental services. Specifically, comprehensive dental service costs for children reared on fluoride-bearing water can be reduced by more than half. In addition to the cost savings, treatment time can be reduced one-third. Through such savings, dental manpower can provide more comprehensive dental services to persons of all ages.

Cost/Benefits

In a recent study, the New York State Department of Health compared the time and cost factors involved in providing regular, periodic dental care to five and sic year-old children in two cities: Newburgh, fluoridated since 1945, and Kingston, not fluoridated. The children were selected on the basis of residence in the poorest socio-economic areas of each city. In fluoridated Newburgh, the group was further limited to children who had resided in the city continuously from birth. During the first year, treatment of the backlog of accumulated dental neglect was completed in both cities.

Newburg children required on the average less than half as many dental services as did the Kingston children, and further, more than twice as many children in the fluoridated city, Newburgh, needed no dental treatment at all.

The children in the nonfluoridated city needed many more two-surface fillings and many more extractions than the children in the fluoridated city. As a result, there was a savings in the fluoridated city of one-third the time needed to provide dental care for children.

The cost difference were dramatic. Data from the study indicates that the cost of providing incremental dental care for five-year-old children in Kingston fro a five-year period was $101.22 per child while it was $48.50 in Newburgh. The cost of fluoridation in Newburgh for this five-year period was approximately $30,000, but the savings in dental care cost for just the five-year-old cohort of children was over $35,000. Thus, the savings in just this one cohort was greater than the cost of providing the benefits of fluoridation to the total community.

Nationwide estimates of the savings that would accrue from fluoridation cannot be made with precision. However, a conservative* estimate of the relative return on each dollar expended for fluoridation can be made by generalizing from data on national dental caries experience, costs of treatment services, benefits known to be derived fluoridation, and per capita costs of fluoridation. The estimate assumes that:

Each child by age 15 has 12 decayed teeth in an unfluoridated community.

Cost of restorative services at $12 per tooth equals $144.

Fluoridation reduces caries by 60%. Therefore, treatment for dental caries would cost only $58 over 15 years or A SAVINGS OF $86 PER CHILD.

Cost of fluoridation per capita for 15 years, based on a cost of 16 cents per capita per year equals $2.40.

Therefore, on this basis SAVINGS IN CHILDREN'S TREATMENT COSTS FOR DENTAL CARIES WOULD BE $36 FOR EVERY $1 EXPENDED, A RATIO OF 36:1.

<u>Current Response and Existing Programs</u>

The primary Federal responsibility for promoting community water fluoridation rests with the Division of Dental Health of NIH-DHEW. Their efforts are limited to consultation and technical assistance to States and communities wishing to organize for fluoridation promotion. This effort is estimated at less than $200,000 per year. The Division of Water Hygiene of the Environmental Protection Agency provides limited training and technical assistance for water suppliers. Some promotional activities are conducted also by the Department of Agriculture Extension Service.

Since 1965, seven States, two of which are in the North Atlantic Region, have enacted laws requireing community water fluoridation. Connecticut in 1965 was the first state to pass a fluoridation act. The act states that a public water supply serving 20,000 or more people with a fluoride level less than 0.8 ppm fluoride must add sufficient

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* The estimate does not take into account the benefits to primary teeth, the benefits derived throughout life after age 15, or reduced need for certain diagnostic services, e.g. X-rays.

fluoride to maintain a level between 0.8 and 1.2 ppm fluoride. The Delaware law which was passed in 1968 delegates the responsibility of requiring and regulating fluoridation of all public water supplies to the State Board of Health.

The following table gives the percentage of population on public water supplies served with fluoridated water as well as the percentage of total population served with fluoridated water for each state in the North Atlantic Region as of December 31, 1969. Total state figures are used instead of the portions of the state within the Region.

Percent of Population Served with Natural and Controlled Fluoridated Water, December 31, 1969

State	1*	2**	3***
Connecticut	3,020,000	90.4	72.2
Delaware	529,000	54.1	40.0
District of Columbia	792,986	100.0	100.0
Maine	976,000	49.4	29.6
Maryland	3,770,000	97.7	76.3
Massachusetts	5,450,000	10.0	9.3
New Hampshire	727,000	13.4	8.8
New Jersey	7,170,000	14.5	12.7
New York	18,470,000	75.1	65.8
Pennsylvania	11,760,000	49.0	39.4
Rhode Island	910,000	89.8	80.3
Vermont	446,000	45.1	26.3
Virginia	4,700,000	93.2	59.6
West Virginia	1,825,000	80.9	50.0
Entire United States	205,800,000	55.9	43.0

*1 Estimated Total Population

**2 Percentage of Population on Public Water Supplies Served with Fluoridated Water

***3 Percentage of Total Population Served with Fluoridated Water

V. VECTOR CONTROL

INTRODUCTION

Vector is here defined as an insect or other arthropod that directly or indirectly transmits a disease agent to man or causes annoyance or irritation. Such a broad use of the term vector is in accordance with the World Health Organization's definition of health -- "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."

This report has been prepared to summarize information on: (1) the present status of vector problems in the North Atlantic Region; (2) the status of vector control programs; (3) existing vector control needs; (4) future needs; and (5) a proposed plan to meet Region needs.

Mosquitoes are the vectors of primary concern and therefore receive major consideration in this report. Other types of biting and pestiferous insect* problems are considered because of their public health importance in localized areas of the Region.

PRESENT STATUS OF VECTOR PROBLEMS

Vector-borne diseases that are a problem in the North Atlantic Region or are potentially important include: malaria, viral encephalitis, and Rocky Mountain spotted fever.

The following groups of insects are of public health importance because they cause serious annoyance and discomfort to the resident and transient population in many areas and are a major deterrent to full development and use of the recreational features in many parts of the Region: salt-marsh mosquitoes, fresh-water mosquitoes, black flies, horse flies and deer flies, biting and non-biting midges, ear-invading beetles, and ticks.

Vector-Borne Diseases

Malaria Historically, malaria was considered to be an endemic disease in the southern portion of the Region. However, for a number of years this disease has been virtually eradicated from the United States. Even though *Anopheles quadrimaculatus* (common malaria mosquito)

*The term insect as used here includes ticks.

breeds in impounded waters in the Region, it is concluded that malaria constitutes only a minor public health threat in the area. The prinicpal threat is associated with introduced cases of malaria, i.e., acquired by mosquito transmission from imported cases, such as military personnel from Vietnam.

Viral Encephalitis Viral encephalitis ("sleeping sickness") is potentially the most important mosquite-borne disease in the North Atlantic Region. It is a serious disease because it has a high epidemic potential, there is no specific treatment, and the disease may damage the brain permanently.

The four principal types of mosquito-borne encephalitis in the United States are Eastern (EE), Western (WE), St. Louis (SLE), and California (CE).

Present knowledge concerning the natural history of the encephalitis viruses indicates that there are two basic groups -- bird reservoir (EE, EW, SLE) nad rodent-rabbit reservoir (CE). Normally, the infection chain is limited to birds and small mammals and mosquitoes. Under certain conditions the virus spills over to horses and humans.

Two types of the viruses have caused outbreaks of disease in the Region, viz, Eastern encephalitis and St. Louis encephalitis. There have been no reported human or equine cases of California encephalitis--one in Rockland County, New York in 1966 and in 1970, three cases in Pennsylvania in the counties of Lawrence, Erie, and Clearfield.

Eastern encephalitis Outbreaks of Eastern encephalitis in the Region have involved humans, horses, and birds including captive ring-necked pheasants and chukar partridges, feral pigeons, and domestic ducklings.

Human cases of Eastern encephalitis occur rather infrequently, the total number reported for the United States for the period of record 1938-68 being 161 cases; but 103 of these cases have been reported from four states of the Region -- Massachusetts 50, New Jersey 46, Maryland 6, and Delaware 1.

A summarization of the reported human cases of Eastern encephalitis by State and year is as follows:

Massachusetts		Maryland		New Jersey		Delaware	
1938	34	1956	2	1959	32	1956	1
1955	4	1959	1	1965	1		
1956	12	1960	2	1967	1		
		1965	1	1968	12		

It should be stressed that the importance of Eastern encephalitis is not that of numbers per se but rather it lies in hysteria or panic which frequently accompanies the unpredictable outbreak, especially when children are involved.

Notable outbreaks of Eastern encephalitis occurred in Massachusetts in 1938 and in New Jersey in 1959. In 1938 it was learned for the first time that humans, especially children, are susceptible to the virus of Eastern encephalitis. Thirty-four cases were identified in southeastern Massachusetts (Fig. V-2) of which 75 percent terminated fatally. Of the nine survivors, at least six showed signs of permanent brain damage.

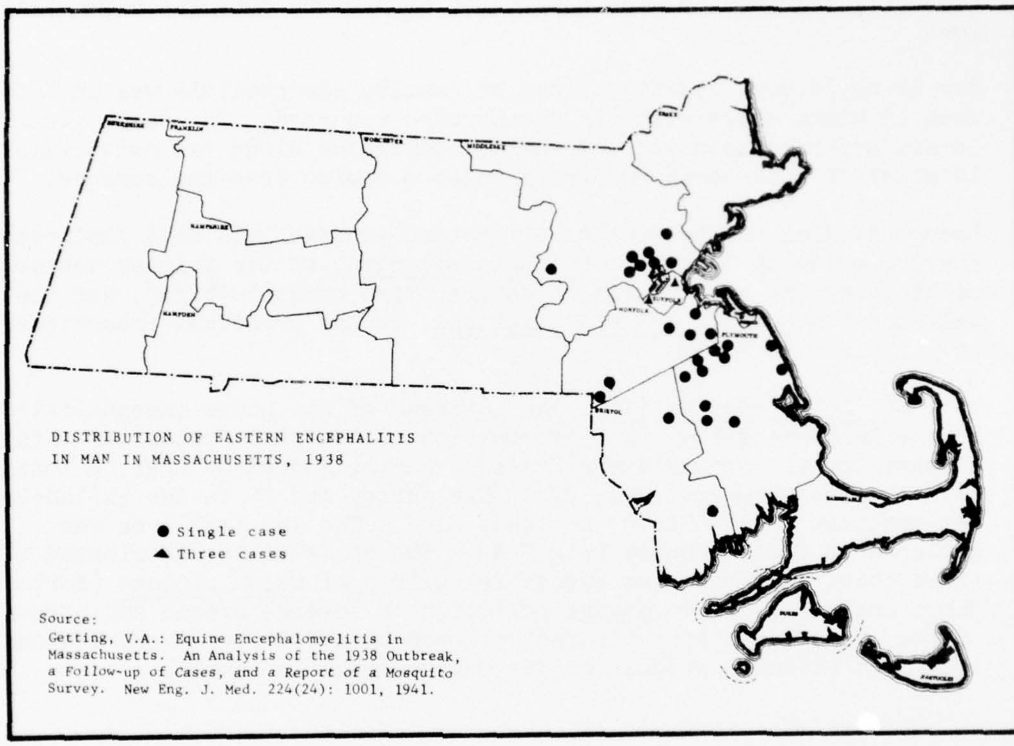
DISTRIBUTION OF EASTERN ENCEPHALITIS
IN MAN IN MASSACHUSETTS, 1938
Single case
Three cases
Source:
Getting, V.A.: Equine Encephalomyelitis in Massachusetts. An Analysis of the 1938 Outbreak, a Follow-up of Cases, and a Report of a Mosquito Survey. New Eng. J. Med. 224(24): 1001, 1941.

FIGURE V-2

New Jersey experienced its first human outbreak of Eastern encephalitis in August-October 1959. This epidemic, with 32 reported cases and 22 fatalities, constituted the second greatest recorded epidemic in the United States. The human cases and deaths were reported from five counties in the southern half of the State (Fig. V-3). The patients lived in rural wooded areas adjacent to both salt marshes and fresh-water swamps inland from the Atlantic coast where mosquito populations were high during the summer months. The 1959 outbreak had far-reaching economic and social effects, particularly on the resort business. It was estimated that hotels in Atlantic City alone suffered a $2 million loss.

New Jersey's most recent episode of Eastern encephalitis was in 1968, when 12 human cases with six deaths were reported. The cases occurred in six southern counties and were concentrated along the coast within 10 miles of salt-marsh and fresh-water mosquito breeding sources.

Recent studies on the vectors of Eastern encephalitis have implicated the bog or swamp mosquito, *Culiseta melanura*, as the primary vector for maintaining the basic chain in nature (bird-mosquito-bird), and the salt-marsh mosquito, *Aedes sollicitans*, as the principal transmitter of the virus to humans.

St. Louis encephalitis. An outbreak of St. Louis encephalitis in the Delaware Valley in 1964 constituted the first report of this disease for the Northeastern States. During August-October, a total of 117 cases were reported, 97 in New Jersey and 20 in the Philadelphia metropolitan area. Eleven patients died. The involved area was centered in Camden County (Fig V-4). The epidemic was attributed to three chief factors -- an excessive buildup of *Culex pipiens* (northern house mosquito) due to sewage pollution in several creeks and streams of the area; heavy spring rains followed by hot dry weather; and the lack of a balanced program of preventive mosquito control.

Source:
Goldfield, M., and Sussman, O.:
The 1959 Outbreak of Eastern
Encephalitis in New Jersey.
Am. J. Epidem. 87(1): 5, 1968

FIGURE V-3

DISTRIBUTION OF EASTERN
ENCEPHALITIS IN MAN IN
NEW JERSEY, 1959

Source:
Altman, R., and Goldfield, M.: The 1964 Outbreak of St. Louis Encephalitis in the Delaware Valley. Am. J. Epidem. 87(2): 460, 1968.

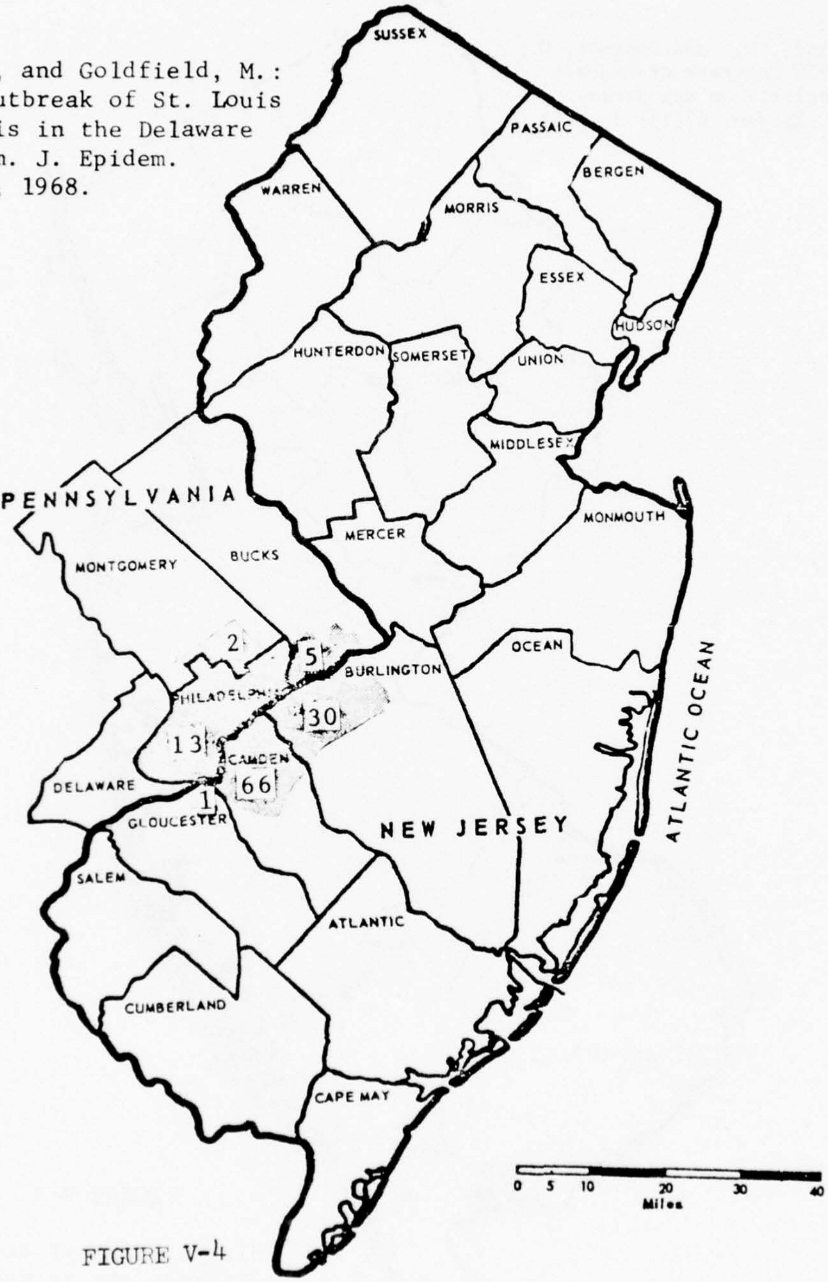

FIGURE V-4

ST. LOUIS ENCEPHALITIS OUTBREAK IN 1964, NEW JERSEY AND PENNSYLVANIA

DISTRIBUTION OF CASES (SHADED AREA) AND NUMBER OF CASES PER COUNTY

Rocky Mountain Spotted Fever. The principal focus of Rocky Mountain spotted fever in the United States at present is the southern portion of the Region. This disease has been reported from areas where the American dog tick (Dermacentor variabilis) is common, particularly the eastern Piedmont section of Virginia, the Baltimore area of Maryland, southeastern Pennsylvania, southern and central New Jersey, and Long Island, New York. Data on reported cases for the 5-year period 1963-67 are shown in table V-4 and Figure V-5. In the East, the incidence of the disease has been highest among vacationists and picknickers, particularly among children.

Vector-Annoyance Problems

Salt-Marsh Mosquitoes. The most formidable biting insects in coastal tidewater areas of the North Atlantic Region are the so-called salt-marsh mosquitoes, particularly Aedes sollicitans. Other important salt-marsh or brackish-water species include Aedes cantator and Culex salinarius (also breeds in fresh water).

At times A. sollicitans (the "Jersey Mosquito") occurs in such overwhelming numbers that outdoor activities during the day or night are practically impossible. The bites of these mosquitoes result in numerous cases of secondary infection in children. Furthermore, scourges of salt-marsh mosquitoes are an impediment to industrial and recreational developments along the coast. Invasions of these mosquitoes are generally an aftermath of unusually high tides and heavy rains that inundate the higher marsh areas that normally are not subjected to daily tides.

Another important habitat is standing water in cracks of hydraulic fills. This problem has been experienced recently in Cecil County, Maryland, in connection with Corps of Engineers' dredging activities of the Chesapeake and Delaware Canal.

Two factors are particularly significant in considering the salt marsh mosquito problem: viz, the extent of the total breeding areas is tremendous (especially after periods of prolonged droughts) and the flight range of these mosquitoes is exceptionally great. Salt-marsh mosquitoes commonly fly 10 miles and under certain wind conditions frequently migrate 20 miles or more.

TABLE V-4

HUMAN CASES OF ROCKY MOUNTAIN SPOTTED FEVER BY STATE AND YEAR

State	1963	1964	1965	1966	1967	Five-year Totals
Maine	0	0	0	0	0	0
New Hampshire	0	0	0	0	0	0
Vermont	0	0	0	0	0	0
Massachusetts	0	2	0	1	3	6
Rhode Island	0	0	0	0	0	0
Connecticut	0	0	0	2	0	2
New York	2	2	9	14	9	36
New Jersey	1	16	17	13	0	47
Pennsylvania	6	15	27	20	8	76
Delaware	0	2	1	2	0	5
Maryland	10	18	21	25	21	95
District of Columbia	2	3	1	0	0	6
West Virginia	2	0	0	0	0	2
Virginia	35	33	40	28	28	164
Total	58	91	116	105	69	439

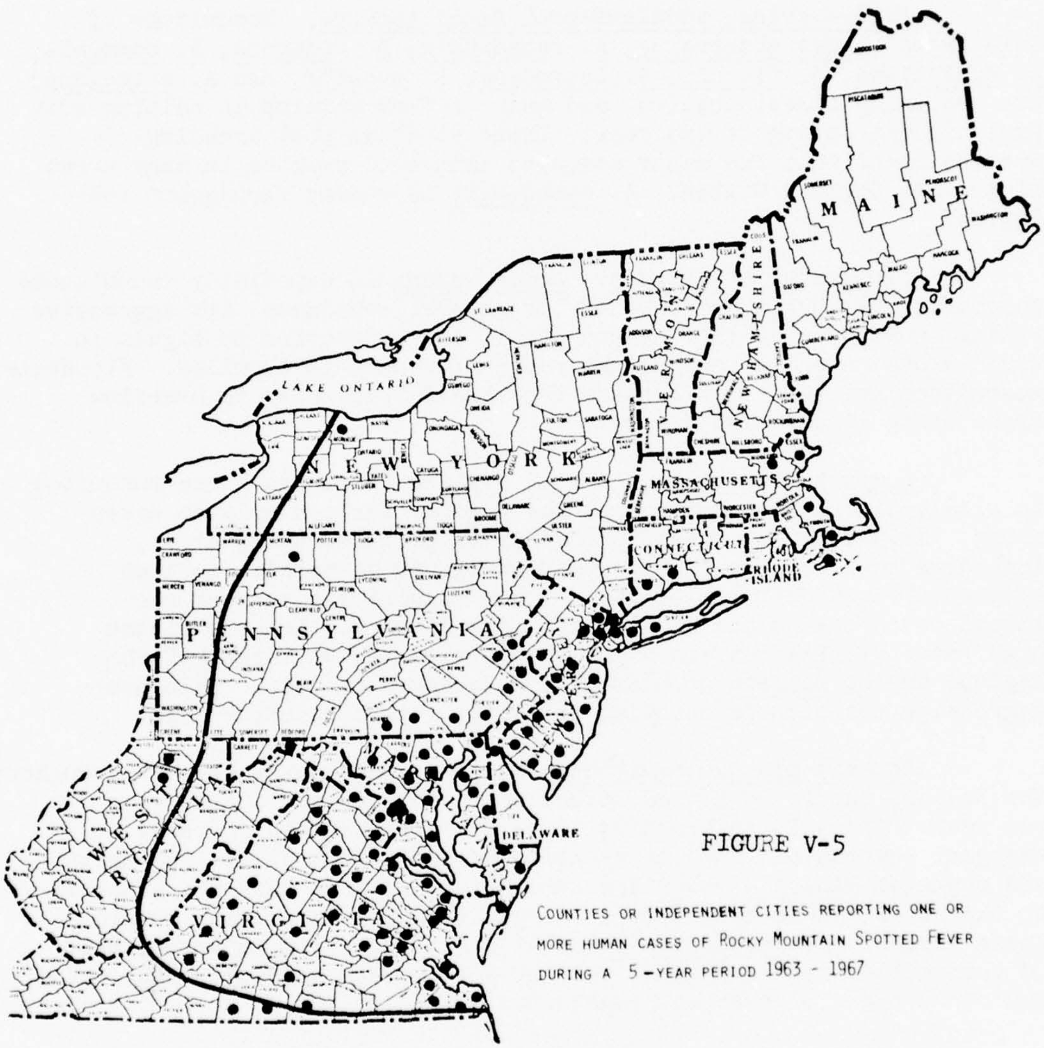

FIGURE V-5

COUNTIES OR INDEPENDENT CITIES REPORTING ONE OR MORE HUMAN CASES OF ROCKY MOUNTAIN SPOTTED FEVER DURING A 5-YEAR PERIOD 1963 - 1967

Fresh-Water Mosquitoes. These mosquitoes may be classified ecologically into four groups: early-spring, woodland-pool Aedes; summer floodwater; domestic or house; and aquatic plant.

Early-spring, woodland-pool Aedes species. Mosquitoes of this group (Aedes abserratus, A. canadensis, A. cinereus, A. communis, A. excrucians, A. fitchii, A. intrudens, A. punctor, and A. stimulans) are typically forest species, and many of them develop in melting snow pools in the spring of the year. These woodland-pool breeding species constitute the major mosquito annoyance problem in many areas of the New England States. A. canadensis is common throughout the Region.

Floodwater mosquitoes. Aedes vexans is especially troublesome throughout the Region because of its general abundance, its aggressive biting habits during the day and night, its attraction to lights in urban areas, and its long flight range of from 5 to 10 miles. Floodwater mosquitoes are so-called because they breed frequently in overflow areas along streams and rivers.

Domestic mosquitoes. Culex pipiens (northern house mosquito) is widely distributed throughout the Region, particularly in urban areas. This mosquito breeds profusely in polluted water areas, including both organic (sewage) and inorganic materials, such as effluent from industrial plants. Other significant sources are street catch basins and clogged drainage ditches. Because of the high industrialization and high urbanization in many areas of the Region, the C. pipiens problem is increasing each year. This non-aggressive mosquito is annoying principally indoors after dark.

Aquatic plant mosquitoes. Mansonia perturbans occurs throughout the Region, but in localized situations. This is correlated with the restriction of its breeding to water areas containing heavy emergent vegetation, such as cattail rooted in soft silt. The larvae and pupae of Mansonia mosquitoes are unique in that they are attached to the roots and submerged stems of plants, from which they obtain their oxygen. M. perturbans bites at night and is an important pest in communities near permanent shallow-water areas infested with cattail and other types of emergent vegetation.

Black Flies. It is probable that next to mosquitoes, black flies (Prosimulium hirtipes, Simulium venustum, S. tuberosum) are the most annoying pests of man in New York State, Vermont, New Hampshire and Maine. In some of the mountainous areas of the Northeast, especially in the White Mountains of New Hampshire and the Adirondacks of New York, certain species are a serious menace to campers, fishermen, hunters, and vacationists. They annoy man both by biting and flying about the face. The toxic effects of black fly bites are much more serious than those of mosquitoes. The larvae of these insects are found primarily in fast-flowing streams, shallow mountain creeks being favored breeding places.

Horse Flies and Deer Flies (Tabanids). Species of horse flies commonly called salt-marsh greenheads (*Tabanus nigrovittatus*) are the second most important biting pests of man in the coastal areas. In general, the number of greenhead flies is related to the amount of salt-marsh cord grass, *Spartina alterniflora*, in the immediate vicinity. Greenhead flies attack humans readily and are of particular concern in resort areas.

Deer flies (*Chrysops* species) by virtue of their biting and persistence cause great annoyance to humans in the field. Localized deer fly problems occur throughout the Region. Their breeding grounds include salt marshes, fresh-water marshes, and margins of ponds and streams. Frequently, the adult flies do not remain on the marsh, but move to adjacent uplands, especially into wooded areas, where they constitute a real daytime pest. Some of the most annoying species to humans in the Region are: *Chrysops atlantica*, *C. callida*, *C. callidula*, *C. carbonaria*, *C. excitans*, *C. flavida*, *C. fuliginosa*, *C. obsoleta*, and *C. vittata*.

Biting Midges. Biting midges ("punkies" or "no-see-ums") are serious blood-sucking pests of man in many **inland** communities and recreational areas and are a localized problem along coastal areas. The dominant species of the Adirondacks and other wooded areas of the Northeast is the vicious biter, *Culicoides sanguisuga* (*obsoletus*). The predominant man-biting species in coastal areas are the brackish-water breeders (larvae develop in the mud on the salt marsh) *C. canithorax*, *C. furens*, and *C. melleus*. Biting midges are so small that they can readily pass through ordinary window screens.

Non-Biting Midges. Problems with chironomid midges ("fuzz bills") are of growing importance in the North Atlantic Region. The larvae, commonly called blood worms, breed in the bottom detritus of shallow lakes and ponds, of slow-moving streams, and of brackish-water habitats. Water containing a heavy load of organic wastes favors midge production. During periods of peak emergence, adult midges by their sheer numbers can be terribly annoying when they swarm on buildings and around lights.

A number of severe chironomid midge problems have been reported in the Northeast during recent years, and the principal sources of these problems were: sewage lagoons at Denton, Maryland; a 750-acre brackish-water sunken meadow in Bergen County, N.J.; Clear Water Reservoir in Trenton, N. J.; Moriches Bay and its tidal creeks, Long Island, Suffolk County, N.Y.; tidal coves and fresh-water ponds, shore of South Cove, Old Saybrook, Conn.; and a 74-acre brackish water Musquashiat Pond, town of Scituate, Plymouth County, Mass.

Ear-Invading Beetles. Human ear invasions by the Asiatic garden beetle, Maladera castanea, were a serious problem at the 1957 and 1964 National Boy Scout Jamborees, Valley Forge National Park, Chester County, Pa. In 1957, 186 ear invasions were recorded, and in 1964, 39 cases. Most of the ear invasions occurred while the scouts were sleeping on the ground. Although much is known about this beetle -- it was first recognized in America (in New Jersey) in 1922, and is now located at widely scattered points along the Atlantic seaboard -- more information is needed on its control as related to public health in mass encampments.

Ticks. The American dog tick (Dermacentor variabilis) is locally abundant in the Cape Cod-Plymouth County and the nearby islands of Martha's Vineyard and Nantucket in Massachusetts, portions of the Rhode Island coast, southeastern Pennsylvania, Long Island, New York, the lower two-thirds of New Jersey, and all of Delaware, Maryland, and Virginia. The heaviest concentrations of this tick appear to center in two ecological settings: (1) recreational areas, and (2) suburban developments intermixed with abandoned farm lands, where small field rodents are abundant. The dog tick is a three-host tick: Larvae and nymphs are frequently found on meadow mice and white-footed mice, while adult ticks commonly attach themselves to racoons, foxes, rabbits, dogs, and humans.

The American dog tick is of public health significance in the Region because it transmits Rocky Mountain spotted fever, and it is feared because of its bite. In rare instances, attachment of the dog tick over the spinal cord or at the base of the skull results in illness called tick paralysis. In July 1968, a case of tick paralysis was identified in Oregon in a 6-year-old girl, who had just returned from a camp in New York. Her physician found a D. variabilis tick at the base of her hairline on the back of her neck.

A problem that appears to be expanding in New Jersey is that caused by the lone-star tick, Amblyomma americanum. Large concentrations of these ticks have been found in the Cumberland-Atlantic-Cape May County area, where deer are plentiful. It is probably that this species was introduced into the area on imported deer and found the environment favorable. The lone-star tick is a recognized vector of Rocky Mountain spotted fever in certain parts of the United States. In contrast to the dog tick, the immature stages bite man, and quite often chiggers are blamed for the intense itching dermatitis produced by their bite.

PRESENT STATUS OF VECTOR CONTROL PROGRAMS

Mosquito Control Programs

Information in this section pertains principally to organized mosquito control programs (Fig. V-6). Some cities carry on "unorganized" mosquito control activities during the summer. This type of work is usually based upon citizen complaints rather than entomological data, and operations are usually limited to chemical control methods -- particularly fogging. This type of activity is not included in this report.

Virginia. Cooperative, State-local mosquito control commission-type programs operate principally in the southeastern portion of the State, where mosquito problems are most severe. The Virginia State Department of Health, through its Bureau of Solid Waste and Vector Control, provides leadership, guidance, technical support, surveillance services, and State-aid funds in the amount of $126,000 per year. The Director of the Bureau of Solid Waste and Vector Control serves as the Chairman of each of the 26 mosquito control commissions. Each commission is under a well-qualified director, who operates programs with emphasis on source reduction and larviciding. These operations are supplemented by adulticiding.

A few municipalities operate organized mosquito control programs that are not commissions. (Virginia is unique in having municipalities that are not included in any county.) These programs are more limited, and State influence is more indirect.

Table V-5 indicates the name, general geographic area covered, and approximate annual budget of each mosquito control commission and program in Virginia.

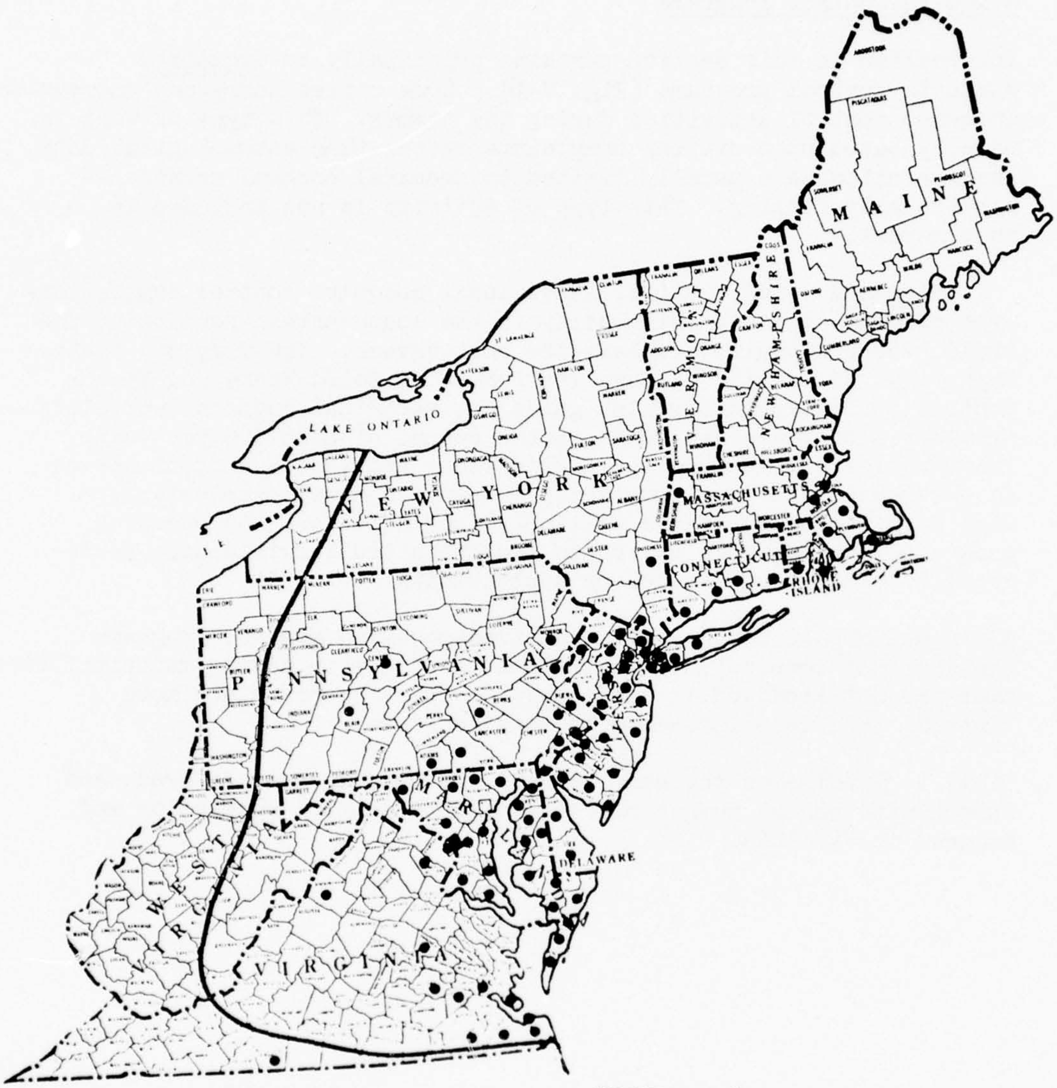

FIGURE V-6

COUNTIES HAVING COUNTYWIDE OR PARTIAL COUNTY ORGANIZED MOSQUITO CONTROL PROGRAM ACTIVITY AS OF DEC. 1968 (●)

TABLE V-5

MOSQUITO CONTROL PROGRAMS IN VIRGINIA

		Approximate Budget	Area Involved
1.	Kempsville-Bayside	$120,000	Two boroughs in City of Virginia Beach
2.	Virginia Beach-Lynnhaven	120,000	Two boroughs in City of Virginia Beach
3.	Washington	35,000	One borough in City of Chesapeake
4.	Deep Creek	15,000	One borough in City of Chesapeake
5.	Great Bridge	10,000	One borough in City of Chesapeake
6.	South Norfolk	40,000	One borough in City of Chesapeake
7.	Western Branch	20,000	One borough in City of Chesapeake
8.	Portsmouth	40,000	Area of original City of Portsmouth
9.	West Portsmouth	40,000	Area annexed in 1960 by Portsmouth City
10.	Churchland	40,000	Area annexed in 1967 by Portsmouth City
11.	Suffolk	6,000	All of City of Suffolk
12.	Courtland	--	All of Town of Courtland
13.	Franklin	15,000	All of City of Franklin
14.	Hopewell	38,000	All of City of Hopewell
15.	Newport News	60,000	Original area of City of Newport News
16.	Warwick	60,000	Area of old City of Warwick
17.	East Hampton	50,000	One-half of City of Hampton
18.	West Hampton	50,000	One-half of City of Hampton
19.	Poquoson	12,000	All of Town of Poquoson
20.	York County	65,000	All of York County
21.	Williamsburg	4,000	All of City of Williamsburg
22.	Chincoteague	6,000	All area on Chincoteague Island
23.	Manassas	10,000	A portion of Prince William County adjacent to Town of Manassas
24.	Woodbridge	20,000	A portion of Prince William County in the Woodbridge Area
25.	Dale City	8,000	A portion of Prince William County in the Dale City Area
26.	James City County	5,000	All of James City County
*27.	Norfolk City	150,000	All of Norfolk City
*28.	Richmond	20,000	All of City of Richmond
	TOTAL	$1,059,000	

*Work performed as a Health Department function -- not a mosquito control district.

The above figures include $126,000 State aid.

New Jersey. New Jersey was a pioneer state in controlling mosquitoes. Organized control programs started more than 55 years ago. At present a cooperative State-County mosquito control commission-type program is active in 20 counties of New Jersey -- all but Hunterdon County (Table V-6). The State program is administered by a group of scientists at the New Jersey Agricultural Experiment Station. The chief mosquito control scientist is the Secretary of the State Mosquito Control Commission, which is a part of the State Department of Conservation and Economic Development. The State Mosquito Control Commission has several functions, all of which are conducted through the Rutgers University group:

(1) Provides inter-departmental coordination at the State level.

(2) Determines broad statewide policy.

(3) Provides State-aid funds including:

(a) $250,000 annually to counties for water management projects.

(b) $100,000 annually for a State-operated aerial adulticiding program, most of which is spent on salt-marsh mosquito control.

(c) $25,000 annually for mosquito control work on State- and federally-owned lands.

(4) Conducts statewide mosquito surveillance activities.

(5) Conducts needed mosquito research.

Each county mosquito control commission conducts a program of water management, larviciding, and supplemental adulticiding.

About 70 cents of each budgeted dollar is spent on water management activities. In addition, several of these commissions have additional county funds for use in providing maintenance work on county drainage channels and streams.

TABLE V-6

NEW JERSEY COUNTY MOSQUITO EXTERMINATION COMMISSIONS REGULAR BUDGET APPROPRIATIONS, 1968

County	Received 1968*	% Water Management
1. Bergen	$ 524,000	70
2. Essex	434,000	65
3. Ocean	368,000	80
4. Morris	312,000	60
5. Hudson	298,000	50
6. Union	293,000	75
7. Cape May	246,000	75
8. Passaic	244,000	70
9. Middlesex	238,000	75
10. Mercer	226,000	75
11. Burlington	156,000	65
12. Atlantic	154,000	60
13. Camden	150,000	70
14. Monmouth	141,000	80
15. Cumberland	103,000	90
16. Somerset	97,000	70
17. Gloucester	80,000	80
18. Salem	63,000	90
19. Warren	10,000	80
20. Sussex	3,000	70
21. Hunterdon	--	--
Total	$4,140,000	
State Mosquito Control Commission	275,000	70
Municipal 300 @ $1000 avg.	300,000	30
Grand total State	$4,715,000	

*Figures do not include accessory budgets.

The New Jersey State Department of Health is actively engaged in encephalitis surveillance and investigation work and cooperates closely with the mosquito control programs. Since four major types of encephalitis viruses have been reported in the State, encephalitis surveillance is of great importance.

Mosquito problems in this highly urbanized megalopolis are changing. State mosquito authorities state that the "effluence of the affluence favors more mosquitoes and disease." This is exemplified by intensified breeding of *Culex pipiens* mosquitoes in the increasing amounts of heavily polluted waters and the backyard breeding habitats such as old vehicles, tires, appliances, swimming and wading pools, and single use drink containers.

New York. Organized mosquito control was started in Nassau County, New York over 50 years ago. Prior to 1966, the principal programs in the State were in the New York City-Long Island area. The 1968 budgets for these programs were as follows:

Program	Budget
Nassau County Mosquito Control Division Department of Public Works	$ 1,027,000
Suffolk County Mosquito Control Commission	990,000
New York City Mosquito Control Program	250,000
Total	$ 2,267,000

In 1966, a new cooperative health department, State-County mosquito control program was initiated which will supplement several existing programs. Mosquito control competence is in the process of being provided at the Central office and at each of five Regional Offices. This group works with counties by making detailed pre-program surveys and then assisting county-wide programs with technical and financial support. State-aid funds can be provided on a 50% matching basis up to a maximum of $25,000. Each participating county must have a well-qualified program director and follow the State-approved methods and materials. Programs of this type are now in operation in Rockland and Dutchess Counties.

In the past, the State entomologist and his staff of the New York State Science Service have provided considerable technical assistance to communities throughout New York.

The New York State Science Service, the State Health Department, and the Suffolk County Mosquito Control Commission have collaborated in research on potential mosquito vectors of arboviruses on Long Island.

Maryland. A cooperative State-local mosquito control program is in operation in 817 towns, located in 19 counties in Maryland. This control work is a joint program of the University of Maryland and the Maryland State Department of Agriculture, with headquarters at the University. The State provides leadership, technical guidance, direct supervision of all field personnel, and State-aid funds in the amount of $350,000 annually. Cities, through county government, contribute about $204,000 annually, yielding a total of about $554,000 annually. The control program consists of source reduction, larviciding, and adulticiding. Control effort is concentrated in counties having salt-marsh mosquitoes. Earth-moving and insecticide-application equipment is moved from county to county as priorities and needs dictate.

A few towns operate small mosquito control programs with their own funds and limited influence from the State group.

Delaware. A statewide mosquito control program, operated in the three counties of Delaware, is administered within the State Highway Department. The program consists of source reduction, water management, larviciding of fresh-water and salt-marsh mosquito breeding sources, and adulticiding for the control of salt-marsh mosquitoes. The budget for 1968 was $267,000. In 1965, a special appropriation of $2,000,000 was made for exclusive use on source reduction work. These funds are being spent during a 5-year period.

A group of scientists at the University of Delaware, Department of Entomology and Applied Ecology, provides technical assistance and guidance to the program, close cooperation, considerable surveillance of important mosquito species, and conducts research on special problems. Of particular interest, is their present research work with slow-releasing Abate button-size pellets, using polyvinyl chloride, for use in salt marshes. Their investigations cover both effect on mosquitoes and non-target organisms in salt marshes. In considering any alteration of the marshes or insecticidal treatment, the potential effects upon the total environment are considered.

District of Columbia. The District of Columbia Department of Sanitary Engineering conducts a continuing mosquite control program, with a budget of about $80,000 per year. Stream clearance and maintenance are the principal activities. Some lariciding is done, especially in sewer catch basins, which at times are heavy breeders of domestic mosquitoes.

Pennsylvania

A cooperative State and County Mosquito Control Program has been in existence since 1966. Surveys, technical training and consultation, evaluation, encephalitis surveillance and emergency control are being provided from the central office in the Department of Environmental Resources, as well as at each of seven regional offices. Vector control personnel of the Department has completed 22 county-wide mosquito surveys, nine locally supported mosquito control programs have been started.

A regional type approach involving eight northwestern counties is being formed into a control program.

The emphasis of the control programs is primarily on the elimination or biologically altering breeding areas, and on the reviews of plans for recreational areas, highway construction and similar development to prevent the creation of new breeding areas.

The following tabulation shows the programs and estimated budget for mosquito control in 1970:

Program	Estimated Budget
Media	$ 3,095
Northhampton County	14,150
Tinicum Township	1,265
Royersford	1,195
Moshannon Valley Mosquito Control Commission	10,455
Blair County Mosquito Control Commission	10,000
Grove City	10,000
Bucks County Mosquito Commission	168,000
Lansdale	860
Chambersburg	675
Meadville	1,000
Sunbury	2,900
Norristown	625
Upper Moreland Township	1,530
Upper Merion Township	1,425
Ambler	890
Gettysburg	5,835
Hatboro	1,045
Hursham	2,125
York	8,540
Pottstown	4,915
Gettysburg National Military Park	308
Maple Township	1,000
Delaware County	63,090
Philadelphis	110,000
	$ 424,995

Massachusetts. In Massachusetts, the State level agency that has the responsibility for the supervision of all organized mosquito control projects in the Commonwealth is the State Reclamation Board.

The organized projects are as follows:

	Mosquito Projects	Annual Assessments
1.	Cape Cod Mosquito Control Project	$ 155,232
2.	Norfolk County Mosquito Control Project	117,760
3.	Plymouth County Mosquito Control Project	111,895
4.	Berkshire County Mosquito Control Project	107,441
5.	Essex County Mosquito Control Project	107,032
6.	Bristol County Mosquito Control Project	102,327
7.	East Middlesex Mosquito Control Project	91,447
8.	South Shore Mosquito Control Project (portions of Norfolk and Plymouth Counties)	79,089
	Total	$ 872,223

The first six are county projects, each organized under special acts of the Legislature.

The State Reclamation Board is responsible for maintenance of salt-marsh ditches, and annual assessments are made by the Board upon the several towns involved in projects of this type. Most of the ditches were installed between 1931 and 1933, with State and Federal funds, largely as an unemployment relief measure.

Annual assessments for salt-marsh ditch maintenance are as follows:

South Shore	$31,300
Bristol-South Plymouth	17,900
North Shore	9,200
Martha's Vineyard	3,715
Total	$62,115

A cooperative study on the ecology of Eastern encephalitis was initiated in 1957 by the Massachusetts Department of Public Health and the Communicable Disease Center of the U.S. Public Health Service. study is still being continued by the State.

Connecticut. In Connecticut, with the exception of salt-marsh mosquitoes, the problem on mosquito control has been left to the individual towns for solution. Up to the present, very few towns have developed programs to deal with the problem.

In the control of salt-marsh mosquitoes, the Mosquito Control Section of the State Department of Health carries out a program involving the maintenance of approximately 1,000 miles of ditches installed on 10,000 acres of salt marsh. These ditches were originally installed by 16 shore towns (prior to WPA days) and accepted by the State for maintenance by the former State Board of Mosquito Control. The Mosquito Control Section also carries out chemical control operations as needed along the shore area. The Section's budget is approximately $80,000.

Rhode Island. Formerly, the State provided financial assistance to several cities and towns for carrying on a mosquito suppression program under supervision of the State Department of Agriculture, all on a voluntary basis. For example, in 1965 the State Legislature appropriated $20,000 for State subsidy, which allowed a reimbursement payment of 18¼% on the money spent by 24 municipalities. However, since 1965, there has been no appropriation for State subsidy. A few towns are operating limited programs with their own funds.

The State's program at present is restricted to State-owned lands, such as parks, bird sanctuaries, and airports. The principal activity is maintenance of salt-marsh ditching.

Other States. There is little State activity in mosquito control in Maine, New Hampshire, Vermont, or West Virginia. At the local level, many towns conduct modest control work in the summertime. This work consists of larviciding open ditches and ponds within the city limits and operating fog machines or power sprayers. These programs are generally motivated by citizen complaints and not upon entomological surveillance. Rockingham County in coastal New Hampshire needs a county-wide mosquito district and has been close several times to starting such a district.

Control of Black Flies, Greenhead Flies, Midges, and Ticks

Black Flies. The principal black fly control activities in the Region are conducted in Hamilton and Herkimer Counties in the Adirondacks of northeastern New York. The amount spent in these two counties is about $75,000 per year. The control program is directed at the larvae which have their heaviest concentration in streams containing rocks and rippling water. At present, the chemical of choice is methoxychlor, which is usually applied by one airplane swath across the streams every quarter of a mile out to a distance of 5 to 10 miles from towns and resorts to be protected. No water management or source reduction work is being done; however, it is technically feasible to gain considerable benefit below dams by shutting off the flow of water for a few days at the appropriate time in the spring, thus lowering the water level in streams and causing the larvae to detach themselves from rocks and other objects in the water.

Excellent research on the control of black flies has been conducted by the New York State Science Service and the Department of Entomology at Cornell University.

Greenhead Flies. In Massachusetts, specific enabling legislation permits the establishment of greenhead fly control projects and districts. With the approval of the State Reclamation Board, any city or town along the sea coast may establish a greenhead fly control project within its area, and two or more adjoining cities or towns may form a district within their combined areas. Where districts are formed, one-third of the cost is borne by the State.

Greenhead fly control programs are in operation in several communities of coastal Massachusetts. These programs are listed below:

Annual Assessments for Greenhead Fly Control Programs

Cape Cod (district)	$ 7,200
Scituate	1,928
Marshfield	1,800
Plymouth	1,600
Duxbury	1,500
Kingston	1,500
North Shore	1,000
Total	$16,528

At present no highly effective control exists for greenheads. Considerable research in developing control methods has been conducted in several areas including Essex County and Cape Cod, Massachusetts, and Long Island, New York.

Biting Midges (Culicoides species). Problems with these pestiferous insects, also known as "sand flies", "no-see-ums", and "punkies," have been studied in several areas, but effective control measures are not yet available. Consequently, no programs have been undertaken to control this group. It has been noted that their number can be decreased in areas where fogging operations are used for control of adult mosquitoes. Although interest in the control of biting midges is growing in many communities of the Region, relief from these pests is predicated on further research on the biology and control of the species involved.

Chironomid Midges. Several mosquito control commissions and other agencies apply chemicals to kill midge larvae. Fenthion (Baytex), Abate, and other organophosphorous toxicants are presently in use. Occasionally, space treatments are applied to kill adult midges down wind from their breeding source.

In Massachusetts, special acts of the Legislature have given the State Reclamation Board authority to carry out programs to control "Animal and Vegetable Nuisances" in two specifically named salt-water ponds having severe midge and algae nuisance problems. These impoundments are Straits Pond in Hull and Cohasset and Musquashait Pond in Scituate. The control procedures used involved periodic salinity adjustments in the ponds by allowing high tides to flow into the brackish ponds for a short period of time. This was accomplished by opening tidal gates at the outlet of the pond and allowing clean sea water to flow in. This procedure of increasing the salinity of the ponds drastically reduced the numbers of Chironomid midges breeding in the ponds; however, the procedure of allowing sea water to flow into the ponds for midge control must be repeated periodically in order to keep the midge population down. Algae control and weed removal were also factors in reducing the midge population of Straits Pond. Assessments for the midge-algae control programs are $3,000 and $4,500 respectively.

Ticks. There are no organized tick control programs in the North Atlantic Region, even though there is a need for them.

In Massachusetts certain "nuisance insects," including the American dog tick, may be controlled by the Bureau of Insect Pest Control of the Department of Natural Resources. The control activities are concentrated in the Cape Cod area.

Because of the concern about the use of DDT and other chlorinated hydrocarbon insecticides as area controls, research is presently directed toward the development and use of less persistent insecticides in tick control.

EXISTING VECTOR CONTROL NEEDS

The need for strengthening vector control activities is increasing rapidly in the North Atlantic Region as elsewhere due to such factors as: (1) the rapid population increases; (2) the development of suburban areas in close proximity to vector breeding sources; (3) the inadequate control of mosquitoes that have their genesis on Federal and State wetland areas; (4) the exposure of man to insects of public health importance due to expanded public use of water-related recreational areas; (5) the growing concern over pesticide residues in food and water; (6) the development of resistance to various insecticides exhibited by many species of mosquitoes, and (7) the ever-increasing demand by the public for relief from annoyance and the threat of vector-borne diseases.

Research

Research on the ecology of the more important vectors, on vector population threshold studies with respect to the transmission of disease agents, on the epidemiology of vector-borne diseases -- particularly encephalitis, and on non-chemical abatement methods is urgently needed to develop more effective prevention and control measures. At present, there is too much reliance on chemical pesticides to control mosquitoes, ticks, black flies, and other vectors. Consequently, there is a great need for expansion of research activity, particularly in developing new ecologic, genetic, and biologic control methods. In the future, more consideration must be given to the ecology of the total environment in developing improved methods of vector control.

Surveillance

The nature and scope of vector problems vary greatly in different parts of the North Atlantic Region.

Consequently, continuous surveillance of these problems is required to: (1) determine prevalence and major sources of important vector species, (2) evaluate factors responsible for the vector problems, (3) ascertain the most appropriate control measures, and (4) determine the need for emergency control measures in time of threatened outbreaks of vector-borne disease.

At present, surveillance activities are conducted by some of the State health departments, usually in conjunction with environmental health programs. The U.S. Public Health Service provides assistance in surveillance and survey activities when requested to do so by State health departments and other interested agencies. Because of limited personnel and the magnitude of problem areas, surveillance activities relating to vector control problems are greatly deficient in many areas of the Region. Surveillance activities should be increased to better define the type and scope of vector problems in this Region.

Technical Assistance

Appropriate Federal and State health agencies should provide technical assistance and basic information relative to vector control problems to all of the various agencies concerned with water resource developments and groups of people residing in affected urban, rural and outdoor recreation areas. Assistance of this nature should include participation in surveys of problem areas, consultation on appropriate control practices, and training of control personnel. This type of assistance must be greatly increased to help close the gap between existing knowledge on vector control and the application of this knowledge in problem areas.

Legislation

During recent years, the need for organized mosquito and other vector control by specific enabling legislation has been given increasing consideration. Because of the importance of adequate financing in relation to the development and operation of control programs, a need exists for State enabling legislation to provide for the establishment of successful vector control programs in States which do not have this kind of legislation.

FUTURE NEEDS

This is a generalized discussion of vector problems and needs likely to develop by the years 1980, 2000, and 2020, as a result of projected future water resource developments, water usage patterns, and other expected ecological changes.

A review of trends over the past 25 years indicates that changes in vector problems occur only very slowly. Among the slow-moving trends noted in the past are the following:

(1) An intensification of the *Culex pipiens* (northern house mosquito) problem due to increased polluted waters as a concomitant of our increasingly urbanized society.

(2) A gradual increase in the size, number, and scope of mosquito control commissions and programs.

(3) More emphasis in mosquito control programs on water management and source reduction.

(4) Better communication and cooperative effort between all affected departments and interests in regard to decisions involving water resources management and vector control technology.

In looking forward to the years 1980, 2000, and 2020, experience would seem to indicate that vector control problems as related to water resource development and associated lands will not change radically. The four slow-moving trends noted above will probably continue. In addition, the following projections are made:

(1) The expected increase in size and number of on-stream and pumped-storage reservoirs for drinking water purposes will be generally beneficial to mosquito control, and adverse effects will be minimal.

(2) The expected increase in dams and reservoirs for flood control purposes will be beneficial to mosquito control, and adverse effects will be greatly overweighed by the beneficial effects.

(3) Few large dams for power generation purposes will be built and thus the effect on vector control will be minimal.

(4) Increases in temperature in impoundments and streams due to atomic energy plants are expected to produce some ecological changes. However, vector problems will probably not be affected in magnitude.

(5) The greatly increased irrigation of crops will be largely accomplished with overhead sprinklers and will not significantly affect vector problems.

(6) The projected large increases in water-oriented recreation participation will tend to increase vector control needs. However, these needs should be effectively and efficiently handled by in-line State-county or district vector control programs. Tick and black fly control districts or programs will gradually become more numerous and better balanced ecologically.

(7) The projected increase in organic pollution of reservoirs, lakes, and streams will lead to increased chironomid midge problems, which should be adequately controlled by vector control districts or programs.

(8) The incidence of encephalitis, Rocky Mountain spotted fever, malaria, and other vector-borne diseases will probably not change radically.

(9) The research on, and the use of genetic methods in vector control will probably increase.

(10) Many county and metropolitan area officials are now looking to regional organizations to solve problems and reduce costs. There is little doubt that regional approaches will soon be too small in many portions of the N.A.R. Accordingly, the principal thrust in the future must be toward state-wide approaches, with Federal leadership and coordination, if effective progress is to be made in the management of the nation's water and related land resources.

VI. ENVIRONMENTAL HEALTH ANALYSIS

This section entitled "Environmental Health Analysis" will give recognition and evaluation of the environmental health factors which may be affected by or affect the development, maintainance, or utilization of water and related land uses.

This chapter will cover:

A. Air Pollution Control

B. Radiation Control

C. Recreation Sanitation

D. Shellfish Sanitation

E. Solid Waste Disposal

AIR POLLUTION

SOURCES PRODUCED OR AFFECTED BY WATER RESOURCE DEVELOPMENT

Power Generation Stations

In providing heat energy necessary for the generation of electric power, the combustion of coal, oil, or gas will result in the production of various air pollutants. In contrast with other cases of combustion related air pollution, power plant air pollution is produced by efficient, rather than inefficient, burning operations.

The common air pollutants produced by the burning of coal for power generation are: solid particles of flyash, and the gases: sulfur dioxide and the oxides of nitrogen. The combustion of oil will also produce sulfur dioxide and the oxides of nitrogen, but very little particulate matter. The only pollutants of consequence from gas burning are the oxides of nitrogen.

Pollutant control equipment for flyash is, of course, an integral part of the modern power plant. The electrostatic precipitators typically used have theoretical control efficiencies approximating 99% by weight, although actual working efficiencies may be appreciably lower. Control equipment for capturing stack gas sulfur dioxide is still early in the development stage, and use of low sulfur content fuels is, at present, the only widely applied means for minimizing sulfur dioxide emissions from combustion processes. There are, at this time, no methods in practice, or even in the serious proposal stage, for controlling oxides of nitrogen.

The following table lists the approximate quantities of pollutants generated, per million BTU's of heat input, for the major power plant fuels. The values in the table are based on the assumption that no control techniques have been applied.

TYPICAL QUANTITIES OF GENERATED POLLUTANTS*
FOR POWER PLANT COMBUSTION PROCESSES PER
MILLION BTU'S OF HEAT INPUT (In Pounds)

Fuel	Particulates	Sulfur Dioxide	Oxides of Nitrogen
Pulverized Coal (General)	.59 x Ash Percentage**	1.41 x Sulfur Percentage**	.67
Oil	.053	1.05 x Sulfur Percentage**	.69
Gas	0.14	.0006	.37

* Assumptions

1. Heat Content of Coal = 23-27 million BTU/ton
2. Heat Content of Oil = 150,000 million BTU/gallon
3. Heat Content of Natural gas = 1,050 BTU/SCF

**Ash percentage and sulfur percentage refer to the content by weight in the fuel. The percentage figure should be used in calculations as a whole number. Thus, the "sulfur percentage" factor for a 2.00% oil would be the digit 2, rather than the decimal fraction .02.

Nuclear generating plants will produce no air pollutants, under normal operating conditions. If all power generating stations were to produce electricity by nuclear means, the power plant would no longer be considered a source of air pollution. However, despite accelerating use of nuclear energy, the consumption of fossil fuels for the generation of electricity is expected to remain at high levels for the near future. As long as fossil-fuel capacity remains competitive with nuclear and "other" fuels, continued use of fossil fuels for generation in the N.A.R. and other coal-producing areas of the market may be expected.

Water Based Industry

Certain industries use large volumes of water for process purposes, while others depend upon inexpensive water transportation for bulk raw materials or bulk finished products. Chemical, metallurgical, and mineral industries often fit into either or both of these categories and are, also, often associated with air pollution problems. The pollutants of concern vary across a wide spectrum, dependent upon the process involved. Commonly, fuel combusion is an integral part of industrial operations, and particulate matter, sulfur dioxide, and/or oxides of nitrogen may be emitted. These industrial combustion emissions can be locally important, in and of themselves, but they more often cause concern as part of a greater pollutant summation affection a widespread area. This summation is of like pollutants from domestic space heating, or power generation, or any of a number of burning operations.

Other air pollution emissions from chemical, metallurgical, or mineral industry processes may be much more unique and have a much more acute and concentrated effect. The ammonia emissions from an ammonia producing plant, located in one of our large cities, may have little overall impact upon the metropolitan area, but it very possibly could have an acute effect upon the plant's immediate surroundings.

The number of process industries with air pollution potential can almost be equated with the number of process industries dependent upon water. The development of water resources to encourage the growth of industry can also be expected to stimulate the growth of a potential for air pollution, unless anticipatory steps are undertaken to insure adequate air pollution control actions.

Disposal of Construction Wastes and Cleared Debris

The disposal problem for construction wastes and cleared debris is often a problem of the disposal of bulky, oversized items, in quantities locally small but, perhaps, collectively great. Typically, these materials are piled and burned on-site, or are consumed in make-shift incinerators. In either event, inefficient combustion is almost guaranteed, and great quantities of black smoke, aldehydes, organic acid gases, etc., will be emitted. It is estimated that 17 pounds of particulate matter will be emitted, to enter the atmosphere, from the open burning of each ton of landscape or agricultural refuse.

General Industry

The development of water resources will not only stimulate the growth of water based industry in the pertinent geographic region, but will likely stimulate the growth of all industry because of a general beneficial impact upon the area's economy. This overall commercial growth is likely to expand the potential for air pollution beyond that earlier discussed with regard to water based industry. This is particularly true with regard to combustion emissions and to pollutants arising from the general use of evaporative materials. By way of example, solvent usage, with its ensuing hydrocarbon evaporation, contributes significantly to the quantity of raw material involved in the formation of Los Angeles type, photochemical, "smog". Consequently, an assessment of the air pollution problems which might ensue, as a result of water resource development, must include problems associated with all of industry, not only water based processes.

STATUS OF AIR QUALITY

The air pollution problems which affect the greatest numbers of citizens today are those associated with major urban areas. In great measure, these arise because people and their related activities are concentrated in relatively limited geographical areas. Very often, these activities result in the emission of air pollutants, particularly when combustion processes are involved. In general, these emission sources contribute relatively small amounts of pollutants as individual entities but, in total, the summation of all pollution contributors may grossly overload the atmosphere over the metropolitan region.

In the event that stagnant meteorological conditions, and/or restraining topographic features, are present with a regional concentration of emission sources, air pollution problems can be compounded to a very serious degree.

The following brief descriptions concern a number of the primary air pollution problems which presently concern the Northeastern United States.

Sulfur Dioxide

The oxidation of sulfur, taking place usually because the element occurs as an impurity in fuel oil or coal, produces a gas which is at once an irritant to respiratory tissue, an attacker of susceptible vegetation, and a raw material which can further react to form sulfuric or sulfurous acid. In this acid form, of course, the pollutant can damage mineral or metal surfaces. Any adverse effects, naturally, are dependent upon the atmospheric concentrations of sulfur dioxide present.

An illustration can be given to indicate the relationship between desired limits for sulfur dioxide concentrations in the atmosphere and actual concentrations measured. The State of New York Division of Air Resources recommends that atmospheric levels of sulfur dioxide in New York City not exceed 0.10 parts per million parts of air, by volume, as a 24 hour average, more than one day out of one hundred. Actual measurements at the New York City Department of Air Pollution Control's sampling station in Upper Manhattan, for the period 1957 through 1966, showed that the average winter's day sulfur dioxide concentration, in the ambient atmosphere, was in excess of 0.20 parts per million. Higher than desired concentrations, such as the case just described, can occur whenever sulfur bearing fuels are burned in large quantities. It has been estimated that over 735,000 tons of sulfur dioxide were emitted into New York City's atmosphere during 1965. Approximately 40% of this total was believed to be the contribution of power generation sources; a slightly lesser percentage resulted from domestic fuel consumption.

Particulate Matter

This category concerns all of the solid materials which can be found in the atmosphere. Much of this particulate matter occurs naturally, as in the case of pollens or wind erosion materials, but much of the solid pollutants result from man's own processes. Particulate matter produces atmospheric haze because of its interference with light transmission; it soiled surfaces, and it can cause adverse health effects -- directly because of its own nature or indirectly because of its capability to absorb and concentrate pollutant gases.

Particulate matter pollution can result from inefficient combustion, as black smoke, or it can result from efficient combusion, as in the case of flyash from coal burning power plants. Industrial processes, such as those of the mineral and metallurgical industries, can produce large quantities of particles. The table below lists the estimated percentage contributions for each major source of atmospheric particulate matter, in the New York metropolitan area.

ESTIMATED PERCENTAGE CONTRIBUTIONS, BY WEIGHT OF ATMOSPHERIC PARTICULATE MATTER FOR NEW YORK METROPOLITAN AREA SOURCES

	Source	Percentage Contribution
1.	Residential Fuel	17.8%
2.	Power Generation	17.3
3.	Industrial Fuel	14.5
4.	Motor Vehicles	14.7
5.	Municipal Incineration	8.7
6.	On Site Incineration	8.7
7.	Industrial Processes	8.6
8.	Commercial and Government Fuel	8.5
9.	Open Burning	0.6
10.	Aircraft and Shipping	0.6
		100.0%

The table above is for only one metropolitan area, and the percentage figures listed would vary for another urban center. The Chicago Metropolitan Area, for example, with its vast steel making complex, would be expected to have a much greater industrial process contribution.

The Federal Government has, for many years, operated sampling stations throughout the country to measure levels of that portion of atmospheric particulate matter which tends to remain suspended, rather than settling out under gravitational influences. These smaller particles are the ones most directly involved in haze formation, and soiling, and offer the greatest potential threat to health. In 1965, results from this National Air Sampling Network indicated the following particulate pollution levels for some of our major cities in the Northeast.

MEASURED SUSPENDED PARTICULATE CONCENTRATIONS AT SAMPLING STATIONS LOCATED IN URBAN AREAS MICROGRAMS PER CUBIC METER 1965

City*	24 Hour Average Concentrations	
	Maximum	Geometric Mean
1. New York City	395	164
2. Philadelphia	312	170
3. Providence	286	117
4. Newark	285	113

*It must be emphasized that the values listed are for a single station in each city. It would be a gross over-simplification to assume that the indicated value represented pollution conditions throughout the entire city. The figure does indicate, however, the levels which can be found in our urban centers. By way of comparison, the maximum 24 hour suspended particulate concentration measured in Yellowstone Park, Wyoming, during 1965, was only 21 micrograms per cubic meter of air.

Automobile Exhaust Gases

The chief primary pollutant resulting from the automobile's internal combustion engine is, of course, carbon monoxide. The damage potential of this pollutant is health related because of the propensity for carbon monoxide to tie up the blood's hemoglobin, and thus interrupt the transfer of oxygen from the lungs to tissue cells in the body. The automobile is, for all practical purposes, the only significant source of carbon monoxide. In New York City, for 1965, it was estimated that 1,628,536 tons of carbon monoxide were emitted to the atmosphere, with 1,584,070 tons coming from the automobile.

The State of New York recommends that carbon monoxide concentrations of 15 parts per million for 8 consecutive hours should not be exceeded more than 15% of the time; actual measurements in mid-town Manhattan have indicated that carbon monoxide concentrations exceed 15 ppm almost continuously during the business day.

Secondary pollution problems stemming from automobile exhaust gases, primarily photochemical "smog" problems, can occur in urban centers other than Los Angeles. Ozone damage to vegetation, apparently the result of photochemical reaction and identical to damage found in Southern California, has been demonstrated in the New York Metropolitan Area. This "smog" reaction of pollutants is between reactive hydrocarbons and oxides of nitrogen in the air. Automobile exhaust gases serve as the chief contributor of the hydrocarbons, although gasoline storage, solvent, and paint vehicle evaporation can contribute significant quantities. Oxides of nitrogen are commonly produced in all combustion operations, with the automobile exhaust contribution being a very large one.

The air pollution problems described are common to all urban areas. It must also be stated that localized, special, problems can be a source of serious concern, as well. This is especially true with regard to industrial process emissions, which can involve effects ranging from the nuisance of an unpleasant odor to the serious health hazard of a toxicant.

REGULATORY CAPABILITY - THE RESPONSIBILITIES OF GOVERNMENT

The Federal Clean Air Act as Amended emphasizes the fact that all levels of Government have roles to play in the proper management of our atmosphere. In this piece of legislation, it is stated that: "The Congress finds...that the prevention and control of air pollution at its source is the primary responsibility of States and Local Governments; and that Federal financial assistance and leadership is essential for the development of cooperative Federal, State, Regional, and Local programs to prevent and control air pollution."

During the 1960's, because of the actions of responsible State and Local authorities and with Federal technical and financial support, strong air pollution control programs have become common in the Northeast. Almost without exception, each State and each major urban center has obtained legal authority to control air pollution within its boundaries and has moved to establish a workable enforcement program designed to implement its legal authority.

The Federal Government has moved to reinforce its technical and financial assistance by obtaining the right, again under the Clean Air Act as Amended, to designate Air Quality Control Regions for pertinent urban areas. These Regions would be designated for the purpose of having the involved state, or states, adopt satisfactory air quality standards and, also, control plans for achieving those standards.

The Federal Government, as well as some of the stronger state and local agencies, also maintains comprehensive research, development, and training efforts.

DEVELOPMENT OF ACTIONS TO PREVENT WATER RESOURCE RELATED AIR POLLUTION PROBLEMS

The principal requirement for avoiding air pollution problems which might result from water resource development is to anticipate those problems and plan for necessary control actions. At times these control actions might involve land use planning for such things as buffer zones around major individual sources, but more likely they would involve the choice of direct controls at the source. Most positively, these direct controls would result in the elimination, or minimization, of pollutant generation through a process of raw material change. Other forms of direct controls, of course, would involve capturing the pollutants after they have been generated, but before they are released to the atmosphere.

In either event, the required problem anticipation and control action planning should be accomplished through coordination between those engaged in the water resource development program and the area's air pollution control authorities. This coordination must be established at the earliest possible moment. Almost all of the major control agencies in the Northeast have existing plan examination and certification, or similar problem anticipatory programs. The structure for coordination is there and should be utilized if air pollution problems are not to result from water resource development.

RADIATION CONTROL

Radiation control is very closely linked with water resources planning with respect to the design and operation of nuclear power generating plants. The large amounts of cooling water used in the generation of steam to produce electricity are not only important from the standpoint that there is a water consumption in open cycle systems but also because there is a potential, though very slight, of releasing radioactive materials back into the environment through the discharge water.

SAFETY CONTROL (8)

Through the efforts of the Atomic Energy Commission and industry initiative, the nuclear power industry has one of the best safety records of any industry, both for in-plant personnel and for the surrounding environment as a whole. The atomic power industry is one of the few industries into which safety and control were built concurrently with the development of the industry itself. Nuclear power plants are designed so that even if the "maximum design basis accident" occurs, the release of radioactive materials to the surrounding environment will still be below the levels at which harm to humans could occur.

As a further safety factor, comprehensive monitoring systems are built into nuclear power plants which keep a close check on the amount of radioactivity present in the discharge water. Monitoring devices should be designed to keep a continuous monitoring check. The monitoring requirements for on-site surveillance are established and enforced by the Atomic Energy Commission. The testing itself is carried on by qualified personnel of the power company under the guidance of the AEC. Monitoring near the site is done by the state health department.

AREAS OF CONCERN

A growing concern centers around what effect thermal pollution originating from the discharge waters of these plants will have on the ecological balance of the watercourse into which the heated water is being discharged. This concern also applies to discharges from fossil fuel plants which also can create thermal pollution. The generally accepted feeling is that a bried exposure of aguatic life to a temperature rise of 1° - 3° F will probable not have any detrimental effects on the balance of the stream or river. However, when the temperature of the water rises more sharply due to thermal pollution, it could cause the dieout of a particular plant or animal which could be part of a food chain. All species of plant and animal including man may be affected by the loss of a vital link in the food chain creating an ecological disruption in the water environment.

Usually nuclear power plants are designed so that the cooling water will be discharged into large receiving bodies such as river, lakes, reservoirs, or the ocean. If it is deemed that lower discharge temperatures are needed, present technology offers the use of holding ponds and/or cooling towers as a means of doing this. However, there are problems associated with cooling towers which include the necessity of having fairly large land areas on which to site them, possible creation of fog problems in the immediate area, possibility of noise problems, and the "visual misfit" potential.

Another problem area involves the reprocessing of spent fuel from nuclear power plants and also the disposal of radioactive waste materials from medical, industrial, and research sources. Reprocessing of spent fuel is a task which can be accomplished only through sophisticated technology and by highly specialized personnel. Processing consists of: (1) de-jacketing the clad; (2) dissolving the fuel; (3) recovering uranium and plutonium and separating these elements from the radioactive fission products; (4) reducing the liquid volume of the fission products; (5) solidifying the reduced volume; (6) immobilizing the reduced volume; and (7) effecting ultimate disposal in a non-leachable medium in a stable seismic zone. The waste products are stored in protective containers at one of 4 or 5 landfill sites in the United States set aside for this purpose.

When there are water supply intakes downstream from a nuclear power plant, it is a necessity to have a contingency plan set up whereby, should an accident occur and radioactive material were released to the receiving stream, immediate notification of the downstream water supplies should be accomplished. It is realized that the possibility of such accidents occuring is extremely remote; however, if one should occur, it is possible that in all the confusion accompanying an incident that the downstream water companies might not hear about it until it was too late if there were not a contingency plan in effect.

RECREATION SANITATION

INTRODUCTION

A major factor in the overall planning, development, and operation of recreational areas is that proper health protection of individuals visiting or residing in such areas will be provided and maintained. These requisites include development of safe water supply and sewage disposal systems; proper storage, collection, and disposal of solid wastes; control of insects and rodents; and the design and operation of safe outdoor bathing areas and swimming pools. (8)(9)

These recreational activities may be separated into two broadly defined areas of "urban" and "out-of-doors". Urban recreation relates directly to health in terms of mental and physical well-being but only indirectly in terms of water resources development. This relationship is in the area of land use in providing necessary space for close-in parks, golf courses, etc.. "Out-of-doors" recreation, however, covers the whole range of environmental health aspects of water resources development.

The demand of the North Atlantic Region for recreational development is great in the future because of projected development of megalopolis stretching from Boston to Washington, D. C. Proper long-range planning of recreational areas for meeting these demands is a necessity so that present recreation areas (some of which are now overcrowded) and future areas will not create a health menace, both physical and mental, rather than an enjoyable recreation site.

PUBLIC HEALTH ASPECTS

From the public health standpoint, one of the most critical forms of outdoor recreation is the water contact sports such as swimming, water skiing, and wading. This is one area where the potential for human disease and suffering can be great through contact with deteriorated water quality in bathing areas, the chance of contracting disease through water-associated vectors, and substandard sanitary facilities (water supply and waste disposal) at recreation areas. With the potential for all these varied problems occurring, it is essential that foresight and comprehensive planning be given to the development of any water-oriented recreation area.

While there is no specific epidemiological evidence that people who swim in polluted water suffer a greater occurrence of disease than those who swim in clean water, health authorities would not want to jeopardize the recreator's health by not setting standards for recreational water quality. The main criteria for the water quality of water contact recreation waters is the bacteriological quality of the bathing water which should be measured by the fecal coliform density. The U. S. Public Health Service's recommended bacteriological, chemical and physical standards are as follows:

Bacteriological

The fecal coliform density should not exceed an arithmetic mean of 200/ 100 ml with a sampling frequency of 5 samples per 30-day period taken during peak recreational use. Not more than 10 percent of the samples' fecal coliform densities during any 30 day period should exceed 400/100 ml.

Chemical

The water should contain no chemical which could cause toxic reaction if ingested or irritation to the skin or eyes. The water's pH should be within the range of 6.5 to 8.3.

Physical

The water's color should not exceed 15 standard units and its turbidity should not exceed 30 standard units. Maximum water temperatures should not exceed $85^{o}F$ ($30^{o}C$)

The recreational water quality standards adopted by the states of the North Atlantic Region follow the U.S.P.H.S. recommended standards with the exception of the bacteriological standard. Most states use the total coliform criteria rather than the fecal coliform at the present time.

The vector-caused waterborne diseases and proper design of recreational sanitation facilities are covered in the Disease Vector Section of this report and the Health Guidelines for Water Resource and Related Land Use Management in the addendum.

PROBLEM AREAS

One of the potential problems facing the North Atlantic area is the degradation of natural ponds and lakes to the point where they will be unfit for water contact recreation. This is occurring in areas of Northern New England where these lakes and ponds presented many opportunities for recreation as little as 10 or 20 years ago. One cause of this degradation of water quality stems from the deteriorated quality of the rivers and streams feeding these bodies of water. A potentially more dangerous cause results from the indiscriminate division of camp lots around lakes where there is insufficient land available for septic tank disposal of wastes or an individual water supply. With the large demand for lakeside property it is very tempting for the land developer to subdivide land into smaller lots in order to increase his financial gain. In doing so, however, he does not give much thought to the amount of land needed for a septic tank system or the distance required between the septic tank and an on-site well. Usually there is insufficient land for the waste disposal system alone creating a possible contamination problem with both ground and nearby surface water.

In many states there is insufficient legislation or personnel for surveillance to control this situation. Strong lobbying tactics have prevented state health departments from gaining this jurisdiction and control over lakeside development. This control should include site inspection by state or local health authorities and the authority to require land developers to provide suitable planning for sanitary facilities so that contamination of ground and surface water will not occur.

The ideal solution would be to incorporate a sewer system into the development plan with the resulting wastewater being treated in a local municipal system. This would especially be desirable where soil conditions were not suitable for septic tanks or where existing or planned lot sizes were too small for adequate on-site disposal. This would be ideal but it is sometimes impractical since many lakeshore developments are too far from municipal sewerage systems. A possible alternative in this case would be to have the waste treated in a local package plant designed for the lakeside community.

One of the ultimate threats to a seashore recreation area is the large oil spills from oil tanker accidents or intentional dumping of flushings of leftover oil from holding tanks. With all the public interest on this subject, it is felt that tighter regulations and better spill prevention and cleanup will minimize the dangers associated with pollution from this source.

Along with the pollution of our coastal and inland waters from domestic and industrial sources, another area of growing concern is pollution from recreational and commercial boats. This pollution may result from the spillage of gas or oil, the discharge of sewage, or from rubbish or garbage being thrown overboard by "unthinking humans". In coastal areas, where boats are usually larger than those on inland water and more often have on-board toilets, the pollution of waters by sewage disposal can be a real problem. This has prompted the State of New York to enact legislation recently to prohibit the dumping of sewage, either treated or untreated, from boats into the coastal waters of New York. Their regulations require that a holding tank be installed on all boats with on-board toilets. The sewage is then to be pumped out at approved dockside facilities and treated. Their studies indicate that on-board treatment such as macerator-chlorinators is not sufficient to eliminate water pollution. The question now remains as to whether or not there will be sufficient dockside pumping and treatment facilities to handle the demand.

Under recently enacted federal legislation, the Secretary of the Department in which the Coast Guard is operating is required to promulgate federal standards of performance for marine sanitation devices which shall be designed to prevent the discharge of untreated or inadequately treated sewage to navigable waters. These standards will become effective for new vessels two years after promulgation and for existing vessels five years after promulgation.

The inland waters which usually cater to smaller pleasure boats will probably not be plagued by this problem of wastewater pollution from boats. Gas and oil pollution, either from spillage or from exhaust waste products, however, may be a consideration. This may especially be so in multi-use recreation facilities where boat launchings take place near bathing areas.

The inconsiderate dumping of solid waste materials from boats is a difficult problem to control. Stricter laws and enforcement may be part of the answer, but the solution probably lies in educating the public on the damage done by these acts and how it could so easily be prevented.

SURVEILLANCE

The surveillance and regulation of water-contact recreational areas usually falls under the jurisdiction of state or local health departments with the exception of the National Park System on the federal level. Surveillance of these areas usually takes the form of an inspection of the recreation facility by qualified personnel before the season begins. A number of bathing beach water samples are taken at that time to ascertain if the area is safe to open for the summer. Licenses are then issued to those recreational areas that pass the inspection.

Unfortunately, in most cases surveillance through the recreation season is usually limited to a somewhat spoardic bathing beach water sampling program. Due to manpower and laboratory facility shortages, it is almost impossible for state and local health departments to carry on any extensive surveillance programs throughout the summer season. This is also due to program pressures which place other responsibilities ahead of recreation facility surveillance. This is somewhat disheartening to health authorities since the latter part of the summer (July and August) brings the highest use of water contact facilities by the public. This high use could create a possible degradation of the bathing water quality especially sinc this maximum use period will often correspond with low flows in tributaries leading to the recreational waters.

It also should be recognized that not only the bathing water but also the drinking water at these recreation areas should be tested more consistently during the summer season in order to minimize the threat of waterborne disease.

STATE AND LOCAL PROGRAM NEEDS

The previous discussion on surveillance points out one of the major needs of state and local health authorities - more emphasis on surveillance throughout the recreation season. With increasing leisure time and the growing demand for water-oriented recreation, it is essential that recreation facility surveillance be made a top priority. Increased staff and laboratory facilities will be required to meet this objective for safe and healthful recreation. The proper development of new recreation areas will require the close attention of the state health departments.

A second area of need is stronger legislation for the regulation of housing developments around lakes and rivers so that pollution from on-site disposal will not occur.

HEALTH BENEFIT OF RECREATION

A monetary benefit that has not been incorporated thus far into water resources and related land use planning is the health benefit that will occur as a result of water-based recreation. As does flood control structures, improvement in water quality, and the provision of a safe and adequate source of water supply improve the health and well-being of the people, so does recreation do much to improve the mental and physical health of the participants and likewise result in an increase in productivity for the national economy.

To appreciate these benefits, one must understand certain premises of health and economics. First is the modern concept of health. The following is paraphrased from the definition from the World Health Organization:

> Health is not only the absence of disease but is also the presence of a positive cheerful outlook on life.

The second premise is the long standing objective of public health, namely the prevention of illness and death. In some ways this presents a problem to the public health worker,for the public often does not appreciate what it cannot see. The fact that a life is saved or a case of disease prevented is hard to visualize. It is also admitted that the estimating of the number of lives saved or diseases prevented by water resources planning may be a difficult taks.

Thirdly, it can be demonstrated that productivity is a function of health. Productivity is also a function of education; however, the ability to learn is also health-related. By using graphical analyses, one could show these relationships by comparing data from countries with varying levels of productivity and health. One can

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NORTH ATLANTIC REGIONAL WATER RESOURCES STUDY. APPENDIX V. HEAL--ETC(U)

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understand the relationship between productivity and health more simply by the following two statements:

1. A sick person produces and learns less than a healthy one.

2. A dead person produces and learns nothing.

It has been shown that recreation can have a direct beneficial effect on the populace by sustaining or improving health and productivity.

In view of this relationship, that there is a health benefit from a day's recreation, the next step is to quantify this benefit. Past studies have shown that by saving a life, an average dollar benefit of $120,000. is realized and by preventing one case of disease, the average value to the national economy is $2,500.. To translate this information into a dollar value toward health for a day's recreation is not an easy task. Such factors as the type of recreation involved, recreation preference, the age and background of the participating recreators, and the value of alternative forms of recreation (other than water-based) are but a few items which must be considered before making an estimate.

Preliminary estimates by this office indicate that the health benefit value to the national economy for one-man-day of recreation is on the order of $3.00 to $7.00 per day. Our office is currently working on a project to more clearly define all the factors and variables involved so that this benefit can be positively established.

When we succeed in firmly establishing the actual dollar value, the impact of this benefit on water resources planning could be substantial. It may be that we will find a significant dollar benefit accruing from water resource and related land use development which previously has gone unrecognized and uncounted.

SHELLFISH SANITATION

INTRODUCTION

Shellfish growing areas directly reflect the success or failure of water resources planning in many ways. Factors such as pollution, nutrient levels, temperature changes, salinity fluctuations, and ocean bottom characteristics which can be affected either beneficially or adversely by water resources development play important roles in the development of a harvestable shellfish product.

The shellfish that will be mainly discussed in this section are the clams, mussels, and oysters. This is not to slight the significance of the effects of water resources development on other crustacea such as lobsters, crabs, et cetera; however, the clams, mussels, and oysters are more severely affected by adverse environmental conditions than are these crustacea. The main varieties of shellfish found along the North Atlantic Coast are the soft shell clam, hard shell clam, blue mussels, and oysters, which are found in many estuaries where the salinity is lower than that of the ocean itself. The sea or surf clam grows in offshore waters with the bulk of the growing areas being within a 25-mile limit.

Why are we concerned about shellfish? Obviously, the main issue is that they are marketable products which help promote both national and local economies. If an area is closed due to pollution or other causes, this becomes a direct economic loss. From a public health standpoint, another more dangerous aspect is brought into play. The fact that these shellfish are eaten whole and many times raw offers a considerable chance for contracting disease when shellfish are taken from contaminated waters. The ability of the shellfish to concentrate the bacteria and other material from the overlying waters definitely aggravates the problem. This ability to magnify their environment around them within their own bodies is of the greatest concern to public health officials.

PROBLEMS ASSOCIATED WITH WATER RESOURCES DEVELOPMENT

There are two areas which we will consider under the Problem category which are interrelated in several ways. We have entitled these two areas "Health Aspects of Water Pollution of Shellfish Growing Areas" and "Resource Availability." The topic of resource availability may be inappropriate for a health aspects appendix; however, the pollution of an estuary can affect both the health aspects of growing areas and the resource availability from this growing area. Furthermore, should pollution continue to increase in the estuaries with a resulting closure of more areas to legal shellfish harvesting, the tendency toward more illegal harvesting to fill the demand will likewise occur. The consequences to the public's health are inescapable.

Health Aspects of Water Pollution of Shellfish Growing Areas.

The consumption of raw shellfish from polluted growing waters can bring about the transmission of any of the known waterborne diseases such as infectious hepatitis, typhoid fever, gastroenteritis, and food poisoning. This is exemplified by the infectious hepatitis outbreak of 1961 in New Jersey during which there was 186 hepatitis cases who had a history of eating raw clams in one or two restaurants, 85 of which were known to have eaten raw clams traced to growing areas in the Raritan Bay. As a result, all of Raritan Bay was closed to the taking of shellfish. This Raritan Bay area was once a leading producer of commercial and sport fish and shellfish. Under optimum water quality conditions the potential harvest of soft and hard clams alone could be on the order of abour $22,000,000 annually. It has since been determined that the "probable" source of the New Jersey outbreak of 1961 was hard shell clams which had been illegally taken from closed areas; however, because the bacteriological quality of the waters is marginal and with the potential threat to public health, the entire Raritan Bay area is still closed to the harvesting of shellfish. (10)

Resource Availability.

One of the prime functions of both the state and federal programs concerned with shellfish sanitation is to protect the shellfish resource and ensure that they continue to exist in a harvestable form. There are many factors which affect the shellfish growing capabilities of an area. These include salinity and temperature of the overlying water, the character of the ocean bottom, and the nutrient and pollutant level of the water. The nutrient and pollutant level have been included in the same phrase since in the proper amounts they can be complimentary and indeed, enhance the shellfish resource. However, too much pollution can produce an area which is incapable of supporting shellfish growth. let us also reemphasize that pollution which may not harm shellfish may cause a loss to the economy due to the area having to be closed to protect the health of consumers of shellfish.

Each of the factors previously named can be affected either beneficially or adversely by water resources development. A discussion of these effects will now be summarized.

1) Salinity - A salinity increase in growing area in an estuary can produce two main adverse effects relative to shellfish survival. The first obvious problem is that most shellfish thrive only in a certain salinity range. If salinity goes out of this range, the shellfish may die. The second factor which results from a salinity increase is an influx of predators to the shellfish

such as drills, starfish, crabs, and fish which have a higher salinity range.

This increase in salinity could be brought about by creating an impoundment on the upper reaches of streams feeding into the estuary. If fresh water is drawn from this impoundment for, drinking water, the fresh water flow to the estuary will likewise be decreased causing a movement of the salt water line further upstream. This also could come about "if the pipeline to the sea" concept were utilized where domestic and industrial wastes are diverted from the river through a pipeline to an ocean outfall. This would have the same effect in that the "fresh" water flow of the river would be decreased. On the other hand, the estuary's water quality could be tremendously improved by such a disposal system.

The salinity of an estuary could also be decreased by providing more sewage treatment systems with the treated effluent going to the streams in areas where on-site disposal methods such as septic tanks were previously practiced.

2) Ocean Bottom Characteristics - Shellfish are usually quite selective as to the type of ocean bottom that they will use as a habitat. Oysters and mussels prefer rocky bottoms whereas the clam family generally seeks a sandy environment.

Dredging in estuaries for navigation construction, or other purposes could have the greatest impact on the disruption of shellfish growing areas by changing the ocean floor characteristics. Dredging also could have an adverse effect in that silty material in suspension could travel to shellfish growing areas. This material could be taken in by the shellfish through its normal pumping action temporarily rendering the shellfish unfit for human consumption.

Dredging in upstream fresh water could also cause problems with growing areas by allowing suspended material to flow to the estuary where the settling of this material could result in the destruction of the shellfish beds since the faculty of the shellfish for moving up through the increasing layer of silt is very limited; in the case of oysters and mussels, it is impossible.

3) Temperature - If thermal effects become severe enough to be a pollutant, they could do significant harm to shellfish areas. However, temperature increases on a lower degree may have a beneficial effect on shellfish. It has been shown to a certain degree that increased temperatures can increase the growth rate of shellfish. However, there is a limit to these temperature increases and fluctuations.

Thermal power generating plants could seriously upset this delicate balance due to the large amount of cooling water that may be discharged into a water course or estuarine area.

4) Nutrients - Water resource development will probably have no significant effect on the nutrient level required by shellfish for growth. Pollution abatement may cause a decrease in estuarine nutrient levels, but this decrease would not be great enough to adversely affect shellfish growth.

5) Pollution - Pollution of an estuary can affect the resource availability of shellfish through two channels; both of which cause a loss to the shellfish market. The first occurs in grossly polluted areas where the environment is not capable of supporting shellfich growth. The second effect is the result of a smaller amount of pollution of an area where the shellfish do thrive but the bacteriological quality of the overlying water necessitates the closing of the area to harvesting in order to prevent the transmission of disease through the ingesting of raw contaminated shellfish.

There are methods available for purifying shellfish grown in moderately polluted or restricted areas. One method involves the relaying of shellfish from a restricted area to an "Approved Growing Area" and keeping the shellfish there for a sufficient lenghth of time to allow them to cleanse themselves by pumping the clean water through their bodies. A second method involves the use of a depuration plant which, in essence, is an artificial man-made environment wherein shellfish harvested from restricted areas are placed in shallow wire baskets. The baskets are then placed in tanks through which clean sea water disinfected with ultraviolet light is passed. This process increases the self-purification rate so that they can cleanse themselves of bacteria and silt in a period of 48 hours. The bacteriological and chemical quality required of a restricted area is given in the Addendum on page 18. Although these two processes would seem to lessen the need for pollution control in shellfish areas, studies have indicated that the depuration and relaying processes may not be as effective in chemical or virus removal as they are with bacterial removal.

Proper water resources planning and implementation can directly benefit the shellfish industry. The abatement of pollution in the estuaries of the North Atlantic Region could do much to bring a marketable product back into the economy; however, if development and utilization of or conversely the abuse of our water resources continues without the proper recognition of the shellfish industry in our economy and heritage, the day may not be far away when our shellfish will have to be completely grown by artificial means. The time is at hand to rectify this situation.

SOLID WASTE MANAGEMENT

On October 20, 1965, Congress passed the Solid Waste Disposal Act (Title II of Public Law 89-272). Among other things, this Act provides for grants meeting up to 50 percent of the cost to state and interstate agencies for developing comprehensive state solid waste disposal plans, and, in conjunction with the plans, for conducting surveys of solid waste disposal practices and problems.

On October 26, 1970, the Solid Water Disposal Act was amended by the Resource Recovery Act of 1970. This new bill provides for the initiation of new steps to promote demonstration projects, technical and financial assistance, and research in the field of solid waste resource recovery and recycling.

Prior to passage of the Solid Waste Disposal Act, few states had established solid waste programs although solid waste planning was becoming recognized as a desirable and necessary activity. It was also becoming evident that a thorough knowledge of solid waste conditions is a prerequisite to developing comprehensive planning programs. But because of a lack of experience and personnel, most states were unable to develop and plan the required data-gathering activity. Thus the states through the Conference of State Sanitary Engineers in July 1966, recommended that the Solid Wastes Program of the U.S. Public Health Service prepare a list of essential data and guidelines for conducting the statewide surveys. The response to this request resulted in the formation of the National Survey of Community Solid Waste Practices.

The data from this first survey have been compiled and published by the U.S. Public Health Service, Solid Waste Program - now called the Solid Waste Management Office, Environmental Protection Agency - as the "Preliminary Data Analysis, 1968 National Survey of Community Solid Waste Practices." The data are from 30 states and the District of Columbia and presented on a regional basis established by the Federal Government on a political boundary division.

States in E. P. A. Regions I and II comprise more than 80 percent of the population in the North Atlantic Study area; therefore, only data from these two Regions will be used. The states involved in this study along with their respective percent of population surveyed are: Connecticut (87.3%), Delaware (79.4%), New Jersey (40.8%), New York (58.3%), Pennsylvania (100%), and Rhode Island (24.8%). The survey included 23.1 percent of the estimated 1967 population (12,000,000) of Region I and 67.4 percent of the estimated 37,000,000 residents of Region II. Only parts of some states in Region II are within the North Atlantic Region. The data available were obtained from 1361 land disposal sites - 134 in Region I and 1227 in Region II.

Over 70% of the sites were publicly operated while only 60% were publicly owned. Approximately two-thirds were regulated by a health agency.

The general character of the landfill disposal sites, the type of waste, and the areas involved are presented in the following tables.

General Character of the Landfill Disposal Sites

Land Type	% of Sites
Quarry or borrow pit	12
Hillside	29
Gully-canyon	11
Marsh, tideland or flood plain	9
Level areas	28
Others	11

Type of Waste and % of Landfill Disposal Sites Accepting Such Waste

Type of Waste	% of Sites Accepting Specific Type of Waste
Household	93
Commercial	54
Industrial	53
Agricultural	33
Institutional	39
Incinerator Residue	3

Area of Disposal Sites

	Total Area per Site (Acres)	Land Disposal Area per Site (Acres)
Average Disposal Site	32.2	21.4

The mean anticipated life remaining for the disposal sites surveyed was found to be about 20 years. Approximately one-third of the sites provided daily soil cover as recommended for sanitary land fill operations while only 12 percent of the sites maintained records relating to the quantity of solid wastes received. Nearly 45 percent of the sites will be controlled by a public agency upon completion of site use.

Data was obtained concerning observed effects on the environment. The potential problems are presented in Table

Summary of Environmental Factors Observed at Survey Disposal Sites

Potential Environmental Problems	Percent Sites Reporting Problems
Surface Drainage	20
Leaching	17
Fill in Water Table	16

About 30 percent of the land disposal sites surveyed could be identified as true sanitary landfill operations. While this figure is twice the national average, it still indicates that potential health hazards exist from substandard disposal practices and thus surface and ground water could become contaminated.

STATE PROGRAMS

Planning for solid waste disposal in the North Atlantic Region will be all important because of the dense population corridor extending from Boston, Massachusetts, to Washington, D.C. Areas currently available as potential landfill sites will be utilized to house the increasing urban population. Possible solutions will be solid waste reduction or disposal facilities. The types of facilities to be considered include incinerators, grinders, crushers, and transfer stations. Of course, these facilities do not eliminate the problem, they merely reduce the volume of waste.

As for the regulation of the design and operation of solid waste management systems, state agencies usually have authority. The Bureau of Solid Waste Management, Public Health Service, Department of Health, Education, and Welfare, now called the Solid Waste Management Office, Environmental Protection Agency, has published a report on the status of state programs. The report is entitled, "State Solid Waste Planning Grants, Agencies, and Progress...1970." In addition, the Bureau has also published an accompanying report, "Developing a State Solid Waste Management Plan," which elaborates on the necessary components of a successful planning process and the methods for implementation of this plan. This is a helpful guide for state planners.

The following discussion is taken directly from the report, "State Solid Waste Planning Grants, Agencies, and Progress...1970," and describes the current status (1970) of the state programs in the North Atlantic Region.

Connecticut - The survey is finished and much of the data are being updated during quarterly site inspections. A special questionnaire collected more detailed information about incinerators. Twelve million dollars has been authorized for the construction of sanitary landfills and incinerators. Two important activities are operator training and public relations. "A Study of Refuse Disposal Methods in Connecticut" was published in 1968. The State plan was to be completed with the help of a consultant by June 1970.

Delaware - Survey data and other pertinent planning information were compiled in a solid waste framework study. Although it represents only 5 percent of the total state plan effort, this study will guide the solid waste planning for each of the state's three counties. Before county planning begins, however, the intent of proposed state legislation to finance these plans must be clarified. When the county plans are finished, the Board of Health will prepare a plan for administering its solid waste responsibilities.

District of Columbia - Solid waste planning activities are shared by two departments. The health department handles legislation, on-site collection and disposal, private incineration, and hospital wastes. The sanitary engineering department is responsible for other special wastes, collection, public incinerators, and disposal sites. A good waste management plan for the District of Columbia is complete.

Maine - Two surveys of statewide solid waste practices preceded the data collection work under this grant. All this information has now been compiled and analyzed. More support for proposed legislation will be fostered through a broader public relations program. Guidelines on solid waste planning will be prepared for state agencies, regional planning commissions, and municipalities. The state plan is keying on solutions to six categories of problems. The scheduled completion date was June 1970.

Maryland - The survey is finished and much of the data are updated through site inspections. This program is organized into the following three sections: technical advice and assistance, planning and program evaluation, and special studies and research. Two popular publications, a pamphlet describing the state's solid waste problems and a monthly newsletter, receive wide distribution. New legislation requires a public hearing prior to the operation of any disposal facility. A "Waste Acceptance Authority" is being considered by the 1970 legislature. Engineering students are hired for summertime work as part of the agency's career development program. A 10-year plan has already been developed. It will serve as the basis for the state's solid waste management plan, scheduled for publication in October 1970.

Maryland-Virginia Interstate - During the past decade, many studies including some about solid wastes have been made in the Metropolitan Washington area. The findings of this work endorse a system of rail hauling solid wastes to disposal sites. A strategy to implement this system is now being planned. The Metropolitan Washington Waste Management Agency, a subsidiary of the grantee, will be the operating agency for the adopted plan.

Massachusetts - This project had to be postponed for nearly 3 years until state administrative procedures were clarified. Now the solid waste survey has begun and additional delays are not expected. Recent legislation authorized the department of public works to operate disposal sites within the state. These operations must have the health department's approval.

New Hampshire - This agency applied for a solid waste planning grant, and the application is now being reviewed by the state's clearinghouse, as required by the Bureau of the Budget circular A-95. The project is expected to begin shortly.

New Jersey - The statewide survey is complete including spot field verification of some of the data. In addition, representative local comprehensive plans with solid waste data and plan elements have been collected and evaluated. Extensive public relations activities have been conducted during the project period as well. Solid waste program legislative efforts have resulted in two new acts and introduction of four additional bills now before the legislature.

Current efforts are being placed upon development of the state plan for solid waste management, which is about 40 percent complete. A systems approach is being taken in planning for New Jersey. In addition, a continual planning process system is being installed and will include a management information system to provide continual current and historic data. Once the basic planning process has been formulated, implementation guidelines will be prepared.

New York - The state has completed its statewide survey of solid waste practices. Additional data are being developed through several regional studies. Considerable interagency coordination and public information activities have been conducted as well.

New York is operating under Part 19 of the State Sanitary Code, which requires that land disposal operations be conducted as sanitary landfills.

The state plan is approximately 85 percent complete and is being developed in two phases. Phase I, sketch plan, is complete and phase II is underway. Phase II is being approached through system analysis and development of models. Mathematical models are being developed that can be applied to solid waste management throughout the state. The state is studying the solid waste problem on a regional basis. Six separate regional studies have been underway during the past two years, covering nine counties and New York City. Plan reports resulting from this statewide planning activity are designed to enhance implementation of study recommendations.

Pennsylvania - The state has completed its statewide survey, which included 100 percent of the total 2,559 political subdivisions. In addition, an industrial-agricultural survey was conducted. Significant legislation, the Pennsylvania Solid Waste Management Act (Act 241), was signed into law by the Governor on July 31, 1968. The Act is broad in its management and planning scope. A unique feature requires municipalities to submit solid waste management plan to the state for approval. Reimbursement of up to 50 percent is available to municipalities for the cost of preparing these plans. Extensive public relations and information activities have continued throughout the project. **The Pennsylvania Solid Waste Management Plan has been completed and printed.**

Rhode Island - The statewide survey has been completed and the solid waste management plan is 80 percent complete. The plan will be finished during 1970.

Legislation for a local grant-in-aid program that assists communities in establishing volume reduction and disposal facilities was passed during this program. The state's solid waste agency administers this program. Grant funds are awarded only if the community's long-range disposal plan is approved by the department of health. An incentive is offered for regional operations by increasing the state's share of the grant.

Vermont - The state survey is being rechecked to evaluate the approved sanitary landfill capacities. A full-time staff is preparing the state plan. A special Governor's Task Force recommended regional disposal sites and compacter container collection techniques. Over 80 percent of the solid waste is now going into approved disposal sites. Approval permits are issued by district environmental commissions after technical approvals are obtained and public environmental hearings are held.

Virginia - Plans for the disposal of solid wastes during the next 20 years have been prepared for 75 percent of Virginia's counties, cities, and towns. Data for this planning were obtained through the statewide survey. Regulations will not be promulgated for some time, but disposal standards have been distributed widely. A special legislative committee is studying the state's solid waste problem and will report its findings to the 1970 Assembly. A bimonthly newsletter promotes better solid waste practices to its 700 subscribers.

West Virginia - Data from the statewide survey are now being analyzed. The grantee prepared several county solid waste plans that have been implemented. A proposed solid waste law could not be accommodated by the 1970 legislature's schedule, and the bill will be resubmitted at next year's session. Public education continues to be one of this agency's most important activities. The state plan is 20 percent complete and will be finished by September 1970.

FUTURE PROBLEMS

It is anticipated that with the increase in population projected for the Region, solid waste management will be one of major concern. The total generation of solid waste will increase not only because of increasing population but also because of an expected increase in per capita generation rates. It has been estimated, on a national basis, that the amount of solid waste material to be collected through municipal and private agencies will rise to eight pounds per person per day by 1980. Using this figure and applying it to the North Atlantic Region, we could expect that over 80 million tons of solid waste material will be collected in the year 1980. Even if per capita output did not rise in the period from 1980 to 2020, we could expect, based on estimated populations, that approximately 100 million tons of solid waste would be generated in the year 2000 and about 125 million tons in the year 2020. With present disposal conditions, this would mean that by 2020, nearly 25,000 additional acres of land would be needed each year for solid waste disposal.

In looking to resolve future problems associated with solid waste material in the North Atlantic Region, some acceptable degree of control over the generation of such wastes must be developed along with methods for collection, transportation, processing, recycling, and efficient disposal of the waste. It appears that the ultimate solution to solid waste management lies in efficient physical handling procedures coupled with the recycling and reclamation of the waste materials.

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ADDENDUM

HEALTH GUIDELINES FOR WATER RESOURCES AND RELATED LAND USE MANAGEMENT

The following report entitled "Health Guidelines for Water Resource and Related Land Use Management" is herein published in a final draft form. These guidelines were initiated by the Water Supply and Sea Resources Program of the U. S. Public Health Service (now the Division of Water Hygiene of the Environmental Protection Agency) in 1967 under partial funding from the North Atlantic Regional study with the purpose of providing a useful document for guiding water resources planning from a health standpoint.

The chapters included in this report are as follows:

CHAPTER I - PUBLIC WATER SUPPLY SYSTEMS

In the PHS Drinking Water Standards(1), a water supply is defined to include "the works and auxiliaries for collection, treatment, storage, and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer." A public water supply system is intended to furnish water for drinking, food processing, or other intimate human uses as well as for a variety of commercial, industrial, municipal, and other uses.

The exact definition of a public water supply system differs from State to State, varying as to the number of families or customers served, but for purposes of this document, includes the idea of service to a community and/or the availability of the system for service to the general public.

The protection and safety of a public water supply system depends upon the sanitary environment, quality and quantity of source waters, the effectiveness and reliability of treatment processes, the integrity and capacity of storage and distribution systems, quality control surveillance, and the qualifications and effectiveness of the operating personnel. Details regarding the sanitary maintenance and evaluation for all aspects of public water supply systems is covered in the Manual for Evaluating Public Drinking Water Supplies.(2)

DRINKING WATER AND HEALTH

Provision of adequate quantities of safe water for drinking and other human uses is important to the public health both because contaminated water can produce disease and illness and because the ready availability of safe water can stimulate better personal hygiene thereby resulting in improved health.

The association of health and water is usually connected with massive outbreaks of typhoid fever and other waterborne diseases which occurred over 50 years ago in the United States and Western countries but have since been largely eliminated by improved water treatment and supply practices. However, it is seldom realized that disease outbreaks still stem from contaminated drinking water; from 1946 to 1960, 228 outbreaks of disease or poisoning with 25,984 cases were attributed to drinking water.(3) Additionally, a variety of significant outbreaks affecting thousands of people have occurred more recently, including ill health from hepatitis,(4) salmonellosis,(5) and gastroenteritis.(6) These outbreaks have been associated with breakdowns both in distribution and treatment processes.

The availability of safe water and modern sanitary facilities in individual homes facilitates good personal hygiene practices and is

(1) Reference numbers refer to bibliography at the end of each respective chapter.

accepted as a key feature of modern life. However, many disadvantaged persons in cities, small towns, and rural areas still do not have adequate supplies of safe water and needed sanitary facilities in their homes. A recent study of American Indian communities has shown that the provision of safe water supply and sanitary facilities in the home reduced the incidence of selected diseases.(7)

RELATION OF PUBLIC WATER SUPPLY SYSTEMS TO WATER RESOURCES DEVELOPMENT

The planning and development of reservoir projects should include consideration not only of the quantity needs of municipalities for water, but also the quality aspects. The effect of all water resource developments upon existing public water supplies should also be considered, especially where the effect may be negative.

In choosing between waters of differing quality, preference should be given to the use of the higher quality water for municipal and drinking purposes. Quality considerations should include a sanitary survey and analysis of the involved watershed, an evaluation of raw water quality and an analysis of trends and forecasts regarding future raw water quality and its relationship to planned water pollution control efforts.

The sanitary survey and analysis of the watershed should be performed by sanitary engineers or other public health specialists and should include examination and evaluation of all existing or potential public health hazards and sources of contamination. Elements to considered in the survey would include:

1. Possible development and activity on the watershed and possible means for control thereof, such as: residential, industrial, recreation, etc. development; and plans for zoning controls and proposed ownership of the watershed lands, particularly adjacent to the reservoir.

2. Major sources of natural contamination including animals, drainage from swamps, bogs, and mineral deposits, and silt from soil erosion.

3. Major sources of man-made contamination including industrial, farm, municipal, and individual home sources.

The determination of raw water quality is frequently difficult because of lack of data on elements important to drinking water quality, variable conditions in the stream which may cause temporal changes in quality and uncertainty with regard to the effects of impoundment on the water quality. (8) Sampling and analysis of a stream should be planned to include the bacterial, chemical, physical, and radiochemical measures which are important to drinking water quality and should be of such frequency and timing as to give an accurate portrayal of the stream's water quality. Samples should be analyzed by methods described in Standard Methods for the Examination of Water and Wastewater(9) or by comparably recognized techniques.

Water pollution and river basin authorities should be contacted with regard to trends in contaminant levels and forecasts for the future. Such an analysis could indicate that current problems may be solved prior to the time that stored water would be used for municipal purposes or that new problems would require new attention and solutions.

RAW WATER QUALITY AND TREATMENT

The quality of the source waters will determine the treatment processes required to produce a water that meets the PHS Drinking Water Standards. High water quality may require minimal treatment whereas low quality water may require extensive treatment to produce a potable water. In the economic analysis of reservoir projects consideration should be given to the costs of water treatment in evaluating alternate means for providing municipal water supply. Municipal supply intakes should be constructed with multi-level inlets so that, where stratification occurs, the best quality water can be taken into the system; or provision should be made for mixing so as to prevent stratification.

In the past many drinking water supplies from protected well sources have been served to customers without any treatment. However, instances of back-siphonage and contamination in distribution sytems together with related disease outbreaks, have demonstrated the need for maintaining residual levels of a disinfectant, usually chlorine, throughout the system. Consequently, the minimum recommended treatment for all public water supply systems is disinfection.

Guides herein are for raw water quality which is to be given two categories of treatment, "Disinfection Only" and "Conventional Treatment." However, it is also recognized that certain waters will require intermediate degrees of treatment between "Disinfection Only" and "Conventional Treatment" and that others will require an advanced level of treatment beyond "Conventional Treatment."

A. Disinfection **Only**

Where ground waters are subject to only low levels of contamination, treatment no greater than disinfection may be adequate.

The raw water quality considered satisfactory for this degree of treatment should meet the following requirements:

1. Bacteriological:

a. Coliform Group - Less than 100/100 ml as measured by a monthly arithmetic mean.

b. Fecal Coliform: If fecal coliform density is measured, the above total coliform density may be exceeded, but fecal coliform density should not exceed 20/100 ml as measured by a monthly arithmetic mean.

2. Physical:

Should meet Public Health Service Drinking Water Standards, including limits as follows:

Turbidity	5 units
Color	15 units
Threshold Odor Number	3

3. Chemical:

Chemicals present should not exceed the following concentrations:

Substance		Concentration (mg/l)
Arsenic (As)		0.01
Barium (Ba)		1
Boron (B)		1
Cadmium (Cd)		0.01
Carbon Chloroform Extract (CCE)		0.2
Chloride (Cl)		250
Chromium (hexavalent, Cr^{+6})		0.05
Copper (Cu)		1
Cyanide (CN)		0.01
Detergents (Methylene Blue Active Substances)		0.5
Fluoride (F)		
50.0-53.7°F	Annual average of maximum daily air temperatures	1.7
53.8-58.3°F		1.5
58.4-63.8°F		1.3
63.9-70.6°F		1.2
70.7-79.2°F		1.0
79.3-90.5°F		0.8
Iron (Fe)		0.3
Lead (Pb)		0.05
Manganese (Mn)		0.05
Mercury (Hg)		0.005
Nitrogen (Nitrate + Nitrite) as N		10
Phenols		0.001
Selenium (Se)		0.01

Substance	Concentration (mg/l)
Silver (Ag)	0.05
Sulfate (SO_4)	250
Total Dissolved Solids	500
Uranyl ion (UO_2^{++})	5
Zinc (Zn)	5

4. Radioactivity:

Should meet the Public Health Service Drinking Water Standards including the following:

a. Radium-226 ---------------------------- 3 μμc/liter

Strontium-90 --------------------------10 μμc/liter

(When these concentrations are exceeded, the water will still be acceptable if surveillance of total intakes of radioactivity from all sources indicates that such intakes are within the limits recommended by the Federal Radiation Council for control action.)

b. In the absence of Strontium-90 and alpha emitters:

Gross beta concentrations --- 1000 μμc/ liter

(When these concentrations are exceeded, the water will be acceptable if more complete analysis indicates that concentrations of nuclides are not likely to cause exposures greater than the Radiation Protection Guides as approved by the President on recommendation of the Federal Radiation Council.)

5. Pesticides:

Should not exceed the following limits:

Pesticide	Maximum Permissible Concentration (mg/l)
Endrin	0.003
Aldrin*	0.01
Dieldrin*	0.01
Lindane	0.1
Toxaphene	0.1
Heptachlor **	0.02
Heptachlor Epoxide **	0.02
DDT	0.1

Pesticide	Maximum Permissible Concentration (mg/l)
Chlordane	0.01
Methoxychlor	0.5
Total Organophosphorous and Carbamate Compounds (expressed in terms of Parathion Equivalent Cholinesterase inhibitions)	0.1
2,4,5-TP	0.2
2,4-D	1.0

*The concentration of aldrin and dieldrin in combination should not exceed 0.01 mg/l.

**The concentration of heptachlor and heptachlor epoxide in combination should not exceed 0.02 mg/l.

Disinfection will normally be accomplished by chlorination with a minimum residual to be maintained in distant parts of the distribution system of 0.1 - 0.2 milligrams per liter for free chlorine or 1.0 milligram per liter for chloramines. The Manual for Evaluating Public Drinking Water Supplies gives details regarding chlorination and regarding other types of disinfection treatment.

B. Intermediate Treatment

Many surface waters are of such a degree of purity as usually to meet the recommended guide limits for "Disinfection Only". Such waters would be derived from grassy, wooded terrain including little swamp land or land which is exposed or under cultivation. When adequate storage is provided in reservoirs and strict control of contamination is practiced on the catchment and storage areas, a high quality raw water can usually be obtained.

However, all surface waters are subject to temporary deterioration in quality through increased levels of turbidity, algae growths, and miscellaneous contaminants. Such contaminants will hinder the effectiveness of disinfection treatment and may reduce the aesthetic properties of the water for drinking purposes. All surface waters, therefore, should receive some degree of treatment more extnesive than "Disinfection Only."

Where surface waters meet or come close to meeting the recommended guide limits for "Disinfection Only", they should be given a degree of intermediate treatment such as flocculation, sedimentation, or filtration or some combination of such treatments.

Some ground waters may contain chemicals or other substances which are removable by less than "Conventional Treatment;" these should be given an intermediate degree of treatment appropriate to the raw water quality problem involved. In any case the objective of the treatment will be to provide continuously an adequate quantity of safe water, meeting the Public Health Service Drinking Water Standards.

C. Conventional Treatment

Waters which are too contaminated for treatment by intermediate means will require conventional treatment. This higher degree of treatment is defined to mean pre-disinfection, coagulation, sedimentation, rapid granular filtration, and post-disinfection.

Even though conventional treatment is to be provided, every effort should be made to prevent and control contamination of the raw water source. Where recreational use is permitted on a reservoir, such use should be accompanied by sanitary controls and should be prohibited in a restricted area surrounding the water supply intake. The design of water treatment plants will vary with local circumstances and should be based on quality problems in the water to be treated.

The raw water quality considered satisfactory for conventional treatment should (in addition to meeting the applicable State Water Quality Standards) meet the following"

1. Bacteriological:

   a. Total Coliform Density: Less than 20,000/100 ml as measured by a monthly geometric mean, or

   b. Fecal Coliform Density: If fecal coliform is measured, the above total coliform density may be exceeded but fecal coliform should not exceed 4,000/100 ml as measured by a monthly geometric mean.

2. Physical:

   Elements of Color, Odor, and Turbidity contribute significantly to the treatability and potability of the water.

   Color --------------- 75 units

   (This limit applies only to non-industrial sources; industrial concentrations of color should be handled on a case-by-case basis and should not exceed levels which are treatable by conventional means.

   Threshold Odor Number ---------- 5
   Turbidity --------------------- Variable

   (Factors of nature, size, and electrical charge for the different particles causing turbidity require a variable limit. Turbidity should remain within a range which is readily treatable by complete means; it should not overload the water treatment works; and it should not change rapidly either in nature or in connection where such rapid shifts would upset normal treatment operations.

3. Chemical:

Since conventional treatment generally produces little reduction in chemical constituents, raw water should meet the limits given for "Disinfection Only".

4. Radioactivity:

Should meet requirements for radioactivity as shown for "Disinfection Only".

5. Pesticides:

Should meet requirements for pesticides as shown for "Disinfection Only"

D. Advanced Treatment

Water of poorer quality (but not sewage) should receive advanced treatment as determined by the user's engineer or consultant and should only be used if no raw water supply of better quality is available. The treated water should continuously meet limits of the Public Health Service Drinking Water Standards unless an exception, related to potability and aesthetic properties, is approved by the State agency responsible for public water supply systems. Additional measurements for constituents, not covered in the PHS Drinking Water Standards, may be necessary under these circumstances.

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CHAPTER II - IRRIGATION WITH SEWAGE TREATMENT PLANT EFFLUENT

The use of effluents from municipal sewage treatment facilities in irrigation has long been practiced. Sewage "farming" in the United States began in the late 19th century in Wyoming, Colorado, California, Utah, and Montana. At the present time, extensive sewage farming is done in the arid western states. Because water availability is critical, little attention is given to the bacteriological quality of the water supply. In water-short areas, available streams are subjected to sewage discharges from small communities, cattle feed lot drainage, infrequent stormwater runoff, and return irrigation water. Since the streams are frequently small, these pollution discharges quickly exceed the normal self-purification capacity of the stream and extend the zone of potential health hazard downstream to other water users, generally farmers dependent upon irrigation water. To prevent disease transmission, the use of raw, settled, or undisinfected sewage has been prohibited on vegetables grown for direct human consumption (produce) in most of the States.

Past experience with unrestricted sewage irrigation has demonstrated that disease outbreaks and worm infestations can be caused by contaminated vegetables and fruits. Today, health department restrictions, low levels of population infection, and curative medicine have practically eliminated disease or worm infestations from food contaminated by irrigation practices in the United States. This does not mean, however, that no threat exists from this source. Irrigation will play an important role in providing the higher food production necessary with an expanding population. As more acreage is developed for irrigation, the demand for water will increase, but the quality of water available will often be poor because of greater reuse.

It is well established that disease-causing bacteria, viruses, protozoa, worms, and fungi are found in fecal material, sewage, and sewage polluted water; consequently, they may contaminate the soil and crops with which they come in contact. Animal as well as human wastes are implicated because many species of pathogens can infect both man and animals. The consumption of uncooked foods contaminated with fecal material may cause the spread of disease in livestock as well as human beings. Microorganisms known to be pathogenic for plants can also be isolated from polluted irrigation water, but the role that water and sewage play in plant disease transmission is not yet completely understood.

The diseases most frequently linked with fecal contamination are typhoid and paratyphoid fevers, Salmonella gastroenteritis, bacillary dysentery, cholera, leptospirosis, infectious hepatitis, viral gastroenteritis, and amoebic dysentery. Typhoid fever, cholera, and amoebic dysentery are now practically nonexistent in this country because of effective sanitation and water treatment practices. Less common diseases associated with irrigation agriculture are brucellosis, tuberculosis, tularemia, swine erysipelas, coccidiosis, ascariasis, cysticercosis, fascioliasis, schistosomiasis, and hookworm and tapeworm infections. Although the route of infection is usually by ingestion, larvae of hookworms and flukes can enter the body directly through the skin.

The only reliable means for preventing exposure of the public from contaminated produce is prevention of such contamination from occurring. This has been achieved in the past by health department regulations prohibiting the use of night soil and municipal sewage for the irrigation of produce. Improvements in sewage treatment practice and the application of secondary treatment on a wide scale have prompted efforts to obtain approval of the use of treated waters for unlimited irrigation. Health authorities are generally reluctant to accept such use due to the hazards associated with the source of the waters, the unknown factors of pathogen survival, and the inconsistency associated with many treatment plant operators. The conservative approach adopted in these guidelines will generally assure a safe use of the subject water.

The selection of agricultural irrigation water sources should not be based principally on the availability of the water supply, but should also take into full consideration the bacteriological and chemical quality of the water. The scarcity of water supplies of acceptable quality in irrigation areas is fully recognized. Unfortunately, surface waters in arid and semi-arid regions are often small streams with disproportionately large pollutional additions from domestic wastes, sugar beet lagoon discharges, feedlot drainage, and irrigation returns. These additions of low quality water bring varying numbers of pathogenic organisms to irrigation waters and ultimately in contact with field crops. Practical reduction of the public health hazard can be accomplished only through a concept of multiple safeguards designed to prevent raw plant food from contact with and retention of pathogens.

Enforcement of the bacteriological quality guidelines for irrigation water, 1,000 fecal coliforms per 100 ml, recommended by the National Technical Advisory Committee on Water Quality Criteria should result in reduced exposure of raw plant foods to pathogens. Data correlating fecal coliform levels to Salmonella occurrence indicate that the proposed standard is realistic, providing the safeguard measures and sanitary practices described are observed along with the use of water of this quality. The standard represents the best scientific information presently available. Further refinement of the fecal coliform limits for irrigation water awaits additional microbiological and epidemiological studies. Standards have as their primary objective the protection of public health, but may also recognize the importance of multiple use in water-short areas, and take into account the specific uses for which the water is needed. The fecal coliform level suggested is attainable only at a cost of adequate waste treatment by all stream users.

For special cases, when environmental conditions are hospitable to pathogens, and/or time of exposure to hostile conditions is short, the local or State health departments should make an appropriate determination regarding the water quality to be used for irrigation.

Because receiving streams may be small and of lesser volume than the sewage effluent, secondary treatment and disinfection of domestic sewages are necessary to ensure substantial reductions of pathogens in irrigation waters. Wastes from food processing plants, meat packing plants and sugar beet mills, and runoff from cattle feedlots should be diverted to lagoons and held for 20 to 30 days to reduce the number of pathogens prior to discharge.

The method of water application influences the amount of fecal contamination to which farm crops are exposed. Flooding, spraying, sub-irrigation, and furrow irrigation are used in various agricultural communities. Waters which are not of potable quality should be applied to crops which may be consumed raw by furrow or sub-irrigation to limit contacts of the disease-causing microorganisms with plant surfaces. The use of primary effluent for spray irrigation is not acceptable.

As a further safeguard against exposure to pathogens and their survival on raw plant foods, farm management of irrigation water should include a program of selective application based on the bacteriological quality of available water. Irrigation water from nearby sources could be applied during the various stages of cultivation but should be discontinued four weeks prior to harvest to further diminish the risk from waterborne pathogens. Water applied after this period should be derived from ground water supplies or farm holding ponds.

Preparation of fruits and vegetables at harvest time includes fresh water rinses to remove soil particles and to maintain the quality of leafy vegetables. From harvest to consumption, all water applied to clean and to freshen raw produce must be of drinking water quality. This water should be applied in a continuously flowing stream or spray with no recirculation of spent water through the system.

Equally important as the water quality are the sanitation practices of the farm laborers who cultivate and harvest the crops and of the produce workers who repackage these perishables for market. Adequate toilet and washing facilities should be provided for both. Every effort should be made to instruct the personnel in principles of hygiene for their own protection and for improvement of the produce. Farm workers must be made aware of the potential dangers of acquiring or spreading disease when working near animals and animal wastes as well as polluted water and soil. Recurring leptospirosis outbreaks in agricultural areas of Israel emphasize some of the hazards associated with irrigation agriculture. In many areas, agricultural workers are in contact with water far exceeding approved bacteriological limits for recreational waters.

MINIMUM RECOMMENDED GUIDELINES FOR USE OF SEWAGE EFFLUENTS FOR IRRIGATION

The practice of irrigation of agricultural crops with sewage effluents raises a number of health questions concerning the bacterial water quality to be used and with regard to vector control. The factors relating to mosquito and other vector problems are primarily those of hydraulics and drainage. These factors are discussed under Chapter V, Vector Control, of this guideline. Recommended water quality criteria for polluted stream waters used for irrigation are presented and adequately discussed in the "Report of the Committee on Water Quality" published by the Department of the Interior and are therefore not covered here.

The recommended guidelines presented below are considered to be the minimum for the direct use of sewage or treated sewage for irrigation. Local and state regulations regarding this usage should be followed if more stringent than these recommendations.

A. Irrigation with Raw Sewage

Raw sewage should not be used for irrigation.

B. Irrigation with Effluent

1. The sewage to be used for irrigation should be treated by stabilization ponds, in series, having a minimum detention period of 20 days with a recommended detention of 30 days or by a minimum of secondary sewage treatment and disinfection.

2. After being treated, the effluent should meet effluent standards or other requirements as established by the State or other agency having jurisdiction for water pollution control but in no case should the bacterial quality exceed 1,000 fecal coliforms per 100 ml.

C. Precautions to be taken before irrigation

Before irrigation with effluent is carried out, the following precautions should be taken:

1. The areas to be irrigated should be clearly designated with signs warning in clear and visible letters that sewage effluent irrigation is being carried out.

2. The pipe network for this effluent irrigation should be completely disconnected from any potable water supply network.

3. All necessary steps should be taken to prevent mosquito and fly breeding in the area to be irrigated.

4. All necessary steps should be taken to prevent the dissemination of odors which may reach residential areas, recreation areas, or other areas in which the public is likely to be present.

5. No spray irrigation with effluent should be carried out less than 200 yards from a residential area or 50 yards from a road.

6. Ridge and furrow irrigation with effluent may be carried out if the distance to residential areas is greater than 100 yards and the distance to roads is greater than 25 yards.

D. Crop limitations for irrigation with effluent

1. Those crops which may be consumed raw and pasture lands should not be irrigated with sewage effluents.

2. Those crops normally eaten cooked or having an outer peel or husk which is normally removed and discarded, crops for industrial use and not used for human consumption, nursery trees, and fodder crops for harvesting may be irrigated with sewage effluent.

E. Irrigation of lawns with effluent

Effluent should be used to irrigate lawns only where the lawns are closed to the public when the effluent is being applied and while the irrigated lawns remain wet from the effluent application.

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CHAPTER III - SHELLFISH GROWING AND HARVESTING WATERS

In the production of shellfish for direct market harvesting, the quality of waters over the shellfish growing areas is of public health importance due to the ability of shellfish to concentrate bacteriological, radiological, or chemical pollutants. The waters of areas approved for the direct market harvesting of shellfish must be free of potentially harmful concentrations of pathogenic micro-organisms, radionuclides, heavy metals, pesticides, other potentially toxic organic compounds, and marine toxins.

Sanitary control of shellfish in the United States is conducted through the National Shellfish Sanitation Program, a cooperative enterprise with participation by the Public Health Service, State control agencies, and the shellfish industry. The participants jointly have developed sanitation guidelines for the sanitary control of shellfish growing areas and for harvesting and processing. These guidelines, titled the National Shellfish Sanitation Manual of Operations(1), are revised and amended periodically at National Shellfish Sanitation Workshops. Interim revisions may be made through joint action of the participants in the program. Currently, the program is coordinated by the Shellfish Sanitation Branch, Division of Sanitation Control, Bureau of Foods and Pesticides, U. S. Food and Drug Administration.

CLASSIFICATION OF GROWING AREAS

The sanitary quality of a shellfish growing area is determined by a sanitary survey which includes:

1. A reconnaissance of the watershed to locate and quantify the sources of domestic and industrial pollution that may potentially affect the quality of the growing area.

2. Hydrographic surveys, supported by bacteriological and chemical analyses to determine the course and fate of the pollutants and the residual levels of pollutants in the water over the shellfish beds and the shellfish meats.

Based on the findings of these surveys, the shellfish area is classified into one of four categories, defined in detail in the Manual of Operations, Part I - Sanitation of Shellfish Growing Areas. The following is an abstract of the manual requirements for these four categories:

Approved Areas

Growing areas may be designated as approved when (a) the sanitary survey indicates that pathogenic microorganisms, radionuclides, and/or harmful industrial wastes do not reach the areas in dangerous concentrations, and (b) this is verified by laboratory findings whenever the sanitary survey indicates the need. Shellfish may be taken from such areas for direct marketing.

Satisfactory Compliance - This item will be satisfied when the following criteria are met:

1. The area is not so contaminated with fecal material that consumption of the shellfish might be hazardous, and

2. The area is not so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous, and

3. The median coliform MPN of the water does not exceed 70/100 ml, and not more than 10 percent of the samples ordinarily exceed an MPN of 230/100 ml for a 5-tube decimal dilution (or 330/100 ml, where the 3-tube decimal dilution is used) in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

The MPN values are based on an assumed normal ratio of coliforms to pathogens and would not be applicable to any situation in which an abnormal ratio of coliforms to pathogens might be present. Consideration must also be given to the possible presence of industrial or agricultural wastes in which there is an abnormal coliform to pathogen ratio.

Conditionally Approved Areas

The suitability of some areas for harvesting shellfish for direct marketing is dependent upon the attainment of an established performance standard by sewage treatment works discharging effluent directly or indirectly to the area. In other cases, the sanitary quality of the area may be affected by seasonal population increases, runoff from farm lands, or sporadic use of a dock or harbor facility. When not adversely affected by these factors, such areas may be classified as conditionally approved.

State shellfish control agencies shall establish conditionally approved areas only when satisfied that (a) all necessary measures have been taken to insure that performance standards will be met and (b) that precautions have been taken to assure that shellfish will not be marketed from the areas subsequent to any failure to meet performance standards and before the shellfish can purify themselves of polluting microorganisms or chemical pollutants.

Satisfactory Compliance - For information on satisfactory compliance specifications for this classification, the National Shellfish Sanitation Manual of Operations, Part I, should be consulted.

Restricted Area

An area may be classified as restricted when a sanitary survey indicates a degree of pollution which would make it unsafe to harvest the shellfish for direct marketing. Alternatively, the states may classify such areas as prohibited. Shellfish from such areas may be marketed after purification or relaying as provided for in Section D of the Manual.

Satisfactory Compliance - This item will be satisfied when the following water quality criteria are met in areas designated by the states as restricted:

1. The area is so contaminated with fecal materials that direct consumption of the shellfish might be hazardous, but

2. The area is not so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous, and

3. The coliform median MPN of the water does not exceed 700/100 ml and not more than 10 percent of the samples exceed an MPN of 2300/100 ml in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

4. Shellfish from restricted areas are not marketed without controlled purification or relaying.

Prohibited Areas

An area shall be classified prohibited if the sanitary survey indicates that dangerous numbers of pathogenic microorganisms might reach an area. The taking of shellfish from such areas for direct marketing shall be carefully prohibited. Relaying or other salvage operations shall be carefully supervised to insure against polluted shellfish entering trade channels. Actual and potential growing areas which have not been subjected to sanitary surveys shall automatically be classified as prohibited.

Satisfactory Compliance - This item will be satisfied when:

1. An area is classified as prohibited if a sanitary survey

indicates either of the following degrees of pollution:

a. The area is so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous, and/or

b. The median coliform MPN of the water exceeds 700/100 ml or more than 10 percent of the samples have a coliform MPN in excess of 2300/100 ml.

2. No market shellfish are taken from prohibited areas except by special permit as described in Section D of the Manual.

3. Coastal areas in which sanitary surveys have not been made shall be automatically classified as prohibited.

RADIOACTIVITY

Radioactive wastes entering the water environment constitute a potential hazard to humans through consumption of shellfish which have taken up the radioactive material from the water. The principal potential sources of such materials are the liquid waste discharges from nuclear energy applications such as nuclear power ships or nuclear power plants. Radioactive wastes from these sources may be discharged into shellfish waters at concentrations not exceeding the applicable standards(2) (or comparable State regulations). Due to the accumulation of radionuclides in aquatic food chains (3)(4), it is possible, however, for certain radionuclides to be present in edible portions of human food organisms in quantities sufficient to be of public health concern, even though the concentrations of the radionuclides in water are within permissible limits according to these standards.

The radionuclides of public health significance which may be found in shellfish include the following:

1. Fission products which include radioisotopes of zirconium, ruthenium, iodine, cerium, and strontium.

2. Activation products which include radioisotopes of chromium, manganese, iron, cobalt, copper, and zinc.

A proposed Appendix C, "Interim Guidelines for Radionuclides for Shellfish" was adopted at the 1968 National Shellfish Sanitation Workshop.(5) This document should be consulted for details of surveillance methods and recommended limits of radionuclides in shellfish. Table I presents a list of selected controlling radionuclides and the recommended guide for radioactivity in shellfish for an assumed intake of 50 grams per day. If the concentration of any single nuclide in shellfish reaches the recommended guide value, the shellfish should be released for public consumption only after a comprehensive evaluation of the dose to the exposed population from all environmental sources shows that the Federal Radiation Council's Radiation Protection Guides(6) will not be exceeded. If more than one nuclide is present in significant amounts, an additional evaluation must be performed as shown in the "Interim Guidelines for Radionuclides in Shellfish."(5)

Table I - Recommended Guides for Selected Radionuclides

Selected Radio-nuclide	Maximum Permissable Concentration $(MPC)_w$(a) uCi/cc x10^{-4}	Maximum Permissable Radioactivity intake uCi/day	Radiological Guide for Radioactivity in Shellfish (Assuming a 50 g day intake) uCi/g
^{51}Cr	6.67	1.47	0.03
^{54}Mn	0.333	0.0733	0.001
^{58}Co	0.333	0.0733	0.001
^{59}Fe	0.2	0.044	0.0009
^{60}Co	0.167	0.0367	0.0007
^{64}Cu	1.0	0.22	0.004
^{65}Zn	0.333	0.0733	0.001
^{90}Sr	—	0.0002	0.000004
^{95}Zr	0.2	0.044	0.0009
^{103}Ru	0.267	0.0587	0.001
^{106}Ru	0.0333	0.00733	0.0001
^{131}I	—	0.0001	0.000002
^{144}Ce	0.0333	0.00723	0.0001

a. $(MPC)_w$ for 168-hour week multiplied by a factor of 1/30 for exposure of the general population.

From the standpoint of public health, radionuclide levels in shellfish cannot be the only source of radionuclides considered. The basic approach specified by the Federal Radiation Council is to limit total intake of radionuclides from all sources so that Radiation

Protection Guides are not exceeded. Under circumstances in which the concentrations in shellfish remain well below the guideline values, there is no need for public health concern from this vector. If the concentration approach or exceed the guidelines, the public health significance must be evaluated in the context of radionuclide intake from all sources so that the total exposure does not exceed the Radiation Protection Guides.

Control of population exposure from radionuclides occurring in the environment is accomplished either by restriction of the entry of radionuclides into the environment or through measures designed to limit the intake of radionuclides by individuals. Both modes of control involve the consideration of actual or potential concentrations of radioactivity in water or food (shellfish). Controls should be based upon an evaluation of population exposure with regard to the radiological guides. Annual averaging of the daily radioactivity intake via shellfish consumption is sppropriate, except for the special case of accidental release or discharge of major significance.

TRACE METALS

The capacity of shellfish to concentrate certain metals up to many hundreds of times those levels found in their environment means that molluscs exposed to pollution may contain quantities of such metals that might produce toxicities in the human consumer.(7) The human hazard presented by the accumulation of toxic chemicals by shellfish is illustrated by the well-known Minimata disease outbreaks in Japan. (8)(9) Sanitary surveys of shellfish growing areas must include identification of potential sources of pollution containing these metals, supplemented by hydrographic studies and analyses of water and shellfish meats to assure that harmful quantities of these agents do not reach the growing area.

Trace metals are among the most common inorganic wastes. Typical trade wastes such as those from copper plating, copper pickling, and cuprammonium rayon manufacture contribute the greatest amounts of copper to streams and other water bodies. Cadmium occurs as an impurity in zinc-lead ores in phosphate deposits. It is used to alloy with copper, lead, silver, aluminum, and nickel and in electroplating, ceramics, pigmentation, photography, and nuclear reactors. Organic mercury compounds are used in herbicides, fungicides, medicines, slime control in paper mills, and in various chemical processes. Small quantities of methyl mercury continuously discharged from a factory during the production of acetaldehyde was considered to be the causative agent of Minimata disease.

Most trace metals either are not significantly accumulated by shellfish or kill the shellfish before levels hazardous to humans can be accumulated. To date six exceptions to this rule have been determined. Certain shellfish species are known to be capable of accumulating zinc, copper, cadmium, mercury, lead, and chromium in sufficient quantity to pose health hazards to human beings.

Recent studies in estuaries and in controlled laboratory experiments lead to the following general conclusions on trace metals accumulation by shellfish:

1. Each species has a different pattern of accumulation of specific metals.

2. A seasonal cycle for trace metals levels in shellfish may be expected.

3. Levels of the metals in the overlying water cannot accurately be determined on the basis of the levels in shellfish; they might have been high in the water for a short period of time, or low for a long period of time.

4. The rate of depletion of metals by shellfish is slow, sometimes requiring many months. Because of this, the depuration process, applicable to the removal of bacteria from shellfish is not feasible for the cleansing of shellfish contaminated with metals.

Tolerance limits for metals in shellfish which would protect the human consumer have been the subject of studies. However, the 1968 Shellfish Sanitation Workshop, in discussing a proposed guideline recommended that inclusion of Guides for Trace Metals in Shellfish in Part I of the manual be deferred.(10) In recommending this action, it was the opinion expressed at the workshop that overall knowledge of trace metals in shellfish is insufficient to warrant such guidelines, but surely indicates potential problems.

PESTICIDES

Pesticides reach shellfish growing areas from many sources, including sewage and industrial waste discharge, runoff from land used for agriculture and forestry, the use of herbicides for the control of aquatic vegetation, and the use of pesticides for the control of shellfish predators. Shellfish rapidly accumulate pesticides and herbicides, often to a concentration which is toxic to the molluscs. Surveys of the pesticides content of shellfish in several estuaries in the United States have shown that, in general, the pesticide levels are low; but in certain isolated instances, the concentrations approached those that might be considered hazardous.

The National Shellfish Sanitation Program has adopted guidelines for concentrations of certain pesticides in shellfish.(11) Limits for other pesticides will be included as additional research findings are obtained. The Recommended Guidelines are shown in Table 2.

Table 2
Recommended Guidelines for Pesticide Levels in Shellfish

Pesticide	Concentration in Shellfish (ppm - drained weight)
Aldrin*	0.20
BHC	0.20
Chlordane	0.03
DDT) DDE) ANY ONE OR ALL, NOT TO EXCEED DDD)	1.50
Dieldrin*	0.20
Endrin*	0.20
Heptachlor*	0.20
Heptachlor Epoxide*	0.20
Lindane	0.20
Methoxychlor	0.20
2,4-D	0.50

* It is recommended that if the combined values obtained for Aldrin, Dieldrin, Endrin, Heptachlor, and Heptachlor Epoxide exceed 0.20 ppm, such values be considered as "alert" levels which indicate the need for increased sampling until results indicate the levels are receding. It is further recommended that when the combined values for the above five pesticides reach the 0.25 ppm level, the areas be closed until it can be demonstrated that the levels are receding.

MARINE BIOTOXINS

Paralytic shellfish poison (PSP, also called Saxitoxin) is produced in certain marine dinoflagellates used as food by shellfish. The toxin, released during digestion by molluscs, is assimilated and migrates to certain specific tissues varying with the species of shellfish. The toxin is retained by the shellfish in concentrations many times greater than it exists in the water. PSP is found in the West Coast areas of the United States, Canada, and Alaska. It also occurs in the Bay of Fundy and the St. Lawrence estuaries on the East Coast. In some areas it occurs seasonally; in other areas, notably Alaska and Canada, it is found during the entire year. The Manual recommends that if the PSP content reaches a level of 80 micrograms per 100 grams of the edible portions of raw shellfish, the area shall be closed to the taking of those edible species of shellfish subject to these toxins.

Another marine biotoxin has been found in shellfish on the Gulf Coast. The occurrence of this toxin in shellfish has been associated with blooms of the dinoflagellate, Gymnodinium breve. Quantitative standards criteria have not been developed to date for this biotoxin in water or shellfish, but State shellfish sanitation control authorities may elect to close shellfish areas to harvesters if the presence of this toxin is detected in shellfish.

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CHAPTER IV - RECREATION AREA DEVELOPMENT

This guideline has been prepared for the use of planners and others interested in water and related land use development. It is intended to serve as an introduction to the factors of concern to health authorities in the development of recreation areas. Winter sports are not considered. Material in PHS Publication No. 1195, Environmental Health Practice in Recreational Areas (1) was heavily used in the preparation of this chapter. This manual should be consulted for additional details.

In many instances the planning, provision, and maintenance of facilities in recreation areas have not kept pace with the rapidly increasing visitor load. As a result optimum use of such areas is not possible and deterioration of overtaxed facilities is frequently encountered. Where facilities such as water supply, sewage disposal, and solid waste handling are inadequate or lacking, the visitors will fend for themselves, often creating conditions which are aesthetically offensive as well as serious environmental health hazards for themselves and neighboring community residents or visitors. Available recreation facilities will need to be at least tripled by the year 2000 to meet the needs of the Nation's exploding population and increased leisure time. Estimates are that adequate environmental health safeguards comprise approximately 30 percent of development costs of new recreation areas. Since these safeguards represent such an appreciable investment, care should be taken in properly planning, constructing, and maintaining adequate facilities.

Adequate consideration of factors influencing the public health can best be achieved through active cooperation between health and recreation agencies. The development and review of plans of proposed developments and facilities including a review of site selection by qualified public health engineers is recommended. A program of periodic surveys and inspection of facilities and their operation in recreation areas should be established by public health and recreation authorities. It is recognized that developments in remote areas, wilderness areas, and low-density use areas will often be served by primitive sanitary facilities.

SITE SELECTION

Sites selected for recreation areas should be well drained, gently sloping, free from topographical or geological hindrances, and suitable for the use and development of a safe and adequate drinking water supply and of sewage disposal works.

Sites should be free from heavy traffic, air pollution sources, and noise sources. Avoiding location near swamps and marshes, where insects such as mosquitoes may breed and cause severe annoyance and discomfort, will significantly enhance enjoyment and utilization of the area by the visiting public.

Other considerations are:

1. Hazard-free entrance to and exit from the recreation area.

2. Surfaced and looped roadways within the recreation area.

3. Availability of an entomological survey of the area.

4. Preclusion of flooding of the recreations area's sanitary facilities.

5. Control of undergrowth in developed places.

6. Not subject to unusual wind conditions.

WATERSHED MANAGEMENT

Watershed management involves the supervision, regulation, maintenance, and wise use of the aggregate resources of a drainage basin to provide an optimum yield of water of desirable quality, including the control of erosion, pollution, and floods. Because the condition of the soil and the growth it supports have a marked influence on the quality and quantity of water contributed by a watershed, the use of various control measures and management practices is essential to conserve water and land resources and to prevent economic losses to municipal, industrial, and agricultural water supplies, fisheries, and recreation. In carrying out the various functional activities on watershed lands, including grazing of livestock and game, logging, roadbuilding, mining, house-building, fire control, sewage disposal, and recreation, it is essential that satisfactory watershed conditions be preserved.

Of particular concern are:

1. Erosion control both during and following construction.

2. Logging practices.

3. Prevention or overgrazing by livestock and game.

4. Control of the disposal of domestic and industrial liquid and solid wastes in and adjacent to recreation areas and watercourses.

5. Control of mining and ore-processing operations.

6. Evaluation of potential health hazards through consideration of the toxicity, persistence, and exposure factors of pesticides or other chemicals to be used.

7. Prohibition of uncontrolled camping in areas without basic facilities.

WATER SUPPLY (See also Chapter I)

An adequate supply of water under pressure which meets the source and protection, bacteriological, chemical, physical, and radiologocal requirements of the Public Health Service Drinking Water Standards(2) is essential for the convenience, comfort, safety, and health of visitors and resident staff at outdoor recreation areas.

Points which should be considered are:

1. Extension to the recreational area of any State-approved public water supply where feasible.

2. Quality and Quantity of water supplies available.

3. Degree of treatment necessary to provide water meeting the USPHS Drinking Water Standards.

4. Appropriate steps to provide disinfection as well as to prevent chance contamination of hauled water.

5. Completion of a sanitary survey by a qualified person as part of the collection of initial engineering data on the development of the water supply source and its capacity.

6. Design, construction, and supervision of the proposed water facilities to minimize potential vandalism.

7. Qualified supervision, operation, and maintenance of the water treatment equipment.

8. Protection of the water quality through the design, construction, and maintenance of the distribution system.

9. Design system to permit emergency operations.

SEWAGE DISPOSAL

Safe disposal of human and domestic wastes in recreation areas is necessary for the preservation of the surface and ground waters and the restoration of such waters to the best possible condition consistent with public health and welfare. Proper sewage disposal prevents damage caused by sewage to the propagation and preservation of fish and wildlife and is essential to protect the visiting public, employees, and nearby communities from diseases transmitted through sewage.

Some important health-related factors are:

1. Provision of a properly designed, constructed, and supervised water-carried sewage disposal system. Experience has shown that pit toilets are a poor second choice and should only be used for remote and lightly used recreation areas.

2. Locating outfalls to minimize the potential effects of sewage effluents.

3. Proximity of septic tank and subsurface disposal systems to buildings, beaches, camping and picnic areas, and water supply systems.

4. Properly planned sludge disposal.

5. Plans for the installation of sewage disposal facilities must provide for adequate operation and maintenance.

PLUMBING

Plumbing includes "the practice, materials, and fixtures used in the installation, maintenance, extension, and alteration of all piping, fixtures, appliances, and appurtences in connection with any of the following: sanitary drainage or storm drainage facilities, the venting system, and the public or private water supply systems within or adjacent to any building structure, or conveyance; also the practice and materials used in the installation, maintenance, extension, or alteration of storm water, liquid waste, or sewerage and water supply systems of any premises to their connection with the public sewer system (or public water system) or other acceptable disposal facility."(3)

In planning the following should be considered:

1. The minimum number of plumbing fixtures should be based upon peak visitor day use (see Table 1).

2. Materials used and their installation should conform to the minimum standards of the National Plumbing Code (as revised) or to local and State codes if they are more restrictive.

BUILDING AND HOUSING HYGIENE

Housing of a healthful quality must provide for fulfillment of the physiological needs of man, which include: a thermal environment

Table 1

SANITARY FACILITIES FOR RECREATION AREAS (4)

Facility	Waterclosets Male	Waterclosets Female	Urinals Male	Lavatories	Showers
Swimming Pools*	1/75	1/50	1/75	1/100 males 1/100 females	1/50 males 1/50 females (minimum of 2)
Campground Sites					
1-20	1	2	1	2	
21-30	2	3	2	4	
Picnic Areas					
Parking					
1-40	1	2	1	2	
41-80	2	4	2	4	
81-120	3	6	3	6	

Each comfort station should be designed to provide service for sites no further than 500 feet away.

*One drinking fountain, not installed in toilet room, should be provided.

that not only is conducive to good health but is comfortable and promotes efficiency of living; air that is chemically pure and free from objectionable odors; humidity that is healthful and comfortable; and air movement that will provide the necessary air changes to assist in maintaining the desired thermal conditions and air purity. Housing should be free of noise that may impair health. Lighting should be quantitatively and qualitatively adequate, including both natural and artificial sources. All buildings and dwelling units should be constructed and maintained in accordance with the minimum requirements set forth in the "APHA-PHS Recommended Housing Maintenance and Occupancy Ordinance"(5) or requirements that are substantially equivalent. The "Basic Principles of Housing and its Environment"(6) is another good reference in the field of housing. Those concerned with the design, operation, and maintenance of public buildings should consult these references for more complete coverage of this subject. Plans and specifications covering housing, dormitories, camps, hotels, restaurants, and similar facilities should be submitted to the appropriate authorities having jurisdiction for review and recommendations.

Some of the more important aspects of housing not covered elsewhere in this Guideline are:

1. Provision of adequate openable window area for habitable rooms.

2. Provision of adequate outlets where electric service is available.

3. Provision of adequate safe heating facilities.

4. Provision of screens for doors and openable windows during seasons when it is necessary to protect against mosquitoes, flies, and other insects.

5. Protection of buildings against rodent entry.

6. Construction of water closet compartment and bathroom floor surfaces of material impervious to wear.

MILK AND FOOD SANITATION

Despite the progress which has been achieved in food protection programs, foodborne illness continues to be a major public health problem. The incidence of such illness can be reduced by the application of the basic principles of food protection. To achieve this on a day-to-day basis, however, better understanding on the part of many food service employees and employers must be developed, and this in turn will necessitate a maximum of cooperation between public health agencies and the food service industry. The need for even greater attention to this problem in recreation areas is due to the seasonal operation of many areas and the widely fluctuating visitor load that must be accomodated by food service facilities provided. Seasonal employees who lack adequate training in good food handling practices introduce additional hazards. The applicable State and local milk sanitation laws and regulations and the Public Health Service "Grade "A" Pasteurized Milk Ordinance"(7) should be followed for the dispensing of milk and milk products. The "Food Service Sanitation Manual"(8) including "A Model Food Service Sanitation Ordinance and Code, 1962 Recommendations of the Public Health Service" is a basic reference in the field of food sanitation. Where ice is produced for public use the "Sanitary Standard for Manufactured Ice - 1964 Recommendations of the Public Health Service"(9) should be applied. A basic reference for the dispensing of foods and beverages is "The Vending of Foods and Beverages",(10), a sanitation ordinance and code recommended by the Public Health Service. Before construction of a food service establishment is initiated, properly prepared plans and specifications showing layout, arrangement, and construction materials and the location, size, and type of fixed equipment and facilities should be submitted for approval to the health authority having jurisdiction.

SOLID WASTE DISPOSAL (See also Chapter VI)

Public health problems are often associated with improper storage, collection, and disposal of solid waste in recreation areas. Experience has shown that the application of the basic principles of sanitation to solid waste handling results in substantial reductions in fly, rodent, and other insect problems.(11) Inadequate handling and disposal of solid wastes may also result in the increased incidence of certain diseases in humans and animals.(12)(13) Many hazards and nuisances, such as fire, smoke, odors, and unsightliness, are also created by poor solid waste handling practices. The full appreciation of recreation area values by the public is often diminished by the disorder of accumulated solid wastes.

Among the elements to be considered in planning are: (14)

1. Collection of solid waste in durable, watertight, rust-resistant, nonabsorbent, and easily washable covered containers.

2. An adequate solid waste collection plan (number of containers, and frequency of collection) to prevent unsightliness and fly and rodent problems.

3. Disposal means for trash and garbage.

   a. by sanitary landfill
   b. by incineration
   c. by garbage grinding (to sewage system)

4. Prohibition of open burning other than campfires.

COMPATIBILITY OF RECREATION AND PUBLIC DRINKING WATER SUPPLY (15)(16)(17)

The competition among multiple uses of our land and water resources demands assessment of the compatibility of uses such as recreation and domestic water supply. There is no doubt that recreation comprises one of the major uses of water resources, representing major economic and social benefits. Domestic use is also a major benefit and may often be the most exacting use of the water resources. When various uses are not compatible and conflicts exist, compromise is necessary. Where multiple use calls for both water supply and recreation, the following factors should be considered:

1. Present physical, chemical, and bacteriological quality of the water resource.

2. Comparison of the probable degree of the contamination of the water resulting from recreational and other uses such as mining, logging, road building, and right of way maintenance; the resulting water quality should meet health guidelines and the applicable State or Federal standards for recreational and water supply use.

3. Degree of toxicological contamination and deterioration of water quality caused by wasted oils, motor fuels, pesticides, and other chemicals used to maintain and operate recreation facilities and equipment.

4. Control of taste, odor, and color producing algal growth.

5. Degree of water treatment required to handle anticipated pollution loads in order to produce water meeting the PHS Drinking Water Standards.

6. Provision for multiple elevation withdrawal points in the water supply intake to allow the advantage of planned withdrawal of the highest quality of water under the varying conditions of water quality in the reservoir.

7. Designation of a restricted area around the water supply intake in which recreational use is prohibited to prevent vandalism and to provide some holding time for the recreation water prior to its use for public water supply.

8. Complete clearance of the restricted area of vegetation, buildings, manure deposits, swamp debris, and other sources of contaminants.

9. Monitoring of the water quality on a regular basis.

These factors are normally considered in any drinking water supply development project. They are included here to remind planners that they should not be overlooked in multiple-use projects.

BODY CONTACT RECREATION WATER QUALITY

Limited biological, chemical, and physical quality guidelines are outlined below.(18) Where questions arise regarding the health aspects of water quality, local and State health authorities should be consulted. Reference should also be made to State Water Quality Standards and the water pollution control authorities responsible for the administration of such standards. Final judgment on the acceptability of the use of any water classified under these guidelines should also include consideration of the significance of the findings of a complete sanitary survey and continuous surveillance of possible hazards including a review of epidemiological data and appropriate safety considerations.

A. Biological:

The fecal coliform density should not exceed an arithmetic mean of 200/100 ml with a sampling frequency of 5 samples per 30-day period taken during peak recreational use. Not more than 10 percent of the samples' fecal coliform densities during any 30-day period should exceed 400/100 ml.

B. Chemical

The water should contain no chemical which could cause toxic reaction if ingested or irritation to the skin or eyes upon contact. The water's pH should be within the range 6.5-8.3.

C. Physical

The water's color should not exceed 15 standard units and its turbidity should not exceed 30 standard units.

SWIMMING POOLS AND OUTDOOR BATHING PLACES

Public health authorities have been concerned with sanitation and safety problems involving swimming and bathing for many years. While the problems of accidents and drownings are the most dramatic events relating to swimming, the communicable disease aspects must also be given attention.

The following factors should be considered:

1. Design, construction, and operation of proposed swimming pools in accordance with requirements of the health authority

having jurisdiction or in accordance with the standards outlined in the "Suggested Ordinance and Regulations Covering Public Swimming Pools"(19) and "Environmental Health Practice in Recreation Areas".

2. Acceptability to health authorities of the proposed water supply system to serve as a potable water source for the pool area.

3. Discharge of the swimming pool water through an air gap to the waste water receiver and recharge of the swimming pool through an air gap.

4. Proper design for "use loading".

5. Practice of continuous disinfection of pool water, where possible.

6. Routine examination of bacteriological samples taken from swimming pools and bathing places.

7. Decisions on the use of natural bathing areas based upon the results of chemical analyses, bacteriological examinations, and a sanitary survey of the proposed natural bathing area.

8. Elimination of possible gross animal pollution of the bathing area.

9. Evaluation of the effects of peak visitor days on water quality and recreational use.

BATHING LOAD FOR OUTDOOR POOLS AND BEACHES (WITHOUT DISINFECTION)

In a swimming pool whose water is derived from a public or other supply of drinking water quality, the presence of organisms of the coli-aerogenes group should be considered as an indication of pollution by fecal matter. The presence of such bacteria in natural bathing places, however, may be an indication of generally harmless soil bacteria. The portion of the total coliforms which is of fecal origin varies radically in surface waters. Routine bacteriological tests can detect the degree of the more hazardous fecal contamination through fecal coliform density determinations. Where outdoor beaches are used, the fecal contamination may be caused by sewage from boats, individual dwellings, hotels, factories or other establishments, public sewerage systems, refuse dumping, warm-blooded animals, and bathers themselves.

Where a beach will be dependent upon stream flow or lake circulation for cleansing and dilution, the amount of water flowing past the beach during the time of its use should be ascertained. Any small stagnant pool patronized by a number of bathers is certain to show bacteriological pollution in considerable amounts unless disinfection is provided. While no specific amount of diluting water for outdoor beaches can be set on a scientific basis, a figure of 500 gallons per bather per day has been used in the past. The American Public Health Association publication, "Recommended Practice for Design, Equipment, and Operation of Swimming Pools and Other Public Bathing Places", (20) states "the total number of bathers using a fill and draw swimming pool shall not exceed one person for each 500 gallons of water in the pool between complete changes of pool water without disinfection".

The "Becker Formula" has been used in New York State(20) as a practical guide in determining necessary volumes of diluting water for outdoor beaches. This formula is $Q = 6.25T^2$ where Q = quantity of water per bather in gallons and T = replacement period in hours. As an example, if the water circulation is such that the beach volume will be replace in eight hours, then Q will be 400 gallons per bather; the number of bathers permitted in eight hours would be the total volume of the swimming area divided by 400.

Whether or not disinfection is employed, every effort should be made to eliminate all sources of sewage pollution on small streams or lakes used for bathing and careful sanitary surveys of the watershed are recommended. It is, of course, desirable that bathing be limited to clear bodies of water and that muddy bottoms which will cause turbid water be avoided.

RECREATION VEHICLE PARKING AREAS

The great increase in the number of recreation vehicles on the highways during the vacationing months is quite evident to the motoring public and reflects the increasing amount of leisure time and extra spending power being enjoyed by more people each year. It also points out the continuing need to expand recreation vehicle parking areas together with related facilities that meet standards of health and safety.

Considerations involving standards of health and safety are:

1. Design of parking facilities for both self-contained and non-self-contained recreation vehicles.

2. Provision of a sanitary station for the disposal of holding tank wastes. (For design, see "Environmental Health Practice in Recreation Areas".(1))

3. Design of recreation vehicle parking areas for overnight or destination use.

4. Availability of adequate water supply and satisfactory means of sewage disposal at each parking site.

5. Design of approach roads for trailer traffic.

6. Conformance of the spacing of recreation vehicles to the minimum 15 foot separation specified by the National Fire Protection Association.

7. Separation of at least 60 feet between the recreation water tank filling station and the sanitary station.

8. Special provisions for the disposal of sink wastes.

9. Development of detailed plans for solid waste disposal.

10. Convenience and adequacy of service buildings for their anticipated use.

11. Provision of electrical service by underground cable.

12. Submission of detailed plans and specifications of the recreation vehicle parking areas to the health authority having jurisdiction for review and approval.

BOATING

The boating industry reported in 1962 that there are more than eight million pleasure boats being used for recreation in the waters of the United States and the trend is increasing upward. More and more of these boats are being equipped with a galley and toilet facilities. Sewage, galley wastes, and other debris are therefore being discharged into our watercourses threatening to damage the recreational values of swimming, fishing, and other aquatic sports. The dredging of boat basins and the construction of small craft harbors, marinas, boat launching ramps, and docking floats are but a few of the projects being constructed or planned for recreation areas. Such new developments which attract and serve boating enthusiasts may create water pollution and related health problems of concern to public health and recreation authorities.

For this reason it is most important that the planning of such developments consider the environmental health aspects involved such as:

1. Inclusion of adequate separate facilities for collection and disposal of sewage, waste oils and fuels, and solid wastes accumulated on boats in the planning and design of proposed marinas.

2. Location of a permanent comfort station with sanitary facilities for both sexes near the piers.

3. Provision of a water-carried sewage disposal system including adequate treatment.

4. Provision of land disposal of wastes from floating facilities.

5. Provisions to eliminate waste and spillage during storage and dispensing of gasoline from floating facilities.

6. Regulation of construction and use of boats with marine toilets.

7. Inclusion of good solid waste disposal practice.

8. Establishment of restricted areas around water supply intakes.

9. Boats should meet safety requirements recommended by the U.S. Coast Guard and regulations should be established to control health and accident hazards associated with boating.

10. Full separation of boating and swimming areas.

11. Adequate parking facilities for automobiles and trailers.

FISH CLEANING FACILITIES

Fishing is an activity many visitors enjoy while visiting recreation areas, especially where natural reproduction and stocking of local waters is accomplished. Where fishing is productive, consideration should be given to the installation of fish cleaning facilities near boat docking and launching areas. These facilities are essential to control nuisances, odor, and pollution from the indiscriminate cleaning of fish and disposal of the resulting wastes into lakes, reservoirs, and along shorelines.

In planning these facilities, consideration should be given to the following factors:

1. Screening or full enclosure of the facility.

2. Provision of tables having impervious, nonabsorbent surfaces sloping to central drains or of adequately maintained wood tables.

3. Provision of potable water under pressure adequately protected against back-flow.

4. Provision of adequate disposal of collected wastes and maintenance of the facility in a clean condition.

INSECT AND RODENT CONTROL (See also Chapter V)

Several groups of arthropods and rodents may create serious public health and nuisance problems at recreation areas. These include species that are vectors of human disease organisms or which serve as reservoirs of these organisms or otherwise interfere with man's health, welfare, and comfort. A number of aquatic insects may be encountered at recreation areas located along the shore of impoundments. Mosquitoes are undoubtedly the most important of these insects, since several species serve as vectors of encephalitis and malaria, and others create public health problems because of their vicious biting habits.(21) Other groups of aquatic insects such as deer flies, horseflies, black flies, and biting midges are vicious biters of man and sometimes are involved in transmission of disease. In addition to the aquatic insects, people who visit water-related and other recreation areas are often exposed to terrestrial arthropods such as ticks, mites, fleas, and flies and rodents including ground squirrels, rats, and mice.(22)(23) The public health importance of these arthropods and rodents involves a number of human diseases including Rocky Mountain spotted fever, Colorado tick fever, tularemia, relapsing fever, tick paralysis, typhus, plague, bacillary dysentery, and typhoid fever. Irritation, discomfort, and annoyance caused by bites of the arthropods can seriously reduce the use of an otherwise attractive recreation area. Thus it becomes most important that measures be taken to eliminate or reduce such insect populations. State health authorities should be asked for pre-construction surveys and technical assistance in preparing control programs based on the following principles:

1. Delineation of mosquito production sites.

2. Implementation of mosquito control practices in preparation of the reservoir basin prior to impoundage.

3. Utilization of naturalistic and source reduction measures.

4. Planning for maintenance practices to control mosquito production within flight range of recreational and inhabited areas.

State and Federal health agencies will also provide technical information concerning:

1. Steps to be taken to control terrestrial arthropods and rodents.

2. Hazards to humans and animals posed by proposed chemical control measures against insects and rodents.

CAMPGROUNDS, PLAYGROUNDS, AND PICNIC AREAS

Camping is often a necessary part of any outdoor recreation outing that extends beyond one day. Many vacationers stay in motels and hotels; however, tents and recreation vehicles have loomed larger and larger on the recreation scene in recent years. Camping is increasing at a faster rate than the provision of sites and facilities for camping. Increases in camping will most certainly accompany increases in travel, for camping makes it possible for families to enjoy weekends and vacations economically far from home.

When resources are developed for boating, fishing, hunting, and related activities, adequate facilities for camping also should be provided. Studies of participation in outdoor recreation have shown that substantial numbers of campers prefer remote areas, while many others prefer camping in an area where they can visit with other campers.(24) Consequently, both types of camping areas are needed, with proper consideration given for environmental health factors relating to this mode of recreation.

Factors of importance are:

1. Provision of level and well-drained tent areas.

2. Plans for regular maintenance of the grounds (cleaned, mowed, and poisonous plants and hazards removed)

3. Remoteness of playgrounds from traffic areas, hazardous topographic features, and hazardous land uses.

4. Convenient location of water supply hydrants and comfort stations in the area.

5. Camping units should be located on one-way loop roads and/or cul-de-sacs.

STABLE SANITATION

The primary environmental health concern associated with the use of horses is the stabling of these animals and related manure disposal. Accumulations of such wastes afford breeding places for flies and unless controlled, will invariably produce large numbers of flies. Public health officials recognize that flies constitute a public health hazard and that the abatement of fly populations is essential to the control of certain communicable diseases.

These principles should be applies:

1. Stables convenient to recreation areas, but located to minimize potential odor and nuisance problems.

2. Provision of water outlets for hosing down feed and tack rooms, adequately protected against back-flow.

3. Provision of adequate water supply and drainage lines.

4. Implementation of insect and rodent control practices.

5. Handling and disposal practices for manure that prevent the breeding of flies.

CONCLUSION

If these factors or principles have been considered and properly resolved, adequate attention has been given to health considerations in the project development. However, if they have not been considered and resolved, the health and well-being of recreationists will not only be endangered but the project will fall short of its optimal development and use. Additional funds for sanitary and related facilities will often be justified in achieving an optimal result from the expenditure of the basic development funds. Health agencies at the local, State, and Federal level can be of considerable assistance in providing the technical direction necessary to insure the inclusion of a healthful environment in the development of water resources.

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CHAPTER V - VECTOR CONTROL

Health Guidelines for Vector Control are intended for the use of public health agencies, water resource construction and operation agencies. The Guidelines should assist in the study and evaluation of vector control problems and in the prevention and control of disease vectors and pests which may be associated with water and related land resources.

The Guidelines may be broken down into two categories:

1. Principles and Practices for the Prevention and Control of Vector Problems.

2. Field Survey and Epidemiological Surveillance.

Major vectors considered include mosquitoes from the water resources and terrestrial arthropods and rodents from the related land resource.

The major disease transmitted by mosquitoes are malaria, yellow fever, dengue, encephalitis, and filariasis. Control programs and climate have now reduced malaria, yellow fever, dengue and filariasis to minor or historical importance in the United States. Five types of encephalitis continue to occur in epidemic form in many parts of this country, however, and are the most important mosquito-borne diseases in the United States today. From 1956-1968, 3,121 cases of human encephalitis were identified as mosquite-borne(1), with the incidence from various strains as follows:

Western Encephalitis	665 cases
Eastern Encephalitis	92 cases
St. Louis Encephalitis	2127 cases
California Encephalitis (Not identified by most laboratories prior to 1964)	236 cases
Venezuelan Encephalitis	1 case
Total	3,121 cases

The maps in Figure 1 illustrate the relative occurrence of the major types of encephalitis in the United States.

At present, ticks are known to transmit five groups of deadly diseases: rickettsial, such as spotted fever; bacterial, such as tularemia; spirochetal, such as relapsing fevers; viral, such as Colorado tick fever; and protozoal, such as Texas cattle fever. They also produce a toxic paralysis. Tick-transmitted diseases have occurred primarily in the South Atlantic, Appalachian, and Western States. Lowest incidences occur in New England, New York, the West

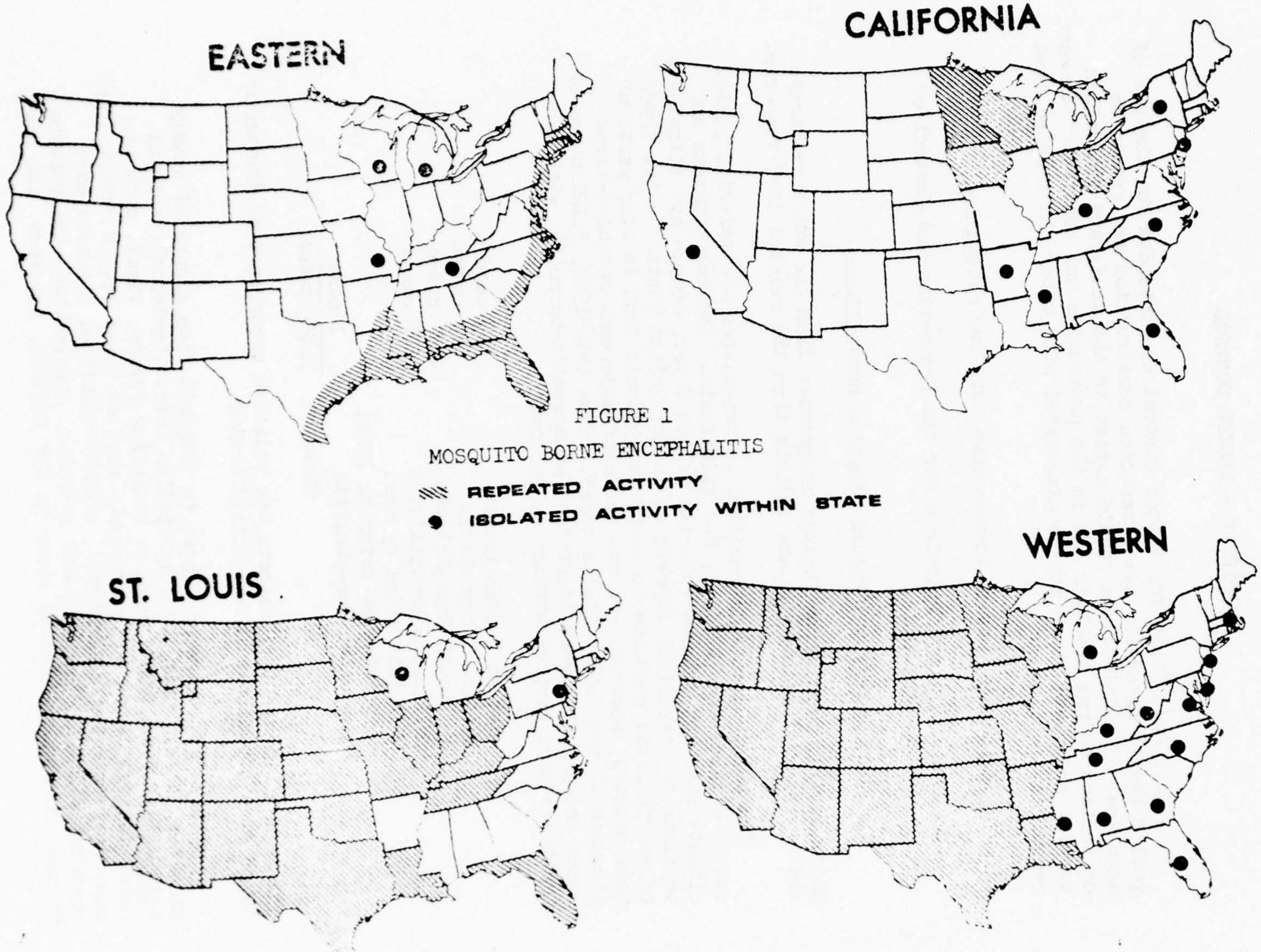

FIGURE 1

MOSQUITO BORNE ENCEPHALITIS

Central states, Hawaii, and Alaska. Since ticks are so widespread, however, the hazard from them should be considered in all regions.

PRACTICES FOR THE PREVENTION AND CONTROL OF VECTOR PROBLEMS

In the prevention and control of vector problems, special emphasis must be placed upon the prevention of physical conditions which may result in increased vector populations and upon the establishment of physical conditions which will minimize or eliminate existing vector problems; attention must also be given to factors such as the maintenance of basic sanitation standards, programs for the application of insecticides, location of habitable areas away from potential mosquito production areas, and so forth. The following principles and practices for prevention and control of vector problems should be followed in the planning, design, construction, operation, and maintenance of water and related land resource projects.

A. Impoundments

Practices leading to the prevention and source reduction of mosquito and other aquatic insect breeding sites include the following:

1. All borrow pits and other potential ponding areas associated with construction of the dam, relocation of highways or roads, etc., which are located above maximum pool level should be made self-draining.

2. Prior to impoundage, the reservoir basin should be prepared as follows:

    a. The normal summer fluctuation zone of the permanent pool should be selectively cleared except for isolated trees and sparse vegetation along abrupt shorelines which will be exposed to wave action.

    b. Dense stands of timber rooted below the normal summer minimum pool level but extending above that level should be selectively cleared.

    c. Borrow pits, depressions, marshes, and sloughs which will be flooded by the reservoir at maximum pool level and which would retain water at lower pool levels should be provided with drains to insure complete drainage with fluctuation of water levels.

    d. If the summer fluctuation zone of the permanent pool is limited to a few feet, consideration should be given to "building out" mosquito-producing areas located within flight range of population groups or recreation areas through the use of measures such as deepening and/or filling. This would minimize the need for repetitious measures for controlling vegetation and mosquito production.

e. If releases of water during portions of the year coincident with mosquito breeding season are quite small, consideration should be given to provision of low flow channels in drainage systems below the dams.

3. After impoundage, the following maintenance measures should be carried out in all potential mosquito-producing areas located within flight range of human population groups or recreation areas frequented by significant numbers of persons.

a. All dense vegetation should be removed periodically from flat, protected areas within the normal summer fluctuation zone of the permanent pool.

b. Vegetation, debris, and flotage should be removed periodically from all drains to insure free flows.

4. Water level management to minimize conditions favorable for mosquito production should be used to the maximum degree permitted by the primary purposes of the reservoir. This will minimize the need for repetitious measures for controlling vegetation and mosquito production.

5. As a general principle, waterside recreation areas, particularly those which have facilities for overnight human occupancy, should be located along sections of the reservoir which have a low production potential for mosquitoes and other aquatic insects of public health importance.

6. Biological control measures such as maintaining populations of mosquito larva predators should be exercised as needed.

B. Recreational Areas

1. Proper storage, collection, and disposal of solid wastes should be practiced in order to prevent and control flies, wasps, other noxious insects, rats, wild rodents, and other small mammals. Disposal of containers such as tin cans which would hold water reduces the breeding of mosquitoes within recreation areas.

2. All buildings should be rodent-proofed at recreation areas where rodents which may create public health hazards are prevalent.

3. Debris, rubbish, and other materials which may serve as harborage for rodents and other small animals should be removed periodically. At least twice a week removal of garbage is necessary to minimize fly production during the summer months. Where pit privies are provided, they should be fly tight and constructed to minimize the possibility of rodent harborage. Where possible, such unsatisfactory facilities should be replaced with modern water carriage sewage disposal systems.

4. Brush and weeds along paths, trails, roadways, and other areas frequently used by visitors should be treated with herbicides or removed in order to reduce the likelihood of tick and chigger infestations; however, herbicides should be used only in accordance with recommendations of appropriate Federal and State agencies.

5. Tree holes which may hold water should be filled with sand or grout to eiminate breeding places for mosquitoes and biting gnats.

6. Proper sewage and solid waste disposal is essential to prevent vector problems.

C. Waterfowl Refuges

1. Whenever possible, waterfowl habitat developments should be constructed so as to minimize mosquito problems.

2. Waterfowl areas which are to be flooded during the mosquito season should be diked or otherwise prepared with steep shorelines to preclude shallow water areas favorable for mosquito production. Banks should not be made so steep as to impair stability.

3. Provision should be made for water level management in waterfowl areas which will minimize mosquito production. This recommendation is particularly applicable to shallow areas used to provide establishment of food producing vegetation.

D. Irrigation

1. Project Conveyance and Distribution Systems

a. Lining or other satisfactory seepage control measures should be provided for all sections of canals and laterals located in porous soils where excessive leakage would result in waterlogged areas, seeps, and ponds.

b. Drains should be installed to prevent ponding of excess irrigation water and natural runoff along the upper side of canals and laterals. All drainage crossing or inlet structures should be placed on grade to prevent ponding.

c. Borrow areas should be made self-draining to prevent the retention of ponded water.

d. Where possible, provision should be made to prevent idle turnouts and other hydraulic structures from retaining residual water.

e. Effective measures should be provided to prevent ponding of leakage from water control structures.

f. Every effort should be made to establish delivery schedules which will provide farmers with adequate but not excessive amounts of water at proper intervals to insure efficient irrigation of the crops concerned.

g. Where feasible, pipes should be used rather than open channels.

h. Vegetation and debris which would retard normal flows should be periodically removed from conveyance channels, water control structures and drains.

2. Project Drainage Systems

a. Trunk drainage systems should be installed to insure complete removal and proper disposal of excess irrigation water, natural runoff, and seepage from both irrigable and nonirrigable lands affected by the distribution and use of irrigation water on the project.

b. Drainage ditches should be designed, constructed, and maintained so as to minimize ponding in the channels and to insure free flows at all times.

c. Provision should be made to prevent water from ponding behind spoil banks.

d. Underdrains, culverts, inlets, etc., should be placed on grade to prevent ponding.

3. **Irrigated Farms**

a. The sponsoring agency and other organizations concerned with irrigation agriculture or mosquito control should encourage irrigation farmers to use the following irrigation and drainage practices which will prevent or minimize mosquito sources:

(1) The farm supply system, drainage system, and field layouts should be properly fitted to the topography, soil, water supply, crops to be grown, and irrigation methods to be used.

(2) All surface irrigated fields should be properly leveled or graded to provide for efficient water application and removal of excess water without ponding.

(3) An adequate drainage system should be provided for removal of excess irrigation water from all portions of the farm.

(4) Irrigation methods should be used which will provide optimum irrigation efficiencies.

(5) Application of irrigation water should be limited to the amount required to fill the crop root zone plus water to cover unavoidable losses and excess water needed to prevent upward movement of salts.

(6) Where feasible, sprinkler systems should be employed.

E. Ponds

1. The pond basins should be cleared of trees, brush, and other dense vegetation prior to impoundage.

2. Ponds should be constructed with steep banks to discourage growth of vegetation. Banks should not be made so steep as to impair stability.

3. All dense vegetation should be removed periodically from shallow water areas.

4. A minimum depth of 2 feet should be maintained.

F. Channel Improvements and Drainage

1. Borrow areas resulting from construction of the project should be made self-draining.

2. Material excavated from channels should be disposed of in such a way that it will not cause ponding of water.

3. Adequate drains should be installed to prevent ponding of water on berms or behind spoil banks, levees, and dikes.

4. Drainage ditches should be designed, constructed, and maintained to concentrate low flows and reduce silt deposition and subsequent ponding, thereby insuring free flows at all times.

5. Underdrains, culverts, inlets, etc., should be place on grade to prevent ponding.

6. Collection sumps should be constructed with steep side slopes, and any emergent vegetation should be removed periodically.

7. Sections of natural channels that are cut off or bypassed by new channels should be filled or provided with adequate drains.

8. Interior drainage facilities should be well maintained to avoid excessive ponding.

9. The use of biological control measures such as stocking with the mosquitofish or top minnows, such as Gambusia affinis, should be used where feasible.

G. Waterways, Terraces, Floodways, Diversion Channels, and Drainage Ditches

1. Waterways, terraces, floodways, diversion channels, and drainage ditches should be designed, constructed, and maintained to prevent the retention of ponded water or the creation of ponded areas which would be suitable for mosquito production.

2. Biological control measures should be used where feasible.

H. Supplemental Chemical Control Measures

1. In situations where adequate vector control is not obtained through prevention and source reduction measures, provision should be made for supplemental use of insecticides and rodenticides to achieve the desired level of control. The use of such chemicals should be closely regulated to prevent the possibility of water pollution resulting from such activity.

FIELD SURVEY AND EPIDEMIOLOGICAL SURVEILLANCE

In order to insure that good principles and practices are actually being implemented, that vectors are being controlled, and that disease and nuisance are being prevented, arrangements should be made for routine field survey and for epidemiological surveillance. The routine field surveys should include not only inspections for implementation of physical measures, but also inspections for the presence of adult and larval mosquitoes and other vectors. Regular information on vector populations or disease occurence is essential in guiding control programs or instituting new programs to cope with existing vector problems as well as unforeseen or emergency situations.

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CHAPTER VI - SOLID WASTE MANAGEMENT

The management of solid wastes is a growing national problem and must meet limitations related to public health, environmental protection, and economic resource recovery. Local and State agencies responsible and interested in public health, environmental protection, solid waste management, water pollution, and water resources development should be consulted regarding such limitations on a case-by-case basis.

Proper solid waste management will improve the safety and quality of the environment:

1. By eliminating harborage and food supply for rats, flies, mosquitoes, and other disease vectors or nuisances.

2. By controlling air pollution through the elimination of open burning or, in the case of incineration, more efficient combustion. Odors, fly ash, and smoke are controlled through proper combustion control design and operation.

3. By safeguarding against surface and ground water pollution associated with improperly disposed solid waste.

4. By reducing accident and fire hazards through the elimination of open burning or dumping of solid waste.

5. By making solid waste disposal mechanisms aesthetically acceptable.

Solid waste management and its potential effects should be considered in water resources development projects, paticularly where recreation and water quality are of importance. Harborage and food supply for insect and animal disease vectors or nuisances, surface and ground water pollution, accident and fire hazards and aesthetic insult often result from improper storage or disposal of solid wastes.

ACCUMULATION AND STORAGE

Solid waste management begins with the provision of an efficient mechanism for the storage of waste generated by individuals at the sites of interest. Normally such a mechanism is simply the provision of insect and rodent proof containers of sufficient volume to hold the maximum amount of waste generated between collections.

COLLECTION

Solid wastes should be collected at appropriate intervals to prevent fly and insect breeding and the occurrence of odor problems. The collection frequency should be adjusted in accordance with rates of accumulation and climatologic and geographic factors. Plans should provide not only for the efficient collection of the solid waste, but also for its effective and economic disposal. (1)

DISPOSAL

After accumulation and collection, treatment and disposal of the solid waste must be accomplished. Acceptable disposal occurs when no significant deterioration of the environment results from disposal operations. Modern practices for disposal are discussed as follows:

Sanitary Landfill

Sanitary landfill is an engineered method in which solid wastes are disposed by spreading them in thin layers, compacting them to the smallest practical volume and covering them with earth each day in a manner that minimizes environmental pollution.(2) The term "sanitary landfill" is sometimes mistakenly associated with open dumping. Dumps, however, are a source of many environmental insults.

Advantages of the sanitary landfill are as follows:

1. Where land is available, a sanitary landfill is usually the most economical method of solid waste disposal.

2. The initial investment is low compared with other disposal methods.

3. A sanitary landfill is a complete or final disposal method as compared to incineration and composting which require additional treatment or disposal operations for residue, quenching water, unusable materials, etc.

4. A sanitary landfill can be put into operation within a short period of time.

5. A sanitary landfill can receive all types of solid wastes, eliminating the necessity of separate collections.

6. A sanitary landfill is flexible; increased quantities of solid wastes can be disposed of with little additional personnel and equipment.

7. Submarginal land may be reclaimed for use as parking lots, playgrounds, golf courses, airports, etc.

Disadvantages of the sanitary landfill are as follows:

1. In highly populated areas, suitable land may not be available within economical hauling distance.

2. Proper sanitary landfill standards must be adhered to daily or the operation may result in an open dump.

3. Sanitary landfills located in residential areas can result in extreme public opposition.

4. A completed landfill will settle and require periodic maintenance.

5. Special design and construction must be utilized for buildings constructed on completed landfill because of the settlement factor.

6. Methane, an explosive gas, and other gases produced from the decomposition of the wastes may become a hazard or nuisance problem and interfere with the use of the completed landfill.

Incineration

Properly designed incinerators can be used for the treatment of solid wastes. It should be noted that the incinerator does not eliminate the need for a sanitary landfill; it simply reduces the volume of the material requiring eventual disposal.

Advantages:

1. Reduces the amount of solid waste requiring final disposal.

2. Allows more efficient collection practices in some situations by reducing haul distances when the incinerator has a central location near the sources of waste.

Disadvantages:

1. Capital costs and operating costs are higher than for the sanitary landfill.

2. Requires full time operators to assure acceptable operation.

WATER RESOURCE ASPECTS OF SOLID WASTE DISPOSAL

Recreation Areas

Recreation areas and their supporting facilities may be expected to generate significant amounts of solid waste and to present varying problems of solid waste management. Solid waste management for recreation areas is discussed in Chapter IV.

Reservoir Planning

Before impoundment, a survey should be made to locate solid waste disposal sites that will be inundated. This survey should be part of a general assessment of pollution sources, levels, and potential. If it is determined that these sites could cause a significant pollution problem, the objectionable material should be removed or the location of the reservoir altered to avoid the solid waste site.

The filling of a reservoir represents a change in hydrologic conditions which will raise the nearby groundwater table. If the higher groundwater table intrudes upon a solid waste disposal site, pollution could result. Further investigation and corrective and/or protective measures should be taken accordingly.

Water Quality

Most solid waste is ultimately placed in contact with the ground, permitting possible contact with both ground and surface water which could cause subsequent impairment of water quality.(3) Investigations into the subject of contamination of water by solid waste disposal have established the fact that the physical, biological, and/or chemical quality of surface and ground water may be affected by nearby solid waste disposal sites.(4) Turbidity is normally a problem only in the immediate vicinity of the disposal site. Taste and odor may be particularly affected by hydrogen sulfide absorbed by water passing through or over anaerobically decomposing wastes. Although color may be present, it is normally removed by natural purification processes.

Bacterial contamination within and close to a disposal site may be very high. For sandy or granular aquifers, bacterial contamination does not normally persist at depths greater than seven feet below a disposal site and seldom persists in ground water in the direction of flow for more than 50 yards.(5) In limestone, lava rock, most sandstones, granite, and other crystalline rocks, however, water travels through discrete openings such as tubes, parting planes between layers, or fissures produced by earth movements. No filtering action occurs in moving through these openings and contamination can travel long distances modified only by dilution.

The mineral and organic substances in solid wastes are present in quantities capable of causing gross contamination of surface and ground water supplies. Soluble inorganics such as chlorides, ammonium hydroxide, and ammonium salts are not rapidly removed by natural means.

Decomposition of organic matter produces carbon dioxide, water, methane, ammonia, and hydrogen sulfide. The increase in hardness caused by carbon dioxide and the increase in nitrate content resulting from the oxidation of ammonia are among the most significant effects on water quality. The highly soluble carbon dioxide also forms a weak acid which can dissolve metals and other substances to produce undesirable contaminants.

Mechanism of Contamination

The major processes by which contaminants are produced or introduced into ground and surface water, other than direct dumping, are infiltration and percolation, solid waste decomposition processes, gas production and movement, leaching and ground water travel, and direct runoff.(6) Infiltration and percolation of rainfall, runoff, irrigation, and flood water can produce contaminating leachates. Decompostion of waste constituents by chemical and bacterial action depends upon time, composition, availability of oxygen, temperature, moisture, salinity, and other factors; and makes many chemical products available as contaminants. Aerobic decomposition produces a rise in temperature and the primary products, carbon dioxide and water. Anaerobic decomposition produces ammonia and methane as the primary products accompanied by a rise in temperature.

For leaching and ground water travel to occur, three conditions must be satisfied:

1. The disposal site must be over, adjacent to, or in an acquifer.

2. The fill or a portion of it must be saturated.

3. Leached fluids must be produced which have access to an acquifer.

The possibility of contamination from a solid waste disposal site will depend upon factors including the composition and quantity of waste involved, the site's physical environment, the operation of the site, and the volume and original quality of the water.

SANITARY LANDFILL SITE SELECTION AND OPERATION

The possibility that a landfill will pollute ground and surface waters in the area of the fill must be considered. Various substances may be present in solid wastes which are capable of causing contamination of surface and ground water supplies.

A competent sanitary engineer should be consulted to evaluate the water pollution potential associated with disposal sites and the protective measures that may be necessary. The services of a soil scientist or a groundwater geologist may also be useful.

To minimize the potential of surface and/or groundwater contamination, the following guidelines should be adhered to:

1. Solid waste should never be buried in direct contact with a groundwater or surface water supply; burial areas should also be located so as to minimize any contamination of waters which may serve as sources for municipal or drinking water supplies.

2. Surface water passing over or through a disposal site should be minimized by proper drainage. Finished sites should be covered and graded to control the flow of runoff across the fill area.

3. Water should not be intentionally added to a solid wastes disposal site, except to extinguish fires.

4. Site selection should be based upon evaluation of the entire physical environment surrounding proposed sites.

5. Recommended procedures for the operation and maintenance of a sanitary landfill, using sound engineering practices and judgment, should be implemented.(2)

6. In the planning and implementation of solid waste disposal, consultation should be sought from local, State, and Federal agencies responsible for and interested in environmental protection, public health, solid waste management, water pollution control, and water resources development in order to minimize the hazard of water contamination and to institute corrective engineering measures where needed to minimize water contamination.

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CHAPTER VII - RADIOLOGICAL HEALTH

This guideline is directed to a general discussion of radiological health aspects of water and related land resources in the United States. The problem areas, sources, mechanisms of exposure, and surveillance, should be considered for the watershed of any project including water supply, irrigation, or recreation as project purposes. In each of the areas discussed, more detailed information is readily available, in the indicated references.

SOURCES OF RADIOACTIVE CONTAMINATION

The sources of radioactive water contamination are numerous and include hospitals, industrial laboratories, nuclear reactors, and fuel fabrication and reprocessing plants. Hospitals and certain industrial and research laboratories dispose of low levels of water-borne radionuclides, used in basic research and in treatment of patients, by flushing to sanitary sewers. Radioactive wastes can also occur at these facilities through leakage from continuous processing systems. Considering the diversity of radiological medical and research applications, almost any radionuclide might occur in the liquid wastes of these facilities. The use of isotopes in medicine and research, however, is not normally great enough in any given area to present a hazard to individuals through contamination of the environment.

The principal types of reactors currently operating in the United States are electric power reactors, production reactors, and research reactors. Of these three types, power reactors will present the greatest problems of radioactive liquid waste disposal in the future due to the increased use of nuclear power for generation of electricity. The data shown in Table I indicates that nuclear power will move from its position of supplying approximately 6% of the electrical energy requirements in 1970 to around 30% in 1980. Production of liquid radioactive wastes can be expected to increase with this increase in nuclear power generation. However, due to the management of the radioactive waste treatment system and development of new technology, the release of radioactive material to the environment will not increase proportionally but will be maintained at the lowest practicable level.

TABLE I

Projected Energy Sources for Electric Power

SOURCE	1970		1975		1980	
	$MW(e) x 10^3$	% of Total	$MW(e) x 10^3$	% of Total	$MW(e) x 10^3$	% of Total
Nuclear	20	6	69	16	160	30
Water	46	14	65	15	70	13
Oil	23	7	13	3	16	3
Gas	69	21	89	21	75	14
Coal	172	52	194	45	214	40
TOTAL	330	100	430	100	535	100

The types of nuclear power plants presently being designed and operated in the United States are pressurized water reactors (PWR) and boiling water reactors (BWR). Both types of facilities have been designed to release relatively low levels of liquid wastes during normal operation. Low level liquid wastes are usually released directly to the condenser cooling water discharge canal where they are diluted (by a factor of 10^4 to 10^6) (1) with the condenser cooling water to acceptable environmental levels. Where liquid wastes generated by reactors utilizing cooling towers are released to the blow down of the cooling towers, available dilution is much smaller than for facilities not using cooling towers. Provisions are made for removing radioactive contaminants contained in high and intermediate level liquid wastes by one or more of the methods given below:

1. Storage to allow decay of relatively short-lived isotopes.
2. Filtration to remove particulate activity.
3. Ion-exchange to remove dissolved activity.
4. Distillation to reduce volume of wastes to be stored.

These treatment methods are commonly applied throughout the reactor industry and may also be applied at any facility where radioactive liquid wastes are generated and discharged.

Uranium milling can contribute to the natural uranium activity of streams used for disposal of wastes from the milling process. The concentration of uranium in such streams should be carefully monitored and controlled in areas where uranium mining is prevalent.

With the projected increase in reactor use, reactor fuel reprocessing plants will become more important as potentailly hazardous sources of contamination. Such plants have a greater potential for contaminated waste production than reactors, but will probably number less than 10 in the United States by 1980.

MECHANISMS OF HUMAN EXPOSURE

Once water becomes contaminated with radioactive pollutants, the following pathways for population exposure should be considered:

1. Human consumption of contaminated drinking water.
2. Use of contaminated water in recreational sports.
3. Concentration of pollutants in edible aquatic biota, especially fish and shellfish.
4. Irrigation and subsequent concentration of radionuclides by food crops.
5. Contamination of various foods by use of contaminated water for processing.
6. Settling of radioactivity and resuspension during periods of flooding. Radioactivity can also be absorbed by particulate deposits and then desorbed upon changes in thermal, chemical, or biological character of the stream.

The most likely occurrence of hazardous exposure would be through drinking of contaminated water and from consumption of contaminated food. Water resource development projects will be most concerned when water supply, irrigation, and/or recreation are included as project purposes. After an unintended release of radioactive materials into a waterway, two principal factors must be considered in controlling exposure from drinking water:

1. Minimum travel time from point of release to water intake - determines time available after a release of pollutants during which authorities may discontinue intake of raw water in order to avoid use of the polluted waters or to prepare treatment processes to remove the pollutants.

2. Water plant storage capacity and population usage rate-determines length of time water intake may be stopped by authorities without discontinuing water service.

3. Water plant contamination removal efficiency - determines amount of contamination which can be removed by treatment. This

efficiency may vary for different pollutants.

4. Decay time during treatment and storage - accounts for radioactive decay during water treatment and storage before use.

5. Dilution, both in-stream and in the treatment plant - determines the concentration which may reach the individual customer.

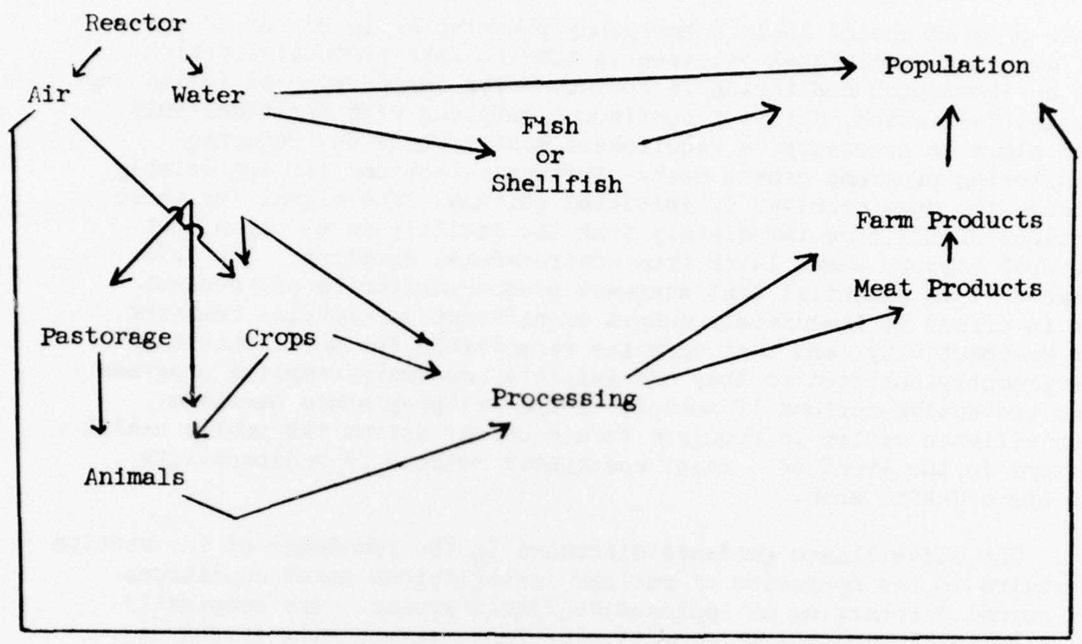
In protecting the population from consumption of radiologically contaminated food, the efficiency of food processing in removal of the contaminant and the decay time between contamination and possible human consumption are important factors. Where food becomes grossly contaminated, removal of the affected foods from the food supply is an obvious and effective method for population exposure control.

Radioactive water contamination can also affect the industrial use of water at a particular location. Any industry which manufactures a product which is affected by radiation such as film manufacturers will be concerned about the concentration of radioactivity in their process water.

Radioactive contamination of land usually occurs via deposition of airborne contaminants or through use of contaminated water for crop irrigation. The pathways for exposures of humans to radioactive contaminants emitted by a source including exposure through the human food chain are shown in Figure 1.(2) The hazard presented in any case is highly dependent on the contaminating radionuclide. Land contamination can create a more serious long-term exposure problem than water contamination because very little dispersion or movement occurs following deposition and fixation in the soil.

The various pathways for population exposure discussed above demonstrates the importance of zoning in areas where facilities discharging radioactive contaminants are located. During the initial evaluation of the site for a facility emitting radioactive substances a certain area of restricted land development is established around the facility. In many cases, it would be possible for population or industrial growth in the area to progress to the point where the criteria established by the original site evaluation will no longer be acceptable due to the larger populations which would be exposed to radiation accidents. Certain zoning restrictions may therefore be required to prevent unacceptable population, commercial, or industrial growth in close proximity to the facility.

Figure 1



Pathways for Human Exposure to
Radioactive Substances

SURVEILLANCE AND CONTROL OF RADIOACTIVE CONTAMINATION

The surveillance and control program proposed for a facility releasing radioactive liquid wastes to surrounding waters depends upon the facility type and the levels of activity discharged relative to permissible levels. There are two published guides currently used for specifying permissible activity levels in water. The first is the "Public Health Service Drinking Water Standards - 1962 (3). The "Radioactivity" section of the drinking water standards discusses, in general, surveillance of drinking water sources and levels of radium-226 and strontium-90 at which various surveillance and control actions are necessary. The second guide is Title 10, Part 20 of the Code of Federal Regulations(4) entitled "Standards for Protection Against Radiation." This guide sets forth "maximum permissible concentrations" (MPC) in air and water for most radioactive isotopes which would be discharged to the air and water environment from nuclear installations.

The prime objectives of environmental surveillance programs for facilities releasing radioactive wastes are:

1. to verify the adequacy of source control.

2. to provide data to estimate population exposure.

3. to provide a source of data for public information.

This program should include emergency planning designed for the purpose of detecting individual releases in time to take protective action. If environmental monitoring is conducted for the purpose of initiating protective action, daily or continuous sampling with rapid analysis and alarm is necessary, a requirement most routine environmental monitoring programs cannot meet. Protective actions can appreciably reduce the dose received if initiated quickly. The signal for these actions should come immediately from the facility in question, not several days or weeks later from environmental sampling. For this reason it is essential that adequate source monitoring and control be in effect to immediately detect significant non-routine releases of radioactivity, and that agencies responsible for public health be promptly notified so thay can initiate necessary sampling programs and protective actions if needed. A special preplanned emergency surveillance system is required to adequately assess the public health hazard in the event of a major accidental release of radioactivity to the off-site area.

The surveillance guidance discussed in the remainder of the section pertains to the operation of nuclear installations under conditions of normal discharging of radioactive liquid wastes. The complexity of a surveillance plan at a particular installation will depend on the types and levels of radioactive releases.

A routine program to meet the environmental surveillance objective given above has been described in detain for a nuclear reactor plant in several references.(5)(6)(7) These references include lists of recommended sample types, frequencies, and radionuclides of principal interest. A typical program for the water environment is outlined in Table 2.

The Federal government conducts a comprehensive nationwide environmental surveillance program in the form of its national surveillance networks.(9) Information from these networks is used to estimate public exposure and doses relatable to environmental radioactivity. The surveillance system is designed to be responsive to changes in radioactivity levels in the environment. The current surveillance activities include the collection and analysis of airborne particulates, water, milk, total diets, human bones and organs, and special samples relating to human body burdens. Many States operate similar statewide networks that are coordinated with the Federal network systems. In addition, environmental surveillance programs are conducted in the vicinity of operating nuclear facilities by the operator and health agencies. With such a system of National, State, and facility surveillance programs in operation, the long-term trends of environmental radioactivity resulting from the nuclear industry can be well documented. In addition, special surveillance systems have been established which can be activated in the event of a facility accident and which will indicate whether levels of radioactive contaminants exceed Federal Radiation Council guidelines for protective action to control population exposure. (10)(11)

TABLE 2

TYPICAL WATER AND LAND SURVEILLANCE PROGRAM

FOR NUCLEAR POWER PLANT(8)

Indices	Recommended Surveillance Program		
	Relative Frequency	Analysis	Sampling Locations
Surface Water Receiving Waters of the Facility	Continuous composite or weekly grab	Gross beta and gamma scans. Periodic beta scintillation analysis for ^{3}H with frequency a function of the levels measured	Stream-above and below the facility; Reservoir, bay, lake - nearest shoreline; any nearby domestic water suppliers using the receiving waters as a raw water source
Bottom Sediments	Semi-annually	Gross beta and gamma scans	Near reactor's outfall or above and below the outfall if the receiving water is a stream
Ground Water	As applicable (usually quarterly or annually)	Gross beta and gamma scans	Supplies within 5 miles of the facility
Aquatic Biota	Variable	Gamma spectrum analysis for selected radionuclides	Near the reactor's outfall or above and below if receiving water is a stream
Food Crops and Other Vegetation	Season (before or at harvesting time)	Gamma spectrum analysis	Within a 10-15 mile radius of the facility
Soil	Annually	^{90}Sr and ^{137}Cs or gross beta	Prevailing downwind direction in nearest agricultural areas.

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CHAPTER VIII - AIR POLLUTION

Air pollutants play a vital and interrelated role with other environmental contaminants in effective water resources and land use management. It is, therefore, quite important in the planning and management of a basin's water and land resources that air pollution factors receive careful consideration.

The popular conception of a few years ago that air pollution and its effects were restricted or peculiar only to the heavy industrialized urban areas of the country has been thoroughly exploded and today it is well recognized that air pollution is of vital concern in suburban and rural areas as well. Air pollution is also not restricted to human effects but manifests itself in esthetic and social effects as well as effects on property, materials, and vegetation. Thus it is obviously clear that an effective grasp on control of air pollution must consider all the above interrelationships.

The control of air pollution must not only be meshed with the control of other environmental pollutants but be attacked on the basis of existing and future regional and urban growth patterns.

The purpose of this chapter of the Health Guidelines is to examine the various aspects of air pollution which should be considered along with other environmental factors in overall water and land resource management and planning.

NATIONAL AIR POLLUTION CONTROL MANAGEMENT

The leadership of the Federal government in air pollution control management is strongly established by the Clean Air Act.(1) Actual control and prevention of air pollution at its source, however, is the responsibility of State and local governments. The Federal government provides the research, financial assistance, and leadership for the development of effective State, regional, and local programs to prevent and control air pollution.

Federal authorities establish Air Quality Criteria (2)(3), define Control Techniques (4)(5), and designate Air Quality Control Regions. State authorities establish air quality standards (based upon Federal Air Quality Criteria) and establish implementation plans which call for the use of control techniques and which are designed to meet the standards within a specialized time frame.

AIR QUALITY CONTROL REGIONS AND RIVER BASIN PLANNING

Air Quality Control Regions (AQCR's) may or may not be contiguous with river basins and will overlap in some instances. These AQCR's are designated on the basis of meteorological, social, and political factors which indicate that a group of communities should be treated as a unit for setting limitations on concentrations of atmospheric pollutants. In general, these AQCR's are centered on standard metropolitan statistical areas. Full development of the AQCR concept will allow for the eventual establishment of over 200 regions in the United States. Federal policy requires that air quality standards be established by State authorities for the AQCR's based upon the Air Quality Criteria and an implementation plan to achieve and maintain the standards within a reasonable time frame must be developed. In river basin planning these AQCR's should be considered and the applicable air quality control regulations evaluated for relationships to river basin planning.

TYPES AND SOURCES OF AIR POLLUTANTS

There are a wide variety of air pollutants which are present in the nation's atmosphere today.(6)(7)(8) The five most common pollutants in tons emitted per year are carbon monoxide, sulfur oxides, hydrocarbons, nitrogen oxides, and particulates. The major sources of these are motor vehicles, industrial plants, electric utility plants, space heating, and refuse disposal.

Air pollutants are emitted in a wide variety of quantities depending upon the source and operating conditions. As an example Table 1 shows that, except for nitrogen and sulfur oxides, considerably more pollutant quantities are emitted from back yard burning and burning dumps than from multiple chamber incinerators. Of course, virtually no air pollution results from properly constructed and maintained sanitary landfills.

TABLE 1
Relative Amounts* of Air Pollutants from Solid Waste Burning(9)

Pollutant	Multiple-Chamber Incinerator	Back Yard Burning	Burning Dump
Aldehydes	1	3	4
Benzo(a)pyrene(BaP)	1	60	40
Hydrocarbons	1	200	280
Nitrogen Oxides	1	0.25	30
Sulfur Oxides	1	0.4	0.5
Ammonia	1	5	8
Organic Acids	1	2.5	2.5
Particulates	1	17	5

*Relative amounts of pollutants were computed using the emission from multiple-chamber incinerators as 1 for each pollutant.

The National Air Pollution Control Administration has developed the following breakdown of air pollution sources:(10)

1. Fuel Consumption (Stationary Sources)

   a. Residential - includes space heating, water heating, and cooking fuels.

   b. Commercial-Institutional-Governmental - includes mainly space heating fuel.

   c. Industrial - includes space heating, process heating, and steam and electric production fuels.

   d. Steam-Electric Power Plants - includes steam and electric production fuels.

2. Industrial Process Losses - includes losses from all manufacturing processes.

3. Solid Waste Disposal

   a. Incineration

   b. Open Burning

4. Transportation (Mobile Sources)

   a. Motor Vehicles

   b. Aircraft

   c. Railroads

   d. Ships

EFFECTS OF AIR POLLUTANTS

The effects of air pollutants upon the environment(11) in which we live are becoming more evident and more people are expressing the need for eliminating these adverse effects. Some effects of particulates and sulfur dioxide which have been established can be summarized as follows:

<u>Particulates</u>

1. <u>Effects on Health</u>

Analysis of numerous epidemiological studies clearly indicate an association between high levels of air pollution, as measured by particulate matter together with sulfur dioxide, and the occurrence of health effects. This association is most firm for the short-term air pollution episodes. Conclusions which have been reached by various studies are:

a. At concentrations of 750 $\mu g/m^3$ and higher for particulates on a 24-hour average, accompanied by sulfur dioxide concentrations of 715 $\mu g/m^3$ and higher, excess deaths and a considerable increase in illness may occur.

b. If concentrations above 300 $\mu g/m^3$ for particulates persist on a 24-hour average and are accompanied by sulfur dioxide concentrations exceeding 630 $\mu g/m^3$ over the same average period, chronic bronchitis patients will likely suffer acute worsening of symptoms.

c. At concentrations over 200 $\mu g/m^3$ for particulates on a 24-hour average, accompanied by concentrations of sulfur dioxide exceeding 250 $\mu g/m^3$ over the same period, increased absence of industrial workers due to illness may occur.

d. Where concentrations range from 100 $\mu g/m^3$ to 130 $\mu g/m^3$ and above for particulates (annual mean) with sulfur dioxide concentrations (annual mean) greater that 120 $\mu g/m^3$, children residing in such areas are likely to experience increased incidence of certain respiratory diseases.

e. At concentrations above 100 $\mu g/m^3$ for particulates (annual geometric mean) with sulfation levels above 30 mg/cm^2-mo., increased death rates for persons over 50 years of age are likely.

2. Effects on Direct Sunlight

At concentrations ranging from 100 $\mu g/m^3$ to 150 $\mu g/m^3$ for particulates, where large smoke turbidity factors persist, in middle and high latitudes direct sunlight is reduced up to one-third in summer and two-thirds in winter.

3. Effects on Visibility

At concentrations of about 150 $\mu g/m^3$ for particulates, where the predominant particle size ranges from 0.2 μ to 1.0 μ and relative humidity is less than 70 percent, visibility is reduced to as low as 5 miles.

4. Effects on Materials

At concentrations ranging from 60 $\mu g/m^3$ (annual geometric mean), to 180 $\mu g/m^3$ for particulates (annual geometric mean), in the presence of sulfur dioxide and moisture, corrosion of steel and zinc panels occurs at an accelerated rate.

5. Effects on Public Concern

At concentrations of approximately 70 $\mu g/m^3$ for particulates (annual geometric mean), in the presence of other pollutants, public awareness and/or concern for air pollution may become evident and increase proportionately up to and above concentrations of 200 $\mu g/m^3$ for particulates.

Sulfur Dioxide

1. Effects of Health

Analyses of numerous epidemiological studies clearly indicate an association between high levels of air pollution, as measured by sulfur dioxide, accompanied by particulate matter, and the occurence of health effects. This association is most firm for the short-term air pollution episodes. Conclusions which have been reached by various studies are:

a. At concentrations of about 1500 $\mu g/m^3$ (0.52 ppm) of sulfur dioxide (24-hour average), and suspended particulate matter measured as a soiling index of 6 Cohs or greater, increased mortality may occur.

b. At concentrations of about 500 $\mu g/m^3$ (0.19 ppm) of sulfur dioxide (24-hour mean), with low particulate levels, increased mortality rates may occur.

c. At concentrations ranging from 300 $\mu g/m^3$ to 500 $\mu g/m^3$ (0.11 ppm to 0.19 ppm) of sulfur dioxide (24-hour mean), with low particulate levels, increased hospital admissions of older persons for respiratory disease may occur; absenteeism from work, particularly with older persons, may also occur.

d. At concentrations of about 120 $\mu g/m^3$ (0.046) of sulfur dioxide (annual mean), accompanied by smoke concentrations of about 100 $\mu g/m^3$, increased frequency and severity of respiratory diseases in school children may occur.

2. Effects on Visibility

At a concentration of 285 $\mu g/m^3$ (0.10 ppm) of sulfur dioxide, with comparable concentration of particulate matter and relative humidity of 50 percent, visibility may be reduced to about five miles.

3. Effects of Materials

At a mean sulfur dioxide level of 345 $\mu g/m^3$ (0.12 ppm), accompanied by high particulate levels, the corrosion rate for steel panels may be increased by 50 percent.

4. Effects on Vegetation

a. At a concentration of about 85 $\mu g/m^3$ (0.03 ppm) of sulfur dioxide (annual mean), chronic plant injury and excessive leaf drop may occur.

b. At concentrations of about 145 $\mu g/m^3$ to 715 $\mu g/m^3$ (0.05 ppm to 0.25 ppm), sulfur dioxide may react synergistically with either ozone or nitrogen dioxide in short-term exposures (e.g. 4 hours) to produce moderate to severe injury to sensitive plants.

EFFECT OF AIR POLLUTION CONTROL ON OTHER ENVIRONMENTAL ASPECTS

In consideration of the air pollution aspects of regional environmental matters, careful attention must be given to the effects of air pollution control upon other environmental areas. Control techniques which reduce the amount of air pollutants discharged to the atmosphere usually result in an increase of materials which must be disposed of by other means. For example, wet collectors used for air cleaning devices result in water pollutants which may be discharged from facilities. Cartrell has given an excellent review of the water pollution potential of air pollution control devices. In this review he states that an impact on stream pollution has been experienced in almost every type of industrial situation where extensive air pollution control or abatement has been attempted. He cites air pollutants such as fluoride compounds from fertilizer, aluminum, steel, and uranium processing plants; sulfur compounds from smelters, power plants, coke plants, and refineries; particulates from power plants, blast furnaces, ferro-alloy, calcium carbide, and other types of plants; and radioactive wastes from atomic energy installations. (9)

In view of the significant effects which air pollution control can have on water pollution, solid wastes, and other environmental factors and the significant effects which water resource development can have on industrial development and other factors which may increase air pollution problems, it is imperative that air pollution aspects be considered in river basin planning and development.

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